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28-Jan-2026_Shift-II_JEE Main-2026_Session-I(Jan)

MATHEMATICS

Max Marks: 100

SECTION-I

(SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions**. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -1 in all other cases.

1. The probability distribution of a random variable X is given below:

X	4k	$\frac{30}{7}k$	$\frac{32}{7}k$	$\frac{34}{7}k$	$\frac{36}{7}k$	$\frac{38}{7}k$	$\frac{40}{7}k$	6k
P(x)	$\frac{2}{15}$	$\frac{1}{15}$	$\frac{2}{15}$	$\frac{1}{5}$	$\frac{1}{15}$	$\frac{2}{15}$	$\frac{1}{5}$	$\frac{1}{15}$

If $E(x) = \frac{263}{15}$, then $p(x < 20)$ is equal to:

- 1) $\frac{11}{15}$ 2) $\frac{3}{5}$ 3) $\frac{8}{15}$ 4) $\frac{14}{15}$

Key: 1

$$\text{Sol: } \frac{1}{15} \left(8 + \frac{30}{7} + \frac{64}{7} + \frac{102}{7} + \frac{36}{7} + \frac{76}{7} + \frac{120}{7} + 6 \right) k = \frac{263}{15}$$

$$\Rightarrow \left(14 + \frac{428}{7} \right) k = 263 \Rightarrow k = 263 \times \frac{7}{526} = \frac{7}{2}$$

$$\Rightarrow P(X < 20) = \frac{2}{15} + \frac{1}{15} + \frac{2}{15} + \frac{3}{15} + \frac{1}{15} + \frac{2}{15} = \frac{11}{15}$$

2. Let

$$A = \{z \in C : |z - 2| \leq 4\} \text{ and}$$

$$B = \{z \in C : |z - 2| + |z + 2| = 5\}.$$

Then the max $\{|z_1 - z_2| : z_1 \in A \text{ and } z_2 \in B\}$ is.

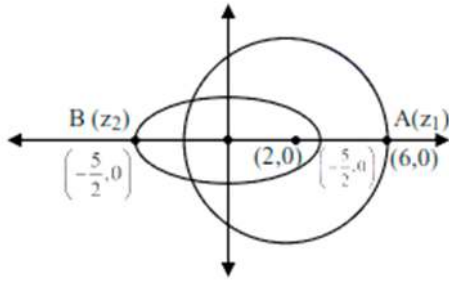
- 1) 9 2) 8 3) $\frac{15}{2}$ 4) $\frac{17}{2}$

Key: 4

$$\text{Sol: } |z - 2| = 4 \Rightarrow (x - 2) + y^2 = 16$$

$$|z - 2| + |z + 2| = 5 \Rightarrow \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$\Rightarrow \frac{4x^2}{25} + \frac{4y^2}{9} = 1$$



Maximum value of $|z_1 - z_2| = 6 + \frac{5}{2} = \frac{17}{2}$

3. $\frac{6}{3^{26}} + \frac{10.1}{3^{25}} + \frac{10.2}{3^{24}} + \frac{10.2^2}{3^{23}} + \dots + \frac{10.2^{24}}{3}$ is equal to:

- 1) 2^{26} 2) 2^{25} 3) 3^{25} 4) 3^{26}

Key: 1

Sol: $S = \frac{6}{3^{26}} + \frac{10}{3^{25}} \left[\frac{(6)^{25} - 1}{6 - 1} \right]$ $S = \frac{6}{3^{26}} + \frac{10}{3^{25}} \left[\frac{6^{25} - 1}{5} \right]$

$S = \frac{2}{3^{25}} + 2 \left[2^{25} - \frac{1}{3^{25}} \right]$ $S = 2^{26}$

4. An ellipse has its center at (1,-2) one focus at (3,-2) and one vertex at (5,-2). Then the length of its latus rectum is:

- 1) $\frac{16}{\sqrt{3}}$ 2) 6 3) $4\sqrt{3}$ 4) $6\sqrt{3}$

Key: 2

Sol: $\Rightarrow ac = 2, a = 4 \Rightarrow b^2 = a^2 - (ac)^2 = 12$

$LR = \frac{2 \times 12}{4} = 6$

5. The sum of the coefficients of x^{499} and x^{500} in $(1+x)^{1000} + x(1+x)^{999} + x^2(1+x)^{998} + \dots + x^{1000}$ is:

- 1) $1000C_{501}$ 2) $1002C_{501}$ 3) $1001C_{501}$ 4) $1002C_{500}$

Key: 4

Sol: $S = (1+x)^{1000} + x(1+x)^{999} + x^2(1+x)^{998} + \dots + x^{1000}$

$= (1+x)^{1000} \frac{\left(1 - \left(\frac{x}{1+x} \right)^{1001} \right)}{1 - \frac{x}{1+x}} = (1+x)^{1001} - x^{1001}$

Required sum = $^{1001}C_{499} + ^{1001}C_{500} = ^{1002}C_{500}$



6. Given below are two statements:

Statement I: The function $f: R \rightarrow R$ defined by $f(x) = \frac{x}{1+|x|}$ is one-one.

Statement II: The function $f: R \rightarrow R$ defined by $f(x) = \frac{x^2 + 4x - 30}{x^2 - 8x + 18}$ is many-one.

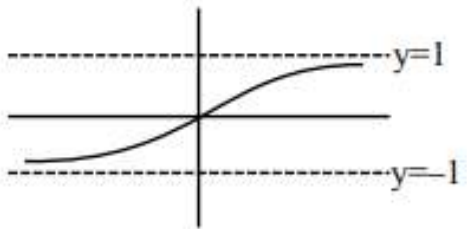
In the light of above statement, chose the correct answer from the options given below:

- 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

Key: 3

Sol: Statement 1: $f(x) = \frac{x}{1+|x|}$

$$f(x) = \begin{cases} \frac{x}{1+x} & x \geq 0 \\ \frac{x}{1-x} & x < 0 \end{cases}$$



$f(x)$ is one-one

Statement 2: $f(x) = \frac{x^2 + 4x - 30}{x^2 - 8x + 18}$, $f(0) = \frac{-30}{18} = \frac{-5}{3}$

$$\frac{-5}{3} = \frac{x^2 + 4x - 30}{x^2 - 8x + 18}$$

On solving $x = 0, -1$

$$\Rightarrow f(0) = f(-1) = \frac{-5}{3}$$

$\therefore f(x)$ is many-one

7. Let the arithmetic mean of $\frac{1}{a}$ and $\frac{1}{b}$ be $\frac{5}{16}$, $a > 2$. if α is such that $a, 4, \alpha, b$ are in A.P., then the equation $\alpha x^2 - ax + 2(\alpha - 2b) = 0$ has :

- 1) One root in $(1, 4)$ and another in $(-2, 0)$
- 2) One root in $(0, 2)$ and another in $(-4, -2)$
- 3) Both roots in the interval $(-2, 0)$
- 4) Complex roots of magnitude less than 2

Key: 1

Sol: $a = 4 - d, \alpha = 4 + d, b = 4 + 2d$

$$\Rightarrow (4 + d)x^2 - (4 - d)x + 2(4 + d - 8 - 4d) = 0$$

$$\Rightarrow (4 + d)x^2 - (4 - d)x + 2(-4 - 3d) = 0$$

$$\text{Also } \frac{\frac{1}{a} + \frac{1}{b}}{2} = \frac{5}{16}$$

$$\Rightarrow \frac{\frac{1}{4-d} + \frac{1}{4+2d}}{2} = \frac{5}{16}$$

$$\Rightarrow d = 2$$

Equation becomes

$$6x^2 - 2x - 20 = 0$$

$$3x^2 - x - 10 = 0$$

$$x = 2, \frac{-5}{3}$$

8. Let P be a point in the plane vectors $AB = 3\hat{i} + \hat{j} - \hat{k}$ and $AC = \hat{i} - \hat{j} + 3\hat{k}$ such that P is equidistant from the lines AB and AC. If $|AP| = \frac{\sqrt{5}}{2}$, then the area of the triangle ABP is :

1) $\frac{\sqrt{26}}{4}$

2) 2

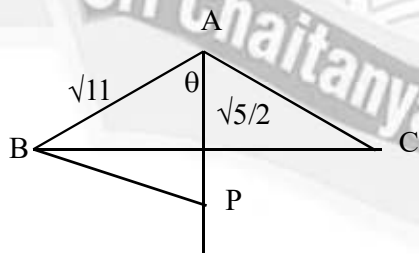
3) $\frac{\sqrt{30}}{4}$

4) $\frac{3}{2}$

Key: 3

Sol: $\cos 2\theta = \frac{-1}{11} \Rightarrow \sin \theta = \sqrt{\frac{6}{11}}$

$$\text{Area} = \frac{1}{2} \sqrt{11} \times \sqrt{5} / 2 \times \sqrt{\frac{6}{11}} = \frac{\sqrt{30}}{4}$$



9. Given below are two Statements:

Statement I: $25^{13} + 20^{13} + 8^{13} + 3^{13}$ is divisible by 7.

