FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
OPEN TEST – II
PAPER –1
TEST DATE: 21-04-2024

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 51 questions.
- Each subject (PCM) has 17 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –03, 18 – 20, 35 – 37):* This section contains **NINE (9)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(04 – 07, 21 – 24, 38 – 41)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A *(08 – 11, 25 – 28, 42 – 45):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (P), (Q), (R) and (S) and **FIVE** statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(12 – 17, 29 – 34, 46 – 51):* This section contains **EIGHTEEN (18)** numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.

MARKING SCHEME

Section – A (One or More than One Correct): 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 and 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.

Section – A (Single Correct): 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.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

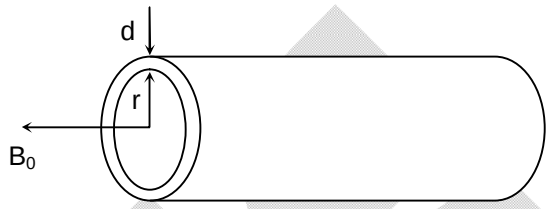
Physics

PART – I

SECTION – A
(One or More than one correct type)

*This section contains **THREE (03)** 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).*

1. A uniform magnetic field of induction B_0 exists everywhere in a long thin walled hollow metallic cylinder parallel to its axis as shown in the figure. The length ℓ of the cylinder is much larger than its radius r that is much larger than its wall thickness d ($\ell >> r >> d$). The resistivity of the material of the cylinder is ρ. Neglect the flux linkage with the material of the cylinder. Now the magnetic field is switched off, then choose the correct option(s).



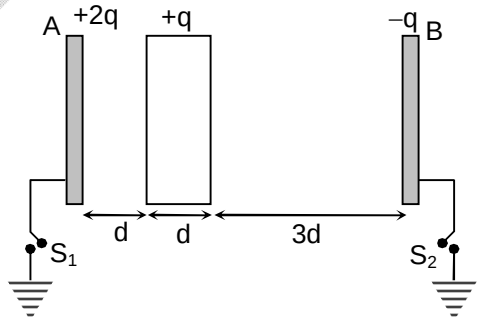
(A) The magnetic induction inside the hollow cylinder will decay as $B = B_0 e^{-\frac{2\rho t}{\mu_0 r d}}$.

(B) The magnetic induction inside the hollow cylinder will decay as $B = B_0 e^{-\frac{4\rho t}{\mu_0 r d}}$

(C) The induced current in the cylinder varies as $I = \left(\frac{B_0 \ell}{\mu_0}\right) e^{-\frac{2\rho t}{\mu_0 r d}}$

(D) The induced current in the cylinder varies as $I = \left(\frac{B_0 \ell}{\mu_0}\right) e^{-\frac{4\rho t}{\mu_0 r d}}$

2. A metal slab of thickness d having charge +q is inserted between two thin parallel metal plates A and B having charges +2q and –q respectively as shown in the figure. Now the plates A and B are earthed by closing the switches S_1 and S_2 simultaneously. Then choose the correct option(s).



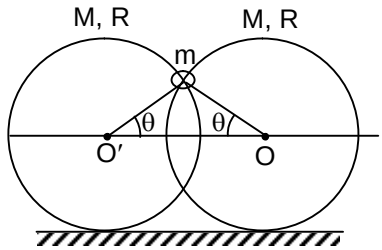
(A) The charge flown through the switch S_1 is $\frac{7q}{4}$

(B) The charge flown through the switch S_1 is $\frac{11q}{4}$

(C) The charge flown through the switch S_2 is $\frac{5q}{4}$

(D) The charge flown through the switch S_2 is $\frac{3q}{4}$

3. A ring of mass m = 1kg connecting freely two identical thin hoops of mass M = 4 kg each, starts sliding down and the hoops start rolling without slipping on the rough horizontal surface as shown in the figure. If $\theta = 37°$ at the initial moment then choose the correct option(s) just after the system is released. Neglect the friction between the ring and the hoops. ($g = 10\ m/s^2$, R = 0.5 m)



(A) The acceleration of the ring is 1 m/s^2.

(B) The acceleration of each hoop is $\frac{3}{4}$ m/s^2.

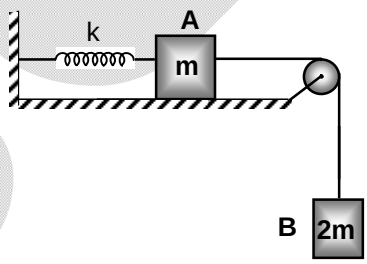
(C) The acceleration of each hoop is $\frac{3}{2}$ m/s^2.

(D) The frictional force acting on each hoop is 3 N.

SECTION – A
(One Options Correct 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.*

4. In the arrangement shown, the blocks A and B are having masses m and 2m respectively and the spring constant is k. The coefficient of friction between the block A and the horizontal surface is $\mu = 0.5$. Initially the spring is relaxed and the system is released form rest. The maximum speed acquired by each block is



(A) $g\sqrt{\frac{3m}{k}}$ (B) $g\sqrt{\frac{3m}{2k}}$

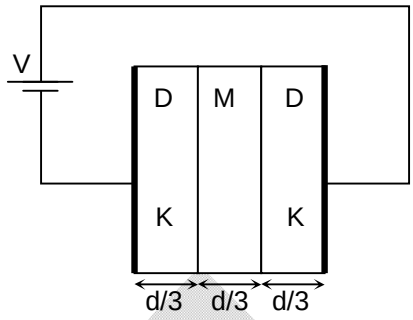
(C) $\frac{g}{2}\sqrt{\frac{3m}{k}}$ (D) $\frac{g}{2}\sqrt{\frac{3m}{2k}}$

5. A particle of mass m is located in a uni-dimensional potential field where the potential energy of the particle varies as $U = \frac{a}{x^4} - \frac{b}{x^2}$, where a and b are positive constants. Find the time period of small oscillations of the particle about the equilibrium position.

