FIITJEE

Solutions to JEE(Main) -2024

Test Date: 5th April 2024 (Second Shift)

MATHEMATICS, PHYSICS & CHEMISTRY

Paper – 1

Time Allotted: 3 Hours **Maximum Marks: 300**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

Important Instructions:

1. The test is of 3 hours duration.
2. This test paper consists of 90 questions. Each subject (MPC) has 30 questions. The maximum marks are 300.
3. This question paper contains three parts**. Part-A** is Mathematics, **Part-B** is Physics and **Part-C** is Chemistry. Each part has only two sections: **Section-A and Section-B**.
4. **Section – A** : Attempt all questions.
5. **Section – B :** Do any 5 questions out of 10 Questions.
6. **Section-A (01 – 20, 31 – 50, 61 – 80)** contains 60 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.
7. **Section-B (21 – 30, 51 – 60, 81 – 90)** contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

Note: For the benefit of the students, specially the aspiring ones, the question of JEE(Main), 2024 are also given in this booklet. Keeping the interest of students studying in class XI, the questions based on topics from class XI have been marked with '*', which can be attempted as a test.

PART – A (MATHEMATICS)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (1), (2), (3) and (4), out of which **ONLY ONE** option is correct.

Q1. If $y(\theta)=\dfrac{2\cos\theta+\cos 2\theta}{\cos 3\theta+4\cos 2\theta+5\cos\theta+2}$, then at $\theta=\dfrac{\pi}{2}$, $y''+y'+y$ is equal to

(A) 2 (B) $\dfrac{3}{2}$

(C) $\dfrac{1}{2}$ (D) 1

Ans. A

Sol.
$$y=\frac{2\cos\theta+2\cos^2\theta-1}{4\cos^3\theta-3\cos\theta+8\cos^2\theta-4+5\cos\theta+2}$$
$$y=\frac{\left(2\cos^2\theta+2\cos\theta-1\right)}{\left(2\cos^2\theta+2\cos\theta-1\right)\left(2\cos\theta+2\right)}$$
$$y=\frac{1}{2}\left(\frac{1}{1+\cos\theta}\right)$$
$$\theta=\frac{\pi}{2},\ y=\frac{1}{2}$$
$$y'=\frac{1}{2}\left(\frac{-1}{(1+\cos\theta)^2}\times(-\sin\theta)\right)$$
$$\Rightarrow \theta=\frac{\pi}{2},\ y'=\frac{1}{2}$$
$$y''=\frac{1}{2}\left[\frac{\cos\theta(1+\cos\theta)^2-\sin\theta\cdot 2\cdot(1+\cos\theta)(-\sin\theta)}{(1+\cos\theta)^4}\right]$$
$$\Rightarrow \theta=\frac{\pi}{2},\ y''=1$$

Q2. Let the set S = {2, 4, 8, 16,…..,512} be partitioned into 3 sets A, B, C with equal number of elements such that $A\cup B\cup C=S$ and $A\cap B=B\cap C=A\cap C=\phi$. The maximum number of such possible partitions of S is equal to

(A) 1710 (B) 1680

(C) 1640 (D) 1520

Ans. B

Sol. $S=\{2,4,8,16.........512\}$

$A\cup B\cup C=S,$

$A\cap B=B\cap C=A\cap C=\phi$

No. of such possible partition of S

$$=\frac{9!}{(3!\,3!\,3!)3!}\times 3!=1680$$

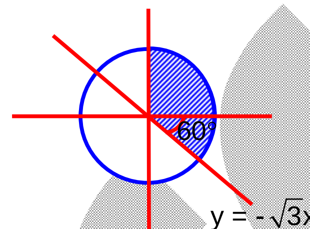
Q3. Let $S_1 = \{z \in C : |z| \le 5\}, S_2 = \left\{z \in C : \text{Im}\left(\dfrac{z+1-\sqrt{3}i}{1-\sqrt{3}i}\right) \ge 0\right\}$ and $S_3 = \{z \in C : \text{Re}(z) \ge 0\}$. Then the area of the region $S_1 \cap S_2 \cap S_3$ is :

(A) $\dfrac{125\pi}{12}$ (B) $\dfrac{125\pi}{6}$

(C) $\dfrac{125\pi}{24}$ (D) $\dfrac{125\pi}{4}$

Ans. A

Sol. $S_1 : x^2 + y^2 \le 25$



$S_2 : \ell m \text{ of } \dfrac{2+\left(1-\sqrt{3}i\right)}{1-\sqrt{3}i} \ge 0$

$\ell m \text{ of } \dfrac{x+iy}{1-\sqrt{3}i} + 1 \ge 0$

$\ell m \text{ of } \left(\dfrac{(x+iy)\left(1+\sqrt{3}i\right)}{4}\right) \ge 0$

$\sqrt{3}x + y \ge 0$ -(ii)

$S_3 : \; x \ge 0$ -(iii)

$\text{Area} = \dfrac{\frac{\pi}{2}+\frac{\pi}{3}}{2\pi} \times \pi(5)^2$

$= \dfrac{5}{12} \times \pi(5)^2 = \dfrac{125\pi}{12}$

Q4. Let the circle $C_1 : x^2 + y^2 - 2(x + y) + 1 = 0$ and C_2 be a circle having centre at (–1, 0) and radius 2. If the line of the common chord of C_1 and C_2 intersects the y-axis at the point P, then the square of the distance of P from the centre of C_1 is

(A) 2 (B) 1

(C) 4 (D) 6

Ans. A

Sol. $S_1 : x^2 + y^2 - 2x - 2y + 1 = 0$

$S_2 : x^2 + y^2 + 2x - 3 = 0$

Common chord $= S_1 - S_2 = 0$

$-4x - 2y + 4 = 0$

At y axis, x = 0

$-2y + 4 = 0$

y = 2

P (0,2)

$d^2_{(C_1 P)} = (1-0)^2 + (2-1)^2 = 2$

Q5. Let $\vec{a} = 2\hat{i} + 5\hat{j} - \hat{k}, \vec{b} = 2\hat{i} - 2\hat{j} + 2\hat{k}$ and $\vec{c}$ be three vectors such that $\left(\vec{c}+\hat{i}\right) \times \left(\vec{a}+\vec{b}+\hat{i}\right) = \vec{a} \times \left(\vec{c}+\hat{i}\right)$. If $\vec{a}.\vec{c} = -29$, then $\vec{c}.\left(-2\hat{i}+\hat{j}+\hat{k}\right)$ is equal to :

(A) 15 (B) 12

(C) 5 (D) 10

Ans. C

Sol. $\vec{a} = 2i + 5j - \hat{k}$

$\vec{b} = 2\hat{i} - 2\hat{j} + 2\hat{k}$

Let assume $\vec{v} = \vec{a} + \vec{b} + \hat{i}$

$= 5\hat{i} + 3\hat{j} + \hat{k}$

and $\vec{c} + \hat{i} = \vec{P}$

So, $\vec{P} \times \vec{v} = \vec{a} \times \vec{P}$

$\vec{P} \times \vec{v} + \vec{P} \times \vec{a} = \vec{0}$

$\vec{P} \times (\vec{v} + \vec{a}) = \vec{0}$

$\Rightarrow \vec{P} = \lambda(\vec{v} + \vec{a})$

$\vec{c} + \hat{i} = \lambda(7\hat{i} + 8\hat{j})$

$\vec{a} \cdot \vec{c} + \vec{a} \cdot \hat{i} \Rightarrow \lambda \vec{a} \cdot (7\hat{i} + 8\hat{j})$

$-29 + 2 = \lambda(14 + 40)$

$\lambda = \frac{-1}{2}$

$\vec{c} \cdot (-2\hat{i} + \hat{j} + \hat{k}) + \hat{i} \cdot (-2\hat{i} + \hat{j} + \hat{k}) = \lambda(7\hat{i} + 8\hat{j}) \cdot (-2\hat{i} + \hat{j} + \hat{k})$

$= \frac{-1}{2}(-14 + 8) + 2 = 5$

Q6. For $x \geq 0$, the least value of K, for which $4^{1+x} + 4^{1-x}$, $\frac{K}{2}$, $16^x + 16^{-x}$ are three consecutive terms of an A.P., is equal to :

(A) 8
(B) 4
(C) 16
(D) 10

Ans. **D**

Sol. $4^{1+x} + 4^{1-x}, \frac{k}{2}, 16^x + 16^{-x}$ are in A.P.

So, $2x\frac{k}{2} = 4^{1+x} + 4^{1-x} + 16^x + 16^{-x}$

$k = 4\left(4^x + \frac{1}{4^x}\right) + \left(4^{2x} + \frac{1}{4^{2x}}\right)$

$4^x + \frac{1}{4^x} \geq 2$

$4^{2x} + \frac{1}{4^{2x}} \geq 2$

$k \geq 4 \times 2 + 2$

$k \geq 10$

Q7. Let $\alpha\beta \neq 0$ and $A = \begin{bmatrix} \beta & \alpha & 3 \\ \alpha & \alpha & \beta \\ -\beta & \alpha & 2\alpha \end{bmatrix}$. If $B = \begin{bmatrix} 3\alpha & -9 & 3\alpha \\ -\alpha & 7 & -2\alpha \\ -2\alpha & 5 & -2\beta \end{bmatrix}$ is the matrix of cofactors of the elements of A, then det(AB) is equal to :

(A) 343
(B) 125
(C) 216
(D) 64

Ans. **C**

Sol. $A = \begin{bmatrix} \beta & \alpha & 3 \\ \alpha & \alpha & \beta \\ -\beta & \alpha & 2\alpha \end{bmatrix}$

Cofactor matrix of A = B = $\begin{bmatrix} 3\alpha & -9 & 3\alpha \\ -\alpha & 7 & -2\alpha \\ -2\alpha & 5 & -2\beta \end{bmatrix}$

Equation co-factor of A_{21}

$\left(2\alpha^2 - 3\alpha\right) = \alpha$

$\alpha = 0, 2 \; (\text{Accept})$

Now, $2\alpha^2 - \alpha\beta = 3\alpha$

$\alpha = 2, \beta = 1$

$|AB| = |A \operatorname{cof}(A)|$

$= |A|^3$

$A = \begin{vmatrix} 1 & 2 & 3 \\ 2 & 2 & 1 \\ -1 & 2 & 4 \end{vmatrix}$

$= 6 - 2(9) + 3(6) = 6.$

$|AB| = 6^3 = 216$

Q8. The coefficients a, b, c in the quadratic equation $ax^2 + bx + c = 0$ are from the set {1, 2, 3, 4, 5, 6}. If the probability of this equation having one real root bigger than the other is p, then 216p equals :

(A) 19 (B) 38

(C) 76 (D) 57

Ans. **B**

Sol. $ax^2 + bx + c = 0$

$a, b, c \in \{1, 2, 3, 4, 5, 6\}$

D > 0, for root bigger than other

$b^2 - 4ac > 0$

$b^2 > 4ac$

b = 1, (a,c) = No solution

b = 2, (a,c) = No solution

b = 3, (a,c) = (1,1), (1,2) (2,1)

b = 4, (a,c) = (1,1), (1,2) (2,1) (1,3), (3,1)

b = 5, (a,c) = (1,1) (1,2) (2,1) (1,3), (3,1) (1,4), (4,1)
(1,5) (5,1) (1,6) (6,1), (2,3), (3,2), (2,2)

b = 6, (a,c) = (1,1) (1,2) (2,1) (1,3) (3,1) (1,4) (4,1)
(1,5) (5,1), (1,6), (6,1),(2,3) (3,2) (2,4) (4,2), (2,2)

Case = 38

Total cases = $6 \times 6 \times 6$

Probability = $\dfrac{38}{6 \times 6 \times 6}$

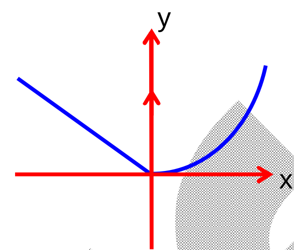
Q9. Let $f, g : R \to R$ be defined as : f(x) = |x – 1| and g(x) = $\begin{cases} e^x, & x \ge 0 \\ x+1, & x \le 0 \end{cases}$

Then the function f(g(x)) is

(A) onto but not one-one
(B) both one-one and onto
(C) one-one but not onto
(D) neither one-one nor onto.

