FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2025
OPEN TEST – II
PAPER –1
TEST DATE: 13-04-2025

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

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 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 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based 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.

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	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

Physics

PART – I

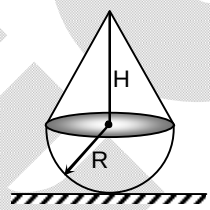
Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

1. Two infinite long thin wire have linear charge density $-\lambda$ and $+\lambda$. They are parallel to z-axis passing through x-axis at point x = –a and x = +a respectively. The equipotential surface having potential $\frac{\lambda \ell n(2)}{4\pi\varepsilon_0}$ is

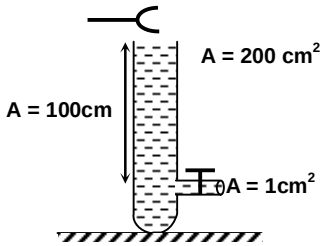
(A) a sphere
(B) A cylinder
(C) having radius of $\sqrt{2}a$
(D) having radius $2\sqrt{2}a$

2. In the shown figure a solid hemisphere of radius R and a cone of radius height H is welded. The object formed is placed on rough horizontal surface. Density of material is same for hemisphere and cone. If it is slightly displaced from its equilibrium position. The correct statements are/is



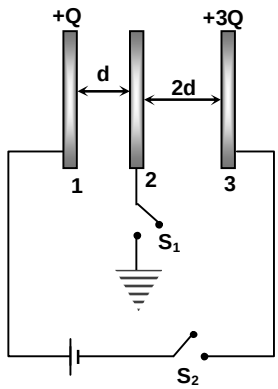
(A) It will oscillate if H = R
(B) It will have finite time period of H = 2R
(C) It will have finite time period if $H \le R\sqrt{3}$
(D) It will not oscillate if H = $R\sqrt{2}$

3. A tuning fork of frequency 1000 Hz is sounded over Resonance tube as shown in the figure. Speed of sound is v = 320 m/s and area of cross-section of tube is 200 cm^2 at the level of 100 cm a water outlet is attached. The water outlet has area of cross-section a = 1 cm^2 water outlet is opened at time t = 0. Neglect the end effect of resonance tube.



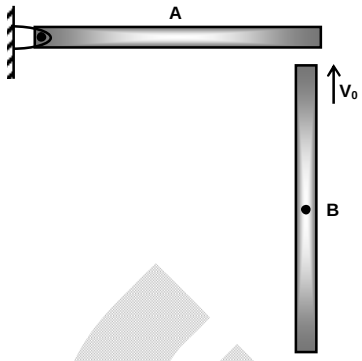
(A) First resonance will occur when water level goes down by 8 cm from open end of tube.
(B) First resonance will occur when water level is 16 cm below open end of tube
(C) The time after which resonance occurs first time is nearly half minutes.
(D) The time between first two resonances is nearly 3 minutes.

4. Three conducting sheets 1, 2 and 3 are placed parallel to each other such that separation between them is negligible. Sheet-1 and sheet-3 are given charges +Q and +3Q respectively. Cell of emf 1 V is to be connected between sheet 1 and 3. (Take $\frac{\varepsilon_0 A}{d} = 30$ mF and Q = 3 mC) where A is area of sheets. First switch S_1 is closed and then switch S_2 is closed.



(A) When switch S_1 is closed charge flow through S_1 is zero.
(B) When switch S_1 is closed charge flow through S_1 is 12 mC.
(C) When S_2 is closed charge flown through S_2 is 2 mC.
(D) When S_2 is closed charge flown through S_2 is 15 mC.

5. In figure shown rod A of mass 2m and length 2ℓ is kept on a horizontal frictional surface and hinged at point O such that it can rotate about vertical axis passing through O. Another identical rod B moving with a constant velocity v_0 collides with rod A at its end and stickes to it (both rods are perpendicular to each other)



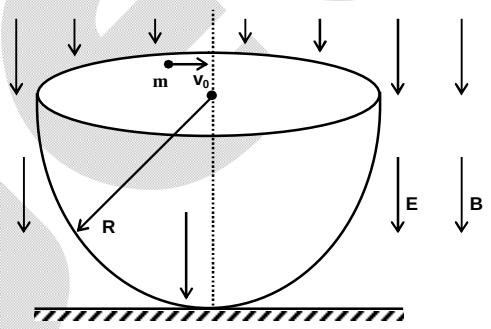
(A) angular velocity of system just after collision is $\frac{3v_0}{10\ell}$

(B) Velocity of centre of mass at system just after collision is $9v_0\sqrt{\frac{2}{5}}$

(C) Centre of mass of system is at a distance of $\sqrt{\frac{5}{2}}\ell$ from O.

(D) Kinetic energy of system just after collision is $\frac{3mv_0^2}{5}$

6. A particle of mass m, charge q is given horizontal velocity v_0 at the rim of smooth, fixed hemispherical shell. The particle moves down and always is in contact with the inner surface of shell uniform electric field E_0 and magnetic field B_0 is present in vertical direction. The correct statements are.



(A) The particle moves down and then it starts moving upwards.

(B) Conservation of energy can be applied.