(A) $2\pi\sqrt{\frac{ma^2}{b^3}}$ (B) $2\pi\sqrt{\frac{2ma^2}{b^3}}$

(C) $2\pi\sqrt{\frac{3ma^2}{b^3}}$ (D) $2\pi\sqrt{\frac{3ma^2}{2b^3}}$

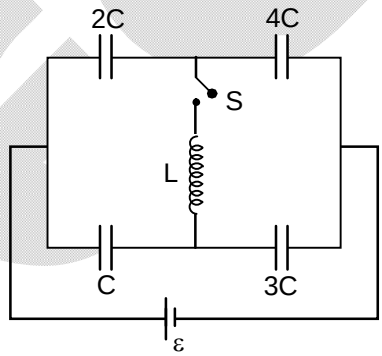
6. The conducting plates of a parallel plate capacitor have area A and distance between them is d. A potential difference V is maintained across the capacitor by a battery. Two identical dielectric slabs D and a metal slab M each of thickness $\frac{d}{3}$ are inserted in the capacitor as shown in the figure. The dielectric constant of each of the dielectric slab is K. The modulus of the force of electrostatic interaction on each plate of the capacitor is



(A) $\frac{3\epsilon_0 AK^2V^2}{8d^2}$ (B) $\frac{3\epsilon_0 AK^2V^2}{4d^2}$

(C) $\frac{9\epsilon_0 AK^2V^2}{8d^2}$ (D) $\frac{9\epsilon_0 AK^2V^2}{4d^2}$

7. The circuit shown consists of four capacitors, an ideal battery of emf ε, a switch 'S' and an inductor of inductance L. The switch S is kept open for a long time. Find the maximum current through the inductor after the switch 'S' is closed.



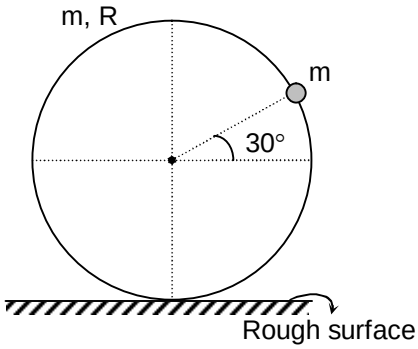
(A) $\frac{\varepsilon}{2}\sqrt{\frac{C}{5L}}$ (B) $\frac{\varepsilon}{2}\sqrt{\frac{C}{15L}}$

(C) $\frac{\varepsilon}{4}\sqrt{\frac{C}{5L}}$ (D) $\frac{\varepsilon}{4}\sqrt{\frac{C}{15L}}$

SECTION – A
(Matching List Type)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (P), (Q), (R) and (S) and FIVE statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

8. A particle of mass m is rigidly attached to the circumference of a uniform circular ring of same mass m and radius R which is placed on a rough horizontal surface as shown in the figure. Initially, the line joining the centre of the ring and the particle makes an angle θ =30° with the horizontal and the system is released from rest. The ring starts rolling without slipping on the rough horizontal surface. When the particle is getting at the right end of the horizontal diameter of the ring. Match each entry in List-I with an appropriate value from List-II and choose the correct option. (Given g = 10 m/s^2, m = 0.8 kg and R = 20 cm)



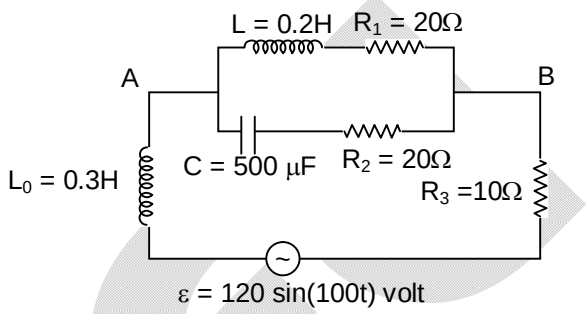
List –I		List –II (in newton)	
(P)	The normal force acting on the ring due to the horizontal surface in Newton	(1)	3
(Q)	The frictional force acting on the ring due to the horizontal surface in Newton	(2)	5.5
(R)	The horizontal component of the force acting on the particle due to the ring in Newton	(3)	13.5

(S)	The vertical component of the force acting on the particle due to the ring in Newton	(4)	0.5
		(5)	2.5

The correct option is:

(A) (P) → (3) (Q) → (1) (R) → (4) (S) → (2)
(B) (P) → (3) (Q) → (4) (R) → (2) (S) → (1)
(C) (P) → (4) (Q) → (2) (R) → (1) (S) → (5)
(D) (P) → (5) (Q) → (1) (R) → (2) (S) → (3)

9. A circuit shown in the adjoining figure is connected to an ac source of 120 sin(100t) volt. Match each entry in List-I with an appropriate value from List-II and choose the correct option.

