FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2025
PART TEST – III
PAPER –1
TEST DATE: 22-12-2024

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 – 04, 18 – 21, 35 – 38)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A *(05 –07, 22 – 24, 39 – 41):* 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 *(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 (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 – 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 – 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.

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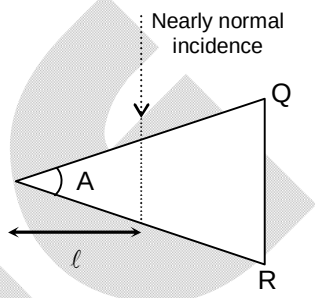
Physics

PART – I

SECTION – A
(One Options Correct Type)

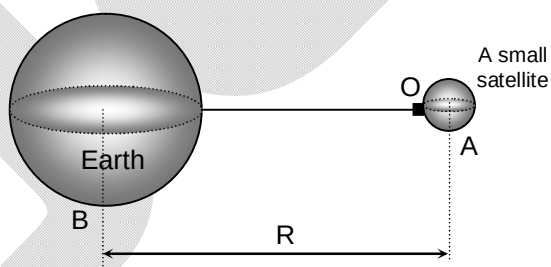
*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

1. A light of wavelength λ = 500 nm is incident on refracting surface PQ of a thin prism as shown in the figure. The refractive index of the prism is $\mu = \frac{5}{3}$. Interference results from light reflected from the outer surface PQ and that emerging after reflection at the inner surface PR. Consider light is made to fall at near normal incidence. The first constructive interference band is observed at a distance ℓ = 6.0 cm from apex of prism as shown. The apex angle of prism is



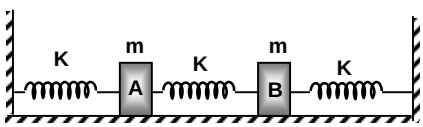
(A) 1.250×10^{-6} degree
(B) 5.275×10^{-5} degree
(C) 3.250×10^{-6} degree
(D) 7.165×10^{-5} degree

2. A small spherical satellite 'A' is orbiting around earth in circular orbit. Earth is assumed to be at rest and radius of satellite is 'r'. Satellite is always keeping the same face, towards the earth. Let an object 'O' on the satellite closest to the earth is in weightlessness. If mass of earth and satellite is M_e and m_s respectively then expression for the orbit radius 'R' (R >> r) is



(A) $\left(\frac{M_e}{m_s}\right)^{1/3} r$
(B) $\left(\frac{M_e}{3m_s}\right)^{1/3} r$
(C) $\left(\frac{3M_e}{m_s}\right)^{1/3} r$
(D) $\left(\frac{2M_e}{m_s}\right)^{1/3} r$

3. A and B are two identical block which are kept on smooth horizontal surface and they are connected with three identical massless springs as shown in the figure. Mass of each block is m and spring constant of spring is k.



Initially all springs are at relaxed position. Under suitable conditions, both blocks are slightly displaced towards right such that they oscillates in same phase and their respective displacements from mean position is given by x_1 = A sin ωt and x_2 = A sin ωt, where 'A' is the amplitude of blocks and ω its angular frequency. The time period of oscillation of block is given by

(A) $\pi\sqrt{\frac{m}{k}}$
(B) $2\pi\sqrt{\frac{m}{2k}}$
(C) $2\pi\sqrt{\frac{2m}{k}}$
(D) $2\pi\sqrt{\frac{m}{k}}$

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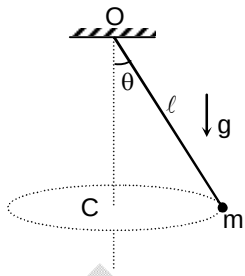
4. A particle of mass m = 2 kg is attached with a wire of length $\ell = \frac{3}{2}$ metre and other end of wire is fixed to point O. Now, particle is rotated in horizontal circular plane such that angle made by wire with vertical line is $\theta = 50°$ as shown in the figure. The diameter and Young's modulus of the wire are d = 0.5 mm and $Y = 2 \times 10^{11}$ N/m^2 respectively. The increase in the length of wire will be (sin 50° = 0.76, cos 50° = 0.64, g = 10 m/s^2, $\pi = 3.14$)

