Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S **JEE-ADVANCE-2021-P1** **Date: 09-04-2023**

Time: 02.00Pm to 05.00Pm **GTA-14** **Max. Marks: 180**

09-04-2023_Sr.Super60_ NUCLEUS&ALL_BT'S_Jee-Adv(2021-P1)_GTA-14_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ____________________ **H.T. NO:** | | | | | | | |

JEE-ADVANCE-2021-P1-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 4)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 5 – 10)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 11 – 16)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 17 – 19)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 20 – 23)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 24 – 29)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 30 – 35)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 36– 38)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 39 – 42)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 43 – 48)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 49 – 54)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 55 – 57)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

PHYSICS **Max Marks: 60**

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 4 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

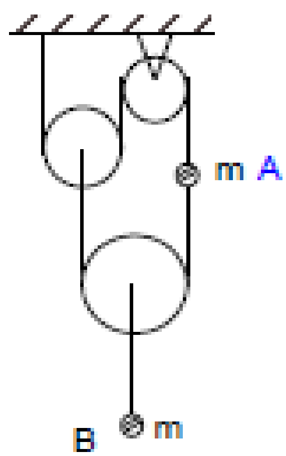
Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases. Section 1 (Max Marks: 12)

- Section 1 contains Four questions
- Each Question has Four Options and Only One of these four will be the correct answer.
- For each question, choose the option corresponding to the correct answer
- The Marking scheme to evaluate Answer to each question will be :
- Full Marks: **+3** (If the answer is correct)
- Zero Marks: **0** (If the question is unanswered)
- Negative Marks: -1 (In all other cases)

1. A ball is dropped from rest at height 4h. After it has fallen a distance d, a second ball is dropped from rest at height h. What should d be (in terms of h) so that the balls hit the ground at the same time?

A) $d = \frac{3H}{2}$ **B)** $d = \frac{H}{3}$ **C)** $d = H$ **D)** $d = 3H$

2. What is the acceleration of the upper block of the system as shown in the figure? Assume pullies and strings are ideal. Given $m_A = 0$



A) 4g **B)** 2g **C)** g **D)** $\frac{g}{2}$

3. The pitch of a screw gauge is 0.5 mm and there are 50 divisions on its circular scale and one main scale division = 0.5 mm. Before starting the measurement it is found that when jaws of the screw gauge are brought in contact, the zero of the circular scale lies 4 division below the reference line. When a metallic wire is placed between the jaws, five main scale divisions are clearly visible and 18th division on the circular scale coincides with the reference line. The diameter of the wire is

A) 2.68 mm **B)** 2.72 mm **C)** 2.64 mm **D)** 2.62 mm

4. A point like particle of mass 'm' (very small) is projected in the vertically upward direction where already exist, a uniform horizontal electric field $\vec{E}$. The field strength is such that $qE = \frac{3}{4}mg$, where q is the charge on the particle. After what time the radius of curvature of the charged particle will be minimum.

A) $\frac{V_0}{g}$ B) $\frac{8V_0}{25g}$ C) $\frac{16V_0}{25g}$ D) $\frac{25V_0}{16g}$

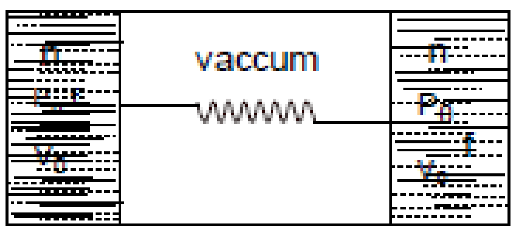
SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- **Zero Marks:0** in all other cases

Question Stem for Question Nos. 5 and 6

Question Stem

In the arrangement shown in the fig the cylinder is insulating one. Both sides same diatomic gas is trapped by two insulting massless pistons with the help of an ideal spring. The natural length of the spring is equal to the length of the cylinder. Initial state of the gases are as shown in the figure.



5. The value of energy stored in the spring is nP_0V_0. Then 'n' is

6. Now the gases are heated slowly, such that their temperature becomes three times to their initial temperature. The total heat given to the system is nP_0V_0. Then 'n' is

Question Stem for Question Nos. 7 and 8

Question Stem

Initially the nucleus of radium-226 is at rest. It decays due to which and α particle and the nucleus of radon are created. The released energy during the decay is 4.87 Mev, which appears as the kinetic energy of the two resulted particles.

$[m_\alpha = 4.002amu, m_{Rn} = 222.017amu]$

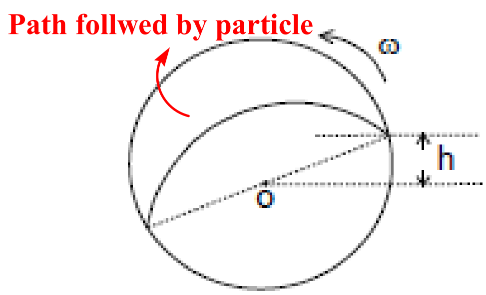
7. Kinetic energies of α . particle is (in MeV)

8. The linear momentum of the α – particle is $n \times 10^{-19}\, kgms^{-1}$ (round-off the value to TWO decimal places.)

Question Stem for Question Nos. 9 and 10

Question Stem

There is a hollow cylinder of radius R and it is rotating with constant angular Speed ω(about its own axis which is horizontal). There is a point mass (inside the cylinder) which rotates along with the cylinder and gets carried upward. Friction is enough such that the point mass does not slip with respect to the cylinder as long as the normal force is becomes zero. If the path of the particle after it lost contact with the cylinder is as shown in the figure then,



9. In Order to happen this where most the particle lose contact with the cylinder $h = \dfrac{R}{\sqrt{n}}$ then 'n' is______

10. What is the value of ω (in terms of g and R) $\sqrt{\dfrac{g}{\sqrt{n}R}}$ then 'n' is

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

11. The position vector of a particle moving in space is given by

$\vec{r} = (1+2\cos 2\omega t)\hat{i} + \left(3\sin^2 \omega t\right)\hat{j} + (3t)\hat{k}$ in the ground frame. All the units are in SI.

Choose the correct statement(s):

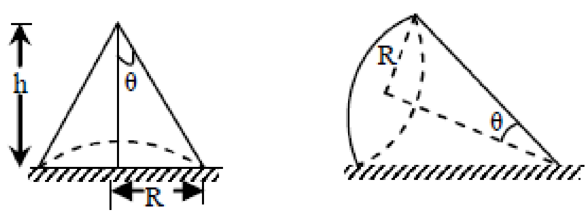
A) The particle executes SHM in the ground frame about the mean position $\left(1, \frac{3}{2}, 3t\right)$

B) The particle executes SHM in a frame S moving along the positive z–axis with a velocity of 3m/s.

C) The amplitude of the SHM of the particle in frame S is $\frac{5}{2}m$

D) The line of the SHM of the particle is parallel to the vector $\left(\frac{4}{5}\hat{i} - \frac{3}{5}\hat{j}\right)$

12. A solid cone is placed on a horizontal surface with height 'h' and radius 'R'. Its apex angle is 'θ'. To change the position of the cone from figure (A) to figure (B), no work is required, then



A) $\theta = \sin^{-1}\left(\frac{1}{3}\right)$ **B)** $\theta = \frac{\pi}{4}$ **C)** $\frac{h}{R} = 1$ **D)** $\frac{h}{R} = 2\sqrt{2}$

13. A standing wave is setup in a string fixed at both ends. Then

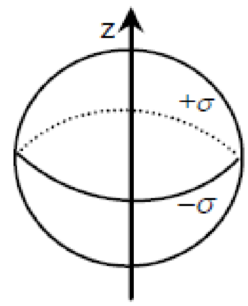
A) The sum of total energy per unit length at nodes and antinodes is constant

B) The total energy of a point midway between a node and an adjacent antinode is constant

C) If the string has a standing wave and a component of travelling wave, then the kinetic energy of the points of minimum amplitude is non-zero at some instant of time.

D) If the string has a standing wave and a component of travelling wave, then the potential energy of the points of maximum amplitude is non zero at some instant of time.

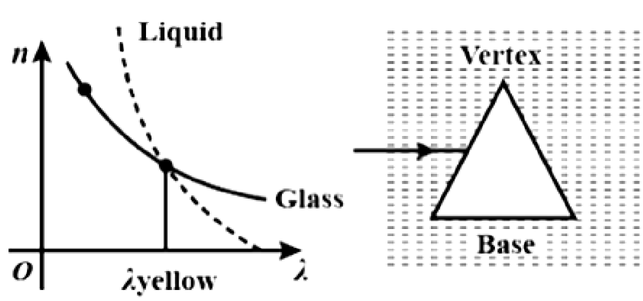
14. A hollow, insulating spherical shell has a surface charge distribution placed upon it, such that the upper hemisphere has a uniform surface charge density $+\sigma$, while the lower hemisphere has a uniform surface charge density $-\sigma$,as shown in the figure. Their interface lies in *x-y* plane. Which of the following statement(s) is/are correct?



A) The field at all points of *x-y* plane within the sphere points in the – ve *z*-direction
B) All points of the *x-y* plane within the sphere are equipotential
C) The field at all points on *z*-axis outside the sphere point along positive *z*-direction
D) The field at points on *z*-axis which are on either side of origin outside the sphere is in opposite directions

15. A planoconvex lens $(\mu-1.5)$ of focal length 20 cm has its plane side silvered. Which of the following statements is/are correct?
A) The radius of curvature of its curved surface is half that of a surface of equiconvex lens of focal length 20 cm made of same material
B) An object placed at 15 cm on the axis on the convex side gives rise to an image at a distance of 30cm from it
C) An object placed at a distance of 20 cm on the axis on the convex side gives rise to an image at 40cm from it
D) It acts as a convex mirror

16. A glass prism is immersed in a hypothetical liquid. The curves showing the refractive index *n* as a function of wavelength λ for glass and liquid are as shown in the figure. When a ray of white light is incident on the prism parallel to the base:



A) Yellow ray travels without deviation

B) Blue ray is deviated towards the vertex

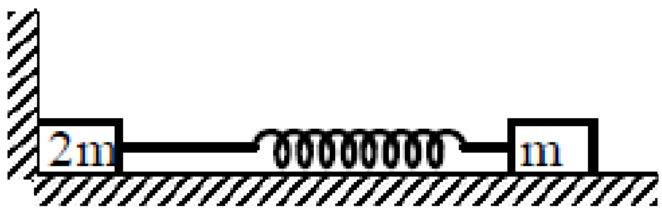
C) Red ray is deviated towards the base

D) There is no dispersion

SECTION 4

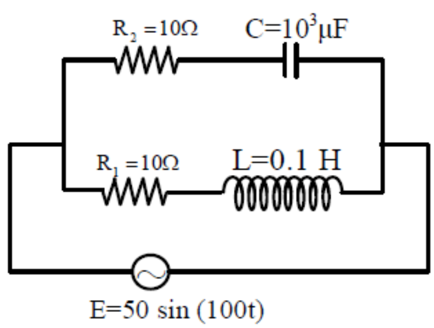
- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : **+4** If ONLY the correct integer is entered;
- ***Zero Marks*** : **0** In all other cases.

17. Two blocks of mass m and 2m connected by a weightless spring of stiffness k rest on a smooth horizontal plane. Block of mass m is shifted to a small distance x to the left and then released. If the duration between releasing mass m and breaking off of mass 2m is Δt, then average force(in newton) exerted by wall on mass 2m is given as $\frac{x}{\Delta t}\sqrt{mkn}$. Find the value of n.



18. One end of a string of length L = 15m is tied to the ceiling of an elevator accelerating upwards with an acceleration $20m/s^2$. The other end of the string is free. The linear mass density of the string varies linearly from 0 to λ_0 from bottom to top. Find the time taken by a pulse (in seconds) to reach from bottom to the top. $\left(g=10ms^{-2}\right)$

19. For the circuit shown in the figure, find the peak current (in ampere) through the source.



CHEMISTRY

Max. Marks: 60

SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : +3 If ONLY the correct option is chosen;
- *Zero Marks* : 0 If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : -1 In all other cases.

20. The enthalpy of combustion of C and CO are – 393.5 KJ and – 283 kJ, respectively, the enthalpy of formation of CO is

A) -110.5 Kj **B)** 6765 kJ **C)** -676.5 kJ **D)** 273.6 kJ

21. Which one of the following statement is not true?

A) In drinking water dissolved oxygen can reach a concentration upto 10ppm

B) Concentration of DO below 6 ppm is good for the growth of fish

C) Clean water would have BOD value of less then 5 ppm

D) Oxides of sulphur, nitrogen and carbon are the most widespread air pollutant

22. For $\left[Ni(CN)_4\right]^{2-}$ and $\left[Ni(CN)_4\right]^{4-}$, which of the following statement(S) is/are INCORRECT?

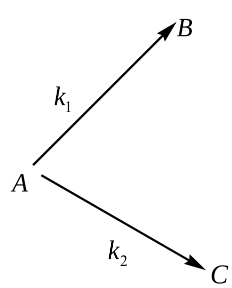
A) Differ in hybridization but magnetic properties are same

B) Differ in magnetic property and hybridization but no one can show geometrical isomerism

C) Differ in shape and EAN value but no one can show geometrical isomerism

D) Different number of atoms are in same plane and same dipole moment

23. Consider the reaction



The rate constant for two parallel reactions were found to be $10^{-2}\,dm^3\ mol^{-1}\ s^{-1}$ and $4\times10^{-2}\,dm^3\ mol^{-1}\,s^{-1}$.if the corresponding energies of activation of the parallel reaction are 100 and 120 kJ/mol respectively, what is the net energy of activation (E_a) of A?

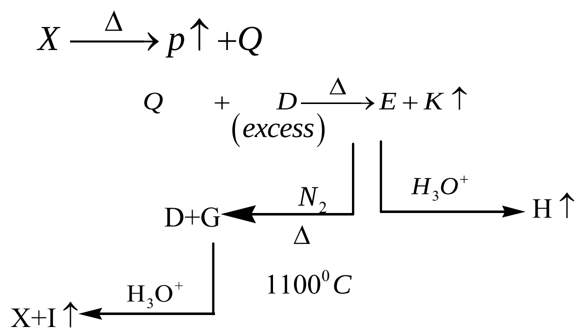
A) $100kJ/mol$ **B)** $120kJ/mol$ **C)** $116kJ/mol$ **D)** $220kJ/mol$

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : **+2** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks*** : *0* In all other cases.

Question Stem for Question Nos. 24 and 25

Question Stem



Gas P makes lime water milky. K is a poisonous gas. H is used in welding.

24. Molar mass ratio of 'G' and that of 'X' would be ___

25. Molar mass ratio of 'H' and that of I would be ___

Question Stem for Question Nos. 26 and 27

Question Stem

(A) $C_5H_{10}O \xrightarrow[PH\,=\,5]{NH_2OH}$ Diastereomeric products (X)

26. Number of possible isomers of A which can produce diastereomeric products is 'X' then value of $\frac{2x}{5} is$ ___

27. If number of possible structures of A which can give positive iodoform test is 'a' and number of possible structural isomers which give positive Fehlings Test is 'b' then value of $\frac{a}{b}$ is ______

Question Stem for Question Nos. 28 and 29

Question Stem

Metal A $\xrightarrow[4.25\ eV]{photons}$ Maximum KE of ejected electron is T_A (in eV); and de –Broglie wave length = λ_A

Metal B $\xrightarrow[4.25\ eV]{photons}$ Maximum KE of ejected electron is T_B (in eV); and de –Broglie wave length = λ_B

If $\lambda_B = 2\lambda_A$ and $T_B = T_A - 1.50$ eV then

28. Work function of A is _____

29. Then value of T_B is _______

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

30. Which of the following are correct statements?

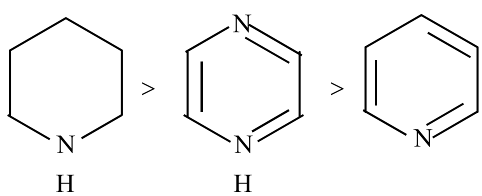
A) The hydro metallurgy process of extraction of silver metal is based on complex formation

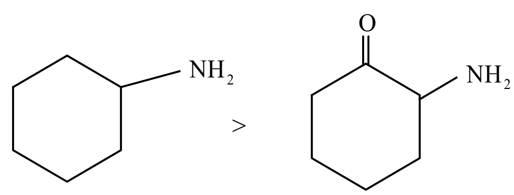
B) Cinnabar ore is concentrated by forth floatation process

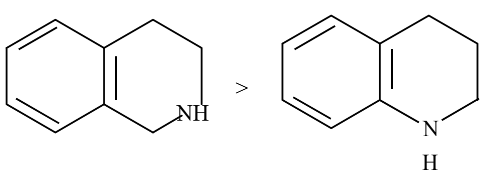
C) The process of converting hydrated alumina into alumina is called calcination

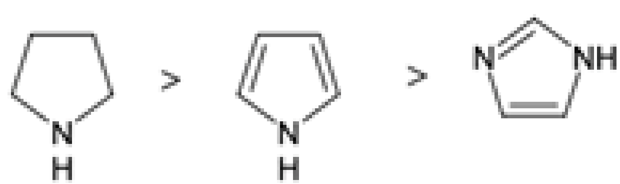
D) In alumino-thermite process Al is used as reducing agent

31. Which of the following order for basic strength is/are correct?

A) 

B) 

C) 

D) 

32. Which of the following are correct regarding Xe and its compound?

A) XeF_2 and SbF_5 reacts to from $[XeF][SbF_6]$

B) XeF_6 and RbF reacts to from $[XeF_5][RbF_2]$

C) XeF_6 and SiO_2 reacts to from $XeOF_4$ and SiF_4

D) XeO_3 can be prepared by direct reaction between constituent elements

33. Which of the following is/are correct statement (s)?

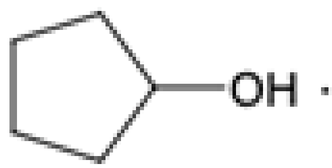
A) 100% tetrahedral voids are occupied by carbon in diamond

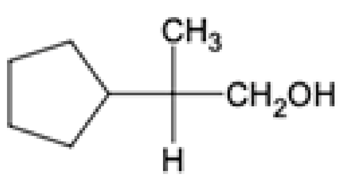
B) Coordination number of HCP is 12

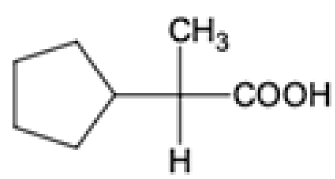
C) In CsCl the coordination number of each ion is 8

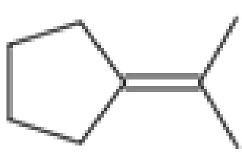
D) HCP shows ABCABCABC……..arrangement

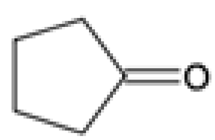
34. An optically active alcohol $A(C_8H_{16}O)$ on oxidation gives B. A on acidic heating gives $C(C_8H_{14})$ as major product. C on ozonolysis produces $D(C_5H_8O)$ and $H_3C-\underset{\underset{O}{\|}}{C}-CH_3$.

D on reduction with $LiAlH_4$ gave .

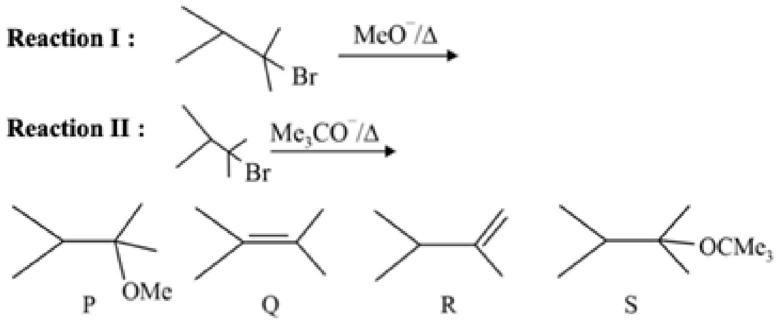
A) A is 

B) B is 

C) C is 

D) D is 

35. After completion of reaction (I & II), the major organic compound (s) in the reaction mixture is/are:



A) Reaction I : P and Reaction II : Q B) Reaction I : Q and Reaction II : R

C) Reaction I : P and Reaction II : S D) Reaction I : R and Reaction II : S

SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

36. 1.3245 g of monobasic acid when dissolved in 100 g of water lowers the freezing point by $0.2046^{o}C$.0.2 g of the same acid when dissolved and titrated required 15.1 ml of $\frac{N}{10}$ alkali. (Assuming molarity = molality), the pH of acid solution is: $\left(K_f \text{ of water} 1.86 \text{K kg mol}^{-1}\right)$

37. In duma's method for estimation of nitrogen 0.25g of an organic compound gave 44 ml of nitrogen collected at 300K temperature and 725 mm pressure. If the aqueous tension at 300K is 25mm, the percentage of nitrogen in the compound is x. What is the $\frac{x}{2}$ ________ (Round off to the nearest integer)

38. If four atoms of same radius are placed at the alternate comer of a cube touching each other, than the length of body diagonal of the cube is equal to $\sqrt{x} \times R$, where R is the radius of atom. Find the value of x?

MATHEMATICS

Max. Marks: 60

SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : +3 If ONLY the correct option is chosen;
- *Zero Marks* : 0 If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : -1 In all other cases.

39. If 5 is subtracted from each observation, then the coefficient of variation is 10% and if 5 is added to each observation, then the coefficient of variation is 6%, then the coefficient of variation of given observations is ______

A) 4% **B)** 8% **C)** 7.5% **D)** 4.5%

40. Let $R = \{(1, 3), (2, 2), (3, 2)\}$ and $S = \{(2, 1), (3, 2), (2, 3)\}$ be two relations on set $A = \{1, 2, 3\}$. Then $RoS^{-1} =$

A) $\{(2,2), (3,2)\}$ **B)** $\{(1,2), (2,2), (3,2)\}$

C) $\{(1,2), (2,2)\}$ **D)** $\{(1,2), (2,2), (3,2), (2,3)\}$

41. The coefficient of x^m in $(1+x)^m + (1+x)^{m+1} + ... + (1+x)^n$, $m \le n$ is

A) ${}^{n+1}c_{m+1}$ **B)** ${}^{n-1}c_{m-1}$ **C)** ${}^{n}c_{m}$ **D)** ${}^{n}c_{m+1}$

42. $\int_0^1 \frac{\sin^{-1} x}{x} dx =$

A) $-\frac{\pi}{2}\ln 2$ **B)** $\frac{\pi}{2}\ln 2$ **C)** $\pi \ln 2$ **D)** 0

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks: 0*** In all other cases.

Question Stem for Question Nos. 43 and 44

Question Stem

$D_1, D_2, ---, D_{1000}$ are 1000 doors and $P_1, P_2, -- P_{1000}$ are 1000 persons. Initially all the doors are closed. P_1 opens all the doors. Then, P_2 closes $D_2, D_4, D_6 --- D_{998}, D_{1000}$. Then P_3 changes the status of $D_3, D_6, D_9, D_{12}, -- etc.$ (doors having numbers which are multiples of 3). Changing the status of a door means closing it if it is open and opening it if it is closed. Then P_4 changes the status of $D_4, D_8, D_{12}, D_{16} -- etc$ (doors having numbers which are multiples of 4). And so on until lastly P_{1000} changes the status of D_{1000}

43. Finally, how many doors are open?

44. What is the greatest number of consecutive doors that are closed finally?

Question Stem for Question Nos. 45 and 46

Question Stem

Consider $\int \frac{x^3+3x^2+2x+1}{\sqrt{x^2+x+1}}dx = \left(ax^2+bx+c\right)\sqrt{x^2+x+1} + \lambda \int \frac{dx}{\sqrt{x^2+x+1}}$ then

45. Value of |c| =

46. Value of 100λ

Question Stem for Question Nos. 47 and 48

Question Stem

Let f(x) be a polynomial of degree 4 satisfying

$$\left(\int_1^x A(t)B(t)dt\right).\left(\int_1^x C(t)D(t)dt\right) - \left(\int_1^x A(t)C(t)dt\right).\left(\int_1^x B(t)D(t)dt\right) = f(x), \forall x \in R$$

where $A(x), B(x), C(x), D(x)$ are non constant continuous and differentiable functions. It is given that the leading co efficient of $f(x)$ is 1, then

47. Area included between the line $y = x-1$ and $y = f(x)$ is....

48. Area of the smaller region intercepted between the curves $y = f(x)$ and $x^2+y^2=1$, is...

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks*** : ***+3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks*** : ***+2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks*** : ***+1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks*** : ***0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

49. Let $f(x)=\dfrac{\left(\sqrt{2}\right)^x-2}{\left(\sqrt{2}\right)^x+2}$. If the graphs of $y=f(x)$ and $y=f(4x)$ are symmetrical about the points $(a_1,0)$ and $(a_2,0)$ respectively, then

A) $a_1=1, a_2=4$ **B)** $a_1=2, a_2=\dfrac{1}{2}$ **C)** $\int_0^2 f(2x)dx=1$ **D)** $\int_0^2 f(2x)dx=0$

50. Let $f(x)=2\tan^{-1}x+\sin^{-1}\dfrac{2x}{1+x^2}$. Then which of the following is/are correct

A) $f'(2)=f'(3)$ **B)** $f'(2)=0$ **C)** $f'\left(\dfrac{1}{2}\right)=\dfrac{16}{5}$ **D)** $f'\left(\dfrac{1}{2}\right)=0$

51. A circle drawn having centre at $C(0,2)$ and passing through focus (s) of the parabola $y^2=8x$, *if radius* (CS) intersects the parabola at point P, then

A) Distance of point P from directrix is $\left(8-4\sqrt{2}\right)$

B) Distance of point C from point P is $\left(6\sqrt{2}-8\right)$

C) angle subtended by intercept made by circle on directrix at its centre is $\dfrac{\pi}{2}$

D) Point 'P' is the midpoint of C and S

52. P denotes plane containing all points equidistant from $A(-4,2,1)$, $B(2,-4,3)$. Q be the plane $x-y+cz=1$ where $c\in R$ then

A) If the line L with equation $\frac{x-1}{1}=\frac{y+2}{3}=\frac{z-7}{-1}$ intersect the plane P at (x_0,y_0,z_0) then $x_0+y_0+z_0=12$

B) If angle between the planes P and Q is 45^0 then product of all values of c is -2

C) The plane P is parallel to plane Q iff $c=\frac{1}{3}$

D) Plane P is perpendicular to plane Q iff $c=1$

53. Which of the following is / are always true?

A) If A is a square matrix such that $A^2=A$ then $(I+A)^3-7A=I$

B) If A is a square matrix such that $A^2=A$ then $(I+A)^3-7A=O$

C) Let B and C be two square matrices such that $BC=CB$ and $C^2=O$. If $A=B+C$ then $A^3-B^3-3B^2C=O$

D) Let B and C be two square matrices such that $BC=CB$ and $C^2=O$. If $A=B+C$ then $A^3+B^3-3B^2C=O$

54. The system of linear equations, $x+y+z=6, x+2y+3z=14$ and $2x+5y+\lambda z=\mu$ have

A) Infinitely many solutions when $\lambda=8$ and $\mu=36$

B) Unique solution when $\lambda\neq 8$

C) No solution when $\lambda=8$ and $\mu\neq 36$

D) Infinitely many solutions when $\lambda\neq 8$

SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

55. The image of the line $\frac{x-1}{3}=\frac{y-3}{5}=\frac{z-4}{2}$ in the plane $2x-y+z+3=0$ be L. A plane $7x+py+qz+r=0$ is such that it contains line L and perpendicular to $2x-y+z+3=0$ then $p+3q+r=$ _______

56. The number of integral values of 'p' satisfying the equation,

$\sin(\pi[x])-2\cos(2\pi[x])+4\left[x^2-37x+22\right]=4p+1$, for every $x\in R$. (where $[.]$denotes greatest integer function)

57. The value of the integral $\int_{1/4}^{3/4} f(f(x))dx$, is K, then find the value of 8K if

$f(x)=x^3-\frac{3}{2}x^2+x+\frac{1}{4}$.

Sri Chaitanya IIT Academy.,India.
✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI
A right Choice for the Real Aspirant
ICON Central Office - Madhapur - Hyderabad

Sec: Sr.Super60_NUCLEUS&ALL_BT'S JEE-ADVANCE-2021_P1 Date: 09-04-2023
Time: 09.00Am to 12.00Pm GTA-14 Max. Marks: 180

KEY SHEET

PHYSICS

1	**C**	2	**A**	3	**C**	4	**C**	5	**1**	6	**12**
7	**4.78**	8	**0.99**	9	**2**	10	**2**	11	**A,B,C,D**	12	**A,D**
13	**A,C,D**	14	**A,B,C**	15	**A,B**	16	**A,B,C**	17	**1**	18	**2**
19	**5**										

CHEMISTRY

20	**A**	21	**B**	22	**B**	23	**C**	24	**0.80**	25	**1.52 - 1.53**
26	**2.40**	27	**0.67**	28	**2.25**	29	**0.50**	30	**A,B,C,D**	31	**B,C**
32	**A,C**	33	**B,C**	34	**A,B,C,D**	35	**B**	36	**2**	37	**9**
38	**6**										

MATHEMATICS

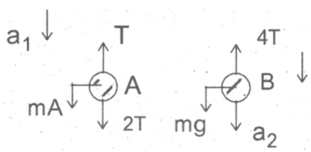
39	**C**	40	**B**	41	**A**	42	**B**	43	**31.00**	44	**60.00**
45	**0.28 – 0.30**	46	**6.24 – 6.26**	47	**0.29 – 0.31**	48	**0.57 – 0.59**	49	**B,D**	50	**A,B,C**
51	**A,B,C**	52	**A,B,C**	53	**A,C**	54	**A,B,C**	55	**4**	56	**0**
57	**2**										

SOLUTIONS
PHYSICS

1. For the 1st ball, $4h=\frac{gt_1^2}{2}\Rightarrow t_1=2\sqrt{\frac{2h}{g}}$ &For second ball $t_2=2\sqrt{\frac{2h}{g}}$ also

$$\sqrt{\frac{2h}{g}}+\sqrt{\frac{2d}{g}}=2\sqrt{\frac{2h}{g}}\Rightarrow 2\sqrt{h}=\sqrt{d}+\sqrt{h}\Rightarrow d=h$$

2. From F. B. D. we get
$$mA-4T=mA_2$$
$$mA+2T-T=mA_1$$



On solving these two we get $a_A=4g$

3. Zero error $=+4\times0.01=+0.04\,mm$

Measured diameter = M. S. R. + L.C. × C. S. R.

$=(5\times0.5)mm+(0.01mm)\times18=2.68mm$

∴ Actual diameter = 2.68 – (0.04) = 2.64 mm

4. When radius of curvature is minimum $\bar{v}$ is $\perp$ to $\bar{a}$ & it is at $t=\frac{16V_0}{25g}$

5. If x be the initial length of the gas chambers & A be the area of cross section of the cylinder then,

$$x=\frac{V_0}{A}\ Also\ P_0A=2kx\ \frac{P_0}{x}=2kx\Rightarrow P_0V_0=kx^2$$

$$\therefore\frac{1}{2}k(2x)^2=\frac{1}{2}K\,4x^2=2kx^2=P_0V_0$$

6. Similarly, $P_fA=2k\frac{v_f}{A}$

$$P_0A=2k\frac{V_0}{A}\Rightarrow\frac{P_f}{P_0}=\frac{V_f}{V_0}\Rightarrow P=\frac{P_0}{V_0}v\ \therefore Q=dU+W=2\frac{5}{2}(P_1V_1-P_0V_0)+w=12P_0V_0$$

7.
$$P=mv\ \&\ \frac{P^2}{2m}=\frac{1}{2}mV^2\quad E_\alpha=\frac{P^2}{2m}\quad E_{radon}=\frac{P^2}{2M}$$

Also $\frac{P^2}{2m}+\frac{P^2}{2M}=\Delta E\Rightarrow P=\sqrt{2\Delta E\frac{mM}{m+M}}$

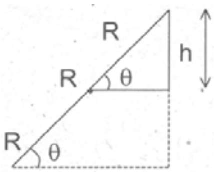
$$m=4.002mu,\ M=222.017\,mu\quad m=6.64\times10^{-27}kg$$

8.
$$P=mv\ \&\ \frac{P^2}{2m}=\frac{1}{2}mV^2\quad E_\alpha=\frac{P^2}{2m}\quad E_{radon}=\frac{P^2}{2M}$$

Also $\frac{P^2}{2m}+\frac{P^2}{2M}=\Delta E\Rightarrow P=\sqrt{2\Delta E\frac{mM}{m+M}}$

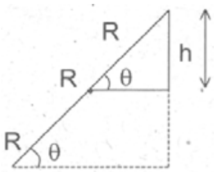
$m=4.002mu,\ M=222.017\,mu \quad m=6.64\times10^{-27}\,kg$

9. $\frac{1}{2}g\sin\theta.\frac{4v^2}{g^2\cos^2\theta}=2R.....(1)$



$v^2=Rg\sin\theta.....(2)$ From(1)and(2) $\tan\theta=1$

10. $\frac{1}{2}g\sin\theta.\frac{4v^2}{g^2\cos^2\theta}=2R.....(1)$



$v^2=Rg\sin\theta.....(2)$

From(1)and(2) $\tan\theta=1$

11. In a frame moving with a velocity of 3 m/s along the z-axis, the displacement of the particle from the equilibrium position is given by

$\Delta\vec{r}=\left(2\hat{i}-\frac{3}{2}\hat{J}\right)\cos t\,2\omega t$

12. Centre of mass should be at the same height in both cases

13. $y=2A\sin(kx-\omega t)$

$$\left(\frac{\partial K}{\partial x}\right)_{antinodes}=2\mu A^2\omega^2\cos^2\omega t$$

$$\left(\frac{\partial U}{\partial x}\right)_{nodes}=2\mu A^2\omega^2\cos^2\omega t$$

$$\left(\frac{\partial U}{\partial x}\right)_{antinodes}+\left(\frac{\partial U}{\partial x}\right)_{nodes}=2\mu A^2\omega^2 Cons\tan t$$

For a point midway between a node and an adjacent antinode

$$\frac{\partial K}{\partial x}=\mu A^2\omega^2\sin^2\omega t$$

$$\frac{\partial U}{\partial x}=\mu A^2\omega^2\cos^2\omega t$$

Let $y=A\sin(kx-\omega t)+2A\sin kx\cos\omega t$

$$\frac{\partial K}{\partial x}=\frac{1}{2}\mu\left(\frac{\partial y}{\partial t}\right)^2=\frac{1}{2}\mu\left[-2A\omega\sin kx\sin\omega t-A\omega\cos(kx-\omega t)\right]^2$$

$$\frac{\partial K}{\partial x}=\frac{1}{2}T\left(\frac{\partial y}{\partial t}\right)^2=\frac{1}{2}V^2\mu\left[2A\omega\cos kx\cos\omega t+Ak\cos(kx-\omega t)\right]^2$$

14. Conceptual

15. $\frac{1}{F}=\frac{(\mu-1)}{R}=\frac{1}{20} \quad \Rightarrow 20=\frac{R}{(\mu-1)}$........(1)

If equiconvex lens of f=20. Then $\frac{1}{20}=(\mu-1)\frac{2}{R}$

From equation (1) and (2) we conclude $\therefore R=40(\mu-1)$

That option (A) is correct, $-\frac{1}{f_L=}(\mu-1)\left[\frac{1}{R}-\frac{1}{\infty}\right]=\frac{(\mu-1)}{R}$ for refraction at the convex surface $\therefore$ power $P_L=\frac{1}{f_L}=-\frac{(\mu-1)}{R}$

For reflection at the silvered plane surface $F_m=\alpha \quad \therefore powerP_M=0$

For reflection at the silvered plane surface $\therefore powerP_M=0$

For reflection at the convex surface again $P_L=\frac{(\mu-1)}{R}$

Hence power of the system $P=P_L+P_M+P_L$

$=2P_L+P_M=-2\frac{(\mu-1)}{R}$ $\therefore$ focal length of the system

$F=\frac{1}{P}=-\frac{R}{2(\mu-1)}=10\,cm$ U=-15cm $\frac{1}{v}+\frac{1}{u}=-\frac{1}{10}$ $\frac{1}{v}=\frac{1}{15}-\frac{1}{10}$

$\Rightarrow v=-30\ cm\ so\ B\ is\ correct$

16. Conceptual

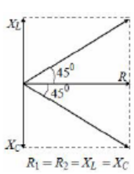
17. As impulse exerted by wall is equal to change in momentum of the system

$F_{av}.\Delta t=3m.V_{cm}=3m.\frac{x}{3}\sqrt{\frac{k}{m}} \Rightarrow F_{av}=\frac{x}{\Delta t}\sqrt{km}=\frac{x}{\Delta t}\sqrt{km}.n(given) \therefore n=1$

18. $T=\int_0^x \frac{\lambda_0 x}{L}g_{off}\,dx=\frac{\lambda_0}{2L}x^2 g_{off} \;\therefore v=\sqrt{\frac{\lambda_0 x^2 g_{off}L}{2L.\lambda_0 x}}=\sqrt{15x} \;\therefore \int_0^{15}\frac{dx}{\sqrt{15x}}=\int_0^t dt \Rightarrow t=2s$

19. Peak current through $R_1, I_1=\frac{50}{10\sqrt{2}}=\frac{5}{\sqrt{2}}A$

Peak current through $R_2\ I_2=\frac{50}{10\sqrt{2}}=\frac{5}{\sqrt{2}}A$



Phase difference between I_1 and I_2 is $\frac{\pi}{2}$ $\therefore$ peak current through the source is

$I=\sqrt{I_1^2+I_2^2}=\sqrt{\left(\frac{5}{\sqrt{2}}\right)^2+\left(\frac{5}{2}\right)^2}=\frac{5}{\sqrt{2}}\times\sqrt{2} \therefore I=5A$

CHEMISTRY

20. $$O+O_2 \longrightarrow CO_2 \quad \Delta H=-393.5kJ \quad ...(1)$$

$$CO+\frac{1}{2}O_2 \longrightarrow CO_2 \; \Delta H=-283.0kJ \quad ...(2)$$

$$C+\frac{1}{12}O_2 \longrightarrow CO \quad \Delta H=-110.5kJ$$

21. Conceptual

22. $(i)\left[Ni(CN)_4\right]^{2-}$

$Ni^{2+} \Rightarrow [Ar]$

3d					4S
↑↓	↑↓	↑↓	↑	↑	

In presence of ligand:

$\Rightarrow$ [Ar]

3d							
↑↓	↑↓	↑↓	↑↓	××	××	××	××
				CN	CN	CN	CN

$\mu=0$

Hybridisation = dsp^2, geometry – square planar

Magnetic nature – diamagnetic

EAN = $[28-2+2\times4]=34$ $(ii)\left[Ni(CN)_4\right]^{4-}$

[Ar]

3d							
↑↓	↑↓	↑↓	↑↓	××	××	××	××
				CN	CN	CN	CN

Ni Þ$[Ar]3d^8 4s^2$

$\mu=0$

Hydridisation = sp^3, geometry – tetrahedral

Magnetic nature – diamagnetic

EAN = $[28\text{-}0+2\times4]=36$

23. $$K_{OV} = K_1 + K_2$$

$$Ae^{-E_{a_1\tau}/R\tau} = Ae^{-E_{a1}/R\tau} + Ae^{-E_{a_2}/R\tau}$$

$$Ae^{-E_{a\tau}/R\tau}\left(\frac{-E_{a\tau}}{R}\right) = Ae^{-E_{a_1}/R\tau}\left(\frac{-E_{a_1}}{R}\right) + Ae^{-E_{a_2}/R\tau}\left(\frac{-E_{a_2}}{R}\right)$$

$$K_{OV}(E_{a\tau}) = K_1E_{a_1} + K_2E_{a_2}$$

$$E_{a_1\tau} = \frac{K_1E_{a_1}+K_2E_{a_2}}{K_1+K_2} = \frac{10^{-2}\times100+4\times10^{-2}\times120}{5\times10^{-2}} = \frac{580}{5}=116$$

24. $$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$X \qquad Q \qquad P$

$CaO + 3C \xrightarrow{\Delta} CaC_2 + CO$

D E K

$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$

H

$CaC_2 + N_2 \rightarrow Ca(NCN) + C$

G D

$Ca(NCN) + 3H_2O \rightarrow 2NH_3 \uparrow + CaCO_3$

G I X

25. $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

X Q P

$CaO + 3C \xrightarrow{\Delta} CaC_2 + CO$

D E K

$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$

H

$CaC_2 + N_2 \rightarrow Ca(NCN) + C$

G D

$Ca(NCN) + 3H_2O \rightarrow 2NH_3 \uparrow + CaCO_3$

G I X

26. Possible isomers of 'A' which can produce diastereomeric products

i) $CH_3-CH_2-CH_2-CH_2-\underset{\underset{O}{\|}}{C}-H$ ii) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_2-\underset{\underset{O}{\|}}{C}-H$

iii) $CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{O}{\|}}{C}-H$ iv) $H_3C-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-\underset{\underset{O}{\|}}{C}-H$ v) $H_3C-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-CH_3$ vi) $H_3C-\overset{\overset{O}{\|}}{C}-\underset{\underset{CH_3}{|}}{CH}-CH_3$

27. Possible isomers of 'A' which can produce diastereomeric products

i) $CH_3-CH_2-CH_2-CH_2-\underset{\underset{O}{\|}}{C}-H$ ii) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-\underset{\underset{O}{\|}}{C}-H$ iii) $CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{O}{\|}}{C}-H$

iv) $H_3C-CH_2-\underset{\underset{O}{\|}}{C}-CH_2-CH_3$ v) $H_3C-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-CH_3$

vi) $H_3C-\overset{\overset{O}{\|}}{C}-\underset{\underset{CH_3}{|}}{CH}-CH_3$

28.
$T_A = \frac{1}{2}mv^2$ $\lambda = \frac{h}{mv} = \frac{1}{2}\frac{m^2v^2}{m}$

$= \frac{1}{2}\frac{h^2}{\lambda_B^2 m}$ ....(1)

$T_B = \frac{1}{2}\frac{h^2}{\lambda_B^2 m}$ ....(2)

$\therefore \frac{T_A}{T_B} = \frac{\lambda_B^2}{\lambda_A^2} = 4$

Again

$T_B = T_A - 1.50$ eV $T_B = 4T_B - 1.50$ eV

$T_B = 0.50$ eV $T_A = 2.00$ eV

Now, Work function of A $= 4.25 - T_A$ $= 2.25$eV

Work function of B $= 4.20 - T_B = 4.20 - 0.50$ $= 3.70$

29.
$T_A = \frac{1}{2}mv^2$ $\lambda = \frac{h}{mv}$

$= \frac{1}{2}\frac{m^2v^2}{m}$ $= \frac{1}{2}\frac{h^2}{\lambda_B^2 m}$ ....(1)

$T_B = \frac{1}{2}\frac{h^2}{\lambda_B^2 m}$ ....(2) $\therefore \frac{T_A}{T_B} = \frac{\lambda_B^2}{\lambda_A^2} = 4$

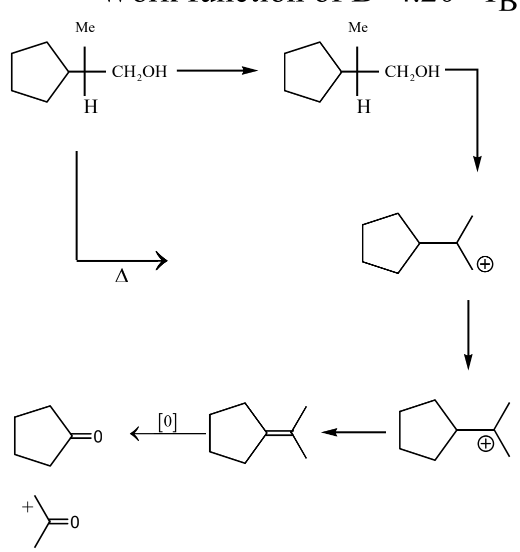
Again

$T_B = T_A - 1.50$ eV $T_B = 4T_B - 1.50$ eV

$T_B = 0.50$ eV $T_A = 2.00$ eV

Now, Work function of A $= 4.25 - T_A$ $= 2.25$eV

Work function of B$= 4.20 - T_B = 4.20 - 0.50$ $= 3.70$

30.


31. A lone pair of N-atom participating in resonance will be less basic

32. $XeF_2 + SbF_5 \longrightarrow [XeF][SbF_6]$, $XeF_6 + RbF \longrightarrow Rb[XeF_7]$

$XeF_6 + SiO_2 \longrightarrow XeOF_4 + SiF_4$, $XeF_6 + H_2O \longrightarrow XeO_3$

33. 50% tetrahedral void in diamond HCP = ABABAB…..

34. Conceptual

35. With MeO^{-}/Δ Saytzeff product is major product. With Me_3CO^{-}/Δ Hoff mann product is major product.

36. Meq. Of alksli = Meq. Of acid

$Þ15.1\times\frac{1}{10}=\frac{0.2}{M}\times 1000$, On, solving M = 132.45 g mol^{-1}

Now, molality of acid solution (m) = $\frac{1.3245\times 1000}{132.45\times 100}=0.1$

$\therefore \Delta_f = i\times K_f \times m$

$0.2048 = i\times 1.86\times 0.1$

$I = 1.1 = 1+\alpha$

$\therefore \alpha = 0.1$

HA	$\rightleftharpoons$	H^{+}	$+$	A^{-}
Now, C		0		0
$C-C\alpha$		$C-C\alpha$		$C\alpha$

$\left[H^{+}\right]=C\alpha=0.1\times 0.1=10^{-2}\ \therefore pH=2$

37. Actual pressure $\rightarrow 725-25=700mm$

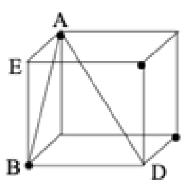
Volume of nitrogen $=\frac{273\times 700\times 44}{300\times 700}=33.52ml$

22400 ml of nitrogen at STP weight = 289

So 33.52 ml of N_2 ast STP weight $=\frac{28\times 33.52}{22400}=0.0419gm$

% of N_2 in organic compund $=\frac{0.0419}{0.25}\times 100=18.4$

38.



Face diagonal of cube $(AB)=2R$, Edge length of cube $(BE)=\frac{2R}{\sqrt{2}}$

Body diagonal of cube $(AD)=\sqrt{3}\times\frac{2R}{\sqrt{2}}=\sqrt{6}\times R$

MATHEMATICS

39. $y = x-5$ $\quad \overline{y} = \overline{x}-5$ $\quad s_y = s_x$

$\text{C.V.} = \frac{s}{x}\times 100 \quad 10 = \frac{s}{\overline{x}-5}\times 100 \quad (1)$

$y = x+5$ $\quad \overline{y} = \overline{x}+5$ $\quad s_y = s_x$

$\text{C.V.} = \frac{s}{x}\times 100 \quad 6 = \frac{s}{\overline{x}+5}\times 100 \quad (2)$

Divide equation (1) by (2),

$\frac{5}{3} = \frac{\overline{x}+5}{\overline{x}-5} \quad 5\overline{x}-25 = 3\overline{x}+15 \quad \therefore \ \overline{x} = 20$

From (1), $10 = \frac{s}{15}\times 100 \quad \therefore \ s = 1.5$

The coefficient of variation $V = \frac{s}{\overline{x}}\times 100 = \frac{1.5}{20}\times 100 = 7.5\%$

40. Conceptual

41. Use Formula for G.P

42. $x = \sin\theta. \int_0^{\pi/2} \theta\cos\theta \, d\theta = \theta\log\sin\theta \Big|_0^{\pi/2} - \int_0^{\pi/2} \log\sin\theta \, d\theta = 0 + \frac{\pi}{2}\ln 2$

43. Conceptual

44. Conceptual

45. Conceptual

46. Conceptual

47. $\int_1^2 (x-1)-(x-1)^4 \, dx = \frac{3}{10}$

48. Req. Area $= \frac{\pi}{4} - \int_0^1 (x-1)^4 \, dx = \frac{\pi}{4} - \frac{1}{5}$

49. $$f(x) = \frac{\left(\sqrt{2}\right)^x\left(1-2\left(\sqrt{2}\right)^{-x}\right)}{\left(\sqrt{2}\right)^x\left(1+2\left(\sqrt{2}\right)^{-x}\right)} = \frac{1-\left(\sqrt{2}\right)^{2-x}}{1+\left(\sqrt{2}\right)^{2-x}}$$

$\Rightarrow f(x) = -f(4-x) \Rightarrow f(x)$ is sym about $(2,\ 0)$

$\Rightarrow a_1 = 2$ and $a_2 = \frac{1}{2}$

50. If $x \le 1, \sin^{-1}\frac{2x}{1+x^2} = 2\tan^{-1}x$, But, if $x > 1, \sin^{-1}\frac{2x}{1+x^2} = \pi - 2\tan^{-1}x$

$\therefore$ for x < 1, we have $f(x) = 4\tan^{-1}x$. So, $f'(x) = \frac{4}{1+x^2}$. $\therefore f'\left(\frac{1}{2}\right) = \frac{4}{1+\frac{1}{4}} = \frac{16}{5}$.

And for x > 1, we have $f(x) = \pi \quad \therefore \ f'(x) = 0$

Hence, $f'(2) = 0$ and $f'(2) = f'(3) = 0$

51. Acording to the given co-ordinates of C and co-ordinate of focus we can see if we

plot the diameter through C and S the other end (say Q) lies on directrix of parabola .
Since , the circle must pass through 'R'

$\overline{CS}$ $Equation\, is\, x+y=2$

$And\ parabola\ Equation\ y^2=8x$

$\Rightarrow x-coordinate\, of\ 'P'is\ \left(6-4\sqrt{2}\right)\therefore P=\left(6-4\sqrt{2},4\sqrt{2}-4\right)$

$Now\,\overline{CP}=r-sp=6\sqrt{2}-8$

$Slope\, of\ \overline{CQ}\times slope\ of\ at\, CR=-1\Rightarrow 'C'\ is\, also$

$correct$

52. Required planed passing through mid (AB) and perpendicular to AB

$\therefore$ equation of P is $3(x+1)-3(y+1)+1(z-2)=0$

$P\equiv 3x-3y+z-2=0$

$Q\equiv x-y+cz-1=0$

$$P//Q\Rightarrow\frac{3}{1}=\frac{1}{c}\Rightarrow c=\frac{1}{3}$$

$$\cos 45^0=\frac{\overrightarrow{n_1}.\overrightarrow{n_2}}{\left|\overrightarrow{n_1}\right|\left|\overrightarrow{n_2}\right|}=\left|\frac{6+c}{\sqrt{19}\sqrt{2+c^2}}\right|$$

$\Rightarrow 17c^2-24c-34=0\Rightarrow c_1c_2=-2$

$\rightarrow x_0=3, y_0=4, z_0=5\Rightarrow x_0+y_0+z_0=12$

53. $(I+A)^3=I^3+3A+3A^2+A^3=I+7A$

$A=B+C \quad \Rightarrow A^3=(B+C)^3$

$=B^3+3B^2C+3BC^2+C^3$ (as BC = CB)

$\Rightarrow A^3-B^3-3B^2C=3BC^2+C^3=(3B+C)C^2=0$

54. $x+y+z=6$

$x+2y+3z=14; 2x+5y+\lambda z=\mu$

$$D=\begin{vmatrix}1&1&1\\1&2&3\\2&5&\lambda\end{vmatrix}, D_x=\begin{vmatrix}6&1&1\\14&2&3\\\mu&5&\lambda\end{vmatrix}$$

$$D_y=\begin{vmatrix}1&6&1\\1&14&3\\2&\mu&\lambda\end{vmatrix}, D_z=\begin{vmatrix}1&1&6\\1&2&14\\2&5&\mu\end{vmatrix}$$

For unique solution $D\neq 0\sec\lambda$ for D non zero.

For infinitely many solutions $D=D_x=D_y=D_z=0$

Solve for value of λ and μ.

55. $$\frac{x-1}{3}=\frac{y-3}{5}=\frac{z-4}{2}=\lambda$$

$(3\lambda+1, 5\lambda+3, 2\lambda+4)$

If $\lambda=-1$ $B(-2,-2,2)$

Image of B in $2x-y+z+3=0$

$$\frac{u+2}{2}=\frac{v+2}{-1}=\frac{w-2}{1}=\frac{-2(-4+2+2-3)}{6}$$

$\frac{u+2}{2}=-1 \Rightarrow u=-4,\ v=-1, w=1 \quad \therefore$ image of B is $(-4,-1,1)=B'$

Let $A=(1,3,4)$ $\quad \frac{u-1}{2}=\frac{v-3}{-1}=\frac{w-4}{4}=\frac{-(2-3+4+3)}{6}$

$u=-3, v=5, w=2 \Rightarrow$ image of $A=(-3,5,2)=A'$

Equation $A'B'$ is $\frac{x+3}{1}=\frac{y-5}{6}=\frac{z-2}{1}$

It lies on $7x+py+qz+r=0 \quad 7(-3)+p(5)+q(2)+r=0$

$5p+2q+r=21 \rightarrow (1)$

$7+6p+q=0 \quad 6p+q=-7 \rightarrow (2)$

$14-p+q=0 \rightarrow (3)$

$p-q=14$

$6p+q=7$

$7p=7 \Rightarrow p=1$

$6+q=-7 \Rightarrow q=-13$

$5-26+r=21$

$r=42$

$p+3q+r=1-39+42=43-39=4$

56. $\sin(\pi[x])-2\cos(2\pi[x])+4\left[x^2-37x+22\right]=4p+1$

$0-2+4\left[x^2-37x+22\right]=4p+1$

$-2+4\left[x^2-37x\right]+88=4p+1$

$86+4\left[x^2-37x\right]=4p+1 \quad 85+4\left[x^2-37x\right]=4p$

As 85 is not an integral multiple of 4, hence no integral value of p is possible

57. $f(x)=\frac{1}{4}\left[4x^3-6x^2+4x+1\right]=\frac{1}{4}\left[x^4-(1-x)^4\right]+\frac{1}{2}$

$f(x)+f(1-x)=\frac{1}{2}+\frac{1}{2}=1$

Replace $x by\ f(x), f\left[f(x)\right]+f\left[1-f(x)\right]=1$

$f(f(x))=1-f(1-f(x))=1-f(f(1-x))$

$$I=\int_{1/4}^{3/4} f\left(f\left(x\right)\right)dx=\int_{1/4}^{3/4} f\left[f\left(1-x\right)\right]dx \Rightarrow 2I=\int_{1/4}^{3/4}\left(1\right)dx \Rightarrow I=\frac{1}{4}$$

NARAYANA IIT ACADEMY INDIA

40+ YEARS OF EXCELLENCE

OUT GOING SR's **Date: 11-05-2023**

Time: 3 Hrs **SGTA-3** **Max. Marks: 186**

11-05-23_SR-OUTGOING_Jee-Adv_2016_P1_SGTA-3(PAPER-1)_QP FINAL

Time: 3HRS **IMPORTANT INSTRUCTIONS** **Max Marks: 186**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 5)	Questions with Single Correct Choice	3	-1	5	15
Sec – II(Q.N : 6 – 13)	Questions with Multiple Correct Choice (Partial Marking +1)	4	-2	8	32
Sec – III(Q.N : 14 – 18)	Questions with Integer Answer Type	3	0	5	15
Total				**18**	**62**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 19 – 23)	Questions with Single Correct Choice	3	-1	5	15
Sec – II(Q.N : 24 – 31)	Questions with Multiple Correct Choice (Partial Marking +1)	4	-2	8	32
Sec – III(Q.N : 32 – 36)	Questions with Integer Answer Type	3	0	5	15
Total				**18**	**62**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 37 – 41)	Questions with Single Correct Choice	3	-1	5	15
Sec – II(Q.N : 42 – 49)	Questions with Multiple Correct Choice (Partial Marking +1)	4	-2	8	32
Sec – III(Q.N : 50 – 54)	Questions with Integer Answer Type	3	0	5	15
Total				**18**	**62**

PHYSICS **Max Marks: 62**

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases.

1. Two planets A and B of masses m_A and m_B are considered fixed in space at separation d. Find the speed with which a body of mass m is to be projected from the mid point of line joining A and B so that the body will escape to infinity.

A) $V \ge \sqrt{\dfrac{G(m_A+m_B)}{d}}$ B) $V \ge \sqrt{\dfrac{2G(m_A+m_B)}{d}}$

C) $V \ge \sqrt{\dfrac{4G(m_A+m_B)}{d}}$ D) $V \ge \sqrt{\dfrac{6G(m_A+m_B)}{d}}$

2. In a region an electric field exist in a given direction and it passes through a circle of radius R normally. The magnitude of electric field is given as $E = E_0\left(1-\dfrac{r}{R}\right)$. Where r is the distance from centre of circle. Find the electric flux passing through the plane of circle within it.

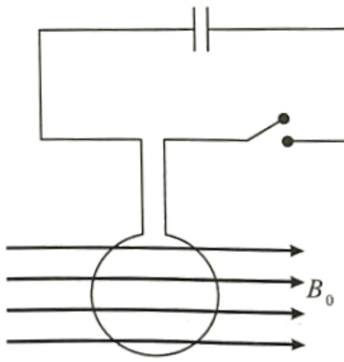
A) $\phi = \dfrac{\pi E_0 R^2}{3}$ B) $\phi = \dfrac{2\pi E_0 R^2}{3}$ C) $\phi = \dfrac{4\pi E_0 R^2}{3}$ D) $\phi = \dfrac{5\pi E_0 R^2}{3}$

3. A circular wire loop of radius r can with stand a maximum radial force F_0 in it before breaking. A particle of mass m and +ve charge q is sliding over the wire. A magnetic field B is applied normal to the plane of wire. What maximum speed the particle can have before loop breaks?

A) $V_{\max} = \dfrac{qB + \sqrt{q^2B^2 + \dfrac{4F_0 m}{r}}}{3(m/r)}$ B) $V_{\max} = \dfrac{qB + \sqrt{q^2B^2 + \dfrac{4F_0 m}{r}}}{4(m/r)}$

C) $V_{\max} = \dfrac{qB + \sqrt{q^2B^2 + \dfrac{4F_0 m}{r}}}{5(m/r)}$ D) $V_{\max} = \dfrac{qB + \sqrt{q^2B^2 + \dfrac{4F_0 m}{r}}}{2(m/r)}$

4. A circular coil of radius R and N turns has negligible resistance. As shown in the schematic figure, its two ends are connected to two wires and it is hanging by those wires with its plane being vertical. The wires are connected to a capacitor with charge Q through a switch. The coil is in a horizontal uniform magnetic field B_0 parallel to the plane of the coil. When the switch is closed, the capacitor gets discharged through the coil in a very short time. By the time the capacitor is discharged fully, magnitude of the angular momentum gained by the coil will be (assume that the discharge time is so short that the coil has hardly rotated during this time).



A) $\frac{\pi}{2}NQB_0R^2$ B) πNQB_0R^2 C) $2\pi NQB_0R^2$ D) $4\pi NQB_0R^2$

5. An AC voltage source of variable angular frequency ω and fixed amplitude V_0 is connected in series with a capacitance C and an electric bulb of resistance R (inductance zero). When ω is increased.

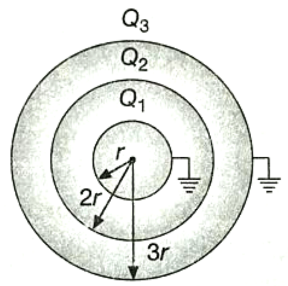
A) The bulb glows dimmer
B) The bulb glows brighter
C) Total impedance of the circuit is unchanged
D) Total impedance of the circuit increases

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 8 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases

6. Three concentric conducting spherical shells A,B and C have radii r, 2r and 3r and possess charges Q_1, Q_2 and Q_3 respectively. The innermost and the outermost shells are earthed as shown in the figure. Select the mathematical relations between the charges that are correct.

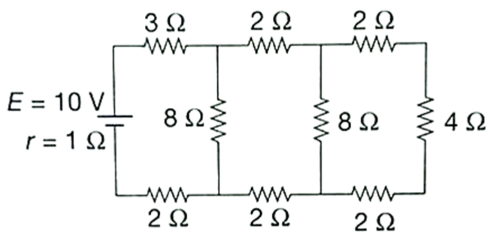


A) $Q_1 + Q_3 = -Q_2$ B) $Q_1 = -\frac{Q_2}{4}$ C) $\frac{Q_3}{Q_1} = 3$ D) $\frac{Q_3}{Q_2} = -\frac{1}{3}$

7. Two identical sheets of a metallic foil are separated by d and capacitance of the system is C_0 and charged to a potential difference V_0. keeping the charge constant, the separation is increased by l. Then the new capacitance and potential difference are C and V respectively. Then

A) $C = \frac{C_0}{\left(1+\frac{l}{d}\right)}$ B) $C = C_0\left(1+\frac{l}{d}\right)$ C) $V = V_0\left(1+\frac{l}{d}\right)$ D) $V = \frac{V_0}{\left(1+\frac{l}{d}\right)}$

8. In the circuit shown, the cell has emf $E = 10V$ and internal resistance $= 1\Omega$.



A) The currect through the 3Ω resistor is 1A.

B) The currect through the 3Ω resistor is 0.5 A.

C) The currect through the 4Ω resistor is 0.5 A

D) The currect through the 4Ω resistor is 0.25 A

9. Two identical charged particles enter a uniform magnetic field with same speed but at angles 30^0 and 60^0 with field. The ratio of their time periods, radii and pitches of the helical paths are a, b and c respectively. Then

A) $abc < 1$ B) $c = 3ab$ C) $abc = 1$ D) $a = bc$

10. Two long, thin, parallel conductors are kept very close to each other whithout touching. One carries a current I and the other has charge λ per unit length. An electron moving parallel to the conductors is undeflected. Let c=velocity of light.

A) $\upsilon = \frac{\lambda c^2}{I}$

B) $\upsilon = \frac{I}{\lambda}$

C) $c = \frac{1}{\lambda}$

D) The electron may be at any distance from the conductor

11. A particle of mass M and positive charge Q, moving with a constant velocity $\vec{u}_1 = 4\hat{i}\ ms^{-1}$, enters a region of uniform static magnetic field normal to the x-y plane. The region of the magnetic field extends from x=0 to x=L for all values of y. After passing through this region, the particle emerges on the other side after 10 milliseconds with a velocity $\vec{u}_2 = 2\left(\sqrt{3}\hat{i} + \hat{j}\right)ms^{-1}$. The correct statement (s) is (are).

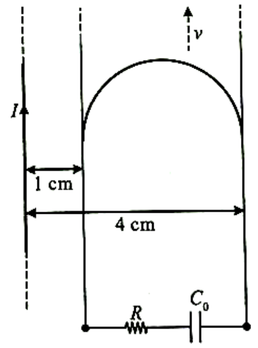
A) The direction of the magnetic field is –z direction

B) The direction of the magnetic field is +z direction

C) The magnitude of the magnetic field $\frac{50\pi M}{3Q}$ units

D) The magnitude of the magnetic field is $\frac{100\pi M}{3Q}$ units

12. A long stright wire carries a current, $I = 2$ ampere. A semi-circular conducting rod is placed beside it on two conducting parallel rails of negligible resistance. Both the rails are parallel to the wire. The wire, the rod and the rails lie in the same horizontal plane, as shown in the figure. Two ends of the semi-circular rod are at distances 1 cm and 4cm from the wire. At time $t = 0$, the rod starts moving on the rails with a speed $v = 3.0\,m/s$ (see the figure).



A resistor R=1.4 Ω and a capacitor $C_0 = 5.0\mu F$ are connected in series between the rails. At time $t = 0, C_0$ is uncharged. Which of the following statement(s) is (are) correct? [$\mu_0 = 4\pi \times 10^{-7}$ SI units. Take $\ln 2 = 0.7$]

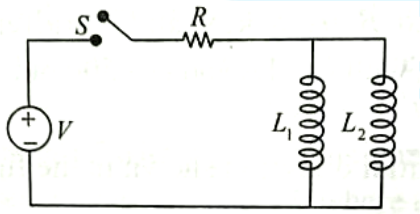
A) Maximum current through R is 1.2×10^{-6} ampere

B) Maximum current through R is 3.8×10^{-6} ampere

C) Maximum charge on capacitor C_0 is 8.4×10^{-12} coulomb

D) Maximum charge on capacitor C_0 is 2.4×10^{-12} coulomb

13. A source of constant voltage V is connected to a resistance R and two ideal inductors L_1 and L_2 through a switch S as shown. There is no mutual inductance between the two inductors. The switch S is initially open. At $t = 0$, the switch is closed and current begins to flow. Which of the following options is/are correct.



A) The ratio of the currents through L_1 and L_2 is fixed at all times $(t > 0)$

B) After a long time, the current through L_1 will be $\frac{V}{R}\frac{L_2}{L_1 + L_2}$

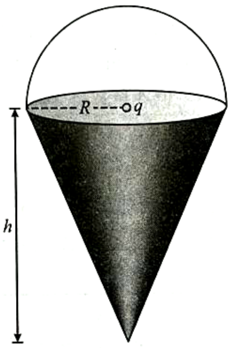
C) After a long time, the current through L_2 will be $\frac{V}{R}\frac{L_1}{L_1 + L_2}$

D) At $t=0$, the current through the resistance R is $\frac{V}{R}$

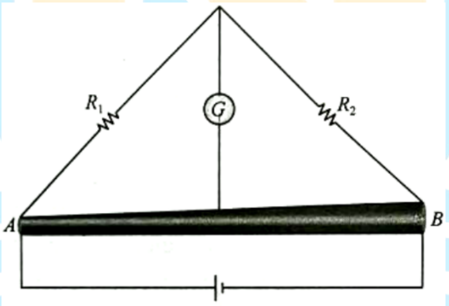
SECTION – III
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).
Marking scheme +3 for correct answer, 0 if not attempted and 0 in all other cases.

14. A charge q is surrounded by a closed surface consisting of an inverted cone of height h and base radius **R**, and a hemisphere of radius R as shown in the figure. The electric flux through the conical surface is $\frac{nq}{6\in_0}$ (in SI units). The value of n is.



15. Two resistances $R_1 = X\Omega$ and $R_2 = 1\Omega$ are connected to a wire AB of uniform resistivity, as shown in the figure. The radius of the wire varies linearly along its axis from 0.2 mm at A to 1 mm at B.A galvanometer (G) connected to the center of the wire 50 cm from each end along its axis, shown zero deflection when A and B are connected to a battery. The value of X is_____



16. A steady current I goes through a wire loop PQR having shape of a right angle triangle with $PQ = 3x, PR = 4x$ and $QR = 5x$. If the magnitude of the magnetic field at P due to this loop is $k\left(\frac{\mu_0 I}{48\pi x}\right)$, find the value of k.

17. An $\alpha-$particle (mass 4 amu) and a single charged sulfur ion (mass 32 amu) are initially at rest. They are accelerated through a potential V and then allowed to pass into a region of uniform magnetic field which is normal to the velocities of the particles. Within this region, the $\alpha-$particle and the sulfur ion move in circular orbits of radii r_α and r_s, respectively. The ratio (r_s / r_α) is____

18. two inductors L_1 (inductance 1 mH, internal resistance 3 Ω) and L_2 (inductance 2mH,internal resistance 4Ω),and a resistance R(resistance 12Ω) are all connected in parallel across a 5V battery. The circuit is switched on at time $t = 0$. The ratio of the maximum to the minimum current $\left(I_{max} / I_{min}\right)$ drawn from the battery is_____

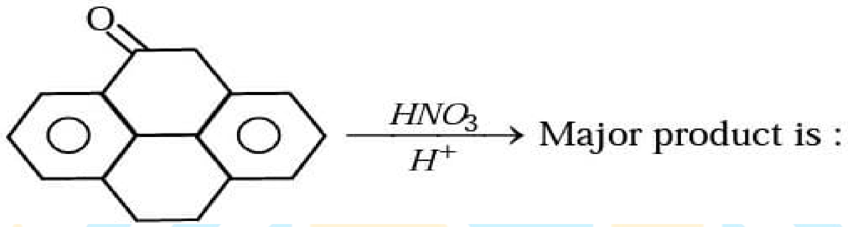
CHEMISTRY **Max Marks: 62**

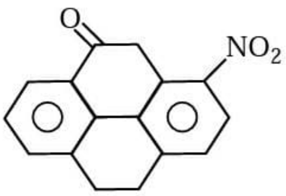
SECTION – I

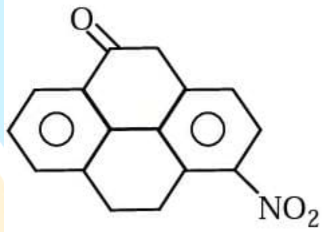
(SINGLE CORRECT ANSWER TYPE)

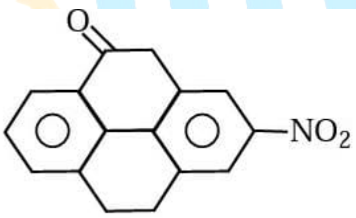
This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

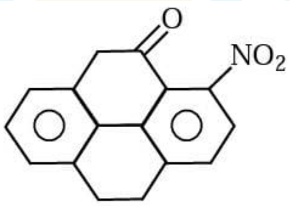
Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases.

19. 

A) 

B) 

C) 

D) 

20. The green colour produced in the borax bead test of chromium (III) salt is due to

A) $Cr_2(B_4O_7)_3$ B) Cr_2O_3 C) $Cr(BO_2)_3$ D) CrB

21. Identify the correct order of solubility of Na_2S ,CuS and ZnS in aqueous medium

A) $CuS > ZnS > Na_2S$ B) $ZnS > Na_2S > CuS$

C) $Na_2S > CuS > ZnS$ D) $Na_2S > ZnS > CuS$

22. Identify the wrong order for the property indicated against it

A) $NCl_3 > NH_3 > NF_3$:basic strength

B) $Lu(OH)_3 > Eu(OH)_3 > La(OH)_3$:basic strength

C) $Ba(OH)_2 > Ca(OH)_2 > Be(OH)_2$:solubility in water at same temperature

D) $HOCl > HClO_2 > HClO_3$:Oxidization power

23. Which of the following alkenes when treated with HCl yields majorly an anti markovnikov product?

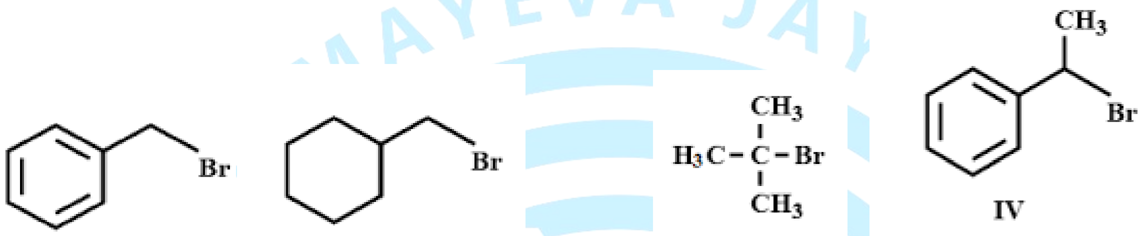
A) $F_3C-CH=CH_2$ B) $CH_3O-CH=CH_2$ C) $H_2N-CH=CH_2$ D) $Cl-CH=CH_2$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 8 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases

24. For the following compounds the correct statements (s) with respect to nucleophilic substitution reaction is (are)



I II III IV

A) I and III follows $S_N1$mechanism

B) I and II follows S_N2 mechanism

C) compound IV undergoes inversion of configuration

D) The order of reactivity for I,III and IV is :IV >I>III

25. Which of the following statements are correct ?

A) Acidic dichromate solutions on treatment with H_2O_2 gives deep blue $CrO(O_2)_2$ in presence of ether layer

B) A deep red liquid, CrO_2Cl_2 is formed by the reaction of chromium (III) oxide with HCl in presence of conc H_2SO_4

C) $(NH_4)_2Cr_2O_7$ on heating yields green chromium (III) oxide and nitrogen gas

D) $K_2Cr_2O_7$ on heating with charcoal produces K_2CO_3

26. The pairs (s) of ions where BOTH the ions are precipitated upon passing H_2S gas in presence of dilute HCl is (are)

A) Ba^{2+}, Zn^{2+} B) Bi^{3+}, Fe^{3+} C) Cu^{2+}, Pb^{2+} D) Hg^{+2}, Bi^{+3}

27. Which of the following is/are true for oxygen

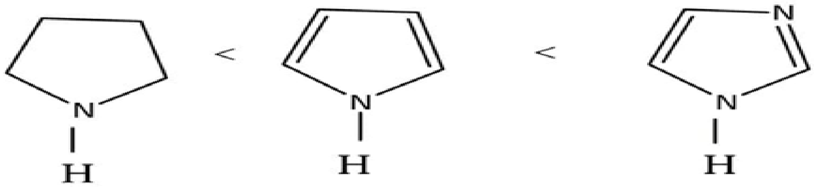
A) $KMnO_4(S)$ on strong heating gives oxygen gas

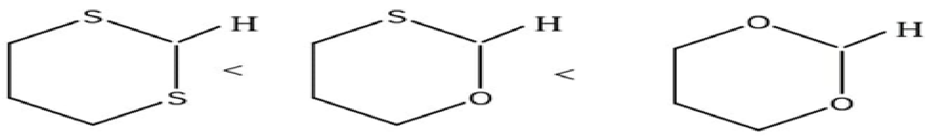
B) Oxygen mixed with helium is used for artificial respiration

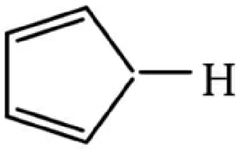
C) It has two unpaired electrons in bonding π molecular orbitals

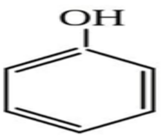
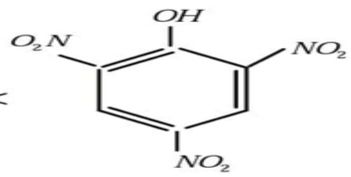
D) Brins process is used as industrial method for the preparation of oxygen gas

28. The correct order (S) of acidity is/are

A) 

B) 

C) $(Ph)_3CH < HC \equiv CH <$ 

D)  $< CH_3COOH <$ 

29. Which of the following can give Oxygen gas with water

A) F_2 B) XeF_2 C) XeF_4 D) $Ce(IV)salt$

30. Select the wrong IUPAC NAME (S) :

A) 2- hydroxyhexen -4 –one B) 2,3- dimethylcyclohexene

B) hept -1 – en -6 –yn- 5 –o1 D) 1,3 – diethoxypropan-1 –one

31. The correct statement (s) regarding a nucleophilic substitution reaction is

A) During SN^1 mechanism electron deficient carbon must attain planar geometry

B) SN^1 reactions are always accompanied by complete racemisation

C) SN^2 reactions are accompanied by inversion of configuration provided the leaving group and the incoming group do not differ in priority

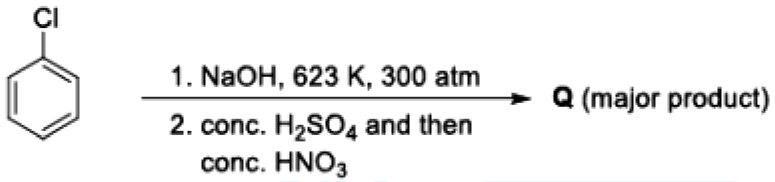
D) Aprotic polar solvent promote SN^1 reaction

SECTION – III
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).
Marking scheme +3 for correct answer, 0 if not attempted and 0 in all other cases.

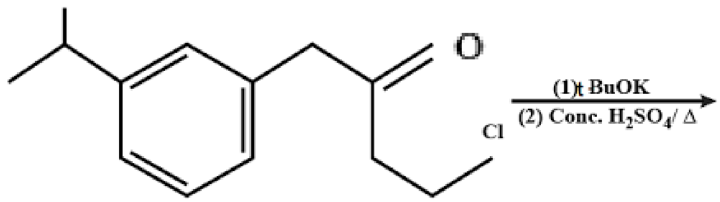
32. An aqueous solution contains $Hg^{2+}, Hg_2^{2+}, Pb^{2+}, Ag^{+}, Bi^{3+}$ and Cd^{2+} .Out of these how many ions will produce white precipitate with dilute HCl ?

33. The weight percentage of hydrogen in Q , formed in the following reaction sequence, is _______



[Given :Atomic mass of $H = 1, C = 12, N = 14, O = 16, S, 32, Cl = 35$]

34. In major product of the following reaction .Find no of sp^2 atoms ________



35. How many of the following ions have spin magnetic moment more than 4 B.M
$Ti^{3+}, Cu^{+}, Ni^{2+}, Fe^{3+}, Mn^{2+}, Co^{2+}$

36. No of correct statement/s about ICl_5 and ICl_4^- is/are

i) ICl_5 is square pyramidal and ICl_4^- is tetrahedral

ii) Both are isostructural

III) ICl_5 is square pyramidal and ICl_4^- is square planar

IV) ICl_5 is trigonal bipyramaidal and ICl_4^- is tetrahedral

MATHEMATICS **Max Marks: 62**

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases.

37. The algebraic sum of distances of the line ax + by + 2 = 0 from (1, 2), (2, 1) and (3, 5) is zero and the lines bx – ay + 4 = 0 and 3x + 4y + 5 = 0 cut the co-ordinate axes at concyclic points then

A) $a+b=-\frac{2}{7}$

B) area of the triangle formed by the line ax + by + 2 = 0 with coordinate axes is $\frac{14}{5}$.

C) line ax + by + 3 = 0 always passes through the point $(-1,1)$

D) max {a, b} = $\frac{5}{7}$

38. Equation of circle touching the line |x – 2| + |y – 3| = 4 will be

A) $(x-2)^2 + (y-3)^2 = 12$ B) $(x-2)^2 + (y-3)^2 = 4$

C) $(x-2)^2 + (y-3)^2 = 10$ D) $(x-2)^2 + (y-3)^2 = 8$

39. The ratio of the area enclosed by the locus of mid-point of PS and area of the ellipse where P is any point on the ellipse and S is the focus of the ellipse, is

A) $\frac{1}{2}$ B) $\frac{1}{3}$ C) $\frac{1}{5}$ D) $\frac{1}{4}$

40. If a chord joining P$(a\sec\theta, a\tan\theta)$, Q$(a\sec\alpha, a\tan\alpha)$ on the hyperbola $x^2 - y^2 = a^2$ is the normal at P,then $\tan\alpha$ =

A) $\tan\theta(4\sec^2\theta+1)$ B) $\tan\theta(4\sec^2\theta-1)$ C) $\tan\theta(2\sec^2\theta-1)$ D) $\tan\theta(1-2\sec^2\theta)$

41. A variable straight line of slope 4 intersects the hyperbola xy = 1 at two points. The locus of the point which divides the line segment between these two points in the ratio 1 : 2 is

A) $16x^2+10xy+y^2=2$ B) $16x^2-10xy+y^2=2$

C) $16x^2+10xy+y^2=4$ D) $16x^2-10xy+y^2=4$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 8 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases

42. If the unit vectors $\vec{a}$ and $\vec{b}$ are inclined at an angle 2θ such that $|\vec{a}-\vec{b}|<1$ and $0 \le \theta \le \pi$, then θ lies in the interval

A) $[0, \pi/6)$ B) $(5\pi/6, \pi]$

C) $(\pi/6, \pi/2]$ D) $[\pi/2, 5\pi/6)$

43. If $\vec{a}$, $\vec{b}$, $\vec{c}$ are non-zero, non-collinear vectors such that a vector

$\vec{p} = ab\cos\left(2\pi - (\vec{a} \wedge \vec{b})\right)\vec{c}$ and a vector $\vec{q} = ac\cos\left(\pi - (\vec{a} \wedge \vec{c})\right)\vec{b}$ then $\vec{p} + \vec{q}$ is

A) parallel to $\vec{a}$ B) perpendicular to $\vec{a}$

C) coplanar with $\vec{b}$ & $\vec{c}$ D) coplanar with $\vec{a}$ and $\vec{c}$

44. Given three vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ such that they are non–zero, non–coplanar vectors, then which of the following are coplanar.

A) $\vec{a}+\vec{b}$, $\vec{b}+\vec{c}$, $\vec{c}+\vec{a}$ B) $\vec{a}-\vec{b}$, $\vec{b}+\vec{c}$, $\vec{c}+\vec{a}$

C) $\vec{a}+\vec{b}$, $\vec{b}-\vec{c}$, $\vec{c}+\vec{a}$ D) $\vec{a}+\vec{b}$, $\vec{b}+\vec{c}$, $\vec{c}-\vec{a}$

45. Let OABC be a tetrahedron whose four faces are equilateral triangles of unit side. Let $\overrightarrow{OA}=\vec{a}$, $\overrightarrow{OB}=\vec{b}$ and $\overrightarrow{OC}=\vec{c}$, then

A) $\vec{c}=\frac{1}{3}\left(\vec{a}+\vec{b}\pm 2\sqrt{2}\,\vec{a}\times\vec{b}\right)$ B) $\vec{c}=\frac{1}{2}\left(\vec{a}+\vec{b}\pm 2\sqrt{3}\,\vec{a}\times\vec{b}\right)$

C) volume of the tetrahedron is $\frac{1}{2\sqrt{3}}$ D) $\left|\left[\vec{a}\ \vec{b}\ \vec{c}\right]\right|=\frac{1}{\sqrt{2}}$

46. If $\vec{a},\vec{b},\vec{c},\vec{d}$ are unit vectors such that $(\vec{a}\times\vec{b}).(\vec{c}\times\vec{d})=1$ and $\vec{a}.\vec{c}=\frac{1}{2}$ then

A) $\vec{a},\vec{b},\vec{c}$ are non coplanar B) $\vec{b},\vec{d}$ are non parallel

C) $\vec{b},\vec{c},\vec{d}$ are coplanar D) $\vec{a},\vec{d}$ are parallel and $\vec{b},\vec{c}$ are parallel

47. The equation of the line x + y + z – 1 = 0, 4x + y – 2z + 2 = 0 written in the symmetrical form is

A) $\frac{x+1}{1}=\frac{y-2}{-2}=\frac{z-0}{1}$ B) $\frac{x}{1}=\frac{y}{-2}=\frac{z-1}{1}$

C) $\frac{x+1/2}{1}=\frac{y-1}{-2}=\frac{z-1/2}{1}$ D) $\frac{x-1}{2}=\frac{y+2}{-1}=\frac{z-2}{2}$

48. Consider the planes 3x – 6y + 2z + 5 = 0 and 4x – 12y + 3z = 3. The plane 67x – 162y + 47z + 44 = 0 bisects that angle between the given planes which

A) Contains origin B) is acute C) is obtuse D) none of these

49. The plane lx + my = 0 is rotated about its line of intersection with the plane z = 0, through an angle α, then equation of plane in its new position may be

A) $lx+my+z\sqrt{l^2+m^2}\tan\alpha=0$ B) $lx+my-z\sqrt{l^2+m^2}\tan\alpha=0$

C) data is not sufficient D) None of these

SECTION – III
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).
Marking scheme +3 for correct answer, 0 if not attempted and 0 in all other cases.

50. The plane $2x-2y+z=3$ is rotated about the line where it cuts the xy plane by an acute angle α. If the new position of plane contains the point (3, 1, 1) then $9\cos\alpha$ equal to …….

51. The value of $x.y.z=55$ or $\frac{343}{55}$ according as the series a,x,y,z,b form an A.P or H.P respectively , where a and b are positive natural numbers. The sum of a+b is____

52. Let $P(x)=x^2+bx+c$, where b and c are integer. If $P(x)$ is a factor of both x^4+6x^2+25 and $3x^4+4x^2+28x+5$, then the value of P(1) is

53. If $\sum_{r=0}^{n}(-1)^r\frac{{}^nC_r}{{}^{(r+2)}C_r}=\frac{k}{n+2}$, then the value of k is

54. If the integers a, b, c in order are in A.P., lying between 1 and 9 and a23, b53, and c83 are three-digit numbers, then the value of the determinant $\begin{vmatrix}2 & 5 & 8\\ a23 & b53 & c83\\ a & b & c\end{vmatrix}$ is...

TG ~ @bohring_bot

OUT GOING SR's Date: 11-05-2023
Time: 3 Hrs SGTA-3 Max. Marks: 186

11-05-23_SR-OUTGOING_Jee-Adv_2016_P1_SGTA-3(PAPER-1)_QP FINAL

KEY

PHYSICS

1	C	2	A	3	D	4	B	5	B
6	ABC	7	AC	8	AD	9	BCD	10	AD
11	AC	12	AC	13	ABC	14	3	15	5
16	7	17	4	18	8				

CHEMISTRY

19	20	21	22	23	24	25	26	27
C	C	D	B	A	ABD	ACD	CD	ABD
28	29	30	31	32	33	34	35	36
ACD	ABCD	ABCD	AC	3	1	8	2	1

MATHS

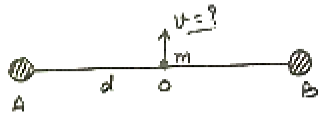
37	38	39	40	41	42	43	44	45
C	D	D	B	A	AB	BC	BCD	AD
46	47	48	49	50	51	52	53	54
BC	ABC	AB	AB	7	8	4	2	0

SOLUTIONS

PHYSICS

1. Due to planets A& B, gravitational Potential at O (mid point) is

$$V_0 = -\frac{Gm_A}{\left(d/2\right)} - \frac{Gm_B}{\left(d/2\right)}$$



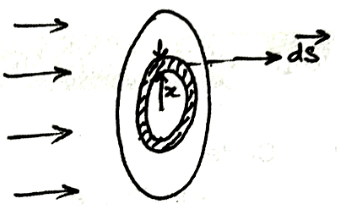
For body projected from O to escape to ∞,we must have.

$$\frac{1}{2}mv^2 + mV_0 \geq 0$$

$$\frac{V^2}{2} - \frac{2Gm_A}{d} - \frac{2Gm_B}{d} \geq 0$$

$$\Rightarrow V \geq \sqrt{\frac{4G\left(m_A + m_B\right)}{d}}$$

2.



Area of elemental ring is

$$dS = 2\pi x dx$$

Electric flux through elemental ring is

$$d\phi = E\,ds$$

$$d\phi = E_0\left(1 - \frac{x}{R}\right).2\pi x dx$$

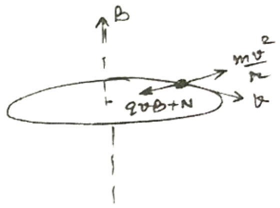
$$d\phi = 2\pi E_0 x dx - \frac{2\pi E_0 x^2}{R}dx$$

Total flux $\phi = \int d\phi = 2\pi E_0 \int_0^R x dx - \frac{2\pi E_0}{R}\int_0^R x^2 dx$

$$= 2\pi E_0\left[\frac{x^2}{2} - \frac{x^3}{3R}\right]_0^R = 2\pi E_0\left[\frac{R^2}{2} - \frac{R^2}{3}\right] = \frac{\pi E_0 R^2}{3}$$

$$\phi = \frac{\pi E_0 R^2}{3}$$

3.



For rev of bead in wire we use
Along radial direction

$$\frac{mv^2}{r} = qvB + N$$

$$\frac{mv^2}{r} - qvB - F_0 = 0$$

$$V_{\max} = \frac{qB \pm \sqrt{q^2B^2 + \frac{4F_0m}{r}}}{2(m/r)}$$

4.

Torque experienced by circular loop due to sudden flow of charge is given as

$$\tau = \vec{M} \times \vec{B}$$

At $\theta = 90°$ for the situation shown in figure, we have

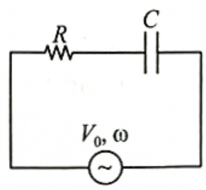
$$\tau = i\pi R^2 N B_0$$

As charge flow is in a very short time ($Q = i\delta t$), the gain in angular momentum is calculated as

$$\vec{\tau}\delta t = d\vec{L} = i\pi R^2 N B_0 \delta t = Q\pi R^2 N B_0$$

5.

Figure below shows the circuit described in the question.



Impedance of series RC circuit is given as

$$Z = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

As ω is increased Z is decreased due to which current in circuit increases so bulb will glow brighter.

6.

Potential of innermost shell is zero, so

$$\frac{Q_1}{r}+\frac{Q_2}{2r}+\frac{Q_3}{3r}=0$$

$$\Rightarrow \quad 6Q_1+3Q_2+2Q_3=0 \qquad \ldots(1)$$

Similarly, potential of the outermost shell is also zero.
So,

$$\Rightarrow \quad \frac{Q_1}{3r}+\frac{Q_2}{3r}+\frac{Q_3}{3r}=0$$

$$\Rightarrow \quad Q_1+Q_3=-Q_2$$

Solving equations (1) and (2), we get

$$Q_1=-\frac{Q_2}{4},\ \frac{Q_3}{Q_1}=3 \text{ and } \frac{Q_3}{Q_2}=-\frac{3}{4}$$

7.

$$q=CV=C_0V_0$$

where $C_0=\frac{\varepsilon_0 A}{d}$ and $q=\frac{\varepsilon_0 A V_0}{d}=\frac{\varepsilon_0 A V}{(d+\ell)}$

$$\Rightarrow \quad \frac{\varepsilon_0 A}{d}V_0=\frac{\varepsilon_0 A}{(d+\ell)}V \ \Rightarrow\ V=\frac{(d+\ell)}{d}V_0=\left(1+\frac{\ell}{d}\right)V_0$$

and $C=\frac{\varepsilon_0 A}{d+\ell}=\frac{\varepsilon_0 A}{d\left(1+\frac{\ell}{d}\right)}=\frac{C_0}{\left(1+\frac{\ell}{d}\right)}$

8.

$$\Rightarrow \quad I=\frac{9}{9}=1\text{ A}$$

At A a current of 1 A divides into 0.5 A and 0.5 A.
At B the current of 0.5 A divides into 0.25 A and 0.25 A

9.

$$T = \frac{2\pi m}{qB}$$

$$\Rightarrow \quad a = \frac{T_1}{T_2} = 1$$

$$r = \frac{mv\sin\theta}{qB}$$

$$\Rightarrow \quad b = \frac{r_1}{r_2} = \frac{\sin 30^\circ}{\sin 60^\circ} = \frac{1}{\sqrt{3}}$$

$$p = (T)(v\cos\theta) = \frac{2\pi mv\cos\theta}{qB}$$

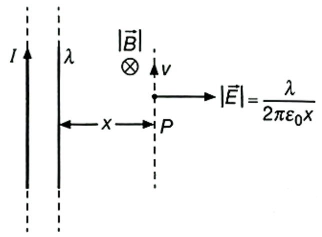
$$\Rightarrow \quad c = \frac{p_1}{p_2} = \frac{\cos 30^\circ}{\cos 60^\circ} = \sqrt{3}$$

From above, we get

$$abc = 1,\ a = bc \text{ and } c = 3ab$$

10.

At P, electric field $E = \frac{\lambda}{2\pi\varepsilon_0 x}$ (to the right), and magnetic field $B = \frac{\mu_0 I}{2\pi x}$ (into the paper).



For no deflection, $qE = qvB\sin(90^\circ)$

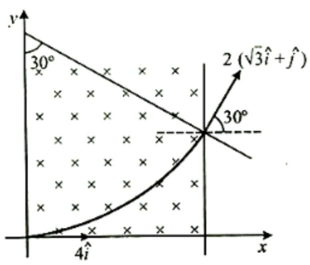
$$\Rightarrow \quad v = \frac{E}{B}$$

$$\Rightarrow \quad v = \left(\frac{\lambda}{2\pi\varepsilon_0 x}\right)\left(\frac{2\pi x}{\mu_0 I}\right) = \frac{\lambda}{I}\frac{1}{\varepsilon_0\mu_0} = \frac{\lambda c^2}{I}$$

11.

With the direction of emerging velocity it can be stated that the magnetic field is along – ve z-direction as shown in figure below. The time spent by particle in the magnetic field is calculated as

$$t = \frac{\pi M}{6QB}$$



$$\Rightarrow \quad B = \frac{\pi M}{60 \times 10^{-3} Q} = \frac{1000\pi M}{60Q}$$

$$\Rightarrow \quad B = \frac{50\pi M}{3Q}$$

12.

EMF induced across semicircular conducting rod is calculated by considering an element of width dx at a distance x from the straight wire as

$$e = \frac{v\mu_0 I}{2\pi}\int_{1\text{ cm}}^{4\text{ cm}} \frac{dx}{x} = \frac{4\pi \times 10^{-7} \times 3 \times 2}{2\pi} \ln 4$$

$$\Rightarrow \quad e = 16.8 \times 10^{-7}\,\text{V}$$

Maximum current through resistor R can be given as

$$I_{max} = \frac{16.8 \times 10^{-7}}{1.4} = 12 \times 10^{-7}\,\text{A} = 1.2 \times 10^{-6}\,\text{A}$$

Maximum charge on capacitor C_0 is given as

$$q_{max} = 5 \times 10^{-6} \times 16.8 \times 10^{-7} = 8.4 \times 10^{-12}\,\text{C}$$

13.

For the given circuit as inductors are in parallel, we use

$$L_1 I_1 = L_2 I_2$$

$$\Rightarrow \quad \frac{I_1}{I_2} = \frac{L_2}{L_1}$$

Hence option (A) is correct.

Equivalent inductance of the two inductors in parallel is taken as

$$L_{eq} = \frac{L_1 L_2}{L_1 + L_2}$$

Current flowing through R-L circuit during growth is written as

$$I = \frac{V}{R}\left(1 - e^{-\frac{tR}{L_{eq}}}\right)$$

At $t=0$ inductors behave like open circuits hence initial current in circuit is zero hence option (D) is NOT correct.

After a long time when $t \to \infty$ circuit current is given as

$$I = \frac{V}{R}$$

Circuit current can be written as sum of the current through two inductors, given as

$$I = I_1 + I_2$$

$$\Rightarrow \quad I = \left(1 + \frac{L_1}{L_2}\right) I_1$$

$$\Rightarrow \quad I_1 = \frac{L_2 I}{L_1 + L_2} = \frac{V}{R} \frac{L_2}{L_1 + L_2}$$

and $$I_2 = \frac{I_1 L_1}{L_2} = \frac{V}{R} \frac{L_2}{L_1 + L_2} \times \frac{L_1}{L_2}$$

$$\Rightarrow \quad I_2 = \frac{V}{R} \frac{L_1}{L_1 + L_2}$$

14.

Total flux coming out of complete closed surface is given as

$$\phi_{\text{hemisphere}} + \phi_{\text{cone}} = \frac{q}{\varepsilon_0} \qquad \ldots(1)$$

Through the hemisphere, half of flux originated by q will come out, given as

$$\phi_{\text{hemisphere}} = \frac{q}{2\varepsilon_0}$$

Thus equation-(1), flux coming out of conical surface is given as

$$\phi_{\text{cone}} = \frac{q}{2\varepsilon_0}$$

$$\Rightarrow \quad \frac{nq}{6\varepsilon_0} = \frac{q}{2\varepsilon_0}$$

$$\Rightarrow \quad n = 3$$

15.

If in the given circuit, resistance of left and right part of wire is taken as R_3 and R_4 then for the balanced Wheastone bridge, the condition used is

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \qquad \ldots(1)$$

For a wire with radius linearly varying from one end to another from radius a to b then its resistance is given as

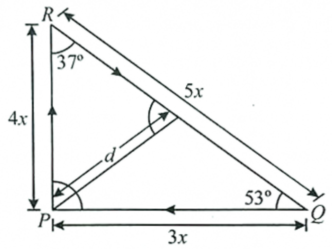
$$R = \frac{\rho l}{\pi ab}$$

$$\Rightarrow \quad \frac{X}{1} = \frac{1}{0.2}$$

$$\Rightarrow \quad X = 5\Omega$$

16.

Below figure shows the situation described in question



Here $d = 4x\cos 37° = 4x \times \frac{3}{5}$

Magnitude of magnetic field at P is given as

$$B_p = \frac{\mu_0 I}{4\pi d}[\sin 37° + \sin 53°]$$

$$\Rightarrow \quad B_p = \frac{\mu_0 I}{4\pi \frac{12x}{5}}\left[\frac{7}{5}\right] = \frac{7}{48}\frac{\mu_0 I}{\pi x}$$

$$\Rightarrow \quad B_p = 7\left(\frac{\mu_0 I}{48\pi x}\right)$$

$\Rightarrow \quad K = 7$

17.

After accelerating by a potential difference V, the kinetic energy gained by the α-particles is given as

$$\frac{1}{2}mv^2 = qV$$

In uniform magnetic field the radius of particles is given as

$$r = \frac{mV}{qB}$$

$$\Rightarrow \quad r = \frac{\sqrt{2mqV}}{qB}$$

$$\Rightarrow \quad r \,\alpha \sqrt{\frac{m}{q}}$$

$$\Rightarrow \quad \frac{r_s}{r_\alpha} = \sqrt{\frac{32}{4}\times\frac{2}{1}} = 4$$

18.

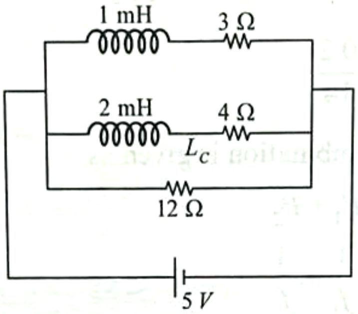
Circuit below shows the situation described in question.
In steady state equivalent resistance of the circuit is given as

$$\frac{1}{R_{eq}} = \frac{1}{3}+\frac{1}{4}+\frac{1}{12} = \frac{4+3+1}{12}$$

$$R_{eq} = \frac{12}{8} = \frac{3}{2}\Omega$$

Maximum current through battery in steady state of circuit is given as

$$I_{max} = \frac{5\times 2}{3} = \frac{10}{3}\text{ A}$$



Minimum current in circuit will be at $t = 0$ when inductors behave as open circuit and it is given as

$$I_{min} = \frac{5}{12}\text{ A}$$

$$\Rightarrow \quad \frac{I_{max}}{I_{min}} = \frac{10}{3}\times\frac{12}{5} = 8$$

MATHS

37. Key.C

Sol. Line always passes through the point $\left(2, \frac{8}{3}\right)$ hence 6a + 8b + 6 = 0 $\Rightarrow$ 3a + 4b + 3 = 0

bx – ay + 4 = 0 and 3x + 4y + 5 = 0 are concyclic.

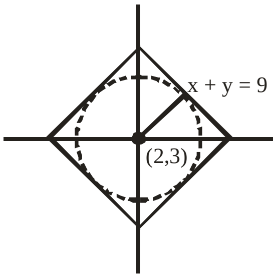
So, $m_1m_2 = 1$

$\frac{b}{a}.-\frac{3}{4} = 1 \Rightarrow$ 4a + 3b = 0

Solving a = 9/7, b = –12/7

38. Key.D

Sol. PERPENDICULAR distance from centre to tangent = radius



$$r = \frac{|2+3-9|}{\sqrt{2}} = \frac{4}{\sqrt{2}} = \frac{4\sqrt{2}}{2} = 2\sqrt{2}$$

Equation of circle is $(x-2)^2 + (y-3)^2 = 8$

39. Key. D

Sol. Ellipse equation is $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, Area = πab

Let $P=(a\cos\theta, b\sin\theta)$

$S=(ae,0)$

M(h,k) mid point of PS

$\Rightarrow h=\frac{ae+a\cos\theta}{2}; k=\frac{b\sin\theta}{2}$

$=\frac{h-\frac{ae}{2}}{a/2}+\frac{k^2}{(b^2/4)}=1$, locus of (h,k) is ellipse

Area $=\pi\left(\frac{a}{2}\right)\left(\frac{b}{2}\right)=\frac{1}{4}\pi ab$

40. Key.B

Sol. Slope of chord joining P and Q = slope of normal at P

$\frac{\text{Tan}\alpha-\text{Tan}\theta}{\sec\alpha-\sec\theta}=-\frac{\text{Tan}\theta}{\sec\theta}\Rightarrow \text{Tan}\alpha-\text{Tan}\theta=-k\text{Tan}\theta$ and $\sec\alpha-\sec\theta=k\sec\theta$

$\therefore(1-k)Tan\theta=Tan\alpha\rightarrow 1.\ (1+k)\sec\theta=\sec\alpha\rightarrow 2.$

$\left[(1+k)\sec\theta\right]^2-\left[(1-k)\text{Tan}\theta\right]^2=\sec^2\alpha-\text{Tan}^2\alpha$

$\Rightarrow k=-2\left(\sec^2\theta+\text{Tan}^2\theta\right)=-4\sec^2\theta+2$

From (1) $Tan\alpha=Tan\theta\left(1+4\sec\theta^2-2\right)=\text{Tan}\theta\left(4\sec\theta^2-1\right)$.

41. Key.A

Sol. Let P(h, k)

y - k = 4(x - h) --- (1)

Let it meets xy = 1 ----(2) at A (x_1,y_1) and B (x_2,y_2)

$x_1+x_2=\frac{4h-k}{4}, x_1x_2=-\frac{1}{4}$ Also $\Rightarrow\therefore\frac{2x_1+x_2}{3}=h\Rightarrow x_1=\frac{8h+k}{4}, x_2=\frac{2h+k}{2}$

$\Rightarrow 16x^2+10xy+y^2=2$

42. Key.A,B

Sol. Since, $\vec{a}$ and $\vec{b}$ are unit vectors, we have

$|\vec{a}-\vec{b}|=\sqrt{(\vec{a}-\vec{b})^2}$

$\therefore\sqrt{(\vec{a})^2+(\vec{b})^2-2\vec{a}.\vec{b}}=\sqrt{1+1-2\cos 2\theta}=2|\sin\theta|$

Therefore, $|\vec{a}-\vec{b}|<1$

$\Rightarrow\quad 2|\sin\theta|<1$

$|\sin\theta| < \frac{1}{2}$

$\Rightarrow$ $\theta \in \left[0, \frac{\pi}{6}\right)$

or $\left(\frac{5\pi}{6}, \pi\right]$

43. Key.B,C

Sol. $\vec{p} = a\,b\cos(2\pi - \theta)\vec{c}$ where □□is the angle between $\vec{a}$ and $\vec{b}$ and

$\vec{q} = a\,c\cos(\pi - \varphi)\vec{b}$ where □ is the angle between $\vec{a}$ and $\vec{c}$

Now $\vec{p} + \vec{q}$ = $(a\,b\cos\theta)\vec{c} - a\,c\,\cos\varphi\,\vec{b}$ = $(\vec{a}.\vec{b})\vec{c} - (\vec{a}.\vec{c})\vec{b}$ = $\vec{a} \times (\vec{c} \times \vec{b})$ □ B and C

44. Key.B,C,D

Sol. Verify $\vec{v}_1 + \vec{v}_2 = \vec{v}_3$ in order to quickly answer

45. Key.A,D

Sol. Let $\vec{C} = x\vec{a} + y\vec{b} + z(\vec{a} \times \vec{b})$. Taking succecive dots with $\vec{a}, \vec{b}, \vec{c}$ and $\vec{a} \times \vec{b}$ we get $x = y = \frac{1}{3}$

and $z = \pm\frac{2\sqrt{2}}{3}$.

46. Key.B,C

Sol. $\left(\vec{a} \times \vec{b}\right).\left(\vec{c} \times \vec{d}\right) = 1 \Rightarrow \sin\alpha\sin\beta\ ((\hat{n}_1.\hat{n}_2) = 1 \Rightarrow \sin\alpha\sin\beta\ \cos\theta = 1$

$\Rightarrow \sin\alpha = 1$, $\sin\beta = 1$ and $\cos\theta = 1 \Rightarrow \alpha = \beta = \pi/2$, $\theta = 0$ i.e., $\hat{n}_1 \| \hat{n}_2$

So, $\vec{a}, \vec{b}, \vec{c}, \vec{d}$ are coplanar. Again $\vec{a}.\vec{c} = \frac{1}{2} \Rightarrow \cos\gamma = \frac{1}{2} \Rightarrow \gamma = \pi/3$

So, no two of vectors $\vec{a}, \vec{b}, \vec{c}, \vec{d}$ are parallel.

47. Key.A,B,C

Sol. $x + y + z - 1 = 0$

$4x + y - 2z + 2 = 0$

$\therefore$ direction ratios of the line are < - 3, 6, - 3 >

i.e. < 1, - 2, 1 >

Let $z = k$, then $x = k - 1$, $y = 2 - 2k$

i.e. $(k - 1, 2 - 2k, k)$ is any point on the line

$\therefore$ (-1, 2, 0), (0, 0, 1) and $\left(-\frac{1}{2}, 1, \frac{1}{2}\right)$ are points on the line

$\therefore$ (A), (B) and (C) are correct options

48. Key.A,B

Sol. $3x - 6y + 2z + 5 = 0$ …(i)

$-4x + 12y - 3z + 3 = 0$ …(ii)

$$\frac{3x - 6y + 2z + 5}{\sqrt{9 + 36 + 4}} = \frac{-4x + 12y - 3z + 3}{\sqrt{16 + 144 + 9}}$$

Bisects the angle between the planes that contains the origin

$13(3x - 6y + 2z + 5) = 7(-4x + 12y - 3z + 3)$

39x – 78y + 26z + 65 = 0 28x + 84y – 2 1z + 21

67x – 162y + 47z + 44 = 0 …(iii)

Further 3 x (-4)+ (-6) (12) + 2 x (- 3) < 0

$\therefore$ origin lies in acute angle

49. Key.A,B

Sol. Equation of required plane is

$lx + my + \lambda z = 0$

angle between (i) &$lx + my = 0$ is α.

$$\Rightarrow \quad \cos\alpha = \frac{l^2+m^2}{\sqrt{l^2+m^2}\sqrt{l^2+m^2+\lambda^2}}$$

$$\Rightarrow \quad \cos^2\alpha = \frac{l^2+m^2}{l^2+m^2+\lambda^2} \quad \Rightarrow \quad \lambda = \pm\sqrt{l^2+m^2}\ \tan\alpha$$

Hence equation of plane is

$$lx + my \pm z\sqrt{l^2+m^2}\tan\alpha = 0$$

50. Key:7

Hint: Let equation of new plane $2x-2y+z-3+\lambda z=0$

Point (3, 1, 1) lie on $it \Rightarrow \lambda = -2$

Hence equation of new plane 2x – 2y –z = 3

$$\cos\alpha = \frac{4+4-1}{3.3} = \frac{7}{9}$$

51. Key.8

Sol. If a,x, y,z, b to are in A.P then the common difference d of the AP is given by

$$b = a+4d \Rightarrow d = \frac{b-a}{4}$$

$$\therefore x = a+d = \frac{a+b-a}{4} = \frac{b+3a}{4}$$

$$y = a+2d = \frac{a+b-a}{2} = \frac{a+b}{2}$$

$$z = a+3d = a+3\left(\frac{b-a}{4}\right) = \frac{a+3b}{4}$$

$$\therefore xyz = \frac{b+3a}{4}\times\frac{a+b}{2}\times\frac{a+3b}{4}$$

$$\Rightarrow 55 = \frac{(3a+b)(a+b)(a+3b)}{32}$$

$$\Rightarrow (3a+b)(a+b)(a+3b) = 55\times 32$$

When a,x,y,z,b are in H.P . Then

$\frac{1}{a},\frac{1}{x},\frac{1}{y},\frac{1}{b}$ are in AP

Let D be the common different of this A.P . Then

$$\frac{1}{b} = \frac{1}{a}+4D \Rightarrow D = \frac{a-b}{4ab}$$

$$\therefore \frac{1}{x} = \frac{1}{a}+D = \frac{1}{a}+\frac{a-b}{4ab} = \frac{3b+a}{4ab}$$

$$\frac{1}{y}=\frac{1}{a}+2D=\frac{1}{a}=\frac{a-b}{2ab}=\frac{a+b}{2ab}$$

$$\frac{1}{z}=\frac{1}{a}+3D=\frac{1}{a}=\frac{3(a-b)}{4ab}=\frac{3a+b}{4ab}$$

$$\therefore\frac{1}{x}.\frac{1}{y}.\frac{1}{z}=\frac{(3a+b)(a+b)(3a+b)}{32a^3\ b^3}$$

$$\Rightarrow\frac{1}{xyz}=\frac{(3a+b)(a+b(a+3b))}{32a^3\ b^3}$$

$$\Rightarrow\frac{55}{343}=\frac{55\times 32}{32\ a^3b^3}$$

$$\Rightarrow (ab)^3=7^3$$

$$\Rightarrow ab=7$$

$$\Rightarrow a=a,\ b=7,\ or\ a=7,\ b=1$$

52. Key.4

Sol. Since $P(x)$ divides into both of them

Hence P(x) also divides

$$(3x^4+4x^2+28x+5)-3(x^4+6x^2+25)$$

$$=-14x^2+28x-70=-14(x^2-2x+5)$$

Which is a quadratic, Hence $P(x)=x^2-2x+5$

$$\therefore P(1)=4$$

53. Key.2

Sol. We have

$$\sum_{r=0}^{n}(-1)^r\ \frac{{}^nC_r}{{}^{n+2}C_r}$$

$$=\sum_{r=0}^{n}(-1)^r\ \frac{n!}{(n-r)!r!}\times\frac{2!r!}{(r+2)!}$$

$$=2\sum_{r=0}^{n}(-1)^r\ \frac{n!}{(n-r)!(r+2)!}$$

$$=\frac{2}{(n+1)(n+2)}\sum_{r=0}^{n}(-1)^r\ \frac{(n+2!)}{\{(n+2)-(r+2)\}!(r+2)!}$$

$$=\frac{2}{(n+1)(n+2)}\sum_{r=0}^{n}(-1)^{r+2}\ {}^{n+2}C_{\ r+2}$$

$$=\frac{2}{(n+1)(n+2)}\sum_{s=2}^{n+2}(-1)^S\ \ {}^2C_s$$

$$=\frac{2}{(n+1)(n+2)}\left[\left(\sum_{s=0}^{n+1}(-1)^s\ {}^{n+2}C_s\right)-\left({}^{n+2}C_0-{}^{n+2}C_1\right)\right]$$

$$=\frac{2}{(n+1)(n+2)}\left[0-\{1-(n+2)\}\right]$$

$$=\frac{2}{n+2}$$

54. Key.0

Sol. We have,

$$\begin{vmatrix} 2 & 5 & 8 \\ a23 & b53 & c83 \\ a & b & c \end{vmatrix}=\begin{vmatrix} 2 & 5 & 6 \\ 100a+20+3 & 100b+50+3 & 100c+80+3 \\ a & b & c \end{vmatrix}$$

$$=\begin{vmatrix} 2 & 5 & 8 \\ 100a & 100b & 100c \\ a & b & c \end{vmatrix}+\begin{vmatrix} 2 & 5 & 8 \\ 20 & 50 & 80 \\ a & b & c \end{vmatrix}+\begin{vmatrix} 2 & 5 & 8 \\ 3 & 3 & 3 \\ a & b & c \end{vmatrix}$$

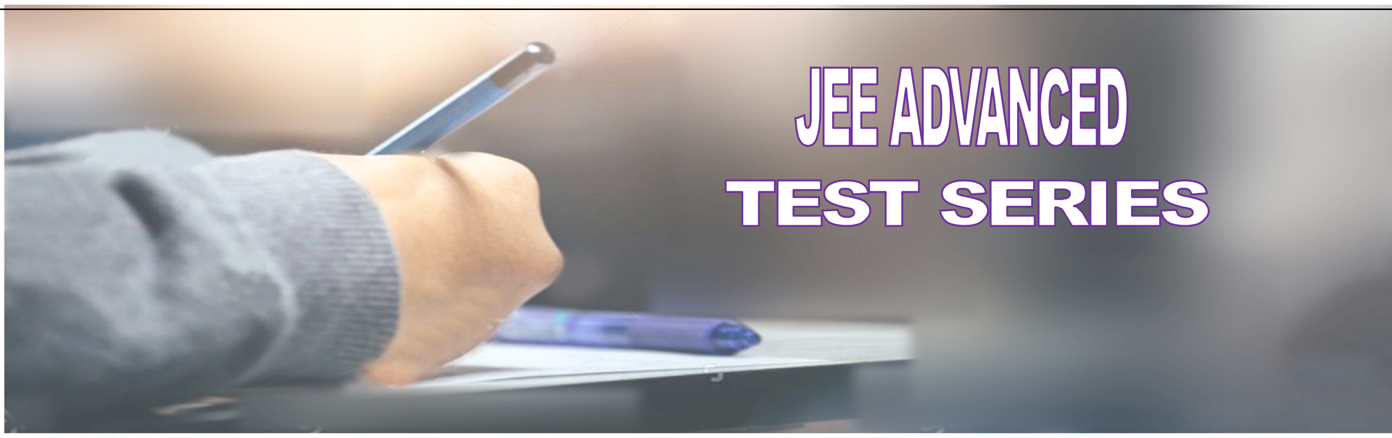
$$=100\begin{vmatrix} 2 & 5 & 8 \\ a & b & c \\ a & b & c \end{vmatrix}+10\begin{vmatrix} 2 & 5 & 8 \\ 2 & 5 & 8 \\ a & b & c \end{vmatrix}+3\begin{vmatrix} 2 & 5 & 8 \\ 1 & 1 & 1 \\ a & b & c \end{vmatrix}$$

$$=0+0+3\begin{vmatrix} 2 & 3 & 6 \\ 1 & 0 & 0 \\ a & b-a & c-a \end{vmatrix}$$

(Applying $C_2 \to C_2 - C_1,\ C_3 \to C_3 - C_1$)

$$=-3\left[3(c-a)-6(b-a)\right]=-9\left[c-a-2b+2a\right]$$

$$=-9(a-2b+c)=0 \qquad \left[\because\ a,b,c \text{ are in A.P., } \therefore 2b=a+c\right]$$



NARAYANA
IIT ACADEMY
INDIA

40+ YEARS OF EXCELLENCE

OUT GOING SR's **Date: 11-05-2023**

Time: 3 Hrs **SGTA-3** **Max. Marks: 186**

11-05-23_SR-OUTGOING_Jee-Adv_2016_P2_SGTA-3(PAPER-1)_QP FINAL

Time: 3 Hrs **IMPORTANT INSTRUCTIONS** **Max Marks: 186**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 6)	Questions with Single Correct Choice	3	-1	**6**	**18**
Sec – II(Q.N : 7 – 14)	Questions with Multiple Correct Choice (Partial Marking +1)	4	-2	**8**	**32**
Sec – III(Q.N : 15 – 18)	Questions with Comprehension Type (2 Comprehension-2+2=4Q)	3	0	**4**	**12**
Total				**18**	**62**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 19 – 24)	Questions with Single Correct Choice	3	-1	**6**	**18**
Sec – II(Q.N : 25 – 32)	Questions with Multiple Correct Choice (Partial Marking +1)	4	-2	**8**	**32**
Sec – III(Q.N : 33 – 36)	Questions with Comprehension Type (2 Comprehension-2+2=4Q)	3	0	**4**	**12**
Total				**18**	**62**

MATHS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 37 – 42)	Questions with Single Correct Choice	3	-1	**6**	**18**
Sec – II(Q.N : 43 – 50)	Questions with Multiple Correct Choice (Partial Marking +1)	4	-2	**8**	**32**
Sec – III(Q.N : 51 – 54)	Questions with Comprehension Type (2 Comprehension-2+2=4Q)	3	0	**4**	**12**
Total				**18**	**62**

PHYSICS **Max Marks: 62**

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

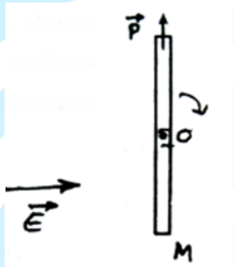
This section contains 6 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases.

1. Distance between two fixed stars in space is 10a and their radii are a and $2a$ with masses M and $16M$. A small body of mass m is fired from the surface of larger star to the smaller star. What should be the minimum initial speed to reach the surface of smaller star.

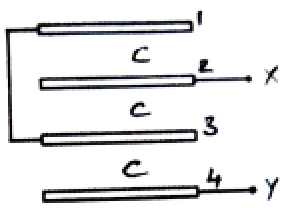
A) $v \geq \frac{3}{5}\sqrt{\frac{5GM}{a}}$ B) $v \geq \frac{3}{2}\sqrt{\frac{3GM}{a}}$ C) $v \geq \frac{3}{5}\sqrt{\frac{3GM}{a}}$ D) $v \geq \frac{3}{2}\sqrt{\frac{5GM}{a}}$

2. A uniform rod of length L and mass M is pivoted at its centre O as shown in figure. At the top end of rod a dipole of dipole moment $\vec{P}$ is fixed along the length of rod. If a uniform electric field $\vec{E}$ is switched on in this region toward right, find angular speed of rod when it becomes horizontal(parallel to $\vec{E}$).



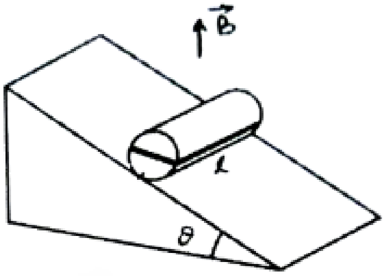
A) $\omega = \sqrt{\frac{24PE}{ML^2}}$ B) $\omega = \sqrt{\frac{18PE}{ML^2}}$ C) $\omega = \sqrt{\frac{12PE}{ML^2}}$ D) $\omega = \sqrt{\frac{6PE}{ML^2}}$

3. Figure shows four parallel plates with some connections .If area of each plate is A and separation between adjoining plates is d. Find the equivalent capacitance across terminals x and y.



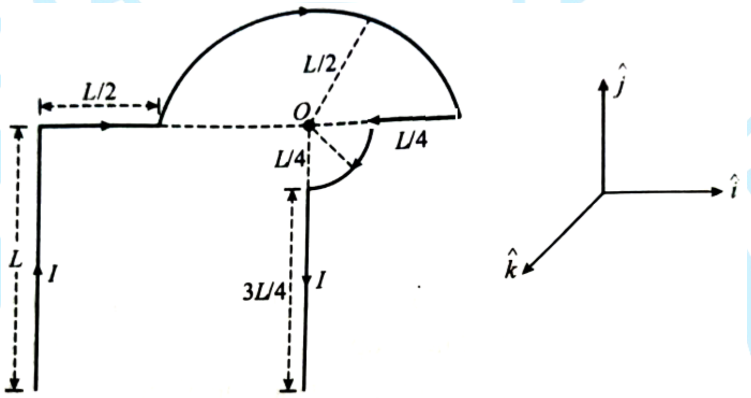
A) $C_{xy} = \frac{2\in_0 A}{7d}$ B) $C_{xy} = \frac{2\in_0 A}{5d}$ C) $C_{xy} = \frac{2\in_0 A}{9d}$ D) $C_{xy} = \frac{2\in_0 A}{3d}$

4. Figure shows a cylinder of length l, radius R and mass m on a rough inclined plane. A coil of N turns is wrapped along a diametrical plane (parallel to the inclined plane) of cylinder as shown. In the space a uniform magnetic field B exist in vertical direction. Find the least current that should pass through the coil which will keep the cylinder in equilibrium.



A) $i = \dfrac{mg}{5BlN}$ B) $i = \dfrac{mg}{3BlN}$ C) $i = \dfrac{mg}{2BlN}$ D) $i = \dfrac{mg}{10BlN}$

5. Which one of the following options represents the magnetic field $\overline{B}$ at O due to the current flowing in the given wire segments lying on the xy plane ?



A) $\overline{B} = \dfrac{-\mu_0 I}{L}\left(\dfrac{3}{2} + \dfrac{1}{4\sqrt{2}\pi}\right)\hat{k}$ B) $\overline{B} = \dfrac{-\mu_0 I}{L}\left(\dfrac{3}{2} + \dfrac{1}{2\sqrt{2}\pi}\right)\hat{k}$

C) $\overline{B} = \dfrac{-\mu_0 I}{L}\left(1 + \dfrac{1}{4\sqrt{2}\pi}\right)\hat{k}$ D) $\overline{B} = \dfrac{-\mu_0 I}{L}\left(1 + \dfrac{1}{4\pi}\right)\hat{k}$

6. A point mass is subjected to two simultaneous sinusoidal displacement in $x - direction$ $x_1(t) = A \sin \omega t$ and $x_2(t) = A \sin\left(\omega t + \dfrac{2\pi}{3}\right)$. Adding a third sinusoidal displacement $x_3(t) = B \sin(\omega t + \phi)$ brings the mass to a complete rest. The values of B and ϕ are :

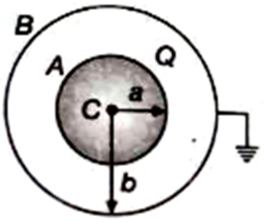
A) $\sqrt{2}A, \dfrac{3\pi}{4}$ B) $A, \dfrac{4\pi}{3}$ C) $\sqrt{3}A, \dfrac{5\pi}{6}$ D) $A, \dfrac{\pi}{3}$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 8 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases

7. A conducting sphere A of radius a, with charge Q, is placed concentrically inside a conducting shell B of radius b. B is earthed. C is the common centre of A and B, then the



A) field at a distance r from C, where $a \le r \le b,$ is $\frac{Q}{4\pi\varepsilon_0 r^2}$

B) potential at a distance r from C, where $a \le r \le b,$ is $\frac{Q}{4\pi\varepsilon_0 r}$

C) potential difference between A and B is $\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{a}-\frac{1}{b}\right)$

D) potential at a distance r from C, where $a \le r \le b,$ is $\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r}-\frac{1}{b}\right)$

8. A $2\,\mu F$ capacitor is charged to a potential of 15V and a $3\,\mu F$ is charged to a potential of 10 V and the capacitors are connected such that positive plate of one is connected to the negative plate of the other capacitor and negative plate of one is connected to the positive plate of the other capacitor. Select the correct statement(s) about the final circuit.

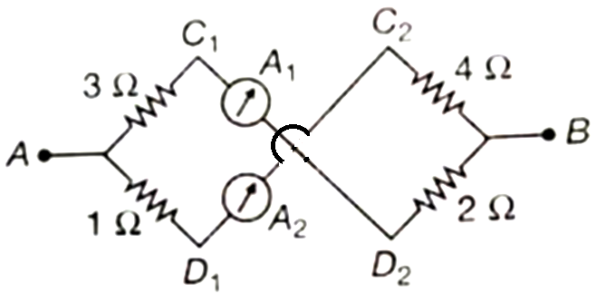
A) Final charge on each capacitor is zero

B) Final total electrical energy of the capacitor will be non zero

C) Total charge flown in the circuit is $30\ \mu C$

D) Total energy loss is 0

9. The ammeters, A_1 *and* A_2, each of resistance 5Ω are connected as shown. An ideal cell of emf 10V is applied between A and B, then



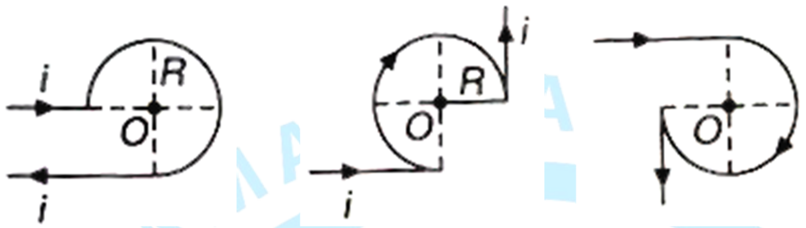
A) the current drawn from the cell is 1 A

B) the reading of A_1 is 1 A

C) the reading of A_2 is 1 A

D) for C_1 joined to C_2 and D_1 joined to D_2, the ammeter readings will become equal

10. Three long straight current carrying conductors are shown in figure. The straight parts are long and the circular part in each case is three fourth of a complete circle. Let B_a, B_b *and* B_c represents the strength of field at the centre O in the three cases, then



A) $B_a = \frac{\mu_0 i}{4R}\left(\frac{3}{2}+\frac{1}{\pi}\right)$

B) $B_b = \frac{\mu_0 i}{2R}\left(\frac{3}{4}-\frac{1}{\pi}\right)$

C) $B_a = \frac{\mu_0 i}{4R}\left(\frac{3}{2}-\frac{1}{\pi}\right)$

D) $B_c = \frac{3\mu_0 i}{8R}$

11. A straight thin walled tube of radius "a" has a current I flowing through it. If $B(r)$ is the magnitude of the magnetic field at a distance r from the axis of the tube then,

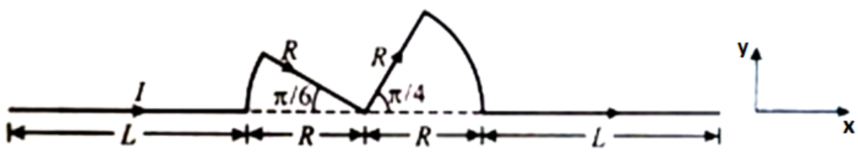
A) $B(r)=0 \;\; for\, 0 \le r < a$

B) $B(r)\alpha\frac{1}{r} \;\; for\, 0 \le r < a$

C) $B(r)\alpha\frac{1}{r} \;\; for \;\; r > a$

D) $B(r)=0 \;\; for \;\; r > a$

12. A conductor (Shown in the figure) carrying constant current I is kept in the x-y plane in a uniform magnetic field $\overline{B}$. If F is the magnitude of the total magnetic force acting on the conductor, then the correct statement (s) is (are) :



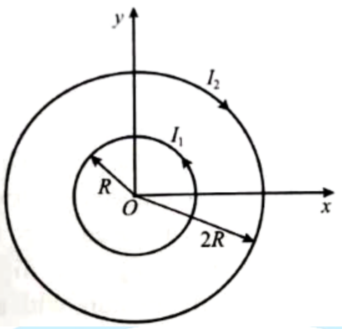
A) If $\overline{B}$ is along $\hat{z}, F\alpha(L+R)$

B) If $\overline{B}$ is along $\hat{x}, F=0$

C) If $\overline{B}$ is along $\hat{y}, F\alpha(L+R)$

D) If $\overline{B}$ is along $\hat{z}, F=0$

13. Two concentric circular loops, one of radius R and the other of radius $2R$, lie in the $xy-plane$ with the origin as their common center, as shown in the figure. The smaller loop carries current I_1 in the anti-clockwise direction and the larger loop carries current I_2 in the clockwise direction, with $I_2 > 2I_1.\vec{B}(x,y)$ denotes the magnetic field at a point (x,y) in the $xy-plane$. Which of the following statement(s) is (are) correct ?



A) $\vec{B}(x,y)$ is perpendicular to the xy-plane at any point in the plane

B) $\left|\vec{B}(x,y)\right|$ depends on $x\, and\, y$ only through the radial distance $r = \sqrt{x^2+y^2}$

C) $\left|\vec{B}(x,y)\right|$ is non-zero at all points for $r < R$

D) $\vec{B}(x,y)$ points normally outward from the xy-plane for all the points between the two loops

14. The instantaneous voltages at three terminals marked X, Y and Z are given by

$V_x = V_0 \sin \omega t, V_Y = V_0 \sin\left(\omega t + \frac{2\pi}{3}\right) and\ V_z = V_0 \sin\left(\omega t + \frac{4\pi}{3}\right)$

An ideal voltmeter is configured to read rms value of the potential difference between its terminals. It is connected between points X and Y and then between Y and Z. The reading(s) of the voltmeter will be :

A) $V_{XY}^{rms} = V_0$

B) $V_{YZ}^{rms} = V_0\sqrt{\frac{1}{2}}$

C) Independent of the choice of the two terminals

D) $V_{XY}^{rms} = V_0\sqrt{\frac{3}{2}}$

SECTION – III
(PARAGRAPH TYPE)

This section contains **2 groups of questions**. Each group has 2 multiple choice questions based on a paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE** is **correct**.
Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.

Paragraph for Questions 15 and 16

A thermal power plant produces electric power of $600\,kW$ at $4000V$, which is to be transported to a place 20 km away from the power plant for consumer's usage. It can be transported either directly with a cable of large current carrying capacity or by using a combination of step-up and step-down transformers at the two ends. The drawback of the direct transmission is the large energy dissipation. In this method using transformers, the dissipation is much smaller. In this method, a step-up transformer is used at the plant side so that the current is reduced to smaller value. At the consumer's end, a step-down transformer is used to supply power to the consumers at the specified lower voltage. It is reasonable to assume that the power cable is purely resistive and the transformers are ideal with a power factor unity. All the currents and voltages mentioned are rms values.

15. If the direct transmission method with a cable of resistance $0.4\Omega km^{-1}$ is used, the power dissipation (in%) during transmission is :

A) 20 B) 30 C) 40 D) 50

16. In the method using the transformers, assume that the ratio of the number of turns in the primary to that in the secondary in the step-up transformer is $1:10$. If the power to the consumers has to be supplied at $200\,V$, the ratio of the number of turns in the primary to that in the secondary in the step-down transformer is:

A) 200:1 B) 150:1
C) 100:1 D) 50:1

Paragraph for Questions 17 and 18

A point charge Q is moving in a circular orbit of radius R in the $x-y$ *plane* with an angular velocity ω.This can be considered as equivalent to a loop carrying a steady current $\frac{Q\omega}{2\pi}$. A uniform magnetic field along the positive $z-axis$ is now switched on, which increases at a constant rate B. The application of the magnetic field induces an emf in the orbit. The induced emf is defined as the work done by an induced electric field in moving a unit positive charge around a closed loop. It is known that, for an orbiting charge, the magnetic dipole moment is proportional to the angular momentum with a proportionality constant γ.

17. The magnitude of the induced electric field in the orbit at any instant of time during the time interval of the magnetic field change is:

A) $\frac{BR}{4}$ B) $\frac{BR}{2}$ C) BR D) $2BR$

18. The change in the magnetic dipole moment associated with the orbit, at the end of the interval of the magnetic field change, is

A) $-\gamma BQR^2$ B) $-\gamma \frac{BQR^2}{2}$ C) $\gamma \frac{BQR^2}{2}$ D) γBQR^2

CHEMISTRY **Max. Marks: 62**

SECTION-I
(Single Correct Answer Type)

This section contains 6 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

19. The increasing order of stability of the following free radicals is

A) $(CH_3)_2\dot{C}H < (CH_3)_3\dot{C} < (C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C}$

B) $(C_6H_5)_3\dot{C} < (C_6H_5)_2\dot{C}H < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$

C) $(C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C} < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$

D) $(CH_3)_2\dot{C}H < (CH_3)_3\dot{C} < (C_6H_5)_3\dot{C} < (C_6H_5)_2\dot{C}H$

20. I_3^+ and I_3^- have same :

A) geometry B) no. of lone pair (s)

C) bond angle D) none of these

21. $CH_3-CH=CH_2+NOCl \rightarrow P$ Identify the adduct :

A) $CH_3-\underset{Cl}{\underset{|}{CH}}-\underset{NO}{\underset{|}{CH_2}}$ B) $CH_3-\underset{NO}{\underset{|}{CH}}-\underset{Cl}{\underset{|}{CH_3}}$

C) $CH_3-CH_2-\underset{Cl}{\underset{|}{CH_2}}$ D) $\underset{NO}{\underset{|}{CH_2}}-CH_2-\underset{Cl}{\underset{|}{CH_2}}$

22. Consider the following reaction :

$$xMnO_4^- + yC_2O_4^{2-} + zH^+ \rightarrow xMn^{2+} + 2yCO_2 + \frac{z}{2}H_2O$$

The values of x,y and z in the reaction are, respectively :

A) 2,5 and 16 B) 5,2 and 8 C) 5,2 and 16 D) 2,5 and 8

23. Select incorrect statement.

A) Shielding effect of " f " electrons are minimum out of all the electrons of N – shell

B) As the "f" electrons increase , $Z_{eff.}$ on outer electron decreases in lanthanides

C) $Z_{eff.}$ on outer electron is $Lu > La$

D) In lanthanide series electrons are filled in (n-2) f subshell

24. Which of the following is example of SN^2

A) $CH_3Br + OH^- \rightarrow CH_3OH + Br^-$

B) $CH_3 - \underset{|\atop Br}{CH} - CH_3 + OH^- \rightarrow CH_3 - \underset{|\atop OH}{CH} - CH_3 + Br$

C) $CH_3 - CH_2 - OH \xrightarrow{-H_2O} H_2C = CH_2$

D) $CH_3 - \overset{CH_3 \atop |}{\underset{|\atop Br}{C}} - CH_3 + OH^- \rightarrow CH_3 + - \overset{CH_3 \atop |}{\underset{|\atop OH}{C}} - CH_3 + Br^-$

SECTION-II
(Multiple Correct Answer Type)

This section contains 8 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases.

25. Select correct statement(s) a:

A) All $N - N$ bond length are same in N_3^- (Azide) ion

B) All $N - N$ bond length are not identical in HN_3 (Hydrazine acid)

C) In HN_3 $N - N$ bond length is shorter than the central $N - N$ bond length

D) Azide ion and hydrazoic acid have same number of electrons

26. Which of the following statements are correct here?

A) $CH_3Br \xrightarrow[in.aq\ HCOOH]{-OH}$ can show S_N1 reaction

B) $\begin{matrix} CH_3 \\ CH_3 \end{matrix} CH - Br \xrightarrow[(CH_3)_3COK]{}$

Follow Hoffmann's rule

C) Walden inversion is always by S_N1 mechanism

D) $R - X \xrightarrow[Acetone]{NaI} S_N2$ mechanism is followed

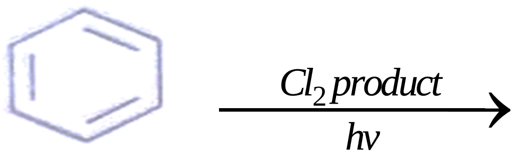
27. $Na_2\left[B_4O_5(OH)_4\right].8H_2O$ is called borax Select correct for borax.

A) On heating glassy solid obtain which is a composition of $NaBO_2$ and B_2O_3.

B) All boron's use sp^3 orbital's for bonding .

C) Its aqueous solution is alkaline in nature.

D) Its aqueous solution produce boric acid when treated with conc. H_2SO_4.

28. 

Which of the following is/are correct here regarding this reaction ?

A) It is a free radical addition reaction

B) Here product is $\gamma-$ Lindane

C) It is an explosive reaction

D) The product is a famous insecticide

29. Which one of the following is/are correct order of boiling points of the alky1/ary1 halides?

A) $CH_3\left(CH_2\right)_3Cl > CH_3\left(CH_2\right)_2Cl$

B) $\left(CH_3\right)_3CCl > \left(CH_3\right)_2CHCH_2Cl$

C) $CHCl_3 > CH_2Cl_2$

D) $C_6H_5Br > C_6H_5Cl$

30. In which of the following coloration does/do not arise due to d-d transition?

A) AgI B) MnO_4^- C) $Fe^{2+}_{(aq.)}$ D) CrO_4^{2-}

31. In the extraction of copper, metal is formed in the Bessemer converter due to which one of the following reaction ?

A) $Cu_2S+2Cu_2O\rightarrow 6Cu+SO_2$ B) $Cu_2S\rightarrow 2Cu+S$

C) $Cu_2O+Fe\rightarrow 2Cu+FeO$ D) $2Cu_2O\rightarrow 4Cu+O_2$

32. The incorrect is /are :

A) $\left(CH_3\right)_3CBr+CN^-\rightarrow E1$ B) $\left(CH_3\right)_3CBr+H_2O\rightarrow E2$

C) $CH_3CHBrCH_3+O^-H\rightarrow SN^2$ D) $CH_3CH_2CH_2Cl+I^-\rightarrow S_N1$

SECTION-III
(Paragraph Type)

This section contains 2 groups of question. Each group has 2 multiple choice questions based on a paragraph. Each question has 4 choice (A), (B),(C) AND (D) for its answer, out of which ONLY ONE is correct.

Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.

Paragraph for Questions 33 and 34:

Aluminium is the most abundant metal in earth crust. It exists in only combine state like oxide, fluoride, sulphates, phosphate etc. Aluminium is mainly extracted by bauxite ore which is generally contaminated by ferric oxide (red bauxite) and silica (white bauxite).

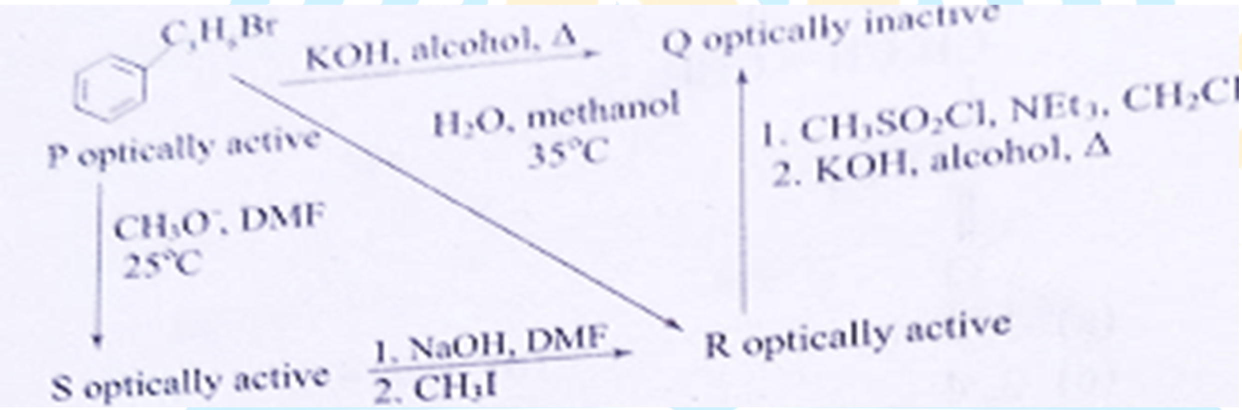
33. Other than caustic soda, which of the following can be used to separate chief impurity in red bauxite?

A) Conc. Nitric acid
B) Conc.hydrochloric acid
C) Conc. aq. Solution of ammonia
D) None of these

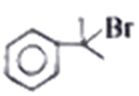
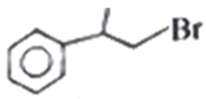
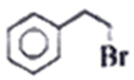
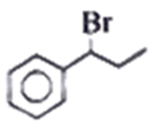
34. If white bauxite is treated with conc. solution of sodium hydroxide silica present in bauxite:

A) remains unaffected
B) forms soluble silicate
C) forms insoluble silicate
D) none of these

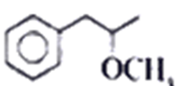
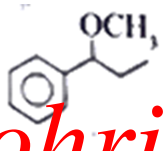
Paragraph for Questions 35 and 36:

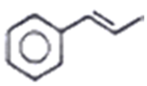
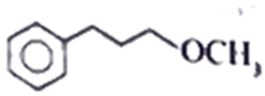


35. Here the compound (p) can be?

A) 
B) 
C) 
D) 

36. Here the compound S can be given as?

A) 
B) 

C)  D) 

MATHEMATICS Max. Marks: 62

SECTION-I
(Single Correct Answer Type)

This section contains 6 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

37. A group of students decided to buy a Alarm Clock priced between Rs. 170 to Rs 195. But at the last moment, two students backed out of the decision so that the remaining students had to pay 1 Rupee more than they had planned. If the students paid equal shares, the price of the Alarm Clock is

A) 190 B) 196
C) 180 D) 171

38. The 2008th term of the sequence $1,\ \underbrace{2,2,2,}_{3}\ \underbrace{3,3,3,3,3,3,}_{6}\ \underbrace{4,4,4,4,4,4,4,4,4,4,}_{10}\ldots$ where n occurs $\frac{n(n+1)}{2}$ times in the sequence, equals

A) 24 B) 23
C) 22 D) 21

39. If 7 divides $32^{32^{32}}$, the remainder is

A) 1 B) 0 C) 4 D) 6

40. The number of positive integral solutions of the equation $\begin{vmatrix} y^3+1 & y^2z & y^2x \\ yz^2 & z^3+1 & z^2x \\ yx^2 & x^2z & x^3+1 \end{vmatrix} = 11$ is

A) 1 B) 2 C) 3 D) 4

41. If α,β,γ are the roots of the equation $x^3 + px + q = 0$, then the value of the determinant

$\begin{vmatrix} \alpha & \beta & \gamma \\ \beta & \gamma & \alpha \\ \gamma & \alpha & \beta \end{vmatrix}$ is

A) 4 B) 2 C) 0 D) –2

42. The coefficient of the term independent of x in the expansion of

$$\left(\frac{x+1}{x^{2/3}-x^{1/3}+1}-\frac{x-1}{x-x^{1/2}}\right)^{10}$$

A) 70 B) 112 C) 105 D) 210

SECTION-II
(Multiple Correct Answer Type)

This section contains 8 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases.

43. If $\bar{a}$ *and* $\bar{b}$ are unit vectors and $\bar{c}$ is a vector such that $\bar{c}=\bar{a}\text{ x }\bar{c}+\bar{b}$ then

A) $\left[\bar{a}\ \bar{b}\ \bar{c}\right]=\bar{b}.\bar{c}-\left(\bar{a}.\bar{b}\right)^2$ B) $\left[\bar{a}\ \bar{b}\ \bar{c}\right]=0$

C) Maximum value of $\left[\bar{a}\ \bar{b}\ \bar{c}\right]=\frac{1}{2}$ D) Minimum value of $\left[\bar{a}\ \bar{b}\ \bar{c}\right]$ is $\frac{1}{2}$

44. If a vector $\vec{r}$ satisfies the equation $\vec{r}\times\left(\hat{i}+2\hat{j}+\hat{k}\right)=\hat{i}-\hat{k}$, then $\vec{r}$ is equal to

A) $\hat{i}+3\hat{j}+\hat{k}$

B) $3\hat{i}+7\hat{j}+3\hat{k}$

C) $\hat{j}+t\left(\hat{i}+2\hat{j}+\hat{k}\right)$ where t is any scalar

D) $\hat{i}+(t+3)\hat{j}+\hat{k}$ where t is any scalar

45. In a four-dimensional space where unit vectors along axes are $\hat{i},\hat{j},\hat{k}$ and $\hat{\ell}$ and $\vec{a}_1,\vec{a}_2,\vec{a}_3,\vec{a}_4$ are four non zero vectors such that no vector can be expressed as linear combination of others and $(\lambda-1)(\vec{a}_1-\vec{a}_2)+\mu(\vec{a}_2+\vec{a}_3)+\gamma(\vec{a}_3+\vec{a}_4-2\vec{a}_2)+\vec{a}_3+\delta\vec{a}_4=\vec{o}$ then

A) $\lambda=1$ B) $\mu=-\frac{2}{3}$ C) $\lambda=\frac{2}{3}$ D) $\delta=\frac{1}{3}$

46. A vector $(\vec{d})$ is equally inclined to three vectors $\vec{a}=\hat{i}-\hat{j}+\hat{k},\vec{b}=2\hat{i}+\hat{j}$ and $\vec{c}=3\hat{j}-2\hat{k}$.

