



## JEE Main Online Exam 2026

Questions & Solution  
24<sup>th</sup> January 2026 | Morning

### MATHEMATICS

#### SECTION-A

1. If the function  $f(x) = \frac{e^x (e^{\tan x - x} - 1) + \log_e (\sec x + \tan x) - x}{\tan x - x}$  is Continuous at  $x = 0$ , then the value of  $f(0)$  is equal to
- (1) 2                                      (2)  $\frac{2}{3}$                                       (3)  $\frac{1}{2}$                                       (4)  $\frac{3}{2}$

Ans. [4]

Sol.  $f(0) = \lim_{x \rightarrow 0} \frac{e^{\tan x} - e^x + \ln(\sec x + \tan x) - x}{\tan x - x}$

Applying L' hospital rule

$$\Rightarrow f(0) = \lim_{x \rightarrow 0} \frac{e^{\tan x} \cdot \sec^2 x - e^x + \sec x - 1}{\sec^2 x - 1}$$

$$\Rightarrow f(0) = \lim_{x \rightarrow 0} \frac{e^{\tan x} (\sec^2 x - 1) + (e^{\tan x} - e^x) + \sec x - 1}{\tan^2 x}$$

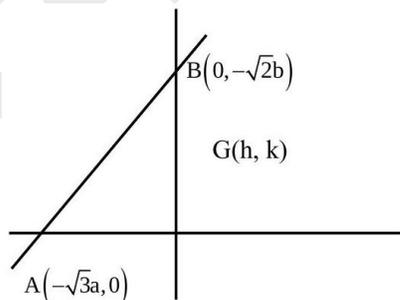
$$\Rightarrow f(0) = \lim_{x \rightarrow 0} \left( e^{\tan x} + \frac{e^x (e^{\tan x - x} - 1)}{\tan^2 x} + \frac{1}{\sec x + 1} \right)$$

$$\Rightarrow f(0) = 1 + 0 + \frac{1}{2} = \frac{3}{2}$$

2. Let a circle of radius 4 pass through the origin O, the points  $A(-\sqrt{3}a, 0)$  and  $B(0, -\sqrt{2}b)$ , where a and b are real parameters and  $ab \neq 0$ . Then the locus of the centroid of  $\Delta OAB$  is a circle of radius
- (1)  $\frac{5}{3}$                                       (2)  $\frac{7}{3}$                                       (3)  $\frac{8}{3}$                                       (4)  $\frac{11}{3}$

Ans. [3]

Sol.



$$AB = 8$$

$$3a^2 + 2b^2 = 64$$

Centroid  $G(h, k)$

$$h = -\frac{\sqrt{3}a}{3}, k = -\frac{\sqrt{2}b}{3}$$

$$a = -\sqrt{3}h, b = \frac{-3}{\sqrt{2}}k$$

$$9h^2 + 9k^2 = 64$$

$$x^2 + y^2 = \frac{64}{9}$$

$$r = \frac{8}{3}$$

3. Let the lines  $L_1 : \vec{r} = \hat{i} + 2\hat{j} + 3\hat{k} + \lambda(2\hat{i} + 3\hat{j} + 4\hat{k})$ ,  $\lambda \in \mathbb{R}$  and  $L_2 : \vec{r} = (4\hat{i} + \hat{j}) + \mu(5\hat{i} + 2\hat{j} + \hat{k})$ ,  $\mu \in \mathbb{R}$ , intersect at the point  $R$ . Let  $P$  and  $Q$  be the points lying on lines  $L_1$  and  $L_2$ , respectively, such that  $|\overline{PR}| = \sqrt{29}$  and  $|\overline{PQ}| = \sqrt{\frac{47}{3}}$ . If the point  $P$  lies in the first octant, then  $27(QR)^2$  is equal to

(1) 340

(2) 360

(3) 320

(4) 348

**Ans.**

[2]

**Sol.**

For POI

$$2\lambda + 1 = 5\mu + 4; 3\lambda + 2 = 2\mu + 1; 4\lambda + 3 = \mu$$

$$\Rightarrow \lambda = \mu = -1$$

$$R(-1, -1, -1) \quad P(2\lambda + 1, 3\lambda + 2, 4\lambda + 3)$$

$$PR^2 = 29 \Rightarrow (2\lambda + 2)^2 + (3\lambda + 3)^2 + (4\lambda + 4)^2 = 29$$

$$\Rightarrow \lambda = 0 \text{ or } \lambda = -2 \text{ (Reject)}$$

$$\Rightarrow P(1, 2, 3)$$

$$Q(5\mu + 4, 2\mu + 1, \mu)$$

$$|\overline{PQ}| = \sqrt{\frac{47}{3}} \Rightarrow PQ^2 = \frac{47}{3}$$

$$\Rightarrow (5\mu + 3)^2 + (2\mu - 1)^2 + (\mu - 3)^2 = \frac{47}{3}$$

$$\Rightarrow \mu = -\frac{1}{3}$$

$$Q = \left(\frac{7}{3}, \frac{1}{3}, -\frac{1}{3}\right)$$

$$(QR)^2 = \left(\frac{7}{3} + 1\right)^2 + \left(\frac{1}{3} + 1\right)^2 + \left(-\frac{1}{3} + 1\right)^2$$

$$= \frac{100 + 16 + 4}{9} = \frac{120}{9}$$

$$\Rightarrow 27 \times (QR)^2 = 27 \times \frac{120}{9} = 360$$

4. Let 729, 81, 9, 1, ... be a sequence and  $P_n$  denote the product of the first  $n$  terms of this sequence.

If  $2 \sum_{n=1}^{40} (P_n)^{\frac{1}{n}} = \frac{3^\alpha - 1}{3^\beta}$  and  $\gcd(\alpha, \beta) = 1$ , then  $\alpha + \beta$  is equal to

- (1) 73                                      (2) 74                                      (3) 75                                      (4) 76

**Ans.** [1]

**Sol.**  $P_n = 729 \cdot 81 \cdot 9 \dots (n \text{ terms})$

$$= 3^6 \cdot 3^4 \cdot 3^2 \dots \cdot 3^{-2n+8}$$

$$P_n = 3^{6+4+2+\dots+(-2n+8)} = 3^{n(7-n)}$$

$$P_n^{1/n} = 3^{7-n}$$

$$\Rightarrow \sum_{n=1}^{40} (P_n)^{\frac{1}{n}} = 3^6 + 3^5 + \dots + (40 \text{ terms})$$

$$= 3^6 \left[ \frac{1 - \left(\frac{1}{3}\right)^{40}}{1 - \frac{1}{3}} \right]$$

$$= \frac{3^6 [3^{40} - 1] \times 3^1}{3^{40} \times 2}$$

$$\sum (P_n)^{\frac{1}{n}} = \frac{(3^{40} - 1)}{2 \times 3^{33}}, \alpha = 40$$

$$\beta = 33$$

$$\alpha + \beta = 73$$

5. Let  $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ ,  $\vec{b} = \hat{i} + \hat{j}$  and  $\vec{c} = \vec{a} \times \vec{b}$ . Let  $\vec{d}$  be a vector such that  $|\vec{d} - \vec{a}| = \sqrt{11}$ ,  $|\vec{c} \times \vec{d}| = 3$  and the angle between  $\vec{c}$  and  $\vec{d}$  is  $\frac{\pi}{4}$ . Then  $\vec{a} \cdot \vec{d}$  is equal to

- (1) 11                                      (2) 3                                      (3) 0                                      (4) 1

**Ans.** [3]

**Sol.**  $\vec{c} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix}$

$$\vec{c} = 2\hat{i} - 2\hat{j} + \hat{k}, |\vec{c}| = 3$$

$$|\vec{c} \times \vec{d}| = 3$$

$$|\vec{c}| |\vec{d}| \sin \frac{\pi}{4} = 3 \Rightarrow |\vec{d}| = \sqrt{2}$$

$$|\vec{d} - \vec{a}| = \sqrt{11}$$

$$\Rightarrow |\vec{a}|^2 + |\vec{d}|^2 - 2\vec{a} \cdot \vec{d} = 11$$

$$9 + 2 - 2\vec{a} \cdot \vec{d} = 11$$

$$\vec{a} \cdot \vec{d} = 0$$

6. If the domain of the function  $f(x) = \log_{(10x^2 - 17x + 7)}(18x^2 - 11x + 1)$  is  $(-\infty, a) \cup (b, c) \cup (d, \infty) - \{e\}$ , then  $90(a + b + c + d + e)$  equals:
- (1) 170                                      (2) 177                                      (3) 307                                      (4) 316

**Ans.** [4]

**Sol.**  $18x^2 - 11x + 1 > 0$   
 $(2x - 1)(9x - 1) > 0$

$$x < \frac{1}{9} \text{ or } x > \frac{1}{2}$$

Also  $10x^2 - 17x + 7 > 0$   
 $(x - 1)(10x - 7) > 0$

$$x < \frac{7}{10} \text{ or } x > 1$$

$$\& 10x^2 - 17x + 7 \neq 1$$

$$x \in \left(-\infty, \frac{1}{9}\right) \cup \left(\frac{1}{2}, \frac{7}{10}\right) \cup (1, \infty) - \left\{\frac{6}{5}\right\}$$

$$90(a + b + c + d + e) = 90\left(\frac{1}{9} + \frac{1}{2} + \frac{7}{10} + 1 + \frac{6}{5}\right)$$

$$= 10 + 45 + 63 + 90 + 108 = 316$$

7. Let each of the two ellipses  $E_1: \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, (a > b)$  and  $E_2: \frac{x^2}{A^2} + \frac{y^2}{B^2} = 1, (A < B)$  have eccentricity  $\frac{4}{5}$ .

Let the lengths of the latus rectum of  $E_1$  and  $E_2$  be  $\ell_1$  and  $\ell_2$ , respectively, such that  $2\ell_1^2 = 9\ell_2$ . If the distance between the foci of  $E_1$  is 8, then the distance between the foci of  $E_2$  is

- (1)  $\frac{96}{5}$                                       (2)  $\frac{32}{5}$                                       (3)  $\frac{16}{5}$                                       (4)  $\frac{8}{5}$

**Ans.** [2]

**Sol.**  $2ae = 8 \Rightarrow a = 5$

$$b^2 = a^2(1 - e^2)$$

$$b^2 = a^2 \times \frac{9}{25} \quad b^2 = 9$$

$$E_1: \frac{x^2}{25} + \frac{y^2}{9} = 1$$

$$\ell_1: \frac{2b^2}{a} = \frac{2 \times 9}{5} = \frac{18}{5}$$

$$A^2 = B^2(1 - e^2) \Rightarrow A^2 = \frac{9}{25}B^2 \Rightarrow A = \frac{3}{5}B$$

$$2\ell_1^2 = 9\ell_2 \Rightarrow 2\left(\frac{18}{5}\right)^2 = 9\ell_2 \Rightarrow \ell_2 = \frac{4 \times 18}{25}$$

$$\frac{2A^2}{B} = \frac{72}{25} \Rightarrow A^2 = \frac{36}{25}B$$

$$\frac{9}{25}B^2 = \frac{36B}{25} \Rightarrow B = 4,$$

$$\text{Distance between foci } 2Be = 2 \times \frac{4}{5} \times 4 = \frac{32}{5}$$

8. The value of  $\frac{\sqrt{3}\operatorname{cosec}20^\circ - \sec20^\circ}{\cos20^\circ \cos40^\circ \cos60^\circ \cos80^\circ}$  is equal to  
(1) 32                                      (2) 16                                      (3) 64                                      (4) 12

Ans. [3]

Sol. 
$$E = \frac{\frac{\sqrt{3}}{\sin20^\circ} - \frac{1}{\cos20^\circ}}{\frac{1}{2} \cdot \frac{1}{4} \cdot \cos60^\circ}$$
$$= \frac{(\sqrt{3}\cos20^\circ - \sin20^\circ)}{\cos20^\circ \cdot \sin20^\circ} \cdot 16$$
$$= \frac{\left(\frac{\sqrt{3}}{2}\cos20^\circ - \frac{1}{2}\sin20^\circ\right) 32 \times 2}{2\cos20^\circ \cdot \sin20^\circ}$$
$$= \frac{\sin40^\circ}{\sin40^\circ} \times 64 = 64$$

9. Let  $S = \left\{ z \in \mathbb{C} \mid \left| \frac{z-6i}{z-2i} \right| = 1 \text{ and } \left| \frac{z-8+2i}{z+2i} \right| = \frac{3}{5} \right\}$ .