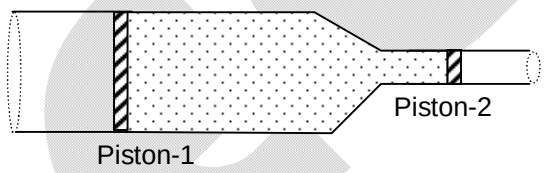


(A) 0.151 mm (B) 0.5971 mm
(C) 2.102 mm (D) 1.978 mm

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).*

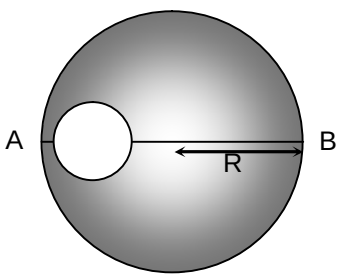
5. An incompressible liquid of density ρ is filled in a horizontal cylindrical pipe consists of two co-axial sections as shown in figure. There is piston in each section, liquid is filled between the pistons. The left section has radius r_1 and right section r_2. A constant pressure P_1 and P_2 ($P_1 > P_2$) is maintained just inside the pistons in the left and right sections respectively. If both pistons acquire constant speeds towards the right then choose the correct option(s).



(A) speed of left piston is $r_2^2\sqrt{\frac{2(P_1-P_2)}{\rho(r_1^4-r_2^4)}}$ (B) speed of right piston is $r_2^2\sqrt{\frac{2(P_1-P_2)}{\rho(r_1^4-r_2^4)}}$

(C) speed of left piston is $r_1^2\sqrt{\frac{2(P_1-P_2)}{\rho(r_1^4-r_2^4)}}$ (D speed of right piston is $r_1^2\sqrt{\frac{2(P_1-P_2)}{\rho(r_1^4-r_2^4)}}$

6. A spherical asteroid of uniform mass density and radius R is shown in the figure. An uniform acceleration due to gravity is observed on its equatorial plane AB. Now, a spherical cavity with its centre in the equatorial plane inside the asteroid is made. So that the minimum acceleration due to gravity becomes $\left(\frac{1}{6}\right)^{th}$ times to its initial value and maximum acceleration due to gravity becomes $\left(\frac{1}{4}\right)^{th}$ times to its initial value. Choose the correct option(s).



(A) Depth of centre of cavity from point A is $\frac{6R}{3+\sqrt{10}}$

(B) Depth of centre of cavity from point A is $\frac{R}{3+\sqrt{10}}$

(C) Radius of cavity is $\frac{(30)^{1/3}}{(3+\sqrt{10})^{2/3}}R$

(D) Radius of cavity is $(5)^{1/3}\left(\frac{6}{3+\sqrt{10}}\right)^{2/3}R$

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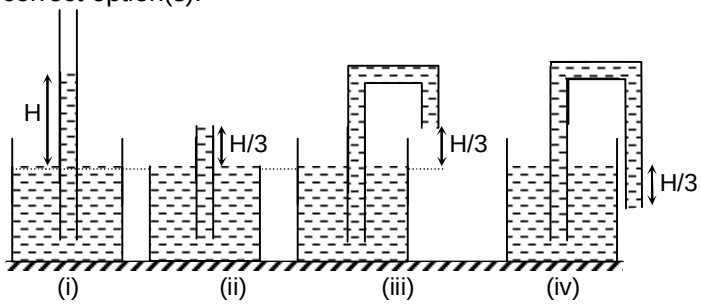
7. A liquid of density ρ and capillary tube of radius r is used in four different cases as shown in the figure. In all cases, capillary tube has same material. The angle of contact between capillary tube and liquid is zero. The maximum height attained by liquid is H as shown in the figure (i). Surface tension of liquid is S, atmospheric pressure is P_0 and acceleration due to gravity is g. Choose the correct option(s).