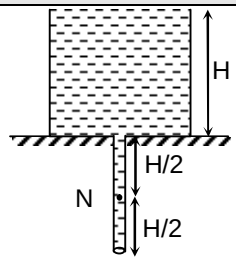
(C) Angular momentum of the particle along the vertical axis passing through centre of shall is conserved

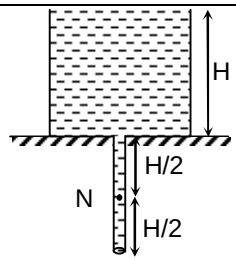
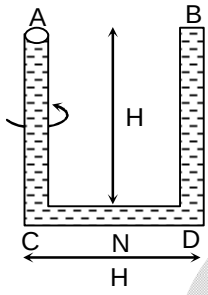
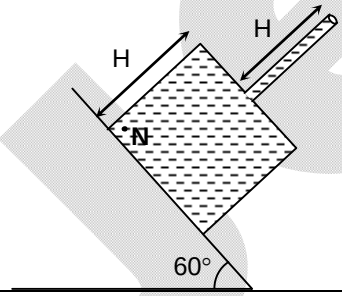
(D) Due to presence of torque. Angular momentum is not conserved

Section – A (Maximum Marks: 12)

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

7. In List-I liquid of uniform density is filled in container and in the List-II gauge pressure at point N is given

List –I				List -II
(I)	Wide container of height H and a pipe of length H is shown in the figure. The end of the pipe is closed		(P)	ρgH

(II)	Wide container of height H is connected with a pipe of small area of cross section. Liquid is allowed to flow out from pipe. Assume Bernoulli's theorem is valid		(Q)	$\frac{5}{4}\rho gH$
(III)	ABCD is U shape tube in which liquid is filled fully and end B is closed with help of cap, while end A is open. It is rotated about AC with angular speed $\omega = \sqrt{\frac{2g}{H}}$. Point N is at mid point of horizontal part of the tube.		(R)	$\frac{-\rho gH}{2}$
(IV)	A thin pipe of height H, connected with a wide vessel of height H filled with liquid is released from rest on smooth inclined plane. Point N is at the edge point of bottom of vessel.		(S)	$\frac{\rho gH}{2}$
			(T)	$\frac{3}{2}\rho gH$

Which one of the following options is correct ?

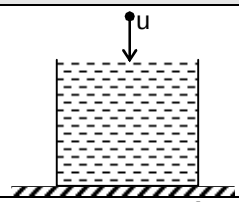
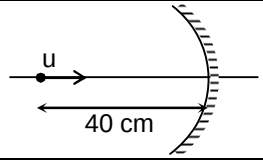
(A) I $\rightarrow$ Q, II $\rightarrow$ P, III $\rightarrow$ S, IV $\rightarrow$ T

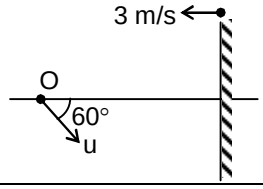
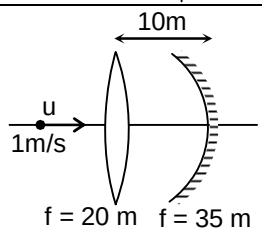
(B) I $\rightarrow$ T, II $\rightarrow$R, III $\rightarrow$ Q, IV $\rightarrow$ P

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

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

8. In List-I motion of a particle is shown and in List-II relative speed between object and its image is given.

List –I				List -II
(I)	Object is moving towards water with velocity 3 m/s. Refractive index of water is 4/3		(P)	10 m/s
(II)	Object O is moving towards concave mirror focal length 10 cm with velocity u= 9 m/s		(Q)	1 m/s

(III)	Object is moving towards plane mirror with velocity u = 2 m/s and mirror is also moving with velocity 3 m/s as shown in the figure.		(R)	0
(IV)	Observer O is moving toward lens with speed 1 m/s, which is at 15 m away from it. The separation between lens (f = 20 m) and mirror (f = 35 m) is 10 m.		(S)	8 m/s
			(T)	15 m

Which one of the following options is correct ?

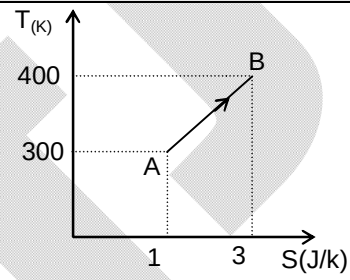
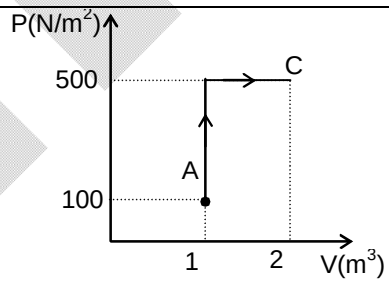
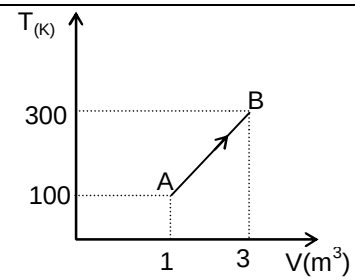
(A) I $\rightarrow$ Q, II $\rightarrow$ P, III $\rightarrow$ Q, IV $\rightarrow$ S

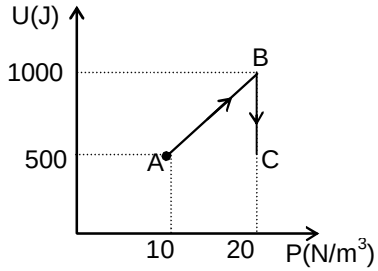
(B) I $\rightarrow$ Q, II $\rightarrow$ P, III $\rightarrow$ S, IV $\rightarrow$ R

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

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

9. In List-I, difference thermodynamics process are given and in List-II magnitude of possible heat exchange between system and surrounding are given due the process.

