CHEMISTRY

Part I

Section–I

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

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1. Oxidation states of the metal in the minerals haematite and magnetite, respectively, are

(A) II, III in haematite and III in magnetite **(B)** II, III in haematite and II in magnetitie

(C) II in haematite and II, III in magnetite **(D)** III in haematite and II, III in magnetitie

Ans. (D)

2. Among the following complexes (K - P),

$K_3[Fe(CN)_6]$ (K), $[Co(NH_3)_6]Cl_3$ (L), $Na_3[Co(oxalate)_3]$ (M), $[Ni(H_2O)_6]Cl_2$ (N),

$K_2[Pt(CN)_4]$ (Q) and $[Zn(H_2O)_6](NO_3)_2$ (P)

the diamagnetic complexes are

(A) K, L, M, N **(B)** K, M, O, P

(C) L, M, O, P **(D)** L, M, N, O

Ans. (C)

3. Passing H_2S gas into a mixture of Mn^{2+}, Ni^{2+}, Cu^{2+} and Hg^{2+} ions in an acidified aqueous solution precipitates

(A) CuS and HgS **(B)** MnS and CuS

(C) MnS and NiS **(D)** NiS and HgS

Ans. (A)

4. Consider the following cell reaction

$$2Fe_{(s)} + O_{2(g)} + 4H^+_{(aq)} \longrightarrow 2Fe^{2+}_{(aq)} + 2H_2O(l) \qquad E^0 = 1.67\ V$$

At $[Fe^{2+}] = 10^{-3}$ M, $P(O_2) = 0.1$ atm pH = 3, the cell potential at 25^{0}C is

(A) 1.47 V **(B)** 1.77 V **(C)** 1.87 V **(D)** 1.57 V

Ans. (D)

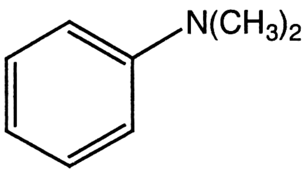
CHEMISTRY

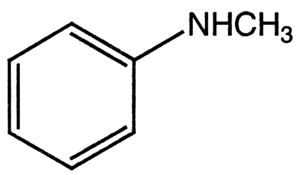
5. The freezing point (in ^0C) of a solution containing 0.1 g of $K_3[Fe(CN)_6]$ (Mol. Wt. 329) in 100 g of water $(K_f = 1.86 \text{ kg mol}^{-1})$ is

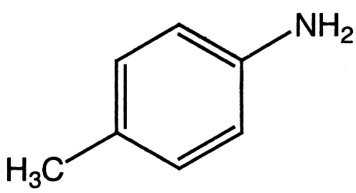
(A) -2.3×10^{-2} **(B)** -5.7×10^{-2} **(C)** -5.7×10^{-3} **(D)** -1.2×10^{-2}

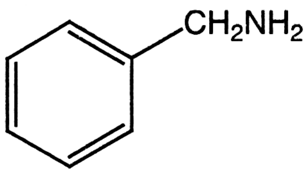
Ans. **(a)**

6. Amongst the compounds given, the one that would form a brilliant colored dye on treatment with $NaNO_2$ in dil. HCl followed by addition to an alkaline solution of $\beta-$ naphtol is

(A)


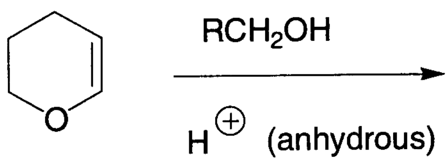
(B)


(C)


(D)


Ans. **(C)**

7. The major product of the following reaction is

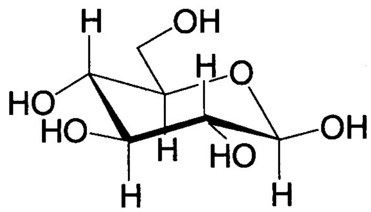


(A) a hemiacetal **(B)** an acetal **(C)** an ether **(D)** an ester

Ans. **(B)**

CHEMISTRY

8. The following carbohydrate is



(A) a ketohexose **(B)** an aldohexose **(C)** an α – furanose **(D)** an α – pyranose

Ans. (B)

Section–II

Multiple Correct Answer Type

This section contains 5 multiple choice questions numbered 8 to 14. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE** is / are correct.

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9. Reduction of the metal centre in aqueous permagnetic ion involves

(A) 3 electron in neutral medium **(B)** 5 electrons in neutral medium

(C) 3 electron in alkaline medium **(D)** 5 electrons in acidic medium

Ans. (C,D)

10. The equilibrium

$2Cu^{I} \rightleftharpoons Cu^{0} + Cu^{II}$

in aqueous medium at 25 ^{0}C shifts towards the left in the presence of

(A) NO_3^- **(B)** Cl^- **(C)** SCN^- **(D)** CN^-

Ans. (B, C, D)

11. For the first order reaction

$2N_2O_5(g) \longrightarrow 4NO_2(g) + O_2(g)$

(A) the concentration of the reactant decreases exponentially with time

(B) the half-life of the reaction decreases with increasing temperature

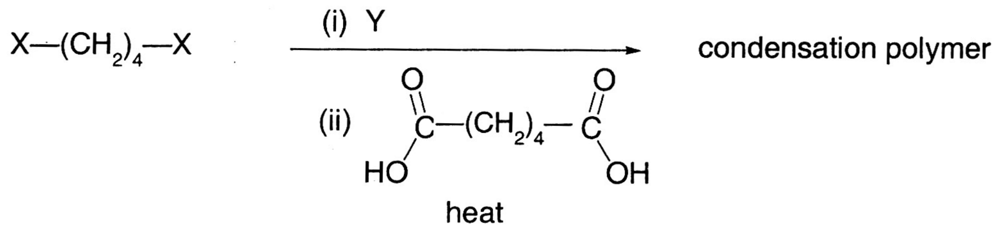
(C) the half-life of the reaction depends on the initial concentration of the reaction

(D) the reaction proceeds to 99.6% completion in eight half-life duration.