(A) liquid will be flowing out in figure (iv), but it will not flow out in figure (ii) and (iii)

(B) Radius of curvature of meniscus at the open end of capillary tube in figure (iii) is $\frac{6S}{\rho gH}$

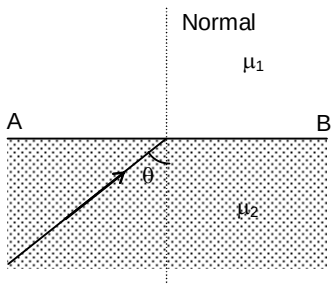
(C) Radius of curvature of meniscus at the open end of capillary tube in figure (iv) is $\frac{6S}{\rho gH}$

(D) Radius of curvature of meniscus in figure (ii) and (iv) is $\frac{1}{2}$

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 beam of light ray is incident at the interface 'AB' separating two mediums of refractive indices μ_1 and μ_2. Medium μ_2 is denser then medium μ_1. The angel of incidence is θ. Now match the **List-I** with **List-II**.



List –I		List –II	
(P)	Deviation in the path of ray if angle of incidence $\theta < \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$	(1)	$\pi - 2\sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$
(Q)	Maximum deviation in the path of ray for refraction at the interface AB	(2)	$\frac{\pi}{2} + \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$
(R)	Maximum deviation in the path of ray for reflection at the interface AB	(3)	$\frac{\pi}{2} - \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$
(S)	Deviation in the path of ray at grazing angle of incidence at the interface AB	(4)	zero
		(5)	$\left[\sin^{-1}\left(\frac{\mu_2 \sin\theta}{\mu_1}\right) - \theta\right]$

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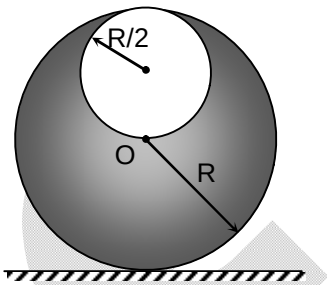
The correct option is:
(A) (P) → (4) (Q) → (5) (R) → (1) (S) → (3)
(B) (P) → (3) (Q) → (2) (R) → (5) (S) → (4)
(C) (P) → (3) (Q) → (2) (R) → (2) (S) → (4)
(D) (P) → (5) (Q) → (3) (R) → (1) (S) → (4)

9. A solid sphere of radius R with uniform volumetric mass density is kept on a rough horizontal surface. A spherical cavity of radius $\left(\frac{R}{2}\right)$ is made in a solid sphere as shown in the figure. Mass of cavitied sphere is M = 2 kg. If cavitied sphere is slightly displaced from its equilibrium position then it oscillates about point of contact. Friction force is sufficient to prevent slipping between sphere and the surface. Radius of sphere R = 70 cm. Now match the **List-I** with **List-II**. (Take g = 10 m/s^2)



List –I		List –II	
(P)	Position of centre of mass (in m) of cavitied sphere from point of contact in equilibrium position	(1)	0.9
(Q)	Moment of inertia (in kg/m^2) of cavitied sphere about an axis passing through O and perpendicular to plane of motion.	(2)	1.68
(R)	Moment of inertia (in kg-m^2) about an axis passing through point of contact and perpendicular to plane of motion.	(3)	0.399
(S)	Angular frequency (in rad/s) of oscillation	(4)	1.23
		(5)	0.65

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

10. It is given that symbol 'G' stands for a universal gravitational contact, 'h' stands for plank constant, 'P' stands for power, 'S' stands for surface tension and 'η' stands for coefficient of viscosity. Some derived physical quantities are given in **List-I** and their dimension's in **List-II**. Now match the **List-I** with **List-II**.

List –I		List –II	
(P)	The dimension of $\frac{hG}{\eta}$	(1)	$\left[M^{-1}L^3T^{-2}\right]$
(Q)	The dimension of $\frac{GS}{P}$	(2)	$\left[MLT^{-2}\right]$
(R)	The dimension of $\frac{\eta P}{S}$	(3)	$\left[M^{-1}LT^{-1}\right]$
(S)	The dimension of $\frac{hP}{G}$	(4)	$\left[M^{-1}L^6T^{-2}\right]$
		(5)	$\left[M^3LT^{-2}\right]$