Then  $\sum_{z \in S} |z|^2$  is equal to

- (1) 398                                      (2) 413                                      (3) 423                                      (4) 385

Ans. [4]

Sol. Solving  $\left| \frac{z-6i}{z-2i} \right| = 1 \Rightarrow y = 4$  ....(1)

(where  $z = x + iy$ )

Now solving  $\left| \frac{z-8+2i}{z+2i} \right| = \frac{3}{5}$

$\Rightarrow x^2 + y^2 - 25x + 4y + 104 = 0$  ....(2)

Solving (1) & (2)  $\Rightarrow z = 17 + 4i$  &  $8 + 4i$

$\Rightarrow \sum |z|^2 = (17)^2 + (4)^2 + (8)^2 + (4)^2 = 385$

10. If  $\cot x = \frac{5}{12}$  for some  $x \in \left( \pi, \frac{3\pi}{2} \right)$ , then  $\sin 7x \left( \cos \frac{13x}{2} + \sin \frac{13x}{2} \right) + \cos 7x \left( \cos \frac{13x}{2} - \sin \frac{13x}{2} \right)$  is equal to

- (1)  $\frac{4}{\sqrt{26}}$                                       (2)  $\frac{6}{\sqrt{26}}$                                       (3)  $\frac{1}{\sqrt{13}}$                                       (4)  $\frac{5}{\sqrt{13}}$

Ans. [3]

Sol.  $\cot x = \frac{5}{12} \Rightarrow \cos x = \frac{-5}{13} = 2\cos^2 \frac{x}{2} - 1$

$\cos \left( \frac{x}{2} \right) = -\frac{2}{\sqrt{13}}$  or  $\frac{2}{\sqrt{13}}$  ( rejected )

$$\left\{ \because \frac{x}{2} \in \left( \frac{\pi}{2}, \frac{3\pi}{4} \right) \right\}$$

$$\Rightarrow \left( \sin 7x \frac{\sin 13x}{2} + \cos 7x \frac{\cos 13x}{2} \right) + \left( \sin 7x \frac{\cos 13x}{2} - \cos 7x \frac{\sin 13x}{2} \right)$$

$$\Rightarrow \cos \left( 7x - \frac{13x}{2} \right) + \sin \left( 7x - \frac{13x}{2} \right)$$

$$\Rightarrow \cos \left( \frac{x}{2} \right) + \sin \left( \frac{x}{2} \right)$$

$$\Rightarrow \frac{3}{\sqrt{13}} - \frac{2}{\sqrt{13}} = \frac{1}{\sqrt{13}}$$

11. Let  $f(t) = \int \left( \frac{1 - \sin(\log_e t)}{1 - \cos(\log_e t)} \right) dt, t > 1$ . If  $f(e^{\pi/2}) = -e^{\pi/2}$  and  $f(e^{\pi/4}) = \alpha e^{\pi/4}$ , then  $\alpha$  equals

- (1)  $-1 - \sqrt{2}$                       (2)  $-1 - 2\sqrt{2}$                       (3)  $1 + \sqrt{2}$                       (4)  $-1 + \sqrt{2}$

Ans. [1]

Sol.  $f(t) = \int \frac{1 - \sin(\ln t)}{1 - \cos(\ln t)} dt$

Let  $\ln t = x \Rightarrow t = e^x \Rightarrow dt = e^x dx$

$$= \frac{1}{2} \int \left( \operatorname{cosec}^2 \frac{x}{2} - 2 \cot \frac{x}{2} \right) e^x dx = -e^x \cdot \cot \left( \frac{x}{2} \right) + C \quad \left( \because \int (f(x) + f'(x)) e^x dx = f(x) \cdot e^x + c \right)$$

$$= -t \cdot \cot \left( \frac{\ln t}{2} \right) + C$$

Now  $f(e^{\pi/2}) = -e^{\pi/2} \cot \left( \frac{\pi}{4} \right) + C = -e^{\pi/2}$  (given)

$\Rightarrow C = 0$

Now  $f(e^{\pi/4}) = -e^{\pi/4} \cot \left( \frac{\pi}{8} \right) = -e^{\pi/4} (\sqrt{2} + 1)$

12. Let R be a relation defined on the set  $\{1, 2, 3, 4\} \times \{1, 2, 3, 4\}$  by

$R = \{((a, b), (c, d)) : 2a + 3b = 3c + 4d\}$ . Then the number of elements in R is

- (1) 6                      (2) 18                      (3) 12                      (4) 15

Ans. [3]

(a, b)	(c, d)
(1, 1)	x
(1, 2)	x
(1, 3)	(1, 2)
(1, 4)	(2, 2)
(2, 1)	(1, 1)
(2, 2)	(2, 1)
(2, 3)	(3, 1)

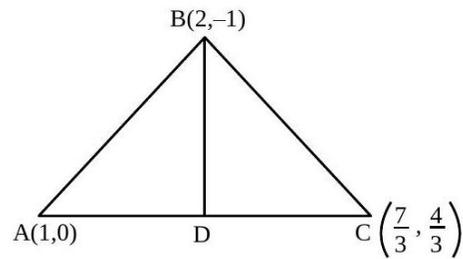
(2,4)	(4,1)
(3,1)	x
(3,2)	x
(3,3)	(1,3)
(3,4)	(2,3)
(4,1)	(1,2)
(4,2)	(2,2)
(4,3)	(3,2)
(4,4)	(4,2)

13. Let  $A(1,0), B(2,-1)$  and  $C\left(\frac{7}{3}, \frac{4}{3}\right)$  be three points. If the equation of the bisector of the angle  $ABC$  is

$\alpha x + \beta y = 5$ , then the value of  $\alpha^2 + \beta^2$  is

- (1) 8                                      (2) 5                                      (3) 13                                      (4) 10

**Ans.**  
**Sol.**



$$\frac{AD}{DC} = \frac{AB}{BC} = \frac{\sqrt{2} \times 3}{5\sqrt{2}} = \frac{3}{5}$$

$$D = \left(\frac{12}{8}, \frac{4}{8}\right) = \left(\frac{3}{2}, \frac{1}{2}\right)$$

$$\text{Slope of } BD = \frac{-3/2}{1/2} = -3$$

$$3x + y = 5$$

$$\alpha = 3, \beta = 1; \alpha^2 + \beta^2 = 10$$

14. Let  $S = \frac{1}{25!} + \frac{1}{3!23!} + \frac{1}{5!21!} + \dots$  up to 13 terms. If  $13S = \frac{2^k}{n!}$ ,  $k \in \mathbb{N}$ , then  $n + k$  is equal to

- (1) 51                                      (2) 52                                      (3) 49                                      (4) 50

**Ans.**

**[3]**

**Sol.**  $\frac{1}{26!} \left( \frac{26!}{25!1!} + \frac{26!}{3!23!} + \frac{26!}{5!21!} + \dots + 13 \text{ terms} \right)$

$$\frac{1}{26!} \left( {}^{26}C_1 + {}^{26}C_3 + {}^{26}C_5 + \dots + 13 \text{ terms} \right)$$

$$\frac{1}{26!} \left( {}^{26}C_1 + {}^{26}C_3 + \dots + {}^{26}C_{25} \right)$$

$$\Rightarrow S = \frac{1}{26!} \times 2^{25}$$

$$\Rightarrow 13S = \frac{2^{24}}{25!}$$

$$\text{so } n + k = 25 + 24 = 49$$

15. Consider an A.P.:  $a_1, a_2, \dots, a_n; a_1 > 0$ . If  $a_2 - a_1 = \frac{-3}{4}$ ,  $a_n = \frac{1}{4}a_1$ , and  $\sum_{i=1}^n a_i = \frac{525}{2}$ , then  $\sum_{i=1}^{17} a_i$  is equal to
- (1) 476                                      (2) 952                                      (3) 238                                      (4) 136

Ans. [3]

Sol.  $S_n = \frac{n}{2}[a_1 + a_n] = \frac{525}{2}$ ,  $d = \frac{-3}{4}$

$$\frac{n}{2}\left[a_1 + \frac{a_1}{4}\right] = \frac{525}{2}$$

$$\frac{5a_1 n}{4} = 525$$

$$a_1 n = 420$$

$$a_n = a_1 + (n-1)\left(\frac{-3}{4}\right)$$

$$\Rightarrow \frac{-3}{4}a_1 = \left(\frac{-3}{4}\right)(n-1) \Rightarrow a_1 = n-1$$

$$n(n-1) = 420$$

$$n^2 - n - 420 = 0$$

$$(n-21)(n+20) = 0$$

$$n = 21, a_1 = 20$$

$$\sum_{i=1}^{17} a_i = \frac{17}{2}[2a_1 + 16d]$$

$$= \frac{17}{2}\left[40 + 16\left(\frac{-3}{4}\right)\right]$$

$$= \frac{17}{2}[40 - 12]$$

$$= 17 \times 14 = 238$$

16. Let  $\alpha, \beta \in \mathbf{R}$  be such that the function

$$f(x) = \begin{cases} 2\alpha(x^2 - 2) + 2\beta x & , x < 1 \\ (\alpha + 3)x + (\alpha - \beta) & , x \geq 1 \end{cases}$$

be differentiable at all  $x \in \mathbf{R}$ . Then  $34(\alpha + \beta)$  is equal to

- (1) 84                                      (2) 48                                      (3) 36                                      (4) 24

Ans. [2]

Sol.  $f(x) = \begin{cases} 2\alpha x^2 + 2\beta x - 4\alpha; & x < 1 \\ (\alpha + 3)x + \alpha - \beta; & x \geq 1 \end{cases}$

$$f(1) = 2\alpha - \beta + 3, f(1^-) = -2\alpha + 2\beta$$

$$2\alpha - \beta + 3 = 2\beta - 2\alpha \Rightarrow 4\alpha - 3\beta + 3 = 0 \quad \dots(1)$$

$$f'(1^-) = 4\alpha + 2\beta, f'(1^+) = \alpha + 3$$

$$4\alpha + 2\beta = \alpha + 3 \Rightarrow 3\alpha + 2\beta - 3 = 0 \quad \dots(2)$$

Solving (1) & (2)

$$\text{We get } \alpha = \frac{3}{17}, \beta = \frac{21}{17}$$

$$\Rightarrow 34(\alpha + \beta) = 34 \times \frac{24}{17} = 48$$

17. From a lot containing 10 defective and 90 non-defective bulbs, 8 bulbs are selected one by one with replacement. Then the probability of getting at least 7 defective bulbs is :-

(1)  $\frac{7}{10^7}$

(2)  $\frac{81}{10^8}$

(3)  $\frac{67}{10^8}$

(4)  $\frac{73}{10^8}$

**Ans.** [4]

**Sol.** 10 defective & 90 non-defective

Req. probability = (7 def 1 fair) or (8 defective)

$$\text{Req. probability} = \frac{(10^7 \times 90) \times 8 + 10^8}{100^8}$$

$$= \frac{72 \times 10^8 + 10^8}{100^8} = \frac{73}{10^8}$$

18. The mean and variance of a data of 10 observations are 10 and 2, respectively. If an observation  $\alpha$  in this data is replaced by  $\beta$ , then the mean and variance become 10.1 and 1.99, respectively. Then  $\alpha + \beta$  equals.