Let $\vec{x},\vec{y},\vec{z}$ be three vectors in the plane of $\vec{a},\vec{b};\vec{b},\vec{c};\vec{c},\vec{a}$ respectively then

A) $\vec{x}.\vec{d}=14$ B) $\vec{y}.\vec{d}=3$

C) $\vec{z}.\vec{d}=0$ D) $\vec{r}.\vec{d}=0$ where $\vec{r}=\lambda\vec{x}+\mu\vec{y}+\delta\vec{z}$

47. $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$ intersects the co-ordinate axes at points A, B and C respectively. If ΔPQR has mid-points A, B and C then

A) centroids of ΔABC and ΔPQR coincide

B) foot of normal to ΔABC from O is circumcentre of ΔPQR

C) $ar(\Delta PQR) = 2\sqrt{a^2b^2 + b^2c^2 + c^2a^2}$

D) incentres of ΔABC and ΔPQR coincide

48. The projection of line $3x - y + 2z - 1 = 0 = x + 2y - z - 2$ on the plane $3x + 2y + z = 0$ is

A) $\frac{x+1}{11} = \frac{y-1}{-9} = \frac{z-1}{-15}$ B) $3x - 8y + 7z + 4 = 0 = 3x + 2y + z$

C) $\frac{x+12}{11} = \frac{y+8}{-9} = \frac{z+14}{15}$ D) $\frac{x+12}{11} = \frac{y+8}{-9} = \frac{z+14}{-15}$

49. The equation of three planes are $x - 2y + z = 3,\ 5x - y - z = 8,\ and\ \ x + y - z = 7$ then

A) they form a triangular prism

B) all three plane have a common line of intersection

C) line $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$ is parallel to each plane

D) line $\frac{x}{1} = \frac{y}{3} = \frac{z}{4}$ intersect all three plane

50. If P_1, P_2, P_3 denote the distances of the plane $2x - 3y + 4z + 2 = 0$ from the planes $2x - 3y + 4z + 6 = 0$, $4x - 6y + 8z + 3 = 0$ and $2x - 3y + 4z - 6 = 0$ respectively, then

A) $P_1 + 8P_2 - P_3 = 0$ B) $P_3 = 16P_2$ C) $8P_2 = P_1$ D) $P_1 + 2P_2 + 3P_3 = \sqrt{29}$

SECTION-III
(Paragraph Type)

This section contains 2 groups of question. Each group has 2 multiple choice questions based on a paragraph. Each question has 4 choice (A), (B),(C) AND (D) for its answer, out of which ONLY ONE is correct.

Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.

Paragraph for Questions 51 and 52:

If $\alpha, \beta, \gamma, \delta$ are eccentric angles of $4-$points on the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ the normals at which are concurrent then

51. $\alpha + \beta + \gamma + \delta =$

A) $2n\pi, n \in z$ B) $(2n+1)\frac{\pi}{2}, n \in z$

C) $(2n+1)\pi, n \in z$ D) $(2n+1)\frac{\pi}{4}, n \in z$

52. $\cos(\alpha+\beta)+\cos(\alpha+\lambda)+\cos(\alpha+\delta)+\cos(\beta+\gamma)+\cos(\beta+\delta)+\cos(\lambda+\delta)=$

A) 6 B) 3 C) 0 D) 1

Paragraph for Questions 53 and 54:

In a ΔPQR, with $PQ=r$, $QR=p$, $PR=q$ the cosine values of the angles are given by $\cos P=\frac{q^2+r^2-p^2}{2qr}$; $\cos Q=\frac{p^2+r^2-q^2}{2pr}$; $\cos R=\frac{p^2+q^2-r^2}{2pq}$, and the area of ΔPQR is $\Delta=\frac{1}{2}pq\sin R=\frac{1}{2}qr\sin P=\frac{1}{2}pr\sin Q$. Let ABCD be a parallelogram whose diagonal equations are $AC\equiv x+2y-3=0$; $BD\equiv 2x+y-3=0$. If $AC=4units$, and area of ABCD = 8 sq units, and $\angle BPC$ is acute where P is point of intersection of diagonals AC, BD, then

53. The length of other diagonal BD is

A) $\frac{10}{3}$ B) 2 C) $\frac{20}{3}$ D) $\frac{11\sqrt{2}}{3}$

54. The length of side AB is equal to

A) $\frac{2\sqrt{58}}{3}$ B) $\frac{4\sqrt{58}}{3}$ C) $\frac{\sqrt{58}}{3}$ D) $\frac{4}{3}\sqrt{58}$

Sec: OUTGOING SR 's | SGTA-3 | Date: 11-05-2023
Time: 3 HRS | 2016_P2 | Max. Marks:186

11-05-23_SR-OUTGOING_Jee-Adv_2016_P2_SGTA-3(PAPER-2)_KEY&SOL

KEY SHEET

PHYSICS

1	**D**	2	**A**	3	**D**	4	**C**	5	**C**
6	**B**	7	**ACD**	8	**AC**	9	**BCD**	10	**ABD**
11	**AC**	12	**ABC**	13	**AB**	14	**CD**	15	**B**
16	**A**	17	**B**	18	**B**				

CHEMISTRY

19	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
A	D	A	A	B	A	A,B,C,D	A,B,D	A,C,D	A,B,D
29	**30**	**31**	**32**	**33**	**34**	**35**	**36**		
A,C,D	A,B,D	A	A,C,D	D	B	D	B		

MATHS

37	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
C	**C**	**C**	**C**	**C**	**D**	**AC**	**ABC**	**ABD**
46	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**
CB	**ABC**	**AB**	**AC**	**ABCD**	**C**	**C**	**C**	**A**

SOLUTIONS:-
PHYSICS

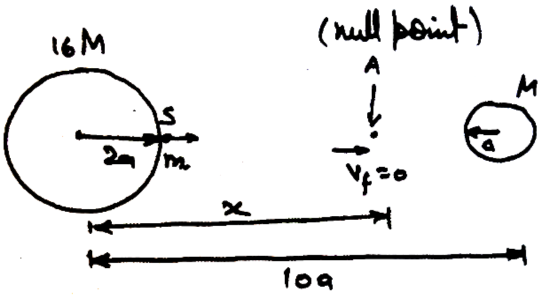
1. If null point is at a distance x from $16M$

$$\frac{G(16M)}{x^2}=\frac{(GM)}{(10a-x)^2}$$

$$4(10a-x)=x$$

$$40a=5x$$

$$x=8a$$



Grav potentials at pt S& A are - $V_s=-\frac{G(16M)}{2a}-\frac{GM}{8a}$; $V_A=-\frac{G(16M)}{8a}-\frac{GM}{2a}$

By energy cons if v is the initial speed of body at S so as to reach/cross pt A,

We use- $\frac{1}{2}mv^2+m\left[\frac{-G(16M)}{2a}-\frac{GM}{8a}\right]\geq m\left[\frac{-G(16M)}{8a}-\frac{GM}{2a}\right]$

$$v\geq\frac{3}{2}\sqrt{\frac{5GM}{a}}$$

2. Initial Int energy of dipole with EF $U_i=-\vec{P}.\vec{E}=0$

Initial Int energy of dipole with Ef $U_f=-\vec{P}.\vec{E}=-PE$

W.D by electric forces on rod is $W=U_i-U_f=0-(-PE)=PE$

If w is the avg speed attained by rod we use

$$PE=\frac{1}{2}=Iw^2=\frac{1}{2}\left(\frac{ML^2}{12}\right)w^2$$

$$w=\sqrt{\frac{24PE}{ML^2}}$$

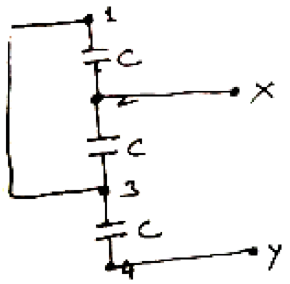
3. Here $C=\frac{\epsilon_0 A}{d}$

$$C_{xy}=[C(p)C](s)c$$

$$=2C(s)C$$

$$=\frac{2C\times C}{2C+C}=\frac{2C}{3}=\frac{2\epsilon_0 A}{3d}$$

$$C_{xy} = \frac{2\epsilon_0 A}{3d}$$



4. torque on a coil is $\tau = MB\sin\theta$

$$\tau_1 = \left[i(2R)lN\right]B\sin\theta$$

Torque on cylinder due to gravity is

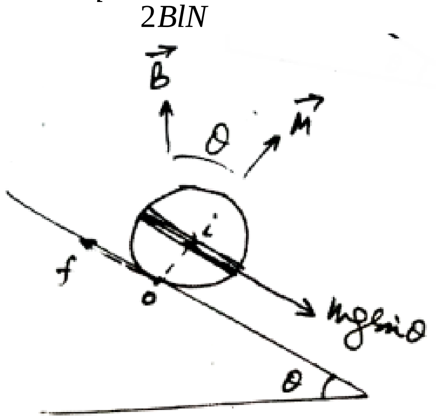
$$\tau_2 = mg\sin\theta\, R$$

For equ of cylinder

$$\tau_1 = \tau_2$$

$$2i\cancel{R}lN3\sin\theta = mg\cancel{R}\sin\theta$$

$$i = \frac{mg}{2BlN}$$

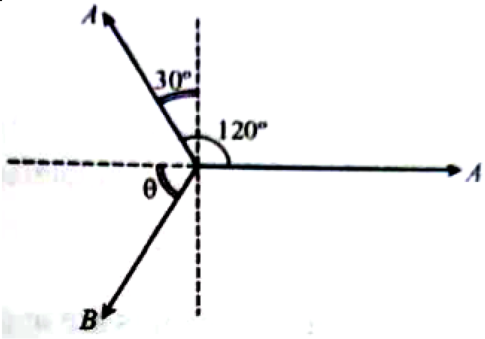


5. Magnetic field induction due to different wire segments in the given conductor is calculated as

$$\bar{B} = \frac{-\mu_0 I}{4\pi L}\sin 45^0\left(-\hat{k}\right) + \frac{-\mu_0 I\pi}{4\pi\frac{L}{2}}\left(-\hat{k}\right) + \frac{-\mu_0 I}{4\pi\frac{L}{4}} \times \frac{\pi}{2}\left(-\hat{k}\right)$$

$$\bar{B} = \frac{-\mu_0 I}{L}\left(1 + \frac{1}{4\sqrt{2}\pi} + 1\right)\left(-\hat{k}\right)$$

6. As the phasor resultant of all three SHMs is zero, below figure shows the phasor diagram of the three SHMs.



Here $\phi = \pi + \theta$ and for zero resultant, we use

$$B\sin\theta = A\cos 30^\circ = \frac{\sqrt{3}A}{2}$$

and $A\sin 30^\circ + B\cos\theta = A$

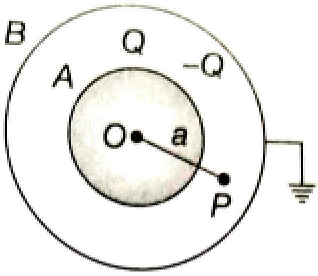
$\Rightarrow$ $$B\cos\theta = \frac{A}{2}$$

Solving equations-(1) and (2) gives

$$B = A \text{ and } \theta = 60^\circ = \frac{\pi}{3}$$

$\Rightarrow$ $$\phi = 240^\circ = \frac{4\pi}{3}$$

7.



$$E = \frac{Q}{4\pi\varepsilon_0 r^2}, \text{ when } a \le r \le b$$

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{r} - \frac{Q}{b}\right), \text{ where } a \le r \le b$$

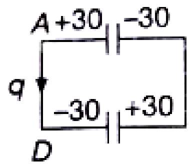
Potential of B is $V_B = 0$

Potential of A is $V_A = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{a} - \frac{Q}{b}\right)$

So, potential difference is $V_A - V_B = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)$

Hence (A), (C) and (D) are correct

8.



The common potential is given by

$$V = \frac{C_1V_1 - C_2V_2}{C_1 + C_2} = \frac{30-30}{C_1+C_2} = 0$$

Final charge on the first capacitor is

$$Q_1' = C_1V = 0$$

Final charge on the second capacitor is

$$Q_2' = C_2V = 0$$

So, final energy stored in the arrangement is zero.

Let a charge q flow from A to D, then

$$30 - q = 0$$

$$\Rightarrow \quad q = 30\ \mu C$$

Hence (A) and (C) are correct

9. The electrical paths AC_1D_2B and AD_1C_2B are in parallel. The resistance of each of them is 10Ω, and hence the current is 1 A. When C_1C_2 *and* D_1D_2 are joined, the ammeters are in parallel combination. As they are of a same resistance, their readings will be equal.

Hence, (B) (c) and (D) are correct .

10.

$$B_a = \frac{\mu_0 i}{4\pi R} + \frac{3\mu_0 i}{8R} = \frac{\mu_0 i}{4R}\left(\frac{1}{\pi} + \frac{3}{2}\right)$$

$$\Rightarrow \quad B_b = \frac{3\mu_0 i}{8R} - \frac{\mu_0 i}{2\pi R} = \frac{\mu_0 i}{2R}\left(\frac{3}{4} - \frac{1}{\pi}\right)$$

$$\Rightarrow \quad B_c = \frac{\mu_0 i}{4\pi R} + \frac{3\mu_0 i}{8R} - \frac{\mu_0 i}{4\pi R} = \frac{3\mu_0 i}{8R}$$

Hence , (A) , (B) and (D) are correct.

11.

Apply Ampere's Circuital Law we get

$$B(r)=0 \qquad \{\text{inside the tube}\}$$

$$\Rightarrow \quad B(2\pi r)=\mu_0 I$$

$$\Rightarrow \quad B=\frac{\mu_0 I}{2\pi r}$$

$$\Rightarrow \quad B \propto \frac{1}{r}$$

Hence , (A) and (C) are correct.

12. For the given conductor the magnetic force can be calculated by considering it as a straight wire of length $2(L+R)$ carrying same current I. If magnetic field is along z direction magnetic force on the conductor is be given as

$$F_m = BI(2L+2R)$$

Hence option (A) is correct and option (D) is NOT zero as current element length is along magnetic field direction hence option (B) is correct. When $\vec{B}$ is along y direction, magnetic force on the conductor is given as

$$F_m = BI(2L+2R)$$

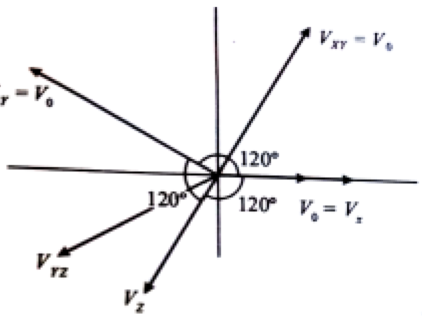
Hence option (C) is correct

13. Magnetic field due to both loops is perpendicular to the x-y plane hence their resultant will also be along this direction only hence option (A) is correct.
As the two loops are symmetric with respect to origin, the magnitude of magnetic field will only upon the radial distance from origin hence option (B) is correct.
For the given condition of current, at center field is inward and as we move radially out then close to $r = R_1$ field becomes outward so at some point it will be zero also hence option (C) is NOT Correct.

From the directions of currents given magnetic field between the region of the two loops magnetic field is in inward direction. Hence option (D) is NOT correct.

14.

Given voltages are drawn in phasor diagram as shown below



Potential difference between X and Y is calculated as

$$V_{XY} = V_X - V_Y = V_0 \sin \omega t - V_0 \sin\left(\omega t + \frac{2\pi}{3}\right)$$

$$V_{XY} = V_0 [2\cos\left(\omega t + \frac{2\pi}{3}\right)\sin\left(-\frac{\pi}{3}\right)]$$

$$V_{XY} = \sqrt{3} V_0 \cos\left(\omega t + \frac{\pi}{3}\right)$$

$$V_{XY}^{rms} = \sqrt{3}\frac{V_0}{\sqrt{2}} = V_0\sqrt{\frac{3}{2}}$$

15. For direct transmission , power dissipation is given as

$$p = i^2 R = (150)^2 (0.4\times 20) = 1.8\times 10^5 W$$

Percentage of power dissipation is given as

$$p_d = \frac{1.8\times 10^5}{6\times 10^5}\times 100 = 30\%$$

16. For step up transformer, we use

$$\frac{4000}{x} = \frac{1}{10} \qquad ....(1)$$

For step down transformer, we use

$$\frac{x}{200} = N \qquad ....(2)$$

Where x is the step up voltage. From equations (1) and (2) we have

$$\frac{4000}{x}\times\frac{x}{200} = \frac{N}{10}$$

$\Rightarrow \quad N = 200 \Rightarrow \quad Ratio = 200:1$

17. For induced electric field, we use

$$\int E.dr = A.\frac{dB}{dt}$$

$$\Rightarrow E(2\pi R) = \pi R^2 \frac{dB}{dt} \Rightarrow E = \frac{RB}{2}$$

18. Total change in angular momentum is given as

$$\Delta L = \int \tau dt$$

$$\Rightarrow \quad \Delta L = Q\left(\frac{RB}{2}\right)R$$

$$\Rightarrow \quad \Delta L = \frac{QR^2 B}{2}$$

Change in magnetic dipole moment is given as

$$\Delta\mu = -\gamma\Delta L = -\gamma\frac{QR^2B}{2}$$

In above expression negative sigh is considered due t induced current in opposite direction.

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S	**JEE-ADVANCE-2022-P2**	**Date: 14-05-2023**
Time: 02.00Pm to 05.00Pm	**GTA-23**	**Max. Marks: 180**

14-05-2023_Sr.Super60_NUCLEUS&ALL_BT'S_Jee-Adv(2022-P2)_GTA-23_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ____________________ **H.T. NO:** | | | | | | | |

JEE-ADVANCE-2022-P2-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 8)	Questions with Integer Answer Type	+3	-1	8	24
Sec – II(Q.N : 9 – 14)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 15 – 18)	Questions with Single Correct Choice	+3	-1	4	12
Total				**18**	**60**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 19 – 26)	Questions with Integer Answer Type	+3	0	8	24
Sec – II(Q.N : 27 – 32)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 33 – 36)	Questions with Single Correct Choice	+3	-1	4	12
Total				**18**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 37 – 44)	Questions with Integer Answer Type	+3	0	8	24
Sec – II(Q.N : 45 – 50)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 51 – 54)	Questions with Single Correct Choice	+3	-1	4	12
Total				**18**	**60**

MATHEMATICS **Max Marks: 60**

SECTION-I
(INTEGER ANSWER TYPE)

- This section contains EIGHT (08) questions.
- The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 TO 9, BOTH INCLUSIVE.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual Numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated **according to the following marking scheme**:

Full Marks: +3 If ONLY the correct integer is entered;
Zero Marks: 0 If the question is unanswered;
Negative Marks: -1 In all other cases

1. Define the sequence $x_1, x_2, \ldots$ inductively by $x_1 = \sqrt{5}$ and $x_{n+1} = x_n^2 - 2$ for each $n \geq 1$.

Compute $\lim\limits_{n\to\infty} \dfrac{x_1 \cdot x_2 \cdot x_3 \cdots x_n}{x_{n+1}}$.

2. The shortest distance between $(1-x)^2 + (x-y)^2 + (y-z)^2 + z^2 = \dfrac{1}{4}$ and $4x + 2y + 4z + 7 = 0$ in 3- dimensional coordinate system is equal to _____

3. $\sum\limits_{r=0}^{9} {}^{20}\mathrm{c}_{2r}\, {}^{20}\mathrm{c}_{2r+2} = \dfrac{\mathrm{a}}{\mathrm{a}+1}\left({}^{39}\mathrm{c}_{21} - {}^{19}\mathrm{c}_{10}\right)$ and $xy = 4a$ then total number of ordered pair solution (x, y) where $x, y \in I^+$ is

4. The number of solution(s) of equation $(x-2) + 2\log_2(2^x + 3x) = 2^x$ is _________

5. Number of solution(s) of the equation $x + \dfrac{7}{2} + \dfrac{1}{\pi}\tan^{-1}(\cot \pi x) = x^3$ for $x \in (1, 2)$ is/are

6. A circle of radius 5 units has diameter along the angle bisector of the lines $x + y = 2$ and $x - y = 2$ & chord of contact from origin makes an angle of 45° with the positive direction of x-axis. If the equation of the circle is $(x+\alpha)^2 + (y+\beta)^2 = 5^2$ then find $|\alpha - \beta|$

7. When $\mathrm{N} = \sum\limits_{k=0}^{n} \binom{2n+1}{2k+1} 2^{3k}$ is divided by 5 then find the smallest integer which can not be the remainder

8. Let $f(x)=\int_{3}^{x^2}\int_{0}^{\sin y}\sqrt{1+t^2}\,dt\,dy$: if $f''(\sqrt{\pi})=k\pi$ then $|k|$ is

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

•This section contains SIX (06) questions.
•Each question has FOUR options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
•For each question, choose the option(s) corresponding to (all) the correct answer(s).
•Answer to each question will be evaluated **according to the following marking scheme**:
Full Marks: +4 If only (all) the correct option(s) is(are) chosen; *Partial Marks* +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -2 In all other cases.

9. Let ℓ be the equation of the line which intersect each of the two lines $x+2y-2=0=2x-2y+z$ and $3x-2y+z-1=0=x+4y+z-3$ and is parallel to the line $x+2y-3z=0=2x+y+z+3$. If line ℓ meets the plane $x+y+z=0$ at the point (α,β,γ), then which of the following options are INCORRECT?

A) $|\alpha+\beta|=1.70$

B) $|\alpha+\beta|=1.40$

C) $\left[\dfrac{\beta}{\gamma}\right]=1$ (where [.] denotes greatest integer function)

D) $\left[\dfrac{\beta}{\gamma}\right]=2$ (where [.] denotes greatest integer function)

10. If $\tan^3\theta-15\tan^2\theta-33\tan\theta+847=0$ where $\theta\in\left(0,\dfrac{\pi}{2}\right)\cup\left(\pi,\dfrac{3\pi}{2}\right)$, then $\cot^3\left(\tan^{-1}\left(\dfrac{\sqrt{122}}{11}\sin\theta\right)\right)$ is

A) 1 **B)** -1 **C)** $\sqrt{3}$ **D)** $-\sqrt{3}$

11. The bisectors of angle between the straight lines $y-b=\dfrac{2m}{1-m^2}(x-a)$ and $y-b=\dfrac{2m'}{1-m'^2}(x-a)$ are:

A) $(y-b)\left(m+m'\right)+(x-a)\left(1-mm'\right)=0$

B) $(y-b)\left(m+m'\right)-(x-a)\left(1-mm'\right)=0$

C) $(y-b)\left(1-mm'\right)+(x-a)\left(m+m'\right)=0$

D) $(y-b)\left(1-mm'\right)-(x-a)\left(m+m'\right)=0$

12. Let A and B be real $n\times n$ matrices such that $A^2+B^2=AB$. If $BA-AB$ is an invertible matrix then n can be

A) 3 **B)** 6 **C)** 14 **D)** 21

13. A tennis match of best of 5 sets is played by two players 'A' and 'B'. The probability that first set is won by A is $\frac{1}{2}$ and if he looses the first then probability of his winning of next set is $\frac{1}{4}$ otherwise it remains same. The probability that A wins the match is

A) $\frac{1}{3}$ **B)** $\frac{11}{16}$ **C)** $\frac{15}{23}$ **D)** $\frac{5}{16}$

14. The value of λ for which the equation

$(10x-5)^2+(10y-7)^2=\lambda^2(5x+12y+7)^2$

represents the parabola is:

A) $\frac{10}{13}$ **B)** $-\frac{10}{13}$ **C)** $\frac{1}{13}$ **D)** None of these

SECTION – III
(SINGLE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases

15. If $\lim_{n\to\infty}\left(\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+........+\frac{1}{n^2}\right)=\frac{\pi^2}{6}$ then

$\int_1^\infty \frac{\{x\}}{x^3}dx$ is $\left(\{\cdot\}\text{ denotes fractional part function}\right)$

A) $1-\frac{\pi^2}{4}$ **B)** $1+\frac{\pi^2}{15}$ **C)** $1-\frac{\pi^2}{12}$ **D)** $\frac{\pi^2}{\sqrt{2}}$

16. In how many ways we can distribute 999 identical balls in 3 identical boxes is?

A) 83664 B) 83665 C) 83666 D) 83667

17. Solution of $ydx-xdy+\left(1+x^2\right)dx+x^2\sin ydy=0$

A) $\frac{y}{x}+\frac{1}{x}-x+\cos y+c=0$ **B)** $\frac{y}{x}+\frac{1}{x^2}-x+\cos y+c=0$

C) $\frac{2y}{x}-\frac{1}{x^2}-x+\cos y+c=0$ **D)** none of these

18. The maximum value of det(A) where A is a 4×4 matrix made by the elements -1 & 1 only is

A) 8 **B)** 16 **C)** 32 **D)** None of these

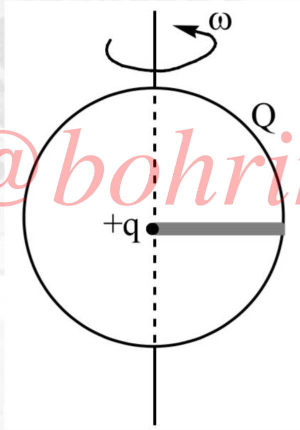
PHYSICS
Max Marks: 60

SECTION-I
(INTEGER ANSWER TYPE)

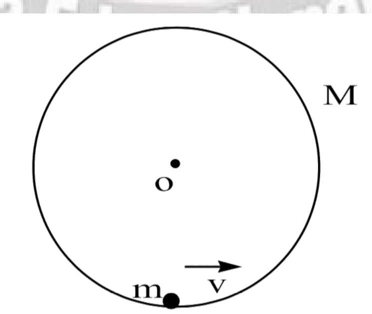
- This section contains EIGHT (08) questions.
- The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 TO 9, BOTH INCLUSIVE.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual Numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated **according to the following marking scheme**:

Full Marks: +3 If ONLY the correct integer is entered;
Zero Marks: 0 If the question is unanswered;
Negative Marks: -1 In all other cases

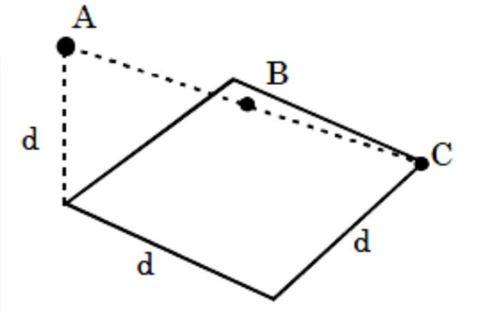
19. A small ball of mass 1 kg and charge $q = \frac{2}{3}\mu C$ is placed at the centre of a uniformly charged sphere of radius 1 m and charge $Q = \frac{1}{3}mC$. A narrow smooth horizontal groove is made in the sphere from centre to surface as shown in figure. The sphere is made to rotate about its vertical diameter at a constant rate of $\frac{1}{2\pi}$ revolutions per second. Find the speed w.r.t. ground (in m/s) with which the ball slides out from the groove. Neglect any magnetic force acting on ball.



20. A ring of mass $M = 90$ gram and radius $R = 3$ meter is kept on a frictionless horizontal surface such that its plane is parallel to horizontal plane. A particle of mass $m = 10$ gram is placed in contact with the inner surface of ring as shown figure. An initial velocity $v = \sqrt{2}\ \text{m/s}$ is given to the particle along the tangent of the ring. Find the magnitude of the force of interaction in milli-newton between them after 1 sec from the start.

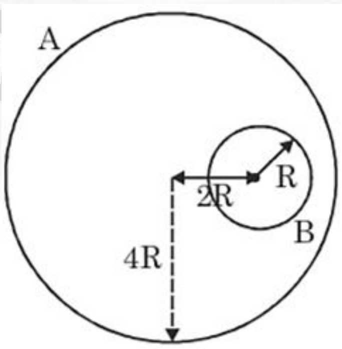


21. A flat square plate with side length d serves as a detector for the radiations emitted by particle. The particle emits the radiations uniformly in all directions.

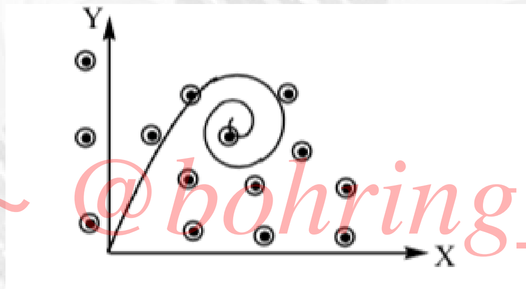


Consider the line joining the point A and C as shown. C is corner of square. A is the point directly above the opposite corner. When particle is placed at point B (halfway between A and C) then fraction of total energy emitted by particle, detected by square plate is f_B. When particle is placed at a point infinitesimally close to C (along line joining ac), corresponding fraction is f_C. The value of $\frac{f_B}{f_C}$ is $\frac{4}{n}$. find value of n

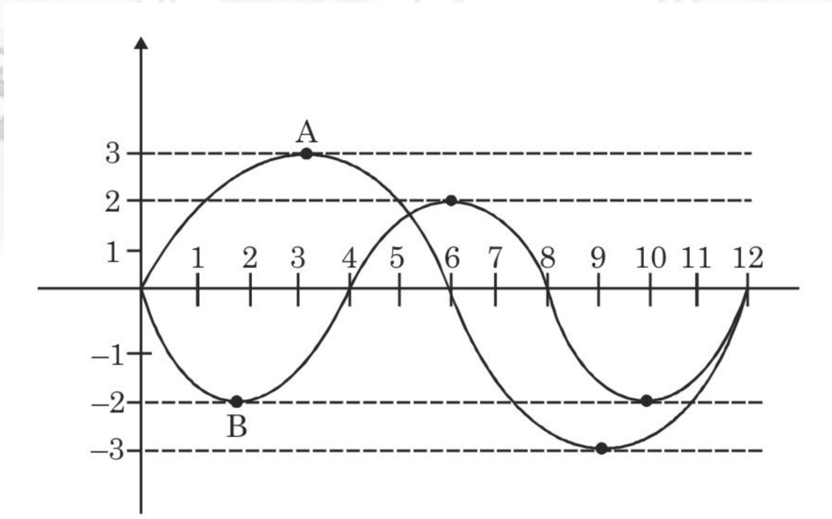
22. Figure shows a uniformly charged spherical shell B of charge $(q_B = q)$ kept inside uniformly charged spherical shell A of charge $(q_A = q)$. Let electric field due to A and B at any point are $\vec{E}_A$ and $\vec{E}_B$ respectively. If dV represents elementary volume, then the value of $\dfrac{\int_{\substack{\text{entire}\\\text{space}}} \vec{E}_B.\vec{E}_B dV}{\int_{\substack{\text{entire}\\\text{space}}} \vec{E}_A.\vec{E}_B dV}$ will be $\frac{1}{\epsilon_0}\left[\frac{kq}{nR}\right]$. The value of "n" is



23. $X-Y$ plane shown in the figure contains uniform magnetic field $\vec{B}=B\vec{k}$ for $y>0$. A particle having charge q and mass m travels along y-axis. At origin of co-ordinate system velocity of particle is v_0 and it entres the region containing magnetic field. Assume that particle is subjected to a frictional force $\vec{f}=-\alpha\vec{v}$ i.e. frictional force is proportional to velocity. Assume frictional force is large enough so that particle remains inside region $y>0$ at all times. The only force acting on particle are frictional force and magnetic force. Particle will remain in $x-y$ plane as no magnetic force will act along z-axis. So $\vec{F}=-\alpha\vec{v}+q\vec{v}\times\vec{B}$. The x-coordinate where particle comes to rest is given by $\dfrac{\lambda qBmV_0}{\alpha^2+(qB)^2}$. Find λ.



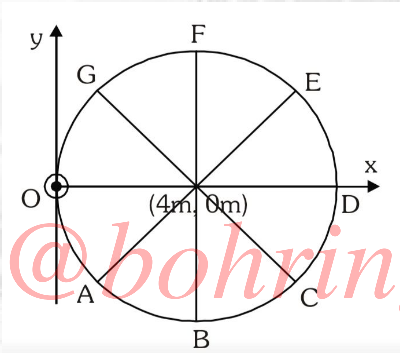
24. The displacement vs time graph for two sound waves A and B which travel along the same medium are shown in the figure. Their loudness are β_A and β_B. If $X=(\beta_A-\beta_B)$, find the value of X.



25. An ammeter and a voltmeter are connected in series to a battery with an emf $E = 6.0V$. When a certain resistance is connected in parallel with the voltmeter, the reading of the voltmeter decreases two times, whereas the reading of the ammeter increases the same number of times. Find the voltmeter reading (in volt) after the connection of the resistance.

26. An infinite uniform current carrying wire is kept along z-axis, carrying current I_0 in the direction of the positive z-axis. OABCDEFG represents a circle (where all the points are equally spaced) whose centre at point $(4m, 0m)$ and radius $4m$ as shown in the figure.

$\int_{DEF} \vec{B} \cdot \vec{dl} = \frac{\mu_0 I_0}{k}$ in S.I. unit, then the value of K is :



SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

- This section contains SIX (06) questions.
- Each question has FOUR options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme**:

Full Marks: +4 If only (all) the correct option(s) is(are) chosen; *Partial Marks* +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -2 In all other cases.

27. Two sound waves travelling in same direction can be represented as

$$y_1 = (0.02\,mm)\sin\left[\left(400\pi\ rads^{-1}\right)\left(\frac{x}{330\,ms^{-1}} - t\right)\right]$$

and $y_2 = (0.02\,mm)\sin\left[\left(404\ \pi\,rads^{-1}\right)\left(\frac{x}{330\,ms^{-1}} - t\right)\right]$

The wave superimpose

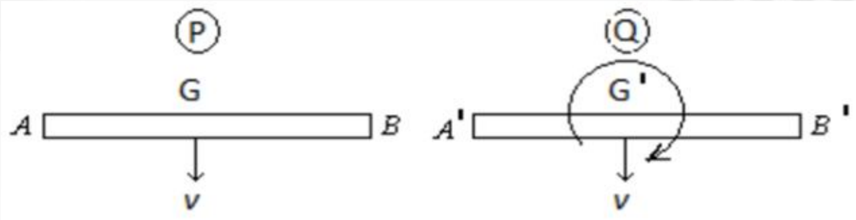
A) Distance between two nearest points where an intensity maximum is recorded simultaneously is $165\,\text{m}$

B) Distance between two nearest points where an intensity maximum is recorded simultaneously is $330\,\text{m}$

C) The time gap between two successive intensity maxima at a given point is 0.5 sec

D) The time gap between two successive intensity maxima at a given point is 1 sec

28. Two equal uniform rods *P* and *Q* each of length ℓ move with the same velocity *v* as shown in the figure. The second rod has an angular velocity ω ($< 6v/l$ and clockwise) about its centre of gravity G^1 in addition to *v*.



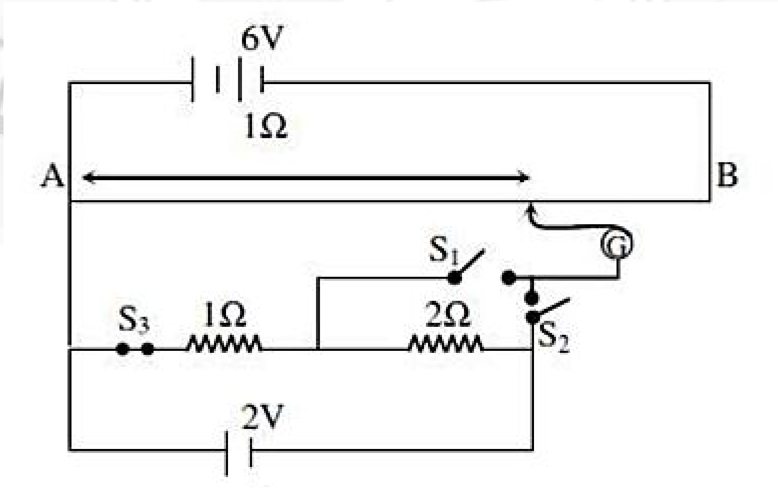
A) If the ends A and A' are suddenly fixed, separately but simultaneously, the rod Q will start to rotate with greater angular velocity

B) If the ends A and A' are suddenly fixed separately but simultaneously, the rod P will start to rotate with greater angular velocity

C) If the ends B and B' are suddenly fixed separately but simultaneously, the rod Q may start to rotate with greater angular velocity

D) If the ends B and B' are suddenly fixed separately but simultaneously, the rod P will definitely start to rotate with greater angular velocity.

29. Figure shows a potentiometer circuit. The length of the potentiometer wire AB is 120 cm and its resistance is 2Ω. The internal resistance of 2V cell is negligible and the internal resistance of 6V cell is 1Ω. Initially the switches S_1 and S_2 are open and S_3 is closed



A) when only S_2 is open balanced length $l = 20cm$

B) when only S_1 is open balanced length $l = 60cm$

C) when all three switches are closed balanced length 60 cm

D) when S_3 is open, S_2 is also open but S_1 is closed balance length is 60 cm

30. $^{40}_{19}K$ converts to $^{40}_{18}Ar$ by positive β decay as well as electron capture. Let Q values for the β decay and electron capture be Q_1 and Q_2 respectively in the above reaction.

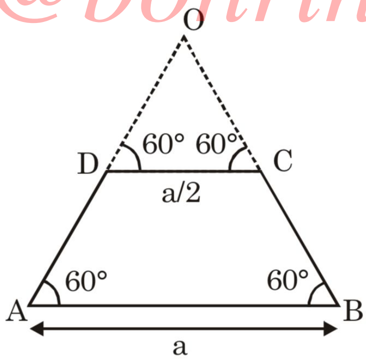
A) $Q_1 = Q_2$

B) $Q_1 < Q_2$

C) neutrino emitted in positive β decay is monoenergetic

D) neutrino emitted in electron capture is monoenergetic

31. Consider a uniformly charged sheet ABCD, which is a part of an equilateral triangular sheet of side a as shown in the figure. Choose the incorrect options regarding the electric field E at point O due to this sheet



A) Magnitude of $\vec{E}$, increases with the increase in a (Keeping charge density same)

B) Magnitude of E, decreases with increase in a (keeping total charge same)

C) If charge density is σ and $a = 1m$, magnitude of E is equal to $\frac{7\sigma}{44\varepsilon_0}\ln\sqrt{2}$.

D) If charge density is σ and $a = 2m$, magnitude of E is equal to $\frac{7\sigma}{22\varepsilon_0}\ln\sqrt{2}$.

32. A ball tied to the end of a string swings in a vertical circle under the influence of gravity

A) When the string makes an angle 90° with the vertical, the tangential acceleration is zero & radial acceleration is somewhere between maximum and minimum

B) When the string makes an angle 90° with the vertical, the magnitude of tangential acceleration is maximum & radial acceleration is somewhere between maximum and minimum

C) At no place in the circular motion, tangential acceleration is equal to radial acceleration

D) Throughout the path whenever radial acceleration has its extreme value, the tangential acceleration is zero.

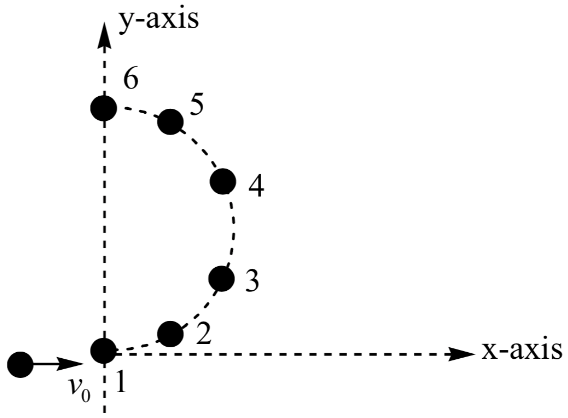
SECTION – III
(SINGLE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases

33. Six identical balls each of mass m are kept equally spaced around a semicircle on a horizontal table as shown in figure. Another identical ball of mass m is projected with speed v_0 in direction perpendicular to diameter joining first and last ball (parallel to x-axis). It collides with 1st ball and gets deviated from it path, In turn 1st ball moves and collides with 2nd ball, after this 2nd ball moves and collides 3rd ball and so on. At last 6th ball is observed to be moving in $(-)$ve x-direction. All collisions are perfectly elastic. All balls are smooth.



Select CORRECT alternative

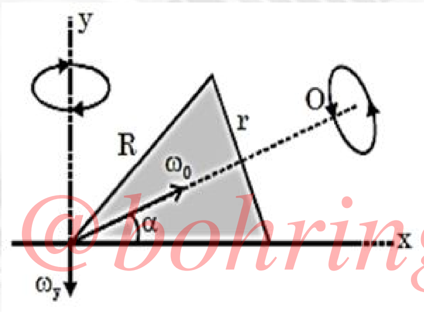
A) Speed of 6th ball after collision is $v_0\,(\cos 36^\circ)^5 \cdot \cos 18^\circ$

B) Speed of 6th ball after collision is $v_0\,\cos^4 36^\circ \cos^2 18^\circ$

C) Speed of 6th ball after collision is $v_0 \cos^6 36^\circ$

D) Speed of 6th ball after collision is $27v_0/64$

34. A cone is rolling on a sufficiently rough surface. The cone has a slant height of R, the radius of the base circle is r and during its movement, the cone rotates about its stationary apex with an angular velocity ω_y. The cone also rotates about its rotational axis with an angular velocity ω_0. What is the angular velocity of any point on the surface of the cone with respect to the immediate axis of rotation?

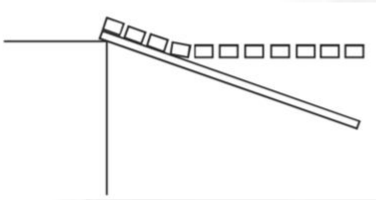


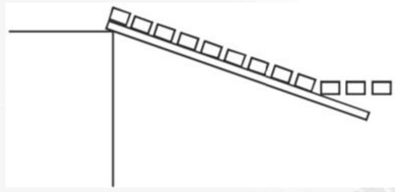
A) $\omega = \omega_0 \dfrac{r}{R}\sqrt{1-\dfrac{r^2}{R^2}}$ **B)** $\omega = \omega_0 \dfrac{r}{R}$

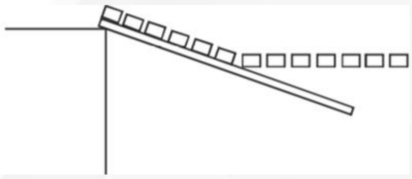
C) $\omega = \omega_0 \sqrt{1+\dfrac{r^2}{R^2}}$ **D)** $\omega = \omega_0 \sqrt{1-\dfrac{r^2}{R^2}}$

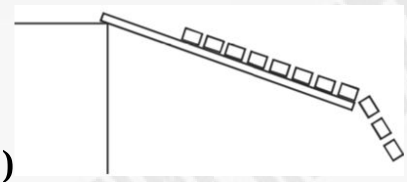
35. A uniform rigid meter-scale is held horizontally with one of its end at the edge of a table and the other supported by hand. Some coins of negligible mass are kept on the meter scale as shown in the figure.

As the hand supporting the scale is removed, the scale starts rotating about its edge on the table and the coins start moving. If a photograph of the rotating scale is taken soon after, it will look closest to:

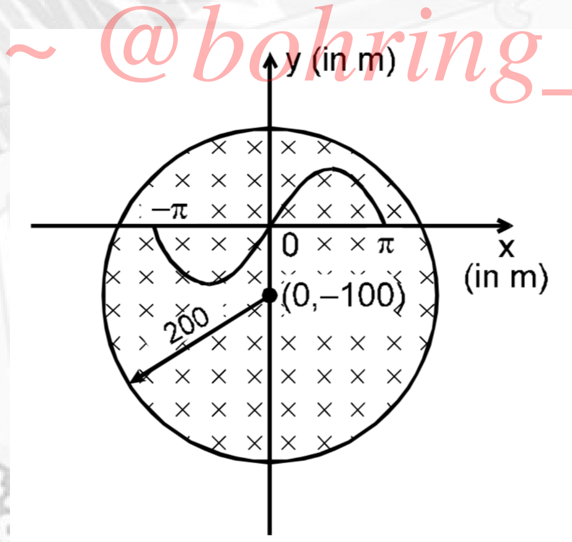
A) 

B) 

C) 

D) 

36. A time varying uniform magnetic field, varying at constant rate $1\,\text{T/sec}$ exists in a circular region of radius $200\,\text{m}$ centered at $(0,-100)$. A conducting wire is placed along $y = \sin kx$, where $k = 1\,\text{rad/m}$, from $x = -\pi$ to $+\pi$. Find the magnitude of e.m.f. generated in the wire.



A) 157V **B)** 314V **C)** 628V **D)** Zero

CHEMISTRY

Max Marks: 60

SECTION-I
(INTEGER ANSWER TYPE)

- This section contains EIGHT (08) questions.
- The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 TO 9, BOTH INCLUSIVE.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual Numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated **according to the following marking scheme**:

Full Marks: +3 If ONLY the correct integer is entered;
Zero Marks: 0 If the question is unanswered;
Negative Marks: -1 In all other cases

37. How many different enols exist for 4-methyl-3-hexanone?

38. How many Group-2 cations upon treatment with dilute HCl and $H_2S(g)$ form a yellow precipitate which dissolves in YAS (Yellow Ammonium Sulphide)

39. 2 moles $C(g)$ and 4 moles $D(g)$ are mixed together in a sealed 1 litre vessel and allowed to attain equilibrium as $A(g)+2B(g) \rightleftharpoons C(g)+D(g)$. K_c for the above equilibria is 10^{-8} lit/mole.

If the equilibrium concentration for $C(g)$ is found to be $x \cdot y \times 10^{-z}$ (x point y into 10 raised to minus z), calculate the value of $x+y-z$.

40. The equilibrium pressure of $A(g)$ is 1 bar for the reaction $A(g) \rightleftharpoons 2B(g)$ whose K_p is 4 bar. If the above equilibrium mixture is compressed reversibly (by slowly increasing the pressure) and isothermally (keeping temperature fixed) such that the total pressure elevates to 8 bar, the partial pressure of $B(g)$ at new equilibrium is ______________ bar.

41. If x is the number of different ways in which a termolecular elementary reaction can be imagined and y is the molecularity of a termolecular elementary reaction, tabulate the product of these two numbers. (i.e. $x \times y$)

42. For the isomeric alkenes corresponding to molecular formula C_4H_8, how many products are formed by addition of Br_2 in CCl_4.

43. The amino acid present in Red Bull (energy drink) is Taurine. The atomic number of the other atom (besides C, H, O, N) in it's structure is __________________.

Report your answer as Z/4 (Z = atomic number)

44. A hydrocarbon $A(C_6H_{10})$ on reductive ozonolysis does not fragment into 2 separate units and instead forms a dialdehyde (B) which on exhaustive and normal Clemmensen reduction forms an alkane (C). The number of possible structures for A is ________. (structural)

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

•This section contains SIX (06) questions.
•Each question has FOUR options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
•For each question, choose the option(s) corresponding to (all) the correct answer(s).
•Answer to each question will be evaluated **according to the following marking scheme**:
Full Marks: +4 If only (all) the correct option(s) is(are) chosen; *Partial Marks* +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -2 In all other cases.

45. When phosphate salt is heated with ammonium molybdate in presence of conc. HNO_3, a precipitate is formed. Following are the steps involved:

1. $Na_3PO_4 + (NH_4)_2MoO_4 \rightarrow (NH_4)_3PO_4 + Na_2MoO_4$
2. $Na_2MoO_4 + 2HNO_3 \rightarrow H_2MoO_4 + 2NaNO_3$
3. $H_2MoO_4 \rightarrow MoO_3 + H_2O$
4. $(NH_4)_3PO_4 + 12MoO_3 + 6H_2O \rightarrow (NH_4)_3PO_4 \cdot 12MoO_3 \cdot 6H_2O$

Identify the correct statements:

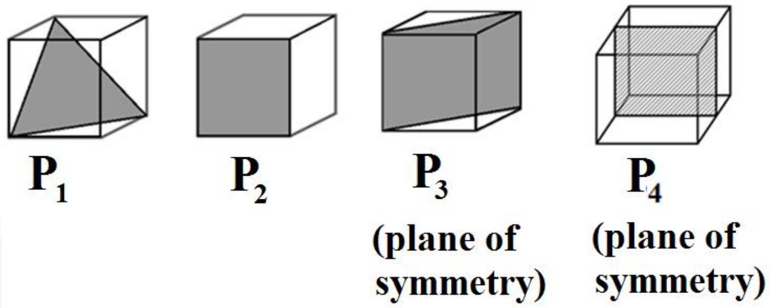
A) Step1 is a double displacement reaction

B) HNO_3 acts as an oxidizing agent in step 2

C) Step 3 is decomposition of molybdic acid

D) A yellow precipitate is formed during adduct formation (step-4)

46. Following four shaded planes- $P_1, P_2, P_3 \& P_4$ in a FCC unit cell are shown. Consider the following statements and choose the correct option(s) that follow:



A) P_1 contains no three dimensional voids.

B) P_2 contains only octahedral voids.

C) P_3 contains both octahedral and tetrahedral voids.

D) P_4 contains only tetrahedral voids.

47. Some dead plaster is taken in a closed and evacuated glass bulb and heated at 1500 K when the following equilibrium is obtained:

$$2CaSO_4(s) \rightleftharpoons 2CaO(s) + 2SO_2(g) + O_2(g) \qquad \Delta H > 0$$

Identify the correction option(s):

A) moles of $CaO(s)$ will increase with increase in temperature

B) if volume of glass bulb is suddenly doubled, partial pressure of $SO_2(g)$ will be instantly and momentarily halved

C) if the volume of glass bulb is *very slowly* halved, partial pressure of $O_2(g)$ will remain constant throughout

D) if helium gas is added to the bulb at constant pressure, more $CaO(s)$ will be produced

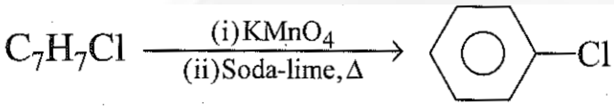
48. Which of the following arguments contribute to explaining why photochemical reactions are zero order w.r.t. reactant concentration:

A) just the right frequency of light would suffice to induce the reaction

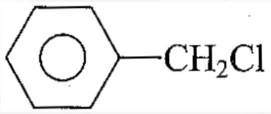
B) as the *right* light is shone *bright* upon reactant, it undergoes reaction in more numbers

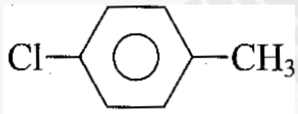
C) gradually decreasing the wavelength causes increase in photon energy and hence reactant disappears faster

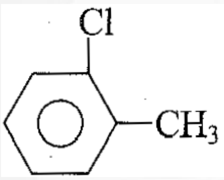
D) unlike other reactions, photochemical reactions do not depend upon collision between reacting molecules

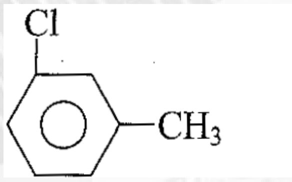
49. 

(A) In the above reactions, compound (A) is:

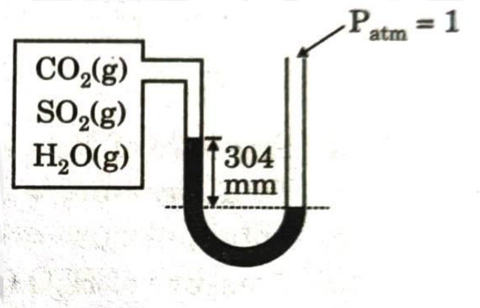
A) 

B) 

C) 

D) 

50. A 82.1 L container connected with manometer contains mixture of CS_2 and H_2S gases and just the required amount of O_2 is added to form to CO_2, SO_2 and $H_2O(g)$ at 227° C. Final condition of manometer is shown.



If moles of SO_2 gas produced is 0.7, select the correct statement(s):

A) Moles of CS_2 originally present is 0.3

B) Moles of CS_2 originally present is 0.2

C) Moles of H_2S originally present is 0.3

D) Total pressure after combustion is 0.6 atm

SECTION – III
(SINGLE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases

51. For pure water at 50°C, ionic product of water is $10^{-13}M^2$ and density of water is 0.9 g/mL. Select the correct options for H_2O at 50°C:

A) pOH of this water is 7

B) dissociation constant (K_a) of this water is 2×10^{-15}

C) degree of dissociation of this water is $2\sqrt{10}\times10^{-8}$

D) any aqueous solution with pH = 6.7 is acidic

52. Identify the correct order of melting point:

A) $KNO_3 > K_2S > H_2O > H_2SO_4$ **B)** $K_2S > KNO_3 > H_2SO_4 > H_2O$

C) $H_2SO_4 > K_2S > KNO_3 > H_2O$ **D)** $KNO_3 > H_2SO_4 > K_2S > H_2O$

53. The *n* –factors for Indium (I) dichromate and Indium (III) dichromate when they behave as powerful oxidizing agents in acidic medium are respectively:

A) 6, 6 **B)** 6, 12 **C)** 6, 18 **D)** 2, 18

54. CO (carbon monoxide) gas is:

A) highly soluble in water due to ion – dipole interaction.

B) highly soluble in water due to chemical reaction

C) slightly soluble in water due to dipole – dipole interaction

D) insoluble in water.

Sri Chaitanya IIT Academy.,India.

A.P T.S KARNATAKA TAMILNADU MAHARASTRA DELHI RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec: Sr.Super60_NUCLEUS&STERLING _BT JEE-ADVANCE-2022_P2 Date: 14-05-2023

Time: 02.00Pm to 05.00Pm GTA-23 Max. Marks: 180

KEY SHEET

MATHEMATICS

1	**1**	2	**2**	3	**8**	4	**2**	5	**1**	6	**4**
7	**0**	8	**4**	9	**ABD**	10	**AB**	11	**AD**	12	**ABD**
13	**D**	14	**AB**	15	**C**	16	**D**	17	**A**	18	**B**

PHYSICS

19	**2**	20	**6**	21	**7**	22	**4**	23	**1**	24	**0**
25	**2**	26	**8**	27	**AC**	28	**AD**	29	**ABCD**	30	**BD**
31	**AD**	32	**BCD**	33	**B**	34	**D**	35	**B**	36	**B**

CHEMISTRY

37	**6**	38	**2**	39	**0**	40	**4**	41	**9**	42	**6**
43	**4**	44	**9**	45	**ACD**	46	**ABC**	47	**ABCD**	48	**ABD**
49	**BCD**	50	**BCD**	51	**B**	52	**B**	53	**D**	54	**C**

SOLUTIONS

MATHEMATICS

1. Sol. Let $y_n = x_n^2$. Then $y_{n+1} = (y_n - 2)^2$ and $y_{n+1} - 4 = y_n(y_n - 4)$. Since $y_2 = 9 > 5$, we have $y_3 = (y_2 - 2)^2 > 5$ and inductively $y_n > 5, n \geq 2$. Hence,

$y_{n+1} - y_n = y_n^2 - 5y_n + 4 > 4$ for all $n \geq 2$, so $y_n \to \infty$.

By $y_{n+1} - 4 = y_n(y_n - 4)$, $\left(\dfrac{x_1 \cdot x_2 \cdot x_3 \cdots x_n}{x_{n+1}}\right)^2 = \dfrac{y_1 \cdot y_2 \cdot y_3 \cdots y_n}{y_{n+1}}$

$$= \frac{y_{n+1} - 4}{y_{n+1}} \cdot \frac{y_1 \cdot y_2 \cdot y_3 \cdots y_n}{y_{n+1} - 4} = \frac{y_{n+1} - 4}{y_{n+1}} \cdot \frac{y_1 \cdot y_2 \cdot y_3 \cdots y_{n-1}}{y_n - 4} = \cdots$$

$$= \frac{y_{n+1} - 4}{y_{n+1}} \cdot \frac{1}{y_1 - 4} = \frac{y_{n+1} - 4}{y_{n+1}} \to 1. \text{Therefore,} \quad \lim_{n \to \infty} \frac{x_1 \cdot x_2 \cdot x_3 \cdots x_n}{x_{n+1}} = 1$$

2. Let $a = 1 - x$ $\quad b = x - y$ $\quad c = y - z$ $\quad d = z$

then $a + b + c + d = 1$ and $a^2 + b^2 + c^2 + d^2 = \dfrac{1}{4}$

$\Rightarrow (a-b)^2 + (a-c)^2 + (a-d)^2 + (b-c)^2 + (b-d)^2 + (c-d)^2 = 0$

$\Rightarrow a = b = c = d$ $\therefore x = \dfrac{3}{4}, y = \dfrac{1}{2}, z = \dfrac{1}{4}$

So the distance from the point $\left(\dfrac{3}{4}, \dfrac{1}{2}, \dfrac{1}{4}\right)$

from the plane $4x + 2y + 4z + 7 = 0$ is $\dfrac{3+1+1+7}{6} = 2$

3. Sol. $\dfrac{(1+x)^{20} + (1-x)^{20}}{2} = {}^{20}c_0 + {}^{20}c_2 x^2 + {}^{20}C_4 x^4 + \cdots --- {}^{20}c_{20} x^{20}$

$= {}^{20}c_0 x^{20} + {}^{20}c_2 x^{18} + {}^{20}c_4 x^{16} + ---- {}^{20}c_{20}$

So, $\sum_{r=0}^{9} {}^{20}c_{2r} \, {}^{20}c_{2r+2} =$ coeff of x^{22} in $\dfrac{\left[(1+x)^{2n} + (1-x)^{2n}\right]}{4}$

$\Rightarrow a = 10 \Rightarrow xy = 40$ has total order pair (x, y) solution

4. Sol. Let $2^x > 3x \Rightarrow 2^{x+1} > 2^x + 3x$

$\Rightarrow (x-2) + 2\log_2\left(2^x + 3x\right) < (x-2) + 2\log_2 2^{x+1} \Rightarrow 2^x < 3x$

Contradiction hence sol. lies on $2^x = 3x$, which has two solution

5. Sol. $f(x) = x - \dfrac{1}{2} + \dfrac{1}{\pi}\tan^{-1}(\cot \pi x)$ is constant on $(n, n+1)$

So; $\forall\, x \in R - z;\ f(x) = [x]$

6. Obviously angle bisectors are $x=2$ and $y=0$. Now centre cannot lies on $y=0$ because their chord of contact from origin will always be parallel to *y*-axis. So let the centre is $(2,\alpha)$ then equation of circle will be

$$(x-2)^2+(y-\alpha)^2=5^2 \Rightarrow x^2+y^2-4x-2\alpha y-21=0$$

Now chord of contact is
$$-4\frac{x}{2}-2\alpha\frac{y}{2}+\alpha^2-21=0 \Rightarrow 2x+\alpha y-\alpha^2+21=0$$

$$now -\frac{2}{\alpha}=1 \Rightarrow \alpha=-2$$

So equation of circle is $(x-2)^2+(y+2)^2=5^2$.

7. Sol. Since $2^3 \equiv -2(\mathrm{mod}\,5)$, an equivalent problem is to prove that

$S_n=\sum_{(k=0)}^{n}\binom{2n+1}{2k+1}-(2)^k$ is not divisible by 5.

Expanding $(1+i\sqrt{2})^{2n+1}$ and then separating the even and odd terms we get

$$(1+i\sqrt{2})^{2n+1}=R_n+i\sqrt{2}S_n$$

where $R_n=\sum_{k=0}^{n}\binom{2n+1}{2k}(-2)^k$.

Passing to the absolute value from (1) it follows that

$$3^{2n+1}=R_n^2+2S_n^2$$

8. Sol. $f''(x)=2\int_0^{\sin x^2}\sqrt{1+t^2}\,dt+4x^2\cos x^2\sqrt{1+\sin^2(x^2)}$

$$f''(\sqrt{\pi})=-4\pi$$

9. Sol. Equation of a line which is coplanar to the lines $x+2y-2+\lambda(2x-2y+z)=0$

$(1+2\lambda)x+(2-2\lambda)y+\lambda z-2=0$

$(3x-2y+z-1)+\mu(x+4y+z-3)=0$

$(3+\mu)x+(-2+4\mu)y+(1+\mu)z+(-1-3\mu)=0$

(1) dot pd with $(5,-7,-3)$

$5+10\lambda-14+14\lambda-3\lambda=0$

10. Sol. $\tan\theta=-7,11,11$

$$\sin\theta=\frac{\pm 11}{\sqrt{122}}$$

11. Sol. It is clear from the diagram

12. Sol. $S=A+\omega B$, where $\omega=-\frac{1}{2}+i\frac{\sqrt{3}}{2}$. We have

$$S\overline{S}=(A+\omega B)(A+\overline{\omega}B)=A^2+\omega BA+\overline{\omega}AB+B^2$$

13. Sol. In the tennis match of best of 5 sets. A can win the match. If score of A against the score of B is $(3,0),(3,1)$ or $(3,2)$.

The probability of A's doing the score of $(3,0)$ is $\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}=\frac{1}{8}$

The probability of A's winning by the score of $(3,1)$

$$=\frac{1}{4}\left(\frac{1}{2}\right)^3+\frac{1}{2}\cdot\left(\frac{1}{2}\right)\cdot\left(\frac{1}{4}\right)\left(\frac{1}{2}\right)+\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{4}=\frac{3}{32}.$$

The probability of A's winning by the score of $(3,2)$

$=P(A$ looses I^{st} and $\mathrm{II}^{\mathrm{nd}}$ sets$)+P$ (A looses I^{st} and $\mathrm{III}^{\mathrm{rd}}$ sets $)+P$ (A looses I^{st} and $\mathrm{IV}^{\mathrm{th}}$ sets) +

$P\left(A looses\, \mathrm{II}^{\mathrm{nd}}\ and\ \mathrm{III}^{\mathrm{rd}}\ sets\right)+P\left(A looses\, \mathrm{II}^{\mathrm{nd}} and\, \mathrm{IV}^{\mathrm{th}}\ sets\right)+P\left(A losses\, \mathrm{III}^{\mathrm{rd}}\ and\, \mathrm{IV}^{\mathrm{th}}\ sets\right)$

$$=\frac{1}{2}\left(\frac{3}{4}\right)\left(\frac{1}{4}\right)\left(\frac{1}{2}\right)^2+\frac{1}{2}\left(\frac{1}{4}\right)\left(\frac{1}{2}\right)\left(\frac{1}{4}\right)\left(\frac{1}{2}\right)+\frac{1}{2}\left(\frac{1}{4}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{4}\right)+\frac{1}{2}\left(\frac{1}{2}\right)\left(\frac{3}{4}\right)\left(\frac{1}{4}\right)\frac{1}{2}$$

$$+\frac{1}{2}\left(\frac{1}{2}\right)\left(\frac{1}{4}\right)\left(\frac{1}{2}\right)\left(\frac{1}{4}\right)+\frac{1}{2}\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{3}{4}\right)\frac{1}{4}$$

The probability that A wins the match $=\frac{1}{8}+\frac{3}{32}+\frac{12}{128}$

$$=\frac{16+12+12}{128}=\frac{40}{128}=\frac{5}{16}.$$

14. Sol. Based on theory

15. Sol. $\lim_{n\to\infty}\int_1^{N+1}\frac{\{x\}}{x^3}dx=\lim_{n\to\infty}\sum_{n=1}^{N}\int_n^{n+1}\frac{\{x\}}{x^3}dx=\lim_{n\to\infty}\sum_{n=1}^{N}\int_n^{n+1}\frac{\{x\}}{(n+\{x\})^2}dx$

Let $\{x\}=t$ So, $=\underset{N\to\infty}{\text{it}}\sum_{n=1}^{N}\int_0^1\frac{t}{(t+n)^3}dx=1-\frac{1}{2}\sum_{n=0}^{\infty}\frac{1}{(n+1)^2}$

16. Sol. If we take boxes to be distinct

Total solution $={}^{999+3-1}C_2=500500$

Total solution (when each box have different number of balls)

$=500500-3\times 499-1=499002$

17. Sol. $\frac{ydx-xdy}{x^2}+\left(\frac{1+x^2}{x^2}\right)dx+\sin ydy=0$

$$-d(y/x)+d\left(\frac{-1}{x}+x\right)+d(-\cos y)=0\Rightarrow y/x+\frac{1}{x}-x+\cos y+c=0$$

18. Sol. $A=\begin{pmatrix}- & - & - & -\\ - & - & - & -\\ - & - & - & -\\ - & - & - & -\end{pmatrix}$ apply, $\begin{matrix}R_2\to R_2-R_1\\ R_3\to R_3-R_1\\ R_4\to R_4-R_1\end{matrix}$

PHYSICS

19. $$\frac{1}{2}mv_r^2=\left(\frac{3}{2}\frac{KQq}{R}-\frac{KQq}{R}\right)+\int_0^R m\omega^2 x dx=\frac{KQq}{2R}+\frac{m\omega^2R^2}{2}$$

Substituting values,

$$v_r^2=2+1=3$$

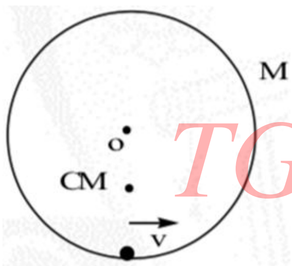
$$v_t\omega=r=1$$

$$v_{net}=\sqrt{V_r^2+V_t^2}=\sqrt{3+1}=2\,m/sec$$

20. $$V_{cm}=\frac{mV}{m+M}$$

$$x=\frac{M\cdot R}{M+m}$$

$$N=\frac{m\left(v-v_{cm}\right)^2}{x}=\frac{mv^2M}{(m+M)R}=6\times10^{-3}\,newton$$



21. Sol. $f_B=\frac{1}{6}$ and $f_C=\frac{7}{24}\Rightarrow\frac{f_B}{f_C}=\frac{1}{6\times\frac{7}{24}}=\frac{24}{6\times7}=\frac{4}{7}$

22. Sol. $$\int\vec{E}_B\cdot\vec{E}_B dV=\frac{2}{\epsilon_0}\int\frac{1}{2}\epsilon_0\vec{E}_B\cdot\vec{E}_B dV$$

$$=\frac{2}{\epsilon_0}\left[\text{self energy of } q_B\right]$$

$$=\frac{2}{\epsilon_0}\left[\frac{1}{2}\frac{kq^2}{R}\right]=\frac{1}{\epsilon_0}\frac{kq^2}{R}$$

$$\int\vec{E}_A\cdot\vec{E}_B dV=\frac{1}{\epsilon_0}\int\epsilon_0\vec{E}_A\cdot\vec{E}_B dV$$

$$=\frac{1}{\epsilon_0}\left[\text{Interaction energy of } q_A \text{ and } q_B\right]$$

$$=\frac{1}{\epsilon_0}\left[\frac{kq}{4R}\right]$$

23. Sol. Using above equation it can easily shown that $m\frac{d^2x}{dt^2} = -\alpha\frac{dx}{dt} + qB\frac{dy}{dt}$ and

$$m\frac{d^2y}{dt^2} = -\alpha\frac{dy}{dt} - qB\frac{dx}{dt}$$

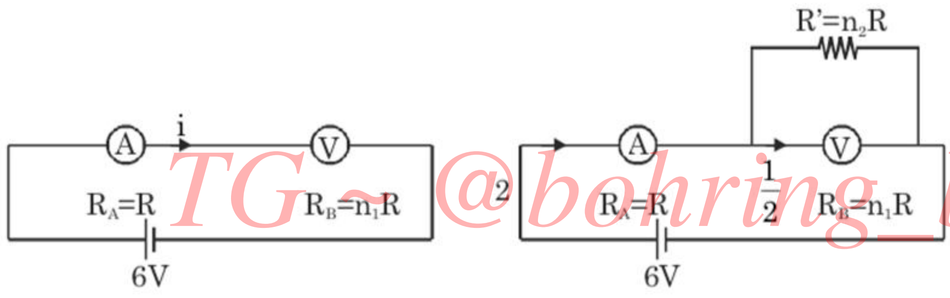
If we integrate above equations from the time particle enters the region $y > 0$ to the time particle comes to rest, then we will get, $m\Delta V_x = -\alpha\Delta x + qB\Delta y$ $\quad m\Delta V_y = -\alpha\Delta y - qB\Delta x$.

Solve the above equations we get $x = \frac{qBmV}{\alpha^2 + (qB)^2}$

24. Sol. $\frac{I_1}{I_2} = \frac{2\pi^2\rho V n_1^2 A_1^2}{2\pi^2\rho V n^2 A_2^2} = \frac{T_2^2 A_1^2}{T_1^2 A_2^2} = \frac{8^2 \times 3^2}{12^2 \times 2^2} = 1$

$$\beta_1 - \beta_2 = 1 - \log_{10}\frac{I_1}{I_2} = 0$$

25. Sol.



$$\frac{n_2R}{n_1R + n_2R}(2i) = \frac{1}{2} \Rightarrow n_1 = 3n_2$$

$$R_{eq} = 2R_{eq}$$

$$R(1+n) = 2\left[R + \frac{n_1Rn_2R}{n_1R + n_2R}\right] \Rightarrow n_2 = \frac{2}{3}$$

$$\Rightarrow n_1 = 2$$

26. Sol. Draw circle assuming OF as radius and O as centre

27. Sol. $y_1 = 0.02\sin\left[400\pi\left(\frac{x}{330} - t\right)\right]$

$$y_2 = 0.02\sin\left[404\pi\left(\frac{x}{330} - t\right)\right]$$

$$y_1 + y_2 = 2(0.02)sin\left[404\pi\left(\frac{x}{330} - t\right)\right]cos\left[2\pi\left(\frac{x}{330} - t\right)\right]$$

$$= 0.04\sin\left[\frac{402}{330}\pi x - 402\pi t\right]\cos\left(\frac{2\pi x}{330} - 2\pi t\right)$$

28. Sol. For P : About A or B

$L_i = L_f \Rightarrow mv\frac{\ell}{2} = \frac{m\ell^2}{3}\omega_p \Rightarrow \omega_p = \frac{3v}{2\ell}$

For Q: About A

$L_i = L_f \Rightarrow mv\frac{\ell}{2} + \frac{m\ell^2}{12}\omega = \frac{m\ell^2}{3}\omega_1 \Rightarrow \omega_1 = \left(\frac{v}{2} + \frac{\omega\ell}{12}\right)\frac{3}{\ell} = \frac{3v}{2\ell} + \frac{\omega}{4} \therefore \omega_1 > \omega_p \Rightarrow$

About B $L_i = L_f \Rightarrow \omega_2 = \frac{3v}{2\ell} - \frac{\omega}{4}$

ω_2 is +ve as $\omega < \frac{6v}{\ell} \therefore \omega_2 < \omega_p \Rightarrow$

29. Sol. When only S_2 is open,

$\frac{2}{3} = \left(\frac{4}{120}\right)l \Rightarrow l = \frac{2}{3} \times \frac{120}{4} = 20\,\text{cm}$

When only S_1 is open,

$2 = \frac{4}{120} \times l \Rightarrow l = 60\,\text{cm}$

When all three are closed,

$2 = \frac{4}{120} \times l \Rightarrow l = 60\,\text{cm}$

When only S_1 is closed,

$2 = \frac{4}{120} \times l \Rightarrow l = 60\,\text{cm}$

30. Sol. $A_X \to A_Y + \beta^+ + v \left(\beta^+ decay\right)$

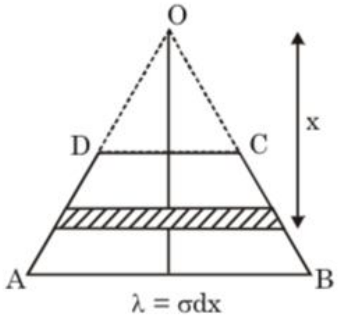
$$\underset{z}{A_X} + \beta^- \to \underset{z-1}{A_Y} + v$$

Qin the β decay $= \left[m\begin{pmatrix} A_X \\ : \end{pmatrix} - m\begin{pmatrix} A_Y \\ z-1 \end{pmatrix} - 2m_e\right]C^2$

Qin EC $= -m\begin{pmatrix} A_X \\ \vdots \end{pmatrix} - m\begin{pmatrix} A_y \\ z-1 \end{pmatrix}\Bigg]C^2$

Since only two particles form from a single particle, the energy of v is unique in EC.

31. Sol.



$$dE = 2\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{\sigma dx}{x}\left(\frac{1}{2}\right)$$

$$dE = \frac{\sigma}{4\pi\varepsilon_0}\frac{dx}{x}$$

$$E = \frac{7\sigma}{44\varepsilon_0}\ln\sqrt{2}$$

32. Sol.

$$a_\tau = \frac{F_\tau}{m} = g, a_c = \frac{v^2}{R} = 0$$

$$a_{C_{max}} = \frac{v_{max}^2}{R} \textit{ at lowest point}$$

$$a_t = \frac{F_\tau}{m} = 0$$

33. Sol. Conceptual

34. Sol. The angular velocity ω, which we are supposed to find, is given by vector addition of the angular velocities ω_0 and ω_y. The vectors are shown in the figure.

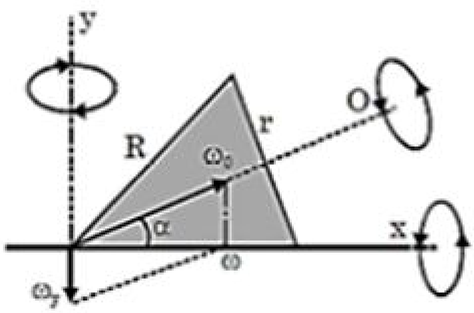


Figure : Analysis of the rotational motion.

Since the moment takes place on a rough surface, the cone cannot slip, so it moves circularly about its apex. We can immediately see the simple relative between ω_y and $\omega_0 . R\omega_y = r\omega_0$

We introduce the angle a between ω and ω_0 : using the cosine law, we can write

$$\omega_y^2 = \omega^2 + \omega_0^2 - 2\omega\omega_0\cos\alpha$$

The angle α is the angle at the apex and satisfies the relation

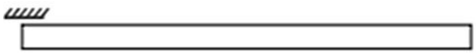
$$\cos\alpha = \sqrt{1-\sin^2\alpha} = \sqrt{1-\frac{r^2}{R^2}} = \frac{\omega}{\omega_0}$$

Substituting into the cosine law (2), we obtain $\omega^2 = \omega_0^2 - \omega_y^2$;

That is the Phythagorean theorem, thus ω must line in the ground plane, as the picture hints. Using the relation (1), we can finally express the magnitude of the angular velocity ω. $\omega = \omega_0\sqrt{1-\dfrac{r^2}{R^2}}$

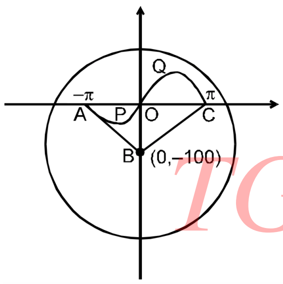
35. Sol. $\alpha = \dfrac{mg\frac{\ell}{2}}{\frac{m\ell^2}{3}} = \dfrac{3g}{2\ell}$

for $x \geq \dfrac{21}{3}$



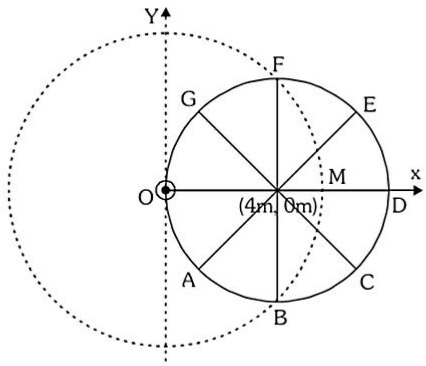
$a \geq g$

36. Sol.



Connect centre B with the two ends points A & C of the curves, by conducting rods.
$\because$ Electric lines of force will be perpendicular to AB & CB.
$\therefore$ E.M.F. developed in the loop, BAPOQCB
will be = E.M.F. developed in the curve APOQC.
Now Flux in loop ABCQOPA = B
[Area of $\triangle$ABC - Area of loop APOA + Area of loop OCOA] = B[Area of $\triangle$ABC]

$= \dfrac{1}{2} \times (100) \times (2\pi)$



$$\int_{MDEFM} \vec{B}\cdot d\ell = \int_M^D \vec{B}\cdot \vec{d\ell} + \int_{DEF} \vec{B}\cdot d\ell + \int_F^M \vec{B}\cdot \vec{d\ell} = 0$$

$$\Rightarrow 0 + x - \mu_0 I_0 \frac{45^\circ}{360^\circ} = 0 \quad \Rightarrow x = \frac{\mu_0 I_0}{8}$$

CHEMISTRY

Sri Chaitanya IIT Academy.,India.

A.P T.S KARNATAKA TAMILNADU MAHARASTRA DELHI RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S	JEE-ADVANCE-2021-P1	Date: 16-04-2023
Time: 09.00Am to 12.00Pm	GTA-15	Max. Marks: 180

16-04-2023_Sr.Super60_ NUCLEUS&ALL_BT'S_Jee-Adv(2021-P1)_GTA-15_Syllabus

PHYSICS : SECOND YEAR SYLLABUS

CHEMISTRY : SECOND YEAR SYLLABUS

MATHEMATICS : SECOND YEAR SYLLABUS

Name of the Student: ____________________ H.T. NO: | | | | | | | |

JEE-ADVANCE-2021-P1-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 4)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 5 – 10)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 11 – 16)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 17 – 19)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 20 – 23)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 24 – 29)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 30 – 35)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 36– 38)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 39 – 42)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 43 – 48)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 49 – 54)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 55 – 57)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

PHYSICS **Max Marks: 60**

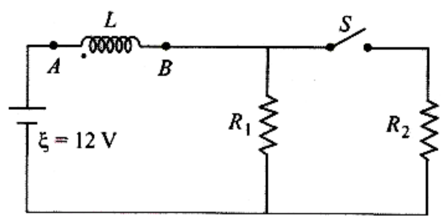
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 4 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases. Section 1 (Max Marks: 12)

- Section 1 contains Four questions
- Each Question has Four Options and Only One of these four will be the correct answer.
- For each question, choose the option corresponding to the correct answer
- The Marking scheme to evaluate Answer to each question will be :
- Full Marks: **+3** (If the answer is correct)
- Zero Marks: **0** (If the question is unanswered)
- Negative Marks: -1 (In all other cases)

1. In the circuit shown, the switch S has been kept closed for a long time and then opened. Just after the switch is opened, what is the voltage across the inductor (V_L) and which labeled point $(A \text{ or } B)$ of the inductor is at a higher potential? Take $R_1 = 4.0\Omega, R_2 = 8.0\Omega$ and $L = 2.5H$.



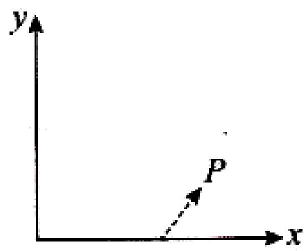
A) $V_L = 12V$; Point A is at higher potential

B) $V_L = 12V$; Point B is at higher potential

C) $V_L = 6V$; Point A is at higher potential

D) $V_L = 6V$; Point B is at higher potential

2. A small electric dipole of dipole moment $\vec{P}$ is placed on the x-axis at the point $(1,0)$. The dipole moment vector forms an angle of 30° with the x-axis. A non uniform electric field has been applied in the region given by the vector $\vec{E} = x^2\hat{i} + y^2\hat{j}$. The electric force acting on the dipole is most appropriately given by



A) $(2P\cos 30°)(\hat{i} + 2\hat{j})$ **B)** $(2P\cos 30°)(\hat{i})$

C) $(2P\cos 30°)(2\hat{j})$ **D)** $(2P\cos 30°)(\hat{i} + \hat{j})$

3. A photon of wavelength $\lambda = \dfrac{4h}{3mc}$ encounters a stationary electron and is scattered directly backwards. What is the final momentum of the electron after the collision? Here m is the mass of electron and c is speed of light in vacuum.

A) mc **B)** $\dfrac{2mc}{3}$ **C)** $\dfrac{mc}{2}$ **D)** $\dfrac{3mc}{4}$

4. n identical coherent isotropic point sources each having power P are kept symmetrically on the periphery of a circle given by the equation $x^2 + y^2 = R^2$. The resultant intensity detected by a detector placed at $(0,0,R)$ is I_1 and the resultant intensity at $(0,0,2R)$ is I_2. The ratio $\dfrac{I_1}{I_2}$ is

A) $\dfrac{2}{5}$ **B)** 1 **C)** $\dfrac{1}{2}$ **D)** > 1

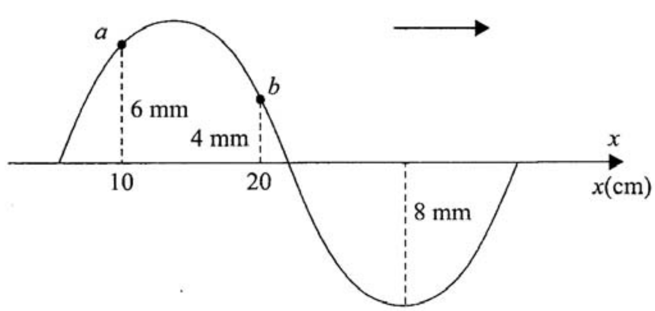
SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- **Zero Marks:0** in all other cases

Question Stem for Question Nos. 5 and 6

Question Stem

A simple harmonic wave is travelling in positive x direction and its $y-x$ graph for an instant is shown. Its amplitude is 8 mm. The particle a moves to its mean position in next $0.01s$. The scale on the y axis is marked in mm and that on the x axis is marked in cm. [Given $\sin(0.85) = 0.75$ and $\pi = 3.14$]



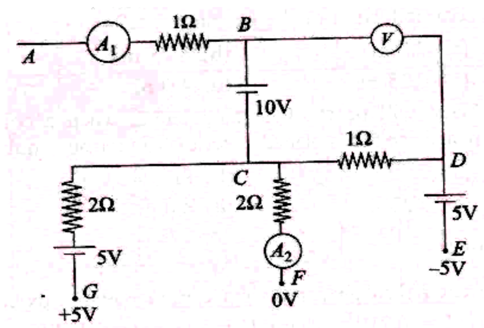
5. The wavelength of the wave is ____ cm.

6. The frequency of the wave is nearly _____ Hz.

Question Stem for Question Nos. 7 and 8

Question Stem

In the circuit shown in the figure, the terminals E, F and G are maintained at potentials $-5V, 0V$ and $+5V$ respectively. The ammeters and voltmeters are ideal. The reading in ammeter A_2 is zero.



7. Value of voltmeter reading is ____ V

8. The reading of ammeter A_1 is____ A

Question Stem for Question Nos. 9 and 10

Question Stem

$A \rightarrow B + C$

A radioactive nucleus A at rest disintegrates into two nuclei B and C. Mass of B is 12m and that of C is 4m. The Q-value of the reaction is $Q = \dfrac{h^2}{24m\lambda^2}$. The energy liberated in reaction is completely imparted to the products (B and C) as kinetic energy.

9. The de Broglie wavelength of B is $l\lambda$. Find l.

10. The mass of the nucleus A is $xm + \dfrac{h^2}{ymc^2\lambda^2}$. Find $x + y$.

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

11. A parallel-plate capacitor is connected to a cell. Its positive plate A and its negative plate B have charges $+Q$ and $-Q$ respectively and then the cell is disconnected from the capacitor. A third plate C, identical to A and B, with charge $+Q$ is now introduced midway between A and B, parallel to them. Which of the following are correct?

A) The charge on the inner face of B now is $\frac{-3Q}{2}$

B) There is no change in the potential difference between A and B

C) The potential difference between A and C is one-third of the potential difference between B and C.

D) The charge on the inner face of A now is $\frac{Q}{2}$.

12. A choke coil is in series with a lamp. The lamp is shining brightly.

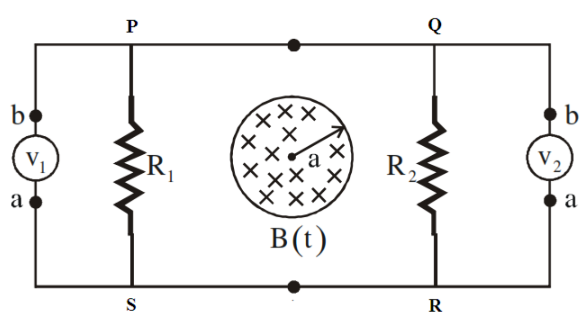
A) If the power supply is DC and an iron core is inserted inside the coil, the lamp becomes brighter.

B) If the power supply is AC and an iron core is inserted inside the coil, the lamp becomes brighter.

C) If the power supply is DC and an iron core is inserted inside the coil, the lamp gives same amount of light.

D) If the power supply is AC and an iron core is inserted inside the coil, then lamp becomes dimmer.

13. The circuit PQRS shown in the figure consists of two resistances R_1 & R_2 connected to two ideal voltmeters V_1 & V_2. A time varying uniform magnetic field B(t) exists in a circular region of radius a and it is directed into the plane of the figure. $B(t) = B_0 t$ where B_0 is a positive constant having proper dimensions and t is the time.



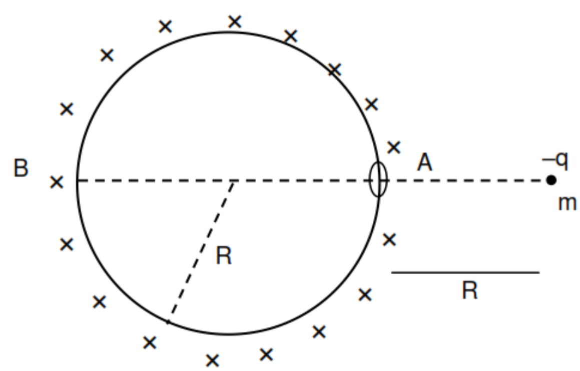
A) The magnitude of emf induced in the circuit PQRS is $\pi a^2 B_0$

B) The reading of V_1 is $\dfrac{\pi a^2 B_0 R_1}{R_1 + R_2}$

C) The reading of V_2 is $\dfrac{\pi a^2 B_0 R_1}{R_1 + R_2}$

D) Readings of two voltmeters V_1 and V_2 are same..

14. Consider a uniformly charged non conducting spherical shell of radius R. Net charge on the shell is Q. There is a small hole in the shell at 'A' shown in the figure. The shell and a and point charge –q are released at a separation 2R from the centre as shown in the figure. The shell and point charge have same mass m. After release, the point charge will move toward shell, passes through the hole and hit the shell at 'B'. (consider $k = \dfrac{1}{4\pi \in_0}$)



Choose the correct option(s):

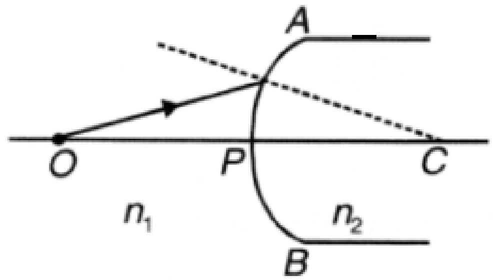
A) The distance travelled by point charge till it hits the shell at B is $\dfrac{5R}{2}$

B) Speed of the point charge when it hits the shell is $\sqrt{\dfrac{kQq}{2mR}}$

C) Time taken by the point charge to travel from A to B is $\sqrt{\dfrac{8mR^3}{kQq}}$

D) The distance travelled by the shell with constant velocity till the collision is R

15. A real point object is kept at a distance of $OP = u$. The radius of curvature of spherical surface APB is $CP = R$. The refractive indices of the media are n_1 and n_2 which are as shown in the diagram. Then (consider only paraxial rays)



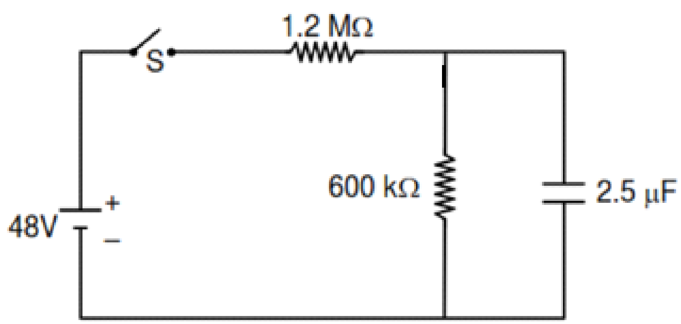
A) if $n_1 > n_2$, the image is virtual for all values of u

B) if $n_2 = 2n_1$, the image is virtual when $R > u$

C) the image is real for all values of u, n_1 and n_2

D) if $n_2 > n_1$, the image will be always real

16. In the circuit shown in figure, capacitor was initially uncharged and switch is closed at $t = 0$. Select the correct alternatives.



A) The initial battery current (immediately after switch S is closed) is $40\mu A$.

B) The battery current, long time after switch S is closed is $\frac{80}{3}\mu A$.

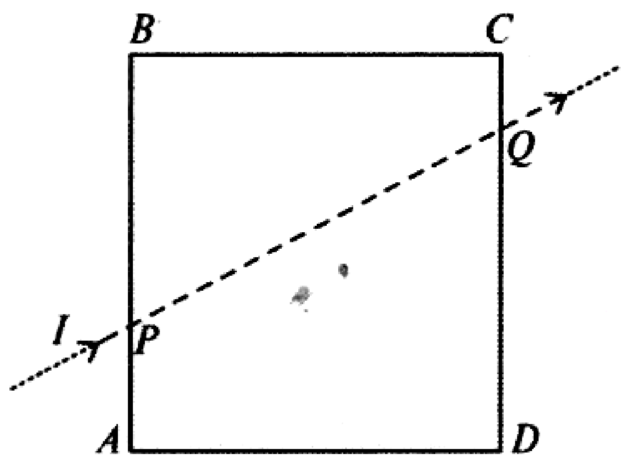
C) The time after which current through capacitor becomes half of the initial value is $\ln 4\, s$.

D) The current through the $600 k\Omega$ resistor as a function of time is $\frac{80}{3}\left(1-e^{-t}\right)\mu A$.

SECTION 4

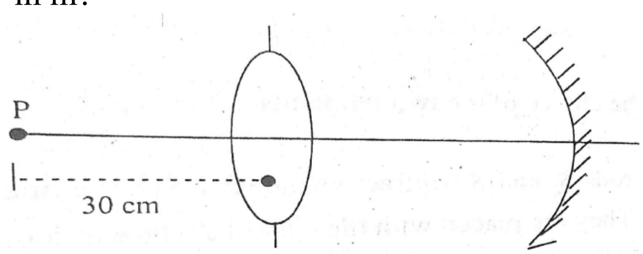
- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : **+4** If ONLY the correct integer is entered;
- ***Zero Marks*** : **0** In all other cases.

17. A uniform rectangular wire frame has side lengths $AB = 2L$ and $BC = L$. A long straight wire carrying current I joins the frame at P such that $AP = \frac{L}{2}$. The current exits into another long wire at Q such that $CQ = \frac{L}{2}$. A uniform magnetic field (B) exists in the entire space parallel to the frame. The direction of $\vec{B}$ is parallel to the two long wires. If the frame is released form this position, what will be its initial acceleration $\left(in\, m.s^{-2}\right)$?
Mass of the frame is m. Assume no other force apart from magnetic force.
$\left(B = 2T, m = 3kg, L = 1m, I = 0.5A\right)$



18. Electrons in hydrogen-like atoms (given Z = 3) make transitions from fifth to the fourth orbit and from fourth to third orbit. The resulting radiations are incident normally on a metal plate and eject photoelectrons. The stopping potential for the photoelectrons ejected is 3.95 V. Find the work - function (in eV) (to nearest integer) of the metal.

19. A lens of focal length 20 cm is placed co axially with a concave mirror of radius of curvature 20cm. A point objects `P' is placed at a distance of 30 cm from the lens on its principal axis as shown. Final image formed after two refractions from lens and one reflection by mirror is coincident with the object `P' itself. If X be maximum distance of mirror from object P and Y be minimum distance of mirror from the object, then what is the value of X + Y in m?



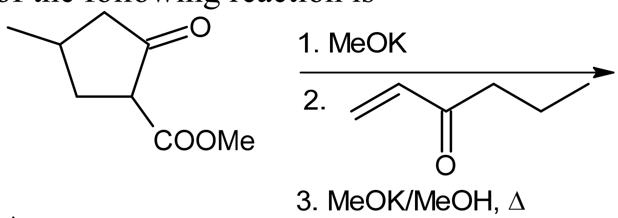
CHEMISTRY

Max. Marks: 60

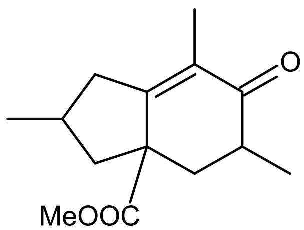
SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : +3 If ONLY the correct option is chosen;
- *Zero Marks* : 0 If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : -1 In all other cases.

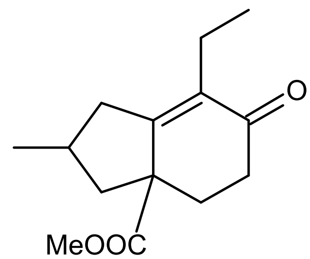
20. The major product of the following reaction is



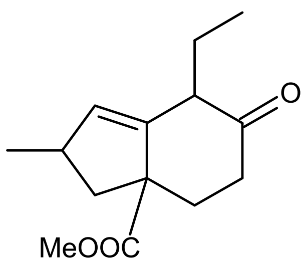
A)



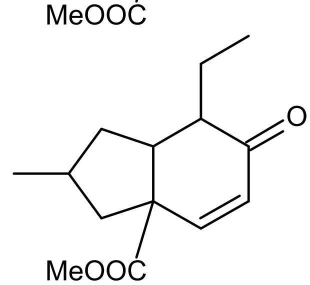
B)



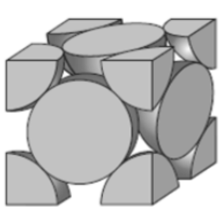
C)



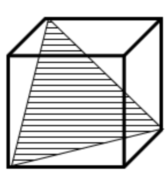
D)



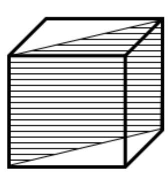
21. Consider the following unit cell of a metal:



Also consider the following shaded planes P and Q representing two 2D lattices.



P



Q

The ratio of packing fraction of P to Q is

A) 1.00 B) 1.63 **C)** 0.55 **D)** 0.74

22. A certain amount of copper has to be dissolved in nitric acid. Which of the following is required in lesser amount of HNO_3

A) 90 % HNO_3 B) 20 % HNO_3

C) 60 % HNO_3 **D)** Funning nitric acid

23. The incorrect order of electro negativities of d-block elements is

A) Cu > Zn B) Au > Ag **C)** $Co \approx Ni$ **D)** Mn > Fe

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : **+2** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks*** : ***0*** In all other cases.

Question Stem for Question Nos. 24 and 25

Question Stem

Cl_2 gas is passed through an aqueous solution containing x g of a salt, NaX. The volatile product of the reaction is driven off by a stream air and is passed through a solution of Na_2CO_3. The resultant solution is then treated with H_2SO_4 and distilled to give a reddish brown fuming distillate. The distillate reacted completely with 9.4 g of phenol in presence of water to given y g of an organic product.

[Atomic weight of $Br = 80$, $Na = 23, Cl = 35.5, I = 127, C = 12, H = 1, O = 16, S = 32$]

24. The value of x is

25. The value of y is

Question Stem for Question Nos. 26 and 27

Question Stem

A urea solution in 250 g of water freezes at $-0.744°C$. This solution was cooled to a temperature x K where y g of ice is formed. Solution was decanted-off and heated to $100°C$ where the vapour pressure was found to be 757.7 mm of Hg. K_f of water is $1.86 \text{ K kg mol}^{-1}$ and freezing point of water is 273.15 K.

26. The value of x is_____.

27. The value of y is_____.

Question Stem for Question Nos. 28 and 29

Question Stem

Chlorine is a very strong oxidizing agent and can oxidize several metals, non-metals and compounds

(At.ws: Fe = 56, Cl = 35.5, S = 32, H = 1)

28. A compound x is formed by adding 3.2gms of sulphur to sodium sulphite in alkaline medium. What is the weight of chlorine required to oxidize the compound x

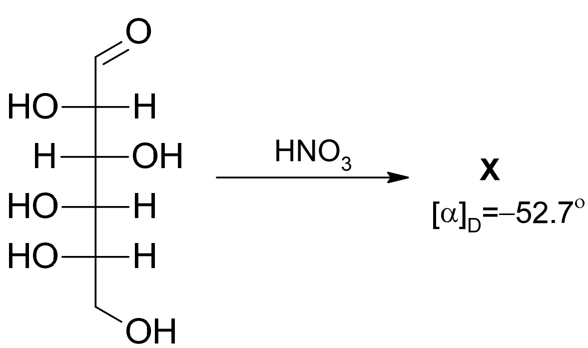
29. What is the weight of the product formed when 3.55gms of chlorine react with iron

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

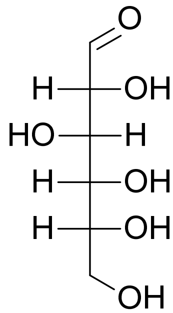
Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

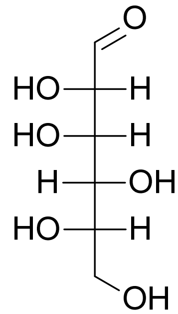
30. Given:

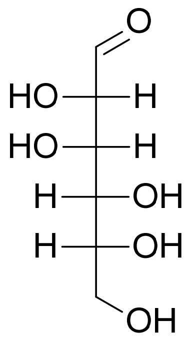


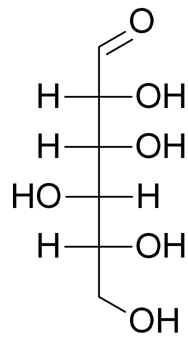
L-Glucose

The compound(s), which on reaction with HNO_3 will give the product having degree of rotation, $[\alpha]_D = +52.7°$ is(are)

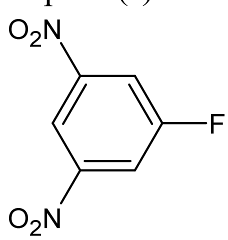
A) 

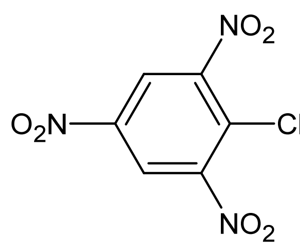
B) 

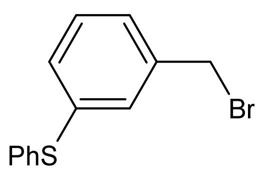
C) 

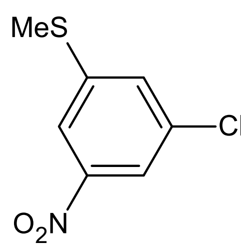
D) 

31. The reaction of **Y** with MeSNa yields an organic compound (major product) that gives positive Carius test on treatment with conc. HNO_3 followed by addition of $BaCl_2$. The correct option(s) for **Y** is(are)

A) 

B) 

C) 

D) 

32. The correct statement(s) related to colloids is(are)

A) The process of converting a freshly prepared precipitate by adding a small amount of electrolyte in a suitable dispersion medium is called peptization.

B) Colloidal solution has higher osmotic pressure than the true solution at the same concentration.

C) Surfactants form micelle above critical micelle concentration (CM**C)**. CMC depends on temperature.

D) Proteins are multimolecular colloids.

33. A compound related to acetylacetone is 1,1,1-trifluoro-acetyl acetone (abbreviated Hffa) $CF_3COCH_2COCH_3$.It forms complexes in a manner similar to acetylacetone. Both Be^{2+} and Cu^{2+} form complexes with ffa^- halving formula $M(ffa)_2$. Regarding these complexes the correct statements is/are

A) Be^{2+} complex is tetrahedral and can exhibit optical isomerism only

B) Cu^{2+} complex is square planar and can exhibit geometrical isomerism only

C) Be^{2+} complex is diamagnetic but Cu^{2+} complex is paramagnetic

D) Both the complexes of Be^{2+} and Cu^{2+} are coloured

34. A sample of ore containing $PbSO_4$ and silica is to be refined to extract Pb metal via calcination followed by roasting. The changes that occur

A) During calcinations $PbSO_4$ converts into PbO liberting SO_2 gas

B) The coke used to provide heat for calcinations provide a reducing atmosphere leading to the formation of lead.

C) If a little lime stone is added during calcination PbO is formed easily and prevents the formation of lead silicate

D) The slag formed is $CaSiO_3$

35. The correct statemens among the following is

A) The element that shows both + 3 and + 4 oxidation states is Tb

B) The terms lanthanoids and lanthanides are synonyms having same meaning

C) Nitrogen is not suitable to maintain inert atmosphere for the reactions in which lanthanides are involved

D) CeO_2 is a useful catalyst for oxidation reactions

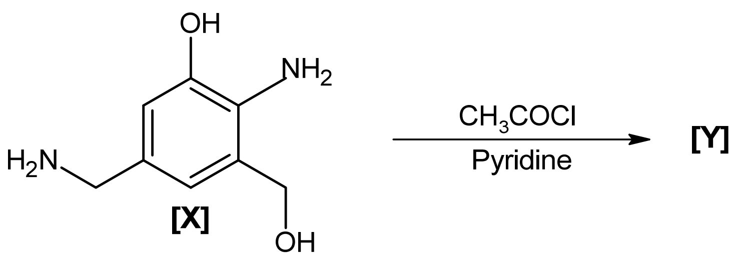
SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

36. Three electrolytic cells are connected in a series. The electrolytes in the cells are aqueous copper (II) sulphate, gold (III) sulphate, and silver nitrate. A current of 2.68 A is applied and after some time 32.4 g of Ag is deposited. The duration of electrolysis in hours is _____.

[Atomic weights: Ag =108, Cu = 63, Au = 197, 1 F = 96500 C]

37. The number of acetyl (CH_3CO) groups in the product $[\mathbf{Y}]$ in the following reaction using sufficient amount of the reagents is



38. The desorption of a single molecular layer of butane from a single crystal of aluminium oxide was found to be first order with a rate constant of $0.138 s^{-1}$ at 150 K. If the surface is initially completely covered with butane at 150 K, the time (in seconds) it will take for 25% of the molecules to desorb is______.

[Given: ln2= 0.69, ln3=1.104]

MATHEMATICS

Max. Marks: 60

SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : +3 If ONLY the correct option is chosen;
- *Zero Marks* : 0 If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : -1 In all other cases.

39. For the differential equation $x^2 f'(x) - e^{-2f(x)}\ln x + x = 0$ given that $y = f(x)$ be a solution such that $f(1) = 0$ then the value of $y(e)$ equals

A) $\ln 3 - 2$ **B)** $\frac{\ln 3 - 1}{2}$ **C)** $\frac{\ln 3 - 2}{2}$ **D)** $\frac{\ln 3 - 2}{3}$

40. If A, B, C are real and $A + B + C = \pi$ and for $k > \frac{1}{2}$ the maximum value of $\cos A + \cos B + k.\cos C$ is $\frac{1}{2}\left(\frac{\alpha}{k} + \beta k\right)$ where $\alpha, \beta \in N, G.C.D(\alpha, \beta) = 1$ then the median of $\alpha, \beta, \alpha + 2, \beta + 2, \alpha + \beta$ equals

A) 2 **B)** 3 **C)** 4 **D)** 11

41. A population includes 15% of individuals carrying a disease exists. When an individual with the disease, tested gives positive with probability 0.8. When an individual without the disease, tested gives positive with probability 0.1. When an individual tested, gives negative the probability that the individual was having disease is ____

A) $\frac{2}{53}$ **B)** $\frac{1}{15}$ **C)** $\frac{1}{37}$ **D)** $\frac{2}{35}$

42. The value of $\int_0^{\frac{\pi}{4}} \frac{\sec x}{1 + 2\sin^2 x}dx$ is equal to

A) $\frac{\pi}{6\sqrt{2}} + \frac{1}{3}\ln\left(\sqrt{2} + 1\right)$ **B)** $\frac{\pi}{3\sqrt{2}} + \frac{1}{3}\ln\left(\sqrt{2} + 1\right)$

C) $\frac{\pi}{6\sqrt{2}} + \frac{2}{3}\ln\left(\sqrt{2} + 1\right)$ **D)** $\frac{\pi}{3\sqrt{2}} + \frac{2}{3}\ln\left(\sqrt{2} + 1\right)$

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks: 0*** In all other cases.

Question Stem for Question Nos. 43 and 44

Question Stem

Given that the parabola $x^2 - y - 9x + 18 = 0$ cuts x-axis at A and B where $OA < OB$ (O is origin). P is a variable point in x-y plane. AP and BP meet y-axis at C and D respectively. The line OP intersects the line AD at Q. If the line CQ always passes through a fixed point whose co-ordinates are (α, β) then answer following

43. The value of $\frac{23}{2}\alpha$ is equal to

44. The value of $\frac{52}{3}\beta$ is equal to

Question Stem for Question Nos. 45 and 46

Question Stem

If $\Delta ABC, AP$ is the angle bisector of $\angle BAC, P$ lies on BC Such that $BP = 16, CP = 20$. Given that the centre of the circumcircle of ΔABP lies on AC, answer the following

45. If $AB = p$ then the value of $\frac{1}{\sqrt{5}}p$ equals

46. If $AC = q$ then the value of $\sqrt{5}q$ equals

Question Stem for Question Nos. 47 and 48

Question Stem

If 10 persons have to be distributed in 4 distinct cars, so that exactly k cars each possesses exactly 4 persons and the number of ways is $n(10, k)$ then answer the following (A car may or may not be empty)

47. The value of $\frac{n(10,2)}{1000}$ is equal to ______

48. The sum of digits of $n(10,1)$ is equal to ______

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** **: +4** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks*** **: +3** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks*** **: +2** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks*** **: +1** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks*** **: 0** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

49. Let $I_1=\int_0^{\pi}\frac{\cos^2 x}{1+\cos x\sin x}dx, I_2=\int_0^{\pi}\frac{\sin^2 x}{1+\cos x\sin x}dx, I_3=\int_0^{2\pi}\frac{1}{2+\sin x}dx$ then what is/are correct

A) $I_1=I_2$ **B)** $I_2=\frac{1}{2}I_1$ **C)** $I_3=2I_1$ **D)** $I_3=\frac{1}{2}I_1$

50. The curve $y=(|x|-1)\mathrm{sgn}(x-1)$ divides area bounded by the curve $\frac{9x^2}{64}+\frac{4}{25}y^2=\frac{1}{\pi}$ into two parts having area $\Delta_1,\Delta_2\left(\Delta_1<\Delta_2\right)$ then which is/are correct

A) $\frac{\Delta_1}{\Delta_2}=\frac{7}{13}$ **B)** $\frac{\Delta_1}{\Delta_2}=\frac{3}{7}$ **C)** $\Delta_1=\frac{7}{3}$ **D)** $\Delta_2=\frac{13}{7}$

51. If a is an integer such that the equality $\frac{2x^2+ax+2}{x^2+x+1}=\frac{e^y}{[y+1]}$ holds $\forall x\in R$ and $y\geq 0$ ([.] is GIF) then which is/are correct

A) A value of a is 3

B) A.M. of distinct values of a equals 1

C) Variance of values of a is equal to 2

D) A.M. of distinct values of a is equal to 1.2

52. Which is/are correct

A) $\lim_{n\to\infty} \frac{1}{n^2}\left[(n+1)\left(n+\frac{1}{2}\right)\left(n+\frac{1}{2^2}\right).....\left(n+\frac{1}{2^{n-1}}\right)\right]^n$ is equal to e

B) $\lim_{n\to\infty} \frac{1}{n^2}\left[(n+1)\left(n+\frac{1}{2}\right)\left(n+\frac{1}{2^2}\right).....\left(n+\frac{1}{2^{n-1}}\right)\right]^n$ is equal to e^2

C) $\int_0^{\pi} \cos x\sqrt{\cos x+1}\,dx = \frac{2\sqrt{2}}{3}$

D) If $f(x)=\int_x^{x+\frac{\pi}{3}} |\sin t|\,dt, 0\le x\le \pi$ has local maximum at $x=k$ then $\frac{k}{\pi}$ is equal to $\frac{1}{3}$.

53. A variable point z_1 in the complex plane moves according to the condition $\left|z_1-\frac{2i}{1+i}\right|=|z_1|\left(i=\sqrt{-1}\right)$. A second variable point z moves according to the condition $z_1 z = i\omega$ where ω is imaginary cube root of unity with imaginary part positive then for the locus of z which is/are correct

A) is a complete circle with centre at $\frac{\omega(1+i)}{\sqrt{2}}$

B) is a complete circle with radius $\sqrt{2}$

C) is a part circle with centre at $\frac{\omega(1+i)}{2}$

D) is a part circle with radius $\frac{1}{\sqrt{2}}$

54. If $f:R\to R$ such that $\left|f(x+y)-f(x-y)-2y^3-6x^2y\right|\le y^4\ \forall x,y\in R$ then for such function $f(x)$ which is/are correct, given that $f(1)=2023$ ([.] GIF)

A) $\left[\int_0^1 f(x)\,dx\right]=2022$

B) $f(x)$ has only one point of inflection

C) $f(x)$ has a local maxima

D) $f(x)$ has no local minima

SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : **+4** If ONLY the correct integer is entered;
- ***Zero Marks*** : **0** In all other cases.

55. If $y-\cos x\left(\frac{dy}{dx}\right)=y^2(1-\sin x)\cos x, y(0)=1$ then the value of $y\left(\frac{\pi}{3}\right)$ equals

56. If $I=\int_0^{\frac{\pi}{2}}\sin x.\ln\left(\sin x.\sin^2\left(\frac{x}{2}\right)\right)dx$ then the value of $|I|$ is equal to

57. If $p=\sum_{r=1}^{50}\left\{\sum_{k=1}^{r}\left(\frac{(-1)^{r-1}}{k}.{}^{50}C_r\right)\right\}$ then the value of $200(p)$ equals

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S JEE-ADVANCE-2021_P1 Date: 16-04-2023

Time: 09.00Am to 12.00Pm GTA-15 Max. Marks: 180

KEY SHEET

PHYSICS

1	**D**	2	**B**	3	**A**	4	**D**	5	**35.20 – 35.80**	6	**13.20 – 13.80**
7	**10**	8	**5**	9	**2**	10	**40**	11	**ABCD**	12	**CD**
13	**AB**	14	**BD**	15	**AB**	16	**ABD**	17	**0**	18	**2**
19	**2**										

CHEMISTRY

20	**B**	21	**B**	22	**B**	23	**D**	24	**33.1**	25	**61.8**
26	**263.15**	27	**64.40 – 64.44**	28	**28.4**	29	**5.40 - 5.43**	30	**AB**	31	**BC**
32	**AC**	33	**ABC**	34	**ABCD**	35	**ACD**	36	**9**	37	**4**
38	**2**										

MATHEMATICS

39	**C**	40	**B**	41	**A**	42	**A**	43	**23**	44	**0**
45	**28.80**	46	**180**	47	**151.2**	48	**18**	49	**AC**	50	**AC**
51	**ABC**	52	**BCD**	53	**CD**	54	**ABD**	55	**2**	56	**2**
57	**4**										

SOLUTIONS

PHYSICS

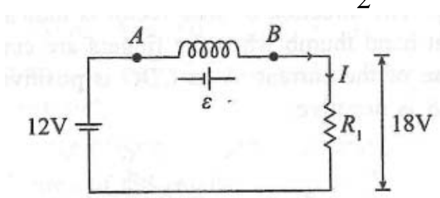
1. When the switch is closed, effective resistance is parallel combination of R_1 and R_2

$$R_0 = \frac{R_1 R_2}{R_1 + R_2} = \frac{4\times 8}{4+8} = \frac{8}{3}\Omega$$

Current through L is $I = \frac{12V}{\frac{8}{3}\Omega} = \frac{9}{2}A$

Immediately after the switch is opened, the current in the inductor remains $I = \frac{9}{2}A$ and the only resistance in the circuit is $R_1 = 4\Omega$.

Drop of potential in $R_1 = \frac{9}{2}\times 4 = 18V$

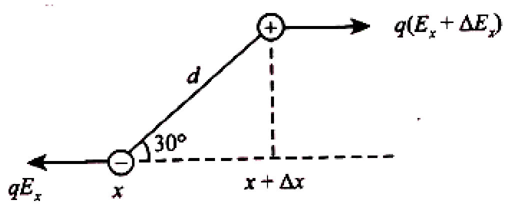


Immediately after S is opened

Obviously, induced emf in the inductor is $6V$ with B at higher potential.

2. We will first calculate the x component of force on the dipole. x component of field at a point having x co-ordinate x is

$E_x = x^2$



Field at $(x+\Delta x)$ is $(E_x + \Delta E_x)$ where

$$\Delta E_x = \left(\frac{dE_x}{dx}\right)\Delta x = 2x(d\cos 30°) = 2xd\cos 30°$$

$\therefore\ F_x = q(E_x + \Delta E_x) - qE_x = q\Delta E_x \qquad = 2qxd\cos 30° = [2P\cos 30°]x$

At $x = 1$ $\qquad F_x = 2P\cos 30°$

Similarly, $F_y = [2P\sin 30°]y$ due to E_y

At $y = 0, F_y = 0.$ (According to the given function, E_x does not give F_y and E_y does not give F_x)

3.

$$\xrightarrow{P_0 = \frac{h}{\lambda}} (e)_{rest} \quad \Rightarrow \quad \xleftarrow{P' = \frac{h}{\lambda'}} \quad (e^-) \rightarrow^{P}$$

$$\frac{h}{\lambda} = -\frac{h}{\lambda'} + P \_\_\_\_ (1)$$

$\frac{hC}{\lambda}=-\frac{hC}{\lambda'}+\frac{(P)^2}{2m}$ ____ (2)

$(1)\times C+(2)\Rightarrow \frac{2hC}{\lambda}=PC+\frac{P^2}{2m}$

from given data, $\frac{h}{\lambda}=\frac{3mC}{4}$ $\therefore \frac{3mC^2}{2}=PC+\frac{P^2}{2m}$

On solving this quadratic equation, we get $P=mC$

4. Resultant intensity at the given points will be directly proportional to intensity due to each source at those points which in turn inversely proportional to square of the distances from sources.

$\frac{I_1}{I_2}=\left(\frac{r_2}{r_1}\right)^2=\left(\frac{\sqrt{5}R}{\sqrt{2}R}\right)^2\Rightarrow \frac{I_1}{I_2}=\frac{5}{2}>1$

5, 6. Let us write the general equation as $y=A\sin(\omega t-kx+\phi)$

Particle 'a' : $6=8\sin[\omega t-k(10)+\phi]$

$0.75=\sin[(\omega t+\phi)-10k]\Rightarrow \sin[\pi-0.85]=\sin[(\omega t+\phi)-10k]$

[from given diagram, velocity of particle 'a' is downwards. Its phase angle will be less than π and more than $\frac{\pi}{2}$)

$\therefore \pi-0.85=(\omega t+\phi)-10k$ ____ (1)

Particle 'b' : $4=8\sin(\omega t-kx+\phi)$

$\frac{\pi}{6}=(\omega t+\phi)-20k$ ____ (2)

$(1)-(2)\Rightarrow \frac{5\pi}{6}-0.85=10\left[\frac{2\pi}{\lambda}\right]$ $\Rightarrow 1.766=\frac{20\times 3.14}{\lambda}\Rightarrow \lambda=35.56\,cm$

Again for 'a' : $y=A\sin\omega(\Delta t)$

$6=8\sin\left[\frac{\omega}{100}\right]\Rightarrow 0.85=\frac{\omega}{100}\Rightarrow \omega=85\,rad/s$ $f=\frac{\omega}{2\pi}=\frac{85}{2\times 3.14}=13.54\,Hz$

7. Since there is no current in path FC, hence $V_C=V_F=0V$.

Moving from C to $E: V_C-i(1)-5=V_E$

[i = current in 1Ω resistor] or, $0-i-5=-5$ $\Rightarrow i=0$.

Moving from B to D through C

$V_B-10-0=V_D$ or, $V_B-V_D=10V$.

8. Moving from G to C gives $V_G+5-(i_1)(2)=V_C$

[i_1 = current in 2Ω resistor above 5V cell] or, $5+5-2i_1=0$

or, $i_1=5A$.

Junction law at C tells us that the current i_1 takes the path CB. Then, this current takes the path BA. [The voltmeter has infinite resistance.]

$\therefore$ Current in A_2 is $5A$.

9, 10. $Q=\frac{h^2}{24m\lambda^2}=K_B+K_C$

Where K is the kinetic energy

From conservation of linear momentum

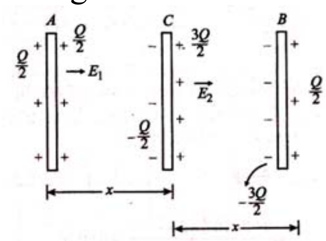
$\left|\vec{P}_C\right| = \left|\vec{P}_B\right| = P \qquad \therefore Q = \dfrac{P^2}{2\times 12m} + \dfrac{P^2}{2\times 4m}$

$\dfrac{h^2}{24m\lambda^2} = \dfrac{P^2}{2}\left(\dfrac{1}{12m} + \dfrac{1}{4m}\right) \qquad \dfrac{h^2}{12m\lambda^2} = P^2\left(\dfrac{1+3}{12m}\right) = \dfrac{P^2}{3m} \quad \Rightarrow \quad P^2 = \dfrac{h^2\times 3m}{12m\lambda^2} \Rightarrow P = \dfrac{h}{2\lambda}$

$\Rightarrow \dfrac{h}{p} = 2\lambda =$ de Broglie wavelength $\because \left|\vec{P}_B\right| = \left|\vec{P}_C\right|$

Mass defect, $\Delta m = \dfrac{Q}{C^2} = \dfrac{h^2}{24mc^2\lambda^2} \qquad \therefore m_A = 16m + \dfrac{h^2}{24mc^2\lambda^2}$

11. Charge distribution on the three plates will be as shown.



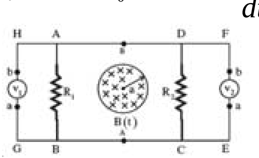
This will ensure that the electric field is zero inside the metal plates.
Potential difference between A and B is

$P_{AB} = E_1x + E_2x = \dfrac{Q}{2A\varepsilon_0}x + \dfrac{3Q}{2A\varepsilon_0}x = \dfrac{2Q}{A\varepsilon_0}x$

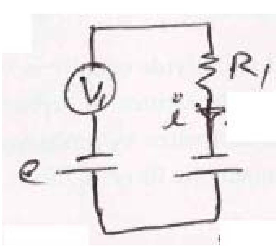
Before insertion of plate C, the potential difference was same.

12. Insertion of iron core increases the inductance. In AC circuit, this increases the impedance and the current falls. The bulb becomes less bright.
In DC circuit, after the transient phase, an inductor has no effect on the current value.

13. $\phi = \pi a^2 B_0 t \qquad \varepsilon = -\dfrac{d\phi}{dt}$



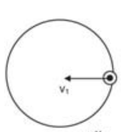
$\rightarrow \varepsilon = \pi a^2 B_0$ (induced emf) $i = \dfrac{\pi a^2 B_0}{R_1 + R_2}$ (induced current) *In loop ABGH*,



on applying loop law, we get $v_1 = iR_1 = \dfrac{\pi a^2 B_0 R_1}{R_1 + R_2}$

In similarly $\Delta V_2 = iR_2 = \dfrac{\pi a^2 B_0 R_2}{R_1 + R_2}$

14.



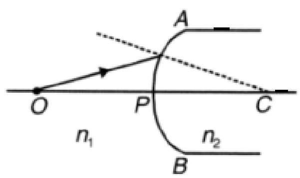
A) $m(3R-X)-mx=0 \Rightarrow x=\frac{3R}{2}$

B) By conservation of energy $2\times\frac{1}{2}mv_1^2-\frac{kQq}{R}=\frac{-kQq}{2R}, mv_1^2=\frac{kQq}{R} \Rightarrow v_1=\sqrt{\frac{kQq}{2mR}}$

C) $t_{AB}=\frac{2R}{2\sqrt{\frac{kQq}{2mR}}}=\sqrt{\frac{2mR^3}{kQq}}$

D) Total distance covered by shell and particle with constant velocity is 2R, therefore distance covered by shell with constant velocity is R.

15. $\frac{n_2}{v}-\frac{n_1}{(-u)}=\frac{n_2-n_1}{R}$



$\frac{n_2}{v}=\frac{n_2-n_1}{R}-\frac{n_1}{u}$

(a) $if\ n_1>n_2 \Rightarrow v\ is-ve; \Rightarrow (a)$

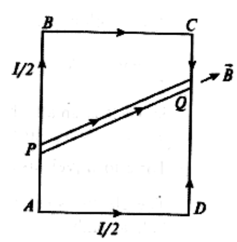
(b) $\frac{2n_1}{v}=\frac{n_1}{R}-\frac{n_1}{u}$ $\quad \frac{2}{v}=\frac{1}{R}-\frac{1}{u}\ if\ R>u \Rightarrow v\ is-ve$

16. At $t=0 \quad R_{eq}=1.2M\Omega \quad I=\frac{48}{1.2\times10^6}=40\mu A$

$t=\infty \quad R_{eq}=1.8M\Omega \quad I=\frac{48}{1.8\times10^6}=\frac{80}{3}\mu A$

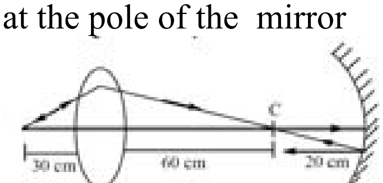
time constant $\quad \tau=RC=\frac{R_1R_2}{R_1+R_2}C=1 \Rightarrow I(t)=\frac{80}{3}(1-e^{-t})\mu A.$

17. Current will divide equally in two identical parallel paths $PBCQ$ and $PADQ$. Force on $PBCQ$ can be written by replacing it with a straight wire PQ. Similarly, force on $PADQ$ can also be written by replacing it with a straight wire PQ. But wire PQ is parallel to $\vec{B}$. Hence magnetic force is zero.



18. $13.6\times3^2\left(\frac{1}{3^2}-\frac{1}{4^2}\right)=3.95+V_0 \Rightarrow V_0=2V$

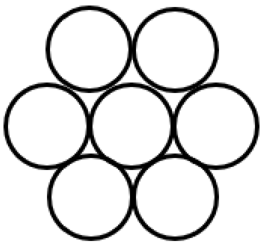
19. First image formed by lens must be at the centre of curvature of the mirror or it must be at the pole of the mirror



CHEMISTRY

20. Conjugate addition of carbanion formed by the abstraction of active methylene hydrogen of the reactant to the unsaturated ketone followed by intramolecular aldol condensation.

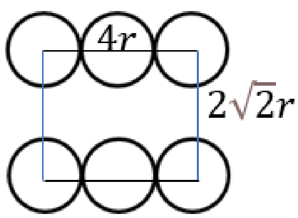
21. Plane P has the following arrangement of circular atoms:



Considering the smallest possible triangle in this arrangement

$$PF = \frac{\frac{1}{6}\times 3\times \frac{22}{7}r^2}{\frac{1}{2}\times 2r\times \sqrt{3}r} = 0.907$$

And Plane **Q** has the arrangement:



$$PF = \frac{[\frac{1}{2}\times 2+\frac{1}{4}\times 4]\times \frac{22}{7}r^2}{4r\times 2\sqrt{2}r} = 0.5555$$

22. The reaction of copper with dilute and concentrated nitric acids are as follows

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$$

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$$

To dissolve one mole of copper metal, 4 moles of concentrated HNO_3 or fuming nitric acid or $90\%\,HNO_3$ is required. To dissolve 3 moles of copper metal 8 moles of dilute HNO_3 is required. This indicates that for the dissolution of one mole of copper the amount of HNO_3 required is $\frac{8}{3} = 2.67$

23. A) Atomic size of Cu is smaller than zinc. Zn has stable $3d^{10}4s^2$ config. But Cu has unstable $3d^{10}4s^1$ config. So Cu will have more affinity towards electron. Thus EN of Cu > Zn

B) Due to lanthanoid contraction atomic sizes of Ag & Au are almost equal but due to poor shielding effect of f electrons Au has more effective nuclear charge thus having more electronegativity

C) Atomic sizes of Co & Ni are almost equal. Thus their electro negativity are also equal

D) Mn has stable $3d^5 4s^2$ config. So it has less tendency to gain electron. Thus having least electro negativity.

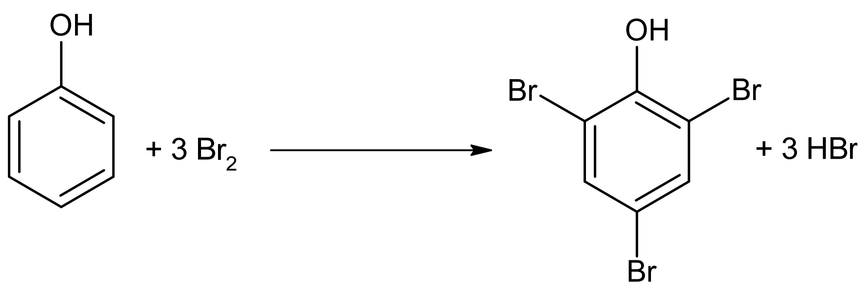
24, 25.

The salt must be NaBr.

$$2NaBr + Cl_2 \longrightarrow 2NaCl + Br_2$$

$$3Br_2 + 3Na_2CO_3 \longrightarrow 5NaBr + NaBrO_3 + 3CO_2$$

$$5NaBr + NaBrO_3 + 3H_2SO_4 \longrightarrow 3Br_2 + 3H_2O + 3Na_2SO_4$$



All NaBr is converted to Br_2.

$$n_{PhOH} = \frac{9.4}{94} = 0.1$$

$$n_{Br_2} = 0.3$$

$$n_{tribromophenol} = 0.1 \Rightarrow y = 0.1 \times 331 = 33.1g$$

$$n_{NaBr} = 2 \times n_{Br_2} = 0.6 \Rightarrow x = 0.6 \times 103 = 61.8g$$

26, 27

$$+0.744 = 1.86.\frac{n_2}{250} \times 1000 \Rightarrow n_2 = 0.1$$

Also, $752.7 = 760.\frac{n_1}{n_1 + 0.1} \Rightarrow n_1 = 10.31$

$\Rightarrow$ Mass of ice formed $= 250 - 10.31 \times 18 = 64.42\,g$

$$-\Delta T_f = 1.86 \times \frac{0.1}{185.58} \times 1000 = 1 \Rightarrow T_f = -1°C$$

28. $Na_2SO_3 + S \rightarrow Na_2S_2O_3$

$Na_2S_2O_3 + 5H_2O + 4Cl_2 \rightarrow 2NaHSO_4 + 8HCl$

$4 \times 71 = 284\,gm$

29. $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

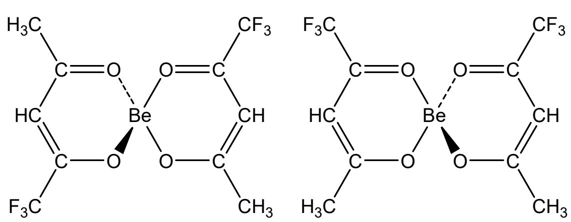
118 213

30. **X** is an aldaric acidand we are expected to get mirror image of **X**.A and B give the same aldaric acid on oxidation which are mirror images of **X.**

31. B and C undergo S_NAr with MeSNa.

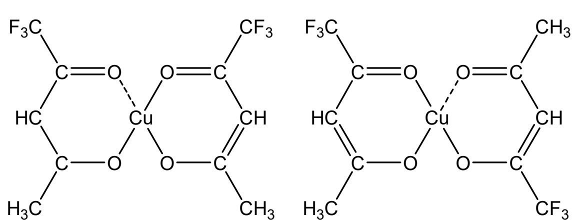
32. Proteins are macromolecular colloids

33. Be^{2+} Complex is tetrahedral can exhibit optical isomerism as is do not possess plane of symmetry Cu^{2+} complex is square planar and it can exhibit geometrical isomerism. Be^{2+} complex is diamagnetic and colourless where as Cu^{2+} complex is paramagnetic and coloured since Cu isi in +2 oxidation state with d^9 configuration



Note the dotted line indicates a bond pointing into the plane of paper, and the wedge indicates a bond pointing out of the plane of paper

Geometrical isomers of $Cu(t+a)_2$ are



34. $PbSO_4 \rightarrow PbO + SO_3$

$PbO + CO \rightarrow Pb + CO_2$

$PbO + SiO_2 \rightarrow PbSiO_3$

$PbO + CaCO_3 \rightarrow PbSiO_3 + CaO$

$PbCO_3 \rightarrow PbO + CO_2$

$CaO + SiO_2 \rightarrow CaSiO_3$

35. A) Usually lanthanoids exhibit + 3 oxidation state but some of them can also exhibit + 2 and + 4 oxidation states due to stable half-filled $\left(4f^7\right)$ as in (terbium) or empty $(4f^0$ is incerium) or completely filled $f-$ subshell. Ce^{4+} has $4f^6$ configuration which is stable.

B) The 15 elements from $La-Lu$ are lanthanoids according to IUPAC where as 14 elements $Ce-Lu$ without lanthanium are called lanthanides (meaning the elements similar to lanthanum)

C) Lanthanides can react with nitrogen, forming the nitrogen LnN

D) Cerium can adopt transition – metal like behavior in switching oxidation states between Ce^{3+} and Ce^{4+}. Hence cerium oxide can effectively act as catalyst.

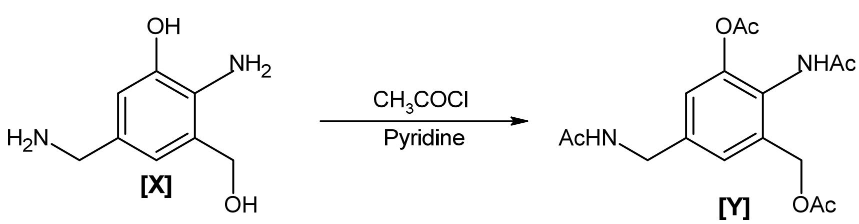
36. The amount of charge passed through AgNO₃ $= \dfrac{32.4}{108} = 0.3\text{F}$

The same amount of charge would pass through other two cells as well.

$\Rightarrow$total charge passed $= 0.9\text{F}$

$0.9 \times 96500 = 2.68 \times \text{t} \times 3600 \Rightarrow \text{t} = 9\text{h}$

37.



38. $t = \dfrac{1}{k}\ln\dfrac{C_0}{C} = \dfrac{1}{0.138}\ln\dfrac{100}{75} = \dfrac{1}{0.138}[1.38 - 1.104] = 2s$

MATHS

39. $GE \Rightarrow \frac{d}{dx}\left(x^2.e^{2y}\right)=2\ln x \Rightarrow x^2.e^{2y}=2\left(x\ln x+x\right)+c$

$(1,0)\, lies\, on\, it \Rightarrow c=3 \Rightarrow x^2e^{2y}=2\left(x\ln x-x\right)+3$

$x=e \Rightarrow e^2.e^{2y}=3 \Rightarrow e^{2y+2}=3 \Rightarrow y=\frac{\ln 3-2}{2}$

40. $y=\cos A+\cos B+k\cos C$

$\Rightarrow g=2\sin\frac{C}{2}\cos\left(\frac{A-B}{2}\right)-k\left(1-2\sin^2\frac{C}{2}\right)$

$\Rightarrow 2kx^2-2\cos\left(\frac{A-B}{2}\right)x+\left(y-k\right)=0 \quad \left(\sin\frac{C}{2}=k\right) \qquad \Rightarrow \Delta \ge 0$

$\Rightarrow 8k\left(y-k\right)\le 4\cos^2\left(\frac{A-B}{2}\right) \; y_{\min}=\frac{1}{2}\left(\frac{1}{k}+2k\right) \qquad A=1, B=2 \qquad A+B=3$

41. $R.8=\frac{(0.15)(1-0.8)}{(0.15)(1-0.8)+(1-0.15)(1-0.1)}=\frac{15\times 2}{15\times 2+85\times 9}=\frac{30}{795}=\frac{2}{53}$

42. $\int_0^{\frac{1}{\sqrt{2}}}\frac{dt}{\left(1+2t^2\right)\left(1-t^2\right)}=\int_0^{\frac{1}{\sqrt{2}}}\frac{\frac{2}{3}}{1+2t^2}dt+\int_0^{\frac{1}{\sqrt{2}}}\frac{\frac{1}{3}}{1-t^2}dt=\frac{1}{3}\int_0^{\frac{1}{\sqrt{2}}}\frac{1}{t^2+\left(\frac{1}{\sqrt{2}}\right)^2}dt+\frac{1}{3}.\frac{1}{2}\left(\ln\left|\frac{1+t}{1-t}\right|\right)_0^{\frac{1}{2}}$

$=\frac{1}{3}\sqrt{2}.\left(\tan^{-1}\left(\sqrt{2}t\right)\right)_0^{\frac{1}{\sqrt{2}}}+\frac{1}{6}.\ln\left(\frac{\sqrt{2}+1}{\sqrt{2}-1}\right) \qquad =\frac{\sqrt{2}}{3}\frac{\pi}{4}+\frac{1}{6}.2\ln\left(\sqrt{2}+1\right) \qquad =\frac{\pi}{6\sqrt{2}}+\frac{1}{3}\ln\left(\sqrt{2}+1\right)$

43, 44.

$P(n,k)\Rightarrow y-k\frac{k}{n-3}(x-h)\Rightarrow C=\left(0,-\frac{3k}{h-3}\right)$

$\Rightarrow y-k\frac{k}{n-3}(x-h)\Rightarrow D=\left(0,-\frac{6k}{h-6}\right)$

$\left(A=(3,0),B=(6,0)\right)$

Now $\overleftrightarrow{OP}: y=\frac{k}{h}x$ ____(1)

$\overleftrightarrow{AD}: y=\frac{2k}{h-6}(x-3)$ ____(2)

Solving $\left(\frac{6h}{h+6},\frac{6k}{h+6}\right)$

Now $\overleftrightarrow{CQ}$ equation $y-\left(-\frac{3k}{h-3}\right)=\frac{\frac{6k}{h+6}-\left(-\frac{3k}{h-3}\right)}{\frac{6h}{h+6}-0}(x-0) \qquad \Rightarrow y=\frac{3k}{2(h-3)}(x-2)$

Which always passes through (2, 0) $\quad \therefore \alpha=2,\beta=0$

45, 46.

Let 'O' be center, r = radious

Let circle intersects OC at $D(\ne A) \qquad \therefore \frac{r+DC}{r}=\frac{20}{16}\Rightarrow DC=\frac{r}{4}$

Also $CD.CA=CP.CB \qquad \Rightarrow \frac{r}{4}.\frac{9r}{4}=20.36$

$\Rightarrow r=16\sqrt{5} \quad \Rightarrow AC=\frac{9}{4}\left(16\sqrt{5}\right) \quad \Rightarrow AC=36\sqrt{5}$

$\frac{AC}{AB}=\frac{20}{16}\Rightarrow AB=\frac{4}{5}\left(36\sqrt{5}\right) \quad \Rightarrow AB=\frac{144}{5}\sqrt{5}$

47, 48.

$n(10,2)=2\times{}^{4}C_{2}\times{}^{10}C_{4}\times{}^{6}C_{4}\times2^{2}=2\times6\times210\times15\times4=151200$

$n(10,1)={}^{4}C_{1}\times{}^{10}C_{4}\times3^{6}-2.{}^{4}C_{2}\times{}^{10}C_{4}\times{}^{6}C_{4}\times2^{2}$

$=612360-151200=461160$

49. $I_1=\int_0^{\frac{\pi}{2}}\frac{\cos^2 x}{1+\cos x\sin x}dx+\int_{\frac{\pi}{2}}^{\pi}\frac{\cos^2 x}{1+\cos x\sin x}$

$=\int_0^{\frac{\pi}{2}}\frac{\sin^2 x}{1+\cos x\sin x}dx+\int_{\frac{\pi}{2}}^{\pi}\frac{(-\sin x)^2}{1+(-\cos x)(-\sin x)}dx \ \left(Kings\ Rules\right)$

$=\int_0^{\pi}\frac{\sin^2 x}{1+\cos x\sin x}dx=I_2$

$I_1+I_2=\int_0^{\frac{\pi}{2}}\frac{1}{1+\sin x\cos x}dx\Rightarrow 2I_1=\int_0^{\frac{\pi}{2}}\frac{2}{2+\sin 2x}dx\Rightarrow I_1=\frac{1}{2}\int_0^{\pi}\frac{1}{2+\sin x}dx \quad \Rightarrow I_1=\frac{1}{2}I_3$

50. $\Delta_1=\frac{7}{3} and\ \Delta_2=\frac{13}{3}$

51. $y\ge0\Rightarrow\frac{e^y}{[y+1]}\le1\ \&\ \frac{2x^2+ax+2}{x^2+x+1}\ge0\Rightarrow x^2+x(a-1)+1\ge\forall x\in R$

$\Rightarrow -1\le a\le3\Rightarrow a\in\{-1,0,1,2,3\}$

52. $GE=e^{1}.e^{\frac{1}{2}}.e^{\frac{1}{2^2}}....\infty=\frac{1}{e^{1-\frac{1}{2}}}=e^2$

53. $\left|\frac{i\omega}{z}-\frac{2i}{1+i}\right|=\left|\frac{i\omega}{z}\right|\Rightarrow\left|1--\frac{2i}{1+i}\times\frac{z}{i\omega}\right|=1$

$\Rightarrow \left|i\omega(1+i)-z\right|=\sqrt{2} \quad \Rightarrow \left|z-\frac{\omega(1+i)}{2}\right|=\frac{1}{\sqrt{2}}$

Part circle $(z\ne0)$, cente $=\frac{\omega(1+i)}{2}$, rad = $\frac{1}{\sqrt{2}}$

54. $x+y=u, x-y=2v$

$\left|f(u)-f(v)-\left((x+y)^3-(x-y)^3\right)\right|\le\left(\frac{u-v}{2}\right)^4$

$\Rightarrow\left|f(u)-f(v)-\left(u^3-v^3\right)\right|\le\left(\frac{u-v}{2}\right)^4$

$\Rightarrow\left|g(u)-g(v)\right|\le\left(\frac{u-v}{2}\right)^4 \quad \left(g(u)=f(x)-x^3\right)$

$\Rightarrow g'(u)=0\Rightarrow g(u)\text{is constant} \quad \therefore f(x)-x^3=c\Rightarrow f(x)=x^3+c$

$\Rightarrow f(x)=x^3+2022$

55. $\cos x\left(\frac{dy}{dx}\right)-y=-y^2(1-\sin x)\cos x \Rightarrow -\frac{1}{y^2}\frac{dy}{dx}+\frac{1}{y}.\sec x=1-\sin x$

$\frac{1}{y}=t \Rightarrow \frac{dt}{dx}+\frac{t}{\cos x}=1-\sin x$

This is LDE $\frac{1}{y}=\left(\frac{1+\sin x}{\cos x}\right)=\sin x+1 \Rightarrow y\left(\frac{\pi}{3}\right)=2$

56. $I=\int_0^{\frac{\pi}{2}}\sin x \ln\left(\sin x.\frac{(1-\cos x)}{2}\right)dx \quad =\int_0^{\frac{\pi}{2}}\ln\left(\frac{\sin x}{2}-\frac{\sin 2x}{4}\right)sinx\,dx$

$I \qquad II$

$=\int_0^{\frac{\pi}{2}}\ln\left(\frac{\sin x}{2}-\frac{\sin 2x}{4}\right).d(1-\cos x)$

$=\left(\ln\left(\frac{\sin x}{2}-\frac{\sin 2x}{4}\right).(1-\cos x)\right)_0^{\frac{\pi}{2}}-\int_0^{\frac{\pi}{2}}\frac{1}{\frac{1}{2}\sin(1-\cos x)}\times\frac{1}{2}(\cos x-\cos 2x)(1-\cos x)$

$=-\ln 2+\int_0^{\frac{\pi}{2}}\frac{(2\cos x+1)(\cos x-1)}{\sin x}dx \quad =-\ln 2+\int_0^{\frac{\pi}{2}}\frac{(2\cos x+1)(\cos x-1)}{(1+\cos x)(1-\cos x)}\sin dx$

$=-\ln 2+-\int_0^1\frac{2t+1}{t+1}dx=-\ln 2-(2-\ln 2)=-2 \Rightarrow |I|=2$

57. $p=\sum_{r=1}^{50}(-1)^{r-1}.\left(1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{r}\right).{}^{50}C_r$

$=\int_0^1\sum_{r=1}^{50}(-1)^{r-1}.\left(1+x+x^2+.....+x^{r-1}\right).{}^{50}C_r$

$=\int_0^1\sum_{r=1}^{50}(-1)^{r-1}.{}^{50}C_r.\frac{(1-x^r)}{1-x}dx$

$=\int_0^1\frac{1}{1-x}\sum_{r=1}^{50}\left\{(-1)^{r-1}.{}^{50}C_r-(-1)^{r-1}.{}^{50}C_r\right\}dx$

$=\int_0^1\frac{1}{1-x}\left\{1+\left((1-x)^{50}-1\right)\right\}dx$

$=\int_0^1(1-x)^{49}dx=\frac{1}{50}=p \Rightarrow GE=4$

Sri Chaitanya IIT Academy.,India.

A.P T.S KARNATAKA TAMILNADU MAHARASTRA DELHI RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec: Sr.Super60_NUCLEUS&ALL_BT'S	JEE-ADVANCE-2022-P1	Date: 17-05-2023
Time: 09.00Am to 12.00Pm	GTA-24	Max. Marks: 180

17-05-2023_Sr.Super60_ NUCLEUS&ALL_BT'S_Jee-Adv(2022-P1)_GTA-24_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ____________________ **H.T. NO:** | | | | | | | |

JEE-ADVANCE-2022-P1-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 8)	Questions with Numerical Value Answer Type	+3	0	8	24
Sec – II(Q.N : 9 – 14)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 15 – 18)	Matching Type	+3	-1	4	12
Total				**18**	**60**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 19 – 26)	Questions with Numerical Value Answer Type	+3	0	8	24
Sec – II(Q.N : 27 – 32)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 33 – 36)	Matching Type	+3	-1	4	12
Total				**18**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 37 – 44	Questions with Numerical Value Answer Type	+3	0	8	24
Sec – II(Q.N : 45 – 50)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 51 – 54)	Matching Type	+3	-1	4	12
Total				**18**	**60**

MATHEMATICS

Max Marks: 60

SECTION – I
(NUMERICAL VALUE TYPE)

This section contains **EIGHT (08)** questions.

- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will bee evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the correct numerical value is entered ;
Partial Mark: 0 In all other cases.

1. The number of possible ordered (n+1) integral tuples $\left(K_1, K_2, ...K_n, n\right); K_i; 1 \le i \le n,\ n, i \in N$. such that $K_1 + K_2 + K_3 + ... + K_n = 5n-4$ and $\sum_{i=1}^{n} \frac{1}{K_i} = 1$ and n always take last position is equal to _______

2. If $\int \frac{(1 + x\cos x - \sin x)\,dx}{(x + \sin x + \cos x)^{1/2}(x - \sin x + \cos x)^{3/2}} = (x + \ell \sin x + m\cos x)^n (x + p\sin x + q\cos x)^r + C$ (where C is constant of integration and $\ell, n > 0$) then the value of $\left(\frac{\ell + m}{n}\right)(p-q)r$ is equal to ______

3. The number of real solutions of the equation $x^{(x-1)^2} = 2x + 1$ is______

4. Let $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ where a, b, c, d are positive integers arranged in ascending order, and exactly two of a, b, c, d are prime numbers and also pair wise coprime and satisfies $A^2 - 16A - 17I = 0$ (where I is an Identity matrix of order 2×2). If $B = \begin{bmatrix} b & a \\ c & d \end{bmatrix}$, then $Det\ B$ equals ______

5. Consider the complex number "z" satisfying $|z-3| + |z| + |z+3| = 12$ and if $|z| \le a$ and $|z| > b$, then the sum of (minimum integral value of a) + (maximum integral value of b) is ______

6. If the equation $x^4 + ax^3 + 2x^2 + bx + 1 = 0$ has at least one real root $(a, b \in R)$ then the minimum value of $4\left(a^2 + b^2\right)$ is equal to ____

7. Let $S=\{2^0,2^1,2^2,..,2^{10}\}$. Consider all possible positive differences of elements of S. If R is the sum of all these differences, then number of divisors of the sum of the digits of R is equal to _______

8. For the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (where a > b), if the locus of centroid of the triangle formed by the centre and the points of intersection of chord with ellipse which subtends right angle at the origin is $4a^2b^2\left(x^2b^4+y^2a^4\right)=K\left(a^2+b^2\right)\left(x^2b^2+y^2a^2\right)^2$, the value of 4K _________

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

This section contains **SIX (06)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks :+4 **ONLY** if (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen;
Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;
Partial Marks: +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

9. If $\int_0^1 \frac{x^4\left(1+x^{10065}\right)}{\left(1+x^5\right)^{2015}}dx=\frac{1}{p}$, then which is/are **CORRECT** ?