Ans. (A, B, D)

CHEMISTRY

12. The correct functional group X and the reagent/reaction conditions Y in the following scheme are



(A) $X = COOCH_3, Y = H_2 / Ni / heat$ **(B)** $X = CONH_2, Y = H_2 / Ni / heat$

(C) $X = CONH_2, Y = Br_2 / NaOH$ **(D)** $X = CN, Y = H_2 / Ni / heat$

Ans. **(A, B, C, D)**

Section–III

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the SORS have to be darkened.

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13. Among the following, the number of compounds than can react with PCl_5 to give $POCl_3$ is
$O_2, CO_2, SO_2, H_2O, H_2SO_4, P_4O_{10}$

Ans. **(3)**

14. The volume (in mL) of 0.1 M $AgNO_3$ required for complete precitation of chloride ions present in 30 mL of 0.01 M solution of $[Cr(H_2O)_5Cl]Cl_2$, as silver chloride is close to

Ans. **(6)**

15. In 1L saturated solution of $AgCl[K_{sp}(AgCl) = 1.6 \times 10^{-10}]$, 0.1 mol of CuCl $[K_{sp}(CuCl) = 1.0 \times 10^{-6}]$ is added. The resultant concentration of Ag^+ in the solution is 1.6×10^{-x}. The value of 'x' is

Ans. **(7)**

16. The number of hexagonal faces that are present in a truncated octahedron is

Ans. **(8)**

CHEMISTRY

17. The maximum number of isomers (including stereoisomers) that are possible on monochlorination of the following compounds is

Ans. **(7)**

18. The total number of contributing structures showing hyperconjugation (involving C - H bonds) for the following carbocation is

Ans. **(6)**

Section–IV

Matrix-Match Type

This section contains 2 questions. The question contains statements given in two columns, which have to be matched. The Statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II**.

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19. All the compounds listed in **Column I** react with water. Match the result of the respective reactions with the appropriate options listed in **Column II.**

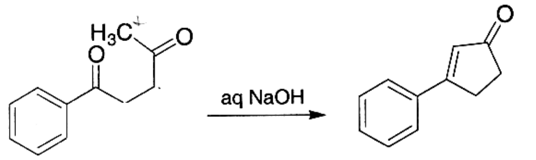
Column I	Column II
(A) $CO_2(s) \longrightarrow CO_2(g)$	**(p)** phase transition
(B) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$	**(q)** allotropic change
(C) $2H^{\bullet} \longrightarrow H_2(g)$	**(r)** ΔH is positive
(D) $P_{(\text{white, solid})} \longrightarrow P_{(\text{red, solid})}$	**(s)** ΔS is positive
	(t) ΔS is negative

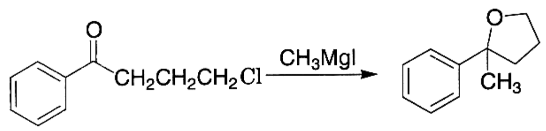
Ans. **[A]** $\rightarrow$ p, r, s,**[B]** $\rightarrow$ r, s, **[C]** $\rightarrow$ t, **[D]** $\rightarrow$ q, t

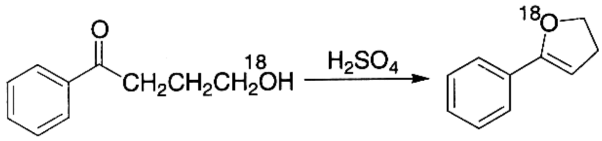
CHEMISTRY

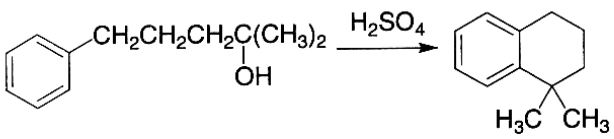
20. All the compounds listed in **Column I** react with water. Match the result of the respective reactions with the appropriate options listed in **Column II.**

Column I | **Column II**

(A)  **(p)** Nucleophilic

(B)  **(q)** Electrophilic

(C)  **(r)** Dehydration

(D)  **(s)** Nucleophilic addition

(t) Carbanion

Ans. **[A]** $\rightarrow$ r, s, t, **[B]** $\rightarrow$ p, s, **[C]** $\rightarrow$ r, s **[D]** $\rightarrow$ q, r

PHYSICS

Part II
Section–I (Total Marks : 24)
(Single Correct Answer Type)

This section contains **8 multiple choice questions** numbered 21 to 28. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

