Corporate Office: Aakash Tower, 8, Pusa Road, New Delhi-110005, Ph.011-47623456

Time : 3 hrs. **MM : 180**

MOCK TEST

for JEE (Advanced)-2023

Paper - I

Pattern of the questions are as under:

(i) The question paper consists of 3 parts **(Physics, Chemistry and Mathematics)**. Each part has **3 sections**.

(ii) **Section-1:** This section contains **8** questions. The answer to each of the questions is a **NUMERICAL VALUE**. If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places. Each question carries **+3 marks** for correct answer and there is **No negative** marking.

(iii) **Section-2:** This section contains **6** Multiple choice questions which have **ONE OR MORE THAN ONE** correct answer(s). Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer. **+3** If all the four options are correct but **ONLY** three options are chosen. **+2** If three or more options are correct but **ONLY** two options are chosen, both of which are correct. **+1** If two or more options are correct but **ONLY** one option is chosen and it is a correct option.

(iv) **Section-3:** This section contains **4** multiple choice questions. Each question has two matching lists: (**List - I** and **List - II**). In general, 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. Each question carries **+3 marks** for correct answer and **–1 mark** for **wrong answer.**

PART – I : PHYSICS

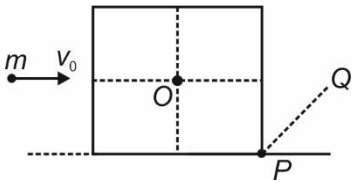
SECTION - 1

Numerical Value Type

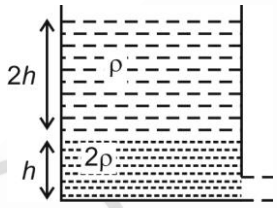
This section contains 8 questions. The answer to each question is a **NUMERICAL VALUE**. If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

1. A superconducting wire shaped in a ring of radius R originally carries no current. A magnet is moved along the axis of the ring, and the flux through the ring changes by $\Delta\phi_B$. If a (<< R) is the radius of wire, n is the density of conducting electrons and e, m_e is the charge and mass of electron then, current in the ring is $\frac{ne^2a^2}{xm_eR}\Delta\phi_B$. Find the value of x.

2. A non-uniform cube of mass M = 4 kg with center of mass at 'O' is being hit by a horizontal moving mass $m = \frac{1}{2}$ kg. Speed of mass m just before striking was v_0 and it hits the cube at central line as shown in figure. Mass m stops just after hitting the cube, and cube does not slip on the rough horizontal surface. Then the minimum speed v_0 (in m/s) so that the cube may topple over the edge PQ is _____. [Side of the cube is 1 m and moment of inertia of cube about edge PQ is $I_0 = \frac{5}{8}(\sqrt{2}+1)$ kg m^2, $g = 10$ m/s^2]

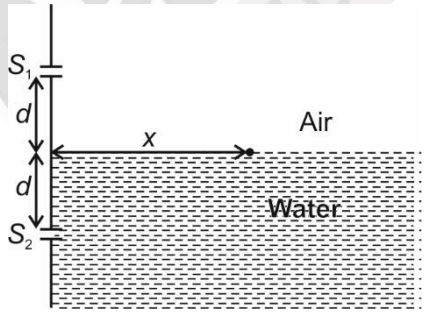


3. A tank of area A is filled with two immiscible liquids of density 2ρ and ρ with height h and $2h$ respectively as shown in figure. If a small orifice of area a is made near bottom, the total time required to empty the tank is $\frac{xA}{a}\sqrt{\frac{h}{g}}\left(2-\frac{1}{\sqrt{2}}\right)$. Find the value of x.



4. In Bohr's hydrogen, an electron makes a transition from energy state n = 6 to n = 4 and consequently it emits a photon of frequency f. Now let f_4 be the frequency of circular motion of electron around the nucleus in n = 4th energy state. The ratio of $\frac{f_4}{f} = k$, then find the value of 10k.

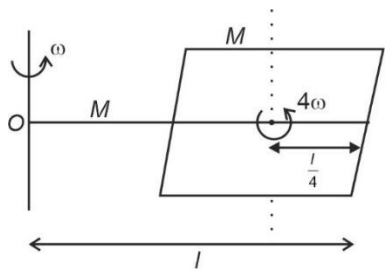
5. A Young's double slit interference arrangement with slits S_1 and S_2 is immersed in water (refractive index = $\frac{4}{3}$) as shown in the figure. The positions of maxima on the surface of water are given by $x^2 = p^2m^2\lambda^2 - d^2$, where λ is the wavelength of light in air (refractive index = 1), $2d$ is the separation between the slits and m is an integer. The value of p is



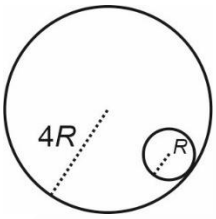
6. The isotope of Boron $^{12}_{5}B$ having mass 12.014 u undergoes β-decay to $^{12}_{6}C$. $^{12}_{6}C$ has an excited state of the nucleus $\left(^{12}_{6}C^*\right)$ at 4.041 MeV above its ground state. If $^{12}_{5}B$ decays to $^{12}_{6}C$, find the Q-value of this β-decay process in units of MeV. (1 u = 931.5 MeV/c^2, where c is the speed of light in vacuum)

7. A thin rod of mass M and length l is free to rotate in horizontal plane about a fixed vertical axis passing through point O. A thin square plate of mass M and side length $\frac{l}{2}$ is pivoted on this rod with its center at a distance $\frac{l}{4}$ from the free end of rod so that it can rotate freely about its vertical axis posing through its centre, as shown in figure. Assume that both the rod and the square plate have uniform density and they remain horizontal during the motion. An outside stationary observer finds the rod rotating with an angular velocity ω and the square plate rotating about its vertical axis with angular velocity 4ω (in same sense).

The total angular momentum of the system about the point O is $\frac{n}{16}Ml^2\omega$. The value of n is _____.



8. A solid sphere of radius R rolls without slipping in a fixed cylindrical tube of radius $4R$. If the time period of small oscillations of the sphere is $2\pi\sqrt{\frac{21R}{xg}}$, find x.

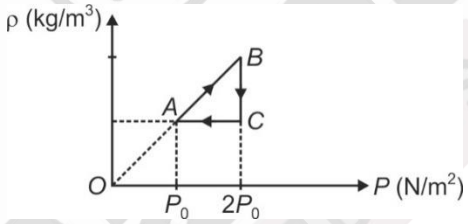


SECTION - 2

One or More Options Correct Type

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONE OR MORE** is/are correct.

9. Consider a thermodynamic cycle as shown in which one mole of a diatomic ideal gas is taken through process $ABCA$. If temperature of gas at A is T_0, then



(A) Molar heat capacity for the process CA is $\frac{5R}{2}$

(B) Molar heat capacity for the process CA is $\frac{3R}{2}$

(C) Work done by the gas during cyclic process $ABCA$ is $RT_0(1 - \ln 2)$

(D) Work done by the gas during cyclic process $ABCA$ is $RT_0(1 + \ln 2)$

10. A projectile is projected from the ground at $t = 0$, with initial speed u at angle θ with horizontal. Then

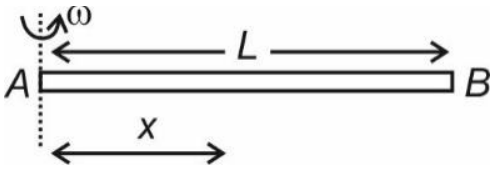
(A) If at a time instant t velocity of projectile is perpendicular to its initial direction of projection, then angle of projection $\theta > \frac{\pi}{4}$

(B) If at a time instant t velocity of projectile is perpendicular to its initial direction of projection, then angle of projection $\theta < \frac{\pi}{4}$

(C) If at a time instant t velocity of projectile is perpendicular to its initial direction of projection, then $t = \frac{u}{g\sin\theta}$

(D) The angle between velocity vectors at instant 1 s before reaching maximum height and 1 s after reaching maximum height is, $\Delta\theta = 2\tan^{-1}\left(\frac{g}{u\cos\theta}\right)$

11. A non-conducting rod of length 'L' with linear charge density $\lambda = \lambda_0 x$ where x is distance from end A is rotating with constant angular speed ω about the same end. Then



(A) Magnetic dipole moment of the system is $\frac{\omega\lambda_0 L^4}{8}$

(B) Magnetic dipole moment of the system is $\frac{3\omega\lambda_0 L^4}{4}$

(C) Magnetic induction (field) at A is $\frac{3\mu_0\omega\lambda_0 L}{4\pi}$

(D) Magnetic induction (field) at A is $\frac{\mu_0\omega\lambda_0 L}{4\pi}$

12. The equation of transverse displacement of a string clamped at both ends is $Y = 0.06\sin\left(\frac{2\pi X}{3}\right)\cos(120\pi t)$, where X, Y are in meters and t is in second. The length of the string is 1.5 m and its mass is 3×10^{-2} kg. Then $\left(\sqrt{2} = 1.4\right)$

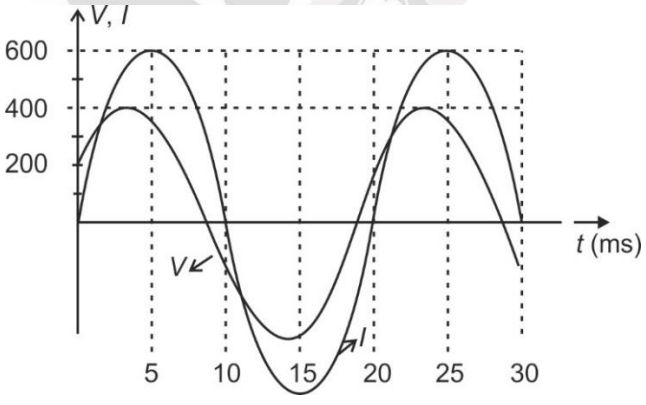
(A) Tension in the string is 648 N

(B) Amplitude of particle at X = 0.375 m is 4.2 cm

(C) X = 1.5 m is the position of node

(D) X = 1.5 m is the position of antinode

13. The graph below shows variation of source voltage V (in volts) and steady state current I (in milliampere) with time t (in millisecond) drawn by a series LCR circuit. If L is the inductance, C is the capacitance and ω is the source angular frequency, then which of the following statement(s) is/are correct?