A) Number of ways in which p can be expressed as a product of two relatively prime factors is 8.

B) Number of ways in which p can be expressed as a product of two relatively prime factors is 4.

C) Number of ways in which p can be expressed as a product of two factors is 8.

D) Number of ways in which p can be expressed as a product of two factors is 4.

10. Let $S_k=\sum_{j=0}^{k} 2^{k-j}\binom{k+j}{j}; k\in W, \binom{n}{r}$ represents ${}^nC_r$ then which is/are **CORRECT**?

A) $S_{100}=4S_{98}$

B) $S_{100}=16S_{98}$

C) $\sum_{k=1}^{100} S_k=\frac{2}{3}\left(2^{200}-1\right)$

D) $\sum_{k=1}^{200} S_k=\frac{4}{3}\left(2^{400}-1\right)$

11. Let $a_n = 3n + \sqrt{n^2 - 1}$ and $b_n = 2\left(\sqrt{n^2 - n} + \sqrt{n^2 + n}\right), n \geq 1$, then the value of $\sqrt{a_1 - b_1} + \sqrt{a_2 - b_2} + ... + \sqrt{a_{49} - b_{49}} = c + d\sqrt{2}$ for some integer c and d then which is/are **CORRECT** ?

A) $c + 2d = 3$ **B)** $d - 2c = 14$ **C)** $c + d = 1$ **D)** $d - c = 9$

12. Two finite sets A and B have $'m'$ and $'n'$ elements respectively. Number of elements in the power set of A is 112 more than the number of elements in the power set of B. The mean of m, n, t is zero and t is a real number. Standard deviation of m, n, t is $\sqrt{P}$ (where $P \in N$). Then $'P'$ is divisible by

A) 2 **B)** 3 **C)** 31 **D)** 37

13. Let P(0, 6) and Q(0, – 4) be distinct points on parabola 'C' with focus O(0, 0). Let 'L' and 'a' denotes the length of latusrectum and length of intercept on x–axis by parabola C respectively. Then which of the following is/are **TRUE** ?

A) The value of L is $\frac{48}{5}$ **B)** The value of 'a' is 240

C) The value of L is $\frac{24}{5}$ **D)** The value of 'a' is 120

14. If $c \geq 0$, then the equation $|z|^2 - 2iz + 2c(1+i) = 0$ (z is complex) has

A) Infinitely many solutions if $c < \sqrt{2} - 1$

B) Has unique solution if $c = \sqrt{2} - 1$

C) Finite number of solutions if $c > \sqrt{2} - 1$

D) No solutions if $c > \sqrt{2} - 1$

SECTION – III
(MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists : **List-I** and **List-II.**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the option corresponding to the correct combination is chosen;
Zero Marks: 0 If none of the options is chosed (i.e. the question is unanswered);
Negative Marks: –1 In all other cases.

15. Considering the equation of the circle $x^2+y^2=9$ and a line $y=1$ which divides the circle in to two regions let small region be R_1 and other be R_2.

	LIST-I		LIST-II
A)	Radius of biggest circle lying in region R_1	**P)**	$2\left(\sqrt{3}-1\right)$
B)	Radius of biggest circle lying in region R_2	**Q)**	$\frac{3}{2}$
C)	If two circles of equal radii touching each other externally lying in region R_2 then maximum value of their radii is	**R)**	2
D)	If the length of intercept made by line $y=1$ on a circle which is concentric with given circle is $\sqrt{5}$ then radius of the circle is	**S)**	1

A) A–Q; B–R; C–S; D–P B) A–S; B–R; C–P; D–Q

C) A–P; B–Q; C–S; D–R D) A–S; B–P; C–R; D–Q

16. A variable plane cuts the positive x–axis, positive y–axis and positive z–axis at the points A, B and C respectively such that the volume of the tetrahedron OABC remains constant equal to 32 cubic units and O is the origin of the co–ordinate system.

	LIST-I		LIST-II
A)	The equation to the locus of the centroid of the tetrahedron is	**P)**	xyz = 24
B)	The equation to the locus of the point equidistant form O, A, B and C is	**Q)**	$\left(x^2+y^2+z^2\right)^3=192\,xyz$
C)	The equation to the locus of the foot of perpendicular from origin to the plane is	**R)**	xyz = 3
D)	If PA, PB and PC are mutually perpendicular then the locus of P is	**S)**	$\left(x^2+y^2+z^2\right)^3=1536\,xyz$

A) A–P; B–Q; C–R; D–S B) A–Q; B–R; C–P; D–S

C) A–R; B–P; C–Q; D–S D) A–Q; B–R; C–S; D–P

17. Match List-I with List-II and select the correct answer using the code given below the lists :

	LIST-I		**LIST-II**
A)	The number of integers satisfying the equation in $n,(1-i)^n = 2^n$, is	**P)**	4
B)	The number of complex common roots of the equations $x^3+2x^2+2x+1=0$ and $x^{2000}+x^{2002}+1=0$, is	**Q)**	3
C)	The number of complex numbers 'Z' satisfying $\overline{Z} = iZ^2$, is	**R)**	2
D)	If Z is a complex number, then the number of solutions of $Z^2+\|Z\|=0$, is	**S)**	1

A) A–S, B–P, C–R, D–Q B) A–Q, B–R, C–P, D–S

C) A–S, B–R, C–P, D–Q D) A–Q, B–P, C–S, D–R

18. Let A and B are non singular square matrices of order 3×3 such that B is adjoint of A and $A^{-1}A^T = |A|B^{-1}$. Match List-I with List-II and select the correct answer using the code given below the list.

	LIST-I		**LIST-II**
A)	$\|A\|$ is equal to	**P)**	1
B)	$\|B\|$ is equal to	**Q)**	$A=I$
C)	If A is symmetric matrix then	**R)**	$A^3=I$
D)	If A is orthogonal matrix then	**S)**	$B=I$
		T)	$B^3=I$
		U)	-1

Where $|X|$ denotes determinant of matrix X and I is identity matrix.

A) A–P, B–U, C–Q,S, D–R,T B) A–U, B–U, C–S,T, D–Q,R

C) A–U, B–U, C–Q,R, D–S,T D) A–P, B–P, C–Q,R,S,T, D–R,T

PHYSICS **Max Marks: 60**

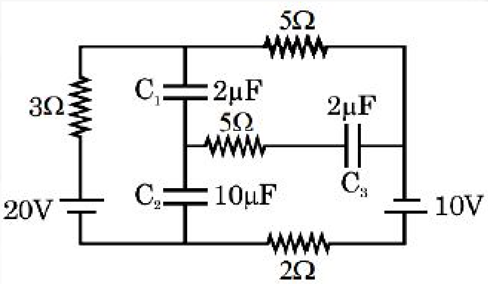
SECTION – I
(NUMERICAL VALUE TYPE)

This section contains **EIGHT (08)** questions.

- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will bee evaluated according to the following marking scheme :

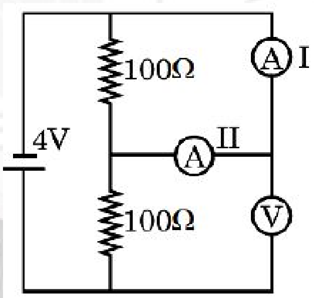
Full Marks:+3 **ONLY** if the correct numerical value is entered ;
Partial Mark: 0 In all other cases.

19. In the circuit shown in figure, if the charge on capacitor C_2 in steady state is $\frac{10x}{3}\mu C$; then x = ?



20. A parallel-plate air capacitor whose electrodes are shaped as discs of radius R = 6.0 cm is connected to a source of an alternating sinusoidal voltage with frequency $\omega = 1000 s^{-1}$. Find the ratio of peak values of magnetic and electric energies within the capacitor. If your answer is $n \times 10^{-15}$ find n = ?

21. In the figure ammeter (I) reads a current of 10mA, while the voltmeter reads a potential difference of 3V. What does ammeter (II) (in mA) read? The ammeter are identical, the internal resistance of the battery is negligible. (Consider all ammeters and voltmeters as non ideal)

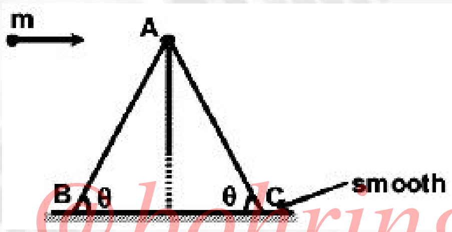


22. The peak emission from a black body at a certain temperature $t^0 C$ occurs at a wavelength $9000\overset{0}{A}$. If the peak emission from the black body at $927^0 C$ is able to just emit photo-electrons from a metal of work function 2.5 eV. The value of t (in ^0C is) is :
$\left[h = 6.6 \times 10^{-34} J - \sec\right]$

23. A balloon is rising up along the axis of a stationary concave mirror of radius of curvature 20m. A ball is dropped from the balloon at a height 15 m from the mirror when the balloon has velocity 2 m/s. Find speed of the image of the ball formed by concave mirror after 0.4 sec from the instant at which it was dropped (in m/s) $\left[g = 10m/s^2\right]$

24. Find the entropy change magnitude of v = 2.0 moles of an ideal gas whose adiabatic exponent $\gamma = 1.30$ if, as a result of a certain process, the gas volume increased $\alpha = 2.0$ times while the pressure dropped $\beta = 3.0$ times.

25. A particle of mass 0.01 kg moving horizontally with velocity 20 m/s strikes a stationary wedge of mass 0.05 kg near the apex of the wedge and comes to rest immediately after the collision. The wedge is free to move on the smooth floor. Second collision of particle with wedge occurs at B. If the length AB of wedge is $\frac{10K}{\sqrt{5}}$ meter, then find K. Take $\theta = \cot^{-1}(2)$. Neglect the toppling of wedge. $\left(g = 10m/\sec^2\right)$



26. A particle of mass equal to mass of the earth is projected by an external agency so that there is no recoil in earth when particle is projected. In this case escape velocity of the particle will be $\sqrt{10kgR_e}$, (g is acceleration due to gravity on the surface of the earth and R_e = radius of the earth). Then find the value of k

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

This section contains **SIX (06)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks :+4 **ONLY** if (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen;
Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;
Partial Marks: +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

27. A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a + bV where a and b are constants. The initial and final pressure are $10^3 kPa$ and 200 kPa and corresponding volumes are $0.2m^3$ and $1.2m^3$. The specific internal energy of the gas is given by $U = 1.5pV - 85kJ/kg$ (where P is in kPa and V in m^3/kg):-

A) Work done by gas during process is 600 kJ

B) Change in internal energy of the gas is 90 kJ

C) Maximum internal energy during process is approximately 500 kJ.

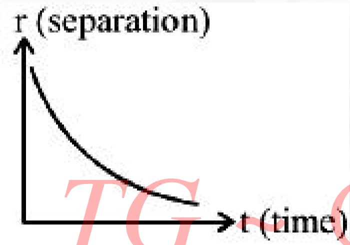
D) Maximum internal energy during process is approximately 300 kJ.

28. A radioactive point source has a decay constant λ. When this source moves towards small area counter kept at large distance from source, then counter records count/second which turns out to be constant:

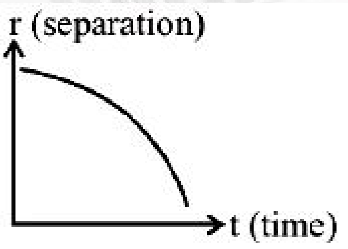
A) When separation between source and counter becomes half of initial value, number of nuclei left undecayed will be $\frac{3}{4}th$ of initial value

B) When separation between source and counter becomes half of initial value, number of nuclei left undecayed will be $\frac{1}{4}th$ of initial value

C) Graph showing variation of separation between source and counter with time is as shown



D) Graph showing variation of separation between source and counter with time is as shown



29. A diatomic gas is kept in a closed container of constant volume. Due to increase in temperature some molecules dissociates into atoms. Neglecting vibrational degrees of freedom

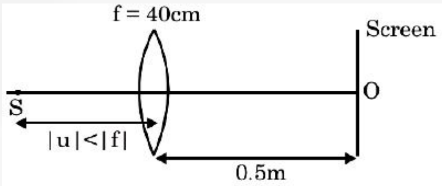
A) Specific heat capacity of mixture will increase.

B) Specific heat capacity of mixture will decrease

C) Specific heat capacity of mixture can change by a maximum value of 8%

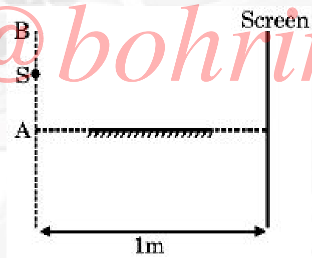
D) Specific heat capacity of mixture can change by a maximum value of 20%

30. A lens of focal length f = 40 cm is cut along the diameter into two equal halves. In this process, a layer of thickness t = 1 mm is lost, then halves are put together to form a composite lens. In between focal plane and the composite lens a narrow slit is placed very close to the focal plane $|u|<|f|$. The slit is emitting monochromatic light of wavelength $0.6\mu m$. Behind the lens a screen is located at a distance L = 0.5 m from it as shown



A) Fringe width is 0.12 mm
B) Fringe width is 0.24 mm
C) Length of interference pattern is 1/8 cm
D) Length of interference pattern is 1/16 cm

31. In an interference experiment as shown in the figure, the source plane and screen are separated by a distance 1m. At a certain position of source, fringe width is $\frac{1}{4}$mm and by moving the source a way from mirror along the line AB by 0.6 mm, the fringe width changed to $\frac{1}{6}mm$



A) Wavelength of light used is $5000\,\overset{0}{A}$
B) Wavelength of light used is $6000\,\overset{0}{A}$
C) Initial distance of source from A is 1.2 mm
D) Initial distance of source from A is 0.6 mm

32. A particle of mass $6.6\times10^{-30}kg$ starts (t = 0) moving on a straight line with velocity 10 m/s. Its velocity decreases with time, however rate of change of de-Broglie wavelength associated with particle remains constant at 10^{-4} m/s. (Take $h=6.6\times10^{-34}J-s$) :-
A) Velocity of particle at t = 0.9s is 1 m/s
B) Velocity of particle at t = 0.9s is 6 m/s
C) Magnitude of retardation of particle at t = 0.9 s is 4 m/s^2
D) Magnitude of retardation of particle at t = 0.9 s is 1 m/s^2

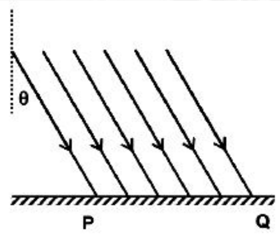
SECTION – III
(MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists : **List-I** and **List-II.**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the option corresponding to the correct combination is chosen;
Zero Marks: 0 If none of the options is chosed (i.e. the question is unanswered);
Negative Marks: –1 In all other cases.

33. A parallel beam of light is incident on a fixed surface PQ at an angle 'θ' with the vertical as shown in the figure. The intensity of light is I and area of surface PQ is A. In List-I nature of reflection are given and in List-II force and generated radiation pressure are given. Then match List-I with suitable option List-II. (Given that I = 500 W$/m^2$, $A=1.5m^2, \theta=37^0$)



	LIST-I		LIST-II
P)	If all the incident energy is absorbed by surface PQ then force on the surface and radiation pressure generated are respectively.	1)	$3.2\times10^{-6}N, 2.13\times10^{-6}N/m^2$
Q)	If all the incident energy is reflected by surface PQ then force on the surface and radiation pressure generated are respectively.	2)	$2.24\times10^{-6}N, 1.38\times10^{-6}N/m^2$
R)	If 30% incident energy is reflected by the surface then force on the surface and pressure generated are respectively. (Rest absorbed)	3)	$2.74\times10^{-6}N, 1.81\times10^{-6}N/m^2$
S)	If 70% incident energy is reflected back then force on the surface and radiation pressure are respectively. (Rest absorbed)	4)	$2\times10^{-6}N, 1.06\times10^{-6}N/m^2$
		5)	$4.2\times10^{-6}N, 3.13\times10^{-6}N/m^2$

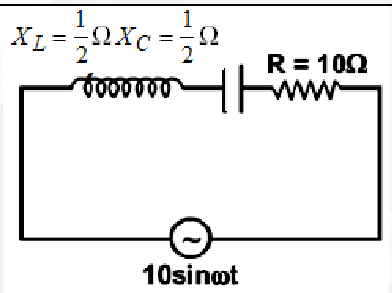
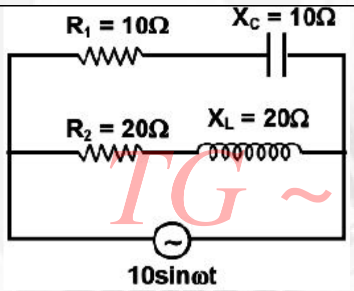
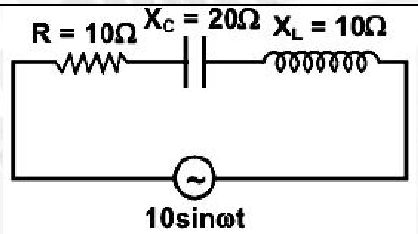
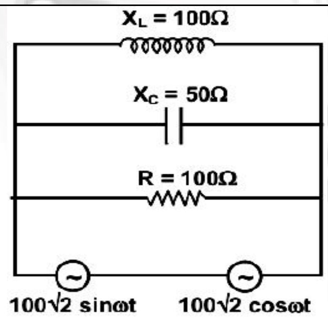
A) $P \to 4;$ $Q \to 1;$ $R \to 3;$ $S \to 2$

B) $P \to 3;$ $Q \to 2;$ $R \to 1;$ $S \to 4$

C) $P \to 3;$ $Q \to 5;$ $R \to 4;$ $S \to 2$

D) $P \to 4;$ $Q \to 1;$ $R \to 2;$ $S \to 3$

34. Some electric circuits with an A.C. source is given in List-I. In List-II instantaneous current and average power delivered by A.C. source are given. The Match List-I with List-II.

	LIST-I		LIST-II
P)		1)	$I = \frac{\sqrt{10}}{4}\sin\left[\omega t + \frac{\pi}{4} - \tan^{-1}\left(\frac{1}{2}\right)\right],$ $P = \frac{15}{4}$ watt
Q)		2)	$I = 2\sqrt{2}\cos\omega t, P = 200$ watt
R)		3)	$I = \sin\omega t, P = 5$ watt
S)		4)	$I = \frac{1}{\sqrt{2}}\sin\left(\omega t + \frac{\pi}{4}\right), P = \frac{5}{2}$ watt
		5)	$I = \frac{\sqrt{10}}{4}\sin\left(\omega t + \frac{\pi}{4} - \tan^{-1}(2)\right), P = \frac{7}{2}$ watt

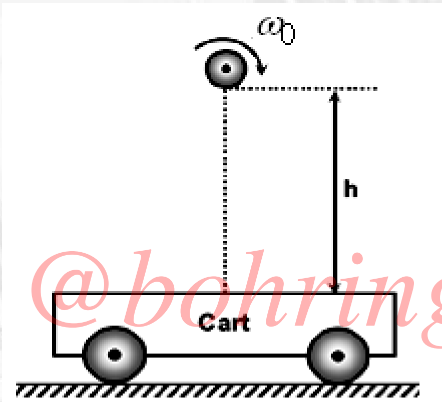
A) $P \to 4;$ $Q \to 4;$ $R \to 1;$ $S \to 4$

B) $P \to 3;$ $Q \to 3;$ $R \to 1;$ $S \to 3$

C) $P \to 3;$ $Q \to 1;$ $R \to 4;$ $S \to 2$

D) $P \to 4;$ $Q \to 3;$ $R \to 4;$ $S \to 1$

35. A solid sphere of mass m = 80 kg and radius r = 0.2 m is released from height h = 5/4 meter. Sphere is initially rotating about horizontal axis passing through its centre of mass. It hits with a stationary cart of mass M = 200 kg exactly at the centre of cart. The cart can move smoothly on the horizontal surface. The collision between sphere and cart occurs in such a way that sphere reaches at same vertical displacement after collision and falls back onto it again. It is found that sphere starts pure rolling at the end of first collision. The coefficient of friction between sphere and cart is $\mu = 0.1$. Match the statement given in **List-I** to the values given in **List-II.** $\left(g = 10m/\sec^2\right)$



LIST-I		LIST-II	
P)	The minimum length (in meter) of cart to occur second collision with the sphere	1)	172
Q)	Initial angular velocity 'ω_0'(in rad/sec) of sphere on the cart during the process.	2)	2.8
R)	Magnitude of work done (in Joule) by sphere on the cart during the process.	3)	156
S)	Magnitude of work done (in Joule) by cart on the sphere during the process	4)	19.5
		5)	16

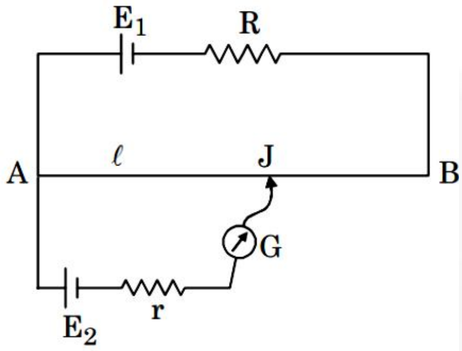
A) $P \to 2;$ $Q \to 4;$ $R \to 5;$ $S \to 1$

B) $P \to 1;$ $Q \to 3;$ $R \to 1;$ $S \to 3$

C) $P \to 3;$ $Q \to 5;$ $R \to 4;$ $S \to 2$

D) $P \to 4;$ $Q \to 3;$ $R \to 4;$ $S \to 1$

36. In the potentiometer arrangement shown in figure, null point is obtained at length ℓ. Match the following (E_2 is ideal)



LIST-I		LIST-II	
P)	If E_1 is increased	1)	ℓ should increase
Q)	If R is increased	2)	ℓ should decrease
R)	If E_2 is increased	3)	ℓ should remain the same to again get null point
S)	If r is shunted	4)	ℓ becomes zero
		5)	

A) $P \to 1;$ $Q \to 2;$ $R \to 3;$ $S \to 4$

B) $P \to 2;$ $Q \to 1;$ $R \to 3;$ $S \to 4$

C) $P \to 2;$ $Q \to 1;$ $R \to 1;$ $S \to 3$

D) $P \to 4;$ $Q \to 1;$ $R \to 2;$ $S \to 3$

CHEMISTRY **Max Marks: 60**

SECTION – I
(NUMERICAL VALUE TYPE)

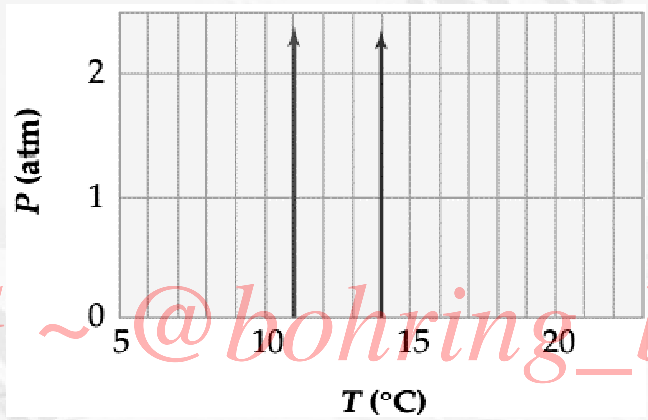
This section contains **EIGHT (08)** questions.

- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will bee evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the correct numerical value is entered ;
Partial Mark: 0 In all other cases.

37. The following phase diagram shows a very small part of the solid–liquid phase-transition boundaries for two solutions of equal concentration. Substance A has i = 1, and substance B has i = 3.

i = vanthoff factor



What is the melting point of the pure liquid solvent in centigrade scale?

38. At constant temperature and volume, X decomposes as $2X(g) \rightarrow 3Y(g) + 2Z(g)$. P_x is the partial pressure of X at given time.

Observation

Number	Time (min)	Px (mm Hg)
1	0	800
2	100	400
3	200	200

What is the time required (in minutes) for completion of 87.5% of the reaction?

Given ln2=0.693

39. What is the millimolar concentration of CH_3COO^- ion in a solution prepared by adding 0.1 mole of $CH_3COOAg(s)$ in 1 L of 0.1 M – HCl solution ?

$\left[Given: Ka(CH_3COOH)=10^{-5}; K_{sp}(AgC\ell)=10^{-10}; K_{sp}(CH_3COOAg)=10^{-8}\right]$

40. Under adiabatic conditions, hydrogen gas and a theoretical amount of air (20% O_2 and 80% N_2, by volume) initially at $27^\circ C$ and a total pressure of 1 atm is burnt in a closed rigid vessel. What is the final pressure (in atm) in the container?

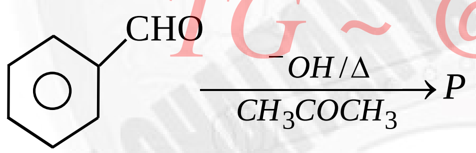
Given:

$C_{V,m(H_2O)_g} = 6.2\,cal/K-mol$

$C_{V,m(N_2)_g} = 4.9\,cal/K-mol$

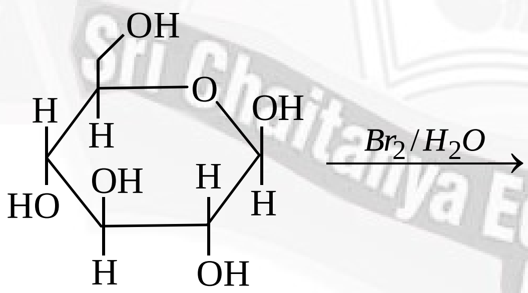
$\Delta_f U[H_2O(g)] = -56.0\,kcal$ U = Intenal energy

41.



A compound 'Q' is obtained when product of above reaction 'P' is kept in OD^-/D_2O.
Molecular mass of Q is:

42.



Number of chiral centres present in the product of the given reaction is :

43. What is the value of 'n' in the following silicate ion?

$[Si_6O_{18}]^{n-}$.

44. How many of the following statements are correct regarding FNNF molecule.

i) It exists as two distinct geometric isomers.

ii) It is planar.

iii) Its nitrogen-nitrogen bond is longer than that in N_2F_4.

iv) It is more stable than its structural isomer with both fluorine atoms bonded to the same nitrogen.

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

This section contains **SIX (06)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks :+4 **ONLY** if (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen;
Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;
Partial Marks: +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

45. Consider the two gaseous equilibria,

$A_2 \rightleftharpoons 2A$

$AB \rightleftharpoons A+B,$

Assume that the $\Delta_r G^0$ and therefore equilibrium constant are same for both. An enclosure is initially packed with A and B in atomic state. B never dimerises. Which of the following is/are must be correct?

A) Extent of formation of AB is more than that of A_2

B) Partial pressure of AB is less than partial pressure of A_2

C) Number of moles of AB is same as number moles of A_2

D) Mole fraction of AB at equilibrium is dependent on initial partial pressures of A and B.

46. A hydrogen atom emits light when electron changes its energy state initially from $(n+3)d_{xy}$ to nP_x, called by transition **(X)**. Which of the following change(s) cause(s) more energy to the emitting photon than transition **X**? n is an integer.

A) The initial state is changed to an orbital with no angular node with principal quantum number (n+4).

B) The initial state is changed to an orbital with two angular nodes with principal quantum number (n+2).

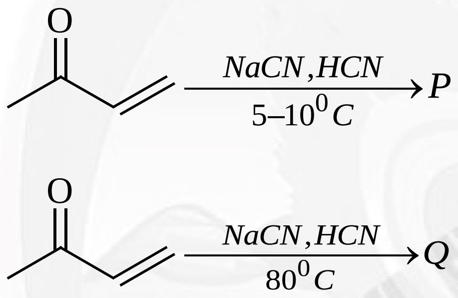
C) The final state is changed to $(n+1)d_{xy}$.

D) The final state is changed to (n–1)s.

47. Which of the following is/are obtained on hydrolysis of Sucrose ?

A) α–D–Glucose **B)** β–D–Glucose **C)** α–D–Fructose **D)** β–D–Fructose

48.



Select the **CORRECT** option(s) :

A) P and Q are same

B) P has one sp^2 carbon while Q has two sp^2 carbons.

C) As per IUPAC nomenclature, parent chain length in both P and Q are different.

D) Degree of unsaturation of both P and Q is same.

49. Which of the following is a pair of a Lewis acid and Lewis base?

A) $H^+, (C_2H_5)_2O$ **B)** $A\ell C\ell_3, H_2O$

C) Fe^{+3}, CO **D)** SiF_4, BF_3

50. The type/s of isomerism that $Co(NH_3)_4Br_2C\ell$ can exhibit is/are

A) Geometrical isomerism **B)** Ionisation isomerism

C) Optical isomerism **D)** Coordination isomerism

SECTION – III
(MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists : **List-I** and **List-II.**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the option corresponding to the correct combination is chosen;
Zero Marks: 0 If none of the options is chosed (i.e. the question is unanswered);
Negative Marks: –1 In all other cases.

51. Match the Column.

LIST-I		LIST-II	
P)	Nylon–6	I)	Natural polymer
Q)	PHBV	II)	Step growth polymer
R)	LDPE	III)	Co–polymer
S)	Buna–S	IV)	Not a polyester

A) P–III, IV ; Q–II, III, IV ; R–II, IV ; S–III, IV

B) P–II, IV ; Q–II, III ; R–IV ; S–III, IV

C) P–II, III ; Q–I, II, IV ; R–I, IV ; S–I, II

D) P–IV ; Q–II, III ; R–III, IV ; S–II, III

52. Match the Column.

LIST-I (Pair of compounds)		LIST-II (Can be distinguished by)	
P)	CH_3CHO and $PhCHO$	I)	Iodoform test
Q)	CH_3CH_2OH and CH_3OCH_3	II)	Barfoed test
R)	Cane sugar and Lactose	III)	Carbylamine reaction
S)	$CH_3CH_2NH_2$ and $PhNH_2$	IV)	Victor meyer test
		V)	Azo–dye test

A) P–IV, V ; Q–IV, R–III ; S–V B) P–I, IV ; Q–I, R–II ; S–III

C) P–I ; Q–I, IV, R–II ; S–V D) P–IV ; Q–IV, R–I ; S–III

53. List-I contains compounds and List-II contains reactions/methods.

LIST-I		LIST-II	
I)	Na_2CO_3	P)	Exhaustive electrolysis of water
II)	H_2O_2	Q)	Heating of $NaHCO_3$
III)	D_2O	R)	Electrolysis of aq. $NaC\ell$
IV)	NaOH	S)	Autooxidation
		T)	Hydrolysis of $(NH_4)_2 S_2O_8$ with D_2O

A) I-Q, II-S, III-P, IV-R B) I-Q, II-T, III-P, IV-R

C) I-R, II-T, III-P, IV-R D) I-R, II-S, III-R, IV-P

54. List-I having complex compounds, List-II having hybridization / no. of unpaired electrons.

LIST-I		LIST-II	
I)	$Ni(CO)_4$	P)	sp^3d^2
II)	$[NiF_6]^{-2}$	Q)	d^2sp^3
III)	$[FeF_6]^{-4}$	R)	Even no. of unpaired electrons.
IV)	$[Co(H_2O)_6]^{+2}$	S)	Odd no. unpaired electrons.
		T)	sp^3

A) I–T, II–Q, III–P, IV–S B) I–T, II–Q, III–R, IV–Q

C) I–Q, II–T, III–P, IV–P D) I–T, II–P, III–R, IV–P

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S   JEE-ADVANCE-2022_P1   Date: 17-05-2023

Time: 09.00Am to 12.00Pm   GTA-24   Max. Marks: 180

KEY SHEET

MATHEMATICS

1	**8**	2	**4**	3	**2**	4	**43**	5	**7**	6	**32**
7	**4**	8	**36**	9	**AC**	10	**BD**	11	**ABD**	12	**AC**
13	**AB**	14	**BD**	15	**B**	16	**C**	17	**C**	18	**D**

PHYSICS

19	**3.0**	20	**5**	21	**6.66 to 6.67**	22	**386 - 389**	23	**8**	24	**11**
25	**0.40**	26	**0.40**	27	**AB**	28	**BC**	29	**AD**	30	**BC**
31	**BC**	32	**AD**	33	**D**	34	**C**	35	**A**	36	**C**

CHEMISTRY

37	**15.50**	38	**300**	39	**1**	40	**10.81 - 10.94**	41	**149**	42	**4**
43	**12**	44	**3**	45	**D**	46	**AD**	47	**ABCD**	48	**CD**
49	**ABC**	50	**AB**	51	**B**	52	**C**	53	**A**	54	**A**

SOLUTIONS

MATHEMATICS

1. A.M. $\geq$ H.M. $\Rightarrow \left(K_1+K_2+........+K_n\right) \geq \dfrac{n^2}{\sum \frac{1}{K_i}}$

$\Rightarrow 5n-4 \geq n^2 \Rightarrow n^2-5n+4 \leq 0 \Rightarrow (n-4)(n-1) \leq 0 \Rightarrow 1 \leq n \leq 4$

$\Rightarrow n=1 \Rightarrow K_1=1;\ n=2;\ \text{not possible} \Rightarrow$ number of $(1,1) \to 1$

$n=3;(2,3,6,3)$ 6 ways $n=4;(4,4,4,4,4)$ 1 way

Total no of required ordered tuples = 8.

2. $\dfrac{x+\sin x+\cos x}{x-\sin x+\cos x}=t^2 \quad \dfrac{2(1+x\cos x-\sin x)}{(x-\sin x+\cos x)^2}dx=2dt$

$I=\int \dfrac{tdt}{t}=t+C \quad =(x+\sin x+\cos x)^{1/2}(x-\sin x+\cos x)^{-1/2}+C$

3. $x^{x^2-2x+1}=2x+1 \Rightarrow x^{x^2+2-(2x+1)}=2x+1$

$\Rightarrow x^{x^2}.x^2=x^{2x+1}.(2x+1) \qquad \Rightarrow x=1\pm\sqrt{2}$

4. Tr(A) = 16, Det(A) = – 17

a + d = 16 and ad – bc = – 17

Given a < b < c < d

(a, d) = (1,15) (2,14) (3,13) (4,12) (5,11) (6,10) (7,9)

bc = ad + 17 = 32, 45, 56 , 65 , 72 , 77 , 80

(b, c) = (4, 8) (5, 9) (7, 8) (5, 13) (8, 9) (7, 11) (8, 10)

(a, b, c, d) = (1, 4, 8, 15) (2, 5, 9, 14) (3, 7, 8, 13) (4, 5, 13, 12)

(5, 8, 9, 11) (6, 7, 11, 10) (7, 8, 10, 9)

Possible values are (2, 5, 9, 14) (3, 7, 8, 13) (5, 8, 9, 11)

Exactly two of a, b, c, d are prime and pair wise also coprime

Case : 1 (2, 5, 9, 14) 2 primes but pair wise not coprime

Case : 2 (3, 7, 8, 13) 3 primes and pair wise coprime (given exactly two are primes)

Case : 3 (5, 8, 9, 11) 2 primes and pair wise coprime

Only possible answer is (5, 8, 9, 11)

$|B|$ = bd – ac = 88 – 45 = 43

5. $RMS \geq AM$

$\Rightarrow \sqrt{\dfrac{|z-3|^2+|z|^2+|z+3|^2}{3}} \geq \dfrac{|z-3|+|z|+|z+3|}{3} \quad \sqrt{\dfrac{3\left(|z|^2+6\right)}{3}}$

$|z| \geq \sqrt{10}$ And $|z-3|+|z|+|z+3| \geq 3|z| \quad |z| \leq 4$

6. Let x be the real root of the equation. So $ax^3+bx=-\left(x^4+2x^2+1\right)$

Using Cauchy-Schwarz inequality $\left(a^2+b^2\right)\left(x^6+x^2\right)\ge\left(x^4+2x^2+1\right)^2$

$$a^2+b^2\ge\frac{\left(x^2+\frac{1}{x^2}+2\right)^2}{x^2+\frac{1}{x^2}}\ge 8$$

7. $S=\left\{2^0,2^1,2^2,..........2^{10}\right\}$ $\qquad\therefore R=\sum_{s=1}^{10}\sum_{r=0}^{s-1}\left(2^s-2^r\right)$

$$=\sum_{s=1}^{10}\left(2^s-2^0\right)+\left(2^s-2^1\right)+....+\left(2^s-2^{s-1}\right)$$

$$=\sum_{s=1}^{10}\underbrace{\left(2^s+2^s+........+2^s\right)}_{s\,times}-\left(2^0+2^1+........+2^{s-1}\right)$$

$$=\sum_{s=1}^{10}s.2^s-\left(2^s-1\right)$$ (using sum of G. P. series) $$=\sum_{s=1}^{10}\left[2^s\left(s-1\right)+1\right]$$

$$=\left[2^1(1-1)+1\right]+\left[2^2(2-1)+1\right]+\left[2^3(3-1)+1\right]+.......+\left[2^{10}(10-1)+1\right]$$

$$=2^2\left(2^0.1+2^1.2+2^2.3+.....+2^8.9\right)+10$$

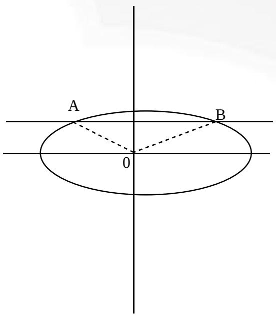
$$=2^2\left[8.2^9+1\right]+10=4\left(8.2^9+1\right)+10$$

$$\boxed{\begin{array}{l}\left(\text{Using sum of A.G. P of n terms, n = 9 and r = 2}\right)\\ S_n=\dfrac{a}{1-r}+\dfrac{ar\left(1-r^{n-1}\right)}{(1-r)^2}-\dfrac{\left[a+(n-1)d\right]r^n}{1-r}\end{array}}$$

$\therefore$ Sum of the digit of R = 1 + 6 + 3 + 9 + 8 = 27 = ___

$\therefore$ Number of divisors of R = 4

8.



Centroid $G\left(\dfrac{x_1+x_2}{3},\dfrac{y_1+y_2}{3}\right)$

$$(\alpha,\beta)=\left(\frac{x_1+x_2}{3},\frac{y_1+y_2}{3}\right)$$

$x_1+x_2=3\alpha, y_1+y_2=3\beta$

$(x_1,y_1)\,\&\,(x_2,y_2)$ are point 7

Ellipse $\Rightarrow \dfrac{x_1^2}{a^2}+\dfrac{y_1^2}{b^2}=1$____(1)

$\dfrac{x_2^2}{a^2}+\dfrac{y_2^2}{b^2}=1$____(2)

$$(1)-(2)\Rightarrow \frac{(x_1-x_2)(x_1+x_2)}{a^2}+\frac{(y_1-y_2)(y_1+y_2)}{b^2}=0$$

$$\Rightarrow \frac{(x_1-x_2)(3\alpha)}{a^2}+\frac{(y_1-y_2)(3\beta)}{b^2}=0$$

$\Rightarrow$ slope of line $AB=\dfrac{y_2-y_1}{x_2-x_1}\quad m=-\dfrac{b^2\alpha}{a^2\beta}$

Consider line AB as $y=mx+c$

(x_1,y_1) and (x_2,y_2) lies on it

$$\left.\begin{array}{l} y_1=mx_1+c \\ y_2=mn_2+c \end{array}\right]\Rightarrow 3\beta=m(3\alpha)+2c \quad \Rightarrow c=\frac{(\beta-m\alpha)3}{2}$$

Homogenizing ellipse with line $\dfrac{b^2x^2+a^2y^2}{a^2+b^2}-\left(\dfrac{y-mx}{c}\right)^2=0$

Right angle at origin $\Rightarrow \dfrac{1}{a^2}+\dfrac{m^2}{c^2}+\dfrac{1}{b^2}-\dfrac{1}{c^2}=0$

9. Put $x^5=t \quad I=\dfrac{1}{5}\displaystyle\int_0^1\frac{1+t^{2013}}{(1+t)^{2015}}dt$

$$=\frac{1}{5}\int_0^1\frac{1}{(1+t)^{2015}}dt+\frac{1}{5}\int_0^1\frac{t^{-2}}{\left(t^{-1}+1\right)^{2015}}dt=\frac{1}{5}\times\frac{1}{2014}$$

$\therefore \quad p=5\times 2014=2\times 5\times 19\times 53$

10. $S_k=\displaystyle\sum_{j=0}^{k}2^{k-j}\left({}^{k+j-1}C_j+{}^{k+j-1}C_{j-1}\right)=2.S_{k-1}+\frac{S_k}{2} \qquad \Rightarrow S_k=4S_{k-1}$

We get $S_k=4^k\,\forall k\in W\,(S_0=1)$

11. $a_k-b_k=\dfrac{1}{2}\left[4k+(k+1)+(k-1)-4\sqrt{k^2+k}+4\sqrt{k^2-k}+2\sqrt{k^2-1}\right]$

$=\dfrac{1}{2}\left(2\sqrt{k}-\sqrt{k+1}-\sqrt{k-1}\right)^2.$ From here we obtain

$$\sqrt{a_k - b_k} = \frac{1}{\sqrt{2}}\left(2\sqrt{k} - \sqrt{k+1} - \sqrt{k-1}\right)$$

$$= -\frac{1}{\sqrt{2}}\left(\sqrt{k+1} - \sqrt{k}\right) + \frac{1}{\sqrt{2}}\left(\sqrt{k} - \sqrt{k+1}\right).$$

Given sum $= -\frac{1}{\sqrt{2}}\left(\sqrt{50} - \sqrt{1}\right) + \frac{1}{\sqrt{2}}\left(\sqrt{49} - \sqrt{0}\right) = -5 + 4\sqrt{2}$

12. $2^m - 2^n = 112 \quad \Rightarrow \quad m = 7$ an n = $4 \Rightarrow t = -11$

$$\sigma^2 = \frac{7^2 + 4^2 + (-11)^2}{3} = 62 \Rightarrow \quad \sigma = \sqrt{62}$$

13. $y = mx + c$ is directrix of parabola. $S(0,0), P(0,6), Q(0,-4)$

$$SP = PM \Rightarrow 6 = \left|\frac{c-6}{\sqrt{1+m^2}}\right| \quad \_\_\_\_\_\_ (1)$$

$$SQ = QM \Rightarrow 4 = \left|\frac{c+4}{\sqrt{1+m^2}}\right| \quad \_\_\_\_\_\_ (2)$$

From (1) and (2) $\Rightarrow c = 0\,(or) - 24 \qquad m = 0\,(or) \pm 2\sqrt{6}$

$c = 0$ *and* $m = 0$ (neglected)

Directrix is $y = 2\sqrt{6}x - 24$ (or) $y = -2\sqrt{6}x - 24$

Length of latusrectum = $4a = 2(2a) = 2\left|\frac{24}{5}\right| = \frac{48}{5}$

Equation of parabola is SP = PM $\Rightarrow \sqrt{x^2 + y^2} = \left|\frac{2\sqrt{6}x + y + 24}{5}\right|$

For x–intercept of parabola put y = 0 $\Rightarrow x^2 - 96\sqrt{x} - 576 = 0 \quad a = |x_1 - x_2| = 240$

14. Let $z = x + iy$. Then

$$\left(x^2 + y^2\right) - 2i(x + iy) + 2c(1 + i) = 0$$

Therefore $x^2 + y^2 + 2y + i(2c - 2x) + 2c = 0 \longrightarrow (1)$

$$x^2 + y^2 + 2y + 2c = 0 \longrightarrow (2)$$

and $2c - 2x = 0$ *or* $x = c$, Substituting $x = c$ in Eq. (2), we get that

$$c^2 + y^2 + 2y + 2c = 0 \longrightarrow (3)$$

Equation (3) has solutions if $4 - 4\left(c^2 + 2c\right) \geq 0$, that is $1 - c^2 - 2c \geq 0$. Therefore

$$(c+1)^2 \leq 2 \text{ or } -\sqrt{2} \leq c + 1 \leq \sqrt{2} \; -\sqrt{2} - 1 \leq c \leq \sqrt{2} - 1$$

It is given that. Therefore $0 \leq c \leq \sqrt{2} - 1$.

(i) If $c < \sqrt{2} - 1$, then $z = c + \left(-1 \pm \sqrt{1 - 2c - c^2}\right)i$.

(ii) If $c=\sqrt{2}-1$, then $z=\left(\sqrt{2}-1\right)-i$.

(iii) If $c>\sqrt{2}-1$, the equation has no solutions.

15. A) $r=1$

B) $r=2$

C) $r=2\sqrt{3}-2$

D) $r=\frac{3}{2}$

16. Given $\frac{abc}{6}=32$ Where $A=(a,0,0),B(0,b,c),C(0,0,c)$

a) Centroid of tetrahedron $(\alpha,\beta,\delta)=\left(\frac{a}{4},\frac{b}{4},\frac{c}{4}\right)\Rightarrow 64\alpha\beta\delta=abc\Rightarrow xyz=3$

b) Equidistant point $(\alpha,\beta,\delta)=\left(\frac{a}{2},\frac{b}{2},\frac{c}{2}\right)\Rightarrow 8\alpha\beta\delta=abc\Rightarrow xyz=24$

c) The equation of the plane is $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$

$\therefore$ Foot of the perpendicular from origin = (α,β,δ)

$$(\alpha,\beta,\delta)=\left(\frac{1/a}{\Sigma\frac{1}{a^2}},\frac{1/b}{\Sigma\frac{1}{a^2}},\frac{1/c}{\Sigma\frac{1}{a^2}}\right)\Rightarrow\left(\alpha^2+\beta^2+\delta^2\right)^3=192\,\alpha\beta\delta$$

D) Let P be (α,β,δ) then $PA\perp PB\Rightarrow\alpha(\alpha-a)+\beta(\beta-b)+\delta\delta=0$

$\Rightarrow a\alpha+b\beta=\alpha^2+\beta^2+\delta^2$

$PB\perp PC\Rightarrow b\beta+c\delta=\alpha^2+\beta^2+\delta^2$

Now $abc=32\times 6\Rightarrow\left(\alpha^2+\beta^2+\delta^2\right)^3=1536\,\alpha\beta\delta$

17. A) $|1-i|^n=2^n\Rightarrow n/2=n\Rightarrow n=0$

B) $x^3+2x^2+2x+1=0\Rightarrow x=-1,\omega,\omega^2$

But $x=\omega,\omega^2$ will only satisfy $\Rightarrow x^{2000}+x^{2002}+1=0$

C) $x+2xy=0$ and $x^2-y^2+y=0$ $\Rightarrow i,\frac{\sqrt{3}}{2}-\frac{i}{2},-\frac{\sqrt{3}}{2}-\frac{i}{2}$

D) $x^2-y^2+\sqrt{x^2+y^2}=0$ and $2xy=0\Rightarrow z=0,i,-i$

18. $A^{-1}A^T=|A|B^{-1},B=adj.A$

taking determinant, $\left|A^{-1}\right|.\left|A^T\right|=|A|^3.\left|B^{-1}\right|\left|A^3\right|.\frac{1}{|B|}=1$

$\frac{|A|^3}{|A|^2}=1\Rightarrow|A|=1\Rightarrow|B|=1$

Now, $A^{-1}A^T = B^{-1}$ If A is symmetric $\Rightarrow A^{-1}A = B^{-1} \Rightarrow B = I$
$\Rightarrow adjA = I \Rightarrow A = I$

If A is orthogonal then $A^T = A^1\ A^{-1}A^{-1} = B^{-1} \Rightarrow B = A^2 \Rightarrow adjA = A^2$

$\Rightarrow A\ adj\ A = A^3 \Rightarrow A^3 = |A|I \Rightarrow A^3 = I \Rightarrow (adjA)^3.A^3 = B^3 \qquad \Rightarrow B^3 = I$

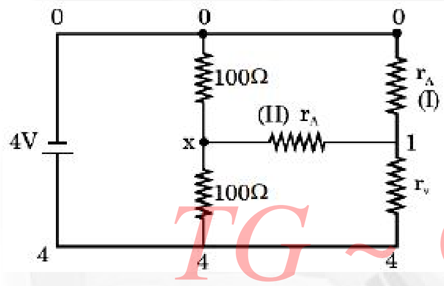
PHYSICS

19. There will be no current in capacitor apply nodal analysis

20. $U_B = d\int \frac{\mu_0}{\cancel{2}}\frac{i^2r^2}{4\alpha^{\cancel{2}}R^2}\cancel{2}\cancel{\alpha}r\,dr \quad = \frac{\mu_0 i^2}{16\alpha}d = \frac{\mu_0\omega^2c^2v^2}{16\alpha}d$

$U_E = \frac{1}{2}cv^2 \quad \frac{U_B}{U_E} = \frac{1}{8\alpha}\mu_0\omega^2cd \quad = \frac{1}{8\cancel{\alpha}}\mu_0\frac{\varepsilon_0\cancel{\alpha}}{\cancel{d}}R^2\omega^2\cancel{d}$

$= \frac{1}{8}\mu_0\varepsilon_0R^2\omega^2 = \frac{1}{8}\times\frac{1}{9\times10^{16}}36\times10^{-4}\times10^6 \qquad = 5\times10^{-15}$

21. 

Given $\frac{1-0}{r_A} = 10mA \qquad r_A = \frac{1}{10\times10^{-3}} = 100\Omega$

Nodal $\frac{x-1}{r_A} + \frac{x-4}{100} + \frac{x-0}{100} = 0$

$\frac{x-1}{100} + \frac{x-4}{100} + \frac{x-0}{100} = 0 \qquad x = \frac{5}{3}$

Current in Ammeter (II) $= \frac{\frac{5}{3}-1}{100}A$ = 6.66 mA

22. Wave length of photon which just emits photo-electron $\frac{hC}{\lambda} = W$

or $\lambda = \frac{hC}{W} = \frac{6.6\times10^{-34}\times3\times10^8}{2.5\times1.6\times10^{-19}} = \frac{19.8\times10^{-26}}{2.5\times1.6\times10^{-19}}$

or $\lambda = 4.95\times10^{-7}m$ or $\lambda = 4950\overset{0}{A}$

Now using wien's displacement law $\lambda_{m_1}T_1 = \lambda_{m_2}T_2$

or $9000(273+t) = 4950(273+927)$

or $273+t = 660$ or t = 660 – 273 or t = 387^0C

23. $V_I = -m^2V_0$

24. $\Delta S=\int nC_V\frac{dT}{T}+\int\frac{nR\cancel{T}}{V}\frac{dV}{\cancel{T}}\qquad=\frac{nR}{r-1}\ell n\frac{P_2V_2}{P_1V_1}+nR\ell n\frac{V_2}{V_1}$

$=\frac{nrR}{r-1}\ell n\frac{V_2}{V_1}+\frac{nR}{r-1}\ell n\frac{P_2}{P_1}\qquad=\frac{2\times1.3\times8.3}{0.3}\ell n2-\frac{2\times1}{0.3}8.3\ell 3$

$=\frac{2\times1.3\times8.3}{0.3}\times0.693$

$-2\times\frac{1}{0.3}\times8.3\times2.303\times0.477\qquad=49.85-60.86\qquad=11J/K$

25. Apply COM

26. Apply COM and Energy conservation

27. w = Area of trapezium

At maximum internal energy PV will be maximum

28.

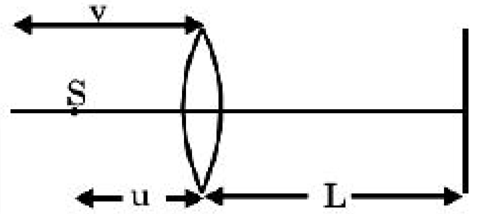
$\frac{N}{r^2}$ = constant $\qquad\frac{N_0}{r^2}=\frac{N_0}{4}\qquad N=\frac{N_0}{4}$

Also $\frac{N_0e^{-\lambda t}}{r^2}$ = constant

29. $2(C_V)_{monoatomic}>(C_V)_{diatomic}$

Maximum change $=\frac{(2)\left(\frac{3R}{2}\right)-(1)\left(\frac{5R}{2}\right)}{\frac{5R}{2}}=\frac{1}{5}$

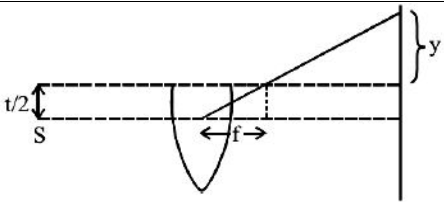
% change = 20%

30. 

$v=\frac{fu}{f-u}$ on the left of lens $\qquad d=2\left(\frac{t}{2}\right)\left(\frac{v}{u}-1\right)=t\left(\frac{u}{f-u}\right)\qquad D=L+\frac{uf}{f-u}$

Fringe width $B=\frac{\lambda\left(L+\frac{uf}{f-u}\right)}{t\left(\frac{u}{f-u}\right)}=\frac{\lambda}{t}\left[f+\frac{L(f-u)}{u}\right]$

$\simeq\frac{\lambda f}{t}=\frac{6\times10^{-7}\times0.4}{10^{-3}}$ = 0.24 mm



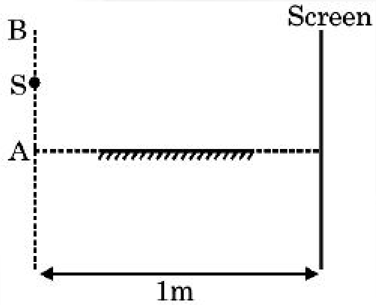
$$\frac{y}{L-f}=\frac{t}{2f}\Rightarrow y=\frac{t(L-f)}{2f}$$

Length of interference pattern

$$\frac{t(L-f)}{f}+t \qquad =t\left(\frac{L}{f}-1+1\right) \qquad =t\frac{L}{f}=\frac{(10-3)\times 50}{40}$$

$$=\frac{5}{4\times 10^3}m=\frac{5}{40}cm=\frac{1}{8}cm$$

31.



Let AS = h

$$\frac{1}{4}=\frac{\lambda(1)}{2h} \qquad \text{.............(i)}$$

$$\frac{1}{6}=\frac{\lambda(1)}{2(h+0.6)} \qquad \text{.............(ii)}$$

$$\frac{\frac{1}{4}}{\frac{1}{6}}=\frac{h+0.6}{h} \qquad \frac{3}{2}=\frac{h+0.6}{h} \qquad h = 1.2\text{ mm}$$

$$\frac{1}{4}mm=\frac{\lambda(1m)}{2\times(1.2)mm} \qquad \lambda=0.6\times 10^{-6}m \qquad \lambda=6000\overset{0}{A}$$

32. $\lambda=\frac{h}{mv} \qquad \frac{dh}{dt}=\frac{h}{mv^2}\frac{dv}{dt}$

$$10^{-4}=-\frac{10^{-34}\times 6.6}{6.6\times 10^{-30}}\frac{1}{V^2}\frac{dV}{dt} \qquad \frac{dV}{dt}=-V^2 \quad \int_{10}^{V}\frac{dV}{V^2}=-\int_0^t dt$$

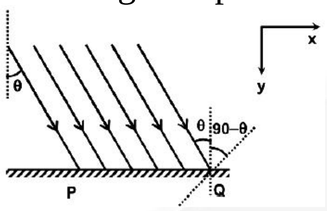
$$\frac{1}{V}-\frac{1}{10}=t \quad \frac{1}{V}=\frac{1+10t}{10} \quad V=\frac{10}{1+10t}$$

at t = 0.9 s V = 1 m/s

Also $a=-V^2$ $|a|=1m/s^2$

33. Intensity is given by $I=\dfrac{N\left(\dfrac{hC}{\lambda}\right)}{(A\cos\theta)\Delta t}$,where

$N\rightarrow$ total number of photons and $\lambda\rightarrow$ wavelength of photons



$(A)\ F_x=\dfrac{\Delta P_x}{\Delta t}=\dfrac{IA\cos\theta.\sin\theta}{C}$

$F_y=\dfrac{\Delta P_y}{\Delta t}=\dfrac{IA\cos\theta\cos\theta}{C}\qquad p_r=\dfrac{F_y}{A}=\dfrac{I\cos^2\theta}{C}$

$(B)\ F_x=0\quad F_y=\dfrac{2IA\cos^2\theta}{C}\qquad p_r=\dfrac{2IA\cos^2\theta}{C}$

(C) and (D)

$F_x=\dfrac{IA\cos^2\theta}{C}(1-r)\qquad F_y=\dfrac{IA\cos^2\theta}{C}(1+r)\qquad p_r\dfrac{I\cos^2\theta}{C}(1+r)$

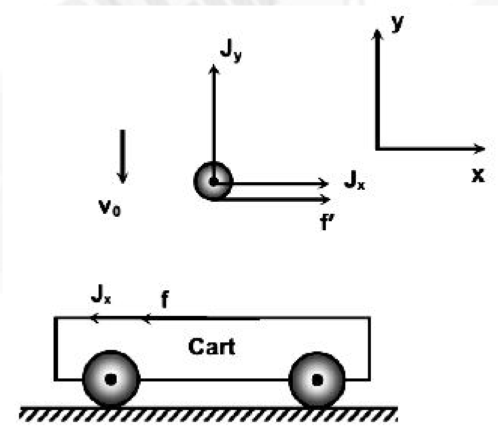
34. Circuit can be solved by using Phasor diagram.

35. $\Rightarrow\quad v_0=\sqrt{2gh}=5m/s$ …………(i)

$\Rightarrow\quad J_y=\Delta P_y=2\times 80\times 5=800\,N-s$ …………..(ii)

$\Rightarrow\quad J_x=\Delta P_x$

$\mu J_y=mv_x$



$v_x=1m/s$ …………..(iii)

$\Rightarrow\quad Mv_C=J_x$

$v_C=0.4m/s$ …………..(iv)

$\Rightarrow\quad t_0=\dfrac{2\times 5}{10}=1\sec$ …………..(v)

$\Rightarrow\quad L_{\min}=2(1+0.4)1=2.8m$ …………..(vi)

$\Rightarrow$ At the time of second collision

$R\omega' - 1 = 0.4$

$\omega' = 7 rad/s$ ....(vii)

$\Rightarrow \quad \vec{J}' = \Delta\vec{L} \quad -J_x R = I(\omega' - \omega_0)$

$-J_x R = I(\omega' - \omega_0)$

$\omega_0 = 19.5 rad/\sec$ ....(viii)

$\Rightarrow \quad W_{m\to M} = \frac{1}{2}Mv_C^2 = 16J$ ....(ix)

$\Rightarrow \quad W_{M\to m} = \frac{1}{2}I(\omega')^2 + \frac{1}{2}mv_x^2 - \frac{1}{2}I\omega_0^2 = -172J$

36. $E_2 = \frac{E_1 R_0}{R + R_0}\frac{\ell}{\ell_0}$

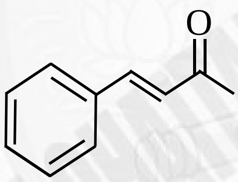
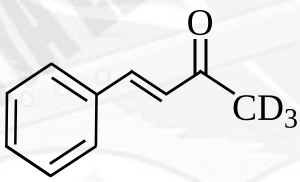
CHEMISTRY

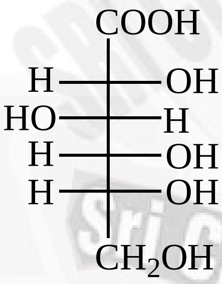
19. Vantof–factor becomes threefold therefore depression in freezing point becomes threefold.

20. $3 \times t_{1/2} = 3 \times \frac{\ln 2}{6.93 \times 10^{-3}} = 300 \min$

21. Almost reaction completes.

22. $\frac{p_1}{n_1 T_1} = \frac{p_2}{n_2 T_2} \Rightarrow \frac{1}{x + \left(\frac{x}{2} + 2x\right) \times 300} = \frac{p_2}{(x + 2x) \times 3800}$

23. P is  Q is 

24. 

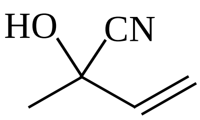
25. $[SiO_3]_n^{-2n}$

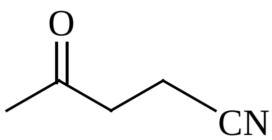
26. N-N bond is shorter in N_2F_2 than N_2F_4

27. If an enclosure at high temperature contains equal number of atoms A and B, then, when the temperatures is lowered, and molecules A_2, AB, B_2 form, they do not form in equal numbers, but in the ratio 1:2:1.

28. n–1 has lower energy.

29. On hydrolysis both α and β forms exists in equilibrium.

30. P is 

; Q is 

31. SiF_4 and BF_3 both are Lewis acids
32. No optical isomerism
33. Information based.
34. Information based.
35. Hydrolysis of T gives D_2O_2
36. $\left[Co\left(H_2O\right)_6\right]^{+2}$ is sp^3d^2

OUT GOING SR's | Date: 18-05-2023
Time: 3 Hrs | SGTA-4 | Max. Marks: 183

18-05-23_SR-OUTGOING_Jee-Adv_2017_P1_SGTA-4(PAPER-1)_QP FINAL

2017-P1 MODEL

Time: 03:00 Hr's | **IMPORTANT INSTRUCTIONS** | Max Marks: 183

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 1 – 7)	Questions With Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	7	28
Sec – II (Q.N : 8 – 12)	Questions With Integer Answer Type	+3	0	5	15
Sec – III (Q.N : 13 – 18)	Three column paragraph Questions With Single Answer Type	+3	-1	6	18
Total				**18**	**61**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 19 – 25)	Questions With Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	7	28
Sec – II (Q.N : 26 – 30)	Questions With Integer Answer Type	+3	0	5	15
Sec – III (Q.N : 31 – 36)	Three column paragraph Questions With Single Answer Type	+3	-1	6	18
Total				**18**	**61**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 37 – 43)	Questions With Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	7	28
Sec – II (Q.N : 44 – 48)	Questions With Integer Answer Type	+3	0	5	15
Sec – III (Q.N : 49 – 54)	Three column paragraph Questions With Single Answer Type	+3	-1	6	28
Total				**18**	**61**

PHYSICS **Max. Marks: 61**

SECTION – I

(MULTIPLE CORRECT ANSWER TYPE)

This section contains 7 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases

1. Light from a discharge tube containing hydrogen atoms falls on the surface of a piece of sodium. The K.E. of the fastest photoelectrons emitted from sodium is 0.73 eV. The work function of sodium is 1.82 eV then,

   a) the energy of the photons causing the photoelectric emission is 2.55 eV

   b) the quantum number of the two levels involved in the emission of these photons are 1 and 4

   c) the change in the angular momentum of the electron in the hydrogen atom is $\frac{h}{2\pi}$ (in the above transition)

   d) assuming it to be at rest before transition, the recoil speed of the emitting hydrogen atom of mass is 0.85 m/s

2. A hydrogen atom having kinetic energy E collides with a stationary hydrogen atom. Assume all motions are taking place along line of motion of the moving hydrogen atom. For this situation, mark out the correct statement (s).

   (a) For E $\geq$ 20.4 eV only collision would be elastic

   (b) For E $\geq$ 20.4 eV only collision would be inelastic

   (c) For E = 24 eV, collision would be perfectly inelastic

   (d) For E = 18 eV, the KE of initially moving hydrogen atom after collision is zero.

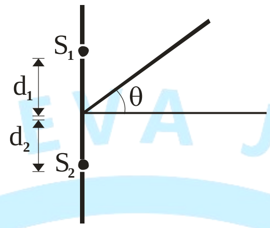
3. White light is used to illuminate the two slits in Young's double slit experiment. The separation between the slits is b and the screen is at a distance d (> b) from the slits. At a point on the screen directly in front of one of the slits, certain wavelength are missing. Some of these missing wavelengths are

   (A) $\lambda = \frac{b^2}{d}$ (B) $\lambda = \frac{2b^2}{d}$

   (C) $\lambda = \frac{b^2}{3d}$ (D) $\lambda = \frac{2b^2}{3d}$

4. In an interference experiment similar to Young's double slit experiment, the slits S_1 and S_2 are illuminated with coherent microwave sources, each of frequency 10^6 Hz. The source are synchronised to have zero phase difference. The slits are separated by a distance d = 150.0 m. The intensity $I(\theta)$ is measured as a function of θ, where θ is defined as shown.

If I_0 is the maximum intensity, then $I(\theta)$ for $0 \le \theta \le 90°$ is given by



(A) $I(\theta) = \frac{I_0}{2}$ for $\theta = 30°$

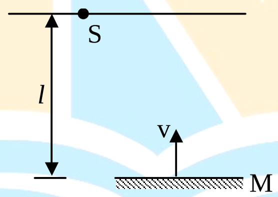
(B) $I(\theta) = \frac{I_0}{4}$ for $\theta = 90°$

(C) $I(\theta) = I_0$ for $\theta = 0°$

(D) $I(\theta)$ is constant for all

5. A plane mirror M is arranged parallel to a wall W at a distance l from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a patch of light on the wall. The mirror moves with velocity v towards the wall.

Which of the following statement(s) is/are correct?



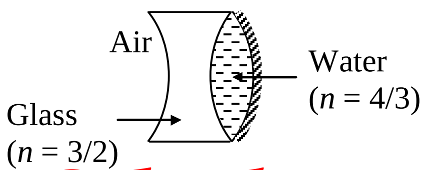
(A) The patch of light will move with speed v on the wall

(B) The patch of light will not move on the wall

(C) As the mirror comes closer, the patch of light will become larger and shift away from the wall with speed larger than v

(D) The size of the patch light on the wall remains the same

6. The radius of curvature of the left and right surface of the thin concave lens are 10 cm and 15 cm respectively. The radius of curvature of the mirror is 15 cm



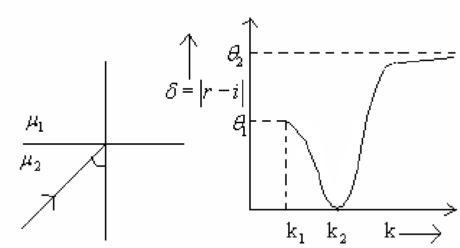
(A) equivalent focal length of the combination is –18 cm

(B) equivalent focal length of the combination is +36 cm

(C) the system behaves like a concave mirror

(D) the system behaves like a convex mirror

7. The figure shows a ray incident at an angle $i = \frac{\pi}{3}$. If the plot drawn shown the variation of $|r-i|$ versus $\frac{\mu_1}{\mu_2} = k, (r = angle\ of\ \ refraction)$:



(A) the value of $k_1\ is \frac{\sqrt{3}}{2}$

(B) the value of $\theta_1 = \frac{\pi}{6}$

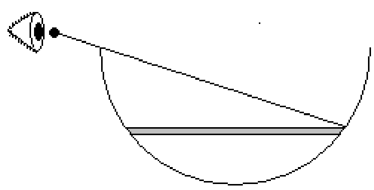
(C) the value of $\theta_2 = \frac{\pi}{3}$

(D) the value of k_2 is 1

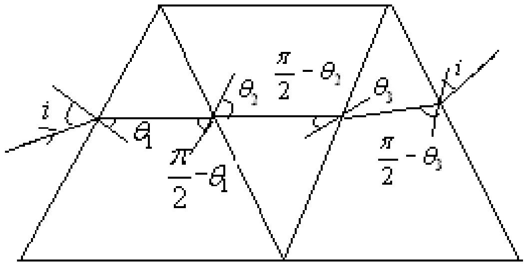
SECTION-II
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).
Marking scheme +3 for correct answer , 0 if not attempted and 0 in all other cases.

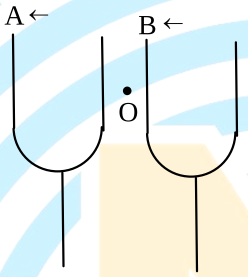
8. A circular disc of diameter d lies horizontally inside a metallic hemispherical bowl radius 8cm. The disc is just visible to an eye looking over the edge. The bowl is now filled with a liquid of refractive index $\sqrt{3}$. Now, the whole of the disc is just visible to the eye in the same position. The value of d (in cm)



9. Three right angle prisms of refractive indices $\mu_1, \mu_2\ and\ \ \mu_3$ are joined together so that the faces of the middle prism are in contact each with one of the outside prisms. If the ray passes through the composite block undeviated, find the value of $\mu_1^2 + \mu_3^2 - \mu_2^2$.



10. Two tuning forks A and B each of natural frequency 85 Hz move with velocity 10m/s relative to stationary observer 'O'. Fork A moves away from the observer while the fork B moves towards him as shown in the figure. A wind is blowing with a speed 10 m/s in the direction of motion of fork A. Find the beat frequency measured by the observer in Hz. [Take speed of sound in air as 340 m/s]



11. In Young's experiment, the source is of red light of wavelength $7X10^{-7}$ m. When a thin glass plate of refractive index 1.5 at this wavelength is put in the path of one of the interfering beams, the central bright fringe shifts by 10^{-3} m to the position previously occupied by the 5th bright fringe. Find the thickness (in μm) of the plate.

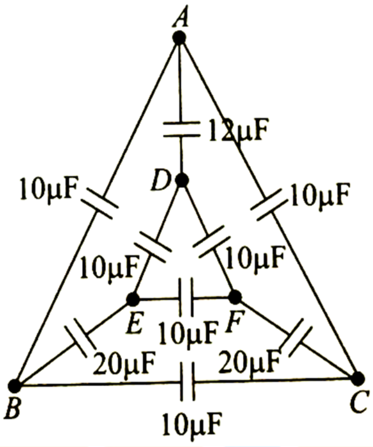
12. In a nuclear reactor an element X decays to a radioactive element Y at a constant rate 10^{15} atoms per sec. Each decay releases 100 MeV energy. Half life of Y equals T and decays to a stable product Z. Each decay of Y releases 50 MeV. All energy released inside the reactor is used to produce electricity at an efficiency of 25%. Electrical power in kw generated in the reactor in steady state is x KW. Find 'x'

SECTION – III
(SINGLE CORRECT ANSWER TYPE)

This section contains 6 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.
Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

Answer the Q.No:13, 14 and 15 by appropriately matching the information given in the following table.

Answer the following three questions based upon the given diagram (take all capacitors to be uncharged initially)



Column I – Charge drawn from battery in μC	Column II – Charge in capacitor connected between A & D in μC	Column III – Charge in capacitor connected between B & C in μC
(I) 100	(i) 120	(P) 0
(II) 210	(ii) 0	(Q) 40
(III) 180	(iii) 40	(R) 50
(IV) 200	(iv) 50	(S) 100

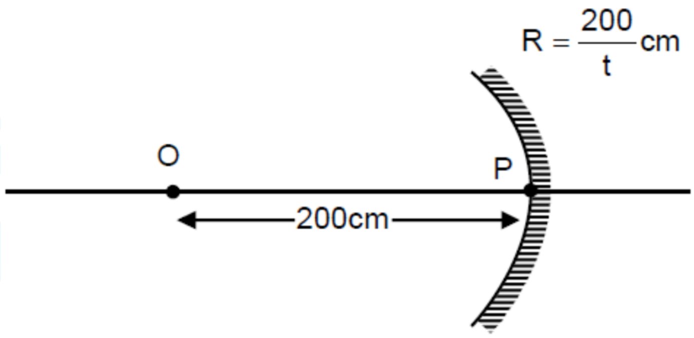
13. If a 10 V battery is connected across the terminals A and D:
A) (I) (ii) (P) B) (IV) (i) (P) C) (II) (i) (Q) D) (IV) (iii) (S)

14. If a 10 V battery is connected across the terminals B and C:
A) (I) (ii) (P) B) (II) (iii) (R) C) (II) (ii) (S) D) (IV) (iii) (S)

15. If a 10 V battery is connected across the terminals E and F:
A) (I) (i) (P) B) (II) (ii) (Q) C) (III) (ii) (Q) D) (IV) (iii) (S)

Answer Q.16. Q.17 and Q.18 by appropriately matching the information given in the three columns of the following table.

An object O is kept on the principal axis of a concave mirror, at a distance 200 cm from pole of the mirror. By some mechanism radius of curvature of mirror is changing with time as $R = \frac{200}{t} cm$, here t is in second. Column–1 shows the time instant, Column–2 represents velocity of image at that time and Column–3 represents acceleration of image at that time.



	Time		Velocity of image		Acceleration of image
(A)	**1 sec.**	**(P)**	$\frac{400}{49} cm/s$	**(1)**	$-\frac{64}{5} cm/s^2$
(B)	2 sec.	**(Q)**	16 cm/s	**(2)**	$-\frac{1600}{343} cm/s^2$
(C)	3 sec.	**(R)**	$\frac{400}{9} cm/s.$	**(3)**	$-\frac{1600}{27} cm/s^2$
(D)	4 sec.	**(S)**	400 cm/s	**(4)**	$-1600\ cm/s^2$

16. Which of the following is correctly matched?

A) (A)(S)(4) B) (A)(Q)(4) C) (A)(S) (1) D) (A) (Q)(1)

17. Which of the following is correctly matched ?

A) (B) (R)(3) B) (B)(S)(3) C) (B)(R)(2) D) (B) (P)(1)

18. Which of the following is correctly matched?

A) (C) (Q)(2) B) (C)(P)(2) C) (D)(P)(2) D) (D)(Q)(1)

CHEMISTRY **Max. Marks: 61**

SECTION – I
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 7 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases

19. Pick out correct statement(s) from the following.

A) In hydrogen atom, the energy of electron is 2s subshell is equal to the energy of electron in 2p subshell

B) The orbital quantum number of 4d electron is 6

C) There are three unpaired electron in nitrogen atom

D) Fe^{3+} ion is more stable than Fe^{2+}

20. Pick out correct statement(s) from the following:

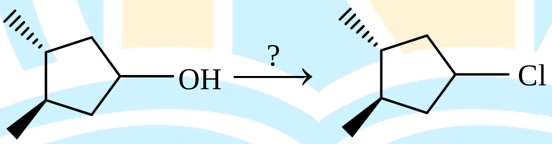
A) The radius of maximum probability for finding the electron in ground state of hydrogen is 0.529A° from nucleus.

B) 2p orbital has one radial node

C) 2p orbital has one nodal plane

D) Angular probability function determine the shape of orbital.

21. Which of the following reagents would **perform** the following transformation?



A) KCl (5molar solution)

B) HCl & $ZnCl_2$

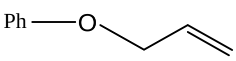
C) $SOCl_2$

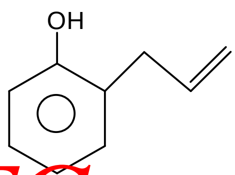
D) PCl_3

22. 

Identify the correct options?

A) A is $Ph-O^{-}Na^{+}$

B) B is 



C) C Can be

D) Conversion B to (C+D) Involve Radical intermediate

23. Correct statement about critical temperature

A) It is highest temperature at which liquid and vapour can coexist

B) Beyond the critical temperature, there is no distinction between two phases and gas cannot be liquefied by compression

C) At critical temperature, the surface tension of system is zero

D) At critical temperature the gas and the liquid phases have different critical densities

24. Which of the following statements is/are correct

A) Iron cobalt and nickel display ferromagnetism in addition to paramagnetism

B) Copper, silver and gold dissolve in aqueous acid to form +1 cation and H_2 gas

C) Manganese exhibits a variety of oxidation state from +2 to +7

D) Dichromate ion $Cr_2O_7^{2-}$ is good oxidizing agent in acidic solution

25. Roasting of an ore is done:

A) To remove moisture.

B) To oxidize free sulphur and antimony.

C) at a temperature below the melting point of the metal.

D) in a reverberatory furnace.

SECTION-II
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).
Marking scheme +3 for correct answer , 0 if not attempted and 0 in all other cases.

26. White phosphorus disproportionate in concentrated NaOH and gives PH_3 and NaH_2PO_2. The sum of stiochiometric coefficients of reactants in the balanced red-ox reactions is __________

27. The minimum number of moles of potassium chlorate required to decompose to give sufficient oxygen for complete combustion of 22.4l of C_2H_4 at NTP are______

28. How many of the following are classified as LINEAR polymers?

LDPE, PVC, amylopectin, cellulose, melamine, nylon 6, isoprene and polystyrene

29. For how many of the following the weight increases in the applied magnetic field.

$NO,\ NO_2,\ O_2,\ K_4[Fe(CN)_6],\ KO_2,\ MnSO_4,\ NiSO_4,\ CuSO_4,\ ZnSO_4$

30. $\underset{(1\,mole)}{XeF_6} + H_2O \rightarrow A + 2HF$, 'A' has $'x'\,\sigma$ bonds, $y\,\pi$ bonds and z lone pairs on Xe atom $(x+y+z)$ is

SECTION – III
(SINGLE CORRECT ANSWER TYPE)

This section contains 6 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

Column – I (Molecule)	Column–II (Hybridisation)	Column – III
(a) OSF_4	(P) dsp^2	(I) Net lone pair repulsion of central atom is zero
(b) XeF_4	(Q) sp^3	(II) Planar molecule
(c) ClO_4^-	(R) sp^3d^2	(III) All bonds with central atom are identical
(d) $XeOF_4$	(S) sp^3d	(IV) Zero lone pair on central atom
	(T) sp^2d	(V) More than one type of bond angle

31. Which of the following set is correct

A) (d) (R) (V) B) (c) (P) (IV) C) (a) (R) (I) D) (b) (Q) (II)

32. Correct combination for XeF_4

A) (Q) (II) (I) (V) B) (R) (I) (II) (III) C) (P) (II) (III) D) (R) (I) (IV) (V)

33. Which of the following is related with SOF_4

A) (R) (II) B) (R) (III) C) (S), (V) D) Both B, C

Answer Q.34, Q.35 and Q.36 by appropriately matching the information given in the three columns of the following table

Column-I (for hydrogen atom)	**Column-II**	**Column-III**
I) 1s orbital	i) Orbital angular momentum (L) is $\sqrt{2}\hbar$	P) One radial node
II) 2s orbital	ii) Orbital angular momentum(L) is $\sqrt{6}\hbar$	Q) Two nodal planes
III) $2p_x$ orbital	iii) Spherically symmetrical shape orbital	R) Zero nodal planes
IV) $3d_{x^2-y^2}$ orbital	iv) Radius of maximum probability is 0.529A° from nucleus	S) YZ plane is nodal plane

34. For the given orbital in Column-I correct combination

A) I,ii,R B) II,iii,Q C) III,i,S D) IV,ii,P

35. For a given orbital in column I, which of the following is incorrect combination.

A) I, iv,R B) II,iii,P C) IV,ii,Q D) III,ii,S

36. For a dumbbell shaped orbital in hydrogen atom. Which of the following combination is correct

A) I, iv,R B) II,iii,P C) III,i,S D) III,iv,S

MATHEMATICS Max. Marks: 61

SECTION – I

(MULTIPLE CORRECT ANSWER TYPE)

This section contains 7 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases

37. A function $f(x)$ is defined as

$$f(x)=\begin{cases}6x-5-x^2, x\le 3\\ 24x-32-4x^2, x>3\end{cases}$$

Tangents are made on $f(x)$ in the first quadrant. Let tangents $T_1: \ y=m_1x+b_1$ and $T_2: \ y=m_2x+b_2$ respectively have highest and lowest y-intercepts of all tangents made in first quadrant then

A) $b_1+b_2=36$ B) $b_1+b_2=28$

C) $m_1 + m_2 = -4$

D) area made by y-axis, $T_1 = 0, T_2 = 0$ is 54 square units

38. $\lim_{x\to\infty} \sqrt{x}\left(\sqrt{x+1} - \sqrt{x}\right)$ equals

A) $\lim_{x\to 0} \frac{\ln(1+x) - x}{x^2}$

B) $\lim_{x\to 0} \frac{1-\cos x}{x^2}$

C) $\lim_{x\to 0} \frac{\sqrt{1+x} - 1}{x}$

D) $\lim_{x\to 0} \frac{\sqrt{x}}{\sqrt{x + \sqrt{x^2 + 2x}}}$

39. Tangents are drawn from (-2,0) to $y^2 = 8x$, radius of circle(s) that would touches these tangents and the corresponding chord of contact, can be equal to,

A) $4\left(\sqrt{2}+1\right)$ B) $4\left(\sqrt{2}-1\right)$ C) $8\sqrt{2}$ D) $4\sqrt{2}$

40. Let s_n be the sum of the first n terms of the arithmetic sequence $b_1, b_2 \ldots\ldots\ldots b_n$, such that

$$f(i, j, k) = \frac{s_i}{i}(j-k) + \frac{s_j}{j}(k-i) + \frac{s_k}{k}(i-j), \quad \forall i, j, k \in N, \text{then}$$

A) f (1,3,5) =15

B) f (2,7,12)<21

C) f(1,3,5) = 21

D) f (2,7,12)<15

41. Given two functions f and g which are integrable on every interval and satisfy (i) f is odd, g is even(ii) g(x) = f(x + 5), then

A) f(x – 5) = g(x)

B) f(x – 5) = –g(x)

C) $\int_0^5 f(t)\,dt = \int_0^5 g(5-t)\,dt$

D) $\int_0^5 f(t)\,dt = -\int_0^5 g(5-t)\,dt$

42. Let $h(x) = f(x) - \left(f(x)\right)^2 + \left(f(x)\right)^3$ for every real number x, then

A) h is increasing whenever f is increasing

B) h is increasing whenever f is decreasing

C) h is decreasing whenever f is decreasing

D) Nothing can be said in general

43. Let $f(x) = \frac{1 - x\left(1 + |1-x|\right)}{|1-x|}\cos\left(\frac{1}{1-x}\right)$ for $x \neq 1$

then

A) $\lim_{x \to 1^-} f(x)$ does not exist

B) $\lim_{x \to 1^+} f(x)$ does not exist

C) $\lim_{x \to 1^+} f(x) = 0$

D) $\lim_{x \to 1^-} f(x) = 0$

SECTION-II

(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).

Marking scheme +3 for correct answer , 0 if not attempted and 0 in all other cases.

44. Let $f(x)$ be differentiable function such that $f(x) = x^2 + \int_0^x e^{-t} f(x-t)\,dt$ then $6f(1) = \_\_$

45. Number of distinct real solutions of $\sin \pi x = \left|\ln|x|\right|$ *is*

46. Number of rational terms in expansion of $\left(\sqrt{2} + \sqrt{3} + \sqrt[3]{5}\right)^{20}$ is two digit number ab, then a + b=

47. Let A be 3×3 matrix given by $A = \left[a_{ij}\right]$ and B be a column matrix such that $B^T AB$ is a null matrix for every column matrix B. If $C = A - A^T$ and $a_{13} = 1, a_{23} = -5, a_{21} = 15$ then the value of $\det(adjA) + \det(adjC)$ is (where A^T is the transpose of A)

48. The distance of the point (1,-2,3) from the plane $x - y + z = 5$ measure parallel To a line whose direction ration are 2, 3, -6 is

SECTION – III

(SINGLE CORRECT ANSWER TYPE)

This section contains 6 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

Answer Q,49, Q,50 and Q,51 by appropriately matching the information given in the three columns of the following table.

COLOUMN-I	COLUMN-II	COLUMN-III
(I) If the range of the function $f(x)=\cos^{-1}([5x])$ Is {a, b, c} and $a+b+c=\dfrac{\lambda\pi}{2}$, Then λ is equal to(where[.]denotes G.I.F)	(i) 1	(P) Prime number
(II) If $\lim\limits_{x\to 0}\dfrac{xe^{\sin x}-e^{x}\sin^{-1}(\sin x)}{\sin^{2}x-x\sin x}=\lambda$ Then λ is equal to	(ii) 2	(Q) Composite number
(III) The number of points at which $g(x)=\dfrac{1}{1+\dfrac{2}{f(x)}}$ Is not differentiable where $f(x)=\dfrac{1}{1+\dfrac{1}{x}}$ is λ then λ is equal to	(iii) 4	(R) Neither prime nor Composite number
(IV) The derivative of $\dfrac{\log(\lvert x\rvert)}{x}$ At x=-1 is λ then λ is equal to	(iv) 3	(S) Irrational number

49. Which of the following options is the only correct combination?

(A) (I) (ii) (P) (B) (II) (i) (R) (C) (III) (ii) (P) (D) (IV) (iii) (Q)

50. Which of the following is the only correct combination?

(A) (IV) (ii) (P) (B) (II) (iii) (Q) (C) (I) (iv) (P) (D) (iii) (ii) (P)

51. Which of the following is the only correct combination?

(A) (I) (ii) (P) (B) (II)(iv) (P) (C) (IV) (iii) (R) (D) (III) (iv) (P)

Answer Q,52, Q,53 and Q,541 by appropriately matching the information given in the three
columns of the following table.

COLUMN-I	COLUMN-II	COLUMN-III
(I) If $\int (\tan x)^{\frac{1}{3}}\, dx =$ $A\ln\left(\frac{(t^4-t^2+1)}{(t^2+1)^2}\right) + B\sqrt{3}\tan^{-1}\left(\frac{2t^2-1}{\sqrt{3}}\right) + c$ Where $t = \tan^{1/3} x$ *then*	(i) $A = \frac{1}{4}$	(P) $B = \frac{1}{4}$
(II) If $\int \frac{(\sin x + \sin^3 x)}{\cos(2x)} dx =$ $A\cos x + \frac{B}{\sqrt{2}}\ln\left\|\frac{\sqrt{2}\cos x + 1}{\sqrt{2}\cos x - 1}\right\| + c$ Then	(ii) $A = \frac{1}{3}$	(Q) $B = \frac{3}{4}$
(III) If $\int \frac{dx}{(x^2+1)(x^2+4)} = A\tan^{-1}(x)$ $+B\tan^{-1}\left(\frac{x}{2}\right) + c$ then	(iii) $A = \frac{1}{2}$	(R) $B = \frac{-1}{6}$
(IV) If $\int \cos^4 x dx = Ax + B\sin(2x) + \frac{1}{32}\sin(4x) + c$ then	(iv) $A = \frac{3}{8}$	(S) $B = \frac{1}{2}$

52. Which of the following options is the only correct combination

(A) (III)(ii)(R) (B) (I)(iii)(S) (C) (IV)(iv)(Q) (D) (II) (ii) (P)

53. Which of the following options is the only correct combination

(A) (II) (i) (Q) (B) (IV) (iv) (P) (C) (I)(iii)(R) (D) (III) (ii) (S)

54. Which of the following is incorrect

(A) (I) (i) (S) (B) (II) (iii) (Q) (C) (III)(iv)(R) (D) None of these

OUT GOING SR's | Date: 18-05-2023
Time: 3 Hrs | SGTA-4 | Max. Marks: 183

18-05-23_SR-OUTGOING_JEE-ADV_2017_P1_SGTA-4(PAPER-1)_KEY&SOL

PHYSICS

1	AD	2	BD	3	AC	4	AC	5	BD
6	AC	7	ABCD	8	8	9	1	10	5
11	7	12	6	13	B	14	C	15	B
16	A	17	A	18	C				

CHEMISTRY

19	ACD	20	ACD	21	BCD	22	ABC	23	ABC
24	ACD	25	ABCD	26	7	27	2	28	4
29	7	30	7	31	A	32	B	33	C
34	C	35	D	36	C				

MATHEMATICS

37	BCD	38	BC	39	AB	40	BD	41	BC
42	AC	43	BD	44	8	45	6	46	8
47	0	48	1	49	B	50	C	51	D
52	A	53	B	54	C				

SOLUTIONS

SOLUTIONS
PHYSICS

1. $h\gamma = KE_{\max} + W$

The energy corresponds to transmission $4 \to 2$ in hydrogen

2. Ans (b, d)

Let collision between two atoms be an inelastic one.

From momentum conservation, $mv_0 = mv_1 + mv_2$

From energy conservation,

$$\frac{mv_1^2}{2} + \frac{mv_2^2}{2} - \frac{mv_0^2}{2} = -\Delta E$$

Where ΔE is the energy absorbed by the initially stationary atom to change its state.

Solving above equations, we get

$$(v_1 - v_2) = v_0^2 - \frac{4\Delta E}{m}$$

For collision to be inelastic, $(v_1 - v_2)^2 \geq 0:$ a real quantity

[equal to sign for perfect inelastic collision.]

The minimum value of ΔE is 10.2 eV, so for collision to be inelastic, $E \geq 20.4\,eV$.

For perfectly inelastic collision, $v_1 = v_2$ and hence E = 20.4 eV.

For E = 18 eV, the collision is elastic one and as masses are the same, velocities would be interchanged during collision.

3. Position of minima

$$y_n = \left(n - \frac{1}{2}\right)\frac{D\lambda}{d}$$

Here $D \to d$ and $d \to b$, $y_n = \frac{b}{2}$

$$\therefore \quad \frac{b}{2} = \left(n - \frac{1}{2}\right)\frac{d\lambda}{b}$$

$$\Rightarrow \quad \lambda = \frac{b^2}{(2n-1)d}, n = 1, 2, 3, \ldots$$

$$\therefore \quad \lambda = \frac{b^2}{d}, \frac{b^2}{3d}, \frac{b^2}{5d}, \ldots.$$

i.e., alternatives (a) and (c) are correct.

4. For microwaves $\lambda = \frac{c}{f} = \frac{3\times10^8}{10^6} = 300$ m.

Path difference $\delta = d\sin\theta$

$\therefore$ Phase difference $\delta = \frac{2\pi}{\lambda}\Delta = \frac{2\pi}{\lambda}(d\sin\theta) = \frac{2\pi}{300}(150\sin\theta) = \pi\sin\theta$

Intensity $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\delta$

when $I_1 = I_2, \delta = \pi\sin\theta$

$$I = 2I_1(1+\cos(\pi\sin\theta)) = 4I_1\cos^2\left(\frac{\pi\sin\theta}{2}\right)$$

I will be maximum when $\cos^2\left(\frac{\pi\sin\theta}{2}\right)$ is maximum = 1.

$\therefore I_{max} = 4I_1 = I_0$ (given)

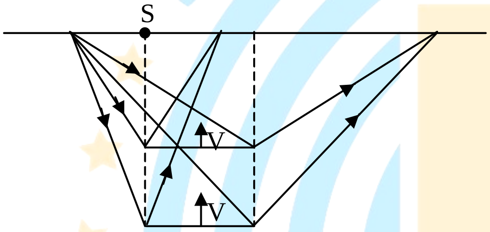
So $I = I_0\cos^2\left(\frac{\pi\sin\theta}{2}\right)$

(a) when $\theta = 0, I = I_0\sin^2 0 = I_0$

(b) when $\theta = 30°, I = I_0\cos^2\left(\frac{\pi\sin 30°}{2}\right) = I_0\cos^2\frac{\pi}{4} = \frac{I_0}{2}$.

(c) when $\theta = 90°, I = I_0\cos^2\left(\frac{\pi\sin 90°}{2}\right) = I_0\cos^2\frac{\pi}{2} = 0$.

i.e, (a) and (c) are correct.

5. 

From the ray diagram, it is clear that the options (b) and (d) are correct.

6. $-\frac{1}{F} = P = 2P_{l_1} + 2P_{l_2} + P_m$ …(1)

$P_{l_1} = \frac{1}{f_1} = (\mu-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$P_{l_1} = [(1.5-1]\left[-\frac{1}{10} - \frac{1}{15}\right] = -\frac{1}{12}$ …(2)

$P_{l_2} = \frac{1}{f_2} = (\mu-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$P_{l_2} = \left(\frac{4}{3}-1\right)\left[\frac{2}{15}\right] = \frac{2}{45}$ …(3)

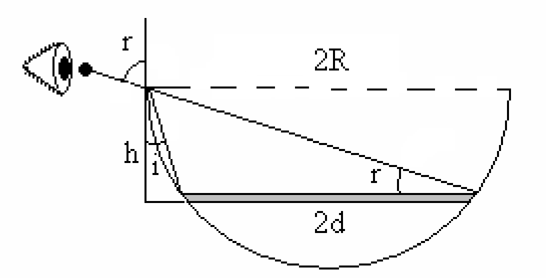
$P_m = -\frac{1}{f} = +\frac{2}{15}$ …(4)

$-\frac{1}{F} = P = 2\left[-\frac{1}{12} + \frac{2}{45}\right] + \frac{2}{15} = -\frac{1}{6} + \frac{4}{45} + \frac{2}{15} = \frac{1}{18}$

$F = -18\,\text{cm}$. Focus is negative means system will behave as concave mirror.

$\therefore$ **(A) and (C)**

8.



$$\mu \sin i = \sin r$$

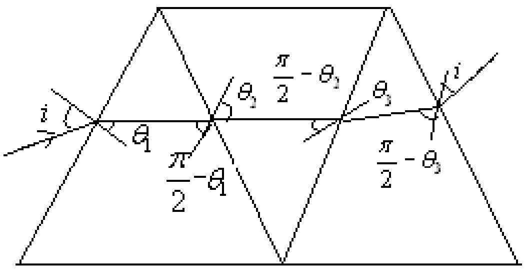
$$\mu \frac{R-d}{\sqrt{(R-d)^2+h^2}} = \frac{R+d}{\sqrt{(R+d)^2+h^2}}$$

$$\therefore h = \sqrt{R^2-d^2}$$

$$\mu\sqrt{\frac{(R-d)}{2R}} = \sqrt{\frac{(R+d)}{2R}}$$

$$\mu^2 = \frac{R+d}{R-d}$$

9.



$1 \sin i = \mu_1 \sin\theta_1$

$\mu_1 \cos\theta_1 = \mu_2 \sin\theta_2$

$\mu_2 \cos\theta_2 = \mu_3 \sin\theta_3$

$\mu_3 \cos\theta_3 = i \sin i$

Squaring and rearranging will give

$\mu_1^2 + \mu_3^2 - \mu_2^2 = 1$

10. $$f_A = \frac{340-10}{340-10+10}\times 85 = \frac{330}{4} Hz$$

$$f_B = \frac{340+10}{340+10-10}\times 85 = \frac{350}{4} Hz$$

$$f_{beat} = f_B - f_A = 5Hz$$

11. For Red Light

The shifts of fringes due to glass plate $=\frac{Dr(\mu-1)}{d}$ where t is the thickness of the plate.

This shifts is equal to 5ω where ω is the fringe width

$$\frac{Dt(\mu-1)}{d} = 5\omega \Rightarrow \frac{Dt(\mu-1)}{d} = \frac{5\lambda_R D}{d}$$

$$t=\frac{5\lambda}{(\mu-1)}=\frac{5\times7\times10^{-7}}{1.5-1}=7\times10^{-6}m=7\mu m$$

12. At steady state energy released per sec

$=\eta\times r(E_1+E_2)$

$\eta=25\%$

$r=10^{15}$

$E_1=100\times10^6\times1.6\times10^{-19}=1.6\times10^{-11}J$

$E_2=50\times10^6\times1.6\times10^{-19}=0.8\times10^{-11}J$

13. $C_{eq}=20\ \mu F$

$q=200\,\mu C$

$q_1=120\,\mu C$

$q_2=0$

14. $C_{eq}=21\mu C$

$q=210\,\mu C$

$q_1=0$

$q_2=100\ \mu C$

15. $C_{eq}=21\mu C$

$q=210\,\mu C$

$q_1=0$

$q_2=40\ \mu C$

16,17,18

$$f=-\frac{100}{t}$$

$$\frac{1}{v}+\frac{1}{-200}=\frac{-t}{100}\Rightarrow\frac{1}{v}=\frac{1}{200}-\frac{t}{100}=\frac{1-2t}{200}$$

$$v=\frac{200}{1-2t}$$

velocity of image $=\frac{dv}{dt}=\frac{(200)^2}{(1-2t)^2}=\frac{400}{(1-2t)^2}cm/s$

acceleration of image $=\frac{d^2v}{dt^2}=\frac{2(400)(2)}{(1-2t)^3}=\frac{1600}{(1-2t)^3}cm/s^2$

(A) t = 1sec, velocity 400 cm/s, acceleration = –1600 cm/s^2

(B) t = 2sec., velocity = $\frac{400}{9}cm/s$, acceleration = $-\frac{1600}{27}cm/s^2$

(C) t = 3sec., velocity = $\frac{400}{25}$ = 16 cm/s, acceleration = $-\frac{1600}{125}=-\frac{64}{5}cm/s^2$

(D) t = 4sec., velocity $=\frac{400}{49}cm/s$, acceleration = $-\frac{1600}{343}cm/s^2$

CHEMISTRY

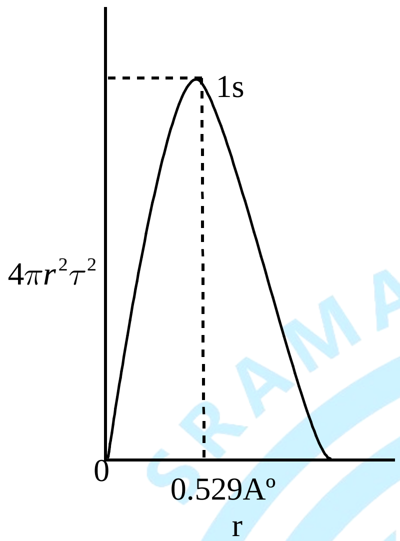
19. Fe^{3+} $([Ar]3d^5)$ is more stable than Fe^{2+} $([Ar]3d^6)$

due to half-filled d-orbitals

orbitals quantum number (l) of 4d electron is 2

Nitrogen $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$

Forhydrogen $1s < 2s = 2p > 3s = 3p = 3d < ....$

20. 

21. KCl cant attack without acidic medium
22. Claisen rearrangement
23. Conceptual
24. Conceptual
25. Conceptual
26. $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$
27. $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

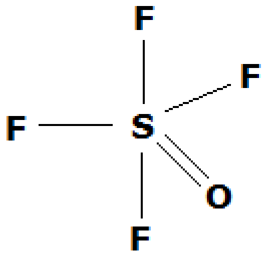
    $22.4LC_4H_4$ at STP require $\rightarrow$ 3 moles O_2

    $2KClO_3 \rightarrow 2KCl + 3O_2$

    Ans: 2 moles
28. PVC, cellulose, nylon 6, polystyrene.

    Isoprene, melamine are monomers
29. NO, NO_2, O_2, $K_3[Fe(CN)_6]$, KO_2, $MnSO_4$, $NiSO_4$, $CuSO_4$ are paramagnetic and their weight increases in the applied magnetic field
30. $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$

31 to 33



OSF_4 has $\left(sp^3d\right)$ with different bon lengths and bond angles

XeF_4 has square planar geometry with sp^3d hybridization.

ClO_4^- has tetrahedral sp^3 hydrization

34 - 36. Orbital angular momentum $L=\sqrt{l\left(l+1\right)\hbar}$

For S L=O

p $L=\sqrt{2}\hbar$

p $L=\sqrt{6}\hbar$

MATHS

41. To test choice (a) and (b), we begin with computing g(x). Indeed g(x) = f(x + 5) (From (ii) in ques.)

$\Rightarrow$ g (– x) = f (– x + 5)

$\Rightarrow$ g (x) = –f (x – 5) (From (i) in question)

$\Rightarrow$ Choice (b) is true and choice (a) is ruled out. To test the choices (c) and (d), we compute

$I = \int_0^5 f(t)\,dt$

Indeed $I = \int_0^5 g(t-5)\,dt$ ($\because$ f(t) = g(t – 5) on replacing x by t – 5 in (ii))

$= \int_0^5 g(t-5)\,dt$ ($\because$ g is even)

$\Rightarrow$ Choice (c) is correct and choice (d) is false.

44. $f\left(x\right)=x^2+\int_0^x e^{-t} f\left(x-t\right)dt=x^2+e^{-x}\int_0^x e^t f\left(t\right)dt$

$\Rightarrow f^1\left(x\right)=2x-e^{-x}\left(e^x\left(f\left(x\right)-x^2\right)\right)+e^{-x}.e^x f\left(x\right)$

$\Rightarrow f^{|}\left(x\right)=2x+x^2 \Rightarrow f\left(x\right)=\frac{x^3}{3}+x^2+K$

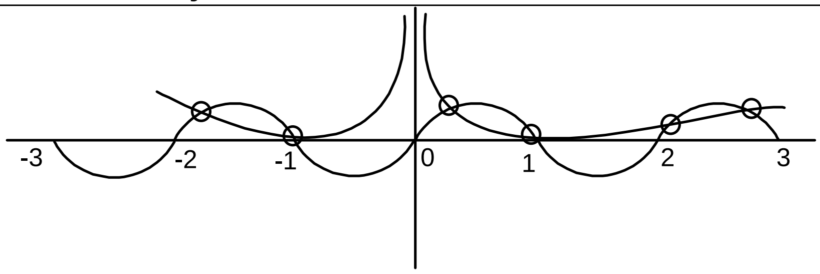
$But,\ f\left(0\right)=0 \Rightarrow k=0$

$\therefore f\left(1\right)=\frac{4}{3}$

45. No. of sol of $\sin\pi x=\left\|n\right|\left|x\right\|$

$y=\sin\pi x, y=\left\|n\right|\left|x\right\|$

No of sol = 6



No. of solutions 6

OUTGOING SR's | Date: 18-05-2023
Time: 3Hrs | SGTA-4 | Max.Marks:183

18-05-23_SR-OUTGOING_Jee-Adv_2017_P2_SGTA-4(PAPER-II)_QP FINAL

JEE-ADVANCE-2017-P2-Model

Time: 07:30 to 10:30 AM **IMPORTANT INSTRUCTIONS** **Max Marks: 183**

PHYSICS

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 1 – 7)	Questions with Single Correct Options	+3	-1	7	21
Sec – II (Q.N : 8 – 14)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-2	7	28
Sec – III (Q.N : 15 – 18)	Questions with Comprehension Type (2 Comprehensions – 2 + 2 = 4Q)	+3	0	4	12
Total				**18**	**61**

CHEMISTRY

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 19 – 25)	Questions with Single Correct Options	+3	-1	7	21
Sec – II (Q.N : 26 – 32)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-2	7	28
Sec – III (Q.N : 33 – 36)	Questions with Comprehension Type (2 Comprehensions – 2 + 2 = 4Q)	+3	0	4	12
Total				**18**	**61**

MATHEMATICS

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 37 – 43)	Questions with Single Correct Options	+3	-1	7	21
Sec – II (Q.N : 44 – 50)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-2	7	28
Sec – III (Q.N : 51 – 54)	Questions with Comprehension Type (2 Comprehensions – 2 + 2 = 4Q)	+3	0	4	12
Total				**18**	**61**

PHYSICS

Max. Marks: 61

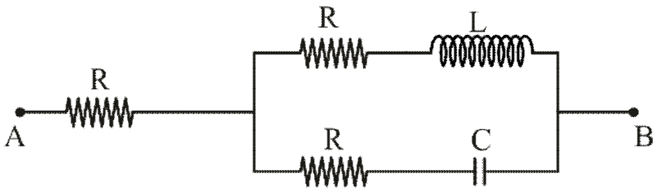
SECTION – I

(SINGLE CORRECT CHOICE TYPE)

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct.**

Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.

01. A voltage $V_{AB} = V_0 \cos \omega t$ where V_0 is a real amplitude, is applied between the points A and B in the network shown, given $C = \frac{1}{\omega R\sqrt{3}}$ and $L = \frac{R\sqrt{3}}{\omega}$, the total impedance between A and B is



A) R B) 2R C) 3R D) 4R

02. A source emitting a sound of frequency n is placed at a large distance from a listner. The source starts moving towards the listner with a uniform acceleration 'a'. The frequency heard by the listner corresponding to the wave emitted just after the source starts is (speed of sound in the medium is C)

A) $\frac{nc^2}{2nc-a}$ B) $\frac{2nc^2}{2nc-a}$ C) $\frac{2n^2c}{2nc-a}$ D) $\frac{2n^2c}{nc-a}$

03. In an experiment on the photoelectric effect it is observed that for light of wavelength 500 nm, a stopping potential of 0.25V is required to cut off the current of photoelectrons, whereas at a wavelength of 375nm a stopping potential of 1.0V is required. From these data the ratio of Planck's constant to the electronic charge (h/e) is found to be

A) $3.75\times10^{-15}\ JSC^{-1}$ B) $4.25\times10^{-15}\ JSC^{-1}$ C) $2.50\times10^{-15}\ JSC^{-1}$ D) $6.25\times10^{-15}\ JSC^{-1}$

04. A soap bubble of radius R_0 is slowly given a charge q. due to mutual repulsion of charges, the radius increases slightly to R. The air pressure inside the bubble drops, because of the expansion, to $P\left(\frac{V_0}{V}\right)$, where P is the atmospheric pressure, V_0 is the initial volume and V is the final volume. Ignoring surface tension, find the value of charge q.

A) $\left[32\pi\varepsilon_0 PR\left(R^3-R_0^3\right)\right]^{\frac{1}{2}}$ B) $\left[16\pi\varepsilon_0 PR\left(R^2-R_0^2\right)\right]^{\frac{1}{2}}$

C) $\left[32\pi^2\varepsilon_0 PR\left(R^3-R_0^3\right)\right]^{\frac{1}{2}}$ D) $\left[16\pi^2\varepsilon_0 PR\left(R^2-R_0^2\right)\right]^{\frac{1}{2}}$

05. ${}^{238}_{92}U$ decays to P_b through the successive emission of 6 electrons and 8 α-particles.

Given:

$$M\left({}^{238}U\right)=238.050786 \text{ amu}$$

$$M\left(P_b\right)=205.9744550 \text{ amu}$$

$$M\left(\alpha\right)=4.002603 \text{ amu}$$

$$M\left(e^-\right)=5.486\times10^{-4} \text{ amu}$$

$$1\text{amu}=931.47\,MeV$$

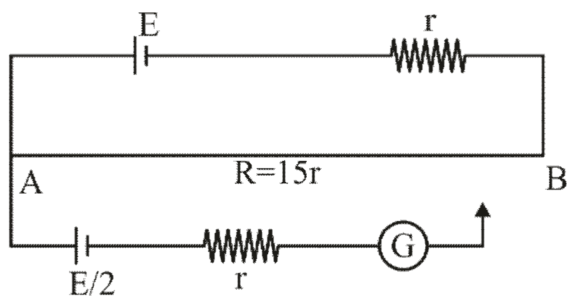
Total Energy evolved in the decay process is

A) 48.6 MeV B) 78.4 MeV C) 23.2 MeV D) 96.8 MeV

06. A Coaxial cable consists of two thin co axial cylinders electrically connected at one end, an inner cylindrical conducting tube of radius, a = 5mm carrying a steady current I which is screened by an outer cylindrical conducting sheath of radius b = 10mm which provides return path. There is no dielectric medium present. The inductance of this cable of length, l = 1000 m is (neglect magnetic field with in the conductors $\left(\log_e 2=0.693\right)$)

A) $3.6\times10^{-4}H$ B) $1.38\times10^{-4}H$ C) $2.4\times10^{-2}H$ D) $4.5\times10^{-2}H$

07. A potentiometer circuit is arranged as shown in given figure. The potentiometer wire is 600cm long. If the jockey touches the wire at a distance of 560 cm from A, the current flowing through galvanometer is



A) $\frac{E}{11r}$ B) $\frac{2E}{5r}$ C) $\frac{2E}{11r}$ D) $\frac{3E}{22r}$

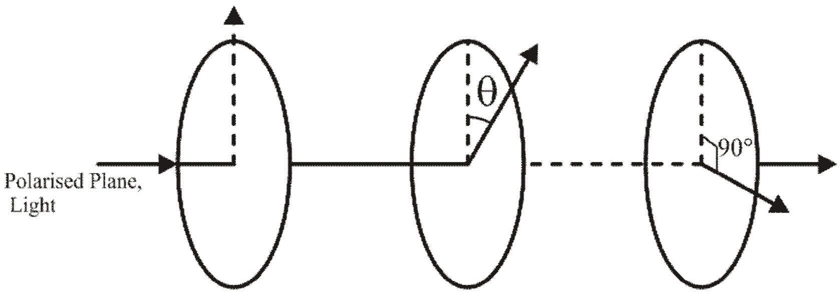
SECTION-II

(ONE OR MORE OPTIONS CORRECT TYPE)

This section contains 7 multiple choice equations. Each question has four choices **(A)** **(B)**,**(C)** and **(D)** out of which **ONE** or **MORE THAN ONE** are correct.

Marking scheme: +4 for all correct options, 0 if not attempted and -2 in all wrong cases.

08. Three coaxial polarizing filters are arranged in such a way that polarizing axes of first and third one are orthogonally oriented. Whereas polarizing axis of middle polarizing



Filter is oriented at an angle θ as shown in figure. A plane polarised light beam is incident on first filter. Then

A) The maximum fraction of the incident intensity that can be transmitted is $\frac{1}{4}$.

B) The maximum fraction of the incident intensity that can be transmitted is $\frac{1}{2}$

C) For maximum fraction of intensity transmission, the value of θ is 60^0

D) For maximum fraction of intensity transmission, the value of θ is 45^0

09. A single electron orbits around a stationary nucleus of charge +Ze, when Z is a constant and e is the magnitude of the electronic charge. If requires 47.2 eV to excite the electron from the second Bohr's orbit to the third Bohr's orbit

A) The energy required to excite the electron from the third to the fourth Bohr's orbit is $16.53eV$

B) The wavelength of the electromagnetic radiation required to remove the electron from the first Bohr's orbit to infinity is (nearly) $36.4A$

C) The energy required to excite the electron from third to fourth Bohr's orbit is $4.23eV$

D) The wavelength of emf radiation required to remove the electron from first Bohr's orbit to infinity is (nearly) $62.7A^{\circ}$

10. A narrow beam of monochromatic light of wavelength λ emitted from a source of power P is propagating in the positive x-direction. Beam is reflected from a perfectly reflecting plane mirror of area vector $\vec{A} = A(-\hat{i} + \hat{j})$. Reflection from the mirror changes momentum of photons and exerts force on the mirror. Which of the following statements is/are correct?

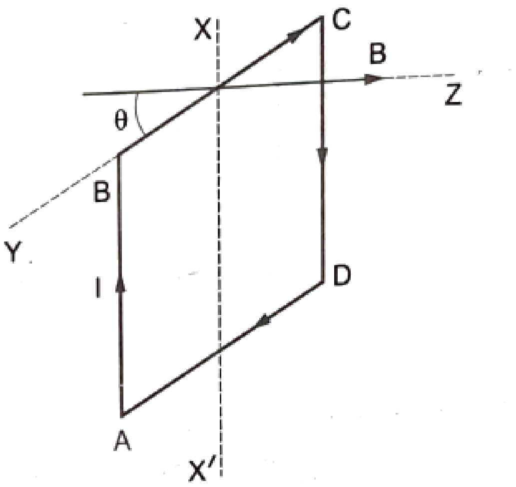
A) Change in momentum $\Delta\vec{P}$ of each photon is given by $\Delta\vec{P} = \frac{h}{\lambda}(-\hat{i} + \hat{j})$

B) Change in momentum $\Delta\vec{P}$ of each photon is given by $\Delta\vec{P} = \frac{h}{\lambda}(\hat{i} - \hat{j})$.

C) Force $\vec{F}$ exerted by light beam on the mirror is given by $\vec{F} = \frac{P}{c}(\hat{i} - \hat{j})$

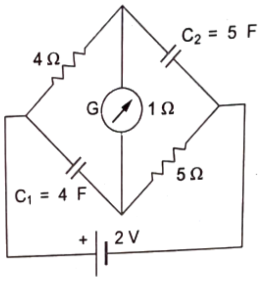
D) Force $\vec{F}$ exerted by light beam on the mirror is given by $\vec{F} = \frac{P}{c}(-\hat{i} + \hat{j})$

11. The square loop ABCD, carrying a current I, is placed in a uniform magnetic field B, as shown. The loop can rotate about the axis XX'. The plane of the loop makes an angle $\theta\left(\theta < 90^\circ\right)$ with the direction of B. Through what angle will the loop rotate by itself before the torque on it becomes zero?



A) θ B) $90^\circ - \theta$ C) $90^\circ + \theta$ D) $180^\circ - \theta$

12. In the circuit shown below, the cell is ideal, with $emf = 2V$. The resistance of the coil of the galvanometer G is $1\,\Omega$



A) No current flows in G. B) 0.2-A current flows in G.

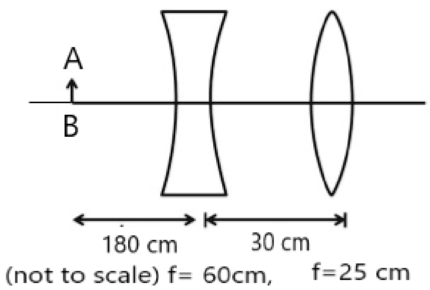
C) Potential difference across C_1 is 1 V. D) Potential difference across C_2 is 1.2 V.

13. Two heaters designed for the same voltage V have different power ratings. When connected individually across a source of voltage V, they produce H amount of heat each in times t_1 and t_2 respectively. When used together across the same source, they produce H amount of heat in time t.

A) If they are in series, $t = t_1 + t_2$ B) If they are in series, $t = 2(t_1 + t_2)$

C) If they are in parallel, $t = \frac{t_1 t_2}{(t_1 + t_2)}$ D) If they are in parallel, $t = \frac{t_1 t_2}{2(t_1 + t_2)}$

14. A thin concave and convex lens of respective focal lengths 60cm and 25cm are placed coaxially separated by a distance of 30 cm as shown in figure. A small linear object is kept at a distance of 180cm from the concave lens on common principal axis.



A) Final image of object is formed at 37.5 cm to the right of the convex lens

B) Final image of object is formed at 50 cm to the right of the convex lens

C) Net linear magnification of image is $\frac{1}{4}$

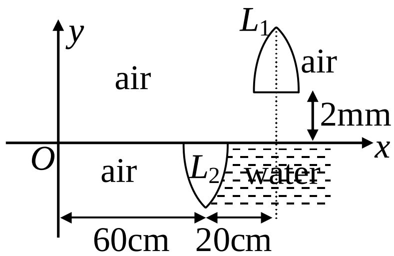
D) Net linear magnification of image is $\frac{1}{3}$

SECTION – III
(PARAGRAPH TYPE)

This section contains **2 groups of questions**. Each group has 2 multiple choice questions based on a paragraph.
Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE** is **correct**.
Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.

Paragraph For Questions 15 and 16

A point object O is placed at the origin of coordinate system. An equi-convex thin lens $(\mu_g = 1.5)$ of focal length $f = 20$ cm in air is placed so that its a principal axis is along x-axis. Now the lens is cut at the middle (along the principal axis) and upper half is shifted along x-axis and y-axis by 20 cm and 2 mm respectively and right side of lower half is filled with water $(\mu_w = 4/3)$.



15. Coordinates of the image produced by the lens L_1 will be

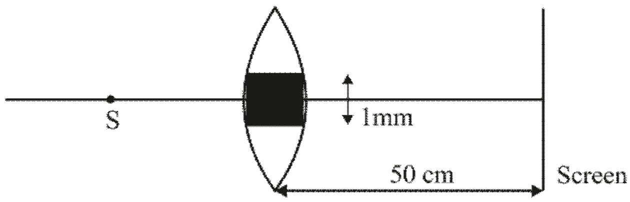
(A) $\left(\frac{320}{3}\text{cm}, \frac{4}{3}\text{mm}\right)$ (B) $\left(\frac{160}{3}\text{cm}, \frac{8}{3}\text{mm}\right)$ (C) $\left(\frac{320}{3}\text{cm}, \frac{8}{3}\text{mm}\right)$ (D) $\left(\frac{160}{3}\text{cm}, \frac{4}{3}\text{mm}\right)$

16. Coordinates of the image produced by the lens L_2 will be

(A) 140cm, 0 (B) 140cm, 20 (C) 70cm, 0 (D) 140cm, 30

Paragraph For Questions 17 and 18

A thin converging lens of focal length 10 cm is cut along a plane that contains the optical axis of the lens, and a small black plate of thickness 1 mm is placed between the two half-lenses. A point light source, S emitting monochromatic light of wavelength $\lambda = 0.5\mu m$ is located on the optical axis, a distance 20 cm from the tens, towards left of the lens. A screen is placed at a distance 50 cm towards right of the lens with its plane perpendicular to the optical axis.



17. Find the separation, d between two images of the source formed by two parts of the lens which produce interference fringes on the screen

A) 1 mm B) 0.5 mm C) 2 mm D) 3 mm

18. Nearly how many interference fringes can be seen on the screen?

A) 46 B) 37 C) 7998 D) 8001

CHEMISTRY **Max. Marks: 61**

SECTION – I

(SINGLE CORRECT CHOICE TYPE)

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct.**

Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.

19. Identify the correct statement

A) A real gas can be liquefied at temperature below T_i, above T_b

(T_i = inversion temperature, T_b = Boyle's temperature)

B) For one mole of vander waal's gas compressibility factor z=0.375 at critical point

C) Ideal gas can be liquefied below its critical temperature by applying high pressure

D) When mixture of ideal gases cooled up to liquid helium temperature (4.22k), an ideal solution is formed.

20. At low pressure Vander Waal's equation is written as $\left(p+\frac{a}{v^2}\right)v = RT$. The compressibility factor is then equal to

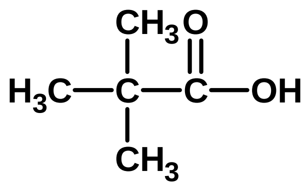
a) $\left(1-\frac{RTV}{a}\right)$ b) $\left(1-\frac{a}{RTV}\right)$ c) $\left(1+\frac{a}{RTV}\right)$ d) $\left(1+\frac{RTV}{a}\right)$

21. Which of the following can be dehydrated by using a drying agent?

A) $\left[Co\left(NH_3\right)_4\left(H_2O\right)Cl\right]Cl_2$ B) $\left[Cr\left(H_2O\right)_6\right]Cl_3$

C) $\left[Co\left(NH_3\right)_4Cl_2\right]Cl.H_2O$ D) All of these

22. Which of the following would be the best synthesis of the acid shown below?



A) $CH_3-CH_2-CHO\xrightarrow[Et_2O]{CH_3MgBr}\xrightarrow{H_3O^+}\xrightarrow{SOBr_2}\xrightarrow[Et_2O]{Mg}\xrightarrow{CO_2}\xrightarrow{H_3O^+}$

B) $CH_3-CH_2-CHO\xrightarrow[Et_2O]{CH_3MgBr}\xrightarrow{H_3O^+}\xrightarrow{SOBr_2}\xrightarrow{KCN}\xrightarrow[heat]{H_3O^+}$

C) $CH_3-CO-CH_3\xrightarrow[Et_2O]{CH_3MgBr}\xrightarrow{H_3O^+}\xrightarrow{SOBr_2}\xrightarrow[Et_2O]{Mg}\xrightarrow{CO_2}\xrightarrow{H_3O^+}$

D) $CH_3-CO-CH_3\xrightarrow[Et_2O]{CH_3MgBr}\xrightarrow{H_3O^+}\xrightarrow{SOBr_2}\xrightarrow{KCN}\xrightarrow[heat]{H_3O^+}$

23. The wavelength of electron in one of the orbits of excited hydrogen atom is 13.32A°. When this electron falls in to a lower orbit its wavelength is found to be 6.66A°. The wavelength of photon emitted in this transition is

A) 486 nm B) 124 nm C) 652 nm D) 100.3 nm

24. Which of the following statement is wrong about the N-N bond length among the following species?

I) H_2N-NH_2 II) N_2 III) $H_3\overset{+}{N}-\overset{+}{N}H_3$ IV) N_2O

A) N-N bond is shortest in II

B) N-N bond is shorter in II than in I

C) N-N bond is shorter in I than in III

D) N-N bond length is intermediate in IV compared to I and II

25. Which of the following conditions is not suitable for the brown ring test of NO_2^-?

A) $FeSO_4$ added must be freshly prepared

B) H_2SO_4 added should be concentrated

C) Acetic acid may be used as an alternative acid

D) Shaking or warming is not allowed

SECTION-II
(ONE OR MORE OPTIONS CORRECT TYPE)

This section contains 7 multiple choice equations. Each question has four choices **(A)** **(B)**,**(C)** and **(D)** out of which **ONE** or **MORE THAN ONE** are correct.

Marking scheme: +4 for all correct options, 0 if not attempted and -2 in all wrong cases.

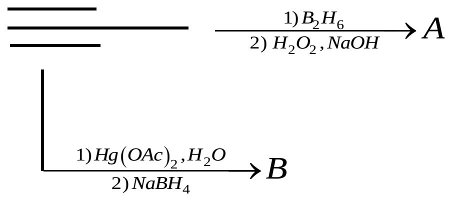
26. The Lucas test is used to distinguish small (7 or fewer carbons) $1^0, 2^0$ and 3^0-alcohols. The alcohol to be tested is added to a solution of anhydrous $ZnCl_2$ in conc. HCl at room temperature. Which of the following statement **is/are** correct?

A) 1^0-alcohols dissolve, but do not react

B) 3^0-alcohols react quickly to give an insoluble alkyl chloride

C) 3^0-alcohols rapidly dehydrate, and the gaseous alkene bubbles come out of the test solution which appears as turbidity.

D) 2^0-alcohols dissolve and react slowly to give an insoluble alkyl chloride



27. Identify the correct statements

A) A is acetone

B) B is Acetone

C) A is Propanal

D) B is gives Haloform reaction

28. Choose correct statement(s) regarding radical addition polymerisation

A) Phenol acts as radical inhibitor

B) Vinyl chloride, styrene etc can undergo radical polymerisation

C) Ethylene upon radical polymerisation gives LDPE

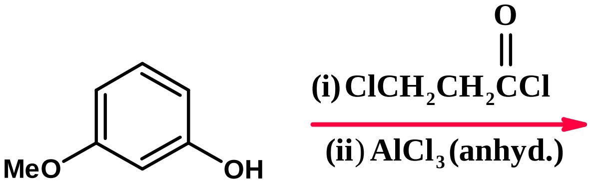
D) Polythene obtained by radical polymerisation has more density than that obtained by using Zieggler-Natta catalyst

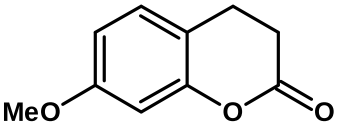
29. XeO_3 can be prepared by:

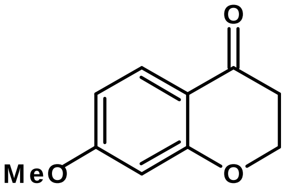
A) hydrolysis of XeF_2 B)the reaction of XeF_4 with OF_2

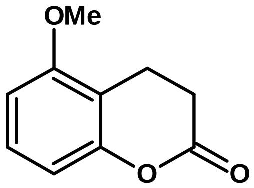
C) the hydrolysis of XeF_4 D) the hydrolysis of XeF_6

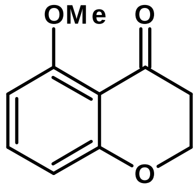
30. The major product of the following reaction is:



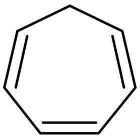
A) 

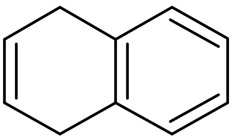
B) 

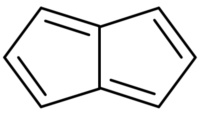
C) 

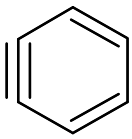
D) 

31. Aromatic compound(s) among the following is/are

A) 

B) 

C) 

D) 

32. The correct statement(s) is/are among the following

A) At very high pressures, diamond is a thermodynamically stable allotrope of carbon

B) Both CO_2 and CS_2 are weak Lewis acids

C) Zeolites are layered materials exclusively composed of alumino silicates

D) The reaction of calcium carbide with water yields ethyne and this product reflects the presence of a highly basic C_2^{2-} ion in calcium carbide.

SECTION – III
(PARAGRAPH TYPE)

This section contains **2 groups of questions**. Each group has 2 multiple choice questions based on a paragraph.

Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE** is **correct**.

Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.

Paragraph For Questions 33 and 34

Element (A) burns in nitrogen to give an ionic compound (B). Compound (B) reacts with water to give (C) and (D). A solution of (C) becomes milky on bubbling CO_2. The chloride of elements (A) imparts brick red colour to Bunsen flame.

Now answer the following questions:

33. The element (A) is:

A) Ca B) Mg C) Al D) K

34. The incorrect statement about aqueous solution of D is:

A) With Hg_2^{2+}, it gives black Precipitate.

B) It dissolves Cu^{2+} salt forming deep – blue colouration.

C) With Fe^{3+} it forms a reddish – brown Precipitate which is soluble in excess of the reagent (D).

D) With Ni^{2+} it forms a green Precipitate which dissolves in excess of the reagent (D).

Paragraph for Questions 35 and 36

$$
\begin{tikzcd}
 & & & F \\
D+B & Na_2B_4O_7 \arrow[l, "\Delta"', "740^oC"] \arrow[r, "H_2SO_4", "H_2O"'] & (A) \arrow[r, "\Delta", "\text{Red Hot}"'] \arrow[d, "C_2H_5OH"] & (B) \arrow[u, "H_2;Al"', "150^oC\ 750\,atm"] \\
 & & (C) &
\end{tikzcd}
$$

Now answer the following questions:

35. The incorrect set is:

A) $A-H_3BO_3$ B) $B-B_2O_3$ C) $C-B(OC_2H_5)_3$ D) $D-Na_2O$

36. The incorrect statement(s):

A) (D) can be used to prepare brightner in washing powder.

B) (F) can undergo symmetrical cleavage with 1° – amines.

C) (C) gives green edged flame.

D) (F) $+NH_3 \xrightarrow[\text{High temperature, } 200^{o}C]{2:1}$ compound (G), which can undergo hydrolysis.

MATHS **Max. Marks: 61**

SECTION – I

(SINGLE CORRECT CHOICE TYPE)

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct.**

Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.

37. If $\lim\limits_{x\to 0}\left(\left[\frac{\sin^{-1}(x)}{x}\right]+\left[\frac{2^2\sin^{-1}(2x)}{x}\right]+\left[\frac{3^2\sin^{-1}(3x)}{x}\right]+.............+\left[\frac{n^2\sin^{-1}(nx)}{x}\right]\right)=100$

then the value of n is ,(where [k] denotes the greatest integer less then or equal to k).

A) 2 B) 3 C) 4 D) 5

38. Let $p(x)=x^{10}+a_2x^8+a_3x^6+a_4x^4+a_2x^2$ be a polynomial with real coefficients. If p(1)=1 and p(2)=-5,then the minimum number of district real zeroes of p(x) is

A) 5 B) 6 C) 7 D) 8

39. If the value of the definite integral $\int_0^1 207C_7x^{200}(1-x)^7\,dx$ is equal to $\frac{1}{k}$ where $K\in N$, the value of 'k' is equal to

A)208 B) 210 C) 212 D) 214

40. Area enclosed by the curve $y=x^2+1$ and a normal drawn to it with gradient -1 is equal to:

A) $\frac{2}{3}$ B) $\frac{4}{3}$ C) $\frac{19}{12}$ D) $\frac{43}{12}$

41. Let α and β be the roots of $x^2-6x-2=0$ with $\alpha>\beta$ if $a_n=\alpha^n-\beta^n$ for $n\geq 1$ then the value of $\frac{a_{10}-2a_8}{3a_9}=$

A) 1 B) 2 C) 3 D) 4

42. If $S_n=\sum\limits_{r=0}^{n}\frac{1}{nc_r}$ and $T_n=\sum\limits_{r=0}^{n}\frac{r}{nc_r}$ then $\frac{T_n}{S_n}$ is equal to

A) n-1 B) $\frac{n}{2}$ C) n D) $\frac{n}{2}$-1

43. Equation of the plane containing the lines $\bar{r} = \bar{i} + 2\bar{j} - \bar{k} + \lambda(\bar{i} + 2\bar{j} - \bar{k})$ and $\bar{r} = \bar{i} + 2\bar{j} - \bar{k} + \mu(\bar{i} + \bar{j} + 3\bar{k})$ is

A) $\bar{r}.(7\bar{i} - 4\bar{j} - \bar{k}) = 0$ B) $7(x-1) - 4(y-1) - (z+3) = 0$

C) $\bar{r}.(\bar{i} + 2\bar{j} - \bar{k}) = 0$ D) $\bar{r}.(\bar{i} + \bar{j} + 3\bar{k}) = 0$

SECTION-II
(ONE OR MORE OPTIONS CORRECT TYPE)

This section contains 7 multiple choice equations. Each question has four choices **(A)** **(B)**,**(C)** and **(D)** out of which **ONE** or **MORE THAN ONE** are correct.

Marking scheme: +4 for all correct options, 0 if not attempted and -2 in all wrong cases.

44. Let $f(x)$ be a function satisfying $f'(x) = 2f(x)$ and f(0)=3.If

$\int \frac{f(x)}{12 + 4f(x)} dx = \frac{1}{k} \ln\left(1 + ae^{bx}\right) + c$ (where a,b are positive integers and gcd of a,b is one)

Then,

A) a + b =3   B) k + b =10   C) ak = 4b   D) a +b +k=0

45. Which of the following curves are orthogonal ?

A) $y = |x|, y = 3 - |x|$ B) $\frac{x^2}{3} + y^2 = 1, x^2 - y^2 = 1$

C) $xy = 1, x^2 - y^2 = 3$ D) $y^2 = 4x, x^2 = 8y$

46. The equation of the line passing through (2,3) and making an intercept of 2 units between the lines y+2x=5 and y+2x=3

A) 5x-4y+2=0   B) 3x+4y=18

C) x=2   D) y=3

47. If A is a square matrix of order three of real entries such that $|A| = 2$ and

$$A^2 \ adj(A) = \begin{pmatrix} 2 & 2 & 0 \\ 0 & 2 & 2 \\ k & 0 & 2 \end{pmatrix}$$

Then $(K \in R)$

A) $A^3 = 2I$ B) $|KA| = 16$ C) $A^2 = 2A$ D) Trace of $A^3 = 6$

48. If $\lim\limits_{x\to 0} \dfrac{a\sin x - bx + cx^2 + x^3}{2x^2 ln(1+x) - 2x^3 + x^4}$ exists and is finite, then

A) $a=6$ B) $b=0$ C) $c=0$ D) The limit = $\dfrac{3}{40}$

49. The lines $(m-2)x+(2m-5)y=0$, $(m-1)x+\left(m^2-7\right)y-5=0$ and $x+y-1=0$ are

A) Concurrent for three values of m

B) Concurrent for one value of m

C) Concurrent for no value of m

D) Are parallel

50. For the cubic, $f(x)=2x^3+9x^2+12x+1$ which of the following statements hold good?

A) $f(x)$ is non monotonic

B) Increasing in $(-\infty,-2)\cup(-1,\infty)$ and decreasing in $(-2,-1)$

C) $f:R\to R$ is bijective

D) Range of $f(x)$ is R

SECTION – III
(PARAGRAPH TYPE)

This section contains **2 groups of questions**. Each group has 2 multiple choice questions based on a paragraph.
Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE** is **correct**.
Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.

Paragraph For Questions 51 and 52

$$I = \int_0^{10\pi} \frac{\cos(6x).\cos(7x).\cos(8x).\cos(9x)}{1+e^{2\sin^3(4x)}}dx$$

Then answer the following questions

51 If $I = K\int_0^{\frac{\pi}{2}} \cos(6x).\cos(7x).\cos(8x).\cos(9x)dx$ then K=

A) 5 B) 10 C) 20 D) 80

52 The value of I=

A) $\dfrac{5\pi}{4}$ B) $\dfrac{5\pi}{8}$ C) $\dfrac{5\pi}{16}$ D) $\dfrac{5\pi}{12}$

Paragraph For Questions 53 and 54

Let a, b, c be three real numbers satisfying

$$\begin{bmatrix} a & b & c \end{bmatrix}\begin{pmatrix} 1 & 9 & 7 \\ 8 & 2 & 7 \\ 7 & 3 & 7 \end{pmatrix} = \begin{bmatrix} 0 & 0 & 0 \end{bmatrix} \to E$$

53 If the point P (a, b, c) with reference to E lies on the plane $2x+y+z=1$ then the value of $7a+b+c$ is

A)0 B) 12 C) 7 D) 6

54 Let w be a solution of $x^3-1=0$ with Im (w)>0 $x^3-1=0$ if a=2 with b and c satisfying E then The value of $\frac{3}{w^a}+\frac{1}{w^b}+\frac{3}{w^c}$ is equal to

A) -2 B) 2 C) 3 D) -3

NARAYANA IIT-JEE ACADEMY-INDIA

OUTGOING SR's		Date: 18-05-2023
Time: 3Hrs	SGTA-4	Max.Marks:183

18-05-23_SR-OUTGOING_Jee-Adv_2017_P2_SGTA-4(PAPER-II)_KEY&SOL

PHYSICS

Q.No	01	02	03	04	05	06	07	08	09
Key	C	C	A	C	A	B	D	AD	AB
Q.No	10	11	12	13	14	15	16	17	18
Key	AC	C	BCD	AC	AD	C	A	C	A

CHEMISTRY

19	B	20	B	21	C	22	C	23	A	24	C	25	B	26	ABD
27	BCD	28	ABC	29	CD	30	A	31	BD	32	ABD	33	A	34	C
35	D	36	B												

MATHS

Q.No	37	38	39	40	41	42	43	44	45
Key	C	A	A	B	B	B	A	ABC	ABC
Q.No	46	47	48	49	50	51	52	53	54
Key	BC	BD	ACD	CD	ABD	B	B	D	A

Hints & Solutions

PHYSICS

01. $Z_1 = R\left(1+i\sqrt{3}\right)$

$Z_2 = R\left(1-i\sqrt{3}\right)$

$Z_{AB} = 3R$

02. $\lambda' = CT - \frac{1}{2}aT^2 = \frac{2CT - aT^2}{2} = \frac{\frac{2C}{n} - \frac{a}{n^2}}{2} = \frac{2Cn - a}{2n^2}$

$n' = \frac{C}{\lambda'} = \frac{2n^2C}{2nc - a}$.

03. $eV_s = \frac{hc}{\lambda} = \phi$,

$V_{S1} - V_{S2} = \frac{hc}{e}\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$

So, $\frac{h}{e} = \frac{V_{S1} - V_{S2}}{e\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)}$.

04. $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{R^2}$

$F_e = \frac{1}{2}\varepsilon_0 E^2 \Delta A = \frac{q^2 \Delta A}{32\pi^2 \varepsilon_0 R^4}$

$F_{gas} = \frac{PV_0}{V}\Delta A = P\frac{R_0^3}{R^3}\Delta A$

For equilibrium $P = \frac{q^2}{32\pi^2\varepsilon_0 R^4} + \frac{PR_0^3}{R^3}$

Solving $q = \left[32\pi^2\varepsilon_0 PR\left(R^3 - R_0^3\right)\right]^{\frac{1}{2}}$

05. $\Delta M = M\left({}^{238}U\right) - \left\{M\left(P_b\right) + 8M\left(\alpha\right) + 6M\left(e^-\right)\right\}$ in amu

$E = \Delta M \times 931.47\, MeV = 48.6\, MeV$

06. $B = \frac{\mu_0 I}{2\pi r}$,

Energy stored in length l, $E = \int_a^b \frac{B^2}{2\mu_0} 2\pi r \ell dr = \frac{\mu_0 I^2}{4\pi}\ell\left(\log_e \frac{b}{a}\right)$

So, $\frac{1}{2}LI^2 = \frac{\mu_0 I^2 \ell}{4\pi}\log_e \frac{b}{a}$

$L = \frac{\mu_0 \ell}{2\pi}\ln 2$

07. use Kirchhoff's loop rule

08. Amplitude, $E = E_0 Cos\theta \cos(90-\theta) = \frac{1}{2}E_0 Sin\theta$

So, for maximum amplitude $Sin2\theta = \pm 1$, or $\theta = \pm 45^0$

Intensity is proportional to square of amplitude

So, Intensity (Maximum transmitted) = $\frac{1}{4}\times$ incident intensity

09. $E_n = \frac{-Rhcz^2}{n^2}$

$E_1 = \frac{hc}{\lambda}$

11. In the position shown, AB is outside and CD is inside the plane of the paper. The Ampere force on AB acts into the paper. The torque on the loop will be clockwise, as seen from above. The loop must rotate through an angle $(90^\circ + \theta)$ before the plane of the loop becomes normal to the direction of B and the torque becomes zero.

12. Disregard the capacitors and find the current through G. The potential difference across each capacitor is the found from the potential differences across the resistors in parallel with them.

13. Let R_1 and R_2 be the resistances of the two heaters. Let H be the heat produced.

$\therefore H = \left(\frac{V^2}{R_1}\right)t_1 = \left(\frac{V^2}{R_2}\right)t_2$

When used in series, $H = \left(\frac{V^2}{R_1 + R_2}\right)t$. When used in parallel, $H = \left(\frac{V^2}{R_1} + \frac{V^2}{R_2}\right)t$

14. Use Lens Formula,

Virtual Image formed by diverging lens behaves as a real object for convex lens)

15. $f = 20\,\text{cm}$

y L1
air
2mm
O air L2 water x
60cm 20cm

$m = \dfrac{v}{u} = \dfrac{I}{O}$

$u = -80\,\text{cm}$

$v = \dfrac{uf}{u+f} = \dfrac{80}{3}\,\text{cm}$

$\therefore$ x-co-ordinate $= 80 + \dfrac{80}{3} = \dfrac{320}{3}\,\text{cm}$

$\therefore$ y-co-ordinate $= \left(\dfrac{2}{3} + 2\right)\text{mm} = \dfrac{8}{3}\text{mm}$

Hence, co-ordinate of image formed by

$L_1 = \left(\dfrac{320}{3}\text{cm}, \dfrac{8}{3}\text{mm}\right)$

$\therefore$ **(C)**

16. By refraction formula $\dfrac{\mu_g}{v_1} - \dfrac{1}{(-60)} = \dfrac{\mu_g - 1}{+20}$ ... (i)

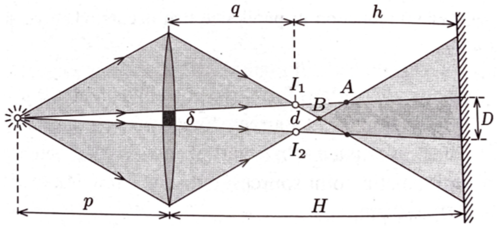
$\dfrac{\mu_w}{v} - \dfrac{\mu_g}{v_1} = \dfrac{\mu_w - \mu_g}{-20}$ ... (ii)

$\therefore$ $v = +80$ cm

So $x = 80 + 60 = 140$ cm

$\therefore$ **(A)**

17.



$\dfrac{1}{p} + \dfrac{1}{q} = \dfrac{1}{f}$

$q = \dfrac{pf}{p-f}, \dfrac{d}{\delta} = \dfrac{p+q}{p}$ (or) $d = \dfrac{p+q}{p}; \delta = \dfrac{p\delta}{p-f} = \dfrac{200\times1}{100} = 2\text{ mm}.$

18. $h = H - q = 50 - 20 = 30$ cm

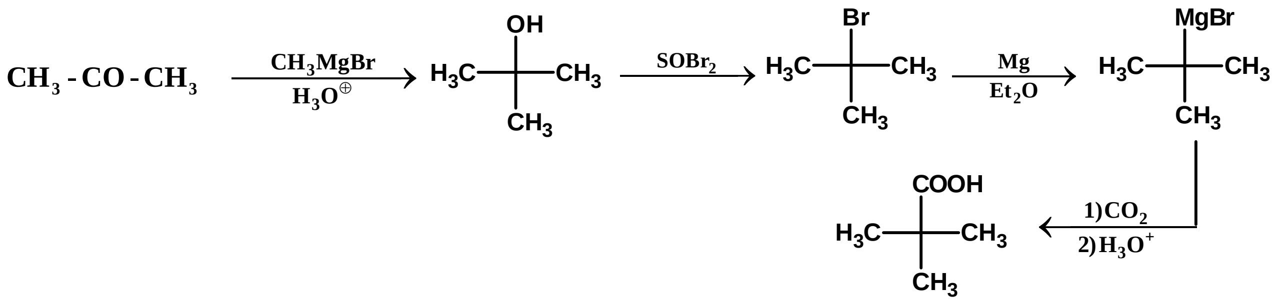
Fringe width, $\beta = \dfrac{\lambda h}{d} = \dfrac{5\times10^{-7}\times30\times10^{-2}}{2\times10^{-3}} = 75\times10^{-6}$ m

$D = \delta\dfrac{H+p}{p} = \dfrac{10^{-3}\times70\times10^{-2}}{20\times10^{-2}} = 3.5\times10^{-3}$ m

So, $N = \dfrac{D}{\beta} = \dfrac{3.5\times10^{-3}}{75\times10^{-6}} \simeq 46.7 \simeq 47$

CHEMISTRY

19. Ideal gases are not liquefied
20. CONCEPTUAL
21. Water of crystallization can be removed by dehydration but not coordinated water.
22.



23. For hydrogen atom $\lambda_1 = 3.33 A^{o}$

$\lambda_n = n \times \lambda_1$

$n_2 = \frac{13.32}{3.33} = 4$

$n_1 = \frac{6.66}{3.33} = 2$

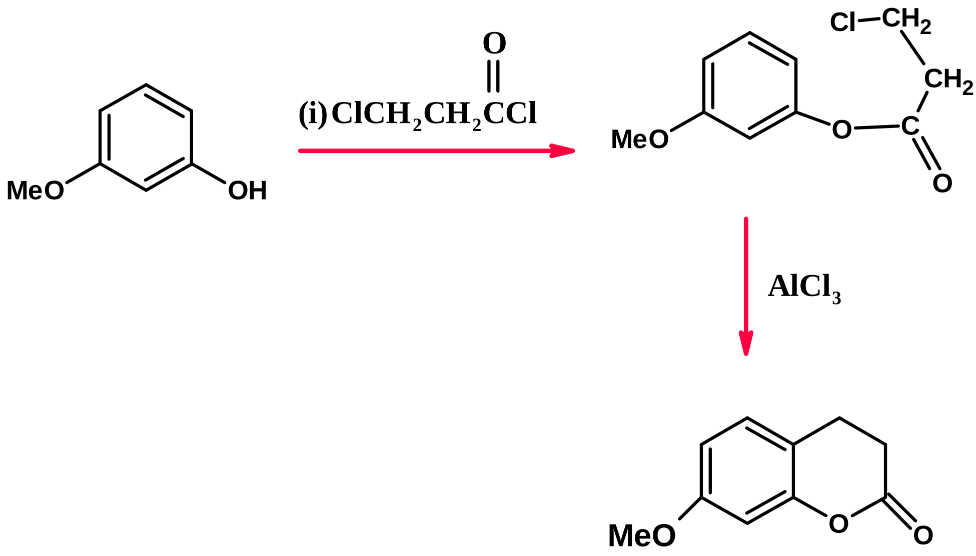
$\Delta E = E_4 - E_2$

$= \left(\frac{-13.6}{16}\right) - \left(\frac{-13.6}{4}\right)$

$= 3.4 - 0.85 = 2.55 eV$

$\lambda = \frac{1240 eV.nm}{2.55 eV} = 486 nm$

24. As the lone pairs are removed by donation to H^+ ions in $N_2H_6^{2+}$, the repulsion between lone pairs is removed. So N-N bond length in $N_2H_6^{2+}$ (1.42) becomes shorter than in N_2H_4 (1.453). In N_2O the N-N bond order will be around 2.5 (between double and triple bonds due to resonance hybrid. The bond length is less 1.126.
25. Concentrated H_2SO_4 cannot be used in this test instead of dil. H_2SO_4 because it produces intense brown fumes with NO_2^- and under these conditions no ring can be observed.
26. Turbidity of alkyl halide is formed not of alkene.
27. A is aldehyde
29. Conceptual
30.