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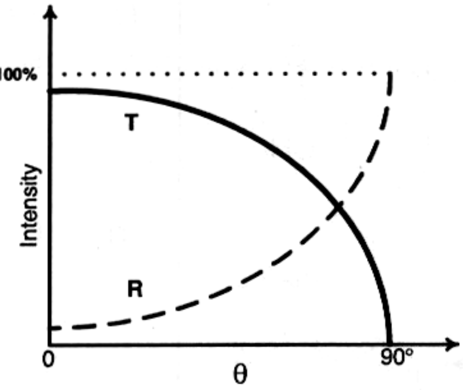
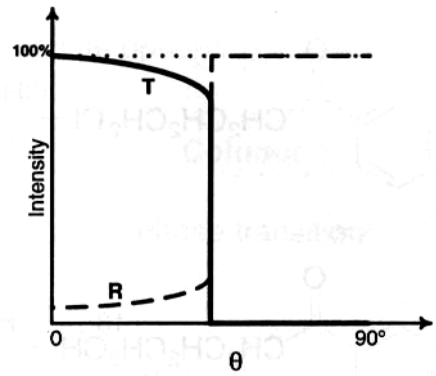
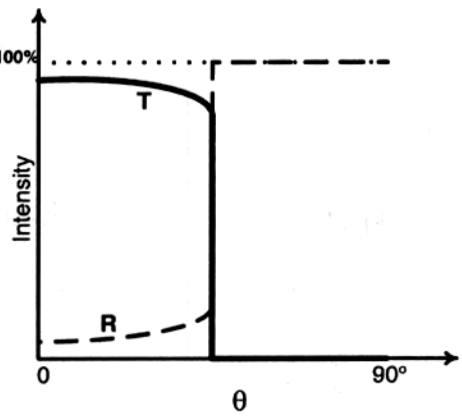
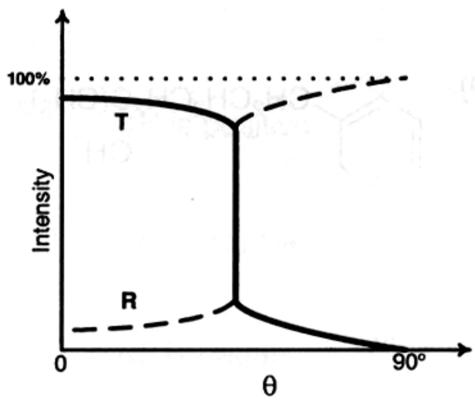
21. A light ray traveling in glass mediumis incident on glass-air interface at an angle of incidence θ. The reflected (R) and transmitted (T) intensities, both as function of θ, are plotted. The correct sketch is

(A)


(B)


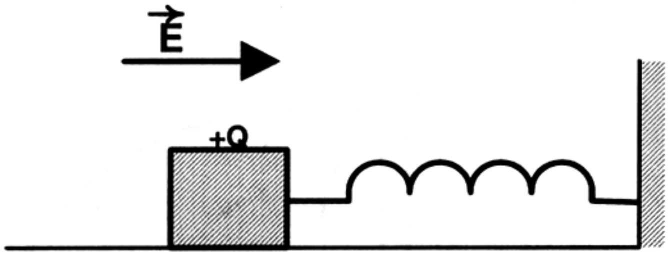
(C)


(D)


Ans: (C)

PHYSICS

22. A wooden block performs SHM on a frictionless surface with frequency, v_0. The block carries a charge $+Q$ on its surface. If now a uniform electric field $\vec{E}$ is switched-on as shown, then the SHM of the block will be



(A) on the same frequency and with shifted mean position.

(B) of the same frequency and withthe same mean position.

(C) of changed frequency andwith shifted mean position.

(D) of changed frequency and with the same mean position.

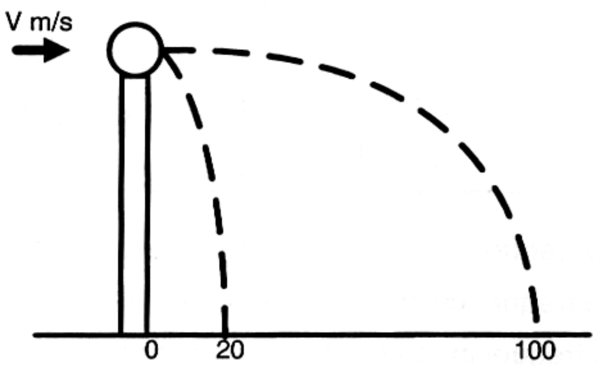
Ans: (A)

23. The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw gauge, whose pitch is 0.5 mm and there are 50 divisions on the circular scale. The reading on the main scale is 2.5 mm and that on the circular scale is 20 divisions. If the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is

(A) 0.9% **(B)** 2.4% **(C)** 3.1% **(D)** 4.2%

Ans: (C)

24. A ball of mass 0.2 kgrests on a vertical post of height 5 m. A bullet of mass 0.01 kg, traveling with a velocity V m / s in ahorizontal direction, hits the centre of the ball. After the collision, the ball and bullet ravel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The intial velocity V of the bullet is