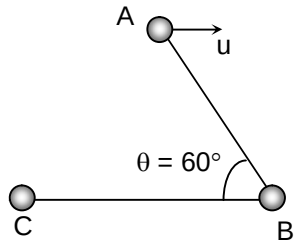


List –I		List –II	
(P)	The peak current (in Amp) through the source	(1)	$40\sqrt{2}$
(Q)	The peak current (in Amp) through the resistor $R_2 = 20\ \Omega$	(2)	40
(R)	The peak potential drop (in Volt) between the points A and B	(3)	80
(S)	The average power (in Watt) dissipated in the resistor $R_3 = 10\ \Omega$	(4)	$2\sqrt{2}$
		(5)	2

The correct option is:

(A) (P) → (4) (Q) → (2) (R) → (5) (S) → (1)
(B) (P) → (5) (Q) → (2) (R) → (1) (S) → (3)
(C) (P) → (4) (Q) → (5) (R) → (1) (S) → (2)
(D) (P) → (2) (Q) → (4) (R) → (3) (S) → (1)

10. Three identical small balls A, B and C each of mass m = 2 kg are connected by two massless inextensible strings and placed on a smooth horizontal surface as shown in the figure. Initially the angle between the strings AB and BC is $\theta = 60°$ and the ball A is imparted an initial horizontal velocity u = 30 m/s parallel to the string BC. Match each entry in List-I with an appropriate value from List-II and choose the correct option. (Take $\sqrt{13} = 3.6$)

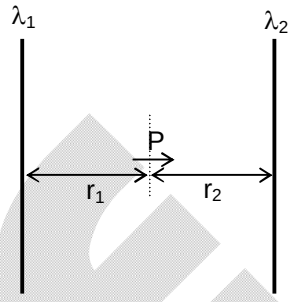


List –I		List –II	
(P)	The initial velocity acquired by the ball B in m/s	(1)	2
(Q)	The initial velocity acquired by the ball C in m/s	(2)	4
(R)	The impulse due to tension in the string AB in N-s	(3)	7.2
(S)	The impulse due to tension in the string BC in N-s	(4)	16
		(5)	3.6

The correct option is:

(A) (P) → (2) (Q) → (5) (R) → (4) (S) → (3)
(B) (P) → (3) (Q) → (1) (R) → (4) (S) → (2)
(C) (P) → (3) (Q) → (5) (R) → (2) (S) → (5)
(D) (P) → (4) (Q) → (2) (R) → (5) (S) → (1)

11. A point electric dipole with dipole moment $\vec{P}$ is located between two uniformly charged long threads with linear charge densities λ_1 and λ_2 at distances r_1 and r_2 from the threads as shown in the figure. List-I provides the different values of λ_1, λ_2, r_1 and r_2 and List-II provides the respective magnitudes of the net electric force experienced by the point electric dipole. Match each entry in List-I with an appropriate value from List-II and choose the correct option.



List –I		List –II	
(P)	$\lambda_1 = 2\lambda,\ \lambda_2 = \lambda,\ r_1 = \frac{d}{2}$ and $r_2 = \frac{d}{2}$	(1)	$\frac{17\,\lambda P}{\pi\varepsilon_0 d^2}$
(Q)	$\lambda_1 = 2\lambda,\ \lambda_2 = -\lambda,\ r_1 = \frac{d}{2}$ and $r_2 = \frac{d}{2}$	(2)	$\frac{\lambda P}{\pi\varepsilon_0 d^2}$
(R)	$\lambda_1 = \lambda,\ \lambda_2 = 2\lambda,\ r_1 = \frac{d}{4}$ and $r_2 = \frac{d}{3}$	(3)	$\frac{2\lambda P}{\pi\varepsilon_0 d^2}$
(S)	$\lambda_1 = \lambda,\ \lambda_2 = -2\lambda,\ r = \frac{d}{4}$ and $r_2 = \frac{d}{3}$	(4)	$\frac{5\lambda P}{\pi\varepsilon_0 d^2}$
		(5)	$\frac{6\lambda P}{\pi\varepsilon_0 d^2}$

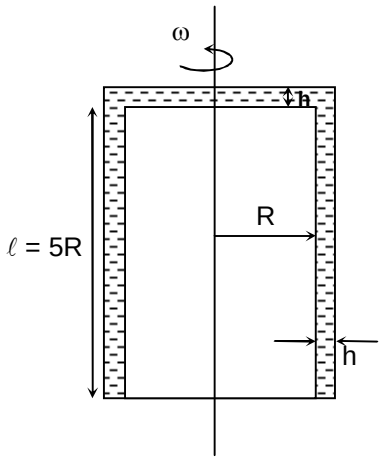
The correct option is:
(A) (P) → (5) (Q) → (3) (R) → (2) (S) → (1)
(B) (P) → (4) (Q) → (3) (R) → (4) (S) → (2)
(C) (P) → (3) (Q) → (5) (R) → (2) (S) → (4)
(D) (P) → (5) (Q) → (3) (R) → (1) (S) → (2)

SECTION – B

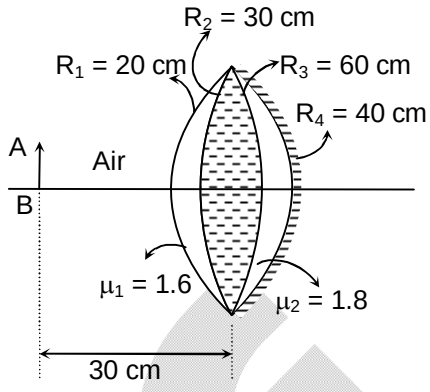
(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

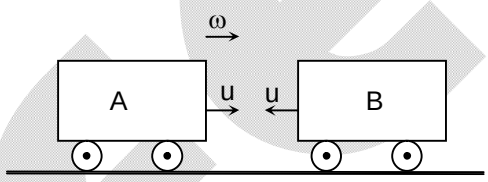
12. A solid cylinder of radius R and length ℓ = 5R is located coaxially in a vertical cylindrical cavity filled with a viscous liquid of viscosity η as shown in the figure. The clearance between the solid cylinder and the cavity is h(<<R). If the torque required to rotate the solid cylinder with a constant angular velocity ω about its vertical axis is $\left(\frac{K\pi\eta\omega R^4}{2h}\right)$. Find the value of K.