Ans. D

Sol. $f(x) = |x-1|$



$g(x) = \left\{\begin{matrix} e^x, & x \ge 0 \\ x+1, & x \le 0 \end{matrix}\right\}$

$f(g(x)) = |g(x) - 1|$

$= \begin{cases} |e^x - 1|, & x \ge 0 \\ |x+1-1|, & x \le 0 \end{cases}$

$= \begin{cases} e^x - 1, & x \ge 0 \\ -x, & x \le 0 \end{cases}$

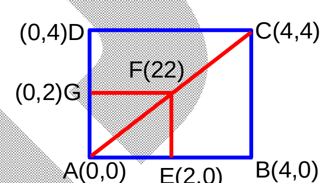
f(g(x)) is neither one-one nor onto.

Q10. Let ABCD and AEFG be squares of side 4 and 2 units, respectively. The point E is on the line segment AB and the point F is on the diagonal AC. Then the radius r of the circle passing through the point F and touching the line segments BC and CD satisfies :

(A) $r^2 - 8r + 8 = 0$
(B) $2r^2 - 8r + 7 = 0$
(C) $2r^2 - 4r + 1 = 0$
(D) r = 1

Ans. A

Sol. ABCD and AEFG are squares



AB = BC = CD = DA = 4

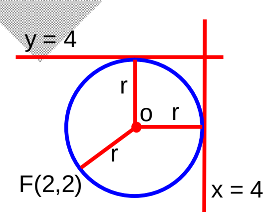
AE = EF = FG = GA = 2

O(4-r, 4-r)

$OF^2 = r^2$

$(2-r)^2 + (2-r)^2 = r^2$

$r^2 - 8r + 8 = 0$



Q11. Let f : [–1, 2] $\to$ R be given by f(x) = $2x^2 + x + [x^2] - [x]$, where [t] denotes the greatest integer less than or equal to t. The number of points, where f is not continuous, is

(A) 6
(B) 5
(C) 3
(D) 4

Ans. D

Sol. $f(x) = 2x^2 + x + [x^2] - [x]$

$F : [-1, 2] \to R$

Doubful points : $-1, 0, 1, \sqrt{2}, \sqrt{3}, 2$

at = x -1 :

$\left.\begin{matrix} \text{L.H.L} \Rightarrow f(x) = (2-1-(-1)) + 0 = 2 \\ \text{R.H.L} \Rightarrow f(x) = (2-1-(-1)) + 1 = 3 \end{matrix}\right\}$ Discontinuous

at x = 2 :

$\left.\begin{array}{l}\text{LHL} \Rightarrow f(x) = 8+2-1+3 = 12 \\ \text{RHL} \Rightarrow f(x) = 8+2-2+4 = 12\end{array}\right\}$ Continuous

at x = 0

$\left.\begin{array}{l}\text{LHL} \Rightarrow 0+0-(-1)+0 = 1 \\ \text{RHL} \Rightarrow f(x) = 0\end{array}\right\}$ Discontinuous.

at x = 1

$\left.\begin{array}{l}\text{LHL} = 2+1-0+0 = 3 \\ \text{RHL} = 3-1+1 = 3\end{array}\right\}$ Continuous

At $x = \sqrt{2}, \sqrt{3}$

$f(x) = \underbrace{\left(2x^2 + x - [x]\right)}_{\text{Continuous}} + \underbrace{\left[x^2\right]}_{\text{Discontinuous}}$

So, Discontinuous at $n = \sqrt{2}, \sqrt{3}$

Q12. If the constant term in the expansion of $\left(\frac{\sqrt[5]{2}}{x} + \frac{2x}{\sqrt[3]{5}}\right)^{12}$, $x \neq 0$, is $\alpha \times 2^8 \times \sqrt[5]{3}$, then 25α is equal to

(A) 639
(B) 724
(C) 742
(D) 693

Ans. D

Sol. $T_{r+1} = 12_{C_r}\left(\frac{3^{1/5}}{x}\right)^{12-r}\left(\frac{2x}{5^{1/3}}\right)^r$

$T_{r+1} = \frac{12_{C_r}(3)^{\frac{12-r}{5}}(2)^r(x)^{2r-12}}{(5)^{r/3}}$

r = 6

$T_7 = \frac{12_{C_6}(3)^{6/5}(2)^6}{5^2}$

$= \left(\frac{9 \times 11 \times 7}{25}\right)2^8.3^{1/5}$

$25\alpha = 693$

Q13. The values of m, n, for which the system of equations
x + y + z = 4,
2x + 5y + 5z = 17,
x + 2y + mz = n
has infinitely many solutions, satisfy the equation :

(A) $m^2 + n^2 - m - n = 46$
(B) $m^2 + n^2 - mn = 39$
(C) $m^2 + n^2 + m + n = 64$
(D) $m^2 + n^2 + mn = 68$

Ans. B

Sol. $x + y + z = 4$

$2x + 5y + 5z = 17$

$x + 2y + mz = n$

Have infinitely many solution

$$D = \begin{vmatrix} 1 & 1 & 1 \\ 2 & 5 & 5 \\ 1 & 2 & m \end{vmatrix} = 0$$

$m = 2$

$$D_3 = \begin{vmatrix} 1 & 1 & 4 \\ 2 & 5 & 17 \\ 1 & 2 & n \end{vmatrix} = 0$$

$n = 7$

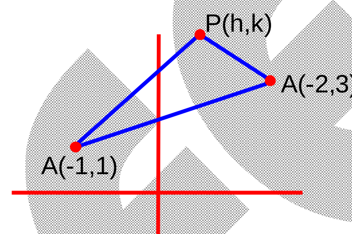
Q14. Let A(–1, 1) and B(2, 3) be two points and P be a variable point above the line AB such that the area of ΔPAB is 10. If the locus of P is ax + by = 15, then 5a + 2b is

(A) $-\frac{12}{5}$ (B) $-\frac{6}{5}$

(C) 4 (D) 6

Ans. **A**

Sol. Area = 10



$$\frac{1}{2}\begin{vmatrix} h & k & 1 \\ -1 & 1 & 1 \\ 2 & 3 & 1 \end{vmatrix} = 10$$

$$-2h + 3k = 25$$

$$-2x + 3y = 25$$

$$\frac{-6x}{5} + \frac{9}{5}y = 15$$

$$a = \frac{-6}{5}, b = \frac{9}{5}$$

$$5a = -6, 2b = \frac{18}{5}$$

Q15. 60 words can be made using all the letters of the word BHBJO, with or without meaning. If these words are written as in a dictionary, then the 50^{th} word is

(A) OBBHJ (B) JBBOH

(C) HBBJO (D) OBBJH

Ans. **D**

Sol. B H B J O

$\boxed{B}$ ------------ $4! = 24$

$\boxed{H}$ ------------ $\frac{4!}{2!} = 12$

$\boxed{J}$ ------------ $\frac{4!}{2!} = 12$

O B B H J = 1

O B B J H $\rightarrow 50^{th}$ rank

Q16. Consider three vectors $\vec{a}, \vec{b}, \vec{c}$. Let $|\vec{a}| = 2, |\vec{b}| = 3$ and $\vec{a} = \vec{b} \times \vec{c}$. If $\alpha \in \left[0, \frac{\pi}{3}\right]$ is the angle between the vectors $\vec{b}$ and $\vec{c}$, then the minimum value of $27|\vec{c} - \vec{a}|^2$ is equal to

(A) 105 (B) 124

(C) 110 (D) 121

Ans. **B**

Sol. $|\vec{c} - \vec{a}| = |\vec{c}|^2 + |\vec{a}|^2 - 2\vec{a}\cdot\vec{c} = |\vec{c}|^2 + 4 - 0$

$\because \ \vec{a} = \vec{b} \times \vec{c}$

$|\vec{a}| = |\vec{b} \times \vec{c}|$

$2 = 3|\vec{c}|\sin\alpha$

$|\vec{c}| = \frac{2}{3}\operatorname{cosec}\alpha, \alpha \in \left[0, \frac{\pi}{3}\right]$

$|\vec{c}|_{min} = \frac{2}{3} \times \frac{2}{\sqrt{3}}$

$\Rightarrow 27|\vec{c} - \vec{a}|^2_{min} = 27\left(\frac{16}{27} + 4\right) = 124$

Q17. The area enclosed between the curves y = x|x| and y = x – |x| is

(A) $\frac{8}{3}$ (B) $\frac{2}{3}$

(C) $\frac{4}{3}$ (D) 1

Ans. C

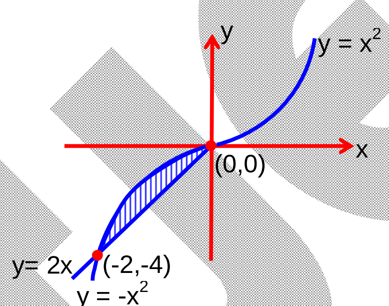
Sol. $y = x|x|$

$y = x - |x|$

$A = \int_{-2}^{0} -x^2 - 2x$

$A = \left.\frac{-x^3}{3} - \frac{2x^2}{2}\right]_{-2}^{0}$

$A = \frac{4}{3}$



Q18. Let (α, β, γ) be the image of the point (8, 5, 7) in the line $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z-2}{5}$. Then $\alpha + \beta + \gamma$ is equal to

(A) 20 (B) 16

(C) 14 (D) 18

Ans. C

Sol. $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z-2}{5}$

$\overline{AM} \cdot \left(2\hat{i} + 3\hat{j} + 5\hat{k}\right) = 0$

$(2\lambda - 7)2 + (3\lambda - 6)3 + (5\lambda - 5)5 = 0$

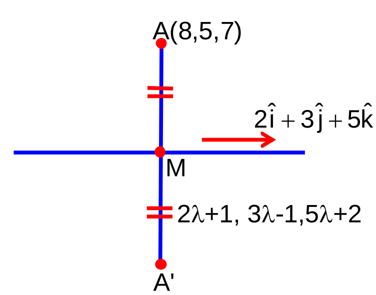
$38\lambda = 57$

$\lambda = \frac{3}{2}$

$M\left(4, \frac{7}{2}, \frac{19}{2}\right)$

M is mid point of AA'

So, $A'(0,2,12)$



Q19. Let $\beta(m, n) = \int_0^1 x^{m-1}(1-x)^{n-1}dx, m, n > 0$. If $\int_0^1 (1-x^{10})^{20}dx = a \times \beta(b, c)$, then 100(a + b+ c) equals _____.

(A) 1120
(B) 2120
(C) 2012
(D) 1021

Ans. B

Sol.
$$I = \int_0^1 1\cdot\left(1-x^{10}\right)^{20} dx$$
$$x^{10} = t$$
$$x = t^{1/10}$$
$$dx = \frac{1}{10}(t)^{-9/10}.dt$$
$$I = \frac{1}{10}\int_0^1 (t)^{-9/10}(1-t)^{20} dt.$$
$$\beta(M, n) = \int_0^1 x^{M-1}(1-x)^{n-1}.dn$$
$$I = a \times \beta(b,c)$$
$$a = \frac{1}{10}, b = \frac{1}{10}, c = 21$$

Q20. The differential equation of the family of circles passing through the origin and having centre at the ling y = x is

(A) $(x^2 + y^2 - 2xy)dx = (x^2 + y^2 + 2xy)dy$
(B) $(x^2 - y^2 + 2xy)dx = (x^2 - y^2 - 2xy)dy$
(C) $(x^2 + y^2 + 2xy)dx = (x^2 + y^2 - 2xy)dy$
(D) $(x^2 - y^2 + 2xy)dx = (x^2 - y^2 + 2xy)dy$

Ans. B

Sol.
$$C \equiv x^2 + y^2 + gx + gy = 0 \quad \text{-(i)}$$
$$2x + 2yy' + g + gy' = 0$$
$$g = -\left(\frac{2x+2yy'}{1+y'}\right)$$
Put in (I)
$$x^2 + y^2 - \left(\frac{2x+2yy'}{1+y'}\right)(x+y) = 0$$
$$\left(x^2 - y^2 - 2xy\right)y' = x^2 - y^2 + 2xy$$

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q21. The number of solutions of $\sin^2 x + (2 + 2x - x^2)\sin x - 3(x-1)^2 = 0$, where $-\pi \le x \le \pi$, is _____.