31. Conceptual
32. Zeolites are frame work silicates not layered and they contain other metal cations in their composition to balance the negative charge of the three dimensional alumino-silicate. So they are not exclusively composed of alumino silicates. Hydrolysis of CaC_2 an ionic compound produces C_2H_2 and $Ca(OH)_2$ in which C_2^{2-} ion accept H^+ ion, which is very weak acid.
33. Calcium.
34. With Fe^{3+} it forms a reddish – brown PPt which is insoluble in excess of the reagent (D)
35. D is $NaBO_2$
36. F is diborane and it undergoes unsymmetrical cleavage with primary amines.

MATHS

41. $\alpha^2-6\alpha-2=0$ $\qquad$ $\beta^2-6\beta-2=0$

$\Rightarrow \alpha^{10}-6\alpha^9-2\alpha^8=0$ ....(1) $\qquad$ $\Rightarrow \beta^{10}-6\beta^9-2\beta^8=0$ ....(2)

subtract (2) from (1)

43. Since both the given lines pass through the point with position vector $i+2j-k$, the required plane also passes through $i+2j-k$ and normal to the plane is perpendicular to the vectors $i+2j-k$ and $i+j+3k$. If $d=ai+bj+ck$ is normal to the required plane, then $a+2b-c=0$ and $a+b+3c=0$

$$\Rightarrow \frac{a}{7}=\frac{b}{-4}=\frac{c}{-1}\Rightarrow d=7i-4j-k.$$

So the required plane passes through $i+2j-k$ and the normal to plane is $7i-4j-k$, hence required equation is $[r-(i+2j-k)].(7i-4j-k)=0$

$r.(7i-4j-k)=1\times 7+2(-4)+(-1)(-1)=0$

Also since the required plane passes through $i+2j-k, i.e.$ the point $-(1,2,-1)$ and the direction ratios of the normal to the plane are 7,-4,-1, the equation of the plane in Cartesian form can be written as $7(x-1)-4(y-2)-(z+1)=0$

48. Givin limit

$$= \lim_{x\to 0} \frac{a\left(x-\frac{x^3}{3!}+\frac{x^5}{5!}-....\right)-bx+cx^2+x^3}{2x^2\left(x-\frac{x^2}{2}+\frac{x^3}{3}-...\right)-2x^3+x^4}$$

$$= \lim_{x\to 0} \frac{(a-b)x+cx^2+\left(1-\frac{a}{6}\right)x^3+\frac{ax^5}{120}....}{2\frac{x^5}{3}-\frac{x^6}{2}+...}$$

For this limit to exist, we must have

$a=b, c=0, a=6$

and given limit = $\frac{a}{120}\times\frac{3}{2}=\frac{6\times 3}{120\times 2}=\frac{3}{40}$

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S	JEE-ADVANCE-2021-P1	Date: 19-04-2023
Time: 09.00Am to 12.00Pm	GTA-16	Max. Marks: 180

19-04-2023_Sr.Super60_ NUCLEUS&ALL_BT'S_Jee-Adv(2021-P1)_GTA-16_Syllabus

PHYSICS : FIRST YEAR SYLLABUS

CHEMISTRY : FIRST YEAR SYLLABUS

MATHEMATICS : FIRST YEAR SYLLABUS

Name of the Student: ___________________ H.T. NO: | | | | | | | |

JEE-ADVANCE-2021-P1-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 4)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 5 – 10)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 11 – 16)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 17 – 19)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 20 – 23)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 24 – 29)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 30 – 35)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 36– 38)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 39 – 42)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 43 – 48)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 49 – 54)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 55 – 57)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

PHYSICS Max Marks: 60

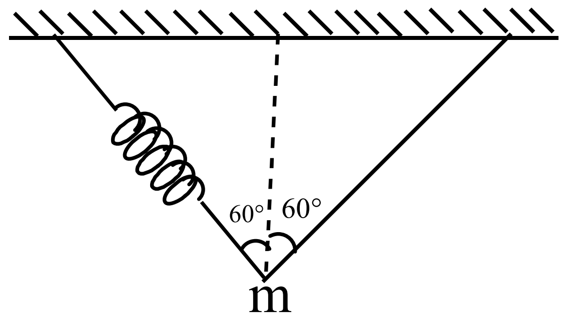
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 4 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases. Section 1 (Max Marks: 12)

- Section 1 contains Four questions
- Each Question has Four Options and Only One of these four will be the correct answer.
- For each question, choose the option corresponding to the correct answer
- The Marking scheme to evaluate Answer to each question will be :
- Full Marks: **+3** (If the answer is correct)
- Zero Marks: **0** (If the question is unanswered)
- Negative Marks: -1 (In all other cases)

1. A ball of mass m is suspended using a thread and a spring as shown. Acceleration of the ball just after cutting the spring is a_1, while it is a_2 just after cutting the string $\frac{a_1}{a_2}$ is equal to?

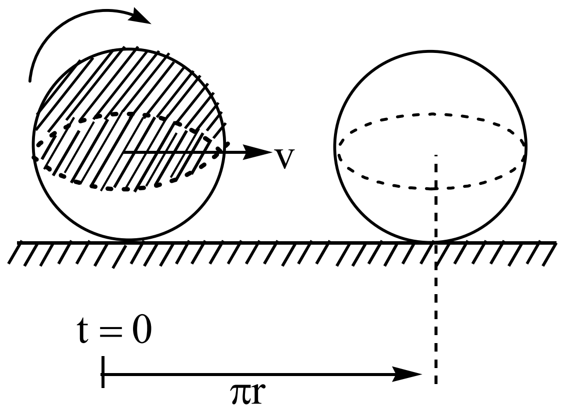


A) 1 **B)** $\frac{1}{2}$ **C)** $\frac{\sqrt{3}}{2}$ **D)** infinite

2. The displacement of a Damped harmonic oscillator is given by $x(t) = e^{-0.1t}\cos(10\pi t + \phi)$. Here t is in sec. The time taken for its amplitude of vibration to drop to half of its initial value is close to

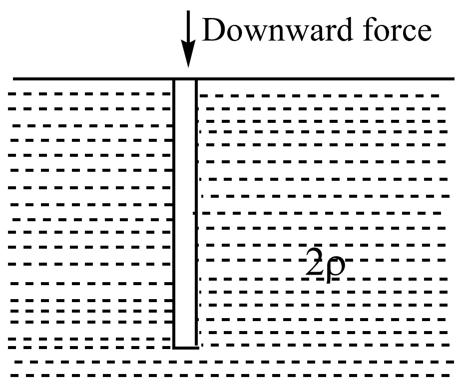
A) 7s **B)** 4s **C)** 3s **D)** 2s

3. A thin hollow spherical shell of mass m and radius r is set into pure rolling on a rough horizontal surface with its centre of mass having velocity v initially as shown. Work done by the upper hemispherical portion(shaded in the figure shown) on the lower hemispherical portion, as the sphere displaces by, πr is



A) $\frac{1}{2}mV^2 + \frac{mgr}{2}$ B) $\frac{1}{2}mV^2 + mgr$ C) $\frac{1}{3}mV^2 + mgr$ D) $\frac{1}{3}mV^2 - mgr$

4. A vertical thin uniform rod is held in equilibrium after immersing completely by applying a vertically downward force at its top end as shown. Net compression in the rod is (length of the rod is L, its density is ρ and Young's modulus of rod's material is Y and density of fluid is 2ρ)



A) $\frac{\rho L^2 g}{2Y}$ B) $\frac{\rho L^2 g}{4Y}$ C) $\frac{3\rho L^2 g}{2Y}$ D) $\frac{2\rho L^2 g}{Y}$

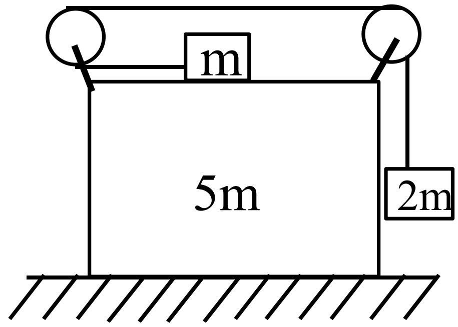
SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks:* +2** If ONLY the correct numerical value is entered at the designated place;
- **Zero Marks:0** in all other cases

Question Stem for Question Nos. 5 and 6

Question Stem

In the systems shown in figure, Wedge has mass 5m, block on top of it has mass m and hanging block has mass 2m. The system is released from rest keeping m, 2m and 5m at rest and released to move under gravity freely. Assume no friction at any of the contacts.



$g = acceleration\ due\ to\ gravity\ \left(g = 10\ ms^2\right)$

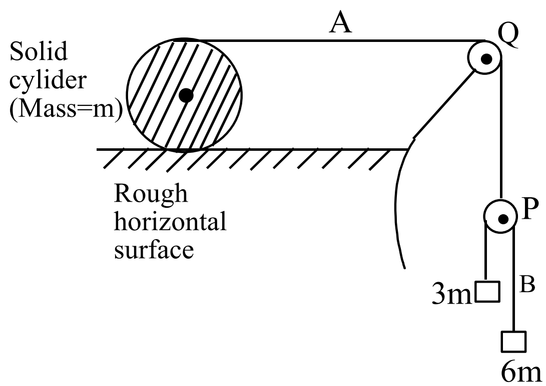
5. The initial acceleration of wedge of mass 5m w.r.t ground, when released form rest. $\left(in\ ms^2\right)$

6. Relative Acceleration of mass m w.r.t wedge of mass 5m., when the system is released from rest. $\left(in\ ms^2\right)$

Question Stem for Question Nos. 7 and 8

Question Stem

Consider the shown arrangement in which a solid cylinder of mass m=0.67 kg is placed on a rough horizontal table. An ideal thread A wound around the cylinder is attached to an ideal movable pulley P going over ideal pulley Q. Another ideal thread B, connecting blocks of masses 3m and 6m, passes over P. The arrangement is released from rest. Assuming that the cylinder does not slip w.r.t its contact with thread A and the horizontal surface, tension in thread A is T and minimum coefficient of friction between the cylinder and the horizontal surface is μ .(Take, g=10m/s^2)



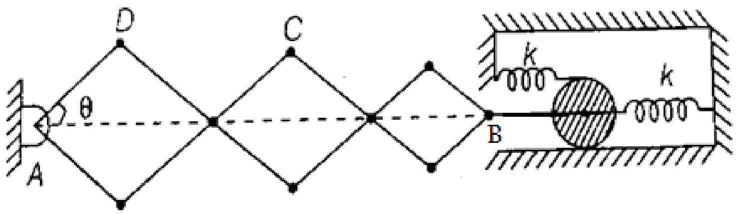
7. The value of T is… N.

8. The value of $\left(\frac{1}{\mu}\right)$ is…………… (Round off upto two significant digits after decimal point)

Question Stem for Question Nos. 9 and 10

Question Stem

Twelve light rods are hinged to each other as shown in the arrangement in the figure geometrically resembling in three rhombuses of sides in the ratio 3:2:1. Hinge A is fixed to a vertical wall while hinge B is connected to centre of an oscillating disc (amplitude of center=A) of mass m by a light rod. The disc is connected to two identical springs of spring constant k each. Friction between disc and horizontal surface in its contact is sufficient to prevent slipping of the disc. It is given that, A=0.2 mm, $m = \frac{1}{3}kg, k = 90N/m, \theta = 45^0$(when the disc is at mean position).



9. Speed of hinge C, at the instant $\theta = 45^0$, is……………………mm/s.

10. Angular speed of rod AD of length $L = \sqrt{2}mm$, at the instant, $\theta = 45^0$, is…..rad/s.

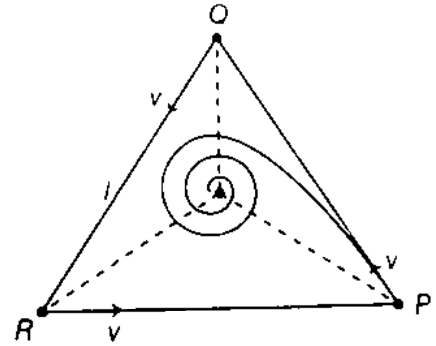
SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and

Choosing any other option(s) will get -2 marks.

11. Three particles P,Q and R initially located at vertices of an equilateral triangle of side ℓ start moving with constant speed v each such that P always chases(moves towards) Q,Q always chases R and R always chases P. Trajectory followed by P is shown in the figure. Choose the correct alternative(s).



A) Average velocity of P for its motion till the instant it catches Q is $\left(\frac{\sqrt{3}}{2}\right)v$

B) Average speed of P for its motion till it completes one revolution around centroid O is v.

C) Distance covered by P when it completes one revolution around centroid O of the triangle $\frac{2l}{3}\left(1-e^{-2\sqrt{3}\pi}\right)$.

D) Separation between P and Q as P completes one revolution around O is $l \quad e^{-(2\pi)\sqrt{3}}$.

12. Two identical uniform discs each of mass m and radius r are placed on a horizontal frictionless floor. One of the disc is given an angular velocity ω about its stationary vertical axis and the other is projected with a horizontal velocity υ without rotation for a head on collision to occur between them. If the collision is perfectly inelastic and slipping between the discs ceases in the end of the collision. Angular velocities of the discs and speeds of their centres after the collisions are

A) $\omega_1 = \frac{2}{3}\omega$ **B)** $\omega_2 = \frac{\omega}{3}$ **C)** $\omega_2 = -\frac{\omega}{3}$ **D)** $\left|\vec{\upsilon_1}\right| = \left|\vec{\upsilon_2}\right| = \frac{1}{2}\sqrt{u^2 + \left(\frac{r\omega}{3}\right)^2}$

13. A uniform disc of mass m and Radius R is rolling on a flat rough surface, without slipping at bottom. If 't' is the thickness of the disc and σ is the Breaking stress of the material of the disc, then

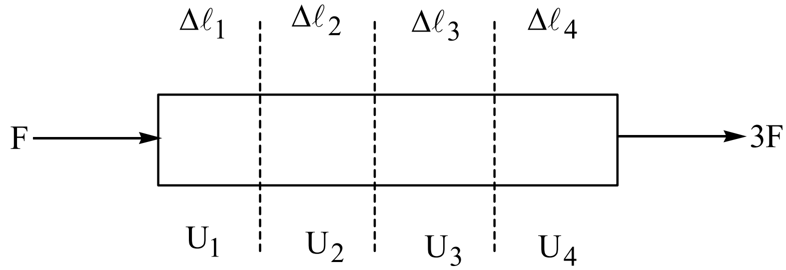
A) Maximum Normal force of Interaction between left half and right half of the disc would be, $\frac{2mRw^2}{3\pi}$.

B) Point of application of Normal force of interaction does not passes through center of the disc.

C) Maximum angular speed at which material ruptures varies with σ as, $\omega \propto \sigma^2$

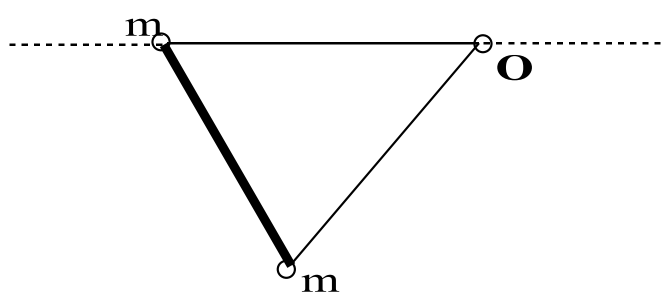
D) Maximum angular speed and Breaking stress of the material are related as $\omega^2 \propto \sigma$

14. If a rod of length l, very small area of cross section A, Young's modulus of Elasticity Y is acted upon by parallel forces 3F and F respectively as shown in fig. Within elastic limit to study change in length of the rod (Δl) and its elastic potential energy (U) the rod in segmented into four equal parts where magnitude of change in lengths are $\Delta l_1, \Delta l_2, \Delta l_3, \Delta l_4$ and elastic potential energy stored in each segment are $U_1, U_2 U_3, U_4$ respectively as shown then which is /are correct.



A) $\Delta l_1 = \frac{\Delta l_3}{3} = \frac{\Delta l}{8}$ **B)** $U_1 < \frac{U}{4} < U_4$ **C)** $\Delta l_2 = \frac{\Delta l_4}{5} = \frac{\Delta l}{8}$ **D)** $U_1 = U_2 < U_3 < U_4$

15. Particle like balls each of mass m are affixed at both the ends of a light rigid rod of length l. The composite body thus formed in suspended from a nail O, with the help of two inextensible cords affixed on each ball length of each chord is also l. Now arrangement in pulled aside bringing one ball in level with the nail and keeping both the chords straight and then released let θ be the angular position of centre of mass of the system from horizontal at any instant of time, then



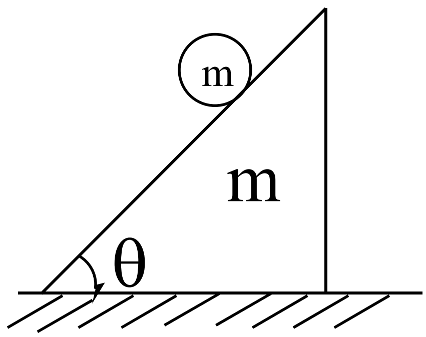
A) Its angular acceleration of the system as a function of θ is $\frac{\sqrt{3}}{2}\frac{g}{l}\cos\theta$

B) If T_1 and T_2 are the tensions in the two threads then $T_1 - T_2 = mg\cos\theta$

C) Angular position θ at which tension becomes maximum is given by $\tan\theta = \frac{10}{\sqrt{3}}$

D) Maximum tension in a cord during subsequent motion $= \frac{mg}{2}\left(\sqrt{\frac{103}{3}} - \sqrt{3}\right)$

16. A triangular wedge of mass m is placed on a frictionless table its inclined face makes an angle θ with the horizontal. A solid cylinder of mass m and radius r rolls down the inclined face without sliding or slipping if a_r, 'a' denote acceleration of cylinder with respect to wedge and wedge with respect to ground respectively then which of the following are correct.



A) $a = \dfrac{g\sin\theta\cos\theta}{2+\sin^2\theta}$

B) $a_r \cos\theta = 2a$

C) Normal force between wedge and incline is in less than $mg\cos\theta$.

D) Minimum coefficient of friction required to support rolling, $\mu = \dfrac{1}{2}\tan\theta$ cylinder along the incline is

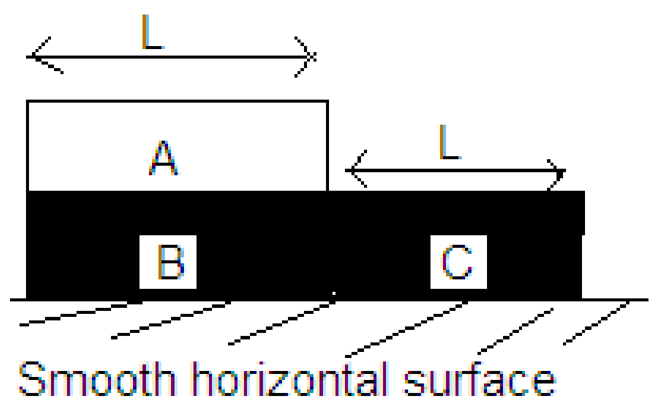
SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : +4 If ONLY the correct integer is entered;
- ***Zero Marks*** : 0 In all other cases.

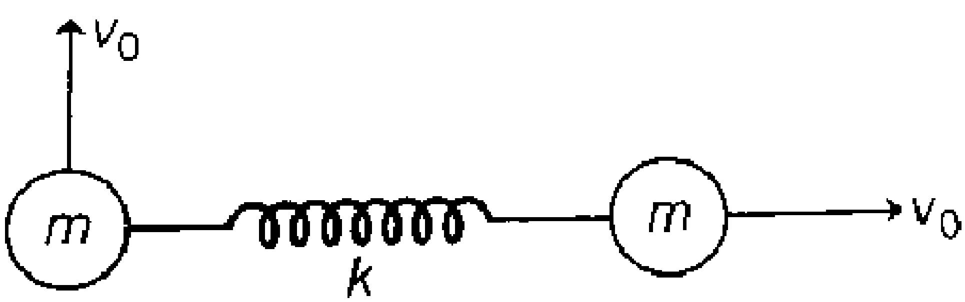
17. Two ideal Carnot engines operate in cascade (all heat given up by one engine is used by the other engine to produce work) between temperatures, T_1 and T_2. The temperature of the hot reservoir of the first engine is T_1 and the temperature of the cold reservoir of the second engine is T_2. T is temperature of the sink of first engine which is also the source for the second engine. If T is related to T_1 and T_2 as $T = \dfrac{T_1 + T_2}{\sqrt{K}}$. Where K = ?

(Assume both the engines perform equal amount of work)

18. Three identical uniform planks A, B and C of mass m = 1kg each and length L= 2m are placed on a smooth fixed horizontal surface as shown in the figure. There is friction between A and B (friction coefficient being μ) while there is no friction between A and C. At the instant shown, that is at t= 0 the block A has horizontal velocity of magnitude $v = 6\,m/s$ towards right, whereas speed of B and C is zero. At the instant, block A has covered a distance L relative to block B velocity of all blocks are same. If heat dissipated due to friction in the system is H, find value of $\frac{H}{\mu g}$ in joule.



19. Two small spheres of mass 2 kg each are connected to each other by means of an undeformed spring of force constant 175 N/m and natural length 1m. The system is placed on a smooth horizontal surface and the two spheres are given velocities v_0 along and perpendicular to the spring, as shown in the figure. The maximum elongation in the spring is found to be 1m during the subsequent motion. Find the value of $\left(\frac{v_0}{5}\right)$ in m/s.



CHEMISTRY

Max. Marks: 60

SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : +3 If ONLY the correct option is chosen;
- *Zero Marks* : 0 If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : -1 In all other cases.

20. Correct statement of the following is

A) Maximum permissible concentration of nitrate in drinking water is 70 ppm

B) In world war-II pesticide used to control malaria is "Lewisite"

C) Hydroxy apatite is much harder than fluorapatite

D) Clean water has BOD value less than 5 ppm

21. Incorrect match is

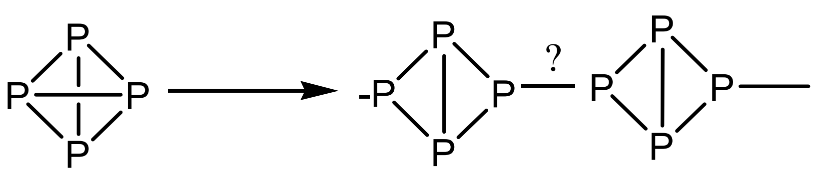
A) $SiF_4 \rightarrow$ can acts as Lewis acid.

B) $Benzyne \rightarrow$ all carbon atoms are SP^2 hybridized.

C) $PBr_3 \rightarrow$ non-polar and non planar.

D) $NaH_2PO_3 \rightarrow$ acidic salt.

22. Solid White Phosphorous undergoes polymerization to give red Phosphorous. What would be the bond enthalpy of P – P bond in red Phosphorous joining the two units of white phosphorous? Given that enthalpy of sublimation of white phosphorous is 59 KJ/mol and enthalpy of atomization is 316.25 KJ/mol of P(g)



White(g) Red(g)

$\Delta H = -104\,KJ / mol\ of\ P_4$

A) 416 KJ/mol **B)** 298 KJ/mol **C)** 305 KJ/mol **D)** 513 KJ/mol

23. A solution contains 0.1 M of Mg^{+2} and 0.1 M of Sr^{+2}. The concentration of H_2CO_3 is adjusted to 0.05 M. Determine the pH range which would permit the precipitation of $SrCO_3$ without any precipitation of $MgCO_3$. The H^+ ion concentration is controlled by external factors. Given that K_{sp} of $SrCO_3$ and $MgCO_3$ 9×10^{-10} and 4×10^{-8} respectively. K_a (overall) of $H_2CO_3 = 5\times10^{-17}$

A) 4.78 to 5.6 **B)** 4.6 to 5.78 **C)** 5.78 to 6.4 **D)** 5.22 to 5.4

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : **+2** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks*** : **0** In all other cases.

Question Stem for Question Nos. 24 and 25

Question Stem

A gas of identical H-like atom has some atoms in the lowest energy level A and some atoms in a particular excited state B and there are no atoms in any other energy level. The atoms of the gas make transition to higher level by absorbing photon having energy 2.7 eV. Subsequently, the atoms emits radiation of only six different photons energies. Some of the emitted photons have energy 2.7eV. Some have more and some have less than 2.7eV.

24. The principal quantum number of initially excited level 'B' is__________.

25. Ionization energy for gas atoms in eV/atom is____________.

Question Stem for Question Nos. 26 and 27

Question Stem

A 10^{-2}M solution of $P_4O_2(NO_3)_2$ was found to have pH of 3.8. Answer the following questions if Antilog(-3.8) =1.6 $\times$ 10^{-4}.

26. Hydrolysis constant for $P_4O_2^{2+}$ is $x \times 10^{-6}$. Then 'x' is______________.

27. The value of K_b for $P_4O_2(OH)^{+}$ is $y \times 10^{-a}$. If a is simple whole number (non zero, +ve) then sum of "y" and "a" is_____________.

Question Stem for Question Nos. 28 and 29

Question Stem

Dehydration of 2,2,3,4,4- Pentamethyl–3–Pentanol gave two alkenes (A) and (B) Ozonolysis of the lower boiling alkene (A) gave formaldehyde and 2,2,4,4- Tetramethyl–3–Pentanone. Ozonolysis of B gave formaldehyde and 3,3,4,4–Tetramethyl–2–Pentanone.

28. The number of alpha – hydrogens in the carbocation intermediate just before formation of 'B'is____.

29. The number of stereogenic carbons present in the product obtained by reduction of A with Pd / H_2 is_.

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

30. The planar compounds are

A) $N(SiH)_3$ (with respect to N) **B)** IF_4^-

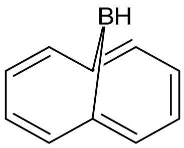
C) BF_3 **D)** BrF_3

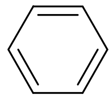
31. Highly pure dilute solution of sodium in liquid ammonia

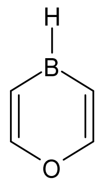
A) shows blue colour **B)** exhibits electric conductivity

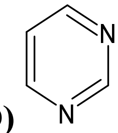
C) produces $NaNH_2$ **D)** produces H_2 gas

32. Aromatic species of following

A) 

B) 

C) 

D) 

33. Compounds with hydrogen bond are

A) solid boric acid **B)** dimer of HCOOH

C) chloral hydrate **D)** Dry ice

34. True statements are for real gas

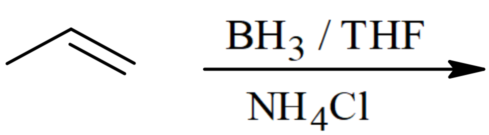
A) $\lim\limits_{p\to 0}(PV) =$ constant at constant T

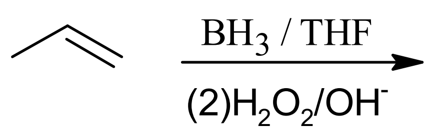
B) $\lim\limits_{p\to 0}\left(\dfrac{PV}{RT}\right) = 1$

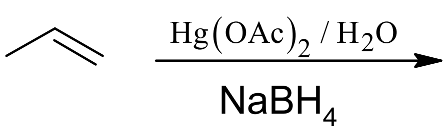
C) $\lim\limits_{v\to 0}\left(\dfrac{PV}{RT}\right) = R$

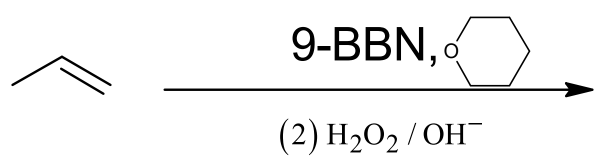
D) critical temperature of gas is lesser than Boyle's temperature.

35. Which of the following are syn addition

A) 

B) 

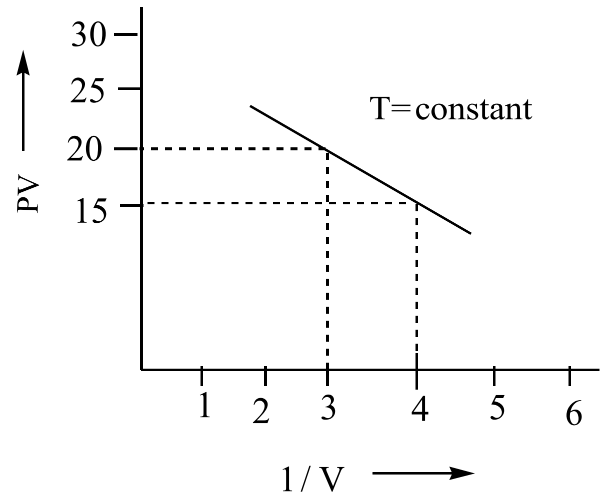
C) 

D) 

SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : *+4* If ONLY the correct integer is entered;
- *Zero Marks* : *0* In all other cases.

36. What would be the value of Vander Waal's constant 'a' when b=0. Here P is in atm and V is in $\frac{litre}{mole}$.



37. Total number of solutions which will have pH greater than of 0.1M $CH_3COOH\,(K_a = 10^{-5})$

(i) 0.1 M HCl

(ii) 0.1 M CH_3COOH + 0.1 M CH_3COONa

(iii) 0.1 M NH_4OH

(iv) 0.1 M CH_3COONa

(v) 10^{-8} M HCl

(vi) 0.1 M CH_3COONH_4 $(K_a = 10^{-5}$ & $K_b = 10^{-5})$

(vii) 0.1 M NaHA $(K_1 = 10^{-5}\quad K_2 = 10^{-7})$

38. For a Single electron system $\Psi_{3P} = \frac{4}{81\sqrt{6}}\left(\frac{Z}{90}\right)^{\frac{3}{2}}\left(6\sigma - \sigma^2\right)e^{\frac{\sigma}{3}}$

If a_0 is Bohr radius, $\sigma = \frac{Zr}{a_0}$ and 'r' is radial node distance from nucleus. The value 'r' in $\overset{o}{A}$ for He^{+2} is (Rounded off to next higher integer)

MATHEMATICS

Max. Marks: 60

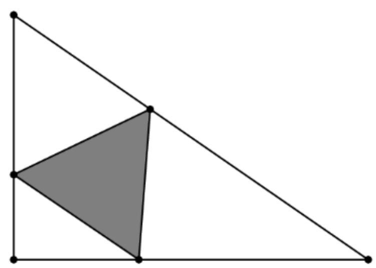
SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : +3 If ONLY the correct option is chosen;
- *Zero Marks* : 0 If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : -1 In all other cases.

39. If $M=\sum_{k=1}^{59}\min\left(f\left(\frac{k}{30}\right),f\left(\frac{k}{60}\right)\right)$, where $f(\lambda)=\min(\lambda-[\lambda],[\lambda]-\lambda+1)$, (where $[\lambda]$ is a greatest integer less than or equal to λ). Then M is equal to

A) 30 **B)** 20 **C)** 10 **D)** 15

40. If the area of the smallest equilateral triangle with one vertex on each of the sides of the right triangle with side lengths $2\sqrt{3}, 5$ and $\sqrt{37}$, as shown, is $\frac{m\sqrt{3}}{n}$, (where m, n are positive integers, m and n are relatively prime) then the value of $m+n=$



A) 132 **B)** 145 **C)** 142 **D)** 155

41. The number of ordered triplet(s) (x,y,z) where $x,y,z\in R^+$ satisfying the following equations is/are

$$2x-2y+\frac{1}{z}=\frac{1}{2023}$$

$$2y-2z+\frac{1}{x}=\frac{1}{2023}$$

$$2z-2x+\frac{1}{y}=\frac{1}{2023}$$

A) 1 **B)** 0 **C)** 2 **D)** infinite

42. Let (x_1,y_1,z_1) *and* (x_2,y_2,z_2) where $(x_1 > x_2)$ be two triplets satisfying the following simultaneous equations:

$$\log_{10}(2xy) = (\log_{10} x)(\log_{10} y)$$

$$\log_{10}(yz) = (\log_{10} y)(\log_{10} z)$$

$$\log_{10}(2zx) = (\log_{10} z).(\log_{10} x)$$

Then the value of $(x_1+y_1+z_1)^{x_2y_2z_2}$ is:

A) 10 **B)** 20 **C)** 15 **D)** 100

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks: 0*** In all other cases.

Question Stem for Question Nos. 43 and 44

Question Stem

Let f(x) be defined as $f(x) = \begin{vmatrix} \sin(x+p) & \sin(x+q) & \sin(x+r) \\ \cos(x+p) & \cos(x+q) & \cos(x+r) \\ \cos(q-p) & \cos(r-q) & \cos(p-r) \end{vmatrix}$ $(p,q,r \in R)$ and Let matrix

$P = \begin{bmatrix} \cos\left(\frac{\pi}{18}\right) & \sin\left(\frac{\pi}{18}\right) \\ -\sin\left(\frac{\pi}{18}\right) & \cos\left(\frac{\pi}{18}\right) \end{bmatrix}$ Where a,b,c be non-zero real numbers such that $\left(aP^{12}+bP^6+cI\right)$ is a zero matrix and where I is identity matrix of order 2. If $f(3) = \lambda \neq 0$.

43. The value of $\dfrac{\sum_{k=1}^{3} f(k)}{f(3)}$ is

44. The absolute value of $\dfrac{2b}{c}$ is

Question Stem for Question Nos. 45 and 46

Question Stem

The quadratic equation $x^2-(a+5)x+2a=0, a\in I$ has rational roots α *and* β

45. The maximum value of $\alpha^2+\beta^2$ is

46. The value of $\alpha^2+\beta^2$ for which $|\alpha+\beta|$ is minimum is

Question Stem for Question Nos. 47 and 48

Question Stem

If $\vec{a}$ and $\vec{b}$ are two vectors, then $\vec{a}.\vec{b}=|\vec{a}||\vec{b}|\cos\theta$ and $|\vec{a}\times\vec{b}|=|\vec{a}||\vec{b}|\sin\theta$, where θ is angle between two vectors, then

47. Let $\vec{a},\vec{b}$ and $\vec{c}$ be three vectors such that $|\vec{a}|=2, |\vec{b}|=3$ and $|\vec{c}|=5$ satisfying $\left|\left[\vec{a}\,\vec{b}\,\vec{c}\right]\right|=30$, then $\left(2\vec{a}+\vec{b}+\vec{c}\right).\left(\left(\left(\vec{a}\times\vec{c}\right)\times\left(\vec{a}-\vec{c}\right)\right)+\vec{b}\right)$ is equal to

48. Let $\vec{a},\vec{b},\vec{c}$ be three vectors satisfying $\vec{a}=\vec{b}\times\vec{c}+2\vec{b}$, where $|\vec{b}|=|\vec{c}|=2$ and $|\vec{a}|\le 4$, then the sum of all possible values of $|2\vec{a}+\vec{b}+\vec{c}|$ is

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** **: +4** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks*** **: +3** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks*** **: +2** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks*** **: +1** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks*** **: 0** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

49. *For all* $n \geq 1$, *let*

$$f(n)=\sum_{k=1}^{n-1}\frac{\sin\left(\frac{(2k-1)\pi}{2n}\right)}{\cos^2\left(\frac{(k-1)\pi}{2n}\right)\cos^2\left(\frac{k\pi}{2n}\right)}$$

A) $\lim_{n\to\infty}\frac{f(n)}{n^3}=\frac{4}{\pi^3}$ **B)** $\lim_{n\to\infty}\frac{f(n)}{n^3}=\frac{8}{\pi^3}$

C) $f(3)=6$ **D)** $f(3)=4$

50. Let $f(x)=\lim_{n\to\infty}\left(-n^3\right)\left(\left|2\tan^{-1}\left(e^{|x|}-e\right)-\frac{1}{n^3}\right|-2\left|\tan^{-1}\left(e^{|x|}-e\right)\right|\right)$, $x\in R$, then which of the following statement(s) is (are) correct?

A) The number of points where $f(x)$ is discontinuous is 1

B) The number of points where $g(x)=|f(x)|$ is discontinuous is 1

C) $f\left(\frac{1}{2}\right)+f(3)=0$

D) Number of solutions of $f(x)=\text{sgn}(x)$ is infinite. (Where $\text{sgn}(x)$ is the signum function of x)

51. Let E-ABCD be a pyramid on square base ABCD where A is the origin and B and D are lying on positive x-axis and positive y-axis respectively. If E is $(0,2,3)$ and $\overrightarrow{DE}.(\hat{i}+\hat{j})=0$, then which of the following statement(s) is (are) correct?

A) Image of the point D in the plane ABE is $\left(0,\frac{-10}{13},\frac{24}{13}\right)$

B) Foot of the perpendicular of the point D in the plane ABE is $\left(0,\frac{8}{13},\frac{12}{13}\right)$

C) Volume of the tetrahedron ABDE is 2 cubic units

D) Perpendicular distance of the point D from the plane ABE is $\frac{9}{\sqrt{13}}$

52. Consider the trigonometric equation

$$\frac{1}{\cot^6 x+2\sqrt{2}\left|\cos^3 x\right|}+\frac{\left|\cos^3 x\right|(\operatorname{cosec} x)^6}{\left|\sec^3 x\right|+2\sqrt{2}}+\frac{2\sqrt{2}\left|\sin^3 x\right|}{\left|\tan^3 x\right|+\left|\cot^3 x\right|}=\frac{3}{2},$$

Which of the following option(s) is/are correct?

A) Number of solutions of the equation in $[0,6\pi]$ is 12

B) Number of solutions of the equation in $[0,4\pi]$ is 4

C) Sum of all solutions of the equation in $[0,4\pi]$ is 16π.

D) Sum of all solution of the equation in $[0,4\pi]$ is 13π.

53. If $f(x)=\lim\limits_{n\to\infty}\left(a^{\frac{1}{n}}+\ln b+\cos\left(\frac{x}{\sqrt{n}}\right)\right)^n$ where $a,b>0$ be a non-constant function and

$L=\lim\limits_{x\to 0}\frac{f(x)-a}{1-\cos x}$. Then which of the following statement(s) is (are) correct?

A) The number of solutions of the equation $f(x)=|x|$ are 3.

B) The number of solutions of the equation $f(x)=|x|$ are 2.

C) $a+L=0$

D) $a+L+3be=0$

54. If $f(n)=\begin{vmatrix} 2 & 1 & 0 \\ \frac{1}{(n+2)^2} & \frac{1}{n} & \frac{1}{(n+2)^2}-\frac{1}{n} \\ \frac{1}{(n+1)^2} & \frac{1}{n+1} & \frac{-(n)}{(n+1)^2} \end{vmatrix}$

Where $n\in N$, then which of the following option(s) is(are) CORRECT?

A) $\sum_{n=2}^{8} f(n) = \frac{49}{900}$

B) $\sum_{n=1}^{7} f(n) = \frac{49}{900}$

C) $\sum_{n=1}^{\infty} f(n) = \frac{1}{18}$

D) $\sum_{n=2}^{\infty} f(n) = \frac{1}{18}$

SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

55. It is given that the sequence $(a_n)_{n=1}^{\infty}$ with $a_1 = a_2 = 2$ is given by the recurrence relation $\frac{2a_{n-1}a_n}{a_{n-1}a_{n+1} - a_n^2} = n^3 - n \,\forall n = 2,3,4\ldots.$ If the value of $\left[\sum_{k=2}^{2023} \frac{a_{k+1}}{a_k}\right] = N$, then the number of digits in the sum of the digits of N is

($[\lambda]$ is a greatest integer less than or equal to λ)

56. For polynomial

$P(x) = 1 - \frac{1}{3}x + \frac{1}{6}x^2$, define $Q(x) = P(x)P(x^3)P(x^5)P(x^7)P(x^9)P(x^{11}) = \sum_{i=0}^{72} a_i x^i$.

Then $\sum_{i=0}^{72} |a_i| = \frac{m}{n}$, where m and n are relatively prime positive integers. The remainder when $m+n$ is divided by 7 is

57. If the greatest value of $\sin^2\alpha \cos^6\alpha$ *is* $\frac{a}{256}$, (a is a positive integer) then the value of $\left[\frac{a}{5}\right]$ is ___ (where [.] denotes greatest integer function)

Sri Chaitanya IIT Academy.,India.

A.P T.S KARNATAKA TAMILNADU MAHARASTRA DELHI RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S JEE-ADVANCE-2021_P1 Date: 19-04-2023

Time: 09.00Am to 12.00Pm GTA-16 Max. Marks: 180

KEY SHEET

PHYSICS

1	**C**	2	**A**	3	**A**	4	**C**	5	**0.86 to 0.88**	6	**6.96**
7	**2.40**	8	**8.38**	9	**4.12**	10	**1.5**	11	**ABCD**	12	**A,C,D**
13	**A,B,D**	14	**A,B,C,D**	15	**A,B,C,D**	16	**A,B,C,D**	17	**4**	18	**1**
19	**2**										

CHEMISTRY

20	**D**	21	**C**	22	**C**	23	**A**	24	**2**	25	**14.40**
26	**2.52 - 2.59**	27	**12.70 - 12.95**	28	**6**	29	**0**	30	**A,B,C,D**	31	**AB**
32	**A,B,C,D**	33	**A,B,C**	34	**A,B,D**	35	**A,B,D**	36	**5**	37	**6**
38	**2**										

MATHEMATICS

39	**C**	40	**C**	41	**A**	42	**B**	43	**3**	44	**2**
45	**65**	46	**25**	47	**309**	48	**20**	49	**B,C**	50	**C,D**
51	**A,B,C**	52	**A,C**	53	**B,C**	54	**A,D**	55	**1**	56	**2**
57	**5**										

SOLUTIONS

PHYSICS

1. Tension in each before cutting T = mg

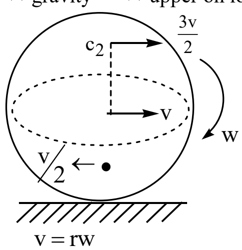
$$\left.\begin{array}{l} a_1 = g\sin 60^0 \\ a_2 = g \end{array}\right\} \frac{a_1}{a_2} = \frac{\sqrt{3}}{2}$$

2.

$$A = A_0 e^{-\left(\frac{b}{2m}\right)t} \qquad \frac{1}{2} = e^{-0.1t} \qquad e^{t/10} = 2$$

$$\frac{t}{10} = \ln 2 \Rightarrow t = 10\ln 2 = 10\times 0.693 = 6.93 \qquad = 7s$$

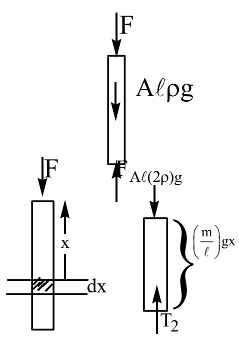
3. $W_{gravity} + W_{upper\ on\ lower\ half} = \Delta K$ of lower half.



$$\Delta K = \frac{1}{2}\left(\frac{m}{2}\right)\left[\frac{9V^2}{4} - \frac{V^2}{4}\right] \quad = \frac{1}{2}mV^2 \Rightarrow -\left(\frac{m}{2}\right)gr + W = \frac{1}{2}mV^2 \Rightarrow W = \frac{m}{2}gr + \frac{1}{2}mV^2$$

4. $F + Al\rho g = Al2\rho g$

$\Rightarrow F = Al\rho g$

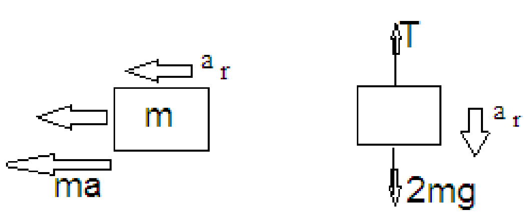


$$T_x = mg + \frac{mg}{l}x$$

Strain in dx, $= \frac{\Delta x}{dx} \quad = \frac{T_x}{AY} \Rightarrow \Delta x = \frac{\left(mg + \frac{mg}{l}x\right)dx}{AY}$

$$\Rightarrow \text{Net Compression} = \left.\frac{\left(mgx + \frac{mg}{l}\frac{x^2}{2}\right)}{AY}\right|_0^l \qquad = \frac{3}{2}\frac{mgl}{AY} = \frac{3}{2}\rho g\frac{l^2}{Y}$$

5.



Let a be the acc of Wedge of 5m towards right, a_r be the acc of m or 2m w.r.t Wedge.

Then $\left(a_{CM}\right)_X = 0 \Rightarrow 7ma + m\left(a - a_r\right) = 0$

$a_r = 8a$ -----------------(1)

FBD of m,2m in the frame of 5m.

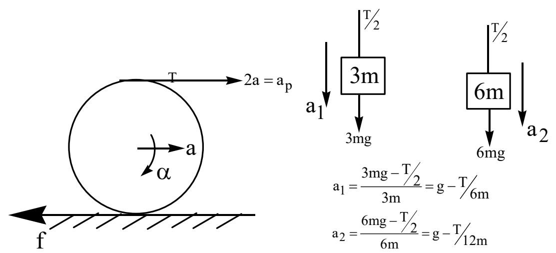
$T + ma = ma_r$ $\qquad\qquad 2mg - T = 2ma_r$

$\Rightarrow 2g + a = 3a_r$ -------------(2)

$\Rightarrow \frac{2g+a}{3} = 8a \Rightarrow 23a = 2g \quad \Rightarrow a = \frac{2g}{23}$

6. $a_r = 8a$ -----------------(1)

7.



$2a = \frac{a_1 + a_2}{2} \qquad 4a = a_1 + a_2$

$T - f = ma \qquad a = R\alpha \qquad 4\left[\frac{4T}{3m}\right] = g - \frac{T}{6m} + g - \frac{T}{12m}$

$T2R = \frac{3}{2}mR^2\alpha \qquad \Rightarrow \frac{16T}{3m} + \frac{T}{6m} + \frac{T}{12m} = 2g$

$T = \frac{3}{4}ma \qquad \Rightarrow \frac{(64+2+1)T}{12m} = 2g$

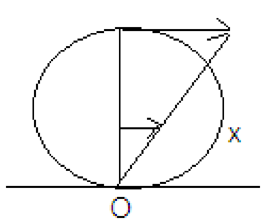
$\Rightarrow T = \frac{24m}{67}g = \frac{24\times 6.7}{67} = 2.40N$

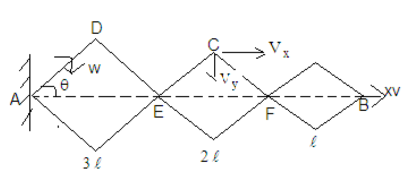
8. $f = T - ma = T - \frac{4T}{3} = \frac{-T}{3}\Big\}\ \mu mg = \frac{8}{67}mg \Rightarrow \mu = 8/67$

9. $\tau_0 = KxR + K(2x)2R \qquad \tau_0 = \frac{3}{2}mR^2\alpha$

$x = R\theta, \alpha = \frac{d^2\theta}{dt^2} \qquad \Rightarrow \frac{3}{2}mR^2\frac{d^2\theta}{dt^2} = -5kR^2\theta$

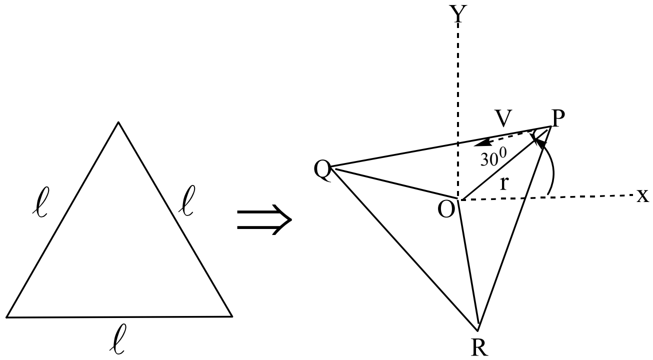
$\Rightarrow \frac{d^2\theta}{dt^2} = -\frac{10k}{3m}\theta \Rightarrow w = \sqrt{\frac{10\times 90}{3\times\frac{1}{3}}} = 30rad/s$





10. $LCOS\theta = \frac{3l}{2} \qquad -L\sin\theta\frac{d\theta}{dt} = \frac{3}{2}\frac{dl}{dt} \qquad \frac{L}{\sqrt{2}}W = \frac{3}{2}\left(\frac{dx_B}{dt}\right)\frac{1}{6} \qquad W = \frac{1}{4}(6) = 1.5rad/s$

11.



$$-\frac{dr}{dt}=V\cos 30^0+\frac{rd\theta}{dt}=V\sin 30^0\Rightarrow-\frac{dr}{rd\theta}=\sqrt{3}$$

$$\int_{\ell/\sqrt{3}}^{r}\frac{dr}{r}=-\sqrt{3}\int_0^{\theta}d\theta\Rightarrow\frac{r}{\ell/\sqrt{3}}=e^{-\sqrt{3}\theta}\Rightarrow r=\frac{\ell}{\sqrt{3}}e^{-\sqrt{3}\theta}\quad;\ dr=\frac{\ell}{\sqrt{3}}e^{-\sqrt{3}\theta}\left(-\sqrt{3}d\theta\right)$$

$$ds=\sqrt{dr^2+\left(\frac{dr}{\sqrt{3}}\right)^2}=\frac{2}{\sqrt{3}}|dr|=\frac{2}{\sqrt{3}}(-\ell)e^{-\sqrt{3}\theta}d\theta$$

$$s=+\frac{2\ell}{\sqrt{3}}\int_0^{2\pi}e^{-\sqrt{3}\theta d\theta}=+\frac{2\ell}{\sqrt{3}}\left(\frac{e^{-\sqrt{3}\theta}}{-\sqrt{3}}\right)_0^{2\pi}=\frac{2\ell}{3}\left(-e^{-\sqrt{3}(2\pi)}+1\right)=\frac{2\ell}{3}\left(1-e^{-\sqrt{3}(2\pi)}\right).$$

Avg. Velocity of P = $=\frac{\ell/\sqrt{3}}{t},t=\frac{\ell}{\frac{3V}{2}}=\sqrt{3}V/2.$

12. Angular Impulse on disc 1

$$\Rightarrow m\frac{r^2}{2}w-Jr=m\frac{r^2}{2}w_1-----------1)$$

Angular Impulse on disc 2

$$\Rightarrow Jr=m\frac{r^2}{2}w_2-----------2)$$

$1,2\Rightarrow w=w_1+w_2$

Conservation of angular momentum about a vertical axis through center of disc 1.

$$m\frac{r^2}{2}w=m\frac{r^2}{2}w_1-m\frac{r^2}{2}w_2+mv(2r)$$

$$\Rightarrow w=w_1-w_2+\frac{4v}{r}--------------3)$$

No slipping at contact points$\Rightarrow rw_1-v=rw_2+v$

$$\Rightarrow r\left(w_1-w_2\right)=2v$$

$$\Rightarrow r\left(w-\frac{4v}{r}\right)=2v$$

$$\Rightarrow rw=6v-----------------4)$$

$$\Rightarrow w_1 = +\frac{2}{3}w \Rightarrow w_2 = -\frac{w}{3}$$

$$v_1 = v_2 = \sqrt{\left(\frac{u}{2}\right)^2 + v^2}.$$

13. Center of mass of each half describes circle of radius $\frac{4R}{3\pi}$ about the center of original disc. $\Rightarrow F = \left(\frac{m}{2}\right)\left(\frac{4R}{3\pi}\right)w^2 = \sigma(2R)t$.

14. Energy stored in a strained rod = $\frac{1}{2}stress \times strain$.

15. At any instant, let θ be the Angular position of center of mass of the system w.r.t horizontal.

Conservation of energy $\Rightarrow 2mg\frac{\sqrt{3}}{2}\ell\left(\sin\theta - \sin 30^0\right) = 2\left(\frac{1}{2}m\ell^2 w^2\right)$

$$\Rightarrow w^2 = \sqrt{3}\frac{g}{\ell}\left(\sin\theta - \frac{1}{2}\right) \ldots\ldots\ldots\ldots\ldots\ldots 1)$$

$$\Rightarrow \alpha = w\frac{dw}{d\theta} = \frac{\sqrt{3}}{2}\frac{g}{\ell}\cos\theta \ldots\ldots\ldots\ldots\ldots 2)$$

<u>CM moves in circular path about point O</u>

$$(T_1 + T_2)\sin 60^0 - 2mg\sin\theta = 2m\left(\frac{\sqrt{3}}{2}\ell\right)w^2 \ldots\ldots\ldots\ldots\ldots\ldots 3)$$

$$1) \text{ in } 3) \Rightarrow T_1 + T_2 = \frac{10}{\sqrt{3}}mg\sin\theta - \sqrt{3}mg$$

<u>Torque about CM</u>

$$(T_1 - T_2)\frac{\sqrt{3}}{2}\frac{\ell}{2} = 2m\left(\frac{\ell}{2}\right)^2\alpha$$

$$\Rightarrow T_1 - T_2 = mg\cos\theta \ldots\ldots\ldots\ldots\ldots 4)$$

$$T_1, \max \Rightarrow \frac{dT_1}{d\theta} = 0, \text{ then we get } \tan\theta = \frac{10}{\sqrt{3}}$$

$$T_1, \max = \frac{mg}{2}\left[\sqrt{\frac{103}{3}} - \sqrt{3}\right]$$

16. $(a_{CM})_x = 0 \Rightarrow a_r\cos\theta - a = a$

$$a_r\cos\theta = 2a \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1)$$

$$mg\sin\theta - f = m(a_r - a\cos\theta) \ldots\ldots\ldots\ldots\ldots 2)$$

$$fR = m\frac{R^2}{2}\alpha \ldots\ldots\ldots\ldots\ldots\ldots\ldots 3)$$

$$a_r = R\alpha \ldots\ldots\ldots\ldots\ldots 4)$$

$$\Rightarrow f = \frac{ma_r}{2} \Rightarrow mg\sin\theta + ma\cos\theta = \frac{3}{2}ma_r = \frac{3}{2}m\frac{2a}{\cos\theta}$$

$$\Rightarrow mg\sin\theta = ma\left[\frac{3-\cos^2\theta}{\cos\theta}\right] \Rightarrow a = \frac{g\sin\theta\cos\theta}{2+\sin^2\theta}$$

$$mg\sin\theta - N = ma\sin\theta \quad \Rightarrow N = mg\cos\theta\left[\frac{2}{2+\sin^2\theta}\right] \; f \le \mu N$$

$$\Rightarrow \frac{m}{2}\frac{2g\sin\theta}{2+\sin^2\theta} \le \mu\frac{2mg\cos\theta}{2+\sin^2\theta} \quad \mu \ge \frac{\tan\theta}{2}$$

17. Conceptual.

18. Work done by friction = Heat dissipated = $-\mu mg\frac{\ell}{2}$

$$\Rightarrow \frac{H}{\mu} = \mu g\frac{\ell}{2} = 1\times 10\times\frac{2}{2} = 10.$$

19. in CM frame initially, $K_i = \frac{1}{2}mv_0^2$

At maximum extension velocity along the length of the spring becomes zero. $\Rightarrow$

finally $K_f = 2\left(\frac{1}{2}mv^2\right)$

Conservation of energy $\Rightarrow \frac{1}{2}mv_0^2 = mv^2 + \frac{1}{2}kx^2$ ……………..1)

COAM w.r.t cm $\quad \frac{m}{2}.v_0.\ell_0 = \frac{m}{2}(2v)(\ell_0 + x)$…………………..2)

$$\Rightarrow v_0.\ell_0 = 2v(\ell_0 + x) \qquad \Rightarrow \frac{1}{2}mv_0^2 = \frac{mv_0^2\ell_0^2}{4(\ell_0+x)^2} + \frac{1}{2}kx^2$$

$$v_0^2\left[\frac{(2\ell_0+x)(x)}{(\ell_0+x)^2}\right] = kx^2 \; v_0^2\left[\frac{3\times 1}{4}\right] = 175\times 1 \Rightarrow v_0 = \sqrt{100} = 10m/s.$$

CHEMISTRY

20. Conceptual

21. PBr_3 is polar and non-planar molecule.

22. P_4(solid) $\rightarrow$ P_4(gas) $\Delta H^0 = 59KJ$

P_4(solid) $\rightarrow$ 4P(gas) $\Delta H^0 = 316.25 \times 4 = +1265KJ$

P_4(solid) $\rightarrow$ 4P(gas) $\Delta H^0 = 1265 - 59 = 1206KJ$

In P_4 tetrahedral of white phosphorous, there are six identical P–P bonds, therefore average P–P bond energy is $\frac{1206}{6} = 201KJ$.

In polymerization, on average one P–P bond joining the two tetrahedral unit is formed,

201-x = - 104

x = 305 KJ/mole.

23. (a) $\left[CO_3^{2-}\right] = K_a \frac{\left[H_2CO_3\right]}{\left[H^+\right]^2}$

To prevent metal carbonate's precipitation

$\left[M^{+2}\right]\left[CO_3^{2-}\right] \le K_{SP}$

$\left[M^{+2}\right]K_a\left[H_2CO_3\right] / \left[H^+\right]^2 \le K_{SP}$

$\left[H^+\right] \ge \sqrt{\frac{\left[M^{+2}\right].K_a\left[H_2CO_3\right]}{K_{SP}}}$

For $MgCO_3$,

$\left[H^+\right] \ge \sqrt{\frac{0.1 \times 5 \times 10^{-17} \times 0.005}{9 \times 10^{-8}}}$

$= 2.5 \times 10^{-6} M$

Hence, $pH \le 5.6$

Similarly, for $SrCO_3$, we get

$\left[H^+\right] \ge 1.67 \times 10^{-5} M : pH \le 4.78$.

24. The electrons being present in 1st shell and another shell n_1. These are excited to higher level n_2 by absorbing 2.7 eV and on de-excitation emits six λ and thus excited state n_2 comes to be 4.

$6 = \sum \Delta n = \sum(n_2 - 1)$, hence $n_2 - 4$

$E_1 = \frac{R_H ch}{1^2}, E_{n_1} = \frac{R_H ch}{n_1^2}, E_4 = \frac{-R_H ch}{4^2}$

Since, de-excitation leads to different λ having photon energy greater or lesser than 2.7 eV and thus absorption of 2.7 eV energy causing excitation to 4th shell and then re-emitting photons of greater or lesser than 2.7 eV is possible only when $n_1 = 2$ (the de-excitation from 4th shell occurs in 1,2 and 3 shell).

$E_4 - E_2 = 2.7eV \qquad E_4 - E_3 < 2.7eV \;\; E_4 - E_1 > 2.7eV$

$\therefore E_{n_1} - E_2 = \frac{R_H ch}{2^2} = \frac{E_1}{4} \qquad$ Hence, $n_1 = 2.$

25. $$E_4 - E_2 = 2.7eV \qquad -\frac{E_1}{(4)^2} - \frac{E_1}{(2)^2} = 2.7eV, E_1 = -14.4eV$$

26. $$P_4O_2^{\,2+} + H_2O \rightleftharpoons P_4O_2(OH)^+ + H^+$$

$0.01 - x \qquad\qquad x \qquad x = 1.6\times10^{-4}$

$\cong 0.01$

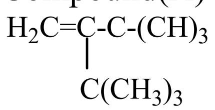
$$K_h = \frac{x.x}{0.01-x} = \frac{x^2}{0.01} = \frac{\left(1.6\times10^{-4}\right)}{0.01} = 2.56\times10^{-6}$$

27. $$K_a = \frac{K_w}{K_b} = K_b = 3.9\times10^{-9}$$

28. The structure of alkenes (A) and (B) can be determined on the basis of ozonolysis data.

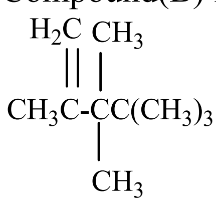
$$compoud(A) \rightarrow HCHO + (CH_3)_3 C\overset{\overset{O}{\|}}{C} C(CH_3)_3$$

Compound(A) is therefore 2-tert-butyl-3,3,-dimethyl-I-butene.



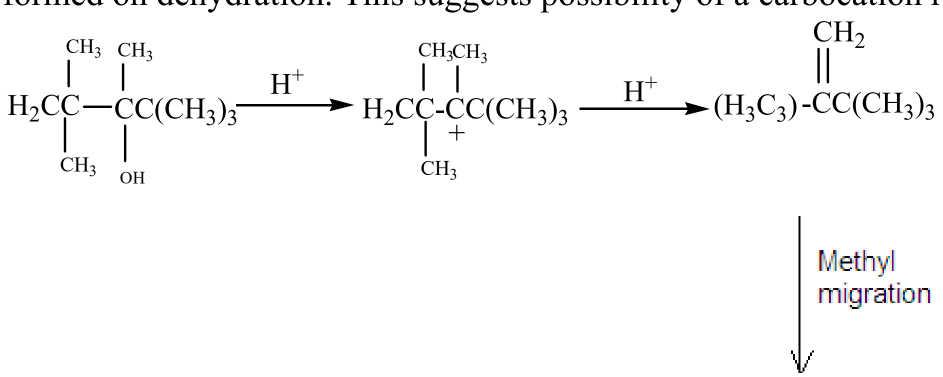
(A)

Compound(B) is therefore 2,3,3,4,4-pentamethyl-I-pentene.

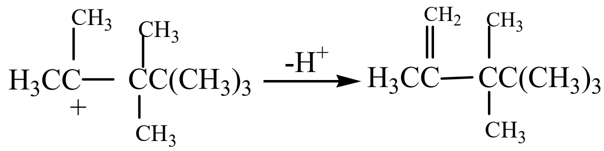


(B)

Compound(B) has a carbon skeleton different from the alcohol from which it was formed on dehydration. This suggests possibility of a carbocation rearrangement.



(A)

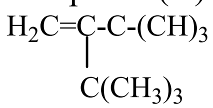


(B)

29. The structure of alkenes (A) and (B) can be determined on the basis of ozonolysis data.

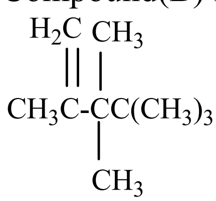
$$compoud\,(A) \rightarrow HCHO + (CH_3)_3C\overset{\overset{O}{\parallel}}{C}C(CH_3)_3$$

Compound(A) is therefore 2-tert-butyl-3,3,-dimethyl-I-butene.



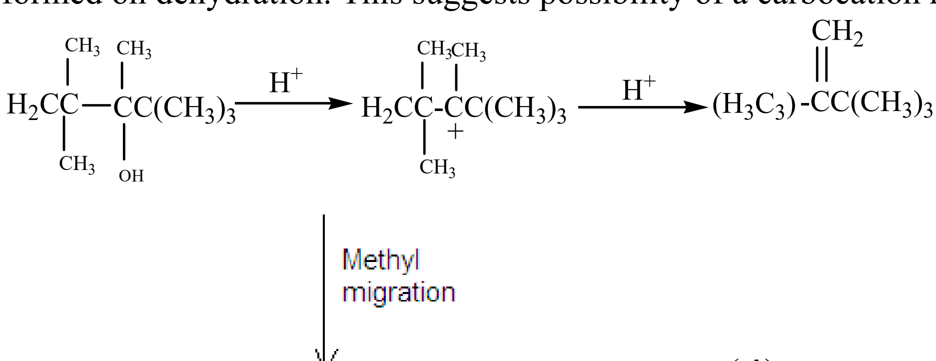
(A)

Compound(B) is therefore 2,3,3,4,4-pentamethyl-I-pentene.

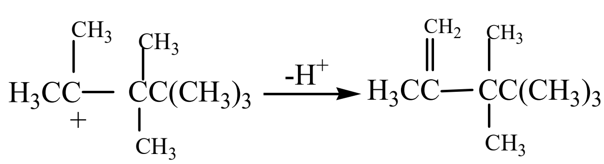


(B)

Compound(B) has a carbon skeleton different from the alcohol from which it was formed on dehydration. This suggests possibility of a carbocation rearrangement.



(A)



(B)

30. Conceptual

31. Conceptual

32. Conceptual

33. Dry ice (solid CO_2) has no hydrogen bond.

34. $T_C = \frac{8a}{27Rb}; T_b = \frac{a}{Rb}$

35. OM-DM is not specific as syn or anti addition due to free radical path during DM with $NaBH_4$.

36. $\left(P+\frac{a}{V^2}\right)V = RT$

$PV = RT - \frac{a}{V}$ when $\frac{1}{V} = 3; PV = 20$

Then 20=RT-3a ---------------1

When $\frac{1}{V} = 4; PV = 15$

Then $15 = RT - 4a - - - - - - - - 2$

37. For 0.1 M CH_3COOH, $K_a = c\alpha^2; 10^{-5} = 0.1\alpha^2$

$$\alpha = 10^{-2}; \left[H^+\right] = c\alpha = 10^{-3}, pH = 3$$

For (i) $pH = 1$

For (ii) $pH = -\log 10^{-5} + \log\left(\frac{0.1}{0.1}\right) = 5$

For (iii) $k_b = c\alpha^2, \alpha = 10^{-2}, \left[OH^-\right] = c\alpha = 10^{-3}$

$$pOH = 3, pH = 11$$

For (iv) $pH = 7 - \frac{1}{2}\log K_a + \frac{1}{2}\log C; pH = 9$

For (v) $\left[H^+\right] = 10^{-8}\left[HCl\right] + 10^{-7}\left[water\right]$

$$= 1.1\times10^{-7}$$
$$pH = 6.9586$$

For (vi) $pH = 7 - \frac{1}{2}\log K_a + \frac{1}{2}\log K_b = 7$

For (vii) $pH = \frac{p^{K_{a_1}} + p^{K_{a_2}}}{2} = \frac{5+7}{2} = 6$

Hence, except 0.1 M HCl, rest all solutions have pH greater than 0.1 M CH_3COOH.

38. at radial node $\psi^2 = 0 \left(6\sigma - \sigma^2\right)^2 = 0$ Then $\sigma = 0$

When $\sigma = 0$, r = 0 at nucleus $6 = \frac{Zr}{A_0} \Rightarrow r = \frac{6\times a_0}{Z} = \frac{6\times0.53}{2} = 1.590$

MATHEMATICS

39. $f\left(\frac{60-r}{30}\right)=f\left(\frac{r}{30}\right)$ and $\phi\left(\frac{60-r}{60}\right)=\phi\left(\frac{r}{60}\right)$

$M=2\sum_{k=1}^{29}\min.\left(\phi\left(\frac{r}{30}\right),\phi\left(\frac{r}{60}\right)\right) \qquad \Rightarrow M=2\sum_{r=1}^{20}\phi\left(\frac{r}{60}\right)+2\sum_{r=21}^{29}\phi\left(\frac{r}{30}\right)=10$

40. The distance between the origin and any point (x, y) on the line p x + q y=1 is atleast $\frac{1}{\sqrt{p^2+q^2}}$

Let the vertices of the right triangle be $(0,0),(5,0),\left(0,2\sqrt{3}\right)$ and let $(a,0),(0,b)$ be two of the vertices of the equilateral triangle. Then, the third vertex of the equilateral triangle is $\left(\frac{a+\sqrt{3}b}{2},\frac{\sqrt{3}a+b}{2}\right)$.

This point must lie on the hypotenuse $\frac{x}{5}+\frac{y}{2\sqrt{3}}=1$ i.e., a,b must satisfy $\frac{a+\sqrt{3}b}{10}+\frac{\sqrt{3}a+b}{4\sqrt{3}}=1$.

Which can be simplified to, $\frac{7}{20}a+\frac{11\sqrt{3}}{60}b=1$.

By the lemma, the minimal value of $\sqrt{a^2+b^2}$ is $\frac{1}{\sqrt{\left(\frac{7}{20}\right)^2+\left(\frac{11\sqrt{3}}{60}\right)^2}}=\frac{10\sqrt{3}}{\sqrt{67}}$,

So the minimum area of equilateral triangle is $\frac{\sqrt{3}}{4}.\left(\frac{10\sqrt{3}}{\sqrt{67}}\right)^2=\frac{\sqrt{3}}{4}.\frac{300}{67}=\frac{75\sqrt{3}}{67}$,

And hence the answer is 75+67=142

41. Now, $2xz-2yz+1=\frac{z}{2023}$ ------------------------------------(1)

and $2yx-2zx+1=\frac{x}{2023}$ ------------------------------------(2)

and $2zy-2xy+1=\frac{y}{2023}$ ------------------------------------(3)

Adding eq.s (1),(2) and (3), we get $3=\frac{z+x+y}{2023}$

i.e., $x+y+z=3\ (2023)$ --(4)

Similarly by adding given expressions,

we get $\frac{1}{x}+\frac{1}{y}+\frac{1}{z}=\frac{3}{2023}$ -------------------(5)

Now by Cauchy-Schwartz inequality, $(x+y+z)\left(\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\right)\geq(3)^2$

i.e., $3(2023)\left(\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\right)\geq 9\Rightarrow\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\geq\frac{9}{3.2023}\geq\frac{3}{2023}$

But, $\frac{1}{x}+\frac{1}{y}+\frac{1}{z}=\frac{3}{2023}$ (from eq.(5))

Hence, equality should hold $\Rightarrow x=y=z$

As, $x+y+z=3(2023) \Rightarrow x=2023; y=2023; z=2023.$

42. Let $\log_{10} x=a, \log_{10} y=b, \log_{10} z=c$

Hence, given equation are $a+b+\log_{10} 2=ab$ ----------------(1)

$b+c=bc$ ----------------(2)

$c+a+\log_{10} 2=ca$ ----------------(3)

Now, (1) – (3)

$\Rightarrow b-c=a(b-c) \quad \Rightarrow b=c$ or $a=1$.

Putting b=c in equation (2), we get $\therefore \quad 2b=b^2 \Rightarrow b=0$ or $b=2$

Putting this in equation(1), $b=0 \Rightarrow a+\log_{10} 2=0 \Rightarrow \log_{10} 2x=0 \Rightarrow x=1/2$

$b=2 \Rightarrow a+2+og_{10} 2=2a \qquad \therefore \quad a=l\,og_{10} 200 \Rightarrow x=200$

Now, a=1 is rejected, as by putting this in first equation.

$1+b+\log_{10} 2=b \Rightarrow 1+\log_{10} 2=0$ which is not possible.

$\therefore \quad (x_1,y_1,z_1)=(200,100,100) \qquad (x_2,y_2,z_2)=\left(\frac{1}{2},1,1\right)$

$$\therefore (x_1+y_1+z_1)^{x_2y_2z_2}=(400)^{1/2}=20.$$

43. $f'(x)=0 \Rightarrow f(x)=constant \because f(3)=\lambda \therefore f(x)=\lambda$

$$\therefore \frac{f(1)+f(2)+f(3)}{f(3)}=3$$

$$P^n=\begin{bmatrix} \cos\frac{n\pi}{18} & \sin\frac{n\pi}{18} \\ -\sin\frac{n\pi}{18} & \cos\frac{n\pi}{18} \end{bmatrix}$$

$$aP^{12}+bP^6+cI=a\begin{bmatrix} -\frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix}+b\begin{bmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}+c\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}=O$$

$$\Rightarrow -\frac{a}{2}+\frac{b}{2}+c=0; \frac{\sqrt{3}}{2}(a+b)=0 \Rightarrow c=a \Rightarrow a=-b.$$

44. $f'(x)=0 \Rightarrow f(x)=constant \because f(3)=\lambda \therefore f(x)=\lambda$

$$\therefore \frac{f(1)+f(2)+f(3)}{f(3)}=3$$

$$P^2=P.P=\begin{bmatrix} \cos\frac{2\pi}{18} & \sin\frac{2\pi}{18} \\ -\sin\frac{2\pi}{18} & \cos\frac{2\pi}{18} \end{bmatrix}; P^n=\begin{bmatrix} \cos\frac{n\pi}{18} & \sin\frac{n\pi}{18} \\ -\sin\frac{n\pi}{18} & \cos\frac{n\pi}{18} \end{bmatrix}$$

$$aP^6+bP^3+cI=a\begin{bmatrix} -\frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix}+b\begin{bmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}+c\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}=O$$

$$\Rightarrow -\frac{a}{2}+\frac{b}{2}+c=0;\frac{\sqrt{3}}{2}(a+b)=0\Rightarrow c=a\Rightarrow a=-b$$

45. Roots of the equation $x^2-(a+5)x+2a=0$ are integers

$\alpha+\beta=a+5;\alpha\beta=2a\Rightarrow(\alpha-2)(\beta-2)=-6$ all combinations

For (α,β) are $(-4,3),(-1,4),(0,5),(1,8)$

46. Roots of the equation $x^2-(a+5)x+2a=0$ are integers

$\alpha+\beta=a+5;\alpha\beta=2a \quad \Rightarrow(\alpha-2)(\beta-2)=-6$ all combinations

For (α,β) are $(-4,3),(-1,4),(0,5),(1,8)$

47. $\left||\vec{a}||\vec{b}||\vec{c}|\cos\phi.\sin\theta\right|=30;\sin\theta\cos\phi=1\Rightarrow\theta=\frac{\pi}{2},\phi=0$

$\Rightarrow \vec{a},\vec{b},\vec{c}$ are mutually perpendicular

So, $(2\vec{a}+\vec{b}+\vec{c}).\left(\left((\vec{a}\times\vec{c})\times(\vec{a}-\vec{c})\right)+\vec{b}\right)=309$

48. $\vec{a}=\vec{b}\times\vec{c}+2\vec{b}$ taking dot product with $\vec{b}$

$\vec{a}.\vec{b}=2|\vec{b}|^2\Rightarrow|\vec{a}|.|\vec{b}|\cos\theta=2|\vec{b}|^2\Rightarrow\cos\theta=\frac{4}{|\vec{a}|}\Rightarrow|a|=4\Rightarrow\theta=0$

$\Rightarrow\vec{a}=2\vec{b}\because\vec{b}\times\vec{c}=0\Rightarrow\vec{b}=\vec{c}$ or $\vec{b}=-\vec{c}$

So, $|2\vec{a}+\vec{b}+\vec{c}|\Rightarrow|\vec{a}|=12$ and $2|\vec{a}|=8 \qquad \therefore 12+8=20$

49. By the double angle and sum-product identities for cosine, we have

$$2\cos^2\left(\frac{(k-1)\pi}{2n}\right)-2\cos^2\left(\frac{k\pi}{2n}\right)=\cos\left(\frac{(k-1)\pi}{n}\right)-\cos\left(\frac{k\pi}{n}\right)$$

$$=2\sin\left(\frac{(2k-1)\pi}{2n}\right)\sin\left(\frac{\pi}{2n}\right)$$

and it follows that the summand in $f(n)$ can be written as

$$\frac{1}{\sin\left(\frac{\pi}{2n}\right)}\left(-\frac{1}{\cos^2\left(\frac{(k-1)\pi}{2n}\right)}+\frac{1}{\cos^2\left(\frac{k\pi}{2n}\right)}\right).$$

Thus the sum telescopes and we find that

$$f(n)=\frac{1}{\sin\left(\frac{\pi}{2n}\right)}\left(-1+\frac{1}{\cos^2\left(\frac{(n-1)\pi}{2n}\right)}\right)=-\frac{1}{\sin\left(\frac{\pi}{2n}\right)}+\frac{1}{\sin^3\left(\frac{\pi}{2n}\right)}.$$

Finally, since $\lim_{x\to0}\frac{\sin x}{x}=1, we\ have$

$$\lim_{n\to\infty}\left(n\sin\frac{\pi}{2n}\right)=\frac{\pi}{2}, and\ thus \lim_{n\to\infty}\frac{f(n)}{n^3}=\frac{8}{\pi^3}.$$

50. $f(x)=\lim_{n\to\infty}\left(-n^3\right)\left(\left|2\tan^{-1}\left(e^{|x|}-e\right)-\frac{1}{n^3}\right|-2\left|\tan^{-1}\left(e^{|x|}-e\right)\right|\right)$

Let $g(x)=e^{|x|}-e$

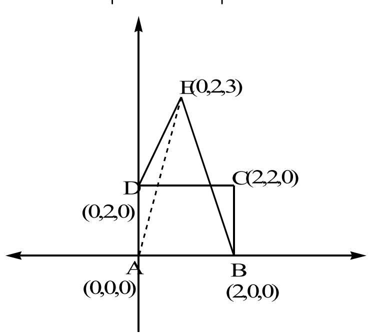
$$=\lim_{n\to\infty}\frac{\left(-n^3\right)\left(\left(2\tan^{-1}g(x)-\frac{1}{n^3}\right)^2-4\left(\tan^{-1}g(x)\right)^2\right)}{\left|2\tan^{-1}g(x)-\frac{1}{n^3}\right|+2\left|\tan^{-1}g(x)\right|}=\lim_{n\to\infty}\frac{\left(-n^3\right)\left(\frac{-4\tan^{-1}g(x)}{n^3}+\frac{1}{n^6}\right)}{\left|2\tan^{-1}g(x)-\frac{1}{n^3}\right|+2\left|\tan^{-1}g(x)\right|}$$

$$=\frac{\tan^{-1}g(x)}{\left|\tan^{-1}g(x)\right|}\quad x\neq\pm1 \qquad f(x)=\begin{cases}\frac{\tan^{-1}g(x)}{\left|\tan^{-1}g(x)\right|} & x\neq\pm1\\ -1 & x=\pm1\end{cases}$$

(A) f(x) is discontinuous at $x=\pm1$

(B) $|f(x)|$ is continuous function

51. Plane ABE is $\begin{vmatrix}x&y&z\\0&2&3\\2&0&0\end{vmatrix}=0$



52. Put $2\sqrt{2}\left|\sin^3x\right|=a,\left|\tan^3x\right|=b,\left|\cot^3x\right|=c$

We get $\frac{a}{b+c}+\frac{b}{c+a}+\frac{c}{a+b}=\frac{3}{2}\Rightarrow\frac{a+b+c}{b+c}+\frac{b+c+a}{c+a}+\frac{c+a+b}{a+b}=\frac{9}{2}$

$(a+b+c)\left(\frac{1}{b+c}+\frac{1}{c+a}+\frac{1}{a+b}\right)=\frac{9}{2}$

Using $AM\geq HM$, $\frac{(a+b)+(b+c)+(c+a)}{3}\geq\frac{3}{\frac{1}{a+b}+\frac{1}{b+c}+\frac{1}{c+a}}$

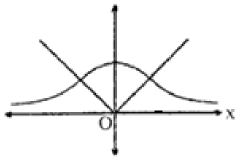
$(a+b+c)\left(\frac{1}{b+c}+\frac{1}{c+a}+\frac{1}{a+b}\right)\geq\frac{9}{2}$

$a=b=c\quad 2\sqrt{2}\left|\sin^3x\right|=\left|\tan^3x\right|=\left|\cot^3x\right|$

53.

SOL: $f(x)=\lim_{n\to\infty}\left(a^{\frac{1}{n}}+l\,n\,b+\cos\frac{x}{\sqrt{n}}\right)^n$

$$\ln b = -1 \Rightarrow b = e^{-1} = e^{\lim\limits_{n\to\infty}\left(\frac{a^{\frac{1}{n}}-1}{\frac{1}{n}} - \frac{\left(1-\cos\frac{x}{\sqrt{n}}\right)}{\frac{1}{n}}\right)} = e^{\ln a - \frac{x^2}{2}}$$



$$\therefore f(x) = |x| \Rightarrow ae^{\frac{-x^2}{2}} = |x|$$

$$L = \lim_{x\to 0} \frac{ae^{\frac{-x^2}{2}} - a}{\left(\frac{1-\cos x}{x^2}\right).x^2} = -a \therefore L + a = 0 \; and \; L + a + 3be = 3.$$

54. Applying $C_3 \to C_3 + C_2 - C_1$

$$f(x) = \begin{vmatrix} 2 & 1 & -1 \\ \frac{1}{(n+2)^2} & \frac{1}{n} & 0 \\ \frac{1}{(n+1)^2} & \frac{1}{n+1} & 0 \end{vmatrix} = \frac{1}{(n)(n+1)^2} - \frac{1}{(n+1)(n+2)^2}$$

55.

$$\frac{2a_{n-1}a_n}{a_{n-1}a_{n+1}-a_n^2} = n^3 - n \Rightarrow \frac{a_{n-1}a_{n+1}-a_n^2}{a_{n-1}a_n} = \frac{2}{n^3-n} = \frac{2}{n(n-1)(n+1)}$$

$$\Rightarrow \frac{a_{n+1}}{a_n} - \frac{a_n}{a_{n-1}} = \frac{(n+1)-(n-1)}{n(n-1)(n+1)} = \frac{1}{(n-1)n} - \frac{1}{n(n+1)}$$

Plugging n=2,3,4,……,n and adding all , we get, $\frac{a_{n+1}}{a_n} - \frac{a_2}{a_1} = \frac{1}{2} - \frac{1}{(n+1)n}$

$$\frac{a_{n+1}}{a_n} = \frac{3}{2} - \frac{1}{n} + \frac{1}{n+1}$$

Again plugging n=2,3,......,n and adding all, we get, $\sum\limits_{k=2}^{n} \frac{a_{k+1}}{a_k} = \frac{3}{2}\times(n-1) - \frac{1}{2} + \frac{1}{n+1}$

For n=2023, $\sum\limits_{k=2}^{2023} \frac{a_{k+1}}{a_k} = \frac{3}{2}(2022) - \left(\frac{1}{2} - \frac{1}{2024}\right) = 3032.5 + \frac{1}{2024}$

56.

Sum is equal to $Q(-1) = \{P(-1)\}^6 = \left(\frac{3}{2}\right)^6 = \frac{729}{64}$

57.

$$y = \sin^2\alpha\left(1-\sin^2\alpha\right)^3 \quad y = t(1-t)^3 \qquad 0 < t \le 1$$

$$\frac{1+\frac{3(1-t)}{3}}{4} \ge \sqrt[4]{\frac{t(1-t)^3}{27}} \quad \frac{t(1-t)^3}{27} \le \frac{1}{4^4} \quad t(1-t)^3 \le \frac{3^3}{256}$$

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S	JEE-ADVANCE-2021-P2	Date:19-04-2023
Time: 02.00Pm to 05.00Pm	GTA-16	Max. Marks: 180

19-04-2023_Sr.Super60_NUCLEUS&ALL_BT'S_Jee-Adv(2021-P2)_GTA-16_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ____________________ H.T. NO: | | | | | | | |

JEE-ADVANCE-2021-P2-Model

Time: 3:00Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 6)	Questions with Multiple Correct Choice with Partial mark	+4	-2	6	24
Sec – II(Q.N : 7 – 12)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 13 – 16)	Paragraph Questions with Single Answer Type	+3	-1	4	12
Sec – IV(Q.N : 17 – 19)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 20 – 25)	Questions with Multiple Correct Choice with Partial mark	+4	-2	6	24
Sec – II(Q.N : 26 – 31)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 32 – 35)	Paragraph Questions with Single Answer Type	+3	-1	4	12
Sec – IV(Q.N : 36– 38)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 39 – 44)	Questions with Multiple Correct Choice with Partial mark	+4	-2	6	24
Sec – II(Q.N : 45 – 50)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 51 – 54)	Paragraph Questions with Single Answer Type	+3	-1	4	12
Sec – IV(Q.N : 55 – 57)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

PHYSICS

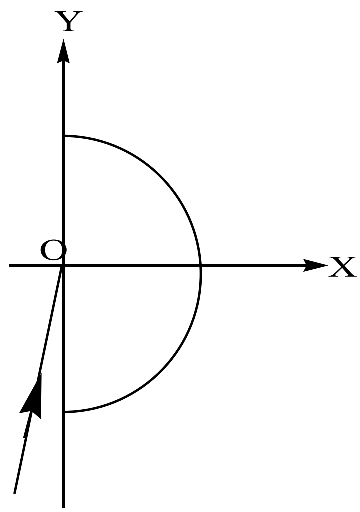
Max. Marks: 60

SECTION-1(Maximum Marks: 24)

One or More Type

- This section contains SIX (06) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +4 If only (all) the correct option(s) is(are) chosen;
  Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
  Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
  Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
  Zero Marks : 0 If unanswered;
  Negative Marks : −2 In all other cases.

1. Consider a hemisphere of radius R with center of curvature at origin O, as shown in figure. Refractive index of material of the hemisphere varies as $\mu = \dfrac{2R}{2R-x}$, where x is x-coordinate of material point. A ray travelling in air in XY-plane is grazingly incident at O, as shown. Choose the correct option(s).



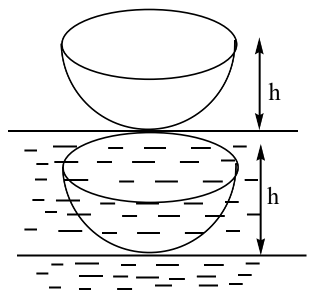
A) Trajectory followed by ray as it travels inside the hemisphere is circular.

B) y-coordinate of the point of hemisphere where the ray comes out of the hemisphere lies between 0.5 R and 0.75 R.

C) Deviation suffered by the ray just before it comes out of the hemispherical surface lies between 0^0 and 30^0.

D) Deviation suffered by the ray just before it comes out of the hemispherical surface lies between 30^0 and 45^0.

2. A solid paraboloid of base Radius R height h, having uniform volume mass density ρ_1 is inverted and just placed above the surface of a liquid of uniform volume mass density ρ_2 as shown in fig. When left free, its maximum displacement is equal to h and it gets submerged just completely. Assume that liquid body is large enough, that level of liquid doesn't change when paraboloid enters the liquid (Neglect viscosity and if any dissipative forces of liquid). Then which of the following are correct?



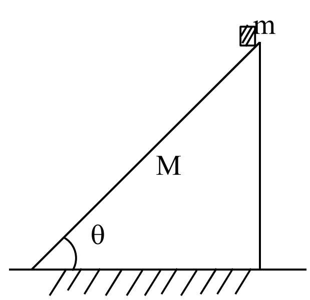
A) $\frac{\rho_2}{\rho_1} = 3$

B) It oscillates between extremes simple harmonically.

C) It oscillates between these extremes, but Oscillations are not SHM.

D) Submerged depth at equilibrium $= \frac{h}{\sqrt{3}}$, Maximum speed in the oscillation = $V = \sqrt{\frac{4gh}{3\sqrt{3}}}$

3. Friction between the wedge shown and horizontal floor is sufficient to prevent the wedge from slipping. The mass of the wedge is M and its angle of inclination is θ. A small block of mass m is just placed near the top of the wedge and released. Coefficient of friction between wedge and block is μ.



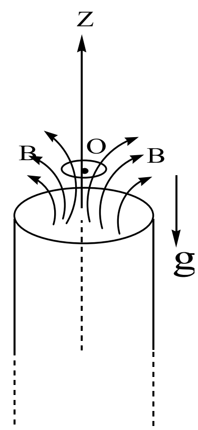
A) If $\mu > \tan\theta$, wedge will not topple for any value of m.

B) The wedge will topple for any value of m, irrespective of μ

C) If $\mu < \tan\theta$, wedge will topple for $m > \dfrac{M}{3\sin\theta(\sin\theta - \mu\cos\theta)}$.

D) If $\mu > \tan\theta$, wedge will topple for any value of m.

4. A thin superconducting ring is held above a vertical long solenoid, as shown in the figure, having the same axis. The cylindrically symmetric magnetic field around the ring can be described approximately in terms of the vertical and radial components of the magnetic field vector as $B_z = B_0(1-\alpha z)$ and $B_r = B_0\beta$ r. (r= radial distance measured from the center of the ring)



Where B_0, α and β are positive constants and z and r are vertical and radial position coordinates, respectively. Initially plane of the ring is horizontal and the ring has no current flowing in it. When released, it starts to move downwards with its axis still in vertical direction. In the given diagram, point O is on the axis and slightly above the solenoid having vertical and radial position coordinates as (0,0). Ring has mass m, radius r_0 and self-inductance L. Assume, the acceleration due to gravity as g.

A) The magnitude of current in the ring is $\dfrac{1}{L}B_0\alpha\pi r_0^2 z$

B) The force(magnitude) acting on the ring is $\dfrac{2B_0^2\alpha\beta\pi^2 r_0^4 z}{L}$.

C) Vertical coordinate z for equilibrium position of the ring is $-\dfrac{mgL}{2B_0^2\alpha\beta\pi^2 r_0^4}$.

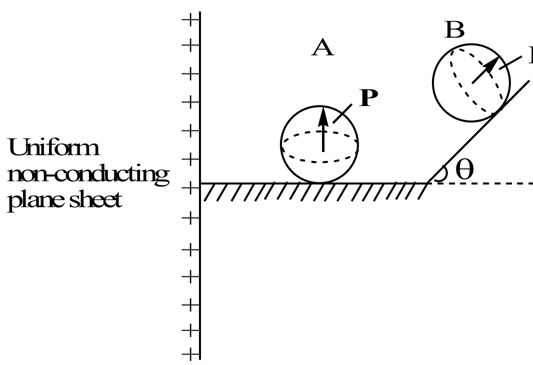
D) The time period of ring's motion is $\dfrac{1}{B_0 r_0^2}\sqrt{\dfrac{2mL}{\alpha\beta}}$.

5. A weight less piston divides thermally insulated cylindrical vessel into two equal parts. One contains one mole of an ideal gas with adiabatic exponent γ, the other is evaccuated. The initial gas temperature is T_0. The piston is released, the gas fills the whole volume of the container. The piston is slowly displaced back to the initial position. Like internal energy U, entropy is another state function of a gas whose change can be calculated as $\Delta S = \int \frac{dQ}{T}$, where dQ = Quantity energy in the form of heat which may be either absorbed or ejected by the gas at temperature T. If $\Delta U_1, \Delta S_1$ denote change in internal energy, change in entropy in the free expansion, and $\Delta U_2, \Delta S_2$ changes in internal energy, change in entropy in the slow compression respectively, then which of the following are correct.

A) $\Delta U_1 = 0, \Delta S_1 \neq 0$ **B)** $\Delta U_2 \neq 0, \Delta S_2 = 0$

C) $\Delta U_1 + \Delta U_2 \neq 0, \Delta S_1 + \Delta S_2 \neq 0$ **D)** $\Delta S_1 \neq 0, \Delta S_2 \neq 0$

6. Two identical solid spheres A and B of mass m and radius r each have short light identical dipoles embedded at their respective centers. B is in equilibrium on an incline of inclination θ as shown such that its dipole moment is parallel to the incline. Sphere A is released, in the position shown, on a rough horizontal surface. Both A and B are located in electric field of a uniform infinite sheet of surface charge density σ. If friction between A and horizontal surface is sufficient to prevent slipping, (neglect mutual interaction between A and B).



A) its acceleration is $\frac{5g}{7}$, just after its release.

B) friction acting on it is $\frac{2mg}{7}$, just after its release.

C) its angular speed at the instant, when it has angularly displaced by $\frac{\pi}{2}$ is $\sqrt{\frac{10P\sigma}{7mr^2 \in_0}}$.

D) friction acting on it, when the dipole becomes parallel to horizontal surface is zero.

SECTION-2(Maximum Marks: 12)

Paragraph with Numerical

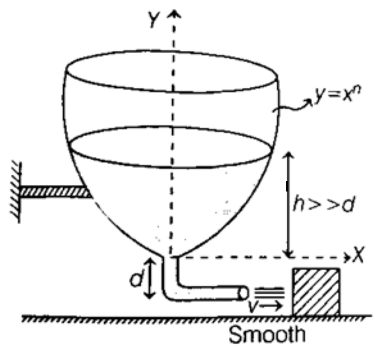
- This section contains THREE (03) question stems.
- There are TWO (02) questions corresponding to each question stem.
- The answer to each question is a NUMERICAL VALUE.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;
Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 7 and 8

Question Stem

A water tank is designed such that its section in XY-plane can be described by $y=x^n$, considering origin at its bottom, which has a small orifice of cross-sectional area a. Value of n is chosen such that, $\frac{dh}{dt}$ does not depend on h. Also, if h is maintained constant by replenishing lost water by a source from top, velocity of efflux also becomes constant equal to v. If the ejecting jet (almost horizontal) strikes surface of a block on smooth horizontal surface (initially at rest), the block begins to accelerate and the, maximum power delivered to the block is $\frac{\rho a v^3}{x}$ during subsequent motion. Here, ρ is density of water. Assume that the water instantly comes to rest after it strikes the block's surface.



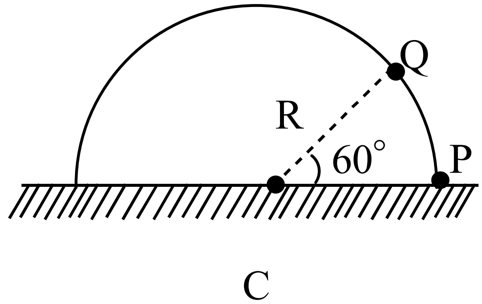
7. The value of n is…………..

8. The value of x is…………..

Question Stem for Question Nos. 9 and 10

Question Stem

A uniform hemisphere of mass 2m and radius R is placed at rest on a smooth horizontal surface. A small insect of mass m is at rest at a point P of the hemisphere near ground as shown. Now, the insect begins to climbing up (without slipping) the hemisphere with constant speed v with respect to the hemisphere. Consider motion of the insect from P to another shown point Q on the hemisphere. Center C of the hemisphere, P and Q lie in same vertical plane.



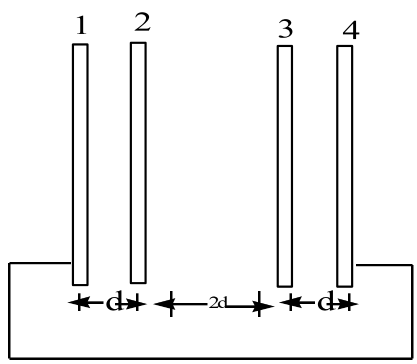
9. Magnitude of Displacement of the hemispherical bowl is $\left(\frac{R}{k}\right)$. The value of k is

10. Acceleration of the hemisphere at the instant, the insect reaches Q is $\frac{v^2}{nR}$, where n =

Question Stem for Question Nos. 11 and 12

Question Stem

Four metallic plates are placed as shown in the figure. Plate 2 is given a charge Q whereas all other plates are uncharged. Plates 1 and 4 are joined together. The area of each plate is same.



11. The charge appearing on the right face of plate 3 is: $n\left(\frac{Q}{4}\right)$, where n=

12. The potential difference between plates 1 and 2 is: $k\left(\frac{Qd}{4\in_0 A}\right)$, where k=

SECTION-3(Maximum Marks: 12)

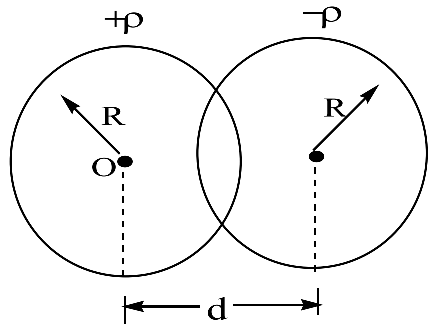
Paragraph with Single Answer Type

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases.

Paragraph-I

There are two non-conducting spheres having uniform volume charge densities ρ and $-\rho$. Both spheres have equal radius R. The spheres are now laid down such that they overlaps as shown in the figure.



13. The electric field $\vec{E}$ in the overlap region is:

A) Non uniform **B)** zero **C)** $\frac{\rho}{3\in_0}\vec{d}$ **D)** $\frac{\rho}{3\in_0}\vec{r}$

14. The potential difference ΔV between the centers of the two spheres for d = R is:

A) $\frac{\rho}{3\in_0}d^2$ **B)** $\frac{\rho}{\in_0}d^2$ **C)** zero **D)** $\frac{2\rho}{\in_0}d^2$

Paragraph-II

Passage: A particle P moving parallel to X-axis in the XY-plane with a constant speed V, starting from position $(0,l)$ at time t=0. Another particle Q starts from origin (0,0) and chases P with same uniform speed V, simultaneously.

15. Radius of curvature of Q in the frame of P at the start of motion is

A) l **B)** $\frac{l}{2}$ **C)** $2l$ **D)** $2\sqrt{2}l$

16. Minimum radius of curvature of Q, in the process of chasing will be

A) $\frac{4l}{\sqrt{3}}$ **B)** $\frac{4l}{3\sqrt{3}}$ **C)** $\frac{4l}{3}$ **D)** $\frac{l}{3\sqrt{3}}$

SECTION-4(Maximum Marks: 12)
Non-Negative Integer Answer Type

- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;
Zero Marks : 0 In all other cases.

17. In diffraction by single slit (Fraunhofer), at the angular position of first minimum, the phase difference between the wavelets from the opposite edges of the slit is $K\left(\frac{\pi}{2}\right)$ Where K = ?

18. A radioactive element is being produced at a constant rate k. The element has decay constant λ. At t=0, number of nuclei of the element is N_0. If $k = 7\lambda N_0$, number of nuclei of the element after one half life of the element is xN_0. Find x.

19. Consider the following statements regarding electromagnetic waves

(i) In free space, its speed, $c = \frac{1}{\sqrt{\mu_0 \in_0}} = 3\times 10^8 m/s$

(ii) In medium, its speed, $v = \frac{1}{\sqrt{\mu \in}}$

(iii) The energy crossing unit area per unit time perpendicular to the direction of propagation of EM wave is called intensity and is equal to $I = \frac{1}{2}\in_0 E^2 c = \frac{B^2}{2\mu_0}c$

(iv) In electro magnetic wave electric and magnetic fields are of different strength but energyof the light is equally shared among the two fields

How many statements are correct in the above ?

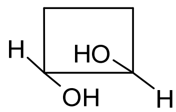
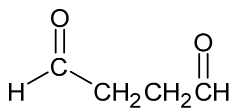
CHEMISTRY

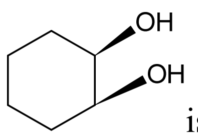
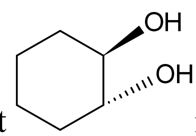
Max. Marks: 60

SECTION-1(Maximum Marks: 24)
One or More Type

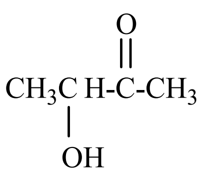
- This section contains SIX (06) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +4 If only (all) the correct option(s) is(are) chosen;
  Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
  Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
  Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
  Zero Marks : 0 If unanswered;
  Negative Marks : −2 In all other cases.

20. Choose the correct statement

A)  is oxidized to  by $Pb(OAC)_4$ in organic solvents.

B)  is oxidized by $HIO_4.2H_2O$ but  is not oxidised with $HIO_4.2H_2O$

C) D-Glucose and D-Fructose gives all products same by oxidation with $HIO_4.2H_2O$

D)  is oxidized by $HIO_4.2H_2O$

21. The correct statement(s) among the following is/are

A) Number of B-O-B bonds in borax is 5.

B) Formula of borax is $Na_2\left[B_4O_5(OH)_4\right]\cdot 8H_2O$

C) BF_3 is a stronger Lewis acid than BI_3

D) $B(OH)_3$ behaves as a strong acid in the presence of glycerol

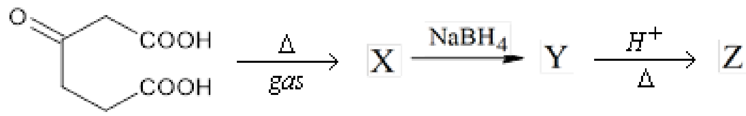
22. Identify correct statements

A) Sucralose has three chlorine atoms per molecule

B) Sucralose in unstable at cooking temperature

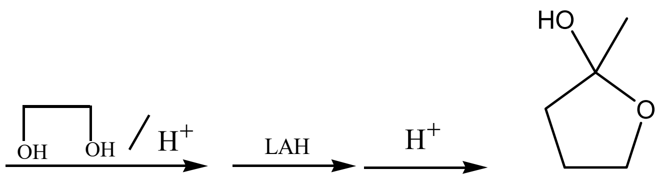
C) Butylated hydroxytoluene and butylated hydroxy anisole are anti oxidatns

D) Sodium rosinate, sodium silicate, borax are fillers in laundry soaps

23. 

Identify correct statement for above reaction sequence?

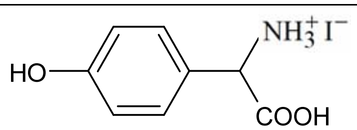
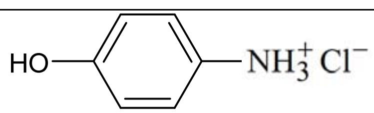
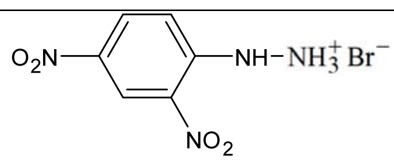
A) 'Z' product is sweet smelling substance

B) Reaction of 'X'  hemi ketal product

C) 'Y' product liberate CO_2 gas with aqueous $NaHCO_3$ and also soluble in aqueous $NaOH$

D) 'Z' product is resolvable

24.

Column I		Column II	
(A)	$H_2N-NH_3^+Cl^-$	**(P)**	Sodium fusion extract of the compound gives Prussian blue colour with $FeSO_4$
(B)		**(Q)**	Gives positive $FeCl_3$ test
(C)		**(R)**	Gives white precipitate with $AgNO_3$
(D)		**(S)**	Reacts with aldehydes to form the corresponding hydrazine derivative

The correct combination from above column-I,II is

A) $A \to RS$ **B)** $B \to PQRS$ **C)** $C \to PQR$ **D)** $D \to PS$

25. Find correct statements

A) Activation energy for acid hydrolysis of sucrose is 6.22 kJ/mole

B) A, D, E, K are fat soluble vitamins

C) Beri-Beri is caused due to deficiency of "Thiamine"

D) Cytosine and Thymine are differed with molar mass difference of "14"

SECTION-2(Maximum Marks: 12)

Paragraph with Numerical

- This section contains THREE (03) question stems.
- There are TWO (02) questions corresponding to each question stem.
- The answer to each question is a NUMERICAL VALUE.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;
  Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 26 and 27

Question Stem

$PCl_5(g)$ When heated in a sealed tube at 500 K it undergoes decomposition as

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

The equilibrium constant K_p is 98.52 at 500 K. Vapour density of equilibrium mixture is 60. $\left(R=0.0821 \text{L atm K}^{-1}\text{mol}^{-1}\right)$

26. Percentage dissociation of PCl_5 is________.

27. Equilibrium constant K_c for the reaction is________________.

Question Stem for Question Nos. 28 and 29

Question Stem

$$\mathrm{B} \xleftarrow{K_1} \mathrm{A} \xrightarrow{K_2} \mathrm{C}$$

Substance 'A' undergoes first order reaction by two parallel paths forming products B and C in two paths respectively as follows

The percentage yield of B is 10% and that of C is 90%. The rate constant for the disappearance of A is $1.4\times10^{-4}\,\sec^{-1}$. The rate constant ($k_1$) for the formation of B is $x\times10^{-5}\,\sec^{-1}$ and the rate constant (k_2) for the formation of C is $y\times10^{-4}\,\sec^{-1}$.

28. The value of x is______________.

29. The value of y is______________.

Question Stem for Question Nos. 30 and 31

Question Stem

A solid metal oxide (M_2O_3) crystallizes as HCP for O^{2-} ions and the metal ions (M^{3+}) occupy only octahedral voids in ideal crystal. The metal may exhibit +3 and+4 oxidation states. The composition of a real metal oxide crystal is found to be $M_{0.60}O_{1.00}$. The percentage of metal atoms missing in the crystal is x% and the ratio of numbers of M^{3+} and M^{4+} ions in the crystal is y:1

30. The value of $\frac{y}{x}$ is__________.

31. The fraction of M^{3+} ions in real crystal is___________.

SECTION-3(Maximum Marks: 12)

Paragraph with Single Answer Type

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases.

Paragraph-1:

Ideal gas equation PV=RT is not followed by real gases. Real gases follow Van-der-waal equations in which pressure is substituted as $P+\frac{an^2}{V^2}$ and volume term is substituted by

$(V-nb)$. i.e., $\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$ where 'a' and 'b' are called Van-der-waal constant. By the help of 'a' and 'b' we can study critical phenomenon of gases.

32. The ratio of coefficient of thermal expansion $\alpha=\left(\frac{dV}{dT}\right)_P/V$ and the isothermal compressibility $K=-\left(\frac{dV}{dP}\right)_T/V$ for an ideal gas is.

A) $-\frac{P}{T}$ **B)** $\frac{P}{T}$ **C)** $\frac{T}{P}$ **D)** $-\frac{T}{P}$

33. **Q:** For $BF_3(g)$ van-der-waal equation can be written as $\left(P+\frac{8}{V^2}\right)(V-0.1)=2RT$ critical volume of BF_3 gas will be:

A) 0.15 litre **B)** 0.3 litre **C)** 24 litre **D)** 0.4 litre

Paragraph-2:

The following column I, II, III represent the different type of observations based on CFT in complex compounds. Answer the questions that follow

Column-I- Crystal field stabilization energy (CFSE) (neglecting PE in all cases)
Column-II- Electronic configuration
Column-III- Type of complex

Column – I CFSE (neglecting PE in all cases)		**Column – II Electronic Configuration**		**Column-III Type of Complex**	
(I)	$-0.4\Delta_0$	(i)	t_{2g}^5, e_g^0	(P)	High spin & paramagnetic
(II)	$-2.0\Delta_0$	(ii)	t_{2g}^4, e_g^0	(Q)	Low spin & paramagnetic
(III)	$-2.4\Delta_0$	(iii)	t_{2g}^6, e_g^0	(R)	High spin & diamagnetic
(IV)	$-1.2\Delta_0$	(iv)	t_{2g}^4, e_g^2	(S)	Low spin & diamagnetic

34. For sodium nitroprusside complex the only **CORRECT** combination is

A) (III),(iv),(Q) **B)** (III),(iii),(S) **C)** (III),(iii),(R) **D)** (II),(iii),(Q)

35. For $\left[Co(H_2O)_3F_3\right]$ complex the only **CORRECT** combination is.

A) (I),(iv),(Q) **B)** (II),(iv),(S) **C)** (III),(ii),(R) **D)** (I),(iv),(P)

SECTION-4(Maximum Marks: 12)
Non-Negative Integer Answer Type

- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;
Zero Marks : 0 In all other cases.

36. $PCl_5(g)$ is taken in a flask at 1.0atm, sealed and allowed to attain the following equilibrium:

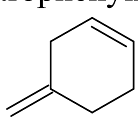
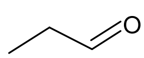
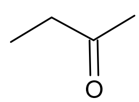
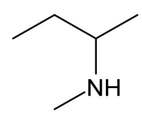
$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

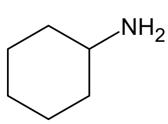
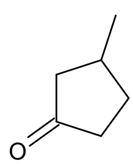
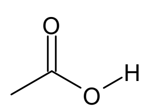
The equilibrium mixture was then allowed to pass through a pin hole and the gases coming out of pin hole initially, was collected, analyzed and mole fraction of Cl_2 was found to be 0.53. What is the value of K_P for the dissociation of $PCl_5(g)$? (in bar) (Rounded off to next nearest integer)

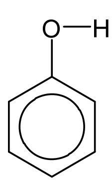
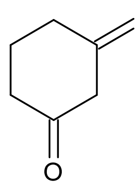
37. Sum of t_{2g} electrons in the following complexes together is x. Then $\frac{x}{2}$ is

$$[TiCl_6]^{2-};\left[Cr^{III}(oxalate)_3\right]^{3-};[FeF_6]^{3-};\left[Co(NH_3)_6\right]^{3+};[NiF_6]^{4-}$$

38. The compound among following which can give 2,4-DNP test (2,4-dinitrophenylhydrazine test)

(i)  (ii)  (iii)  (iv) 

(v)  (vi)  (vii)  (viii) HCHO

(ix)  (x) 

MATHEMATICS

Max. Marks: 60

SECTION-1(Maximum Marks: 24)

One or More Type

- This section contains SIX (06) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is(are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If unanswered;
Negative Marks : −2 In all other cases.

39. If $\sum_{k=1}^{\infty} \operatorname{cosec}^{-1}\left(\dfrac{\sqrt{k^2+4k+3}}{\sqrt{k+2}-\sqrt{k}}\right)=\alpha$, then which of the following option(s) is/are CORRECT? (where [.] denotes the greatest integer function)

A) $\dfrac{d}{dx}\left(\sin^{-1}\dfrac{2x}{1+x^2}\right)$ at $x=\tan\left(\dfrac{3\pi}{4}-\alpha\right)$ is $-\dfrac{2}{3}$

B) $\int_0^{\frac{\alpha+\tan^{-1}\sqrt{2}}{2}}[\tan x]dx=\dfrac{\pi}{2}-\tan^{-1}2$

C) $\lim\limits_{x\to\tan\left(\frac{3\pi}{4}-\alpha\right)}\left(1+\sin\left(x-\sqrt{2}\right)\right)^{\frac{x}{\tan\left(x-\sqrt{2}\right)}}=e^{\sqrt{2}}$

D) $\int_0^{\tan^2\left(\frac{3\pi}{4}-\alpha\right)}\left[\tan^{-1}x\right]dx=2-\tan 1$

40. Let a line parallel to the axis of the parabola $y^2=4x$ be drawn through point $P(\alpha-5,\alpha),(\alpha\neq 0)$ to meet the parabola at Q. Equation of tangent at Q is $x-2y+4=0$. Let $T(\neq Q)$ be a point on the tangent, and M, N be feet of perpendiculars on SQ and directrix respectively from point T. (S is focus), then which of the following option(s) is/are INCORRECT?

A) α is equal to -4

B) If QM=3, then TN is 2

C) If two tangents are drawn from point P to the parabola touching it at A and B and Circumcentre of ΔPAB is at (β,γ), then γ is -1

D) If orthocenter of ΔPAB (as defined in option C) is at (a,b), then $a+b=3$

41. Let $f:[0,\infty)\to R$ be a differentiable function satisfying $f(x)e^{f(x)}=x\forall x\in[0,\infty)$, then which of the following statements is(are) TRUE?

A) $f'(x)\ge 0\forall x\in(0,\infty)$

B) $\lim\limits_{x\to\infty} f(x)=0$

C) $\lim\limits_{x\to\infty}\dfrac{f(x)}{\ln x}=1$

D) $\lim\limits_{x\to\infty}\dfrac{f(x)}{\ln x}=0$

42. If $E_n=\left(5+2\sqrt{6}\right)^n+\left(5-2\sqrt{6}\right)^n, n\in N$ then which of the following statement(s) is/are INCORRECT?

A) $E_{n+1}=10E_n-E_{n-1}$

B) $E_{n+1}=10E_n+E_{n-1}$

C) E_n is divisible by 4

D) E_n is divisible by $2^n \ \forall n\in N$

43. Let a class have 20 students. The average marks of these students in the mathematics examination is 62 and their variance is 30. A student fails in the examination if he/she gets less than 40 marks, then the number of students that may fail is

A) 1 **B)** 0 **C)** 2 **D)** 3

44. Which of the following statement(s) is/are CORRECT?

A) The line of intersection of planes $\vec{r}.\vec{n_1}=q_1, \vec{r}.\vec{n_2}=q_2$ and $\vec{r}.\vec{n_3}=q_3, \vec{r}.\vec{n_4}=q_4$ are perpendicular if $\left(\vec{n_1}.\vec{n_3}\right)\left(\vec{n_2}.\vec{n_4}\right)=\left(\vec{n_1}.\vec{n_4}\right)\left(\vec{n_2}.\vec{n_3}\right)$

B) If three distinct planes $\vec{r}.\vec{n_1}=q_1, \vec{r}.\vec{n_2}=q_2; \vec{r}.\vec{n_3}=q_3$ intersect in a line which is contained by the plane $\vec{r}.\vec{n_4}=q_4$; then $\left[\vec{n_1}\ \vec{n_2}\ \vec{n_4}\right]\vec{n_3}=\left[\vec{n_1}\ \vec{n_2}\ \vec{n_3}\right]\vec{n_4}$

C) If a plane contains line of intersection of planes $\vec{r}.\vec{n_1}=q_1, \vec{r}.\vec{n_2}=q_2$ and is parallel to line of intersection of planes $\vec{r}.\vec{n_3}=q_3, \vec{r}.\vec{n_4}=q_4$ then $\left[\vec{n_1}\ \vec{n_2}\ \vec{n_4}\right]\vec{n_3}=\left[\vec{n_1}\ \vec{n_2}\ \vec{n_3}\right]\vec{n_4}$

D) Given three non-parallel planes $\vec{r}.\vec{a}=1, \vec{r}.\vec{b}=4, \vec{r}.\vec{c}=5$ where $\vec{a},\vec{b},\vec{c}$ are mutually perpendicular vectors, then the position vector of point of intersection of planes is

$$\vec{r}=\frac{\vec{a}+4\vec{b}+5\vec{c}}{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}$$

SECTION-2(Maximum Marks: 12)

Paragraph with Numerical

- This section contains THREE (03) question stems.
- There are TWO (02) questions corresponding to each question stem.
- The answer to each question is a NUMERICAL VALUE.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;
Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 45 and 46

Question Stem

Let z_1, z_2, z_3 be three complex numbers such that $z_1+z_2+z_3=i$, $z_1z_2+z_2z_3+z_1z_3=-1$, $z_1z_2z_3=-i$. Let minimum value of $\left|z_1-kz_2+(k-1)z_3\right| \forall k\in[0,1]$ equals 'a' and minimum value of $|z-z_1|^2+|z-z_2|^2+|z-z_3|^2 \forall z\in C$ is 'b' (where $i=\sqrt{-1}$, C is set of complex numbers)

45. The value of 'a' is

46. The value of $\frac{b}{2}$ is

Question Stem for Question Nos. 47 and 48

Question Stem

Let $f: N\to Q$ be a function, where N denotes the set of natural numbers, and Q denotes the set of rational numbers. Suppose that $f(1)=\frac{3}{2}$, and

$$f(x+y)=\left(1+\frac{y}{x+1}\right)f(x)+\left(1+\frac{x}{y+1}\right)f(y)+x^2y+xy+xy^2$$ for all natural numbers x,y.

47. The value of $\frac{f(20)}{100}=$

48. The value of $\lim_{n\to\infty}\frac{f(n)}{n^3}$

Question Stem for Question Nos. 49 and 50

Question Stem

For a real valued function

$$f(x,k)=\lim_{n\to\infty}\left(\frac{k}{(x)^{1/n}+k-1}\right)^n \quad \forall x\in(0,1), k\in R, k>1, n\in N \text{ and let}$$

$$T(k)=\int_0^1 f(x,k)(\ln x)^2 dx, \text{ then}$$

49. If $\int_0^1 f\left(x,\frac{9}{2}\right)dx = L$ then the value of $2L$ is__________.

50. The value of T(4) is___________.

SECTION-3(Maximum Marks: 12)
Paragraph with Single Answer Type

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases.

Paragraph-1:

Consider the ellipse $x^2+2y^2=2$ with ends of major axis as A and A'. Point P lying on the ellipse is joined to A and A'. From A', perpendicular is drawn to AP & from A, perpendicular is drawn to $A'P$. Let the locus of the point of intersection of the perpendicular lines be another conic E.

51. Square root of length of latus rectum of conic E is

A) 2 **B)** $\sqrt{2}$ **C)** 1 **D)** $2\sqrt{2}$

52. If the equation of directrix of E is $\lambda x+y=k$, then which of the following option may be correct?

A) $\lambda+k=2$ **B)** $k-\lambda=-2$ **C)** $\lambda-k=\sqrt{2}$ **D)** $\lambda+k=2\sqrt{2}$

Paragraph-II:

Consider a function $f(x)=\left|\sin^2\left(\pi\{x\}\right)-2\cos\left(\pi\{x\}\right)+1\right|$, where $x\in[0,3]$ ($\{\cdot\}$ represents fractional part function)

53. The number of solution(s) of the equation $f\left(x\right)=1$ lying in the interval $[0,3]$ is/are

A) 6 **B)** 5 **C)** 7 **D)** 4

54. If the number of points of discontinuity function f(x) lying in the interval $[0,3]$ is n_1 and the number of points of non-differentiability of the function in the interval $(0,3)$ is n_2, then n_1+n_2 is equal to

A) 7 **B)** 8 **C)** 6 **D)** 9

SECTION-4(Maximum Marks: 12)
Non-Negative Integer Answer Type

- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;
Zero Marks : 0 In all other cases.

55. Federer, Nadal, Djokovic and Murray are the four players left in a singles tennis tournament. They are randomly assigned opponents in the semi final matches, and the winners of those matches play each other in the final match to determine the winner of the tournament. When Federer plays Nadal, Federer will win the match with probability $\frac{2}{3}$. When either Federer or Nadal plays either Djokovic or Murray, Federer or Nadal will win the match with probability $\frac{3}{4}$. Assume that outcomes of different matches are independent. The probability that Nadal will win the tournament is $\frac{p}{q}$, where p and q are relatively prime positive integers. Find units digit of p + q.

56. If the sum of all the elements of the set $\{\alpha:\alpha\in\{1,2,3,......100\}$ and $\text{HCF}(\alpha,24)=1\}$ is N, then the units digit of N is

57. Given eight distinguishable rings, let N be the number of possible five-ring arrangements on the four fingers (not the thumb) of one hand. The order of rings on each finger is significant, but it is not required that each finger have a ring. The number of distinct digits in N are

Sri Chaitanya IIT Academy.,India.
✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI
A right Choice for the Real Aspirant
ICON Central Office - Madhapur - Hyderabad

Sec: Sr.Super60_NUCLEUS&ALL_BT'S JEE-ADVANCE-2021_P2 Date: 19-04-2023
Time: 02.00Pm to 05.00Pm GTA-16 Max. Marks: 180

KEY SHEET

PHYSICS

1	**A,C**	2	**A,C,D**	3	**AC**	4	**A,C,D**	5	**A,B,C**	6	**A,D**
7	**4.00**	8	**6.75**	9	**6**	10	**6**	11	**3**	12	**3**
13	**C**	14	**A**	15	**D**	16	**B**	17	**2**	18	**4**
19	**4**										

CHEMISTRY

20	**A,D**	21	**A,B,D**	22	**ACD**	23	**A,B,C,D**	24	**A,C,D**	25	**A,B,C,D**
26	**73.60 - 73.80**	27	**2.25 - 2.55**	28	**1.40**	29	**1.26**	30	**0.20**	31	**0.65 - 0.67**
32	**B**	33	**A**	34	**B**	35	**D**	36	**3**	37	**9**
38	**5**										

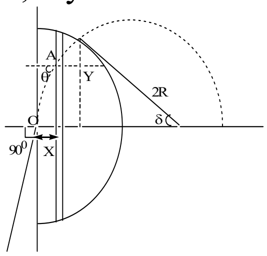
MATHEMATICS

39	**A,B,C,D**	40	**A,C**	41	**A,C**	42	**B,C,D**	43	**A,B**	44	**A,B**
45	**1**	46	**1.33**	47	**43.05**	48	**0.5**	49	**2.57**	50	**4.74**
51	**B**	52	**D**	53	**C**	54	**B**	55	**5**	56	**3**
57	**5**										

SOLUTIONS

PHYSICS

1. The figure shows a strip at a distance x of thickness dx, As μ of material increases with x, ray will deviate continuously as shown. By Snell's law, between O and A,



$$1 \times \sin 90^0 = \frac{2R}{2R-X} \times \sin\theta \Rightarrow \tan\theta = \frac{2R-X}{\sqrt{(2R)^2-(2R-X)^2}}$$

$$\Rightarrow \frac{dy}{dx} = \frac{2R-X}{\sqrt{(2R)^2-(2R-X)^2}} \Rightarrow \int_0^y dy = \int_0^x \frac{2R-X}{\sqrt{(2R)^2-(2R-X)^2}} dx$$

$$\Rightarrow Y = \sqrt{(2R)^2-(2R-X)^2} \Rightarrow Y^2 + (X-2R)^2 = (2R)^2$$

Which is equation of circle of radius 2R centered at (2R,0). Also, equation of hemispherical surface is,

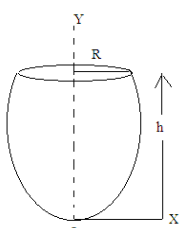
$$X^2 + Y^2 = R^2 \Rightarrow Y^2 = R^2 - X^2$$

Putting this value of Y^2 in equation of trajectory, we can find coordinates of point where the ray comes out of hemisphere, as $R^2 - X^2 + (X-2R)^2 = 4R^2$

$$\Rightarrow X = \frac{R}{4} \Rightarrow Y = \sqrt{R^2 - X^2} \quad = \sqrt{R^2 - \left(\frac{R}{4}\right)^2} = \frac{\sqrt{15}R}{4} \quad = 0.97R$$

From the diagram, $\sin\delta = \frac{Y}{2R} = \frac{\sqrt{15}}{8} \simeq \frac{\sqrt{16}}{8} = \frac{1}{2}$ $\Rightarrow 0 < \delta < 30^0$

2.



From fig; $y = \frac{h}{R^2}x^2$; $volume = \frac{1}{2}\pi R^2 h$

At any instant, Let y be the submerged depth, then equation of motion$\Rightarrow m\frac{dv}{dt} = mg - \left(\frac{1}{2}\pi x^2 y\right)\rho_\ell g$ $\quad v\frac{dv}{dy} = g - \frac{\rho_\ell}{\rho_s}\frac{g}{h^2}y^2$

$$y_{\max} = h \Rightarrow gh = \frac{\rho_\ell}{\rho_s}\frac{g}{h^2}\frac{h^3}{3} \Rightarrow \frac{\rho_\ell}{\rho_s} = 3 \ldots\ldots\ldots\ldots\ldots\ldots.(A)$$

At equilibrium, a=0 $\quad mg = \frac{1}{2}\pi x^2 y_0.\rho_\ell g$

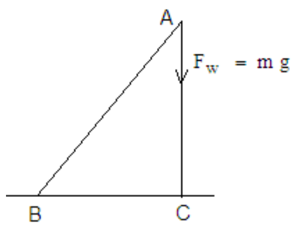
$\frac{1}{2}\pi R^2 h y_0.\rho_s g = \frac{1}{2}\pi x^2 h y_0.\rho_\ell g.y_0 \quad = \frac{1}{2}\pi y_0 \frac{R^2}{h}\rho_\ell g y_0$

$\frac{1}{2}\pi R^2 h y_0.\rho_s g = \frac{1}{2}\pi x^2 h y_0.\rho_\ell g.y_0$

$\Rightarrow y_0{}^2 = h^2 \frac{\rho_s}{\rho_\ell} \Rightarrow y_0 = \frac{h}{\sqrt{3}}$ ....(D)

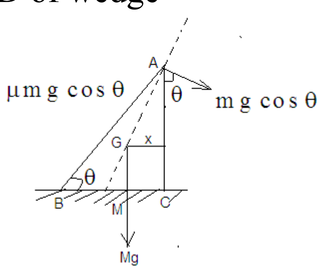
$\frac{v^2}{2} = gy - \frac{3g}{h^2}\frac{y^3}{3} \quad v_0{}^2 = 2g\frac{h}{\sqrt{3}} - \frac{g}{h^2}(2)\frac{h^3}{3\sqrt{3}} = \frac{4}{3\sqrt{3}}gh$ ....(D)

3. i) $\mu > \tan\theta$, block does not slide Torque about C=0



ii) $\mu < \tan\theta$, block slides down $mg\sin\theta > \mu mg\cos\theta$

FBD of wedge



$\Rightarrow$

τ_C should be clockwise for toppling

$\Rightarrow \left(mg\cos\theta\sin\theta - \mu mg\cos^2\theta\right)h > Mgx$

$\frac{x}{Mc} = \frac{2}{3}, Mc = \frac{h}{2}\cot\theta \Rightarrow x = \frac{h}{3}\cot\theta \Rightarrow 3m\left(\sin^2\theta - \mu\sin\theta\cos\theta\right) > M$.

4. Total magnetic flux at any position, $\phi = B_z \pi r_0^2 - LI =$ constant

From initial condition (z=0, I=0), the value of constant is $\phi = B_0 \pi r_0^2$.

Using the above equation, the current in the ring, $I = \frac{1}{L}B_0 \alpha \pi r_0^2 z$

The Lorentz force acting on the ring (which can only be vertical, because of the symmetry of the assembly) can be expressed as $F_z = -B_r I(z) 2\pi r_0$

$$= -\frac{2B_0{}^2 \alpha\beta\pi^2 r_0^4 z}{L} = -kz$$

Equation of motion of the ring is $ma_z = F_z + mg = -kz + mg$

At equilibrium position,

$$z_0 = -\frac{mg}{k} = -\frac{mgL}{2B_0^2\alpha\beta\pi^2 r_0^4} \qquad \omega_0 = \sqrt{\frac{k}{m}} = \sqrt{\frac{2B_0^2\alpha\beta\pi^2 r_0^4}{Lm}}$$

$$= B_0\pi r_0^2\sqrt{\frac{2\alpha\beta}{mL}} \qquad \therefore T = \frac{2\pi}{\omega} = \frac{2\pi}{= B_0\pi r_0^2}\sqrt{\frac{mL}{2\alpha\beta}} = \frac{1}{B_0 r_0^2}\sqrt{\frac{2mL}{\alpha\beta}}$$

5. Conceptual

6. Consider FBD of sphere B as shown in Fig.1.

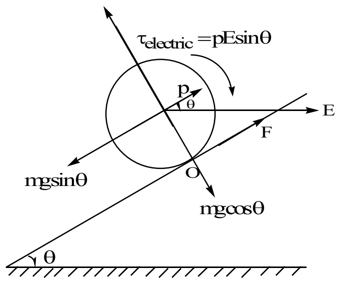


Fig.1.

About contact point O of the sphere with the incline,

τ_1 =torque of $mg\sin\theta = mg\sin\theta.r$ (anti-clockwise)

τ_1 =torque of electric field E due to infinite sheet = $pE\sin\theta$,(clockwise)

For equilibrium of B, $\tau_1 = \tau_2 \Rightarrow mg\sin\theta.r = pE\sin\theta$

$\Rightarrow mgr = pE$ ……………………..(i)

Consider FBD of sphere A, just after release as shown in Fig.2.

Let a and α are acceleration of center of mass and angular acceleration of the sphere, respectively.

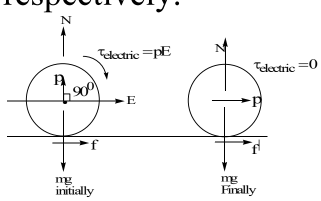


Fig.2.

Moment of inertia of the sphere about O, using parallel axes theorem,

$$I = I_{CM} + md^2 = \frac{2}{5}mr^2 + mr^2 = \frac{7}{5}mr^2 ....(ii)$$

Torque of electric force of sheet on dipole, $\tau = pE\sin 90^0 = pE..........(iii)$

Using Eq.s (iii) and (ii), We get

Angular acceleration of the sphere is $\alpha = \frac{\tau}{1} = \frac{pE}{\frac{7}{5}mr^2} = \frac{5pE}{7mr^2}$

By condition of rolling without slipping, $a = \alpha r = \frac{5pE}{7mr} = \frac{5mgr}{7mr}$

[using Eq. (i)] $\Rightarrow a = \frac{5g}{7}.................(iv)$ $\therefore$ Option (a) is correct.

From FBD in Fig.2, using, F=ma in horizontal direction, We get $f = m\left(\frac{5g}{7}\right) = \frac{5mg}{7}4$

[using Eq.(iv)] $\therefore$ Option (b) is incorrect.
Due to electric field torque experienced by sphere A, will rotate the dipole clockwise.
Potential energy of a dipole is given by $U = -pE\cos\theta$

Therefore, $U_{initial} = -pE\cos 90^0 = 0$.............(v)

$$U_{final} = -pE\cos 0^0 = -pE \text{............}(vi)$$

Considering, rotation of sphere by $\frac{\pi}{2}$,

Gain in KE = Loss in PE $\frac{1}{2}I\omega^2 = U_{initial} - U_{final}$

$$\frac{1}{2}\cdot\frac{7}{5}mr^2\omega^2 = 0-(-pE) \Rightarrow \omega = \sqrt{\frac{10pE}{7mr^2}} = \sqrt{\frac{10p\left(\frac{\sigma}{2\epsilon_0}\right)}{7mr^2}} = \sqrt{\frac{5\rho\sigma}{7mr^2\epsilon_0}}$$

$\Rightarrow$ Option © is incorrect.
Finally, When dipole is parallel to horizontal surface, torque due to electric force is equal to $\tau = pE\sin 0^0 = 0 \Rightarrow \alpha_{CM} = \frac{\tau}{1} = 0 \Rightarrow f^{|} = ma_{CM} = 0$ $\therefore$ Option (d) is correct.

7. By Torricelli's equation, velocity of efflux is $v = \sqrt{2gy}$.

$\therefore$ volume flow rate of ejecting fluid, $Q_1 = av = a\sqrt{2gy}$ ....(i)
At top surface, radius of cross-section is equal to x. Therefore, cross-sectional area is $a' = \pi x^2$ $\therefore$ volume flow rate at surface, $Q_2 = a'v' = \pi x'v'$......................(ii)
Here, v' is fluid velocity. By continuity equation, $Q_1 = Q_2$

$\Rightarrow a\sqrt{2gy} = \pi x^2 v'$ [using Eq.s (i) and (ii)]

$\Rightarrow v' = \frac{a\sqrt{2gy}}{\pi x^2}$ $\Rightarrow \left|\frac{dh}{dt}\right| = \frac{a\sqrt{2gy}}{\pi x^2}$ As, $\frac{dh}{dt}$ is given to be independent of y or is constant, therefore, $\frac{\sqrt{y}}{x^2} = constant$ $\Rightarrow \frac{y}{x^4} = constant$ $\Rightarrow y \alpha x^4 \Rightarrow n = 4$.

8. Let dm mass of water is striking the block in time dt. Relative velocity with which water strikes the block's surface is $v_{rel} = v - u$ ....(iii)
So, change in momentum of dm mass of water is $dp = dmv_{rel} = dm(v-u)$

$\therefore$ Force applied by jet in block, $F = \frac{dp}{dt} = \frac{dm}{dt}(v-u)$ ....(iv)

Also, relative mass flow rate is $\frac{dm}{dt} = \rho a v_{rel} = \rho a(v-u)$ ....(v)
[using Eq. (iii)]

Using Eq.s (iv) and (v), we get $P = Fu = \rho a(v-u)^2 u$ ....(vi)

For P to be maximum, $\frac{dp}{du}=0$ $\qquad \Rightarrow \frac{d\left[(v-u)^2 u\right]}{du}=0$

$\Rightarrow -2(v-u)u+(v-u)^2=0 \qquad \Rightarrow u=\frac{v}{3}$

$\therefore P=\rho a\left(v-\frac{v}{3}\right)^2\frac{v}{3}=\frac{4\rho a v^3}{27}$ $\qquad$ [using Eq. (vi)] $\quad \therefore x=\frac{27}{4}=6.75$

9. Displacement of CM=0 along x-axis $\Delta\vec{x}=$ displacement of sphere w.r.t ground
$\Delta\vec{r}=$ displacement of onset w.r.t sphere $\Rightarrow 2m\Delta\vec{x}+m\left[\Delta\vec{x}+\Delta\vec{r}\right]=0$

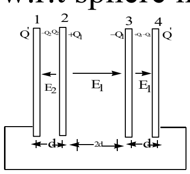
$\Rightarrow \Delta\vec{x}=-\frac{\Delta\vec{r}}{3}\Rightarrow \Delta\vec{x}=-\frac{R}{6}$ w.r.t sphere inset moves in a uniform circular motion.

10. Displacement of CM=0 along x-axis $\Delta\vec{x}=$ displacement of sphere w.r.t ground
$\Delta\vec{r}=$ displacement of onset w.r.t sphere

$\Rightarrow 2m\Delta\vec{x}+m\left[\Delta\vec{x}+\Delta\vec{r}\right]=0\Rightarrow \Delta\vec{x}=-\frac{\Delta\vec{r}}{3}\Rightarrow \Delta\vec{x}=-\frac{R}{6}$

w.r.t sphere inset moves in a uniform circular motion.

11.



(1) Since plate 3 is isolated so net charge on it will be zero. Let it is having charge Q, on each face.

(2) Since plate 1 and 4 are connected by a conducting wire so

$V_1=V_4 \qquad \Rightarrow V_2-V_1=V_2-V_4$

So $\quad V_2-E_2 d=V_2-E_1\times 2d-E_1 d$

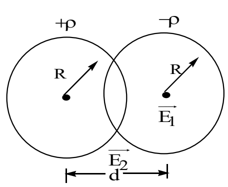
$E_2=3E_1 \qquad \frac{Q_2}{\epsilon_0 A}=\frac{3Q_1}{\epsilon_0 A} \qquad \Rightarrow Q_2=3Q_1$ ....(i)

Since net charge on plate 2 is Q $\qquad Q_1+Q_2=Q$

From equations (i) and (ii) $\qquad Q_1=\frac{Q}{4}, Q_2=\frac{3Q}{4}$

12. $V_1-V_2=E_2 d=\frac{Q_2}{\epsilon_0 A}d \quad V_1-V_2=\frac{3Q}{4\epsilon_0}\frac{d}{A}$.

13.



$\vec{E}=\frac{kQ}{x^2} \quad \vec{E_1}=\frac{1}{4\pi\epsilon_0}\frac{\frac{4}{3}\pi x^3\rho}{x^2} \quad \vec{E_2}=+\frac{\rho(d-x)}{3\epsilon_0}=\frac{\rho d}{3\epsilon_0}(d-x)$

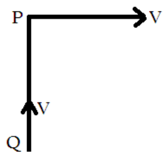
$$E_{net} = E_1 + E_2 = \frac{\rho(d-x)}{3\epsilon_0} + \frac{\rho x}{3\epsilon_0}\ E = \frac{\rho d}{3\epsilon_0}.$$

14.

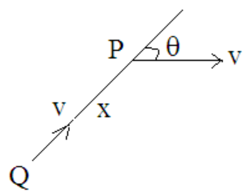
$$V = -\int E - dx\ \int_{v_1}^{v_2} V = -\int_0^d \frac{\rho d}{3\epsilon_0} dx\ V_2 - V_1 = -\frac{\rho d^2}{3\epsilon_0}\ |\Delta V| = \frac{\rho d^2}{3\epsilon_0}.$$

15.

$$\left.\begin{matrix} \omega = \dfrac{V}{l} \\ a_Q = V\omega \\ = \dfrac{V^2}{l} \end{matrix}\right\} R_Q = \frac{V^2}{a_Q}\ R_Q \text{ in the frame of P} = \frac{\left(\sqrt{2}V\right)^2}{\dfrac{V^2}{\sqrt{2}l}} = 2\sqrt{2}l$$



16.

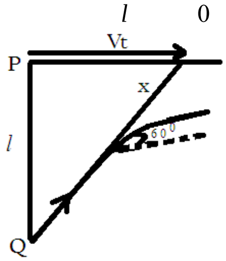


$$W = \frac{V\sin\theta}{x}\quad a_Q = V^2\frac{\sin\theta}{x}\quad R_Q = \frac{V^2}{a_Q} = \frac{x}{\sin\theta}\quad R_Q \min \Rightarrow \frac{dR_Q}{dt} = 0$$

$$\Rightarrow \frac{1}{\sin\theta}(V\cos\theta - V) + x - \frac{1}{\sin^2\theta}\cos\theta\left(-\frac{V\sin\theta}{x}\right) = 0$$

$$\Rightarrow \frac{V(\cos\theta - 1)}{\sin\theta} = -V\frac{\cos\theta}{\sin\theta}\quad \Rightarrow 2\cos\theta = 1\quad \Rightarrow \theta = 60^0.$$

$$-\int_l^x dx = \int_0^t (V - V\cos\theta)dt\qquad \int_0^t V\cos\theta dt + \frac{x}{2} = \int_0^t Vdt\qquad \Rightarrow l - x = \frac{x}{2}\quad \Rightarrow x = \frac{4l}{3}.$$



17. Conceptual.

18. For such a radioactive decay,

$$N = \frac{1}{\lambda}\left[k - (k - \lambda N_0)e^{-\lambda t}\right] = \frac{1}{\lambda}\left[7\lambda N_0 - 6\lambda N_0\left(\frac{1}{2}\right)\right] = 4N_0 \therefore x = 4.$$

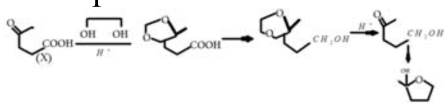
19. Conceptual.

CHEMISTRY

20. Conceptual.

21. BF_3 is a weaker Lewis acid than BI_3.

22. Conceptual.

23. 

24. Conceptual.

25. Conceptual.

26. $\alpha = \dfrac{D-d}{d(n-1)} = \dfrac{104.25-60}{60(2-1)} = 0.7375$ Percentage dissociation = 73.75 (73.60 to 73.80)

27. $K_p = K_c (RT)^{\Delta n}$ $98.52 = K_c (0.0821\times 500)$ $K_c = 2.40$ (2.25 to 2.55)

28. $k_1 = k\times\dfrac{10}{100} = 1.4\times10^{-4}\times\dfrac{10}{100} = 1.4\times10^{-5}\,\sec^{-1}$ $\therefore x = 1.40$

29. $k_2 = k\times\dfrac{90}{100} = 1.4\times10^{-4}\times\dfrac{90}{100} = 1.26\times10^{-4}\,\sec^{-1}$ $\therefore y = 1.26$

30. $M = \dfrac{+2}{0.6} = x(4)+(1-x)\times(+3)$ $\Rightarrow 4x-3x+3 = \dfrac{2}{0.6}$

$\Rightarrow x = \dfrac{2-1.8}{0.6} = \dfrac{1}{3}$ $\Rightarrow fr^n$ of atoms in +4 oxidation state = 1/3. fr^n of atoms in +3 oxidation state = 2/3 $x = \dfrac{2-1.8}{2}\times 100 = 10\%$ $y = \left(\dfrac{2}{1}\right) = 2$ $\Rightarrow y/x = 0.2$

31. Conceptual.

32. $PV = RT; V = \dfrac{RT}{P}$ $\left(\dfrac{dV}{dT}\right)_P = \dfrac{R}{P} = \dfrac{RV}{RT} = \dfrac{V}{T}$

So, $\alpha = \dfrac{\left(\dfrac{dV}{dT}\right)_P}{V} = \dfrac{V}{T.V} = \dfrac{1}{T}$ Again, PV=RT PdV+VdP=0

$\left(\dfrac{dV}{dT}\right)_T = -\dfrac{V}{P}$ $K = -\left(\dfrac{dV}{dP}\right)_T / V = \dfrac{V}{P.V} = \dfrac{1}{P}$ $\dfrac{\alpha}{K} = \dfrac{P}{T}$

33. From the equation nRT=2RT

n = 2(2 mol of BF_3) nb = 0.1; b = 0.05

Critical volume = 3b = 0.05 x 3 = 0.15 litre

34. Conceptual.

35. Conceptual.

36. $\underset{1-\alpha}{PCl_5} \rightleftharpoons \underset{\alpha}{PCl_3} + \underset{\alpha}{Cl_2}$ $\dfrac{\gamma Cl_2}{\gamma PCl_3} = \sqrt{\dfrac{137.5}{71}} = \dfrac{0.53}{x}; x = 0.3$

Hence, the mol fraction of PCl_5 outside of flask = 0.09

$\dfrac{\gamma PCl_5}{\gamma PCl_3} = \dfrac{1-\alpha}{\alpha}\sqrt{\dfrac{71}{208.5}} = \dfrac{0.09}{0.53}; \alpha = 0.77$ $K_P = \dfrac{\alpha^2}{1-\alpha} = \dfrac{(0.77)^2}{0.23} = 2.577 bar$

37. Conceptual.

38. (ii), (iii), (vi), (viii), (x)

MATHEMATICS

39.

$$\alpha = \sum_{K=1}^{\infty} \tan^{-1}\left(\sqrt{k+2}\right) - \tan^{-1}\left(\sqrt{k}\right) = \frac{3\pi}{4} - \tan^{-1}\sqrt{2}$$

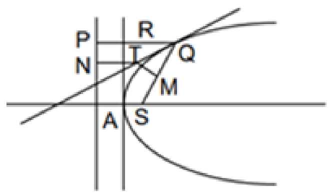
40.

Let $Q \equiv \left(\frac{\alpha^2}{4}, \alpha\right)$ lies on x-2y+4=0 $\Rightarrow \alpha = 4$

Δs TMQ and TRQ are congruent $\Rightarrow QM = QR \Rightarrow SM = TN = SQ - QM = 5 - 3 = 2$

Now, P=(-1,4) which lies on directrix $\Rightarrow$ Two tangents are perpendicular

$\Rightarrow$ P is orthocentre and mid-point of AB as circumcentre which has same y coordinate as that of P



41. Let f(x) is decreasing $x_2 > x_1 \Rightarrow f(x_2) < f(x_1)$

$\Rightarrow e^{f(x_2)} < e^{f(x_1)} \Rightarrow e^{f(x_2)} f(x_2) < e^{f(x_1)} f(x_1) \Rightarrow x_2 < x_1$ which is not possible.

$\Rightarrow$ so f(x) is increasing

Now $x \to \infty \Rightarrow f(x) \to \infty$ $\quad \frac{\ln x}{f(x)} = 1 + \frac{\ln f(x)}{f(x)} \Rightarrow \lim_{x\to\infty} \frac{\ln x}{f(x)} = 1$

42.

$$E_n = \left(5+2\sqrt{6}\right)^n + \left(5-2\sqrt{6}\right)^n, E_n = \alpha^n + \beta^n, n \in N$$

α, β are the roots the equation $x^2 - 10x + 1 = 0$. So $E_{n+1} = 10E_n - E_{n-1}$

43.

$$\text{Variance} = \frac{\sum |x_i - \bar{x}|^2}{n}$$

$$\Rightarrow \quad 30 = \frac{|x_1 - 62|^2 + |x_2 - 62|^2 + |x_3 - 62|^2 + ----- + |x_{20} - 62|^2}{20}$$

$$\Rightarrow \quad |x_1 - 62|^2 + |x_2 - 62|^2 + |x_3 - 62|^2 + ----- + |x_{20} - 62|^2 = 600$$

If one student gets less than 40, $|40 - 62|^2 = |22|^2 = 484$

If two students fail $\quad 2|40 - 62|^2 = 968 > 600$ Which is a contradiction

So, number of students that may fail =0 or 1

44. The line of intersection of planes $\vec{r}.\vec{n_1} = q_1, \vec{r}.\vec{n_2} = q_2$ and $\vec{r}.\vec{n_3} = q_3, \vec{r}.\vec{n_4} = q_4$ are perpendicular if $\left(\vec{n_1} \times \vec{n_2}\right).\left(\vec{n_3} \times \vec{n_4}\right) = 0$

45.