13. Two thin concavo-convex lenses are kept in contact and the gap formed between them is filled with water of refractive index $\mu_w = \frac{4}{3}$ and the last convex surface of radius of curvature R_4 = 40 cm is silvered as shown in the figure. A linear object AB of size 0.5 cm is placed perpendicular to the optic axis in air at a distance 30 cm from the silvered lens. Find the distance (in cm) of the image formed from the silvered lens.



14. Two cars A and B are moving towards each other with the same speed u = 25 m/s along a straight road as shown in the figure. The wind is blowing with a velocity ω = 5 m/s in the direction of velocity of the car A. The car A emits a sound of frequency f = 310 Hz and the velocity of sound relative to air is v = 330 m/s. Find the frequency (in Hz) of the reflected back sound from the car B received by the driver of the car A.



15. The distance between the centres of two stars of masses $4M_S$ and $12M_S$ is 36R. Here R is the mean distance between the centres of the Earth and the Sun and M_S is the mass of the Sun. The two stars orbit around their common centre of mass in circular orbits with a time period ηT, where T is the time period of Earth's revolution around the Sun. Find the value of n.

16. Nuclei of deuterium can fuse according to the following reaction to produce a proton and a tritium atom.

$$_1^2H + _1^2H \longrightarrow _1^3H + _1^1P$$

The binding energy per nucleon of deuterium and tritium are 1 MeV and 2.8 MeV respectively and neglect the kinetic energy of the nuclei before the fusion. If the kinetic energies of the proton and the tritium produced in the above nuclear reaction are K_1 and K_2 respectively. Find the value of (10 K_1 + 20 K_2) in MeV.

17. Two capacitors with capacitance values $C_1 = (10 \pm 0.10)\mu F$ and $C_2 = (40 \pm 0.20)\mu F$ are connected in Series. The voltage applied across this combination is $V = (8.00 \pm 0.02)$ volt. If the percentage error in the calculation of the energy stored in this combination of capacitors is n%. Find the value of 5n.

Chemistry

PART – II

SECTION – A
(One or More than one correct type)

*This section contains **THREE (03)** 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).*

18. Which of the following option is correctly matched with free expansion of an ideal gas?
(A) $\Delta S_{syst} > 0$ (B) $\Delta G = 0$
(C) $(\Delta S)_{univ.} > 0$ (D) $w = 0$

19. In the reaction sequence choose the **incorrect** statement

$$THF \xrightarrow[\Delta]{HCl(excess)} (A) \xrightarrow{KCN(excess)} (B) \xrightarrow[\Delta]{H_2/Ni} (C)$$

$$(B) \xrightarrow{H_3O^+} D \xrightarrow{\Delta} E + F\uparrow$$

(A) Compound 'E' will give $NaHCO_3$ test.
(B) Compound (C) and (D) can be used to prepare Nylon-6, 6.
(C) Compound (E) on reaction with Grignard reagent (CH_3MgBr) produced optically active salt.
(D) Compound (B) after Stephen's reduction followed by hydrolysis give silver mirror test.

20. The cell potential for the unbalanced chemical reaction

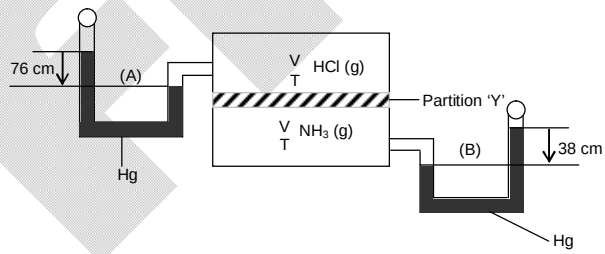
$$Hg_2^{2+} + NO_3^- + H^+ \longrightarrow Hg^{2+} + HNO_2 + H_2O \qquad E^o_{cell} = 0.02\ V$$

Is measured under standard state conditions. For the electro chemical cell at 25°C;
(A) Solution in cathodic compartment is acidic.
(B) Solution in anodic compartment is acidic.
(C) Cell potential will be zero at $pH = \frac{2}{9}$, if activity of other components are equal to one.
(D) 0.6 moles of electron pass through the circuit when 0.6 moles of Hg^{2+} are produced in the cell

SECTION – A
(One Options Correct 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.*

21.



HCl react NH_3 to form NH_4Cl (s) when partition 'Y' is removed. The difference in Hg level in two columns of A and B manometers after the removal of partition are (in cm) respectively is…….
[Given P_{atm} = 76 cm Hg and temperature constant. V and T are volume and temperature respectively.]
(A) 38, 38 (B) 57, 57
(C) 57, 38 (D) 39, 38

22. A certain reaction obeys the following rate law $-\frac{dC}{dt} = K(C)^{3/2}$. The value of rate constant (k) and $t_{1/2}$, expression respectively are…. (concentration at time $t = 0$ is C_o and at time t, C_t)

(A) $k = \frac{2}{t}\left[\frac{1}{\sqrt{C_t}} - \frac{1}{\sqrt{C_o}}\right]$, $\frac{0.829}{k\sqrt{C_o}}$

(B) $k = \frac{1}{2t}\left[\frac{1}{\sqrt{C_t}} - \frac{1}{\sqrt{C_o}}\right]$, $\frac{0.829}{k\sqrt{C_o}}$