(1) 10

(2) 15

(3) 5

(4) 20

**Ans.** [4]

**Sol.** Let first 10 numbers are  $x_1, x_2, \dots, x_9, \alpha$

$$\Rightarrow \alpha + \sum_{i=1}^9 x_i = 100 \Rightarrow \sum_{i=1}^9 x_i = 100 - \alpha$$

$$\text{Variance} = \left( \frac{\sum x_i^2}{n} \right) - \left( \frac{\sum x_i}{n} \right)^2$$

$$\Rightarrow \frac{\sum x_i^2}{n} = 102$$

$$\Rightarrow x_1^2 + x_2^2 + \dots + x_9^2 + \alpha^2 = 1020 \Rightarrow \sum_{i=1}^9 x_i^2 = 1020 - \alpha^2$$

In second case, let number are

$$x_1, x_2, \dots, x_9, \beta$$

$$100 - \alpha + \beta = 101 \Rightarrow \beta - \alpha = 1$$

$$\frac{\sum x_i^2 + \beta^2}{10} - (10.1)^2 = 1.99$$

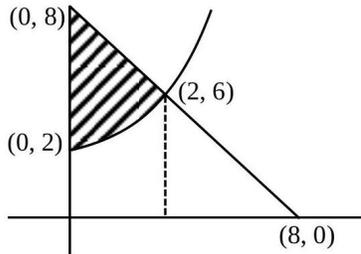
$$\beta^2 - \alpha^2 = 20 \Rightarrow \beta + \alpha = 20$$

19. Let  $A_1$  be the bounded area enclosed by the curves  $y = x^2 + 2$ ,  $x + y = 8$  and  $y$ -axis that lies in the first quadrant. Let  $A_2$  be the bounded area enclosed by the curves  $y = x^2 + 2$ ,  $y^2 = x$ ,  $x = 2$ , and  $y$ -axis that lies in the first quadrant. Then  $A_1 - A_2$  is equal to

- (1)  $\frac{2}{3}(2\sqrt{2} + 1)$       (2)  $\frac{2}{3}(4\sqrt{2} + 1)$       (3)  $\frac{2}{3}(\sqrt{2} + 1)$       (4)  $\frac{2}{3}(3\sqrt{2} + 1)$

Ans. [1]

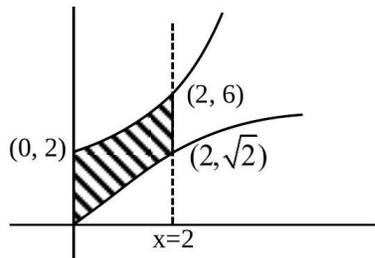
Sol.



$$A_1 = \int_0^2 ((8-x) - (x^2 + 2)) dx$$

$$A_1 = \int_0^2 (6 - x - x^2) dx$$

$$A_1 = \left( 6x - \frac{x^2}{2} - \frac{x^3}{3} \right)_0^2 = 12 - 2 - \frac{8}{3} = 10 - \frac{8}{3} = \frac{22}{3}$$



$$A_2 = \int_0^2 (x^2 + 2) dx - \frac{2}{3}(2\sqrt{2})$$

$$A_2 = \left( \frac{x^3}{3} + 2x \right)_0^2 - \frac{4\sqrt{2}}{3}$$

$$A_2 = \frac{8}{3} + 4 - \frac{4\sqrt{2}}{3} = \frac{20}{3} - \frac{4\sqrt{2}}{3}$$

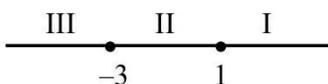
$$A_1 - A_2 = \frac{2}{3} + \frac{4\sqrt{2}}{3}$$

20. The number of the real solutions of the equation :  $x|x+3| + |x-1| - 2 = 0$  is

- (1) 3      (2) 2      (3) 5      (4) 4

Ans. [1]

Sol.



(I)  $x^2 + 3x + x - 1 - 2 = 0$

$$x^2 + 4x - 3 = 0$$

$$x = -2 + \sqrt{7} \text{ (rejected)}, -2 - \sqrt{7} \text{ (rejected)}$$

(II)

$$x^2 + 3x + 1 - x - 2 = 0$$

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

$$x = -1 + \sqrt{2}, -1 - \sqrt{2}$$

(III)

$$-x^2 - 3x + 1 - x - 2 = 0$$

$$x^2 + 4x + 1 = 0$$

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

### SECTION-B

21. Let a differentiable function  $f$  satisfy the equation

$$\int_0^{36} f\left(\frac{tx}{36}\right) dt = 4\alpha f(x). \text{ If } y = f(x) \text{ is a standard parabola passing through the points } (2,1) \text{ and}$$

$(-4, \beta)$ , Then  $\beta^\alpha$  is equal to \_\_\_\_ .

Ans. [64]

Sol.  $\int_0^{36} f\left(\frac{tx}{36}\right) dt = 4\alpha f(x), \text{ Put } \frac{tx}{36} = y$

$$\frac{dy}{dt} = \frac{x}{36}$$

$$\int_0^x \frac{f(y)36dy}{x} = 4\alpha f(x)$$

$$\int_0^x f(y)dy = \frac{\alpha f(x)x}{9}$$

$$f(x) = \frac{\alpha}{9}(f(x) + xf'(x))$$

$$\left(1 - \frac{\alpha}{9}\right)f(x) = \frac{\alpha x}{9}f'(x) \Rightarrow (9 - \alpha)f(x) = \alpha xf'(x)$$

$$\frac{f'(x)}{f(x)} = \left(\frac{9}{\alpha} - 1\right)\frac{1}{x}$$

$$\log_e f(x) = \left(\frac{9}{\alpha} - 1\right)\log_e x + \log_e c$$

$$f(x) = cx^{\left(\frac{9}{\alpha} - 1\right)} \text{ for standard parabola}$$

$$\frac{9}{\alpha} - 1 = 2$$

$$\alpha = 3$$

$$f(x) = cx^2$$

passing through  $(2,1)$

$$1 = 4c \Rightarrow c = 1/4$$

$$y = \frac{x^2}{4} \text{ passing through } (-4, \beta)$$

$$\beta = 4$$

$$\beta^\alpha = 4^3 = 64$$

22. Let a line L passing through the point P(1,1,1) be perpendicular to the lines  $\frac{x-4}{4} = \frac{y-1}{1} = \frac{z-1}{1}$  and  $\frac{x-17}{1} = \frac{y-71}{1} = \frac{z}{0}$ . Let the line L intersect the yz -plane at the point Q. Another line parallel to L and passing through the point S(1,0,-1) intersects the yz -plane at the point R. Then the square of the area of the parallelogram PQRS is equal to \_\_\_\_\_.

Ans. [6]

Sol.  $d_1 = \langle 4, 1, 1 \rangle$  and  $d_2 = \langle 1, 1, 0 \rangle$

$$d_L = d_1 \times d_2 = \begin{vmatrix} i & j & k \\ 4 & 1 & 1 \\ 1 & 1 & 0 \end{vmatrix} = \langle -1, 1, 3 \rangle$$

Line L passes through P(1,1,1) with  $d_L = \langle -1, 1, 3 \rangle$

$$r(t) = \langle 1, 1, 1 \rangle + t \langle -1, 1, 3 \rangle$$

$$= \langle 1-t, 1+t, 1+3t \rangle$$

For point Q;  $x = 0$

$$\Rightarrow t = 1$$

$$Q = \langle 0, 2, 4 \rangle$$

Another

Line parallel to L passes through S(1,0,-1)

with  $d_L = \langle -1, 1, 3 \rangle$

$$r'(u) = \langle 1, 0, -1 \rangle + u \langle -1, 1, 3 \rangle$$

$$= \langle 1-u, u, -1+3u \rangle$$

for point R,  $x = 0$

$$\Rightarrow u = 1$$

$$R = \langle 0, 1, 2 \rangle$$

Area of parallelogram with adjacent vectors  $\overline{PQ}$  and  $\overline{PS}$

$$\overline{PQ} = \langle -1, 1, 3 \rangle$$

$$\overline{PS} = \langle 0, -1, -2 \rangle$$

Area of parallelogram

$$\overline{PQ} \times \overline{PS} = \begin{vmatrix} i & j & k \\ -1 & 1 & 3 \\ 0 & -1 & -2 \end{vmatrix} = \langle 1, -2, 1 \rangle$$

$$\text{Area} = \sqrt{1^2 + (-2)^2 + 1^2} = \sqrt{6}$$

23. The number of numbers greater than 5000, less than 9000 and divisible by 3, that can be formed using the digits 0, 1, 2, 5, 9, if the repetition of the digits is allowed, is \_\_\_\_\_

**Ans.** [42]

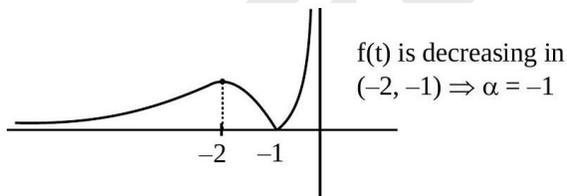
**Sol.** (1) all different  
 $5, 0, 1, 9 \Rightarrow \underline{3} = 6$  ways  
 (2) 2 alike, 2 different  
 $5, 0, 0, 1 \Rightarrow 3$  ways  
 $5, 1, 1, 2 \Rightarrow 3$  ways  
 $5, 2, 2, 0 \Rightarrow 3$  ways  
 $5, 2, 2, 9 \Rightarrow 3$  ways  
 $5, 5, 0, 2 \Rightarrow 6$  ways  
 $5, 5, 2, 9 \Rightarrow 6$  ways  
 $5, 1, 9, 9 \Rightarrow 3$  ways  
 (3) 3 alike, 1 different  
 $5, 5, 5, 0 \Rightarrow 3$  ways  
 $5, 5, 5, 9 \Rightarrow 3$  ways  
 (4) 2 alike, 2 other alike  
 $5, 5, 1, 1 \Rightarrow 3$  ways  
 Total ways = 42

24. Let  $(2\alpha, \alpha)$  be the largest interval in which the function  $f(t) = \frac{|t+1|}{t^2}, t < 0$ , is strictly decreasing. Then the local maximum value of the function

$g(x) = 2 \log_e(x-2) + \alpha x^2 + 4x - \alpha, x > 2$ , is \_\_\_\_\_

**Ans.** [4]

**Sol.** Drawing graph of  $f(t)$  for  $t < 0$



$$g(x) = 2 \log_e(x-2) - x^2 + 4x + 1; x > 2$$

$$g'(x) = \frac{2}{x-2} - 2(x-2); x > 2$$

$$g'(x) = 2 \frac{1 - (x-2)^2}{(x-2)} = 2 \frac{-(x-3)(x-1)}{(x-2)}$$

$$\begin{array}{c} + \quad - \\ \hline 2 \quad 3 \end{array} \quad \text{as } x > 2$$

maxima occur at  $x = 3$

$$g(3) = 2 \log_e 1 - 9 + 12 + 1 = 4$$

25. The number of  $3 \times 2$  matrices  $A$ , which can be formed using the elements of the set  $\{-2, -1, 0, 1, 2\}$  such that the sum of all the diagonal elements of  $A^T A$  is 5, is \_\_\_\_\_