Ans. **2**

Sol.

$$\sin^2 x - \left(x^2 - 2x - 2\right)\sin x - 3\left(x-1\right)^2 = 0$$

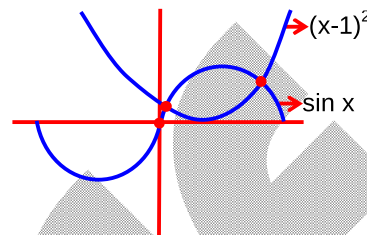
$$\sin^2 x - \left(\left(x-1\right)^2 - 3\right)\sin x = 3\left(x-1\right)^2$$

$$\sin^2 x - \left(x-1\right)^2 \sin x + 3\sin x = 3\left(x-1\right)^2$$

$$\sin x\left(\sin x + 3\right) = \left(x-1\right)^2\left(3 + \sin x\right)$$

$$\sin x = \left(x-1\right)^2$$

So, 2 solution.



Q22. Let $a > 0$ be a root of the equation $2x^2 + x - 2 = 0$. If $\lim_{x\to\frac{1}{a}} \frac{16(1-\cos(2+x-2x^2))}{(1-ax)^2} = \alpha + \beta\sqrt{17}$, where $\alpha, \beta \in Z$, then $\alpha + \beta$ is equal to _____.

Ans. **170**

Sol. $2x^2 + x - 2 = 0$ have roots (a, b)

$2x^2 - x - 2 = 0$ have roots $\left(\frac{1}{a}, \frac{1}{b}\right)$

$$\lim_{x\to\frac{1}{a}} 16\cdot\frac{\left(1-\cos 2\left(x-\frac{1}{a}\right)\left(x-\frac{1}{b}\right)\right)}{4\left(x-\frac{1}{b}\right)^2}\times\frac{4\left(x-\frac{1}{b}\right)^2}{a^2\left(x-\frac{1}{a}\right)^2}$$

$$= 16\times\frac{2}{a^2}\left(\frac{1}{a}-\frac{1}{b}\right)^2$$

$$= \frac{32}{a^2}\left(\frac{17}{4}\right) = \frac{17\times 8}{a^2}$$

$$= \frac{17\times 8\times 16}{\left(-1+\sqrt{117}\right)^2} = \frac{136.16}{18-2\sqrt{7}}$$

$$= 153 + 17\sqrt{17}$$

$$\alpha = 153, \beta = 17$$

$$\alpha + \beta = 153 + 17 = 170$$

Q23. If $1 + \frac{\sqrt{3}-\sqrt{2}}{2\sqrt{3}} + \frac{5-2\sqrt{6}}{18} + \frac{9\sqrt{3}-11\sqrt{2}}{36\sqrt{3}} + \frac{49-20\sqrt{6}}{180} + \ldots\text{upto } \infty = 2 + \left(\sqrt{\frac{b}{a}}+1\right)\log_e\left(\frac{a}{b}\right)$, where a and b are integers with gcd(a, b) = 1, then 11a + 18b is equal to_____.

Ans. **76**

Sol. $S = 1 + \frac{x}{2\sqrt{3}} + \frac{x^2}{18} + \frac{x^3}{36\sqrt{3}} + \frac{x^4}{180} + \ldots\ldots\infty$

$$\frac{x}{\sqrt{3}} = t,\ x = \sqrt{3} - \sqrt{2}.$$

$$S = 1 + \frac{t}{2} + \frac{t^2}{6} + \frac{t^3}{12} + \frac{t^4}{20} + \ldots\ldots\ldots.$$

$$S = 1 + t\left(1 - \frac{1}{2}\right) + t^2\left(\frac{1}{2} - \frac{1}{3}\right) + t^3\left(\frac{1}{3} - \frac{1}{4}\right)\ldots\ldots\ldots.\ S = \left(1 + t + \frac{t^2}{2} + \frac{t^3}{3} + \ldots\ldots\right) - \left(\frac{t}{2} + \frac{t^2}{3} + \frac{t^3}{4} + \ldots\ldots\right)$$

$$S = 2 + \left(1 - \frac{1}{t}\right)\left(-\ell og(1-t)\right)$$

$$S = \left(\frac{1}{t} - 1\right)\log(1-t) + 2$$

$$S = 2 + \left(\frac{\sqrt{3}}{\sqrt{3} - \sqrt{2}} - 1\right)\log\left(1 - \frac{\sqrt{3} - \sqrt{2}}{\sqrt{3}}\right)$$

$$S = 2 + \left(\frac{\sqrt{2}}{\sqrt{3} - \sqrt{2}}\right)\log\frac{\sqrt{2}}{\sqrt{3}}$$

$$S = 2 + \left(\sqrt{\frac{3}{2}} + 1\right)\log\frac{2}{3}$$

a = 2, b = 3

$11a + 18b = 11 \times 2 + 18 \times 3 = 76$

Q24. If $f(t) = \int_0^{\pi} \frac{2x\,dx}{1 - \cos^2 t \sin^2 x}$, $0 < t < \pi$, then the value of $\int_0^{\frac{\pi}{2}} \frac{\pi^2 dt}{f(t)}$ equals_____.

Ans. 1

Sol. $f(t) = \int_0^{\pi} \frac{2x}{1 - \cos^2 t \sin^2 x}.dx.$

$$= 2\int \frac{(\pi - x)dx}{1 - \cos^2 t \sin^2 x}$$

$$2f(t) = 2\int_0^{\pi} \frac{\pi}{1 - \cos^2 + \sin^2 x}.dx$$

$$f(t) = \int_0^{\pi} \frac{\pi}{1 - \cos^2 t \sin^2 x}.dx$$

$$f(t) = \pi\int_0^{\pi} \frac{\sec^2 x.dx}{\sec^2 x - \cos^2 t + \tan^2 x}$$

$$f(t) = 2\pi\int_0^{\pi/2} \frac{\sec^2 x.dx}{\sec^2 x - \cos^2 t\,\tan^2 x}$$

$\tan x = z$

$\sec^2 x\,dx = dz$

$$f(t) = 2\pi\int_0^{\infty} \frac{dz}{1 + \sin^2 t.z^2} = \frac{\pi^2}{\sin t}$$

Then, $\int_0^{\pi/2} \frac{\pi^2}{f(t)}dt = \int_0^{\pi/2} \sin t.dt = 1$

Q25. Let the maximum and minimum value of $\left(\sqrt{8x-x^2-12}-4\right)^2+(x-7)^2, x\in R$ be M and m, respectively. Then M^2-m^2 is equal to_____.

Ans. **1600**

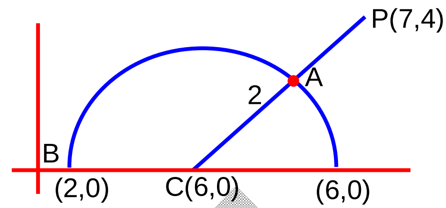
Sol. Let $y=\sqrt{8x-x^2-12}$

$y^2=-(x-4)^2+16-12$

$(x-4)^2+y^2=4$

$\left(\sqrt{8x-x^2-12}-4\right)^2+(x-7)^2$

$=(y-4)^2+(x-7)^2$



m = 9

M = 41

$M^2-m^2=41^2-9^2$

$= 1600$

Q26. The number of real solutions of the equation x | x + 5 | + 2 | x + 7 | – 2 = 0 is_____.

Ans. **3**

Sol. Case 1: $x\ge -5$

$x^2+5x+2x+12=0$

$x^2+7x+12=0$

$x=-3,-4$

Case – II : $-7<x<-5$

$-x^2-5x+2x+14-2=0$

$-x^2-3x+12=0$

$x=\dfrac{-3\pm\sqrt{9+48}}{2}$

$=\dfrac{-3\pm\sqrt{57}}{2}$

$x=\dfrac{-3-\sqrt{57}}{2},\dfrac{-3+\sqrt{57}}{2}$ (rejected)

Case –III : $x\le -7$

$-x^2-5x-2x-14-2=0$

$x^2+7x+16=0$

$D=49-64<0$

No solutions

No. of solutions = 3

Q27. Let the mean and the standard deviation of the probability distribution

x	α	1	0	–3
P(x)	$\frac{1}{3}$	K	$\frac{1}{6}$	$\frac{1}{4}$

be μ and σ, respectively. If $\sigma-\mu=2$, then $\sigma+\mu$ is equal to _____.

Ans. **5**

Sol. Sum of probability = 1

$\frac{1}{3}+k+\frac{1}{6}+\frac{1}{4}=1$

$$\Rightarrow K = \frac{1}{4}$$
$$\mu = \frac{\alpha}{3} + \frac{1}{4} - \frac{3}{4}$$
$$\mu = \frac{\alpha}{3} - \frac{1}{2}$$
$$\sigma = \sqrt{\alpha^2 \frac{1}{3} + \frac{1}{4} + 9 \times \frac{1}{4} - \left(\frac{\alpha}{3} - \frac{1}{2}\right)^2}$$
$$\sigma = \sqrt{\frac{2\alpha^2}{9} + \frac{\alpha}{3} + \frac{9}{4}}$$
$$\sigma = \mu + 2$$
$$\sigma^2 = (\mu + 2)^2 = \frac{2\alpha^2}{9} + \frac{\alpha}{3} + \frac{9}{4} = \frac{\alpha^2}{9} + \frac{9}{4} + \alpha$$
$$\frac{\alpha^2}{9} - \frac{2\alpha}{3} = 0$$
$\alpha = 0$ (reject), $\alpha = 6$

$\alpha + \mu = 2\mu + 2$

= 5

Q28. Let a line perpendicular to the line 2x – y = 10 touch the parabola $y^2 = 4(x - 9)$ at the point P. The distance of the point P from the centre of the circle $x^2 + y^2 - 14x - 8y + 56 = 0$ is _____.

Ans. **10**

Sol. $y^2 = 4(x - 9)$

Slope of tangent $= \frac{-1}{2}$

Point of contact $= \left(h + \frac{1}{m^2}, k + \frac{2a}{m}\right)$

$$= \left(9 + \frac{1}{\left(-\frac{1}{2}\right)^2}, 0 + \frac{2 \times 1}{\frac{-1}{2}}\right)$$

$P(13, -4)$

Equation of circle is

$x^2 + y^2 - 14x - 8y + 56 = 0$

Centre of circle C (7,4)

Distance CP = $\sqrt{(13-7)^2 + (-4-4)^2}$ = 10

Q29. Let y = y(x) be the solution of the differential equation

$$\frac{dy}{dx} + \frac{2x}{(1+x^2)^2} y = xe^{\frac{1}{(1+x^2)}}; y(0) = 0.$$

Then the area enclosed by the curve $f(x) = y(x)\, e^{-\frac{1}{(1+x^2)}}$ and the line y – x = 4 is_____.

Ans. **18**

Sol. $$\frac{dy}{dx} + \frac{2x}{(1+x^2)^2} y = xe^{\frac{1}{(1-x^2)}}$$

$IF = e^{\int \frac{2x}{(1+x^2)^2}dx} = e^{-\frac{1}{1+x^2}}$

$y.e^{\frac{-1}{1+x^2}} = \int x.e^{\frac{1}{1+x^2}}.e^{\frac{-1}{1+x^2}}.dx.$

$ye^{\frac{-1}{1+x^2}} = \frac{x^2}{2} + c$

(0,0) satisfy the equation

C = 0

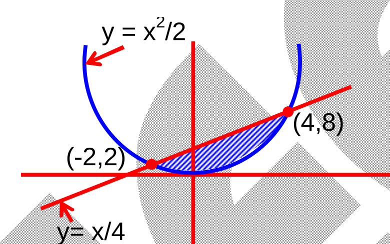
$y(x) = \frac{x^2}{2}e^{\frac{1}{1+x^2}}$

$f(x) = \frac{x^2}{2}$

Area $= \int_{-2}^{4}\left((x+4) - \frac{x^2}{2}\right).dx$

$= \left[\frac{x^2}{2} + 4x - \frac{x^3}{6}\right]_{-2}^{4}$

= 18



Q30. Let the point $(-1, \alpha, \beta)$ lie on the line of the shortest distance between the lines $\frac{x+2}{-3} = \frac{y-2}{4} = \frac{z-5}{2}$ and $\frac{x+2}{-1} = \frac{y+6}{2} = \frac{z-1}{0}$. Then $(\alpha-\beta)^2$ is equal to _____.