List –I				List -II
(I)	2 mole monoatomic ideal gas is taken through process A $\rightarrow$ B which is shown in temperature (T) and entropy(s) diagram		(P)	1850J
(II)	2 mole ideal monoatomic gas is taken through process A$\rightarrow$ B$\rightarrow$ C as shown in P-V diagram		(Q)	8314J
(III)	Two mole monoatomic ideal gas is taken through the process A$\rightarrow$B as shown in the T-V diagram		(R)	333J

(IV)	One mole monoatomic ideal gas is taken through the process ABC as shown in the figure, with the help of internal energy U and pressure P of the gas		(S)	400J
			(T)	700J

Which one of the following options is correct ?

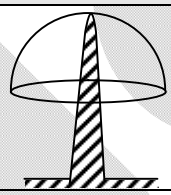
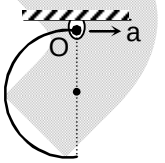
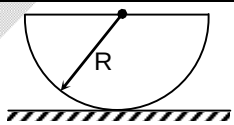
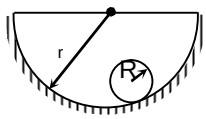
(A) I $\rightarrow$ T, II $\rightarrow$ P, III $\rightarrow$ R, IV $\rightarrow$ Q

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

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

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

10. In List-I a body is given which can oscillate if slightly disturbed from its equilibrium position. In List-II time period of oscillation is given.

List –I				List -II
(I)	A thin hemispherical shell of radius R is supported on the end of thin fixed vertical rod		(P)	$2\pi\sqrt{\frac{26R}{15g}}$
(II)	A thin semicircular ring of radius R is hanging from point O which is accelerating in horizontal direction with some acceleration so that the line joining two ends of the semicircular ring is vertical.		(Q)	$2\pi\sqrt{\frac{R}{g\sqrt{\left(1+\frac{4}{\pi^2}\right)}}}$
(III)	Solid hemisphere of radius R is placed on rough sufficiently rough horizontal surface to support rolling.		(R)	$2\pi\sqrt{\frac{2R}{g\left(1+\frac{4}{\pi^2}\right)}}$
(IV)	A solid sphere of radius R is placed in side a fixed concave surface of radius r = 6R friction is large between sphere and concave surface to support rolling.		(S)	$2\pi\sqrt{\frac{4R}{3g}}$
			(T)	$2\pi\sqrt{\frac{7R}{g}}$

Which one of the following options is correct ?

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

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

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

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

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based 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.*

11. A circular metal disc has some moment of inertia about it tangent passing in its plane as shown in figure-A. Now half of the disc is folded over the other half as shown in the figure. B. Find the fractional change in moment of inertia about the same axis rotation (use value of $\pi = 3.14$)

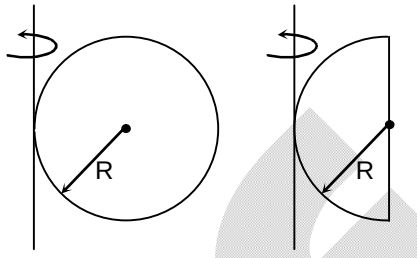
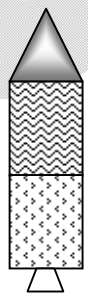
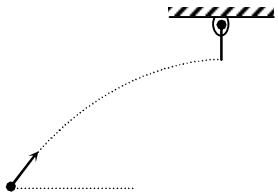


Fig-A Fig-B

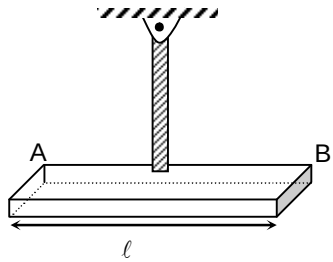
12. In year 2050 humans on earth as mastered in fusion reactor technology and due to atomic war possibility some of the people with all genetic material go on space journey for safer planet. Total mass of rocket system is 300000 kg thrust force is provided by radiation coming out of rocket system. Find the minimum rate of fuel consumption (in kg/s) so that rocket system can leave the earth. (Assume all radiation is coming out of nozzle of the rocket and it is in the form of parallel beam)



13. A thin rod of mass m = 1kg length ℓ = 20 cm is hanging from a high point. The point of suspension is capable of bearing only 10 N force. A particle of mass m′ = 1 kg is thrown from ground with velocity v_0 = 20 m/s at angle $\theta = 45°$ from horizontal. It collides with rod at its lowest point and sticks to it. The collision takes place when particle was moving horizontally. Find the number of rotation completed by rod before it falls on the ground. (Take value of g = 10 m/s^2 and π = 3.14)



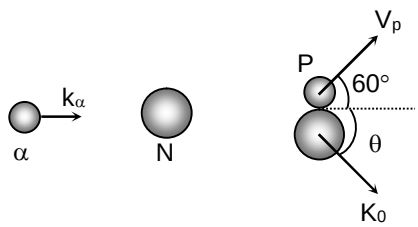
14. A bar AB of mass m = 10 kg and length ℓ = 10m is glued with a massless rod of length L = 20 m. The rod is free to rotate in vertical plane about horizontal axis passing at end O. An insect of mass m = 0.02 kg lands smoothly on the bar at end A and runs towards end B such that the rod remains vertical. Find the time taken by insect to reach at end B in seconds.