Ans. [312]

Sol. 
$$\begin{pmatrix} a_1 & b_1 \\ a_2 & b_2 \\ a_3 & b_3 \end{pmatrix}_{3 \times 2}$$

$$A^T A = \begin{pmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{pmatrix}_{2 \times 3} \begin{pmatrix} a_1 & b_1 \\ a_2 & b_2 \\ a_3 & b_3 \end{pmatrix}_{3 \times 2}$$

$$= \begin{pmatrix} a_1^2 + a_2^2 + a_3^2 & \text{---} \\ \text{---} & b_1^2 + b_2^2 + b_3^2 \end{pmatrix}$$

$$\text{Tr}(A^T A) = a_1^2 + a_2^2 + a_3^2 + b_1^2 + b_2^2 + b_3^2 = 5$$

$$\{2, 1, 0, 0, 0, 0\}$$

$$\{2, -1, 0, 0, 0, 0\}$$

$$\{-2, 1, 0, 0, 0, 0\}$$

$$\{-2, -1, 0, 0, 0, 0\}$$

$$\{1, 1, 1, 1, 1, 0\}$$

$$\{-1, -1, -1, -1, -1, 0\}$$

$$\{1, 1, 1, 1, -1, 0\}$$

$$\{-1, -1, -1, -1, 1, 0\}$$

$$\{1, 1, 1, -1, -1, 0\}$$

$$\{-1, -1, -1, 1, 1\}$$

$$\text{No. of ways} = \frac{6!}{4!} \times 4 + 2 \times \frac{6!}{5!} + 2 \times \frac{6!}{4!} + 2 \times \frac{6!}{3!2!}$$

$$= \frac{6!}{3!} + 2 \times 6 + \frac{6!}{3!} \left( \frac{1}{2} + 1 \right)$$

$$= 120 + 120 + 12 + 60 = 312$$



## JEE Main Online Exam 2026

Questions & Solution  
24<sup>th</sup> January 2026 | Morning

### PHYSICS

#### SECTION-A

26. Match the List-I with List-II

List-I		List-II	
A.	Magnetic induction	I.	$MLT^{-2}A^{-2}$
B.	Magnetic flux	II.	$ML^2T^{-2}A^{-2}$
C.	Magnetic permeability	III.	$ML^0T^2A^{-1}$
D.	Self inductance	IV.	$ML^2T^{-2}A^{-1}$

Choose the correct answer from the options given below:

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

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

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

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

Ans. [4]

Sol. Magnetic induction

$$F = qvB$$

$$[B] = \left[ \frac{F}{qV} \right]$$

$$[B] = [MT^{-2} A^{-1}]$$

Magnetic Flux ( $\phi$ )

$$\phi = (B) \cdot (\text{Area})$$

$$[\phi] = [ML^2 T^{-2} A^{-1}]$$

Magnetic Permeability

$$[\mu] = [MLT^{-2} A^{-2}]$$

Self inductance

$$\text{Using } U = \frac{1}{2} LI^2$$

$$[\text{Self inductance}] = [ML^2 T^{-2} A^{-1}]$$

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

27. Three charges  $+2q$ ,  $+3q$  and  $-4q$  are situated at  $(0, -3a)$ ,  $(2a, 0)$  and  $(-2a, 0)$  respectively in the  $xy$  plane. The resultant dipole moment about origin is \_\_\_\_\_

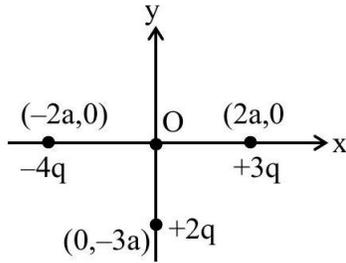
(1)  $2qa(3\hat{j} - \hat{i})$

(2)  $2qa(3\hat{i} - 7\hat{j})$

(3)  $2qa(7\hat{i} - 3\hat{j})$

(4)  $2qa(3\hat{j} - 7\hat{i})$

Ans. [3]

**Sol.**


$$\vec{p} = q_1 \vec{r}_1 + q_2 \vec{r}_2 + q_3 \vec{r}_3$$

$$\vec{p} = (2q)(-3a)\hat{j} + (3q)(2a)\hat{i} + (-4q)(-2a)\hat{i}$$

$$\vec{p} = 2qa(7\hat{i} - 3\hat{j})$$

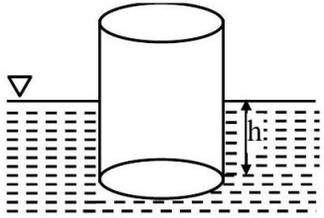
28. A cylindrical block of mass  $M$  and area of cross section  $A$  is floating in a liquid of density  $\rho$  and with its axis vertical. When depressed a little and released the block starts oscillating. The period of oscillation is

(1)  $2\pi\sqrt{\frac{M}{\rho Ag}}$

(2)  $\pi\sqrt{\frac{2M}{\rho Ag}}$

(3)  $\pi\sqrt{\frac{\rho A}{Mg}}$

(4)  $2\pi\sqrt{\frac{\rho A}{Mg}}$

**Ans.**
**[1]**
**Sol.**


At equilibrium

$$\rho Ahg = Mg$$

 After displacing by  $x$ ,

$$Ma = -\rho A(h+x)g + Mg$$

$$Ma = -\rho Ahg - \rho A xg + Mg$$

$$Ma = -\rho A xg$$

$$a = \left( \frac{-\rho Ag}{M} \right) x$$

on comparing with,

$$a = -\omega^2 x$$

$$\omega = \sqrt{\frac{\rho Ag}{M}}$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{M}{\rho Ag}}$$

29. Density of water at 4°C and 20°C are 1000 kg/m<sup>3</sup> and respectively. The increase in internal energy of 4 kg water when it is heated from 4°C to 20°C is \_\_\_\_ J.

(Specific heat capacity of water = 4.2 J/kg . and 1 atmospheric pressure = 10<sup>5</sup> Pa )

- (1) 315826.2                      (2) 234699.2                      (3) 258700.8                      (4) 268799.2

**Ans.** [4]

**Sol.**  $Q = m\Delta T = 4 \times 4200 \times 16 \text{ J} = 268800 \text{ J}$

$$W = P\Delta V$$

$$\Delta V = \left( \frac{m}{\rho_f} - \frac{m}{\rho_i} \right) = 4 \left[ \frac{1}{998} - \frac{1}{1000} \right]$$

$$P = 10^5 \text{ Pa .}$$

$$\therefore W = 10^5 \times 4 \times \left[ \frac{1}{998} - \frac{1}{1000} \right] = \frac{8 \times 10^5}{10^3 \times 998} \approx 0.8 \text{ J}$$

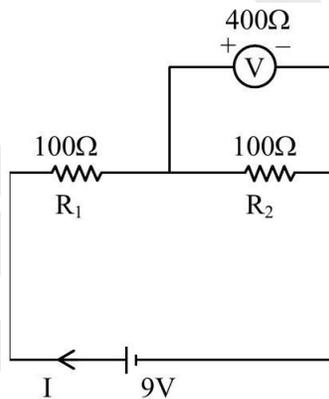
$$\Delta U = Q - W = 268799.2 \text{ J}$$

30. Two resistors of 100Ω each are connected in series with a 9 V battery. A voltmeter of 400Ω resistance is connected to measure the voltage drop across one of the resistors. The voltmeter reading is \_\_\_\_ V.

- (1) 3                                      (2) 4.5                                      (3) 4                                      (4) 2

**Ans.** [3]

**Sol.**



Current in circuit.

$$I = \frac{E}{R_{eq}}$$

$$R_{eq} = 100 + \frac{400 \times 100}{400 + 100} = 180\Omega$$

$$\therefore I = \frac{9}{180} = \frac{1}{20} \text{ A}$$

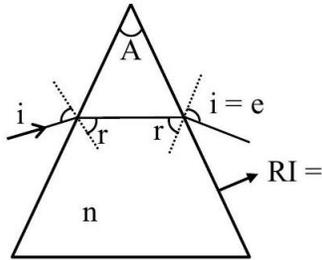
$$\text{Reading of voltmeter} = V = I \times 80 = \frac{1}{20} \times 80 = 4 \text{ V}$$

31. The exit surface of a prism with refractive index  $n$  is coated with a material having refractive index  $n/2$ . When this prism is set for minimum angle of deviation it exactly meets the condition of critical angle. The prism angle is

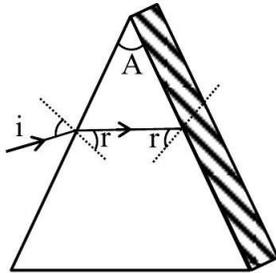
- (1) 60°                                      (2) 15°                                      (3) 30°                                      (4) 45°

**Ans.** [1]

**Sol.**  $i = e$  &  $r = A/2$  for minimum deviation



For TIR ;  $r = \theta_c$



$$\sin r = \sin \theta_c$$

$$\sin r = \frac{n/2}{n}$$

$$\sin r = \frac{1}{2}$$

$$\sin \frac{A}{2} = \sin 30^\circ$$

$$\frac{A}{2} = 30^\circ \Rightarrow A = 60^\circ$$

32. Two electrons are moving in orbits of two hydrogen like atoms with speeds  $3 \times 10^5$  m/s and  $2.5 \times 10^5$  m/s respectively. If the radii of these orbits are nearly same then the possible order of energy states are \_\_\_\_\_ respectively.

(1) 6 and 5

(2) 9 and 8

(3) 8 and 10

(4) 10 and 12

**Ans.** [1]

**Sol.**  $V \propto \frac{Z}{n}$

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

Thus ;  $r \propto \frac{n}{V}$

Radii are same then

$$\frac{n_1}{V_1} = \frac{n_2}{V_2}$$

$$\frac{n_1}{n_2} = \frac{3 \times 10^5}{2.5 \times 10^5} = \frac{6}{5}$$

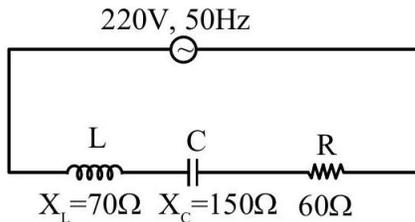
Possible order is 6 and 5

33. In a microscope of tube length 10 cm two convex lenses are arranged with focal length of 2 cm and 5 cm . Total magnification obtained with this system for normal adjustment is  $(5)^k$ . The value of k is \_\_\_\_  
 (1) 2 (2) 5 (3) 3.5 (4) 4

**Ans.** [1]

**Sol.**  $f_0 = 2$  cm,  $f_e = 5$  cm  
 $\ell = 10$  cm,  $D = 25$  cm  
 $M = \frac{\ell}{f_0} \cdot \frac{D}{f_e} = 25$

34. For the series LCR circuit connected with 220 V , 50 Hz a.c source as shown in the figure, the power factor is  $\frac{\alpha}{10}$ . The value of  $\alpha$  is \_\_\_\_



- (1) 4 (2) 10 (3) 6 (4) 8

**Ans.** [3]

**Sol.** Power factor =  $\frac{R}{Z}$   
 $Z = \sqrt{R^2 + (X_L - X_C)^2}$   
 $= \sqrt{60^2 + (150 - 70)^2} = 100\Omega$   
 $\therefore$  Power factor =  $\frac{60}{100} = \frac{6}{10}$

Then  $a = 6$

35. Match the List-I with List-II

List-I		List-II	
A	Radio-wave	I	is produced by Magnetron valve
B	Micro-wave	II	Due to change in the vibrational modes of atoms
C	Infrared-wave	III	Due to inner shell electrons moving from higher energy level to lower energy level
D	X-ray	IV	Due to rapid acceleration of electrons