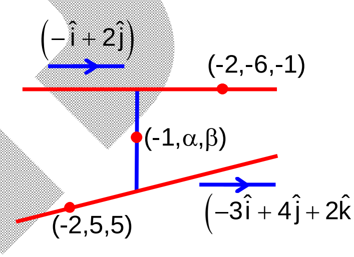
Ans. 25

Sol. $P(-3\lambda-2, 4\lambda+2, 2\lambda+5)$

$Q(-\mu-2, 2\mu-6, 1)$

$DR_s^1 = (3\lambda-\mu, 2\mu-4\lambda-8, -2\lambda-4)$

$DR_s^1 \text{ of } PQ = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -1 & 2 & 0 \\ -3 & 4 & 2 \end{vmatrix}$



$= 4\hat{i} + 2\hat{j} + 2\hat{k}$

$\frac{3\lambda-\mu}{2} = \frac{2\mu-4\lambda-8}{1} = \frac{-2\lambda-4}{1}$

$\Rightarrow \mu = \lambda + 2 \text{and } 7\lambda = \mu - 8$

$\lambda = -1, \mu = 1$

$Q : (-3, -4, 1)$

$L_{PQ} = \frac{x+3}{2} = \frac{y+4}{1} = \frac{z-1}{1}$

$(-1, \alpha, \beta) \Rightarrow 1 = \frac{\alpha+4}{1} = \frac{\beta-1}{1}$

$\alpha = -3, \beta = 2$

$(\alpha-\beta)^2 = 25$

PART – B (PHYSICS)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (1), (2), (3) and (4), out of which **ONLY ONE** option is correct.

Q31. A man carrying a monkey on his shoulder does cycling smoothly on a circular track of radius 9 m and completes 120 resolutions in 3 minutes. The magnitude of centripetal acceleration of monkey is (in m/s^2) :

(A) $4\pi^2\,ms^{-2}$ (B) $57600\pi^2\,ms^{-2}$

(C) Zero (D) $16\pi^2\,ms^{-2}$

Ans. D

Sol. Magnitude of centripetal acceleration

$a_c = \omega^2 r$ **…………………**(I)

$$\omega = \frac{120\times 2\pi}{3\times 60}\text{rad/s}$$

$$\omega = \frac{4\pi}{3}\text{rad/s}$$

$r = 9\text{m}$

$$a_c = \left(\frac{4\pi}{3}\right)^2 .9\text{ rad/s}^2$$

$$a_c = 16\pi^2\text{rad/s}^2$$

Q32. Match List-1 with List-II :

	List-I		List-II
(A)	A force that restores an elastic body of unit area to its original state	(I)	Buik modulus
(B)	Two equal and opposite forces parallel to opposite faces	(II)	Young's modulus same everywhere
(C)	Forces perpendicular everywhere to the surface per unit area same everywhere	(III)	Stress
(D)	Two equal and opposite forces perpendicular to	(IV)	Shear modulus

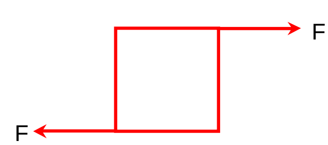
Choose the correct answer from the options given below :

(A) (A)-(III), (B)-(I), (C)-(II), (D)-(IV) (B) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

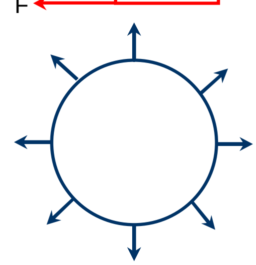
(C) (A)-(III), (B)-(IV), (C)-(I), (D)-(II) (D) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

Ans. C

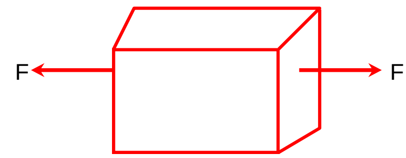
Sol. The force that restores an elastic body of unit area to its original state is called stress. Two equal and opposite forces parallel to opposite faces is related to shear stress and shear modulus



Force perpendicular everywhere to the surface per unit area same everywhere i.e, volumetric stress per unit area (Bulk modulus)



Two equal and opposite forces perpendicular to opposite forces i.e longitudinal stress (Young's modulus)



Q33. A vernier callipers has 20 divisions on the vernier scale, which coincides with 19th division on the main scale. The least count of the instrument is 0.1mm. One main scale division is equal to ________mm,

(A) 0.5
(B) 1
(C) 2
(D) 5

Ans. **C**

Sol. Least count = 1MSD-1VSD

Given 20VSD = 19MSD

$$0.1\text{mm} = 1\text{MSD} - \frac{19}{20}\text{MSD}$$

$$0.1\text{mm} = \frac{1}{20}\text{MSD}$$

$$1\text{MSD} = 2\text{mm}$$

Q34. Given below are two statements :

Statement I: When the white light passed through a prism, the red light bends lesser than yellow and violet.

Statement II : The refractive indices are different for different wavelengths in dispersive medium.

In the light of the above statements, chose the correct answer from the options given below :

Options

(A) Statement I is true but Statement II is false
(B) Both Statement I and Statement II are false
(C) Both Statement I and Statement II are true
(D) Statement I is false but Statement II is true

Ans. **C**

Sol. As we know that $\lambda_{\text{Red}} > \lambda_{\text{Yellow}} > \lambda_{\text{Violet}}$

According to Cauchy's equation Refractive index 'μ' of the material of the prism for a wavelength λ is given as

$$\mu = A + \frac{B}{\lambda^2} + ------$$

So, $\mu_{\text{Red}} < \mu_{\text{Yellow}} < \mu_{\text{Violet}}$

For this prism deviation

$$\delta = A(\mu - 1)$$

So, $\delta_{\text{red}} < \delta_{\text{yellow}} < \delta_{\text{violet}}$

Q35. During an adiabatic process, if the pressure of a gas is found to be proportional to the cube of its absolute temperature, then the ratio of $\frac{C_P}{C_V}$ for the gas is :

(A) $\frac{7}{5}$
(B) $\frac{5}{3}$
(C) $\frac{9}{7}$
(D) $\frac{3}{2}$

Ans. **D**

Sol. For adiabatic process PV^{γ} = constant where $\gamma = \frac{C_p}{C_v}$

$P \propto T^3$
PT^{-3} = constant
$P(PV)^{-3}$ = constant $(PV = nRT)$
$P^{-2}V^{-3}$ = constant
P^2V^3 = constant
$PV^{3/2}$ = constant

Here $\gamma = \frac{3}{2}$

i.e $\frac{C_p}{C_v} = \frac{3}{2}$

Q36. If n is the number density and d is the diameter of the molecule, then the average distance covered by a molecule between two successive collisions (i.e. mean free path) is represented by :

(A) $\sqrt{2}n\pi d^2$
(B) $\frac{1}{\sqrt{2}n\pi d^2}$
(C) $\frac{1}{\sqrt{2n\pi d^2}}$
(D) $\frac{1}{\sqrt{2n^2\pi^2 d^2}}$

Ans. B

Sol. From kinetic theory of gases

Mean free path $\lambda = \frac{1}{\sqrt{2}n\pi d^2}$

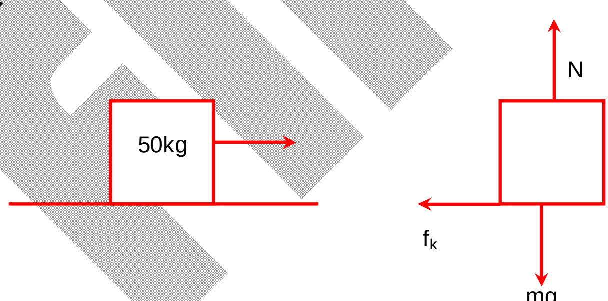
Where, n= number of molecular per unit volume
d= diameter of the molecule

Q37. A heavy box of mass 50 kg is moving on a horizontal surface. If co-efficient of kinetic friction between the box and horizontal surface is 0.3 then force of kinetic friction is :

(A) 1.47 N
(B) 1470 N
(C) 147 N
(D) 14.7 N

Ans. C

Sol.



$N = mg$
$f_k = \mu_k N$
$f_k = \mu_k mg = 0.3 \times 50 \times 9.81$
$f_k = 147N$

Q38. A particle moves in x-y plane under the influence of a force $\vec{F}$ such that its linear momentum is $\vec{P}(t) = \hat{i}\cos(kt) - \hat{j}\sin(kt)$. If k is constant, the angle between $\vec{F}$ and $\vec{P}$ will be :

(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{6}$

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

Ans. D

Sol. $\vec{P} = \cos(kt)\hat{i} - \sin(kt)\hat{j}$

$$\vec{F} = \frac{d\vec{P}}{dt} = -k\sin(kt)\hat{i} - k\cos(kt)$$

$$\vec{P} - \vec{F} = -k\cos(kt)\sin(kt) + k\sin(kt)\cos(kt)$$

$$\vec{P}.\vec{F} = 0$$

i.e angle between $\vec{F}$ and $\vec{P}$ will be $\frac{\pi}{2}$

Q39. A body is moving unidirectionally under the influence of a constant power source. Its displacement in time t is proportional to :

(A) t^2 (B) $t^{2/3}$

(C) t (D) $t^{3/2}$

Ans. D

Sol. Power = (Force) (velocity) = constant

Fv=constant

(ma) v = constant

$$\left(m\frac{dv}{dt}\right)v = \text{constant}$$

$$\int_0^v vdv = k\int_0^t dt \text{ (where k is constant)}$$

$$\frac{v^2}{2} = kt$$

i.e $v \propto t^{1/2}$

$$\frac{dx}{dt} = ct^{1/2} \text{ (where c is constant)}$$

$$\int_0^x dx = c\int_0^t t^{1/2}dt$$

$$x = c\frac{2}{3}t^{3/2}$$

$$x \propto t^{3/2}$$

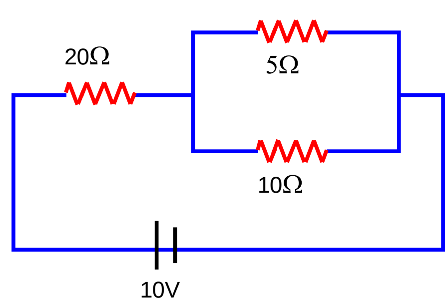
Q40. The ratio of heat dissipated per second through the resistance 5Ω and 10Ω in the circuit given below is :

(A) 1 : 1

(B) 1 : 2

(C) 4 : 1

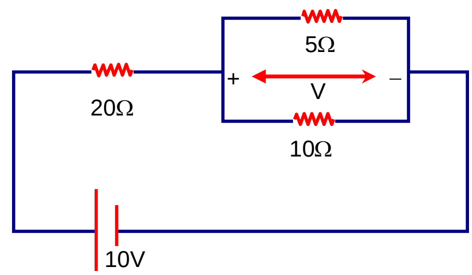
(D) 2 : 1



Ans. D

Sol. Resistor 5Ω and 10Ω are parallel, so potential
Ratio of heat displaced per second

$$\frac{P_1}{P_2} = \frac{\left(v^2/R_1\right)}{\left(v^2/R_2\right)} = \frac{R_2}{R_1} = \frac{10\Omega}{5\Omega} = 2:1$$



Q41. Match List-I with List-II :

List-I EM-Wave		List-II Wavelength Range	
(a)	Intra-red	(I)	$<10^{-3}$ nm
(b)	Ultraviolet	(II)	400nm to 1 nm
(c)	X-rays	(III)	1mm to 700nm
(d)	Gamma rays	(IV)	1nm to 10^{-3} nm

Choose the correct answer from the options given below :

(A) (a) (III), (b)-(II), (c)-(IV), (d)-(I)
(B) (a)-(IV), (b)-(III), (c)-(II), (d)-(I)
(C) (a) (I), (b)-(III), (c)-(II), (d)-(IV)
(D) (a)-(II), (b)-(I), (c)-(IV), (d)-(III)

Ans. A

Sol.

EM. Wave	Wavelength range
Infra-red	1nm to 700 nm
Visible ray	400nm to 700nm
Ultraviolet	400nm to 1nm
X –rays	1nm to 10^{-3}nm
Gamma rays	$<10^{-3}$nm

Q42. The vehicles carrying inflammable fluids usually have metallic chains touching the ground.