(C) $k = \frac{1}{t}\left[\frac{1}{\sqrt{C_t}} - \frac{1}{\sqrt{C_o}}\right]$, $\frac{0.829\sqrt{C_o}}{k}$

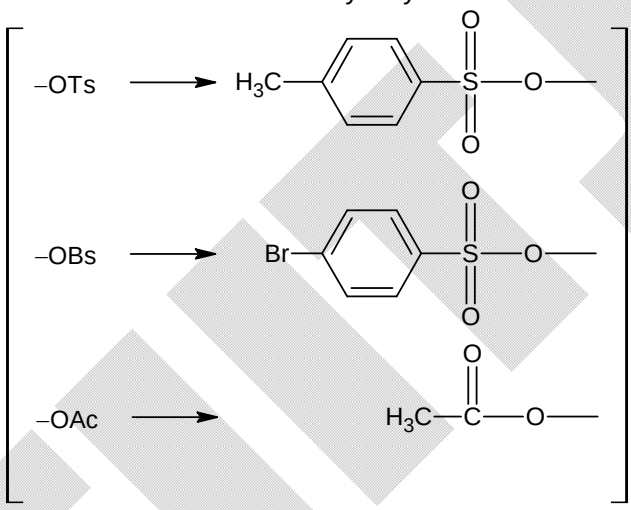
(D) $k = \frac{1}{t}\left[\frac{1}{\sqrt{C_t}} - \frac{1}{\sqrt{C_o}}\right]$, $\frac{1.658}{k\sqrt{C_o}}$

23. Which of the following species is non polar as well as planar?

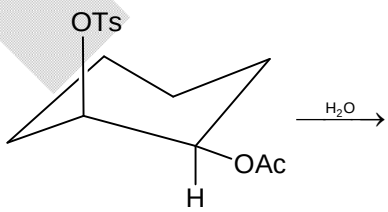
(A) XeF_5^- (B) XeO_6^{4-}

(C) $Fe(CO)_5$ (D) S_2Cl_2

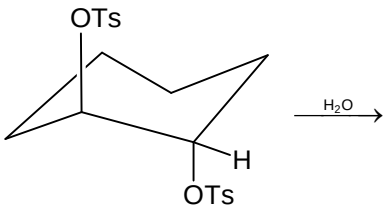
24. The correct order of rate of hydrolysis and rate of reaction of the following given reactions:



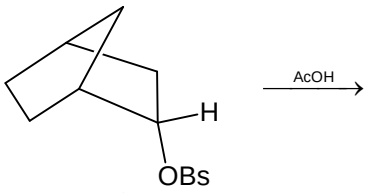
Case 1: (I)



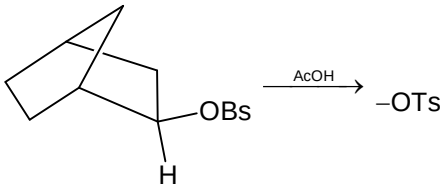
(II)



Case 2: (III)



(IV)



(A) I > II and III > IV
(B) I > II and IV > III
(C) II > I and IV > III
(D) II > I and III > IV

SECTION – A
(Matching List Type)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (P), (Q), (R) and (S) and FIVE statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

25. Match the solution in List-I with the nearest pH given in List-II and choose the correct option.
[Given at 25°C K_a of CH_3COOH 1.0×10^{-5}, H_3PO_4. $K_{a_1} = 10^{-3}, 10^{-8}, 10^{-12}$ respectively, K_a of $NH_4^+ = 10^{-9}$)

List – I		List – II	
(P)	$Na_3PO_4 + H_3PO_4$ 0.1 M 0.2M 50 ml 25 ml	(1)	10.00
(Q)	$CH_3COONa + HCl + NaCl$ 0.5 M 0.5M 0.5M 100 ml 50 ml 50ml	(2)	8.00
(R)	$(NH_4)_2SO_4 + NH_3(aq.)$ 0.01M 0.2M	(3)	9.00
(S)	$(CH_3COO)_2Ba$ 0.05M	(4)	5.00
		(5)	12.00

(A) P → 2; Q → 4; R → 1; S → 3
(B) P → 5; Q → 4; R → 1; S → 3
(C) P → 3; Q → 4; R → 2; S → 5
(D) P → 2; Q → 2; R → 1; S → 4

26. Match the reactions (in the given stoichiometry of the reactants) in List-I with one of their products given in List-II and choose the correct option.

List – I		List – II	
(P)	$XeF_4 + O_2F_2 \longrightarrow$	(1)	XeF_6
(Q)	$P_4 + SO_2Cl_2 \longrightarrow$	(2)	O_2
(R)	$SbF_5 + XeF_4 \longrightarrow$	(3)	SO_2
(S)	$P_4 + 8SOCl_2 \longrightarrow$	(4)	PCl_3
		(5)	PCl_5

(A) P → 2; Q → 3; R → 1; S → 3, 5
(B) P → 1, 2; Q → 3, 5; S → 3, 4
(C) P → 1, 2; Q → 3, 4; R → 1; S → 3, 5
(D) P → 1; Q → 3, 5; R → 1; S → 3, 4