(A) For circuit, $\frac{1}{\omega C} < \omega L$

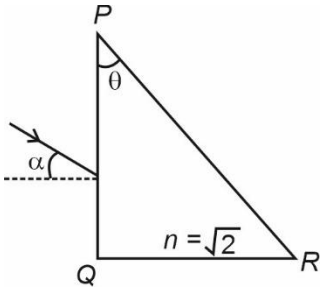
(B) Reactance of the circuit is $\frac{2000}{3}\Omega$

(C) Average power dissipation in the circuit is $60\sqrt{3}$ watt

(D) Power factor of the circuit is $\frac{1}{2}$

14. A parallel beam of light is incident (near point *P*) from air at angle α on the side *PQ* of a right angled triangular prism of refractive index $n = \sqrt{2}$. The angle of prism $\theta = 15°$. Choose the correct option(s).

$\left(\text{Take, } \sin^{-1}\left(\frac{\sqrt{3}}{2\sqrt{2}}\right) = 37.7° \text{ and } \sin^{-1}\left(\frac{1}{2\sqrt{2}}\right) = 20.7°\right)$



(A) The beam will come out of face *PR* if $\alpha = 60°$

(B) The beam will come out of face *PR* if $\alpha = 30°$

(C) At $\alpha = 45°$, the beam undergoes a deflection of 30° in clockwise sense before reaching *QR*

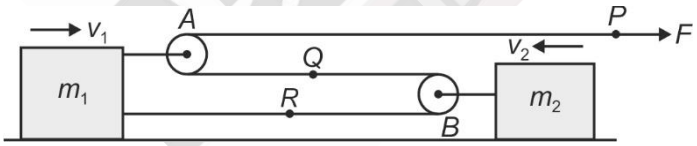
(D) Minimum value of α for TIR to take place at *PR* is 60°

SECTION - 3

Matching List Type

This section contains 4 multiple choice questions. Each question has two matching lists : (List-I and List-II). In general, 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.

15. In the figure shown below, at any instant, velocities of two different masses are given. Pulleys *A* and *B* are identical and can move freely. Velocity of mass m_1 is $v_1 = 3$ m/s and velocity of mass m_2 is $v_2 = 2$ m/s as shown.



List-I represents the speed of points mentioned and speed of pulleys and List-II contains the numericals in SI units. Mark the correct matching.

List-I	**List-II**
(I) Speed of point *P* of the string is	(P) 4
(II) Speed of point *Q* of the string is	(Q) 2
(III) Speed of point *R* is	(R) 7
(IV) Speed of pulley *B* is	(S) 3
	(T) 13

(A) I $\rightarrow$ T; II $\rightarrow$ R; III $\rightarrow$ S; IV $\rightarrow$ P

(B) I $\rightarrow$ T; II $\rightarrow$ R; III $\rightarrow$ S; IV $\rightarrow$ Q

(C) I $\rightarrow$ T; II $\rightarrow$ S; III $\rightarrow$ R; IV $\rightarrow$ P

(D) I $\rightarrow$ T; II $\rightarrow$ S; III $\rightarrow$ R; IV $\rightarrow$ Q

16. List-I contains the value of electric flux due to charge distribution and the situations are indicated in List-II. Match the entries of List-I with those of List-II.

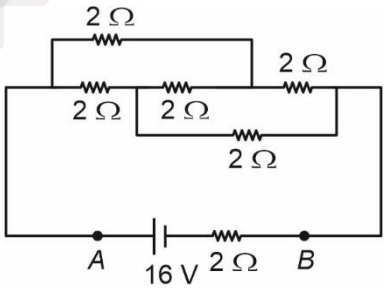
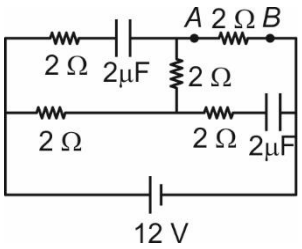
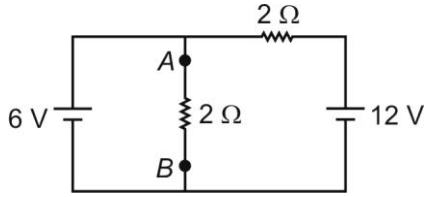
List-I	**List-II**
(I) $\frac{Q}{6\varepsilon_0}$	(P) Charge Q is just inside a cube along body diagonal. The flux through a face containing corner nearest to charge, is
(II) $\frac{7Q}{24\varepsilon_0}$	(Q) Charge Q is just inside a cube along body diagonal. The flux through a face containing farthest corner from charge, is
(III) $\frac{Q}{4\varepsilon_0}$	(R) Charge Q is at centre of a cube and flux through any one face
(IV) $\frac{Q}{24\varepsilon_0}$	(S) Charge Q is at (0, 0, a) and flux through infinite stripe in xy plane between $-a \le y \le a$
	(T) Charge Q is at centre of a regular tetrahedron and flux through any one face

The correct match is

(A) I $\rightarrow$ R; II $\rightarrow$ P; III $\rightarrow$ S, T; IV $\rightarrow$ Q (B) I $\rightarrow$ R; II $\rightarrow$ S, T; III $\rightarrow$ P; IV $\rightarrow$ P

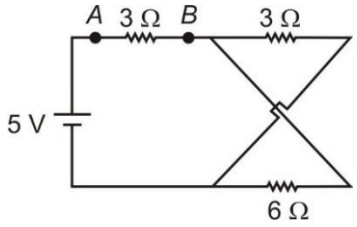
(C) I $\rightarrow$ R; II $\rightarrow$ P; III $\rightarrow$ P; IV $\rightarrow$ S, T (D) I $\rightarrow$ P; II $\rightarrow$ Q; III $\rightarrow$ R; IV $\rightarrow$ T

17. List-I contains the current through the branch AB of the circuit (in steady state) shown in List-II. Match the entries of List-I to that of List-II.

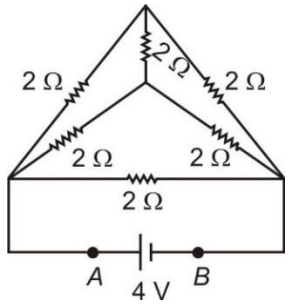
List-I	**List-II**
(I) 3 A	(P) 
(II) 4 A	(Q) 
(III) 2 A	(R) 

(IV) 1 A

(S)



(T)



The correct match is

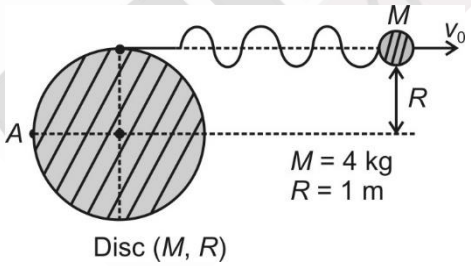
(A) I → R; II → P, T; III → Q, T; IV → S

(B) I → P; II → R; III → Q; IV → S, T

(C) I → R; II → P, T; III → S; IV → Q, T

(D) I → P; II → R; III → Q, T; IV → S

18. An ideal inextensible string is wrapped over a uniform circular disc (mass M = 4 kg, radius R = 1 m). The other end of the string is attached to a particle of same mass M. The complete arrangement is placed on a smooth horizontal surface. The particle is projected with velocity v_0 = 4 m/s along the tangent of disc as shown. If v, v_{cm}, ω, J denote velocity of particle, velocity of centre of mass of disc, angular velocity of disc and impulse on disc just after string becomes taut then choose the correct option (all values are in S.I. units in List-II)



List-I	**List-II**
(I) v	(P) 1
(II) v_{cm}	(Q) 2
(III) ω	(R) 3
(IV) J	(S) 4
	(T) 5

The correct match is

(A) I → R; II → P; III → Q; IV → T

(B) I → Q; II → P; III → T; IV → R

(C) I → R; II → Q; III → P; IV → S

(D) I → R; II → P; III → Q; IV → S

PART – II : CHEMISTRY

Section - 1

Numerical Value Type

This section contains 8 questions. The answer to each question is a **NUMERICAL VALUE**. If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

19. A sample of water has a hardness expressed as 100 ppm of $CaCO_3$. This sample is passed through ion exchange column and Ca^{2+} is replaced by H^+. The concentration of H^+ in water after treatment is 2×10^{-Y} M. The value of Y is

20. If an equimolar mixture of the two radioactive substances (having decay constant 5.303 hr^{-1} and 3 hr^{-1} respectively) decay simultaneously. Then ratio of nuclides (2^{nd} with respect to 1^{st}) at the end of 2 hr is 10×P. The value of P is [Given, lnA = 2.303 $\log_{10}$A]

21. In ABAB type packing, an axis is passing through the centre of atom of layer A. This axis is perpendicular to the layers A and B. If this axis passes through Y number of octahedral void(s), the value of 3Y is

22. Consider the first order gaseous phase decomposition reaction

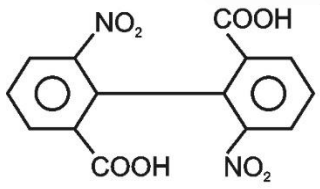
    $4A(g) \rightarrow B(g) + 2C(g)$

    At t = 0, the pressure inside a container with only A present was 1600 torr and after 10 minutes, the pressure reduced to 1300 torr. What would be the partial pressure of A in torr at 25 minutes from start of the reaction?