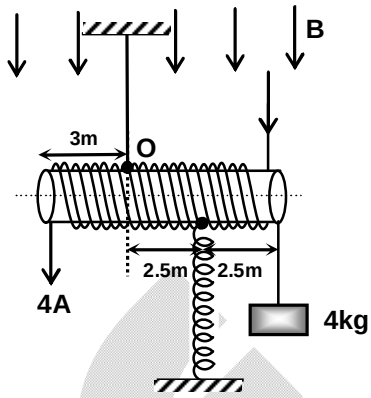
15. Consider the nuclear reaction, in which α particle collides with stationary nitrogen nucleus

$\alpha^4 + N^{14} \rightarrow O^{17} + P^1$

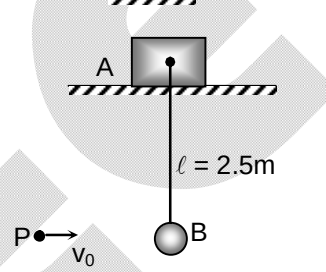
in which incoming α-particle has kinetic energy k_α = 4.0 MeV and outgoing proton going at angle 60° from incoming direction of α-particle has kinetic energy k_P = 2.09 MeV. The Q value of the reaction in MeV is



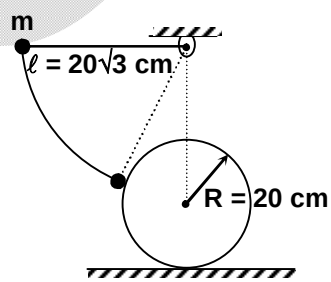
16. The figure shows a massless rod having current carrying coil of cross section area 10^{-2} m^2, current I= 4A and 20 turns. A spring of force constant k = 100 N/m is connected to rod at 2.5 m from point O. The other end of spring is connected to ground. Initially the spring is in relaxed state. At the end of rod a block of mass 4 kg is attached. When magnetic field of 5T is switched on. The spring is extended. Find extension in the spring in steady state in meter (for small angle $\sin\theta \approx \theta$).



17. A block with horizontal nail has total mass 5 kg, can move on smooth horizontal surface. A small sphere B of mass 4 kg is hanging from the nail with the help of thin, mass less string of length ℓ = 2.5 m. A small particle of mass m = 1kg moving horizontal with velocity v_0, hits the block B and get stuck with it. The minimum value of v_0 (in m/s) such that block B can complete circular motion about nail in vertical plane is $N\times10^2 m/s$ .The value of N is



18. A pendulum of mass m connected with string of length $\ell = 20\sqrt{3}$ cm. It is suspended above the centre of a sphere of radius 20 cm and mass m, at a distance 40 cm above centre of sphere. After collision pendulum stops. All surfaces are smooth. The coefficient of restitution is



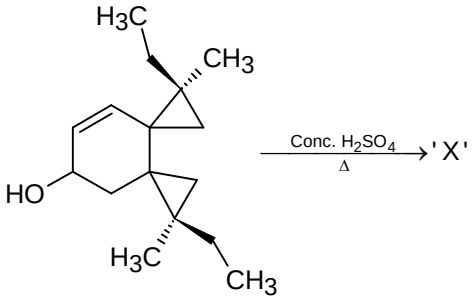
Chemistry

PART – II

Section – A (Maximum Marks: 24)

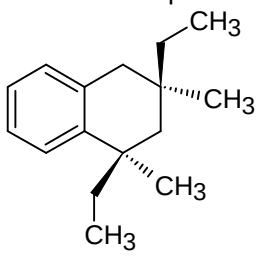
*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

19. Consider the following reaction:

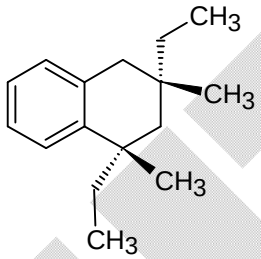


The structure of the product can be:

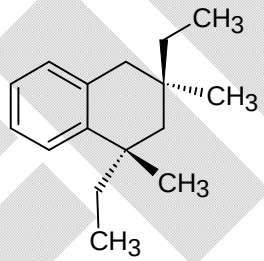
(A)



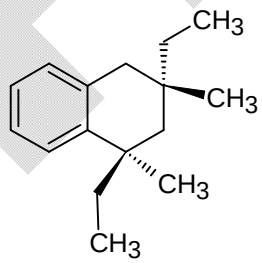
(B)



(C)



(D)



20. Which of the following reaction(s) can take place?

(A) $CH_3Br + 2Li \xrightarrow{Et_2O} LiCH_3 + LiBr$

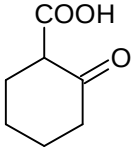
(B) $MgCl_2 + LiC_2H_5 \xrightarrow{Et_2O} C_2H_5MgCl + LiCl$

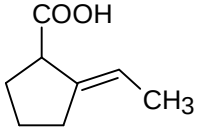
(C) $C_2H_5Li + C_6H_6 \xrightarrow{Et_2O} C_6H_5Li + C_2H_6$

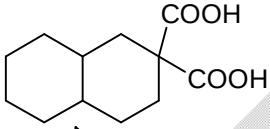
(D) $Li_3N + 2H_2 \xrightarrow{Et_2O} LiNH_2 + 2LiH$

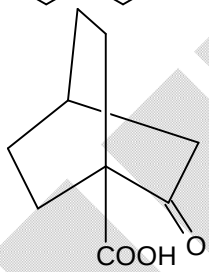
21. What happens when beryllium oxide is added to baryta water solution?
(A) BeO is insoluble in baryta water.
(B) BeO dissolves in baryta water.
(C) Basic character of the solution increases as the concentration of basic substance increases.
(D) pH of the solution decreases.