(A) To alert other vehicles
(B) To conduct excess charge due to air friction to ground and prevent sparking
(C) It is a custom
(D) to protect tyres from catching dirt from ground

Ans. B

Sol. Due to air friction static charge is developed. This static charge can result in combustion of inflammable fluids.
To discharge this excess static charge to ground (zero potential), we have to connect metallic (conductor) chain touching to ground.

Q43. What is the dimensional formula of ab^{-1} in the equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, where letters have their usual meaning.

(A) $\left[ML^2T^{-2}\right]$
(B) $\left[M^0L^3T^{-2}\right]$
(C) $\left[M^{-1}L^5T^3\right]$
(D) $\left[M^6L^7T^4\right]$

Ans. A

Sol. $\left(P + \frac{a}{v^2}\right)(v - b) = RT$

$\left[\frac{a}{V^2}\right] = [P]$

$[a] = \left[PV^2\right] = \left[ML^{-1}T^{-2}\right]\left[L^6\right] = \left[ML^5T^{-2}\right]$ and $[b] = [v] = \left[L^3\right]$

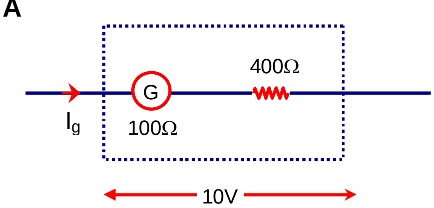
$\therefore \left[ab^{-1}\right] = \left[ML^5T^{-2}\right]\left[L^{-3}\right] = \left[ML^2T^{-2}\right]$

Q44. A galvanometer of resistance 100 Ω when connected in series with 400 Ω measures a voltage of upto 10V. The value of resistance required to convert the galvanometer into ammeter to read upto 10A is $x \times 10^{-2}\Omega$. The value of x is :

(A) 20 (B) 200
(C) 800 (D) 2

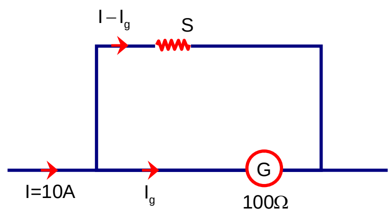
Ans. A

Sol.



$I_g(100+400)=10$

$I_g = 20\times10^{-3}$ A



$I_g(100)=(I-I_g).S$

$20\times10^{-3}\times100=(10-20\times10^{-3})S$

$S\approx 20\times10^{-2}\Omega$

$x = 20$

Q45. A satellite revolving around a planet in stationary orbit has time period 6 hours. The mass of planet is one-fourth the mass of earth. The radius orbit of planet is: (Given = Radius of geo-stationary orbit for earth is 4.2×10^4 km)

(A) 1.4×10^4 km (B) 8.4×10^4 km
(C) 1.68×10^5 km (D) 1.05×10^4 km

Ans. D

Sol. $T^2 = \frac{4\pi^2 r^3}{GM}$

$T \propto \frac{r^{3/2}}{M^{1/2}}$

$\left(M_1 = \frac{M}{4}\right)$

$\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2}\left(\frac{M_2}{M_1}\right)^{1/2}$

$\frac{6h}{24h} = \left(\frac{r_1}{4.2\times10^4}\right)^{3/2}\left(\frac{M}{M/4}\right)^{1/4}$

$\frac{1}{4} = \left(\frac{r_1}{4.2\times10^4}\right)^{3/2}(2)$

$\left(\frac{r_1}{4.2\times10^4}\right)^{3/4} = \frac{1}{8}$

$\frac{r_1}{4.2\times10^4} = \frac{1}{4}$

$$r_1 = \frac{4.2\times10^4}{4} = 1.05\times10^4 \text{km}$$

Q46. The electrostatic force $\left(\vec{F_1}\right)$ and magnetic force $\left(\vec{F_2}\right)$ acting on a charge q moving with velocity v can be written :

(A) $\vec{F}_1 = q\vec{B}, \vec{F}_2 = q(\vec{B}\times\vec{V})$
(B) $\vec{F}_1 = q\vec{E}, \vec{F}_2 = q(\vec{B}\times\vec{V})$
(C) $\vec{F}_1 = q\vec{E}, \vec{F}_2 = q(\vec{V}\times\vec{B})$
(D) $\vec{F}_1 = q\vec{V}\cdot\vec{E}, \vec{F}_2 = q(\vec{B}\cdot\vec{V})$

Ans. **C**

Sol. According to lorentz force

$$\vec{F} = q\left[\vec{E} + \left(\vec{v}\times\vec{B}\right)\right]$$

$$\vec{F} = q\vec{E} + q\left(\vec{v}\times\vec{B}\right)$$

$$\vec{F} = \vec{F}_1 + \vec{F}_2$$

$\vec{F}_1 = q\vec{E} \Rightarrow$ electrostatic force

$\vec{F} = q\left(\vec{v}\times\vec{B}\right) \Rightarrow$ Magnetic force

Q47. Which of the following statement is not true about stopping potential (V_0)?

(A) It depends upon frequency of the incident light
(B) It increases with increase in intensity of the incident light
(C) It depends on the nature of emitter material
(D) It is 1 / e times the maximum kinetic energy of electrons emitted.

Ans. **B**

Sol. $eV_s = KE_{max} = h\nu - \phi$

$$V_s = \frac{KE_{max}}{e} = \frac{h\nu-\phi}{e}$$

Stopping potential doesn't depend on intensity of incident light.

Q48. A series LCR circuit is subjected to an ac signal of 200V, 50Hz. If the voltage across the inductor (L=10mH) is 31.4V, then the current in this circuit is .

(A) 10 mA
(B) 10 A
(C) 68 A
(D) 63 A

Ans. **B**

Sol. Given voltage across inductor

$V_L = 31.4V$

$I\times X_L = 31.4$

$I(2\pi fL) = 31.4$

$I\left(2\pi\times50\times10\times10^{-3}\right) = 31.4$

$I = 10A$

Q49. The angular momentum of an electron in a hydrogen atom is proportional to:
(Where r is the radius of orbit of electron)

(A) $\frac{1}{r}$
(B) $\sqrt{r}$
(C) r
(D) $\frac{1}{\sqrt{r}}$

Ans. **B**

Sol. Angular momentum of an electron in hydrogen atom.

$L = mvr = \frac{nh}{2\pi}$

$L \propto n$ ....(I)

$r \propto \frac{n^2}{z}$

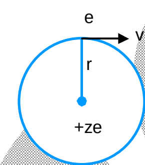
$(z = 1)$

$r \propto n^2$ ....(II)

For equation 1 & II

$L \propto \sqrt{r}$

Alternate solution



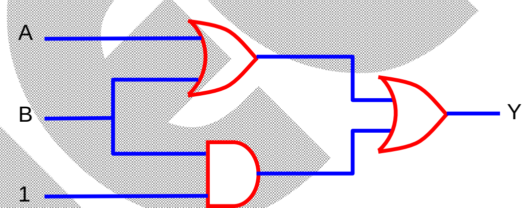
$\frac{mv^2}{r} = \frac{kze^2}{r^2}$

$m^2v^2r^2 = kze^2mr$

$L^2 \propto r$

$L \propto \sqrt{r}$

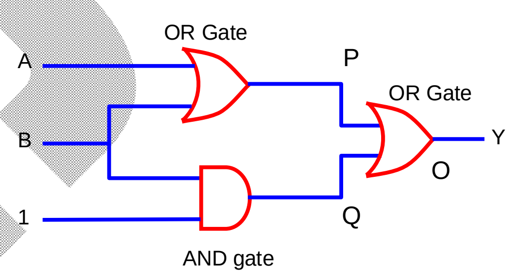
Q50. The output (Y) of logic circuit given below is 0 only when :



(A) A = 1, B = 1
(B) A = 1, B = 0
(C) A = 0, B = 0
(D) A = 0, B = 1

Ans. C

Sol. For output (Y) to be zero, the output at P and Q should be zero, this will be only possible if A=0 and B=0

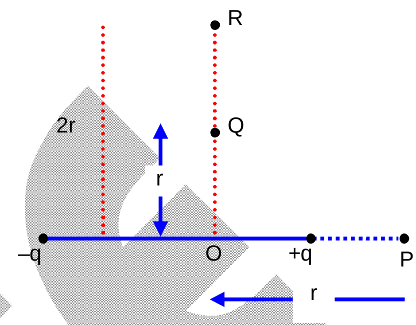


SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q51. The electric field at point p due to an electric dipole is E. The electric field at point R on equatorial line will be $\frac{E}{x}$. The value of x :



Ans. **16**

Sol. Due to short dipole

Electric field at axial point is

$$E_P = \frac{2kP}{r^3} = E$$

$$E_R = \frac{KP}{(2r)^3} = \frac{KP}{8r^3} = \frac{2KP}{16r^3} = \frac{E}{16}$$

$$x = 16$$

Q52. The shortest wavelength of the spectral lines in the Lyman series of hydrogen spectrum is 915 Å. The longest wavelength of spectral lines in the Balmer series will be ________Å.

Ans. **6588**

Sol. $\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For hydrogen $(z = 1)$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Shortest wavelength of Lyman series $(n_2 = \infty) \longrightarrow (n_1 = 1)$

$$\frac{1}{915A^o} = R\left(\frac{1}{1} - \frac{1}{\infty}\right) = R \text{ ....(I)}$$

Longest wavelength of Balmer series $(n_2 = 3) \longrightarrow (n_1 = 2)$

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36} \text{ ....(II)}$$

For equation (I) and (II)

$$\lambda = \frac{36}{5R} = \frac{36}{5} \times 915A^o$$

$$\lambda = 6588A^o$$

Q53. In a single slit experiment, a parallel beam of green light of wavelength 550nm passes through a slit of width 0.20mm. The transmitted light is collected on a screen 100cm away. The distance of first order minima from the central maximum will be $x \times 10^{-5}$ m. The value of x is :

Ans. **275**

Sol. Diffraction of light
The distance of first order minima from the central maximum will be

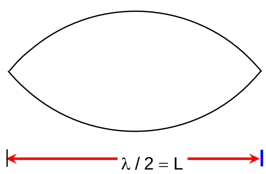
$$y = \frac{D\lambda}{d} = \frac{\left(100\times10^{-2}\right)\times\left(550\times10^{-9}\right)}{\left(0.2\times10^{-3}\right)}$$

$$y = 275\times10^{-5}\,m$$

Q54. A sonometer wire of resonating length 90cm has a fundamental frequency of 400Hz when kept under some tension. The resonating length of the wire with fundamental frequency of 600Hz under same tension _________cm.

Ans. **60**

Sol.



$$\lambda = 2L$$

$$f = \frac{V}{2L} = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

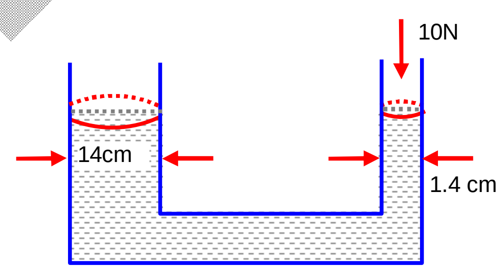
$$f \propto \frac{1}{L}$$

$$\frac{f}{f'} = \frac{L'}{L}$$

$$L' = \frac{fL}{f'} = \frac{(400\,Hz)(90\,cm)}{600Hz}$$

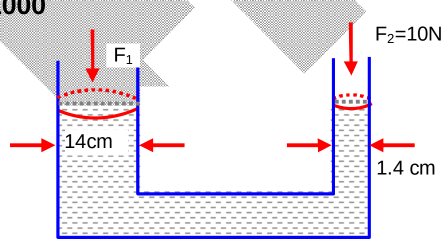
$$L' = 60\,cm$$

Q55. A hydraulic press containing water has two arms with diameters as mentioned in the figure. A force of 10 N is applied on the surface of water in the thinner arm. The force required to be applied on the surface of water in the thicker arm to maintain equilibrium of water is________ N.



Ans. **1000**

Sol.



$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = \frac{A_1}{A_2}(F_2) = \frac{\frac{\pi}{4}(14\,cm)^2}{\frac{\pi}{4}(1.4\,cm)^2}\times10N$$

$$F_1 = 1000N$$

Q56. The current in an inductor is given by I = (3t + 8) where t is in second. The magnitude of induced emf produced in the inductor is 12mV. The self-inductance of the inductor _________mH.