Statement II: The integral part of $(7 + 4\sqrt{3})^{25}$ is an odd number.

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



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

Key: 4

Sol: Statement – 1:

$$\begin{array}{ccc} 25^{13} + 3^{13} & + & 20^{13} + 8^{13} \\ \downarrow & & \downarrow \\ \text{divisible by} & & \text{divisible by} \\ (25+3) & & (20+8) \\ \swarrow & & \searrow \\ \therefore \text{divisible by } 7 \end{array}$$

Statement – 2: $R = (7 + 4\sqrt{3})^{25} = I + f$

$$R' = (7 - 4\sqrt{3})^{25} = f'$$

$$\therefore R + R' = 2 \left[{}^{25}C_0 7^{25} + {}^{25}C_2 7^{23} (4\sqrt{3})^2 + \dots \right]$$

$$I + f + f' = \text{even integer}$$

$$\therefore I = \text{odd integer}$$

$$0 < f + f' < 2 \Rightarrow f + f' = 1$$

\Rightarrow Both the statements are correct

10. Considering the principal values of inverse trigonometric functions, the value of the expression $\tan \left(2 \sin^{-1} \left(\frac{2}{\sqrt{13}} \right) - 2 \cos^{-1} \left(\frac{3}{\sqrt{10}} \right) \right)$ is equal to:

- 1) $-\frac{33}{56}$ 2) $\frac{16}{63}$ 3) $\frac{33}{56}$ 4) $-\frac{16}{63}$

Key: 3

Sol: $\sin^{-1} \frac{2}{\sqrt{13}} = \theta, \cos^{-1} \frac{3}{\sqrt{10}} = \phi, \tan(2\theta - 2\phi) = \frac{33}{56}$

11. Let A be the focus of the parabola $y^2 = 8x$. Let the line $y = mx + c$ intersect the parabola at two distinct points B and C. If the centroid of the triangle ABC is $\left(\frac{7}{3}, \frac{4}{3} \right)$, then $(BC)^2$ is equal to :

- 1) 89 2) 32 3) 41 4) 80

Key: 4

Sol: $2t_1^2 + 2t_2^2 + 2 = 7 \quad t_1 + t_2 = 1$

$$2t_1^2 + 2(1+t_1^2 - 2t_1) + 2 = 7 \quad t_2 = 1 - t_1$$

$$4t_1^2 - 4t_1 - 3 = 0$$

$$4t_1^2 - 6t_1 + 2t_1 - 3 = 0$$

$$2t_1(2t_1 - 3) + 1(2t_1 - 3) = 0$$

$$t_1 = -\frac{1}{2} \quad t_1 = \frac{3}{2}$$

$$t_1 = -\frac{1}{2} \quad t_2 = 1 + \frac{1}{2} = \frac{3}{2}$$

$$B(2t_1^2, 4t_1) = \left(\frac{1}{2}, -2\right)$$

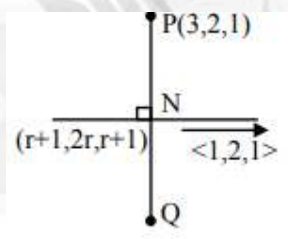
$$C(2t_2^2, 4t_2) = \left(\frac{9}{2}, 6\right)$$

$$(BC)^2 = \left(\frac{9-1}{2}\right)^2 + (6+2)^2 = 16+64 = 80$$

12. Let Q (a, b, c,) be the image of the point P(3,2,1) in the line $\frac{x-1}{1} = \frac{y}{2} = \frac{z-1}{2}$. Then the distance of Q from the line $\frac{x-9}{3} = \frac{y-9}{2} = \frac{z-5}{-2}$ is

- 1) 8 2) 5 3) 6 4) 7

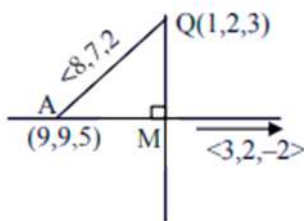
Key: 4



Sol:

$$\text{drs of PN} = \langle r-2, 2r-2, r \rangle \cdot \langle 1, 2, 1 \rangle = (r-2) + 2(2r-1) + 1 \cdot (r) = 0$$

$$6r = 6 \Rightarrow r = 1 \quad \therefore N \equiv (2, 2, 2) \quad \Rightarrow Q \equiv (1, 2, 3)$$



$$AQ = \sqrt{64 + 49 + 4} = \sqrt{117}$$

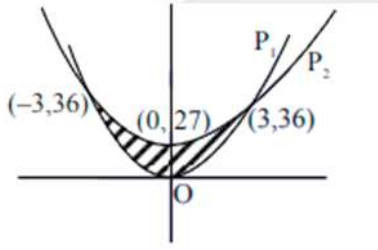
$$AM = \frac{|24 + 14 - 4|}{\sqrt{9 + 4 + 4}} = \frac{34}{\sqrt{17}} = 2\sqrt{17}$$

$$\therefore QM = \sqrt{117 - 68} = \sqrt{49} = 7$$

13. Let $P_1 : y = 4x^2$ and $P_2 : y = x^2 + 27$ be two parabolas. If the area of the bounded region enclosed between P_1 and P_2 is six times the area of the bounded region enclosed between the line $y = \alpha x, \alpha > 0$ and P_1 , then α is equal to:

- 1) 15 2) 8 3) 6 4) 12

Key: 4



Sol:

Area bounded between P_1 & P_2 is

$$\int_{-3}^3 ((x^2 + 27) - (4x^2)) dx = 2 \int_0^3 (27 - 3x^2) dx = 2 \left[27x - x^3 \right]_0^3 = 2[81 - 27] = 108$$

\therefore Area bounded between P_1 & L is 18 sq. units

(Area between $x^2 = 4ay$ & line $x = my$) is $\frac{8a^2}{3m^3}$

\therefore Area between $x^2 = \frac{y}{4}$ & $x = \frac{y}{\alpha}$ is

$$\frac{8 \cdot \left(\frac{1}{16}\right)^2}{3 \cdot \left(\frac{1}{\alpha}\right)^3} = 18 \Rightarrow \frac{8}{\frac{3}{\alpha^3}} = 18 \Rightarrow \alpha^3 = 2^6 \cdot 3^3 \Rightarrow \alpha = 12$$

14. Let $f(x) = \lim_{\theta \rightarrow 0} \left(\frac{\cos \pi x - x^{\left(\frac{2}{\theta}\right)} \sin(x-1)}{1 + x^{\left(\frac{2}{\theta}\right)} (x-1)} \right), x \in R$. Consider the following two statements:

- (I) $f(x)$ is discontinuous at $x = 1$
 (II) $f(x)$ is continuous at $x = -1$

Then

- 1) Neither (I) nor (II) is true 2) Both (I) and (II) are true
 3) Only (II) is true 4) Only (I) is true