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

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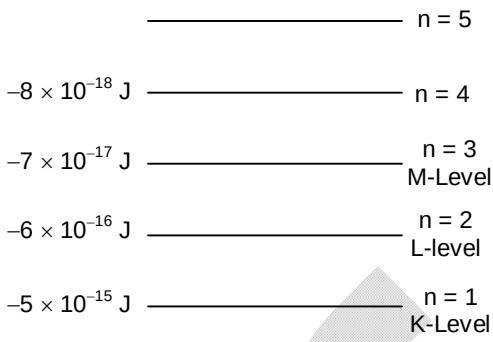
11. Energy levels of a hypothetical atom are shown in the figure. The hypothetical atom is bombarded with high energetic electrons. The bombarded electrons has ability to complete removal of electrons from k-level, this vacancy is filled by de-excitation of electrons from L-level to k-level, this energy may appear as x-rays or may all be used to kick out electron from M-level of the atoms. Now match the **List-I** with **List-II**.



List –I		List –II	
(P)	The minimum potential difference (in volt) of high energetic electron required to kick out the electrons from k-level of atom.	(1)	4.33×10^{-15}
(Q)	Energy released (in Joule) when L-level electron moves to fill the vacancy in the k-level.	(2)	4.4×10^{-15}
(R)	Wave length of x-ray emitted (in joule) in meter	(3)	5.12×10^{-15}
(S)	Kinetic energy (in joule) of electron emitted from the M-level	(4)	3.125×10^{4}
		(5)	4.54×10^{-11}

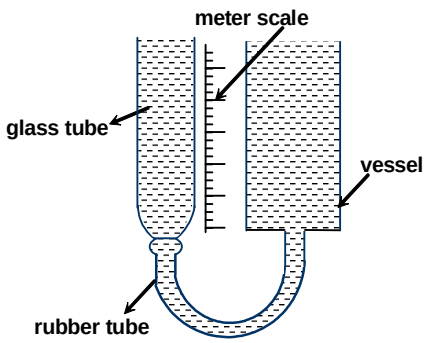
The correct option is:

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

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 reservoir and a resonance tube is used to measure the speed of sound in air by using a tuning fork of frequency 678 Hz as shown in the figure. The reservoir can be used to change the level of water in resonance tube and thus the length of the air column in the tube. Initially, the reservoir is kept in such a way so that the pipe is full up to the brim. The area of cross-section of resonance tube is $\left(\frac{1}{5}\right)$ times that of the reservoir. Now, the tunning fork is sounded and the reservoir is lowered. When the reservoir is lowered by 24 cm, first resonance is recorded. When the reservoir is lowered further by 30 cm the second resonance is observed. Find the speed of the sound (in m/s) in the air.



13. Three similar particles of mass 'm' are kept on the vertices of an equilateral triangle of side 'ℓ' and located in a space. System is revaluing in circular orbit under mutual gravitational attractive force. Suddenly, one of the particles loses its ability to exert gravitational force on other particles and immediately escapes without disturbing the other particles. The velocity of centre of mass of other two particles after this incident is $\sqrt{\frac{8Gm}{\lambda\ell}}$. Find the value of λ.

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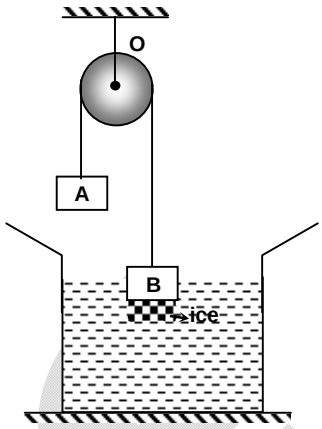
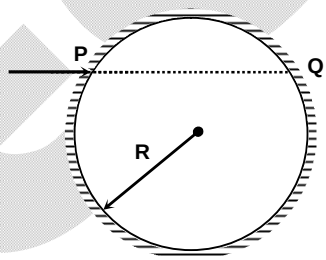
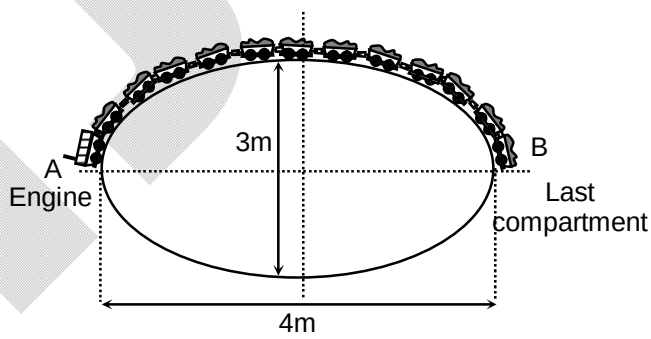
14. Two blocks A and B are suspended from ideal massless fixed pulley with the help of massless string. Pulley is attached from point O and system is kept in vertical plane. At the bottom of block B an ice of unknown mass is affixed as shown in the figure. Initially, half volume of block B is submerged in water kept in a large tank such that ice is completely immersed and system is in equilibrium. Now, ice melts very slowly, when all the ice melts, the system still remain in equilibrium but block B is now completely submerged in water. Block A remains in air all the time. It is given that density of block B is ρ_B = 8000 kg/m^3, density of ice $\rho_i = 900$ kg/m^3 and density of water $\rho_w = 1000$ kg/m^3. To happened the above said condition, if ratio of mass of block B to mass of ice is $\frac{\lambda_1}{\lambda_2}$, then find the minimum value of $\lambda_1 + \lambda_2$ in nearest integer.