Choose the correct answer from the options given below:

- (1) A-II,B-IV,C-III,D-I (2) A-IV,B-III,C-I,D-II (3) A-IV,B-I,C-II,D-III (4) A-IV,B-II,C-I,D-III

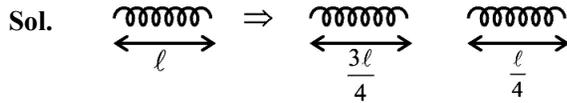
**Ans.** [3]

**Sol.** Radio wave  $\Rightarrow$  Produced by rapid acceleration of electrons  
 Micro wave  $\Rightarrow$  By magnetron valve  
 Infrared wave  $\Rightarrow$  Change in vibrational modes  
 X ray  $\Rightarrow$  Transition of inner shell electrons from high energy level to low energy level.  
 A - IV, B - I, C - II, D - III

36. A spring of force constant  $15 \text{ N/m}$  is cut into two pieces. If the ratio of their length is  $1:3$ , then the force constant of smaller piece is \_\_\_\_  $\text{N/m}$

- (1) 15                                      (2) 20                                      (3) 60                                      (4) 45

Ans. [3]



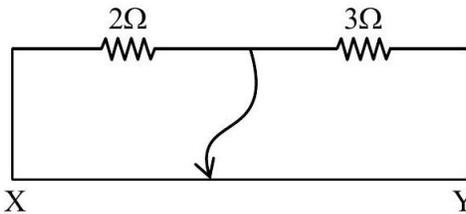
$K\ell = \text{constant}$

$$K\ell = K' \left( \frac{\ell}{4} \right)$$

$$K' = 4K$$

$$K' = 60 \text{ N/m}$$

37. Two resistors  $2\Omega$  and  $3\Omega$  are connected in the gaps of bridge as shown in figure. The null point is obtained with the contact of jockey at some point on wire  $XY$ . When an unknown resistor is connected in parallel with  $3\Omega$  resistor, the null point is shifted by  $22.5 \text{ cm}$  toward  $Y$ . The resistance of unknown resistor is  $\Omega$ .



- (1) 3                                      (2) 2                                      (3) 4                                      (4) 1

Ans. [2]

Sol. Initially,  $\frac{2}{3} = \frac{x}{100-x}$

$$\Rightarrow x = 40 \text{ cm}$$

Now when 'R' connected in parallel

$$\frac{2}{\frac{3R}{3+R}} = \frac{40+22.5}{60-22.5} = \frac{62.5}{37.5}$$

$$\therefore R = 2\Omega$$

38. Given below are two statements:

**Statement I :** For all elements, greater the mass of the nucleus, greater is the binding energy per nucleon.

**Statement II :** For all elements, nuclei with less binding energy per nucleon transforms to nuclei with greater binding energy per nucleon.

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

- (1) Both Statement I and Statement II are true  
 (2) Statement I is true but Statement II is false  
 (3) Both Statement I and Statement II are false  
 (4) Statement I is false but Statement II is true

Ans. [4]

Sol. Theoretical

39. A brass wire of length 2 m and radius 1 mm at  $27^\circ\text{C}$  is held taut between two rigid supports. Initially it was cooled to a temperature of  $-43^\circ\text{C}$  creating a tension  $T$  in the wire. The temperature to which the wire has to be cooled in order to increase the tension in it to  $1.4 T$ , is \_\_\_\_\_  $^\circ\text{C}$

(1)  $-86$                       (2)  $-71$                       (3)  $-65$                       (4)  $-80$

Ans. [2]

Sol.  $T = \alpha YA(27 - (-43))$

$$1.4 T = \alpha YA(27 - \theta)$$

using (ii)/(i)

$$1.4 = \frac{27 - \theta}{70}$$

$$27 - \theta = 98 \therefore \theta = -71^\circ\text{C}$$

40. The electrostatic potential in a charged spherical region of radius  $r$  varies as  $V = ar^3 + b$ , where  $a$  and  $b$  are constants. The total charge in the sphere of unit radius is  $\alpha \times \pi a \epsilon_0$ . The value of  $\alpha$  is \_\_\_\_\_ .

(permittivity of vacuum is  $\epsilon_0$ )

(1)  $-12$                       (2)  $-6$                       (3)  $-9$                       (4)  $-8$

Ans. [1]

Sol.  $v = ar^3 + b$

$$E = -\frac{dv}{dr} = -3ar^2$$

$$\phi_{\text{closed}} = \frac{q_{\text{enc}}}{\epsilon_0}$$

$$q_{\text{enc}} = \epsilon_0 \cdot E \cdot A$$

$$= \epsilon_0 (-3a \cdot (1)^2) 4\pi(1)^2$$

$$= -12\pi a \epsilon_0$$

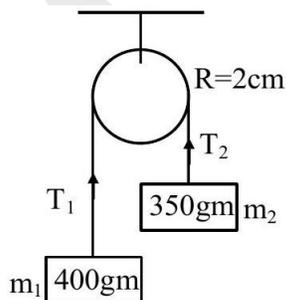
$$\therefore x = -12$$

41. Two masses 400 g and 350 g are suspended from the ends of a light string passing over a heavy pulley of radius 2 cm. When released from rest the heavier mass is observed to fall 81 cm in 9 s. The rotational inertia of the pulley is \_\_\_\_\_  $\text{kg}\cdot\text{m}^2$ . ( $g = 9.8 \text{ m/s}^2$ )

(1)  $9.5 \times 10^{-3}$                       (2)  $4.75 \times 10^{-3}$                       (3)  $1.86 \times 10^{-2}$                       (4)  $8.3 \times 10^{-3}$

Ans. [1]

Sol.



$$S = ut + \frac{1}{2}at^2$$

$$a = \frac{2s}{t^2} = \frac{2 \times 0.81}{81} = 0.02 \text{ m/s}^2$$

$$m_1 g - T_1 = m_1 a$$

$$T_2 - m_2 g = m_2 a$$

$$(T_1 - T_2)R = I \cdot \frac{a}{R}$$

$$\therefore a = \frac{(m_1 - m_2)g}{m_1 + m_2 + \frac{I}{R^2}}$$

$$0.02 = \frac{(400 - 350)(10^{-3})g}{(400 + 350)(10^{-3}) + \frac{I}{R^2}}$$

$$\frac{I}{R^2} = \frac{50 \times 10^{-3} g}{0.02} - 750 \times 10^{-3} = 23.75$$

$$I = 23.75 \times 4 \times 10^{-4} = 9.5 \times 10^{-3} \text{ kg-m}^2$$

42. An unpolarised light is incident at an interface of two dielectric media having refractive indices of 2 (incident medium) and  $2\sqrt{3}$  (medium) respectively. To satisfy the condition that reflected and refracted rays are perpendicular to each other, the angle of incidence is \_\_\_\_\_ .

- (1)  $60^\circ$                       (2)  $10^\circ$                       (3)  $30^\circ$                       (4)  $45^\circ$

Ans. [1]

Sol. Brewster's law

$$\tan\theta = \mu_{\text{rel}} = \sqrt{3}$$

$$\theta = 60^\circ$$

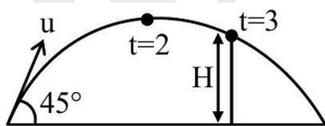
43. A boy thrown a ball into air at  $45^\circ$  from the horizontal to land it on a roof of a building of height H. If the ball attains maximum height in 2 s and lands on the building in 3 s after launch, then value of H is \_\_\_\_\_ m.

$$(g = 10/\text{s}^2)$$

- (1) 20                      (2) 10                      (3) 25                      (4) 15

Ans. [4]

Sol.  $T = \frac{2u_y}{g} = 4$



$$\Rightarrow u_y = \frac{40}{2} = 20 \text{ m/s}$$

$$y = u_y \Delta t - \frac{1}{2} g (\Delta t)^2$$

$$\Rightarrow H = 20 \times 3 - 5 \times 9$$

$$= 60 - 45$$

$$= 15 \text{ m}$$

44. There are three co-centric conducting spherical shells A, B and C of radii  $a$ ,  $b$  and  $c$  respectively. The potential of the spheres A, B and C respectively, are :

$$(1) \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{a} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{b} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{c} \right)$$

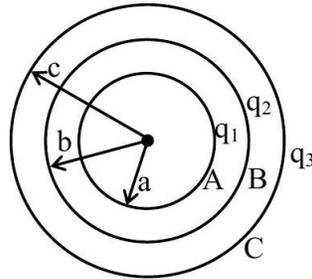
$$(2) \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{a} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{b} + \frac{q_3}{c} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1}{a} + \frac{q_2}{b} + \frac{q_3}{c} \right)$$

$$(3) \frac{1}{4\pi\epsilon_0} \left( \frac{q_1}{a} + \frac{q_2}{b} + \frac{q_3}{c} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{b} + \frac{q_3}{c} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{c} \right)$$

$$(4) \frac{1}{4\pi\epsilon_0} \left( \frac{q_1}{a} + \frac{q_2}{b} + \frac{q_3}{c} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{b} \right), \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{c} \right)$$

Ans. [3]

Sol.



$$V_A = \frac{Kq_1}{a} + \frac{Kq_2}{b} + \frac{Kq_3}{c} = \frac{1}{4\pi\epsilon_0} \left( \frac{q_1}{a} + \frac{q_2}{b} + \frac{q_3}{c} \right)$$

$$V_B = \frac{Kq_1}{b} + \frac{Kq_2}{b} + \frac{Kq_3}{c} = \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2}{b} + \frac{q_3}{c} \right)$$

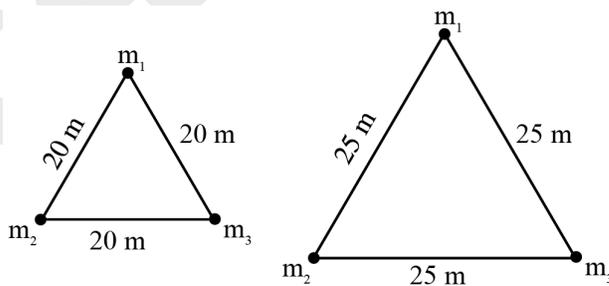
$$V_C = \frac{Kq_1}{c} + \frac{Kq_2}{c} + \frac{Kq_3}{c} = \frac{1}{4\pi\epsilon_0} \left( \frac{q_1 + q_2 + q_3}{c} \right)$$

45. Three masses 200 kg, 300 kg and 400 kg are placed at the vertices of an equilateral triangle with sides 20 m. They are rearranged on the vertices of a bigger triangle of side 25 m and with the same centre. The work done in this process \_\_\_\_\_ J. (Gravitational constant  $G = 6.7 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$ )

- (1)  $9.86 \times 10^{-6}$       (2)  $2.85 \times 10^{-7}$       (3)  $1.74 \times 10^{-7}$       (4)  $4.77 \times 10^{-7}$

Ans. [3]

Sol.