27. Match the reactions in List-I with test given by one of their end product given in List-II:

List – I		List – II	
(P)	$Mg_2C_3 \xrightarrow{H_2O}$	(1)	Final product(s) can liberate $CO_2 \uparrow$ on reaction with $NaHCO_3$
(Q)	$H_5C_2-CH_2-\underset{\underset{O}{\|}}{C}-NH_2 \xrightarrow[(2)\ H_2O\ (3)\ CHCl_3/OH^-\ (4)\ H^+/H_2O]{(1)\ LAH}$	(2)	Final product can reduce Tollen's reagent
(R)	$H_3C-\underset{\underset{O}{\|}}{C}-CH_2-\underset{\underset{O}{\|}}{C}-OMe \xrightarrow[(2)\ Me-\underset{\underset{O}{\|}}{C}-Br\ (3)\ H^+/H_2O/\Delta]{(1)\ MeO^-}$	(3)	Final product can give Haloform or carbyl amine test
(S)	$CaC_2 \xrightarrow{H_2O} A \uparrow \xrightarrow[Red\ hot]{Cu-Fe} B \xrightarrow[AlCl_3]{Ph-\underset{\underset{Cl}{\|}}{CH}-CH_3} \xrightarrow[(ii)\ H_2SO_4]{(i)\ O_2/\Delta}$	(4)	Final product(s) can give violet colour with neutral $FeCl_3$.
		(5)	Final product(s) after OMDM can give iodoform test

(A) P → 1, 5; Q → 2, 3, 4; R → 3, 4, 5; S → 1, 2, 3, 4
(B) P → 2, 3; Q → 3, 4; R → 2, 3; S → 3, 5
(C) P → 5; Q → 1, 2, 3; R → 3, 4; S → 3, 4
(D) P → 2, 5; Q → 1, 3; R → 3; S → 3, 4, 5

28. Match the compound in List-I with one of the property given in List-II and choose the correct options

List – I		List – II	
(P)	$\left[Co(NH_3)_2(H_2O)_2Cl_2\right]$	(1)	Total possible stereo isomers are 6
(Q)	$\left[Co(en)(H_2O)_2Cl_2\right]Cl$	(2)	Total possible isomers are 6
(R)	$\left[Pt(NH_3)_2(NO_2)_2\right]$	(3)	Total possible geometrical isomers are 5
(S)	$H_3C-\underset{\underset{OH}{\|}}{CH}-CH=CH-\underset{\underset{OH}{\|}}{CH}-CH_3$	(4)	At least two or more than two optical active isomers are possible
		(5)	Meso isomer is possible

(A) P → 1, 2, 3, 4; Q → 4; R → 2; S → 1, 4, 5
(B) P → 1, 2, 3, 4; Q → 2, 3, 5; R → 2, 4; S → 1, 5
(C) P → 1, 2, 3, 5; Q → 1, 2, 4; R → 2; S → 1, 5
(D) P → 2, 4, 5; Q → 1, 4, 5; R → 3, 5; S → 5

SECTION – B

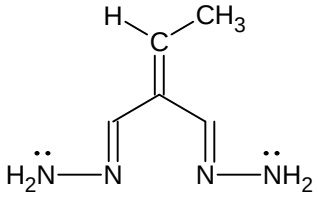
(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

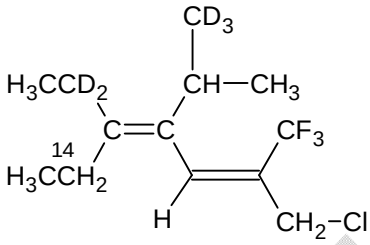
29. Among $[Br_3]^+$, $[SiO_4]^{4-}$, S_2Cl_2, XeF_4, PH_3, $Ni(CO)_4$, $[Ni(CN)_4]^{2-}$, $[PdCl_4]^{2-}$, $SOCl_2$, B_2H_6 $[NiCl_4]^{2-}$, $K[AgF_4]$, $\dot{C}F_3$, SNF_3, BF_4^-, BrF_3 and SF_4 the total number of species having sp^3 hybridized central atom is/are_____.

30. Identify the sum of the total number of stereo isomers for the following given compounds

(I)

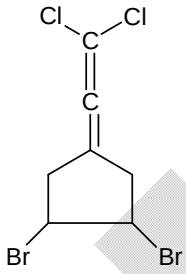


(II)

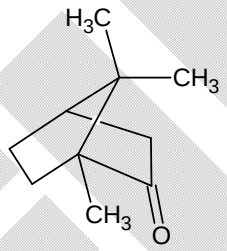


(Configuration about double bond is fixed)

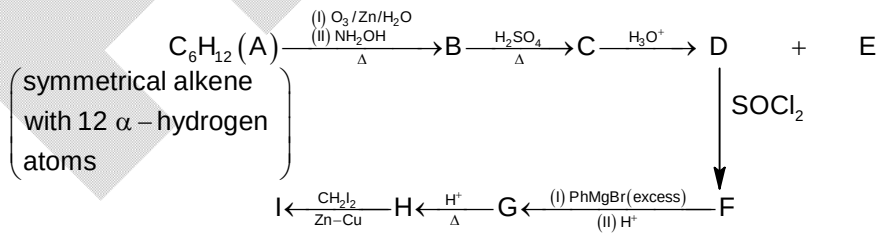
(III)



(IV)



31.



In the above reaction sequence molar mass of J is 'x' g/mol and index of hydrogen deficiency (IHD). Number of I is 'y'.

Then the value of $\frac{x+4}{y}$ is ……

32. In an elementary chemical reaction

$X(aq) \xrightarrow{t_{1/2}=15\ min} 2B(aq) + Y(aq)$

Reaction mixture react with another reactant (A) and n-factor of X, B and Y when react with (A) in the ratio 2 : 1 : 2 respectively.
If volume of (A) used at 15 min is 40 ml if the volume of (A) used at t = 0 is 'a' ml, at t = 30 min is 'b' ml and at t = ∞ is 'c' ml.