$z_i = 1, -1, i$; a = min. of $\left| z_1 - \frac{kz_2 + (1-k)z_3}{k + (1-k)} \right| = 1$

46. $z=\frac{i}{3}\Rightarrow b=\frac{8}{3}$

47. Letting y = 1, one gets $f(x+1)=\left(1+\frac{1}{x+1}\right)f(x)+\left(1+\frac{x}{2}\right)\frac{3}{2}+x^2+2x.$

Upon rearranging, one gets $\frac{f(x+1)}{x+2}-\frac{f(x)}{x+1}=x+\frac{3}{4}.$

Then we have $\frac{f(n)}{n+1}-\frac{f(n-1)}{n}=n-1+\frac{3}{4},\ \frac{f(n-1)}{n}-\frac{f(n-2)}{n-1}=n-2+\frac{3}{4},$

….. $\frac{f(2)}{3}-\frac{f(1)}{2}=1+\frac{3}{4}.$

Adding these equalities together, we get

$$\frac{f(n)}{n+1}-\frac{f(1)}{2}=1+2+....+(n-1)+\frac{3}{4}(n-1)=\frac{(n-1)n}{2}+\frac{3}{4}(n-1).$$

Thus, $f(n)=(n+1)\left[\frac{(n-1)n}{2}+\frac{3}{4}(n-1)+\frac{1}{2}.\frac{3}{2}\right]=\frac{n(n+1)(2n+1)}{4}.$

Hence, $f(20)=\frac{(20)(21)(41)}{4}=4305.$

48. Letting y = 1, one gets $f(x+1)=\left(1+\frac{1}{x+1}\right)f(x)+\left(1+\frac{x}{2}\right)\frac{3}{2}+x^2+2x.$

Upon rearranging, one gets $\frac{f(x+1)}{x+2}-\frac{f(x)}{x+1}=x+\frac{3}{4}.$

Then we have $\frac{f(n)}{n+1}-\frac{f(n-1)}{n}=n-1+\frac{3}{4},$

$\frac{f(n-1)}{n}-\frac{f(n-2)}{n-1}=n-2+\frac{3}{4},\quad \frac{f(2)}{3}-\frac{f(1)}{2}=1+\frac{3}{4}.$

Adding these equalities together, we get

$$\frac{f(n)}{n+1}-\frac{f(1)}{2}=1+2+....+(n-1)+\frac{3}{4}(n-1)=\frac{(n-1)n}{2}+\frac{3}{4}(n-1).$$

Thus, $f(n)=(n+1)\left[\frac{(n-1)n}{2}+\frac{3}{4}(n-1)+\frac{1}{2}.\frac{3}{2}\right]=\frac{n(n+1)(2n+1)}{4}.$

Hence, $f(20)=\frac{(20)(21)(41)}{4}=4305.$

49.

$$f(x,k)=e^{\lim\limits_{n\to\infty}\frac{n.\left(1-x^{1/n}\right)}{\left(x^{1/n}+k-1\right)}}=e^{\ln\left(x^{-1/k}\right)}=x^{-1/k}\int_0^1 x^{-2/9}dx=9/7$$

$T(k)=\int_0^1 x^{-1/k}(\ln x)^2\,dx$ (Apply integration by parts)

$$T(k)=\frac{2k^3}{(k-1)^3}\Rightarrow T(4)=\frac{128}{27}$$

50.

$$f(x,k)=e^{\lim\limits_{n\to\infty}\frac{n.\left(1-x^{1/n}\right)}{\left(x^{1/n}+k-1\right)}}=e^{\ln\left(x^{-1/k}\right)}=x^{-1/k}$$

$$\int_0^1 x^{-2/9}dx=9/7$$

$$T(k)=\int_0^1 x^{-1/k}(\ln x)^2\,dx \text{ (Apply integration by parts)}$$

$$T(k)=\frac{2k^3}{(k-1)^3}\Rightarrow T(4)=\frac{128}{27}$$

51. If $A\left(\sqrt{2},0\right),A^{'}\left(-\sqrt{2},0\right)$ are the ends of major axis and $P(\sqrt{2}\cos\theta,\sin\theta)$

Equation of the line passing through A perpendicular to $A^{'}P$ is

$$y=\frac{-\sqrt{2}(1+\cos\theta)}{\sin\theta}\left(x-\sqrt{2}\right)$$

Equation of the line passing through $A^{'}$ perpendicular to AP is

$$y=\frac{-\sqrt{2}(\cos\theta-1)}{\sin\theta}\left(x+\sqrt{2}\right)$$

On solving above equations we get the locus of E is $\frac{x^2}{2}+\frac{y^2}{4}=1$

52. If $A\left(\sqrt{2},0\right),A^{'}\left(-\sqrt{2},0\right)$ are the ends of major axis and $P(\sqrt{2}\cos\theta,\sin\theta)$

Equation of the line passing through A perpendicular to $A^{'}P$ is

$$y=\frac{-\sqrt{2}(1+\cos\theta)}{\sin\theta}\left(x-\sqrt{2}\right)$$

Equation of the line passing through A' perpendicular to AP is

$$y=\frac{-\sqrt{2}(\cos\theta-1)}{\sin\theta}\left(x+\sqrt{2}\right)$$

On solving above equations, we get the locus of E is $\frac{x^2}{2}+\frac{y^2}{4}=1$

53.

$$g(x)=\sin^2(\pi\{x\})-2\cos(\pi\{x\})+1=3-(\cos(\pi\{x\})+1))^2$$

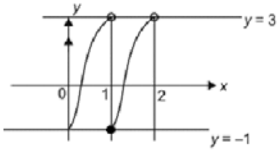
$g(x)$ is periodic with fundamental period 1

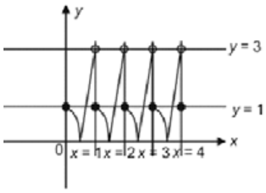
When $x\in(0,1)\,g(x)=3-(\cos\pi x+1)^2\Rightarrow g'(x)=$

$+2\left(\cos(\pi x)+1\right)\sin(\pi x)\pi$

$g'(x)>0 \Rightarrow g(x)$ is increasing function in (0,1)

at $x=0,\ g(0)=-1,\ g(1)=-1$





Two points of discontinuously and 5 non differentiability in (0, 3)

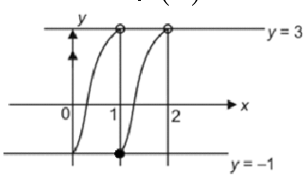
54. $g(x)=\sin^2(\pi\{x\})-2\cos(\pi\{x\})+1=3-(\cos(\pi\{x\}+1)^2$

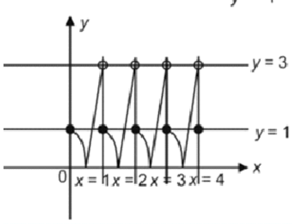
$g(x)$ is periodic with fundamental period 1

When $x\in(0,1)\,g(x)=3-(\cos\pi x+1)^2 \Rightarrow g'(x)=+2\left(\cos(\pi x)+1\right)\sin(\pi x)\pi$

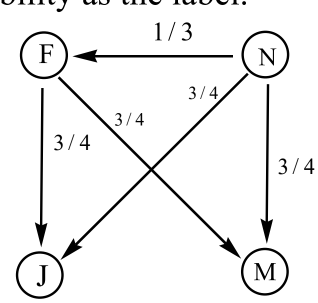
$g'(x)>0 \Rightarrow g(x)$ is increasing function in (0,1)

at $x=0,\ f(0)=-1.at\,x=1,\ f(1)=-1$





55. Let F be Federer, N be Nadal, J be Djokovic, and M be Murray. The 4 circles represent the 4 players, and the arrow is from the winner to the loser with the winning probability as the label.



The problem can be solved in 2 cases.

Case1: N's opponent for the semifinals is F.

The probability N's opponent is F is $\frac{1}{3}$. Therefore the probability N wins the semifinal in this case is $\frac{1}{3}.\frac{1}{3}$. The other semifinal game is played between J and M, it doesn't matter who wins because N has the same probability of winning either one. The probability of N winning in the final is $\frac{3}{4}$, So the probability of N winning the tournament in case1 is $\frac{1}{3}.\frac{1}{3}.\frac{3}{4}$

Case2: N's opponent for the semifinal is J or M.

It doesn't matter if N's opponent is J or M because N has the same probability of winning either one. The probability N's opponent is J or M is $\frac{2}{3}$. Therefore the probability N wins the semifinal in this case is $\frac{2}{3}.\frac{3}{4}$. The other semifinal game is played between F and J or M. In this case it matters who wins in the other semifinal game because the probability of N winning F and J or M is different.

Case2.1: N's opponent for the final is F.

For this to happen, F must have won J or M in the semifinal, the probability is $\frac{3}{4}$. Therefore the probability that N won F in the final is $\frac{3}{4}.\frac{1}{3}$

Case2.2: N's opponent for the final is J or M.

For this to happen, J or M must have won F in the semifinal, the probability is $\frac{1}{4}$. Therefore the probability that N won J or M in the final is $\frac{1}{4}.\frac{3}{4}$

In Case2, the probability of N winning the tournament is $\frac{2}{3}.\frac{3}{4}.\left(\frac{3}{4}.\frac{1}{3}+\frac{1}{4}.\frac{3}{4}\right)$

Adding Case1 and Case2 together, we get $\frac{1}{3}.\frac{1}{3}.\frac{3}{4}+\frac{2}{3}.\frac{3}{4}.\left(\frac{3}{4}.\frac{1}{3}+\frac{1}{4}.\frac{3}{4}\right)=\frac{29}{96}$,

So the answer is 29 + 96 = 125.

56. $D=(1+2+3+----+100)-(2+4+6+----+100)-(3+6+9+---+99)$
$+(6+18+24+-----+96)=1633$

57. There are $\binom{8}{5}$ ways to choose the rings, and there are 5! Distinct arrangements to order the rings [we order them so that the first ring is the bottom-most on the first finger that actually has a ring, and so forth]. The number of ways to distribute the rings among the fingers is equivalent the number of ways we can drop five balls into 4 urns, or similarly dropping five balls into four compartments split by three dividers. The number of ways to arrange those dividers and balls is just $\binom{8}{3}$.

Multiplying gives the answer: $\binom{8}{5}\binom{8}{3}5!=376320$

Sri Chaitanya IIT Academy.,India.

A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S	**JEE-ADVANCE-2021-P1**	**Date: 19-05-2023**
Time: 09.00Am to 12.00Pm	**GTA-25**	**Max. Marks: 180**

19-05-2023_Sr.Super60_ NUCLEUS&ALL_BT'S_Jee-Adv(2021-P1)_GTA-25_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ________________ **H.T. NO:** | | | | | | | |

JEE-ADVANCE-2021-P1-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 4)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 5 – 10)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 11 – 16)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 17 – 19)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 20 – 23)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 24 – 29)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 30 – 35)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 36– 38)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 39 – 42)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 43 – 48)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 49 – 54)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 55 – 57)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

PHYSICS

Max Marks: 60

SECTION – I

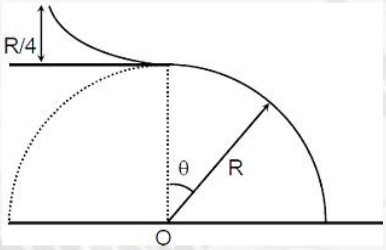
(SINGLE CORRECT ANSWER TYPE)

This section contains 4 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases. Section 1 (Max Marks: 12)

- Section 1 contains Four questions
- Each Question has Four Options and Only One of these four will be the correct answer.
- For each question, choose the option corresponding to the correct answer
- The Marking scheme to evaluate Answer to each question will be :
- Full Marks: **+3** (If the answer is correct)
- Zero Marks: **0** (If the question is unanswered)
- Negative Marks: -1 (In all other cases)

1. A skier plans to ski a smooth fixed hemisphere of radius R. He starts from rest from a curved smooth surface of height (R/4). The angle θ at which he leaves the hemisphere is:



A) $\cos^{-1}\left(\frac{2}{3}\right)$ **B)** $\cos^{-1}\left(\frac{5}{\sqrt{3}}\right)$

C) $\cos^{-1}\left(\frac{5}{6}\right)$ **D)** $\cos^{-1}\left(\frac{5}{2\sqrt{3}}\right)$

2. One mole of an ideal diatomic gas undergoes a thermodynamic process, in which its molar heat capacity varies directly proportional to temperature as $C = \alpha T$,where α is a positive constant. Work done by the gas when it is heated from initial temperature T_0 to a final temperature $3T_0$ will be

A) $4\alpha T_0^2$ **B)** $(\alpha T_0 - R)\frac{3T_0}{2}$

C) $(4\alpha T_0 - 5R)T_0$ **D)** $(3\alpha T_0 - 5R)\frac{T_0}{2}$

3. A point source S of light is placed at a depth d below the surface of water in a large and deep lake. Maximum fraction of light that escapes inspace above directly from water (refractive index = μ) surface is given by

A) $\frac{1}{2} - \sqrt{\frac{\mu^2 - 1}{\mu}}$ **B)** $\sqrt{\frac{\mu^2 - 1}{\mu}}$ **C)** $\frac{1}{2} - \frac{\sqrt{\mu^2 - 1}}{2\mu}$ **D)** $\frac{1}{2} - \frac{\sqrt{\mu^2 - 1}}{\mu^2}$

4. A total charge Q is uniformly distributed over a non-conducting disc of radius r. There is a time varying magnetic field perpendicular to its plane and changing at the uniform rate of $\frac{dB}{dt}$. The magnitude of torque experienced by the disc is

A) $\frac{Qr^2}{2}\left(\frac{dB}{dt}\right)$ **B)** $\frac{Qr^3}{3}\left(\frac{dB}{dt}\right)$ **C)** $\frac{1}{4}Qr^2\left(\frac{dB}{dt}\right)$ **D)** $\frac{1}{2}Qr^3\left(\frac{dB}{dt}\right)$

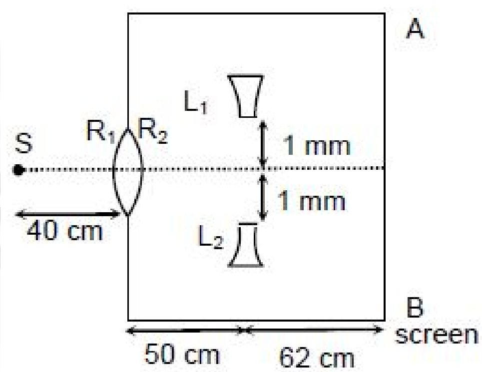
SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks:* +2** If ONLY the correct numerical value is entered at the designated place;
- **Zero Marks:0** in all other cases

Question Stem for Question Nos. 5 and 6

Question Stem

A cuboidal container is filled with liquid of refractive index 1.2. A convex lens having radius of curvature $R_1 = 20$ cm and $R_2 = 24$ cm is fixed in one face of cuboid. Parts of concave lens having (concave lens is cut into two equal parts along its principal axis) having focal length 20 cm in liquid are placed as shown (refractive index of material of concave lens 1.15). An interference pattern is obtained on screen AB for source S. Distance between images formed by parts of concave lens is X mm and fringe width of pattern formed on the screen is Y mm. (Consider rays passing through parts of the concave lens only, λ for source is 500 nm in liquid and refractive index of material of convex lens is 1.5)



5. The value of X is ………..

6. The value of Y is ………..

Question Stem for Question Nos. 7 and 8

Question Stem

A radioactive nucleus A at rest disintegrates into two nuclei B and C. $\{A \to B + C\}$. Mass of B is 12m and that of C is 4m. The Q-value of the reaction is, $Q = \dfrac{h^2}{24m\lambda^2}$. The energy liberated in reaction is completely imparted to the products (B and C) as kinetic energy.

7. The de Broglie wavelength of B is $\ell\lambda$. Find ℓ.

8. The mass of the nucleus A is $xm + \dfrac{h^2}{ymc^2\lambda^2}$. Find $x + y$

Question Stem for Question Nos. 9 and 10

Question Stem

Consider two radioactive nuclei A and B . Both convert into a stable nucleus C. Nucleus A converts into C after emitting two α - particles and three β -particles . Nucleus B converts into C after emitting one α -particle and five β - particles. At time t =0 , number of nuclei of A are 4N0 and that of B are N0. In the conversion of A into C half life of A is 1 minute and that of B in the conversion of B into C is 2 minute. Initially number of nuclei of C is zero

9. The magnitude of difference between mass number of A and that of B is

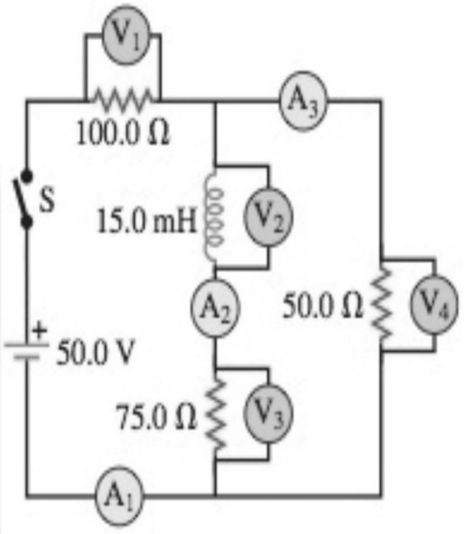
10. If at an instant number of nuclei of A is equal to the number of nuclei of B then at that instant the ratio between number of nuclei of C and number of nuclei of B is

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

11. In the circuit shown in figure, just after switch S is closed, the reading ammeter (in amp) and voltmeter (in V) will be :- (Ammeters and voltmeters are ideal)



A) $A_1 = \frac{1}{3}, A_2 = 0$ and $A_3 = \frac{1}{3}$

B) $A_1 = \frac{5}{13}, A_2 = \frac{2}{13}$ and $A_3 = \frac{3}{13}$

C) $V_1 = \frac{100}{3}, V_3 = 0$

D) $V_2 = \frac{50}{3}, V_4 = \frac{100}{3}$

12. A drum of mass m_1 and radius r_1 rotates freely with initial angular velocity ω_0. A second drum with mass m_2 and radius $r_2 \left(r_2 > r_1\right)$ is mounted on same axle and is at rest although it is free to rotate. A thin layer of sand with mass m is distributed on inner surface of smaller drum. At $t = 0$, small perforations in the inner drum are opened. The sand starts to fly out at a constant rate $\lambda kg / s$ and sticks to the outer drum. Ignore the transit time of the sand. Choose the correct alternatives.

A) Angular speed of outer drum at time is $\frac{\lambda t \omega_0}{m_2 + \lambda t}\left(\frac{r_1}{r_2}\right)^2$

B) Difference in final angular speeds of two drums is 0

C) Difference in final angular speeds of two drums is $\left(\frac{m\left(r_2^2 - r_1^2\right) + m_2 r_2^2}{\left(m + m_2\right) r_2^2}\right)\omega_0$

D) Angular speed of inner drum remains constant

13. A long straight cylindrical shell has inner radius R_i and outer radius R_0. It carries current i, uniformly distributed over its cross-section. A wire is to placed parallel to the cylinder axis, in the hollow region $(r < R_i)$

A) The magnetic field is zero everywhere in hollow region. We conclude that the wire is on the cylinder axis and carries current i in the same direction as current in the shell

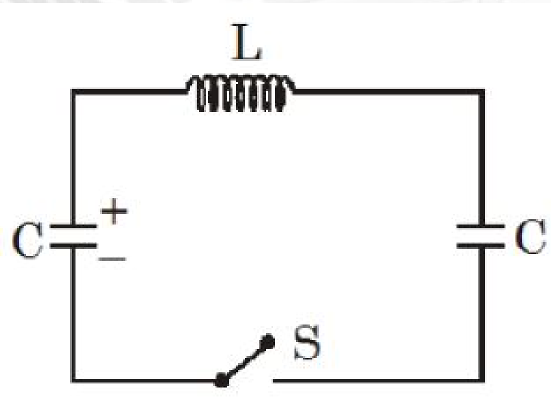
B) The magnetic field is zero everywhere outside the shell $(r > R_0)$.

We conclude that the wire is on the cylinder axis and carries i in the direction opposite to the direction of current in the shell

C) The magnetic field is zero everywhere in the hollow region. We conclude that the wire may be anywhere in the hollow region but must be carrying current i in the same direction as the current in the shell

D) The magnetic field is zero everywhere in the hollow region $(r < R_i)$. We conclude that wire does not carry any current

14. Figure shows an electric circuit with negligibly small active resistance. Initially left capacitor is charged to a potential V_0 and then the switch was closed.



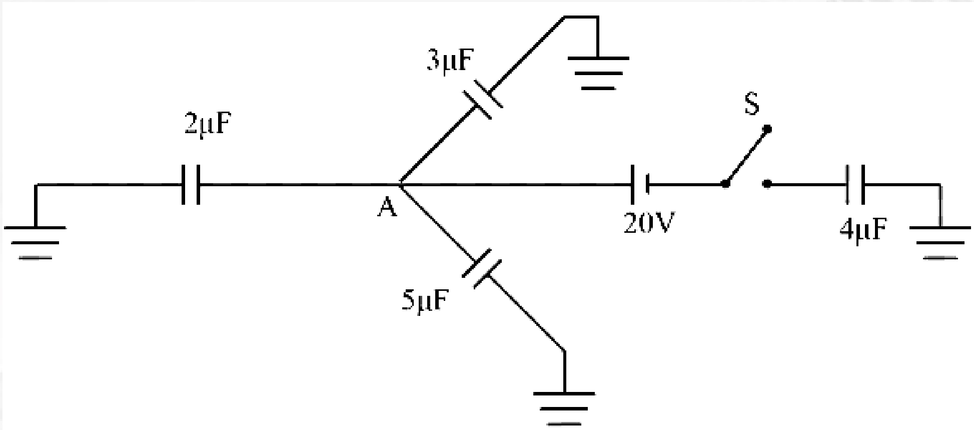
A) Charge on right capacitor is given by $\frac{CV_0}{2}(1-\cos\omega t); \omega = \sqrt{\frac{2}{LC}}$

B) At the instant when charge on capacitor plates have same magnitude, total energy in capacitor and inductor is equal.

C) Maximum current in the circuit has magnitude $V_0\sqrt{\frac{C}{2L}}$

D) Maximum magnitude of induced emf in circuit is V_0

15. Three capacitors of $2\mu F, 3\mu F$ and $5\mu F$ are individually charged with batteries of emf's 5V, 20V and 10V, respectively. After disconnecting from the voltage sources, these capacitors are connected as shown in the figure with their positive polarity plates connected to A and their negative polarity plates being earthed. Now, a battery of 20V and an uncharged capacitor of $4\mu F$ capacitance are connected to the junction A with a switch S, as shown. The switch is closed. Then



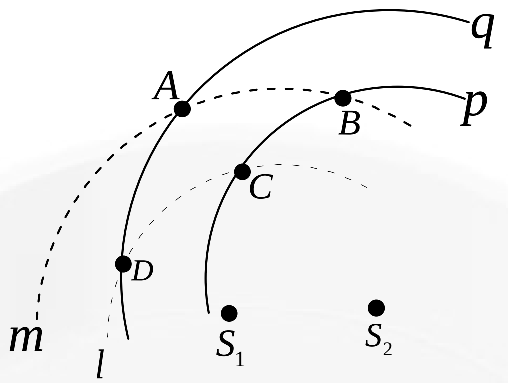
A) the potential of the junction A becomes $(100/7)V$

B) final charges on the capacitance of lowest capacitance is $200\mu F$

C) the total charge flow to the ground after closing the switch is $200\mu C$

D) the charge flow to the ground after closing the switch is zero.

16. In the figure Shown, $S_1 and S_2$ are two identical point sources of sound which are coherent having phase difference 180^0 (out of phase). Taking S_1 as Centre, two circular arcs ℓ *and* m of radii 1m and 2m respectively are drawn. Taking S_2 as center two circular arcs p and q of radii 2m and 4m respectively are drawn. It is given that wavelength of wave produced by each source is 4.0 m. then correct options among the following assuming amplitude of wave on arc 'm' be A due to source S_1 about Out of the four intersection points A, B,C and D is/are



A) At point A intensity of sound of resultant wave must be Zero

B) At point D amplitude of sound of resultant wave is $\frac{\sqrt{17}}{2}A$

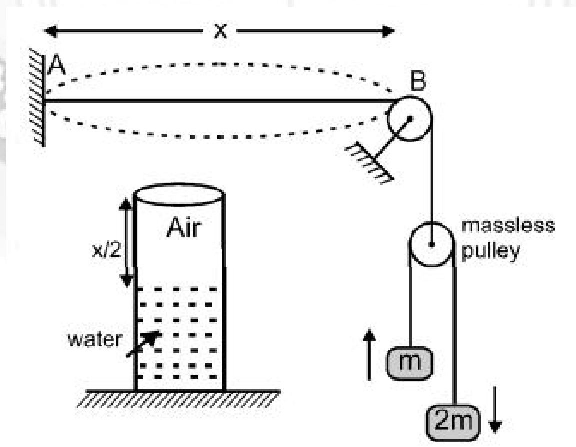
C) At point B amplitude of sound of resultant wave will be $\sqrt{5}A$

D) At point C amplitude of sound of resultant wave is $\sqrt{5}A$

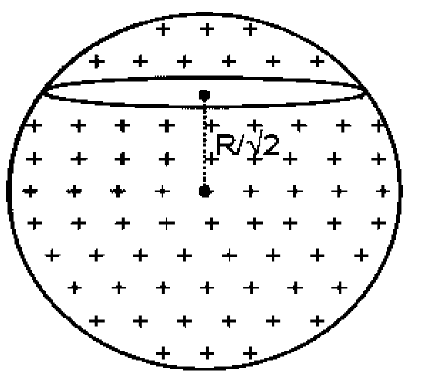
SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

17. Consider the arrangement shown in the figure. A uniform wire (linear mass density 0.2 g/m) vibrating in its fundamental mode is in resonance with air column in a resonance tube vibrating in 1st overtone. The value of m is $\frac{54}{K}$kg. Find the value of k. (Given that speed of sound in air is 400m/s and $g = 10m/s^2$)

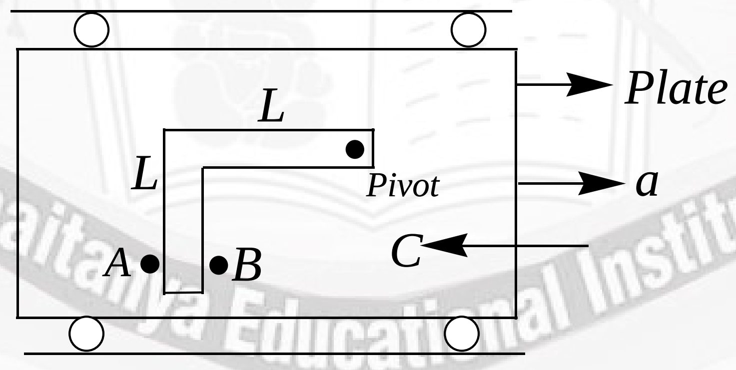


18. A uniform solid non conducting sphere contains uniformly distributed charge Q. Consider the shown section at a perpendicular distance $\frac{R}{\sqrt{2}}$ from centre of the shown uniform solid sphere. Electric flux through the section is $\frac{Q}{k\sqrt{2}\,\varepsilon_0}$.Find the value of k.



Uniform solid sphere
(Total charge = Q, Radius = R)

19. An L shaped thin uniform rod of mass M and total length 2L is freely hinged to vertical plane at C. The bar is prevented from rotating by two pegs A and B fixed to the plate. If the acceleration of plate is given by 'a' $(in\,m/s^2)$ for which no force is exerted on the either peg A or B. Find the value of $\frac{a}{10}$? $\left(g = 10m/s^2\right)$



CHEMISTRY

Max. Marks: 60

SECTION 1

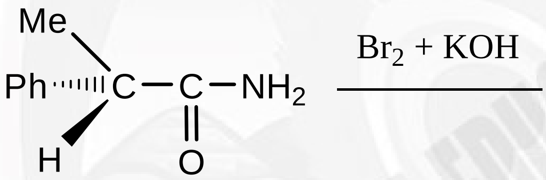
- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : *+3* If ONLY the correct option is chosen;
- *Zero Marks* : *0* If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : *-1* In all other cases.

20. The e.m.f. of the cell reaction $2\ CeCl_{4(aq)} + Zn_{(s)} \longrightarrow 2\ CeCl_{3(aq)} + ZnCl_{2(aq)}$

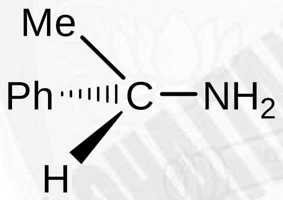
$$\frac{E}{V} = 0.4108 + 0.003\frac{T}{K} \quad V \to Volts\ ; K \to Kelvin$$

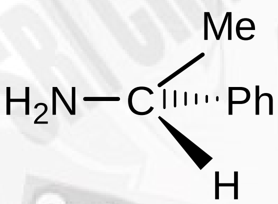
The ΔS for the reaction is (F = 96500 C)

A) 579 JK^{-1} **B)** 289.5 JK^{-1} **C)** 1158 JK^{-1} **D)** 868.5 JK^{-1}

21. 

The product formed is

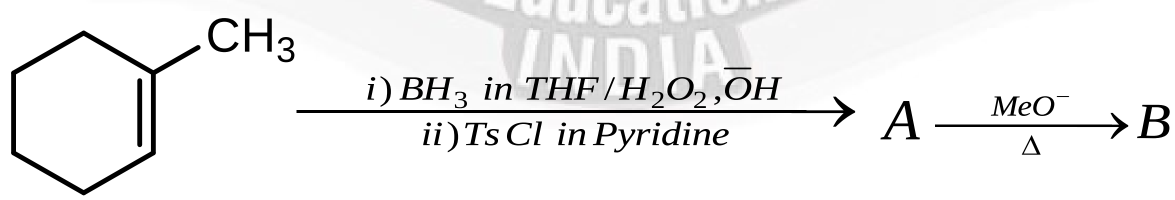
A) 

B) 

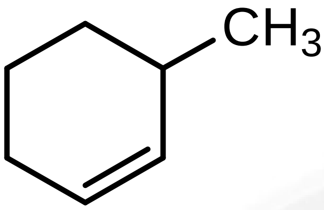
C) completely racemized mixture of (A) & (B)

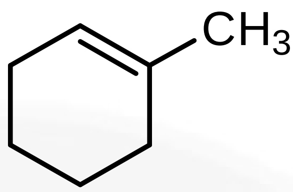
D) Partially racemized mixture of (A) & (B) with predominant (A)

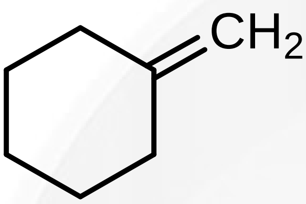
22.

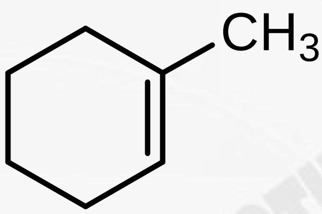


The product B is (major)

A) 

B) 

C) 

D) 

23. The shape of XeO_2F_2 is

A) Tetrahedral
B) Square planar
C) See-saw
D) Irregular tetrahedron

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : **+2** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks*** : **0** In all other cases.

Question Stem for Question Nos. 24 and 25

Question Stem

$100mL$ solution containing $'x'MSO_3^{2-}$ *and* $'y'MS_2O_3^{2-}$ exactly requires $80mL$ of $0.05M\ CrO_4^{2-}$ in alkaline medium for complete oxidation. CrO_4^{2-} reduces to CrO_2^{1-} and the only sulphur containing product formed is SO_4^{2-}. After the completion of reaction, the solution is treated with excess $BaCl_2$ and all the SO_4^{2-} is precipitated as $BaSO_4$. The weight of $BaSO_4$ formed is found to be 0.9336g. (Molecular weight of $BaSO_4$ is 233.4 g/mol)

(Molecular weight of $BaSO_4$ is 233.4 g/mol)

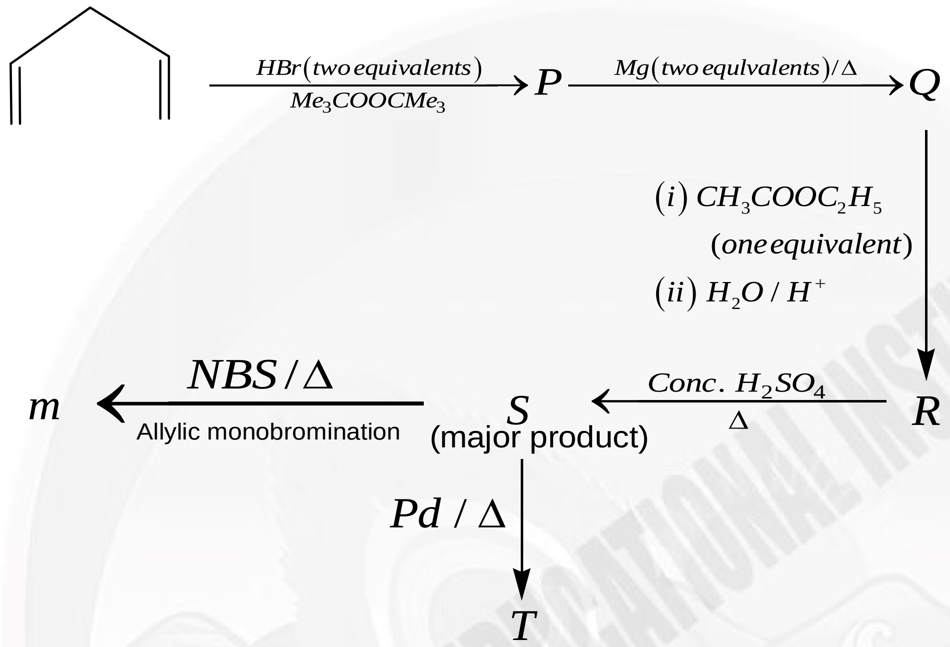
24. The value of $'x'$ is ---------------

25. The value of $'y'$ is --------------

Question Stem for Question Nos. 26 and 27

Question Stem

Consider the following scheme of reactions



'm' is total number of products including stereoisomers

26. The value of '*m*' is ------------------------

27. 0.48g of liquid 'T' when completely combusted in a bomb calorimeter, the rise in temperature of calorimeter system is found to be $0.6°C$. Thermal heat capacity of calorimeter including its contents is $8K.Cal/°C$. The standard molar enthalpy of combustion of liquid 'T' at $27°C$ is $'-xK.Cal.'$ The value of 'x' is _____

(Take molar gas constant, $R = 2.0\ cal\ K^{-1}mol^{-1}$)

Question Stem for Question Nos. 28 and 29

Question Stem

'TRIS' buffer which is a mixture of a primary amine, $(CH_2OH)_3CNH_2$ and its salt, $(CH_2OH)_3CNH_3^+Cl^-$ has found extensive use in clinical chemistry. For the preparation of 500 mL 0.5M 'TRIS' buffer of $pH = 7.4$, '*x*' grams of solid amine and '*v*' mL of $1.0\ M\ HCl$ is required.

[Given that, pK_a of $(CH_2OH)_3CNH_3^+Cl^- = 8.0$, $\log 2 = 0.30$, $pK_w = 14$

Molecular weight of $(CH_2OH)_3CNH_2 = 121g/mol$]

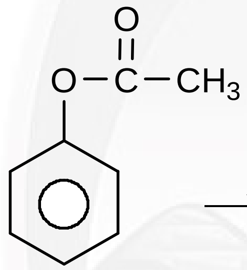
28. The value of '*x*' is -------------

29. The value of '*v*' *is* -----------

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

30.  $\xrightarrow[CS_2, 100^0 C]{AlCl_3(anhydrous)} \underset{major}{A} + \underset{minor}{B}$

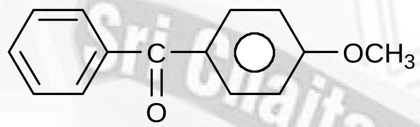
Which of the following statement(s) are true?

A) Reaction involves the attack of acylium carbocation at ortho and para positions of benzene ring

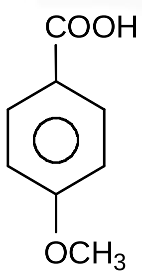
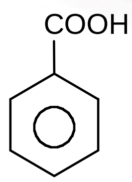
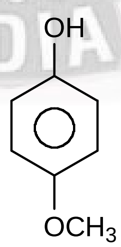
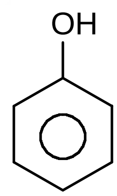
B) Products A & B gives violet colour with $FeCl_3$

C) A & B mixture can be separated by steam distillation in which A is collected as distillate

D) A & B mixture can be separated by steam distillation in which B is collected as distillate

31.  $\xrightarrow[(ii) H_3O^+/\Delta]{(i) F_3CCO_3H}$

The major products formed in this reaction are

A)  **B)**  **C)**  **D)** 

32. Pick out correct statement(s) regarding non-stochiometric Zinc Oxide.

A) It is yellow in colour

B) It exhibits n-type semi-conduction due to presence of electrons in interstials

C) When heated in dioxygen and then cooled to room temperature its conductivity increases

D) When heated in dioxygen and then cooled to room temperature its conductivity decreases

33. Setting of plaster of paris involves two stages i.e., setting stage & hardening stage. Which of the following are true regarding setting of plaster of paris?

A) Setting stage is a hydration process in which monoclinic form of gypsum is formed

B) Setting stage is a hydration process in which orthorhombic form of gypsum is formed

C) Hardening stage is a crystalline change in which monoclinic gypsum convert into orthorhombic gypsum

D) Hardening state is a crystalline change in which orthorhombic gypsum convert into monoclinic gypsum

34. Pick out correct statement(s) regarding oxyanions

$SiO_4^{4-}(P), PO_4^{3-}(Q), SO_4^{2-}(R) \& ClO_4^{1-}(S)$

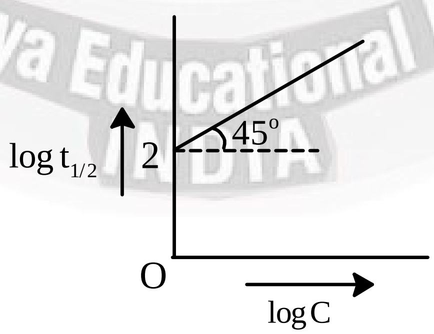
A) All four ions are tetrahedral in shape

B) Polymerization tendency is in the order $P > Q > R > S$

C) $p\pi$ - $d\pi$ bond strength is in the order $P < Q < R < S$

D) $p\pi$ - $d\pi$ bond strength is in the order $P > Q > R > S$

35. For the reaction $P \rightarrow Q$ $\log t_{1/2}$ $\underset{\cdot\cdot}{\underline{vs}}$ $\log C$ ($C \rightarrow$ is initial conc. of P) is given below.



Which of the following statement(s) is / are correct for above reaction?

A) Reaction follows Zero order kinetics

B) Reaction follows Second order kinetics

C) The rate constant for the reaction is $5\times10^{-3}Ms^{-1}$

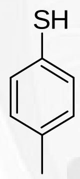
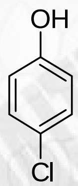
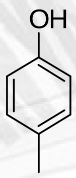
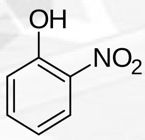
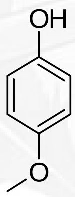
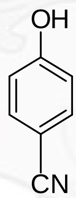
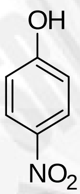
D) The rate constant for the reaction is $10^{-2}M^{-1}S^{-1}$

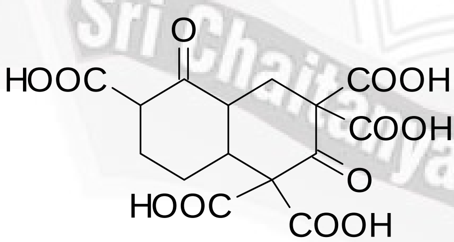
SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

36. Among SO_3, SO_2, Cl_2O, H_2O, SF_4, ClO_3^-, NO_3^-, CO_3^{2-}, XeF_4, XeO_3, XeO_4, & NH_4^+, how many species contain sp^3 hybridized central atom?

37. How many of the following compounds are more acidic than phenol?

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. H_2CO_3

38. 

The number of moles of CO_2 liberated on heating one mole of above compound is ____________

MATHEMATICS

Max. Marks: 60

SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks : +3* If ONLY the correct option is chosen;
- *Zero Marks : 0* If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks : -1* In all other cases.

39. Given four unit vectors $\vec{a},\vec{b},\vec{c}$ and $\vec{d}$. The vectors $\vec{a},\vec{b}$,and $\vec{c}$ are coplanar but not collinear pair by pair and vector $\vec{d}$ is not coplanar with vectors $\vec{a},\vec{b}$ and $\vec{c}$ and

$\left(\vec{a},\vec{b}\right)=\left(\vec{b},\vec{c}\right)=\frac{\pi}{3},\left(\vec{d},\vec{a}\right)=\alpha$ and $\left(\vec{d},\vec{b}\right)=\beta$, *if* $\left(\vec{d},\vec{c}\right)=\cos^{-1}\left(m\cos\beta+n\cos\alpha\right)$ then

$|m-n|$ is:

($\left(\vec{x},\vec{y}\right)=\theta$ represents the angle between the vector between $\vec{x}$ and $\vec{y}$ is θ)

A) 2 **B)** 0 **C)** 1 **D)** 4

40. $L=2\sum_{n=1}^{\infty}2^n\sin^2\left(\frac{\pi}{2^{n+1}}\right)\tan\left(\frac{\pi}{2^{n+2}}\right)=$

A) 1 **B)** 2π **C)** π **D)** $\pi-2$

41. Real numbers x,y,z satisfy $x+xy+xyz=1, y+yz+xyz=2$, $z+xz+xyz=4$. The largest possible value of xyz is $\frac{a+b\sqrt{c}}{d}$, where a,b,c,d are integers, d is positive, c is square-free, and $\gcd(a,b,d)=1$. Then $1000a+100b+10c+d$.

A) 5172 **B)** 5179 **C)** 5072 **D)** 5272

42. There is exactly one real $x\in(0,\pi/2)$ such that

$\left(\tan^2\frac{x}{2}\right)\left(\cot^4x+1\right)\left(\operatorname{cosec}^2x+\tan^2x\right)=1$ Find the positive integer k such that

$\cos^{2022}x=\sin^k x.$

A) 2023 **B)** 4044 **C)** 2696 **D)** 1011

SECTION 2

- This section contains **THREE (03)** questions stems.

- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks: 0*** In all other cases.

Question Stem for Question Nos. 43 and 44

Question Stem

Let A be matrix of order 3×3 with real entries and satisfying the condition

$$A^{2019}+A=\begin{pmatrix}2&2&0\\0&2&2\\0&0&2\end{pmatrix} \text{ then}$$

43. $2019\ tr(A)$ is ($tr(A)$ is sum the elements in the principal diagonal)

44. $4\det(A)$ is

Question Stem for Question Nos. 45 and 46

Question Stem

Let A,B,C be three points on the Argand plane represented by the complex numbers z_1,z_2,z_3 respectively and satisfy following conditions

(1) $z_1\neq z_2\neq z_3$

(2) $|z_1|=|z_2|=|z_3|=1$

(3) $\arg(z_1)=\alpha,\ \arg(z_2)=\beta,\ \arg(z_3)=\gamma$.

If $z_1z_2(z_1+z_2)+z_2z_3(z_2+z_3)+z_3z_1(z_3+z_1)+2z_1z_2z_3=0$ Then

45. $|\cos(\alpha-\beta)+\cos(\beta-\gamma)+\cos(\gamma-\alpha)|=$

46. $\underset{cyc}{\pi}\left(AB^2+AC^2-BC^2\right)=$

Question Stem for Question Nos. 47 and 48

Question Stem

Let L_1 *and* L_2 be the following straight lines.

$L_1 : \frac{x-1}{1} = \frac{y}{-1} = \frac{z-1}{3}$ *and* $L_2 : \frac{x-1}{-3} = \frac{y}{-1} = \frac{z-1}{1}$. Suppose the straight line $L : \frac{x-\alpha}{l} = \frac{y-1}{m} = \frac{z-\gamma}{-2}$ lies in the plane containing L_1 *and* L_2 and passes through the point of intersection of L_1 *and* L_2. If the line L bisects the acute angle between the lines L_1 *and* L_2, then

47. $\alpha - \gamma =$

48. $l\alpha - m\gamma =$

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks*** : ***+3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks*** : ***+2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks*** : ***+1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks*** : ***0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

49. For 0<t<1, let $F_n(t) = \frac{1}{2t}\int_0^1 \left|x^n - t\right| dx + \frac{1}{2}$ and let a_n be the least value of $F_n(t)$ *for* $0 < t < 1$, *then*

A) $F_n(t) = \frac{n}{(n+1)}\left[\frac{1}{t} + 2nt^{1/n}\right]$ **B)** $a_n = 2^{\left(\frac{-1}{n+1}\right)}$

C) $\lim_{n\to\infty}(a_n a_{n+1} \dots a_{2n-1}) = 2^{\log_e 2}$ **D)** $\lim_{n\to\infty} F_n(t) = 1$

50. $A(\alpha)$ denotes the area of the region bounded by $x=0,\ x=2,\ y^2 = 4x$ and $y = |\alpha x - 1| + |\alpha x - 2| + \alpha x$ then the value of $A(\alpha) + \frac{8\sqrt{2}}{3}$ is

A) 5 When $\alpha = 1$ **B)** 10 When $\alpha = 1$

C) 6 When $\alpha = 0$ **D)** 12 When $\alpha = 0$

51. Let T be the line passing through the points $P(-2,7)$ and $Q(2,-5)$. Let F_1 be the set of all pairs of circles (S_1, S_2) such that T is tangent to S_1 at P and tangent to S_2 at Q, and also that S_1 and S_2 touch each other at a point, say M. Let E_1 be the set representing the locus of M as the pair (S_1, S_2) varies in F_1. Let the set of all straight line segments joining a pair of distinct points of E_1 and passing through the point $R(1,1)$ be F_2. Let E_2 be the set of the midpoints of the line segments in the set F_2. Then, which of the following statement(s) is (are) TRUE?

A) The point $(-2,7)$ lies in E_1 **B)** The point $\left(\frac{4}{5}, \frac{7}{5}\right)$ Does NOT lie in E_2

C) The point $\left(\frac{1}{2}, 1\right)$ lies in E_2 **D)** The point $\left(0, \frac{3}{2}\right)$ Does NOT lie in E_1

52. A triangle with vertices P(2,5),Q(5,2) and R(-1,-1) is inscribed in the rectangular hyperbola xy-x-y-3=0 and let $H = (\lambda, \lambda)$ is orthocenter of triangle PQR, let A,B and C be the feet of perpendicular from P, Q and R on the sides $\overline{QR}$, $\overline{RP}$ and $\overline{PQ}$ respectively and r is inradius of triangle ABC, then

A) Circumcentre of ΔPQR is $\left(-\frac{3}{2}, -\frac{3}{2}\right)$ **B)** incenter of ΔABC is (3,3)

C) Equation of AB is $x + y - \frac{26}{5} = 0$ **D)** $r = \frac{2\sqrt{2}}{5}$

53. Let $S_1 = \left\{x \in [0, 2\pi] : 1 + 2\cos x \cos 2x \cos 5x = \cos^2 x + \cos^2 2x + \cos^2 5x\right\}$

$$S_2 = \left\{x \in (0, 2\pi) : \sin x + \cos x + \tan x + \cot x + \frac{1}{2}(\sec x + \operatorname{cosec} x) = 2\left(\sqrt{2} + 1\right)\right\}$$

$$S_3 = \left\{x \in R : \left(\sin^{-1}[x]\right)\left(\cos^{-1}[x]\right) = \frac{\pi x}{2} - x^2, \ where\ [.] is\ G.I.F\right\}.$$

$n(S)$ denotes the number of elements in S

The which of the following is (are) TRUE

A) $n(S_1) = 13$

B) $S_3 \subset S_2$

C) $S_1 \Delta S_2 = S_1 \Delta S_3$ $\quad (A \Delta B = (A \cup B) - (A \cap B))$

D) $n(S_2 \cup S_3) = 3$

54. Let $f(x)$ be a continuous function defined for every real $x \in R$. For any real numbers 'a' and 'b' that satisfy a < b, $f(x)$ always satisfies $f(a) > f(b)$. Then which of the following is/are correct ?

A) $\lim\limits_{h \to 0} \dfrac{f(2+h) - f(2)}{h}$ exists and negative.

B) There is always only one root of $f(x) = 0$

C) There is always only one root of $f(x) = f(-x+1)$

D) There is no real of $f(x) = f(x+1)$

SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

55. Let the Mean and the variance of 5 observations x_1, x_2, x_3, x_4, x_5 be $\dfrac{24}{5}$ *and* $\dfrac{194}{25}$ respectively. If the mean and variance of the first 4 observations are $\dfrac{7}{2}$ and a respectively, then $(4a + x_5) - 7$ is equal to

56. n is a natural number,

$\cos^4\left(\dfrac{\pi}{2n+1}\right) + \cos^4\left(\dfrac{2\pi}{2n+1}\right) + \cos^4\left(\dfrac{3\pi}{2n+1}\right) + ... + \cos^4\left(\dfrac{n\pi}{2n+1}\right) = \dfrac{55}{16}$ then the largest prime factor of n is

57. For any finite set X, let $|X|$ denote the number of elements in X. Define $S_n = \sum |A \cap B|$, where the sum is taken over all ordered pairs (A, B) such that A and B are subsets of $\{1, 2, 3, ..., n\}$ with $|A| = |B|$.

(For example, $S_2 = 4$ because the sum is taken over the pairs of subsets

$(A, B) \in \{(0,0), (\{1\},\{1\})(\{1\},\{2\}), (\{2\},\{1\}), (\{2\},\{2\}), (\{1,2\},\{1,2\})\}$,

$\Rightarrow S_2 = 0+1+0+0+1+2 = 4$.) Then $S_3 - 10 =$


Sri Chaitanya Educational Institutions
Infinity Learn
38
Our Students Conquer JEE Main 2023
29 out of 100 Ranks
ALL INDIA OPEN CATEGORY
PERFECT SCORE 300/300
1st RANK
SINGARAJU VENKAT KOUNDINYA
Appl. No.: 230310124339
CLASSROOM STUDENT FROM GRADE I - XII
10th Rank
KALLAKURI SAINADH SRIMANTH
Appl. No.: 230310286801
CLASSROOM STUDENT FROM GRADE I - XII
SRI CHAITANYA SCHOOL TECHNO CURRICULUM
Turning their IIT dream into reality!
12 RANK D PRATAP SINGH APPL. NO. 230310167803 (DLP)
15 RANK V CHIDVILAS REDDY APPL. NO. 230310481885
16 RANK B ABHINAV APPL. NO. 230310146952
20 RANK RAGHAV GOEL 3 Year Classroom Program
24 RANK G ABHIRAM APPL. NO. 230310180674
26 RANK SOHAM DAS APPL. NO. 230310332864 (DLP)
27 RANK P G KOUSIK REDDY APPL. NO. 230310129610
28 RANK R SURYA THEJA APPL. NO. 230310127660
34 RANK MAYANK SONI APPL. NO. 230310210909 (DLP)
39 RANK APURVA SAMOTA APPL. NO. 230310376645 (DLP)
42 RANK N D TEJA REDDY APPL. NO. 230310542321
43 RANK D VENKATA YUGESH APPL. NO. 230310434666
44 RANK THOTA RITHVIK APPL. NO. 230310331093
47 RANK N MOHITH SAI APPL. NO. 230310079263
51 RANK A LEKHASREE APPL. NO. 230310143426
53 RANK ANIRUDDH K APPL. NO. 230310157626
63 RANK MALPANI TUSHAR APPL. NO. 230310246220
68 RANK M DATHA RISHYANTH APPL. NO. 230310691307
70 RANK M AVINASH KUMAR APPL. NO. 230310560186
74 RANK SHAIK SAHIL CHANDA APPL. NO. 230310121837
77 RANK D PANEENDRA NADHA APPL. NO. 230310072859
78 RANK M PRANATHI SREEJA APPL. NO. 230310108777
83 RANK MANOJ KUMAR A APPL. NO. 230310506920
86 RANK M SREEKANTH APPL. NO. 230310176875
88 RANK GUNDA SUSHANTH APPL. NO. 230310281475
97 RANK P P KUMAR REDDY APPL. NO. 230310182687
99 RANK D LATHIK ABHINAY APPL. NO. 230310333578
Below 100 All India Open Category Ranks 29 Ranks
Below 1000 All India Open Category Ranks 149 Ranks
Below 100 All Category Ranks Count 91 Ranks
Below 1000 All Category Ranks Count 653 Ranks
Total Qualified Ranks for JEE Advanced-2023
18736
srichaitanya.net
040 66 15 15 15

37 Years of Excellence 1986-2022
Sri Chaitanya Educational Institutions
Infinity Learn
ALWAYS NO. 1
Formula Of Success Perfected At Sri Chaitanya
JEE ADVANCED 2022
Today's JEE ADVANCED Top Rankers = Tomorrow's Glorious Engineers
ALL INDIA RANKS
RANK 1
DAYYALA JOHN JOSEPH
H.T.NO: 6036441
RANK 2
MENDA HIMA VAMSI
H.T.NO: 6038250
SRI CHAITANYA TECHNO SCHOOL
RANK 3
PALLI JALAJAKSHI
H.T.NO: 6039005
SRI CHAITANYA TECHNO SCHOOL
RANK 5
KAJJAYAM VARUN GUPTHA
H.T.NO: 6037016
SRI CHAITANYA TECHNO SCHOOL
RANK 6
POLISETTY KARTHIKEYA
H.T.NO: 6038078
All India Open Category Ranks Below 100
14 RANK P RAVIKISHORE H.T.NO. 6037002
19 RANK MRINAL GARG H.T.NO. 7017231
21 RANK HARSH KUMAR H.T.NO. 2021562 (DLP)
22 RANK MENDA HIMA VAMSI H.T.NO. 6038250 TECHNO SCHOOL
23 RANK J Y VIJAY VENKATA SAI H.T.NO. 6089322
24 RANK PALLI JALAJAKSHI H.T.NO. 6039005 TECHNO SCHOOL
25 RANK KAVYA GUPTA H.T.NO. 2070337 (DLP)
30 RANK GEET SINGHI H.T.NO. 2044357 (DLP)
34 RANK N SAI DEEPTHIKA H.T.NO. 6039222 TECHNO SCHOOL
35 RANK SANSKAR SHAURYA H.T.NO. 2070283 (DLP)
38 RANK GOURISH GARG H.T.NO. 7018056
42 RANK CHINMAY KHOKAR H.T.NO. 7018036
50 RANK ANIRUDH GARG H.T.NO. 7017347
53 RANK B S N VENKATA ADITYA H.T.NO. 6100252 TECHNO SCHOOL
58 RANK KANISHK SHARMA H.T.NO. 4033132 (DLP)
60 RANK NIVESH AGGARWAL H.T.NO. 7017291
62 RANK K VARUN GUPTHA H.T.NO. 6037016 TECHNO SCHOOL
63 RANK GANDU HARIDEEP H.T.NO. 6041275
73 RANK D JOHN JOSEPH H.T.NO. 6036441
78 RANK NAMAN GOYAL H.T.NO. 7017489
87 RANK J SAI CHARITHA H.T.NO. 6040186 TECHNO SCHOOL
93 RANK SINGH SIDDHARTHA H.T.NO. 1030435 TECHNO SCHOOL
95 RANK R RUSHIKESH H.T.NO. 6040165 TECHNO SCHOOL
96 RANK KUSHAGAR GARG H.T.NO. 7016091
98 RANK D SARANYA H.T.NO. 6041281 TECHNO SCHOOL
Below 100 All India Open Category Ranks 26 Ranks
Below 1000 All India Open Category Ranks 124 Ranks
Below 100 All India Category Ranks 89 Ranks
Below 1000 All India All Category Ranks 581 Ranks
DLP - DISTANCE LEARNING PROGRAMME
TG ~ @bohring_bot
Congratulations Students! You make us proud!

Sri Chaitanya IIT Academy.,India.

A.P T.S KARNATAKA TAMILNADU MAHARASTRA DELHI RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S JEE-ADVANCE-2021_P1 Date: 19-05-2023

Time: 09.00Am to 12.00Pm GTA-25 Max. Marks: 180

KEY SHEET

PHYSICS

1	C	2	C	3	C	4	C	5	3.41 to 3.68	6	0.16 to 0.18
7	2.00	8	40.00	9	4	10	18	11	A,C	12	A,C,D
13	B,D	14	A,B,C,D	15	A,D	16	B,D	17	5	18	8
19	3										

CHEMISTRY

20	A	21	A	22	A	23	C	24	0.02	25	0.01
26	9	27	921.20	28	30.25	29	200	30	A,B,C	31	B,C
32	A,B,D	33	B,D	34	A,B,C	35	A,C	36	6	37	6
38	5										

MATHEMATICS

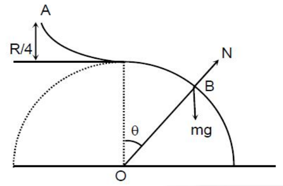
39	A	40	D	41	D	42	C	43	6057	44	4
45	1	46	0	47	3	48	3	49	B,D	50	A,C
51	B,D	52	B,C,D	53	A,D	54	C,D	55	8	56	5
57	8										

SOLUTIONS

PHYSICS

1.

Conserving energy between points A and B, $mg\left[\frac{R}{4}+R(1-\cos\theta)\right]=\frac{1}{2}mv^2$



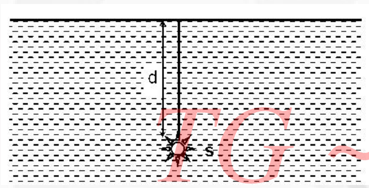
Also at point B, N = 0 So, $mg\cos\theta=\frac{mv^2}{R}$

$\frac{1}{4}+(1-\cos\theta)=\frac{1}{2}\cos\theta \quad \frac{5}{4}=\frac{3}{2}\cos\theta \quad \cos\theta=\frac{5}{6}$

2.

$C=C_V+\frac{dW}{ndT}, \int dW=\int_{T_0}^{3T_0}\alpha T dT-\int_{T_0}^{3T_0}\frac{5R}{2}dT$ for one mole $W=(4\alpha T_0-5R)T_0$

3.



$f=\frac{2\pi(1-\cos\theta_c)}{4\pi} \quad f=\frac{2\pi}{4\pi}\left[1-\sqrt{1-\frac{1}{\mu^2}}\right]=\frac{1}{2}\left[1-\sqrt{1-\frac{1}{\mu^2}}\right]$

4.

$E2\pi r=\frac{dB}{dt}(B\pi r^2) \quad E=\frac{r}{2}\frac{dB}{dt}$

$d\tau=(2\pi r dr)\sigma.E.r \quad \tau=\int d\tau=\int\frac{r}{2}\frac{dB}{dt}(2\pi r dr)\sigma.r$

5.

$\frac{1.2}{V_1}-\frac{1}{-40}=\frac{1.5-1}{20}+\frac{1.2-1.5}{-24}, \frac{1.2}{V_1}=\frac{1}{40}+\frac{3}{240}-\frac{1}{40} \quad V_1=96cm$

For concave lens

$\frac{1}{V_2}-\frac{1}{46}=-\frac{1}{20}, \frac{1}{V_2}=-\frac{1}{20}+\frac{1}{46}, V_2=-\frac{460}{13}cm$

$\frac{h_i}{h_0}=\frac{\frac{460}{13}}{46}, \; h_i=-\frac{10}{13}=0.769mm$

6.

Distance between image formed by L_1 *and* $L_2=3.4mm \; \beta=\frac{\lambda D}{d}$

7.

$Q=\frac{h^2}{24m\lambda^2}=K_B+K_C$

Where K is the kinetic energy from conservation of linear momentum

$$\left|\overrightarrow{P_C}\right| = \left|\overrightarrow{P_B}\right| = P \because K = \frac{P^2}{2m} \therefore Q = \frac{P^2}{2\times 12m} + \frac{P^2}{2\times 4m}$$

$$\frac{h^2}{12m\lambda^2} = \frac{P^2}{2}\left(\frac{1}{12m}+\frac{1}{4m}\right) \frac{h^2}{12m\lambda^2} = P^2\left(\frac{1+3}{12m}\right) = \frac{P^2}{3m}$$

$$\Rightarrow P^2 = \frac{h^2\times 3m}{12m\lambda^2} \Rightarrow P = \frac{h}{2\lambda}$$

$$\Rightarrow \frac{h}{P} = 2\lambda = \text{de Broglie wavelength} \because \left|\overrightarrow{P_B}\right| = \left|\overrightarrow{P_C}\right|$$

$$\text{Mass defect}, \Delta m = \frac{Q}{C^2} = \frac{h^2}{24mc^2\lambda^2} \therefore m_A = 16m + \frac{h^2}{24mc^2\lambda^2}$$

8.

$$Q = \frac{h^2}{24m\lambda^2} = K_B + K_C$$

Where K is the kinetic energy from conservation of linear momentum

$$\left|\overrightarrow{P_C}\right| = \left|\overrightarrow{P_B}\right| = P \because K = \frac{P^2}{2m} \therefore Q = \frac{P^2}{2\times 12m} + \frac{P^2}{2\times 4m} \frac{h^2}{12m\lambda^2} = \frac{P^2}{2}\left(\frac{1}{12m}+\frac{1}{4m}\right)$$

$$\frac{h^2}{12m\lambda^2} = P^2\left(\frac{1+3}{12m}\right) = \frac{P^2}{3m} \Rightarrow P^2 = \frac{h^2\times 3m}{12m\lambda^2} \Rightarrow P = \frac{h}{2\lambda}$$

$$\Rightarrow \frac{h}{P} = 2\lambda = \text{de Broglie wavelength} \because \left|\overrightarrow{P_B}\right| = \left|\overrightarrow{P_C}\right|$$

$$\text{Mass defect}, \Delta m = \frac{Q}{C^2} = \frac{h^2}{24mc^2\lambda^2} \therefore m_A = 16m + \frac{h^2}{24mc^2\lambda^2}$$

9.

$$^{A_1}_{Z_1} \xrightarrow{2\alpha} {}^{A_1-8}_{Z_1-4}A \xrightarrow{3\beta} {}^{A_1-8}_{Z_1-1}A$$

$$^{A_2}_{Z_2}B \xrightarrow{1\alpha} {}^{A_1-4}_{Z_1-2}B \xrightarrow{5\beta} {}^{A_2-4}_{Z_2+3}B$$

A: Given $Z_2 + 3 = Z_1 - 1$

$Z_1 - Z_2 = 4$

B:Given $A_1 - 8 = A_2 - 4 \Rightarrow A_1 - A_2 = 4$

C:D: $N_A = N_B$

$4N_0e^{-\lambda_2 t}$

Find t and $N_B : N_C$

10.

$$^{A_1}_{Z_1} \xrightarrow{2\alpha} {}^{A_1-8}_{Z_1-4}A \xrightarrow{3\beta} {}^{A_1-8}_{Z_1-1}A$$

$$^{A_2}_{Z_2}B \xrightarrow{1\alpha} {}^{A_1-4}_{Z_1-2}B \xrightarrow{5\beta} {}^{A_2-4}_{Z_2+3}B$$

A: Given $Z_2 + 3 = Z_1 - 1$

$Z_1 - Z_2 = 4$

B:Given $A_1 - 8 = A_2 - 4 \Rightarrow A_1 - A_2 = 4$

C:D: $N_A = N_B$

$4N_0 e^{-\lambda_2 t}$

Find t and $N_B : N_C$

11. At t = 0, Inductor behaves as open circuit.

So, $A_1 = A_3 = \frac{50}{100+50} + \frac{1}{3}$ & $A_2 = 0$

$V_1 = 100\left(\frac{1}{3}\right), V_2 = V_4 = 50\left(\frac{1}{3}\right)$

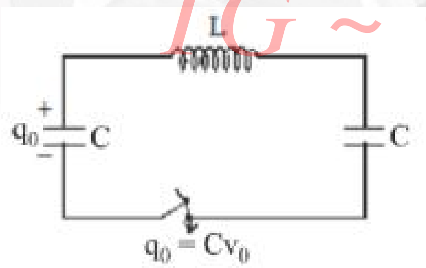
12. As the sand leaves the inner drum through the open holes, it does not exert any force of the drum, angular momentum remains conserved.

At time t, $m_1 r_1^2 \omega_0 = (m_1 - \lambda t) r_1^2 \omega_0 + (m_2 + \lambda t) r_2^2 \omega_2 \quad \omega_2 = \frac{\lambda t r_1^2 \omega_0}{(m_2 + \lambda t) r_2^2}$

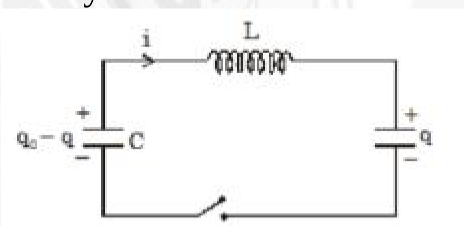
The speed of inner drum does not change.

13. Use Ampere's circuital law.

14. At $t = 0$



At any time t



Loop equation at $t = \frac{q_0 - q}{C} - L\frac{di}{dt} - \frac{q}{C} = 0$

$$\Rightarrow L\frac{di}{dt} = \left(\frac{q_0}{C} - \frac{2q}{C}\right) \Rightarrow \frac{d^2q}{dt^2} = \frac{2}{LC}\left(q - \frac{q_0}{C}\right)$$

Above equation of SHM with $\omega = \sqrt{\frac{2}{LC}}$

And solution of this equation will be

$$q - \frac{q_0}{2} = -\frac{q_0}{2}\cos\omega t \{As\ at - 0, q - 0]$$

$$\Rightarrow q = \frac{q_0}{2}(1 - \cos\omega t) \qquad i = \frac{q_0\omega}{2}\sin\omega t$$

$i_{max} = \frac{q_0\omega}{2} = V_0\sqrt{\frac{C}{2L}}$ $\varepsilon = \frac{d\phi}{dt} = -L\frac{di}{dt} = \frac{q_0\omega^2 L}{2}\cos\omega t$ $\varepsilon_{max} = \frac{q_0\omega^2 L}{2} = V_0$

Energy stored in inductor = Initial energy in capacitor- Final energy in capacitors

$$= \frac{1}{2}\frac{q_0^2}{C} = -\left(\frac{1}{2}\frac{(q_0/2)^2}{C}\times 2\right) = \frac{1}{4}\frac{q_0^2}{C}$$

15. Total charge on the three pates connected to A is $= 2\times5 + 3\times20 + 5\times10 = 12\mu C$.

After closing the switch, the sum of charges on the plates shown inside box is still zero.

Let potential of point A be V_0

Charge on $2\mu F$ capacitor $= 2V_0$

Charge on $3\mu F$ capacitor $= 3V_0$

Charge on $5\mu F$ capacitor$= = 5V_0$

Charge on $4\mu F$ capacitor $= = 4(V_0 - 20)$

$$2V_0 + 3V_0 + 5V_0 + 4(V_0 - 20)120\ Or, V_0 = \frac{200}{14} = \frac{100}{7}V$$

Charge on $2\mu F$ capacitor is $= 2V_0 = \frac{200}{7}\mu C$

Sum of chare on the plates of the capacitors facing A has not changed. Therefore, sum of charge on the 4 plates connected to the ground is still $-120\mu C$. The total charge flow to the ground is zero.

16. Let amplitude of wave on arc m and p be a due to individual sources

Amplitude on arc ℓ due to $S_1 = 2a$

Amplitude on arc q due to $S_2 = \frac{a}{2}$

At point $A: \Delta\phi = \frac{2\pi}{\lambda}\Delta x + \pi = \frac{2\pi}{4}(2) + \pi = 2\pi$

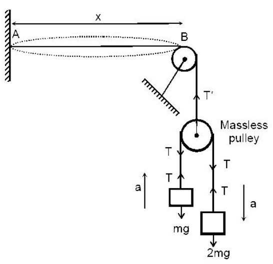
$$\therefore a_A = \sqrt{a^2 + \left(\frac{a}{2}\right)^2 + 2.a.\frac{a}{2}.\cos 2\pi} = \frac{\sqrt{5}}{2}a$$

At $B; \Delta\phi = \pi\,[\because \textit{no pathdifference}]\ \therefore a_B = 0$

$At C;\ \Delta\phi = \frac{2\pi}{4}(1) + \pi = \frac{3\pi}{2}$

At $D: \Delta\phi = \frac{2\pi}{4}(3) + \pi = \frac{3\pi}{2} + \pi = \frac{5\pi}{2}$

17.



Consider FBD of blocks. For mass m, using F = ma, we get T - mg = ma …(i)
Similarly for mass 2m, we get
2mg -T = 2ma ...(ii)
From Equation (i) and (ii)

$$T = \frac{4mg}{3} \qquad ....(iii)$$

From FBD of pulley, $T' = 2T = \frac{8mg}{3}$

Therefore, frequency of vibration of wire in fundamental mode,

$$f_1 = \frac{1}{2l}\sqrt{\frac{T'}{\mu}} = \frac{1}{2X}\sqrt{\frac{8mg}{3\mu}}$$

Also, frequency of vibration of air in 1st overtone (3rd harmonic)

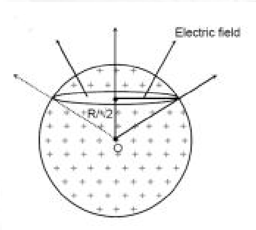
$$f_2 = \frac{3v}{4l} = \frac{3v}{4\frac{X}{2}} = \frac{3v}{2X}$$

As, resonance implies frequencies are equal

i.e., $f_1 = f_2 \Rightarrow \frac{1}{2X}\sqrt{\frac{8mg}{3\mu}} = \frac{3v}{2X}$ [using Eq.(v) and (vi)]

$$\Rightarrow m = \frac{27\mu v^2}{8g} = \frac{27(0.2\times10^{-3})(400)^2}{8\times10} = \frac{54}{5}kg$$

18. Let's construct a cone as shown. By field picture, ϕ through lateral surface zero.



$$\Rightarrow \phi_{section} = \phi_{cone} = \frac{q_{inside}}{\varepsilon_0} = \frac{\rho.\frac{1}{3}\pi\left(\frac{R}{\sqrt{2}}\right)}{\varepsilon_0}$$

$$= \frac{\left(\frac{Q}{\frac{4}{3}\pi R^3}\right).\left(\frac{1}{3}\pi\frac{R^3}{2\sqrt{2}}\right)}{\varepsilon_0} = \frac{Q}{8\sqrt{2}\varepsilon_0}$$

19. Apply torque equations due to pseudo force and weight. $mg\frac{l}{2} + mgl = ma\frac{l}{2}$

$$a = 3g$$

CHEMISTRY

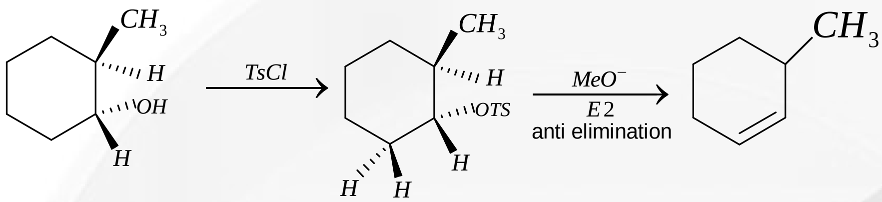
20. $\frac{\partial E}{\partial T} = 0.003VK^{-1}$

$nF\left(\frac{\partial E}{\partial T}\right) = \Delta S = 2\times 96500C\times 0.003Vk^{-1}$

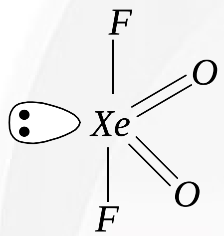
$= 2\times 965\times 0.3Jk^{-1} = 579Jk^{-1}$

21. Reaction involves retention in configuration

22.



23.



$See - saw$

24. $2Cro_4^{2-} + 3SO_3^{2-} \rightarrow 2CrO_2^{1-} + 3SO_4^{2-}$

$8CrO_4^{2-} + 3S_2O_3^{2-} \rightarrow 8CrO_2^{1-} + 6SO_4^{2-}$

Total moles of $CrO_4^{2-} = 0.05\times\frac{80}{1000} = 0.004$

moles of CrO_4^{2-} used for oxidation of $SO_3^{2-} = x$

moles of CrO_4^{2-} used for oxidation of $S_2O_3^{2-} = 0.004 - x$

No. of moles of SO_4^{2-} formed from $SO_3^{2-} = \frac{3x}{2}$

No. of moles of SO_4^{2-} formed from $S_2O_3^{2-} = \frac{0.004 - x}{8}\times 6$

Total $SO_4^{2-} = \frac{3x}{2} + \frac{(0.004 - x)\times 3}{4} = \frac{0.9336}{233.4} = 0.004,\ x = \frac{0.004}{3}$

2 moles $CrO_4^{2-} \rightarrow 3moles\ SO_3^{2-}$

$\frac{0.004}{3}$ moles $CrO_4^{2-} \rightarrow \frac{0.004}{3\times 2}\times 3 = 0.002\,moles\,SO_3^{2-}$

$[SO_3^{2-}] = \frac{0.002}{100}\times 1000 = 0.02M$

25. $2Cro_4^{2-} + 3SO_3^{2-} \rightarrow 2CrO_2^{1-} + 3SO_4^{2-}$

$8CrO_4^{2-} + 3S_2O_3^{2-} \rightarrow 8CrO_2^{1-} + 6SO_4^{2-}$

Total moles of $CrO_4^{2-} = 0.05\times\frac{80}{1000} = 0.004$

moles of CrO_4^{2-} used for oxidation of $SO_3^{2-} = x$

moles of CrO_4^{2-} used for oxidation of $S_2O_3^{2-} = 0.004 - x$

No. of moles of SO_4^{2-} formed from $SO_3^{2-} = \dfrac{3x}{2}$

No. of moles of SO_4^{2-} formed from $S_2O_3^{2-} = \dfrac{0.004 - x}{8} \times 6$

Total $SO_4^{2-} = \dfrac{3x}{2} + \dfrac{(0.004 - x)\times 3}{4} = \dfrac{0.9336}{233.4} = 0.004$

$x = \dfrac{0.004}{3}$

No of moles of CrO_4^{2-} used for oxidation of

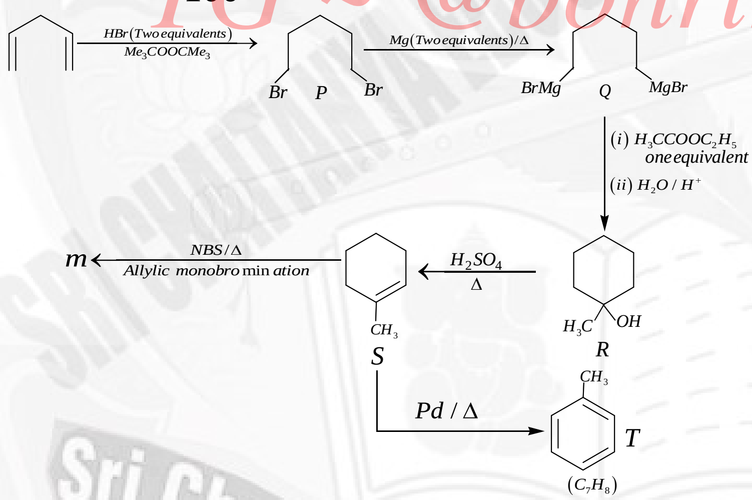
$S_2O_3^{2-} = 0.004 - \dfrac{0.004}{3} = \dfrac{0.008}{3}$

8 moles CrO_4^{2-} oxidises 3 moles $S_2O_3^{2-}$

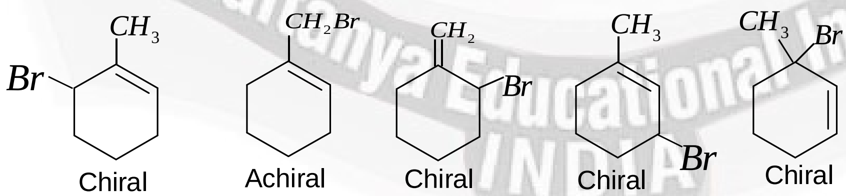
$\dfrac{0.008}{3} CrO_4^{2-} \rightarrow \dfrac{0.008}{3\times 8} \times 3 = 0.001 moles\ S_2O_3^{2-}$

$[S_2O_3^{2-}] = \dfrac{0.001}{100} \times 1000 = 0.01M$

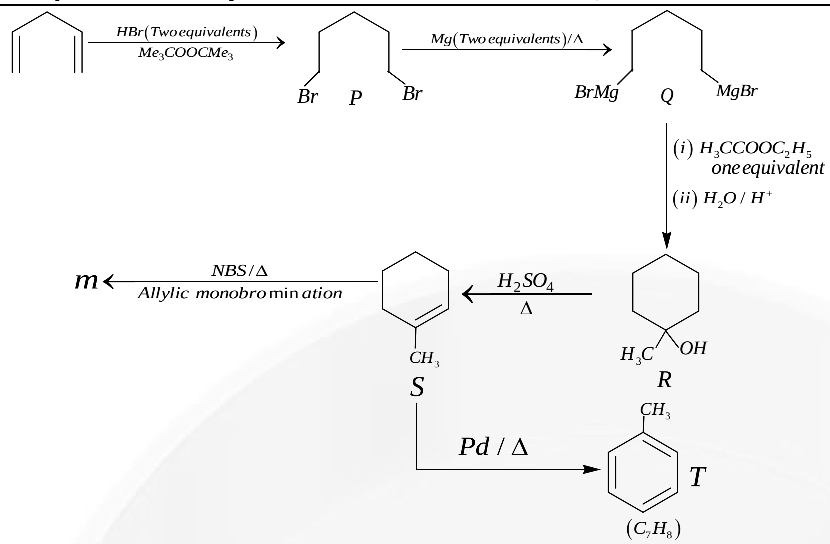
26.



$m = 9$



27.



Heal liberated for combustion of one mole of liquid T

$$=8\times 0.6\times \frac{92}{0.48}=920k.cal\ mol^{-1}$$

$$\Delta U=-920k.cal\ mol^{-1}$$

$$C_7H_{8(l)}+9O_{2(g)}\rightarrow 7CO_{2(g)}+4H_2O_{(\ell)}$$

$$\Delta n=7-9=-2$$

$$\Delta H=-920+\left[(-2)\times \frac{2}{1000}\times 300\right]$$

$$=-920-1.2=-921.2\ \text{k.cal/mole}$$

28.

$$Pk_a\ of\ (CH_2OH)_3CNH_3^+Cl^-=8$$

$$Pk_b\ of\ (CH_2OH)_3CNH_2=6$$

For alkaline buffer, $pOH=pK_b+\log\frac{[salt]}{[Amine]}$

$$6.6=6+\log\frac{[salt]}{[Amine]}\ \frac{4}{1}=\frac{[salt]}{[Amine]}$$

Total moles of buffer required $=0.5\times\frac{500}{1000}=0.25$

No of moles salt required $=0.25\times\frac{4}{5}=0.2$

No of moles of amine required $=0.25\times\frac{1}{5}=0.05$

$$(CH_2OH)_3CNH_2+HCl\rightarrow(CH_2OH)_3CNH_3^+Cl^-$$

Intial	0.25 mole	0.2 mole	-
After reaction	0.05moles	-	0.2moles

0.25 moles of amine(solid) should be mixed with 0.2 mole HCl

wt. of amine required $=0.25\times 121g=30.25g=x$

volume of 1M HCl required $=\frac{0.2}{1}L=200ml=V$

29. $Pk_a \text{ of } (CH_2OH)_3 CNH_3^+Cl^- = 8$

$Pk_b \text{ of } (CH_2OH)_3 CNH_2 = 6$

For alkaline buffer, $pOH = pK_b + \log\dfrac{[salt]}{[Amine]}$

$6.6 = 6 + \log\dfrac{[salt]}{[Amine]}\ \dfrac{4}{1} = \dfrac{[salt]}{[Amine]}$

Total moles of buffer required $= 0.5 \times \dfrac{500}{1000} = 0.25$

No of moles salt required $= 0.25 \times \dfrac{4}{5} = 0.2$

No of moles of amine required $= 0.25 \times \dfrac{1}{5} = 0.05$

$$(CH_2OH)_3 CNH_2 + HCl \rightarrow (CH_2OH)_3 CNH_3^+Cl^-$$

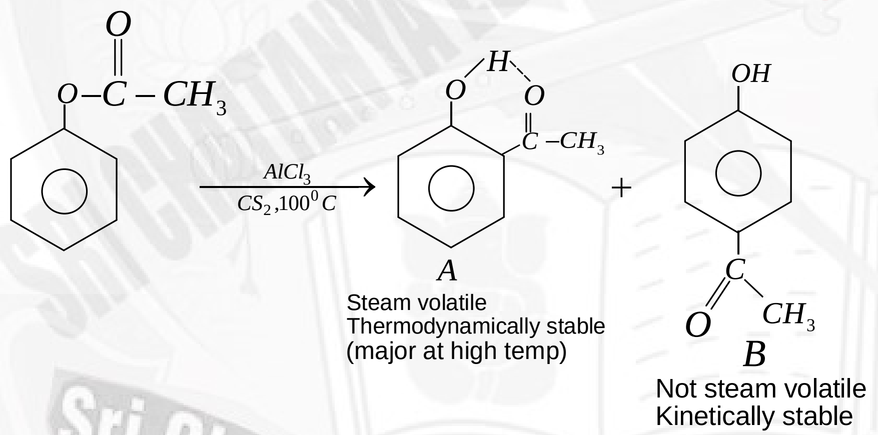
Intial	0.25 mole	0.2 mole	-
After reaction	0.05moles	-	0.2moles

0.25 moles of amine(solid) should be mixed with 0.2 mole HCl

wt. of amine required $= 0.25 \times 121g = 30.25g = x$

volume of 1M HCl required $= \dfrac{0.2}{1} L = 200ml = V$

30.

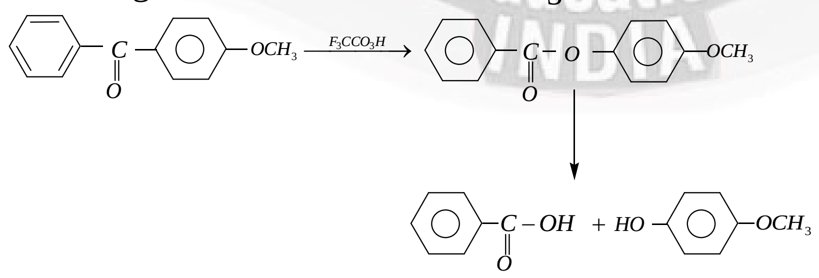


Reaction is Fries rearrangement

It involves attack of acylium carbocation on $o-\&\,p-$positions of positions of benzene ring

Phenols gives violet color with $FeCl_3$

31.



32. Stoichiometric ZnO (white) loses O_2 reversibly and convert into non – stoichiometric ZnO which is yellow in color

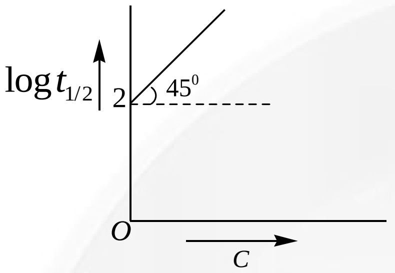
(metal excess crystal defect)

$$ZnO_{(s)} \rightleftharpoons Zn^{2+}_{(s)} + \frac{1}{2}O_{2(g)} + 2e^{-} \text{(n-type conduction)}$$

33. Conceptual

34. Strength of $P\pi - d\pi$ bond increases from SiO_4^{4-} to ClO_4^{-} due to decreases in the size of 3d orbital

35.



For Zero order rxn,

$$k = \frac{C - C_t}{t}$$

$C \rightarrow$ initial concentration of reactant

$C_t \rightarrow$ concentration reactant at time t

At $t = t_{1/2}, C_t = \frac{C}{2}\ k = \frac{C}{2t_{1/2}}$

$$t_{1/2} = \frac{c}{2k} \Rightarrow \log t_{1/2} = \log c + \log 1/2k$$

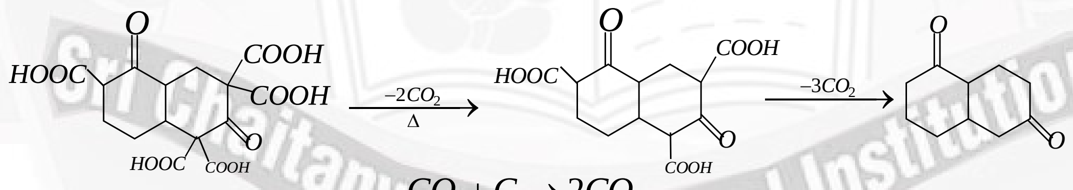
Slope=1 $\log\frac{1}{2k} = 2\ \frac{1}{2k} = 10^2 = 100$

$$k = \frac{1}{200} = 5\times10^{-3} Ms^{-1}$$

36. In Cl_2O, H_2O, ClO_3^-, XeO_3, XeO_4 & NH_4^+ central atom is sp^3hybridized.

37. 1,2,4,6,7 &9 are more acidic than phenol

38.



$$\underset{5moles}{CO_2} + C \rightarrow \underset{10moles}{2CO}$$

MATHEMATICS

39. $\bar{a}.\bar{b} = \bar{b}.\bar{c} = \dfrac{1}{2}$

$\bar{a}.\bar{d} = \cos\alpha$

$\bar{b}.\bar{d} = \cos\beta$

Also $\bar{b} = \lambda(\bar{a}+\bar{c}) \Rightarrow |\bar{b}| = |\lambda(\bar{a}+\bar{c})|$

$\Rightarrow 1 = \lambda(1+1-1) \Rightarrow \lambda = 1 \therefore \bar{b} = \bar{a}+\bar{c}$

$\Rightarrow \bar{c} = \bar{b}-\bar{a} \Rightarrow \bar{d}.\bar{c} = \bar{d}.\bar{b} - \bar{d}.\bar{a}$

$\Rightarrow \cos\theta = \cos\beta - \cos\alpha$

$\Rightarrow \theta = \cos^{-1}(\cos\beta - \cos\alpha)$

40. $L = 8\sum_{n=1}^{\infty} 2^n \sin^3\dfrac{\pi}{2^{n+2}}\cos\dfrac{\pi}{2^{n+2}} = \sum_{n=1}^{\infty}\left(2^{n+1}\sin\dfrac{\pi}{2^{n+1}} - 2^n\sin\dfrac{\pi}{2^n}\right)$

$= \underset{x\to\infty}{Lt}\ 2^{n-1}\left(\sin\dfrac{\pi}{2^{n+1}}\right) - 2\sin\dfrac{\pi}{2} = \pi - 2$

41. Let $p = xyz,\ q = (1+x)(1+y)(1+z)\ pq = x(1+y).y(1+z).z(1+x)$

$\Rightarrow 2p(4-p) = (1-p)(2-p)(4-p) \Rightarrow p = 4,\ \dfrac{5-\sqrt{17}}{2},\ \dfrac{5+\sqrt{17}}{2}$

42. $\left(\cot^4 x+1\right)\left(\cos ec^2 x+\tan^2 x\right) = \cot^2\dfrac{x}{2}$

Let $a_1 = \cot^2 x \qquad b_1 = 1$

$a_2 = \tan x \qquad b_2 = \cos ec\, x$

$(a_1a_2+b_1b_2)^2 \le \left(a_1^2+b_1^2\right)\left(a_2^2+b_2^2\right)$

$\Rightarrow (\cot x + \cos ec\, x)^2 \le \left(\cot^4 x+1\right)\left(\tan^2 x+\cos ec^2 x\right)$

$\Rightarrow \cot^2\dfrac{x}{2} \le \cot^2\dfrac{x}{2}$

Equality holds $\Rightarrow \dfrac{a_1}{b_1} = \dfrac{a_2}{b_2}$

$\cot^2 x = \dfrac{\sin^2 x}{\cos x} \Rightarrow \cos^3 x = \sin^4 x$

43. Let $A = \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}, B = \begin{pmatrix} 2 & 2 & 0 \\ 0 & 2 & 2 \\ 0 & 0 & 2 \end{pmatrix}$

$AB = BA \Rightarrow d = g = h = 0,\ b = f, a = e = i$

$$\therefore A=\begin{pmatrix} a & b & c \\ 0 & a & b \\ 0 & 0 & a \end{pmatrix}=\begin{pmatrix} a & 0 & 0 \\ 0 & a & 0 \\ 0 & 0 & a \end{pmatrix}+\begin{pmatrix} 0 & b & c \\ 0 & 0 & b \\ 0 & 0 & 0 \end{pmatrix}$$

$= aI + C$, when $C^3 = C^4 = ... = 0$

$B = (aI + C)^{2019} + A \Rightarrow a = 1$

$TrA = 3, \quad \det A = 1$

44. Let $A=\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}, B=\begin{pmatrix} 2 & 2 & 0 \\ 0 & 2 & 2 \\ 0 & 0 & 2 \end{pmatrix}$

$AB = BA \Rightarrow d = g = h = 0, b = f, a = e = i$

$$\therefore A=\begin{pmatrix} a & b & c \\ 0 & a & b \\ 0 & 0 & a \end{pmatrix}=\begin{pmatrix} a & 0 & 0 \\ 0 & a & 0 \\ 0 & 0 & a \end{pmatrix}+\begin{pmatrix} 0 & b & c \\ 0 & 0 & b \\ 0 & 0 & 0 \end{pmatrix}$$

$= aI + C$, when $C^3 = C^4 = ... = 0$

$B = (aI + C)^{2019} + A \Rightarrow a = 1$

$TrA = 3, \quad \det A = 1$

45. $\frac{z_1}{z_2}+\frac{z_2}{z_1}+\frac{z_2}{z_3}+\frac{z_3}{z_2}+\frac{z_3}{z_1}+\frac{z_1}{z_3}+2=0$

$\Rightarrow \cos(\alpha-\beta)+\cos(\beta-\gamma)+\cos(\gamma-\alpha)+1=0$

$\cos\frac{\alpha-\gamma}{2}\cos\frac{\gamma-\beta}{2}\cos\frac{\alpha-\beta}{2}=0$

$\alpha = n\pi + \gamma \quad or \quad \beta = n\pi + \gamma \quad or \quad \alpha = n\pi + \beta$

Two vertices are diametrically opposite triangle ABC is right angled triangle

46. $\frac{z_1}{z_2}+\frac{z_2}{z_1}+\frac{z_2}{z_3}+\frac{z_3}{z_2}+\frac{z_3}{z_1}+\frac{z_1}{z_3}+2=0$

$\Rightarrow \cos(\alpha-\beta)+\cos(\beta-\gamma)+\cos(\gamma-\alpha)+1=0$

$\cos\frac{\alpha-\gamma}{2}\cos\frac{\gamma-\beta}{2}\cos\frac{\alpha-\beta}{2}=0$

$\alpha = n\pi + \gamma \quad or \quad \beta = n\pi + \gamma \quad or \quad \alpha = n\pi + \beta$

Two vertices are diametrically opposite triangle ABC is right angled triangle

47. Vector equation of the given straight lines are

$r=(\hat{i}+\hat{k})+\lambda(\hat{i}-\hat{j}+3\hat{k})$ and $r=(\hat{i}+\hat{k})+\upsilon(-3\hat{i}-\hat{j}+\hat{k})$

$\because (\hat{i}-\hat{j}+3\hat{k}).(-3\hat{i}-\hat{j}+\hat{k})=-3+1+3=1$ is positive,

$\therefore$ Angle between supporting line vectors of lines L_1 *and* L_2 is acute, and point of intersection of given lines L_1 *and* L_2 is $(1,0,1)$.

vector along the acute angle bisector of vectors

$\left(\hat{i}-\hat{j}+3\hat{k}\right) and \left(-3\hat{i}-\hat{j}+\hat{k}\right) is \left(\hat{i}-\hat{j}+2\hat{k}\right) or \left(\hat{i}+\hat{j}-2\hat{k}\right)$.

It is given that line $L:\dfrac{x-\alpha}{l}=\dfrac{y-1}{m}=\dfrac{z-\gamma}{-2}$ is the bisector of the acute angle between the lines L_1 *and* L_2, so $l=1$ *and* $m=1$ and $\dfrac{1-\alpha}{1}=\dfrac{0-1}{1}=\dfrac{1-\gamma}{-2}$

$\Rightarrow \alpha=2, \gamma=-1$

$\therefore \alpha-\gamma=3, l+m=2$

48. Vector equation of the given straight lines are

$r=\left(\hat{i}+\hat{k}\right)+\lambda\left(\hat{i}-\hat{j}+3\hat{k}\right)$ and $r=\left(\hat{i}+\hat{k}\right)+\upsilon\left(-3\hat{i}-\hat{j}+\hat{k}\right)$

$\because \left(\hat{i}-\hat{j}+3\hat{k}\right).\left(-3\hat{i}-\hat{j}+\hat{k}\right)=-3+1+3=1$ is positive,

$\therefore$ Angle between supporting line vectors of lines L_1 *and* L_2 is acute, and point of intersection of given lines L_1 *and* L_2 is $(1,0,1)$.

vector along the acute angle bisector of vectors

$\left(\hat{i}-\hat{j}+3\hat{k}\right) and \left(-3\hat{i}-\hat{j}+\hat{k}\right) is \left(\hat{i}-\hat{j}+2\hat{k}\right) or \left(\hat{i}+\hat{j}-2\hat{k}\right)$.

It is given that line $L:\dfrac{x-\alpha}{l}=\dfrac{y-1}{m}=\dfrac{z-\gamma}{-2}$ is the bisector of the acute angle between the lines L_1 *and* L_2, so $l=1$ *and* $m=1$ and $\dfrac{1-\alpha}{1}=\dfrac{0-1}{1}=\dfrac{1-\gamma}{-2}$

$\Rightarrow \alpha=2, \gamma=-1 \therefore \alpha-\gamma=3, l+m=2$

49. For $0<t<1$, $2tF_n(t)-t=\int_0^{t^{1/n}}\left(t-x^n\right)dx+\int_{t^{1/n}}^{1}\left(x^n-t\right)dx$

$$=\left(tx-\frac{x^{n+1}}{n+1}\right)\Bigg]_0^{t^{1/n}}+\left(\frac{x^{n+1}}{n+1}-tx\right)\Bigg]_{t^{1/n}}^{1}$$

$$=(t)\left(t^{1/n}\right)-\frac{t^{1+1/n}}{n+1}+\frac{1}{n+1}-t-\frac{t^{1+1/n}}{n+1}+(t)\left(t^{1/n}\right)$$

$$\Rightarrow 2tF_n(t)=\frac{1}{n+1}+\frac{2n}{n+1}t^{1+1/n}\Rightarrow 2F_n(t)=\frac{1}{n+1}\left[\frac{1}{t}+n\left(2t^{t/n}\right)\right]$$

$$\ge\left[\frac{1}{t}2^n\left(t^{1/n}\right)^n\right]^{\frac{1}{n+1}}=2^{n/(n+1)}$$

[The equality holds if $\dfrac{1}{t}=2t^{\frac{1}{n}} \Rightarrow t=\left(\dfrac{1}{2}\right)^{\frac{n}{n+1}}$]

Now, $a_n a_{n+1}......a_{2n-1}=2^{-b_n}$

Where $b_n=\dfrac{1}{n+1}+\dfrac{1}{n+2}........+\dfrac{1}{2n}=\dfrac{1}{n}\sum_{k=1}^{n}\left(\dfrac{1}{1+k/n}\right)$

$$\Rightarrow \lim_{n\to\infty} a_n a_{n+1}......a_{2n-1} = \lim_{n\to\infty} 2^{-b_n}$$

Where $\lim_{n\to\infty} b_n = \lim_{n\to\infty} \frac{1}{n}\sum_{k=1}^{n}\frac{1}{1+k/n} = \int_0^1 \frac{1}{1+x}dx = 1n2$

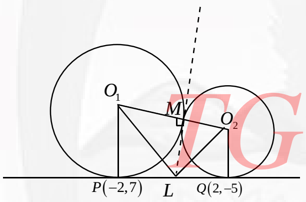
Thus, $\lim_{n\to\infty}\left(a_n a_n + 1.....a_{2n-1}\right) = 2^{-\log 2}$

50. When $\alpha = 1$ $y = \begin{cases} -x+3, & x<1 \\ x+1, & 1\le x<2 \\ 3x-3, & x\ge 2 \end{cases}$

$$\Rightarrow A(1) = \int_0^1\left(-x+3-2\sqrt{x}\right)dx + \int_1^2\left(x+1-2\sqrt{x}\right)dx = 5-\frac{8\sqrt{2}}{3}$$

When $\alpha = 0$ $y=3$ $A(0) = \int_0^2\left(3-2\sqrt{x}\right)dx = 6-\frac{8\sqrt{2}}{3}$

51.



$\rightarrow PL = QL = ML \Rightarrow L$ is mid point of $\overline{PQ}$

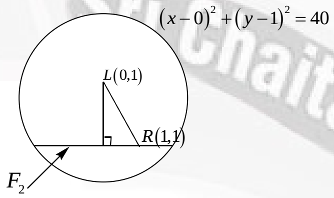
the coordinates of L is(0,1).Let coordinates of M be(x,y).

$\because Ml = PL \Rightarrow (x-0)^2 + (y-1)^2 = 40$

Therefore, locus of M is a part of circle with centre (0,1) and radius $\sqrt{40}$.

$\therefore E_1 = \{(x,y):(x-0)^2 + (y-1)^2 = 40$

Clearly, (-2,7) does not lie in E_1.Also , $\left(0,\frac{3}{2}\right)$ does not lie in E_1.



Locus of points in E_2 is part of a circle with coordinates of diameter

$L(0,1)$ and $R(1,1)$.$\therefore E_2 = \{(x,y):(x-0)(x-1)+(y-1)^2 = 0\}$

i.e, $E_2 = \{(x,y):(x-0)(x-1)+(y-1)^2 = o\}$

$\Rightarrow \left(\frac{4}{5},\frac{7}{5}\right),\left(\frac{1}{2},1\right)$ does not lie in E_2

52. Orthocentre of ΔPQR lies on hyperbola

$\Rightarrow \lambda = 3$

Incentre of ΔABC is orthocenter of ΔPQR.

Equation of AB is $x+y-\dfrac{26}{5}=0$

53. $S_1: a=\cos x, b=\cos 2x, c=\cos 5x$

$1+2abc=a^2+b^2+c^2 \Rightarrow c^2-2ab.c+a^2+b^2-1=0$

$\Rightarrow c=ab\pm\sqrt{a^2b^2-a^2-b^2+1} \Rightarrow \cos 5x=\cos x, \cos 2x \pm \sin x \sin 2x$

$\Rightarrow \cos 5x=\cos 3x.\ \cos 5x=\cos x \Rightarrow 5x=2n\pi\pm 3x\ \ 5x=2m\pi\pm x$

$\Rightarrow x=n\pi, \dfrac{n_2\pi}{4},\ x=\dfrac{n_3\pi}{3}, \dfrac{n_4\pi}{2}$

$S_2: E+S+C+\dfrac{S}{C}+\dfrac{C}{S}+\dfrac{1}{2}\left(\dfrac{1}{C}+\dfrac{1}{S}\right)=2\left(1+\sqrt{2}\right)$

Let $C+S=y=\sin 2x=y^2-1 \therefore E=\dfrac{y^2-2}{y^2-1}=2\left(1+\sqrt{2}\right)$

$\Rightarrow y^3-\left(2+2\sqrt{2}\right)y^2+4+2\sqrt{2}=0$

$y=\sqrt{2}$ only Sol. $S_3=\left\{0,\dfrac{\pi}{2}\right\}$

54. (a) $f(x)=-(x-2)^{1/3} \Rightarrow \lim\limits_{h\to 0}\dfrac{f(2+h)-f(2)}{h}$ does not exist.

(b) $f(x)=e^{-x}$ Solution for $f(x)=0$ does not exist.

(c) $f(x)$ is monotonously deceasing and $f(-x+1)$ monotonously increases. And since its clear that $y=f(x)$ and $y=f(-x+1)$ meets at point $\left(\dfrac{1}{2}, f\left(\dfrac{1}{2}\right)\right)$,they must meet at only one point.

Thus, the solution for $f(x)=f(-x+1)$ only one, $x=\dfrac{1}{2}$.

55. $\sum x_i=24\quad \sigma^2=\dfrac{194}{25} \Rightarrow \sum x_i^2=154$

$x_1+x_2+x_3+x_4=14$

$x_5=10 \Rightarrow \sigma^2=\dfrac{x_1^2+x_2^2+x_3^2+x_4^2}{4}-\dfrac{49}{4}=a \therefore 4a+x_5=15$

56. $8\cos^4 x=3+4\cos 2x+\cos 4x$

$8\sum\limits_{k=1}^{n}\cos^4\dfrac{k\pi}{2n+1}=\sum\limits_{k=1}^{n}\left(3+4\cos\dfrac{2k\pi}{2n+1}+\cos\dfrac{4k\pi}{2n+1}\right)$

$\Rightarrow 8\left(\dfrac{55}{16}\right)=3n+4\left(-\dfrac{1}{2}\right)-\dfrac{1}{2} \Rightarrow n=10$

57. $S_n=n\left(2n-2_{C_{n-1}}\right)$

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S **JEE-ADVANCE-2021-P2** **Date: 19-05-2023**

Time: 02.00Pm to 05.00Pm **GTA-25** **Max. Marks: 180**

19-05-2023_Sr.Super60_NUCLEUS&ALL_BT'S_Jee-Adv(2021-P2)_GTA-25_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ___________________ **H.T. NO:** | | | | | | | |

JEE-ADVANCE-2021-P2-Model

Time: 3:00Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 6)	Questions with Multiple Correct Choice with Partial mark	+4	-2	6	24
Sec – II(Q.N : 7 – 12)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 13 – 16)	Paragraph Questions with Single Answer Type	+3	-1	4	12
Sec – IV(Q.N : 17 – 19)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 20 – 25)	Questions with Multiple Correct Choice with Partial mark	+4	-2	6	24
Sec – II(Q.N : 26 – 31)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 32 – 35)	Paragraph Questions with Single Answer Type	+3	-1	4	12
Sec – IV(Q.N : 36– 38)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 39 – 44)	Questions with Multiple Correct Choice with Partial mark	+4	-2	6	24
Sec – II(Q.N : 45 – 50)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 51 – 54)	Paragraph Questions with Single Answer Type	+3	-1	4	12
Sec – IV(Q.N : 55 – 57)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

PHYSICS

Max. Marks: 60

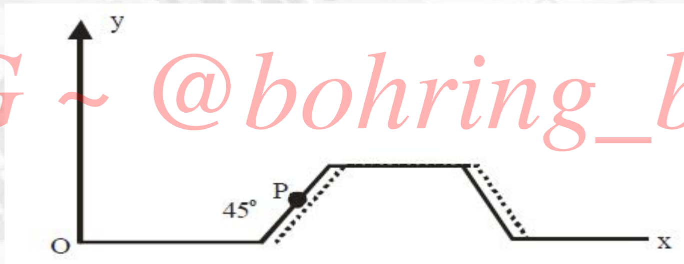
SECTION-1(Maximum Marks: 24)

One or More Type

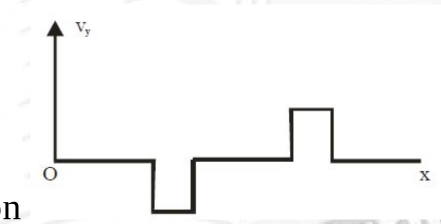
- This section contains SIX (06) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +4 If only (all) the correct option(s) is(are) chosen;
  Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
  Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
  Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
  Zero Marks : 0 If unanswered;
  Negative Marks : −2 In all other cases.

1. The figure shows a taut string, initially aligned with the x-axis, which carries a waveform travelling towards the right without any change its shape. The bold line and the dotted line indicate the displacement of the string (i.e., shape of the wave form)at time = t second at time = (t + dt) second, respectively. The speed of particle at point P at t = 2 sec is 1cm/s. Choose the correct statement (s) from the following

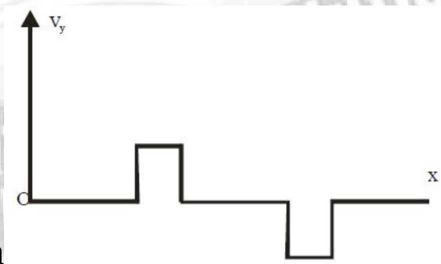
(assume that dt is positive & slope of y-x at p is $45°$)



A) Particle velocity as a function of position



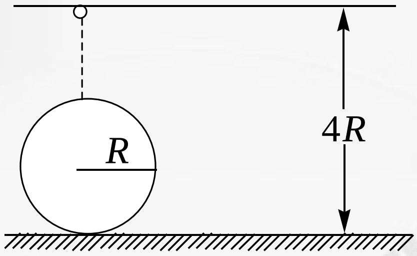
B) Particle velocity as a function of position



C) Speed of waveform is 1 cm/s and it is moving along positive x-axis

D) Speed of waveform is 1 cm/s and it is moving along negative x-axis

2. Electrically charged Hg drops fall from certain height $4R$, where R is the radius of a metallic fixed sphere on the non conducting floor. In the top most portion of the sphere there is a small opening as shown in the figure, q, m are charge and mass of each drop, acceleration due to gravity is g, then



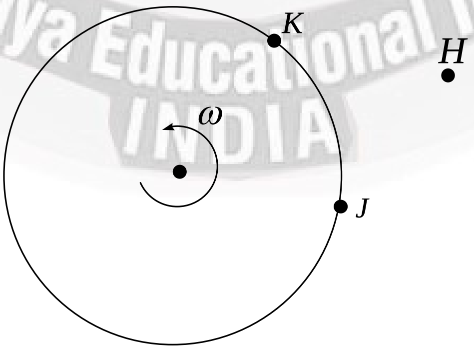
A) Charged drops fall freely and acquire the speed $2\sqrt{gR}$ when they reach the top most point of the sphere

B) Succeeding drops reach the top most of the sphere with lesser speed as compared to preceding one

C) Maximum number of drops that can enter the sphere is $\dfrac{12\pi\varepsilon_0 mgR^2}{q^2}$

D) Maximum number of drops that can enter the sphere is $\dfrac{6\pi\varepsilon_0 mgR^2}{q^2}$

3. After writing an exam paper on Sunday three boys **K,H** and **J** went to a carnival. There was a merry go round of radius R which was moving with uniform angular velocity ω about a fixed axis. **K** and **J** went on to enjoy the ride and **H** decided to stand nearby. **K** and **J** sat on the edge of merry go round as shown in figure (i.e at distance R from the axis).Then choose the correct option (s) about their relative motion.



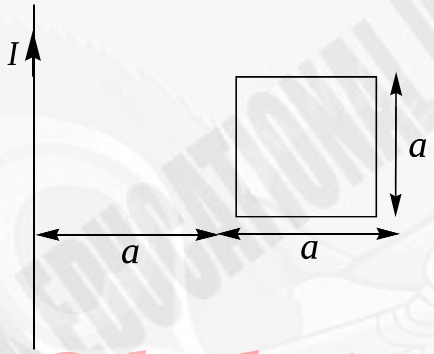
A) Acceleration of **K** and **J** as observed by **H** are equal

B) Acceleration of **H** as observed by **K** and **J** are equal in magnitude.

C) Acceleration of **K** as observed by **H** and **J** are equal in magnitude and direction.

D) Acceleration of **H** as observed by **K** and **J** are zero each.

4. A long fixed straight conductor carrying current I and a square conducting loop of side a ,mass m and resistance R are located in the same plane in a gravity free space as shown in the figure . The current in the long straight conductor is suddenly switched off. Then choose the correct option(s).



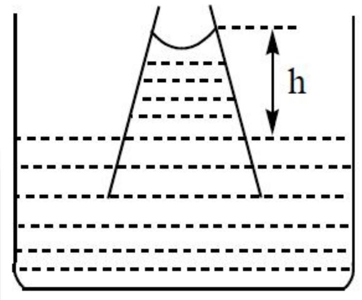
A) The charge $\left(\frac{\mu_0 I a(\ln 2)}{2\pi R}\right)$ will flow through the loop.

B) The charge $\left(\frac{\mu_0 I a(\ln 2)}{4\pi R}\right)$ will flow through the loop

C) The velocity acquired by the loop is $\left(\frac{\mu^2{}_0 I^2 a(\ln 2)}{4\pi^2 mR}\right)$

D) The velocity acquired by the loop is $\left(\frac{\mu^2{}_0 I^2 a(\ln 2)}{16\pi^2 mR}\right)$

5. A conical capillary tube as shown in figure is submerged in a liquid. Contact angle between the liquid and capillary is 0^0 and the weight of liquid inside the meniscus is to be neglected. T is surface tension of the liquid, r is radius of the meniscus, g is acceleration due to gravity and ρ is density of the liquid. Semi vertex angle of conical tube is θ



A) The height h in equilibrium is $\frac{2T}{r\rho g}$

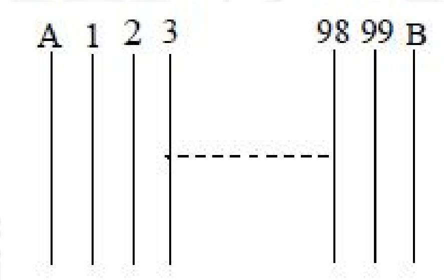
B) The height h in equilibrium is $\frac{2T\cos\theta}{r\rho g}$

C) The radius of conical tube at the level where meniscus is formed is almost equal to r $\cos\theta$

D) The radius of conical tube at the level where meniscus is formed is almost equal to $\frac{r}{\cos\theta}$

6. Two perfectly black parallel plates A and B of equal area facing each other are maintained at constant temperature T_A *and* $T_B\left(T_A > T_B\right)$. 99 perfectly black and conducting identical screens of same area as plates are introduced between A and B, parallel to each other having equal space between them. Once the thermal equilibrium is reached. Choose the CORRECT statements:

(Take $\sigma\left(T_A^4 - T_B^4\right) = 500\frac{W}{m^2}$; Ignore convection)



A) Heat flux between screen 1 and 2 is greater than heat flux between screen 98 and 99

B) Heat flux between plate A and screen 1 is $5000\frac{W}{m^2}$

C) Heat flux between screen 99 and plate B is $50\frac{W}{m^2}$

D) Effective heat flux between plates A and B reduces due to introduction of screens between them

SECTION-2(Maximum Marks: 12)

Paragraph with Numerical

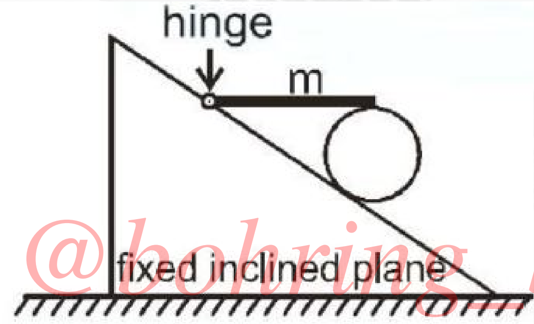
- This section contains THREE (03) question stems.
- There are TWO (02) questions corresponding to each question stem.
- The answer to each question is a NUMERICAL VALUE.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;
Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 7 and 8

Question Stem

A horizontal uniform rod of mass 'm' has its left end hinged to the fixed incline plane, while its right end rests on the top of a uniform cylinder of mass 'm' which in turn is at rest on the fixed inclined plane as shown. The coefficient of friction between the cylinder and rod, and between the cylinder and inclined plane, is sufficient to keep the cylinder at rest



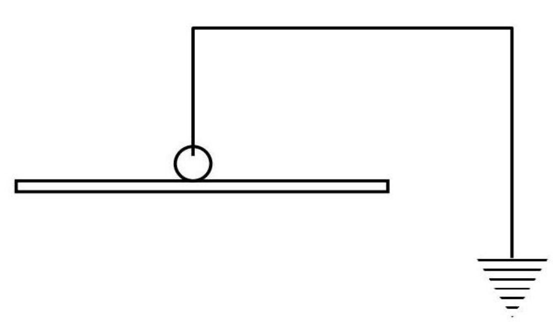
7. The ratio of the magnitude of normal reaction exerted by the, inclined surface on the cylinder and the magnitude of normal reaction exerted by the rod on the cylinder is.

8. The ratio of magnitude of frictional force on the cylinder due to the rod and the magnitude of frictional force on the cylinder due to the inclined plane is

Question Stem for Question Nos. 9 and 10

Question Stem

A grounded metallic ball of radius 'a' is placed on the centre of a uniformly charged thin insulating disc of radius $R(R >> a)$. The total charge on the disc is Q.



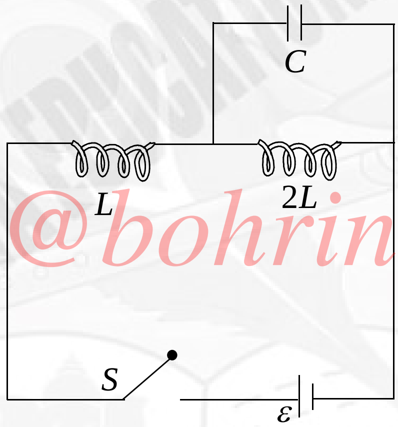
9. If the electrostatic force on the ball due to the uniformly charged disc is $\left(\frac{nQ^2a}{4\pi\varepsilon_0 R^b}\right)$. n and b are integers Find the value of $(n+b)$

10. If the electrostatic force on the ball due to the uniformly charged disc is F, in another case of similar context If charge of the disc made four times and radius of the disc doubled without changing the other quantities, now the electrostatic force on the ball due to disc is ***m*** F. Find the value of ***m***

Question Stem for Question Nos. 11 and 12

Question Stem

The circuit shown ,initially the current through each inductor is zero and capacitor is uncharged . Now the switch 'S' is closed at t = 0.



11. If the charge on the capacitor at $t=\frac{\pi}{2}\sqrt{\frac{2LC}{3}}$ is $\frac{C\varepsilon}{n}$, then the value of n is___

12. If the maximum potential drop across the capacitor is $\frac{4\varepsilon}{m}$ then the value of m is___

SECTION-3(Maximum Marks: 12)

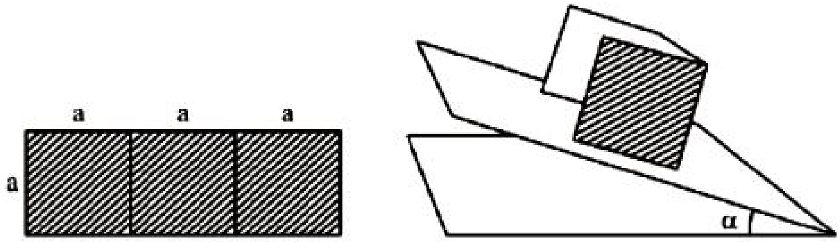
Paragraph with Single Answer Type

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases.

Paragraph-I

A cardboard strip, bent in the shape of the letter C, is put on a rough inclined plane, as shown in the figure.



13. At what angle of inclination to be horizontal plane will it topple? (assume that it does not slide).

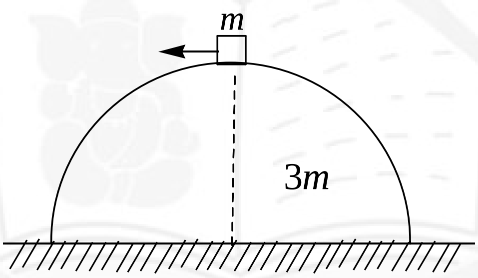
A) $\tan^{-1}\left(\frac{2}{3}\right)$ **B)** $\tan^{-1}\left(\frac{3}{2}\right)$ **C)** $45°$ **D)** $\tan^{-1}\left(\frac{1}{3}\right)$

14. What should be the minimum coefficient of friction so that it does not slide before toppling.

A) 0.66 **B)** 0.75 **C)** 1.0 **D)** 0.33

Paragraph-I

A hemisphere of mass 3m and radius R is free to slide with its base on a smooth horizontal surface. A small block of mass m is placed on top of the hemisphere. The block is given a negligible velocity from this position towards left as shown. Let θ be the angular displacement of the block with respect to centre of curvature of hemisphere at any instant. Consider the situation when the block is in contact with the hemisphere



15. Speed of the hemisphere as a function of θ is

A) $\sqrt{\frac{gR(1-\cos\theta)}{(8\sec^2\theta-2)}}$ **B)** $\sqrt{\frac{gR(1+\cos\theta)}{(8\sec^2\theta+2)}}$

C) $\sqrt{\frac{gR(1-\cos\theta)}{(8\sec^2\theta+2)}}$ **D)** $\sqrt{\frac{gR(1+\cos\theta)}{(8\sec^2\theta-2)}}$

16. Angular velocity of the block relative to centre of curvature of the hemisphere is

A) $4\sec\theta\sqrt{\dfrac{g(1-\cos\theta)}{R\left(8\sec^2\theta-2\right)}}$ **B)** $4\sec\theta\sqrt{\dfrac{g(1+\cos\theta)}{R\left(8\sec^2\theta+2\right)}}$

C) $4\sec\theta\sqrt{\dfrac{g(1-\cos\theta)}{R\left(8\sec^2\theta+2\right)}}$ **D)** $4\sec\theta\sqrt{\dfrac{g(1+\cos\theta)}{R\left(8\sec^2\theta-2\right)}}$

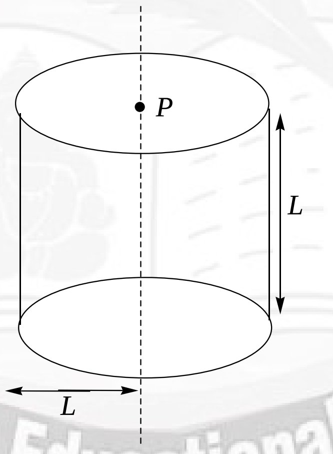
SECTION-4(Maximum Marks: 12)

<u>Non-Negative Integer Answer Type</u>

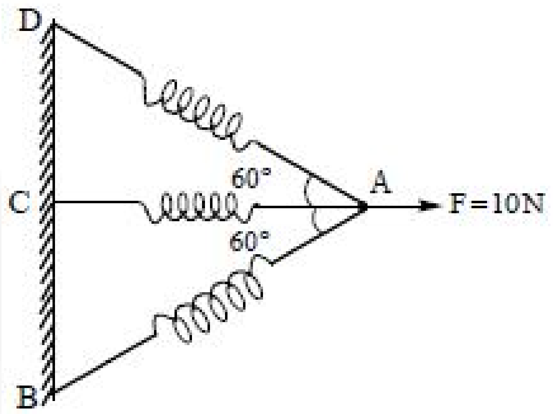
- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;
Zero Marks : 0 In all other cases.

17. A thin hollow cylinder (opened at the both ends)of radius and length both equal to L. This object carries a uniform surface-charge density σ .The electrostatic potential at the point P on the axis of the cylinder(as shown in the figure)comes out to be $V_P = \dfrac{\sigma L}{k\varepsilon_0} ln(1+\sqrt{h})$ Find the value of $(k+h)$.

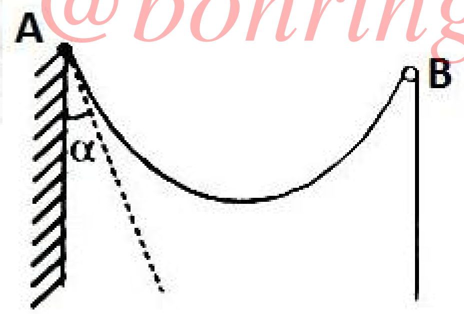


18. Three segments (of lengths 2L,L,2L) cut from a long light spring are attached at point A and the other ends are fixed to the points B,C and D in horizontal plane as shown in the figure. Initially all three springs are at their natural length. The point A is pulled horizontally on a smooth horizontal table by a force F = 10 N



At steady state, find the tension (in N) in middle section. Assume that elongation in spring segments are much smaller that their relaxed lengths

19. A uniform rope of length 26 m which is tied on a peg A on a wall and passes over a frictionless peg B fixed in level with peg A as shown in the figure. If in equilibrium, length of rope hanging between the pegs is 16 m, if α is the angle which the rope makes with the wall at the peg A (in degrees) . Then the value of $\frac{\alpha}{9}$ with nearest integer.



CHEMISTRY

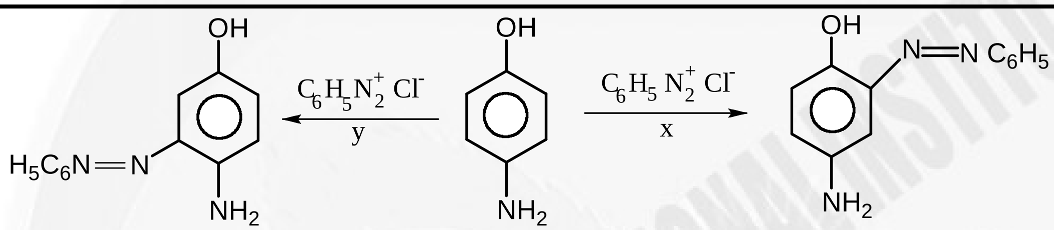
Max. Marks: 60

SECTION-1(Maximum Marks: 24)

One or More Type

- This section contains SIX (06) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +4 If only (all) the correct option(s) is(are) chosen;
  Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
  Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
  Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
  Zero Marks : 0 If unanswered;
  Negative Marks : −2 In all other cases.

20.



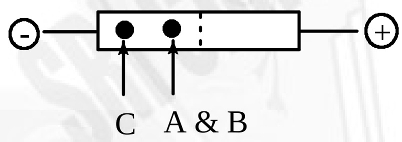
Maximum yield of respective products is formed, when

A) x = dil. NaOH **B)** y = dil. HCl

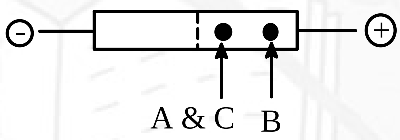
C) x = conc. NaOH **D)** y = conc. HCl

21. A mixture of methionine (A), glutamic acid (B) and lysine (C) is separated by paper electrophoresis in two experiments, one at $pH = 1$ and one at $pH = 12$. After the separation, the paper strips are treated with ninhydrin to reveal the location of amino acids (Purple spots). Which of the following correct match is of strips with appropriate pH ?

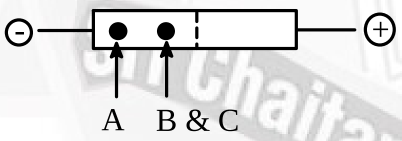
A) At $pH = 1$



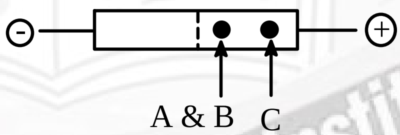
B) At $pH = 12$



C) At $pH = 1$



D) At $pH = 12$



22. The steps involved in the extraction of silver from Argentite ore by MacArthur- Forrest process are,

A) concentration of ore by froth flotation process

B) leaching of concentrated ore in dilute solution of $NaCN$ by passing a current of hot air

C) leaching of concentrated ore in dilute solution of $NaCN$ in the absence of air

D) Precipitation of Ag from solution by adding Zinc followed by fusion and electrolytic refining of filtered silver

23. What happens when solid $CuCN$ is dissolved in aqueous solution of KCN?

A) $\left[Cu\left(CN\right)_4\right]^{3-}$ is formed

B) $\left(CN\right)_2$ is formed

C) Depression in freezing point of solution increases

D) $\left[Cu\left(CN\right)_4\right]^{2-}$ is formed

24. Pick out correct statement(s) from the following

A) The e/m of particles constituting cathode rays is independent of nature of cathode and the nature of gas used in the discharge tube

B) Discovery of neutron is the result of a nuclear reaction

C) Anode rays are the rays emitted from anode during electrical discharge through gases

D) The e/m of particles constituting anode rays is independent on nature of gas used in the discharge tube

25. One mole of helium is placed in a container at a pressure of 2 atmospheres and at a temperature of 300K. The gas is allowed to expand irreversibly and adiabatically to a pressure of 1 atm. Which of the following is true for this process?

$$\left(C_p = \frac{5}{2}R,\ \log 2 = 0.3,\ \log 5 = 0.7, R = 2cal\,k^{-1}mol^{-1}\right)$$

A) ΔS_{system} = zero

B) ΔS_{system} = 0.23 cal

C) ΔH_{system} = -300 cal

D) $\Delta S_{surroundinags}$ = Zero

SECTION-2(Maximum Marks: 12)

Paragraph with Numerical

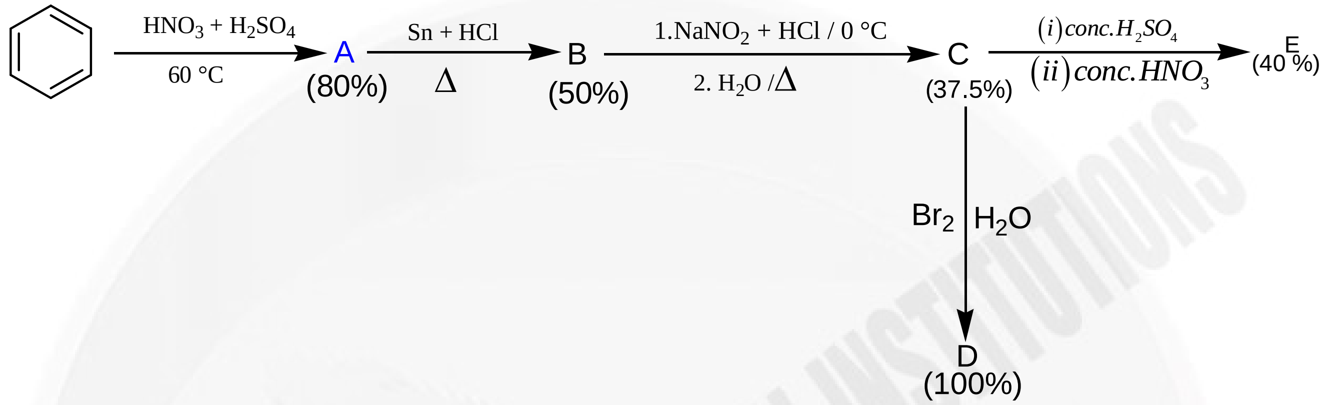
- This section contains THREE (03) question stems.
- There are TWO (02) questions corresponding to each question stem.
- The answer to each question is a NUMERICAL VALUE.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;
  Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 26 and 27

Question Stem

In the following reaction sequence, the % yield corresponding to the product in each step is given in the parenthesis.

(A.W(in g.mol^{-1}) : H = 1, C = 12, N = 14, O = 16 & Br = 80)



26. The amount of D (in g) formed from 10 moles of benzene is ----------

27. The amount of E (in g) formed from 10 moles of benzene -------------

Question Stem for Question Nos. 28 and 29

Question Stem

A sample of water contain 244ppm HCO_3^{1-} and 240ppm of SO_4^{2-} with Ca^{2+} as the only cation. When one kg of this water is treated with calculated quantity of $NaOH$ to remove all the HCO_3^{1-}, the concentration of Ca^{2+} in the treated water is found to be $'x'\,ppm$. (Neglect the solubility of $CaCO_3$ in water) If all the Ca^{2+} present in one kg of treated water is exchanged for H^+ ions, the pH of the resultant water is found to be $'y'$

(Atomic Weight (g/mol): H = 1, C = 12, O = 16, S = 32 and Ca = 40)

(Density of Ca^{2+} free water = 1 g/mL)

28. The value of $'x'$ is --------------

29. The value of $'y'$ is -----------

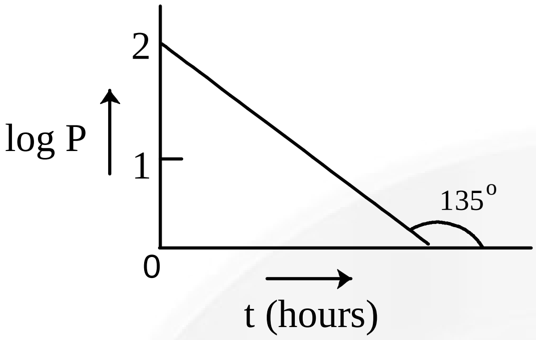
Question Stem for Question Nos. 30 and 31

Question Stem

Gas phase decomposition of Di-tert-butyl peroxide $(Me_3CO-OCMe_3)$ (DTBP) to acetone and ethane follows first order kinetics. The plot of log P vs time (t) is as given below.

(P is pressure of DTBP in torr)

$$Me_3COOCMe_3(g) \rightarrow 2MeCOMe(g) + C_2H_6(g)$$



In one hour, the percentage dissociation of DTBP is found to be $'x'$ and the pressure of the system after one hour is found to be $'y'$ torr.

30. The value of $'x'$ is ----------------

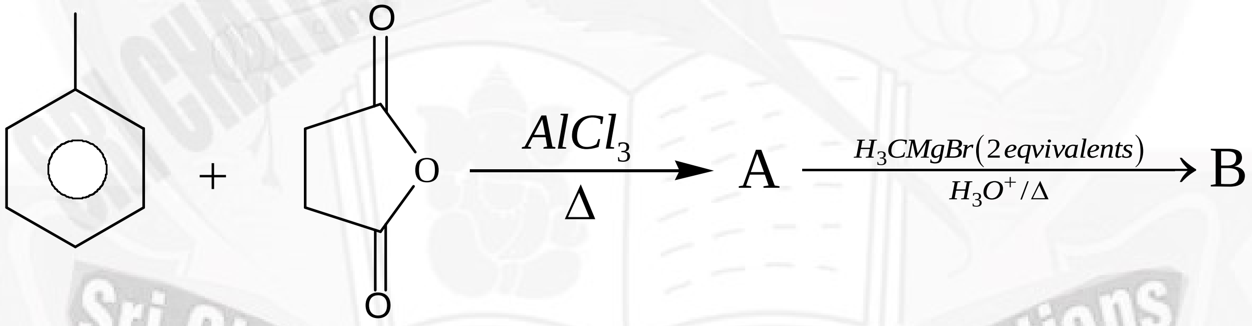
31. The value of $'y'$ is ------------

SECTION-3(Maximum Marks: 12)
Paragraph with Single Answer Type

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases.

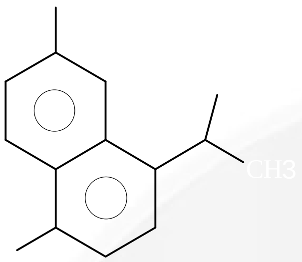
Paragraph-1:

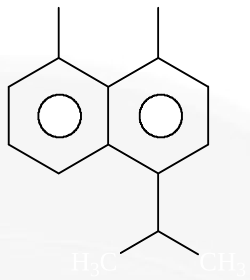


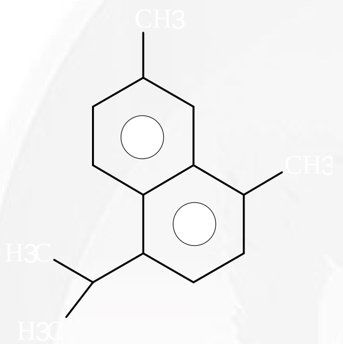
$$B \xrightarrow[Pt]{H_2(1\,eqvivalents)} C$$

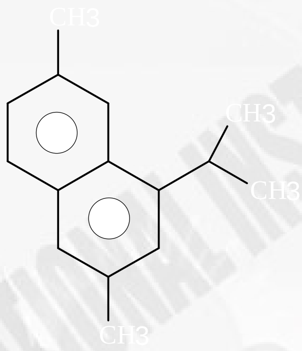
$$C \xrightarrow[\Delta]{HF(g)} D \xrightarrow[(iii)\,H^+/\Delta]{(i)(H_3C)_2CHMgBr,\,(ii)\,H_2O} E + F \xrightarrow[\Delta]{Pd} G$$

32. The compounds 'G' is

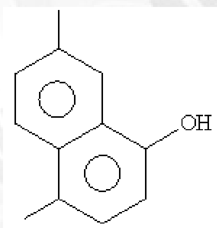
A) 

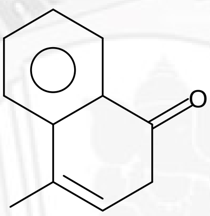
B) 

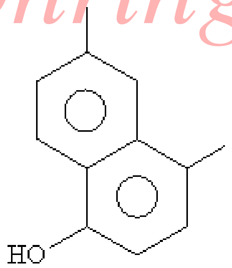
C) 

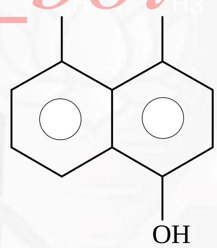
D) 

33. In the above scheme of reactions, if B is not hydrogenated and directly treated with HF(g) it is impossible to prepare 'G'. This is because, B on reaction with HF(g) forms a compound 'X' that does not yield E & F on reaction with $(H_3C)_2CHMgBr$. The compound 'X' formed is

A) 

B) 

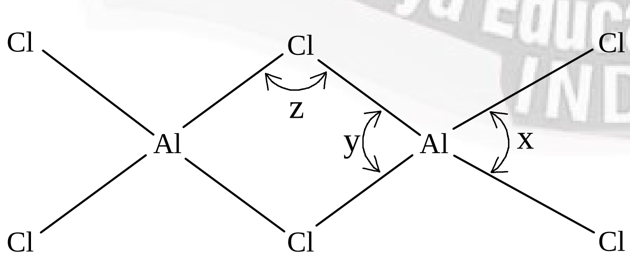
C) 

D) 

Paragraph-2:

Anhydrous aluminium chloride exist as a dimer at below 625 K and as a monomer at above 1025 K. In between temperatures it is an equilibrium mixture of $AlCl_3$ and Al_2Cl_6.

The structure of dimer is



34. The correct order of bond angles in Al_2Cl_6 is

A) $x > z > y$ **B)** $z > x > y$ **C)** $y > x > z$ **D)** $z > y > x$

35. Pick out correct statement(s) from the following?

I. On methylation Al_2Cl_6 forms $(CH_3)_6Al_2$ and B_2H_6 form $(CH_3)_4B_2H_2$

II. On methylation both Al_2Cl_6 and B_2H_6 forms hexamethyl derivatives $((CH_3)_6M_2)$

III. In Al_2Cl_6, $Al-Cl-Al$ bridge is 3c – 4e bond while in B_2H_6, B – H – B bridge is 3c – 2e bond.

IV. Both Al_2Cl_6 and B_2H_6 acts as Lewis acids

V. In gaseous state both compounds exist as a mixture of monomer and dimer.

A) II, III, IV **B)** I, III, IV **C)** I, III, IV, V **D)** II, III, IV, V

SECTION-4(Maximum Marks: 12)
Non-Negative Integer Answer Type

- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;
Zero Marks : 0 In all other cases.

36. The potential of the cell $Pt,\ \underset{(1\,atm)}{H_2}\,|0.1M\,BCl + 0.2M\,BOH||Cu^{2+}(1M)|Cu$ is 0.88 v at 25°C. BOH is a weak base. $E^o_{Cu^{2+}/Cu}$ is 0.34 V. If 20 ml 0.1 M BOH is titrated with 0.1 M HCl, the pH at equivalence point is ------

(Given, $\frac{2.303RT}{F} = 0.06; \log 2 = 0.3 \, and \log 5 = 0.7, K_w = 10^{-14}$)

37. Cyclic silicates contain $(SiO_3)_n^{2n-}$ type of anion. Beryl is a cyclic silicate. What is the value of 'n' in Beryl mineral?

38. The depression in freezing point for 0.1m NH_4Cl is found to be 0.37944K. Considering complete ionization of NH_4Cl, the percentage hydrolysis of NH_4Cl is ------- $\left(K_f \; of \; H_2O = 1.86 k.kg\,mol^{-1}\right)$

MATHEMATICS

Max. Marks: 60

SECTION-1(Maximum Marks: 24)

One or More Type

- This section contains SIX (06) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is(are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If unanswered;
Negative Marks : −2 In all other cases.

39. Let $f(x)=\begin{cases}\cos^{-1}x, & -1\le x<0\\ \sin^{-1}x, & 0\le x\le 1\end{cases}$, *and* $g(x)=\begin{cases}\sin^{-1}x, & -1\le x<0\\ \cos^{-1}x, & 0\le x\le 1\end{cases}$. If $h(x)=\min.\{f(x), g(x)\}$, then :

A) h(x) is continuous $\forall\ x\in[-1,1]$

B) h(x) is non derivable at exactly one point in $x\in(-1.1)$

C) minimum value of h(x) is equal to $\frac{-\pi}{4}$

D) maximum value of h(x) is equal to $\frac{\pi}{4}$

TG ~ @bohring_bot

40. Given a positive integer r, let $M(r)$ be the largest positive integer 'n' such that ${}^{n}C_{r-1}>{}^{(n-1)}C_{r}$ and $\lim\limits_{r\to\infty}\frac{M(r)}{r}$ is $\frac{a+\sqrt{b}}{2}$ then which of the following is/are True (where a and b are rational numbers) $\left(where\ \ {}^{n}C_{r}=\frac{n!}{(n-r)!r!}\right)$

A) $a+b=8$

B) $\frac{b}{2},a,2b$ are in A.P

C) $|z-a|+|z-b|>2$ is true for every complex number z

D) z is a complex number and $\left||z-a|-|z-b|\right|=1$ Then locus of z is a hyperbola

41. In a drawer Mr.Chakri has 5 pairs of socks, each pair a different colour. On Monday Mr.Chakri selects two individual socks at random from the 10 socks in the drawer. On Tuesday Mr.Chakri selects 2 of the remaining 8 socks at random and on Wednesday two of the remaining 6 socks at random. The probability that Wednesday is the first day Mr.Chakri selects same colour socks is $\frac{m}{n}$, where m and n are relatively prime positive integers, then

A) $m+n=341$

B) $\lim_{x\to 0^+} x\left(\left[\frac{1}{x}\right]+\left[\frac{2}{x}\right]+\left[\frac{3}{x}\right]+..........+\left[\frac{m}{x}\right]\right)=m+n$ $\left([\bullet] is\, G.I.F\right)$

C) Number of ordered pairs $(\alpha,\beta),(\alpha,\beta\in z^+)$ satisfy the condition $x+y<28, x+y\geq 6, x>0, y>0$ is $m+n$

D) $\lim_{x\to 0^+} x\left(\left[\frac{1}{x}\right]+\left[\frac{2}{x}\right]+\left[\frac{3}{x}\right]+..........+\left[\frac{m}{x}\right]\right)=n-m$ $\left([\bullet] is\, G.I.F\right)$

42. For any real numbers α *and* β, let $y_{\alpha,\beta}(x), x\in\mathbb{R}$, be the solution of the differential equation $\frac{dy}{dx}+\alpha y = xe^{\beta x}, y(1)=1$ Let $S=\left\{y_{\alpha,\beta}(x):\alpha,\beta\in\mathbb{R}\right\}$. Then which of the following functions belong(s) to the set S

A) $f(x)=\frac{x^2}{2}e^{-x}+\left(e-\frac{1}{2}\right)e^{-x}$ **B)** $f(x)=-\frac{x^2}{2}e^{-x}+\left(e-\frac{1}{2}\right)e^{-x}$

C) $f(x)=\frac{e^x}{2}\left(x-\frac{1}{2}\right)+\left(e-\frac{e^2}{4}\right)e^{-x}$ **D)** $f(x)=\frac{e^x}{2}\left(\frac{1}{2}-x\right)+\left(e-\frac{e^2}{4}\right)e^{-x}$

43. If $A,B,C\in M_2(R)$, $\det(A)>0$, $\det(B)>0$, $\det(C)>0$, $\det(ABC)=8$ and $D=\det(A+B+C)+\det(-A+B+C)+\det(A-B+C)+\det(A+B-C)$ (where M_2(R) represents 2×2 matrics with real entries). Then value of D can be

A) 24 **B)** 36 **C)** 48 **D)** 12

44. Consider lines $L_1 : y = ax, z = c;$

$$L_2 : y = -ax, z = -c;$$

$$L_3 : y = z, ax = -c.$$

Then L is a variable line which intersects the given lines $(a \neq b \neq c)$, then which of the following are correct

A) Locus of L passes through point $(0,0,c)$

B) Locus L is $a^2x^2 - y^2 + z^2 - c^2 = 0$

C) Locus L intersects the $XZ-$plane in hyperbola

D) Locus L intersects the $XY-$plane an ellipse

SECTION-2(Maximum Marks: 12)

Paragraph with Numerical

- This section contains THREE (03) question stems.
- There are TWO (02) questions corresponding to each question stem.
- The answer to each question is a NUMERICAL VALUE.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;
Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 45 and 46

Question Stem

Let $M = \{(x,y) \in \mathbb{R} \times \mathbb{R} : x^2 + y^2 \leq r^2\}$ Where $r > 0$, consider the geometric progression $a_n = \dfrac{1}{2^{n-1}}, n = 1,2,3,........$Let $S_0 = 0$ and, for $n \geq 1$, let S_n denote the sum of the first n terms of this progression. For $n \geq 1$, let C_n denote the circle with center $(S_{n-1},0)$ and radius a_n *and* D_n denote the circle with center (S_{n-1}, S_{n-1}) and radius a_n.

45. Consider M with $r = \dfrac{1025}{513}$. Let k be the number of all those circles C_n that are inside M. Let l be the maximum possible number of circles among these k circles such that no two circles intersect. Then $3k + 2l$ is

46. Consider M with $r = \dfrac{(2^{199} - 1)\sqrt{2}}{2^{198}}$. The number of all those circles D_n that are inside M is

Question Stem for Question Nos. 47 and 48

Question Stem

Let α *and* β be the roots of $x^2 - x - 1 = 0$, with $\alpha > \beta$. For all positive integers n, define

$$a_n = \frac{\alpha^n - \beta^n}{\alpha - \beta}, n \geq 1;\ b_1 = 1 \text{ and } b_n = a_{n-1} + a_{n+1}, n \geq 2$$

47. $\sum_{n=1}^{\infty} \frac{89a_n}{10^n} + \sum_{n=1}^{\infty} \frac{178b_n}{10^n} =$

48. Ten students in a class are allotted 10 different chairs. After interval if a student is allowed to sit randomly in any chair, in how many ways a student can sit either in his allotted seat or the neighboring seat only is a_n then n is

Question Stem for Question Nos. 49 and 50

Question Stem

The number of necklaces that can be made from $6n$ identical blue beads and 3 identical red beads is m

49. If $n = 3$ Then m is

50. If $n = 4$ Then m is

SECTION-3(Maximum Marks: 12)

Paragraph with Single Answer Type

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases.

Paragraph-I:

Let $P\left(2\sqrt{3}, \frac{5}{2}\right)$ is any point on the ellipse $\frac{x^2}{16} + \frac{y^2}{25} = 1$ having centre at C.

Let Q and R are feet of perpendicular from foci S_1 and S_2 on the tangent at P, tangent at P intersect $y - axis$ at T. N is foot of perpendicular from centre C on the normal at P and normal at P intersect major and minor axes at A and B, then

51. $(CA)(CT) + (PN)(PB) =$

A) 9 **B)** 25 **C)** 16 **D)** 34

52. $(S_1Q)(S_2R)+(S_1P)(S_2P)=$

A) $\frac{145}{4}$ B) $\frac{165}{4}$ C) $\frac{155}{4}$ D) 34

Paragraph-II:

Let U_1 *and* U_2 be two urns such that U_1 contains 3 white and 2 red balls, and U_2 contains only 1 white ball. A fair coin is tossed. If head appears then 1 ball is drawn random from U_1 and put into U_2. However, if tail appears then 2 balls are drawn at random from U_1 and put into U_2. Now 1 ball is drawn at random from U_2.

53. The probability of the drawn ball from U_2 being white is

A) $\frac{13}{30}$ B) $\frac{23}{30}$ C) $\frac{19}{30}$ D) $\frac{11}{30}$

54. Given that the drawn ball from U_2 is white, the probability that head appeared on the coin is

A) $\frac{17}{23}$ B) $\frac{11}{23}$ C) $\frac{15}{23}$ D) $\frac{12}{23}$

SECTION-4(Maximum Marks: 12)
Non-Negative Integer Answer Type

- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;
Zero Marks : 0 In all other cases.