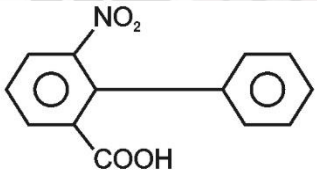
23. In the cyanide extraction process of silver from argentite ore, the number of electrons gained by one molecule of oxidising agent (other than silver) is x then the value of $4x^2$ is

24. White phosphorus reacts with thionyl chloride and form compounds A, B and C. Chlorine is present in compounds A and B while sulphur is present in compounds B and C. If percentage by mass of sulphur is more in C than B, the total number of lone pair of electrons in one molecule of 'A' is

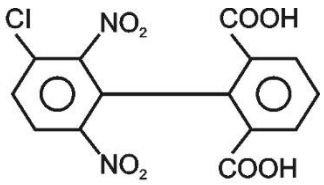
25. In the following compounds, the number of optically active compound(s) is x and that are inactive is y. The value of (x)(y) is



(I)



(II)



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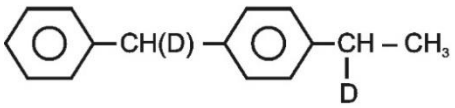

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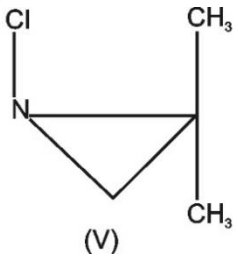

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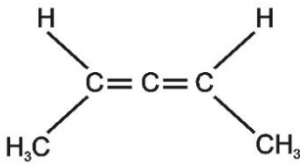

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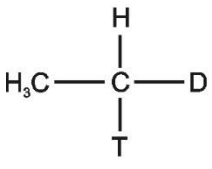

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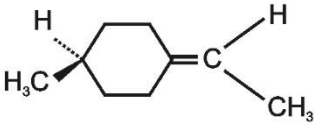

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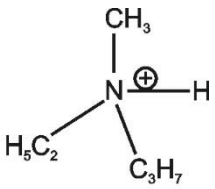

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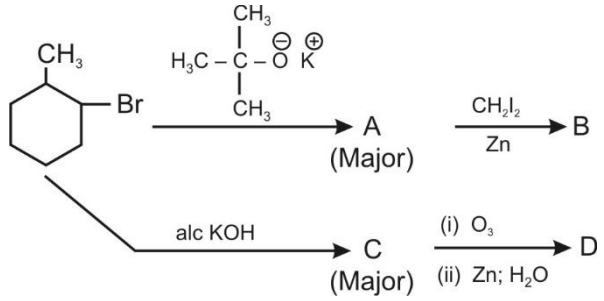
26.



Degree of unsaturation of B and D are x and y respectively then x + y is equal to

SECTION - 2

One or More Options Correct Type

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONE OR MORE** is/are correct.

27. Sodium carbonate is generally prepared by Solvay process. Select the correct statement(s) about the Solvay process.

(A) K_2CO_3 cannot be prepared by this process

(B) In this process, $Ca(OH)_2$ produce $NH_3(g)$ on reaction with NH_4Cl

(C) K_2CO_3 can be prepared by this process

(D) Sodium hydrogen carbonate on heating produce Na_2CO_3, O_2 and H_2O

28. Which of the following order is/are correct for solubility in water?

(A) $BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3$

(B) $Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

(C) $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4$

(D) $BeSO_4 < MgSO_4 < CaSO_4 > SrSO_4$

29. Consider the 3c - $2e^-$ bonding in following options and choose the correct option(s).

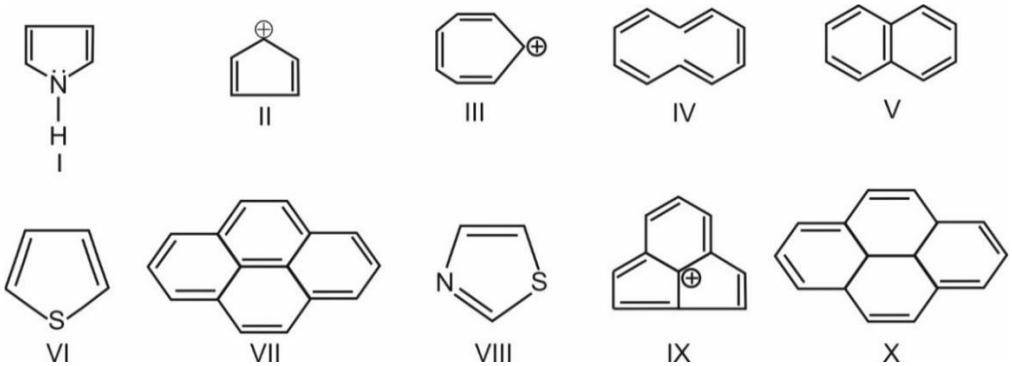
(A) All the bonds are 3c - $2e^-$ in polymer of BeH_2 (except at the extreme end), with sp^3 hybridized Be atoms.

(B) In dimer of BeH_2 and BH_3, two 3c - $2e^-$ bonds are present and hybridization of central atom is sp^2 for both compounds.

(C) In the dimer of BH_3, all bond lengths are not identical.

(D) The polymer of $BeCl_2$ contains both 3c - $4e^-$ bonds and 3c - $2e^-$ bonds

30. Consider the following molecules



The correct option(s) is/are

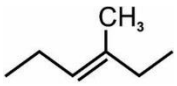
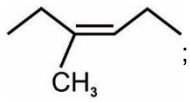
(A) Total 6 molecules are aromatic in nature, having electron in bonding molecular orbital only

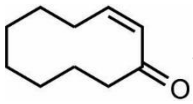
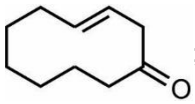
(B) Molecules VII and IX are aromatic in nature

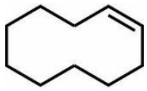
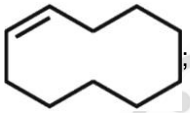
(C) Compound IV is non-aromatic in nature

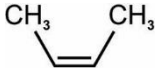
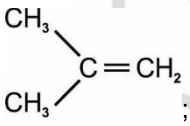
(D) Compound II is anti-aromatic in nature

31. From the following given pair of compounds given along with their relationship, select the correct options.

(A)  and  ; Geometrical isomers

(B)  and  ; Constitutional isomers

(C)  and  ;Identical

(D)  and  ; Constitutional isomers

32. Consider the following electrochemical cells

	E_{cell}
Cell I : Pt $\|H_2$(1 atm)$\|$HA(0.1 M)$\|\|Ag^+$(0.1 M)$\|$Ag	E_1
Cell II : Pt $\|H_2$(1 atm)$\|$HB(0.1 M)$\|\|Ag^+$(0.1 M)$\|$Ag	E_2
Cell III : Pt $\|H_2$(1 atm)$\|$HC(0.1 M)$\|\|Ag^+$(0.1 M)$\|$Ag	E_3
Cell IV : Pt $\|H_2$(1 atm)$\|$HD(0.1 M)$\|\|Ag^+$(0.1 M)$\|$Ag	E_4

HA, HB, HC and HD are all weak acids and cell potentials are in order $E_1 > E_2 > E_3 > E_4$. Select the correct statement(s) if molality $\simeq$ molarity of weak acids.

(A) Dissociation constant of HD is more than that of HA

(B) If 0.1 M aq. solution of HA, HB, HC and HD are taken then, freezing point of aq. HA solution is greatest

(C) Order of dissociation constant is HA > HC > HB > HD

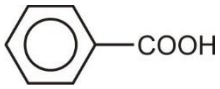
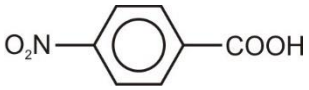
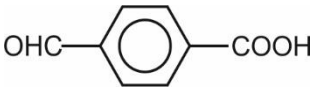
(D) If 0.1 M aq. solution of HA, HB, HC and HD are taken in separate containers at 27°C then osmotic pressure of HD solution is highest

SECTION - 3

Matching List Type

This section contains 4 multiple choice questions. Each question has two matching lists : (List-I and List-II). In general, 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.