Then find out the value of $\frac{a+3c}{b}$ is…..

33. In the following given compounds

SO_2, SO_3, XeO_4, B_2H_6, $Al(BH_4)_3$, $Be(BH_4)_2$

If number of $p\pi - d\pi$ bonds are x and number of banana bonds are y.

Calculate the value of x + y is……..

34. 2 mole of AB(s) is taken in close container of volume of 2 litre. If 1 mole of AB(s) has taken part in reaction to attain the equilibrium state and equilibrium moles of $D_2(g)$ is 0.75.

$AB(s) \rightleftharpoons A(g) + B(g)$ $\qquad K_C = a(mol/\ell)^2$

$A(g) \rightleftharpoons \frac{1}{2}C_2(g) + \frac{3}{2}D_2(g)$ $\qquad K_C = b(mol/\ell)^2$

at equilibrium [A] = x (mol/litre) [C_2] = y(mol/litre)

Calculate the value of $\frac{b\sqrt{3}}{a(x+y)}$ is.....

Mathematics

PART – III

SECTION – A
(One or More than one correct type)

*This section contains **THREE (03)** 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).*

35. Tangent drawn at some point P on the parabola $x^2 - 2xy + y^2 + ax + by + c = 0$ intersects the axis and tangent at the vertex at points Q(–12, 0) and R(–6, 0) respectively, then
(A) a – b + c is equal to 24
(B) equation of axis is x – y + 12 = 0
(C) vertex is (–9, 3)
(D) equation of directrix is x + y + 12 = 0

36. Let |z| = r and |z| = 1, be the equation of circumcircle and incircle of an equilateral ΔABC having vertices A, B and C represented by z_1, z_2 and z_3 respectively. If incircle touches the sides BC, CA and AB at D(z_4), E(z_5) and F(z_6) respectively, then
(A) for any point P_1 on circumcircle $DP_1^2 + EP_1^2 + FP_1^2$ is equal to 15
(B) if maximum area of ΔP_1ED is A_1 (in square units), then $\frac{16}{5}A_1^2$ is equal to 15
(C) for any point P_2 on incircle $AP_2^2 + BP_2^2 + CP_2^2$ is equal to 24
(D) if maximum area of ΔP_2AB is A_2 (in square units), then A_2^2 is equal to 12

37. A circle is drawn with centre (α, β), then which of the following is/are not true?
(A) If α and β are both irrational, then there exist at most one rational point on the circle $x^2 + y^2 - 2\alpha x - 2\beta y + c = 0$
(B) If $(\alpha, \beta) \equiv (e, \pi)$, then there exist no rational point on the circle $x^2 + y^2 - 2\alpha x - 2\beta y + c = 0$, $c \in R$
(C) If α is rational and β is irrational and there exist exactly two rational points P and Q on the circle, then slope of PQ must be 0
(D) If there exists only one rational point (x_1, y_1) on circle with $\left(2, \sqrt{3}\right)$ as centre, then $x_1 = 1$

SECTION – A
(One Options Correct 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.*

38. $\lim\limits_{x\to 0}\left[\left(\tan\left(\frac{\pi}{4}+x\right)\right)^{\cot x} - e^2\right]\cot^2 x$; is equal to
(A) $\frac{2}{3}e$
(B) $\frac{11}{12}e^2$
(C) $\frac{2}{3}e^2$
(D) none of these

39. A rectangle ABCD (anticlockwise order) with one vertex at $A\left(\sqrt{3}, 1\right)$ and sides parallel to the coordinate axes is inscribed in a circle of radius 2 units with centre at origin. A point P moves inside the circle such that d(P, AB) $\le$ min{d(P, BC), d(P, CD), d(P, DA), (where d(P, AB) represents distance between point P and line AB). Then area of the region containing point P, inside the circle is equal to
(A) $\sqrt{3} + 2 + \frac{\pi}{3}$
(B) $3 + \frac{2\pi}{3}$
(C) $\sqrt{3} + 1 + \frac{\pi}{3}$
(D) π

40. Let $S_1 = \sum\limits_{1\le r<q\le 10}\sum \tan^{-1}\frac{q}{r}$ and $S_2 = \sum\limits_{1\le q\le r\le 10}\sum \tan^{-1}\left(\frac{q}{r}\right)$, then $S_1 + S_2$ is equal to

(A) 50π (B) 22.5π
(C) 100π (D) 25π

41. If $E: \frac{x^2}{25}+\frac{y^2}{9}=1$ and $H: \frac{x^2}{2+k}-\frac{y^2}{14-k}=1$; k is some fixed natural number. If E and H intersect in 4 points A, B, C and D in 1st, 2nd, 3rd and 4th quadrant respectively. If equation of tangent to H at A is $ax-\sqrt{3}y-8=0$ and equation of normal to E at D is –5x + by + 8 = 0, then a + b is equal to

(A) $-5+\sqrt{3}$ (B) $5-\sqrt{3}$
(C) $5+\sqrt{3}$ (D) $-5-\sqrt{3}$

SECTION – A
(Matching List Type)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (P), (Q), (R) and (S) and FIVE statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

42. If $(y^3 – x^2y – 2y^2 + y) + \lambda xy(y – 1) = 0$; ($\lambda$ is a parameter) represents three lines forming a triangle, then

List – I		List – II	
(P)	locus of circumcentre of variable triangle is	(1)	$y – 1 = 0$
(Q)	locus of centroid of variable triangle is	(2)	$y = 0$
(R)	locus of incenter of variable triangle is	(3)	$3y – 1 = 0$
(S)	locus of ex-centre opposite vertex (0, 1) of variable triangle is	(4)	$x^2 – y^2 – 2y + 1 = 0$
		(5)	$x^2 – y^2 + 2y + 1 = 0$