Key: 1

$$\text{Sol: } f(x) = \begin{cases} \cos \pi x & x \rightarrow 1^- \\ \frac{-\sin(x-1)}{(x-1)} & x \rightarrow 1^+ \end{cases}$$

$$RHL = \lim_{x \rightarrow 1} \frac{\sin(x-1)}{(x-1)} = -1$$

$$LHL = \lim_{x \rightarrow 1} \cos \pi x = -1$$

$f(x)$ is discontinuous at $x = 1$

$$f(x) = \begin{cases} \frac{-\sin(x-1)}{-(x-1)} & x \rightarrow -1^- \\ \cos \pi x & x \rightarrow -1^+ \end{cases}$$

$$LHL = \lim_{x \rightarrow -1} \frac{-\sin(x-1)}{-(x-1)} = \frac{\sin 2}{2}$$

$f(x)$ is discontinuous at $x = -1$

15. Let the circle $x^2 + y^2 = 4$ intersect x-axis at the point $A(a, 0), a > 0$ and $B(b, 0)$. Let $P(2 \cos \alpha, 2 \sin \alpha), 0 < \alpha < \frac{\pi}{2}$ and $Q(2 \cos \beta, 2 \sin \beta)$ be two points such that $(\alpha - \beta) = \frac{\pi}{2}$. Then the

point of intersection of AQ and BP lies on :

- 1) $x^2 + y^2 - 4x - 4y = 0$ 2) $x^2 + y^2 - 4x - 4 = 0$
 3) $x^2 + y^2 - 4x - 4y - 4 = 0$ 4) $x^2 + y^2 - 4y - 4 = 0$

Key: 4

Sol: $x^2 + y^2 = 4$ intersects x-axis at $A(a, 0) a > 0$

$$y = 0 \quad x^2 = 4$$

$$x = 2 = a; \quad A(2, 0)$$

$$x = -2 = b; \quad B(-2, 0)$$

$$P(2 \cos \alpha, 2 \sin \alpha) \quad Q(2 \cos \beta, 2 \sin \beta) \quad 0 < \alpha < \frac{\pi}{2} \quad \alpha - \beta = \frac{\pi}{2} \quad \beta = \alpha - \frac{\pi}{2}$$

$$Q(2 \sin \alpha, -2 \cos \alpha)$$

P I of AQ and BP

$$t \frac{\alpha}{2} - t \frac{\beta}{2} = 1 + t \frac{\alpha}{2} - t \frac{\beta}{2} \quad \frac{(y^2 + x^2 - 4)}{4y} = 1$$

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



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

$$x \frac{dy}{dx} - y = x^2 \cot x, x \in (0, \pi). \text{ If } y\left(\frac{\pi}{2}\right) = \frac{\pi}{2}, \text{ then } 6y\left(\frac{\pi}{6}\right) - 8y\left(\frac{\pi}{4}\right) \text{ is equal to :}$$

- 1) 3π 2) π 3) -3π 4) $-\pi$.

Key: 4

Sol: $xdy - ydx = x^2 \cot x dx$

$$x^2 d\left(\frac{y}{x}\right) = x^2 \cot x dx$$

$$d\left(\frac{y}{x}\right) = \cot x dx$$

$$\int d\left(\frac{y}{x}\right) = \int \cot x dx$$

$$\frac{y}{x} = \log_e \sin x + C$$

given $y\left(\frac{\pi}{2}\right) = \frac{\pi}{2}$

$$\Rightarrow c = 1$$

$$y = x(\log_e \sin x + 1)$$

$$y\left(\frac{\pi}{6}\right) = \frac{\pi}{6}[-\log_e 2 + 1]$$

$$y\left(\frac{\pi}{4}\right) = \frac{\pi}{4}\left[-\frac{1}{2}\log_e 2 + 1\right]$$

$$6y\left(\frac{\pi}{6}\right) - 8y\left(\frac{\pi}{4}\right)$$

$$= \pi \left[(-\log_e 2 + 1) + 2\left(\frac{1}{2}\log_e 2 - 1\right) \right]$$

$$= \pi [1 - 2] = -\pi$$

17. Let $f(x) = \int \frac{dx}{x^{\frac{2}{3}} + 2x^{\frac{1}{2}}}$ be such that $f(0) = -26 + 24\log_e(2)$. If

$f(1) = a + b\log_e(3)$, where $a, b \in \mathbb{Z}$, then $a + b$ is equal to

- 1) -18 2) -11 3) -5 4) -26

Key: 2

Sol: $f(x) = \int \frac{dx}{x^{\frac{2}{3}} + 2x^{\frac{1}{2}}}$

Put $x = t^6 \Rightarrow dx = 6t^5 dt$

$$\begin{aligned}
 &= \int \frac{6t^5 dt}{t^4 + 2t^3} = 6 \int \frac{(t^2 - 4) + 4}{t + 2} dt \\
 &= 6 \left[\int (t - 2) dt + 4 \int \frac{1}{t + 2} dt \right] \\
 &= 6 \left[\frac{t^2}{2} - 2t + 4 \ln(t + 2) \right] + C \\
 &= 3x^{13} - 12x^{16} + 24 \ln(x^{16} + 2) + C \\
 f(0) &= 24 \ln 2 + C = -26 + 24 \ln 2 \text{ (given)} \\
 \Rightarrow C &= -26 \\
 \text{Now} \\
 f(1) &= -35 + 24 \ln 3 = A + B \ln 3 \text{ (as given in ques.)} \\
 \Rightarrow A &= -35 \text{ \& } B = 24 \\
 \Rightarrow A + B &= -11
 \end{aligned}$$

18. Let $[.]$ denote the greatest integer function. Then $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \left(\frac{12(3 + [x])}{3 + [\sin x] + [\cos x]} \right) dx$ is equal to
- 1) $15\pi + 4$ 2) $12\pi + 5$ 3) $13\pi + 1$ 4) $11\pi + 2$

Key: 4

Sol:

$$\begin{aligned}
 I &= \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{12(3 + [x]) dx}{3 + [\sin x] + [\cos x]} \\
 I &= \int_{-\frac{\pi}{2}}^{-1} \frac{12(1) dx}{2} + \int_{-1}^0 \frac{12(2) dx}{2} + \int_0^1 \frac{12(3) dx}{3} + \int_1^{\frac{\pi}{2}} \frac{12(4) dx}{3} \\
 I &= 6 \left(\frac{\pi}{2} - 1 \right) + 12(0 + 1) + 12(1 - 0) + 16 \left(\frac{\pi}{2} - 1 \right) \\
 I &= 3\pi - 6 + 12 + 12 + 8\pi - 16 \\
 I &= 11\pi + 2
 \end{aligned}$$

19. Let the ellipse $E: \frac{x^2}{144} + \frac{y^2}{169} = 1$ and the hyperbola $H: \frac{x^2}{16} - \frac{y^2}{\lambda^2} = -1$ have the same foci. If e and L respectively denote the eccentricity and the length of the latus rectum of H , then the value of $24(e + L)$ is:
- 1) 296 2) 148 3) 126 4) 67

Key: 1

Sol: Equation of hyperbola: $\frac{y^2}{\lambda^2} - \frac{x^2}{16} = 1$

$$\text{Equation of ellipse : } \frac{x^2}{144} + \frac{y^2}{169} = 1$$

$$e' = \sqrt{1 - \frac{144}{169}} = \frac{5}{13}$$

$$\text{focus} \Rightarrow (0, 5)$$

$$\Rightarrow \lambda \sqrt{1 + \frac{16}{\lambda^2}} = 5$$

$$\Rightarrow \lambda^2 + 16 = 25$$

$$\lambda = 3$$

$$\text{Eccentricity of hyperbola} = \sqrt{1 + \frac{16}{\lambda^2}} = \frac{5}{3}$$

$$\text{Length of latus rectum of hyperbola} = \frac{2(16)}{3} = \frac{32}{3}$$

$$24(e + l) = 24 \left[\frac{5}{3} + \frac{32}{3} \right] = 8 \times 37 = 296$$

20. The sum of all the elements in the range of

$$f(x) = \text{sgn}(\sin x) + \text{sgn}(\cos x) + \text{sgn}(\tan x) + \text{sgn}(\cot x), x \neq \frac{n\pi}{2}, n \in \mathbb{Z}, \text{ where } \text{sgn}(t) = \begin{cases} 1, & \text{if } t > 0 \\ -1, & \text{if } t < 0 \end{cases} \text{ is:}$$

1) 0

2) 4

3) 2

4) -2

Key: 3

$$\text{Sol: } x \in (0, \pi/2) \Rightarrow y = 1 + 1 + 1 + 1 = 4$$

$$x \in (\pi/2, \pi) \Rightarrow y = 1 - 1 - 1 - 1 = -2$$

$$x \in (\pi, 3\pi/2) \Rightarrow y = -1 - 1 + 1 + 1 = 0$$

$$x \in (3\pi/2, 2\pi) \Rightarrow y = -1 + 1 - 1 - 1 = -2$$

$$\therefore \text{Range of } y \text{ is } \{-2, 0, 4\}$$

$$\text{Required sum} = -2 + 0 + 4 = 2$$

SECTION-II (NUMERICAL VALUE TYPE)

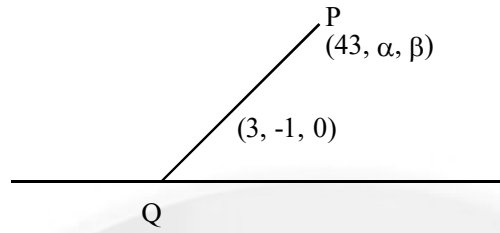
This section contains 5 Numerical Value Type Questions. The Answer should be within 0 to 9999. If the Answer is in Decimal then round off to the Nearest Integer value (Example i.e. If answer is above 10 and less than 10.5 round off is 10 and If answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases.