33. Match the following.

List-I (Acid)	**List-II (K_a value at 25°C)**
(I) 	(P) 3.3×10^{-5}
(II) 	(Q) 10.2×10^{-5}
(III) 	(R) 30.6×10^{-5}
(IV) 	(S) 6.4×10^{-5}
	(T) K_a value is more than that of acetic acid

The correct match is

(A) I $\rightarrow$ R, T; II $\rightarrow$ S, T; III $\rightarrow$ Q, T; IV $\rightarrow$ P, T

(B) I $\rightarrow$ S, T; II $\rightarrow$ R, T; III $\rightarrow$ Q, T; IV $\rightarrow$ P

(C) I $\rightarrow$ Q; II $\rightarrow$ S; III $\rightarrow$ P; IV $\rightarrow$ R

(D) I $\rightarrow$ P; II $\rightarrow$ Q; III $\rightarrow$ R; IV $\rightarrow$ S, T

34. Match the following:

List-I (Complex)	**List-II (Geometry and Magnetic behaviour)**
(I) $[Ni(CN)_4]^{2-}$	(P) Octahedral (inner)
(II) $[MnF_6]^{4-}$	(Q) Paramagnetic
(III) $[Fe(CN)_6]^{3-}$	(R) Square planar
(IV) $\left[Cr(NH_3)_6\right]^{3+}$	(S) Octahedral (outer)
	(T) Diamagnetic

The correct match is

(A) I $\rightarrow$ R, T; II $\rightarrow$ Q, S; III $\rightarrow$ P, Q; IV $\rightarrow$ P, Q

(B) I $\rightarrow$ Q, T; II $\rightarrow$ R, T; III $\rightarrow$ P, Q; IV $\rightarrow$ R, S

(C) I $\rightarrow$ P, R; II $\rightarrow$ Q, S; III $\rightarrow$ R, T; IV $\rightarrow$ Q, R

(D) I $\rightarrow$ R, T; II $\rightarrow$ P, Q; III $\rightarrow$ Q, S; IV $\rightarrow$ R, T

35. Match List-I with List-II.

List-I	List-II
(I) 4.1 g H_2SO_3	(P) 200 ml of 0.5 N NaOH is used for complete neutralisation
(II) 4.9 g of H_3PO_4	(Q) 200 millimoles of oxygen atoms are present
(III) 4.5 g oxalic acid ($H_2C_2O_4$)	(R) Central atom is in its highest oxidation state
(IV) 5.3 g Na_2CO_3	(S) Can react with an oxidising agent

[H = 1, C = 12, O = 16, Na = 23, P = 31, S = 32]

The correct match is

(A) I $\rightarrow$ P, S; II $\rightarrow$ Q, R; III $\rightarrow$ P, Q; IV $\rightarrow$ R

(B) I $\rightarrow$ P; II $\rightarrow$ Q, S; III $\rightarrow$ P, S; IV $\rightarrow$ P, Q

(C) I $\rightarrow$ R, S; II $\rightarrow$ Q, R; III $\rightarrow$ P, S; IV $\rightarrow$ P, Q

(D) I $\rightarrow$ P; II $\rightarrow$ P, Q; III $\rightarrow$ Q, S; IV $\rightarrow$ P, S

36. List-I contains different types of ionic solids while List-II contains properties associated with those solids.

List-I	List-II
(I) NaCl type crystal	(P) $\sqrt{3}\,a = 4(r_+ + r_-)$
(II) ZnS (Zinc Blende) type crystal	(Q) $\sqrt{3}\,a = 2(r_+ + r_-)$
(III) CsCl type crystal	(R) $\sqrt{2}\,a = 2(r_+ + r_-)$
(IV) A_3B type crystal in which anion B forms simple cubic unit cell and cation A occupies all the square planar voids	(S) $a = 2(r_+ + r_-)$

The correct match is

(A) I $\rightarrow$ S; II $\rightarrow$ P; III $\rightarrow$ Q; IV $\rightarrow$ R

(B) I $\rightarrow$ S; II $\rightarrow$ P; III $\rightarrow$ R; IV $\rightarrow$ Q

(C) I $\rightarrow$ P; II $\rightarrow$ S; III $\rightarrow$ R; IV $\rightarrow$ Q

(D) I $\rightarrow$ P; II $\rightarrow$ R; III $\rightarrow$ S; IV $\rightarrow$ Q

PART – III : MATHEMATICS

Section - 1

Numerical Value Type

This section contains 8 questions. The answer to each question is a **NUMERICAL VALUE**. If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

37. If a chord PQ of hyperbola $xy = 4$ is normal at the point P, subtending an angle α at origin O, then the value of $\left|\frac{\tan\alpha}{\tan\beta}\right|$ (Where $\angle OPQ = \beta$) is equal to

38. The base of triangle is divided into three equal parts. If t_1, t_2, t_3 be tangents of the angle subtended by these parts at the opposite vertices then the relation $\left(\frac{1}{t_1}+\frac{1}{t_2}\right)\left(\frac{1}{t_2}+\frac{1}{t_3}\right)=\lambda\left(1+\frac{1}{t_2^2}\right)$ is satisfied, where λ is

39. Let $f: R^+ \rightarrow R$ be a differentiable function satisfying $f(x) = e + (1 - x)\ln\left(\frac{x}{e}\right) + \int_1^x f(t)dt \;\forall\; x \in R^+$. If the area enclosed by the curve $g(x) = x(f(x) - e^x)$ and x-axis; lying in the fourth quadrant is A, then the value of A^{-2} is

40. Consider a differentiable function $f(x)$ such that $f(x)=\int_3^x \frac{\sqrt{6f'(t)-1}}{x}\,dt$. Then the value of $\left(f'(3)\right)^{-1}$ is

41. Consider a function $f(x) = [\sin 10x]\cdot[\cos 10x]$, $x \in \left(0, \frac{9\pi}{10}\right)$. Then the number of points of non-differentiability of the function $f(x)$ in its domain is (where $[\cdot]$ represents the greatest integer function)

42. Let the number of ordered pairs (α, β) for which the line $\frac{x}{1}=\frac{y}{2}=\frac{z}{3}$ intersects line $3\beta^2 x + 3(1-2\alpha)y + z = 3 = -\frac{1}{2}(6\alpha^2 x + 3(1-2\beta)y + 2z)$ be M and the number of ordered pairs (x, y) satisfying the equation $3x^2 - 8xy + 9y^2 - 4x + 6y + 13 = 0$ be N. The value of $M + N$ is equal to

43. Let $f(x)=\begin{cases}\cos^{-1}\dfrac{1+x}{\sqrt{2(1+x^2)}}, & x \le 0\\ \tan^{-1} x, & x > 0\end{cases}$

If the range of values of k for which the equation $f(x) = k$ has exactly two solutions is $[a, b)$ then find the value of $\left(\frac{1}{a}+\frac{1}{b}\right)\pi$

44. For $n \ge 3$, $A^n = A^{n-2} + A^2 - I$, where $A=\begin{bmatrix}1&0&0\\1&0&1\\0&1&0\end{bmatrix}$, then sum of all elements of A^{50} is

SECTION - 2

One or More Options Correct Type

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONE OR MORE** is/are correct.

45. Let L, M are the feet of perpendiculars drawn from the point $P(c, 0)$ to the pair of lines $ax^2 + 2hxy + by^2 = 0$ and the equation of LM is $px + qy + r = 0$, then which of the following statement(s) can be true?

(A) $\frac{p}{q}=\frac{a-b}{2h}$ (B) $\frac{p}{q}=\frac{a+b}{2h}$

(C) $\frac{p}{r}=\frac{a-b}{bc}$ (D) $\frac{p}{r}=\frac{a+b}{bc}$

46. For $x, y, z \in \left(0, \frac{\pi}{2}\right)$, let x, y, z be the first three consecutive terms of an arithmetic progression such that $\cos x + \cos y + \cos z = \frac{1}{2}$ and $\sin x + \sin y + \sin z = \sqrt{2}$, which of the following is/are correct?

(A) $\cos(x-y)=\frac{\sqrt{3}-1}{2\sqrt{2}}$

(B) $\left|\sin(x-y)-\sin(z-y)\right|=\frac{\sqrt{15}}{2}$

(C) $\tan 2y = \frac{-4\sqrt{2}}{7}$

(D) $\cot y = \sqrt{2}$

47. Let $f(z) = |z| + |z - 1| + |z - i| + |z - 3 - 4i|$ then ($z \in$ complex number)

(A) Minimum value of $f(z) = 5 + \sqrt{2}$

(B) Minimum value of $f(z) = 5 - \sqrt{2}$

(C) Minimum value of $f(z)$ occurs at $\text{Re}(z) = \frac{3}{7}$

(D) Minimum value of $f(z)$ occurs at $\text{Im}(z) = \frac{4}{7}$

48. Let, for $z_1 = 3 + 4i$ and $z_2 = 1 - 2i$, z satisfies the equation $z^3 = \alpha^3 z_1^3 + (1-\alpha)^3 z_2^3 + 3(\alpha - \alpha^2) z z_1 z_2$. Which of the following statement(s) is/are correct?

(A) If $\alpha = 2$, then $|z| = 5\sqrt{5}$

(B) If $\alpha = 3$, then $|z| = \sqrt{405}$

(C) If $\alpha \in R$, then minimum value of |z| is $\sqrt{\frac{5}{2}}$

(D) If $\alpha \in (0, 1)$, then $|z| < 5$

49. If $\sum_{k=0}^{10} \frac{(k-1)^2}{(k+1)(k+2)} \, {}^{10}C_k = \frac{a \cdot 2^{10} - b}{c}$, where $a, b, c \in N$ and b is coprime with both 'a' and 'c' then

(A) $a + b = 105$

(B) $c - a = 84$

(C) $b + c = 189$

(D) $c + a = 150$

50. Define the function $f : R \to R$ by

$$f(x) = \begin{cases} \frac{1}{x^2 + \sqrt{x^4 + 2x}} & \text{if } x \notin (-\sqrt[3]{2}, 0] \\ 0 & \text{otherwise} \end{cases}$$

$f^n(x)$ denotes the function $f(x)$ iterated n times. For example, $f^3(x) = f(f(f(x)))$.

Which of the following is/are solution of the equation $f^{10}(x) = 1$?

(A) 1

(B) $-\frac{1+\sqrt{3}}{2}$

(C) $\frac{1+\sqrt{3}}{2}$

(D) $\frac{1-\sqrt{3}}{2}$

SECTION - 3

Matching List Type

This section contains 4 multiple choice questions. Each question has two matching lists : (List-I and List-II). In general, 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.

51. Consider the parabola P whose equation is $y = x^2 - 4x$ and the line L: $y = 2x - b$. List-I contains some information about line and parabola and List-II contains some conditions on b. Match the entries in List-I to entries in List-II.