15. A vertical cylinder of radius R = 20 cm is kept on a horizontal surface, its outer surface is polished so that reflection takes place from it. There is a very small hole at P, a light ray enters horizontally along the chord PQ = 32 cm, a multiple reflection takes place from inner surface of cylinder. After how many reflections on the inner surface of the cylinder the light ray will be incident at point P.



16. In a children amusement park, a toy train AB is running on an elliptical path as shown in the figure. The major and minor axes of elliptical paths are 4m and 3m respectively. The length of train AB is exactly equal to half the perimeter of the elliptical path. The toy train is running at a constant speed of 5 m/s. Assume the length of the engine and compartment of toy train is very small. The engine sounds a whistle when its acceleration is minimum. Let f_C is the frequency observed by an observer in the central compartment and f_L is the frequency observed by an observer in the last compartment. The speed of sound in the air is 332 m/s and whistle has a frequency f_0 = 4325 Hz. If $\frac{f_C}{f_2}$ is equal to $\frac{\lambda_1}{\lambda_2}$, then find the minimum value of $(\lambda_1 + \lambda_2)$ in nearest integer.



17. In a photoelectric setup a beam of light has intensity of 500 W/m^2,it is equally distributed among there wavelength of 310 nm, 496 nm, and 620 nm. The work function of metallic surface is ϕ = 2.2 eV and its surface area A = 3 cm^2. Light is incident at an angle of 37° with the normal of surface. Assuming that there is no loss of energy and each energetically capable photons effects a photoelectron. Find the saturation photocurrent in milliampere.

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Chemistry

PART – II

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.*

18. Which of the following configuration **do not show John Teller** distortion
(A) d^5 (low spin) (B) d^6 (high spin)
(C) d^6 (low spin) (D) d^4 (low spin)

19. An ice at temperature T°C is added to 25 g of liq water at 40°C. The final temperature of the 30 g equilibrium mixture is 19°C. The value of T is
Given : Specific heat of $H_2O(\ell) = 4.2\,J/g^oC$, specific heat of $H_2O(s) = 2.0\,J/g^oC$,
Latent heat of fusion of $H_2O(s) = 330\ J/g$
(A) –9.8 (B) –15.6
(C) –10.2 (D) –8.4

20. $[Re_2Cl_8]^{2-}$ has quadruple metal – metal bond and it has intense blue colour. Hence, its intense blue colour is due to?
(A) $d \rightarrow d$ transition (B) $\sigma \rightarrow \sigma^*$ transition
(C) $\pi \rightarrow \pi^*$ transition (D) $\delta \rightarrow \delta^*$ transition

21. 2 mole benzene and 1 mole toluene are mixed to form an ideal liquid solution. What will be the ratio of moles of benzene to toluene in last trace of liquid
Given: $P^o_{Benzene} = 100$ mm of Hg
$P^o_{Toluene} = 60$ mm of Hg
(A) 0.83 (B) 1.2
(C) 0.6 (D) 0.3

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).*

22. Correct order among the following is/are?
(A) HF > HCl > HBr > HI (Dipole moment)
(B) $HOCl < HClO_2 < HClO_3 < HClO_4$ (Acidic strength)
(C) $H_2S < H_2Se < H_2Te < H_2O$ (Boiling point)
(D) $NH_3 > PH_3 > AsH_3 > SbH_3$ (Bond angle)