21. If the distance of the point $P(43, \alpha, \beta)$, $\beta < 0$, from the line $r = 4\hat{i} - \hat{k} + \mu(2\hat{i} + 3\hat{k})$, $\mu \in \mathbb{R}$ along a line with direction ratios $3, -1, 0$ is $13\sqrt{10}$, then $\alpha^2 + \beta^2$ is equal to _____

Key: 170

Sol:



$$Q = (43 + 3r, \alpha - r, \beta) = (2s + 4, 0, 3s - 1), (PQ)^2 = 1690 = 10\alpha^2$$

Gives $\alpha = 13, \beta = 1$

22. Let f be a differentiable function satisfying $f(x) = 1 - 2x + \int_0^x e^{(x-t)} f(t) dt, x \in \mathbb{R}$ and Let

$g(x) = \int_0^x (f(t) + 2)^{15} (t - 4)^6 (t + 12)^{17} dt, x \in \mathbb{R}$. if p and q are respectively the points of local minima and local maxima of g , then the value of $|p + q|$ is equal to _____

Key: 9

Sol:

$$f(x) = 1 - 2x + e^x \int_0^x e^{-t} f(t) dt$$

$$e^{-x} f(x) = (1 - 2x)e^{-x} + \int_0^x e^{-t} f(t) dt$$

$$e^{-x} f'(x) - e^{-x} f(x) = -2e^{-x} + (1 - 2x)e^{-x}(-1) + e^{-x} f(x)$$

$$f'(x) - 2f(x) = 2x - 3$$

$$\frac{dy}{dx} - 2y = 2x - 3$$

$$\Rightarrow y \cdot e^{-2x} = \int e^{-2x} (2x - 3) dx$$

On solving we get

$$y = 1 - x$$

$$g'(x) = (3 - x)^{11} (x + 12)^{17} (x - 4)^4$$

$$\begin{array}{c} - \quad + \quad - \\ | \quad | \quad | \\ -12 \quad 3 \end{array}$$

minima at $x = -12$ & maxima at $x = 3$

$$p = -12, q = 3 \Rightarrow |p + q| = 9$$

23. Let $A = \begin{bmatrix} 3 & -4 \\ 1 & -1 \end{bmatrix}$ and B be two matrices such that $A^{100} = 100B + I$. Then the sum of all the elements of B^{100} is _____

KEY: 0

Sol:

$$A^2 = A \cdot A = \begin{pmatrix} 3 & -4 \\ 1 & -1 \end{pmatrix} \begin{pmatrix} 3 & -4 \\ 1 & -1 \end{pmatrix} = \begin{pmatrix} 5 & -8 \\ 2 & -3 \end{pmatrix}$$

$$A^3 = A^2 \cdot A = \begin{pmatrix} 5 & -8 \\ 2 & -3 \end{pmatrix} \begin{pmatrix} 3 & -4 \\ 1 & -1 \end{pmatrix} = \begin{pmatrix} 7 & -12 \\ 3 & -5 \end{pmatrix}$$

$$A^n = \begin{pmatrix} 2n+1 & -4n \\ n & -(2n-1) \end{pmatrix}$$

$$A^{100} = \begin{pmatrix} 201 & -400 \\ 100 & -199 \end{pmatrix}$$

$$A^{100} - I = \begin{pmatrix} 200 & -400 \\ 100 & -200 \end{pmatrix} = 100B$$

$$B = \begin{pmatrix} 2 & -4 \\ 1 & -2 \end{pmatrix}$$

$$B^2 = B \cdot B = \begin{pmatrix} 2 & -4 \\ 1 & -2 \end{pmatrix} \begin{pmatrix} 2 & -4 \\ 1 & -2 \end{pmatrix} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

Sum of all elements in B^{100} is zero

24. If $\sum_{r=1}^{25} \left(\frac{r}{r^4 + r^2 + 1} \right) = \frac{p}{q}$, where p and q are positive integers such that $\gcd(p, q) = 1$, then $p+q$ is equal to _____

Key: 976

Sol:

$$S = \sum_{r=1}^{25} \frac{r}{(r^2 + r + 1)(r^2 - r + 1)}$$

$$= \frac{1}{2} \sum_{r=1}^{25} \left(\frac{1}{r^2 - r + 1} - \frac{1}{r^2 + r + 1} \right)$$

$$= \frac{1}{2} \left[\left(\frac{1}{1} - \frac{1}{3} \right) + \left(\frac{1}{3} - \frac{1}{7} \right) + \dots + \left(\frac{1}{601} - \frac{1}{651} \right) \right]$$

$$= \frac{1}{2} \left[\frac{1}{1} - \frac{1}{651} \right]$$

$$= \frac{1}{2} \left[\frac{650}{651} \right] = \frac{325}{651}$$

$$\frac{p}{q} = \frac{325}{651} \Rightarrow p + q = 976$$

25. Three persons enter in a lift at the ground floor. The lift will go upto 10th floor. the number of ways, in which the three persons can exit the lift at three different floors, if the lift does not stop at first, second and third floor, is equal to _____

Key: 210

Sol: Number of ways = ${}^7C_3 \times 3! = 7 \times 6 \times 5 = 210$

PHYSICS

Max Marks: 100

SECTION-I
(SINGLE CORRECT ANSWER TYPE)

This section contains 20 Multiple Choice Questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -1 in all other cases.

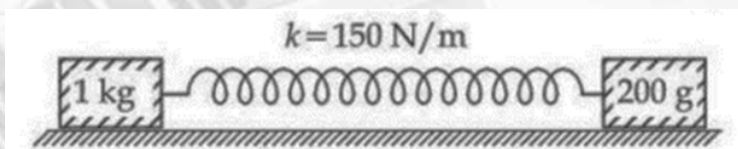
26. The mean free path of a molecule of diameter $5 \times 10^{-10} \text{ m}$ at the temperature 41°C and pressure $1.38 \times 10^5 \text{ Pa}$, is given as ___ m. (Given $k_B = 1.38 \times 10^{-23} \text{ J/K}$).

- 1) $10\sqrt{2} \times 10^{-8}$ 2) $2\sqrt{2} \times 10^{-10}$ 3) $2\sqrt{2} \times 10^{-8}$ 4) 2×10^{-8}

Key: 3

$$\begin{aligned} \text{Sol: } \lambda &= \frac{1}{\sqrt{2}\pi d^2 n} = \frac{k_B T}{\sqrt{2}\pi d^2 p} = \frac{1.38 \times 10^{-23} \times (273 + 41)}{\sqrt{2} \times \pi \times (5 \times 10^{-10})^2 \times 1.38 \times 10^5} \\ &= \frac{314 \times 10^{-21}}{\sqrt{2}\pi 25 \times 10^{-20} \times 10^5} \\ &= \frac{100 \times 10^{-8}}{25\sqrt{2}} \\ &= 2\sqrt{2} \times 10^{-8} \end{aligned}$$

27. As shown in figure, a spring is kept in a stretched position with some extension by holding the masses 1 kg and 0.2 kg with a separation more than spring natural length and are released. Assuming the horizontal surface to be frictionless, the angular frequency (in SI unit) of the system:



- 1) 5 2) 30 3) 27 4) 20

Key: 2

$$\text{Sol: } w = \sqrt{\frac{k}{\mu}} = \sqrt{\frac{150}{1/6}}, \quad \mu = \frac{m_1 m_2}{m_1 + m_2} = \sqrt{150 \times 6} = \sqrt{900} = 30$$

28. Identify the correct statements:

- A. Effective capacitance of a series combination of capacitors is always smaller than the smallest capacitance of the capacitor in the combination.
- B. When a dielectric medium is placed between the charged plates of a capacitor, displacement of charges cannot occur due to insulation property of dielectric.
- C. Increasing of area of capacitor plate or decreasing of thickness of dielectric is an alternate method to increase the capacitance.
- D. For a point charge, concentric spherical shells centred at the location of the charge are equipotential surfaces.