List-I	List-II
(I) The line is a tangent to the parabola	(P) For $b = 7$
(II) The line cuts the parabola in A and B such that the $\angle AOB$ is a right angle when 'O' is the origin	(Q) No such value of b is possible
(III) The line cuts the parabola in C and D such that x-axis bisects the $\angle COD$	(R) For $b = 9$
(IV) The line passes outside the parabola	(S) For $b > 9$
	(T) For $b > 8$

(A) I $\rightarrow$ R; II $\rightarrow$ P; III $\rightarrow$ Q; IV $\rightarrow$ S

(B) I $\rightarrow$ P; II $\rightarrow$ R; III $\rightarrow$ Q; IV $\rightarrow$ P

(C) I $\rightarrow$ R; II $\rightarrow$ T; III $\rightarrow$ S; IV $\rightarrow$ S

(D) I $\rightarrow$ T; II $\rightarrow$ R; III $\rightarrow$ S; IV $\rightarrow$ P

52. Let $|\vec{a}| = |\vec{b}| = 2$ and $|\vec{c}| = 1$. Also $(\vec{a} - \vec{c}) \cdot (\vec{b} - \vec{c}) = 0$ and $|\vec{a} - \vec{b}|^2 + |\vec{a} + \vec{b}|^2 = 16$

List-I	List-II
(I) $\lvert\vec{a} - \vec{b}\rvert^2 + 2\vec{c} \cdot (\vec{a} + \vec{b})$ has the value equal to	(P) 7
(II) $\lvert\vec{a} + \vec{b} - \vec{c}\rvert^2$ has the value equal to	(Q) 2
(III) If the maximum value of $\lvert\vec{a} + \vec{b}\rvert$ is $1 + \sqrt{m}$, then m is equal to	(R) 10
(IV) Difference between the maximum and minimum value of $\lvert\vec{a} + \vec{b}\rvert$ is equal to	(S) 1
	(T) 5

Mark the option which correctly matches the entries in List-I to entries in List-II

(A) I $\rightarrow$ T; II $\rightarrow$ P; III $\rightarrow$ R; IV $\rightarrow$ Q

(B) I $\rightarrow$ T; II $\rightarrow$ Q; III $\rightarrow$ P; IV $\rightarrow$ R

(C) I $\rightarrow$ R; II $\rightarrow$ P; III $\rightarrow$ P; IV $\rightarrow$ Q

(D) I $\rightarrow$ R; II $\rightarrow$ Q; III $\rightarrow$ R; IV $\rightarrow$ T

53. Match the entries in List-I correctly to the entries in List-II.

List-I	**List-II**
(I) The value of $100.\prod_{n=1}^{\infty}(1+10^{-2^n})$ is equal to	(P) 30
(II) Suppose that x and y are complex numbers such that $x^2 + y^2 = 11$, $x^3 + y^3 = 20$, $x^4 + y^4 = 23$ and $x^5 + y^5 = -25$. The value of $\lvert x^6 + y^6\rvert$ is equal to	(Q) 180
(III) If $y^2 - x^2y - 2x = 0$, $x, y > 0$ and $\int\frac{y-x^2}{(x^2+y)(y^2+x)}dx$ $= f(y) + C$, where C is an arbitrary constant, then the value of $(f'(y))^{-1}$ at $x = 1$ is equal to	(R) 99
(IV) Let a, b, c are different integers less than or equal to 10. The arithmetic mean of a and b is 9. The geometric mean of a and c is $6\sqrt{2}$. The nineteen times the harmonic mean of b and c is equal to	(S) 2
	(T) 286

(A) I $\rightarrow$ R; II $\rightarrow$ T; III $\rightarrow$ Q; IV $\rightarrow$ P

(B) I $\rightarrow$ R; II $\rightarrow$ T; III $\rightarrow$ P; IV $\rightarrow$ Q

(C) I $\rightarrow$ T; II $\rightarrow$ R; III $\rightarrow$ P; IV $\rightarrow$ Q

(D) I $\rightarrow$ T; II $\rightarrow$ R; III $\rightarrow$ Q; IV $\rightarrow$ P

54. If A and B are two matrices and A^T is transpose of matrix A then $(AB)^T = B^T \cdot A^T$ and if $A \cdot A^T = A^TA = I$, then A is called orthogonal matrix. Also, if $A^n = A$ then period of A is $(n - 1)$, (where $n \in N - \{1\}$).

List-I	**List-II**
(I) If A, B, C, D are four rectangular matrices such that $A^T = BCD$, $B^T = CDA$, $C^T = DAB$ and $D^T = ABC$. If $X = ABCD$, then least period of X is	(P) 0
(II) If A is square matrix such that $A-\frac{1}{2}I$ and $A+\frac{1}{2}I$ are orthogonal, then $4A^2 + 3I$ is equal to	(Q) 3
(III) P is an orthogonal matrix and A is a periodic matrix of period 4, $Q = PAP^T$ then $X = P^TQ^{2023}P$ is equal to A^K, where K is equal to	(R) 6
(IV) If $A=\begin{bmatrix}0 & 2b & c\\ a & b & -c\\ a & -b & c\end{bmatrix}$ is orthogonal, then $\frac{1}{\lvert abc\rvert}$ is equal to	(S) 1
	(T) 2

Choose the option which correctly matches to the entries in List-I to entries in List-II

(A) I $\rightarrow$ T; II $\rightarrow$ Q; III $\rightarrow$ S; IV $\rightarrow$ R

(B) I $\rightarrow$ R; II $\rightarrow$ P; III $\rightarrow$ Q; IV $\rightarrow$ S

(C) I $\rightarrow$ R; II $\rightarrow$ Q; III $\rightarrow$ S; IV $\rightarrow$ S

(D) I $\rightarrow$ T; II $\rightarrow$ P; III $\rightarrow$ Q; IV $\rightarrow$ R

❐ ❐ ❐

Corporate Office : Aakash Tower, 8, Pusa Road, New Delhi-110005, Phone : 011-47623456

Time : 3 hrs. **MM : 180**

MOCK TEST

for JEE (Advanced)-2023

Paper - II

Pattern of the question are as under:

(i) The question paper consists of 3 parts **(Physics, Chemistry and Mathematics)**. Each part has **3 sections**.

(ii) **Section-1:** This section contains **8** questions. The answer to each of the questions is a **single-digit integer**, ranging from 0 to 9. Each question carries **+3** marks for correct answer and **–1** mark for wrong answer.

(iii) **Section-2:** This section contains **6** Multiple choice questions which have **ONE OR MORE THAN ONE** correct answer(s). Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer. **+3** If all the four options are correct but **ONLY** three options are chosen. **+2** If three or more options are correct but **ONLY** two options are chosen, both of which are correct. **+1** If two or more options are correct but **ONLY** one option is chosen and it is a correct option.

(iv) **Section-3:** This section contains **4** Multiple choice questions which have only **one correct answer**. Each question carries **+3** marks for correct answer and **–1** mark for wrong answer.

PART - I : PHYSICS

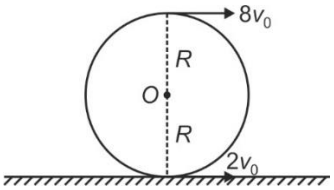
SECTION - 1

Integer Value Type

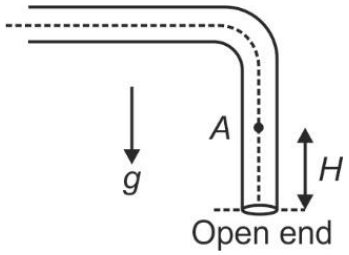
This section contains 8 questions. The answer to each of the questions is a **single-digit integer,** ranging from 0 to 9. The answer will have to be appropriately bubbled in the OMR as per the instructions as follows. **Examples-** If the correct answer to question numbers X, Y and Z (say) are 6, 0 and 9 respectively, then mark 6, 0 and 9 in OMR respectively.

X	0	1	2	3	4	5	**6**	7	8	9
Y	**0**	1	2	3	4	5	6	7	8	9
Z	0	1	2	3	4	5	6	7	8	**9**

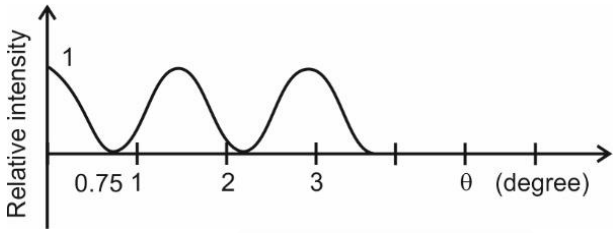
1. A circular disk is rolling over surface. Velocity of top and bottom points are $8v_0$ and $2v_0$ as shown. If velocity of centre of disk is Nv_0, then the value of N is



2. An ideal liquid of density ρ is flowing down in a uniform tube. If pressure at point A is $P_A = P_0 - N\rho gH$, then the value of N is (P_0 is the atmospheric pressure)



3. Light of wavelength 520 nm passing through double slit of YDSE, produces interference pattern whose variation of relative intensity versus deflection angle (θ) is shown in figure. The separation d between the slits is $d = k \times 10^{-2}$ mm. Find the value of k, to the nearest integer



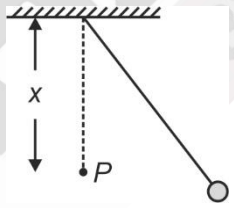
4. Nuclei of deuterium D ($_1H^2$) and tritium T ($_1H^3$) can fuse according to the following reaction to produce a neutron and an alpha particle.

$D + T \longrightarrow {}_2He^4 + n$

Assuming binding energies per nucleon of deuterium, tritium and helium to be 1.00 MeV, 2.40 MeV and 7.30 MeV respectively and neglect the kinetic energies of nuclei before the collision.