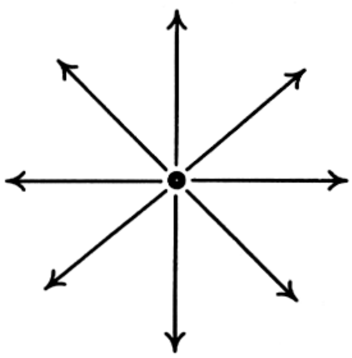


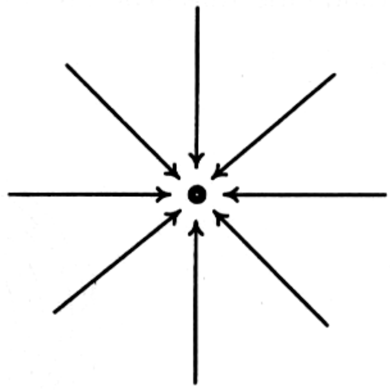
(A) 250 m / s **(B)** $250\sqrt{2}$ m / s **(C)** 400 m / s **(D)** 500 m / s

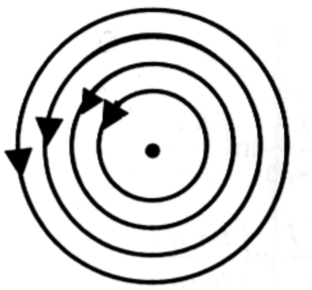
Ans: (D)

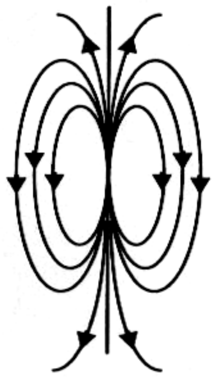
PHYSICS

25. Which of the file patterns given below is valid for electric field as well as for magnetic field?

(A) 

(B) 

(C) 

(D) 

Ans: (D)

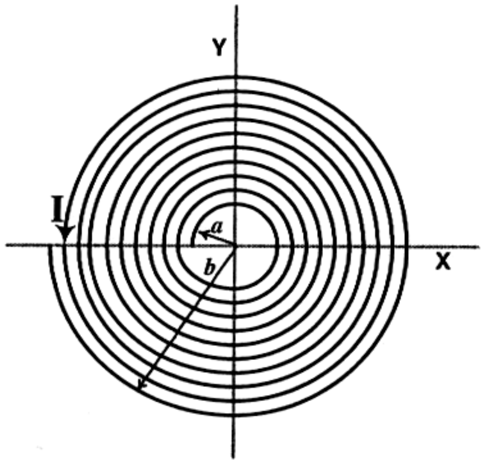
26. A point mass is subjected to two simultaneous sinusoidal displacements in x-direction, $x_1(t) = A\sin\omega t$ and $x_2(t) = A\sin\left(\omega t + \frac{2\pi}{3}\right)$. Adding a third sinusoidal displacement $x_3(t) = B\sin(\omega t + \phi)$ brings the mass to a complete rest. The values of B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

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

Ans: (B)

PHYSICS

27. A long insulated copper wire is closely wound as a spiral of 'N' turns. The spiral has inner radius 'a' and outer radius 'b'. The sprial lies in the X-Y plane and a steady current 'I' flows through the wire. The Z-component of the magnetic field at the center of the sprial is



(A) $\frac{\mu_0 N I}{2(b-a)}\ln\left(\frac{b}{a}\right)$ **(B)** $\frac{\mu_0 N I}{2(b-a)}\ln\left(\frac{b+a}{b-a}\right)$ **(C)** $\frac{\mu_0 N I}{2b}\ln\left(\frac{b}{a}\right)$ **(D)** $\frac{\mu_0 N I}{2b}\ln\left(\frac{b+a}{b-a}\right)$

Ans: (A)

28. A satellite is moving with a constant speed 'V' in a circular orbit about the earth. An object of mass 'm' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of its ejection, the kinetic energy of the object is

(A) $\frac{1}{2}mV^2$ **(B)** mV^2 **(C)** $\frac{3}{2}mV^2$ **(D)** $2mV^2$

Ans: (B)

PHYSICS

Section–II

Multiple Correct Answer Type

This section contains 4 **multiple choice questions** numbered 29 to 32. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE** is / are correct.

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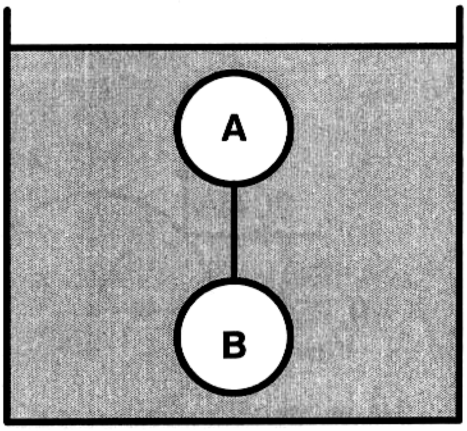
29. Two solid spheres A and B of equal volumes but of different densities d_A and d_B are connected by a string. They are fully immersed in a fluid of density d_F. They get arranged into an equilibrium state as shown in the figure with a tension in the string. The arrangement is possible only if



(A) $d_A < d_F$ **(B)** $d_B > d_F$ **(C)** $d_A > d_F$ **(D)** $d_A + d_B = 2d_F$

Ans: (A, B, D)

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

(A) If the electric field due to a point charge varies as $r^{-2.5}$ instead of r^{-2}, then the Gauss law will still be valid.

(B) The Gauss law can be used to calculate the field distribution around an electric dipole.

(C) If the electric field between two point charges is zero somewhere, then the sign of the two charges is the same.