55. The number of values of $a \in N$ such that the variance of $3,7,12,a,43-a$ is natural number is

56. The function $f(x)$ is differentiable, continuous, and $f(x) \neq 0$ for all x in the interval $[4,8]$. $f(4)=\frac{1}{4}, f(8)=\frac{1}{2}, \int_4^8 \frac{\left[f'(x)\right]^2}{\left[f(x)\right]^4}dx=1$ then $6f(6)=$

57. Let $M=\left\{\begin{bmatrix} a & b \\ c & d \end{bmatrix} : a,b,c,d \in \mathbb{R}(\textit{set of all real numbers})\right\}$ and $I=\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

If $A \in M$, $\det(A)=tr(A)=1$ and

$\det(A^4+I)+10\det(A^2+I)+x=4\det(A^3+I)+16\det(A+I)$ then $45-x=$

($tr(A)$ is sum the elements in the principal diagonal)

Sec: Sr.Super60_NUCLEUS&STERLING _BT JEE-ADVANCE-2021_P2 Date: 19-05-2023
Time: 02.00Pm to 05.00Pm GTA-25 Max. Marks: 180

KEY SHEET

PHYSICS

1	**A,C**	2	**B,C**	3	**B**	4	**A,D**	5	**A,C**	6	**C,D**
7	**3**	8	**1**	9	**7**	10	**2**	11	**1.5**	12	**3**
13	**A**	14	**A**	15	**A**	16	**A**	17	**4**	18	**8**
19	**4**										

CHEMISTRY

20	**A,B**	21	**A,B**	22	**A,B,D**	23	**A,C**	24	**A,B**	25	**B,C,D**
26	**496.50**	27	**137.40**	28	**20**	29	**3**	30	**90**	31	**280**
32	**A**	33	**A**	34	**A**	35	**B**	36	**5**	37	**6**
38	**4**										

MATHEMATICS

39	**A,B,D**	40	**A,D**	41	**A,C**	42	**A,C**	43	**A,B,C**	44	**A,B**
45	**40**	46	**199**	47	**34**	48	**11**	49	**37**	50	**61**
51	**D**	52	**C**	53	**B**	54	**D**	55	**0**	56	**2**
57	**8**										

SOLUTIONS

PHYSICS

1. Particle velocity = - wave velocity x slope.

2. $$mg(4R-2R)=\frac{1}{4\pi\varepsilon_0}nq.q\left[\frac{1}{R}-\frac{1}{3R}\right]$$

3. $$\bar{a}=\bar{a}'+\bar{\omega}\times(\bar{\omega}\times\bar{r})$$

4. $$\phi=\int_a^{2a}\frac{\mu_0 l}{2\pi r}adr=\frac{\mu_0 la}{2\pi}\ln 2$$

The current that will flow through the loop,

$$q=\left|\frac{\Delta\phi}{R}\right|=\frac{\mu_0 la\ell 2}{2\pi R} \qquad \text{.................................... (i)}$$

The current induced in the loop is

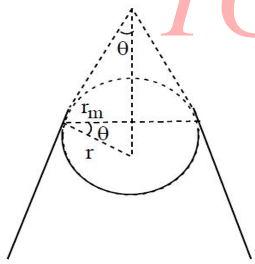
$$i=\frac{1}{R}\frac{d\phi}{dt}=\frac{-\mu_0 a\ln 2}{2\pi R}\frac{dl}{dt}$$

The net attractive force on the loop is

$$F=\left(\frac{\mu_0 lia}{2\pi a}\right)-\left(\frac{\mu_0 lia}{4\pi a}\right)=\frac{\mu_0 li}{4\pi} \qquad \text{...(ii)}$$

Now, $mv=\int Fdt$ $\;mv=\int_1^0\frac{\mu_0 l}{4\pi}\left(-\frac{\mu_0 a\ln 2}{2\pi R}\frac{dl}{dt}\right)dt$ $\;v=\frac{\mu_0^2 l^2 a\ell n\,2}{16\pi^2 mR}$

5.



$r_m=r\cos\theta$

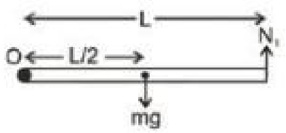
Also, $P_0-\frac{2T}{r}+\rho gh=P_0\Rightarrow h=\frac{2T}{r\rho g}$

6. $$q''_{net},f=\sigma\left(T_A^4-T_1^4\right)=\sigma\left(T_1^2-T_2^2\right)........=\sigma\left(T_{n-1}^4-T_n^4-T_B^4\right)$$

$$\Rightarrow\sigma\left(T_A^4-T_1^4\right)=(n+1)q''_{net},f\Rightarrow q''_{net},f=\frac{\sigma}{(nH)}\left(T_A^4-T_B^4\right)\Rightarrow\frac{q''_{net,f}}{q''_{net,i}}=\frac{1}{n+1}$$

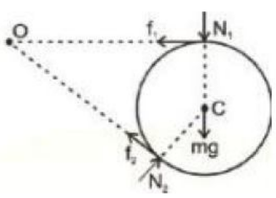
7. FBD of rod and cylinder is as shown.

$\therefore$ Net torque on rod about hinge $'O'=0$



$$\therefore N_1\times L=mg\times\frac{L}{2}or N_1=\frac{mg}{2}$$

Net torque on cylinder about its centre C is zero $\therefore f_1R=f_2R\ or f_1=f_2$

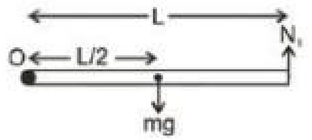


Net torque on cylinder about its centre O is zero

$\therefore N_2 \times L = N_1 \times L + mgL \ or \ N_2 = \dfrac{3mg}{2}$

8. FBD of rod and cylinder is as shown.

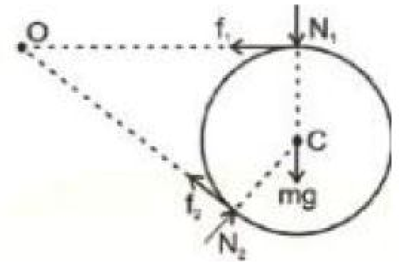
$\therefore$ Net torque on rod about hinge $'O' = 0$



$\therefore N_1 \times L = mg \times \dfrac{L}{2} or N_1 = \dfrac{mg}{2}$

Net torque on cylinder about its centre C is zero

$\therefore f_1 R = f_2 R \ or f_1 = f_2$



Net torque on cylinder about its centre O is zero

$\therefore N_2 \times L = N_1 \times L + mgL \ or \ N_2 = \dfrac{3mg}{2}$

9. $\sigma = \dfrac{Q}{\pi R^2}$

Let the charge on the ball be 'q'

$\dfrac{\sigma R}{2\varepsilon_0} + \dfrac{q}{4\pi\varepsilon_0 a} = 0 \ q = -\sigma R 2\pi a$

The electrostatic force on the ball due to the uniformly charged disc is

$F = \dfrac{\sigma}{2\varepsilon_0}|q| = \dfrac{\sigma}{2\varepsilon_0}(\sigma R 2\pi a) = \dfrac{\sigma^2 \pi a R}{\varepsilon_0}$

$F = \left(\dfrac{Q}{\pi R^2}\right)^2 \dfrac{\pi a R}{\varepsilon_0} \ F = \dfrac{Q^2 a}{\pi \varepsilon_0 R^3}$

10. $\sigma = \dfrac{Q}{\pi R^2}$

Let the charge on the ball be 'q'

$\dfrac{\sigma R}{2\varepsilon_0} + \dfrac{q}{4\pi\varepsilon_0 a} = 0$

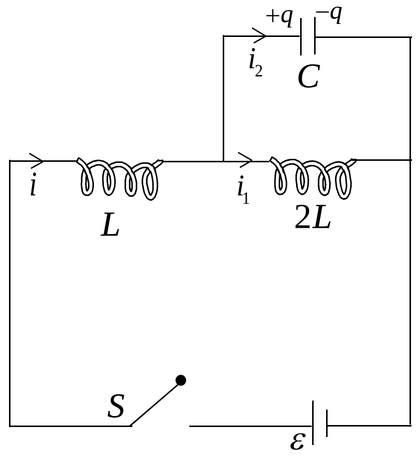
$q = -\sigma R 2\pi a$

The electrostatic force on the ball due to the uniformly charged disc is

$F = \dfrac{\sigma}{2\varepsilon_0}|q| = \dfrac{\sigma}{2\varepsilon_0}(\sigma R 2\pi a) = \dfrac{\sigma^2 \pi a R}{\varepsilon_0}$

$F = \left(\dfrac{Q}{\pi R^2}\right)^2 \dfrac{\pi a R}{\varepsilon_0} \ F = \dfrac{Q^2 a}{\pi \varepsilon_0 R^3}$

11.



$$L\frac{di}{dt}+2L\frac{di_1}{dt}=\varepsilon$$

$$\frac{di}{dt}=\frac{\varepsilon}{L}-2\frac{di_1}{dt}\ \text{............ (i)}$$

$$\frac{di}{dt}=\frac{di_1}{dt}+\frac{di_2}{dt}$$

$$\frac{\varepsilon}{L}=2\frac{di_1}{dt}=\frac{di_1}{dt}+\frac{di_2}{dt}$$

$$\frac{di_2}{dt}=\frac{\varepsilon}{L}-3\frac{di_1}{dt}$$

$$\frac{d^2q}{dt^2}=\frac{\varepsilon}{L}-\frac{3q}{2LC}\Rightarrow\frac{d^2q}{dt^2}=-\frac{3}{2LC}\left(q-\frac{2C_\varepsilon}{3}\right)$$

$$\omega=\sqrt{\frac{3}{2LC}}$$

Now, $q-\frac{2C_\varepsilon}{3}=A\sin(\omega t+\alpha)$ .... (iii)

$i_2=\frac{dq}{dt}=\omega A\cos(\omega t+\alpha)$ .... (iv)

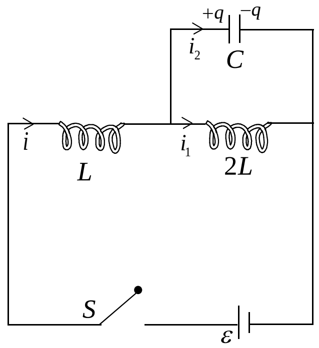
At $t=0, q=0, i_2=0$

From (iii) and (iv), we get

$$\alpha=\frac{3\pi}{2}, A=\frac{2C\varepsilon}{3}$$

Hence $q=\frac{2C\varepsilon}{3}\left[1-\cos\left(t\sqrt{\frac{3}{2LC}}\right)\right]$ $i_2=\varepsilon\sqrt{\frac{2C}{3L}}\sin\left(t\sqrt{\frac{3}{2LC}}\right)$

12.



$$L\frac{di}{dt}+2L\frac{di_1}{dt}=\varepsilon$$

$$\frac{di}{dt}=\frac{\varepsilon}{L}-2\frac{di_1}{dt}\ldots\ldots\ldots\ldots \text{(i)}$$

$$\frac{di}{dt}=\frac{di_1}{dt}+\frac{di_2}{dt}$$

$$\frac{\varepsilon}{L}=2\frac{di_1}{dt}=\frac{di_1}{dt}+\frac{di_2}{dt}$$

$$\frac{di_2}{dt}=\frac{\varepsilon}{L}-3\frac{di_1}{dt}$$

$$\frac{d^2q}{dt^2}=\frac{\varepsilon}{L}-\frac{3q}{2LC}\Rightarrow\frac{d^2q}{dt^2}=-\frac{3}{2LC}\left(q-\frac{2C_\varepsilon}{3}\right)$$

$$\omega=\sqrt{\frac{3}{2LC}}$$

Now, $q-\frac{2C_\varepsilon}{3}=A\sin(\omega t+\alpha)$ .... (iii)

$i_2=\frac{dq}{dt}=\omega A\cos(\omega t+\alpha)$ .... (iv)

At $t=0, q=0, i_2=0$

From (iii) and (iv) , we get

$$\alpha=\frac{3\pi}{2}, A=\frac{2C\varepsilon}{3}$$

Hence $q=\frac{2C\varepsilon}{3}\left[1-\cos\left(t\sqrt{\frac{3}{2LC}}\right)\right]$

$$i_2=\varepsilon\sqrt{\frac{2C}{3L}}\sin\left(t\sqrt{\frac{3}{2LC}}\right)$$

13. $y_{cm}=a/2$

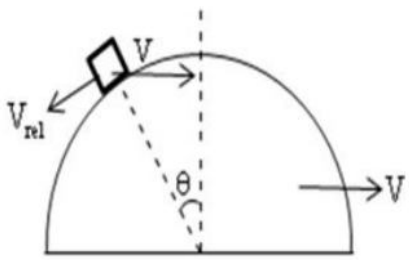
$$X_{cm}=\frac{2ma/2}{3m}=a/3$$

$$mg\cos\theta\times a/3=mg\sin\theta\frac{a}{2}$$

$$\tan\theta=2/3$$

14. $\mu>\frac{2}{3}$

15.



Assume velocity of m is $-V_x\hat{i}-V_y\hat{j}$

And velocity $3m$ $V_2\hat{i}$

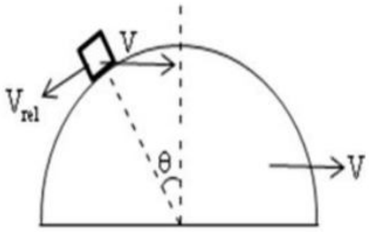
As per $LCLM\Rightarrow m\,V_x=3mV_2$ ....(1)

As per $L.C.E\Rightarrow\frac{1}{2}m\,V_x^2+\frac{1}{2}m\,V_y^2+\frac{1}{2}3mV_2^2=mg\,R(1-\cos\theta)$ ....(2)

From constraint relation $V_y \cos\theta - V_x \sin\theta = (V_2 \sin\theta)$ ……………………..(3)

Solving (1), (2) and (3) we get V_x, V_y, V_2

16.



$3mV = m\left(V_{rel}\cos\theta - V\right)$ ________ (i)

$mgR(1-\cos\theta) = \frac{1}{2}mV^2 + \frac{1}{2}m\left(V_t^2 + 2VV_t\cos(\pi-\theta)\right)$ _____ (ii)

$\omega = \frac{V_{rel}}{R}$

17. $dq = 2\pi L dx\sigma \quad dv = \frac{2\pi L\sigma dx}{4\pi\varepsilon_0\sqrt{x^2+L^2}}$

$\therefore dv = \frac{\sigma L}{2\varepsilon_0}\int_O^L \frac{dx}{\sqrt{x^2+L^2}} \Rightarrow V = \frac{\sigma L}{2\varepsilon_0}\left|\ln(X+\sqrt{X^2+L^2}\right|_O^L$

$V = \frac{\sigma L}{2\varepsilon_0}\left[\ln(L+L\sqrt{2}) - \ln L\right] \quad V = \frac{\sigma L}{2\varepsilon_0}\ln(1+\sqrt{2})$

18. Let natural length of middle segment is x and that of after segment is y.

Hence $y^2 = (BC)^2 + X^2 or 2y\frac{dy}{dX} = 2X$. Or ydy=xdx $\Rightarrow dy = \frac{x}{y}dX = \cos\theta$

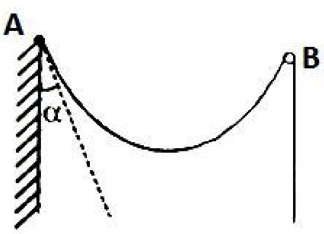
Also, $\cos\theta = \frac{X}{y}$, For equilibrium of Point P.

$QF = K_1\Delta X + 2k_2\Delta y\cos\theta$ Or $F = \frac{c}{X}\Delta X + \frac{2c}{y}\times\Delta y\cos\theta$

Or $F = \frac{c}{X}\Delta X + \frac{2c}{X}\times\cos^3\theta \;\; F = T + 2T\cos^3\theta \;\therefore T = \frac{F}{1+2\cos^3\theta} = \frac{10}{1+2\times\left(\frac{1}{2}\right)^3} = 8N$

19. By symmetry tension at A=tension at $B = 10\lambda g$

$2T\cos\alpha = 16\lambda g$



$\Rightarrow \cos\alpha = \frac{16\lambda g}{20\lambda g} = \frac{4}{5}$

CHEMISTRY

20. Conceptual

21. At $pH-1$ (A) Methionine exist as $+1$ cation

(B) Glutamic acid exist as $+1$ cation

(C) Lysine exist as $+2$ cation

Electrophoretic mobility is directing proportional to magnitude of change

At $pH-12$ Methionine exist as -1 anion

Lysine exist as -1 anion

Glutamic acid exist as -2 anion

22. Conceptual

23. $CuCN$ is in soluble on addition of KCN complex is formed so number of ions increases depression in freezing point increases

$$\underset{(S)}{CuCN}+\underset{(aq)}{3KCN}\rightarrow K_3\left[Cu(CN)_4\right]_{(aq)}$$

$$Cu(CN)_S+\underbrace{3K^+_{(aq)}+3CN^-_{(aq)}}_{6\,moles}\rightarrow\underbrace{3K^+_{(aq)}+\left[Cu(CN)_4\right]^{3-}_{(aq)}}_{4\,moles}$$

$\Delta T_f\alpha$ number of particles of solute

24. Conceptual

25. $\Delta U=C_V(T_2-T_1)\ \Delta U=-P^{ext}(V_2-V_1)$

$$\frac{3}{2}R(T_2-T_1)=-1\left[\frac{RT_2}{P_2}-\frac{RT_1}{P_1}\right]=-R\left[\frac{T_2}{1}-\frac{T_1}{2}\right]3T_2-3T_1=-2T_2+T_1$$

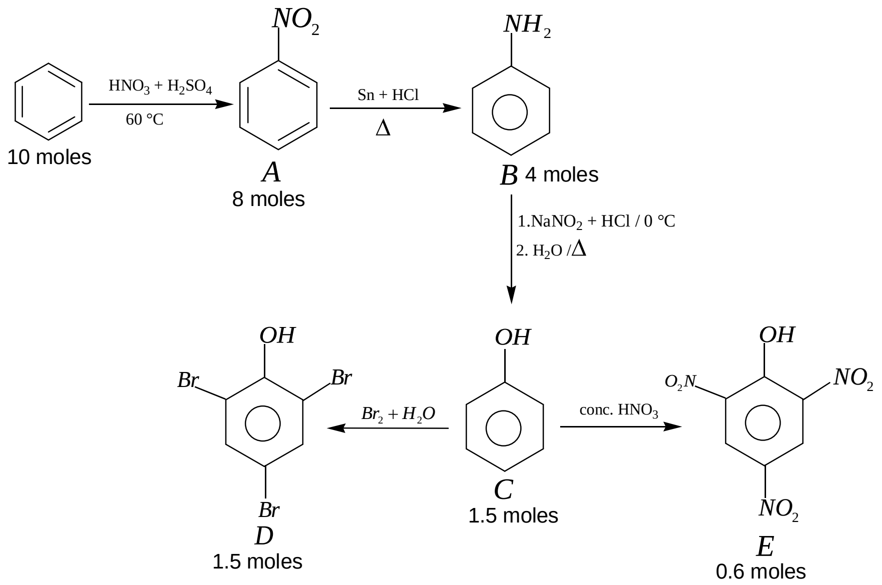
$$5T_2=4T_1\Rightarrow T_2=\frac{4}{5}\times T_1=\frac{4}{5}\times300=240K$$

$$\Delta S=2.303\left[nC_p\log\frac{T_2}{T_1}+nR\log\frac{P_1}{P_2}\right]=2.3\left[1\times\frac{5}{2}\times2\times\log\frac{240}{300}+1\times2\times\log\frac{2}{1}\right]$$

$$=2.3\left[5\times\log\frac{4}{5}+2\log2\right]=2.3\left[5(0.6-07)+(2\times0.3)\right]$$

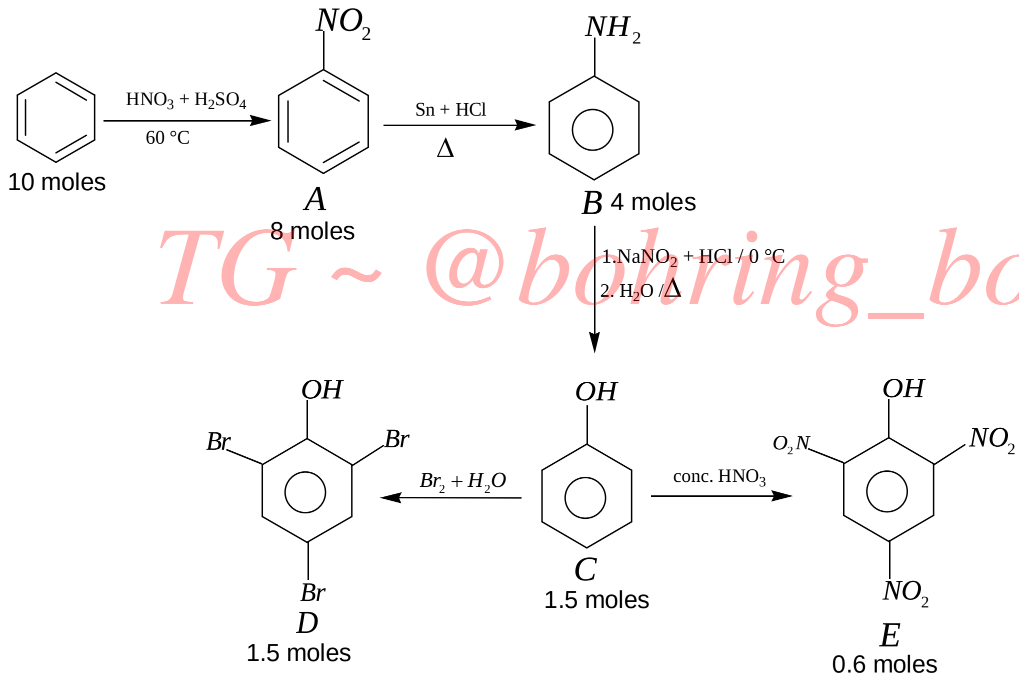
$$=2.3\times0.1=0.23cal\ \Delta H=nCp\Delta T=1\times\frac{5}{2}\times2\times(240-300)=-300cal$$

26.



Weight of $D = 1.5 \times 331 = 496.50g$

27.



Weight of $E = 0.6 \times 229 = 137.40g$

28.

$$10^6 g\ of\ H_2O \rightarrow \frac{244}{61} = 4moles\, HCO_3^- \equiv 2moles\, Ca\left(HCO_3\right)_2$$

$$10^3 g\ of\ H_2O \rightarrow 2\times10^{-3} moles\, Ca\left(HCO_3\right)_2$$

$$10^6 g\ of\ H_2O \rightarrow \frac{240}{96} = 2.5moles\, SO_4^{2-} \equiv 2.5moles\, CaSO_4$$

$$10^3 g\ of\ H_2O \rightarrow 2.5\times10^{-3} moles\, CaSO_4$$

$$\underset{2.0\times10^{-3} moles}{Ca\left(HCO_3\right)_2} + 2NaOH \rightarrow CaCO_3 \downarrow + \underset{2.0\times10^{-3} moles}{Na_2CO_3} + 2H_2O$$

$$\underset{2.5\times10^{-3} moles}{CaSO_4} + \underset{2\times10^{-3} moles}{Na_2CO_3} \rightarrow \underset{2\times10^{-3} moles}{CaCO_3} \downarrow + Na_2SO_4$$

Number of moles of $CaSO_4$ left in $H_2O = moles\ of\ Ca^{2+}$

in 1kg of Treated water $= 0.5\times10^{-3}$

In $10^6 g$ of treated water moles of $Ca^{2+} = 0.5 moles = 0.5 \times 40 = 20g$

Concentration of Ca^{2+} in treated water $= 20\,ppm$

29.
$$10^6 g \text{ of } H_2O \rightarrow \frac{244}{61} = 4 moles\, HCO_3^- \equiv 2 moles\, Ca(HCO_3)_2$$

$$10^3 g \text{ of } H_2O \rightarrow 2 \times 10^{-3} moles\, Ca(HCO_3)_2$$

$$10^6 g \text{ of } H_2O \rightarrow \frac{240}{96} = 2.5 moles\, SO_4^{2-} \equiv 2.5 moles\, CaSO_4$$

$$10^3 g \text{ of } H_2O \rightarrow 2.5 \times 10^{-3} moles\, CaSO_4$$

$$\underset{2.0\times10^{-3} moles}{Ca(HCO_3)_2} + 2NaOH \rightarrow CaCO_3 \downarrow + \underset{2.0\times10^{-3} moles}{Na_2CO_3} + 2H_2O$$

$$\underset{2.5\times10^{-3} moles}{CaSO_4} + \underset{2\times10^{-3} moles}{Na_2CO_3} \rightarrow \underset{2\times10^{-3} moles}{CaCO_3} \downarrow + Na_2SO_4$$

Number of moles of $CaSO_4$ left in $H_2O = moles\ of\ Ca^{2+}$

in 1kg of Treated water $= 0.5 \times 10^{-3}$

Each Ca^{2+} is exchanged for two H^+ ions

Number of moles of H^+ in 1kg of treated water

$= 2 \times 0.5 \times 10^{-3} = 10^{-3}$ $\left[H^+\right] = 10^{-3} M$

$pH = 3$

30.
$K = \frac{2.303}{t}\log\frac{p_0}{p}$ $\quad p_0 \rightarrow Pressure\ of\ DTBP\ at\ t = 0$

$p \rightarrow Pressure\ of\ DTBP\ at\ t$

$\frac{Kt}{2.303} = \log p_0 - \log p$ $\log p = \frac{-kt}{2.303} + \log p_0$

$y = mx + c$

Slope $= -1 = \frac{-K}{2.303}$ $K = 2.303$

$\log p_0 = 2$ $p_0 = 10^2 = 100\ torr$

$$2.303 = \frac{2.303}{1}\log\frac{100}{p}$$

$$\log\frac{100}{p} = 1 \Rightarrow \frac{100}{p} = 10 \Rightarrow p = 10$$

Pressure of DTBP after 1 hour = 10 torr

% DTBP decomposed in hour =100-10=90

31.
$K = \frac{2.303}{t}\log\frac{p_0}{p}$ $\quad p_0 \rightarrow Pressure\ of\ DTBP\ at\ t = 0$

$p \rightarrow Pressure\ of\ DTBP\ at\ t$

$$\frac{Kt}{2.303} = \log p_0 - \log p$$

$$\log p = \frac{-kt}{2.303} + \log p_0 \quad y = mx + c$$

$$\text{Slope } = -1 = \frac{-K}{2.303} \quad K = 2.303$$

$$\log p_0 = 2$$

$$p_0 = 10^2 = 100\ torr$$

$$2.303 = \frac{2.303}{1}\log\frac{100}{p}$$

$$\log\frac{100}{p} = 1 \Rightarrow \frac{100}{p} = 10 \Rightarrow p = 10$$

Pressure of DTBP after 1 hour = 10 torr

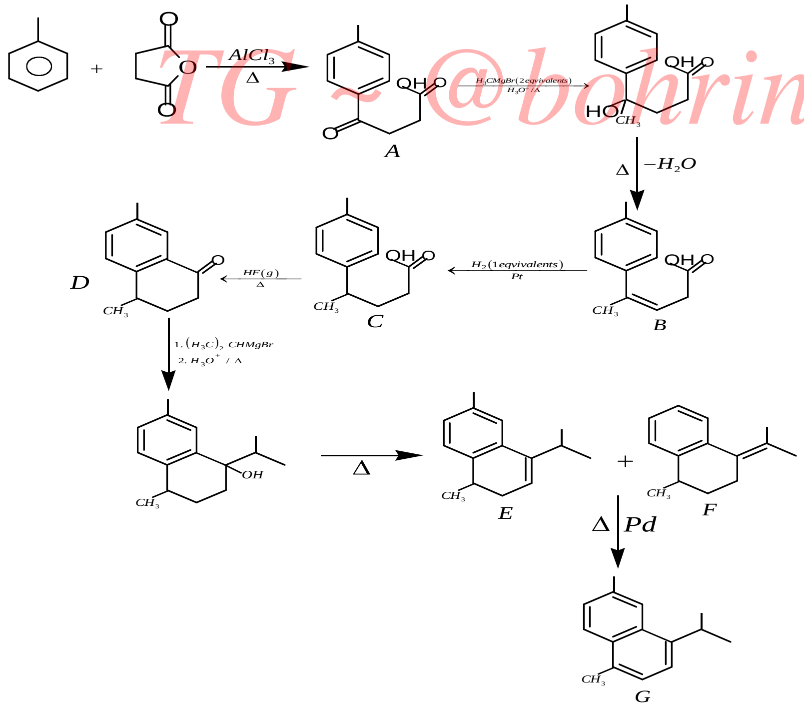
% DTBP decomposed in hour =100-10=90

$$Me_3COOCMe_3(g) \rightarrow 2MeCOMe(g) + C_2H_6(g)$$

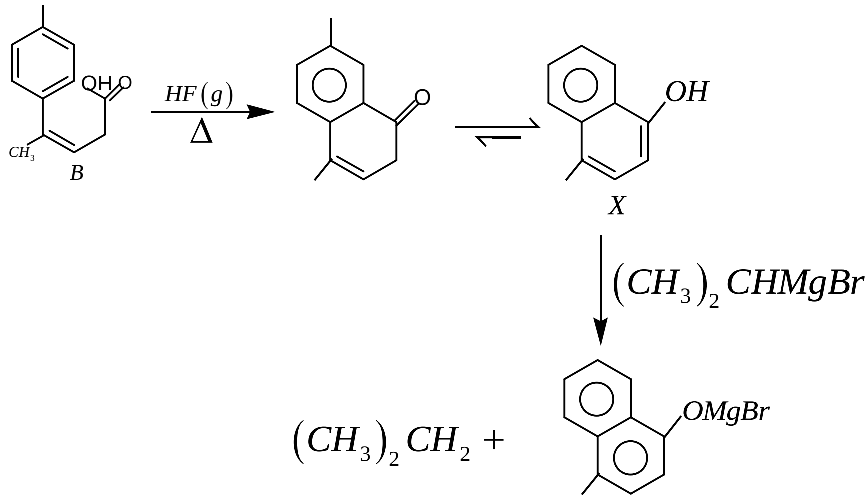
$t=0$	100	0	0
$t=1$	10	2×90	90

Total pressure after 1 hour $= 10 + 180 + 90 = 280\ torr$

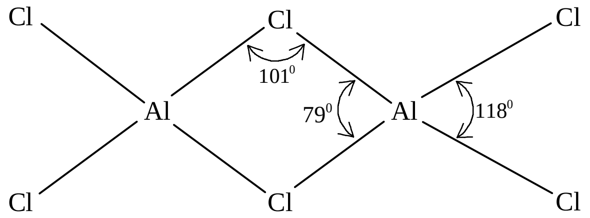
32.



33.



34.



35. Conceptual

36. $E_{cell} = E_{Cu} - E_H = 0.34 - 0.88 = -0.54V$

$2H^+_{(aq)} + 2e^- \to H_2(g)$

$$-0.54V = 0 - \frac{0.06}{2}\log\frac{1}{\left[H^+\right]^2}$$

$$-0.54 = -\frac{0.06}{2} \times -2\log\left[H^+\right] = -0.06 \times pH$$

$pH = 9$

$$pOH = pK_b + \log\frac{[BCl]}{[BOH]}$$

$$5 = pK_b + \log\frac{0.1}{0.2}$$

pK_b of $BOH = 5.3$

At equivalence point, volume of HCl consumed $= 20ml$

$$BOH + HCl \to BCl + H_2O$$

	BOH	HCl	BCl
Initial m. moles	2	2	0
At eq. point	0	0	2

$$[BCl] = \frac{2}{40} = 5\times10^{-2}M \quad pH = 7 - \frac{1}{2}\left[pK_b + \log[BCl]\right]$$

$$= 7 - \frac{1}{2}\left[5.3 + \log 5\times10^{-2}\right] = 7 - \frac{1}{2}[5.3 + 0.7 - 2] = 5$$

37. Beryl is $Be_3Al_2[SiO_3]_6$

Ans: 6

38. $\left(\Delta t_f\right)_{expected} = 2\times1.86\times0.1$

$\left(\Delta t_f\right)_{actual} = 0.37944K$

$$NH_4^+ + Cl^- + H_2O \rightarrow NH_4OH + H^+$$

	NH_4^+	Cl^-	NH_4OH	H^+
Initial	0.1	0.1	0	0
After hydrolysis	0.1-x	0.1	x	x

Total moles of particles after hydrolysis $= 0.2 + x$

$$\frac{0.37944}{2 \times 1.86 \times 0.1} = \frac{0.2 + x}{0.2}$$

$x = 0.004$

% hydrolysis $= \frac{100 \times 0.004}{0.1} = 4$

MATHEMATICS

39.
$$f(x)=\begin{cases}\cos^{-1}x, & -1\le x<0\\ \sin^{-1}x, & 0\le x\le 1\end{cases} \quad and \quad g(x)=\begin{cases}\sin^{-1}x, & -1\le x<0\\ \cos^{-1}x, & 1\ge x\ge 0\end{cases}$$

$$h(x)=\min\{f(x),g(x)\}=\begin{bmatrix} g(x), & -1\le x<0\\ f(x), & 0\le x<\frac{1}{\sqrt{2}}\\ g(x), & \frac{1}{\sqrt{2}}\le x\le 1\end{bmatrix}$$

$$h(x)=\begin{bmatrix}\sin^{-1}x, & -1\le x<0\\ \sin^{-1}x, & 0\le x<\frac{1}{\sqrt{2}}\\ \cos^{-1}x, & \frac{1}{\sqrt{2}}\le x\le 1\end{bmatrix}$$

$\Rightarrow$ h(x) is continuous and not differentiable at $x=-1,\frac{1}{\sqrt{2}},1$ and $h_{\max}=h\left(\frac{1}{\sqrt{2}}\right)=\frac{\pi}{4}$

40.
$$n_{c_{r-1}}>n-1_{c_r}\Rightarrow\frac{n}{(n-r+1)(n-r)}>\frac{1}{n}$$

$$\Rightarrow n^2-(3r-1)n+r^2-r<0$$

$$\Rightarrow n\in\left(\frac{3r-1-\sqrt{5r^2-2r+1}}{2},\frac{(3r-1)+\sqrt{5r^2-2r+1}}{2}\right)$$

Let $\alpha(r)=\frac{3r-1-\sqrt{5r^2-2r+1}}{2}\ \beta(r)=\frac{(3r-1)+\sqrt{5r^2-2r+1}}{2}$

$\beta(r)-\alpha(r)=\sqrt{5r^2-2r+1}>1$

$M(r)$ be largest integer in $(\alpha(r),\beta(r))$

$$\beta(r)-1\le M(r)<\beta(r)\ \underset{r\to\infty}{lt}\frac{\beta(r)-1}{r}\le\underset{r\to\infty}{lt}\frac{M(r)}{r}<\underset{r\to\infty}{lt}\frac{\beta(r)}{r}$$

$$\Rightarrow\frac{3+\sqrt{5}}{2}\le\underset{r\to\infty}{lt}\frac{M(r)}{r}<\frac{3+\sqrt{5}}{2}\ a=3,b=5$$

41.
$$P=\frac{5_{c_1}(8_{c_2}-4)\cdot(6_{c_2}-2)}{10_{c_2}.8_{c_2}.6_{c_2}}=\frac{26}{315}=\frac{m}{n}$$

42.
$$\frac{dy}{dx}+\alpha y=x.e^{\beta x}$$
$$\Rightarrow y.e^{\alpha x}=\int x.e^{(\alpha+\beta)x}.dx$$

Case (i) if $\alpha+\beta \neq 0$

$$y.e^{\alpha x} = \left(\frac{x}{(\alpha+\beta)} - \frac{1}{(\alpha+\beta)^2}\right)e^{(\alpha+\beta)x} + c$$

$$\Rightarrow y = \frac{e^{\beta x}}{\alpha+\beta} - \left(x - \frac{1}{\alpha+\beta}\right) + c.e^{-x}$$

Case (ii) if $\alpha+\beta=0$, Then, $y.e^{\alpha x} = \frac{x^2}{2} + c$

sub $\alpha=1$, $y = \frac{x^2}{2}.e^{-x} + c.e^{-x}$

$$y(1)=1 \Rightarrow c = e - \frac{1}{2}$$

43.

$$D \geq 12\left(\det(A).\det(B).\det(c)\right)^{\frac{1}{3}}$$

$$\Rightarrow D \geq 12.(8)^{1/3}$$

$$\Rightarrow D \geq 24$$

44. Plane through line $y=ax,\ z=c$ is $(y-ax)+\lambda_1(z-c)=0$

Similarly, $(y+ax)+\lambda_2(z+c)=0$

$\Rightarrow (y+c)+\lambda_1(y-c)=0$ and $\Rightarrow (y-c)+\lambda_2(y+c)=0$

$$\Rightarrow \lambda_1 = \frac{y+c}{y-c}, \frac{-1}{\lambda_2} = \frac{y+c}{y-c}; \lambda_1\lambda_2 = 1$$

$\therefore$ Locus is $\left(\frac{y-ax}{z-c}\right)\left(\frac{y+ax}{z+c}\right)=1$

45.

$$\because a_n = \frac{1}{2^{n-1}} \text{ and } S_n = 2\left(1-\frac{1}{2^n}\right)$$

For circles C_n to be inside M

$$S_{n-1}+a_n < \frac{1025}{513} \Rightarrow S_n < \frac{1025}{513} \Rightarrow 1-\frac{1}{2^n} < \frac{1025}{1026} = 1-\frac{1}{1026}$$

$$\Rightarrow 2^n < 1026 \Rightarrow n \leq 10$$

$\therefore$ Number of circles inside be $10 = K$

Clearly alternate circles do not intersect each other i.e., C_1, C_3, C_5, C_7, C_9 do not as C_2, C_4, C_6, C_8 and C_{10} do not intersect each other hence maximum 5 set of other. $\therefore l = 5 \therefore 3K + 2l = 40$

46.

$$\because r = \frac{\left(2^{199}-1\right)\sqrt{2}}{2^{198}}$$

Now, $\sqrt{2}S_{n-1} + a_n < \left(\frac{2^{199}-1}{2^{198}}\right)\sqrt{2}$

$$2\sqrt{2}\left(1-\frac{1}{2^{n-1}}\right)+\frac{1}{2^{n-1}}<\left(\frac{2^{199}-1}{2^{198}}\right)\therefore 2\sqrt{2}-\frac{\sqrt{2}}{2^{n-2}}+\frac{1}{2^{n-1}}<2\sqrt{2}-\frac{\sqrt{2}}{2^{198}}$$

$$\frac{1}{2^{n-2}}\left(\frac{1}{2}-\sqrt{2}\right)<-\frac{\sqrt{2}}{2^{198}}$$

$$\frac{2\sqrt{2}-1}{2\cdot 2^{n-2}}>\frac{\sqrt{2}}{2^{198}}\quad 2^{n-2}<\left(2-\frac{1}{\sqrt{2}}\right)2^{197}\therefore n\le 199\therefore \text{ Number of circles }=199$$

47. $\alpha=\frac{\sqrt{5}+1}{2}\ \beta=\frac{-\sqrt{5}+1}{2}$

$$\alpha-\beta=\sqrt{5}$$

$$\sum_{n=1}^{\infty}\frac{a_n}{10^n}=\frac{1}{\sqrt{5}}\sum_{n=1}^{\infty}\left(\left(\frac{\alpha}{10}\right)^n-\left(\frac{\beta}{10}\right)^n\right)=\frac{1}{\sqrt{5}}\left(\frac{\alpha}{10-\alpha}-\frac{\beta}{10-\beta}\right)$$

$$=\frac{1}{\sqrt{5}}\left(\frac{10(\alpha-\beta)}{100-10(\alpha+\beta)+\alpha\beta}\right)=\frac{10}{89}$$

$$b_n=a_{n-1}+a_{n+1}=\alpha^n+\beta^n$$

$$\sum_{n=1}^{\infty}\frac{b_n}{10^n}=\sum_{n=1}^{\infty}\left(\left(\frac{\alpha}{10}\right)^n+\left(\frac{\beta}{10}\right)^n\right)$$

48. Required number of ways is 89 is the 11th Fibonacci number

49. $m=3n^2+3n+1=37$

50. $n=3m^2+3n+1=61$

51. (CA)(CT)=$(CS)^2=b^2e^2$

$(PN)(PB)=b^2$

52. $(S_1Q)(S_2R)=a^2$

53. $P(white)=P(H\cap white)+P(T\cap white)=$

$$\frac{1}{2}.\left\{\frac{3}{5}\times 1+\frac{2}{5}.\frac{1}{2}\right\}+\frac{1}{2}\left\{\frac{{}^3C_2}{{}^5C_2}\times 1+\frac{{}^2C_2}{{}^5C_2}\right\}$$

$$=\frac{1}{2}\times\frac{8}{10}+\times\left\{\frac{3}{10}+\frac{1}{30}+\frac{12}{30}\right\}=\frac{23}{30}$$

54. $$P\left(Head/White\right)=\frac{P(Head\cap White)}{P(White)}=\frac{\frac{1}{2}\times\left\{\frac{3}{5}\times 1+\frac{2}{5}\times\frac{1}{2}\right\}}{\frac{23}{30}}=\frac{12}{23}$$

55. Mean $=13$

Variance $=\dfrac{9+49+144+a^2+(43-a)^2}{5}-(13)^2\in N$

$\Rightarrow 2a^2 - a + 1 - 5n = 0$ must have solution as natural number

Its $D = 40n - 7$ always has 3 at unit place

$\Rightarrow$ so, a can't be integer

56.
$$\int_4^8 \frac{f'(x)}{(f(x))^2}dx = -\frac{1}{f(x)}\Big|_4^8 = 2$$

$$\int_4^8 \left(\left(\frac{f'(x)}{(f(x))^2}\right)^2 - \frac{f'(x)}{(f(x))^2} + \frac{1}{4}\right)dx = 0$$

$$\Rightarrow \int_4^8 \left(\frac{f'(x)}{(f(x))^2} - \frac{1}{2}\right)^2 = 0 \Rightarrow \frac{f'(x)}{(f(x))^2} = \frac{1}{2}$$

$$\Rightarrow \frac{-1}{f(x)} = \frac{x}{2} - 6$$

57.
$A^2 = A - I$

$A^3 = -I$

$A^4 = -A$

$\det(A^4 + I_2) + 10\det(A^2 + I_2) + x = 4\det(A^3 + I_2) + 16\det(A + I_2)$

$= \det(I - A) + 10\det(A) + x = 16\det(A + I)$

$\Rightarrow x = 37$

44 YEARS OF EXCELLENCE | NARAYANA IIT-JEE ACADEMY-INDIA

Sec: OSR.IIT_*CO-SC **Date: 21-05-23**
Time: 3HRS **Max. Marks: 198**

Name of the Student: ___________________ **H.T. NO:**

21-05-23_OSR.STAR CO-SUPER CHAINA_JEE-ADV_GTA-10(P1)_SYLLABUS

PHYSICS: TOTAL SYLLABUS

CHEMISTRY: TOTAL SYLLABUS

MATHEMATICS: TOTAL SYLLABUS

TIME: 3HRS **IMPORTANT INSTRUCTIONS** Max Marks: 198

PHYSICS

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 1 – 6)	Questions with Single Correct Options	+3	-1	6	18
Sec – II (Q.N : 7 – 12)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-1	6	24
Sec – III (Q.N : 13 – 18)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+4	0	6	24
Total				**18**	**66**

CHEMISTRY

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 19 – 24)	Questions with Single Correct Options	+3	-1	6	18
Sec – II (Q.N : 25 – 30)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-1	6	24
Sec – III (Q.N : 31 – 36)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+4	0	6	24
Total				**18**	**66**

MATHEMATICS

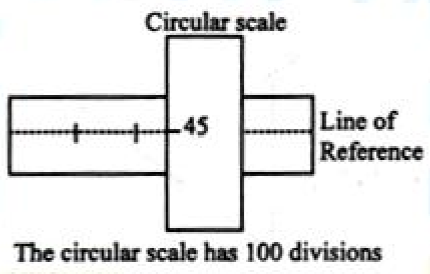
Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 37 – 42)	Questions with Single Correct Options	+3	-1	6	18
Sec – II (Q.N : 43 – 48)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-1	6	24
Sec – III (Q.N : 49 – 54)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+4	0	6	24
Total				**18**	**66**

PHYSICS **MAX.MARKS: 66**

SECTION – 1 (Maximum Marks: 18)

This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). **ONLY ONE** of these four option is the correct answer.
For each question, choose the correct option corresponding to the correct answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If only the correct option is chosen.
Zero Marks: 0 If none of the option is chosen.(i.e the question is un answered)
Negative Marks: -1 In all other cases.

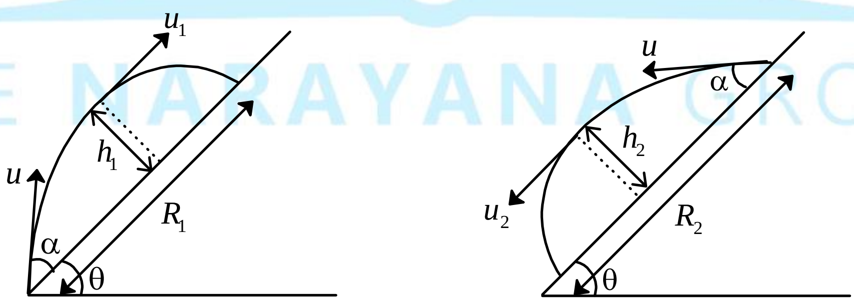
1. Consider a screw gauge without any zero error. What will be the final reading corresponding to the final state as shown? It is given that the circular head translates P main scale divisions in N rotations. One main scale division is equal to 1mm.



A) $(P/N)(2+45/100)$mm B) $(N/P)(2+45/N)$mm

C) $P(2/N+45/100)$mm D) $\left(2+\frac{45}{100}\times\frac{P}{N}\right)$mm

2. Two balls are thrown from an inclined plane at angle of projection α with the plane, one up the plane while other down the inclined plane (as shown in figure). In the figure u_1 and u_2 are the speeds when the line of motion of the particle is parallel to the inclined plane and h_1, h_2 are maximum displacement perpendicular to inclined plane respectively.



(i) $h_1 = h_2 = \frac{u^2 \sin^2\alpha}{2g\cos\theta}$ (ii) $T_1 = T_2 = \frac{2u\sin\alpha}{g\cos\theta} = T$

(iii) $R_2 - R_1 = g\sin\theta T^2$ (iv) $u_1 = u_2$

The correct choice is:

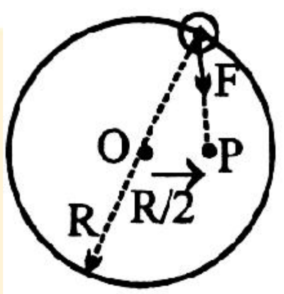
A) All are true

B) Statements (iii) and (iv) are true

C) Statements (i), (ii) and (iii) are true

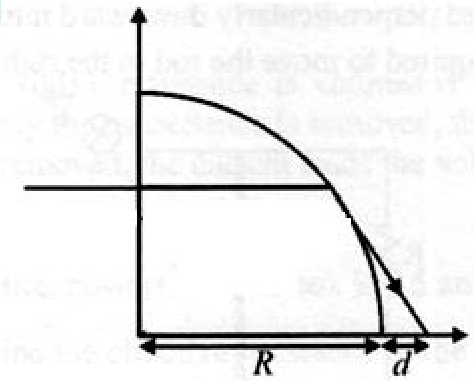
D) Statements (i), (ii) and (iv) are true

3. A small bead of mass m can move on a smooth circular wire (radius R) under the action of a force $F = \frac{Km}{r^2}$ directed (r = position of bead from P & K = constant) towards a point P with in the circle at a distance $\frac{R}{2}$ from the centre. What should be the minimum velocity of bead at the point of the wire nearest the centre of force (P) so that bead will complete the circle



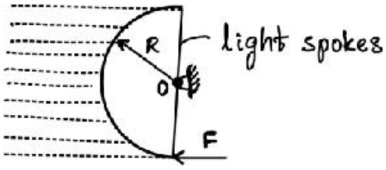
A) $\sqrt{\frac{3K}{R}}$ B) $\sqrt{\frac{8K}{3R}}$ C) $\sqrt{\frac{6K}{R}}$ D) none of these

4. A uniform horizontal light beam is incident upon a prism (quarter cylindrical shape) as shown in the figure. The radius of the prism is R and the cylinder material has a refractive index $\frac{2}{\sqrt{3}}$. A patch on the table for a distance d from the surface of the cylinder is unilluminated. Find the value of d in terms of R.



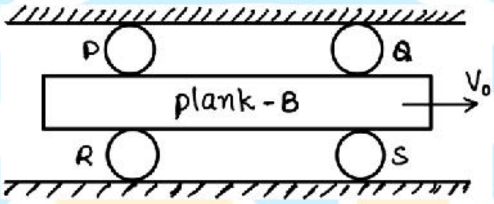
A) $R/2$ B) R C) $\sqrt{3}R$ D) $2R$

5. A hallow semi cylindrical gate of radius R, length ℓ, mass m is pivoted at its midpoint O of the diameter as shown in the figure holding liquid of density ρ. The force F required to prevent the rotation of the gate is equal to:



A) $\frac{2mg}{\pi}$ B) $\frac{mg}{\pi}$ C) zero D) $\frac{2\pi\rho g R^3 \ell}{3}$

6. A long plank B of mass 4m is moving horizontally with a speed v_0 . Let four identical uniform solid cylinders P,Q,R and S each of mass m are tightly placed between the plank and the horizontal fixed supports as shown in figure. There is no slipping at any contact. Kinetic energy of the system is:

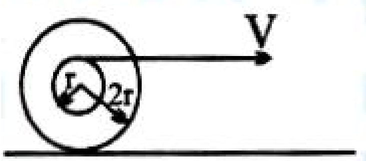


A) $\frac{11}{4} m\upsilon_0^2$ B) $3m\upsilon_0^2$ C) $5m\upsilon_0^2$ D) $7m\upsilon_0^2$

SECTION - 2 (Maximum Marks : 24)

This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

7. A bobbin of mass m and moment of inertia I relative to its own axis is being pulled along a horizontal surface by the light string tightly wrapped as shown in figure. There is no slipping on the surface throughout the motion.



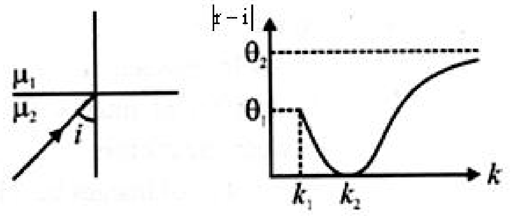
A) The angular velocity of bobbin when string is pulled horizontally with velocity V is $\omega = \frac{V}{3r}$

B) The angular velocity of bobbin when string is pulled horizontally with velocity V is $\omega = \frac{V}{r}$

C) If string is pulled by horizontal acceleration a. Then tension in string is $T = \frac{a}{9}\left(4m + \frac{I}{r^2}\right)$

D) If string is pulled by horizontal acceleration a. Then tension in string is $T = \left(\frac{I}{r^2} + 2m\right)\frac{a}{2}$

8. The figure shows a ray incident at an angel $i = \frac{\pi}{3}$. If the plot drawn shown in the variation of $|r-i|$ versus $\frac{\mu_1}{\mu_2} = k$, ($r =$ angle of refraction)



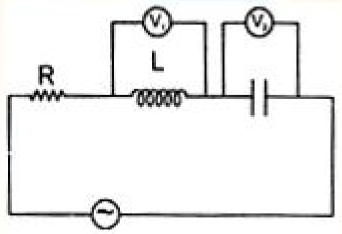
A) the value of k_1 is $\frac{2}{\sqrt{3}}$

B) the value of $\theta_1 = \frac{\pi}{6}$

C) the value of $\theta_2 = \frac{\pi}{3}$

D) the value of k_2 is 1

9. In the circuit shown, resistance $R = 100\Omega$, inductance $L = \frac{2}{\pi}H$ and capacitance $C = \frac{8}{\pi}\mu F$ are connected in series with an ac source of 200 volt and frequency 'f'. If the readings of the hot wire voltmeters V_1 and V_2 are same then:



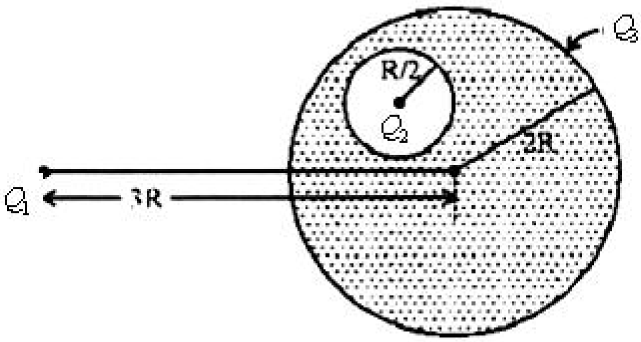
A) $f = 125\,Hz$

B) $f = 250\pi\,Hz$

C) current through R is 2A

D) $V_1 = V_2 = 1000\,volt$

10. A spherical conductor of radius 2R has a spherical cavity of radius $\frac{R}{2}$. The cavity does not enclose the centre of sphere. Charges Q_1 and Q_2 are placed as shown in figure. Q_2 is at the centre of cavity. An additional charge Q_3 is given to the sphere. $\left(K=\frac{1}{4\pi\varepsilon_0}\right)$



A) The potential of the sphere is $\frac{KQ_1}{3R}+\frac{K(Q_2+Q_3)}{2R}$

B) The potential inside the cavity at a distance $r\left(r<\frac{R}{2}\right)$ from the centre of cavity is $\frac{KQ_2}{r}+\frac{5KQ_1}{6R}-\frac{3KQ_2}{2R}$

C) The value of potential outside the sphere at a distance r from the centre of sphere is $\frac{k(Q_2+Q_3)}{r}+\frac{kQ_1}{r'}$ where r' is the distance from Q_1

D) The charge that will flow into ground if the sphere is grounded $Q_2+Q_3+\frac{2Q_1}{3}$

11. Consider the following decay schemes:

$${}^{198}_{79}Au \rightarrow X+\beta_1^- \rightarrow {}^{198}_{80}Hg+\gamma_1; \quad Au \rightarrow Y+\beta_2^- \rightarrow {}^{198}_{80}Hg+\gamma_2$$

$${}^{198}_{79}Au \rightarrow X+\beta_1^- \rightarrow Y+\gamma_3 \rightarrow {}^{198}_{80}Hg+\gamma_2$$

The energies corresponding to X and Y with respect to ${}^{198}_{80}Hg$ are 1.088 MeV and 0.412 MeV respectively [Note the energy of ${}^{198}_{80}Hg$ is taken to be 0.0 MeV]. The atomic masses of ${}^{198}_{79}Au$ and ${}^{198}_{80}Hg$ are 197.968 u and 197.966 u, respectively, where 1 u should be taken as $931 MeV/c^2$. Then,

A) the energies corresponding to γ_1 and γ_2 are 1.088 MeV and 0.412 MeV respectively.

B) the energies corresponding to γ_1 and γ_3 are 1.088 MeV and 0.412 MeV respectively.

C) the maximum kinetic energies of β_1^- and β_2^- are about 0.77 MeV and 1.45 MeV respectively.

D) the energy corresponding to ${}^{198}_{79}Au$ is 1.50 MeV.

12. Two speakers are driven by the same oscillator of frequency f. they are located a distance d from each other on a vertical pole. An observer far away walks slowly, straight towards the lower speaker and his ears are at the same level as the lower speaker. Let υ represent the speed of sound and assume that there is no reflection from the ground. Let n_{max} be the number of times the observer hears the minimum in sound intensity and let $\lambda = \upsilon / f$ be wavelength of the sound emitted. Choose the correct alternative(s).

A) $n_{max} \le \frac{d}{\lambda} + 0.5$

B) A minimum occurs at $\frac{4d^2 - 9\lambda^2}{12\lambda}$

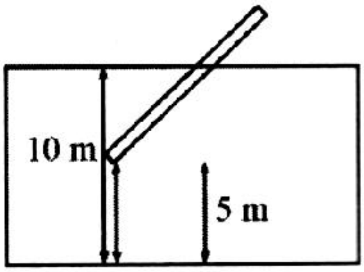
C) $n_{max} \le \frac{d}{\lambda} - 0.5$

D) A minimum occurs at $\frac{4d^2 - 9\lambda^2}{4\lambda}$

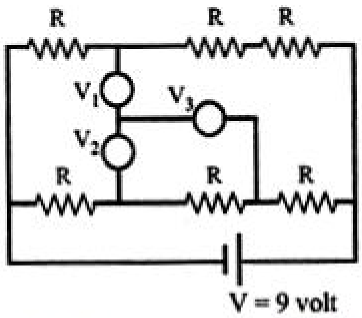
SECTION - 3 (Maximum Marks : 24)

This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**
For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter answer. If the numerical value has more than two decimal places **truncate/round- off** the value to **TWO** decimal places.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +4 If ONLY the correct numerical value is entered as answer.
Zero Marks: 0 In all other cases.

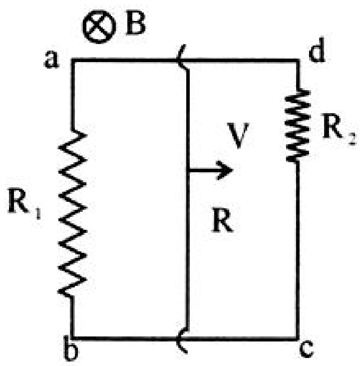
13. A rod of length 6 m has specific gravity $\rho(=25/36)$. One end of the rod is tied to a 5 m long rope, which in turn is tied to the floor of a pool 10 m deep, as shown. Find the length (in m) of the part of rod which is out of water.



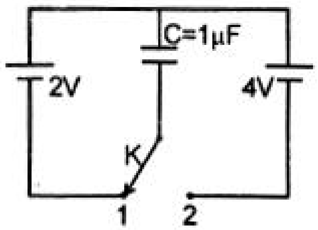
14. In the circuit shown below, all the three voltmeters are identical and have very high resistance. Each resistor has the same resistance. The voltage of the ideal battery shown is $9V$. Find the reading of voltmeter V_3 (in volts).



15. A rectangular loop with a sliding connector of length 0.5 m is located in a uniform magnetic field perpendicular to loop plane. The magnetic induction is equal to B. The connector has an electric resistance R, the sides ab and cd have resistance R_1 and R_2. Neglect the self-inductance of the loop. The connector is moving with a uniform velocity V. Given $R = 0.1\Omega,\ R_1 = R_2 = 0.2\Omega,\ B = 2.0\,T,\ V = 1\,m/s$, find the current flowing in the connector in ampere.



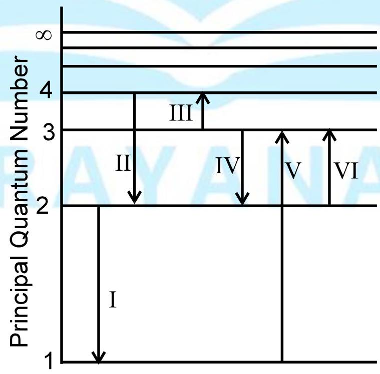
16. The circuit involves two ideal cells connected to a $1\mu F$ capacitor via a key K. Initially the key K is in position 1 and the capacitor is charged fully by 2V cell. The key is pushed to position 2. After shifting the switch the net heat produced in circuit in (μJ) is…



17. Two moles of an ideal mono atomic gas undergo a thermodynamic process in which the molar heat capacity 'C' of the gas depends on absolute temperature as $C = \frac{RT}{T_0}$, where R is gas constant and T_0 is the initial temperature of the gas. (V_0 is the initial volume of the gas). If the equation of process is given by $\frac{1}{P} = \frac{V_0 T_0^{3/2}}{XRT^{5/2}} e^{\left(\frac{T-T_0}{T_0}\right)}$, the value of X is ____

18. The figure shows an energy level diagram for the hydrogen atom. Several transitions are marked as I, II, III, IV, V & VI. The diagram is only indicative and not to scale. The wavelength(in nm) of the radiation involved in transition V is ____

(Take $hc = 1240\,ev\,nm$)

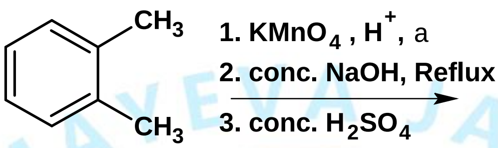


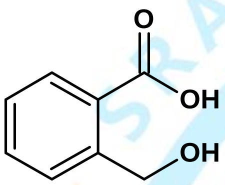
CHEMISTRY MAX.MARKS: 66

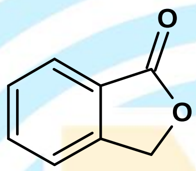
SECTION – 1 (Maximum Marks: 18)

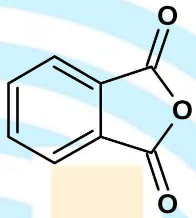
This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). **ONLY ONE** of these four option is the correct answer.
For each question, choose the correct option corresponding to the correct answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If only the correct option is chosen.
Zero Marks: 0 If none of the option is chosen.(i.e the question is un answered)
Negative Marks: -1 In all other cases.

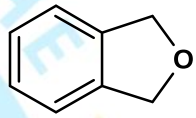
19. The major product formed in the following reaction is:



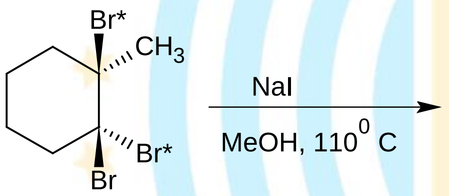
A) 

B) 

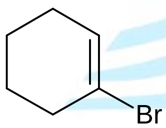
C) 

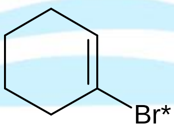
D) 

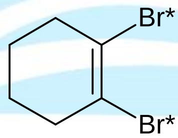
20. The major product of the reaction is

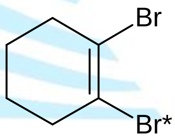


Br*=Br^{82}

A) 

B) 

C) 

D) 

21. A solution of 0.1 M Na_2CO_3 is titrated against 0.1 M HCl using (i) phenolphthalein as an indicator and (ii) Methyl orange as an indicator.

If $K_{a_1(H_2CO_3)} = 2\times10^{-6}, K_{a_2} = 4\times10^{-10}$, then $\left[pH_{(1)} - pH_{(2)}\right]$ equals to___ ?

(Where pH_1 is at end point with phenolphthalein and pH_2 is at end point with methyl orange) (Assume the gaseous products are completed evolved from the reaction mixture)

A) 1 B) $1+\frac{3}{2}\log 2$ C) 0 D) $1-\frac{3}{2}\log 2$

22. For a dilute solution containing 2.5 g of non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2^0C. Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take $K_b = 0.76\text{K kg}mol^{-1}$)

A) 724 B) 740 C) 736 D) 718

23. An alkaline (NaOH) solution of a compound produces a yellow colored solution on addition of $NaBO_3$. The compound is

A) $Mn(OH)_2$ B) $Pb(OH)_2$ C) $Cr(OH)_3$ D) $Fe(OH)_3$

24. Select the **correct** combination in which hydrogen gas is released as one of the product.

A) Li metal and C_2H_2 gas.

B) KO_2 and water

C) Zn metal and dilute HNO_3

D) Al metal and conc. NaOH

SECTION - 2 (Maximum Marks : 24)

This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

25. An element A (Atomic weight = 120) having bcc structure has unit cell edge length 400 pm. Identify the correct option(s) (Given: $N_A = 6\times10^{23}$)

A) The density of solid element is 6.25 gm/cm^3.

B) There are 6×10^{22} unit cells in 24 gm of the solid element.

C) The atomic radius is about $1.732\,\overset{o}{A}$

D) In 25 gm of solid element, the volume occupied by atoms is nearly 2.72 cm^3 only.

26. In a constant pressure calorimeter with heat capacity of 453 J k^{-1}, 200 mL of 0.862 M HCI and 200 mL of 0.431 M $Ba(OH)_2$ are mixed. (density = 1 g mL^{-1}) Initially, both solutions are at 20.48^0C. Select correct statement(s):

A) $\Delta_r H^0$ is -9.86 kJ

B) Final temperature is 25.16^0C

C) Some HCI is left unreacted

D) Some $Ba(OH)_2$ is left unreacted

27. The ground state energy of hydrogen atom is – 13.6 eV. Consider an electronic state ψ of He^+ whose energy, azimuthal quantum number and magnetic quantum number are – 3.4 eV, 2 and 0, respectively. Which of the following statement(s) is (are) true from the state ψ?

A) It is a 4d state.

B) It has 3 radial nodes.

C) It has 2 angular nodes.

D) The nuclear charge experienced by the electron in this state is less than 2e, where e is the magnitude of the electronic charge.

28. Which of the following can be explained by intermolecular hydrogen bonding?

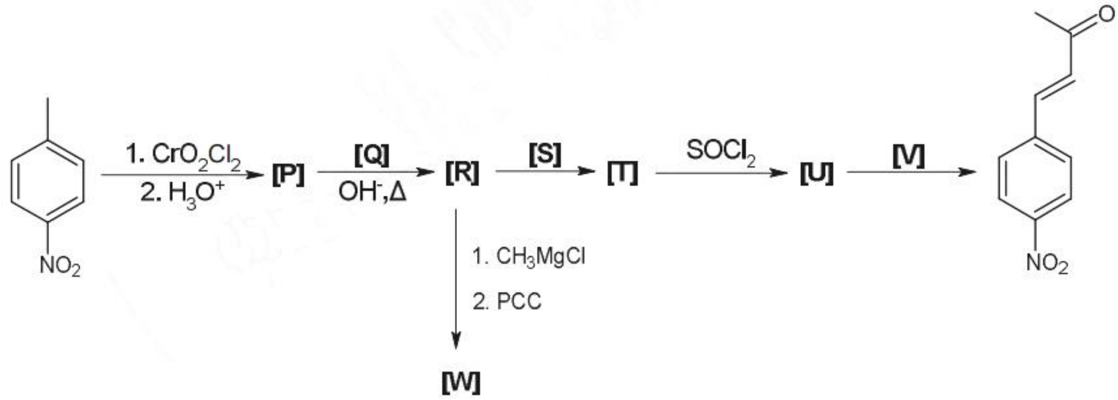
A) Double helical structure of DNA strands

B) Negative deviation of mixture of $CHCl_3$ and CH_3COCH_3 from Raoult's law

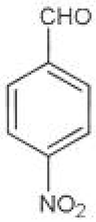
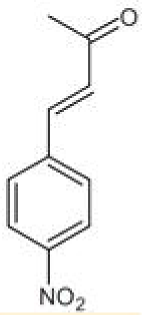
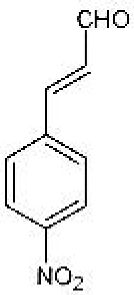
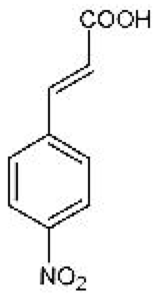
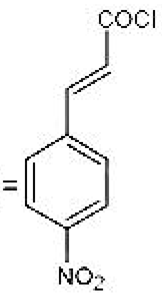
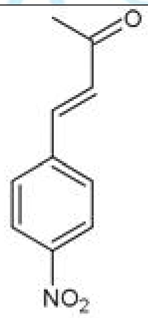
C) Higher acidic strength of $HClO_4$ than HCl

D) Steam volatility of o-nitro phenol.

29. Consider the following reaction sequence,



The correct option(s) is (are)

A)	[P] =  [S] = Tollen's reagent [V] = $(CH_3)_2Cd$
B)	[Q] = CH_3CHO [S] = Fehling's reagent [W] = 
C)	[R] =  [T] =  [U] = 
D)	[Q] = CH_3COCH_3 [S] = PCC [W] = 

30. The correct statement(s) about the complexes I ($K_3[CoF6]$) and II ($K_3[RhF_6]$) is/are

(Given atomic number $Co = 27, Rh = 45$)

A) Both complexes are high spin.

B) Complex I is paramagnetic.

C) Complex II is diamagnetic.

D) The crystal field stabilization energy of complex II is more than that of complex I.

SECTION - 3 (Maximum Marks : 24)

This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**
For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter answer. If the numerical value has more than two decimal places **truncate/round- off** the value to **TWO** decimal places.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +4 If ONLY the correct numerical value is entered as answer.
Zero Marks: 0 In all other cases.

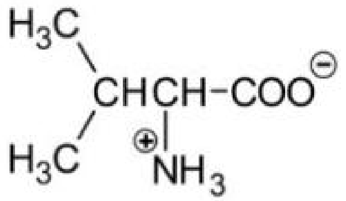
31. Total number of regents given below reacted with KI (aq.) to produce I_2, is

$CuSO_4$	$Hg(NO_3)_2$	Conc. H_2SO_4
Concentrate H_3PO_4	$KMnO_4 / H^+$	$K_2Cr_2O_7 / H^+$
Cl_2 water	Acidified bleaching powder	
$Pb(NO_3)_2$	$NaNO_2 +$ HCl (dil.)	

32. The volume (L) occupied by the gases released on reaction of 2.54 g of I_2 with the stoichiometric amounts of $NaBH_4$ at 1 atm and 300 K is______.

(I- 127 g/mol, $R = 0.08 L\,atm/mol\,K$)

33. The pH at the half-equivalence point of titration of the Zwitter ion (A), valine is 9.714 with NaOH and 2.286 with HCI. Thus, its isoelectric pH is ....



34. Consider following polymers:

Polythene, PVC, Bakelite, Nylon-6,6, Dacron, Buna-N, Buna-S, Neoprene, Teflon,

Number of homopolymer = X

Number of co-polymer = Y

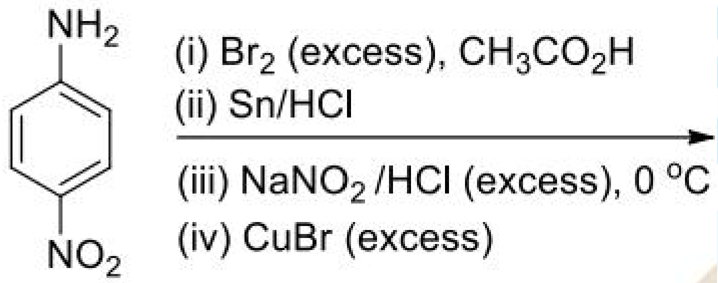
Number of addition polymer = J

Number of condensation polymer = K

The four digit number XYJK is __________

35. The number of $-OH$ groups present in the phosphorus containing compound formed by reaction of PCl_3 with H_3PO_3 followed by hydrolysis is _________ .

36. The molecular weight (g/mol) of the major product of the reaction is ____



(Atomic weight H=1, C=12, N=14, Br=80)

MATHEMATICS MAX.MARKS: 66

SECTION – 1 (Maximum Marks: 18)

This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). **ONLY ONE** of these four option is the correct answer.
For each question, choose the correct option corresponding to the correct answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If only the correct option is chosen.
Zero Marks: 0 If none of the option is chosen.(i.e the question is un answered)
Negative Marks: -1 In all other cases.

37. If two perpendicular planes $P_1 = 0$ and $P_2 = 0$ intersect on a line $L = 0$. Line $L_1 = 0$ lies on $P_1 = 0$ which makes an angle $\frac{\pi}{3}$ with $L = 0$. Line $L_2 = 0$ lies on $P_2 = 0$ which makes an angle $\frac{\pi}{4}$ with $L = 0$. Acute angle between the lines $L_1 = 0 \& L_2 = 0$ is____

A) $\frac{\pi}{2}$ B) $\frac{\pi}{6}$ C) $\cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$ D) $\cos^{-1}\left(\frac{1}{2\sqrt{2}}\right)$

38. $I_r = \int_0^1 \frac{dx}{(2+x)(1+x)^r}$, then $|9I_{10} + I_9 - 8I_8| = \frac{1}{M}$, then M =

A) 2048 B) 256 C) 1024 D) 512

39. If a, b, c are positive integers which satisfy $c = (a+bi)^3 - 107i; \left(i = \sqrt{-1}\right)$, then $a+b+c =$ ____

A) 205 B) 198 C) 213 D) 153

40. Two real sequences $x_1, x_2, ...\& y_1, y_2, ...$ are defined in the following way.

$$x_1 = y_1 = \sqrt{3},\ x_{n+1} = x_n + \sqrt{1+x_n^2} \text{ and } y_{n+1} = \frac{y_n}{1+\sqrt{1+y_n^2}} \forall n \ge 1. \text{ Then } [x_{2023}\, y_{2023}] = ...$$

$([.]$ is G.I.F$)$

A) 1 B) 2 C) 3 D) 4

41. Let f be a real valued function defined on R (the set of all real numbers) such that

$f(1) = f(-1) = 5$ and whose graph of f is symmetrical with respect to the lines $x = \pm 1$.

Given $\sum_{r=50}^{99} f\left(\frac{r}{100}\right) = 10$ and $\sum_{r=50}^{99} f\left(\frac{-r}{100}\right) = 5$. If $S = \sum_{r=50}^{150} f\left(\frac{r}{100}\right) + \sum_{r=50}^{150} f\left(\frac{-r}{100}\right)$. Then find S.

A) 10 B) 20 C) 80 D) 40

42. Consider

$$f_1(x) = \int_0^x \sin^{-1} t\, dt; x \in (0,1), \quad f_2(x) = \int_0^x \tan t\, dt; x \in (0,1)$$

$$f_3(x) = \int_0^x \sin t\, dt;\ x \in (0,1), \quad f_4(x) = \int_0^x \tan^{-1} t\, dt; x \in (0,1)$$

Then which of the following options is/are correct ?

A) $f_2\left(\frac{®}{4}\right) < f_1\left(\frac{®}{4}\right) < f_3\left(\frac{®}{4}\right) < f_4\left(\frac{®}{4}\right)$

B) $f_2\left(\frac{®}{4}\right) > f_1\left(\frac{®}{4}\right) > f_3\left(\frac{®}{4}\right) > f_4\left(\frac{®}{4}\right)$

C) $f_1\left(\frac{®}{4}\right) > f_2\left(\frac{®}{4}\right) > f_3\left(\frac{®}{4}\right) > f_4\left(\frac{®}{4}\right)$

D) $f_1\left(\frac{®}{4}\right) < f_2\left(\frac{®}{4}\right) < f_3\left(\frac{®}{4}\right) < f_4\left(\frac{®}{4}\right)$

SECTION - 2 (Maximum Marks : 24)

This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

43. Let "S_1" be the set of all points which are equidistant from (1, 2, 3) and (3, 4, 5). Let "S_2" be the set of all points which are equidistant from two lines $\frac{x-3}{1} = \frac{y-2}{1} = \frac{z-1}{2}$ and $\frac{x}{1} = \frac{y}{1} = \frac{z}{2}$. Then which of the following is INCORRECT ?

A) Curve containing "S_1" is $x+y+z=9$

B) Curve containing "S_2" is $11x+5y-8z=35$

C) $(5,\ 2,\ 3)\in S_1\cap S_2$

D) $(3,\ 3,\ 3)\in S_1\cap S_2$

44. Let 'S' be the set of all arithmetic sequences with total number of terms in each sequence as 20 and consisting terms 1,4,10 in it with common difference as integer. Then which of the following options is/are correct ?

(n(A) denotes number of elements in set S)

A) n(S) = 56

B) n(S) = 58

C) Number of common terms between two distinct elements of 'S' lies in [4, 19]

D) Maximum value of sum of terms of an element of 'S' is 590.

45. Consider $f(x)=\sum_{r=0}^{10}\sin\left(x+\frac{r®}{6}\right),\ g(x)=\sum_{r=0}^{10}\cos\left(x+\frac{r®}{6}\right),\ x\in(0,2®)$,

then which of the following options is/are correct ?

A) Number of points in $(0,2\pi)$ for which $h_1(x)=|f(x)+g(x)|$ isn't differentiable is 2

B) Number of points in $(0,2\pi)$ for which $h_2(x)=|f(x)-g(x)|$ isn't differentiable is 2

C) Number of critical points in $(0,2\pi)$ for which $h_3(x)=|f(x)|+|g(x)|$ is 8

D) Number of critical points in $(0,2\pi)$ for which $h_3(x)=|f(x)|+|g(x)|$ is 4

46. $f(x)=\tan^{-1}x+\cot^{-1}x^2, \forall x\in R$ & $g(x)=\cot^{-1}x+\tan^{-1}x^2, \forall x\in R$

then which of the following options is/are correct ?

A) Number of solutions for $f(x)=g(x)$ is 2

B) Number of points of local extrema for $y=f(x)$ is atleast 2.

C) Number of points of local extrema for $y=g(x)$ is atmost 1.

D) $y=f(x)$ & $y=g(x)$ intersects orthogonally at all points of inter section

47. From $(-2, 0)$ a line is drawn to intersect the circle $x^2+y^2=1$ at two points A & B. An ellipse with foci A & B and passing through $(-2, 0)$ is drawn whose eccentricity can be

A) $\frac{1}{3}$ B) $\frac{1}{2}$ C) $\frac{3}{5}$ D) $\frac{2}{5}$

48. In the expansion of $(1+x)^n; n\in N$ & $n>2$, the coefficients of three consecutive powers of 'x' are in A.P., then value of 'n' can be

A) 7 B) 21 C) 14 D) 23

SECTION - 3 (Maximum Marks : 24)

This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**
For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter answer. If the numerical value has more than two decimal places **truncate/round- off** the value to **TWO** decimal places.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +4 If ONLY the correct numerical value is entered as answer.
Zero Marks: 0 In all other cases.

49. Number of 3×3 diagonal matrices 'A' with real entries satisfying

$A^3-7A^2+14A-8I=O$ is

50. Consider $A^2=4A, B^3=9B, C^9=16C,$ order of square matrices A,B,C are all less than or equal to 3 and $\det\left(Adj\left(\left(A-A^T\right)\left(B-B^T\right)\left(C-C^T\right)\right)\right)\neq 0,$ then sum of all possible real values of $m=\left(\det(A)+\det(B)+\det(C)\right)$ is

51. $S=\{1,3,5,7,9\}$. A non empty subset 'S$_1$' of S is randomly chosen. Let 'A' be the event where standard deviation of 'S$_1$'=Variance of element(s) of 'S$_1$'. Let 'B' be the event where variance of element(s) in 'S$_1$' is non zero. Then $P\left(\frac{A}{B}\right)=\frac{\lambda}{\mu}$ (λ,μ are relatively prime natural numbers), then $\mu-\lambda=$____

52. Slope of common tangent to $x^2-y^2=1$ & $y^2=4x$ is m, then $m^2\sin\left(\frac{®}{10}\right)=$___

53. $S=\{(x,y):x^2+y^2\le 5 \text{ and} [|x|]=[|y|]\}$. Area plotted by all points lying in 'S' (where [.] denotes G.I.F) is $\lambda\tan^{-1}\left(\frac{3}{4}\right)$sq.units. Then $\lambda=$____

54. Let a function 'f' be defined from $R\to R$ such that $f(x)=x^2+134x+4422,$ then the number of real roots of the equation $f_{2023}(x)=0,$ where $f_n(x)=\underbrace{f(f(f..........f(x)))}_{\text{n times}}$, is

NARAYANA IIT-JEE ACADEMY-INDIA

44 YEARS OF EXCELLENCE

Sec: OSR.IIT_*CO-SC	GTA-10(P1)	Date: 21-05-23
Time: 3HRS	2020_P1	Max. Marks: 198

KEY SHEET

PHYSICS

1	**D**	2	**C**	3	**B**	4	**B**	5	**A**
6	**A**	7	**AC**	8	**BCD**	9	**ACD**	10	**AD**
11	**AC**	12	**AD**	13	**1**	14	**2**	15	**5**
16	**2**	17	**2**	18	**102 to 104**				

CHEMISTRY

19	**B**	20	**A**	21	**D**	22	**A**	23	**C**
24	**D**	25	**ABCD**	26	**AB**	27	**AC**	28	**AB**
29	**ABC**	30	**BCD**	31	**7**	32	**0.48**	33	**6**
34	**4563**	35	**2**	36	**394**				

MATHEMATICS

37	**D**	38	**D**	39	**A**	40	**B**	41	**D**
42	**B**	43	**BCD**	44	**AD**	45	**ABC**	46	**AB**
47	**ABD**	48	**ACD**	49	**27**	50	**0**	51	**11**
52	**0.5**	53	**10**	54	**2**				

SOLUTIONS
PHYSICS

1. N rotations $\rightarrow$ P main scale divisions

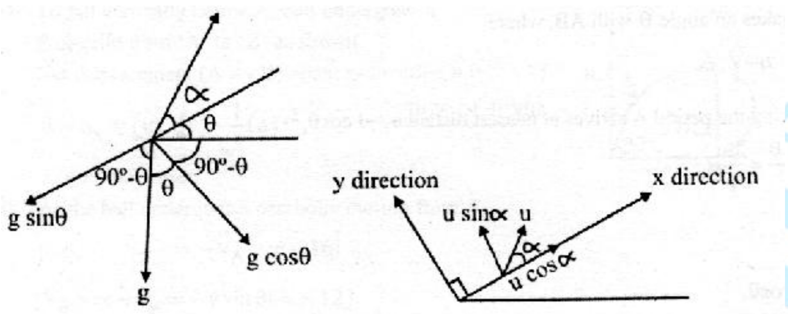
1 rotation (100 divisions) $\rightarrow \frac{P}{N}$ main scale divisions

45 division $\rightarrow \frac{1}{100} \times \frac{P}{N} \times 45$ msd(mm)

The reading shows two main scale divisions and 45 on the circular therefore reading

$= 2mm + \frac{1}{100} \times \frac{P}{N} \times 45$ mm

2.



$$T = \frac{2u_\perp}{a_\perp}$$

$$T = \frac{2 \times (u \sin\alpha)}{g\cos\theta}$$

In both the cases, $u_\perp$ and $a_\perp$ is same, so the time

$$T_1 = T_2 = \frac{2u\sin\alpha}{g\cos\theta} = T$$

(ii) $v = u + at$

$$u_x = u\cos\alpha + (-g\sin\theta)t$$

$$u_y = u\sin\alpha + (-g\cos\theta)t$$

For maximum height $\perp$ to the incline.

$U_y = 0$

$\therefore \quad u\sin\alpha = g\cos\theta t$

$$t = \frac{u\sin\alpha}{g\cos\theta}$$

$$h = ut - \frac{1}{2}at^2$$

$$h = u\sin\alpha \times \left(\frac{u\sin\alpha}{g\cos\theta}\right) - \frac{1}{2} \times (g\cos\theta)\left(\frac{u\sin\alpha}{g\cos\theta}\right)^2$$

$$h = \frac{u^2\sin^2\alpha}{2g\cos\theta}$$

As u_y is same for both the cases and a_y is same so

$$h_1 = h_2 = \frac{u^2\sin^2\alpha}{2g\cos\theta}$$

(iii) $R = (u\cos\alpha)_T + \frac{1}{2}\times(-g\sin\theta)T^2$

$R = g\sin\theta T^2$

As T is same for both

$\therefore$ $R_1 = R_2 = g\sin\theta . t^2 = R$

$u_{xp_2} = u\cos\alpha + g\sin\theta t$; $u_{x_1p_2} = u\cos\alpha + g\sin\theta t$

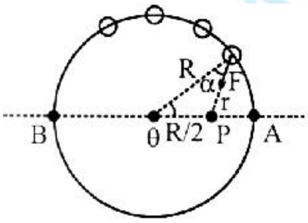
$u_2 = u\cos\alpha + g\sin\theta\times\frac{u\sin\alpha}{g\cos\theta}$

$u_2 = u\cos\alpha + g\sin\theta\times\frac{u\sin\alpha}{g\cos\theta}$; Clearly $u_1 \neq u_2$

$u_1 = u\cos\alpha - g\sin\theta\times\frac{u\sin\alpha}{g\cos\theta}$

3. Value of F at any angular position ‘ θ ’ is given by

$F = \frac{km}{r^2}$, here r is given by



$r = \sqrt{(R\cos\theta - R/2)^2 + (R\sin\theta)^2} = \sqrt{R^2 + R^2/4 - R^2\cos\theta} = \frac{R}{2}\sqrt{5-4\cos\theta}$

Also $\frac{2\sin\alpha}{R} = \frac{\sin\theta}{r}$ i.e. $\sin\alpha = \frac{\sin\theta}{\sqrt{5-4\cos\theta}}$

For small angular displacement ‘ $d\theta$ ’ work done by this fore

dw = $F R d\theta \cos(90-\alpha) = -F R \sin\alpha\, d\theta$

$= \frac{4kmR}{R^2(5-4\cos\theta)}\cdot\frac{\sin\theta}{\sqrt{5-4\cos\theta}}\, d\theta$

$\therefore$ work done in moving bead from A to B

$\Delta w = -\frac{4km}{R}\int_0^{\pi}\frac{\sin\theta\, d\theta}{(5-4\cos\theta)^{3/2}} = -\frac{km}{R}\int_0^{\pi}\frac{4\sin\theta\, d\theta}{(5-4\cos\theta)^{3/2}}$

$= \frac{km}{R}\int_0^9\frac{dt}{t^{3/2}} = -\frac{km}{R}\left|\frac{t^{-1/2}}{-1/2}\right|_1^9$

$= +\frac{2km}{R}\left(\frac{1}{3}-1\right) = -\frac{4}{3}\frac{km}{R}$

$\therefore$ Energy provided at point A must be equal to this work done

$\therefore$ $\frac{1}{2}m v_m{}^2 m = \frac{4}{3}\frac{km}{R}$ $\Rightarrow v_{min} = \sqrt{\frac{8k}{3R}}$

4. $\sin\theta_c = \frac{\sqrt{3}}{2}$

$\theta_c = 60^o$

$\therefore$ $\cos 60^o = \frac{R}{R+d}$

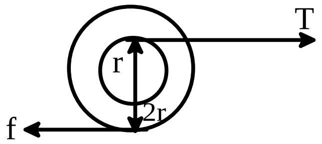
$d = R$.

7. $V_0 + \omega r = V; V_0 = 2\omega r \Rightarrow 3\omega r + V \Rightarrow \omega = \dfrac{V}{3r}$

$a_0 + \alpha r = a; a_0 = 2\alpha r \Rightarrow 3\alpha r = a \Rightarrow \alpha = \dfrac{a}{3r} \Rightarrow a_0 = \dfrac{2a}{3}$

$T - f = Ma_0 T$

$\Rightarrow T - f = M\left(\dfrac{2a}{3}\right)$ ...(1)

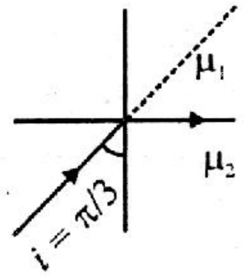


Also, $f(2r) + T(r) = I\alpha$

$\Rightarrow f + \dfrac{T}{2} = \dfrac{I\alpha}{2r}$ ...(2)

$(1)+(2) \Rightarrow \dfrac{3T}{2} = a\left[4m + \dfrac{I}{r^2}\right] \Rightarrow T = \dfrac{a}{9}\left[4m + \dfrac{I}{r^2}\right]$

8.



Apply Snell's law: $\mu_2 \sin i = \mu_1 \sin r \Rightarrow \sin i = k \sin r$

From the given graph, angle of deviation decreases and becomes zero at $k = k_2$

Hence, $\theta_1 = |r - i| = \dfrac{\pi}{6}$ (By geometry)

$\Rightarrow$ at $k = k_2, \theta = |r - i| = 0$ means, $k_2 = 1.$

$\Rightarrow$ when $k = \infty, r = 0$, by the Snell's law, $\theta_2 = |r - i| = i = \dfrac{\pi}{3}$

$\Rightarrow$ $k_1 =$ must be less than k_2 from the given graph.

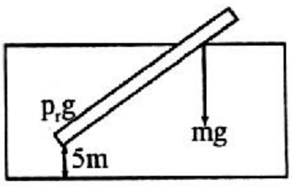
9. $V_1 = V_2$

$\Rightarrow$ $x_L = x_C \Rightarrow$ $f = \dfrac{1}{2\pi\sqrt{LC}} = 125\,Hz$

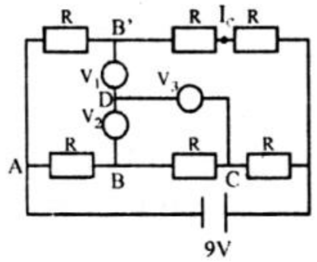
$i_0 = \dfrac{v_0}{R} = \dfrac{200}{100}$ $(\because X = 0 \;\therefore Z = R) = 2A$

$V_1 = V_2 = IX_L = I.\varepsilon L = 2 \times 2\pi \times 125 \times 2/\pi = 1000\,\text{volt}$

13. $(6 - x)^2 A\rho_w \dfrac{g}{2} = 18A\,P_r$ solving we get $x = 1m$



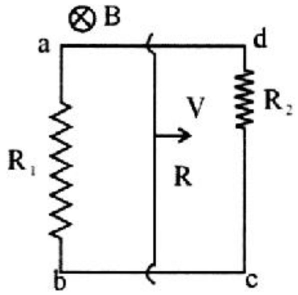
14. Taking potential at A to be zero potential at $B = 3V$ and potential at $B' = 3V$ and potential at $C = 6V$ so reading of $V_3 = 3V$



Let V_D be potential of pint D then sum of charged reaching point D is zero

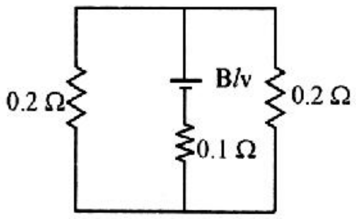
$$\frac{V_B - V_D}{R_{V_2}} + \frac{V_{B'} - V_D}{R_{V_1}} + \frac{(V_C - V_D)}{R_{V_3}} = 0 \qquad \left[R_{V_1} = R_{V_1} = R_{V_3} = R\right]$$

$$\Rightarrow \quad \frac{3 - V_D}{R} + \frac{3 - V_D}{R} + \frac{6 - R_D}{R} = 0$$

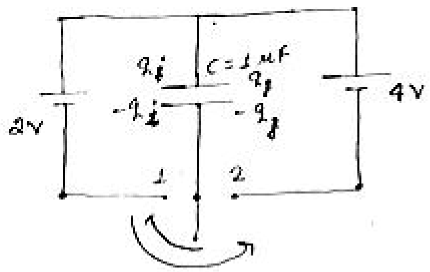


$\Rightarrow \quad 12 - 3V_D = 0$; $V_D = 4$ volts reading of $V_3 = 2$ volts

15.



16.



$w + U_i = U_f + \text{loss}$

$\Rightarrow \text{loss} = w + U_i - U_f$

$= 8\mu J + \frac{1}{2}(1\,\mu F)(2V)^2 - \frac{1}{2}(1\,\mu F)(4V)^2$

$= 8\mu J + 2\mu J - 8\mu J$

$\Rightarrow \boxed{\text{loss} \Rightarrow 2\mu J}$

18.

$dQ = dU + dW$

$\Rightarrow nCdT = nC_vdT + PdV$

$\Rightarrow \frac{2RT}{T_0} - 3R = \frac{2RT}{V} \cdot \frac{dV}{dT}$ ...(1)

From (1) $\int_{T_0}^{T}\left(\frac{1}{T_0} - \frac{3}{2T}\right)dT = \int_{V_0}^{V}\frac{dV}{V}$

On solving, $V = V_0\left(\frac{T_0}{T}\right)^{3/2} e^{\left(\frac{T-T_0}{T_0}\right)}$

$\frac{2RT}{P} = V_0\left(\frac{T_0}{T}\right)^{3/2} e^{\left(\frac{T-T_0}{T_0}\right)}$

$\frac{1}{P} = \frac{V_0T_0^{3/2}}{2RT^{5/2}}e^{\left(\frac{T-T_0}{T_0}\right)}$

For minimum volume, $\frac{dv}{dT} = 0$

So, $T = \frac{3}{2}T_0$,

$V_{min} = V_0\left(\frac{T_0}{\frac{3}{2}T_0}\right)^{3/2} e^{\left(\frac{\frac{3}{2}T_0 - T_0}{T_0}\right)}$

$V_{min} = \left(\frac{2}{3}\right)^{3/2} V_0e^{1/2}$

CHEMISTRY

23. $CrOH_3 \xrightarrow[NaOH]{NaBO_3} Na_2CrO_4$

24. $Al + NaOH + H_2O \longrightarrow NaAlO_2 + H_2$

25.

(A) $d = \frac{Z \times M}{a^3 \times N_A} = \frac{2 \times 120}{64 \times 10^{-24} \times 6 \times 10^{23}}$

$= \frac{40}{6.4} = \frac{1}{0.16} gm/cm^3 = 6.25\ gm/cm^3$

(B) Number of unit cell = $\frac{\text{Number of particle}}{2}$

$= \frac{\frac{24}{120} \times 6 \times 10^{23}}{2} = 6 \times 10^{22}$ unit cell

(C) $\sqrt{3}a = 4r$

$\Rightarrow r = \frac{\sqrt{3}}{4} \times 400 = 1.732 \times 100pm = 1.732\ \mathring{A}$

(D) $V_{occupied} = 0.68 \times \frac{25}{6.25} = 2.72\ cm^3$

27.

$E = -13.6 \times \frac{2^2}{n^2} = -3.4$

$13.6 \times \frac{2^2}{n^2} = 3.4$

$n^2 = 4^2 \qquad \Rightarrow n = 4$

Wave function corresponds to $\psi_{4,2,0}$ represents $4d_{z^2}$ – orbital which has only one radial nodes and two angular nodes. It experiences nuclear change of 2e units.

31.

Isoelectric pH is the pH at which there is no migration of Zwitter ion on passing electric current.

$$pH = \frac{pH(\text{with NaOH}) + pH(\text{with HCl})}{2}$$

$$= \frac{9.714 + 2.286}{6} = 6$$

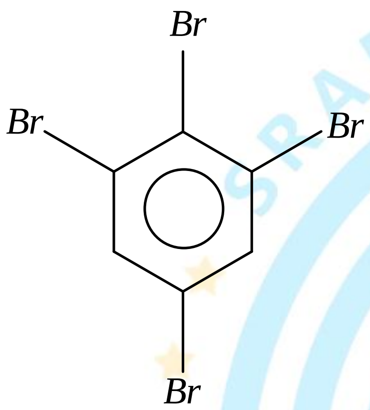
32. $2NaBH_4 + I_2 \longrightarrow 2NaI + B_2H_6 + H_2$

34.

Number of homopolymer = 4 Polythene Neopren, Teflon , PVC
Number of co-polymer = 5 Bakelite, nylon66, Buna-S, Buna-N, Dacron
Number of addition polymer = 6 Polythene, PVC, Buna-S, Buna-N, Teflon, Neoprene
Number of condensation polymer = 3 nylon66, Bakelite Dacron

35. $PCl_3 + H_3PO_3 \longrightarrow H_4P_2O_5$

36.



MATHS

37. $\cos\theta = \cos\alpha\cos\beta$

$$\Rightarrow \theta = \cos^{-1}\left(\frac{1}{2\sqrt{2}}\right)$$

38.

$$I_r = \int_0^1 \frac{(2+x)-(1+x)}{(1+x)^r(2+x)}dx = \int_0^1 \frac{dx}{(1+x)^r} - \int_0^1 \frac{dx}{(1+x)^{r-1}(2+x)}$$

$$I_r + I_{r-1} = \frac{2^{1-r}-1}{1-r} = \frac{1-2^{1-r}}{r-1}$$

$$I_{10} + I_9 = \frac{1-2^{-9}}{9} \Rightarrow 9(I_{10}+I_9) = 1-2^{-9}$$

$$I_9 + I_8 = \frac{1-2^{-8}}{8} \Rightarrow 8(I_9+I_8) = 1-2^{-8}$$

$$\Rightarrow 9I_{10} + I_9 - 8I_8 = \frac{1}{2^9}$$

39.
$$c = a^3 - 3ab^2 + i\left(3a^2b - b^3 - 107\right)$$
$$b\left(3a^2 - b^2\right) = 107$$
$$b = 1, a = 6$$
$$c = 216 - 18$$
$$= 198$$

40.
$$x_{n+1} = \frac{1 + \sin a_n}{\cos a_n} = \tan\left(\frac{90^0 + a_n}{2}\right)$$
$$a_n = \frac{90^0 - 30^0}{2^{n-1}} \Rightarrow x_n = \cot\left(\theta_n\right)\left[\theta_n = \frac{30^0}{2^{n-1}}\right]$$
$$y_n = \tan\left(2\theta_n\right)$$
$$\Rightarrow x_n y_n = \frac{2}{1 - \tan^2\theta_n} \in (2,3)\forall\ n > 1$$

41. 5 + 5 + 5 + 10 + 5 + 10 = 40

42.
$$\tan t > \sin^{-1} t > \sin t > \tan^{-1} t \,\forall t \in \left(0, \frac{\pi}{4}\right)$$

43. $S_1 : x + y + z = 2 + 3 + 4 = 9$

S_2 : Plane parallel to both the lines whose normal lies along line joining (3,2,1) and
$$\left(\frac{7}{6}, \frac{7}{6}, \frac{7}{3}\right) \Rightarrow 22x + 10y - 16z = 35$$

44. Common difference can be "± 3"± 1". $|d| = 3, \to 1, 4, 7, 10........ \Rightarrow 17(2) = 34$

$|d| = 1, \to -9....1, 2....,10,....20 \Rightarrow 11(2) = 22$

45.
$$f(x) = -\sin\left(x + \frac{11\pi}{6}\right), g(x) = -\cos\left(x + \frac{11\pi}{6}\right)$$

46.
$$f + g = \pi \because f = g \Rightarrow f = \frac{\pi}{2} \Rightarrow x = x^2 \Rightarrow x = 0, 1$$
$$f^1 = \frac{1}{1 + x^2} - \frac{2x}{1 + x^4} \to \left\{\begin{array}{c} > 0 \ \ if\ x = 0\ \ atleast \\ < 0 if\ x = 1\ twolocalextrema \\ > 0 if\ x \to \infty \end{array}\right\}$$
$$m_1 = \frac{1}{2}; m_2 = \frac{-1}{2} at\, x = 1$$

47.

If inclination is 'θ'

$$\text{Then } \frac{ae}{a} = \frac{\sqrt{1 - 4\sin^2\theta}}{2\cos\theta} = \frac{1}{2}\sqrt{\frac{1 - 4\sin^2\theta}{\cos^2\theta}}$$

$$=\frac{1}{2}\sqrt{Sec^2\theta-4\left(Sec^2\theta-1\right)}$$
$$=\frac{1}{2}\sqrt{4-3\sec^2\theta}$$
$$\le\frac{1}{2}$$

48. $${}^nC_{r-1}+{}^nC_{r+1}=2\left({}^nC_r\right)$$
$$\frac{r}{n-r+1}+\frac{n-r}{r+1}=2$$
$$\Rightarrow(n-2r)^2=n+2$$

49. $A=\begin{bmatrix} d_1 & 0 & 0 \\ 0 & d_2 & 0 \\ 0 & 0 & d_3 \end{bmatrix}\Rightarrow d_1,d_2,d_3$ can be roots of $x^3-7x^2+14x-8=0$ 1, 2, 4 are roots

50. $|A|=0,|B|=0,\pm9,|C|=0,\pm2, as\ order=2$

51. S.D=1$\Rightarrow$ (1,3), (3,5),(5,7),(7,9) are possibilities
$$\Rightarrow\frac{4}{2^5-6}=\frac{4}{26}=\frac{2}{13}$$

52. $\frac{1}{m}=\pm\sqrt{m^2-1}\Rightarrow m^4-m^2=1$

53. Area $=4\int_1^2\sqrt{5-x^2}\,dx$
$$=4\times\frac{5}{2}\times\left(\tan^{-1}(2)-\tan^{-1}\left(\frac{1}{2}\right)\right)$$
$$=10\tan^{-1}\left(\frac{3}{4}\right)$$

54. $f(x)=(x+67)^2-67=\lambda$ will always have 2 real roots for any $\lambda>0$

NARAYANA IIT ACADEMY INDIA

JEE ADVANCED GRAND TEST SERIES

NARAYANA IIT ACADEMY INDIA

Sec: OSR.IIT_*CO-SC | **Date: 21-05-23**

Time: 3HRS | **Max. Marks: 198**

Name of the Student: ____________________ **H.T. NO:** [ ][ ][ ][ ][ ][ ][ ]

21-05-23_OSR.STAR CO-SUPER CHAINA_JEE-ADV_GTA-10(P2)_SYLLABUS

PHYSICS: TOTAL SYLLABUS

CHEMISTRY: TOTAL SYLLABUS

MATHEMATICS: TOTAL SYLLABUS

TIME: 3HRS **IMPORTANT INSTRUCTIONS** Max Marks: 198

PHYSICS

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 1 – 6)	Questions with Single digit integer(0-9)	+3	-1	6	18
Sec – II (Q.N : 7 – 12)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-1	6	24
Sec – III (Q.N : 13 – 18)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -1 27.30)	+4	0	6	24
Total				**18**	**66**

CHEMISTRY

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 19 – 24)	Questions with Single digit integer(0-9)	+3	-1	6	18
Sec – II (Q.N : 25 – 30)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-1	6	24
Sec – III (Q.N : 31 – 36)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -1 27.30)	+4	0	6	24
Total				**18**	**66**

MATHEMATICS

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I (Q.N : 37 – 42)	Questions with Single digit integer(0-9)	+3	-1	6	18
Sec – II (Q.N : 43 – 48)	One of More Correct Options Type (partial marking scheme) (+1)	+4	-1	6	24
Sec – III (Q.N : 49 – 54)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -1 27.30)	+4	0	6	24
Total				**18**	**66**

PHYSICS **MAX.MARKS: 66**

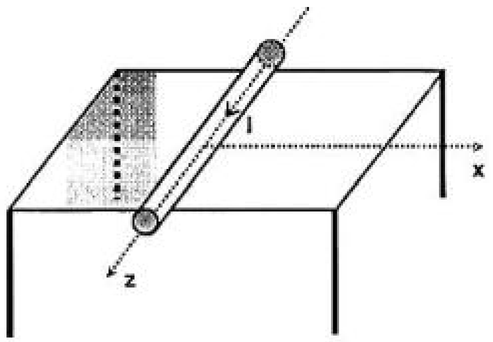
SECTION – 1 (Maximum Marks: 18)

This section contains SIX (06) questions.
The answer to each question is **A SINGLE DIGIT INTEGER** rangeing from **0 TO 9 , BOTH INCLUSIVE.**
For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric
keypad in the place designated to enter answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If only the correct option is chosen.
Zero Marks: 0 If none of the option is chosen.(i.e the question is un answered)
Negative Marks: -1 In all other cases.

1. In an experiment, the angles are required to be measured using an instrument. 29 divisions of the main scale coincide with 30 divisions of the vernier scale. If the smallest division of main scale is half a degree, then the least count of the instrument is $\frac{1^{\circ}}{10n}$. Find the value of n.

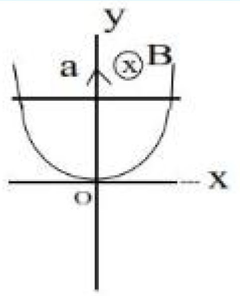
2. A steel wire is heated to $170^{\circ}C$ and held between two rigid supports which are 20 cm apart. The wire is allowed to cool to a temperature of $29.6^{\circ}C$. If the frequency of the note produced when the wire is plucked at the middle is $100y Hz$, then find the value of y.
(The density of steel is 7.8×10^{3} kg / m^{3} and for steel $\sim = 16\times10^{-6}$ / K and Young's modulus for steel $= 20\times10^{10}$ Pa)

3. A conducting rod of length $'\ell' = 2\sqrt{5}$ meter and mass $'m' = 4$ kg lies on the horizontal table. Coefficient of friction between the rod and the table is $'\mu' = \left(\frac{1}{2}\right)$. If the current in the conductor is 2 A, then find the minimum magnitude of magnetic field strength (in tesla) such that conducting rod just starts to translate along x-axis.(taking $g = 10$ m / s^{2}) [neglect the radius of rod]



4. A non conducting sphere of radius R has a positive charge which is distributed over its volume with density $° = °_0\left[1-\frac{x}{R}\right]$ where x is the distance from the centre. If dielectric constant of material of sphere is $\mathrm{K}=1$, the energy stored in the surrounding space is $\frac{®°_0^2 R^5}{(9n)(£_0)}$. Find n

5. A wire bent as a parabola $\mathrm{y}=\mathrm{cx}^2$ is located in a uniform magnetic field of magnitude B perpendicular to the xy plane as shown. At the instant $t=0$, a long metal rod starts from rest translating from the vertex of the parabola with a constant acceleration a along positive y-axis. The induced emf across the points of contact of the rod with the wire is given by $£ = 2\mathrm{By}\sqrt{\frac{\mathrm{ka}}{\mathrm{c}}}$; where $\mathrm{k}=$



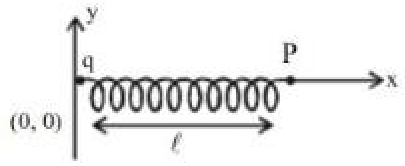
6. The reaction ${}_3^7\mathrm{Li}+{}_1^1\mathrm{H}\rightarrow{}_4^7\mathrm{Be}+{}_0^1\mathrm{n}$ is endothermic. Assuming that Li nuclei is free and at rest initially. The minimum kinetic energy (in keV) of incident proton so that this reaction occurs is $\mathrm{n}\times 235$. Find the value of n. Take Q value of this reaction as -1645 keV.

SECTION - 2 (Maximum Marks : 24)

This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). ONE OR MORE THAN ONE of these four option(s) is (are) correct option(s).
For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

7. One end of a spring of negligible unstretched length and spring constant k is fixed at the origin $(0,0)$. A particle of mass m carrying a positive charge q is attached at its other end P. The entire system is kept on a smooth horizontal surface. Now, another positive point charge 'q' is fixed at the origin, and the spring is slowly allowed to get stretched to a length ℓ and to attain a new equilibrium position at rest when released. If the spring is now elongated slightly from equilibrium and released, it is found that



A) Particle P will oscillate with time period $T = 2$®$\sqrt{\frac{m}{3k}}$

B) Particle P will oscillate with time period $T = \pi\sqrt{\frac{m}{3k}}$

C) When the particle moves from mean position to extreme position then modulus of change in potential energy of spring is approximately equal to modulus of change in electrostatic potential energy due to charge at origin(for very small amplitude)

D) When the particle moves from mean position to extreme position then modulus of change in potential energy of spring is approximately half the modulus of change in electrostatic potential energy due to charge at origin.(for very small amplitude)

8. A proton collides with a free stationary deuteron and a ${}^{3}He$ nucleus is formed. For this reaction to take place, the proton must have minimum kinetic energy of $1.4MeV$. If instead, a deuteron collides with a free stationary proton to make a

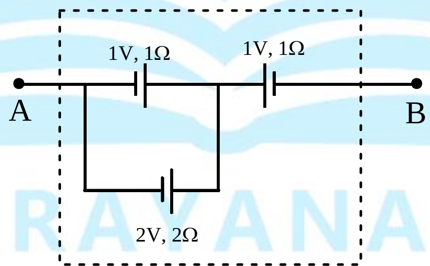
A) minimum kinetic energy deuteron must possess $= 2.8MeV$

B) minimum kinetic energy deuteron must possess $= 0.7MeV$

C) The modulus of Q-value of the reaction is approximately $0.93MeV$ upto two significant figures

D) The modulus of Q-value of the reaction is approximately $2.8MeV$ upto two significant figures

9. An electric box contains three emf sources as shown in the figure.



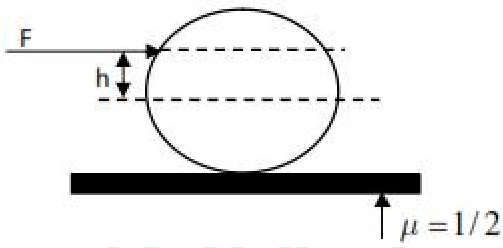
A) emf of the electric box is $\frac{1}{3}$ volts.

B) point B is at higher potential than point A

C) Internal resistance of the box is $\frac{5}{3}\Omega$.

D) EMF of the electric box is $\frac{4}{3}$ volts

10. A solid sphere of mass m, radius R rests on a rough horizontal surface $\mu = \frac{1}{2}$. A force F is applied at a height h above the centre of sphere horizontally as shown in figure at $t = 0$.



A) If $F = Mg/2, h = R/2$, frictional force acts in forward direction.

B) If $F = Mg/2, h = R/2$, linear velocity of sphere at $t = 14\text{sec}$ is $75\ ms^{-1}$.

C) If $F = Mg/2, h = R$, the magnitude of frictional force would be zero.

D) If $F = Mg/2, h = R/2$, the sphere undergoes pure rolling.

11. In Young's double slit experiment, white light is used. The separation between the slits is b. The screen is at a distance $d(d \gg b)$ from the slits. Some wavelengths are missing exactly in front of one slit. These wavelengths are

A) $\lambda = \frac{b^2}{d}$ B) $\lambda = \frac{2b^2}{d}$ C) $\lambda = \frac{b^2}{3d}$ D) $\lambda = \frac{2b^2}{3d}$

12. A long block A is at rest on a smooth horizontal surface. A small block B, whose mass is half of A, is placed on A at one end and projected along A with some velocity u. The coefficient of friction between the blocks is μ.

A) The blocks will reach a final common velocity $u/3$

B) The work done against friction is two-thirds of the initial kinetic energy of B

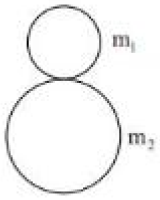
C) Before the blocks reach a common velocity, the acceleration of A relative to B is $\frac{2}{3}\mu g$

D) Before the blocks reach a common velocity the acceleration of A relative to B is $\frac{3}{2}\mu g$

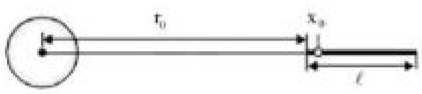
SECTION - 3 (Maximum Marks : 24)

This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**
For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter answer. If the numerical value has more than two decimal places **truncate/round- off** the value to **TWO** decimal places.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +4 If ONLY the correct numerical value is entered as answer.
Zero Marks: 0 In all other cases.

13. Two elastic balls of masses m_1 and m_2 are placed on top of each other (with a small gap between them) and then dropped onto the ground. What is the ratio m_2 / m_1, for which the upper ball ultimately receives the largest possible fraction of the total energy in the collision between the two bolls.



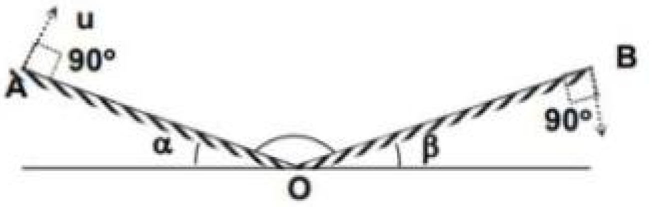
14. A small bead can slide without friction on a wooden rod of length $\ell = 10.0$ m. Initially the rod and the bead both are held motionless with the rod aligned radially with the earth. The left end of the rod is at a distance $r_0 = 4\times10^8$ m from the earth centre and the bead is at a distance $x_0 = 2.0$ cm away from the left end. Both the bodies are released simultaneously. Considering gravitational interaction only with the earth, if time after the release, the bead will be separated from the rod, is $P\times10^4$ sec. Find P. Radius of the earth is $R = 6400$ km and acceleration due to gravity on the surface of earth is $g = 10\ m/s^2$. (consider $x_0 << \ell r_0$ in your calculations). Ignore rotation of earth.



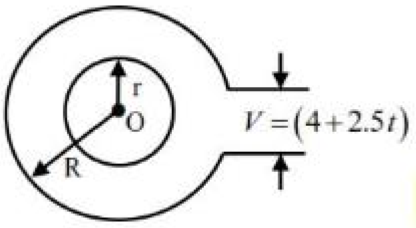
15. Sharp image of an extended linear object which is placed perpendicular to the principle axis of a lens is ¦ times that of the object in length for a particular position of object on a screen. Without disturbing the position of object and screen, by shifting lens, a position can be obtained where the sharp image is 1/¦ times that of object in length. Ratio of distance between the two positions of lens to the focal length of lens for ¦ = 5 is x. Find the value of x.

16. In order to impart an angular velocity to an earth satellite, the geomagnetic field can be used. Find the maximum possible angular velocity (in 10^{-2} rad / s) about its own axis gained by the satellite if a storage battery with a capacity of $Q = 5$Amp - hours is discharged suddenly through a coil of $N = 20$ turns wound around the satellite's surface along the circumference of the largest circle. The satellite has a mass of $m = 10^3$ kg and is a thin walled uniform sphere. The geomagnetic field is parallel to the winding plane and its flux density is $B = 0.5$ Gauss. (1 Gauss $= 10^{-4}$ Tesla) (Take ® $= 3.14$)

17. Two inclined planes OA and OB of inclinations to the horizontal are ~ and , each equal to 30° are as shown in the figure. A particle is projected at an angle of 90° with plane OA from point A and it strikes the plane OB at point B normally. Then find the speed of projection u in m / s.
(Given that $OA = OB = 20$ cm and $g = 10$ m / s^2)



18. Two concentric coplanar loops made of wire with resistance per unit length $10^{-4}\Omega m^{-1}$, have diameters 0.2 m and 2m. A time varying potential difference $(4+2.5t)$ in volt is applied to the larger loop. The current in the smaller loop is $\frac{x}{4}$ amp. Find the value of 'x'



CHEMISTRY **MAX.MARKS: 66**

SECTION – 1 (Maximum Marks: 18)

This section contains SIX (06) questions.
The answer to each question is **A SINGLE DIGIT INTEGER** rangeing from **0 TO 9 , BOTH INCLUSIVE.**
For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric
keypad in the place designated to enter answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If only the correct option is chosen.
Zero Marks: 0 If none of the option is chosen.(i.e the question is un answered)
Negative Marks: -1 In all other cases.

19. An aromatic compound contains 69.4% carbon and 5.8% hydrogen. A sample of 0.303 g of this compound was analyzed for nitrogen by kjeldahl's method. The ammonia evolved was absorbed in 50ml of 0.05 M H_2SO_4. The excess of the acid required 25 ml of 0.1 M NoaOH for neutralization. Its molecular mass is 121. Determine the molecular formula and express the answer in the form of $\frac{w+x-y-z}{2}$ if the molecular formula of the compound is $C_wH_xN_yO_z$.

20. No.of unpaired electrons in $K_4\left[Fe^{II}(CN)_5(O_2)\right]=x$

No. of stereoisomers in M [abcdef]=y

EAN of $\left[Fe(CO)_2(NO)_2\right]=z$

Find the value of $\frac{z-y}{x}$

21. Consider the heating reactions of dicarboxylic acids, $HOOC-(CH_2)_x-COOH$ where x is the number of methylene groups between the COOH groups varies from 1 to 5.

P= number of acids in which one of the products is CO_2

q= number of acids in which one of the products in H_2O

r= number of acids in which products contain both CO_2 and H_2O

the value of $(p+q)-r$ is____

22. Number of reagents that can differentiate $Fe^{2+}_{aq.}$ and $Fe^{3+}_{aq.}$

1) H_2S/H^+ 2) $KI_{aq.}$ 3) $K_4\left[Fe(CN)_6\right]$ 4) $KSCN$

5) $KMnO_4/H^+$ 6) $K_2Cr_2O_7/H^+$ 7) $K_3\left[Fe(CN)_6\right]$

23. Consider the following reactions:

i)	Glucose + ROH $\xrightarrow{\text{dry HCl}}$ Acetal $\xrightarrow[(CH_3CO)_2O]{\text{x.eq.of}}$ Acetyl derivative
ii)	Glucose $\xrightarrow{Ni/H_2}$ A $\xrightarrow[(CH_3CO)_2O]{\text{y.eq.of}}$ acetyl *derivative*
iii)	Glucose $\xrightarrow[(CH_3CO)_2O]{\text{z.eq.of}}$ acetyl derivative

Find the value of $(x+y)\div z$

24. How many of the following drugs are bactericidal in nature?

Erthromycin, tetracycline, penicillin, oflaxcin, chloramphenicol.

SECTION - 2 (Maximum Marks : 24)

This section contains SIX (06) questions.

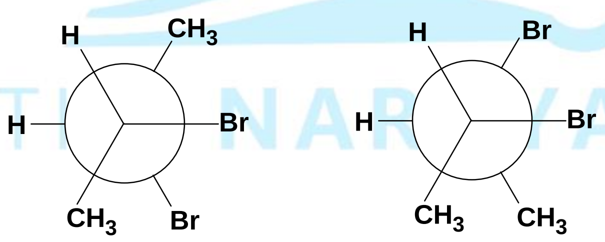
Each question has FOUR options for correct answer(s). ONE OR MORE THAN ONE of these four option(s) is (are) correct option(s).

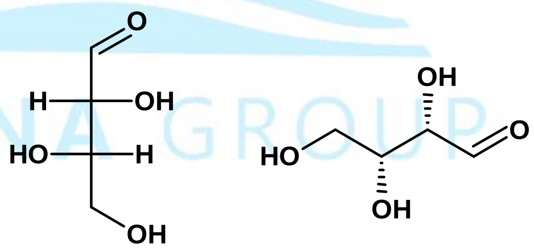
For each question, choose the correct option(s) to answer the question.

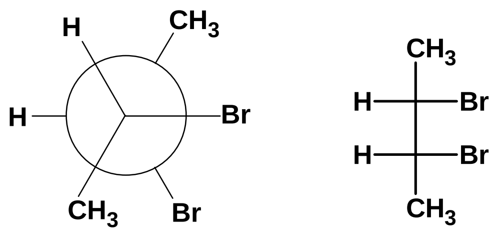
Answer to each question will be evaluated according to the following marking scheme:

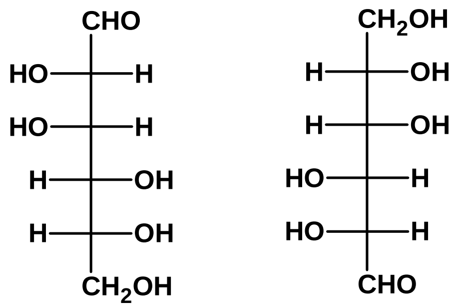
Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

25. Among the following, the pairs which have same melting point is(are):

A) 

B) 

C) 

D) 

26. If s-p mixing is not operative, then which of the following statement is not true?

A) B_2 contains 1® bond and no ± bond

B) N_2^+ contains 1± bond and 1.5 ® bond

C) C_2 would be diamagnetic

D) N_2^{2+}, N_2^+, N_2 would show increased magnetic moment compared to SP mixing

27. Non-stoichiometric cuprous oxide, Cu_2O, can be prepared in laboratory. In this oxide, oxygen to copper ratio is slightly more than 1 : 2. The correct information about this compound is:

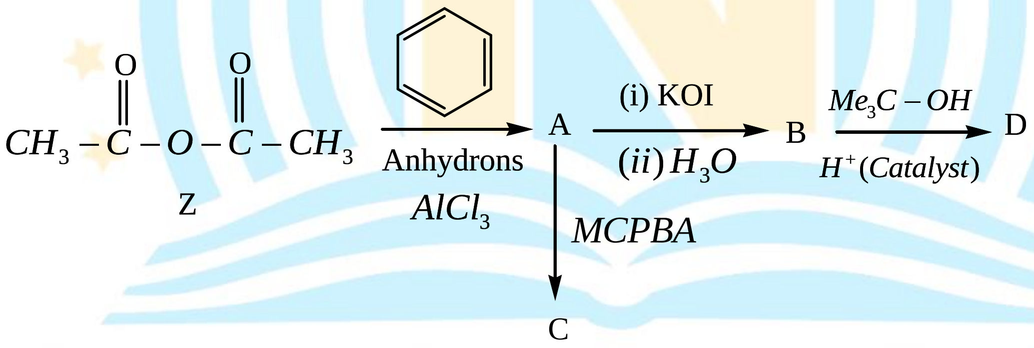
A) It has metal deficiency defect.

B) Some O^{2-} ions are missing from the crystal but all copper are as Cu^+ ions.

C) It behaves as p-type semiconductor

D) The density of solid is less than that of ideal crystal.

28. Consider the following sequence of reactions:



A gives positive DNP test. B gives positive $NaHCO_3$ test. Which of the following statements is /are correct?

A) A on reaction with NaOD in D_2O shows an increase of 3 amu in molecular mass.

B) The solution of B in benzene gives Colligative properties with van't Hoff factor greater than 1.

C) Z on reaction with benzaldehyde in presence of CH_3COONa followed by acidification gives a product with molecular mass 148 amu.

D) The pattern of hydrolysis of C and D in NaOH solution can be different

29. Cetyl trimethyl ammonium bromide (**CTAB**) is a cationic surfactant having critical micelle concentration (**CMC**) $9.0\times10^{-4}\ \text{mol}/\text{L}$. **CTAB** is gradually added to water till it's concentration reaches **CMC.** Which of the following changes occur during this process?

A) entropy increases

B) surface tension decreases

C) osmotic pressure increases

D) molar conductivity decreases.

30. Which of the following is/are correct statement(s) regarding extraction of Iron from heamatite ore?

A) CO is the main reducing agent for major amount of Fe_2O_3

B) Fe_2O_3 is used to oxidise impurities in reverberatory furnace

C) Slag formed in metallurgy of iron is $CaSiO_3$

D) Iron obtained from blast furnace is wrought iron

SECTION - 3 (Maximum Marks : 24)

This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**

For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter answer. If the numerical value has more than two decimal places **truncate/round- off** the value to **TWO** decimal places.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +4 If ONLY the correct numerical value is entered as answer.

Zero Marks: 0 In all other cases.

31. A saturated solution in AgA $\left(K_{sp}=3\times10^{-14}\right)$ and AgB $\left(K_{sp}=1\times10^{-14}\right)$ has conductivity of $375\times10^{-10}\ Scm^{-1}$ and limiting molar conductivity of Ag^{+} and A^{-} are $60\,Scm^{2}\,mol^{-1}$ and 80 $Scm^{2}\,mol^{-1}$ respectively then what will be the limiting molar conductivity of $B^{-}\left(in\,Scm^{2}mol^{-1}\right)$

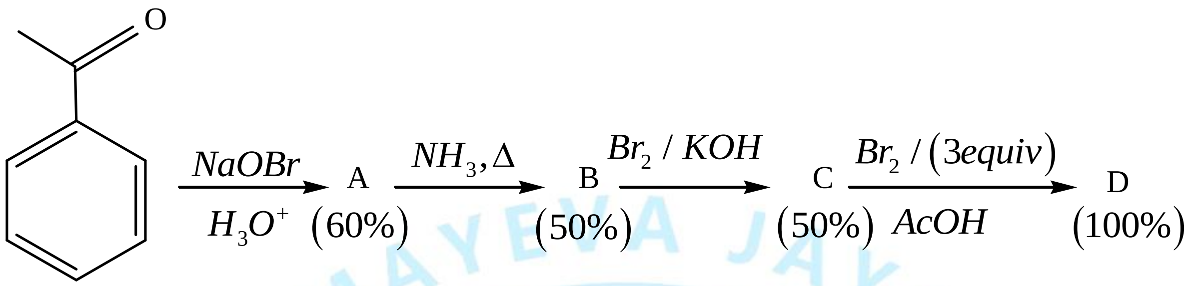
32. The wave function for an atomic orbital of single electron atom or ion is

$$\cdot\ (r,¯,¤)=\frac{2}{3}\left(\frac{Z}{3a_0}\right)^{\frac{1}{2}}(1-\pm)\left(12-8\pm+\pm^{2}\right)\pm.e^{-\frac{\pm}{2}}\cos¯.\ \text{Where}\ \pm=\frac{2Zr}{na_0}\ a_0=0.529A$$

Find the value of $\left(n+\ell+|m_{\ell}|\right)$ for the given orbital. (Assuming z-axis is the internuclear axis & all other parameters have their usual meaning)

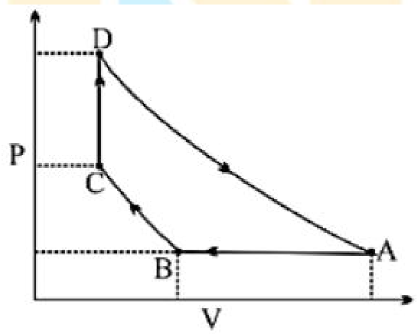
33. In the following reaction sequence, the amount of D (in g) formed from 10 moles of acetophenone is ______

(Atomic weight in g mol-1: H=1, C=12, N=14, O=16, Br=80. The yield (%) corresponding to the product in each step is given in the parenthesis)



34. One mole of a monoatomic gas behaving ideally is used as working substance in an engine working in the cycle as shown in the figure. The process AB, BC, CD and DA are respectively reversible isobaric, adiabatic, isochoric and isothermal. If the maximum T is 800 K and ¥ $= 5/3$. Calculate $\Delta U (In\, J)$ for the process BC.

Given: $R = 8\, J / K - mol; \frac{V_A}{V_D} = 8\sqrt{2}; \frac{V_A}{V_B} = 4; \frac{T_D}{T_B} = 4$



35. Number of moles $HNO_3(dil)$ required to dissolve 6 moles of copper completely is_____

36. If sum of number of moles of oxyacids and hydra-acids formed upon the hydrolysis of 1 mole each of NCl_3, ClF_3 and SO_2Cl_2 is _______

MATHEMATICS MAX.MARKS: 66

SECTION – 1 (Maximum Marks: 18)

This section contains SIX (06) questions.
The answer to each question is **A SINGLE DIGIT INTEGER** rangeing from **0 TO 9 , BOTH INCLUSIVE.**
For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric
keypad in the place designated to enter answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If only the correct option is chosen.
Zero Marks: 0 If none of the option is chosen.(i.e the question is un answered)
Negative Marks: -1 In all other cases.

37. Let $\vec{a}=-3\hat{i}+\hat{j}+\hat{k},\vec{b}=4\hat{i}+2\hat{j}+4\hat{k},\vec{c}=2\hat{i}+2\hat{j}$. If V_1 is the volume of parallelopiped whose three coterminous edges are the vectors $\vec{a}+\vec{b},\ \vec{b}+\vec{c},\ \vec{c}+\vec{a}$ and V_2 is the volume of tetrahedron whose coterminous edges are the vectors $\vec{a}\times\vec{b},\ \vec{b}\times\vec{c},\ \vec{c}\times\vec{a}$, then the value of $\left[\dfrac{V_1+V_2}{100}\right]$ is ___(where [.] denotes Greatest Integer Function)

38. If difference between greatest & least value of function

$$f(x)=\int_0^x\left(at^3+t+\cos^2 t\right)dt,\ a>0,\ \forall x\in[1,3] \text{ is } 25+\sin 1\cos 1\cos 4, \text{ then value of a is}$$

39. Let $xg(f(x))f'(g(x))g'(x)=f(g(x))g'(f(x))f'(x),\ \forall x\in R$. f & g are positive valued functions. Also $\int_0^a f(g(x))dx=\dfrac{1-e^{-2a}}{2},\forall a\in R$. Given that $g(f(0))=1$, then the value of $\left|\ell n(g(f(2)))\right|$ is equal to

40. A square ABCD of side length $\sqrt{50}$ is folded along diagonal AC so that planes ACB' and ACD are perpendicular to one another, where B' is the new position of B. If the shortest distance between AB' and CD is $\dfrac{10}{\sqrt{n}}$ units, then n is

41. Given two curves lying above X-axis : $y=f(x)$ passing through (0, 1) and $y=\int_{-\infty}^{x} f(t)dt$ passing through $\left(0,\dfrac{1}{3}\right)$. The tangents drawn to both the curves at the points with equal abscissae always intersects on X-axis. Find the value of $\log_e f(3)$

42. Let $f(x)=ax^2+bx+c$, where $b,c\in R$ and $a>0$. If $f(x)=0$ has two real and different positive roots α and β $(\alpha<\beta)$, then the value of $\int_{-\beta}^{\beta}\left(f(|x|)+|f(|x|)|\right)dx$ is $k\int_0^{\alpha} f(x)dx$, where k =

SECTION - 2 (Maximum Marks : 24)

This section contains SIX (06) questions.
Each question has FOUR options for correct answer(s). ONE OR MORE THAN ONE of these four option(s) is (are) correct option(s).
For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

43. If $f(x)$ is an identify function in $\mathbb{R}$ and $g(x)=\sum_{k=1}^{3}\{f(x)-(2020+k)\}^{-1}$, then

A) $g(x)$ is strictly decreasing in (2022, 2023)

B) $g(x)$ has two distinct real roots

C) Slope of tangent to the curve $y=g(x)$ at x = f(2020) is $\frac{-49}{36}$

D) $\lim_{x\to-\infty} g(x)=0$

44.. If equation of tangents at P, Q and vertex A of a parabola are $3x+4y-7=0,\ 2x+3y-10=0$ and $x-y=0$ respectively, then

A) focus is (4, 5)

B) Length of latus rectum is $2\sqrt{2}$

C) axis is $x+y-9=0$

D) Vertex is $\left(\frac{9}{2},\frac{9}{2}\right)$

45. Let $a=\sin^{-1}(\sin 3)+\sin^{-1}(\sin 4)+\sin^{-1}(\sin 5)$. Consider an onto function $f:[a,\infty)\to[b,\infty)$ such that $f(x)=e^{x^2+|x|}$. Also $g:R\to R$ such that $g(x)=\left(4\cos^4 x-2\cos 2x-\frac{1}{2}\cos 4x-x^7\right)^{\frac{1}{7}}$. Which of the following statements are correct ?

A) $a = -2$

B) $a + b = -1$

C) $f\left(g\left(g\left(b\right)\right)\right) = e^2$

D) Both f(x) and g(x) are non invertible functions.

46. The correct statement(s) is/are

A) If the line of intersection of planes $\vec{r}.\vec{n}_1 = q_1, \vec{r}.\vec{n}_2 = q_2$ and the line of intersection of $\vec{r}.\vec{n}_3 = q_3, \vec{r}.\vec{n}_4 = q_4$ are perpendicular, then $(\vec{n}_1.\vec{n}_3)(\vec{n}_2.\vec{n}_4) = (\vec{n}_1.\vec{n}_4)(\vec{n}_2.\vec{n}_3)$

B) If three distinct planes $\vec{r}.\vec{n}_1 = q_1, \vec{r}.\vec{n}_2 = q_2$ and $\vec{r}.\vec{n}_3 = q_3$ intersect in a line which is contained by the plane $\vec{r}.\vec{n}_4 = q_4$, then $[\vec{n}_1\,\vec{n}_2\,\vec{n}_4]\vec{n}_3 = [\vec{n}_1\,\vec{n}_2\,\vec{n}_3]\vec{n}_4$

C) If four distinct planes $\vec{r}.\vec{n}_1 = q_1, \vec{r}.\vec{n}_2 = q_2, \vec{r}.\vec{n}_3 = q_3$ and $\vec{r}.\vec{n}_4 = q_4$ intersect in a line, then $[\vec{n}_1\,\vec{n}_2\,\vec{n}_4]\vec{n}_3 = [\vec{n}_1\,\vec{n}_2\,\vec{n}_3]\vec{n}_4$

D) If a plane contains line of intersection of planes $\vec{r}.\vec{n}_1 = q_1, \vec{r}.\vec{n}_2 = q_2$ and is parallel to line of intersection of planes $\vec{r}.\vec{n}_3 = q_3, \vec{r}.\vec{n}_4 = q_4$, then $[\vec{n}_1\,\vec{n}_2\,\vec{n}_4]\vec{n}_3 = [\vec{n}_1\,\vec{n}_2\,\vec{n}_3]\vec{n}_4$

47. Which of the following statements are correct (where c is integration constant)

A) The solution of the differential equation $y\left(x^2y + e^x\right)dx - e^x dy = 0$ is $x^3y + 3e^x = 3cy$ (where c is constant)

B) The solution of $\dfrac{xdx + ydy}{xdy - ydx} = \sqrt{\dfrac{a^2 - x^2 - y^2}{x^2 + y^2}}$ is

$\tan^{-1}\left(\dfrac{y}{x}\right) + \sin^{-1}\left(\dfrac{\sqrt{x^2 + y^2}}{a}\right) = c \quad (\text{given } 'a' < 0)$

C) $xdy = \left(y + x^2 + 9y^2\right)dx$ then its solution is $\tan^{-1}\left(\dfrac{3y}{x}\right) = 3x + c$

D) The solution of the differential equation $\dfrac{dy}{dx} - y\dfrac{\phi'(x)}{\phi(x)} = \dfrac{-y^2}{\phi(x)}$ is $\phi(x) = (x + c)y$

48. Consider the region in the argand plane containing complex numbers given by the set S , where

$$S=\left\{z\neq 0:0\le \operatorname{Re}\left(\frac{z}{10}\right)\le 1,\ 0\le \operatorname{Im}\left(\frac{z}{10}\right)\le 1,\ 0\le \operatorname{Re}\left(\frac{10}{z}\right)\le 1,\ 0\le \operatorname{Im}\left(\frac{10}{\bar{z}}\right)\le 1\right\}.$$

Which of the following options is/are correct ?

A) The area of the region represented by S is $\frac{25}{2}(6-\pi)$ square units

B) Minimum value of $|z|$ equals $5\sqrt{2}$ for $z\in S$

C) Maximum value of $|z-10i|$ equals $10\sqrt{2}$ for $z\in S$

D) $\operatorname{Arg}\left(\frac{z-10}{z-10i}\right)$ is π only for two values of z, where $z\in S$

SECTION - 3 (Maximum Marks : 24)

This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**

For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter answer. If the numerical value has more than two decimal places **truncate/round- off** the value to **TWO** decimal places.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +4 If ONLY the correct numerical value is entered as answer.

Zero Marks: 0 In all other cases.

49. Let $(a_1, a_2, a_3.........)$ be a sequence denoted by A and a sequence ΔA is defined such that ΔA is the following sequence: $(a_2-a_1, a_3-a_2, a_4-a_3.........)$. Suppose that all of the terms of the sequence $\Delta(\Delta A)$ are 1 and it is given that $a_{19}=a_{92}=0$. Find a_3

50. Let P(a, b), Q(c, d) & R(e, f) be three non-collinear points satisfying the inequality $x^2+y^2-6x-8y<0$, where a, b, c, d, e & f are integers. Point P is at least possible distance from A(-2, 4). Q is located at maximum possible distance under the condition AQ=AR. Tangents are drawn to the given circle at origin and $\left(\frac{c+e}{2}+1, b\right)$. These two tangents intersect the internal angular bisector of $\angle P$ of triangle PQR. If the area of the triangle formed by these three lines (two tangents and internal bisector of angle P) is Δ, then find the value of 3Δ

51. Let m and c be two real numbers belonging to the sets

$S_1 = \{x : x = \frac{p}{q}$ where $3 \le p, q \le 4$ and p, q are integers$\}$ and

$S_2 = \{x : x = n + \frac{1}{n}$ where n is an integer and $2 \le n \le 5\}$ respectively such that the line whose equation is $y = mx + c$ is tangent to the parabola $y^2 = 4ax$ but is neither tangent to $\frac{x^2}{9} - \frac{y^2}{4} = 1$ (nor) a tangent to $x^2 + y^2 = 4$. Sum of all distinct values of length of latus rectum for the parabola is 'S' then the value of S is ___

52. Let $f(x) = x^4 + ax^3 + bx^2 + cx + d$ be a polynomial whose roots are all negative integers. If $a + b + c + d = 2009$, then the value of d is___

53. There is a test for the dangerous virus that is 99 % accurate. In other words, if someone has the virus and undergoes the test, there is a 99 % chance that the test will show positive and 1% percent chance that the test will show negative and if someone does not have it and undergoes the test then there is a 99 % chance that test will show negative and 1% chance that test will show positive. Assume that 1% of the general population has the virus. Given an individual has tested positive from test, then what is the probability that the individual actually has the virus.

54. Compute the summation $\sum_{k=0}^{2023} k\binom{2023}{k}\left(\frac{1}{3}\right)^k\left(\frac{2}{3}\right)^{2023-k}$ (where $\binom{n}{r}$ denotes ${}^nC_r$)

NARAYANA IIT-JEE ACADEMY-INDIA

Sec: OSR.IIT_*CO-SC	GTA-10(P2)	Date: 21-05-23
Time: 3HRS	2020_P2	Max. Marks: 198

KEY SHEET

PHYSICS

1	**6**	2	**6**	3	**2**	4	**8**	5	**2**
6	**8**	7	**AC**	8	**AC**	9	**ABC**	10	**ABD**
11	**AC**	12	**ABD**	13	**3**	14	**2.40 TO 2.60**	15	**4.80**
16	**8.40 TO 8.58**	17	**2**	18	**5**				

CHEMISTRY

19	**6**	20	**6**	21	**5**	22	**7**	23	**2**
24	**2**	25	**BD**	26	**ACD**	27	**ACD**	28	**ACD**
29	**ABCD**	30	**ABC**	31	**270**	32	**6**	33	**495**
34	**2400**	35	**16**	36	**10**				

MATHEMATICS

37	**2**	38	**1**	39	**4**	40	**3**	41	**9**
42	**4**	43	**ABCD**	44	**ABCD**	45	**ABC**	46	**ABC**
47	**ABCD**	48	**ABC**	49	**712**	50	**200**	51	**116.55**
52	**528**	53	**0.5**	54	**674.33**				

SOLUTIONS

PHYSICS

1. Least count of a vernier - 1MSD-1V SD

Given

$$\text{IVSD} = \frac{29}{30}\text{MSD}$$

$$\therefore \text{LC} - \text{MC} - \frac{29}{30}\text{MSD} - \frac{1}{30}\text{MSD}$$

Given

$$\text{MSD} = \left(\frac{1}{2}\right)^2 \Rightarrow \frac{1}{30}\text{MSD} = \left(\frac{1}{60}\right)^0$$

Also,

$$1^0 = 60^1 \Rightarrow \left(\frac{1}{60}\right)^0$$

2. Thermal stress in the wire $= \sim Y\Delta T$

Tension in the wire $= \sim Y\Delta T ® r^2$

$$n = \frac{1}{2L}\sqrt{\frac{T}{® r^2 D}} = \frac{1}{2L}\sqrt{\frac{\sim Y\Delta T ® r^2}{® r^2 D}} = \frac{1}{2L}\sqrt{\frac{\sim Y\Delta T}{D}}$$

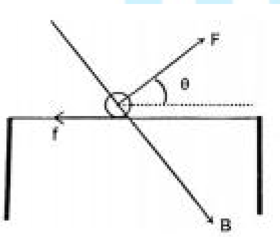
Putting values $n = 600$ Hz.

In the fundamental mode as the wire is plucked in the middle.

$$F_{\min} = \frac{« mg}{\sqrt{1+«^2}}$$

$$ilB_{\min} = \frac{« mg}{\sqrt{1+«^2}}$$

3. $B_{\min} = 2$ Tesla



4. $dq = ° dv = °_0\left[1-\frac{x}{R}\right]dx, dq = 4®°_0\left(x^2-\frac{x^3}{R}\right)dx$

$$du = \frac{1}{2}£_0 E^2 dV, E = \frac{1}{4®£_0}\frac{q}{r^2}, dV = 4® r^2 dr$$

$$q = \int_0^{®} dq = \frac{® R^3 °_0}{3}$$

$$u = \int_{®}^{\infty} du = \frac{®°_0^2 R^3}{72£_0}$$

5. $Y = \frac{1}{2}at^2 \quad V = \sqrt{2ay}$

$$X = \sqrt{\frac{2y}{C}}$$

$$s = B(2x)V$$

6. $n \times 235 = 1645\left(1+\frac{1}{7}\right)$

7. $k_x \ell = \frac{kq^2}{\ell^2}$

$k_2(\ell + x) - \frac{kq^2}{(\ell + x)^2} = Ma$

$a = \left(\frac{3k_p}{M}\right)x$ [From (i)

$\Delta U_{eqring} = K_e \ell x$

$T = 2® \sqrt{\frac{M}{3k_s}} = \frac{2®}{3}\sqrt{\frac{3M}{k_s}}$

$\Delta U_{chetriatuic} = \frac{Kq^2}{f^3}x$

8. For the first reaction

$\sqrt{2MK_p} = \sqrt{6KM}$ ...(i)

$K_p = K + Q$ ...(ii)

From (i) & (ii)

$2K_p = 3Q$

$\sqrt{4MK_d} = \sqrt{6MK_1}$

$K_d = K_1 + Q$

$4K_d = 6(K_d - Q) = 6Q = 2K_d$

$K_d = 3Q = 2K_p$

9. Conceptual

10. $F = \frac{Ma_{arn} R\left(\frac{u^2}{R^2}+1\right)}{(h+R)}$ for pure rolling; $f = F - Mg$

$h = R/2, k^2 = \frac{2}{8}R^2; F = \frac{Mg}{2}$

$a_{am} = \frac{155}{28}$; $f = \frac{Mg}{28}$ forward.

At $t = 14$sec; $v = a_{amt} = \frac{159}{28} \times 14 = 75 \text{ ms}^{-1}$

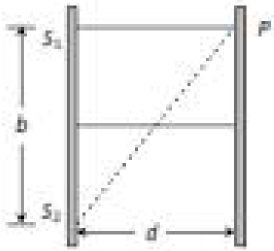
$h = R$; $f = \frac{3mg}{14}$ backward.

At $t = 14$sec;

11. Path difference between the rays reaching infront of slit S_l is.

$S_1P - S_2P = \left(b^2 + d^2\right)^{1/2} - d$

For distructive interference at P



$$S_1P - S_2P = \frac{(2n-1)\lambda}{2}$$

i.e., $(b^2 + d^2)^{1/2} - d = \frac{(2n-1)\lambda}{2}$

$$\Rightarrow d\left(1 + \frac{b^2}{d^2}\right)^{1/2} - d = \frac{(2n-1)\lambda}{2}$$

$$\Rightarrow d\left(1 + \frac{b^2}{2d^2} + \ldots\ldots\right) - d = \frac{(2n-1)\lambda}{2}$$

(Binomial Expansion)

$$\Rightarrow \frac{b}{2d} = \frac{(2n-1)\lambda}{2} \Rightarrow \lambda = \frac{b^2}{(2n-1)d}$$

For $n = 1, 2, \ldots\ldots, \lambda = \frac{b^2}{d}, \frac{b^2}{3d}$

12. As there are no external forces acting on the ' $A+B$ ' system, its total momentum is conserved. If the masses of A and B are $2 m$ and m respectively, and v is the final common velocity, $mu = (m+2m)v = u/3$

Work done against friction $=$ loss in $K \cdot E = \frac{1}{2}mu^2 - \frac{1}{2}(3m)v^2$

$$\frac{1}{2}mu^2 - \frac{1}{2}(3m)\frac{u^2}{9} = \frac{1}{2}mu^2\left[1 - \frac{1}{3}\right] = -\frac{2}{3} \times -\frac{1}{2}mu^2$$

The force of friction between the blocks is «mg.