Work done by external agent :

$$W_{\text{ext}} = \Delta U$$
$$U_i = -\frac{Gm_1m_2}{r_i} - \frac{Gm_2m_3}{r_i} - \frac{Gm_1m_3}{r_i}; r_i = 20 \text{ m}$$
$$U_f = -\frac{Gm_1m_2}{r_f} - \frac{Gm_2m_3}{r_f} - \frac{Gm_1m_3}{r_f}; r_f = 25 \text{ m}$$
$$U_i = \frac{-6.67 \times 10^{-11}}{20} [200 \times 300 + 300 \times 400 + 200 \times 400]$$
$$= \frac{-6.67 \times 10^{-11}}{20} \times 26 \times 10^4 = -86.71 \times 10^{-8} \text{ J}$$
$$U_f = \frac{-6.67 \times 10^{-11}}{0.25} [200 \times 300 + 300 \times 400 + 200 \times 400]$$
$$= \frac{-6.67 \times 10^{-11}}{0.25} \times 26 \times 10^4 = -693.68 \times 10^{-9}$$
$$= -69.36 \times 10^{-8} \text{ J}$$
$$\Delta U = U_f - U_i = 1.74 \times 10^{-7} \text{ J}$$

### SECTION-B

46. A short bar magnet placed with its axis at  $30^\circ$  with an external field of 800 Gauss, experiences a torque of 0.016 N.m. The work done in moving it from most stable to most unstable position is  $\alpha \times 10^{-3}$  J. The value of  $\alpha$  is \_\_\_\_\_ .

Ans. [64]

Sol.  $\tau = \mu B \sin \theta \Rightarrow 0.016 = \mu \times B \times \frac{1}{2}$

$$\Rightarrow \mu = \frac{0.032}{B}$$

$$W_{\text{ext}} = U_f - U_i = \mu B - (\mu B) = 2\mu B$$

$$= 2 \times \frac{0.032}{B} \times B$$

$$= 0.064 \text{ J}$$

47. A gas of certain mass filled in a closed cylinder at a pressure of 3.23 kPa has temperature  $50^\circ\text{C}$ . The gas is now heated to double its temperature. The modified pressure is \_\_\_\_\_ Pa.

Ans. [3730]

Sol. As per NTA

$$V = \text{constant}$$

$$\text{so } P \propto T$$

$$T_i = 50^\circ\text{C} = 323 \text{ K}$$

$$T_f = 100^\circ\text{C} = 373 \text{ K}$$

$$\Rightarrow \frac{P_f}{P_i} = \frac{T_f}{T_i}$$

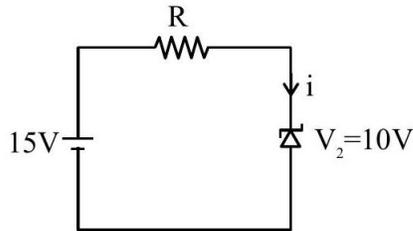
$$\Rightarrow \frac{P_f}{3.23 \text{ kPa}} = \frac{373}{323}$$

$$\Rightarrow P_f = 3730 \text{ Pa}$$

48. A voltage regulating circuit consisting of Zener diode, having break-down voltage of 10 V and maximum power dissipation of 0.4 W, is operated at 15 V. The approximate value of protective resistance in this circuit is \_\_\_\_  $\Omega$ .

Ans. [125]

Sol.

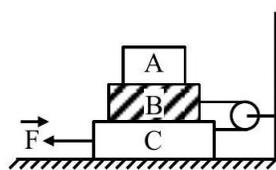


$$P_D = 0.4 \text{ W} = 10i$$

$$i = 0.04 \text{ A}$$

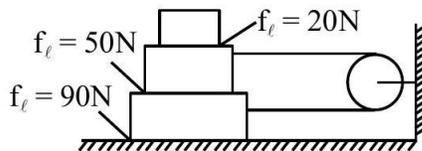
$$R = \frac{15 - 10}{0.04} = \frac{5}{0.04} = 125 \Omega$$

49. In the given figure the blocks A, B and C weigh 4 kg, 6 kg and 8 kg respectively. The co-efficient of sliding friction between any two surfaces is 0.5. The force  $\vec{F}$  required to slide the block C with constant speed is \_\_\_\_ N. (Used  $g = 10 \text{ m/s}^2$ )



Ans. [210]

Sol. For 8 kg to move with constant velocity  $F_{\text{net}} = 0$ .



$$\therefore F = 90 + T + 50 \text{ (for 8kg block)}$$

$$T = 20 + 50 \text{ (for 6kg block)}$$

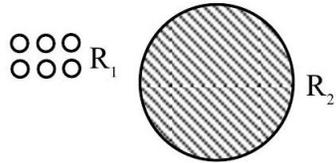
$$\therefore F = 210 \text{ N.}$$

50. Sixty four rain drops of radius 1 mm each falling down with a terminal velocity of 10 cm/s coalesce to form a bigger drop. The terminal velocity of bigger drop is \_\_\_\_ cm/s.

Ans. [160]

Sol. 
$$V_T = \frac{2r^2}{9\eta} g [\sigma - \rho]$$

$$V_T \propto r^2$$



64 drop

$$64 \left( \frac{4}{3} \pi R_1^3 \right) = \frac{4}{3} \pi R_2^3$$

$$R_2 = 4R_1$$

$$\frac{(V_T)_1}{(V_T)_2} = \left( \frac{R_1}{R_2} \right)^2 = \left( \frac{1}{4} \right)^2$$

$$\frac{10}{(V_T)_2} = \frac{1}{16}$$

$$(V_T)_2 = 160 \text{ cm / sec}$$



## JEE Main Online Exam 2026

Questions & Solution  
24<sup>th</sup> January 2026 | Morning

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### CHEMISTRY

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#### SECTION-A

51. Given below are two statements :

**Statement-I** Hybridisation, shape and spin only magnetic moment of  $K_3[Co(CO_3)_3]$  is  $sp^3 d^2$ , octahedral and 4.9 BM respectively.

**Statement-II** Geometry, hybridisation and spin only magnetic moment values (BM) of the ions  $[Ni(CN)_4]^{2-}$ ,  $[MnBr_4]^{2-}$  and  $[CoF_6]^{3-}$  respectively are square planar, tetrahedral, octahedral :  $dsp^2, sp^3, sp^3 d^2$  and 0, 5.9, 4.9.

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

- (1) Both statement-I and statement-II are false
- (2) Statement I is false but statement-II is true
- (3) Both statement-I and statement-II are true
- (4) Statement-I is true but statement-II is false

**Ans.** [3]

**Sol.** In  $K_3[Co(CO_3)_3] \Rightarrow sp^3 d^2$  hybridized, octahedral

$\Rightarrow$  4 unpaired electron

$\Rightarrow$  4.9 B.M.

$[Ni(CN)_4]^{2-} \Rightarrow dsp^2$  hybridized, square planar

$\Rightarrow$  0 unpaired electron

$\Rightarrow$  0 B.M.

$[MnBr_4]^{2-} \Rightarrow sp^3$  hybridized, tetrahedral

$\Rightarrow$  5 unpaired electron

$\Rightarrow$  5.9 B.M.

$[CoF_6]^{3-} \Rightarrow sp^3 d^2$  hybridized, octahedral

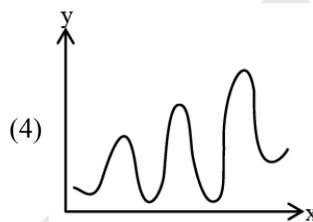
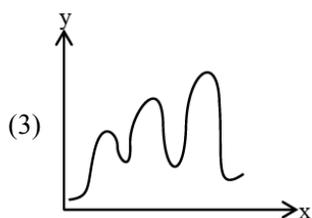
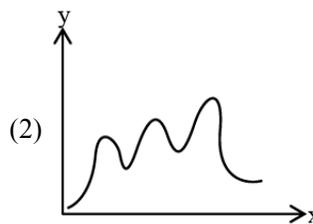
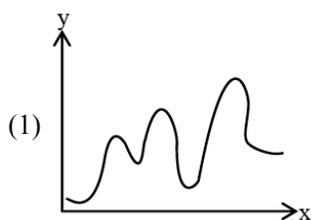
$\Rightarrow$  4 unpaired electron

$\Rightarrow$  4.9 B.M.

52.  $A \rightarrow D$  is an endothermic reaction occurring in three steps (elementary).

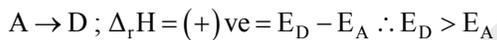


Which of the following graphs between potential energy (y -axis) vs reaction coordinate (x -axis) correctly represents the reaction profile of  $A \rightarrow D$  ?

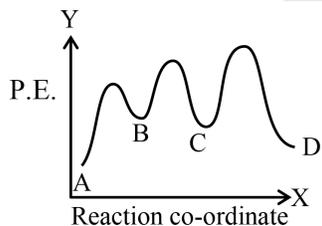
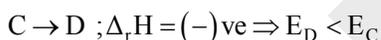
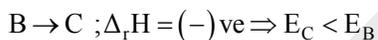
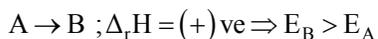


Ans. [3]

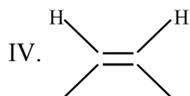
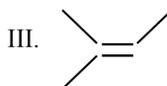
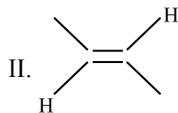
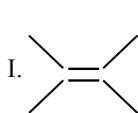
Sol. Given



Mechanism



53. Arrange the following alkenes in decreasing order of stability

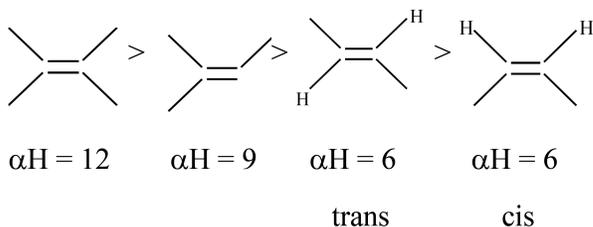


Choose the correct answer from the options given below :

- (1) III > I > II > IV    (2) III > II > I > IV    (3) I > III > II > IV    (4) I > III > IV > II

Ans. [3]

Sol. Stability order :



Trans is more stable than cis

54. Given below are statements about some molecules/ions. Identify the CORRECT statements.

- A. The dipole moment value of  $\text{NF}_3$  is higher than that of  $\text{NH}_3$  .  
B. The dipole moment value of  $\text{BeH}_2$  is zero.  
C. The bond order of  $\text{O}_2^{2-}$  and  $\text{F}_2$  is same.  
D. The formal charge on the central oxygen atom of ozone is -1 .  
E. In  $\text{NO}_2$  , all the three atoms satisfy the octet rule, hence it is very stable.

Choose the correct answer from the options given below :

- (1) A, B, C, D & E      (2) B & C only      (3) B, C & D only      (4) A, C & D only

Ans. [2]

Sol. (A) Dipole moment :  $\text{NF}_3 < \text{NH}_3$

(B)  $\text{BeH}_2$  is 'sp' hybridized, linear molecule with zero dipole moment.

(C)  $\text{O}_2^{2-} \Rightarrow$  bond order = 1

$\text{F}_2 \Rightarrow$  bond order = 1

(D) Formal charge on central oxygen atom in  $\text{O}_3$  is +1 .

(E) In  $\text{NO}_2$  ; nitrogen does not follow octet rule.