(D) The work done by the external force in moving a unit positive charge from point A at potential V_A to point B at potential V_B is $(V_B - V_A)$

Ans: (C, D)

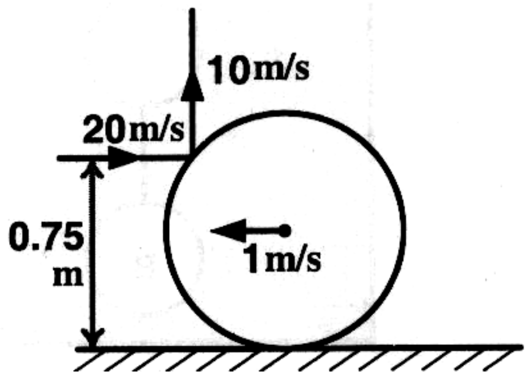
PHYSICS

31. A series R-C circuit is connected to AC voltage source. Consider two cases; (A) when C is without a dielectric medium and (B) when C is filled with dielectric of constant 4. The current I_R through the resistor and voltage V_C across the capacitor are compared in the two cases. Which of the following is/are true?

(A) $I_R^A > I_R^B$ **(B)** $I_R^A < I_R^B$ **(C)** $V_C^A > V_C^B$ **(D)** $V_C^A < V_C^B$

Ans: (B, C)

32. A thin ring of mass 2 kg and radius 0.5 m is rolling without slipping on a horizontal plane with velocity 1 m / s. A small ball of mass 0.1 kg, moving with velocity 20 m / s in the opposite direction, hits the ring at a height of 0.75 m and goes vertically up with velocity 10 m / s. Immediately after the collision



(A) the ring has pure rotation about its sitationary CM.

(B) the ring comes to a complete stop.

(C) friction between the ring and the ground is to the left.

(D) there is no friction between the ring and the ground.

Ans: (A, C)

PHYSICS

Section–III

Integer Type

This section contains **6 questions**. The answer to each of the questions is a **single digit integer**, ranging from 0 to 9. The correct digit below the question number in the ORS is to be bubbled.

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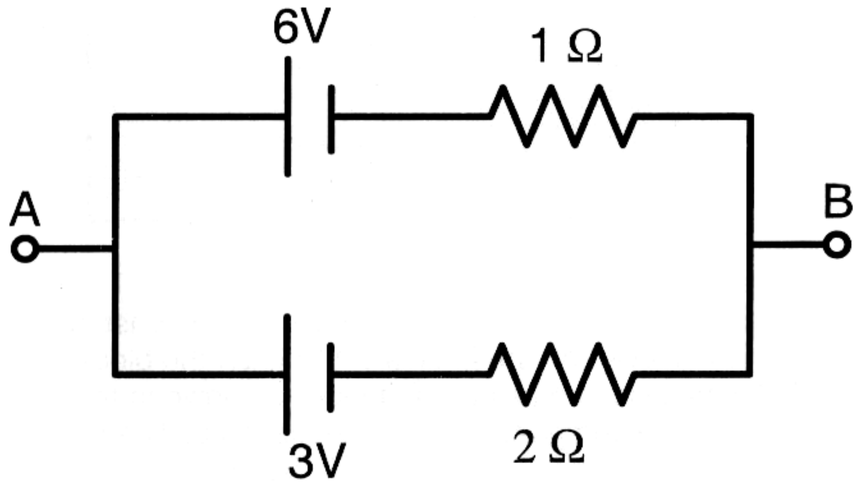
33. Two batteries of different emfs and different internal resistances are connected as shown. The voltage across AB in volts is



Ans: 5

34. A series R-C combinationis connected to an AC voltage of angular frequency $\omega = 500$ radian/s. If the impedance of the R-C circuit is $R\sqrt{1.25}$, the time constant (in millisecond) of the circuit is

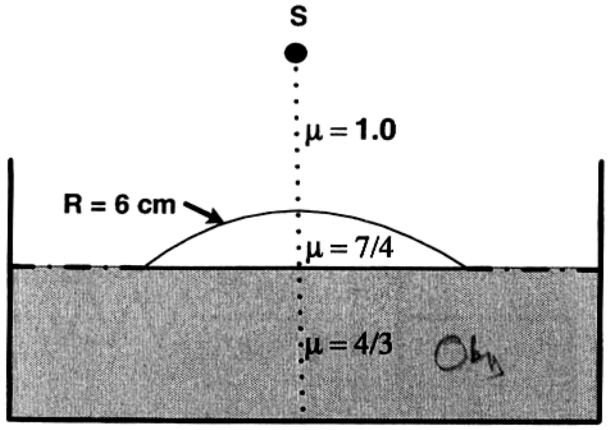
Ans: 4

35. A train is moving along a straight line with a constant acceleration 'a'. A body standing in the train throws a ball forward with a speed of $10\ m/s$, at an angle of 60^o to the horizontal. The body has to move forward by 1.15 m inside the train to catch the ball back atthe intial height. The acceleration of the train, in m/s^2, is