Find the energy (in MeV) carried away by the helium (approximately).

5. A Second's pendulum is slightly displaced from vertical position. A nail P is pivoted in wall at a depth x cm below the suspension point of the string. If the new time period of pendulum is $\frac{3}{2}$ s, then the value of $\frac{x}{15}$ is [take $\pi^2 = g$]



6. A stationary source S is emitting sound of frequency 220 Hz. An observer O approaching the source with constant speed records frequency of 240 Hz over a distance of 110 m. If source is active for time interval of t_0 seconds, then the value of t_0 is [Speed of sound = 330 m/s]

7. The instantaneous voltages at three terminals A, B and C are given by

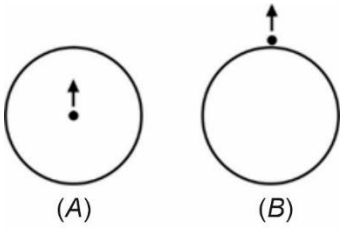
$V_A = V_0 \sin\omega t$

$V_B = V_0 \sin\left(\omega t + \frac{\pi}{3}\right)$

$V_C = V_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

An ideal voltmeter is connected to read the rms value of the potential difference between its terminals. The ratio of readings of voltmeter when it is connected between A and B to that between A and C is $\left(\frac{1}{n}\right)^{\frac{1}{2}}$. Find n.

8. Consider a hypothetical situation *A* (see figure) where an object is thrown from the centre of earth and in situation *B* same object is thrown from the surface of earth away from it perpendicular to the surface. Assume that in situation *A*, there is a thin radial tunnel for the particle to escape.



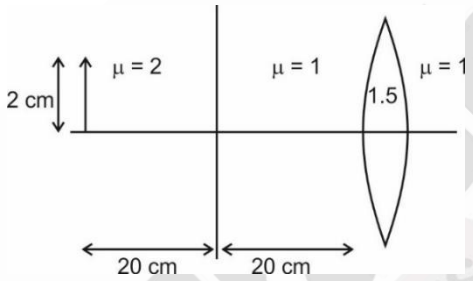
Let v_A and v_B be the escape speeds of object in situation *A* and *B* respectively. If $\frac{v_A}{v_B}=\left(\frac{x}{2}\right)^{1/2}$, find *x*.

SECTION - 2

One or More Options Correct Type

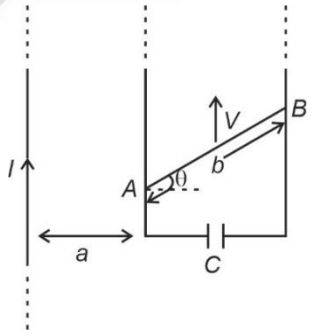
This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONE OR MORE** is/are correct.

9. An object of length 2 cm is placed on principal axis of equiconvex lens of radius 10 cm. Distance between the lens and object is 40 cm. Space between the lens and object is filled with mediums of two different refractive index of value 2 and 1 as shown in figure. Boundary of both mediums is mid-way between the object and lens as shown in figure. Choose the correct option(s).



(A) The image will be formed at distance of 15 cm from the optical centre of the lens
(B) The image will be formed at distance of 20 cm from the optical centre of the lens
(C) The size of image is 1 cm
(D) The size of image is 0.5 cm

10. As shown, long straight wire carries a current *I*. A rod *AB* is placed beside it on two conducting parallel rails of negligible resistance. Both the rails are parallel to wire. The wire, the rod & the rails lie in the same horizontal plane as shown in figure. Length of the rod is *b*. At *t* = 0, the rod starts moving on the rails with a speed *V*.



Which of the following statement(s) is (are) correct at the moment shown?

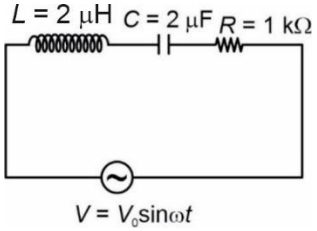
(A) Induced emf across the ends of the rod is $\frac{\mu_0 IV}{2\pi}\ln\left(\frac{a+b\cos\theta}{a}\right)$

(B) Left end of rod is at higher potential than right end.

(C) Right end of rod is at higher potential than left end.

(D) Charge on capacitor will be $\frac{C\mu_0 IV}{4\pi}\ln\left(\frac{a+b\cos\theta}{a}\right)$

11. In the circuit shown $L = 2\ \mu H$, $C = 2\ \mu F$ and $R = 1\ k\Omega$. They are connected in series with an A.C. source $V = V_0 \sin\omega t$ as shown. Which of the following option(s) is/are correct?



(A) The frequency at which the current in the circuit is maximum is independent of R

(B) At $\omega \approx 0$, the current flowing through the circuit becomes nearly zero

(C) The current will be in phase with the voltage if angular frequency is 5×10^5 rad/s

(D) The current will be in phase with voltage if $\omega = 10^4$ rad/s

12. A vertical cylinder closed from both ends is equipped with an easily moving conducting piston dividing the volume into two portions each containing one mole of air. In equilibrium at $T_0 = 400$ K, the ratio of volume in both containers is 4 : 1. Now, the gas are heated to temperature T such that ratio of volume in both the compartments is 3 : 1. If initial pressure in lower compartment is P_0 and area of cross-section is A, then

(A) Mass of piston is $\frac{3P_0A}{g}$

(B) $T = 580.5$ K

(C) Mass of piston is $\frac{3P_0A}{4g}$

(D) $T = 562.5$ K

13. When photons of energy 4.25 eV strike the surface of metal 'A', the ejected photoelectrons have maximum kinetic energy T_A (eV) and corresponding de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal 'B' by photons of energy 5.25 eV is $T_B = (T_A - 2.0\ eV)$. If de Broglie wavelength of these photoelectrons is $\lambda_B = 3\lambda_A$, then

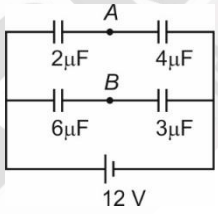
(A) The work function of 'A' is $\phi_A = 2.0$ eV

(B) The work function of 'B' is $\phi_B = 5$ eV

(C) $T_A = 2.25$ eV

(D) $T_B = 0.50$ eV

14. In the circuit shown in figure:



(A) Charge on 2 μF capacitor is 16 μC

(B) Charge on 3 μF capacitor is 36 μC

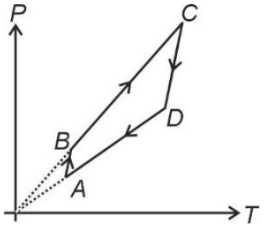
(C) Potential difference between points A and B, $V_A - V_B$, is –4 V

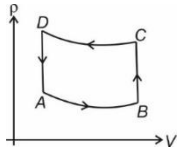
(D) Potential difference between points A and B, $V_A - V_B$, is –6 V

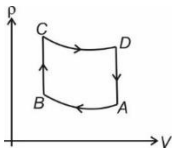
SECTION - 3
Only One Option Correct Type

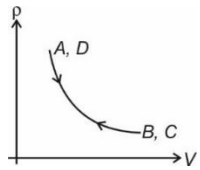
This section contains **4** multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

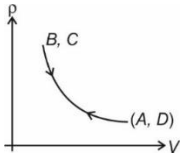
15. The given graph shows the pressure-temperature variation for n-moles of an ideal gas for a cyclic process. Which of the following graph gives density-volume (ρ - V) graph for the given process?



(A) 

(B) 

(C) 

(D) 

16. A proton is introduced at the origin (0, 0, 0) with a given initial velocity $\vec{v}$. A uniform electric field $\vec{E}$ and magnetic field $\vec{B}$ exists in the region. Choose the correct option for the proton to describe a helical path with axis along the positive *z*-direction.

(A) $\vec{v} = \frac{2E_0}{B_0}\hat{x},\ \vec{E} = E_0^2\hat{x},\ \vec{B} = B_0\hat{z}$

(B) $\vec{v} = 2\frac{E_0}{B_0}\hat{x},\ \vec{E} = E_0^2\hat{z},\ \vec{B} = B_0\hat{z}$

(C) $\vec{v} = \frac{2E_0}{B_0}\hat{x},\ \vec{E} = E_0^2\ \hat{y},\ \vec{B} = B_0\hat{y}$

(D) $\vec{v} = \frac{2E_0}{B_0}\hat{x}\ ,\ \vec{E} = E_0^2\hat{y},\ \vec{B} = -B_0\hat{y}$

17. The position vector $\vec{r}$ of a particle of mass *m* is given by the following equation :

$\vec{r} = at^3\hat{i} + bt^2\hat{j}, a = 2\ \text{ms}^{-3}, b = 3\ \text{ms}^{-2},\ m = 0.1\ \text{kg}.$

At *t* = 1 s, which of the following option is correct about the particle?

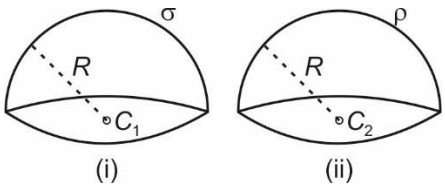
(A) The velocity $\vec{v}$ is given by $\left(2\hat{i} + 6\hat{j}\right)\text{ms}^{-1}$

(B) The angular momentum $\vec{L}$ with respect to origin is given by $\vec{L} = -(0.6)\hat{k}\ \text{Nms}$.