23. The spin only magnetic momentum of Fe^{x+} is found to be 4.89 B.M, the value of x could be
(A) 0 (B) 4
(C) 2 (D) 6

24. The **INCORRECT** option(s) is/are
(A) In 1-euqivalent of H_2SO_4, only 1-equivalent of H-atom present
(B) Number of moles of oxygen atom present in 138 g of N_2O_4 is 6
(C) 28 gm of ethene required minimum 48 gm of O_2 (g) for complete combustion
(D) Volume strength of 0.1 N H_2O_2 is 1.12

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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 action List – I with corresponding reagents in List – II and choose the correct option

List – I (Observations)		List – II (Reagents)	
(P)	Mg^{2+} gives pale pink mass with	(1)	NaOH solution
(Q)	Pb^{2+} gives yellow ppt. with	(2)	H_2S gas
(R)	Ag^{+} gives black/brown ppt. with	(3)	K_2CrO_4 solution
(S)	Hg_2^{2+} gives black ppt. with	(4)	KI (not in excess)
		(5)	Cobalt nitrate in charcoal cavity test

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

26. Match the following

List – I		List – II	
(P)	Gold number	(1)	Optical properties of colloids
(Q)	Miscelles	(2)	Flocculation power
(R)	Hardy Schulze rule	(3)	Protecting power of lyophilic colloids
(S)	Tyndall effect	(4)	Peptization
		(5)	Associated colloids

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

27. Match the following

List – I		List – II	
(P)	Triclinic	(1)	$a = b = c$
(Q)	Orthorhombic	(2)	$a = b \neq c$
(R)	Tetragonal	(3)	$a \neq b \neq c$
(S)	Hexagonal	(4)	$\alpha = \beta = \gamma \neq 90^o$
		(5)	$\alpha = \beta = \gamma = 90^o$

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

28. Match the following

List – I		List – II	
(P)	Antibiotic	(1)	Paracetamol
(Q)	Antipyretic	(2)	Terpineol
(R)	Tranquilizer	(3)	Aspirin
(S)	Analgesic	(4)	Ofloxacin
		(5)	Meprobamate

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

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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. The number of black coloured compounds among the following
Ag_2SO_3, $AgNO_2$, Ag_2S, AgI, PbS, ZnS, FeS, $Fe(OH)_3$, $BaCO_3$.

30. Total number of possible isomers for $\left[Fe(gly)_2Cl_2\right]^{-2}$
$\left[gly = NH_2 - CH_2 - COO^-\right]$

31. 1 g (80% pure) sample of $CaCO_3$(s) was strongly heated and the liberated CO_2 was absorbed in 100 ml 0.2 M NaOH solution, resulting solution was titrated against 0.3 M HCl in presence of phenolphthalein indicator. Find the volume (in ml) of HCl required to reach the end point.

32. The percentage of butane by volume in a mixture of butane, propane and propyne is 40%. What will be the value of CO_2(g) produced when 150 ml of gaseous mixture is burnt in excess of O_2.

33. How many of the following pair of liquid solution(s), show positive deviation from ideality
Ethanol + H_2O
Ethanol + Hexane
Benzene + CCl_4
Acetone + CS_2
Acetone + Chloroform
Phenol + Aniline
$H_2O + HNO_3$
Ethyl bromide + Ethyl iodide

34. The freezing point of aqueous solution that contains 5% each of urea and acetic acid by weight is found to be -3.33^oC, what will be the percentage degree of dissociation of acetic acid at freezing point.
Given K_f of $H_2O = 1.62 kgK\ mol^{-1}$

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Mathematics

PART – III

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.*

35. Let A(1, 0, 0), B(0, 3, 0), C(0, 0, 5) and D(3, 2, 1) form a tetrahedron. If points E, F, G are taken on AD, BD, CD such that they divide those line segments in the ratio 1 : 2, 2 : 3, 3 : 4 respectively, then ratio of volume of the solid; formed by the triangles ABC, EFG and edges AE, GC, BF; to that of volume of tetrahedron ABCD is