Choose the correct answer from the options given below:

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

Key:4

Sol: Polarisation (movement of charges occur inside dielectric)

29. Number of photons of equal energy emitted per second by a 6 mW laser source operating at 663 nm is _____ (Given: $h = 6.63 \times 10^{-34} \text{ J.S}$ and $c = 3 \times 10^8 \text{ m/s}$)

- 1) 10×10^{15} 2) 2×10^{16} 3) 5×10^{15} 4) 5×10^{16}

Key:2

$$p = \frac{n}{t} \times \frac{hc}{\lambda}$$

Sol: $6 \times 10^{-3} = \frac{n}{t} \times \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{6.63 \times 10^{-9} \times 100}$

$$\frac{n}{t} = \frac{2 \times 10^{-3} \times 10^{-7}}{10^{-26}}$$

$$= 2 \times 10^{16}$$

30. Which one of the following is not a measurable quantity?

- 1) Voltage 2) Displacement current 3) Resistance 4) Voltage difference

Key:1

Sol: We can only measure potential difference

31. Match List - I with List - II.

List – I

- A. Coefficient of viscosity
B. Surface tension
C. Pressure
D. Surface energy

List – II

- I. $[ML^{-1}T^{-2}]$
II. $[ML^2T^{-2}]$
III. $[ML^0T^{-2}]$
IV. $[ML^{-1}T^{-1}]$

Choose the correct answer from the given options given below:

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

Key:4

Sol: $F = 6\pi\eta rv$

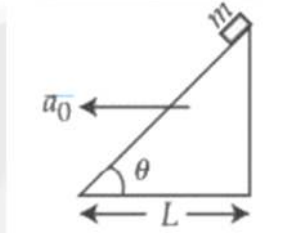
$$MLT^{-2} = \eta \times L \times LT^{-1}$$

$$\eta = M^1 L^{-1} T^{-1}$$

$$S = \frac{\text{Force}}{\text{Length}}$$

$$P = \frac{F}{A}$$

32. A small block of mass m slides down from the top of a frictionless inclined surface, while the inclined plane is moving towards left with constant acceleration a_0 . The angle between the inclined plane and ground is θ and its base length is L . Assuming that initially the small block is at the top of the inclined plane, the time it takes to reach the lowest point of the inclined plane is _____



- 1) $\sqrt{\frac{4L}{g \sin 2\theta - a_0(1 + \cos 2\theta)}}$ 2) $\sqrt{\frac{2L}{g \sin \theta - a_0 \cos \theta}}$
 3) $\sqrt{\frac{2L}{g \sin 2\theta - a_0(1 + \cos 2\theta)}}$ 4) $\sqrt{\frac{4L}{g \cos^2 \theta - a_0 \sin \theta \cos \theta}}$

Key:1

Sol: $ma_{rel} = mg \sin \theta - ma_0 \cos \theta$

$$a_{rel} = g \sin \theta - a_0 \cos \theta$$

$$s = 0(t) + \frac{1}{2} a_{rel} t^2$$

$$\frac{L}{\cos \theta} = \frac{1}{2} \times (g \sin \theta - a_0 \cos \theta) \times t^2$$

$$t = \sqrt{\frac{2L}{g(\sin \theta \cos \theta - a_0 \cos^2 \theta)}}$$

$$t = \sqrt{\frac{4L}{g(2 \sin \theta \cos \theta - a_0 (2 \cos^2 \theta))}}$$

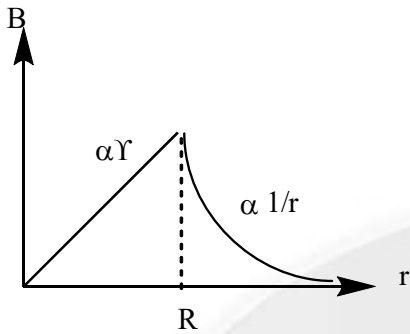
33. A long cylindrical conductor with large cross section carries an electric current distributed uniformly over its cross-section. Magnetic field due to this current is:
- maximum at either ends of the conductor and minimum at the midpoint
 - maximum at the axis of the conductor
 - minimum at the surface of the conductor
 - minimum at the axis of the conductor
 - same at all points in the cross-section of the conductor

Choose the correct answer from the options given below:

- 1) A, D Only 2) E Only 3) D Only 4) B, C Only

Key:3

Sol: B due to solid cylindrical wire



34. A particle starts moving from time $t=0$ and its coordinate is given as $x(t) = 4t^3 - 3t$

- A. The particle returns to its original position (origin) 0.866 units later
- B. The particle is 1 unit away from origin at its turning point
- C. Acceleration of the particle is non-negative
- D. The particle is 0.5 units away from origin at its turning point
- E. Particle never turns back as acceleration is non-negative

Choose the correct answer from the options given below:

- 1) A, B, C Only 2) A, C Only 3) A, C, D Only 4) C, E Only

Key: 1

Sol: $V = \frac{dx}{dt} = 12t^2 - 3$

$$V = 0 \Rightarrow 12t^2 = 3$$

$$t = \frac{1}{4} \Rightarrow t = \pm \frac{1}{2}$$

$$t = 0.5$$

$$a = \frac{dv}{dt} = 24t \Rightarrow a = 24 \left(\frac{1}{2} \right) = 12 \text{ units / time}^2$$

$$x = 4 \left(\frac{1}{4} \right)^3 - 3 \left(\frac{1}{2} \right) = -1$$

$$x = 0 \Rightarrow 4t^3 = 3t$$

$$t = \frac{\sqrt{3}}{2} = 0.866$$

35. A plane electromagnetic wave is moving in free space with velocity $c = 3 \times 10^8 \text{ m/s}$ and its electric field is given as $E = 54 \sin(kz - \omega t) j \text{ T V/m}$, where j is the unit vector along y-axis. The magnetic field vector B of the wave is :

- 1) $-1.8 \times 10^{-7} \sin(kz - \omega t) i \text{ T}$
- 2) $1.4 \times 10^{-7} \sin(kz - \omega t) k \text{ T}$
- 3) $+1.8 \times 10^{-7} \sin(kz - \omega t) i \text{ T}$
- 4) $1.4 \times 10^{-7} \sin(kz - \omega t) i \text{ T}$

Key: 1

Sol: $B_o = \frac{E_o}{c} = 1.8 \times 10^{-7} T$

Magnetic field along x-axis

$\therefore B = B_o \sin(kz - wt)i$

$\vec{V} = \vec{E} \times \vec{B}$

$B = -1.8 \times 10^{-7} \sin(kz - wt)i$

36. When the position $r = xi + yj + zk$ changes sign as $-r$, which one of the following vector will not flip under sign change?