Ans: 5

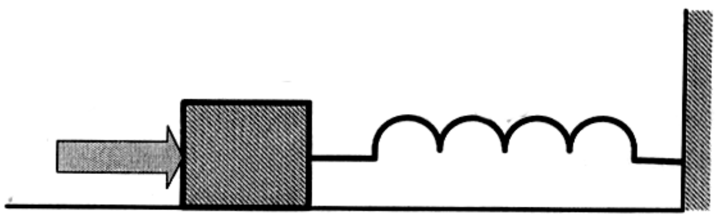
PHYSICS

36. Water (with refractive index $= \frac{4}{3}$) in a tank is 18 cm deep. Oil of refractive index $\frac{7}{4}$ lies on water making a convex surface of radius of curvature 'R = 6 cm' as shown. Consider oil to act as a thin lens. An object 'S' is placed 24 cm above water surface. The location of its image is at 'x' cm above the bottom of the tank. Then 'x' is



Ans: 2

37. A block of mass 0.18 kg is attached to a spring of force-constant 2 N / m. The coefficient of friction between the block and the floor is 0.1. Initially the block is at rest and the spring is un-stretched. An impulse is given to the block as shown in the figure. The block slides a distance of 0.06 m and comes to rest for the first time. The intial velocity of the block in m / s is V = N / 10. Then N is



Ans: 4

38. A silver sphere of radius 1 cm and work function 4.7 eV is suspended from an insulating thread in free-space. It is under continuous illumination of 200 nm wavelength light. As photoelectrons are emitted, the sphere gets charged and acquires a potential. The maximum number of photelectrons emitted from the sphere is $A \times 10^{z}$ (where $1 < A < 10$). The value of 'Z' is

Ans: 7

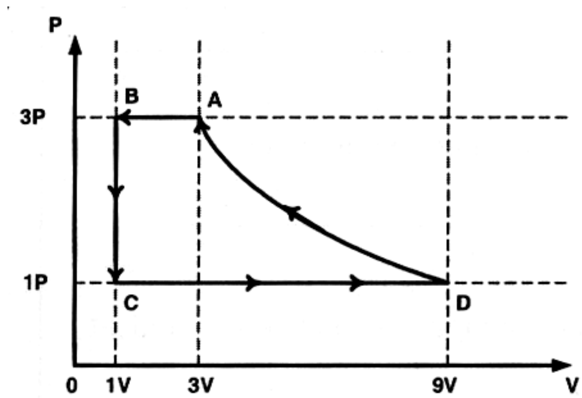
PHYSICS

Section – IV

Matrix-Match Type

This section contains **2 questions.** Each question has **four statements** (A, B, C and D) given in **Column I** and **five statements** (p, q, r, s and t) in **Column II**. Any given statement in **Column I** can have correct mathcing with **ONE or MORE** statement(s) given in **Column II**. For example, if for a given question, statement B matches with the statements given in q and r, then for that particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

39. One mole of a monatomic ideal gas is taken through a cycle ABCDA as shown in the P-V diagram. **Columne II** gives the characteristic involved in the cycle. Match them with each of the prcess given in **Column I.**



Column I		Column II	
(A)	Process $A \rightarrow B$	**(p)**	Internal energy decreases.
(B)	Process $B \rightarrow C$	**(q)**	Internal energy increases.
(C)	Process $C \rightarrow D$	**(r)**	heat is lost.
(D)	Process $D \rightarrow A$	**(s)**	Heat is gained.
		(t)	Work is done on the gas.

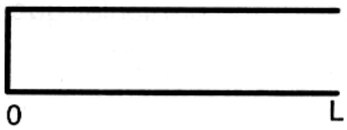
Ans: [A] $\rightarrow$ p, r, t **; [B]** $\rightarrow$ p, r **; [C]** $\rightarrow$ q, s **; [D]**$\rightarrow$ r, t

PHYSICS

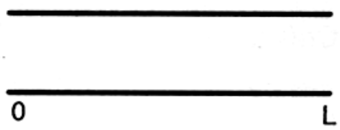
40. **Column I** shows four systems, each of the same length L, for producing standing waves. The lowest possible natural frequency of a system is called its fundamental frequency, whose wavelength is denoted as λ_f. Match each system with statements given in **Column II** describing the nature and wavelength of the standing waves.

Column I

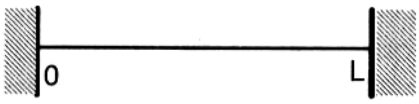
(A) Pipe closed at one end



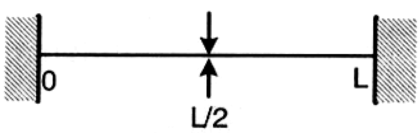
(B) Pipe open at both ends



(C) Stretched wire clamped at both ends



(D) Stretched wire clamped at both ends and at mid-point



Column II

(p) Longitudinal waves

(q) Transverse waves

(r) $\lambda_f = L$

(s) $\lambda_f = 2L$

(t) $\lambda_f = 4L$

Ans: [A] $\rightarrow$ p, t **; [B]** $\rightarrow$ p, s **; [C]** $\rightarrow$ q, s **; [D]**$\rightarrow$ q, r

MATHEMATICS

Section–I

Straight Objective Type

This section contains 6 multiple choice questions numbered 20 to 23. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

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41. Let $f:[-1,2]\to[0,\infty)$ be a continuous function such that $f(x)=f(1-x)$ for $x\in[-1,2]$. Let $R_1=\int_{-1}^{2} x\,f(x)\,dx$, and R_2 be the area of the region bounded by $y=f(x)$, $x=-1$, $x-2$, and the x-axis. Then