55. A solution is prepared by dissolving 0.3 g of a nonvolatile non-electrolyte solute ' A ' of molar mass  $60 \text{ g mol}^{-1}$  and 0.9 g of a non-volatile nonelectrolyte solute ' B ' of molar mass  $180 \text{ g mol}^{-1}$  in  $100 \text{ mL H}_2\text{O}$  at  $27^\circ \text{C}$  . Osmotic pressure of the solution will be [Given :  $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$  ]

- (1) 1.23 atm      (2) 2.46 atm      (3) 0.82 atm      (4) 1.47 atm

Ans. [2]

Sol. Mass of solute ' A ' = 0.3 g

$$\text{Moles of solute 'A'} = \frac{0.3 \text{ g}}{60 \text{ g/mol}} = \frac{1}{200} \text{ mol}$$

Mass of solute 'B' = 0.9 g

$$\text{Moles of solute 'B'} = \frac{0.9 \text{ gm}}{180 \text{ g/mol}} = \frac{1}{200} \text{ mol}$$

Total molarity of all solutes

$$= \frac{2/200}{100} \times 1000 = \frac{1}{10} \text{ M}$$

$$\therefore \pi = \frac{1}{10} \times 0.082 \times 300$$

$$\pi = 2.46 \text{ atm.}$$

56. Among the following, the CORRECT combinations are :

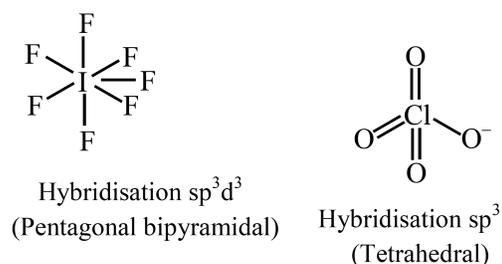
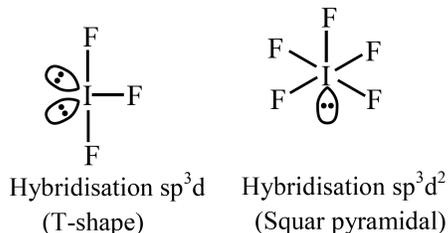
- A.  $\text{IF}_3 \rightarrow \text{T-shaped (sp}^3 \text{d)}$
- B.  $\text{IF}_5 \rightarrow \text{Square pyramidal (sp}^3 \text{d}^2)$
- C.  $\text{IF}_7 \rightarrow \text{Pentagonal bipyramidal (sp}^3 \text{d}^3)$
- D.  $\text{ClO}_4^- \rightarrow \text{Square planar (sp}^2 \text{d)}$

Choose the correct answer from the options given below :

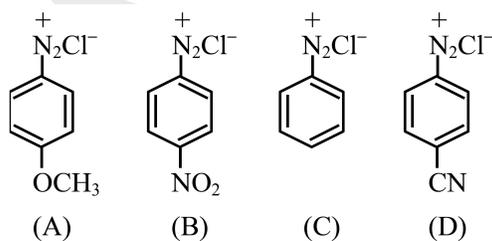
- (1) A, B and C only      (2) A and B only      (3) A, B, C and D      (4) B, C and D Only

Ans. [1]

Sol.



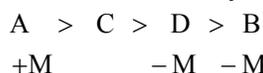
57. The correct stability order of the following diazonium salts is ?



- (1)  $A > B > C > D$       (2)  $C > D > B > A$       (3)  $A > C > D > B$       (4)  $C > A > D > B$

Ans. [3]

Sol. Correct order of stability



EDG increases stability

EWG decreases stability

58. Consider a mixture 'X' which is made by dissolving 0.4 mol of  $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$  and 0.4 mol of  $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$  in water to make 4 L of solution. When 2 L of mixture 'X' is allowed to react with excess of  $\text{AgNO}_3$ , it forms precipitate 'Y'. The rest 2 L of mixture 'X' reacts with excess  $\text{BaCl}_2$  to form precipitate 'Z'. Which of the following statements is CORRECT.?

- (1) 0.2 mol of 'Z' is formed (2) 'Y' is  $\text{BaSO}_4$  and 'Z' is  $\text{AgBr}$   
(3) 0.4 mol of 'Z' is formed (4) 0.1 mol of 'Y' is formed

Ans. [1]

Sol.  $0.4 \text{ mol} [\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br} + 0.4 \text{ mol} [\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$  are present in 4 lit. solution.

2 lit. of mixture will contain 0.2 mol of each complex.

2 lit. mixture on reaction with excess  $\text{AgNO}_3$ , 0.2 mole  $\text{AgBr}$  will be formed (Y).

2 lit. mixture on reaction with excess  $\text{BaCl}_2$ , 0.2 mole  $\text{BaSO}_4$  will be formed (Z).

59. Given below are two statements

Statements-I : The number of paramagnetic species among  $[\text{CoF}_6]^{3-}$ ,  $[\text{TiF}_6]^{3-}$ ,  $\text{V}_2\text{O}_5$  and  $[\text{Fe}(\text{CN})_6]^{3-}$  is 3.

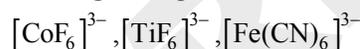
Statement-II :  $\text{K}_4[\text{Fe}(\text{CN})_6] < \text{K}_3[\text{Fe}(\text{CN})_6] < [\text{Fe}(\text{H}_2\text{O})_6]\text{SO}_4 \cdot \text{H}_2\text{O} < [\text{Fe}(\text{H}_2\text{O})_6]\text{Cl}_3$  is the correct order in terms of number of unpaired electron(s) in the complexes.

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

- (1) Both statement-I and statement-II are true (2) Both statement-I and statement-II are false  
(3) Statement-I is true but statement-II is false (4) Statement-I is false but statement-II is true

Ans. [1]

Sol. Paramagnetic species :



Diamagnetic species :  $\text{V}_2\text{O}_5$

In  $\text{K}_4[\text{Fe}(\text{CN})_6] \Rightarrow$  No. of unpaired electron = 0

$\text{K}_3[\text{Fe}(\text{CN})_6] \Rightarrow$  No. of unpaired electron = 1

$[\text{Fe}(\text{H}_2\text{O})_6]\text{SO}_4 \cdot \text{H}_2\text{O} \Rightarrow$  No. of unpaired electron = 4

$[\text{Fe}(\text{H}_2\text{O})_6]\text{Cl}_3 \Rightarrow$  No. of unpaired electron = 5

60. Consider three metal chlorides x, y and z, where x is water soluble at room temperature, y is sparingly soluble in water at room temperature and z is soluble in hot water. x, y and z are respectively

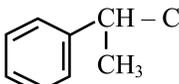
- (1)  $\text{MgCl}_2$ ,  $\text{AgCl}$  and  $\text{AlCl}_3$  (2)  $\text{AgCl}$ ,  $\text{Hg}_2\text{Cl}_2$  and  $\text{PbCl}_2$   
(3)  $\text{AlCl}_3$ ,  $\text{PbCl}_2$  and  $\text{BaCl}_2$  (4)  $\text{CuCl}_2$ ,  $\text{AgCl}$  and  $\text{PbCl}_2$

**Ans.** [4]

**Sol.**  $MgCl_2, AlCl_3, CuCl_2$  are water soluble at room temperature.

$AgCl, Hg_2Cl_2$  are sparingly soluble in water  $PbCl_2$  is soluble in hot water.

**61.** Match the List-I with List-II

	List-I (Chloro derivative)		List-II (Example)
A.	Vinyl Chloride	I.	$CH_2 = CH - CH_2Cl$
B.	Benzyl chloride	II.	$  \begin{array}{c}  CH_3 - CH - CH_3 \\    \\  Cl  \end{array}  $
C.	Alkyl chloride	III.	$CH_2 = CHCl$
D.	Allyl chloride	IV.	

Choose the correct answer from the options given below:

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

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

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

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

**Ans.** [3]

**Sol.** Common Name (Theory based)

**62.** 'W' g of a non-volatile electrolyte solid solute of molar mass 'M'  $gmol^{-1}$  when dissolved in 100 mL water, decreases vapour pressure of water from 640 mm Hg to 600 mm Hg. If aqueous solution of the electrolyte boils at 375 K and  $K_b$  for water is  $0.52 K kg mol^{-1}$ , then the mole fraction of the electrolyte solute ( $x_2$ ) in the solution can be expressed as

(Given : density of water = 1 g / mL and boiling point of water = 373 K )

(1)  $\frac{1.3}{8} \times \frac{W}{M}$

(2)  $\frac{16}{2.6} \times \frac{W}{M}$

(3)  $\frac{2.6}{16} \times \frac{M}{W}$

(4)  $\frac{1.3}{8} \times \frac{M}{W}$

**Ans.** [1]

**Sol.**  $P^\circ = 640 \text{ mmHg}$

$P_s = 600 \text{ mmHg}$

$\Delta P = 40 \text{ mmHg}$

$$\text{moles of solute} = \frac{W}{M}$$

$$\frac{\Delta P}{P^\circ} = i \cdot X_{\text{solute}}$$

Again :

$$\Delta T_b = i \times k_b \times m$$

$$2 = i \times 0.52 \times \frac{W/M}{100} \times 1000$$

$$i = \frac{2}{5.2} \times \frac{M}{W}$$

$$X_{\text{solute}} = \frac{40}{640} \times \frac{1}{i} = \frac{1}{16} \times \frac{5.2}{2} \times \frac{W}{M}$$

$$X_{\text{solute}} = \frac{1.3}{8} \times \frac{W}{M}$$

63. Match the List-I with List-II

	<b>List-I</b> <b>(Isothermal process for ideal gas system)</b>		<b>List-II</b> <b>Work done ( if <math>V_f &gt; V_i</math> )</b>
A.	Reversible expansion	I.	$w = 0$
B.	Free expansion	II.	$w = -nRT \ln \frac{V_f}{V_i}$
C.	Irreversible expansion	III.	$w = -p_{\text{ex}} (V_f - V_i)$
D.	Irreversible compression	IV.	$w = -p_{\text{ex}} (V_i - V_f)$

Choose the correct answer from the options given below :

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

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

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

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

**Ans. [4]**
**Sol.** (A)  $W_{\text{Rev.}} = -\int p_{\text{gas}} dV$ 

$$W_{\text{Rev. Isot. Exp.}} = -nRT \ln \left[ \frac{V_f}{V_i} \right]$$

 (A)  $\rightarrow$  (II)

(B) Free expansion

$$W_{\text{irrev.}} = -P_{\text{ext}} \Delta V$$

$$P_{\text{ext}} = 0$$

$$W = 0$$

 (B)  $\rightarrow$  (I)

(C) Irreversible expansion

$$W_{\text{irrev.}} = -P_{\text{ext}} \Delta V$$

$$W_{\text{irrev.}} = -P_{\text{ext}} (V_f - V_i)$$

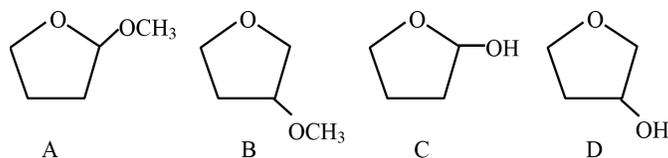
 (C)  $\rightarrow$  (III)

(D) Irreversible compression

$$W_{\text{irrev.}} = -P_{\text{ext}} \Delta V$$

$$W_{\text{irrev.}} = -P_{\text{ext}} (V_i - V_f)$$

64. A student is given one compound among the following compounds that gives positive test with Tollen's reagent.



The compound is :

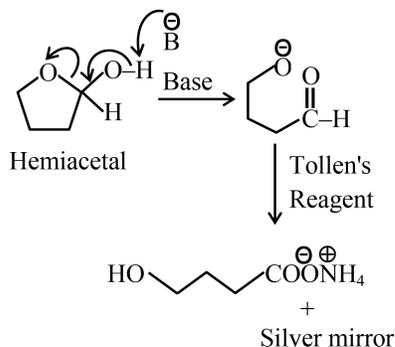
(1) D

(2) A

(3) B

(4) C

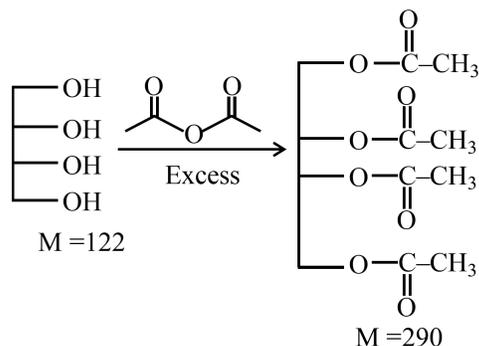
**Ans.** [4]

**Sol.**


65. A hydroxy compound (X) with molar mass  $122 \text{ g mol}^{-1}$  is acetylated with acetic anhydride, using a large excess of the reagent ensuring complete acetylation of all hydroxyl groups. The product obtained has a molar mass of  $290 \text{ g mol}^{-1}$ . The number of hydroxyl groups present in compound (X) is :

(1) 3                      (2) 5                      (3) 2                      (4) 4

**Ans.** [4]

**Sol.**


$$\text{No. of OH groups} = \frac{290 - 122}{42} = 4$$

66. At  $27^\circ\text{C}$  in presence of a catalyst, activation energy of a reaction is lowered by  $10 \text{ kJ mol}^{-1}$ . The logarithm ratio of  $\frac{k(\text{catalysed})}{k(\text{uncatalysed})}$  is .....