- 1) Velocity 2) Acceleration 3) Linear momentum 4) Angular momentum

Key:4

Sol: v, mv, a will change its sign

$L = r \times P$

$L' = -r \times -p = L$

37. In an experiment, a set of reading are obtained as follows -1.24 mm, 1.25 mm, 1.23 mm, 1.21 mm. The expected least count of the instrument used in recording these readings is _____ mm

- 1) 0.1 2) 0.01 3) 0.001 4) 0.05

Key: 2

Sol: Readings are:

1.24 mm, 1.25mm, 1.23mm

1.21 mm have two decimal places

This means this instrument can measure upto hundredth place of millimetre. i.e, 0.01mm

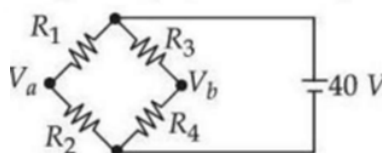
38. A nucleus has mass number α and radius R_α . Another nucleus has mass number β and radius R_β . If $\beta = 8\alpha$ then R_α / R_β

- 1) 2 2) 8 3) 0.5 4) 1

Key:C

Sol: $R = R_o A^{1/3}$ $\frac{R_\alpha}{R_\beta} = \frac{R_o \alpha^{1/3}}{R_o \beta^{1/3}} = \left(\frac{\alpha}{\beta}\right)^{1/3} = \left(\frac{\alpha}{8\alpha}\right)^{1/3} = \left(\frac{1}{8}\right)^{1/3} = \frac{1}{2}$

39. A Wheatstone bridge is initially at room temperature and all arms of the bridge have same value of resistances ($R_1 = R_2 = R_3 = R_4$). When R_3 resistance is heated to some temperature, its resistance value has gone up by 10%. The potential difference ($V_a - V_b$)(after R_3 is heated) is _____ V



- 1) 0 2) 1.05 3) 2 4) 0.95

Key:D

Sol: R_3 increased by 10%

Initially

$$V_a = 40 \times \frac{R}{R+R} = 20$$

$$\therefore V_6 = 20$$

New Resistance

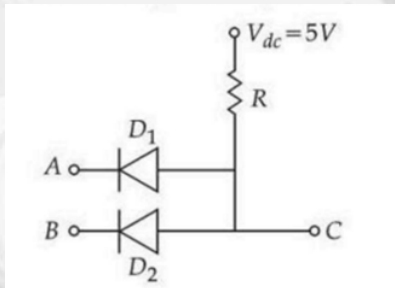
$$R_3^1 = R_3 + 0.10 \times R_3 = 1.1R$$

$$V_a = 20V (R_1 \text{ \& } R_e \text{ No change})$$

$$V_b^1 = V \times \frac{R_4}{R_3^1 + R_4} = \frac{40}{2.1} V = 19.048$$

$$V_a - V_b^1 = 20 - 19.048 = 0.95$$

40. Two p-n junction diodes D_1 and D_2 are connected as shown in figure. A and B are input signal and C is the output. The given circuit will function as a _____



- 1) NOR Gate 2) NAND Gate 3) AND Gate 4) OR Gate

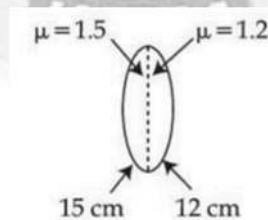
Key: 3

Sol:

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Configuration of AND Gate

41. A biconvex lens is formed by using two thin planoconvex lenses, as shown in the figure. The refractive index and radius of curved surfaces are also mentioned in figure. When an object is placed on the left side of lens at a distance of 30 cm from the biconvex lens, the magnification of the image will be :



- 1) +2 2) -2.5 3) -2 4) +2.5

Key:3

Sol: $\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$

$$= \left(\frac{1}{2}\right)\left(\frac{1}{15}\right) + \left(\frac{1}{5}\right)\left(\frac{1}{12}\right) = \frac{1}{20}$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_{net}} = \frac{1}{20} \Rightarrow \frac{1}{v} = \frac{1}{60}$$

$$\therefore M = \frac{v}{u} = \frac{60}{-30} = -2$$

42. The time period of simple harmonic oscillator $T = 2\pi\sqrt{\frac{k}{m}}$. Measured value of mass (m) of the object is 10 g with an accuracy of 10 mg and time for 50 oscillations of the spring is found to be 60 s using a watch of 2 s resolution. Percentage error in determination of spring constant (k) is _____ %

- 1) 6.76 2) 3.35 3) 3.43 4) 7.60

Key: 1

Sol: $T = 2\pi\sqrt{\frac{k}{m}} \Rightarrow k = \frac{T^2 m}{4\pi^2} \Rightarrow \frac{\Delta k}{k} = 2\left(\frac{\Delta T}{T} + \frac{\Delta m}{m}\right) = \left[2\left(\frac{2}{60}\right) + \frac{10 \times 10^{-3}}{10}\right] \times 100\% = 6.76\%$

43. Identify the correct statements:

- A. Electrostatic field lines form closed loops.
 B. The electric field lines point radially outward when charge is greater than zero.
 C. The Gauss - Law is valid only for inverse - square force.
 D. The workdone in moving a charged particle in a static electric field around a closed path is zero.
 E. The motion of a particle under Coulomb's force must take place in a plane.

Choose the correct answer from the options given below:

- 1) A, C, E Only 2) B, C, D, E Only 3) A, B, C, D Only 4) A, B, D, E Only

Key: 2

Sol: [Electrostatic lines are not closed]

44. For a transparent prism, if the angle of minimum deviation is equal to its refracting angle, the refractive index n of the prism satisfies.

- 1) $\sqrt{2} < n < 2$ 2) $n \geq 2$ 3) $1 < n < 2$ 4) $\sqrt{2} < n < 2\sqrt{2}$

Key: 1 option 3 also matches

$$\text{Sol: } \delta_{\min} = 2i - A = A$$

$$\Rightarrow i = A$$

$$\sin i = \mu \sin\left(\frac{A}{2}\right)$$

$$\Rightarrow 2 \sin\left(\frac{A}{2}\right) \cos\left(\frac{A}{2}\right) = \mu \sin\left(\frac{A}{2}\right) \Rightarrow \mu = 2 \cos\left(\frac{A}{2}\right)$$

$$\text{But } \cos\left(\frac{A}{2}\right) \leq 1$$

$$\therefore \mu \leq 2$$

Another limit is:

$$\sin i = \mu \sin r_1$$

if i becomes $\max = 90^\circ$

$$r_1 = \frac{1}{2} = \frac{A}{2} = 45^\circ$$

$$\therefore \mu \geq \frac{1}{1/\sqrt{2}}$$

45. The speed of a longitudinal wave in a metallic bar is 400 m/s. If the density and Young's modulus of the bar material are increased by 0.5% and 1%, respectively then the speed of the wave is changed approximately to m/s.

1) 402

2) 398

3) 401

4) 399

Key: 3

$$\text{Sol: } v \propto \sqrt{\frac{Y}{\rho}} \Rightarrow \frac{\Delta v}{v} = \frac{1}{2} \frac{\Delta Y}{Y} - \frac{1}{2} \frac{\Delta \rho}{\rho}$$

$$= \left(\frac{1}{2} - \frac{1}{4}\right) \times \frac{1}{100} = \frac{1}{400}$$

$$\therefore \frac{v_2 - v_1}{v_1} = \frac{1}{400} \Rightarrow v_2 = 401$$

SECTION-II (NUMERICAL VALUE TYPE)

This section contains 5 Numerical Value Type Questions. The Answer should be within 0 to 9999. If the Answer is in Decimal then round off to the Nearest Integer value (Example I.e. If answer is above 10 and less than 10.5 round off is 10 and If answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

46. An inductor stores 16 J of magnetic field energy and dissipates 32 W of thermal energy due to its resistance when an a.c. current of 2 A (rms) and frequency 50 Hz flows through it. The ratio of inductive reactance to its resistance is. ($\pi=3.14$)

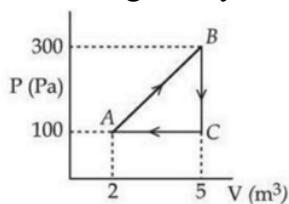
Key: 314

$$\text{Sol: } \frac{1}{2} Li^2 = 16 \Rightarrow \frac{32}{i^2}$$

$$i^2 R = 32 \Rightarrow R = \frac{32}{i^2}$$

$$\therefore \frac{XL}{R} = \frac{L\omega}{R} = \omega = 2\pi f = 314$$

47. A thermodynamic system is taken through the cyclic process ABC as shown in the figure. The total work done by the system during the cycle ABC is _____ J.