22. Which of the following compound(s) lose(s) CO_2 just on heating?

(A)


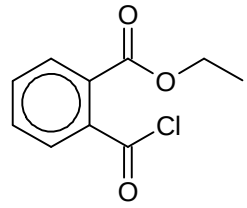
(B)


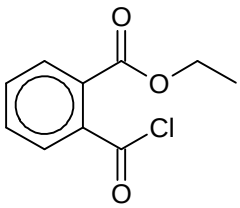
(C)


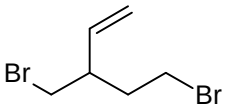
(D)


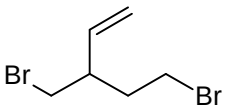
23. Which of the following statement(s) is/are correct?
(A) Eight Cs^+ ions occupy the second nearest neighbour locations of a Cs^+ ion in CsCl crystal.
(B) Each sphere is surrounded by six voids in two dimensional hexagonal close packed layers.
(C) If the radius of cation and the anion are 0.3 $\overset{o}{A}$ and 0.4 $\overset{o}{A}$ respectively, then coordination number of the cation of crystal is 6.
(D) In AgCl, the silver ion is displaced from its lattice positions to an interstitial positions, such a defect is called Frankel defect.

24. Which of the following is/are correct matched structure and IUPAC name?

(A)  : 2-Carboxyethyl benzoyl chloride

(B)  : Ethyl-2-(chloro-carbonyl) benzoate

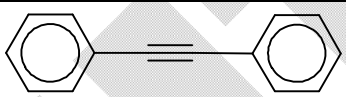
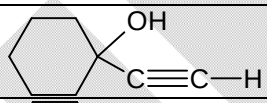
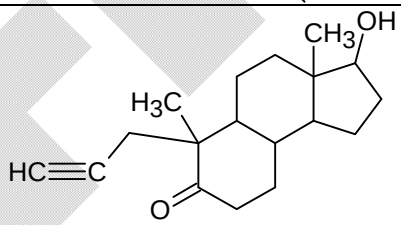
(C)  : 5-Bromo-3-(bromomethyl) pent-1-ene

(D)  : 1, 4-dibromo-3-ethyl butane

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). 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 compounds in List-I with their characteristics in List-II and choose the answer from the codes given below:

List – I		List – II	
(I)		(P)	Reacts with Lindlar's catalyst $(H_2 / Pd - BaSO_4)$.
(II)		(Q)	Trans alkene will form, when reacts with $Na / liq.\ NH_3$.
(III)		(R)	Produces hydrogen gas by means of sodium suspended in n-hexane.
(IV)		(S)	Degree of unsaturation is greater than two.
		(T)	Gives a white precipitate on reaction with $\left[Ag(NH_3)_2\right]NO_3$.

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

26. Match the compounds given in List-I with their corresponding characteristics in List-II and choose the correct option from the codes given below:

List – I		List – II	
(I)	$AlCl_3$	(P)	Lewis acid
(II)	BCl_3	(Q)	Forms acidic solution in water
(III)	B_2H_6	(R)	Sublimes on heating
(IV)	Alum	(S)	Swells on heating
		(T)	Empty orbital is involved in hybridisation

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

27. Consider the following galvanic cell at 25°C.

$$\underset{(1\,bar)}{Pt(s)/H_2(g)}\,|\left(\underset{(100\,mL,\,0.2\,M)}{H_3PO_4}+\underset{(100\,mL,\,0.1\,M)}{Na_3PO_4}\right)\Big\|\left(\underset{(100\,mL,\,0.1\,M)}{CH_3COOH}\,|\,\underset{(1\,bar)}{H_2(g)}/Pt(s)\right)$$

For $H_3PO_4: K_{a_1}=10^{-4},\ K_{a_2}=10^{-8},\ K_{a_3}=10^{-12}$ at 25^oC

For $CH_3COOH: K_a=1\times10^{-5}$ at 25^oC

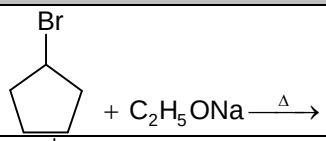
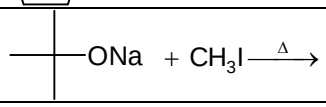
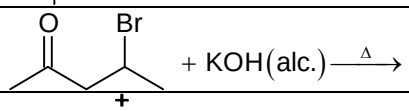
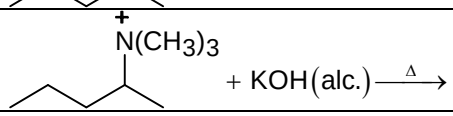
Now, some electrolyte is added in one of the compartment of the given cell in List-I and corresponding cell potential is given in List – II. Choose the correct option(s) from the codes given below:

[Take $\frac{2.303\,RT}{F}=0.06\ V,\ \log 2=0.3$]

List – I		List – II	
(I)	If no electrolyte is added in either of the compartment of cell, then	(P)	$E_{cell}=0.06\ V$
(II)	If 100 mL, 0.1 M NaOH solution is added in the anode compartment of the original cell, then	(Q)	$E_{cell}=0.282\ V$
(III)	If 50 mL, 0.1 M NaOH solution is added in the cathode compartment of original cell, then	(R)	$E_{cell}=0.18\ V$
(IV)	If 100 mL, 0.1 M HCl solution is added in the anode compartment of original cell, then	(S)	$E_{cell}=0.078\ V$
		(T)	E_{cell} decreases after addition with respect to its initial value.