(A) $R_1=2R_2$ **(B)** $R_1=3R_2$ **(C)** $2R_1=R_2$ **(D)** $3R_1=R_2$

Ans. **(C)**

42. Let $f(x)=x^3$ and $g(x)=\sin x$ for all $x\in R$. Then the set of all x satisfying $(f \circ g \circ g \circ f)(x)=(g \circ g \circ f)(x)$, where $(f \circ g)(x)=f(g(x))$ is

(A) $\pm\sqrt{n\pi},\ n\in\{0,1,2,...\}$ **(B)** $\pm\sqrt{n\pi},\ n\in\{1,2,...\}$

(C) $\frac{\pi}{2}+2n\pi,\ n\in\{...,-2,-1,0,1,2,...\}$ **(D)** $2n\pi,\ n\in\{...,-2,-1,0,1,2,...\}$

Ans. **(A)**

43. Let (x, y) be any point on the parabola $y^2=4x$. Let P be the point that divides the line segment from $(0,0)$ to (x, y) in the ratio $1:3$. Then the locus of P is

(A) $x^2=y$ **(B)** $y^2=2x$ **(C)** $y^2=x$ **(D)** $x^2=2y$

Ans. **(C)**

MATHEMATICS

44. Let $P(6, 3)$ be a point on the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$. If the normal at the point P intersects the $x - \text{axis}$ at (9, 0), then the eccentricity of the hyperbola is

(A) $\sqrt{\frac{5}{2}}$ **(B)** $\sqrt{\frac{3}{2}}$ **(C)** $\sqrt{2}$ **(D)** $\sqrt{3}$

Ans. **(B)**

45. A value of b for which the equations

$$x^2 + bx - 1 = 0$$
$$x^2 + x + b = 0$$

have one root in common is

(A) $-\sqrt{2}$ **(B)** $-i\sqrt{3}$ **(C)** $-i\sqrt{5}$ **(D)** $\sqrt{2}$

Ans. **(B)**

46. Let $\omega \neq 1$ be a cube root of unity and S be the set of all non singular matrices of the form

$$\begin{bmatrix} 1 & a & b \\ \omega & 1 & c \\ \omega & \omega & 1 \end{bmatrix}$$

where each of a, b, and c is either ω or ω^2. Then the number of distinct matrices in the set S is

(A) 2 **(B)** 6 **(C)** 4 **(D)** 8

Ans. **(B)**

47. The circle passing through the point (-1, 0) and touching the y-axis at (0, 2) also passes through the point

(A) $\left(-\frac{3}{2}, 0\right)$ **(B)** $\left(-\frac{5}{2}, 2\right)$ **(C)** $\left(-\frac{3}{2}, \frac{5}{2}\right)$ **(D)** $(-4, 0)$

Ans. **(D)**

48. If $\lim_{x\to 0}\left[1 + x\ln(1+b^2)\right]^{1/x} = 2b\sin^2\theta$, $b > 0$ and $\theta \in (-\pi, \pi]$, then the value of θ is

(A) $\pm\frac{\pi}{4}$ **(B)** $\pm\frac{\pi}{3}$ **(C)** $\pm\frac{\pi}{6}$ **(D)** $\pm\frac{\pi}{2}$

Ans. **(D)**

Section–II

Straight Objective Type

This section contains 4 multiple choice questions numbered 54 to 57. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE** is / are correct.

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49. Let E and F be two independent events. The probability that exactly one of them occurs is $\frac{11}{25}$ and the probability of none of them occuring is $\frac{2}{25}$. If P(T) denotes the probability of occurrence of the event T, then

(A) $P(E) = \frac{4}{5}, P(F) = \frac{3}{5}$ **(B)** $P(E) = \frac{1}{5}, P(F) = \frac{2}{5}$ **(C)** $P(E) = \frac{2}{5}, P(F) = \frac{1}{5}$ **(D)** $P(E) = \frac{3}{5}, P(F) = \frac{4}{5}$

Ans. **(A, D)**

50. If

$$\begin{cases} -x - \frac{\pi}{2}, & x \le -\frac{\pi}{2} \\ -\cos x, & -\frac{\pi}{2} < x \le 0 \\ x - 1, & 0 < x \le 1 \\ \ln x, & x > 1 \end{cases},$$

then

(A) $f(x)$ is continuous at $x = -\frac{\pi}{2}$ **(B)** $f(x)$ is not differentiable at $x = 0$

(C) f(x) is differentiable at $x = 1$ **(D)** f(x) is differentiable at $x = -\frac{3}{2}$

Ans. **(A, B, C, D)**

51. $f : (0, 1) \to R$ be defined by

$$f(x) = \frac{b - x}{1 - bx}$$

where b is a constant such that $0 < b < 1$. Then

(A) f is not invertiable on (0, 1)

(B) $f \neq f^{-1}$ on (0, 1) and $f'(b) = \frac{1}{f'(0)}$

(C) $f = f^{-1}$ on (0, 1) and $f'(b) = \frac{1}{f'(0)}$

(D) f^{-1} is differentiable on (0, 1)

Ans. **(A)**

52. Let L be a normal to the parabola $y^2 = 4x$. If L passes through the point (9, 6), then L is given by

(A) $y - x + 3 = 0$ **(B)** $y + 3x - 33 = 0$

(C) $y + x - 15 = 0$ **(D)** $y - 2x + 12 = 0$

Ans. **(A, B, D)**

Part II

Section–III

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the SORS have to be darkened.