The correct option is:
(A) (P) → (2); (Q) → (4); (R) → (3); (S) → (5)
(B) (P) → (4); (Q) → (3); (R) → (2); (S) → (4)
(C) (P) → (4); (Q) → (3); (P) → (1); (S) → (5)
(D) (P) → (2); (Q) → (3); (R) → (4); (S) → (4)

43. Let A = {1, 2, 3, 4, 5, 6} and B = {1, 2, 3, 4}, then number of functions

List – I		List – II	
(P)	Defined from A to B and are either non-increasing or non-decreasing and into	(1)	is a prime no
(Q)	Defined from A to B and are either non-increasing or non-decreasing and onto	(2)	is a perfect square
(R)	Defined from B to B such that $f(i) \ne i\ \forall\ i \in B$ and into	(3)	is a multiple of 4
(S)	Defined from B to A such that $f(i) \ne i\ \forall\ i \in B$ and one-one	(4)	is having exactly 12 factors
		(5)	is a perfect cube

The correct option is:
(A) (P) → (2, 4); (Q) → (3); (R) → (1, 5); (S) → (3)
(B) (P) → (2, 3); (Q) → (3); (R) → (3, 4); (S) → (1)
(C) (P) → (2, 4); (Q) → (5); (R) → (3, 4); (S) → (3)
(D) (P) → (2, 3); (Q) → (3); (R) → (4, 5); (S) → (1)

44. Let ABCD be a rectangle of dimension $2a \times a$. If it is folded along its diagonal BD at an angle of 135°. If $a = \sqrt{10}$, then

List – I		List – II	
(P)	If distance between A and C (in new position) is $\sqrt{34 - b\sqrt{2}}$, then b is	(1)	6
(Q)	If volume of tetrahedron formed by points A, B, C and D (in new position) is V, then [V] is (where [.] represents greatest integer function)	(2)	5
(R)	If shortest distance between AB and CD (in new position) is $\frac{10}{\sqrt{d+\sqrt{2}}}$, then d is	(3)	8
(S)	If distance between A and C (in new position) if rectangle is folded completely is $c\sqrt{2}$, then 2c is	(4)	3
		(5)	4

The correct option is:
(A) (P) → (2); (Q) → (4); (R) → (3); (S) → (1)
(B) (P) → (3); (Q) → (1); (P) → (5); (S) → (4)
(C) (P) → (3); (Q) → (1); (P) → (5); (S) → (1)
(D) (P) → (2); (Q) → (3); (R) → (4); (S) → (4)

45. Let ABC be the triangle formed by joining ex-centre of triangle DEF. If AD intersects the circumcircle of ΔABC at point G such that D ≡ (8, 9) and G ≡ (6, 3) and circumcentre of ΔABC is at (30, 10), then

List – I		List – II	
(P)	if abscissa of orthocentre of ΔABC is	(1)	5
(Q)	the value of cos B cos C = k, then $\sqrt{\frac{10}{k^2}}$ is	(2)	10
(R)	the distance between vertex A and orthocentre is equal to d, then $\frac{d^2}{10}$	(3)	15
(S)	area of ΔABC is equal to Δ, then $\sqrt{\frac{\Delta}{21}}$ is	(4)	20
		(5)	25

The correct option is:
(A) (P) → (2); (Q) → (5); (R) → (5); (S) → (1)
(B) (P) → (5); (Q) → (3); (R) → (2); (S) → (4)
(C) (P) → (5); (Q) → (3); (P) → (2); (S) → (1)
(D) (P) → (2); (Q) → (3); (R) → (5); (S) → (4)

SECTION – B

(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

46. Number of triplets (α, β, γ) such that $\left|\frac{a\alpha^7 + b\beta^4 + c\gamma}{a\beta + b\gamma^4 + c\alpha^7}\right| = 1$ where $\alpha, \beta, \gamma \in \{1, \omega, \omega^2\}$ is equal to (ω and ω^2 are imaginary cube roots of unity)

47. Sum of series $\cot^{-1}\left(\frac{6}{k}\right) + \cot^{-1}\left(\frac{11}{k}\right) + \cot^{-1}\left(\frac{18}{k}\right) + \cot^{-1}\left(\frac{27}{k}\right) + ... + \infty$ upto infinite terms is equal to θ, then $2\cot\frac{\pi}{6}\cot\left(\frac{5\pi}{6} - \theta\right)$ is (Where $k = 2\sqrt{3}$)

48. Let $S = \sum_{b=1}^{\infty}\sum_{c=1}^{\infty}\frac{1}{b^2c + 2bc + bc^2}$ is $\frac{p}{q}$; p and q are relatively prime natural numbers, then p + q is

49. If $f(x) = \frac{2^{23}x + 2^{24}}{x^2 + 2^{24}x + 2^{24}}$, if f(1) + f(2) + f(4) + f(8) + ... + f(2^{24}) is k, then 2k is equal to

50. Product of roots of equation $\begin{vmatrix} 1+2x^7 & 1+x^4 & 1-x^1 \\ 2-x^4 & 2+x^5 & 3+x^6 \\ x^1 & 1+x^2 & 1-x^5 \end{vmatrix} = 0$ is p, then $16p^2$ is equal to

51. If S = {1, 2, 3, ..., 100}. Three numbers a, b, c are selected at random (with replacement) from set S. If largest number which appears is at least 81, then the probability that smallest number which appears is at most 40 is $\frac{p}{q}$; (q is a prime number), then p + q is equal to