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

28. Match the reactions given List-I with their corresponding characteristics in List-II and select the correct option from the codes given below:

List – I		List – II	
(I)		(P)	Major product is formed via E1cb mechanism
(II)		(Q)	Major product is formed via E_2 or E_2' mechanism
(III)		(R)	Reaction proceeds with the formation of transition state
(IV)		(S)	Carbanion is formed as intermediate
		(T)	Major product is formed via S_N2 mechanism

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

Section – B (Maximum Marks: 24)

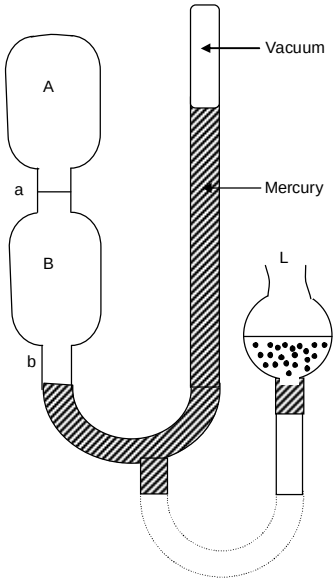
*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

29. Consider the following statements:

(i) There are a maximum of 5 plane of symmetry in a molecule of SF_6.
(ii) Paracetamol gives positive $FeCl_3$ test.
(iii) Asprin is used as an antipyretic as well as analgesic.
(iv) About 60% of the solar energy reaching the earth is absorbed by earth surface, which increases its temperature.
(v) Methane is one of the gas responsible for global warming.
(vi) SO_2 and NO_2 are major contributors of acid rain.
(vii) Clean water would have biochemical oxygen demand (BOD) value less than 5 ppm.
(viii) Water sample having nitrate content of 40 ppm is good for drinking purpose.
(ix) Azurite is a mineral of copper metal.

Of the above statements, the ratio of number of correct statements to the number of incorrect statements is:

30. Helium is contained at $30.2^{o}C$ in the system as shown in the figure.



Figure

The leveling bulb (L) can be raised so as to fill the lower bulb with mercury and force the gas into the upper part of the device. The volume of bulb 'A' to the mark 'a' is 100.5 cm^3 and volume of bulb 'B' between the marks 'a' and 'b' is 110 cm^3. The pressure exerted by helium is measured by the difference between the mercury levels in the device and in evacuated arm of the manometer. When mercury level is at 'b', the pressure is 20.14 mm Hg. If the mass of helium in the container be $x \times 10^{-4}$ g (scientific notation) $\left(R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}\right)$, then the value of 'x' is……

31. Two moles of an ideal gas at 1 bar and 298 K are compressed at constant temperature by use of constant pressure of 5 bar. If the compression is driven by a 100 kg mass, how far (in 'metres') will it fall in the earth's gravitational field? $\left(g = 10 \text{ m/s}^2\right)$.

32. The iodine content of a solution was determined by titration with cerium (IV) sulphate in the presence of HCl, in which I^- is converted to ICl. A 200 mL sample of the solution required 15 mL of 0.05 N Ce^{4+} solution, calculate the iodine concentration in original solution in g/L?

33. Ratio of the total number of isomers of Benzene hexachloride to that of $K\left[Co\left(NH_3\right)_2\left(F\right)_2\left(Cl\right)_2\right]$ is:

34. Consider the following reactions

$$P_4S_{10} + H_2O \longrightarrow (X) + \underset{(\text{Containing sulphur})}{(Y)}$$

$$P_4S_{10} \xrightarrow{PCl_5} (Z)$$

Let, the sum of all atoms in one molecule each of 'X' and 'Y' be x, and total number of atoms in a molecule (Z) = y, then calculate the value of $\frac{x}{y}$

35. Let, the maximum number of electrons present in palladium atom (Z = 46) satisfying the condition $\ell + m_\ell > 0$ be 'x' and the total number of plane of symmetry in $\sigma^*_{2p_z}$ orbital be 'y', then the value of $\frac{x}{y}$ will be……

36. Ratio of the total number of triangular faces to that of octagonal faces in a truncated solid cube is

Mathematics

PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

37. Which of the following is/are CORRECT statement(s)?

(A) The number of ways of arranging 5 boys and 5 girls in a queue if infront of each girl number of girls are more than or equal to the number of boys is k, then $\frac{k}{(5!)^2}$ is 42

(B) Let $z_1, z_2, ... z_n$ be complex number such that $|z_1| = |z_2| = ... = |z_n|$ and $\text{Re}\left(\sum_{j=1}^{n}\sum_{k=1}^{n}\frac{z_j}{z_k}\right) = 0$ if and only if $\sum_{k=1}^{n} z_k = 0$