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53. The straight line $2x - 3y = 1$ divides the circular region $x^2 + y^2 \leq 6$ into two parts. If

$$S = \left\{\left(2, \frac{3}{4}\right), \left(\frac{5}{2}, \frac{3}{4}\right), \left(\frac{1}{4}, -\frac{1}{4}\right), \left(\frac{1}{8}, \frac{1}{4}\right)\right\}$$

then the number of point(s) in S lying inside the smaller part is

Ans. **(1)**

MATHEMATICS

54. Let $\omega = e^{i\pi/e}$ and a, b, c, x, y, z be non zero complex numbers such that

$a + b + c = x$

$a + b\omega + c\omega^2 = y$

$a + b\omega + c\omega = z$

Then value of $\dfrac{|x|^2 + |y|^2 + |z|^2}{|a|^2 + |b|^2 + |c|^2}$ is

Ans. (3)

55. The number of distinct real roots of $x^4 - 4x^3 + 12x^2 + x - 1 = 0$

Ans. (2)

56. Let $y'(x) + y(x)g'(x)g'(x)$, $y(0) = 0, x \in R$ where $f'(x)$ denotes $\dfrac{d\,f(x)}{dx}$ and $g(x)$ is a given non-constant differentiable function on R with $g(0) = g(2)$. Then the value of $y(2)$ is

Ans. (0)

57. Let M be a 3×3 matrix satisfying

$$M\begin{bmatrix}0\\1\\0\end{bmatrix} = \begin{bmatrix}-1\\2\\3\end{bmatrix},\ M\begin{bmatrix}1\\-1\\0\end{bmatrix} = \begin{bmatrix}1\\1\\-1\end{bmatrix} \text{ and } M\begin{bmatrix}1\\1\\1\end{bmatrix} = \begin{bmatrix}0\\0\\12\end{bmatrix}$$

The the sum of the diagonal entries of M is

Ans. (9)

58. Let $\vec{a} = -\hat{i} - \hat{k}$, $\vec{a} = -\hat{i} - \hat{k}$ and $\vec{c} = \hat{i} + 2\hat{j} + 3\hat{k}$ be three given vectors . If $\vec{r}$ is a vectors such that $\vec{r} \times \vec{b} = \vec{c} \times \vec{b}$ and $\vec{r} \cdot \vec{a} = 0$ then the value of $\vec{r} \cdot \vec{b}$ is

Ans. (9)

MATHEMATICS

Section–IV

Matrix-Match Type

This section contains 2 questions. The question contains statements given in two columns, which have to be matched. The Statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II**. The appropriate bubbles corresponding to the answers to the question have to be darkened as illustrated in the following example:

---

59. Match the statements in **Column I** with those in **Column II.**

[**Note:** Here z takes values in the complex plane and Im z and Re z denote, respectively, the imaginary part and the real part of z.]

Column I	Column II
(A) The set $\left\{\mathrm{Re}\left(\frac{2iz}{1-z^2}\right): z \text{ is a complex number}, \lvert z\rvert = 1, z \neq \pm 1\right\}$ is	**(p)** $(-\infty, -1) \cup (1, \infty)$
(B) The domain of the function $f(x) = \sin^{-1}\left(\frac{8(3)^{x-2}}{1-3^{2(x-1)}}\right)$ is	**(q)** $(-\infty, 0) \cup (0, \infty)$
	(r) $[2, \infty)$
(C) If $f(\theta) = \begin{vmatrix} 1 & \tan\theta & 1 \\ -\tan\theta & 1 & \tan \\ -1 & -\tan\theta & 1 \end{vmatrix}$, then the set $\left\{f(\theta) : 0 \le \theta < \frac{\pi}{2}\right\}$ is	**(s)** $(-\infty, -1] \cup [1, \infty)$
(D) If $f(x) = x^{3/2}(3x-10)$, $x \ge 0$, then $f(x)$ is increasing in	**(t)** $(-\infty, 0] \cup [2, \infty)$

Ans. **(A)** $\to$ s, **(B)** $\to$ t, **(C)** $\to$ r, **(D)** $\to$ r

MATHEMATICS

38. Match the statements in **Column I** with the values in **Column II.**

	Column I		Column II
(A)	If $\vec{a} = \hat{j} + \sqrt{3}\hat{k}$, $\vec{b} = -\hat{j} + \sqrt{3}\hat{k}$ and $\vec{c} = 2\sqrt{3}\hat{k}$ form a triangle, then the internal angle of the triangle between $\vec{a}$ and $\vec{b}$ is	**(p)**	$\frac{\pi}{6}$
(B)	If $\int_a^b (f(x) - 3x)dx = a^2 - b^2$, then the value of $f\left(\frac{\pi}{6}\right)$ is	**(q)**	$\frac{2\pi}{3}$
(C)	The value of $\frac{\pi}{\ln 3}\int_{7/6}^{5/6} \sec(\pi x)\, dx$ is.	**(r)**	$\frac{\pi}{3}$
		(s)	π
(D)	The maximum value of $\left\vert \text{Arg}\left(\frac{1}{1-z}\right)\right\vert$ for $\vert z\vert = 1,\ z \neq 1$ is given by	**(t)**	$\frac{\pi}{2}$

Ans., **(A)** $\rightarrow$ q, **(B)** $\rightarrow$ p, **(C)** $\rightarrow$ s, **(D)** $\rightarrow$ s