Ans. **4**

Sol. Current is given as

$I = 3t + 8 \quad A$

$|\,emf\,| = \left|L\frac{dI}{dt}\right|$

$12\times10^{-3} = L\times3$

$L = 4\times10^{-3}H$

$L = 4mH$

Q57. A solenoid of length 0.5 m has a radius of 1 cm and is made up of 'm' number of turns. It carries a current of 5A. If the magnitude of the magnetic field inside the solenoid is 6.28×10^{-3} T, then the value of m is_________.

Ans. **500**

Sol. Magnetic field inside solenoid is

$B = \mu_0 ni$ (where n is number of turns per unit length)

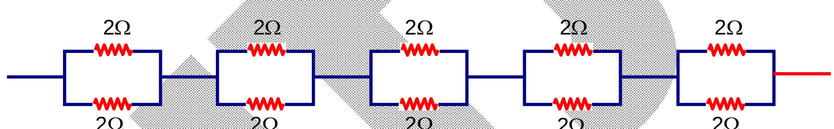
$$6.28\times10^{-3} = \left(4\pi\times10^{-7}\right)\times\left(\frac{m}{0.5}\right)\times5$$

$m = 500$

Q58. A wire of resistance 20Ω is divided into 10 equal parts, resulting pairs. A combination of two parts are connected in parallel and so on. Now resulting pairs of parallel combination are connected in series. The equivalent resistance of final combination is_________ Ω.

Ans. **5**

Sol.



$R_{eq} = 5\Omega$

Q59. A hollow sphere is rolling on a plane surface about its axis of symmetry. The ratio of rotational kinetic energy to its total kinetic energy is $\frac{x}{5}$. The value of x is_________.

$$\frac{RE}{TE} = \frac{2/3}{1+\frac{2}{3}} = \frac{2}{5}$$

Ans. **2**

Sol. Total kinetic energy $= \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$

$(TE) = \frac{1}{2}MR^2\omega^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2}\left(MR^2 + I\right)\omega^2$

Rotation kinetic energy $= \frac{1}{2}I\omega^2$

(RE)

i.e $\frac{RE}{TE} = \frac{\frac{1}{2}I\omega^2}{\frac{1}{2}\left(I+MR^2\right)\omega^2} = \frac{I}{I+MR^2}$

$$\frac{RE}{TE}=\frac{\frac{2}{3}MR^2}{\frac{2}{3}MR^2+MR^2}\quad\left(I_{hollowsphere}=\frac{2}{5}MR^2\right)$$

$$\frac{RE}{TE}=\frac{2}{5}$$

Alternate

$$\frac{RE}{TE}=\frac{\frac{1}{2}Mv^2\left(\frac{k^2}{R^2}\right)}{\frac{1}{2}Mv^2\left(1+\frac{k^2}{R^2}\right)}=\frac{\left(K^2/R^2\right)}{\left(1+\frac{k^2}{R^2}\right)}$$

For hollow sphere $\frac{K^2}{R^2}=\frac{2}{3}$

$$\frac{RE}{TE}=\frac{2/3}{1+\frac{2}{3}}=\frac{2}{5}$$

Q60. The maximum height reached by a projectile is 64 m. If the initial velocity is halved, the new maximum height of the projectile is ________m.

Ans. **16**

Sol. Maximum height of projectile is

$$H_{max}=\frac{u^2\sin^2\theta}{2g}$$

$$H_{max}\propto u^2$$

$$\frac{H}{H}=\left(\frac{u}{u'}\right)^2=\left(\frac{u}{u/2}\right)^2=4$$

$$H'=\frac{H}{4}=\frac{64}{4}=16m$$

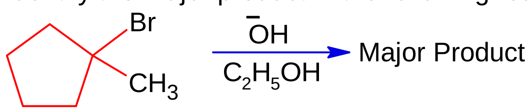
PART – C (CHEMISTRY)

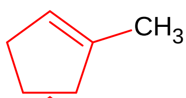
SECTION - A

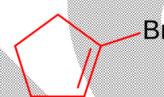
(One Options Correct Type)

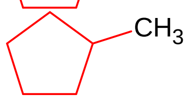
This section contains **20 multiple choice questions**. Each question has **four choices** (1), (2), (3) and (4), out of which **ONLY ONE** option is correct.

Q61. Identify the major product in the following reaction.



(A) 

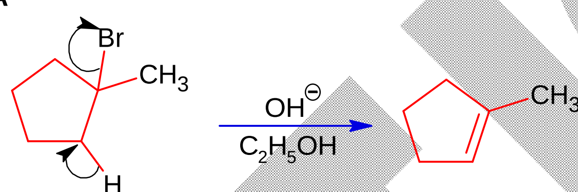
(B) 

(C) 

(D) 

Ans. A

Sol.



Q62. Match **List-I** with **List-II**

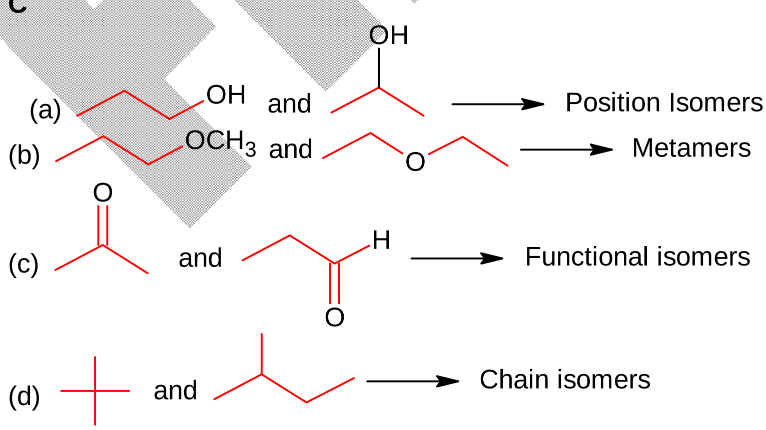
List –I **(Pair of Compounds)**	**List – II** **(Isomerism)**
(a) n-propanol and isopropanol	(I) Metamerism
(b) Methoxypropane and ethoxyethane	(II) Chain Isomerism
(c) Propanone and propnal	(III) Position Isomerism
(d) Neopentane and Isopentane	(IV) Functional Isomerism

Choose the correct answer from the options given below:

(A) (a – I), (b – III), (c – IV), (d – II)
(B) (a – III), (b – I), (c – II), (d – IV)
(C) (a - III), (b – I), (c – IV), (d – II)
(D) (a – II), (b – I), (c – IV), (d – III)

Ans. C

Sol.



Q63. While preparing crystals of Mohr's salt, dil. H_2SO_4 is added to a mixture of ferrous sulphate and ammonium sulphate, before dissolving this mixture in water, dil. H_2SO_4 is added here to:
(A) prevent the hydrolysis of ferrous sulphate
(B) increase the rate of formation of crystals
(C) prevent the hydrolysis of ammonium sulphate
(D) make the medium strongly acidic

Ans. **A**

Sol. Mohr's salt = $FeSO_4.(NH_4)_2SO_4.6H_2O$

$$FeSO_4(aq)+(NH_4)_2SO_4(aq)+dil.H_2SO_4 \rightarrow FeSO_4(NH_4)_2SO_4.6H_2O$$

dil. H_2SO_4 is added to prevent hydrolysis of $FeSO_4$ to Fe^{+3} salt without addition of dil H_2SO_4 Mohr's solution gives yellow colour solution.

Q64. The number of ions from the following that have the ability to liberate hydrogen from a dilute acid is __________.
Ti^{2+}, Cr^{2+} and V^{2+}
(A) 3 (B) 0
(C) 2 (D) 1

Ans. **A**

Sol. The ions Ti^{+2}, Cr^{+2} and V^{+2} are strong reducing agents and will liberate H_2 from dil acids.

$$Cr^{+2}_{(aq)} + 2H^{+}_{(aq)} \longrightarrow 2Cr^{+3}_{(aq)} + H_2(g)$$

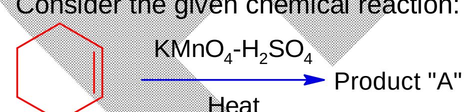
Q65. Given below are two statements:

Statement I : The metallic radius of Na is 1.86 $\mathring{A}$ and the ionic radius of Na^+ is lesser than 1.86 $\mathring{A}$.
Statement II: Ions are always smaller in size than the corresponding elements.
In the light of the above statements, choose the **correct** answer from the options given below:
(A) Both **Statement I** and **Statement II** are false.
(B) **Statement I** is correct but **Statement II** is false.
(C) Both **Statement I** and **Statement II** are true
(D) **Statement I** is incorrect. but **Statement II** is true.

Ans. **B**

Sol. $r_{Na} > r_{Na^+}$
Cation is smaller in size than corresponding element, so statement (I) is correct
$r_{anion} > r_{Neutral}$ atom.
So statement (II) is correct.

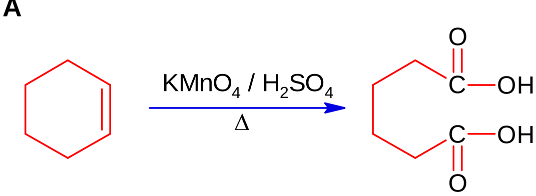
Q66. Consider the given chemical reaction:



Product "A" is:
(A) adipic acid (B) picric acid
(C) oxalic acid (D) acetic acid

Ans. **A**

Sol.



Oxidation takes place by cleavage of π -bond, thus adipic acid formed.

Q67. The quantity of silver deposited when one coulomb charge is passed through $AgNO_3$ solution:
(A) 0.1 g atom of silver
(B) 1 g of silver
(C) 1electrochemical equivalent of silver
(D) 1chemical equivalent of silver

Ans. **C**

Sol. $W = ZIt$
$= ZQ$
When $Q = 1\text{coul}$
$\therefore W = Z =$ electrochemical equivalent.

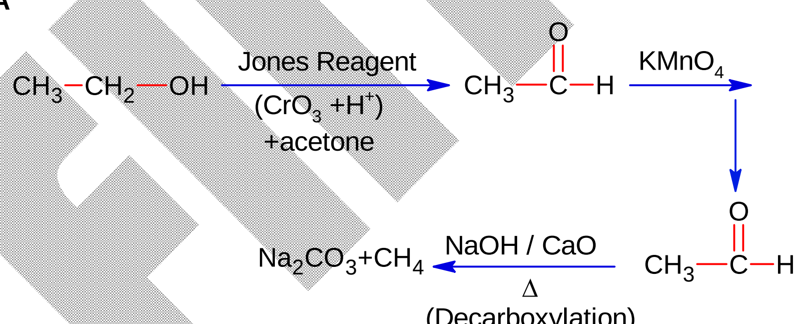
Q68. The number of complexes from the following with no electrons in the t_2 orbital is______.
$TiCl_4, \left[MNO_4^-\right], \left[FeO_4\right]^{2-}, \left[FeCl_4\right]^- \left[CoCl_4\right]^{2-}$
(A) 1
(B) 2
(C) 3
(D) 4