(C) The number of ways of arranging 5 boys and 5 girls in a queue if infront of each girl number of girls are more than or equal to the number of boys is k, then $\frac{k}{(5!)^2}$ is 45

(D) Let a, b, c, x, y, z > 0 and ax + by + cz < d, then maximum value of xyz (d – ax – by – cz) is $\frac{d^4}{4^4 abc}$

38. Let $S_n = \sum_{r=1}^{n} t_r$ where $t_1 = 1$ and $t_r \geq 0$, $n \in N$. If $S_n = \frac{1}{2}\left(t_n + \frac{1}{t_n}\right)$, then

(Where [.] represents greatest integer function)

(A) $S_{100} = 10$

(B) $\lim_{n\to\infty}(S_n t_n) = \frac{1}{2}$

(C) $\left[\sum_{n=1}^{100}\frac{1}{S_n}\right] = 18$

(D) $\lim_{n\to\infty}(S_n t_n) = 1$

39. $\sum_{r=0}^{10}\frac{{}^{10}C_r}{{}^{30}C_{10+r}}$ is equal to

(A) $\frac{1}{{}^{30}C_{20}\cdot{}^{20}C_{10}}\sum_{r=0}^{10}{}^{10+r}C_r\cdot{}^{20+r}C_{10}$

(B) $\frac{1}{{}^{30}C_{20}\cdot{}^{20}C_{10}}\sum_{r=0}^{10}{}^{10+r}C_r\cdot{}^{20-r}C_{10}$

(C) $\frac{{}^{31}C_{10}}{{}^{30}C_{20}\cdot{}^{20}C_{10}}$

(D) $\frac{{}^{40}C_{10}}{{}^{30}C_{20}\cdot{}^{20}C_{10}}$

40. Let $f(x) = \lim_{m\to\infty}\frac{\ln(3+x^2) - x^{2m}\sin(x^2)}{1+x^{2m}}$, then which of the following is/are CORRECT?

(A) f(x) is discontinuous at two points

(B) There exists α such that $f(\alpha) = 1$

(C) The equation f(x) = 0 has atleast one root in $(1, \infty)$

(D) Minimum value of f(x) is equal to (–sin 1)

41. Let F(x) be a six degree polynomial with leading coefficient k. If y = F(x) touches, f(x) = x + α at x = 1, 2, and 3, then which of the following is/are CORRECT?

(A) If $\int_1^3 (F(x)-f(x))dx = \frac{32}{105}$, then k = 2

(B) F(x) – f(x) is divisible by $(x-1)^2(x-2)^2$

(C) If $\int_1^3 (F(x)-f(x))dx = \frac{32}{105}$, then k = 1

(D) F(x) – f(x) is divisible by $(x-2)(x-3)^2$

42. Consider the 3 planes $\vec{r}\cdot\vec{n}_1 = a$, $\vec{r}\cdot\vec{n}_2 = b$ and $\vec{r}\cdot\vec{n}_3 = c$ where abc $\neq$ 0, then which of the following is/are CORRECT?

(A) If the above 3 planes have common line of intersection, then $a(\vec{n}_2\times\vec{n}_3)+b(\vec{n}_3\times\vec{n}_1)+c(\vec{n}_1\times\vec{n}_2)=0$

(B) If the above 3 planes have a common line of intersection, then $a(\vec{n}_2\times\vec{n}_3)+b(\vec{n}_3\times\vec{n}_1)+c(\vec{n}_1\times\vec{n}_2)\neq 0$

(C) If $[\vec{n}_1\ \vec{n}_2\ \vec{n}_3]\neq 0$, then the above 3 planes will intersect at a point

(D) If $\vec{n}_1, \vec{n}_2, \vec{n}_3$ are non coplanar vectors, then the above 3 planes will intersect at point with position vector = $\frac{1}{[\vec{n}_2\ \vec{n}_2\ \vec{n}_3]}\{c(\vec{n}_1\times\vec{n}_2)+a(\vec{n}_2\times\vec{n}_3)+b(\vec{n}_3\times\vec{n}_1)\}$

Section – A (Maximum Marks: 12)

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

43. Let $f(x)=\begin{cases}\sqrt{1-x^2} & ; \ -1\le x\le 0\\ 1+x^2 & ; \ 0<x\le 1\\ 1+x^3 & ; \ x>1\end{cases}$ and g(x) is a function such that g(f(x)) = x, $\forall$ x $\geq$ –1 and f(g(x)) = x, $\forall$ x $\geq$ 0, then match the following List-I with List-II

List-I		List-II	
(I)	The range of y = g(x) is	(P)	[–2, ∞)
(II)	The domain of y = g(x) is	(Q)	[–1, ∞)
(III)	The range of y = f(f(f(g(x)))) is	(R)	[0, ∞)
(IV)	The domain of y = g(g(g(f(x)))) is	(S)	[1, ∞)
		(T)	[2, ∞)

The correct option is:

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

(B) (I) → (R); (II) → (Q); (III) → (T); (IV) → (S)

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

(D) (I) → (Q); (II) → (T); (III) → (R); (IV) → (S)