(C) The force $\vec{F}$ is given by $\vec{F} = \left(\hat{i} + 0.6\hat{j}\right)\text{N}$

(D) The torque $\vec{\tau}$ with respect to the origin is given by $\vec{\tau} = -1.2\hat{k}\ \text{N m}$

18. Two uniformly charged bodies are given as shown in figure. Body (i) is non-conducting hemispherical shell with surface charge density σ, body (ii) is non-conducting solid hemisphere with volume charge density ρ. A unit positive point charge is brought at the centre C_1 & C_2 from infinity (Assume that these processes are done separately from each other). If W_1 & W_2 are the work done in these processes, then $\frac{W_1}{W_2}$ is equal to



(A) $\frac{4\sigma}{R\rho}$

(B) $\frac{\sigma}{R\rho}$

(C) $\frac{8\sigma}{R\rho}$

(D) $\frac{2\sigma}{R\rho}$

PART – II : CHEMISTRY

Section - 1

Integer Value Type

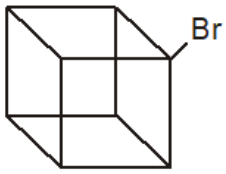
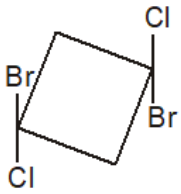
This section contains 8 questions. The answer to each of the questions is a **single-digit integer,** ranging from 0 to 9. The answer will have to be appropriately bubbled in the OMR as per the instructions as follows. **Examples-** If the correct answer to question numbers X, Y and Z (say) are 6, 0 and 9 respectively, then mark 6, 0 and 9 in OMR respectively.

X	0	1	2	3	4	5	**6**	7	8	9
Y	**0**	1	2	3	4	5	6	7	8	9
Z	0	1	2	3	4	5	6	7	8	**9**

19. A hydrocarbon which is virtually immiscible with water was steam distilled at a temperature of 95°C when the atmospheric pressure was 720 torr. The vapour pressure of pure water at this temperature is 600 torr and the distillate contains 60 percent by weight of the hydrocarbon. If the molar mass of hydrocarbon is M, then the value of M/27 is

20. The number of electrons in σ_{2p} bonding orbital of B_2, C_2 and O_2 are x, y and z respectively. The value of $\frac{x+y+z}{2}$ is

21. Consider the following statements:

1. Substitution reaction in alkyl halides is possible in both aqueous and polar aprotic medium.
2. The nucleophilic strength and basic strength for $\bar{C}H_3$, $\bar{N}H_2$, $\bar{O}H$ and F^- have same order.
3. SCN^- is an ambident nucleophile.
4.  the double bond equivalence of this molecule is 6.
5.  has centre of symmetry.
6. Butan – 2 – ol is optically active.

How many of the above statements are correct?

22. $PCl_3 + H_3PO_3 \longrightarrow \underset{\text{(Phosphorous containing compound)}}{A}$

$\text{Red } P_4 + \text{alkali} \longrightarrow \underset{\text{(Phosphorus containing Compound)}}{B}$

Total number of P – H bonds in A and total number of $\overset{O}{\underset{P}{\|}}$ bonds in B are x and y respectively. Then the value of $\frac{x}{y}$ is

23. A certain hydrocarbon A (acyclic) was found to contain 85.7 percent carbon and 14.3 percent hydrogen. This compound consumes 1 molar equivalent of hydrogen to give a saturated hydrocarbon B. 1.00 g of hydrocarbon A just decolourised 38.05 g of a 5 percent solution (by weight) of Br_2 in CCl_4. Compound A, on oxidation with concentrated $KMnO_4$, gave non-acidic compound C and acetic acid. The number of hyperconjugable hydrogens in A would be (Atomic mass of Br = 80)

24. The pH at which $Mg(OH)_2$ precipitates out from 0.01 M magnesium nitrate is_____ (K_{SP} of $Mg(OH)_2$ is 1×10^{-12})

25. Some compounds are given. How many compounds are amphoteric in nature?

    PbO_2, SnO_2, GeO, GeO_2, CO, SiO_2, Na_2O, BeO, Al_2O_3 , SnO

26. A_2 and B_2 are introduced into a 3 L vessel. Partial pressures of A_2 and B_2 at equilibrium are 1 atm and 2 atm respectively. The value of K_p for the following reaction is 10 atm.

    $$A_2B_2(g) \rightleftharpoons A_2(g) + B_2(g)$$

    The total pressure at equilibrium is a atm. Find 2.5a.

SECTION - 2

One or More Options Correct Type

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONE OR MORE** is/are correct.

27. Select the correct statement(s) about beneficiation of bauxite ore.
    (A) Bayer's process is used for beneficiation of red bauxite
    (B) Bayer's process is used for beneficiation of white bauxite
    (C) Serpeck's process is used for beneficiation of red bauxite
    (D) Serpeck's process is used for beneficiation of white bauxite

28. In the given reaction sequence

    $$H_2C=CH_2 + PdCl_2 + H_2O \longrightarrow (P) \xrightarrow[(ii)\ H_3O^+]{(i)\ Ag_2O} (Q)$$

    Which of following is correct?

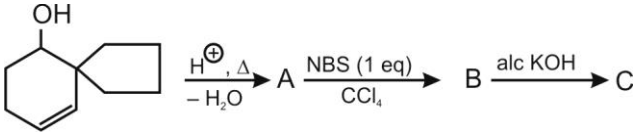
    (A) (P) is $CH_3-\overset{\overset{O}{\|}}{C}-OH$

    (B) (P) is $CH_3-\overset{\overset{O}{\|}}{C}H$

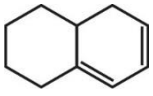
    (C) (Q) is $\underset{\underset{OH}{|}}{CH_2}-CH_2-\overset{\overset{O}{\|}}{C}-H$

    (D) Black – shiny surface is observed at the end of reaction

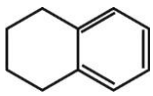
29. In the following reaction sequence

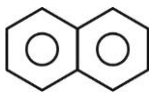
    

    Which of the following is correct?

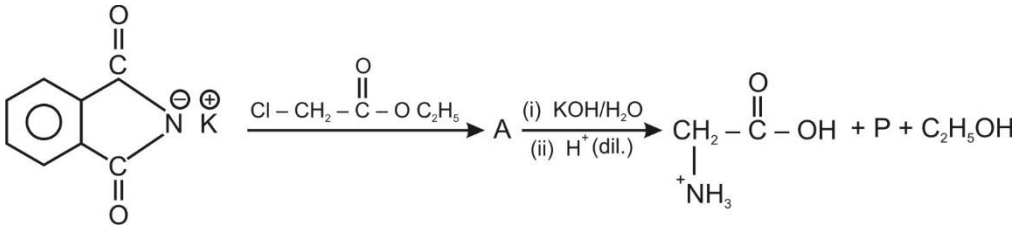
    (A) A is 

    (B) A is 

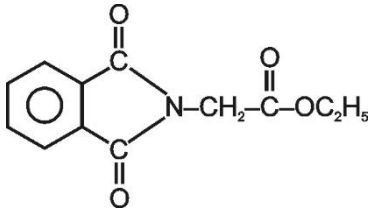
    (C) C is 

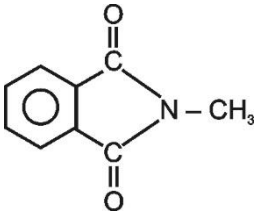
    (D) C is 

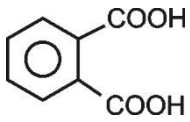
30. In the given reaction sequence

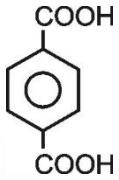


Which of the following is correct?

(A) A is 

(B) A is 

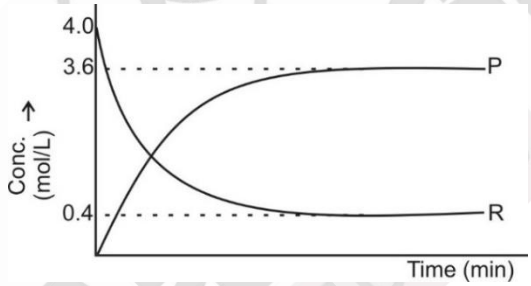
(C) P is 

(D) P is 

31. Consider the following first order reversible reaction

$$R \underset{k_2(s^{-1})}{\overset{k_1(s^{-1})}{\rightleftharpoons}} P$$

(Assume Arrhenius factor for forward and backward reaction is same)



Rate constant $k_1 = 4 \times 10^{-2}\ s^{-1}$

Select the correct option(s).

(A) The value of $k_2 = 0.44 \times 10^{-3}\ s^{-1}$

(B) Equilibrium constant for the reaction is 9

(C) On increasing temperature of system, the percentage increase in rate constant of backward reaction is higher than that of forward reaction

(D) The reaction is exothermic in nature

32. Consider the following surfactants.

$CH_3(CH_2)_8COONa$: Surfactant I

$CH_3(CH_2)_{10}COONa$: Surfactant II

$CH_3(CH_2)_{12}COONa$: Surfactant III

Select the correct statement(s).