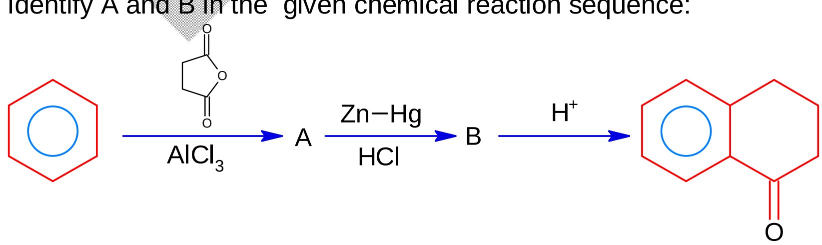
Ans. **C**

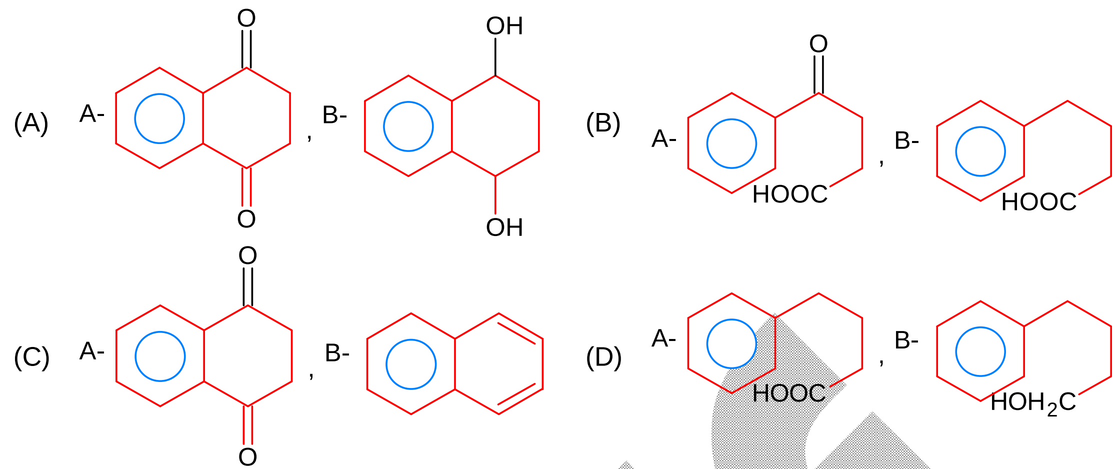
Sol. $TiCl_4 = Ti^{+4} = -4s^0 3d^0 = e^0 t_2^0$
$MnO_4^- = Mn^{+7} = -4s^0 3d^0 = e^0 t_2^0$
$\left[FeO_4\right]^{-2} = Fe^{+6} = -4s^0 3d^2 = e^2 t_2^0$
$\left[FeCl_4\right]^{-1} = Fe^{+3} = -4s^0 3d^5 = e^3 t_2^2$
$\left[CoCl_4\right]^{-2} = Co^{+2} = -4s^0 3d^7 = e^4 t_2^3$

Q69.
$$CH_3CH_2{-}OH \xrightarrow[\text{(ii) } KMnO_4 \text{ (iii) NaOH, CaO,}\Delta]{\text{(i) Jone's Reagent}} P$$
Consider the above reaction sequence and identify the major product P,
(A) Methane
(B) Methanoic acid
(C) Methoxymethane
(D) Methanal

Ans. **A**

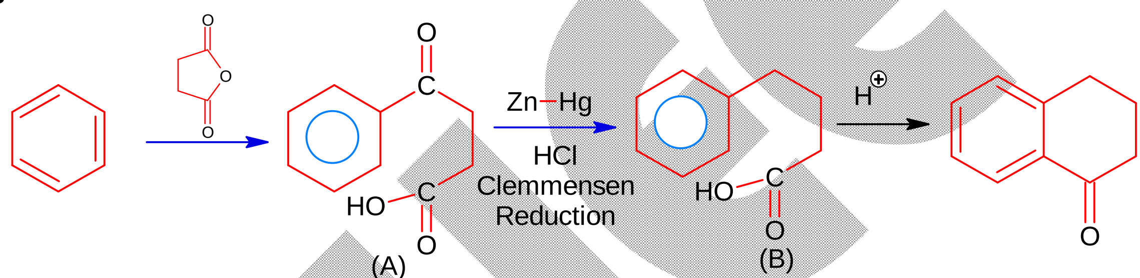
Sol.


Q70. Identify A and B in the given chemical reaction sequence:




Ans. B

Sol.

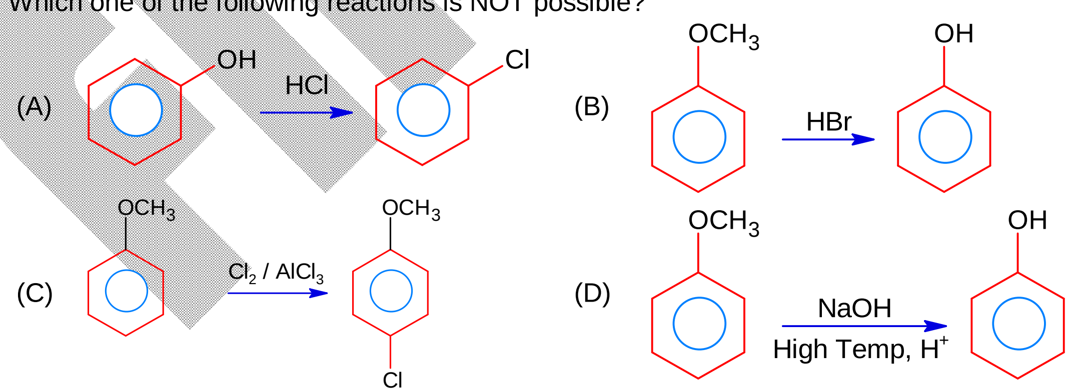


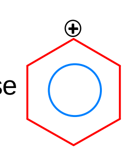
Q71. Coagulation of egg, on heating is because of :
(A) Breaking of the peptide linkage in the primary structure of protein occurs
(B) Denaturation of protein occurs
(C) The secondary structure of protein remains unchanged
(D) Biological property of protein remains unchanged

Ans. B

Sol. Coagulation of egg on heating is due to denaturation. Due to denaturation, the secondany and tertiary structure are destroyed but primary structure remains intact.

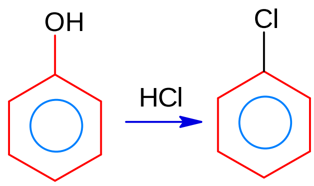
Q72. Which one of the following reactions is NOT possible?

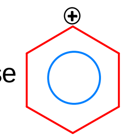


This reaction is not possible because  is unstable.

Ans. A

Sol.



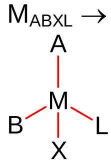
This reaction is not possible because  is unstable.

Q73. The metal atom present in the complex M_{ABXL} (where A,B,X and L are unidentate ligands and M is metal) involes sp^3 hybridisation. The number of geometrical isomers exhibited by the complex is:

(A) 3
(B) 2
(C) 4
(D) 0

Ans. D

Sol. $M_{ABXL} \rightarrow$ Teterahedral (sp^3)



It does not show any geometrical isomers

Q74. For the electro chemical cell

$M\,|\,M^{2+}\,||\,X\,|\,X^{2-}$

If $E^0_{(M^2/M)} = 0.46V$ and $E^0_{(X/X^{2-})} = 0.34V$

Which of the following is correct?

(A) $M^{2+} + X^{2-} \rightarrow M + X$ is a spontaneous reaction
(B) $M + X \rightarrow M^{2+} + X^{2-}$ is a spontaneous reaction
(C) $E_{cell} = 0.08V$
(D) $E_{cell} = -0.80V$

Ans. A

Sol4. $M\,/\,M^{+2}\,||\,X\,|\,X^{-2}$

$E^0_{M^{+2}/M} = 0.46V$ $\quad E^0_{x^0/x^{-2}} = 0.34V$

$M^{+2} + 2e^- \longrightarrow M$ $\quad E^0 = +0.46$

$x^{-2} \longrightarrow x + 2e^-$ $\quad E^0 = -0.34V$

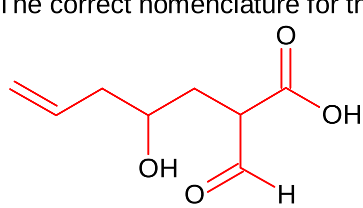
$M^{+2} + X^{-2} \longrightarrow M + X$

$\therefore E^0_{cell} = E^0_{M^{+2}/M} + E^0_{x^{-2}/x}$

$= (0.46 - 0.34)V = 0.12V$

E^0 is (+ve) thus spontaneous reaction.

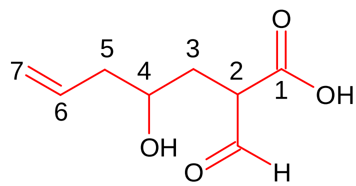
Q75. The correct nomenclature for the following compound is:



(A) 2-formyl-4-hydroxyhept-7-enoic acid
(B) 2-carboxy-4-hydroxyhept-6-enal
(C) 2-carboxy-4-hydroxyhept-7-enal
(D) 2-formyl-4-hydroxyhept-6-enoic acid

Ans. D

Sol.



2-formyl-4- hydroxylhept -6-en-1-oic acid

Q76. Give below are two statements: One is labeled as **Assertion (A)** and the other is labelled as **Reason (R):**

Assertion (A): NH_3 and NF_3 molecule have pyramidal shape with a lone pair of electrons on nitrogen atom. The resultant dipole moment of NH_3 is greater than that of NF_3.

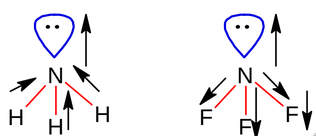
Reason R: In NH_3 the orbital dipole due to lone pair is in the same direction as the resultant dipole moment of the N-H bonds. F is the most electronegative element.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both **(A)** and **(R)** are true but **(R)** is the correct explanation of **(A)**
(B) (A) is false but **(R)** is true.
(C) Both (A) and **(R)** are true but **(R)** is NOT the correct explanation of **(A)**
(C) **(A)** is true but **(R)** is false.

Ans. **A**

Sol.



$\therefore\ \mu_{NH_3} > \mu_{NF_3}$ because bond moments are in the same direction in NH_3 and additive.

Q77. The number of moles of methane required to produce 11g $CO_2(g)$ after complete combustion is: (Given: molar mass of methane in g mol^{-1}:16)

(A) 0.75 (B) 0.5
(C) 0.25 (D) 0.35

Ans. **C**

Sol. $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

$\because$ 44g CO_2 obtained on complete combustion of 16 g CH_4

$\therefore$ 11g CO_2 obtained on complete combustion of $\frac{16}{44} \times 11 = 4g$

$\therefore\ n_{CH_4} = \frac{4}{16} = \frac{1}{4} = 0.25$

Q78. Match **List – I** with **List – II**

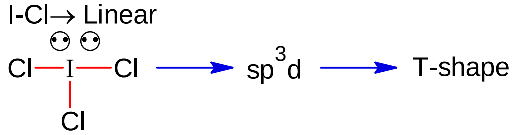
List –I	**List – II**
(a) ICl	(I) T-shape
(b) ICl_3	(II) Square pyramidal
(c) ClF_5	(III) Pentagonal bipyramidal
(d) IF_7	(IV) Linear

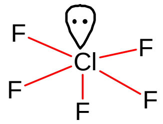
Choose the **correct** answer from the options given below:

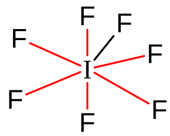
(A) (a – IV), (b – III), (c – II), (d – I) (B) (a – I), (b - III), (c – II), (d - IV)
(C) (a – I), (b – IV), (c – III), (d – II) (D) (a – IV), (b – I), (c – II), (d –III)

Ans. **D**

Sol. I-Cl$\rightarrow$ Linear



 $\longrightarrow sp^3d^2 \longrightarrow$ Square pyramidal

 $\longrightarrow sp^3d^3 \longrightarrow$ Pentagonal bipyramidal

Q79. Given below are two statements:
Statement I : On passing HCl(g) through a saturated solution of $BaCl_2$ at room temperature white turbidity appears.
Statement II: When HCl gas is passed through a saturated solution of NaCl, sodium chloride is precipitated due to common ion effect.
In the light of the above statements, choose the **most appropriate** answer from the options given below:
(A) **Statement I** is correct but **Statement II** is incorrect.
(B) **Statement I** is incorrect. but **Statement II** is correct.
(C) Both **Statement I** and **Statement II** are correct.
(D) Both **Statement I** and **Statement II** are incorrect.

Ans. **A**

Sol. $BaCl_2$ and NaCl are soluble, but on adding HCl(g) to $BaCl_2$ & NaCl solution, NaCl or $BaCl_2$ ppt out. HCl(g) is strong electrolyte & completely dissociated in aqueous solution

$$HCl \longrightarrow H^+ + Cl^-$$

Due to high concentration of Cl^- solubility of NaCl and $BaCl_2$ decreases.