Acceleration of A (to the right) $= a_1 = \frac{«mg}{2m} = \frac{«g}{2}$

Acceleration of B (to the left) $= a_2 = \frac{«mg}{m} = «g$

Acceleration of A relative to $B = a_1 - (-a_2) = \frac{3}{2}«g$

13. Air resistance is neglected and the balls are considered as perfectly elastic. If the balls are dropped from height h, they reach the ground with speed $v = \sqrt{2gh}$. The bottom ball first hits the ground, and then collides with the top ball, which receives the largest possible energy if the lower ball is at rest after the two collisions. The bottom ball rebounds with speed v and collides with the top ball moving downwards at speed $-v$. Since the speed of the ball of mass $m 2$ is to be zero after the collision, the equations expressing the conservation of momentum and energy are $(m_2 - m_1)v = m_1 u$ and $(m_1 + m_2)\frac{v^2}{2} = m_1\frac{u^2}{2}$.

The speed u of the top ball after the collision and the ratio of the masses can be calculated from these equations, giving $u = 2v$ and $m_1/m_2 = 1/3$.

14. For the rod,

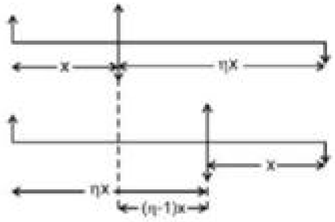
$$\int_0^{\ell}\frac{GMmdx}{(r_0+x)\ell}=ma \quad \frac{GM}{\ell}\left(\frac{1}{r_0+\ell}-\frac{1}{r_0}\right)=a$$

Relative acceleration of the bead is calculated as follows, $\frac{GM}{\ell}\frac{\ell}{(r_0)(r_0+\ell)}-\frac{GM}{(r_0+x)^2}=a_{net}$

$$\frac{GM}{r_0^2}\left[\left(1-\frac{\ell}{r_0}\right)-\left(1-\frac{2x}{r_0}\right)\right]=a_{st} \quad \frac{GM\ell}{r_0^3}=a_{rad}$$

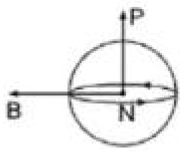
r_0 is very large and hence r_0 can taken constant. Bead will move towards left relatively.

$$a_{vel}=\frac{GM\ell}{r_0^3} \text{ and } x_0=\frac{1}{2}a_{n\ell 1^2}{}^2$$



15. Using lens formula : $\frac{1}{\eta x}+\frac{1}{x}=\frac{1}{f}\Rightarrow f=\frac{\eta x}{\eta+1}$

So the given ratio is $\frac{(\eta^2-1)}{\eta}$



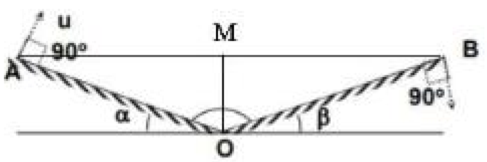
16. Torque on the (coil + sphere) due to flow of charge through coil is $=|\vec{p}\times\vec{B}|$ (where $\vec{p}$ is the dipole moment of the coil and $\vec{B}$ is the geomagnetic field)

$$=i\,N\pi r^2\,B=I\frac{d\mu}{dt}$$

$$\therefore d\mu=\frac{N\pi r^2\,B}{I}idt \text{ or } \mu=\frac{N\pi r^2\,B}{\frac{2}{3}mr^2}\int_0^{4}idt=\frac{3\pi N\,BQ}{2}$$

Ans: $\mu=\frac{3}{2}\frac{BN\pi Q}{M}=2.7\pi\times10^{-2}\,rad/s$.

17. $\theta=60^\circ$



$AM=OA\cos30^\circ$

$=0.I(\sqrt{3})m$

Range $AB=2AM$

$=0.2(\sqrt{3})m$

$$R=\frac{u^2\sin2\theta}{g}$$

$$u^2 = \frac{2\sqrt{3}}{\cos 60} = 4$$

$$u = 2 \ m/s$$

18. $$B = \frac{\mu_0 i}{2R}$$

$$i = \frac{V}{R}$$

$$i = \frac{(4+2.5t)}{(2\pi R)^{\circ}}$$

$$B = \frac{\mu_0}{2R}\left[\frac{4+2.5t}{2\pi R \cdot ^{\circ}}\right]$$

$$r \lll R$$

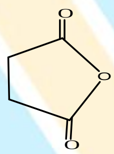
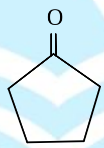
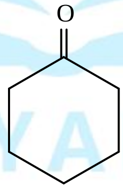
$$\phi = B_0 \ A = B_0 \pi \ r^2$$

$$E = \left|\frac{d\phi}{dt}\right| = \frac{\mu_0 r^2}{4R^2 \circ}(2.5)$$

$$i = 1.25 \ A$$

CHEMISTRY

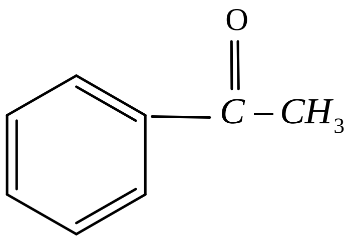
21.

Reactant	Product
$HOOC-(CH_2)-COOH$	$CH_3COOH + CO_2$
$HOOC-(CH_2)_2-COOH$	 $+H_2O$
$HOOC-(CH_2)_3-COOH$	Gluataric anhydride + H_2O
$HOOC-(CH_2)_4-COOH$	 $+H_2O+H_2O$
$HOOC-(CH_2)_5-COOH$	 $+CO_2+H_2O$

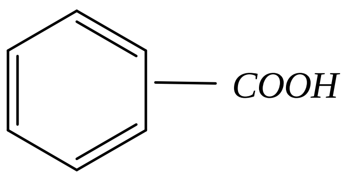
23. $x = 4, y = 6, z = 5$

27. Some Cu^+ ions are missing from crystal.

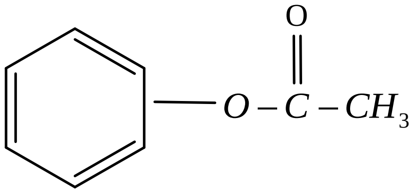
28.

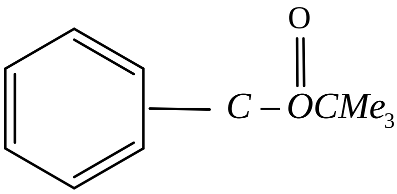


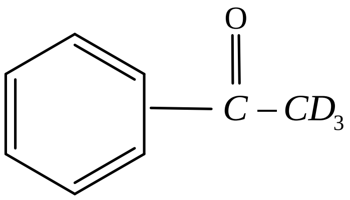
a)

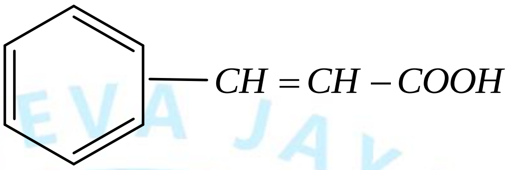


b)

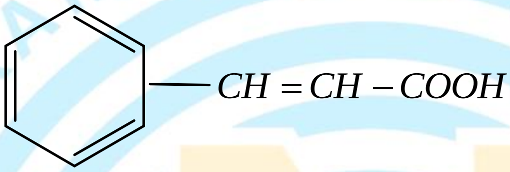
c) 

d) 

a) 



b) Dimerization pheneomenon , i<1
(148 amu)



c) Perkin reaciton
d) One is BAc_2 and another is BAl_1

31.

$$AgA(s) \xrightleftharpoons{3\times10^{-14}} Ag^+(aq) + A^-(aq)$$

$$S_1 + S_2 \quad S_1$$

$$AgB(s) \xrightleftharpoons{10^{-14}} Ag^+(aq) + B^-(\text{aq})$$

$$(S_1 + S_2) \quad S_2$$

$S_1(S_1 + S_2) = 3\times10^{-14}$ ---------(1)

$S_2(S_1 + S_2) = 10^{-14}$ -----------(2)

Solving we get $S_1 = 1.5\times10^{-7}M$

$S_2 = 0.5\times10^{-7}M$

$\therefore [A^-] = 1.5\times10^{-7}M, [B^-] = 0.5\times10^{-7}M,$

$[Ag^+] = 2\times10^{-7}M$

$$a_{[Ag+]} = \frac{K_{Ag+}\times1000}{[Ag^+]} \Rightarrow 60 = \frac{K_{Ag+}\times1000}{2\times10^{-7}}$$

Or, $K_{Ag+} = 120\times10^{-10}\,Scm^{-1}$

Similarly, $K_{A^-} = 80\times1.5\times10^{-10}$

$= 120\times10^{-10}\,Scm^{-1}$

$K_{B^-} = a_{B^-} + K_{A^-} = 375\times10^{-10}$

$K_{Ag^+} + K_{B^-} + K_{A^-} = 375\times10^{-10}$

Or, $120 + ª_{B^-} \times 0.5 + 120 = 375$

$\Rightarrow ª_B = 270$

32. $\Psi(r, ¯, ¤) \sim r^{\ell}$

$\therefore \ell = 1$

No of radial node=3=n+$\ell - 1$

$\therefore$ n=5

$\therefore (n+\ell) = 6$

Angular Node at:

$Cos¯ = 0 \Rightarrow ¯ = \frac{®}{2} \Rightarrow xy\,p$lane

$\therefore$ Orbital is P_z

$\therefore\ m_\ell = 0$

34. $\frac{V_A}{V_D - V_C} = 8\sqrt{2}$ ------------------(1)

$\frac{V_A}{V_B} = 4$ ----------------------(2)

$\frac{T_A = T_D}{T_B} = 4$

$T_B V_B^{¥-1} = T_C V_C^{¥-1}$

Or, $T_C = T_B\left(\frac{V_B}{V_C}\right)^{¥-1} = 200\left(2\sqrt{2}\right)^{2/3} = 400K.$

$\Delta U_{BC} = nC_{Vm}\Delta T$

$= \frac{1\times8\times(400-200)}{2/3} = 2400J$

35. $3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

36. $NCl_3 \xrightarrow{H_2O} 3HOCl + NH_3$

$ClF_3 \xrightarrow{H_2O} HClO_2 + 3HF$

$SO_2Cl_2 \xrightarrow{H_2O} H_2SO_4 + 2HCl$

Oxo acids = 5

Hydracid = 5

MATHS

37. $V_1 = (\bar{a}+\bar{b}).((\bar{b}+\bar{c})\times(\bar{c}+\bar{a})) = 2[\bar{a}\ \bar{b}\bar{c}]$

$V_2 = \frac{1}{6}(\bar{a}\times\bar{b}).[(\bar{b}\times\bar{c})\times(\bar{c}\times\bar{a})]$

$= \frac{1}{6}(\bar{a}\times\vec{b}).[((\vec{b}\times\vec{c}).\vec{a})\vec{c} - ((\vec{b}\times\vec{c}).\vec{c})\vec{a}]$

$= \frac{1}{6}[\bar{a}\ \vec{b}\vec{c}]^2$

$$\left[\vec{a}\;\vec{b}\;\vec{c}\right] = \begin{vmatrix} -3 & 1 & 1 \\ 4 & 2 & 4 \\ 2 & 2 & 0 \end{vmatrix} = 36$$

$\therefore V_1 = 72$ and $V_2 = 216$

38. $f'(x) = ax^3 + x + \cos^2 x > 0 \ \forall\ x \in [1, 3]$

$\Rightarrow\ f(x)$ is increasing function

$\Rightarrow$ Difference between maximum & minimum value $= f(3) - f(1)$

$$= \int_0^3 (at^3 + t + \cos^2 t)dt - \int_0^1 (at^3 + t + \cos^2 t)dt$$

$$= \left|\frac{at^4}{4} + \frac{t^2}{2} + \frac{t}{2} + \frac{\sin 2t}{4}\right|_0^3 - \left|\frac{at^4}{4} + \frac{t^2}{2} + \frac{t}{2} + \frac{\sin 2t}{4}\right|_0^1$$

$$= 20a + 4 + 1 + \frac{\sin 6 - \sin 2}{4}$$

$= 20a + 5 + \sin 1 \cos 1 \cos 4 \Rightarrow\quad a = 1$

39. $\int_0^a f(g(x))dx = 1 - \frac{e^{-2a}}{2} \ \Rightarrow\ f(g(a)) = e^{-2a}$

Given $\dfrac{xd\{f(g(x))\}}{f(g(x))} = \dfrac{d\{g(f(x))\}}{g(f(x))}$

$\Rightarrow\ \dfrac{x(-2e^{-2x})dx}{e^{-2x}} = \dfrac{d\{g(f(x))\}}{g(f(x))}$

or $-2xdx = \dfrac{d\{g(f(x))\}}{g(f(x))}$

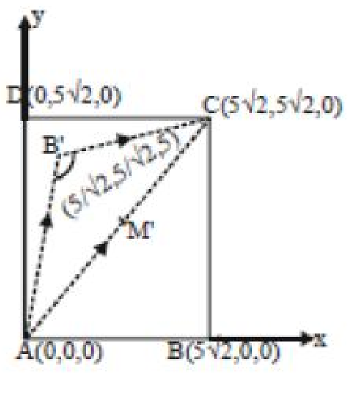
$\Rightarrow -x^2 = \ln\{g(f(x))\} + c$

$\Rightarrow\ g(f(x)) = e^{-x^2}$ as $g(f(0)) = 1$

$\Rightarrow |\ln\{g(f(2))\}| = \mathbf{4}$

40.

Let $x\hat{i} + y\hat{j} + z\hat{k} = (x, y, z)$



Let M be the mid point of AC

B'M = 5

$\Rightarrow$ coordinates of B' are $\left(\frac{5}{\sqrt{2}},\frac{5}{\sqrt{2}},5\right)$

Equation of AB' = $t\left(\frac{5}{\sqrt{2}},\frac{5}{\sqrt{2}},5\right)$

equation of CD = $\left(0,5\sqrt{2},0\right)+\lambda\left(5\sqrt{2},0,0\right)$

Shortest distance between AB and CD

$$\frac{\left|\left(0,5\sqrt{2},0\right).\left(\left(\frac{5}{\sqrt{2}},\frac{5}{\sqrt{2}},5\right)\times\left(5\sqrt{2},0,0\right)\right)\right|}{\left|\left(\left(\frac{5}{\sqrt{2}},\frac{5}{\sqrt{2}},5\right)\times\left(5\sqrt{2},0,0\right)\right)\right|}=\frac{10}{\sqrt{3}}$$

41.

Equation the tangent to the curve y = f(x) is (Y-y) = f'(x (X-x) equation of the tangent to the curve

$y_1 = g(x) = \int_{-\infty}^{x} f(t)dt$ is

$(Y-y_1) = g'(x)(X-x)$

$\Rightarrow (Y-y_1) = f(x)(X-x)$

Given that tangent with equal abscissa intersects on x-axis

$\therefore x-\frac{y}{f'(x)} = x-\frac{y_1}{f(x)}$

$\frac{f(x)}{f'(x)}-\frac{y_1}{f(x)}$ $\quad \frac{f(x)}{y_1}=\frac{f'(x)}{f(x)}$ $\quad \frac{g'(x)}{g(x)}=\frac{f'(x)}{f(x)}$

Integrating both sides we get, $\ell ng(x) = \ell nf(x) + c$

$\Rightarrow \ln\left(\frac{g(x)}{f(x)}\right)=c \quad \Rightarrow g(x)=kf(x)$

$\Rightarrow g(0)-kf(0) \quad \Rightarrow k=\frac{1}{3}$

$g(x)=\int_{-\infty}^{x} f(x)dx \quad kf(x)=\int_{-\infty}^{x} f(x)dx \quad kf'(x)=f(x)$

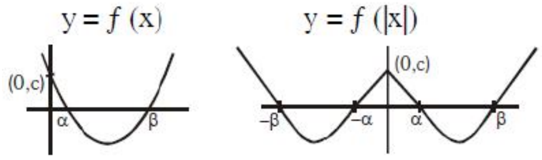
$\frac{f'(x)}{f(x)}=3$

$\ln f(x)=3x+c$

$f(x)=\lambda e^{3x}$

$1=\lambda\{\because$ Curve passes through $(0,1)\}$ $\ell n f(3)=9$

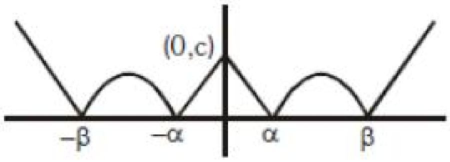
42.



$$\therefore \quad I_1 = \int_{-\beta}^{\beta} f(|x|)dx = 2\int_0^{\beta} f(x)dx$$

$$= 2\int_0^{\alpha} f(x)dx + 2\int_{\alpha}^{\beta} (f(x))dx$$

$$y = |f(|x|)|$$



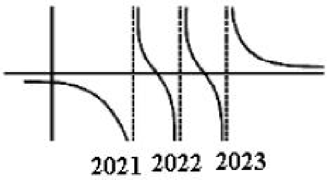
$$I_2 = \int_{-\beta}^{\beta} |f(|x|)|dx = 2\int_0^{\beta} |f(x)|dx$$

$$= 2\int_0^{\alpha} f(x)dx + 2\int_{\alpha}^{\beta} (-f(x))dx$$

$$\Rightarrow \quad I_1 + I_2 = 4\int_0^{\alpha} f(x)dx$$

43. $$f(x) = x$$

$$g(x) = \frac{1}{x-2021} + \frac{1}{x-2022} + \frac{1}{x-2023}$$

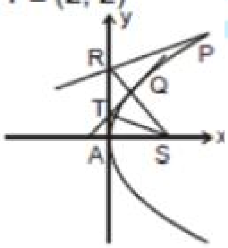


$$g'(x) = -\left(\frac{1}{(x-2021)^2} + \frac{1}{(x-2022)^2} + \frac{1}{(x-2023)^2}\right)$$

$$g'(2020) = -\left(1 + \frac{1}{4} + \frac{1}{9}\right) = \frac{-49}{36}$$

44.

$R \equiv (1, 1)$
$T \equiv (2, 2)$



Equation of RS is $4x - 3y - 1 = 0$

Equation of TS is $3x - 2y - 2 = 0$

$\therefore$ focus $S \equiv (4, 5)$

length of latus ractum = $4 \times \frac{1}{\sqrt{2}} = 2\sqrt{2}$

axis is $x + y - 9 = 0$

vertex $\equiv \left(\frac{9}{2}, \frac{9}{2}\right)$

45.

$a = (\pi - 3) + (\pi - 4) + (5 - 2\pi) = -2$

$f(-2) = f(2) \Rightarrow f(x)$ is many one $\Rightarrow$ non invertible

Let $t = x^2 + |x|, t \in [0, \infty)$

$f(x) \in [1, \infty)$

$\Rightarrow b = 1 \,\&\, a + b = -1$

$$g(x) = \left[(1+\cos 2x)^2 - 2\cos x - \frac{1}{2}(2\cos^2 2x - 1) - x^7\right]^{1/7}$$

$$g(x) = \left(\frac{3}{2} - x^7\right)^{1/7}$$

$$g(g(x)) = \left[\frac{3}{2} - \left(\frac{3}{2} - x^7\right)\right]^{1/7}$$

$f(g(g(b))) = f(b) = e^2$

46.

(A) Line of intersection of

$\bar{r}.\bar{n}_1 = q_1$ & $\bar{r}.\bar{n}_2 = q_2$ is along $\bar{n}_1 \times \bar{n}_2$.

line of intersection of

$\bar{r}.\bar{n}_3 = q_3$ & $\bar{r}.\bar{n}_4 = q_4$ is along $\bar{n}_3 \times \bar{n}_4$.

$\Rightarrow$ The two lines are perpendicular when

$(\bar{n}_1 \times \bar{n}_2).(\bar{n}_3 \times \bar{n}_4) = 0$

$\Rightarrow (\bar{n}_1.\bar{n}_3)(\bar{n}_2.\bar{n}_4) - (\bar{n}_1.\bar{n}_4)(\bar{n}_2.\bar{n}_3) = 0$

(B) $(\bar{n}_1 \times \bar{n}_2).\bar{n}_4 = 0 = (\bar{n}_2 \times \bar{n}_3).\bar{n}_4 = (\bar{n}_1 \times \bar{n}_3).\bar{n}_4$

(C) $(\bar{n}_1 \times \bar{n}_2) \times (\bar{n}_3 \times \bar{n}_4) = 0$

$\Rightarrow [\bar{n}_1\ \bar{n}_2\ \bar{n}_4]\bar{n}_3 = [\bar{n}_1\ \bar{n}_2\ \bar{n}_3]\bar{n}_4$

(D) Plane contains line along $\bar{n}_1 \times \bar{n}_2$.

Also plane is parallel to the line along $\bar{n}_3 \times \bar{n}_4$.

But does not imply that $\bar{n}_1 \times \bar{n}_2$ is parallel to $\bar{n}_3 \times \bar{n}_4$.

47.

A) $\int x^2 dx + \int d\left(\frac{e^x}{y}\right) = \int 0\, dx$

$$x^3 y + 3e^x = 3cy$$

B) put $x = r\cos\theta, y = r\sin\theta \Rightarrow x^2 + y^2 = r^2; \tan\theta = \frac{y}{x}$

$$d\theta = \frac{xdy - ydx}{x^2 + y^2}$$

$$\Rightarrow r^2 d\theta = xdy - ydx$$

$$\therefore \frac{rdr}{r^2 d\theta} = \sqrt{\frac{a^2 - r^2}{r^2}}$$

$$\int \frac{dr}{\sqrt{a^2 - r^2}} = \int d\theta \Rightarrow \sin^{-1}\left(\frac{x}{a}\right) = \theta + c$$

$$\sin^{-1}\left(\frac{\sqrt{x^2 + y^2}}{a}\right) = \tan^{-1}\frac{y}{x} + c$$

C) $\frac{xdy - ydx}{x^2 + 9y^2} = dx$

$$\frac{\frac{xdy - ydx}{x^2}}{1 + \left(\frac{3y}{x}\right)^2} = dx$$

$$\frac{1}{3}\int \frac{d\left(\frac{3y}{x}\right)}{1 + d\left(\frac{3y}{x}\right)} = \int dx$$

$$\frac{1}{3}\tan^{-1}\left(\frac{3y}{x}\right) = x + c$$

$$\tan^{-1}\left(\frac{3y}{x}\right) = 3x + c$$

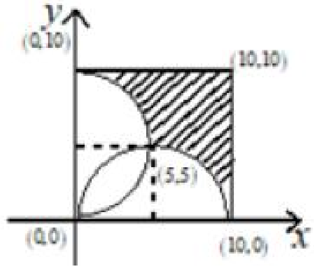
D) $\frac{-\phi(x)dy + y.\phi'(x)dx}{y^2} = dx$

$$\int d\left(\frac{\phi(x)}{y}\right) = \int dx$$

$$\frac{\phi(x)}{y} = x + c$$

$$\phi(x) = y(x + c)$$

48.



Non hatched area = 5× 5 + $\frac{\pi(5)^2}{4}+\frac{\pi(5)^2}{4}=25+\frac{25\pi}{2}=\frac{25}{2}(\pi+2)$

$\therefore$ required area = 100 - $\frac{25}{2}(\pi+2)$ = 75 - 25$\frac{\pi}{2}$ = $\frac{25}{2}(6-\pi)$

49.

Suppose that the first term of the sequence ΔA is d then

$\Delta A=\{d, d+1, d+2, \dots\dots (d+(n-1)\}$

hence $A=(a_1, a_1+d, a_1+d+(d+1),$

$a_1+d+(d+1)+(d+2)\dots\dots\dots)$

$a_n=a_1+(n-1)d+\frac{1}{2}(n-1)(n-2)$

so a_n is a quadratic polynomial in n.

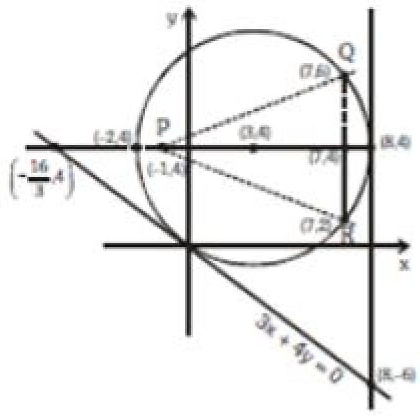
so $a_n=\frac{(n-\alpha)(n-\beta)}{2}$

since $a_{19}=a_{92}=0$ we must have

$a_n=\frac{1}{2}(n-19)(n-92)$

so $a_3=\frac{1}{2}(3-19)(3-92)=712$

50.



$x^2+y^2-6x-8y<0$

$(x-3)^2+(y-4)^2-25<0$

Point atleast distance from

$(-2,4)$ is $P(a,b)\equiv P(-1,4)$

Points which are greatest distance from $(-2, 4)$

are $Q(c, d)$

& $R(e, f) \equiv Q(7, 6)$ & $R(7, 2)$

ΔPQR is an isosceles triangle & internal bisector of $\angle P$ is $y = 4$

Equation of tangent at origin is $3x + 4y = 0$

equation of tangent at $\left(\frac{c+e}{2}+1, b\right) \equiv (8, 4)$ is

$x = 8$

Area of the right angled triangle formed by above three lines is $\Delta = \frac{1}{2} \times 10 \times \frac{40}{3} = \frac{200}{3}$

$\therefore \quad 3\Delta = 200$

51. $y = mx + c$ is tangent to $y^2 = 4ax$

$\Rightarrow a = mc \qquad ...(1)$

$c^2 \neq 9m^2 - 4$ and $c^2 \neq 2\sqrt{1+m^2}$

$m \in \left\{\frac{3}{4}, 1, \frac{4}{3}\right\}$

m value	Value of $\sqrt{9m^2-4}$	Value of $\sqrt{4m^2+4}$
1	Irrational	Irrational
$\frac{3}{4}$	Irrational	$\frac{5}{2}$
$\frac{4}{3}$	Irrational	$\frac{10}{3}$

$c \in \left\{\frac{5}{2}, \frac{10}{3}, \frac{17}{4}, \frac{26}{5}\right\}$

$\Rightarrow$ c can be either $\frac{17}{4}$ (or) $\frac{26}{5}$

& $m \in \left\{\frac{3}{4}, 1, \frac{4}{3}\right\}$

$a = mc$

$\Sigma 4a = 4 \Sigma mc$

$= 4\left(\frac{3}{4}+1+\frac{4}{3}\right)\left(\frac{17}{4}+\frac{26}{5}\right)$

$= 116.55$

52. Call the roots $-x_1, -x_2, -x_3$, and r_4. Then f (x) must factor as

$$(x+x_1)(x+x_2)(x+x_3)(x+x_4)$$

If we evaluate fat 1, we get $(x+x_1)(x+x_2)(x+x_3)(x+x_4)$

= a + b + c d + 1 = 2009 + 1 =2010 = 2.3.5.67. d is the product of the four roots, so
d = (-1). (-2). (-4). (-66).

53. Let $T^{+/-}$ indicate the test result and $B^{+/-}$ indicate whether the person actually does or does not have virus. The probability that someone has the virus, given that their test is positive, is equal to the probability that a given person tests positive and has it over the total probability of testing positive. In statistical notation.

$$P(B^+/T^+) = \frac{P(T^{+/-}/B^+).P(B^+)}{P(T^+/B^+).P(B^+) + P(T^+/B^-).P(B^-)}$$

$$= \frac{0.99.0.01}{0.99.0.01 + (1-0.99).(1-0.01)}$$

$$= 1/2.$$

54. Let $n = 2023$ and $p = \frac{1}{3}$. The answer can be computed as follows

$$\sum_{k=0}^{n} k\binom{n}{k} p^k (1-p)^{n-k} = \sum_{k=0}^{n} k \frac{n!}{k!(n-k)!} p^k (1-p)^{n-k}$$

$$= \sum_{k=1}^{n} n \frac{(n-1)!}{(k-1)!((n-1)-(k-1))!} p^k (1-p)^{n-k}$$

$$= n\sum_{k=1}^{n} \binom{n-1}{k-1} p^k (1-p)^{n-k}$$

$$= n\sum_{i=0}^{n-1} \binom{n-1}{i} pp^i (1-p)^{n-1-i}$$

$$= np(p+1-p)^{n-1}$$

$$= np$$

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S	JEE-ADVANCE-2020-P1	Date: 23-04-2023
Time: 09.00Am to 12.00Pm	GTA-17	Max. Marks: 198

23-04-2023_Sr.Super60_ NUCLEUS&ALL_BT'S_Jee-Adv(2020-P1)_GTA-17_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ___________________ H.T. NO: | | | | | | | |

JEE-ADVANCE-2020-P1-Model

Time: 3:00Hour's **IMPORTANT INSTRUCTIONS** Max Marks: 198

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total mark
Sec – I(Q.N : 1 – 6)	Questions with Single Correct Choice	3	-1	6	18
Sec – II(Q.N : 7 – 12)	**Questions with Multiple Correct Choice +1 partial marks**	4	-2	6	24
Sec – III(Q.N : 13 – 18)	Questions with Numerical Value Answer Type	4	0	6	24
Total				**18**	**66**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 19 – 24)	Questions with Single Correct Choice	3	-1	6	18
Sec – II(Q.N : 25 – 30)	**Questions with Multiple Correct Choice +1 partial marks**	4	-2	6	24
Sec – III(Q.N : 31 – 36)	Questions with Numerical Value Answer Type	4	0	6	24
Total				**18**	**66**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 37 – 42)	Questions with Single Correct Choice	3	-1	6	18
Sec – II(Q.N : 43 – 48)	**Questions with Multiple Correct Choice +1 partial marks**	4	-2	6	24
Sec – III(Q.N : 49 – 54)	Questions with Numerical Value Answer Type	4	0	6	24
Total				**18**	**66**

PHYSICS **Max Marks: 66**

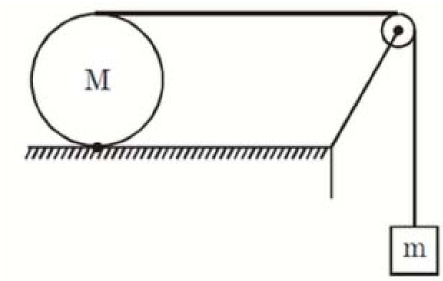
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains **SIX** (06) questions.
- Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +3 If ONLY the correct option is chosen;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -1 In all other cases

1. A massless inextensible string is wrapped over a cylinder of radius 20 cm and mass 2kg. It is connected to a hanging block of mass 1kg. If the surface were smooth, the cylinder would reach a distance ℓ in time t_1. If the surface were sufficiently rough, the cylinder would reach the distance ℓ in time t_2.

Then $\frac{t_1}{t_2} =$



A) 1 **B)** $\sqrt{\frac{7}{10}}$ **C)** $\sqrt{\frac{10}{7}}$ **D)** $\frac{1}{\sqrt{2}}$

2. An equi-convex lens $(\mu = 1.5)$ is combined with an equi concave lens $(\mu = 1.3)$. The radii of curvature of all surface is the same. (assume thin lenses)

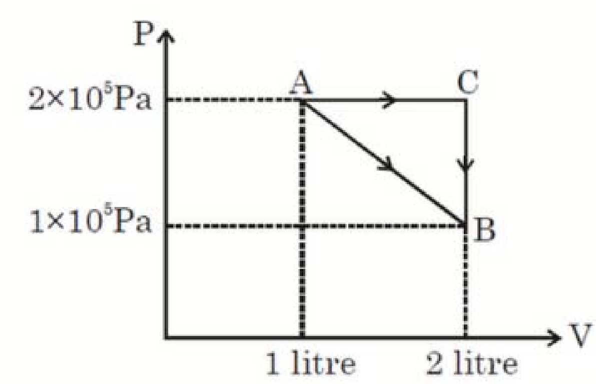
A) The combination behaves like a converging lens in medium of refractive index 1.4 and diverging lens in a medium of refractive index 1.6.

B) The combination behaves like a converging lens in a medium of refractive index 1.2 as well as 1.4.

C) The combination behaves like a diverging lens in medium of refractive index 1.2 as well as 1.6.

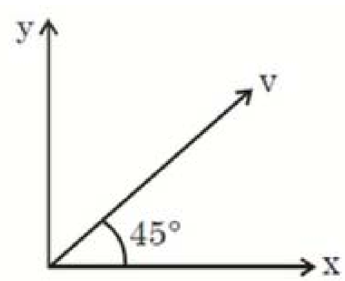
D) The combination behaves like a diverging lens in medium of refractive index 1.4 and converging lens in a medium of refractive index 1.6.

3. A certain substance (not an ideal gas) has a PV graph as a straight line AB when subjected to an adiabatic process. If the same substance goes through process $A \to C \to B$, what is the heat given to it?



A) 50 J **B)** 200 J **C)** 150 J **D)** 100 J

4. A charge of $+10\mu C$ and mass of 1gm is moving with velocity of 10^6 m/s at an angle of 45° to x & y axis as shown. In this case it experiences a magnetic force along – ve z – direction. If it were projected with 10^6 m/s along +ve z – direction, it would experience a magnetic force of 10^{-2}N in +ve x-direction. The magnetic field $\vec{B}$ is:



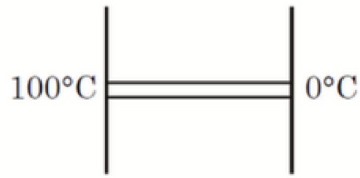
A) $-10^{-3}T\left(\hat{i}+\hat{j}\right)$ **B)** $10^{-3}T\left(\hat{j}+\hat{k}\right)$ **C)** $10^{-3}T\hat{i}$ **D)** $-10^{-3}T\hat{j}$

5. Electromagnetic waves of wavelength λ = 500 nm are incident on a standard YDSE apparatus. Both slits are of same width. Here slit separation d = 3 mm, and screen distance D = 2m. Intensity at central maximum is 1 W/m^2, what is the intensity (in W/m^2) at a point 1 mm above maxima of order 1?

A) 2 **B)** 1 **C)** 3 **D)** 4

6. Two rigid walls at a distance of 1m act as heat reservoirs at 100ºC and 0ºC. A well lagged uniform rod having length of 1m at 0ºC is held between both the walls. It is found that when the system reaches steady state, the supporting force can be removed and limiting friction acts on the rod at both the ends. Here α for $rod = 10^{-5} / °C$,

$Y = 2\times10^{11} N/m^2$, $\mu_{walls} = 0.3$ and what is the mass of the rod in Kg? Cross sectional area $A = 4mm^2$



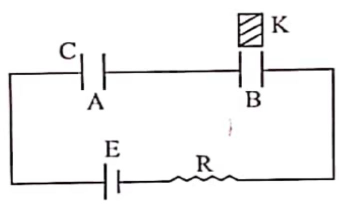
A) 12 **B)** 36 **C)** 24 **D)** 18

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

- This section contains **SIX** (06) questions.
- Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +4 If only (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -2 In all other cases

7. In the figure shown capacitors A and B of capacitance C each are in steady state. A dielectric slab of dielectric constant K = 2 and dimensions equal to the inner dimensions of the capacitor is inserted in the space between the plates of the capacitor B. Choose the correct options(s).



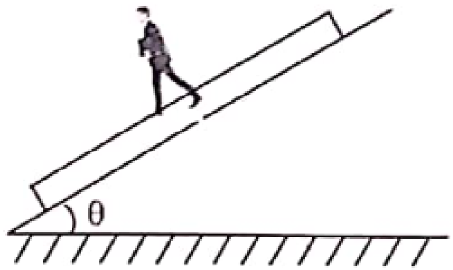
A) Charge on each capacitor will increases by CE / 6

B) In the process of inserting the dielectric, energy of the cell decreases by an amount of $\frac{CE^2}{6}$

C) In the process of inserting the dielectric, energy of the cell increases by an amount of $\frac{CE^2}{6}$

D) In the process of inserting the dielectric, the energy in the capacitor A increases by an amount of $\frac{7CE^2}{72}$

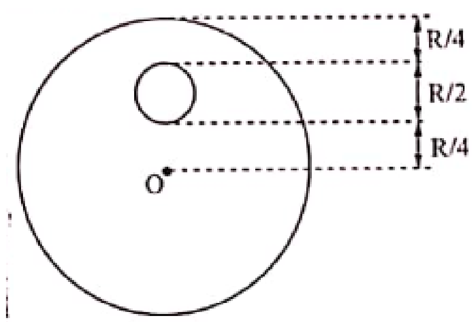
8. A board of mass M is placed on a rough inclined plane and a man of mass m walks down the board. If the coefficient of friction between the board and inclined plane is μ, the acceleration of the man, such that plank does not slip, is given by



A) $a \geq \left(\frac{M+m}{m}\right)(\sin\theta - \mu\cos\theta)g$ **B)** $a \geq \left(\frac{M+m}{M}\right)(\sin\theta - \mu\cos\theta)g$

C) $a \leq \left(\frac{M+m}{M}\right)(\sin\theta + \mu\cos\theta)g$ **D)** $a \leq \left(\frac{M+m}{m}\right)(\sin\theta + \mu\cos\theta)g$

9. A hole of radius $\frac{R}{4}$ is drilled from a disc of radius R and of mass m as shown. The disc of radius R can roll on the horizontal surface without slipping.



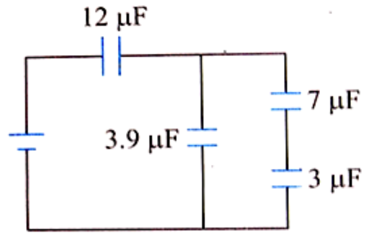
A) If it is slightly rolled and released from the shown situation then time period of oscillation nearly becomes $T = 6\pi\sqrt{\frac{5R}{g}}$

B) If is slightly rolled from the shown situation and released then the time period of oscillation nearly becomes $T = 3\pi\sqrt{\frac{5R}{g}}$

C) In the shown situation location of centre of mass is $\frac{R}{30}$ distance above O.

D) The moment of inertia of the disc about an axis passing through O and perpendicular to the plane of disc is $\frac{1}{2}mR^2$ approximately

10. Four capacitors and a battery are connected as shown in figure. If the potential difference across the $7\mu F$ capacitor is 6V, then which of the following statement(s) is/are correct?



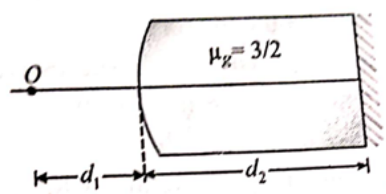
A) The potential drop across the $12\mu F$ capacitor is 10 V.

B) The charge in the $3\mu F$ capacitor is $42\mu C$.

C) The potential drop across the $3\mu F$ capacitor is 10 V.

D) The emf of the battery is 30 V.

11. In the figure shown a point object O is placed in air on the principal axis. The radius of curvature of the spherical surface is 60cm. I_f is the final image formed after all the refractions and reflections:



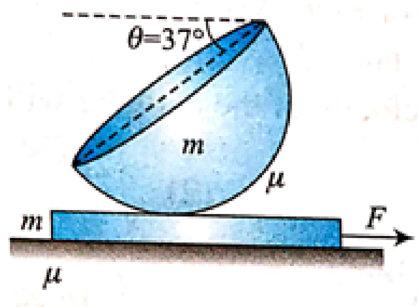
A) If $d_1 = 120cm$, then the $'I_f'$ is formed on $'O'$ for any value of d_2

B) If $d_1 = 240cm$, then the $'I_f'$ is formed on 'O' only if $d_2 = 360cm$

C) If $d_1 = 240cm$, then the $'I_f'$ is formed on 'O' for all value of d_2

D) If $d_1 = 240cm$, then the $'I_f'$ cannot be formed on 'O'

12. A force F is applied on the plank such that the hollow hemispherical shell is in equilibrium as shown in figure. The coefficient of friction μ is same between the with respect to plank hemispherical shell and the plank as its between the plank and the ground. Friction is just sufficient to prevent the slipping (Take $g = 10m/s^2$ and $m = 5kg$). Then



A) The minimum magnitude of coefficient of friction $\mu = 1/2$

B) The minimum magnitude of coefficient of friction $\mu = 1/4$

C) The magnitude of applied force is 100 N.

D) The acceleration of plank is $10 m/s^2$.

SECTION – III
(NUMERICAL VALUE TYPE)

• This section contains **SIX** (06) questions. The answer to each question is a **NUMERICAL VALUE.**
• For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. **If** the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.
• Answer to each question will be evaluated **according to the following marking scheme:**
Full Marks: +4 **If** ONLY the correct numerical value is entered;
Zero Marks: 0 In all other cases

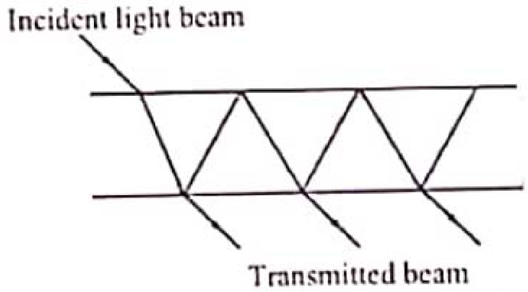
13. In young's double slit interference experiment, the distance between two secondary sources is $\frac{0.1}{\pi} mm$. The distance of the screen from the secondary sources is 25 cm. Wavelength of light used is $6000 \overset{0}{A}$. Then what is the angular position of the first dark fringe (in degrees)?

14. A certain amount of poly linear atomic gas undergoes a process for which $U^4 \alpha V$, where U is internal energy and V is volume of gas. Find the ratio of $\frac{\Delta U}{\Delta Q}$ for the given process?

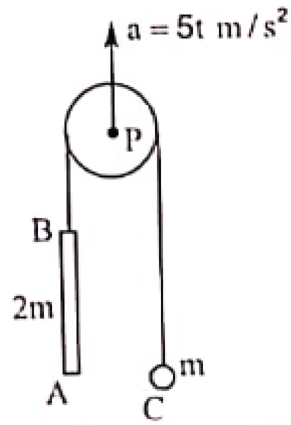
15. A vessel of volume 125 cm^3 contains tritium $\left({}_1H^3\right)$ With half life 12.5 days at 500 kpa and 300 K. If the radioactive disintegration activity of the gas (in disintegrations / second) initially is $\frac{N}{864} \times 10^{17}$. Where N is _____

(Take $R = \frac{25}{3} \frac{J}{mol.K}$; $1 day = 86400 sec$; $\ln 2 = 0.7$ *and avagrso's number* $N_A = 6 \times 10^{23}$)

16. A narrow beam of light has entered a large thin glass plate. Each reflection is accompanied by reflection of 40 % of beam energy of the incident light. Find the fraction of incident light energy is transmitted through the plate is ?



17. There is a massless pulley which is going upward with an acceleration $a = 5t\, m/s^2$. A string is passing over the pulley as shown in the igure. At one end of the string a plank of mass 2m kg is attached and at the other end a small ball mass m kg is attached. It is given that after 1 sec small ball just passes other end of the plank. If N is the length of plank in (m) is $\frac{N}{9}$, where N is____ $\left(g = 10\, m/s^2\right)$



18. The pitch of a screw gauge is 1 mm and there are 100 divisions on its circular scale. When nothing is put in between its jaws, the zero of the circular scale lies 4 divisions below the reference line. When a steel wire is placed between the jaws, two main scale divisions are clearly visible and 67 divisions on the circular scale are observed. The diameter of the wire is (in mm).

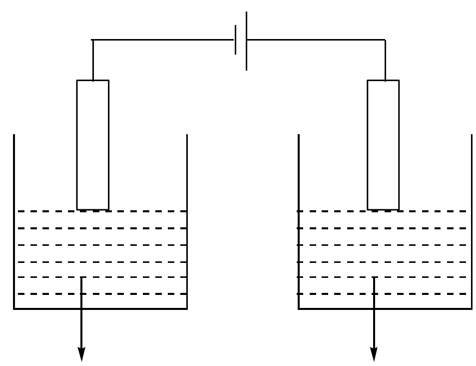
CHEMISTRY **Max Marks: 66**

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains **SIX** (06) questions.
- Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +3 If ONLY the correct option is chosen;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -1 In all other cases

19. 1 mole of electrons are transferred during electrolysis consider only electrolysis of water in both compartments pKa_1, pKa_2 values of H_2CO_3 are x & y respectively. pH of anode & cathode respectively after electrolysis



1 lit. solution of $Na_2CO_3, NaHCO_3$ 2M each

1 lit. solution of $Na_2CO_3, NaHCO_3$ 2M each

A) $x+\log\frac{1}{3},\ x+\log 3$ **B)** $y+\log 3,\ y+\log\frac{1}{3}$

C) $y+\log\frac{1}{3},\ y+\log 3$ **D)** $x+\log 3,\ x+\log\frac{1}{3}$

20. Which of the following are common components of photochemical smog?

1) chlorofluorocarbons 2) acrolein

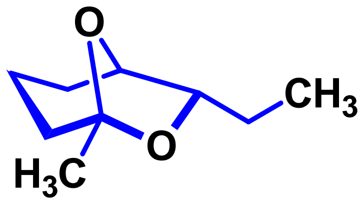
3) ozone 4) peroxyacetyl nitrate

A) 2, 3 **B)** 3, 4 **C)** 1, 2 **D)** 2, 3, 4

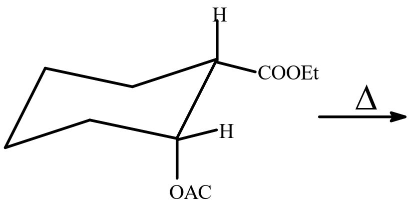
21. Industrially extraction of metal from sphalerite is achieved by

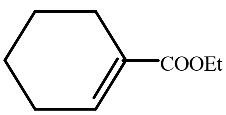
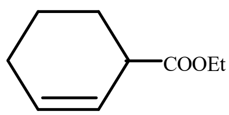
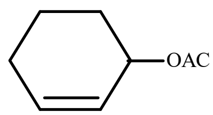
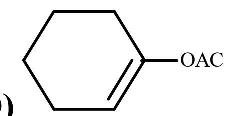
A) Electrolytic reduction
B) Roasting followed by reduction with C
C) Roasting followed by reduction with another metal
D) Roasting followed by self reduction

22. Pheromones are chemicals that animals produce for social response. The structure of brevicomin, a pheromone, is shown below. The open chain ketodiol that would form brevicomin is

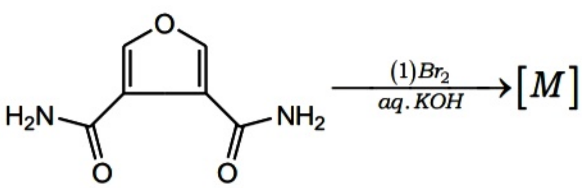


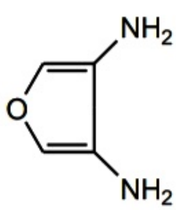
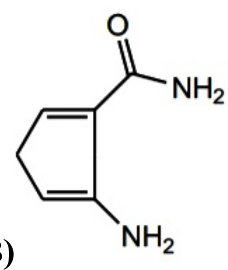
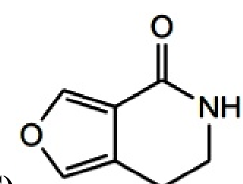
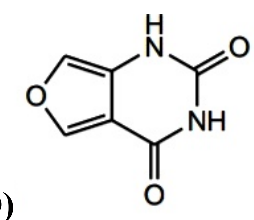
A) 7,8-dihydroxynonan-3-one **B)** 6,7-dihydroxynonan-3-one
C) 7,8-dihydroxynonan-2-one **D)** 6,7-dihydroxynonan-2-one

23.  major product of the reaction is

A)  **B)**  **C)**  **D)** 

24. Identify the most probable product (M) in the following reaction



A)  **B)**  **C)**  **D)** 

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

- This section contains **SIX** (06) questions.
- Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +4 If only (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -2 In all other cases

25. In the following gaseous phase first order reaction $A(g) \rightarrow 2B(g) + C(g)$ initial pressure was found to be 400 mm of Hg and it changed to 1000 mm of Hg after 20 min. then

A) Half life for A is 10 min

B) Rate constant is $0.0693 \ \text{min}^{-1}$

C) Partial pressure of C at 30 min is 350 mm of Hg

D) Total pressure after 30 min is 1100 mm of Hg

26. Which of the following statements is (are) incorrect?

A) 0.1 M KCl solution will have the same osmotic pressure as 0.1 M glucose solution

B) 0.1 M KCl solution will have the same boiling point as 0.1 M urea solution

C) 0.1 M glucose and 0.1 M urea are isotonic

D) 0.1 M $MgCl_2$ solution will have less relative lowering of vapour pressure than 0.1 M $NaCl$

27. Highly pure dilute solution of sodium in liquid ammonia :

A) Shows blue colour

B) Exhibits electrical conductivity

C) Produces sodium amide

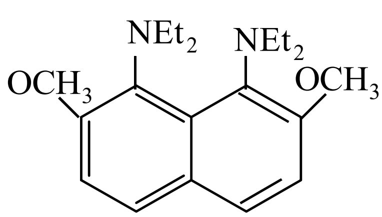
D) Produces hydrogen gas

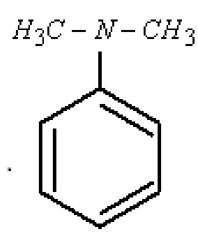
28. Which of the following species is/are paramagnetic?

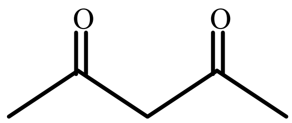
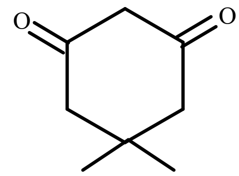
A) N_2^- **B)** O_2^{2+} **C)** NO^+ **D)** B_2^+

29. Which of the following is / are correct order with respect to their property?

A) 2,6-di-tert-butylpyridine is a weaker base than pyridine

B) 

is stronger base than 

C)  is weaker acid than 

D) $H_3O^+ > H_3S^+ > H_3Se^+ \left(Acidic\ nature\right)$

30. This conversion can be carried out by using the following sequence

$$CH_3-CH_2-C(=O)OH \longrightarrow CH_3-CH_2-C(=O)H$$

A) I) $SOCl_2$ II) $H_2, Pd / BaSO_4$

B) I) $R'-OH / H^+$ II) DIBAL-H

C) I) $Ca(OH)_2$ II) $(HCOO)_2$Ca/Dry distillation

D) I) $LiAlH_4$ II) $Cu / 300^0C$

SECTION – III
(NUMERICAL VALUE TYPE)

- This section contains **SIX** (06) questions. The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. **If** the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +4 **If** ONLY the correct numerical value is entered;
Zero Marks: 0 In all other cases

31. For the following molecules:

$PCl_5, BrF_3, ICl_2^-, XeF_5^-, NO_3^-, XeO_2F_2, PCl_4^+, CH_3^+$ calculate the value of $\frac{a+b}{c}$

a = Number of species having sp^3d-hybridization

b = Number of species which are planar

c = Number of species which are non – planar

32. Find total number of inner orbital diamagnetic complexes

$\left[Fe(CN)_6\right]^{3-}, \left[Co(H_2O)_6\right]^{2+}, \left[Cr(en)_3\right]^{3+}, \left[Fe(CN)_6\right]^{4-}, \left[Co(H_2O)_6\right]^{3+}, \left[Cr(CN)_6\right]^{3-},$

$\left[Pt\ Cl_6\right]^{2-}, \left[Ni(H_2O)_6\right]^{2+}, \left[Cr(CO)_6\right]$

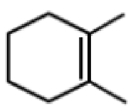
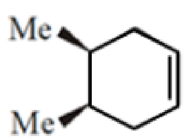
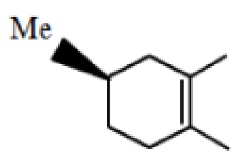
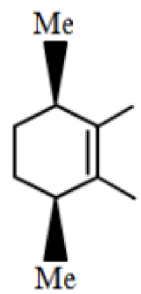
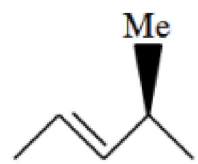
33. A solution of 0.1 M CH_3COOH is placed between parallel electrodes of cross-section area 4 cm^2, separated by 2 cm. For this solution, resistance measured is 100Ω. Calculate elevation in boiling point of the 0.1 M CH_3COOH solution, using following information

$$K_b = 0.5\,K\,kg/mol;\ \Lambda_m^{\infty}\left(H^+\right) = 300\,S\ cm^2\ mole^{-1};$$

$$\Lambda_m^{\infty}\left(CH_3COO^-\right) = 100\,S\ cm^2\ mole^{-1}$$

34. The Henry's law constant for the solubility of N_2 gas in water at 298K is 10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298K and 5atm pressure is $y \times 10^{-5}$. What is 'y'?

35. Among the following alkenes :

P)  Q)  R)  S)  T)  U) 

In above mentioned alkenes on reductive ozonolysis optically active products is X and meso products is Y, what is the value of (X + Y)

36. In caprolactum if 'a' is number of lone pairs of e^- and 'b' is number of sp^3 hybridized atoms. What is the value of a + b?

MATHEMATICS

Max Marks: 66

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains **SIX** (06) questions.
- Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +3 If ONLY the correct option is chosen;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -1 In all other cases

37. (x – 1) (y – 2) = 5 and $(x-1)^2+(y+2)^2=r^2$ intersect at four points A, B, C, D and if centroid of ΔABC lies on line y = 3x – 4, then locus of D is

A) A line **B)** A hyperbola

C) A circle **D)** Two points

38. Solution of the differential equation $\left\{\frac{1}{x}-\frac{y^2}{(x-y)^2}\right\}dx+\left\{\frac{x^2}{(x-y)^2}-\frac{1}{y}\right\}dy=0$ (where 'c' is the parameter)

A) $\ln\left|\frac{x}{y}\right|+\frac{xy}{x-y}=C$ **B)** $\frac{xy}{x-y}=Ce^{x/y}$

C) $\ln|xy|=C+\frac{xy}{x-y}$ **D)** $\ln|xy|=C+\frac{2xy}{x-y}$

39. The equation of the curve passing through (1, 0) and satisfying the differential equation $\left(y\frac{dy}{dx}+2x\right)^2=\left(y^2+2x^2\right)\left(1+\left(\frac{dy}{dx}\right)^2\right)$, is given by

A) $\sqrt{2}x^{\pm\sqrt{2}}=\frac{y+\sqrt{y^2+2x^2}}{x}$ **B)** $\sqrt{2}x^{\pm\frac{1}{\sqrt{2}}}=\frac{y+\sqrt{y^2+2x^2}}{x}$

C) $\frac{1}{\sqrt{2}}x^{\pm\frac{1}{\sqrt{2}}}=\frac{y+\sqrt{y^2+2x^2}}{y}$ **D)** $\sqrt{2}y^{\pm\frac{1}{\sqrt{2}}}=\frac{y+\sqrt{y^2+2x^2}}{y}$

40. The absolute value of $\dfrac{\int_0^{\pi/2}(x\cos x+1)e^{\sin x}dx}{\int_0^{\frac{\pi}{2}}(x\sin x-1)e^{\cos x}dx}$ is equal to

A) e B) πe C) e/2 D) $\dfrac{\pi}{e}$

41. If $\begin{vmatrix} a & b & 1 \\ b & c & 1 \\ c & a & 1 \end{vmatrix} = 2010$ *and* $\begin{vmatrix} c-a & c-b & ab \\ a-b & a-c & bc \\ b-c & b-a & ca \end{vmatrix} - \begin{vmatrix} c-a & c-b & c^2 \\ a-b & a-c & a^2 \\ b-c & b-a & b^2 \end{vmatrix} = P$ then sum of all digits in the number 'P' is

A) 7 B) 8 C) 9 D) None

42. Let A = {2, 3, 4, 5, …….., 30} and $\simeq$ be an equivalence relation on $A\times A$, defined by $(a, b)\simeq(c, d)$, if and only if ad = bc. Then the number of $((a,b),(c,d))$ pairs with (a,b) taken as $(4,3)$ is equal to

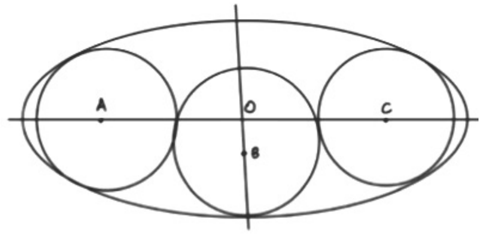
A) 8 B) 7 C) 5 D) 6

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

- This section contains **SIX** (06) questions.
- Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +4 If only (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: -2 In all other cases

43. Three circles, each of radius 1, are packed inside an ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1(a>b>0)$, $(2\theta=\angle ABC)$, as shown in the fig. Two of these circles, touch the ellipse at two points each, and the middle circle touches it at the end of minor axis. A, B and C are centres of these circles.



If the area of ellipse is minimum, then which of the following options is/are correct?

A) $6\tan\theta=\sqrt{35}$ **B)** $\sqrt{6}e=\sqrt{5}$ **C)** $3b=4$ **D)** $a=4\sqrt{3}$

44. Points $A_1, A_2, A_3, \ldots\ldots, A_n$ lie on +ve y-axis, and points $B_1, B_2, B_3, \ldots\ldots, B_n$ lie on curve $y=\sqrt{2x}$, such that

$OA_n=OB_n=\frac{1}{n}\forall\ n\in\{1, 2, 3, \ldots\ldots, n\}$.

If a_n denotes the x-intercept of line A_nB_n *and* b_n denotes the x-coordinate of B_n for all $n\in\{1, 2, 3, \ldots., n\}$, then which of the following options is/are correct?

A) $a_n>a_{n+1}\forall n\in\{1,2,3,\ldots,n\}$ **B)** $a_n>4\forall n\in\{1,2,3,\ldots,n\}$

C) $a_{10}=\frac{1}{10}\left(10+\sqrt{101}\right)\left(\sqrt{2}+1\right)$ **D)** $b_{10}=\frac{1}{10}\left(-10+\sqrt{101}\right)$

45. Which of the following options is/are correct?

A) *If* $f(x)=\sqrt{x}$ *and* $g(x)=x^{\frac{1}{3}}$, *then* $\int_0^2\left(f\left(1+x^3\right)+g\left(x^2+2x\right)\right)dx=6$

B)Let f : (-1, 1) $\rightarrow$ R be a twice differentiable function such that $2f'(x)+xf''(x)=1\ \forall x$, $\int_{-1}^{1}x^3f(x)\,dx=\frac{1}{5}$, *if* $f'\left(\frac{1}{2}\right)=\frac{1}{2}$

C)If 'f' is a function satisfying $f(x)=x+\int_0^1(x+t)\ f(t)dt$, *then* $\int_0^1 f(x)\,dx=-6$

D) *If* $f(x)=\ln x$ *then* $\int_1^{e^2}\frac{f\left(xe^{x+1}\right)}{(x+1)^2+\left(f\left(x^x\right)\right)^2}dx>\frac{\pi}{4}$

46. Suppose y = f(x) is a differentiable function of interval [a, b], such that $f'(a) = f'(b)$.

Then, consider the following statement P,

P : There exists atleast one $c \in (a, b)$ *such that* $f'(c) = \dfrac{f(c) - f(a)}{c - a}$

Then which of the following options is/are correct?

A) For all possible functions $y = f(x)$, statement P is true

B) There exists at least one function $y = f(x)$ such that P is false

C) There exists at least one function $y = f(x)$ such that P is true

D) Statement P is false for all possible functions $y = f(x)$

47. For the parabola $\sqrt{\dfrac{x}{2}} + \sqrt{\dfrac{y}{3}} = 1$, which touches x-axis at (2, 0) and y-axis at (0, 3) which of the following is/are true?

A) Equation of axis is 39x – 26y – 30 = 0

B) Focus is $\left(\dfrac{18}{13}, \dfrac{12}{13}\right)$

C) Directrix is 2x + 3y = 0

D) Latusrectum is $\dfrac{144}{(13)^{3/2}}$

48. Consider the cubic function f(x) = x(x – 2) (x – 6). Which of the following is/are true?

A) Tangent line drawn to the curve y = f(x) at the point (1, 5), meets the curve again at the point (6, 0)

B) Tangent line drawn to the curve y = f(x) at the point (3, -9), meets the curve again at the point (2, 0)

C) Tangent line drawn to the curve y = f(x) at the point (4, -16), meets the curve again at the point (0, 0)

D) Tangent curve drawn to the curve y = f(x) at the point (4, -16), meets the curve again at the point (2, 0)

SECTION – III
(NUMERICAL VALUE TYPE)

- This section contains **SIX** (06) questions. The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. **If** the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks: +4 **If** ONLY the correct numerical value is entered;
Zero Marks: 0 In all other cases

49. If z_1 *and* z_2 are two complex numbers such that

$|z_1 - z_2| = 4, |z_1 - z_2\omega| = 5, |z_1 - z_2\omega^2| = 3,$ where ω represents an imaginary cube of unity, then the value of $|z_2|^2 - 4\sqrt{3}$ is equal to (correct 2-decimal places)

50. Let N denote the number of ways in which 135 can be written as sum of 'n' natural numbers in the following manner.

$$135 = a_1 + a_2 + a_3 + ... + a_n \left(n \in N\right)$$

The digits `1, 2, 3…….9 are used to form numbers $a_1, a_2, a_3, ..., a_n$ such that all the digits are used and each digit is used exactly once in the sum. For example

$$135 = \underline{18 + 95 + 2 + 3 + 4 + 6 + 7}_{\text{each digit from } 1-9 \text{ is used once}}$$

Then $\frac{N}{6!}$ *equals*

51. Two knights of different colours are placed on any two squares of an empty chessboard. If 'p' denotes the probability that these two knights are placed in such away that each can kill the other in 1 move, then 15p is equal to

Note : The knight (♘, ♞) is a piece in the game of chess and is represented by a horse's head and neck.

52. Let set 'X' be the set of first 100 natural numbers i.e. X = {1, 2, 3, ..,, 100} and set Y be a subset of set 'X', such that

$Y = \{a_1, a_2, a_3, \ldots\ldots, a_n\}$, *where* $a_i + a_j \neq 7k \ \forall i \neq j \ (k \in \mathbb{Z})$

If $\lambda = \alpha \tan 108^0 + \beta \tan 8^0$ is a real number satisfying

$$\lambda = \frac{\tan 8^0}{1-3\tan^2 8^0} + \frac{3\tan 24^0}{1-3\tan^2 24^0} + \frac{9\tan 72^0}{1-3\tan^2 72^0} + \frac{27\tan 216^0}{1-3\tan^2 216^0}$$

Then the value of $\alpha + \beta + \max|Y|$ is equal to (|A| denotes cardinality of set A)

53. Let $f(x, y, z) = \begin{vmatrix} 1+x^2-y^2-z^2 & 2xy+2z & 2zx-2y \\ 2xy-2z & 1+y^2-z^2-x^2 & 2yz+2x \\ 2xz+2y & 2yz-2x & 1+z^2-x^2-y^2 \end{vmatrix}$

If 'm' is the number of positive divisors of f(1, 2, 3) and 'n' be the number of positive divisors of f(2, 3, 4), then n – m is equal to

54. Find $|l|$, where $l = \lim_{x\to 0}\left(\frac{1}{\ln\left(x+\sqrt{x^2+1}\right)} - \frac{1}{\ln(x+1)}\right)$

Sec:Sr.Super60_NUCLEUS&ALL_BT'S JEE-ADVANCE-2020_P1 Date: 23-04-2023
Time: 09.00Am to 12.00Pm GTA-17 Max. Marks: 198

KEY SHEET

PHYSICS

1)	C	2)	B	3)	A	4)	D	5)	B
6)	C	7)	A,B,D	8)	A,D	9)	A,D	10)	A,B,D
11)	A,B	12)	A,C	13)	0.54	14)	0.38	15)	84
16)	0.43	17)	35	18)	2.63				

CHEMISTRY

19)	C	20)	D	21)	B	22)	D	23)	B
24)	D	25)	A,B,C,D	26)	A,B,D	27)	A,B	28)	A,D
29)	A,B,C,D	30)	A,B,C,D	31)	3	32)	4	33)	0.05 - 0.06
34)	40	35)	3	36)	9				

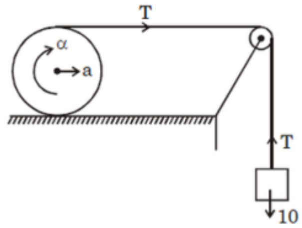
MATHEMATICS

37)	D	38)	A	39)	B	40)	A	41)	C
42)	B	43)	B,C	44)	A,B,D	45)	A,B,D	46)	A,C
47)	A,B,C,D	48)	A,B,C	49)	8.33	50)	1676	51)	1.25
52)	55	53)	48	54)	0.50				

SOLUTIONS

PHYSICS

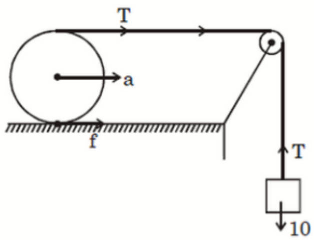
1. Smooth



$10-T=1a_1=a+R\alpha \quad TR=\frac{1}{2}\times 2R^2\alpha=R\alpha$

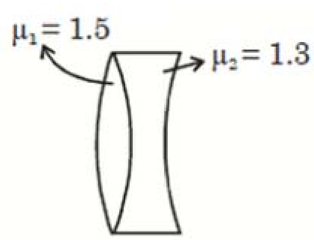
$T=2a \Rightarrow 10-T=\frac{T}{2}+T \quad 10=2.5T \Rightarrow T=4 \quad a=2m/s^2 \Rightarrow \ell=\frac{1}{2}\times 2t_1^2 t_1=\sqrt{\ell}$

Case (ii)



$10-T'=1a_1'=a'+R\alpha'+2R\alpha', \quad T'\times 2R=\frac{3}{2}\times 2\times R^2\alpha'$

2.



$F_{eq} \Rightarrow +ve\ converging$

$F_{eq} \Rightarrow -ve\ diverging$

$$\frac{1}{F_{eq}}=\frac{1}{F_1}+\frac{1}{F_2}\ \frac{1}{F_1}=\left[\frac{\mu_1}{\mu_m}-1\right]\left[\frac{2}{R}\right] and\ \frac{1}{F_2}=\left[\frac{\mu_2}{\mu_m}-1\right]\left[\frac{-2}{R}\right]$$

$$\frac{1}{F_{eq}}=\frac{2}{R}\left[\left(\frac{\mu_1}{\mu_m}-1\right)-\left(\frac{\mu_2}{\mu_m}-1\right)\right]\ \frac{1}{F_{eq}}=\frac{2}{R}\left[\frac{\mu_1}{\mu_m}-\frac{\mu_2}{\mu_m}\right]$$

$$(A)\frac{1}{F_{eq}}=\frac{2}{R}\left[\frac{1.5}{1.4}-\frac{1.3}{1.4}\right], \frac{1}{F_{eq}}=\frac{2}{R}\left[\frac{1.5}{1.6}-\frac{1.3}{1.6}\right]$$

Converging Converging

$$(B)\ \frac{1}{F_{eq}}=\frac{2}{R}\left[\frac{1.5}{1.2}-\frac{1.3}{1.2}\right], \frac{1}{F_{eq}}=\frac{2}{R}\left[\frac{1.5}{1.4}-\frac{1.3}{1.4}\right]$$

Converging Converging

(C) $\frac{1}{F_{eq}} = \frac{2}{R}\left[\frac{1.5}{1.6} - \frac{1.3}{1.6}\right], \frac{1}{F_{eq}} = \frac{2}{R}\left[\frac{1.5}{1.2} - \frac{1.3}{1.2}\right]$

Converging Converging

3. $\Delta W_{AB} + \Delta U_{AB} = 0$

$\Delta U_{AB} = -\frac{1}{2} \times 3 \times 10^5 (10^{-3}) = -150J$

$\Delta Q_{ACB} \quad = W + \Delta V$

$= -150 + 200 = 50J$

4. $q = 10\mu C = 10^{-5}C \quad m = 10^{-3}kg$

$\vec{v} = 10^6\left[\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right] \quad \vec{F} = q[\bar{v} \times \bar{B}]$

5. Fringe width,

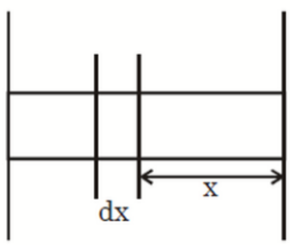
$\beta = \frac{D\lambda}{d} = \frac{1}{3}mm$

At a point 1mm above maxima of order – 1

= 4^{th} order maxima will be formed

$\therefore$ Intensity at this point = $1W/m^2$

6. In steady state,



$d\ell = dx\, \alpha \Delta T$

T = ax + b

x = 0, T = 0

x = 1m, T = 100°C

T = 100x $\quad \int d\ell = \int 100x \times dx \times 10^{-5}$

$\Delta\ell = 10^{-3} \times \frac{1}{2} \quad F = \frac{YA}{\ell}\Delta\ell$

$= \frac{2 \times 10^{11} \times 4 \times 10^{-6} \times 10^{-3}}{1} \times \frac{1}{2} = 400N$

$2\mu N = mg \quad m = \frac{2 \times 0.3 \times 400}{10} = 24kg$

7. Initially, $Q_A = Q_B = \frac{CE}{2}$, when dielectric is inserted.

$Q'_A = Q'_B = \frac{2CE}{2}, \therefore \Delta Q = \frac{2CE}{3} - \frac{CE}{2} = \frac{CE}{6}$

Work done by battery $= \frac{CE}{6} \times E = \frac{CE^2}{6} U_f - U_t$

8. Let F be the force exerted by the man on the board along the icline, then

$$Mg\sin\theta - \mu(M+m)g\cos\theta \le F \le Mg\sin\theta + \mu(M+m)g\cos\theta ......(1)$$

$\therefore$ *for man*, $F + mg\sin\theta = ma$ ....(2)

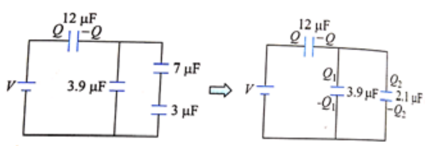
From equation (1) and (2)

$$\left(\frac{M+m}{m}\right)(\sin\theta - \mu\cos\theta)g \le a \le \left(\frac{M+m}{m}\right)(\sin\theta + \mu\cos\theta)g$$

9. On slight rolling, total energy associated is

$$E = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2 + mg(1-\cos\theta)\frac{\pi}{30}\frac{dE}{dt} = 0 \Rightarrow \alpha = \frac{-mgR\theta}{30\left(1+mR^2\right)} = -\omega^2\theta \therefore T = 6\pi\sqrt{\frac{\pi}{g}}$$

10. Equivalent capacitance of network is $C_{eq} = 4\mu F$.



Charge $Q = C_{eq}\ V = 4V\mu C$

The charge on the $7\mu F$ or $3\mu F$ capacitor is $Q_2 = (7\mu F)(6V) = 42\mu C$

$$\frac{Q_2}{2.1\mu F} = \frac{Q_1}{3.9\mu F} \text{ or } Q_1 = (42\mu C)\frac{(3.9\mu F)}{(2.1\mu F)} = 78\mu C$$

$Q = Q_1 + Q_2 = (78\mu C + 42\mu C) = 120\mu C = 4V\mu C$, Emf of the battery is $V = 30V$

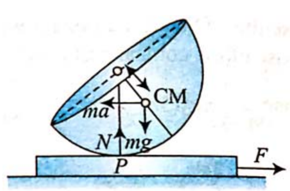
The potential drop across $12\mu F$ capacitor is $\frac{Q}{12\mu F} = \frac{120\mu C}{12\mu F} = 10V$

11. If $d_1 = 120$ cm then by refraction at curved surface, by refraction formula, we have

$$\frac{3}{2v} - \frac{1}{-120} = \frac{\left(\frac{3}{2}-1\right)}{60} \qquad \Rightarrow v = \infty$$

Thus parallel light incident normally on mirror and hence image will form on object itself, hence option (A) is correct. If $d_1 = 240$ cm then using refraction formula we get $v = 360cm$ so if $d_2 = 360cm$, then plane mirror form image at same place and again final image form on object itself hence option (B) is also correct.

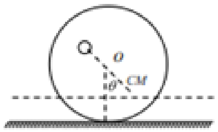
12. From the plank frame net torque about 'P' $ma\left(R - \frac{R}{2}\cos\theta\right) = mg.\frac{R}{2}\sin\theta$



$a = \frac{g\sin\theta}{2-\cos\theta}$ when $\theta = 37^0$ $a = 5m/s^2$ and $f = ma$ ….(ii)

$\mu N = ma \Rightarrow \mu.mg = ma \Rightarrow \mu = \frac{a}{g} = \frac{1}{2}$ and $F - \mu(2mg) = 2ma$, So, $F = 100N$

13.



The angular position $\theta = \frac{\beta}{D} = \frac{\lambda}{d}\left(\therefore \beta = \frac{\lambda D}{d}\right)$

The first dark fringe will be at half the fringe width from the mid-point of central maximum. Thus the angular position of first dark fringe will be

$$\alpha = \frac{\theta}{2} = \frac{1}{2}\left[\frac{\lambda}{d}\right] = \frac{1}{2}\left[\frac{6000\times\pi}{0.1\times10^{-3}}\times10^{-10}\right]\frac{180}{\pi} = 0.54^0$$

14. $\frac{\Delta U}{\Delta Q} = \frac{C_V}{C} = \frac{5}{13}$

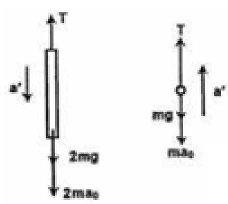
15. $Activity = \lambda N = \frac{\ln 2}{t/2}\left[\frac{PV\ N_A}{RT}\right]$ $\qquad N_A = Avogadro\ constant$

16. $Transmitted\ energy\ fraction = (1-\alpha)^2 + \alpha^2(1-\alpha)^2 + ... = \frac{1-\alpha}{1+\alpha} = \frac{3}{7}$

17. For the rod

2mg + 2ma – T = 2ma' ....(1)

$T - mg - ma_0 = ma'$ ....(2)



Equation (1) and (2)

$$mg + ma_0 = 3ma' \quad a' = (g + a_0)/3 \quad a_{R/ball} = \frac{2}{3}(g + a_0) \quad \frac{dV_{rel}}{dt} = \frac{2}{3}(g + 5t)$$

$$\int dV_{rel} = \int \frac{2}{3}(g+5t)dt \quad at\ t = 0,\ v_{max} = 0 \quad V_{rel} = \frac{2}{3}\left[gt + \frac{5t^2}{2}\right] \quad \frac{dx_{rel}}{dt} = \frac{2}{3}\left[gt + \frac{5t^2}{2}\right]$$

$$dx_{rel} = \frac{2}{3}\left[gt + \frac{5t^2}{2}\right]dt \quad \int_0^{x_{rel}} dx_{rel} = \frac{2}{3}\left[g\frac{t^2}{2} + \frac{5t^2}{6} + c\right] \quad x_{rel} = \frac{gt^2}{3} + \frac{5t^3}{9}\ in\ \text{sec.}$$

$$x_{rel} = \frac{g}{3} + \frac{5}{9} = \frac{9.8}{3} + \frac{5}{9} = 3.8\ m$$

18. (P) at centre of thin spherical shell $V \neq 0,\ E = 0$

(Q) At centre of solid sphere $V \neq 0,\ E = 0$

(R) At centre of spherical cavity inside solid sphere $V \neq 0,\ E \neq 0$

(S) At centre of two point masses $V \neq 0,\ E = 0$

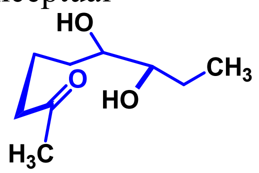
CHEMISTRY

19. Conceptual

20. The common components of photochemical smog are ozone , nitric oxide , acrolein, formaldehyde and peroxy acetyl nitrate(PAN) . hence chlorofluorocarbons is not common component of photochemical smog.

21. Conceptual

22.



(7*S*)-6,7-dihydroxynonan-2-one

23. It is synpyrolytic elimination

24. Intra Hoffmann bromide degradation

25. $A(g) \rightarrow 2B(g) + C(g)$

$t = 0 \quad 400$

$t = 20 \qquad 400 - x \qquad 2x \qquad x$

So $400 - x + 2x + x = 1000 \; x = 300\,\text{mmHg}$

$$K = \frac{1}{20}\ln\frac{400}{100} = \frac{2\ln 2}{20} = 0.0693\,\text{min}^{-1}$$

$$t_{1/2} = \frac{\ln^2}{K} = \frac{0.693}{0.0693} = 10\,\text{min}$$

$$\frac{30}{10} \times \ln 2 = \ln\frac{400}{400-x} \quad 8 = \frac{400}{400-x} \Rightarrow 400 - x = 50$$

$\Rightarrow x = 350$ mmHg

Partial pressure of C after 30 min = 350 mmHg

Total pressure after 30 min

$= 400 + 2x = 400 + 700 = 1100\,\text{mmHg}$

26. Isotonic solutions have same osmotic pressure and same particle concentration

27. The alkali metals dissolve in liquid ammonia without the evolution of hydrogen. The colour of the dilute solution is blue.

$$Na^{+} + (x+y)NH_3 \rightarrow \left[Na(NH_3)_x\right]^{+} + \left[e(NH_3)_y\right]^{-}$$

28. Conceptual

29. Due to steric effect 2,6-di-tertbutyl pyridine is weaker base than pyridine
In option (C) due to cyclisation acidic character increases

30. Conceptual

31.

$PCl_5 \rightarrow sp^3d, \; non-planar$

$BrF_3 \rightarrow sp^3d, \; bent, T-shape \; planar$

$ICl_2^- \rightarrow sp^3d, linear, \; planar$

$XeF_5^- \rightarrow sp^3d^3, \; pentagonal \; planar$

$NO_3^- \rightarrow sp^2 \; planar$

$XeO_2F_2 \rightarrow sp^3d$, see – saw, non – planar

$PCl_4^+ \rightarrow sp^3$, tetrahedral, non – planar

$CH_3^+ \rightarrow sp^2$, trigonal planar

$a = 4, b = 5, c = 3$

$$so, \frac{a+b}{c} = 3$$

32. $\left[Fe(CN)_6\right]^{4-}, \left[Co(H_2O)_6\right]^{3+}$

$\left[Pt\,Cl_6\right]^{2-}, \left[Cr(CO)_6\right]$

33. $\frac{\ell}{A} = \frac{2}{4};\ R = \rho.\frac{\ell}{A} \Rightarrow 100 = \rho.\frac{1}{2}$ or $\rho = 200\Omega$

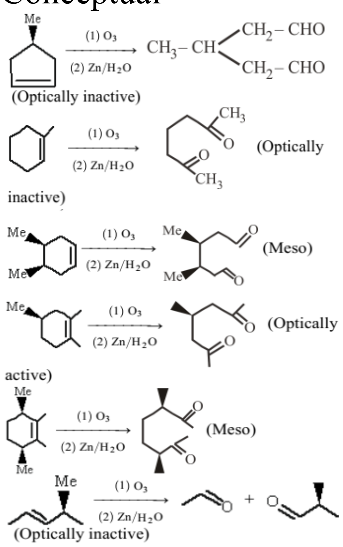
$\kappa = \frac{1}{200}\Omega^{-1}cm^{-1}\ \Lambda = \frac{1}{200} \times \frac{1000}{0.1} = 50$

$\Lambda^0 = 300 + 100 = 400$

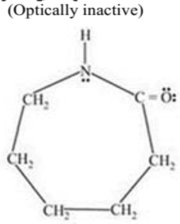
$\alpha = \frac{\Lambda}{\Lambda^0} = \frac{50}{400} = \frac{1}{8} \quad \Delta T_b = i \times K_b \times m = \left(1 + \frac{1}{8}\right) \times 0.5 \times 0.1 = 0.05625$

34. Conceptual

35.



36.



Number of lone pairs = a = 3

Number of sp^3 hybridised atoms = b = 5 + 1 = 6

C N

Sum of a + b = 3 + 6 = 9

MATHEMATICS

37.

If (x_t, y_t) is the point of intersection of given curves, then $\frac{\sum_{i=1}^{4} x_i}{4} = \frac{1+1}{2}$ *and* $\frac{\sum_{i=1}^{4} y_i}{4} = 0$

Now $\frac{\sum_{i=1}^{3} x_i}{3} = \frac{4-x_4}{3}$ *and* $\frac{\sum_{i=1}^{3} y_i}{3} = -\frac{y_4}{3}$

Centroid $\left(\frac{\sum_{i=1}^{3} x_i}{3}, \frac{\sum_{i=1}^{3} y_i}{3}\right)$ lies on the line y = 3x – 4. Hence,

$$\frac{-y_4}{3} = \frac{3(4-x_4)}{3} - 4 \Rightarrow y_4 - 3x_4$$

38.

Rearranging the terms of differential equation, we get $\left(\frac{dx}{x} - \frac{dy}{y}\right) + \left(\frac{x^2dy - y^2dx}{(x-y)^2}\right) = 0$

Observing the complete differentials by method of inspection

$$\Rightarrow \left(\frac{dx}{x} - \frac{dy}{y}\right) + \left[\frac{\left(\frac{dy}{y^2} - \frac{dx}{x^2}\right)}{\left(\frac{1}{y} - \frac{1}{x}\right)^2}\right] = 0 \qquad \because d\left(\frac{1}{\frac{1}{y} - \frac{1}{x}}\right) = \left(\frac{\frac{dy}{y^2} - \frac{dx}{x^2}}{\left(\frac{1}{y} - \frac{1}{x}\right)^2}\right)$$

$$\Rightarrow \ln|x| - \ln|y| - \frac{1}{\left(\frac{1}{x} - \frac{1}{y}\right)} = C$$

$$\Rightarrow \ln\left(\frac{x}{y}\right) + \frac{xy}{(x-y)} = C \text{ is the general solution}$$

39.

$$2x^2\left(\frac{dy}{dx}\right)^2 - 4xy\frac{dy}{dx} + 2y^2 = y^2 + 2x^2$$

$$2\left[x\frac{dy}{dx} - y\right]^2 = y^2 + 2x^2 \quad x\frac{dy}{dx} - y = \pm\sqrt{\frac{y^2 + 2x^2}{2}}$$

$$\frac{dy}{dx} = \frac{y}{x} \pm \frac{\sqrt{y^2 + 2x^2}}{\sqrt{2}x} \quad v + x\frac{dv}{dx} = v \pm \frac{\sqrt{v^2 + 2}}{\sqrt{2}}$$

$$\sqrt{2}\int\frac{dv}{\sqrt{v^2 + 2}} = \pm\int\frac{dy}{dx} \quad \sqrt{2}\sinh^{-1}\left(\frac{v}{\sqrt{2}}\right) = \log cx$$

$$\sqrt{2}\log\left(\frac{y}{\sqrt{2}x}+\sqrt{\frac{y^2}{2x^2}+1}\right)=\log cx\ (1,0)\ \log c=0\Rightarrow c=1$$

$$\frac{y+\sqrt{y^2+2x^2}}{x}=\sqrt{2}x^{\frac{1}{\sqrt{2}}}$$

40.

$$I_{Nr}=\int_0^{\frac{\pi}{2}}\underset{I}{x}\ \underset{II}{\cos x.\,e^{\sin x}}\ dx+\int_0^{\frac{\pi}{2}}e^{\sin x}dx$$

$$=xe^{\sin x}\Big|_0^{\pi/2}-\int_0^{\frac{\pi}{2}}e^{\sin x}dx+\int_0^{\frac{\pi}{2}}e^{\sin x}dx=\frac{e\pi}{2}$$

$$I_{Dr}=-xe^{\cos x}\Big|_0^{\pi/2}+\int_0^{\frac{\pi}{2}}e^{\cos x}dx-\int_0^{\frac{\pi}{2}}e^{\cos x}dx=-\frac{\pi}{2}\ \therefore\left|\frac{I_{Nr}}{I_{Dr}}\right|=\frac{e\pi.2}{2\pi}=e$$

41. $\Delta_C=\Delta^2=(2010)^2$

42. ad = bc

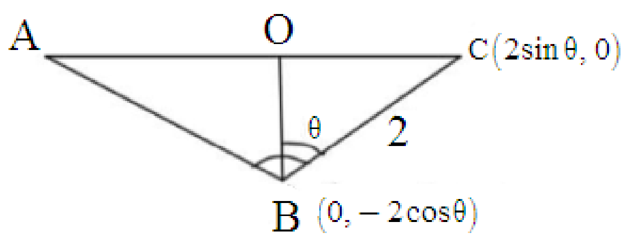
$$\frac{a}{b}=\frac{c}{d}\Rightarrow\frac{4}{3}=\frac{c}{d}$$

$$\Rightarrow c=\frac{4d}{3}\ so,\ d=3k\ \ d=3,6,9.......21.$$

$\therefore$ The number of pairs equivalent to (4, 3) is 7

43.

$$E:\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$



$$area,\ \Delta=\pi\ ab\ \ OBJ:\Delta=f(\theta)$$

$$\therefore b-2\cos\theta=1\Rightarrow b=1+2\cos\theta$$

Also normal to ellipse at H passes through C

$$Let\ H(p,q)\Rightarrow N@H\equiv\frac{a^2x}{p}-\frac{b^2y}{q}=a^2-b^2=a^2e^2\Rightarrow c\left(pe^2,0\right)$$

$$pe^2=2\sin\theta\ and\ b-1=2\cos\theta\ \therefore\left(pe^2\right)^2+(b-1)^2=4$$

$HC = 1 \therefore (p - 2\sin\theta)^2 + q^2 = 1 \; HC = 1 \therefore (p - 2\sin\theta)^2 + q^2 = 1 \; \therefore \left(p\left(1-e^2\right)\right)^2 + q^2 = 1$

$also\ H\ lies\ on\ ellipse \Rightarrow \dfrac{p^2}{a^2} + \dfrac{q^2}{b^2} = 1 \Rightarrow p^2\left(1-e^2\right) + q^2 = b^2$

$p^2e^2\left(1-e^2\right) = b^2 - 1\ and\ p^2e^4 = 4 - (b-1)^2$

$\Rightarrow \dfrac{1-e^2}{e^2} = \dfrac{b^2-1}{3-b^2+2b} \Rightarrow 1 - e^2 = \dfrac{b^2-1}{2+2b} = \dfrac{b^2}{a^2}$

$\Rightarrow a^2 = \dfrac{2b^2}{b-1} \Rightarrow \Delta = \pi ab = \dfrac{\pi b^2\sqrt{2}}{\sqrt{b-1}} = \dfrac{\pi\sqrt{2}}{\sqrt{b^{-3}-b^{-4}}}$

$\therefore \dfrac{d\Delta}{db} = 0 \Rightarrow b = \dfrac{4}{3} \Rightarrow 2\cos\theta = \dfrac{1}{3} \Rightarrow \tan\theta = \sqrt{35}$

44. Let $A_n\left(0, \dfrac{1}{n}\right), B_n\left(b, \sqrt{2b}\right)$

$OA_n = \dfrac{1}{n}\ and\ OB_n = \dfrac{1}{n} \Rightarrow b^2 + 2b = \dfrac{1}{n^2} \Rightarrow b + 2 = \dfrac{1}{bn^2}$

$also\ a_n = x - intercept\ of\ A_nB_n = \dfrac{b}{1-n\sqrt{2b}}$

$\Rightarrow a_n = \dfrac{b\left(1+n\sqrt{2b}\right)}{1-2bn^2} = \dfrac{b\left(1+n\sqrt{2b}\right)}{n^2b^2} = \dfrac{1+n\sqrt{2b}}{bn^2}$

$= \dfrac{1}{bn^2} + \dfrac{\sqrt{2}}{n\sqrt{b}} = b + 2 + \sqrt{2}\ \sqrt{b+2}$

$= \sqrt{1+\dfrac{1}{n^2}} + 1 + \sqrt{2}\sqrt{1+\sqrt{1+\dfrac{1}{n^2}}}$

$\therefore a_n > a_{n+1}\ \text{since}\ \dfrac{1}{n} > \dfrac{1}{n+1}$

$also\ a_n > 4$

45. A) $LHS = I_1 + I_2 \qquad x^2 + 2x + 1 = t^3 + 1$

$put\ x^2 + 2x = t^3\ in\ I_2 \qquad x + 1 = \sqrt{t^3+1}$

$\therefore I_2 = \int_0^2 \left(x^2+2x\right)^{\frac{1}{3}} dx = \int_0^2 t\, d\left(t^3+1\right)^{\frac{1}{2}}$

$\therefore LHS = \int_0^2 \left(f(t) + t\,f'(t)\right) dt = \left(t\,f(t)\right)_0^2$

$= 2(3) - 0 = 6$

B) $2f'(x) + xf''(x) = 1 \Rightarrow (xf(x))'' = 1$

$$\left[\left(x\ f(x)\right)'\right]_0^x = x \Rightarrow \left(x\ f(x)\right)' = x + f(0)$$

$$\Rightarrow x\,f(x) = \frac{x^2}{2} + x\ f(0)$$

$$\Rightarrow f(x) = \frac{x}{2} + f(0)$$

C) $f(x) = x + x\int_0^1 f(t)\,dt + \int_0^1 t\,f(t)\,dt$

$$\therefore f(x) = x + ax + b\ \ a = \int_0^1 f(t)dt \text{ and } b = \int_0^1 t\ f(t)\,dt$$

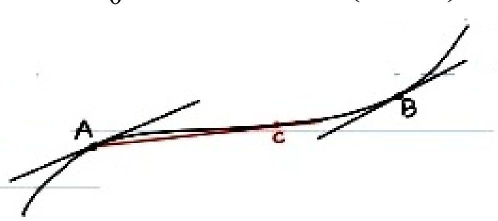
$$\Rightarrow \frac{a}{2} = \frac{1}{2} + b \text{ and } \frac{b}{2} = \frac{a+1}{3} \Rightarrow \frac{a-1}{2} = \frac{2a+2}{3} \Rightarrow 3a - 3 = 4a + 4 \Rightarrow a = -7$$

D) $I = \int_1^{e^2} \frac{x+1+\ln x}{(x+1)^2 + (x\ln x)^2}\,dx = \int_1^{e^2} \frac{\left(\frac{x+1+\ln x}{(x+1)^2}\right)}{1+\left(\frac{x\ln x}{x+1}\right)^2}$

$$let\ \frac{x\ln x}{x+1} = t \Rightarrow \frac{(x+1)(1+\ln x) - x\ln x}{(1+x)^2}dx = dt$$

$$\therefore I = \int_0^{\frac{2e^2}{e^2+1}} \frac{dt}{1+t^2} = \tan^{-1}\left(\frac{2e^2}{e^2+1}\right) > \tan^{-1}(1)$$

46.



$f'(a) = f'(b)$ means tangents at A, B are par

Hence AC such that AC is tangent at C

$$m_{AC} = \frac{f(c) - f(a)}{c - a} = m_{T@c} = f'(c)$$

$$g(x) = \begin{cases} \dfrac{f(x) - f(a)}{x - a}; & x \neq a \\ f'(a); & x = a \end{cases}$$

$\therefore$ if g(x) is not strictly monotonic, then

$\exists c \in (a,b): g'(c) = 0 \Rightarrow f'(c) = \dfrac{f(c)-f(a)}{c-a}$

Otherwise, we assume $g(a) \le g(x) \le g(b)$

$\therefore g(x) \le g(b) \Rightarrow f(x) \le f(a) + (x-a)g(b)$

$now\ f'(b) = \lim\limits_{t\to b} \dfrac{f(t)-f(b)}{t-b} \ge \lim\limits_{t\to b} \dfrac{f(a)-f(b)+(t-a)g(b)}{t-b}$

$\Rightarrow f(b) \ge g(b) \ge g(x) \ge g(a) = f'(a)$

This is only possible when g(x) = g(a) = g(b) = constant

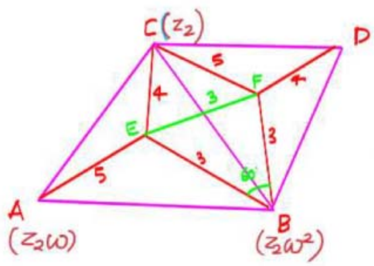
47. For the parabola $\sqrt{\dfrac{x}{a}} + \sqrt{\dfrac{y}{b}} = 1$

Focus is $\left(\dfrac{ab^2}{a^2+b^2}, \dfrac{a^2b}{a^2+b^2}\right)$, Axis is ay – bx = $\dfrac{ab\left(a^2-b^2\right)}{a^2+b^2}$

Directrix is ax + by = 0

48. For the function f(x) = (x – a) (x – b) (x – c) has three distinct zeroes. A tangent line drawn at the average of the two zeroes a and b, intersects the graph of 'f' again at the third zero.

49.



ΔCEF *is a right* Δ

$\angle E = \dfrac{\pi}{2} \therefore \angle CEB = 60 + 90$

$\cos 150 = \dfrac{16+9-BC^2}{2\times 4\times 3} \Rightarrow BC^2 = 16 + 9 + 12\sqrt{3}$

$|z_2 - z_2\omega^2|^2 = 25 + 12\sqrt{3} \Rightarrow |z_2| = \dfrac{25+12\sqrt{3}}{|1-\omega^2|} =$

50. None of $a_1, a_2, a_3, ...a_n$ can be a 3-digit numbers

Hence, a few of them are 2-digit numbers, and rest are 1-digit numbers

Let sum of digits in terms in the place = k. Then sum of units place = 45 – k

$\therefore 135 = 10\times k + 45 - k \Rightarrow 9k = 135 - 45 = 90 \Rightarrow k = 10$

$k = 1+9 = 2+8 = 3+7 = 4+6 \to 4\times {}^7P_2 \times 7!$

$k = 1+2+7 = 1+3+6 = 1+4+5 = 2+3+5 \to 4\times {}^6P_3 \times \underline{|6}$

$k = 1+2+3+4 \to 1\times {}^5P_4 \times \underline{|5}$

$\therefore total = 4\times7\times6\times\underline{|7} + 4\times6\times5\times4\times\underline{|6} + 5\times4\times3\times2\times\underline{|5}$

$= 21\times\underline{|8} + 500\times\underline{|6}$

$= 1676\times\underline{|6}$

51. Required probability $= \dfrac{[7\times6+6\times7]\times2\times\underline{|2}}{^{64}P_2} = \dfrac{42\times8}{64\times63} = \dfrac{1}{12}$

52. $7k\to14;\ 7k+1\to15; 7k+2\to15;\ 7k+3\to14;\ 7k+4\to14\leftarrow7k+5,\ 6$

$\therefore \max|y| = 1+15+15+14$

$\dfrac{\tan 8}{1-3\tan^2 8} = \dfrac{\tan 24}{3-\tan^2 8} = \dfrac{\tan 24 - 3\tan 8}{9-1} \Rightarrow sum = \dfrac{81\tan 648 - \tan 8}{8}$

53. $R_1 \to xR_1 + yR_2 + zR_3$

$$Ax = \begin{vmatrix} x(1+x^2+y^2+z^2) & y(1+x^2+y^2+z^2) & z(1+x^2+y^2+z^2) \\ 2(xy-z) & 1+y^2-x^2-z^2 & 2(yz+x) \\ 2(xz+y) & 2(yz-x) & 1+z^2-x^2-y^2 \end{vmatrix}$$

$R_2 \to -2y\ R_1 + R_2$

$R_3 \to -2z\ R_1 + R_3$

$$=(1+x^2+y^2+z^2)\begin{vmatrix} x & y & z \\ -2z & 1-(x^2+y^2+z^2)\to k & 2x \\ 2y & -2x & 1-(x^2+y^2+z^2) \end{vmatrix}$$

$=(1+x^2+y^2+z^2)\left[xk^2+4xy^2+4xz^2-2yzk+2yzk+4x^3\right]$

$=x(1+x^2+y^2+z^2)\left[k^2+4y^2+4z^2+4x^2\right]$

$Ax = x(1+x^2+y^2+z^2)^3$

54.

$$\lim_{x\to0}\frac{\ln(x+1)-\ln\left(x+\sqrt{x^2+1}\right)}{x^2\dfrac{\ln(x+1)}{x}.\dfrac{\ln\left(x+\sqrt{x^2+1}\right)}{x}} = \lim_{x\to0}\frac{\dfrac{1}{x+1}-\left(\dfrac{1}{x^2+1}\right)^{\frac{1}{2}}}{2x}$$

$$=\lim_{x\to0}\frac{1}{2}\left[\frac{-1}{(1+x)^2}+\frac{1}{2}\left(x^2+1\right)^{-3/2}.2x\right]=\frac{-1}{2}$$

NARAYANA IIT-JEE ACADEMY-INDIA

OUTGOING SR'S

Time: 3 Hrs

SGTA-5

DATE: 25-05-2023

Max. Marks: 180

Paper - I

JEE-ADVANCE -2018-P1- Model

Important Instructions

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec - I(Q.N : 1 - 6)	Questions with Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	6	24
Sec - II(Q.N : 7 - 14)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+3	0	8	24
Sec - III(Q.N : 15-18)	Questions with Comprehension Type (2 Comprehensions - 2 +2 = 4Q)	+3	-1	4	12
Total				18	60

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec - I(Q.N :19 - 24)	Questions with Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	6	24
Sec – II(Q.N : 25 –32)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+3	0	8	24
Sec - III(Q.N : 33-36)	Questions with Comprehension Type (2 Comprehensions - 2 +2 = 4Q)	+3	-1	4	12
Total				18	60

MATHEMATICS

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec - I(Q.N:37 - 42)	Questions with Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	6	24
Sec – II(Q.N :43–50)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+3	0	8	24
Sec –III(Q.N : 51-54)	Questions with Comprehension Type (2 Comprehensions - 2 +2 = 4Q)	+3	-1	4	12
Total				18	60

PHYSICS MAX.MARKS: 60

SECTION- I (Maximum Marks: 24)

This section contains **SIX (06)** questions. Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s). For each question, choose the correct option(s) to answer the question.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.

Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.

Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.

Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.

Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).

Negative Marks: -2 In all other cases.

1. A particle of mass m, moving with a velocity $\vec{v} = v_0\hat{i} + v_0\hat{j}$, elastically collides with another particle of mass 2m at rest. Mark the correct statement

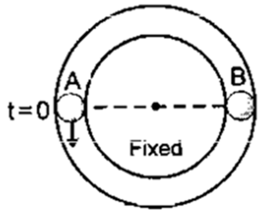
(A) The direction along which C.M move is $-\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(B) The speed of m just before collision in C-frame is $\sqrt{2}\,v_0$

(C) The speed of 2m just before collision in C-frame is $\sqrt{2}\,v_0$

(D) The speed of 2m just after collision in C-frame is $\frac{\sqrt{2}\,v_0}{3}$

2. Particle 'A' moves with speed 10 m/s in a frictionless circular fixed horizontal pipe of radius 5 m and strikes with 'B' of double mass that of A. Coefficient of restitution is 1/2 and particle 'A' starts its journey at t = 0. The time at which second collision occurs is :

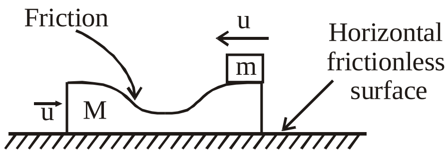


(A) $\frac{\pi}{2}$ (B) $\frac{2\pi}{3}$ (C) $\frac{5\pi}{2}$ (D) 4π

3. An object is projected with a speed 10 m/s at an angle of 30º with the horizontal. The object breaks down into n equal fragments during its motion. One fragment is found to strike the ground at a distance of $\sqrt{3}$ m from the point of projection in the same azimuthal plane, in which the object is projected. If the centre of mass of the remaining fragments strikes the ground at distance of $7\sqrt{3}$ m from the point of projection, then the value of n is

(A) 2 (B) 3 (C) 4 (D) 5

4. A small block of mass m is placed on a bigger block of mass M, which is placed on a horizontal frictionless plane. The two blocks are given equal speeds u, but in opposite directions, as shown in the figure. After sometime, it is observed that both the blocks are moving in the direction of motion of the lower block, with a velocity greater than $\frac{u}{2}$. It can be concluded that



(A) M > 3 m (B) 3 M < m

(C) m > 2 M (D) M, m can have any value such that M > m.

5. Two pucks are initially moving along a frictionless surface as shown in the diagram. The pucks have mass $m_1 < m_2$ and begin with equal magnitude of momentum. A constant force F is applied to each puck directly to the right for the same non-zero interval of time. After the pushes are complete, what is the relationship between the size of the momenta of pucks (p_1 and p_2) ?

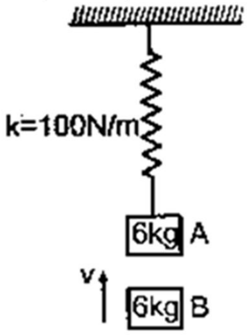
(A) $p_1 < p_2$
(B) $p_1 = p_2$
(C) $p_1 > p_2$
(D) More information about the masses, speeds, force and time are required to answer the questions

6. The resultant force on a system of particles is non-zero.
(A) The linear momentum of the system must increase
(B) The velocity of the center of mass of the system must change
(C) The distance of the centre of mass may remain constant from a fixed point
(D) Kinetic energy of all particles must either increase simultaneously or decrease simultaneously

SECTION – II (Maximum Marks: 24)

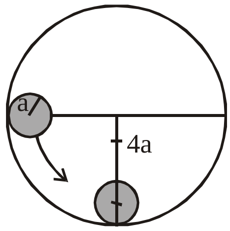
This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) designated to enter the answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +3 If ONLY the correct numerical value is entered as answer.
Zero Marks: 0 In all other cases

7. Block 'A' is hanging from a vertical spring and is at rest. Block 'B' strikes the block 'A' with velocity 'v' and sticks to it. Then the value of 'v'(in m/s) for which the spring just attains natural length is :



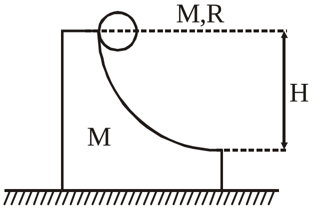
8. Sand drops vertically (from negligible height) at a rate of 4kg/s on to a conveyer belt moving at constant speed 2m/s. Energy lost the heat per unit time is ______ (in j/s)

9. A ring of radius 4a is rigidly fixed in vertical position on a table. A small disc of mass m and radius a is released as shown in the figure. When the disc rolls down, without slipping, to the lowest point of the ring, then its speed in m/s will be

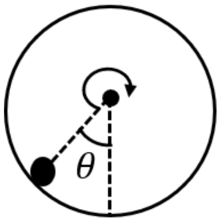


(take g = 10 m/s^2 and a = 0.4 m)

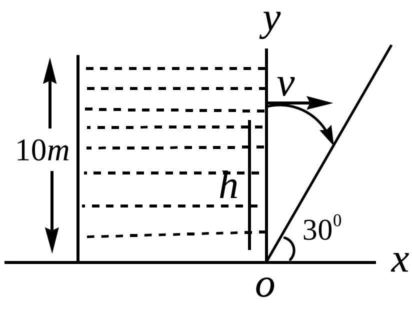
10. In the given diagram co-efficient of friction between sphere and surface is very high to ensure no relative sliding where as that between block and surface is zero .The system is released from given position. If the ratio of the K.E. for block to sphere in ground frame is x then find the value of 13 x.



11. A hollow cylinder of radius R=2.0 m is rotating at constant angular acceleration about its stationary horizontal axis into the plane of the paper as shown in the figure. If a uniform solid cylinder is placed horizontally with its axis parallel to the axis of hollow cylinder at an angular position of $\theta = 30^0$, the solid cylinder starts rolling with its axis motionless. The angular acceleration α (in rad/s^2) of the hollow cylinder is *x*. Find *x*

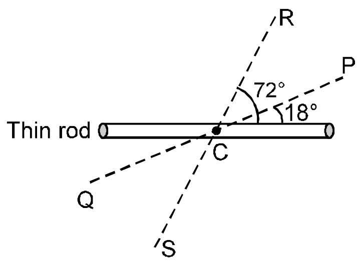


12. A rectangular tank of height 10m filled with water is placed near the bottom of a plane inclined at an angle 30^0 with horizontal. At height h from bottom a small hole is made (as shown in figure) such that the stream coming out from hole, strikes the inclined plane normally. The value of 'h' is $\frac{(x)^2}{3}$. Find the value of 'x' in meters



13. A rod AB of mass M and length L is lying on a horizontal frictionless surface. A particle of mass m travelling along the surface hits one end A of the rod with a velocity v_0 in a direction perpendicular to AB. The collision is elastic. After the collision the particle comes to rest. Find the ratio M/m.

14. The moment of inertia of a uniform thin rod of mass m and length L about two axis PQ and RS passing through centre of rod C and in the plane of the rod are I_{PQ} and I_{RS} respectively. Then $I_{PQ}+I_{RS}=\frac{mL^2}{3x}$. The value of x is



SECTION – III (Maximum Marks: 12)

This section contains **TWO (02)** Paragraphs. Based on each paragraph, there are 2 questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases

Passage-I

A syringe is filled with water. Its volume is 20 cm^3, and the cross section of its interior part is 4 cm^2. The syringe is held vertically such that its nozzle is at its top, and its 100g piston is pressed by external agent and it moves with a constant speed. The ejected water has an initial upward velocity of 2 m/s, and the cross-section of the beam of water at the nozzle is 1 mm^2. (Neglect the dissipated energy due to friction)

15. Find the speed of the piston.

(A) 5 mm/s (B) 5 cm/s (C) 0.5 m/s (D) 0.5 mm/s

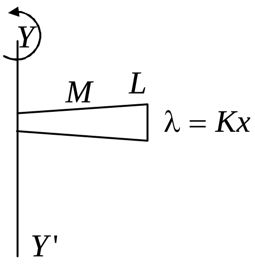
16. What is the total work done by external agent?

(A) 0.04 J (B) 0.045 J (C) 0.095 J (D) 4.5 MJ

Passage-II

Moment of inertia is a physical term which oppose the change in rotational motion. Moment of inertia depends on distribution of mass, shape of the body as well as distance from the rotational axis. Moment of linear momentum is called angular momentum. If no external torque act on the system then angular momentum of the system remains conserved. Geometrical meaning of angular momentum relates to the real velocity.

17. Mass M is distributed over the rod of length L. If linear mass density (λ) linearly increases with length as $\lambda = Kx$. The M.I. of the rod about one end perpendicular to rod i.e. (YY')



(A) $\frac{ML^2}{3}$ (B) $\frac{ML^2}{12}$ (C) $\frac{2}{3}ML^2$ (D) $\frac{KL^4}{4}$

18. A particle of mass m is moving along the line $y=3x+5$ with speed V. The magnitude of angular momentum about origin is

(A) $\sqrt{\frac{5}{2}}mV$ (B) $\frac{5}{2}mV$ (C) $\frac{1}{2}mV$ (D) $\frac{1}{\sqrt{3}}mV$

CHEMISTRY MAX.MARKS: 60

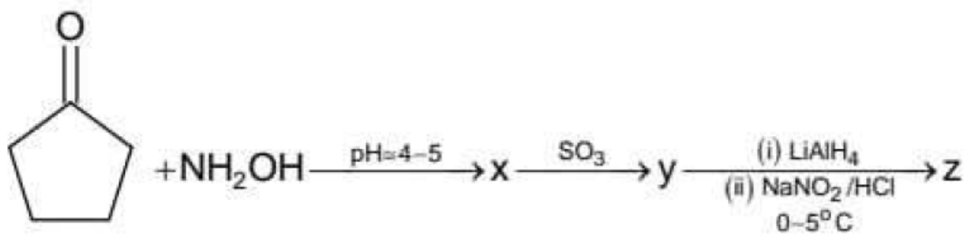
SECTION- I (Maximum Marks: 24)

This section contains **SIX (06)** questions. Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s). For each question, choose the correct option(s) to answer the question.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

19. Which option is correct?



(A) 'x' is α-amino ketone (B) 'y' is cyclic amide

(C) 'z' is yellow oily liquid (D) Compound X has 2 geometrical Isomers

20. An acidic solution contains Cu^{2+}, Pb^{2+} and Zn^{2+}. If $H_2S(g)$ is passed through the solution the precipitate will contain

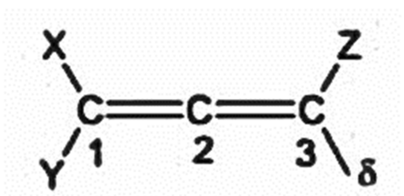
(A) CuS and ZnS (B) PbS and ZnS

(C) CuS and PbS (D) CuS, PbS and ZnS

21. According to Charle's law:

(A) $V \propto \frac{1}{T}$ (B) $\left(\frac{dV}{dT}\right)_P = K$ (C) $\left(\frac{dT}{dV}\right)_P = K$ (D) $\left(\frac{1}{T} - \frac{V}{T^2}\right)_P = 0$

22. The π electron cloud of $C_1 - C_2$ is present in the plane of paper than which of the following is incorrect?



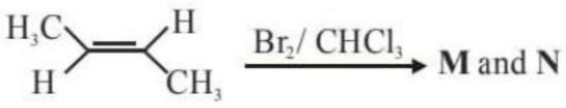
(A) Z is perpendicular to the plane of paper

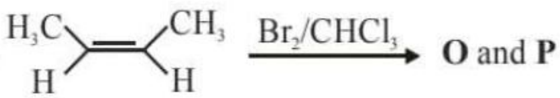
(B) X is present in the plane of paper

(C) σ bond of $C_2 - C_3$ is perpendicular to the plane of paper

(D) π electron cloud of $C_2 - C_3$ bond and X is present in same plane

23. The correct statement(s) for the following addition reactions is(are)

(i) 

(ii) 

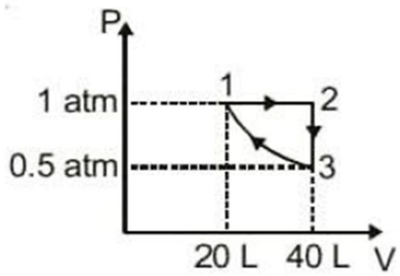
(A) (M and O) and (N and P) are two pairs of diastereomers

(B) Bromination proceeds through trans-addition in both the reaction

(C) O and P are identical molecules

(D) (M and O) and (N and P) are two pairs of enantiomers

24. For the given graph, which parameters will be zero?



(A) ΔQ (B) ΔH (C) ΔU (D) ΔS

SECTION – II (Maximum Marks: 24)

This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +3 If ONLY the correct numerical value is entered as answer.

Zero Marks: 0 In all other cases

25. 25 calories of heat is required to raise the temperature by 10^0C for 0.5 mole of a unknown gas at constant volume. Find molar heat capacity at constant pressure of unknown gas (in calorie) [Given R = 2 calorie/mole/K]

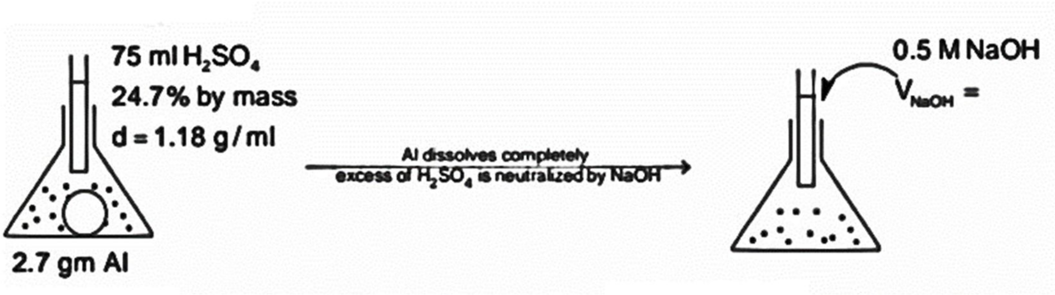
26. Identify numbers of reagent that can be used for below conversion

$$R-\overset{\overset{O}{\|}}{C}-R \xrightarrow{?} R-CH_2-R$$

(I) $Zn-Hg/HCl$ (II) $LiAlH_4$ (III) $CHCl_3+NaOH$ (IV) $N_2H_4/\bar{O}H$

(V) $\underset{\underset{CH_2-SH}{|}}{CH_2-SH}$, H_2/Ni (VI) SeO_2

27. Value of V_{NaOH} is (in mL)



28. How many maximum spectral lines are possible if electron is present in 4th shell and only two atom are present in sample?

29. At 25^0C, the solubility product of $Mg(OH)_2$ is $1.0\times10^{-11}M^3$. At which pH will Mg^{2+} ions start precipitating in the form of $Mg(OH)_2$ from a solution of 0.001 M Mg^{2+} ions?

30. The reaction $A+2B+C\rightarrow 2D+E$ is found to be `1, 2 and zero order with respect to A, B and C respectively. What will be the final rate, if concentration of each reactant is doubled? (in times)

31. How many mL of 1.00 M NaOH must be added to 100 ml of 0.1 M H_3PO_4 solution to obtain a phosphate buffer solution with pH of about 8.2? (in mL) (The pK values of H_3PO_4 are $pK_1 = 2.1$, $pK_2 = 8.2$, $pK_3 = 12$)

32. In 1 litre saturated solution of AgCl [$K_{sp} = 1.6\times10^{-10}$], 0.1 mole of CuCl [$K_{sp} = 1\times10^{-6}$] is added. The resultant concentration of Ag^+ in the solution is $1.6\times10^{-x}M$. The value of 'x' is

SECTION – III (Maximum Marks: 12)

This section contains **TWO (02)** Paragraphs. Based on each paragraph, there are 2 questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases

Passage-I

All values are in Kcal per mole at 25^0C given below

$\Delta H^0_{Combustion(ethane)} = -372.0$

$\Delta H^0_{Combustion(propane)} = -530.0$

ΔH^0 for $C(graphite)\longrightarrow C(g) = 172.0$

Bond energy of H – H = 104.0

ΔH_f^0 of $H_2O(\ell) = -68.0$

ΔH_f^0 of $CO_2(g) = -94.0$.

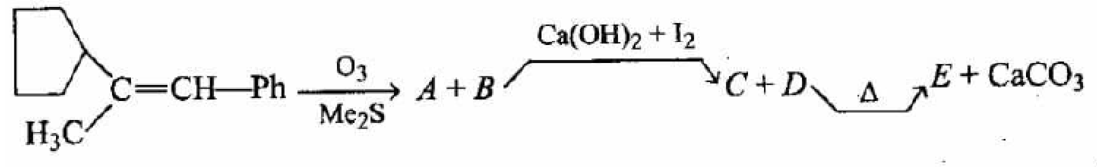
33. Find the C – C bond energy in Kcal/mole ________

(A) 41 (B) 52 (C) 82 (D) 92

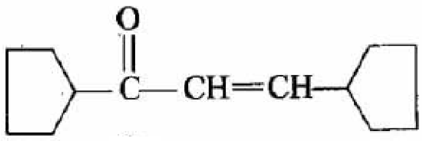
34. Find the C – H bond energy in Kcal/mole ________

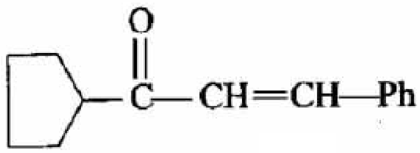
(A) 99 (B) 77 (C) 55 (D) 33

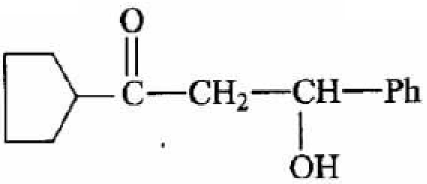
Passage-II

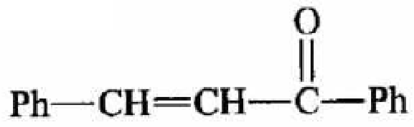


35. $A + B \xrightarrow[\Delta]{NaOH}$ Product:

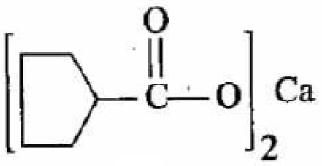
(A) 

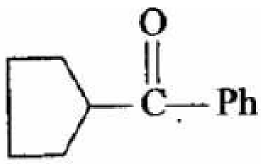
(B) 

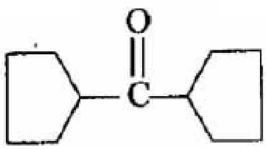
(C) 

(D) 

36. Find correct structure of E

(A) 

(B) 

(C) 

(D) None of these

MATHEMATICS MAX.MARKS: 60

SECTION- I (Maximum Marks: 24)

This section contains **SIX (06)** questions. Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s). For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

37. Using the elements $-3,-2,-1,0,1,2,3$, then

(A) The number of 3×3 matrices having trace 0 is are 35×7^7

(B) The number of 3×3 matrices having trace 0 are $35(7^6)$

(C) The number of 3×3 skew symmetric matrices are 7^3

(D) The number of 3×3 symmetric matrices are 7^6

38. A rational number is selected at random from the set of all rational numbers from the interval (2010, 2011) all of whose digits after the decimal point are non-zero and are in the decreasing order, then

(A) The probability that it has exactly seven digits after the decimal point is $\frac{36}{511}$

(B) The probability that it contains the digit 3 after the decimal point is $\frac{256}{511}$.

(C) The probability that the last digit after the decimal is atleast 4 is $\frac{63}{511}$.

(D) The probability that the last digit after the decimal point is 4 is $\frac{32}{511}$

39. Let $f:N\times N\to N$ be a function such that $f(1,1)=2$ and $f(\alpha+1,\beta)=f(\alpha,\beta)+\alpha$ and $f(\alpha,\beta+1)=f(\alpha,\beta)-\beta;\forall\alpha,\beta\in N$ and $f(a,b)=2001;\ a,b\in N$. Then which of the following statements is/are true?

(A) Number of ordered pairs (a,b) is 2
(B) Maximum value of $a+b$ is 3999
(C) Minimum value of $a+b$ is 2000
(D) Minimum value of $a+b$ is 1999

40. If $f:R\to R$ be differentiable function such that $(f(x))^7=x-f(x)$. Then

(A) $\int\limits_0^{\sqrt{2}} f^{-1}(x)dx=3$

(B) $f(x)$ is increasing $\forall x\in R$

(C) $\frac{d}{dx}(f^{-1}(x))$ at $x=2$ is 449

(D) Let $g(x)$ be the inverse of $f(x)$. Then $g''(1)=42$

41. To the parabola $y^2 = 4x$ three real and distinct normals are drawn from the point $(\lambda, 2)$. Then λ can be

(A) 6 (B) $\frac{17}{2}$ (C) 1 (D) $\frac{19}{2}$

42. If $a_1, a_2, a_3, ..., a_n$ is sequence of positive numbers which are in A.P. with common difference 'd' and $a_1 + a_4 + a_7 + ... + a_{16} = 147$ then,

(A) $a_1 + a_6 + a_{11} + a_{16} = 98$ (B) $a_1 + a_{16} = 49$

(C) $a_1 + a_4 + a_7 + ...a_{16} = 6a_1 + 45d$ (D) Maximum value of $a_1 a_2 .... a_{16}$ is $\left(\frac{49}{2}\right)^{16}$

SECTION – II (Maximum Marks: 24)

This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +3 If ONLY the correct numerical value is entered as answer.

Zero Marks: 0 In all other cases

43. An in complete frequency distribution is given as follows

Variable	$10-20$	$20-30$	$30-40$	$40-50$	$50-60$	$60-70$	$70-80$	Total
Frequency	12	30	x	65	y	25	18	229

Given that the median value is 46 and x, y are missing frequencies, where x and y are integers. $(y > x)$ and sum of all fractional parts of the equation $(y-x)\{t\} + 2[t] = 3$ is $\frac{\lambda_1}{\lambda_2}$. Then $\left[\frac{\lambda_1}{\lambda_2}\right]$ is _____

(where $\{.\}$ denotes Fractions part of x, [.] = GIF)

44. A four digit natural number is selected at random. The probability that the product of digits is 12, is k, then sum of the digits $1/k$ is __________

45. For a group of 200 candidates the mean and standard deviation of scores were found to be 40 and 15 respectively. Later on it was discovered that the scores 43 and 35 were misread as 34 and 53 respectively. Then the corrected standard deviation corresponding to the corrected figures is

46. Let the equation $(a-1)x^2 = x(2b+3)$ be satisfied by three distinct values of x, where $a, b \in R$. If $f(x) = (a-1)x^3 + (2b+3)x^2 + 2x + 1$ and $f(g(x)) = 6x - 7$, where $g(x)$ is a linear function. Then the value of $f'(2023) + g'(2023)$ is

47. If $f(x)$ is a polynomial function of degree 4 and leading coefficient is 1 and $f(1) = 10$, $f(2) = 20$, $f(3) = 30$. Then the value of $\frac{f(12) + f(-8)}{1984000}$ is

48. C is the centre of the hyperbola $\frac{x^2}{4} - \frac{y^2}{1} = 1$ and A is any point on it. The tangent at A to the hyperbola meet the line $x - 2y = 0$ and $x + 2y = 0$ at Q and R respectively. Then the value of $CQ \cdot CR$ is

49. The sum of the series $\frac{2}{4-1}+\frac{2^2}{4^2-1}+\frac{2^4}{4^4-1}+....\infty$ terms __________

50. If $|\vec{\ell}_1|=1,\ |\vec{\ell}_2|=2$ and $(\vec{\ell}_1,\vec{\ell}_2)=\frac{\pi}{3}$ and $\vec{b}_1=7\vec{\ell}_1+2\mu\vec{\ell}_2;\ \vec{b}_2=\mu\vec{\ell}_1+\vec{\ell}_2$ and $(\vec{b}_1,\vec{b}_2)\in\left(\frac{\pi}{2},\pi\right)$ and $\mu\in(\lambda_1,\lambda_2)-\{\lambda_3\}$. Then $\lambda_1^2+4\lambda_2^2+\lambda_3^2$ is _____

SECTION – III (Maximum Marks: 12)

This section contains **TWO (02)** Paragraphs. Based on each paragraph, there are 2 questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases

Passage-I

A is a set containing n elements. A subset S_1 of A is chosen. The set A is reconstructed by replacing the elements of S_1. Again, a subset S_2 of A is chosen and again the set is reconstructed by replacing the elements of S_2. The number of ways of choosing S_1 or S_2 where

51. S_1 and S_2 have one element common is

(A) 3^{n-1} (B) n . 3^{n-1} (C) 2^{n-1} (D) n

52. $S_1 \cup S_2 = A$ is

(A) 3^n (B) n . 3^n (C) 4^n (D) 4^{n-1}

Passage-II

Let S be the set of first 18 natural Numbers. Then attempt the following.

53. The probability of choosing $\{x, y\}\subseteq S$ such that x^3+y^3 is divisible by 3.

(A) 1/3 (B) 1/6 (C) 1/5 (D) 1/4

54. The probability of choosing $\{x, y, z\}\subseteq S$ such that x, y, z are in A.P is

(A) 1/17 (B) 2/17 (C) 5/34 (D) 3/34

OUTGOING SR'S
Time: 3 Hrs

SGTA-5 **(Paper - I)**

DATE: 25-05-2023
Max. Marks: 180

Answer Key

PHYSICS

1. (D)	2. (C)	3. (B)	4. (A)	5. (A)	6. (BC)
7. (6)	8. (8)	9. (4)	10. (5)	11. (5)	12. (5)
13. (4)	14. (4)	15. (A)	16. (C)	17. (D)	18. (A)

CHEMISTRY

19. (BC)	20. (C)	21. (BCD)	22. (ABC)	23. (AB)	24. (BCD)
25. (7)	26. (3)	27. (291)	28.(4)	29. (10)	30.(8)
31. (15)	32. (7)	33.(C)	34. (A)	35. (B)	36.(C)

MATHEMATICS

37. (BCD)	38. (ABCD)	39. (ABC)	40. (ABCD)	41. (ABD)	42. (ABCD)
43. (2)	44. (7)	45. (14.97)	46. (5)	47. (0.01)	48. (5)
49. (1)	50. (64)	51. (A)	52. (A)	53. (A)	54. (D)

Explanations

PHYSICS

1. (D)

$$\vec{v}_{CM} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$$

$$\vec{v}_{1c} = \frac{\mu}{m_1}\vec{v}_{12} \quad \vec{v}_{2c} = \frac{\mu}{m_2}\vec{v}_{21}$$

2. (C)

For first collision v = 10 m/s.

$t_1 = \frac{\pi(5)}{10} = \frac{\pi}{2}$ s

velocity of sep = e. velocity of opp.

$v_2 - v_1 = 5$ m/s

for second collision :

$$\therefore \quad t_2 = \frac{2\pi(5)}{5} = 2\,\pi$$

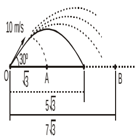
$$\therefore \quad \text{total time: } t = t + t_2$$

3. (B)

$R_{cm} = \frac{10^2 \sin 60}{g} = 5\sqrt{3}$

$5\sqrt{3} = \frac{m\sqrt{3} + m(n-1)7\sqrt{3}}{mn}$

$n = 3$



4. (A)

Total momentum is conserved along the horizontal direction; and so

$$(M+m)\frac{u}{2} < (M-m)u$$

or $M > 3$ m.

5. (A)

Conceptual

6. (BC)

Conceptual

7. (6)

Applying conservation of energy between initial and final states

$$\frac{1}{2}2m\left(\frac{v}{2}\right)^2 + \frac{1}{2}k\left(\frac{mg}{k}\right)^2 = 2mg\left(\frac{mg}{k}\right)$$

Solving we get v = $\sqrt{\frac{6mg^2}{k}}$ = 6 m/sec.

8. (8)

Conceptual

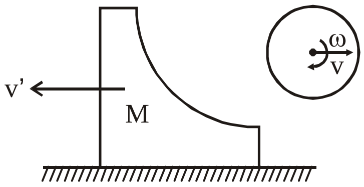
9. (4)

According to law of conservation of energy

$$mgh = \frac{1}{2}mv^2\left(1+\frac{k^2}{R^2}\right) \text{ or } mg\cdot 3a = \frac{1}{2}mv^2\times\frac{3}{2} \text{ or } v = 2\sqrt{ga}.$$

10. (5)

In ground frame



$$MV' = MV$$

$$R\omega - V = V'$$

$$\therefore \quad V = \frac{\omega R}{2}$$

$$\frac{1}{x} = \frac{\frac{1}{2}MV^2 + \frac{1}{2}\frac{2}{5}MR^2\omega^2}{\frac{1}{2}MV^2} = 1+\frac{8}{5} = \frac{13}{5}$$

$$\Rightarrow \quad 13x = 5.$$

11. (5)

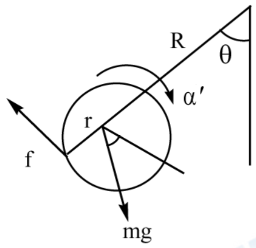
$$mg\sin\theta = f \quad [\because a_{cm} = 0]$$

$$R\alpha = r\alpha'$$

$$f(\cancel{r}) = \frac{mr^{\cancel{2}}\alpha'}{2}$$

$$f = \frac{\cancel{m}R\alpha'}{2}$$

$$\alpha = \frac{2g\sin\theta}{R}$$



12. (5)

Component of its velocity parallel to the plane is $v\cos 30^0$

Let the stream strike the plane after time t. Then $0 = v\cos 30^0 - g\sin 30^0 t$

$$\therefore \quad t = \frac{v\cot 30}{g}$$

Further $x = vt = \frac{v^2\cot 30^0}{g} = \sqrt{3}y$

Or $\frac{v^2\cot 30^0}{g} = \sqrt{3}\left(h - \frac{1}{2}gt^2\right)$

$$\therefore \quad \frac{\sqrt{3}v^2}{g} = \sqrt{3}\left(h - \frac{g}{2}\frac{v^2\cot^2 30^0}{g^2}\right)$$

Or $$\frac{v^2}{g} = h - \frac{3}{2}\frac{v^2}{g} \Rightarrow \frac{5}{2}\frac{v^2}{g} = h$$

$$\frac{v^2}{4} = \frac{x^2}{3} \Rightarrow x = 5$$

13. (4)

Applying conservation of angular momentum about COM of rod, we get $mv_0\left(\frac{L}{2}\right) = I\omega$

Or $$mv_0\frac{L}{2} = \frac{ML^2\omega}{12}$$

Or $$mv_0 = \frac{ML\omega}{6}$$

Since, the collision is elastic, kinetic energy is also conserved.

$$\therefore \quad \frac{1}{2}mv_0^2 = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$$

Or $$mv_0^2 = Mv^2 + \frac{ML^2}{12}\omega^2$$

$$\frac{M}{m} = 4$$

14. (4)

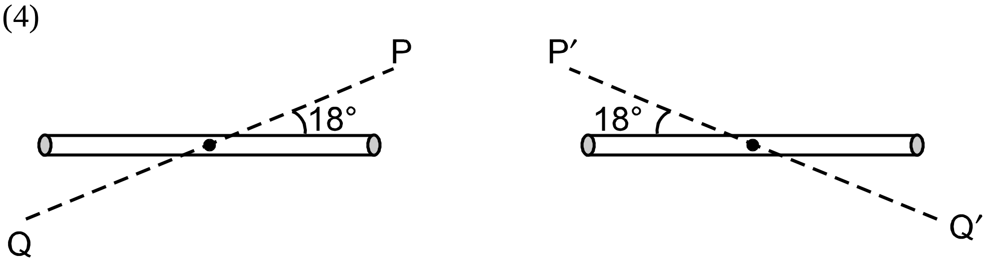
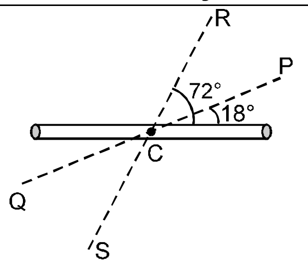


Figure - a Figure - b

The MI of rod about axis PQ figure(a) and MI of rod about axis $P'Q'$ figure (b) are same by symmetry.

$$\therefore I_{PQ} + I_{RS} = I_{P'Q'} + I_{RS} = \frac{m\ell^2}{12}$$



$\equiv$

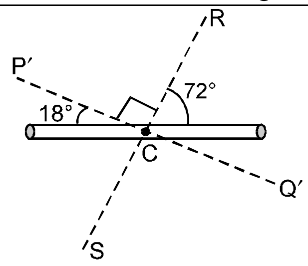


Figure - c

Figure - d

15. (A)

$A_1V_1 = A_2V_2$

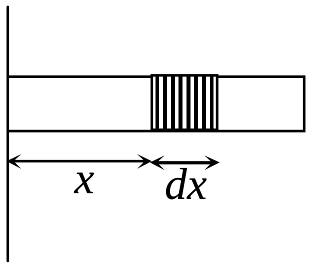
16. (C)

W = Increase in Gravitational Potential Energy of water and piston + Increase in Kinetic Energy of Water

17. (D)

$$I = \int dm\, x^2 = \int_0^2 (\lambda dx)x^2 = k\int_0^L x^3 dx$$

$$I = \frac{KL^4}{4}$$

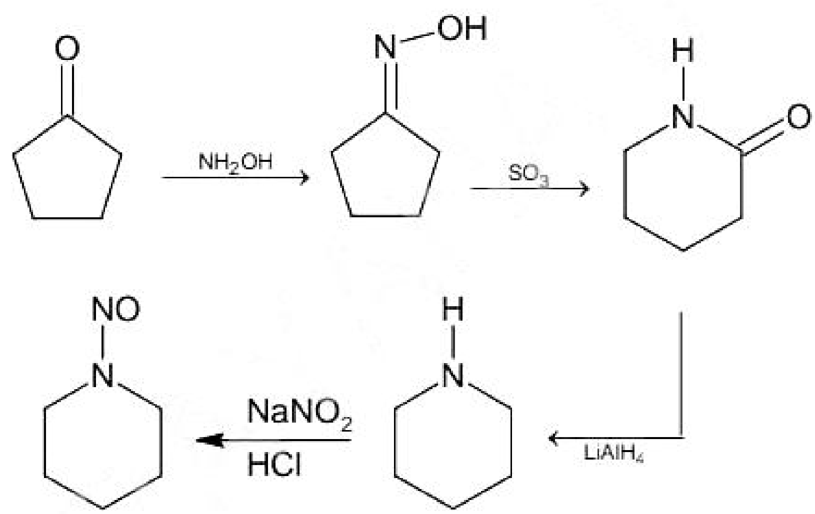


18. (A)

$$L = mvr = mv\frac{5}{\sqrt{1^2+3^2}} = \sqrt{\frac{5}{2}}mv$$

CHEMISTRY

19. (BC)



20. (C)

When H_2S is passed in acidic solution the ionisation of H_2S is suppressed, because of the common ions, furnished by the strong acid. The conc. of S^{2-} ion is not sufficient for the precipitation of Zn^{2+} as ZnS. Only Cu^{2+} and Pb^{2+} are precipitated because their solubility products are less.

21. (BCD)

According to Charle's law $V \propto T \Rightarrow V = KT$

$$\left(\frac{dV}{dT}\right)_P = K$$

$$\left(\frac{dT}{dV}\right)_P = K$$

$$\frac{d}{dT}\left(\frac{V}{T} - K\right)_P = 0$$

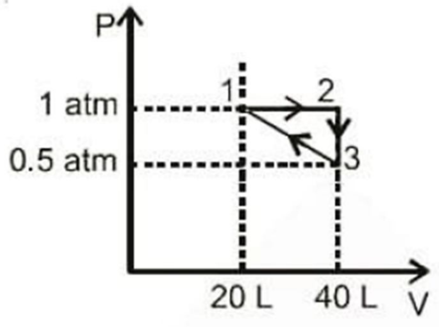
$$\left(\frac{1}{T} - \frac{V}{T^2}\right)_P = 0$$

22. (ABC)

23. (AB)

24. (BCD)

Above is a cyclic process hence ΔU, ΔH and ΔS will be zero



As these are state functions.

25. (7)

$q = 25 \times 2 = 50\,\text{cal/mole}$

$$C_V = \frac{50}{10} = 5\,\text{cal/mole/K}$$

$C_P = 5 + 2 = 7\,\text{cal/mole/K}$

26. (3)

27. (291)

$$M_{H_2SO_4} = \frac{24.7}{98} \times \frac{1000 \times 1.18}{100} = 2.97$$

$N_{H_2SO_4} = 5.94$

Meq. of H_2SO_4 = meq. of NaOH + meq. of Al

$5.94 \times 75 = 0.5 \times V_{NaOH} + 300$

$V_{NaOH} = 291$ ml

28. (4)

In two and two path is possible

$4 \rightarrow 3$	$4 \rightarrow 2$
$3 \rightarrow 2$	$2 \rightarrow 1$
$2 \rightarrow 1.$	

29. (10)

30. (8)

The given reaction is

$A + 2B + C \rightarrow 2D + E$

Order = 1 w.r.t. A; 2 w.r.t. B and zero w.r.t. C

Initially $\frac{dx}{dt} = k[A][B]^2$

Now when concentration is doubled

$$\left(\frac{dx}{dt}\right)' = k(2)[A](2)^2[B]^2$$

$$\left(\frac{dx}{dt}\right)' = 8k[A][B]^2 \qquad \therefore \left(\frac{dx}{dt}\right)' = 8\left(\frac{dx}{dt}\right)$$

The rate of reaction increases by 8 times.

31. (15)

$$\underset{10}{H_3PO_4} + \underset{10}{NaOH} \rightarrow \underset{10}{NaH_2PO_4} + H_2O$$

Let millimole of NaOH further added are 'x'

$$\underset{\substack{10 \\ 10-x}}{NaH_2PO_4} + \underset{x}{NaOH} \rightarrow \underset{\substack{0 \\ x}}{Na_2HPO_4} + H_2O$$

$$pH = 8.2 + \log\left(\frac{x}{10-x}\right)$$

$\Rightarrow \quad x = 5$

Therefore total millimoles of NaOH = 10 + 5 = 15

Let volume of NaOH is V_{ml}

$1 \times V_{ml} = 15$

$V_{ml} = 15$

32. (7)

33. (C)

34. (A)

$$C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

$$-372 = 2\times(-94) + 3(-68) - \Delta H_f^o(C_2H_6)$$

$$\Delta H_f^o(C_2H_6) = -20$$

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

$$-530 = 3(-94) + 4(-68) - \Delta H_f^o(C_3H_8)$$

$$\Delta H_f^o(C_3H_8) = -24$$

$$2C(s) + 3H_2 \longrightarrow C_2H_6$$

$$-20 = 2\times172 + 3\times(104) - (x + 6y)$$

$$3C(s) + 4H_2 \longrightarrow C_3H_8$$

$$-24 = 3\times172 + 4(104) - (2x + 8y)$$

After solving, we get x and y

x = 82 Kcal/mol

y = 99 Kcal/mol

35. (B)

36. (C)

MATHEMATICS

37. (BCD)

(A) $a_{11}+a_{22}+a_{33}=0$

$0+0+0 \to 0 \to 1$ way

$-1+1+0 \to 0 \to 6$ ways

$-2+1+1 \to 0 \to 3$ ways

$-3+1+2 \to 0 \to 6$ ways

$0-2+2 \to 0 \to 6$ ways

$0-3+3 \to 0 \to 6$ ways

$-1-1+2 \to 0 \to 3$ ways

$-1-2+3 \to 0 \to 6$ ways

$\therefore$ The required number of matrices = 37×7^6

(C) All diagonal elements are zero and 3 places above diagonal can be filled in 7^3

(D) Diagonal places and 3 places either above or below the diagonal places can be filled is 7^6.

38. (ABCD)

Digits after decimal point came one among 9 non-zero digit or two among 9 non-zero digits etc.

$\therefore\ n(S) = {}^9C_1 + {}^9C_2 + ... + {}^9C_9 = 2^9 - 1 = 511$

(A) $n(E) = {}^9C_7 \times 1 = 36 \Rightarrow P(E) = \dfrac{36}{511}$

(B) $n(E) = {}^8C_0 + {}^8C_1 + ... + {}^8C_8 = 2^8 \Rightarrow P(E) = \dfrac{2^8}{511} = \dfrac{256}{511}$

(C) $n(E) = {}^6C_1 + {}^6C_2 + {}^6C_3 + ... + {}^6C_6 = 2^6 - 1 = 63 \Rightarrow P(E) = \dfrac{63}{511}$

(D) $n(E) = {}^5C_0 + {}^5C_1 + {}^5C_2 + ... + {}^5C_5 = 2^5 \Rightarrow P(E) = \dfrac{32}{511}$.

39. (ABC)

$$\begin{aligned} f(a,b) &= f(a-1,b)+a-1 \\ &= f(a-2,b)+(a-2)+(a-1) \\ &= \cdots \quad \cdots \quad \cdots \\ &= f(1,b)+\frac{a(a-1)}{2} \\ &= f(1,b-1)-(b-1)+\frac{a(a-1)}{2} \\ &= f(1,b-2)-(b-2)-(b-1)+\frac{a(a-1)}{2}. \\ &= \cdots \quad \cdots \quad \cdots \\ &= f(1,1)-\frac{b(b-1)}{2}+\frac{a(a-1)}{2} \end{aligned}$$

$\Rightarrow (a-b)(a+b-1) = 2 \times 1999$

$\Rightarrow (a,b) = (2000,1999)$ or $(1001,999)$.

40. (ABCD)

$f(x)[(f(x))^6+1] = x$

$f(0)[(f(0))^6+1] = 0 \Rightarrow f(0) = 0$

$7(f(x))^6 f'(x) = 1 - f'(x)$

$f'(x)[7(f(x))^6+1] = 1 \Rightarrow f'(x) > 0$

$\therefore f(x)$ is increasing function.

$(f(x))^7 = x - f(x)$

$x \to f^{-1}(x)$

$x^7 = f^{-1}(x) - x \;\Rightarrow\; f^{-1}(x) = x^7 + x$.

41. (ABD)

Use $27ak^2 < 4(h-2a)^3$ and $h > 2a$, where $a = 1$, $h = \lambda$, $k = 2$

$\therefore\; 27(1)(4) < 4(h-2)^2$ and $\lambda > 2$

$\therefore\; \lambda > 5$ and $\lambda > 2$

$\therefore\; \lambda \in (5, \infty)$.

42. (ABCD)

$a_1, a_4, a_7 + ... + a_{16} = 147 \;\Rightarrow\; 3(a_1 + a_{16}) = 147 \Rightarrow\; a_1 + a_{16} = 49$

Again $a_1 + a_4 + a_7 + a_{10} + ... + a_{16}$

$= a_1 + a_1 + 3d + a_1 + 6d + ... + a_1 + 15d$

$= 6a_1 + 45d = 147 = 2a_1 + 15d = 49$.

$a_1 + a_6 + a_{11} + a_{16} = a_1 + a_1 + 5d + a_1 + 10d + a_1 + 15d$.

$= 4a_1 + 30d = 2(2a_1 + 15d) = 2(49) = 98$

Now using AM $\geq$ GM

$$\frac{a_1 + a_2 + ... + a_{16}}{16} \geq (a_1 a_2 a_3 .... a_{16})^{1/16}$$

$$\frac{8(a_1 + a_{16})}{16} \geq (a_1 a_2 a_3 .... a_{16})^{1/16}.$$

$$\left(\frac{49}{2}\right)^{16} \geq a_1 a_2 a_3 .... a_{16}.$$

43. (2)

Frequency of the class 30-40 is x and that of 50-60 is y

$\therefore\; x + y = 229 - (12 + 30 + 65 + 25 + 18) = 79$

But given that median is 46 and the class 40-50 is the median class.

But median = $\ell + \dfrac{h}{f}\left(\dfrac{N}{2} - C\right)$

$$46 = 40 + \frac{10(114.5 - (12 + 30 + x))}{65}$$

$$46 - 40 = \frac{72.5 - x}{65} \times 10 \;\Rightarrow\; x = 72.5 - 39 = 33.5 = 34$$

$\therefore\; y = 79 - 34 = 45$.

$(y - x)\{t\} = 3 - 2[t]$

$11\{t\} = 3 - 2[t]$

$$0 \leq \frac{3 - 2[t]}{11} < 1$$

$\therefore\; t = -3, -2, -1, 0, 1$

$$\therefore\; \{t\} = \frac{9}{11}, \frac{7}{11}, \frac{5}{11}, \frac{3}{11}, \frac{1}{11}$$

$$\therefore\; \text{Sum of } \{t\} = \frac{25}{11} = \frac{\lambda_1}{\lambda_2} \;\Rightarrow\; \left[\frac{\lambda_1}{\lambda_2}\right] = 2.$$

44. (7)

Total cases = $9\times 10^3 = 9000 = n(S)$

Possible sets {1, 1, 2, 6}; {1, 1, 3, 4}; {1, 2, 2, 3}

$\therefore\ n(E) = \frac{4!}{2!} + \frac{4!}{2!} + \frac{4!}{2!} = 36$

$\therefore\ P(E) = \frac{36}{9000} = \frac{2}{500} = \frac{1}{250}$.

45. (14.97)

Given that $n = 200$, $\overline{x} = 40$, $\sigma = 15$.

$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \Rightarrow \sum_{i=1}^{n} x_i = n\cdot\overline{x} = 200\times 40 = 8000$

$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n} x_i^2 - \overline{x}^2$.

$\therefore\ \sum x_1^2 = n(\sigma^2 + \overline{x}^2) = 200(225+1600) = 36500$

Corrected $\sum x_i = 8000 - 34 - 53 + 43 + 35 = 7991$

Corrected $\sum x_i = 365000 - (34)^2 - (53)^2 + (43)^2 + (35)^2 = 364109$.

Correct mean = $\frac{7991}{200} = 39.955$

Correct standard deviation = $\sigma^2 = \frac{364109}{200} - (39.955)^2$ = $1820.54 - 1596.40$

$\sigma^2 = 224.14$.

$\therefore$ Correct standard deviation = 14.97

46. (5)

$(a-1)x^2 - (2b+3)x = 0$ is an identity

$$\therefore \left.\begin{array}{l} a-1=0 \Rightarrow a=1 \\ 2b+3=0 \Rightarrow b=\frac{-3}{2} \end{array}\right\} \Rightarrow f(x) = 2x+1.$$

Let $g(x) = px + q$.