Key: 300

Sol: Area of graph = work = $\frac{1}{2} \times 3 \times 200 = 300 J$

48. A fly wheel having mass 3 kg and radius 5 m is free to rotate about a horizontal axis. A string having negligible mass is wound around the wheel and the loose end of the string is connected to 3 kg mass. The mass is kept at rest initially and released. Kinetic energy of the wheel when the mass descends by 3 m is J. ($g=10 \text{ m/s}^2$)

Key: 30

Sol: Decrease in gravitational p.e of connected Mass = increase in k.e of connected mass + increase in k.e of wheel

$$\Rightarrow 3 \times 10 \times 3 = \left(\frac{1}{2} \times 3v^2 \right) + \frac{1}{2} \left(\frac{3v^2}{2} \right) \quad \therefore \frac{1}{2} \left(\frac{3v^2}{2} \right) = 30 J$$

49. A beam of light consisting of wavelengths 650 nm and 550 nm illuminates the Young's double slits with separation of 2 mm such that the interference fringes are formed on a screen, placed at a distance of 1.2 m from the slits. The least distance of a point from the central maximum, where the bright fringes due to both the wavelengths coincide, is $\times 10^{-5} \text{ m}$.

Key: 429

Sol: $y_{nthbright} = \frac{n\lambda D}{d}$

$$n_1 \lambda_1 = n_2 \lambda_2$$

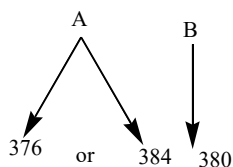
$$\Rightarrow \frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{11}{13}$$

$$\therefore \text{Ans} = \frac{11 \times 650 \times 10^{-9} \times 1.2}{2 \times 10^{-3}} = 429 \times 10^{-5} \text{ m}$$

50. Two tuning forks A and B are sounded together giving rise to 8 beats in 2 s. When fork A is loaded with wax, the beat frequency is reduced to 4 beats in 2 s. If the original frequency of tuning fork B is 380 Hz then the original frequency of tuning fork A is _____ Hz

Key: 384

Sol:



\therefore From second hint

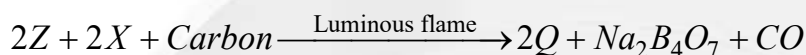
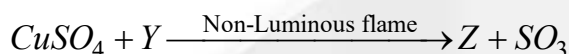
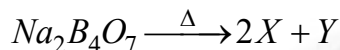
384 Hz is confirmed

CHEMISTRY**Max Marks: 100****SECTION-I
(SINGLE CORRECT ANSWER TYPE)**

This section contains **20 Multiple Choice Questions**. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -1 in all other cases.

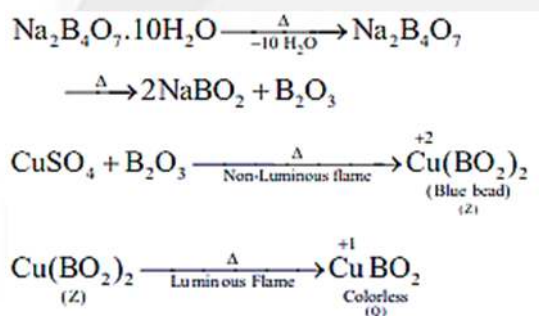
51. Consider the following reactions



The oxidation states of Cu in Z and Q, respectively are:

- 1) +1 and +1 2) +1 and +2 3) +2 and +2 4) +2 and +1

Key: 4



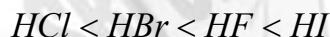
Sol: Oxidation states of Cu in Z and Q are +2 & +1

52. Given below are two statements:

Statement I: The increasing order of boiling point of hydrogen halides is



Statement II: The increasing order of melting point of hydrogen halides is



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

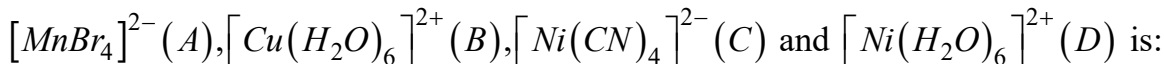
- 1) Statement I is true but Statement II is false
 2) Both Statement I and Statement II are true
 3) Statement I is false but Statement II is true
 4) Both Statement I and Statement II are false

Key: 2

Sol: B.P. $\text{HF} > \text{HI} > \text{HBr} > \text{HCl}$

M.P. $\text{HI} > \text{HF} > \text{HBr} > \text{HCl}$

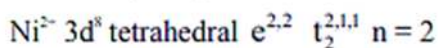
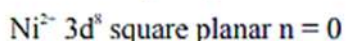
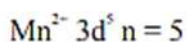
53. The correct increasing order of spin-only magnetic moment values of the complex ions



- 1) $C = D < B < A$ 2) $A = B < C < D$ 3) $C < B < D < A$ 4) $A = B < D < C$

Key: 3

Sol:



54. Consider the elements N, P, O, S, Cl and F. The number of valence electrons present in the elements with most and least metallic character from the above list is respectively.
 1) 5 and 6 2) 5 and 7 3) 6 and 7 4) 7 and 5

Key: 2

Sol: Least metallic = F, valence electrons = 7

Most metallic = P, valence electrons = 5

55. The wavelength of photon 'A' is 400nm. The frequency of photon 'B' is $10^{16} s^{-1}$. The wave number of photon 'C' is $10^4 cm^{-1}$. The correct order of energy of these photons is:
 1) $A > C > B$ 2) $A > B > C$ 3) $C > B > A$ 4) $B > A > C$

Key: 4

Sol: (1) Wavelength of A = 400 nm.

$$(2) \nu = \frac{c}{\lambda} \Rightarrow \text{wavelength of B } (\lambda) = \frac{3 \times 10^8}{10^{16}}$$

$$= 3 \times 10^{-8} = 30 \times 10^{-9} = 30 \text{ nm.}$$

$$(3) \text{Wavelength of C } (\lambda) = \frac{1}{\bar{\nu}} = \frac{1}{10^4} = 10^{-4} \text{ cm}$$

$$= 10^{-6} \text{ m} = 1000 \text{ nm}$$

Here $\lambda_c > \lambda_a > \lambda_b$

$$E \propto \frac{1}{\lambda}$$

So $E_c < E_a < E_b$

56. Consider the following aqueous solutions.

I. 2.2 g Glucose in 125 mL of solution.

II. 1.9 g Calcium chloride in 250 mL of solution.

III. 9.0 g Urea in 500 mL of solution.

IV. 20.5 g Aluminium sulphate in 750 mL of solution.

The **correct** increasing order of boiling point of these solutions will be:

[Given: Molar mass in $g \text{ mol}^{-1}$: H = 1, C = 12, N = 14, O = 16, Cl = 35.5, Ca = 40, Al = 27 and S = 32]

- 1) $I < II < III < IV$ 2) $III < I < II < IV$ 3) $II < III < IV < I$ 4) $II < III < I < IV$

Key: 1

Sol: $\Delta T_b = i.k_b.m$

For dilute solution ($M = m$)

Molarity	$i \times m$
$M_{\text{glucose}} = \frac{2.2}{180} \times \frac{1000}{125} = 0.09$	0.09×1
$M_{\text{urea}} = \frac{9}{60} \times \frac{1000}{500} = 0.3$	0.3×1
$M_{\text{CaCl}_2} = \frac{1.9}{111} \times \frac{1000}{250} = 0.068$	0.068×3
$M_{\text{Al}_2(\text{SO}_4)_3} = \frac{20.5}{342} \times \frac{1000}{750} \approx 0.08$	0.08×5

Order of $\Delta T_b = \text{Al}_2(\text{SO}_4)_3 > \text{Urea} > \text{CaCl}_2 > \text{Glucose}$

57. A student performed analysis of aliphatic organic compound 'X' which on analysis gave $C = 61.01\%$, $H = 15.25\%$, $N = 23.74\%$