(A) $-\overset{\overset{O}{\|}}{C}-O^-$ part of each surfactant is water loving and is called as head

(B) Alkyl group of each surfactant is water repelling and is called as tail

(C) If critical micelle concentration of surfactant I, II and III are x, y and z respectively then x > y > z

(D) If critical micelle concentration (C.M.C) of surfactant I, II and III are x, y and z respectively, then z > y > x

SECTION - 3

Only One Option Correct Type

This section contains **4** multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

33. A non-electrolytic and non-volatile solute is added to pure water, difference between freezing point and boiling point is now 105°C. Calculate mass of solute present in 500 g of solvent.
(Given molar mass of solute = 120 g/mol, K_b = 0.512 °Cm^{-1}, K_f =1.86 °Cm^{-1})
(A) 102 g (B) 126.5 g
(C) 90.5 g (D) Cannot be calculated due to insufficient data

34. In FCC crystal lattice of metal, the distance from corner to non-touching face centre is _____ and number of such particles are _____
(A) $a\sqrt{\frac{3}{2}}, 12$ (B) $a\sqrt{\frac{2}{3}}, 24$
(C) $a\sqrt{\frac{3}{2}}, 24$ (D) $a\sqrt{\frac{3}{2}}, 6$

35. Conversion of SO_2 to SO_3 finds great importance in the manufacture of sulphuric acid by Contact process. Consider the following equilibrium

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g), \quad K_c = 1.7 \times 10^{26}$$

Some statements are given w.r.t. the above process.
I. The value of K_c is suggestive of reaction going to almost completion.
II. Practically the oxidation of SO_2 to SO_3 is very slow.
III. By using catalyst, the rate of reaction increases.
IV. Catalysts are of major help only for equilibriums having very small value of K_c (K_c< 1).
The correct statements from the given above are
(A) I and III only (B) II and IV only
(C) I, III and IV only (D) I, II and III only

36. A solution contains 0.1 molar each of CH_3COOH and CH_3COONa. If a piece of charcoal is added that adsorbs only CH_3COOH and pH was found to be x after adsorption. Select the incorrect statement(s) about this process (K_a of CH_3COOH is 10^{-5}).
(A) The extent of adsorption decreases with an increase in temperature
(B) The extent of adsorption depends on the concentration of CH_3COOH
(C) Value of x must be greater than 5
(D) Value of x must be less than 5

PART – III : MATHEMATICS

Section - 1

Integer Value Type

This section contains 8 questions. The answer to each of the questions is a **single-digit integer,** ranging from 0 to 9. The answer will have to be appropriately bubbled in the OMR as per the instructions as follows. **Examples-** If the correct answer to question numbers X, Y and Z (say) are 6, 0 and 9 respectively, then mark 6, 0 and 9 in OMR respectively.

X	0	1	2	3	4	5	**6**	7	8	9
Y	**0**	1	2	3	4	5	6	7	8	9
Z	0	1	2	3	4	5	6	7	8	**9**

37. The value of $\frac{y_1 \cdot y_2 \cdot y_3}{(y_1 - x_1)(y_2 - x_2)(y_3 - x_3)}$ when (x_i, y_i), i = 1, 2, 3 satisfy both $x^3 - 3xy^2 = 2005$ and $y^3 - 3x^2y = 2004$ is A. The value of $(A - 1000)$ is equal to

38. If the equation $x^3 + 2x^2 + x + 6 = 0$ has only one real root α, then $|[\alpha]|$ is equal to (where $[\cdot]$ represents the greatest integer function)

39. A line from the origin meets the lines $\frac{x-2}{1}=\frac{y-1}{-2}=\frac{z+1}{1}$ and $\frac{x-8/3}{2}=\frac{y+3}{-1}=\frac{z-1}{1}$ at P and Q respectively. If the distance $PQ = l$ then the value of $[l]$ (where $[\cdot]$ represents the greatest integer function), is

40. If $\lim_{n\to\infty}\left(\frac{2^{\frac{1}{n}}}{n+1}+\frac{2^{\frac{2}{n}}}{n+\frac{1}{2}}+\ldots+\frac{2^{\frac{n}{n}}}{n+\frac{1}{n}}\right)=L$, then the value of $e^{\frac{1}{L}}$ is equal to

41. f and g are two real valued continuous functions and let $\int g(x)dx = f^{-1}(x)$ and $f(x) = x^3 + x + \sin \pi x + 2$. If the value of $\int_2^4 xg(x)dx$ is $\frac{m}{2n}+\frac{n}{\pi}$, then the value of $(m - n)$ is equal to

42. Consider sequences that consist of 0′s and 1′s. The probability that a random sequence of length 2021 contains an equal number of occurrences of ′01′ and ′10′ is $\frac{m}{n}$, where m, n are positive, relatively prime integers. Find $m + n$.

43. Given $\log_2 a = p, \log_4 b = p^2$ and $\log_{c^2}(8)=\frac{2}{p^3+1}$. If $\log_2\left(\frac{c^8}{ab^2}\right)=(\alpha p^3-\beta p^2-\gamma p+\delta)$ where α, β, γ, $\delta \in N$, then find the value of $(\alpha + \beta + \gamma + \delta - 10)$.

44. If the value of $\frac{\sum_{i=0}^{\infty}\frac{(2\pi)^{4i+1}}{(4i+1)!}}{\sum_{i=0}^{\infty}\frac{(2\pi)^{4i+1}}{(4i+3)!}}$ is K then the value of $[K - 30]$ is equal to … (where $[y]$ denotes the greatest integer less than or equal to y)

SECTION - 2
One or More Options Correct Type

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONE OR MORE** is/are correct.

45. Let S and S' be two circles touching side BC of triangle ABC at B and C respectively. If x and y be the radii of the circles and these circles also passes through the vertex A. If $\sin A = \frac{1}{4}$ and geometric mean of x and y is an integer, then possible length of side BC is

(A) 2 (B) $\frac{4}{3}$

(C) $\frac{5}{2}$ (D) $\frac{2}{3}$

46. If the normal at any given point $P(\theta)$ on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, meets its auxiliary circle at Q and R such that $\angle QOR = 90^\circ$. O is centre of ellipse, then

(A) $2\left(a^2-b^2\right)^2 = a^4\sec^2\theta + a^2b^2\operatorname{cosec}^2\theta$ (B) $a^4 + 5a^2b^2 + 2b^4 = a^4\tan^2\theta + a^2b^2\cot^2\theta$

(C) $a^4 + 5a^2b^2 + 2b^4 > 2a^3b$ (D) $a^4 + 2b^4 \geq 5a^2b^2 + 2a^3b$

47. If $\vec{a}, \vec{b}, \vec{c}$ are unit vectors, then the value of $|2\vec{a}-3\vec{b}|^2 + |2\vec{b}-3\vec{c}|^2 + |2\vec{c}-3\vec{a}|^2$ cannot be equal to

(A) 57 (B) 58

(C) 59 (D) 60

48. There are three coins C_1, C_2 and C_3. C_1 is a fair coin painted blue on the head side and white on the tail side. C_2 and C_3 are biased coins so that the probability of a head is K. They are painted blue on the tail side and red on the head side. Two of the three coins are selected at random and tossed. If the probability that both the coins land up with sides of the same colour is $\frac{29}{96}$, then the possible value(s) of K is/are

(A) $\frac{5}{8}$ (B) $\frac{7}{8}$

(C) $\frac{3}{8}$ (D) $\frac{1}{8}$

49. Suppose that a, b, c are real numbers which satisfy $a^2 + b^2 + c^2 = 2022$. Let $x = \sqrt{2022 - c^2}$ and $y = \sqrt{2022 - 2ac}$. Consider the expression.

$$E = \frac{xy \cdot (x + y + c)}{b^2 c}.$$

Which of the following statement(s) is/are correct above expression?

(A) Minimum of E occurs when $a = \frac{\sqrt{1011}}{2}$

(B) Minimum of E occurs when $b = \frac{3\sqrt{437}}{2}$

(C) Minimum of E occurs when $c = \sqrt{1011}$

(D) Minimum possible value of E is equal to 4

50. Let $|S|$ denotes the number of elements in set S and min(S) and max(S) denote the minimum and maximum element of set S. If the number of nonempty subsets $S \subseteq \{-10, -9, -8, \ldots, 8, 9, 10\}$ that satisfy $|S| + \min(S) \cdot \max(S) = 0$, is equal to N, then N is divisible by

(A) 5 (B) 67

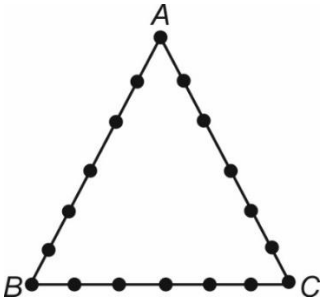
(C) 7 (D) 13

SECTION - 3

Only One Option Correct Type

This section contains **4** multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

51. Points are indicated on the perimeter of a triangle ABC (see figure).



How many triangles are there with vertices at these points?

(A) 331 (B) 408

(C) 710 (D) 711

52. Let $y = \sum_{r=1}^{n-1} \frac{2r^2 - r(n-2)+1}{(n-r)\cdot {}^nC_r}$; $n \in N$, then

(A) $y = n + \frac{1}{n}$ (B) $y \geq 2$

(C) $y = n - \frac{1}{n}$ (D) $y = 2n$

53. Given $y = \tan^{-1}\left(\frac{2x}{1-x^2}\right)$ then $\left(\frac{d^5y}{dx^5}\right)_{x=0}$ equals

(A) 84

(B) 48

(C) 12

(D) $-\frac{1}{12}$

54. If the square of the volume of a tetrahedron *OABC* formed by the vectors $\overrightarrow{OA} = \vec{a}$, $\overrightarrow{OB} = \vec{b}$ and $\overrightarrow{OC} = \vec{c}$, where $|\vec{a}|$ = 3, $|\vec{b}|$ = 4, $|\vec{c}|$ = 6, and the angle between the vector-pairs $\{\vec{a}, \vec{b}\}, \{\vec{b}, \vec{c}\}$ and $\{\vec{c}, \vec{a}\}$ be $\frac{\pi}{3}, \cos^{-1}\frac{1}{4}$ and $\cos^{-1}\left(\frac{-1}{18}\right)$ respectively, is equal to $\frac{pq}{r^2}$ where *p*, *q* and *r* are prime numbers. Which of the following is NOT equal to any of the *p*, *q* or *r* ?

(A) 79 (B) 3

(C) 11 (D) 13

❐ ❐ ❐