44. Match the following List-I with List-II

List-I		List-II	
(I)	The distance between the point A(–1, –5, –10) and point of intersection of $\frac{x-2}{3}=\frac{y+1}{4}=\frac{z-2}{12}$ with the plane $x + 5y + z + 1 = 0$ is	(P)	$\frac{1}{3}$
(II)	The distance of the point P(–2, 3, –4) from the line $\frac{x+2}{3}=\frac{2y+3}{4}=\frac{3z+4}{5}$ measured parallel to the plane $4x + 12y – 3z + 1 = 0$ is	(Q)	2
(III)	In ΔABC let P and Q be points on AB and BC respectively, such that $\frac{AP}{BP}=\frac{1}{3}$ and $\frac{CQ}{BQ}=\frac{3}{1}$. Let R be the point of intersection of AQ and CP, then area of ΔABC is (given area of ΔBRC is 1 square unit)	(R)	$\frac{13}{9}$
(IV)	If $f(x)=\int_{x}^{x+\frac{\pi}{3}}\lvert\sin t\rvert dt$, $0 \le x \le \pi$ has local maximum at x = k, then $\frac{k}{\pi}$ is	(S)	13
		(T)	$\frac{17}{2}$

The correct option is:
(A) (I) → (S); (II) → (T); (III) → (P); (IV) → (R)
(B) (I) → (S); (II) → (R); (III) → (T); (IV) → (P)
(C) (I) → (S); (II) → (P); (III) → (R); (IV) → (T)
(D) (I) → (S); (II) → (T); (III) → (R); (IV) → (P)

45. Let a double differentiable function g(x), satisfies the relation $g(x)\,g''(x) = (g'(x))^2 + g(x)\,g'(x)$, $g(0) = g'(0) = 1$, then match the following List-I with List-II

List-I		List-II	
(I)	The number of solution of the equation $g(x) = e^x$ is	(P)	1
(II)	$\lim_{x\to-\infty}(3e)^{g(x)}$ is	(Q)	5
(III)	$\lim_{x\to0}\frac{4(g(x)-1)}{x}$ is	(R)	4
(IV)	The number of real roots of the equation g(x) = x	(S)	3
		(T)	0

The correct option is:
(A) (I) → (P); (II) → (T); (III) → (R); (IV) → (S)
(B) (I) → (P); (II) → (S); (III) → (R); (IV) → (T)
(C) (I) → (P); (II) → (S); (III) → (T); (IV) → (R)
(D) (I) → (P); (II) → (R); (III) → (S); (IV) → (T)

46. Match the following List-I with List-II

List-I		List-II	
(I)	Let $2g(x)=\int_0^x (x-t)^2 f(t)dt$ and $\int_0^1 f(t)dt=3$, then g″(1) is	(P)	8
(II)	Let $g(x) = e^x + x + 1$, then $\int_2^{e+2} g^{-1}(x)dx$ is	(Q)	$\frac{1}{2}$
(III)	Let g: R → R be a differentiable function such that $g\left(\frac{x+y}{2}\right)=\frac{g(x)+g(y)}{2}$ ∀ x, y ∈ R. If g(0) = 1, g′(0) = 1, then area bounded by y = g(x) and co-ordinate axes is	(R)	4
(IV)	If the area bounded by $\|x\| \le 2$, $\|y\| \le 2$, $2xy \le x + y \le x^2 + y^2$ is A, then $A+\frac{\pi}{2}-\frac{1}{2}\ln 15$ is	(S)	3
		(T)	$\frac{3}{2}$

The correct option is:
(A) (I) → (S); (II) → (Q); (III) → (P); (IV) → (T)
(B) (I) → (S); (II) → (T); (III) → (P); (IV) → (Q)
(C) (I) → (S); (II) → (T); (III) → (Q); (IV) → (P)
(D) (I) → (S); (II) → (T); (III) → (Q); (IV) → (R)

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based 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.*

47. The number of polynomials P(x) with integral coefficient such that P(a) = b, P(b) = c and P(c) = a is (Where a, b and c are distinct integers)

48. Let a tangent to the parabola with focus S(1, 2), is x + y = 1 at A. If tangent intersects directrix and tangent at vertex at B and C respectively, then the value of AC·BC is equal to

49. Let AB and CD be the direct common tangents to $x^2 + y^2 = 4$ and $(x - 3)^2 + (y - 4)^2 = 9$. Let both the circles intersect at the point P. Let the Circumradius of the ΔCPD be r, then [r] is
(Where [.] represents greatest integer function)

50. The variable chords of the ellipse $\frac{x^2}{4}+y^2=1$ which subtends right angle at $\left(\sqrt{2},\frac{1}{\sqrt{2}}\right)$ pass through a fixed point P, the length of the tangent drawn from P to $x^2+y^2=\frac{1}{4}$ is $\sqrt{\frac{p}{q}}$, then p + q is equal to
(Where HCF of (p, q) is 1)

51. The value of $1+\sum_{k=1}^{8}\frac{\cos k\theta}{\cos^k\theta}$ for θ = 30° is p, then $\frac{\sin 9\theta}{p\sin\frac{\pi}{6}\left(\cos\frac{\pi}{6}\right)^8}$ is equal to

52. Let P and Q be invertible matrices of order 3×3 with real entries such that $P^{-1} + Q^{-1} = (P + Q)^{-1}$. If |P| = 5, then |Q| is equal to

53. Two persons A and B fire at the target. A fires 9 times and B fires 10 times. If probability of their success is $\frac{1}{2}$, then the probability that number of successful hit of B is more than that of A is

54. Let $N = \prod_{r=1}^{45} \sin((2r-1)^\circ)$, then $\sqrt{2}\, 2^{45} N$ is equal to