(A) $\frac{8}{35}$ (B) $\frac{19}{35}$

(C) $\frac{27}{35}$ (D) $\frac{31}{35}$

36. If two non-null, idempotent matrices A and B are such that AB + BA = 0, then which of the following is **NOT** true?

(A) A has to be singular matrix (B) B has to be singular matrix

(C) AB has to be singular matrix (D) None of these

37. Locus of foot of perpendicular of any point on the curve x = 0, $\frac{y^2}{16}+\frac{z^2}{9}=1$ to the plane x + y + z = 1 is

(A) $16x^2 + 9y^2 + 25z^2 - 18xz - 32xy = 1$ (B) $16x^2 + 9y^2 + 25z^2 - 32xz - 18xy = 144$

(C) $25x^2 + 9y^2 + 16z^2 - 18xy - 32xz = 144$ (D) $25x^2 + 9y^2 + 16z^2 - 32xy - 16xz = 1$

38. Number of real roots of the equation $x^5 + 2x^4 - 2x^3 - 3x^2 + 2x = 0$ is

(A) 0 (B) 1

(C) 3 (D) 5

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).*

39. There are 3 apples of which 1 is rotten, 4 oranges of which 2 are rotten and 2 pears of which 1 is rotten. Number of ways to arrange them in a straight line such that (rotten oranges are considered similar)

(A) any two rotten fruits have atleast 2 fruits in between them is 0

(B) all apples, oranges and pears are together respectively is 216

(C) any 2 rotten fruits have exactly 1 fruit between them is 1080

(D) all rotten fruits are together is 2160

40. If $\sum_{r=2}^{n}\frac{r^6-3r^4-3r^2-3}{r^6-3r^4+3r^2-1}=f(n)+\frac{g(n)}{(h(n))^3}$ where f(n), g(n), h(n) are linear, cubic and quadratic in 'n', respectively, then

(A) $f(1)=-\frac{5}{4}$ (B) g(1) = 9

(C) h(1) = 2 (D) $f(1)+g(1)+h(1)=\frac{39}{4}$

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41. Let $S_r = \left\{ z \mid \sum_{k=1}^{\frac{2024}{r}} z^{(k-1)r} = 0 \right\}$ where 'r' is a natural number which divides 2024, then

(A) maximum possible value of $n(S_r)$ $\forall$ r is 2024
(B) there exists more than 8 ordered pairs (i, j) such that $S_1 = S_i \cup S_j$ $(i, j \neq 1)$
(C) there does not exist any ordered pair (i, j) such that $S_8 = S_i \cap S_j$ $(i, j \neq 8)$
(D) $n(S_8 \cap S_{11} \cap S_{23}) = 1984$

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. Let $A = \{z \mid z\bar{z} - 4i\bar{z} + 4iz + 15 = 0\}$, $B = \{z \mid z(i + \sqrt{3}) + \bar{z}(i - \sqrt{3}) - 2\sqrt{3}i = 0\}$. Let $z_1 \in A$, $z_2 \in B$, then match entries in List-I to their corresponding values in List-II. (arg(z) represents principal argument of complex number z)

List – I		List - II	
(P)	If $\arg(z_1 - z_2) \in (a, b)$ and $b - a < c$ $\forall$ z_1, z_2, then minimum value of $\frac{2c}{\pi}$ is	(1)	2
(Q)	If $\arg(z_1 - z_2) = 0$, then maximum possible value of $\lvert z_1 - z_2 \rvert$ is less than	(2)	$\frac{10}{3}$
(R)	If $\arg(z_1 - z_2) = 0$, then minimum possible value of $\lvert z_1 - z_2 \rvert$ is greater than	(3)	4
(S)	If $\arg(z_1 - z_2) = \frac{\pi}{2}$, then difference of maximum and minimum possible values of $\frac{\lvert z_1 - z_2 \rvert}{2}$ is	(4)	7
		(5)	8

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

43. There is a bag containing 5 balls of 5 colours each from which 5 balls are randomly drawn. Let x represent the number of different colored balls drawn, P(i) represent probability of x = i, S(n) represents sum of digits of the number 'n'