(Consider that the frequency factor for both the reactions is same)

(1) 17.41                      (2) 1.741                      (3) 3.482                      (4) 0.1741

**Ans.** [2]

**Sol.**

$$\frac{K_{\text{catalyst}}}{K_{\text{uncatalyst}}} = e^{\frac{\Delta E_a}{RT}}$$

$$\ln \frac{K_{\text{catalyst}}}{K_{\text{uncatalyst}}} = \frac{\Delta E_a}{RT}$$

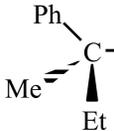
$$\log \frac{K_{\text{catalyst}}}{K_{\text{uncatalyst}}} = \frac{\Delta E_a}{2.303RT}$$

$$= \frac{10 \times 1000}{2.303 \times 8.314 \times 300}$$

$$\log \frac{K_{\text{catalyst}}}{K_{\text{uncatalyst}}} = 1.741$$

67. Given below are two statements :

**Statement I:** 'C - Cl' bond is stronger in  $\text{CH}_2 = \text{CH} - \text{Cl}$  than  $\text{CH}_3 - \text{CH}_2 - \text{Cl}$

**Statement II :** The given optically active molecule,  on hydrolysis gives a solution that can

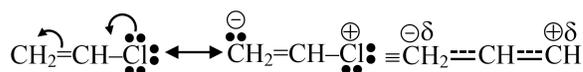
rotate the plane polarized light.

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

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are true
- (3) Both Statement I and Statement II are false
- (4) Statement I is true but Statement II is false

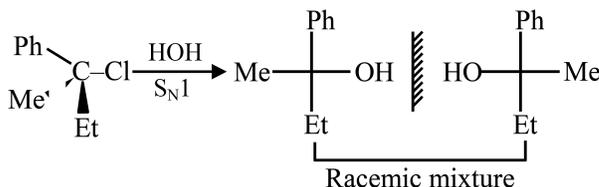
**Ans.** [4]

**Sol.** **Statement-I :**



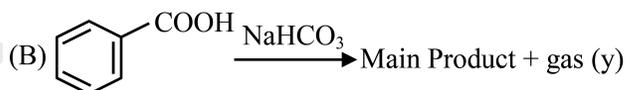
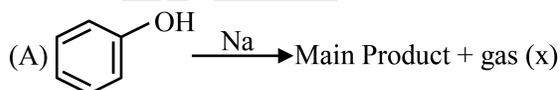
C - Cl bond is strong in vinyl chloride because of double bond character.

**Statement-II :**



Racemic mixture is optically inactive, which can not rotate PPL.

68. Consider the following two reactions A and B ?



Numerical value of [molar mass of x + molar mass of y] is \_\_\_\_\_

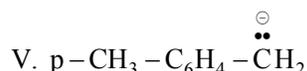
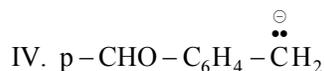
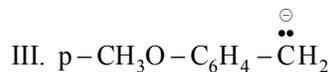
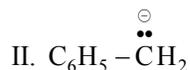
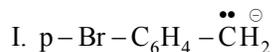
- (1) 4                                      (2) 88                                      (3) 46                                      (4) 160

**Ans.** [3]

**Sol.**  $x = \text{H}_2$  (gas),  $y = \text{CO}_2$  (gas)

Sum of molar mass =  $2 + 44 = 46$

69. Arrange the following carbanions in the decreasing order of stability



Choose the correct answer from the options given below :

(1)  $\text{I} > \text{II} > \text{IV} > \text{V} > \text{III}$

(2)  $\text{I} > \text{IV} > \text{II} > \text{V} > \text{III}$

(3)  $\text{IV} > \text{I} > \text{II} > \text{V} > \text{III}$

(4)  $\text{IV} > \text{II} > \text{I} > \text{III} > \text{V}$

Ans. [3]

Sol. Electron withdrawing groups increases stability of carbanion and electron donating groups decreases stability of carbanion.

70. Given below are two statements :

**Statement I:**  $\text{K} > \text{Mg} > \text{Al} > \text{B}$  is the correct order in terms of metallic character.

**Statement II:** Atomic radius is always greater than the ionic radius for any element.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

(3) Statement I is false but Statement II is true

(4) Statement I is true but Statement II is false

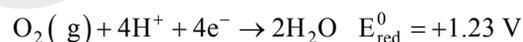
Ans. [4]

Sol. Metallic character of s-block elements is greater than p-block elements. Anionic radius is greater than atomic radius but cationic radius is always less than atomic radius for any element.

## SECTION-B

71. Electricity is passed through an acidic solution of  $\text{Cu}^{2+}$  till all the  $\text{Cu}^{2+}$  was exhausted, leading to the deposition of 300 mg of Cu metal. However, a current of 600 mA was continued to pass through the same solution for another 28 minutes by keeping the total volume of the solution fixed at 200 mL. The total volume of oxygen evolved at STP during the entire process is \_\_\_\_ mL. (Nearest integer)

[Given :



$$\text{Molar mass of Cu} = 63.54 \text{ g mol}^{-1}$$

$$\text{Molar mass of O}_2 = 32 \text{ g mol}^{-1}$$

$$\text{Faraday Constant} = 96500 \text{ C mol}^{-1}$$

$$\text{Molar volume at STP} = 22.4 \text{ L}]$$

**Ans.** [111]

**Sol.** Eq of Cu = Eq of O<sub>2</sub>

$$\frac{300 \times 10^{-3} \times 2}{63.54} = n_{O_2} \times 4.$$

$$2.36 \times 10^{-3} = n_{O_2}$$

When current is further passed

$$n_{O_2} \times 4 = \frac{600 \times 28 \times 60}{96500 \times 1000}$$

$$n_{O_2} = 2.611 \times 10^{-3}$$

Total O<sub>2</sub> released

$$= [10^{-3} \times (2.36 + 2.611)] \times 22400 \text{ml}$$

$$= 111.35 \text{ml}$$

**72.** Consider two Group IV metal ions X<sup>2+</sup> and Y<sup>2+</sup>.

A solution containing 0.01 MX<sup>2+</sup> and 0.01 MY<sup>2+</sup> is saturated with H<sub>2</sub>S. The pH at which the metal sulphide YS will form as a precipitate is \_\_\_\_

(Nearest integer)

(Given : K<sub>sp</sub>(XS) = 1 × 10<sup>-22</sup> at 25°C, K<sub>sp</sub>(YS) = 4 × 10<sup>-16</sup> at 25°C, [H<sub>2</sub>S] = 0.1M in solution,

K<sub>a1</sub> × K<sub>a2</sub>(H<sub>2</sub>S) = 1.0 × 10<sup>-21</sup>, log2 = 0.30, log3 = 0.48, log5 = 0.70 )

**Ans.** [4]

**Sol.** XS(s) ⇌ X<sup>2+</sup>(aq) + S<sup>2-</sup>(aq)

For precipitation of XS(s)

$$[X^{2+}][S^{2-}] \geq K_{sp}(XS)$$

$$[S^{2-}] \geq \frac{1 \times 10^{-22}}{0.01} = 10^{-20}$$

YS(s) ⇌ Y<sup>2+</sup>(aq) + S<sup>2-</sup>(aq)

For precipitation of YS(s)

$$[Y^{2+}][S^{2-}] \geq K_{sp}(YS)$$

$$[S^{2-}] \geq \frac{4 \times 10^{-16}}{10^{-2}} = 4 \times 10^{-14}$$

Now, H<sub>2</sub>S(aq) ⇌ 2H<sup>+</sup>(aq) + S<sup>2-</sup>(aq)

$$\frac{[S^{2-}][H^+]^2}{[H_2S]} = K_{a1} \times K_{a2} = 1 \times 10^{-21}$$

$$[S^{2-}] = \frac{1 \times 10^{-21} \times [H_2S]}{[H^+]^2} \geq 4 \times 10^{-14}$$

$$[H^+]^2 \leq \frac{1}{4} \times 10^{-7} \times 10^{-1}$$

$$[H^+] \leq \frac{1}{2} \times 10^{-4} \Rightarrow \text{pH} \geq 4.3$$

73. The hydrogen spectrum consists of several spectral lines in Lyman series ( $L_1, L_2, L_3, \dots$ ;  $L_1$  has lowest energy among Lyman series). Similarly it consists of several spectral lines in Balmer series ( $B_1, B_2, B_3, \dots$ ;  $B_1$  has lowest energy among Balmer lines). The energy of  $L_1$  is  $x$  times the energy of  $B_1$ . The value of  $x$  is  $\quad \times 10^{-1}$  (Nearest integer)

Ans. [54]

Sol. 
$$\Delta E(L_1) = 13.6 \times Z^2 \left( \frac{1}{1^2} - \frac{1}{2^2} \right) = 13.6 Z^2 \times \frac{3}{4}$$
$$\Delta E(B_1) = 13.6 \times Z^2 \times \left( \frac{1}{2^2} - \frac{1}{3^2} \right) = 13.6 \times Z^2 \times \frac{5}{4 \times 9}$$
$$\frac{\Delta E(L_1)}{\Delta E(B_1)} = \frac{3}{5} \times 9 = \frac{27}{5} = x$$
$$x = \left( \frac{27}{5} \times 10 \right) \times 10^{-1} = 54 \times 10^{-1}$$

74. In Dumas method for estimation of nitrogen, 0.50 g of an organic compound gave 70 mL of nitrogen collected at 300 K and 715 mm pressure. The percentage of nitrogen in the organic compound is  $\quad \%$  (Aqueous tension at 300 K is 15 mm).

Ans. [15]

Sol. 
$$P_{N_2} = (715 - 15) \text{ mm} = \frac{700}{760} \text{ atm}$$
$$V_{N_2} = 70 \text{ ml} = \frac{70}{1000} \text{ l}$$
$$n_{N_2} = \frac{PV}{RT} = \frac{\left( \frac{700}{760} \right) \times \left( \frac{70}{1000} \right)}{0.0821 \times 300}$$
$$W_{N_2} = \frac{700}{760} \times \frac{70}{1000} \times 28$$
$$\% N = \frac{W_{N_2}}{0.5} \times 100 = \frac{700}{760} \times \frac{70 / 1000 \times 28}{0.0821 \times 300} \times 100$$
$$= 14.65\% \approx 15$$

75.  $X$  and  $Y$  are the number of electrons involved, respectively during the oxidation of  $I^-$  to  $I_2$  and  $S^{2-}$  to  $S$  by acidified  $K_2Cr_2O_7$ . The value of  $X + Y$  is  $\quad$ .

Ans. [12]