$f(g(x)) = 6x - 7$.

$2(px+q)+1 = 6x-7 \Rightarrow 2p = 6 \Rightarrow p = 3$ and $q = -4$

$\therefore\ g(x) = 3x - 4$.

47. (0.01)

$f(1) = 1(10) \Rightarrow f(1) - 10(1) = 0$

$f(2) - 10(2) = 0$

$f(3) - 10(3) = 0$

$\therefore\ x = 1, 2, 3$ are the roots of $f(x) - 10x = 0$.

$\therefore\ f(x) - 10x = 1(x-1)(x-2)(x-3)(x-\alpha)$

Put $x = 12 \Rightarrow f(12) - 120 = (11)(10)(9)(12-\alpha)$ …. (1)

Put $x = -8 \Rightarrow f(-8) + 80 = (9)(10)(11)(8+\alpha)$ …. (2)

From (1) + (2) $\Rightarrow f(12) + f(-8) - 40 = 9\cdot 10\cdot 11\cdot 20$

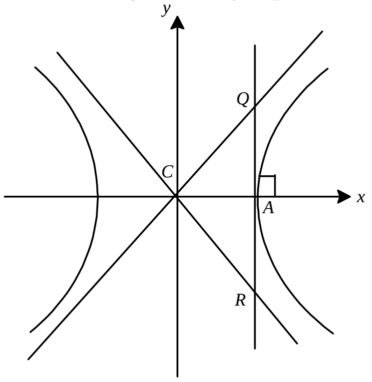
$\Rightarrow f(12) + f(-8) = 990(20) + 40$

$\Rightarrow \frac{f(12)+f(-8)}{19840000} = \frac{19840}{1984000} = 0.01$.

48. (5)

Let A(2, 0) $\Rightarrow$ Equation of tangent at A is $x = 2$

Solve the given asymptotes with $x = 2$



$\therefore$ Q(2, 1), R(2, –1)

$\therefore$ $CQ \cdot CR = \sqrt{5} \cdot \sqrt{5} = 5$.

49. (1)

$$T_k = \frac{2^{2^k}}{4^{2^k} - 1} = \frac{2^{2^k} + 1 - 1}{4^{2^k} - 1} = \frac{2^{2^k} + 1}{4^{2^k} - 1} - \frac{1}{4^{2^k} - 1}.$$

$$T_k = \frac{2^{2^k} + 1}{(2^{2^k} + 1)(2^{2^k} - 1)} - \frac{1}{4^{2^k} - 1}.$$

$$T_k = \frac{1}{4^{2^{k-1}} - 1} - \frac{1}{4^{2^k} - 1}$$

$\therefore$ $S_n = \sum_{k=1}^{n} \left(\frac{1}{4^{2^k} - 1} - \frac{1}{4^{2^k} - 1} \right)$ and take as $n \to \infty$.

$$\therefore\ S_\infty = \frac{1}{4^{2^{-1}} - 1} - \frac{1}{\sqrt{4} - 1} = 1.$$

50. (64)

$\vec{b}_1 \cdot \vec{b}_2 = 2\mu^2 + 15\mu + 7 < 0$

$\mu \in \left(-7, \frac{-1}{2} \right) - \left\{ -\sqrt{14} \right\}$

$\therefore$ $\lambda_1^2 + 4\lambda_2^2 + \lambda_3^2 = 49 + 1 + 14 = 64$.

51. (A)

Required number of ways = ${}^nC_1 \cdot (3)^{n-1}$

52. (A)

Each element $\in S_1 \cup S_2$ in 3 ways

53. (A)

1	4	7	10	13	16
2	5	8	11	14	17
3	6	9	12	15	18

$$probability = \frac{6_{c_2} + (6_{c_1})^2}{18_{c_2}} = \frac{1}{3}$$

54. (D)

1	3	5	7	9	11	13	15
2	4	6	8	10	12	14	16

$$probability = \frac{2(9_{c_2})}{18_{c_3}} = \frac{3}{34}.$$

NARAYANA IIT-JEE ACADEMY-INDIA

44 YEARS OF EXCELLENCE

OUTGOING SR'S

Time: 3 Hrs

SGTA-5

DATE: 25-05-2023

Max. Marks: 180

Paper - I I

JEE-ADVANCE -2018-P2- Model

Important Instructions

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec - I(Q.N : 1 - 6)	Questions with Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	6	24
Sec - II(Q.N : 7 - 14)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+3	0	8	24
Sec - III(Q.N : 15-18)	Matrix Matching Type	+3	-1	4	12
Total				18	60

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec - I(Q.N :19 - 24)	Questions with Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	6	24
Sec – II(Q.N : 25 –32)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+3	0	8	24
Sec - III(Q.N : 33-36)	Matrix Matching Type	+3	-1	4	12
Total				18	60

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec - I(Q.N:37 - 42)	Questions with Multiple Correct Choice (partial marking scheme) (+1,0)	+4	-2	6	24
Sec – II(Q.N :43–50)	Questions with Numerical Value Type (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)	+3	0	8	24
Sec –III(Q.N : 51-54)	Matrix Matching Type	+3	-1	4	12
Total				18	60

PHYSICS MAX.MARKS: 60

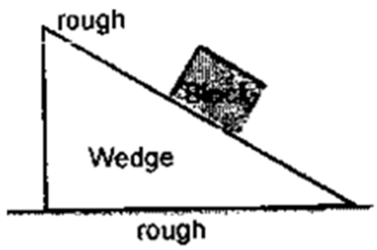
SECTION- I (Maximum Marks: 24)

This section contains **SIX (06)** questions. Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s). For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

1. A train of mass M is moving on a circular track of radius 'R' with constant speed V. The length of the train is half of the perimeter of the track. The linear momentum of the train will be

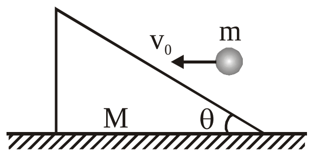
(A) 0 (B) $\frac{2MV}{\pi}$ (C) MVR (D) MV

2. When a block is placed on a wedge as shown in figure, the block starts sliding down and the wedge also start sliding on ground. All surface are rough. The centre of mass of (wedge + block) system will move



(A) Leftward and downward. (B) Rightward and downward.
(C) Leftward and upwards. (D) Only downward.

3. In the figure a wedge of mass M is placed at rest on a smooth horizontal surface. A small sphere of mass m hits the inclined face of the wedge with horizontal speed v_0. The impact is perfectly inelastic. There is no friction anywhere and bodies are rigid.



Following four statements are given regarding this problem.
(i) After impact both bodies will be moving with same velocity along horizontal.
(ii) After impact the sphere will be moving only parallel to the inclined plane with speed $v_0\cos\theta$ as observed from the ground.
(iii) Just after collision component of the velocity of the sphere along the plane is $v_0\cos\theta$.
(iv) After collision sphere will come to stop and wedge will move with the speed of $\frac{mv_0}{M}$.

(A) Only (i) is true (B) (i) and (ii) both are correct
(C) Only (iii) is correct (D) all four are wrong

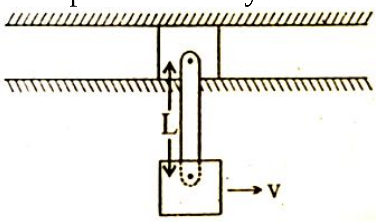
4. A trolley is moving horizontally with a velocity of v m/s w.r.t. earth. A man starts running from one end of the trolley with a velocity 1.5 v m/s w.r.t. the trolley. After reaching the opposite end, the man turns back and continues running with a velocity of 1.5 v m/s w.r.t. trolley in the backward direction. If the length of the trolley is L then the displacement of the man with respect to earth measured as a function of time, will attain a maximum value of

(A) $\frac{4}{3}L$ (B) $\frac{2}{3}L$ (C) $\frac{5L}{3}$ (D) 1.5 L

5. A particle is projected from a smooth horizontal surface with velocity v at an angle θ from horizontal. Coefficient of restitution between the surface and ball is e. The distance of the point where ball strikes the surface second time from the point of projection is

(A) $\frac{v^2\sin\theta(1+e^2)}{g}$ (B) $\frac{v^2\sin\theta(1+e^3)}{g}$ (C) $\frac{v^2\sin\theta(1+e^4)}{g}$ (D) $\frac{v^2\sin\theta(1+e^2)}{g}$

6. Shown in the figure is two identical blocks connected through a massless rigid rod by hinge connection. Upper block is free to move along horizontal groove. Lower block is free to move in vertical circle about upper block. Lower block is imparted velocity v. Assume friction is absent.

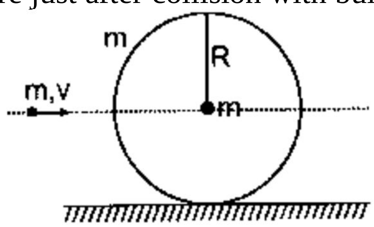


(A) At highest point both block will have same speed when v is minimum to complete the circle
(B) Minimum v to complete circle is $\sqrt{8gL}$
(C) Minimum v to complete circle is $\sqrt{5gL}$
(D) Minimum v to complete circle is $\sqrt{4gL}$

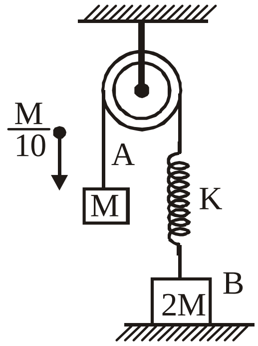
SECTION – II (Maximum Marks: 24)

This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) designated to enter the answer.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks: +3 If ONLY the correct numerical value is entered as answer.
Zero Marks: 0 In all other cases

7. A hollow sphere of mass m = 1kg and radius R = 1m rests on a smooth horizontal surface. A simple pendulum having string of length R and bob of mass m = 1kg hangs from top most point of the sphere as shown. A bullet of mass m = 1kg and velocity v = 2m/sec partially penetrates the left side of the sphere. The velocity of the sphere just after collision with bullet is.

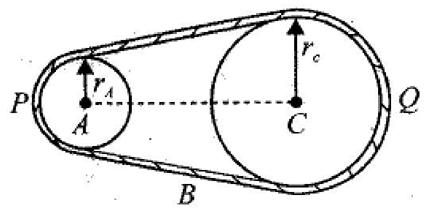


8. In the shown figure, a particle of mass $\frac{M}{10}$ strikes the block of mass M with velocity v_0 and gets attached to it. For what velocity v_0 (in ms^{-1}), the block B is just able to leave the ground? (Given M = 100 gm, K = 880 N/m)

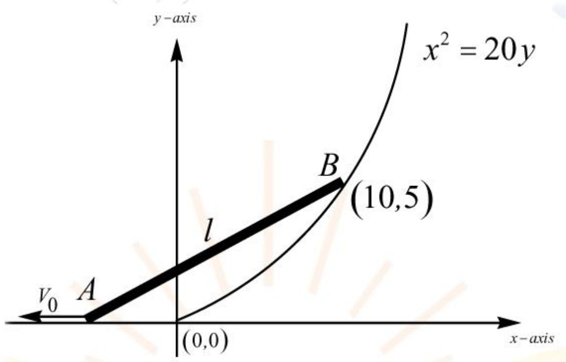


9. A uniform cylinder rests on a cart with the axis vertical. The coefficient of static friction between the cylinder and the cart is 0.9. If the cylinder is 4 cm in diameter and 10 cm in height, find the minimum horizontal acceleration of the cart needed in m/s^2 to cause the cylinder to tip over. Take $g = 10 m/s^2$.

10. Two wheels A and C connected by a belt B as shown in the figure. The radius of C is three times the radius of A. What would be the ratio of the rotational inertias $\frac{I_C}{I_A}$ if both the wheels have the same rotational kinetic energy?

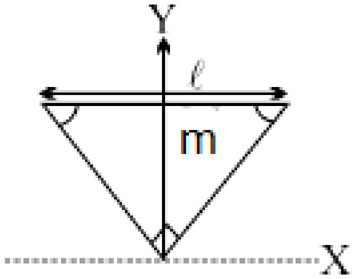


11. A uniform rod has mass m = 2 kg and length l = 13m. One end of the rod is pulled with a constant velocity of v_0 = 34 m/s along a frictionless horizontal floor in the negative x direction. The other end is moving along a parabolic fixed curve. The equation of the parabola is $x^2 = 20y$. Find the angular velocity of the rod (in rad/s) when the end point 'B' is at (10,5)



12. There are two identical small holes on the opposite sides of a tank containing a liquid. The tank is open at the top. The difference in height between the holes is h. As the liquid comes out to the two holes, the tank will experience a net horizontal force proportional to h^N. N is equal to

13. The figure shows an isosceles triangular plate of mass m and base ℓ . The angle at the apex is 90°. The apex lies at the origin and the base is parallel to X–axis. The moment of inertia of the plate about the z-axis is $\frac{ml^2}{n}$. Find the value of n.

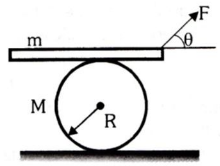


14. A particle of mass 2 kg located at the position $\left(\hat{i}+\hat{j}\right)$ m has a velocity $2\left(\hat{i}-\hat{j}+\hat{k}\right)m/s$.
The magnitude of its angular momentum about z-axis in kg.m^2/s is:

SECTION – III (Maximum Marks: 12)

Each question has **TWO (02)** matching lists: LIST-I and LIST-II. FOUR options are given representing matching of elements from LIST-I and LIST-II. ONLY ONE of these four options corresponds to a correct matching.
For each question, choose the option corresponding to the correct matching. For each question, choose the option corresponding to the correct matching.
Full Marks : +3 If ONLY the option corresponding to the correct matching is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks : –1 In all other cases.

15. Consider a cylinder of mass M and radius R lying on a rough horizontal plane. It has a plank lying on its top as shown in figure. A force F is applied on the plank such that the plank moves and causes the cylinder to roll. The plank always remains horizontal. There is no slipping at any point of contact

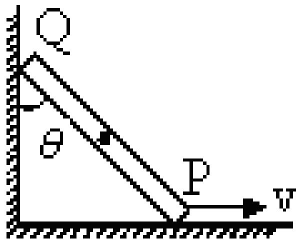


Column-I	**Column-II**
I) The magnitude of acceleration of the plank	P) $\frac{3MF\cos\theta}{[3M+8m]}$
II) The magnitude of frictional force acting on the plank	Q) $\frac{MF\cos\theta}{[3M+8m]}$
III) Magnitude of acceleration of centre of mass of the cylinder	R) $\frac{8F\cos\theta}{3M+8m}$
IV) The frictional force on the cylinder at the point of contact with the horizontal lane	S) $\frac{4F\cos\theta}{3M+8m}$

The correct match is
(A) I-(R); II-(S); III-(P); IV-(Q)
(B) I-(R); II-(P); III-(S); IV-(Q)
(C) I-(S); II-(R); III-(P); IV-(Q)
(D) I-(P); II-(S); III-(Q); IV-(R)

16. Matching – I: A rod moves in the vertical plane against horizontal and vertical surface. The lowest point P of the rod is pulled with a constant velocity v. At any angular position θ of the rod, match the following V_Q=speed of point Q $\omega =$ angular speed of rod l= length of rod a_Q=acceleration of point Q

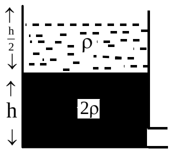
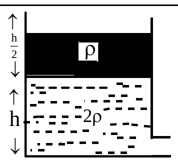
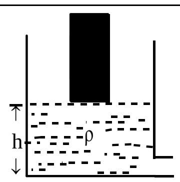
Column I	**Column II**
I) $\frac{v_Q}{v}$	P) $\sec\theta$
II) $\frac{\ell a_Q}{v^2}$	q) $\tan\theta$
III) $\frac{\omega\ell}{v}$	r) $\sec^3\theta$
IV) $\frac{v}{v_Q}$	s) $\cot\theta$



The correct match is

(A) I-(R); II-(S); III-(P); IV-(Q)
(B) I-(R); II-(P); III-(S); IV-(Q)
(C) I-(Q); II-(R); III-(P); IV-(S)
(D) I-(P); II-(S); III-(Q); IV-(R)

17. The cases in Column I match the velocity of efflux cross section of opening is very small in Column II

Column I		**Column II**	
I)	 Two immiscible liquids of density ρ & 2ρ	P)	$\sqrt{2gh}$
II)	 A perfectly fitting piston made of material of density ρ which can slide without friction	Q)	$\sqrt{2.5gh}$
III)	 A solid cylinder of half the cross section of tankIs just touching the water surface. Now it is pushed by a distance $\frac{h}{2}$ downward (An external agent holds cylinder, vessel is large).	R)	$\sqrt{3gh}$
IV)	Arrangement is same as in option C but cylinder is pushed down by a distance h	S)	$\sqrt{3.5gh}$
		T)	$\sqrt{4gh}$

The correct match is

(A) I-(R); II-(T); III-(P); IV-(S)
(B) I-(P); II-(Q); III-(R); IV-(S)
(C) I-(P); II-(S); III-(Q); IV-(T)
(D) I-(T); II-(S); III-(R); IV-(Q)

18. A particle of mass 1 kg is projected upwards with velocity 60 m/s. Another particle of mass 2 kg is just dropped from a certain height Alter 2s, match the following: [Take g = 10 m/s^2]

Column-I		**Column-II**	
(I)	Acceleration of COM	(P)	Zero
(II)	Velocity of COM	(Q)	10 SI unit
(III)	Displacement of COM	(R)	20 SI unit
		(S)	None

The correct match is

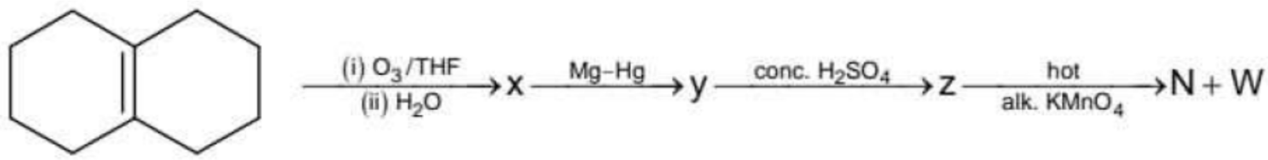
(A) I-(R); II-(S); III-(P)
(B) I-(P); II-(Q); III-(R)
(C) I-(P); II-(R); III-(S)
(D) I-(Q); II-(P); III-(R)

CHEMISTRY MAX.MARKS: 60

SECTION- I (Maximum Marks: 24)

This section contains **SIX (06)** questions. Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s). For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

19. Which of the following option(s) is/are correct?



(A) 'x' is a diketone
(B) 'y' is a gemdiol
(C) 'z' is a conjugated diene
(D) W and N are β-diketone and β-carboxylic acid

20. The correct statement(s) about the oxoacids, $HClO_4$ and HClO, is(are)

(A) $HClO_4$ is more acidic than HClO because of the resonance stabilization of its anion
(B) $HClO_4$ is formed in the reaction between Cl_2 and H_2O
(C) The central atom in both $HClO_4$ and HClO is sp^3 hybridized
(D) The conjugate base of $HClO_4$ is weaker base than H_2O

21. Which of the following mixtures constitute a buffer?

(A) $CH_3COOH + CH_3COONa$
(B) $Na_2CO_3 + NaHCO_3$
(C) NaCl + HCl
(D) $NH_4Cl + (NH_4)_2SO_4$

22. When HCl(g) is passed through a saturated solution of common salt, pure NaCl is precipitated because

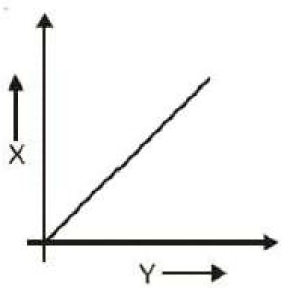
(A) HCl is highly soluble in water

(B) the ionic product $[Na^{+}][Cl^{-}]$ exceeds its solubility product (K_{sp})

(C) the K_{sp} of NaCl is lowered by the presence of Cl^{-} ions

(D) HCl causes precipitation

23. The plot given is not possible for



(A) 2^{nd} order reaction $\rightarrow \frac{1}{[A]}$ vs time

(B) 1^{st} order reaction $\rightarrow t_{1/2}$ vs concentration

(C) Zero order reaction $\rightarrow t_{1/2}$ vs concentration

(D) n^{th} order reaction $\rightarrow$ rate vs concentration

24. Which of the following are true about silicones?

(A) They are formed by hydrolysis of R_2SiCl_2

(B) They are polymer, made up of R_2SiO_2 units

(C) They are made up of SiO_4^{4-} units

(D) They are macromolecules

SECTION – II (Maximum Marks: 24)

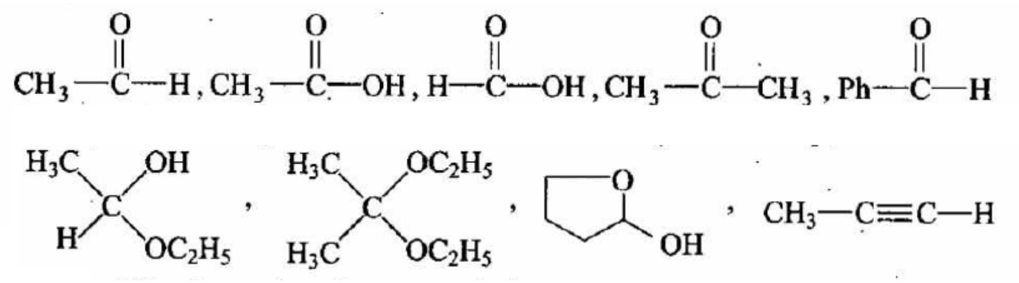
This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +3 If ONLY the correct numerical value is entered as answer.

Zero Marks: 0 In all other cases

25. Of the following compounds, how many would give positive test with Tollen's reagent



26. One mole of an ideal monoatomic gas expands reversibly and adiabatically from a volume of 'x' litre to 14 litre at $27^{0}C$. The value of 'x' will be [Given, final temperature 189 K and $C_V = 3/2R$]

27. The degree of hydrolysis of a mixture containing 0.1 N NH_4OH and 0.1 N HCN is 10^{-x}. If $K_a = 10^{-5}$ and $K_b = 10^{-5}$ then 'x' is

28. The enthalpy of combustion of C and CO are – 393.5 kJ and – 283 kJ respectivley, the enthalpy of formation of CO is (in kJ)

29. The dissolution of $CaCl_2 \cdot 6H_2O$ in a large volume of water is endothermic to the extent of 3.5 kcal/mol. For the reaction $CaCl_2(s) + 6H_2O(\ell) \longrightarrow CaCl_2 \cdot 6H_2O(s)$; ΔH is – 23.2 Kcal/mol. The heat of solution of anhydrous $CaCl_2$ in large quantity of water will be (in Kcal/mol)

30. The uncertainty in the position of an electron (mass = 9.1×10^{-28} g) moving with a velocity of $3.0 \times 10^4 \, cm\, s^{-1}$ accurate upto 0.001% will be (in cm) (Use $\frac{h}{4\pi}$ in the uncertainty expression, where $h = 6.626 \times 10^{-27}$ erg – s)

31. On monochlorination of 2-methyl butane, the total number of chiral compounds is

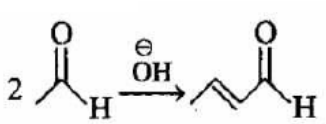
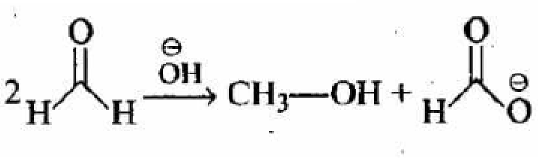
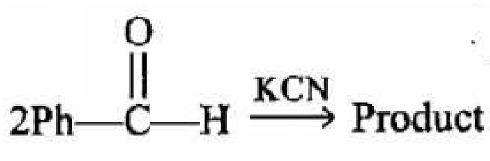
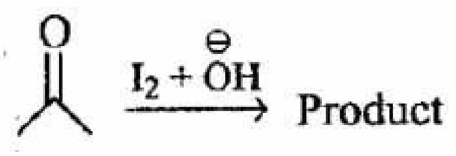
32. The magnetic moment of $K_3[Fe(CN)_6]$ is found to be 1.7 *B.M.* How many unpaired electron (s) is/are present per molecule

SECTION – III (Maximum Marks: 12)

Each question has **TWO (02)** matching lists: LIST-I and LIST-II. FOUR options are given representing matching of elements from LIST-I and LIST-II. ONLY ONE of these four options corresponds to a correct matching.
For each question, choose the option corresponding to the correct matching. For each question, choose the option corresponding to the correct matching.

Full Marks : +3 If ONLY the option corresponding to the correct matching is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks : –1 In all other cases.

33. Match the following

Column-I		**Column-II**	
(I)		(P)	Oxidation
(II)		(Q)	Condensation
(III)		(R)	Nucleophilic addition
(IV)		(S)	Electrophilic substitution
		(T)	Nucleophilic substitution

The correct match is

(A) I-(QR); II-(PRT); III-(QR); IV-(RST)
(B) I-(PQR); II-(RST); III-(PR); IV-(RST)
(C) I-(PR); II-(PT); III-(QS); IV-(ST)
(D) I-(PR); II-(RT); III-(PR); IV-(RT)

34. Match the following column. Column-I with Column-II

Column-I		Column-II	
(I)	$\underline{N}(SiH_3)_3$	(P)	$p\pi - d\pi$ back bonding
(II)	$\underline{N}(CH_3)_3$	(Q)	sp^3-hybridization for underlined atom
(III)	$\underline{B}_2H_6$	(R)	$p\pi - p\pi$ back bonding
(IV)	$\underline{B}F_3$	(S)	Neither $p\pi - p\pi$ nor $p\pi - d\pi$ back bonding
		(T)	Underlined atom combines with Lewis base

The correct match is

(A) I-(QR); II-(PRT); III-(QR); IV-(RST)
(B) I-(P); II-(ST); III-(PR); IV-(RST)
(C) I-(P); II-(QS); III-(QST); IV-(RT)
(D) I-(PR); II-(RT); III-(PR); IV-(RT)

35. Match the following column. Column-I with Column-II

Column-I		Column-II	
(I)	$[Ma_3b_2c]$	(P)	All stereoisomers are optically inactive
(II)	$[Ma_3b_3]$	(Q)	Number of geometrical isomers = 2
(III)	$[Ma_3bcd]$	(R)	Number of geometrical isomers = 4
(IV)	$[Ma_4bc]$	(S)	Total 3 stereoisomers
		(T)	Only one enantiometric pair is possible

The correct match is

(A) I-(QR); II-(PRT); III-(QR); IV-(RST)
(B) I-(PR); II-(ST); III-(PR); IV-(RST)
(C) I-(QS); II-(QR); III-(QST); IV-(RT)
(D) I-(PS); II-(PQ); III-(RT); IV-(PQ)

36. Dilution processes of different aqueous solutions, with water, are given in Column-I. The effects of dilution of the solution on $[H^+]$ are given in Column-II. [Degree of dissociation (α) of weak acid and weak base is <<1; degree of hydrolysis of salt <<<1; $[H^+]$ represents the concentration of H^+ ions]

Column-I		Column-II	
(I)	(10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL	(P)	the value of $[H^+]$ does not change on dilution
(II)	(20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL	(Q)	the value of $[H^+]$ changes to half of its initial values on dilution
(III)	(20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL	(R)	the value of $[H^+]$ changes to two times of its initial value on dilution
(IV)	10 mL saturated solution of $Ni(OH)_2$ in equilibrium with excess solid $Ni(OH)_2$ is diluted to 20 mL (solid $Ni(OH)_2$ is still present after solution)	(S)	the value of $[H^+]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution
		(T)	the value of $[H^+]$ changes to $\sqrt{2}$ times of its initial value on dilution

Match each process given in Column-I with one or more effects in Column-II. The correct match is

(A) I-(S); II-(Q); III-(R); IV-(P)
(B) I-(S); II-(R); III-(Q); IV-(R)
(C) I-(P); II-(S); III-(T); IV-(R)
(D) I-(P); II-(T); III-(S); IV-(P)

MATHEMATICS MAX.MARKS: 60

SECTION- I (Maximum Marks: 24)

This section contains **SIX (06)** questions. Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s). For each question, choose the correct option(s) to answer the question.
Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks: +3 If all the four options are correct but ONLY three options are chosen.
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks: -2 In all other cases.

37. Let $f(x)=\lim_{n\to\infty}\log\left(\sqrt{e^{\cos x}\sqrt{e^{3\cos x}\sqrt{e^{5\cos x}\ldots\ldots\sqrt{e^{(2n+1)\cos x}}}}}\right)$ and $g(x)=\left[\frac{1}{3}f(x)\right]$. Then which of the following are discontinuous points for the function $g(x)$?

(A) 0 (B) $\frac{\pi}{2}$ (C) $\frac{3\pi}{2}$ (D) 2π

38. To the parabola $y^2=4x$ at the point P(4, 4) normal cuts the parabola again at Q. Then $\underline{|PSQ}$ is not equal to

(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{3}$ (C) $\frac{\pi}{4}$ (D) $\frac{\pi}{6}$

39. If the ratio of 6$^{\text{th}}$ term from beginning and 6$^{\text{th}}$ term from end in the expansion of $(x^3+\sqrt{2}x^{-2})^{15}$ is $\frac{4\sqrt{2}}{243}$, then the value of x is less than?

(A) 2 (B) 1 (C) $(\sqrt{2})^{1/5}$ (D) $(\sqrt{3})^{1/5}$

40. A student has a collection of blue and red marbles. The number of red marbles belong to the set {20, 21, 22, …., 38}. If two marbles are chosen simultaneously at random from this collection, the probability that they have different colours is $\frac{1}{2}$. Then possible number of blue marbles is/are

(A) 21 (B) 36 (C) 38 (D) 15

41. A sequence $a_1,a_2,a_3,\ldots.,a_n$ of real numbers is such that $a_1=0$, $|a_2|=|a_1+1|$, $|a_3|=|a_2+1|$, …., $|a_n|$ is equal to $|a_{n-1}+1|$, where the arithmetic mean of $a_1,a_2,a_3,\ldots,a_n$ cannot be less than $-\frac{\lambda}{\mu}$, then find the value of $\lambda+\mu$

(A) $\lambda+\mu=3$ (B) $\lambda\mu=2$

(C) $\lambda^{\mu}+\mu^{\lambda}=3$ (d) λ and μ can be roots of a quadratic equation with rational coefficient

42. If $a_1<a_2<a_3<a_4<a_5<a_6$, then the equation
$(x-a_1)(x-a_3)(x-a_5)+3(x-a_2)(x-a_4)(x-a_6)=0$ has

(A) three reals roots (B) a root in $(-\infty,a_1)$ (C) a root in (a_1,a_2) (D) a root in (a_5,a_6)

SECTION – II (Maximum Marks: 24)

This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded off to the second decimal place; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +3 If ONLY the correct numerical value is entered as answer.

Zero Marks: 0 In all other cases

43. Let $\frac{\pi}{3}<\theta<\frac{\pi}{2}$ and a function $f(x)$ is defined as

$$f(x)=\begin{cases}\lim\limits_{n\to\infty}\dfrac{\lambda_1 x^2(\sin\theta-\sin^3\theta)-(5x-\lambda_2)|\sin\theta-\sin^3\theta|^n}{(\sin\theta-\sin^3\theta)-|\sin\theta-\sin^3\theta|^n}; & x\in Q\\ \lim\limits_{n\to\infty}\dfrac{\lambda_1 x^2(\sin\theta+\sin^3\theta)+(5x-\lambda_2)|\sin\theta-\sin^3\theta|^n}{(\sin\theta+\sin^3\theta)+|\sin\theta+\sin^3\theta|^n}; & x\notin Q\end{cases}$$

and $f(x)$ is continuous at $x=2$ and $x=3$. Then the value of $\lambda_2-\lambda_1$ is _________

44. A line $3x+y=8$ touches a hyperbola at P(1, 5) meets its asymptotes at A and B. If $AB=2\sqrt{10}$ and centre of the hyperbola is C(1, 1) and its eccentricity is $\frac{\sqrt{a}}{b}$. Then $\frac{a+b}{100}$ is

45. The value of $\dfrac{\sum\limits_{r=1}^{k}2^r\cdot {}^nC_r\ {}^{(k-1)}C_{r-1}}{\sum\limits_{r=0}^{k}{}^nC_r\cdot {}^{(n+k-r-1)}C_{n-1}}$ (where $n\ge k$) is

46. A sequence is defined by $x_1=2$ and $x_{n+1}=\frac{x_n}{1+x_n}$ for all $n\ge 1$ and $a_{101}=\frac{a}{b}$, then $b-a$ is ____

47. Let matrix $M=\begin{bmatrix}1&0&0\\1&0&1\\0&1&0\end{bmatrix}$ satisfies the equation $M^n=M^{n-2}+M^2-I$ for $n=3,4,5,6,.....,$ where $I=I_{3\times3}$. Then $\det(\text{Adj}\,M^{50})$ is

48. The value of $\dfrac{\sum\limits_{r=1}^{n}\frac{1}{r}}{\sum\limits_{k=1}^{n}\frac{k}{(2n-2k+1)(2n-k+1)}}$ is

49. Let three dimensional vector $\vec{v}$ satisfy the vector equation $2\vec{v}+(\vec{v}\times(i+2\hat{j}))=2\hat{i}+\hat{k}$ and $3|\vec{v}|=\sqrt{m}$, then the value of m is

50. Let $\vec{a}=\frac{1}{7}(2\hat{i}+3\hat{j}+6\hat{k})$, $\vec{b}=\frac{1}{7}(6\hat{i}+2\hat{j}-3\hat{k})$ and $\vec{c}=C_1\hat{i}+C_2\hat{j}+C_3\hat{k}$ and the matrix $A=\begin{bmatrix}\frac{2}{7} & \frac{3}{7} & \frac{6}{7}\\ \frac{6}{7} & \frac{2}{7} & \frac{-3}{7}\\ C_1 & C_2 & C_3\end{bmatrix}$ and $A\cdot A^T=I$, then $\begin{vmatrix}\vec{a}\cdot\vec{a} & \vec{a}\cdot\vec{b} & \vec{a}\cdot\vec{c}\\ \vec{a}\cdot\vec{b} & \vec{b}\cdot\vec{b} & \vec{b}\cdot\vec{c}\\ \vec{a}\cdot\vec{c} & \vec{b}\cdot\vec{c} & \vec{c}\cdot\vec{c}\end{vmatrix}$ is equal to

SECTION – III (Maximum Marks: 12)

Each question has **TWO (02)** matching lists: LIST-I and LIST-II. FOUR options are given representing matching of elements from LIST-I and LIST-II. ONLY ONE of these four options corresponds to a correct matching.

For each question, choose the option corresponding to the correct matching. For each question, choose the option corresponding to the correct matching.

Full Marks : +3 If ONLY the option corresponding to the correct matching is chosen.

Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).

Negative Marks : –1 In all other cases.

51. Four digit natural number is formed using, the digits from the set {0, 1, 2, 3, 4, 5}, repetition of digits is allowed

Column I (Conditions)		**Column II (Number of natural numbers)**	
(I)	Number formed is multiples of 3	(P)	480
(II)	number formed contains exactly two different digits	(Q)	540
(III)	Numbers formed contains exactly three different digits	(R)	360
(IV)	Number formed is odd	(S)	175

The correct match is

(A) I-(P); II-(R); III-(Q); IV-(S)
(B) I-(P); II-(R); III-(S); IV-(Q)
(C) I-(R); II-(S); III-(R); IV-(P)
(D) I-(R); II-(S); III-(R); IV-(Q)

52. There are 10 pairs of shoes in a cup board from which 4 shoes are taken at random. If P(E) denotes the probability of the event E . Match the following:

Column I		**Column II**	
(I)	P (getting no pair)	(P)	$\frac{99}{323}$
(II)	P (getting at least one pair)	(Q)	$\frac{96}{323}$
(III)	P (getting exactly two pairs)	(R)	$\frac{224}{323}$
(IV)	P (getting exactly one pair)	(S)	$\frac{3}{323}$

The correct match is

(A) I-(P); II-(R); III-(Q); IV-(S)
(B) I-(P); II-(R); III-(S); IV-(Q)
(C) I-(R); II-(P); III-(S); IV-(Q)
(D) I-(R); II-(S); III-(R); IV-(Q)

53. Match the following:-

Column – I	**Column – II**
I) The area of the figure bounded by $y = x^2$ and $y = \sqrt{x}$ is	P) 4/3
II) $\int_0^4 \{\sqrt{x}\}dx$ has the value ({x} denotes fractional part of x}	Q) 5/3
III) The area of the region for which $0 < y < 3 - 2x - x^2$ and $x > 0$ is	R) 7/3
IV) $\int_{-\pi/2}^{\pi/2} \sqrt{\cos x - \cos^3 x}\, dx$ equals	S) 1/3

The correct match is

(A) I-(S); II-(R); III-(Q); IV-(P)
(B) I-(P); II-(R); III-(S); IV-(Q)
(C) I-(R); II-(P); III-(S); IV-(Q)
(D) I-(R); II-(S); III-(R); IV-(Q)

54. Match the following Column-I with Column-II

Column I	**Column II**
I) The distance between the lines $(x+7y)^2 + 4\sqrt{2}(x+7y) - 42 = 0$ is	P) 2
II) If the sum of the distance of a point from two perpendicular lines in a plane is 1, then its locus is |x| + |y| = k, where k is equal to	Q) 7
III) If 6x + 6y + m = 0 is acute angle bisector of line x + 2y + 4 = 0 and4x + 2y – 1 = 0, then m is equal to	R) 3
IV) Area of the triangle formed by the lines $y^2 - 9xy + 18x^2 = 0$ and y = 6 is	S)1

The correct match is

(A) I-(S); II-(R); III-(Q); IV-(P)
(B) I-(P); II-(S); III-(Q); IV-(R)
(C) I-(R); II-(P); III-(S); IV-(Q)
(D) I-(R); II-(S); III-(R); IV-(Q)

44 YEARS OF EXCELLENCE | NARAYANA IIT-JEE ACADEMY-INDIA

OUTGOING SR'S | DATE: 25-05-2023

Time: 3 Hrs | **SGTA-5 (Paper - II)** | Max. Marks: 180

Answer Key

PHYSICS

1. (B)	2. (B)	3. (C)	4. (C)	5. (D)	6. (AB)
7. (1)	8. (1)	9. (4)	10. (9)	11. (2)	12. (1)
13. (6)	14. (8)	15. (B)	16. (C)	17. (B)	18. (D)

CHEMISTRY

19. (ACD)	20. (ACD)	21. (AB)	22. (BD)	23. (ABD)	24. (ABD)
25. (6)	26. (7)	27. (2)	28. (-110.5)	29.(-19.7)	30. (1.92)
31. (4)	32. (1)	33. (A)	34. (C)	35. (D)	36. (D)

MATHEMATICS

37. (ABCD)	38. (BCD)	39. (ABCD)	40. (ABD)	41. (ABCD)	42. (ACD)
43.(5)	44.(0.07)	45.(1)	46.(199)	47. (1)	48. (0.50)
49. (6)	50. (1)	51. (D)	52. (C)	53. (A)	54. (B)

Explanations

PHYSICS

1. (B)

If we treat the train as a ring of mass 'M' then its COM will be at a distance from the

$R_{CM} = \frac{2R}{\pi}$ centre of the circle.

The linear Momentum of system = $MV_{CM} = MR_{CM}\,\omega$

2. (B)

friction force between wedge and block is internal i.e. will not change motion of COM. Friction force on the wedge by ground is external and causes COM to move towards right. Gravitational force (mg) on block brings it downward hence COM comes down.

3. (C)

Conceptual

4. (C)

Since velocity of man w.r.t trolley is greater than velocity of trolley w.r.t. earth, after the man turns back displacement of the man will decrease, so maximum displacement will be at the moment when man turns back.

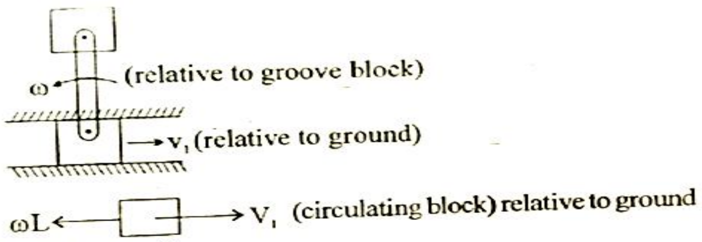
$\therefore \quad t = \frac{L}{1.5V}$

$\therefore \quad \text{Displacement} = (v + 1.5v)t = 2.5v\frac{L}{1.5v} = \frac{5}{3}L$

5. (D)

Conceptual

6. (AB)



for v_{min}, $\omega = 0$

so both will move with v_1

$mv_{min} = mv_1 + mv_1$ = conservation of momentum along horizontal $v_1 = \frac{v_{min}}{2}$

conservation of mech. energy

$$\frac{1}{2}mv_{min}^2 + mg(-L) = 2\times\frac{1}{2}m\left(\frac{v_{min}}{2}\right)^2 + mg(+L)$$

$$v_{min} = \sqrt{8gL}$$

7. (1)

For the duration of collision the pendulum does not exert any force on the sphere in the horizontal direction. Hence the horizontal momentum of bullet + sphere is conserved for the duration of collision. Let v' be the velocity of bullet and sphere just after the collision.

from conservation of linear momentum

(m + m) v' = mv orv' = = 1m/sec

8. (1)

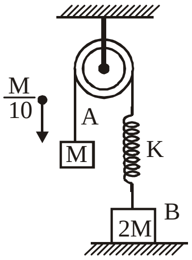
From C.L.M.

$\frac{M}{10}v_0 = \frac{11}{10}Mv \quad \Rightarrow \quad v = \frac{v_0}{11}$ ...(i)

For block B to leave ground

$K(x_0 + x) = 2\,Mg$ (where $x_0 = \frac{Mg}{K}$)

$\therefore \quad x = \frac{Mg}{K}$ …(ii)



From COE

$$\frac{11}{10}Mgx - \left[\frac{1}{2}K(x_0 + x)^2 - \frac{1}{2}Kx_0^2\right]$$

$$= 0 - \frac{1}{2}\frac{11}{10}Mv^2$$

solving

9. (4)

$5a = 2g \;\Rightarrow a = 4\ m/s^2$

10. (9)

As the belt does not slip, $v_p = v_Q$

i.e., $r_A\omega_A = r_C\omega_C\,[as\,v = r\omega]$ (i)

According to the given problem if $r_A = r, r_C = 3r,$ so Eq. (i)

$\omega_A = 3\omega_C$ (ii)

If both the wheels have the same rotational kinetic energy, then

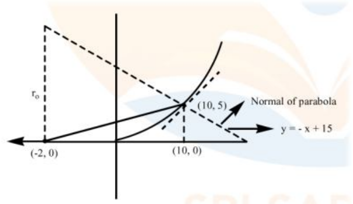
$$\frac{1}{2}I_A\omega_A^2 = \frac{1}{2}I_C\omega_c^2$$

or $\frac{I_A}{I_C} = \left[\frac{\omega_C}{\omega_A}\right]^2 = \left[\frac{1}{3}\right]^2 = \frac{1}{9} \;\Rightarrow \frac{I_C}{I_A} = 9$

11. (2)

$r_o = 17$

$\omega = \frac{V_o}{r_o} = \frac{34}{17} = 2\,rad/s$



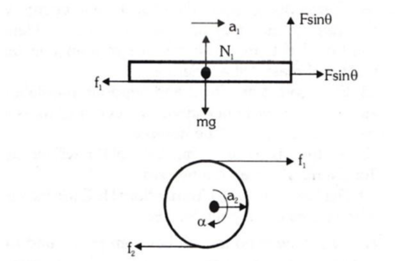
12. (1)

$F = av^2d$

$F = a\left(v_2^2 - v_1^2 d\right) = a\,2g\left(h_2 - h_1\right)d = 2aghd$

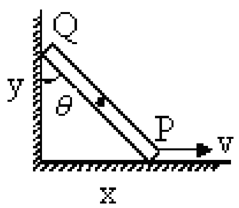
13. (6)
Moment of inertia of the segment of plate will be same as that of complete plate if axis of rotation is same and mass of plate is taken same as that of segment.

14. (8)
$\overline{L} = \overline{r} \times \overline{p}$
$= 2\hat{i} - 2\hat{j} - 8\hat{k}$
$l_z = -8$

15. (B)
The FBD & various parameters are shown in figure. From various dynamics Equation
$F\cos\theta - f_1 = ma_1$
$f_1 - f_2 = Ma_2$
$$\alpha = \frac{(f_1 + f_2)R}{\frac{1}{2}MR^2}$$


Solving above equation we get
$$a_2 = \frac{4F\cos\theta}{[3M + 8m]}, f_1 = \frac{3MF\cos\theta}{[3M + 8m]}$$
$$a_1 = \frac{8F\cos\theta}{[3M + 8m]}, f_1 = \frac{3MF\cos\theta}{[3M + 8m]}$$

16. (C)
$x^2 + y^2 = PQ^2 = \text{Constant}$

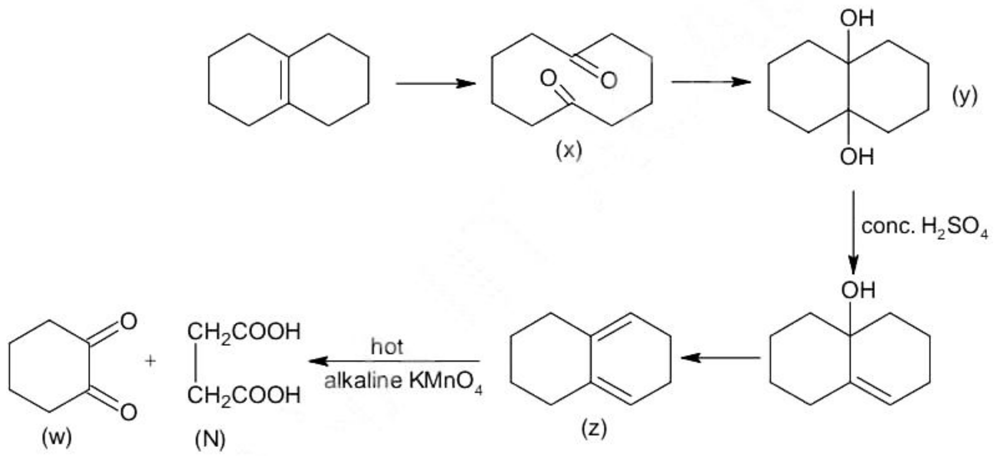
$2xx^1 + 2yy^1 = 0 \quad x^1 = v$
$2xv + 2yy^1 = 0$
$y^1 = V_Q = \frac{1}{V_{Tan\theta}}$
$y^1 = V_Q = \frac{-2xv}{2y} = Tan\theta \times V$
$\frac{V_Q}{V} = Tan\theta$


Similarly
$\frac{V}{V_2} = \sec^3\theta$
$\frac{\omega}{V} = \sec\theta$
$\frac{V}{V_Q} = \cot\theta$

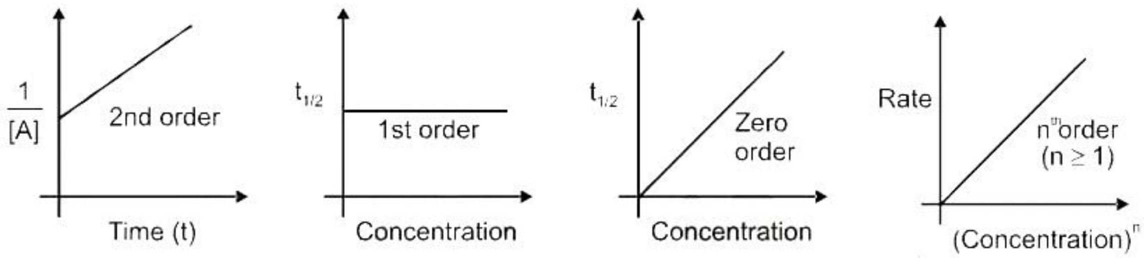
17. (B)
18. (D)
Conceptual

CHEMISTRY

19. (ACD)



20. (ACD)
21. (AB)
22. (BD)
23. (ABD)



24. (ABD)
25. (6)
26. (7)

$q = 0, T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

or $\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma-1}, \gamma = \frac{5}{3}$

$\Rightarrow x = 7$

27. (2)

Salt is [WA – WB]

$$h = \sqrt{\frac{K_W}{K_a \times K_b}} = \sqrt{\frac{10^{-14}}{10^{-5} \times 10^{-5}}} = \sqrt{10^{-14} \times 10^{10}} = \sqrt{10^{-4}} = 10^{-2}.$$

28. (–110.5)

$C + O_2 \longrightarrow CO_2; \quad \Delta H = -393.5\,kJ$ …. (1)

$CO + \frac{1}{2}O_2 \longrightarrow CO_2; \quad \Delta H = -283.0\,kJ$ ….. (2)

$C + \frac{1}{2}O_2 \longrightarrow CO; \quad \Delta H = -110.5\,kJ$ ….. (3)

29. (–19.7)

$$\Delta H_{dissolution}\overset{o}{CaCl_2} = \Delta H_{dissolution} CaCl_2.6H_2O + \Delta H_{dissolution}\, CaCl_2$$
$$= (+3.5) + (-23.2) = -19.7\, k.cal / mole$$

30. (1.92)

$\Delta p = m \times \Delta v$

$\Delta p = 9.1\times10^{-28} \times 3.0\times10^{4} \times \dfrac{0.001}{100}$

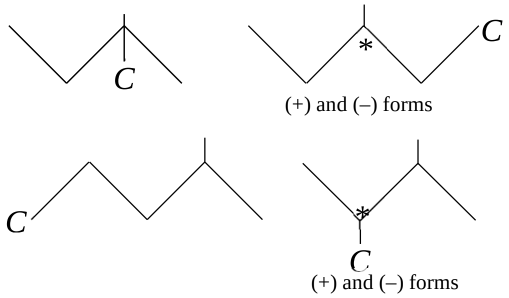
$\Delta P = 2.73\times10^{-24}$

Hence $\Delta x = \dfrac{h}{\Delta p \times 4\pi} = \dfrac{6.626\times10^{-27}}{2.73\times10^{-28}\times4\times3.14}$

$\Delta x = 1.92\ cm.$

31. (4)

The possible monochlorinated products of 2-methyl butane are

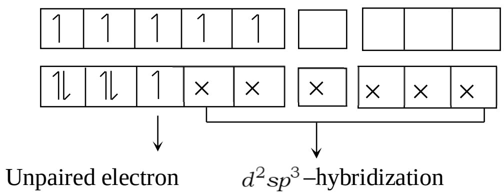


Therefore, a total of four chiral compounds are obtained.

32. (1)

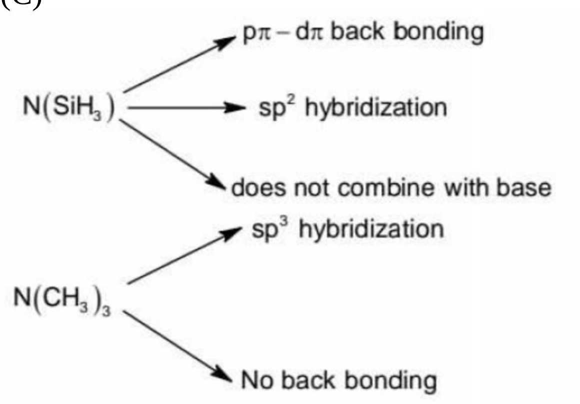
$Fe_{26} = 4s^2 3d^6$

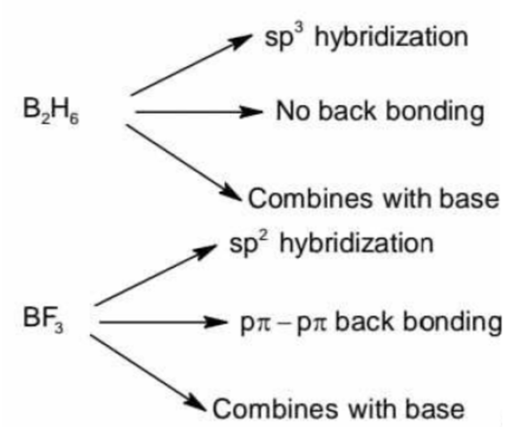
$Fe^{3+} = 3d^5 4s^0$



33. (A)

34. (C)





35. (D)

$[Ma_3b_2c]$	Geometrical isomerism $\rightarrow$ 3	Stereoisomer $\rightarrow$ 3
$[Ma_3b_3]$	Geometrical isomerism $\rightarrow$ 2	Stereoisomer $\rightarrow$ 2
$[Ma_3bcd]$	Geometrical isomerism $\rightarrow$ 4	Stereoisomer $\rightarrow$ 5
$[Ma_4bc]$	Geometrical isomerism $\rightarrow$ 2	Stereoisomer $\rightarrow$ 2

36. (D)

MATHEMATICS

37. (ABCD)

$$f(x) = \lim_{n\to\infty} e^{\frac{\cos x}{2}+\frac{3\cos x}{2^2}+\frac{5\cos x}{2^3}+....+\frac{(2n+1)\cos x}{2^n}}.$$

$$f(x) = \frac{\cos x}{2} + \frac{3\cos x}{2^2} + \frac{5\cos x}{2^3} + ...\infty \text{ terms} \quad .... (1)$$

$$\frac{1}{2} f(x) = \frac{\cos x}{2^2} + \frac{3\cos x}{2^3} + ...\infty \text{ terms} \quad .... (2)$$

From (1) – (2) $\Rightarrow$ $f(x) = \cos x + \cos x + \frac{\cos x}{2} + \frac{\cos x}{2^2} .....\infty$ terms

$$f(x) = \cos x + \frac{\cos x}{1-\frac{1}{2}} = 3\cos x.$$

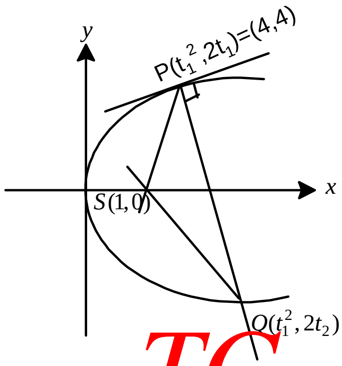
$g(x) = [\cos x]$ is discontinuous at $x = 0, \frac{\pi}{2}, \frac{3\pi}{2}, 2\pi$

38. (BCD)

Let $P(t_1^2, 2t_1) = (4,4)$

$$\Rightarrow t_1 = 2,\ t_2 = -t_1 - \frac{2}{t_1} = -2-1 = -3$$

$Q(9,-6)$



$$m(SP)\cdot m(SQ)=\frac{4}{3}\times\frac{-6}{8}=-1$$

$$\therefore \ \underline{|PSQ}=\frac{\pi}{2}.$$

39. (ABCD)

$$\frac{T_6 \text{ in } (x^3+\sqrt{2}x^{-2})^{15}}{T_6 \text{ in } (\sqrt{2}x^{-2}+x^3)^{15}}=\frac{4\sqrt{2}}{243}$$

$$\Rightarrow \frac{{}^{15}C_5(x^3)^{10}(\sqrt{2}x^{-2})^5}{{}^{15}C_5(\sqrt{2}x^{-2})^{10}(x^3)^5}=\frac{4\sqrt{2}}{243}.$$

$$\Rightarrow \left(\frac{x^3}{\sqrt{2}x^{-2}}\right)^5=\left(\frac{\sqrt{2}}{3}\right)^5.$$

$$\Rightarrow \frac{x^5}{\sqrt{2}}=\frac{\sqrt{2}}{3} \ \Rightarrow \ x^5=\frac{2}{3}$$

$$\therefore \ x=\left(\frac{2}{3}\right)^{1/5}.$$

40. (ABD)

Let the number of blue marbles is x and number of red marbles is y

$$\therefore \ \frac{xy}{{}^{(x+y)}C_2}=\frac{1}{2}\Rightarrow 2xy=\frac{(x+y)(x+y-1)}{2}.$$

$$\Rightarrow (x+y)(x+y-1)=4xy \Rightarrow \ y^2-(2x+1)y+(x^2-x)=0$$

$y\in N$ discriminant must be perfect square

$$\therefore \ D=(2x+1)^2-4(x^2-x)$$

$$D=4x^2+4x+1-4x^2+4x$$

$D=8x+1$ must be perfect square.

(A) $x=21 \Rightarrow 168+1=169$

(B) $x=36 \Rightarrow 288+1=289$

(C) $x=38 \Rightarrow 304+1=305$

(D) $x=15 \Rightarrow 120+1=121$

41. (ABCD)

Let us add one more number, a_{n+1} to the given sequence.

The number a_{n+1} is such that $|a_{n+1}|=|a_n+1|$

Squaring all the numbers, we have

$$a_1^2=0$$

$$a_2^2=a_1^2+2a_1+1$$

$$a_3^2=a_2^2+2a_2+1$$

$$a_4^2=a_3^2+2a_3+1.$$

$\ldots$

$\ldots$

$$a_n^2=a_{n-1}^2+2a_{n-1}+1$$

$$a_{n+1}^2=a_n^2+2a_n+1$$

Adding the above equalities, we get

$$a_1^2+a_2^2+\ldots+a_n^2+a_{n+1}^2=a_1^2+a_2^2+\ldots+a_n^2+2(a_1+a_2+\ldots+a_n)+n$$

$\Rightarrow\ 2(a_1+a_2+...+a_n)=-n+a_{n+1}^2\geq -n$

$\Rightarrow\ \dfrac{a_1+a_2+...+a_n}{n}\geq -\dfrac{1}{2}=\dfrac{-\lambda}{\mu}$

So, $\lambda=1$ and $\mu=2$.

$\therefore\ \lambda+\mu=3,\ \lambda\mu=2,\ \lambda^{\mu}+\mu^{\lambda}=3$

λ and μ can be roots of a quadratic equation with rational coefficient.

42. (ACD)

Let $f(x)=(x-a_1)(x-a_3)(x-a_5)+3(x-a_2)(x-a_4)(x-a_6)$

Note that, $f(x)\to-\infty$ as $x\to-\infty$

$f(a_1)=3(a_1-a_2)(a_1-a_4)(a_1-a_6)<0$

Similarly, $f(a_2)>0, f(a_3)>0, f(a_4)<0, f(a_5)<0, f(a_6)<0$

Thus, f(x) = 0 has a root in each of the following intervals $(a_1,a_2),(a_3,a_4)\&(a_5,a_6)$. Thus f(x) = 0 has three real roots.

43. (5)

$0<\sin\theta-\sin^3\theta<1$ and $\sin\theta+\sin^3\theta>1$

$\therefore\ f(x)=\begin{cases}\lambda_1 x^2; & x\in Q\\ 5x-\lambda_2; & x\notin Q\end{cases}$ and $f(x)$ is continuous at $x=2, x=3$.

$\lambda_1 x^2=5x-\lambda_2$ have roots 2, 3

$\lambda_1 x^2-5x+\lambda_2=0\ \Rightarrow\ \dfrac{5}{\lambda_1}=5\ \Rightarrow\ \lambda_1=1$ and $\dfrac{\lambda_2}{\lambda_1}=6\Rightarrow\ \lambda_2=6$

$\therefore\ \lambda_2-\lambda_1=6-1=5$.

44. (0.07)

By properties PA = PB = $\sqrt{10}$

$\therefore\ A\left(1+\sqrt{10}\left(\dfrac{-1}{\sqrt{10}}\right),5+\dfrac{3}{\sqrt{10}}\cdot\sqrt{10}\right)=(0,8)$

$B\left(1-\sqrt{10}\left(\dfrac{-1}{\sqrt{10}}\right),5-\dfrac{3}{10}\sqrt{10}\right)=(2,2)$.

Slopes of asymptotes are – 7 and 1

If angle between the asymptotes is θ. Then

$\tan\theta=\left|\dfrac{-7-1}{1-7}\right|=\dfrac{4}{3}$.

$\therefore\ 2\tan^{-1}\dfrac{b}{a}=\tan^{-1}\dfrac{4}{3}$

$\tan^{-1}\left(\dfrac{\frac{2b}{a}}{1-\frac{b^2}{a^2}}\right)=\tan^{-1}\dfrac{4}{3}\ \Rightarrow\ \dfrac{b}{a}=\dfrac{1}{2}\ \Rightarrow\ 2b=a$

$b^2=a^2(e^2-1)$

$b^2=4b^2(e^2-1)\ \Rightarrow\ e=\dfrac{\sqrt{5}}{2}=\dfrac{\sqrt{a}}{b}\Rightarrow\ \dfrac{a+b}{100}=\dfrac{7}{100}=0.07$.

45. (1)

Denominator = ${}^nC_0 \cdot {}^{(n+k-1)}C_{n-1} + {}^nC_1 \cdot {}^{(n+k-2)}C_{n-1} + {}^nC_2 \cdot {}^{(n+k-3)}C_{n-1} + ... + {}^nC_{k-1} \cdot {}^nC_{n-1} + {}^nC_k \cdot {}^{(n-1)}C_{n-1}$.

= Coefficient of x^{n-1} in ${}^nC_0(1+x)^{n+k-1} + {}^nC_1(1+x)^{n+k-2} + {}^nC_2(1+x)^{n+k-3} +$

$.... + {}^nC_{k-1}(1+x)^n + {}^nC_k(1+x)^{n-1}$

= Coefficient of x^{n-1} in ${}^nC_0(1+x)^{n+k-1} + {}^nC_1(1+x)^{n+k-2} + {}^nC_2(1+x)^{n+k-3} +$

$....... + {}^nC_{k-1}(1+x)^n + {}^nC_{k+1}(1+x)^{n-2} + {}^nC_{k+2}(1+x)^{n-3} + ... + {}^nC_n(1+x)^{k-1}$.

= Coefficient of x^{n-1} in $(1+x)^{n+k-1}[1+(1+x)^{-1}]^n = (1+x)^{k-1}(x+2)^n$

= Coefficient of x^{n-1} in $\sum_{r=1}^{n} {}^nC_r 2^r x^{n-r}(1+x)^{k-1} = \sum_{r=1}^{n} 2^r \cdot {}^nC_r \cdot {}^{(k-1)}C_{r-1}$.

$\therefore \dfrac{N^r}{D^r} = 1$.

46. (199)

$x_{n+1} = \dfrac{x_n}{1+x_n}, \; \dfrac{1}{x_{n+1}} = 1 + \dfrac{1}{x_n}$.

Put $n = 1, 2, 3, ..., n$

$\dfrac{1}{x_2} = 1 + \dfrac{1}{x_1} = 1 + \dfrac{1}{2}$

$\dfrac{1}{x_3} = 1 + \dfrac{1}{x_2} = 1 + 1 + \dfrac{1}{2} = 2 + \dfrac{1}{2}$

$\dfrac{1}{x_4} = 1 + \dfrac{1}{x_3} = 1 + 2 + \dfrac{1}{2} = 3 + \dfrac{1}{2}$

$\cdots \quad \cdots \quad \cdots \quad \cdots$

$\dfrac{1}{x_{n+1}} = n + \dfrac{1}{2} \Rightarrow \dfrac{1}{x_{101}} = 100 + \dfrac{1}{2}$

$\Rightarrow x_{101} = \dfrac{2}{201}$.

$\therefore b - a = 201 - 2 = 199$.

47. (1)

$M^n - M^{n-2} = M^2 - I$

$M^{50} - M^{48} = M^2 - I$

$M^{48} - M^{46} = M^2 - I$

$M^{46} - M^{44} = M^2 - I$

$\cdots \quad \cdots \quad \cdots$

$\cdots \quad \cdots \quad \cdots$

$\cdots \quad \cdots \quad \cdots$

$M^6 - M^4 = M^2 - I$

$M^4 - M^2 = M^2 - I$

Added, $M^{50} = 25M^2 - 24MI$

$$M^{50} = \begin{bmatrix} 25 & 0 & 0 \\ 25 & 25 & 0 \\ 25 & 0 & 25 \end{bmatrix} - \begin{bmatrix} 24 & 0 & 0 \\ 0 & 24 & 0 \\ 0 & 0 & 24 \end{bmatrix}$$

$$M^{50} = \begin{bmatrix} 1 & 0 & 0 \\ 25 & 1 & 0 \\ 25 & 0 & 1 \end{bmatrix} \Rightarrow \det(M^{50}) = 1.$$

48. (0.50)

Let $A=\sum_{k=0}^{n}\frac{k}{(2n-2k+1)(2n-k+1)}=\sum_{k=1}^{n}\frac{1}{2n-2k+1}-\sum_{k=1}^{n}\frac{1}{2n-k+1}$; $B=\sum_{r=1}^{n}\frac{1}{r}$.

$$A=\left(\frac{1}{1}+\frac{1}{3}+\frac{1}{5}+\ldots+\frac{1}{2n-1}\right)-\left(\frac{1}{n+1}+\frac{1}{n+2}+\ldots+\frac{1}{2n}\right).$$

$$B-A=\left(\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\ldots+\frac{1}{n}+\frac{1}{n+1}+\frac{1}{n+2}+\ldots.+\frac{1}{2n}\right)-\left(\frac{1}{1}+\frac{1}{3}+\frac{1}{5}+\ldots+\frac{1}{2n-1}\right)$$

$$B-A=\frac{1}{2}B \Rightarrow \frac{A}{B}=\frac{1}{2}=0.50.$$

49. (6)

$2\vec{v}+(\vec{v}\times(\hat{i}+2\hat{j}))=2\hat{i}+\hat{k}$ ..... (1)

Take dot product of (1) with $\hat{i}+2\hat{j}$

$2\vec{v}\cdot(\hat{i}+2\hat{j})=2$.

$|\vec{v}\cdot(\hat{i}+2\hat{j})|=1$

$|\vec{v}|^2(\hat{i}+2\hat{j})^2\cos^2\theta=1$ ($\because \theta$ is the angle between $\vec{v}$ and $\hat{i}+2\hat{j}$)

$|\vec{v}|^2(5\cos^2\theta)=1$

$|\vec{v}|^2\cdot 5\sin^2\theta=5|\vec{v}|^2-1$ ..... (2)

From the equation (1)

$|2\vec{v}+\vec{v}\times(\hat{i}+2\hat{j})|^2=|2\hat{i}+\hat{k}|^2$

$4|\vec{v}|^2+|\vec{v}|^2(\hat{i}+2\hat{j})^2\sin^2\theta=5$

$9|\vec{v}|^2=6 \Rightarrow m=6$.

50. (1)

$$A\cdot A^T=\begin{bmatrix}1 & 0 & \frac{2C_1+3C_2+6C_3}{7}\\ 0 & 1 & \frac{6C_1+2C_2-3C_3}{7}\\ \frac{2C_1+3C_2+6C_3}{7} & \frac{6C_1+2C_2-3C_3}{7} & C_1^2+C_2^2+C_3^2\end{bmatrix}.$$

$$\therefore \left.\begin{array}{l}C_1^2+C_2^2+C_3^2=1\\ 2C_1+3C_2+6C_3=0\\ 6C_1+2C_2-3C_3=0\end{array}\right\} \Rightarrow \vec{c}=\frac{C_1}{3}(3\hat{i}-6\hat{j}+2\hat{k}) \text{ and } |\vec{c}|=1$$

$$\therefore \vec{c}=\pm\frac{(3\hat{i}-6\hat{j}+2\hat{k})}{7}.$$

51. (D)

For I $\rightarrow$ 5 × 6 × 6 × 2 = 360

For II $\rightarrow$ ${}^5C_2\left[\frac{4!}{2!2!}+\frac{4!}{3!}\times 2\right]+{}^5C_1\left[\frac{3!}{2!}\times 2+1\right]$ = 175

For III $\rightarrow$ ${}^5C_3\times\frac{4!}{2!}$ + ${}^5C_2$ [9 × 2 + 6] = 360

52. (C)

I) P (no pair) = $\frac{20}{20}\cdot\frac{18}{19}\cdot\frac{16}{18}\cdot\frac{14}{17}=\frac{224}{323}$

II) P (at least one pair) = $1-\frac{224}{323}=\frac{99}{323}$

III) P (exactly two pairs) = $\frac{^{10}C_2}{^{20}C_4}=\frac{3}{323}$

IV) P (exactly one pair) = 1 - $\left[\frac{224}{323}+\frac{3}{323}\right]=\frac{96}{323}$

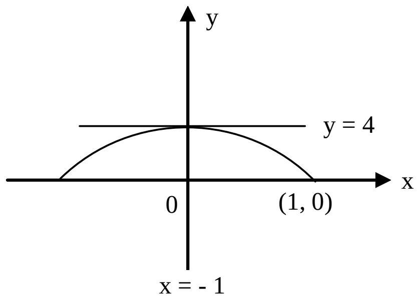
53. (A)

I) Required area = $\int_0^1\left(\sqrt{x}-x^2\right)dx=1/3$

II) $\int_0^4\left\{\sqrt{x}\right\}dx=\int_0^4\left(\sqrt{x}-\left[\sqrt{x}\right]\right)dx$

$\int_0^4\sqrt{x}\ dx=\int_0^1\left[\sqrt{x}\right]dx-\int_0^4\left[\sqrt{x}\right]dx=7/3$

III) Area = $\int_0^1\left(3-2x-x^2\right)dx=\left[3x-x^2-\frac{x^3}{3}\right]_0^1$ = 5/3



IV) $2\int_0^{\pi/2}\sqrt{\cos x}\sin x\,dx=4/3$

54. (B)

I) $(x+7y)^2+7\sqrt{2}(x+7y)-42=0$

$\Rightarrow(x+y)[x+7y+7\sqrt{2}]-3\sqrt{2}(x+y)-42=0$

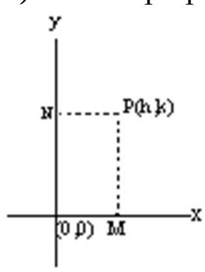
$\Rightarrow(x+y)[x+7y+7\sqrt{2}]-3\sqrt{2}(x-7y+7\sqrt{2})=0$

$\Rightarrow(x+7y+7\sqrt{2})(x+7y-3\sqrt{2})=0$

$x+7y+7\sqrt{2}=0$ and $x+7y-3\sqrt{2}=0$

$\Rightarrow d=\left|\frac{7\sqrt{2}+3\sqrt{2}}{\sqrt{1+49}}\right|=\frac{10\sqrt{2}}{\sqrt{50}}=2$

II) Let two perpendicular lines are coordinate axes.



Then, PM + PN = 1$\Rightarrow h+k=1$

Hence, the locus is x + y =1

But if the point lies in other quadrants also, then $|x|+|y|=1$. Hence, value of k is 1.

III) Angle bisector between the lines x + 2y +4 = 0 and 4x + 2y – 1 = 0

$\frac{x+2y+4}{\sqrt{1+4}}=\pm\frac{(-4x+2y+1)}{\sqrt{16+4}} \Rightarrow x+2y+4=\pm\frac{(-4x+2y+1)}{2}$

$\Rightarrow 2(x+2y+4)=\pm(-4x-2y+1)$

Since $AA^{'}+BB^{'}<0$, so +ve sign gives acute angle bisector. Hence,

$2x+4y+8=-4x-2y+1 \Rightarrow 6x+6y+7=0 \Rightarrow m=7$

IV) We have, $y^2-9xy+18x^2=0$ or $y^2-16xy-3xy+18x^2=0$

$\Rightarrow y(y-6x)-3x(y-6x)=0$

$\Rightarrow (y-3x)=0$ and $y-6x=0$

The third line is y = 6. Therefore, area of the triangle formed by these lines,

$$=\frac{1}{2}\begin{vmatrix}0 & 0 & 1\\ 1 & 6 & 1\\ 2 & 6 & 1\end{vmatrix}=\frac{1}{2}|6-12| \ =3units^2$$

Sri Chaitanya IIT Academy.,India.

A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S	**JEE-ADVANCE-2021-P1**	**Date: 26-04-2023**
Time: 09.00Am to 12.00Pm	**GTA-18**	**Max. Marks: 180**

26-04-2023_Sr.Super60_ NUCLEUS & ALL_BT'S_Jee-Adv(2021-P1)_GTA-18_Syllabus

PHYSICS : TOTAL SYLLABUS

CHEMISTRY : TOTAL SYLLABUS

MATHEMATICS : TOTAL SYLLABUS

Name of the Student: ___________________ **H.T. NO:** | | | | | | | |

JEE-ADVANCE-2021-P1-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** Max Marks: 180

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 4)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 5 – 10)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 11 – 16)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 17 – 19)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 20 – 23)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 24 – 29)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 30 – 35)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 36– 38)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 39 – 42)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 43 – 48)	Paragraph Questions with Numerical Value Answer Type	+2	0	6	12
Sec – III(Q.N : 49 – 54)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – IV(Q.N : 55 – 57)	Questions with Non-negative Integer Value Type	+4	0	3	12
Total				**19**	**60**

PHYSICS **Max Marks: 60**

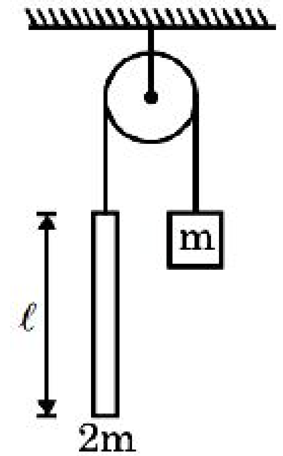
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 4 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases. Section 1 (Max Marks: 12)

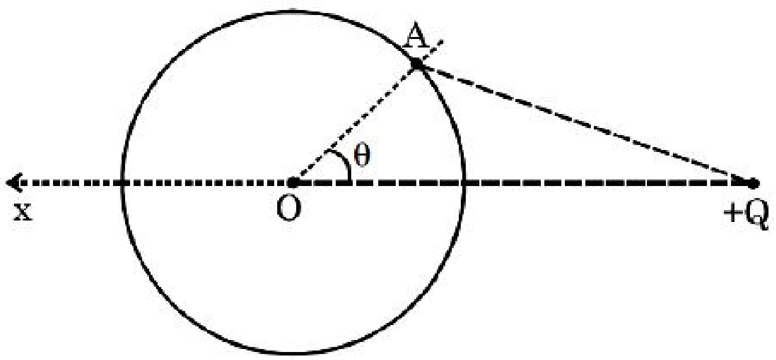
- Section 1 contains Four questions
- Each Question has Four Options and Only One of these four will be the correct answer.
- For each question, choose the option corresponding to the correct answer
- The Marking scheme to evaluate Answer to each question will be :
- Full Marks: **+3** (If the answer is correct)
- Zero Marks: **0** (If the question is unanswered)
- Negative Marks: -1 (In all other cases)

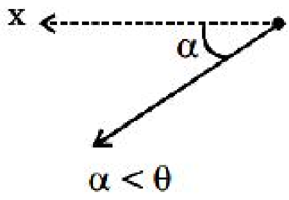
1. A system consist of block of mass m, rod of length ℓ and mass 2m connected with the help of string, which passes through an ideal pulley is released from rest as shown in the figure. Tension in the rod at a distance $\frac{\ell}{3}$ from the upper end of the rod is

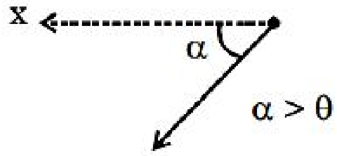


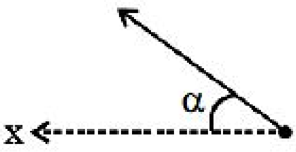
A) $\frac{2mg}{9}$ **B)** $\frac{4mg}{9}$ **C)** $\frac{8mg}{9}$ **D)** $\frac{2mg}{3}$

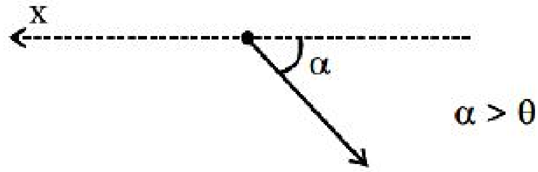
2. Consider a conducting sphere having net charge zero and a positive point charge Q is placed as shown in figure. Choose the option correctly representing the direction of electric field at point A (just outside the sphere) due to induced charges on sphere.



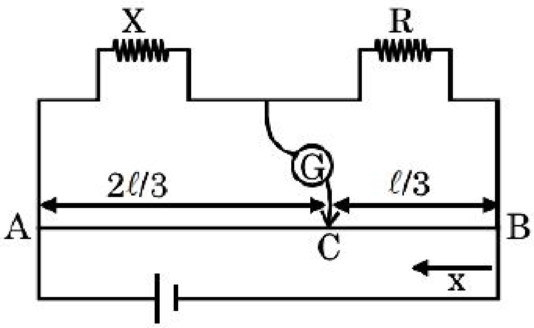
A) 

B) 

C) 

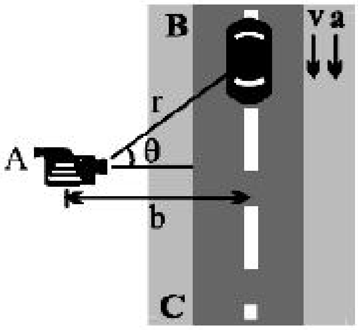
D) 

3. Resistivity of wire AB is given by $\rho = \rho_0\left(1-\frac{x}{\ell}\right)$ where $(AB=\ell)$ and x is measured from end B. If balancing length is $\frac{2\ell}{3}$ from end A, find x.



A) $\frac{4R}{5}$ B) $\frac{5R}{4}$ C) $\frac{3R}{4}$ D) $\frac{3R}{5}$

4. To study the performance of a race car, a high speed motion picture camera is positioned at point A. The camera is mounted on a mechanism which permits it to record the motion of the car as the car travels on straightway BC. The speed of the car in terms of b, θ, and $\frac{d\theta}{dt}$ is given by :



A) $b\left|\frac{d\theta}{dt}\right|\cos^2\theta$ B) $b\left|\frac{d\theta}{dt}\right|\sin^2\theta$ C) $b\left|\frac{d\theta}{dt}\right|\sec^2\theta$ D) $b\left|\frac{d\theta}{dt}\right|cosec^2\theta$

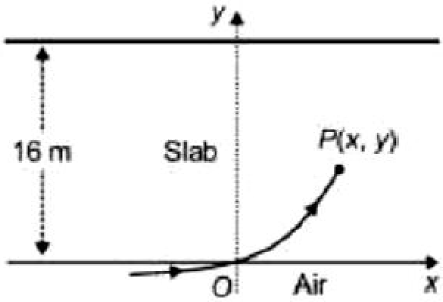
SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- **Zero Marks:0** in all other cases

Question Stem for Question Nos. 5 and 6

Question Stem

A ray of light travelling in air is incident at nearly grazing incidence on a large rectangular slab of transparent medium having thickness 16 m. Treating the point of incidence as the origin and the refractive index of medium varies with thickness as a function of y (in metre), $\mu(y)=\sqrt{\frac{3}{2}y^{2}+1}$. If equation of the path of ray is $x=KY^{1/k}$ and ray emerges out of the slab at $x=x_0$, then



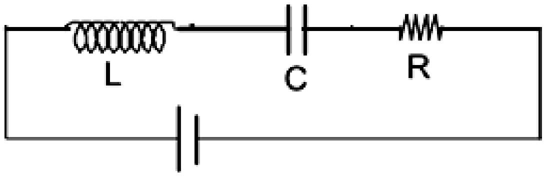
5. Value of k is ________.

6. Value of x_0 ________m.

Question Stem for Question Nos. 7 and 8

Question Stem

RLC circuit can be taken similar to damped oscillation, the equation $\frac{q}{C}+R\frac{dq}{dt}+L\frac{d^2q}{dt^2}=E$ is similar to $Kx+b\frac{dx}{dt}+m\frac{d^2x}{dt^2}=F$ where K is analogus to $\frac{1}{C}$, b to R and m to L. A constant DC excitation is switched on at t = 0



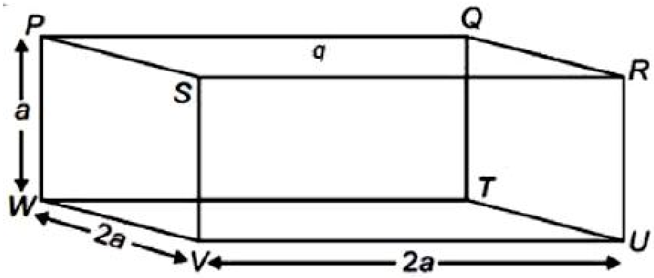
7. If L = 1 mH and $C=10\mu F$ then find value of R for which circuit is critically damped?

8. If $R=10\Omega, L=1mH$ and $C=10\mu F$, then find time in (m sec), at which current is 0 for first time after switching the circuit $(t\neq 0)$

Question Stem for Question Nos. 9 and 10

Question Stem

A point charge q is placed at the centre of one of the faces of cuboid PQRS as shown in the figure. If $\int \vec{E}.d\vec{s}$ is electric flux through area ds. If value of $\int \vec{E}.d\vec{s}$ over the surface QRUT is $\frac{q}{k\varepsilon_0}$ and value of $\int \vec{E}.d\vec{s}$ over the surface PQRS is $\frac{Nq}{\varepsilon_0}$, then



9. Value of k is _______.

10. Value of N _______.

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

11. The length of sonometer wire between two fixed ends is 100 cm. Three bridges be placed so as to divide the wire into four segments whose fundamental frequencies are in the ratio of 1 : 2 : 3 : 4 from the left end. Then which of the following is/are correct.

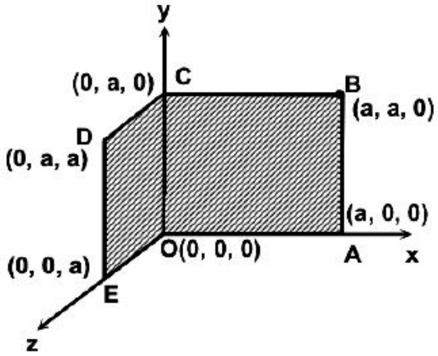
A) The position of the first bridge from the left fixed end is 48 cm.

B) The position of the 2^{nd} bridge from the right fixed end is 28 cm.

C) The position of the 3^{rd} bridge from the left fixed end is 88 cm.

D) The separation between the first bridge and the 3^{rd} bridge is 40 cm.

12. Two surface OABC and OCDE lies in the plane of xy and yz as shown in the figure. A charged particle 'q' lies in the space at a point P, if



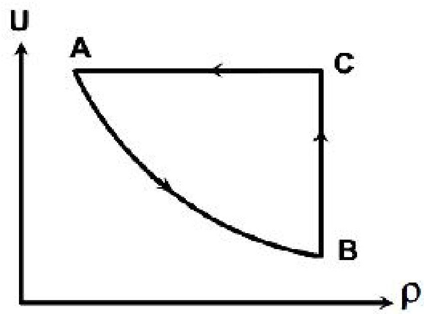
A) Coordinates of 'P' is $(a-\Delta r, a-\Delta r, \Delta r)$ and $a >> \Delta r$, then flux passing through surface OABC is $\frac{7q}{24\varepsilon_0}$.

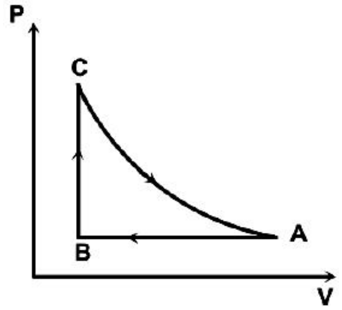
B) Coordinates of 'P' is $(a-\Delta r, a-\Delta r, \Delta r)$ and $a >> \Delta r$, then flux passing through surface OCDE is $\frac{q}{24\varepsilon_0}$.

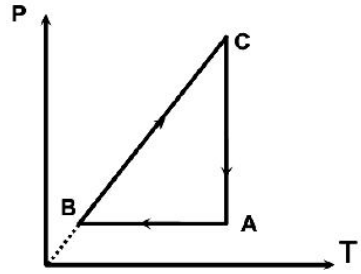
C) Coordinates of 'P' is $(a+\Delta r, a+\Delta r, -\Delta r)$ and $a >> \Delta r$, then flux passing through surface OABC is $\frac{q}{24\varepsilon_0}$.

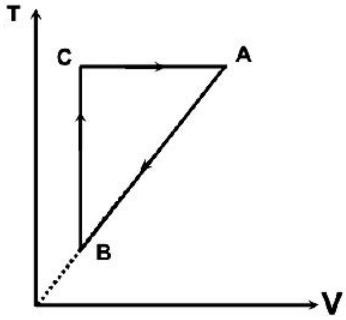
D) Coordinates of 'P' is $(a+\Delta r, a+\Delta r, -\Delta r)$ and $a >> \Delta r$, then flux passing through surface OCDE is $\frac{q}{24\varepsilon_0}$.

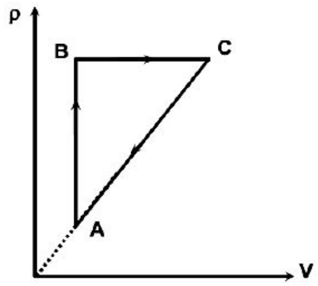
13. U – ρ (U $\rightarrow$ Internal energy of the gas and $\rho \rightarrow$ density of the gas) plot of an ideal mono–atomic gas undergoing a cyclic process is shown in the figure. $A \rightarrow B$ is part of a rectangular hyperbola. Then which of the following graphs in options below correspond to the process given in adjacent diagram ?



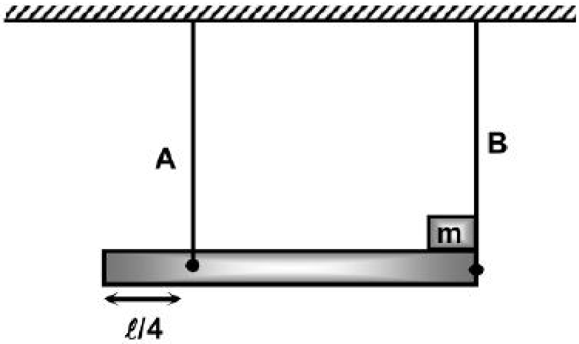
A) 

B) 

C) 

D) 

14. A uniform rod of mass 'm' and length 'ℓ' is held horizontally by two vertical strings 'A' and 'B' of negligible mass and a small block of mass 'm' is also placed on the top of the rod as shown in the figure. Then which of the following is/are correct.



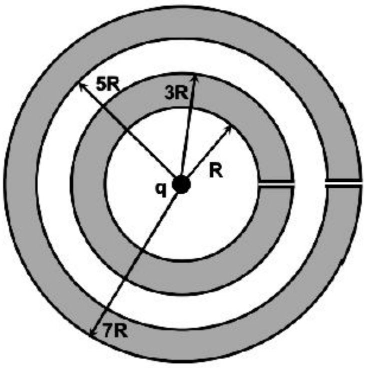
A) The tension in the string 'A' immediately after the string 'B' is cut, it $\frac{4}{7}mg$.

B) The tension in the sting 'A' immediately after the string 'B' is cut, is $\frac{2}{7}mg$.

C) The acceleration of centre of mass of the rod immediately after the string 'B' is cut, is $\frac{3}{7}g$.

D) The acceleration of centre of mass of the rod and the block immediately after the string 'B' is cut, is $\frac{5}{7}g$.

15. A small charged particle 'q' lies at the centre of two concentric conducting hollow spheres of inner radii R and 5R and outer radii 3R and 7R respectively. Then which of the following is/are correct.



A) The energy stored in the space between 3R to 5R (cavity) is $\frac{kq^2}{15R}$.

B) The energy stored in the space between 3R to 5R (cavity) is $\frac{kq^2}{30R}$.

C) The amount of work has to be performed to slowly transfer the charge 'q' from center through the orifice to infinity is $\frac{29}{210}\frac{kq^2}{R}$.

D) The amount of work has to be performed to slowly transfer the charge 'q' from center through the orifice to infinity is $\frac{38}{105}\frac{kq^2}{R}$.

16. A source 'S' of sound wave of fixed frequency 'f' and an observer 'O' are located in air initially at the space point A and B, a fixed distance apart. State in which of the following cases, the observer will not see any Doppler effect and will receive the same frequency 'f' as produced by the source.

A) Both the source 'S' and observer 'O' remains stationary but wind blows with constant speed in arbitrary direction.

B) The observer 'O' remains stationary but the source 'S' moves parallel to and in the same direction and with the same speed as wind.

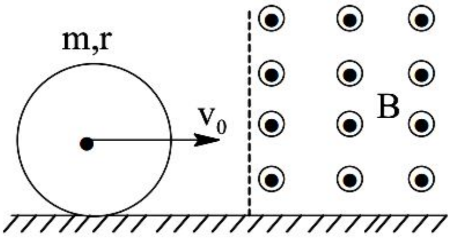
C) The source 'S' remains stationary but the observer 'O' and the wind have same speed away from the source.

D) The source 'S' and the observer 'O' move directly against the wind but both with the same speed.

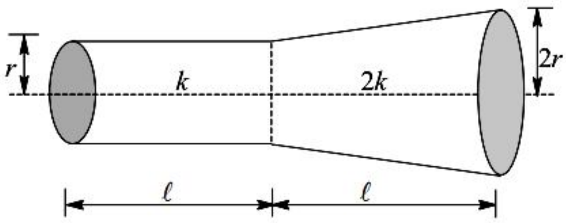
SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

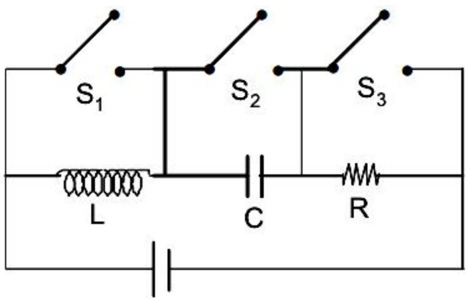
17. A ring of mass m and radius r and made of an insulating material carries uniformly distributed charge. Initially it rests on a frictionless horizontal tabletop with its plane vertical. The charge on the ring so that it starts rolling on entering completely into the region of the magnetic field is $\frac{\sqrt{N}mv_0}{rB}$, then find the value of 'N'.



18. A composite object is formed by combining a uniform rod of circular cross–section with thermal conductivity k and a frustum of same length with thermal conductivity 2k as shown in the figure. The equivalent thermal conductivity of the object is given as $\frac{Nk}{5}$, find 'N'.



19. Consider the circuit shown in figure. With switch S1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S3 closed and the other two switches open, the circuit oscillates with a period T. Find T/5 (in sec).
(Take $\pi^2 = 10$),



CHEMISTRY

Max. Marks: 60

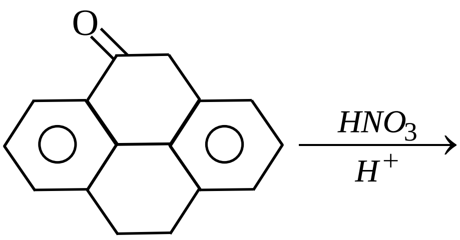
SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : +3 If ONLY the correct option is chosen;
- *Zero Marks* : 0 If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : -1 In all other cases.

20. Electron in Li^{+2} ion having magnitude of potential energy **P,** was provided with sufficient energy so that it jumps to higher energy level with kinetic energy **Y**. If it has probability of emitting Electromagnetic radiations of six different wavelengths while de-excitation between these two energy levels, then what is the correct relationship between **P** and **Y**? Here **n** is the orbit number of higher energy state.

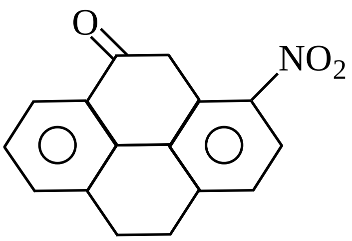
A) $\sqrt{\frac{P}{Y}}=1-\frac{3}{n}$ **B)** $\sqrt{\frac{2Y}{P}}=1-\frac{3}{n}$ **C)** $\sqrt{\frac{P}{Y}}=1+\frac{3}{n}$ **D)** $\frac{P}{Y}=1-\frac{3}{n}$

21.

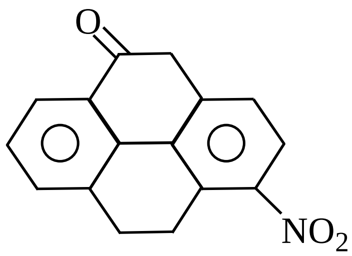


Major product is :

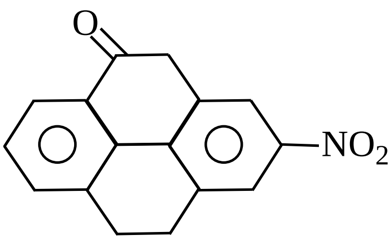
A)



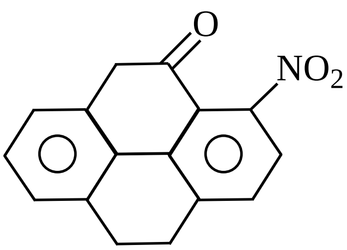
B)



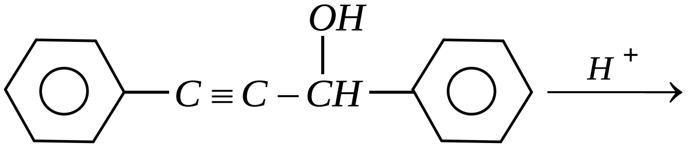
C)

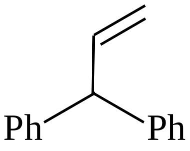


D)



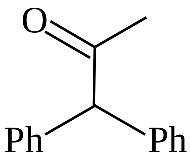
22. Product obtained in the given reaction is:



A) 

B) $Ph-CH=C=CH-Ph$

C) $Ph-\overset{\overset{\displaystyle O}{\|}}{C}-CH=CH-Ph$

D) 

23. The oxidizing power of $[CrO_4]^{2-}$, $[MnO_4]^{2-}$ and $[FeO_4]^{2-}$ follows the order.

A) $[CrO_4]^{2-} < [MnO_4]^{2-} < [FeO_4]^{2-}$
B) $[FeO_4]^{2-} < [MnO_4]^{2-} < [CrO_4]^{2-}$

C) $[MnO_4]^{2-} < [FeO_4]^{2-} < [CrO_4]^{2-}$
D) $[CrO_4]^{2-} < [FeO_4]^{2-} < [MnO_4]^{2-}$

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** ***: +2*** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks*** ***: 0*** In all other cases.

Question Stem for Question Nos. 24 and 25

Question Stem

Consider the reaction (at 300K) whose free energy of reaction is expressed as

$\Delta G_{Reaction} = \Delta G^0_{Reaction} + RT\ln\dfrac{[C]}{[A][B]} < 0$ at non equilibrium state. Forward reaction being spontaneous, the net rate of reaction (observed rate) is defined as $r_1 - r_2$ where r_1 and r_2 are rate of forward and backward reaction at the given instant defined by the values $\dfrac{r_{obs}}{r_1} = 0.5$, [A] = 0.5 M, [B] = 1 M, [C] = 2 M.

Hint: Law of mass action is known to be applicable for the given stoichiometry R=8.30 J/mol K, ln2=0.7.

24. What is the equilibrium constant at 300K?

25. What is the absolute free energy of reaction (KJ/mol), for a given stoichiometry, when concentrations of all species are taken as 1 M at 300K? (Round of to nearest integer)

Question Stem for Question Nos. 26 and 27

Question Stem

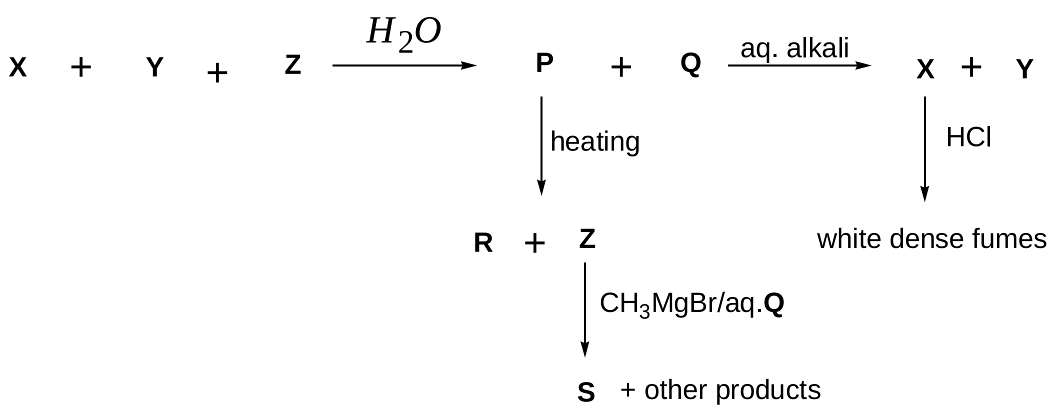
An organic compound 'A' $(C_9H_8O_2)$ does not decolorizes bromine water and evolves no gas with CH_3MgBr, but gives orange precipitate with 2, 4 – dinitro phenyl hydrazine. 'A' on refluxing with dil. H_2SO_4 produces $B(C_9H_{10}O_3)$ which forms salt with NaOH and on treatment with $CH_3COC\ell$ yields $C_{13}H_{14}O_5$. B is a non–resolvable compound which on heating with $N_2H_4 / NaOH$ yields 'C' $(C_9H_{12}O_2)$. 'C' on dehydrating with conc. H_3PO_4 yields 'D' $(C_9H_{10}O)$ as major product. 'D' on ozonolysis following by work–up with $(CH_3)_2S$ yields 'E' $(C_7H_6O_2)$ which can also be obtained by the action of phenol with alkaline solution of chloroform followed by acidification of product.

26. What will be the molecular mass of the product obtained after acidic hydrolysis of the compound $C_{13}H_{14}O_5$ formed in above passage (ignore AcOH)?

27. What will be the degree of unsaturation of the compound obtained after treating 'E' with Tollen's reagent followed by acidification?

Question Stem for Question Nos. 28 and 29

Question Stem



(P can be used in the preparation of pastries and as firextinguisher)

28. Number of water molecules present in the crystalline compound of **R** is

29. Number of pi-bonds present in the organic compound '**S**' of the above reaction scheme.

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks: +3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks: +2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks: +1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks: 0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

30. Choose the correct reason (s) for acquiring stability by lyophobic colloidal particles.

A) Preferential adsorption of specific ions on their surface from the colloidal system.

B) Preferential adsorption of molecules of dispersion medium on their surface from the colloidal system.

C) Attraction between different colloidal particles having opposite charges on their surface.

D) Potential difference between the fixed layer and the diffused layer of opposite charges around the colloidal particles.

31. Atoms of element B (as anions) form hexagonal close packing (hcp) lattice and atoms of element A (as cations) occupy 2/3rd of tetrahedral voids. If atoms of element B (as anions of same charge as hcp lattice) forms cubic close packing (ccp) and atoms of element A (as cations) occupy octahedral voids, then,

A) Total number of voids unoccupied per unit-cell must be same in both crystal structures.

B) Total number of tetrahedral voids occupied in hcp is same as that of octahedral voids occupied in ccp.

C) Radii of cations of element A is same in both the crystal structures.

D) Average oxidation state of metal ion is different in hcp and ccp.

32. Select the wrong IUPAC name(s) :

A) 2–hydroxyhexen–4–one **B)** 2,3–dimethylcyclohexene

C) hept–1–en–6–yn–5–ol **D)** 1,3–diethoxypropan–1–one

33. Glucose and cane sugar can be distinguished by :

A) iodine solution **B)** Fehling's solution

C) Molisch test **D)** Tollen's reagent

34. Hydrometallurgy is used for extraction of noble metals like silver and gold, which of the following steps/observations takes place?

A) Leaching **B)** Reduction

C) Displacement reaction **D)** Complex formation

35. The melting point of lithium metal is 454 K, and that of sodium is 371 K. Which of the following statements can explain this difference in their melting points?

A) Metallic bonding in lithium is stronger than metallic bonding in sodium.

B) The delocalized electrons are more strongly attracted to the metal cation of lithium.

C) The lithium cations have a greater charge density than sodium cation.

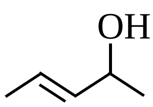
D) Li^+ cations are smaller than Na^+ cations.

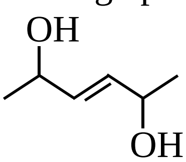
SECTION 4

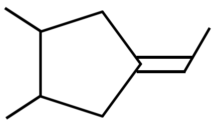
- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

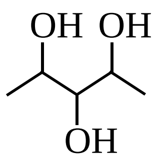
36. The Cell $Ag(s)|Ag_2SO_4(s)|Hg_2SO_4(aq,sat)|Hg_2SO_4(s)|Hg_{(l)}|Pt$ has emf of 0.140V at 298K and 1 bar. Close to 298 K emf varies with temperature by $1.39\times10^{-4}VK^{-1}$. How much heat (by magnitude) is absorbed by cell if it discharges isothermally and reversibly to deposit one gram equivalent of copper from its aqueous solution in units of kJ? (1F=96500C). Report the value to nearest integer.

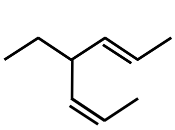
37. How many of the given compounds shows both geometrical and optical isomerism with all the stereo isomers being optically active?

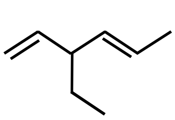
i) 

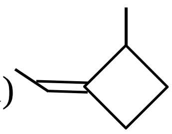
ii) 

iii) 

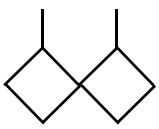
iv) 

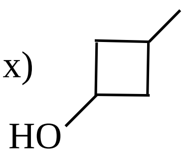
v) 

vi) 

vii) 

viii) $CH_3-CH=C=CH_2$

ix) 

x) 

38. Number of S-S linkages present in the ion of tetrathionate.

MATHEMATICS

Max. Marks: 60

SECTION 1

- This section contains **Four (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
- *Full Marks* : *+3* If ONLY the correct option is chosen;
- *Zero Marks* : *0* If the none of the options is chosen (i.e. the question is unanswered);
- *Negative Marks* : *-1* In all other cases.

39. Let $f(x)=e^{\left\{e^{|x|}\operatorname{sgn} x\right\}}$ and $g(x)=e^{\left[e^{|x|}\operatorname{sgn} x\right]}, x\in R$ where { } and [ ] denotes the fractional and integral part functions, respectively. Also $h(x)=\log_e(f(x))+\log_e(g(x))$ then for real x, h(x) is

A) An odd function **B)** An even function

C) Neither odd nor an even function **D)** Both odd as well as even function

40. In the equation A + B + C + D + E = FG, where FG is the two digit number whose value is 10F + G and letters, A, B, C, D, E, F and G each represents different digits and FG is as large as possible.
If a five digit number is made using the digits A, B, C, D, E without repetition then

A) The probability that the number is divisible by 11 is $\frac{2}{5}$

B) The probability that the number is divisible by 11 is $\frac{1}{5}$

C) The probability that the number is divisible by 4 is $\frac{1}{4}$

D) The probability that the number is divisible by 4 is $\frac{3}{10}$

41. Let $\alpha=\sum_{k=1}^{\infty}\sin^{2k}\left(\frac{\pi}{6}\right)$

Let $g:[0,1]\to R$ be the function defined by $g(x)=2^{\alpha x}+2^{\alpha(1-x)}$

Then, which of the following statements is/are **NOT CORRECT**?

A) The minimum value of $g(x)$ is $2^{7/6}$

B) The maximum value of $g(x)$ is $1+2^{1/3}$

C) The function $g(x)$ attains its maximum at more than one point

D) The function $g(x)$ attains its minimum at more than one point

42. The value of $\lim_{x\to 0}\left(\int_0^1 \left(by+a(1-y)\right)^x dy\right)^{\frac{1}{x}}$ where $b>a$.

A) $\frac{1}{e}\left(\frac{b^b}{a^a}\right)^{\frac{1}{b-a}}$ **B)** $\frac{b^a}{a^a}$ **C)** $\left(\frac{b^b}{a^a}\right)^{\frac{1}{b-a}}$ **D)** $e\left(\frac{b^b}{a^a}\right)$

SECTION 2

- This section contains **THREE (03)** questions stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks: +2*** If ONLY the correct numerical value is entered at the designated place;
- ***Zero Marks: 0*** In all other cases.

Question Stem for Question Nos. 43 and 44

Question Stem

Let $f:R\to R$ such that $f'(0)=1$ and

$f(x+2y)=f(x)+f(2y)+e^{x+2y}(x+2y)-x.e^x-2ye^{2y}+4xy$ for all $x,y\in R$ then

43. The value of $f(2)-2e^2$ is

44. The value of $f'(3)-4e^3$ is

Question Stem for Question Nos. 45 and 46

Question Stem

Let L_1 and L_2 be the lines $x+2y-z-3=0=3x-y+2z-1$ and

$2x-2y+3z-2=0=x-y+z+1$.

45. Square of the distance of the origin from the point of intersection of L_1 and L_2 is

46. The distance of the origin from the plane through the lines is $\dfrac{1}{a\sqrt{b}}$ units then a + b is equal to ______ (given b is prime)

Question Stem for Question Nos. 47 and 48

Question Stem

An equation of the form $2m\log_a f(x) = \log_a g(x)$, $a > 0, a \neq 1, m \in N$ is equivalent to the system $f(x), g(x) > 0$ and $(f(x))^{2m} = g(x)$.

47. Number of values of x satisfying the equation

$(\log_x 2)\ (\log_{2x} 2) = \log_{4x} 2$ is________

48. Number of values of x satisfying the equation

$\log_{(x^3+6)}(x^2-1) = \log_{(2x^2+5x)}(x^2-1)$ is________

SECTION 3

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If only (all) the correct option(s) is (are) chosen;
- ***Partial Marks*** : ***+3*** If all the four options are correct but **ONLY** three options are chosen,
- ***Partial Marks*** : ***+2*** If three or more options are correct but **ONLY** two options are chosen, both of which are correct:
- ***Partial Marks*** : ***+1*** If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
- ***Zero Marks*** : ***0*** If unanswered;
- ***Negative Marks: -2*** In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to the correct answer, then

Choosing ONLY (A), (B) and (D) will get +4 marks;
Choosing ONLY (A), will get +1 mark;
Choosing ONLY (B), will get +1 mark;
Choosing ONLY (D), will get +1 mark;
Choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
Choosing any other option(s) will get -2 marks.

49. A differentiable function $f : R \to R$ satisfies the functional equation

$f(x).f(y) + f(x+y) = e^x f(y) + e^y f(x) + xy \forall x, y \in R$. If $f'(0) = 0$ and $f(0) = 0$, then which of the following statements is/are correct?

A) $\lim_{x\to 0}\frac{f(x)}{x^2}=\frac{1}{2}$

B) $\int_{x}^{x^2}\left(f'(t)-f(t)\right)dt>0\,\forall |x|>1$

C) $F(x_2)>F(x_1)\forall x_2>x_1$, where $F(x)=f'(x)-f(x)$

D) There exists at least two horizontal tangents to the curve $y=f(x)$ in $(-1,1)$.

50. Which is / are CORRECT ?

A) Let the mean and variance of four numbers 3, 7, x and y $(x>y)$ be 5 and 10 respectively. Then the mean of four numbers $3+2x, 7+2y, x+y$ and $x-y$ is 10

B) Let in a series of 2n observations, half of them are equal to a and remaining half are equal to $-a$. Also by adding a constant b to each of these observations, the mean and standard deviation of new set becomes 5 and 20, respectively. Then the value of a^2+b^2 is equal to 425

C) Consider a set of 3n numbers having variance 4. In this set, the mean of first 2n numbers is 6 and the mean of the remaining n numbers is 3. A new set is constructed by adding 1 into each of first 2n numbers, and subtracting 1 from each of the remaining n numbers. If the variance of the new set is k, then 9k is equal to 68

D) Consider three observations a, b and c such that b = a + c. If the standard deviation of $a+2, b+2, c+2$ is d, then $b^2=3\left(a^2+c^2\right)-9d^2$

51. If $I=\sum_{k=1}^{100}\int_{k}^{k+1}\frac{k+1}{x(x+1)}dx$, then

A) $I>\log_e 101$ **B)** $I<\log_e 101$ **C)** $I<\frac{50}{51}$ **D)** $I>\frac{50}{51}$

52. The number of ordered triplets of sets (A, B, **C)** such that:

A) $A, B, C\subseteq\{1,2,3,.....,8\}$.

B) $|A\cap B|=|B\cap C|=|C\cap A|=2$.

C) $|A|=|B|=|C|=4$.

(Here, $|S|$ denotes the number of elements in the set S).

A) 45300 **B)** 45360 **C)** 42840 **D)** 5040

53. From the set of n number $\{1,3,5......,2n-1\}$ five consecutive numbers are removed and the mean of remaining numbers is $\frac{393}{5}$. Choose the **correct** option(s).

A) The value of n is 80.
B) The value of n is 75.
C) The mean of removed number is 101.
D) The mean of removed number is 99.

54. If the graphs of the functions y = lnx and y = ax intersect at exactly two points, then a must be lying in

A) (1, e) **B)** (1/e, 1) **C)** (0, 1/e) **D)** (0, 1/2)

SECTION 4

- This section contains **THREE (03)** question.
- The answer to each question is a **NON-NEGATIVE INTEGER.**
- For each question, enter the correct integer corresponding to the answer the using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
- ***Full Marks*** : ***+4*** If ONLY the correct integer is entered;
- ***Zero Marks*** : ***0*** In all other cases.

55. Let $A=[a_{ij}]$ be a real matrix of order 3×3, such that $a_{i1}+a_{i2}+a_{i3}=2$, for $i=1,2,3$. Then, the sum of all the entries of the matrix A^3 is equal to R then $\frac{R}{3}=$

56. The number of real solutions of the equation

$$\sin^{-1}\left(\sum_{i=1}^{\infty}x^{i+1}-x\sum_{i=1}^{\infty}\left(\frac{x}{2}\right)^i\right)=\frac{\pi}{2}-\cos^{-1}\left(\sum_{i=1}^{\infty}\left(-\frac{x}{2}\right)^i-\sum_{i=1}^{\infty}(-x)^i\right)$$

lying in the interval $(0,2)$ is _____.

(Here, the inverse trigonometric function $\sin^{-1}x$ and $\cos^{-1}x$ assume values in $\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$ and $[0,\pi]$, respectively.)

57. A, B, C, D are four points in the space and satisfy $|\overrightarrow{AB}|=3, |\overrightarrow{BC}|=7, |\overrightarrow{CD}|=11$ and $|\overrightarrow{DA}|=9$. Then $\overrightarrow{AC}.\overrightarrow{BD}$ has value __________

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec:Sr.Super60_NUCLEUS&ALL_BT'S JEE-ADVANCE-2021_P1 Date: 26-04-2023

Time: 09.00Am to 12.00Pm GTA-18 Max. Marks: 180

KEY SHEET

PHYSICS

1	**C**	2	**B**	3	**A**	4	**C**	5	**4**	6	**8**
7	**20**	8	**0.36**	9	**12**	10	**0**	11	**ABCD**	12	**ABCD**
13	**ABC**	14	**ACD**	15	**AD**	16	**AD**	17	**2**	18	**6**
19	**4**										

CHEMISTRY

20	**B**	21	**C**	22	**C**	23	**A**	24	**8**	25	**5**
26	**166**	27	**5**	28	**10**	29	**1**	30	**AD**	31	**D**
32	**ABCD**	33	**BD**	34	**ABCD**	35	**ABCD**	36	**4**	37	**5**
38	**3**										

MATHEMATICS

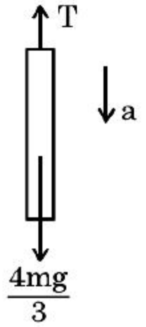
39	**A**	40	**D**	41	**D**	42	**A**	43	**4**	44	**6**
45	**33**	46	**5**	47	**2**	48	**1**	49	**ABC**	50	**BCD**
51	**BD**	52	**B**	53	**AC**	54	**CD**	55	**8**	56	**1**
57	**0**										

SOLUTIONS

PHYSICS

1. $a = \dfrac{2m - m}{3m} g = \dfrac{g}{3}$

Now apply Newton's 2nd law on lower 2/3rd part of rod.



We get $\dfrac{4mg}{3} - T = \dfrac{4m}{3} a = \dfrac{4m}{3} \times \dfrac{g}{3}$ $\quad T = \dfrac{4mg}{3} - \dfrac{4mg}{9}$ $\quad T = \dfrac{8mg}{9}$

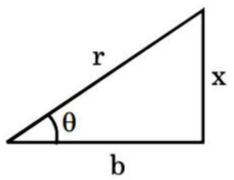
2. Net field will be normal to conductor.

3. $R_{AB} = \int_0^{\ell} \dfrac{\rho_0}{A}\left(1 - \dfrac{x}{\ell}\right) dx = \dfrac{\rho_0}{2A}\ell$ $\quad R_{BC} = \int_0^{\ell/3} \dfrac{\rho_0}{A}\left(1 - \dfrac{x}{\ell}\right) dx = \dfrac{5\rho_0 \ell}{18A}$

And $R_{AC} = \dfrac{\rho_0 \ell}{2A} - \dfrac{4\rho_0 \ell}{18A} = \dfrac{2}{9}\dfrac{\rho_0 \ell}{A}$

At null point ; $\dfrac{X}{R} = \dfrac{R_{AC}}{R_{CB}} = \dfrac{2}{9} \times \dfrac{18}{5} = \dfrac{4}{5}$ $\quad \therefore X = \dfrac{4R}{5}$

4.



$x = b\tan\theta$ $\quad v = \left(\dfrac{dx}{dt}\right) = b\sec^2\theta \left|\dfrac{d\theta}{dt}\right|$

5&6

$1 = \mu \sin\theta$ $\quad \sin\theta = \dfrac{1}{\sqrt{1 + y^{3/2}}}$

$\tan\theta = \dfrac{1}{y^{3/4}} = \dfrac{dx}{dy}$ $\quad \int y^{-3/4} dy = \int dx$ $\quad 4y^{1/4} = x$

7&8

1) $b^2 = 4mK$ $\quad R = 20\Omega$

2) $q = A - \dfrac{A \times 2}{\sqrt{3}} e^{-5000t}$

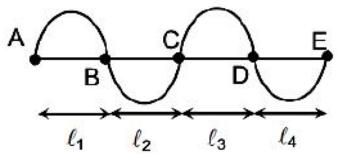
$\sin\left(5000\sqrt{3}t + \dfrac{\alpha}{3}\right)$ $\quad t = \dfrac{\pi}{\omega} = 0.36$ mS

9&10

Just put one more cuboid above PQRS.

11. $\ell_1 + \ell_2 + \ell_3 + \ell_4 = 100\ cm$

Let n_1, n_2, n_3 and n_4 are fundamental frequencies of these segments respectively.



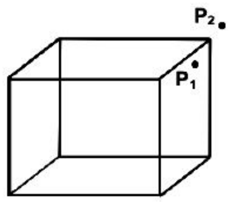
$$\frac{n_1}{n_2} = \frac{1}{2}, \frac{n_2}{n_3} = \frac{2}{3}, \frac{n_3}{n_4} = \frac{3}{4}, \frac{n_2}{n_4} = \frac{2}{4} = \frac{1}{2} \qquad n = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}} \Rightarrow n\ell = \text{constant}$$

$$n_1\ell_1 = n_2\ell_2 = n_3\ell_3 = n_4\ell_4 \qquad \ell_1 = \frac{n_2}{n_1}\ell_2, \ell_3 = \frac{n_2}{n_3}\ell_2, \ell_4 = \frac{n_2}{n_4}\ell_2$$

$$\ell_1 + \ell_2 + \ell_3 + \ell_4 = 100cm \qquad 2\ell_1 + \ell_2 + \frac{2}{3}\ell_2 + \frac{\ell_2}{2} = 100$$

$\ell_2 = 24cm$ So, $\ell_1 = 48$ cm $\quad \ell_3 = 16cm \quad \ell_4 = 12cm$

12. Using symmetry if charged particle lies at P_1 then $\phi_{OCDE} = \dfrac{q}{24\varepsilon_0}$



and $\phi_{OABC} = \dfrac{\left(\dfrac{q}{\varepsilon_0} - \dfrac{q}{8\varepsilon_0}\right)}{3} = \dfrac{7q}{24\varepsilon_0}$

If the charge particle lies at P_2 then $\phi_{OCDE} = \dfrac{q}{24\varepsilon_0}$ and $\phi_{OABC} = \dfrac{q}{24\varepsilon_0}$

13. AB$\rightarrow$U ρ = constant $\qquad nC_vT\dfrac{PM}{RT}$ = constant

P = constant $\qquad$ Isobaric process

BC$\rightarrow$ ρ = constant $\qquad \dfrac{PM}{RT}$ = constant $\qquad P \propto T$

Isochoric process CA$\rightarrow$U = constant $\qquad U = nC_vT$ = constant $\qquad$ T = constant

Isothermal process

14. Just after cutting the string B, block looses the contact with the rod.

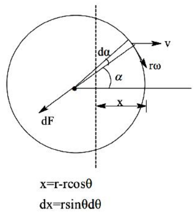
Taking torque about P. $\quad mg\dfrac{\ell}{4} = \left(\dfrac{m\ell^2}{12} + \dfrac{m\ell^2}{16}\right)\alpha$

$$\alpha = \frac{12}{7}\frac{g}{\ell}, a_{cm} = \frac{\ell}{4}\alpha = \frac{3}{7}g \qquad mg - T = ma_{cm} \qquad T = \frac{4}{7}mg$$

15. Work performed = $\displaystyle\int_R^{3R} \frac{1}{2}\varepsilon_0 E^2 dV + \int_{5R}^{7R} \frac{1}{2}\varepsilon_0 E^2 dV = \frac{kq^2}{3R} + \frac{kq^2}{35R}$

16. In both case (A) and (D) source and observer are relatively at rest. Thus there is no change in the frequency.

17. $mr^2\beta = \int_0^0 \frac{2q}{2\pi} d\alpha vBr\cos\alpha$



$$\beta = \frac{dw}{dt} = \frac{qUB\sin\theta}{\pi\ mr} \ \ldots\ldots\ldots..\ (1)$$

$$-ma = \int_0^0 2\frac{q}{2\pi} d\,\alpha\, rwB\cos\alpha \qquad a = \frac{dv}{dt} = \frac{qrwB\sin\theta}{\pi\ m} \ \ldots\ldots\ldots..\ (2)$$

$$= \frac{dw}{dv} = \frac{v}{r^2 w} \Rightarrow r^2\int_0^w wdw = -\int_{-v_0}^{v} vdv \qquad \Rightarrow v = \frac{v_0}{\sqrt{2}}$$

$$\frac{vdv}{dx} = \frac{qrwB\sin\theta}{\pi m} \qquad \int_{v_0}^{v_0/\sqrt{2}} \frac{vdv}{\sqrt{v_0^2 - v^2}} = \frac{qrB}{m\pi}\int_0^{\pi}\sin^2\theta d\theta \qquad \Rightarrow q = \frac{\sqrt{2}mv_0}{Br}$$

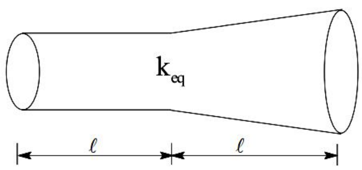
18. Consider the object as two portion 'A uniform rod' and 'A frustum' with thermal resistance R_1 and R_2 respectively then

$$R_1 = \frac{\ell_1}{k_1 A_1} = \frac{\ell}{k\pi r^2} \quad \text{And} \quad R_2 = \frac{\ell_2}{k_2 A_2} = \frac{\ell}{(2k)(\pi r_1 r_2)} = \frac{\ell}{4k\pi r^2}$$

$\therefore$ Equivalent thermal resistance $R_{eq} = R_1 + R_2$

$$\Rightarrow R_{eq} = \frac{5\ell}{4k\pi r^2} \ \ldots\ldots\ldots..\ (1)$$

Now if we consider the same lamina with equivalent thermal conductivity K_{eq}, then



$$R_{eq} = R_1 + R_2 = \frac{\ell}{k_{eq}\pi r^2} + \frac{\ell}{k_{eq}\left(2\pi r^2\right)} = \frac{3\ell}{2k_{eq}\pi r^2} \ \ldots\ldots\ldots..\ (2)$$

By equating the terms of R_{eq} from eqn. (1) & (2), we get

$$\frac{5\ell}{4k\pi r^2} = \frac{3\ell}{2k_{eq}\pi r^2}\ k_{eq} = \frac{6k}{5} \qquad \therefore N = 6$$

19. $t1 = RC; t2 = R/L$

$$\to LC = t1t2 = 0.1\sec -> T = 2\,pie\sqrt{\frac{1}{LC}},\ \frac{T}{5} = 4\sec$$

CHEMISTRY

20. Electron excites initially from n-3 state to n

21. Left ring is deactivated, EAS will take place on right side ring at para position w.r.t aromatic system.

22.

$$Ph-C\equiv C-\overset{+}{C}H-Ph \longleftrightarrow Ph-\overset{+}{C}=C=CH-Ph$$

$$\downarrow H_2O$$

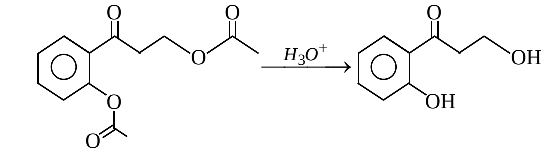
$$Ph-\overset{\overset{O}{\|}}{C}-CH=CH-Ph$$

23. Ferrate is very unstable and strong oxidizing agent.

24&25

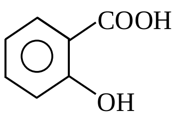
At equilibrium rate of forward reaction is same as rate of backward reaction.

26.



$C_{13}H_{14}O_5$

27.



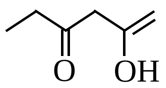
28&29

Acetic acid

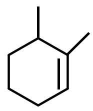
30. NCERT

31. Radius changes as charge is different.

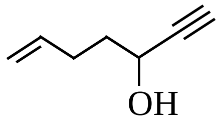
32.



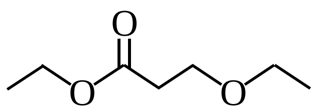
2-hydroxyhexen-4-one (wrong name)
5-hydroxyhex-5-en-3-one (correct name)



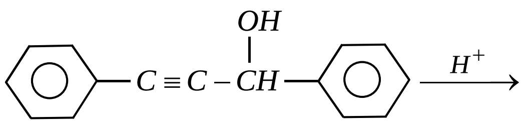
2,3-dimethylcyclohexene (wrong name)
1,6-dimethylcyclohexene (correct name)



hept-1-en-6-yn-5-ol (wrong name)
hept-6-en-1-yne-3-ol (correct name)



1,3-diethoxy propan-1-one (wrong name)
ethyl-3-ethoxy propanoate (correct name)



33. Glucose is a reducing sugar while sucrose (cane sugar) is non–reducing sugar.

34. All steps takes place

35. All statements explains the given difference.

36. q = TDS = 298 x 13.41=4 KJ

37. i, iii, vi, vii, ix

38. $S_4O_6^{-2}$

MATHEMATICS

39. $h(x)=\log\left(f(x).g(x)\right)=\log e^{\{y\}+[y]}=\{y\}+[y]=e^{|x|}\operatorname{sgn} x$

$$\therefore h(x)=e^{|x|}\operatorname{sgn} x=\begin{cases} e^{x} & , \quad x>0 \\ 0 & , \quad x=0 \\ -e^{x} & , \quad x<0 \end{cases}$$

$$\Rightarrow h(-x)=\begin{cases} e^{-x} & , \quad x<0 \\ 0 & , \quad x=0 \\ -e^{x} & , \quad x<0 \end{cases} \Rightarrow h(x)+h(-x)=0 \;\; for\ all\ x.$$

40. 9, 8, 6, 5, 4

(A and B) ……. + 9 + 8 + 6 + 5 + 4 = 32

$|(9+8)-(6+5+4)|=2$ not divisible by 11

$|(9+6)-(8+5+4)|=3$ not divisible by 11

$|(9+5)-(8+6+4)|=4$ not divisible by 11

$|(9+4)-(8+6+5)|=6$ not divisible by 11

$|(8+6)-(9+5+4)|=4$ not divisible by 11

$|(8+5)-(9+6+4)|=6$ not divisible by 11

$|(8+4)-(9+6+5)|=8$ not divisible by 11

$|(6+5)-(9+8+4)|=10$ not divisible by 11

$|(6+4)-(9+8+5)|=12$ not divisible by 11

$|(5+4)-(9+8+6)|=14$ not divisible by 11

(C) …….. $\underline{4}\ \underline{8}$

$\underline{5}\ \underline{6}$

$\underline{6}\ \underline{8}$

$\underline{8}\ \underline{4}$

$\underline{9}\ \underline{6}$

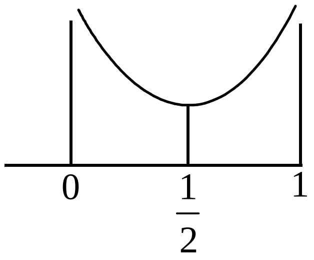
Probability $=\dfrac{6\times 3!}{5!}=\dfrac{6}{20}=\dfrac{3}{10}$

41. $\alpha=\left(\dfrac{1}{2}\right)^2+\left(\dfrac{1}{2}\right)^4+........=\dfrac{\left(\dfrac{1}{2}\right)^2}{1-\dfrac{1}{4}}=\dfrac{1}{3}$

$\therefore g(x)=2^{x/3}+2^{(1-x)/3}=2^{x/3}+\dfrac{2^{1/3}}{2^{x/3}},$

Where $g(0)=1+2^{1/3}$ and $g(1)=1+2^{1/3}$

By A.M.–G.M. inequality, we have $g(x) \geq 2\sqrt{2^{1/3}}$ and its minimum value is attained, when $g'(x) = 0 \quad \Rightarrow x = \frac{1}{2}$



The graph of $g'(x)$ is as shown here. And $g\left(\frac{1}{2}\right) = 2^{7/6}$

42. Let $L = \lim\limits_{x\to 0}\left(\int\limits_0^1 (by + a(1-y))^x\, dy\right)^{\frac{1}{x}}$

Let $I = \int_0^1 (by + a(1-y))^x\, dy$

Let $by + a(1-y) = t, (b-a)dy = dt$

$$\Rightarrow I = \int \frac{t^x}{(b-a)} dt = \frac{t^{x+1}}{(x+1)(b-a)}$$

$$I = \left[\frac{(by + a(1-y))^{x+1}}{(x+1)(b-a)}\right] \text{[Computer at } y = 1 \text{ and } y = 0\text{]}$$

$$I = \frac{b^{x+1} - a^{x+1}}{(x+1)(b-a)} \quad \Rightarrow L = \lim_{x\to 0}\left(\frac{b^{x+1} - a^{x+1}}{(x+1)(b-a)}\right)^{\frac{1}{x}}$$

$$ln(L) = \lim_{x\to 0} \frac{ln\left(\frac{\left(b^{x+1} - a^{x+1}\right)}{(x+1)(b-a)}\right)}{x}$$

As x approaches 0, denominator and numerator approaches 0.
Hence, we can use L–hospital's rule.

$$ln(L) = \lim_{x\to 0}\left(\frac{b^{x+1} ln(b) - a^{x+1} ln(a)}{(x+1)(b-a)} - \frac{1}{x+1}\right)$$

$$ln(L) = \frac{1}{b-a} ln\frac{b^b}{a^a} - 1 \Rightarrow L = \frac{1}{e}\left(\frac{b^b}{a^a}\right)^{\frac{1}{(b-a)}}$$

<u>43&44</u>

$$f(x+2y) = f(x) + f(2y) + e^{x+2y}(x+2y) - xe^x - 2y\,e^{2y} + 4xy$$

Replace $x, y = 0 \Rightarrow f(0) = 0$

Put 2y = –x we have $f(0) = f(x) + f(-x) - xe^{x} + xe^{-x} - 2x^2$

$\Rightarrow -f(x) = f(-x) - xe^{x} + xe^{-x} - 2x^2$. Now, $f'(x) = \lim\limits_{h \to 0} \dfrac{f(x+h) - f(x)}{h}$

$= \lim\limits_{h \to 0} \dfrac{f(x+h) + f(-x) - xe^{x} + xe^{-x} - 2x^2}{h}$

$= \lim\limits_{h \to 0} \dfrac{f(h) - e^{h}h + (x+h)e^{x+h} - xe^{-x} + 2(x+h) - xe^{x} + xe^{-x} - 2x^2}{h}$

$\lim\limits_{h \to 0} \dfrac{f(h) - e^{h}h + xe^{x}e^{h} + 2hx - xe^{x}}{h} = \lim\limits_{h \to 0} \dfrac{(f(h) - f(0)) - e^{h}h(e^{x} - 1) + xe^{x}(e^{h} - 1) + 2hx}{h}$

$\Rightarrow f(x) = x^2 + xe^{x} \Rightarrow f(2) = 4 + 2e^2$

45. L_1 is $x + 2y = 3 + z, 3x - y = 1 - 2z$ …….. (i)

L_2 is $2x - 2y = 2 - 3z, x - y = -1 - z$ …….. (ii)

$(ii) \Rightarrow 2 - 3z = -2 - 2z \Rightarrow z = 4$

$x + 2y = 7, 2x - 2y = -10 \Rightarrow x = -1, y = 4, z = 4$

The distance of the point $(-1, 4, 4)$ from the origin is

$\sqrt{1 + 16 + 16} = \sqrt{33}$

46. The plane through L_1 is

$x + 2y - z - 3 + \lambda(3x - y + 2z - 1) = 0$ …….. (i)

The plane through L_2 is

$2x - 2y + 3z - 2 + \mu(x - y + z + 1) = 0$ …….. (ii)

(i) and (ii) are same if $\dfrac{1 + 3\lambda}{2 + \mu} = \dfrac{2 - \lambda}{-(2 + \mu)}$

$\Rightarrow 1 + 3\lambda = \lambda - 2 \Rightarrow \lambda = \dfrac{-3}{2}$

Now (i) gives $7x - 7y + 8z + 3 = 0$

The distance of (0, 0, 0) from it is $\dfrac{3}{\sqrt{49 + 49 + 64}} = \dfrac{3}{\sqrt{162}} = \dfrac{1}{3\sqrt{2}}$

47. $\log_x 2 \log_{2x} 2 = \log_{4x} 2$

Here $x > 0$ and $x \neq 1, \dfrac{1}{2}, \dfrac{1}{4} \left\{ \because \log_a x = \dfrac{1}{\log_x a} \right\}$

$\Rightarrow \quad \dfrac{1}{\log_2 x} \cdot \dfrac{1}{\log_2 2x} = \dfrac{1}{\log_2 4x}$

$\Rightarrow \quad \log_2 x.(1 + \log_2 x) = 2 + \log_2 x$

Put $\log_2 x = t$

$\Rightarrow \quad t^2 = 2 \Rightarrow \quad t = \pm\sqrt{2}$

$\Rightarrow \quad \log_2 x = \pm\sqrt{2} \quad \Rightarrow \quad x = 2^{\pm\sqrt{2}}$

$\therefore \quad x = 2^{-\sqrt{2}}, 2^{\sqrt{2}}$

48. $x^2 - 1 > 0$

$2x^2 + 5x > 0, x \neq 1 \Rightarrow x < \frac{-5}{2}$ and $x > 1$

$x^3 + 6 = 2x^2 + 5x$

$x = 3$ and $x^2 + x - 2 = 0$

$x = -2, 1, 3$

49. $f(x).f(y) + f(x+y) = e^x f(y) + e^y (x) + xy$

$\therefore f(x).f'(y) + f'(x+y) = e^x f'(y) + e^y f(x) + x$

Put y = 0

$f(x).f'(0) + f'(x) = e^x f'(0) + f(x) + x$

$\Rightarrow f'(x) - f(x) = x \Rightarrow f(x) = e^x - x - 1$

$\therefore (A) \lim_{x\to 0} \frac{f(x)}{x^2} = \lim_{x\to 0} \frac{e^x - x - 1}{x^2} = \frac{1}{2}.$

$(B) \int_x^{x^2} t\,dt = \left(\frac{t^2}{2}\right)_x^{x^2} = \frac{x^4 - x^2}{2} > 0 \, \forall |x| > 1$

$(C) F(x) = f'(x) - f(x) = (e^x - 1) - (e^x - x - 1) = x$ which is increasing function so

$F(x_2) > F(x_1)$ if $x_2 > x_1$

(D) Now $f'(x) = e^x - 1$ and $f''(x) = e^x > 0 \, \forall x \in R$

$\therefore f'(x)$ is increasing function or R

$\because f'(-1) = -ve$ and $f'(1) = +ve$

$\therefore f'(c) = 0$ has exactly are root in (-1 ,1).

i.e., one horizontal tangent. In (-1,1)

50. A) $5 = \frac{3+7+x+y}{4} \Rightarrow x + y = 10$

Var(x) = $10 = \frac{3^2 + 7^2 + x^2 + y^2}{4} - 25$

$140 = 49 + 9 + x^2 + y^2$

$x^2 + y^2 = 82$

X + y = 10

$\Rightarrow (x, y) = (9, 1)$

Four numbers are 21, 9, 10, 8

$\text{Mean} = \frac{48}{4} = 12$

B) Let observations are denoted by x_i for $1 \le i < 2n$

$\bar{x} = \frac{\sum x_i}{2n} = \frac{(a+a+.........+a)-(a+a+..........+a)}{2n}$

$\Rightarrow \bar{x} = 0$

and $\sigma_x^2 = \frac{\sum x_i^2}{2n} - (\bar{x})^2 = \frac{a^2+a^2+.......+a^2}{2n} - 0 = a^2$

$\Rightarrow b = 5$

and $\sigma_y = \sigma_x$(No change in S.D.) $\Rightarrow$ a = 20

$\Rightarrow a^2 + b^2 = 425$

C) Let number be $a_1, a_2, a_3, ...a_{2n}, b_1, b_2, b_3........b_n$

$\sigma^2 = \frac{\sum a^2 + \sum b^2}{3n} - (5)^2$

$\Rightarrow \sum a^2 + \sum b^2 = 87n$

Now, distribution becomes

$a_1+1, a_2+1, a_3+1, ...a_{2n}+1, b_1-1,$

$b_2-1.............b_n-1$

Variance

$= \frac{\sum(a+1)^2 + \sum(b-1)^2}{3n} - \left(\frac{12n+2n+3n-n}{3n}\right)^2$

$= \frac{\left(\sum a^2 + 2n + 2\sum a\right) + \left(\sum b^2 + n - 2\sum b\right)}{3n}$

$= \frac{\left(\sum a^2 + 2n + 2\sum a\right) + \left(\sum b^2 + n - 2\sum b\right)}{3n} - \left(\frac{16}{3}\right)^2$

$= \frac{87n + 3n + 2(12n) - 2(3n)}{3n} - \left(\frac{16}{3}\right)^2 \quad \Rightarrow k = \frac{108}{3} - \left(\frac{16}{5}\right)^2$

$\Rightarrow 9k = 3(108) - (16)^2 = 324 - 256 = 68$

D) For a, b, c

$\text{mean} = \frac{a+b+c}{3} (= \bar{x})$

$b = a + c \qquad \Rightarrow \qquad \bar{x} = \frac{2b}{3} \qquad ....(1)$

S.D. (a + 2, b + 2, c + 2) = S. D. (a, b, c) = d

$\Rightarrow d^2 = \frac{a^2+b^2+c^2}{3} - (\bar{x})^2$

$$\Rightarrow \quad d^2 = \frac{a^2+b^2+c^2}{3} - \frac{4b^2}{9} \qquad \Rightarrow \quad 9d^2 = 3\left(a^2+b^2+c^2\right) - 4b^2$$

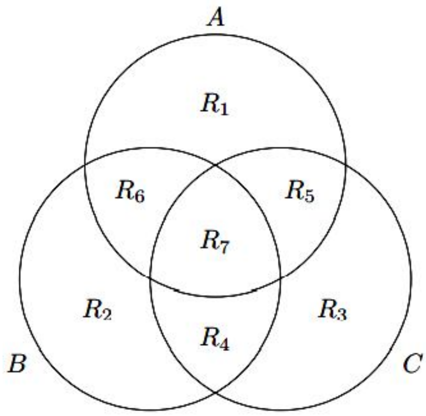
$$\Rightarrow \quad b^2 = 3\left(a^2+c^2\right) - 9d^2$$

51. $$\sum_{K=1}^{100}\int_k^{k+1}\frac{1}{x+1}dx < \sum_{k=1}^{100}\int_k^{k+1}\frac{k+1}{x(x+1)}dx < \sum_{k=1}^{100}\int_k^{k+1}\frac{dx}{x}$$

$$\sum_{k=1}^{100}\left(\ell n(k+2) - \ell n(k+1)\right) < I < \sum_{k=1}^{100}\left(\ell n(k+1) - \ell nk\right)$$

$$\ell n5 < I < \ell n101 \quad \Rightarrow \quad \frac{49}{50} < I < \ell n101$$

52.



Consider $N = |R_7| = |A \cap B \cap C|$

Case 1 : N = 2

$|R_4| + N = |R_5| + N = |R_6| + N = 2$

$|R_4| = |R_5| = |R_6| = 0$.

$|R_1| + |R_5| + |R_6| + N = 4$, so $|R_1| = 2$. Similarly, $|R_2| = |R_3| = 2$.

Number of ways = $\binom{8}{2}\binom{6}{2}\binom{4}{2}\binom{2}{2} = 2520$ ways

Case 2 : N = 1

$|R_4| + N = |R_5| + N = |R_6| + N = 2$

$|R_4| = |R_5| = |R_6| = 1$.

$|R_1| + |R_5| + |R_6| + N = 4$, so $|R_1| = 1$. Similarly, $|R_2| = |R_3| = 1$.

Number of ways = $\binom{8}{1}\binom{7}{1}\binom{6}{1}..........\binom{2}{1} = 40320$ ways

Case 3 : N = 0

$|R_4| + N = |R_5| + N = |R_6| + N = 2$,

$|R_4| = |R_5| = |R_6| = 2$.

$|R_1| + |R_5| + |R_6| + N = 4$,

$|R_1| = 0$. Similarly, $|R_2| = |R_3| = 0$.

Number of ways = $\binom{8}{2}\binom{6}{2}\binom{4}{2} = 2520$.

Total number of ways = 2520 + 40320 + 2520 = 45360

53. $n^2 - 5(2n-5) \le \frac{393(n-5)}{5} \le n^2 - 25$

$\Rightarrow 73.6 \le n \le 83.6, n = 80$ is only possible value

54. Given curves are y = lnx and y = ax

$\Rightarrow \quad \ln x = ax$ has exactly two solutions.

$\Rightarrow \frac{\ln x}{x} = a$ has exactly two solutions.

Let $y = \frac{\ln x}{x}, x > 0, \frac{dy}{dx} = \frac{x.\frac{1}{x} - \ln x}{x^2} = \frac{1-\ln x}{x^2}$

y is increasing if 1 – ln x > 0, ln x < 1, 0 < x < e, range of y is $\left(-\infty, \frac{1}{e}\right]$. Thus, for exactly two solutions of $\frac{\ln x}{x} = a, a \in \left(0, \frac{1}{e}\right)$.

55. $A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$

Let $x = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$

$AX = \begin{bmatrix} a_{11}+a_{12}+a_{13} \\ a_{21}+a_{22}+a_{23} \\ a_{31}+a_{32}+a_{33} \end{bmatrix} = \begin{bmatrix} 2 \\ 2 \\ 2 \end{bmatrix} \quad \Rightarrow \quad AX = 2X$

$A^2X = 2AX = 2(2X) = 4X$

$A^3X = 4AY = 8X$

Let $A^3 = \begin{bmatrix} x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \\ z_1 & z_2 & z_3 \end{bmatrix}$

$A^3\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} x_1+x_2+x_3 \\ y_1+y_2+y_3 \\ z_1+z_2+z_3 \end{bmatrix} = \begin{bmatrix} 8 \\ 8 \\ 8 \end{bmatrix}$

Sum of all the element = 24

56. $\sin^{-1}\left(\frac{x^2}{1-x} - \frac{x\left(\frac{x}{2}\right)}{1-\frac{x}{2}}\right) = \frac{\pi}{2} - \cos^{-1}\left(\frac{-x/2}{1+\frac{x}{2}} - \frac{(-x)}{1+x}\right)$

$$\Rightarrow \quad \sin^{-1}\left(x^2\left(\frac{1}{1-x}-\frac{1}{2-x}\right)\right)=\frac{\pi}{2}-\cos^{-1}\left(x\left(\frac{1}{1+x}-\frac{1}{2+x}\right)\right)$$

$$\sin^{-1}\left[\frac{x^2}{(1-x)(2-x)}\right]=\frac{\pi}{2}-\cos^{-1}\left[\frac{x}{(1+x)(2+x)}\right]=\sin^{-1}\left[\frac{x}{(1+x)(2+x)}\right]$$

$$\Rightarrow \quad x\left[\frac{x}{(1-x)(2-x)}-\frac{1}{(1+x)(2+x)}\right]=0$$

$x=0$ or $x^3+3x^2+2x=x^2-3x+2$

$\Rightarrow x^3+2x^2+5x-2=0$

increasing function $\forall x$

$f(0)=-2,\ f(2)>0$

$\Rightarrow$ one root between $\left(0,\frac{1}{2}\right)$

$\Rightarrow$ total number of solutions = 1

57. $\left|\overrightarrow{AB}\right|^2+\left|\overrightarrow{CD}\right|^2=3^2+11^2=7^2+9^2=\left|\overrightarrow{BC}\right|^2+\left|\overrightarrow{DA}\right|^2$

$\overrightarrow{AB}+\overrightarrow{BC}+\overrightarrow{CD}+\overrightarrow{DA}=\vec{0}$

$\overrightarrow{AB}+\overrightarrow{CD}=\left(\overrightarrow{BC}+\overrightarrow{DA}\right)$

$\left|\overrightarrow{AB}\right|^2+\left|\overrightarrow{CD}\right|^2+2\overrightarrow{AB}.\overrightarrow{CD}=|BC|^2+|DA|^2+2\overrightarrow{BC}.\overrightarrow{DA}$

$\overrightarrow{AB}.\overrightarrow{CD}=\overrightarrow{BC}.\overrightarrow{DA}$

$\left(\overrightarrow{OB}-\overrightarrow{OA}\right).\left(\overrightarrow{OD}-\overrightarrow{OC}\right)=\left(\overrightarrow{OC}-\overrightarrow{OB}\right).\left(\overrightarrow{OA}-\overrightarrow{OD}\right)$

$\overrightarrow{OB}.\overrightarrow{OD}-\overrightarrow{OB}.\overrightarrow{OC}-\overrightarrow{OA}.\overrightarrow{OD}+\overrightarrow{OA}.\overrightarrow{OC}=$

$\overrightarrow{OC}.\overrightarrow{OA}-\overrightarrow{OC}.\overrightarrow{OD}-\overrightarrow{OB}.\overrightarrow{OA}+\overrightarrow{OB}.\overrightarrow{OD}$

$\Rightarrow \quad \overrightarrow{OB}.\left(\overrightarrow{OA}-\overrightarrow{OC}\right)+\overrightarrow{OD}\left(\overrightarrow{OC}-\overrightarrow{OD}\right)=0$

$\Rightarrow \quad \left(\overrightarrow{OC}-\overrightarrow{OA}\right).\left(\overrightarrow{OD}-\overrightarrow{OB}\right)=0$

$\Rightarrow \quad \overrightarrow{AC}=\overrightarrow{BD}=0$