List – I		List - II	
(P)	If P(k) is maximum of all possible values of k, then $S\left({}^{25}C_5\, P(k)\right)$ equals	(1)	5
(Q)	If P(a) > P(b) > P(c) > P(d) > P(e), then S(a + b + c – d – e) equals	(2)	7
(R)	If E is the expectation value of the probability distribution, then $S\left({}^{25}C_5\, E\right)$ equals	(3)	9
(S)	If P(k) is minimum for all possible values of k, then $S\left({}^{25}C_5\, P(4-k)\right)$	(4)	15
		(5)	23

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

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44. Given that x + y + z + ω = 30. Match the number of solutions to this equation in List-II with the constraints placed on x, y, z, ω in List-I

List – I		List - II	
(P)	x, y, z, ω ∈ I ; x ≥ –1, y ≥ 3, z ≥ 5, ω ≥ 0	(1)	585
(Q)	x, y, z, ω ∈ I ; x ≥ 0, 2 ≤ y ≤ 7, 4 ≤ z ≤ 8, ω ≥ 1	(2)	680
(R)	x, y, z, ω ∈ W and x, y are odd while z, ω are even	(3)	816
(S)	x, y, z, ω ∈ N and ω is multiple of 5	(4)	580
		(5)	2600

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

45. Let $f(i) = {}^{n}C_{i}(i+1)^2$, $g(i) = \frac{{}^{n}C_{i}}{i+1}$. Let a(n) and b(n) be any polynomial functions of 'n', then match number of roots of a(n) = b(n) in List-II with corresponding a(n) and b(n) obtained from List-I

List – I		List - II	
(P)	$\sum_{r=0}^{n} f(r) = a(n)2^{b(n)}$	(1)	0
(Q)	$\sum_{r=0}^{n} g(r) = a(n)2^{b(n)} - a(n)$	(2)	1
(R)	$\sum\sum_{i=j} f(i)g(j) = (a(n) - b(n) + 2)\,{}^{a(n)}C_{b(n)}$	(3)	2
(S)	$\sum\sum_{i\neq j} f(i)g(j) = (n+4)(2^{a(n)} - 2^{b(n)}) - (n+2)\,{}^{a(n)}C_{1+b(n)}$	(4)	3
		(5)	∞

The correct option is:
(A) (P) → (1); (Q) → (3); (R) → (2); (S) → (2)
(B) (P) → (3); (Q) → (1); (R) → (5); (S) → (4)
(C) (P) → (2); (Q) → (3); (R) → (2); (S) → (4)
(D) (P) → (1); (Q) → (1); (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. If $\sum_{r=1}^{2025} \frac{2025^r}{r!}(4050 + 2024r - r^2) = \frac{a^a \cdot b}{c!} - 4050$ where b > a > c ; a, b, c ∈ N, then minimum value of a + b + c is

47. Let $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + 10\hat{j} + 3\hat{k}$, $\vec{c} = 3\hat{i} - \hat{j} + \hat{k}$, $\vec{p} = (\vec{a} \times \vec{b}) \times \vec{c}$, $\vec{q} = (\vec{b} \times \vec{c}) \times \vec{a}$, $\vec{r} = (\vec{c} \times \vec{a}) \times \vec{b}$, then $[\vec{p}\ \vec{q}\ \vec{r}]$ equals

48. If $\Delta(x) = \begin{vmatrix} \cos x & \cos 2x & \cos 3x \\ \cos 4x & \cos 5x & \cos 6x \\ \cos 7x & \cos 8x & \cos 9x \end{vmatrix}$, then $\Delta'(0) + \Delta'\left(\frac{\pi}{2}\right) + \Delta'(\pi)$ is

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49. If P and Q be two invertible matrices of order 2025 $\times$ 2025 such that |P| = –2025 and $P^{-1}Q + Q^{-1}P = I$, then |Q| is

50. A bag contains 2 red, 2 blue and 2 green balls. A fair dice is rolled. Balls are randomly picked from the bag equal to the number on the dice. Given that the ball drawn consists of 3 different colours, the probability of getting a 6 on dice is 'k', then 90k equals

51. Maximum possible distance of line $\frac{x-1}{a} = \frac{y-2}{b} = \frac{z-3}{c}$ the plane 2x + 2y + z + 27 = 0

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