Q80. The correct statements from the following are:
(A) The decreasing order of atomic radii of group 13 elements is Tl > In > Ga > Al > B
(B) Down the group 13 electronegativity decreases from top to bottom.
(C) Al dissolves in dil. HCl and liberates H_2 but conc. HNO_3 renders Al passive by forming a protective oxide layer on the surface.
(D) Hybridisation of Al in $[Al(H_2O)_6]^{3+}$ ion is sp^3d^2

Ans. **B**

Sol. Atomic radii of 13th group elements are

$T\ell > In > A\ell > Ga > B$

Electronegativity order is

$B > A\ell < Ga < In < T\ell$

B & Al are more stable in (+3) state & lower elements are more stable in (+1) state

In $\left[Al(H_2O)_6\right]^{+3}$ hybridization of Al is sp^3d^2

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q81. The fusion of chromite ore with sodium carbonate in the presence of air leads to the formation of products A and B along with the evolution of CO_2. The sum of spin-only magnetic moment values of A and B is__________ B.M.(Nearest integer)
[Given: atomic number : C:6, Na:11, O:8, Fe:26,Cr:24]

Ans. **6**

Sol. $FeCr_2O_4 + Na_2CO_3 + O_2 \longrightarrow \underset{(A)}{Na_2CrO_4} + \underset{(B)}{Fe_2O_3} + CO_2$

Spin only magnetic moment in

$\underset{(A)}{Na_2\overset{+6}{Cr}O_4} \longrightarrow Cr^{+6} = 4s^0 3d^0$ $\quad\quad \therefore \mu = 0$

$\underset{(B)}{\overset{+3}{Fe_2}O_3} \longrightarrow Fe^{+3} = -4s^0 3d^5$ $\quad\quad \mu = \sqrt{5(5+1)} = \sqrt{35} = 5.9\,BM \approx 6B.M$

Q82. Combustion of 1 mole of benzene is expressed as

$C_6H_6\,(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$

The standard enthalpy of combustion of 2 mol of benzene is $-$'x' kJ. x=__________.

Given:

1. Standard Enthalpy of formation of 1 mol of $C_6H_6(l)$, for the reaction $6C$ (graphite) $+3H_2(g) \rightarrow C_6H_6(l)$ is 48.5 kJ mol^{-1}.
2. Standard Enthalpy of formation of 1 mol of $CO_2(g)$, for the reaction C(graphite) $+O_2(g) \rightarrow CO_2(g)$ is $-$ 393.5 kJ mol^{-1}
3. Standard and Enthalpy of formation of 1 mol of $H_2O(l)$ for the reaction $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ is $-286\,kJ/mol$

Ans. **6535**

Sol. $\therefore C_6H_6(\ell) + \frac{15}{2}O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(\ell)$

$\therefore \Delta_C H^0_{(C_6H_6)} = 6 \times \Delta_f H^0_{(CO_2)} + 3 \times \Delta_f H^0_{(H_2O)} - \Delta_f H^0_{(C_6H_6)}$

$= 6 \times (-393.5) + (-286) \times 3 - (48.5)\,kJ/mole$

$= (-2361 - 858 - 48.5)\,kJ/mole$

$= -3267.5\,kJ/mol$

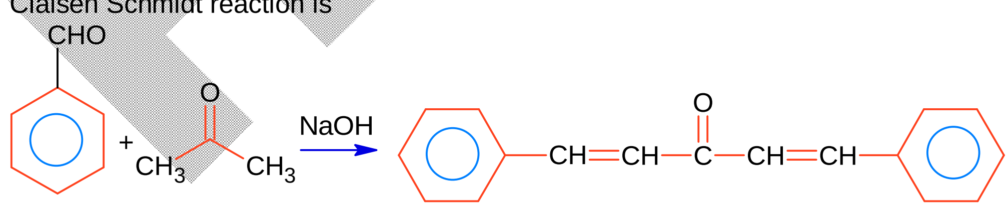
$\therefore$ for 2 mole $\Delta_C H^0_{(C_6H_6)} = -3267.5 \times 2\,kJ$

$= -6535\,kJ$

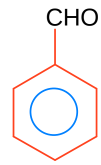
Q83. In the Claisen–Schmidt reaction to prepare 351 g of dibenzalacetone using 87 g of acetone, the amount of benzaldehyde required is _________g. (Nearest integer)

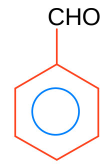
Ans. **318**

Sol. Claisen Schmidt reaction is



	87g	Dibenzal acetone 351 g M.wt =324
	$n = \frac{87}{58} = 1.5$	$n = \frac{351}{234} = 1.5$
(2 mole) 3 mole	(1 mole) 1.5 mole	(1 mole) 1.5 mole

1.5 mole dibenzalacetone required 3 mole 

m. wt of 

is 106

$\therefore$ mass of benzaldehyde= n x m.wt = 3x106=318g

Q84. Consider the following single step reaction in gas phase at constant temperature

$2A_{(g)} + B_{(g)} \rightarrow C_{(g)}$

The initial rate of the reaction is recorded as r_1 when the reaction starts with 1.5 atm pressure of A and 0.7 atm pressure of B. After some time, the rare r_2 is recoded when the pressure of C becomes 0.5 atm. The ratio r_1:r_2 is __________ $\times 10^{-1}$. (Nearest integer)

Ans. **315**

Sol.

	$2A(g)$	+	$B(g)$	$\longrightarrow$	$C(g)$
t_1 time $\rightarrow$	1.5 atm		0.7 atm		–
t_2 time $\rightarrow$	$1.5-2\times0.5$ =0.5		$0.7-0.5$ =0.2		0.5 atm

$\therefore r_1 = K(P_A)^2(P_B) = (1.5)^2(0.7)$

$r_2 = K(P_A)^2(PB) = 0.5\times0.2$

$\therefore \frac{r_1}{r_2} = \frac{(1.5)^2(0.7)}{0.5\times0.2} = 9\times\frac{7}{2} = 31.5$

$= 315\times10^{-1}$

Q85. Using the given figure, the ratio of R_f values of sample A and sample C is $x\times10^{-2}$. Value of x is____________.

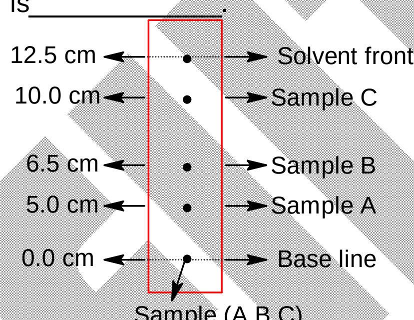


Fig: Paper chromatography of Samples

Ans. **50**

Sol. R_f of A $= \frac{5}{12.5}$

R_f of C $= \frac{10}{12.5}$

Ratio $= \frac{R_f(A)}{R_f(C)} = \frac{5}{10} = \frac{1}{2} = 0.5 = 50\times10^{-2}$

$x\times10^{-2} = 50\times10^{-2}$

$\therefore \boxed{x = 50}$

Q86. In an atom, total number of electron having quantum numbers n=4, $|m_1|$ =1 and $m_s = -\frac{1}{2}$ is__________.

Ans. **6**

Sol. $n = 4 \quad \ell = 0 \quad 0$

$= 1 \quad -1, 0, +1$

$= 2 \quad -2, -1, 0, +1, +2$

$= 3 \quad -3, -2, -1, 0, +1, +2, +3$

$|m_\ell| = 1$ then number of orbitals = 6

Each orbital contains one e^- with $m_s = -\frac{1}{2}$

Total number of $e^- = 6$

Q87. Considering acetic acid dissociates in water, its dissociation constant is 6.25×10^{-5}. If 5 mL of acetic acid is dissolved in 1 litre water, the solution will freeze at $-x \times 10^{-2\,o}C$, provided pure water freezes at 0^oC.

X= ______________. (Nearest integer)

Given: $(K_f)_{water}$ = 1.86 K kg mol^{-1}

Density of acetic acid is 1.2 g mol^{-1}

Molar mass of water = 18 g mol^{-1}

Molar mass of acetic acid = 60 g mol^{-1}

Density of water = 1 gm cm^{-3}

Acetic acid dissociates as $CH_3COOH \rightleftharpoons CH_3COO{+}H\,CH_3COO^- + H^+$

Ans. **19**

Sol87. $CH_3COOH \rightleftharpoons CH_3COO^- + H^{\oplus}$

$C \quad - \quad -$

$C - C\alpha \quad C\alpha \quad C\alpha$

$\therefore \quad Ka = \frac{C\alpha^2}{1-\alpha} \quad$ If $\quad 1 - \alpha \approx 1$

$Ka = C\alpha^2$

$\therefore \alpha = \sqrt{\frac{Ka}{c}} = \sqrt{\frac{625 \times 10^{-5}}{c}}$ sss

$V_{H_2O} = 1lit \; V_{CH_3COOH} = 5ml, d_{CH_3COOH} = 1.2\,g/mol$

$\therefore$ mass of $CH_3COOH = v \times d = 5 \times 1.2 = 6g$

$\therefore n = \frac{6}{60} = 0.1 \quad m = \frac{0.1}{1} = 0.1$

$\therefore \alpha = \sqrt{\frac{6.2 + 10^{-5}}{0.1}} = \sqrt{6.25 \times 10^{-6}} = 25 \times 10^{-3}$

$i = 1 + (n-1)\alpha = 1 + (2-1)\alpha = 1 + \alpha$

$= 1 + 0.025 = 1.025$

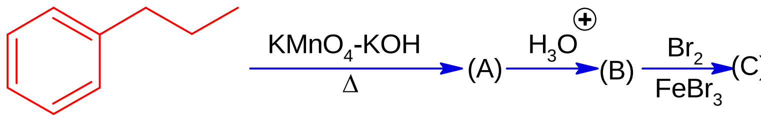
$\Delta T_f = ik_f m = (1.025) \times 1.86 \times 0.1$

$= 0.19 = 19 \times 10^{-2}$

$x \times 10^{-2} = 19 \times 10^{-2}$

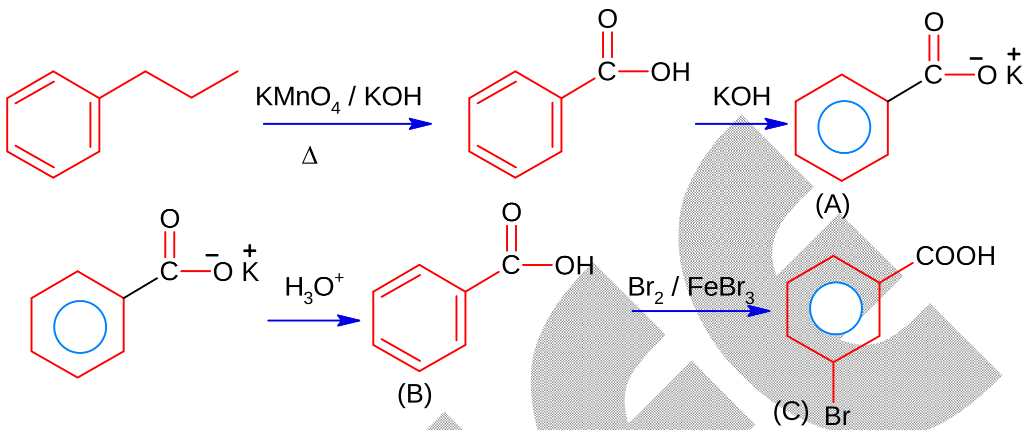
$\therefore \boxed{x = 19}$

Q88. The product (C) in the following sequence of reactions has________π bonds.



Ans. 4

Sol.



Number of π bonds in (C) = $\boxed{4}$

Q89. Number of compounds from the following with zero dipole moment is_____________.
HF, H_2, H_2S, CO_2, NH_3, BF_3, CH_4, $CHCl_3$, SiF_4, H_2O, BeF_2

Ans. 6

Sol. The compounds having zero dipole moments are H_2, CO_2, BF_3, CH_4, SiF_4, BeF_2
$\therefore$ Number of compounds having zero dipole moment are $= \boxed{6}$

Q90. X g ethanamine was subjected to reaction with $NaNO_2$ / HCl followed by hydrolysis to liberate N_2 and HCl. The HCl generated was completely neutralized by 0.2 moles of NaOH. X is ________g.

Ans. 9

Sol.

$$\underset{(x\,g)}{CH_3-CH_2-NH_2} \xrightarrow{NaNO_2+HCl} CH_3CH_2-\overset{+}{N_2}\,Cl^- \xrightarrow{HOH} CH_3-CH_2-OH+N_2+HCl$$

$$\underset{0.2\,mole}{HCl}+\underset{0.2\,mole}{NaOH} \longrightarrow NaCl+H_2O$$

$\therefore$ mole of $CH_3-CH_2-NH_2 = 0.2$

$\therefore CH_3-CH_2-NH_2 = 0.2\times 45 = 9\,gm$