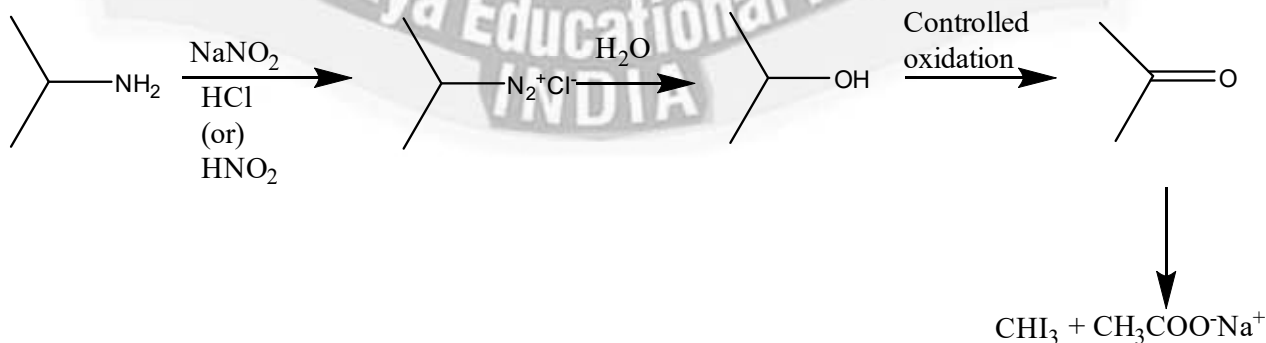
This compound, on treatment with $\text{HNO}_2 / \text{H}_2\text{O}$ produced another compound 'Y' which did not contain any nitrogen atom. However, the compound 'Y' upon controlled oxidation produced another compound 'Z' that responded to Iodoform test. The structure of 'X' is:

- 1) $\text{CH}_3 - \text{CH}_2\text{CH}(\text{NH}_2) - \text{CH}_3$
- 2) $\text{Ph} - \text{CH}(\text{NH}_2) - \text{CH}_3$
- 3) $\text{CH}_3 - \text{C}(\text{CH}_3)_2 - \text{CH}_2 - \text{NH}_2$
- 4) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$

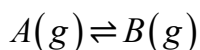
Key: 3

$$\text{Sol: } C = \frac{61.01}{12} = 5.08 \quad H = \frac{15.25}{1} = 15.25 \quad N = \frac{23.74}{14} = 1.69$$

$$\frac{5.08}{1.69} = 3 \quad \frac{15.25}{1.69} = 9 \quad \frac{1.69}{1.69} = 1$$

Emp. For = $\text{C}_3\text{H}_9\text{N}$ 

58. Observe the following equilibrium in a 1 L flask.



At T (K), the equilibrium concentrations of A and B are 0.5 M and 0.375 M respectively.

0.1 moles of A is added into the flask and heated to T (K) to establish the equilibrium again. The new equilibrium concentrations (in M) of A and B are respectively

- 1) 0.367, 0.275 2) 0.53, 0.4 3) 0.557, 0.418 4) 0.742, 0.557

Key: 3

Sol:



0.5 0.375

$$K_{eq} = \frac{[B]_{eq}}{[A]_{eq}} = \frac{0.375}{0.5} = 0.75$$

Now 0.1 mole of A is added so reaction will move in forward direction.



0.6-x 0.375+x

$$K_{eq} = 0.75 = \frac{0.375+x}{0.6-x}$$

$$0.45 - 0.75x = 0.375 + x$$

$$1.75x = 0.075$$

$$x = \frac{0.075}{1.75} = \frac{3}{70} = 0.043$$

$$\text{Moles of A} = 0.043 = 0.557$$

$$\text{Moles of B} = 0.418$$

59. A student has been given 0.314 g of an organic compound and asked to estimate Sulphur. During the experiment, the student has obtained 0.4813g of barium sulphate. The percentage of sulphur present in the compound is _____ . (Given Molar mass in g

$\text{mol}^{-1} S : 32, BaSO_4 : 233$)

- 1) 21.05% 2) 63.15% 3) 48.24% 4) 42.10%

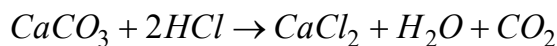
Key: 1

Sol: $233 \rightarrow 32$

$$1g \rightarrow \frac{32}{233} \times 0.4813$$

$$\%S = \frac{32 \times 0.4813}{233 \times 0.314} \times 100 = 21.05$$

60. For the given reaction;



If 90 g CaCO_3 is added to 300 mL of HCl which contains 38.55% HCl by mass and has density 1.13 g mL^{-1} , then which of the following option is **correct**?

Given molar mass of H, Cl, Ca and O are 1, 35.5, 40 and 16 g mol^{-1} respectively.

- 1) 32.85g of CaCO_3 remains unreacted
- 2) 60.32 g of HCl remains unreacted
- 3) 97.30g of HCl reacted
- 4) 64.97g of HCl remains unreacted

Key: 4

$$\text{Sol: } M_{\text{HCl}} = \frac{38.55 \times 1.13 \times 10}{36.5} = 11.93$$

$$\eta_{\text{HCl}} = \frac{11.93 \times 300}{1000} = 3.58$$



Initial molar	0.9	3.58	0	0	0
After Rxn	0	1.78	0.9	0.9	0.9

$$\text{Unreacted weight} = 1.78 \times 36.5 = 64.97$$

61. Identify the **correct** statements:

The presence of $-\text{NO}_2$ group in benzene ring

- A. Activates the ring towards electrophilic substitutions.
- B. deactivates the ring towards electrophilic substitutions.
- C. activates the ring towards nucleophilic substitutions.
- D. deactivates the ring towards nucleophilic substitutions.

Choose the correct answer from the options given below:

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

Key: 4

Sol: Conceptual

62. The plot of $\log_{10} K$ vs $\frac{1}{T}$ gives a straight line. The intercept and slope respectively are (Where K is equilibrium constant).

- 1) $-\frac{\Delta S^\circ R}{2.303}, \frac{\Delta H^\circ R}{2.303}$ 2) $\frac{2.303R}{\Delta H^\circ}, \frac{2.303R}{\Delta S^\circ}$ 3) $\frac{\Delta S^\circ}{2.303R}, -\frac{\Delta H^\circ}{2.303R}$ 4) $-\frac{\Delta H^\circ}{2.303R}, \frac{\Delta S^\circ}{2.303R}$

Key: 3

Sol: $\Delta G^\circ = -2.303RT \log_{10} k$

$$\Delta H^\circ - T \cdot \Delta S^\circ = -2.303RT \log_{10} k$$

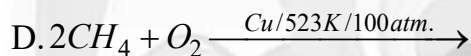
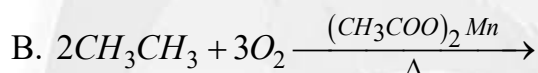
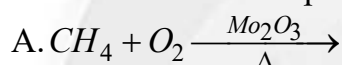
$$\frac{T \cdot \Delta S^\circ}{2.303RT} - \frac{-\Delta H^\circ}{2.303RT} = \log_{10} k$$

$$\frac{\Delta S^\circ}{2.303R} - \left(\frac{\Delta H^\circ}{2.303R} \right) \frac{1}{T} = \log k$$

$$\text{Slop} = \frac{-\Delta H^\circ}{2.303R}$$

$$\text{Intercept} = \frac{\Delta S^\circ}{2.303R}$$

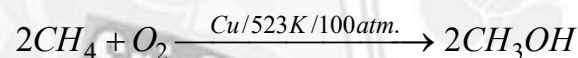
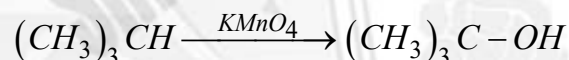
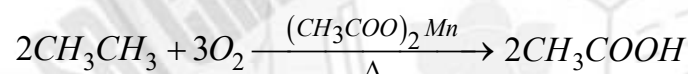
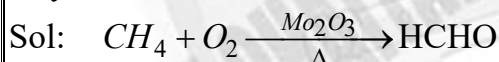
63. The reactions which produce alcohol as the product are:



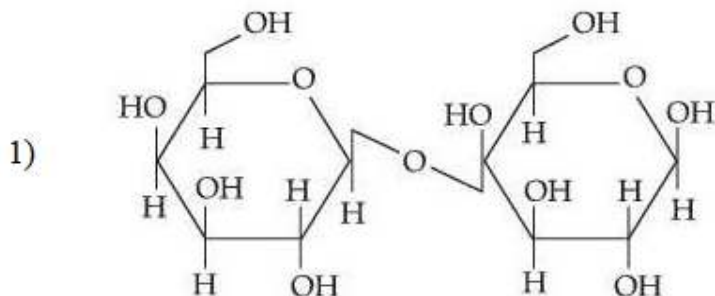
Choose the correct answer from the options given below:

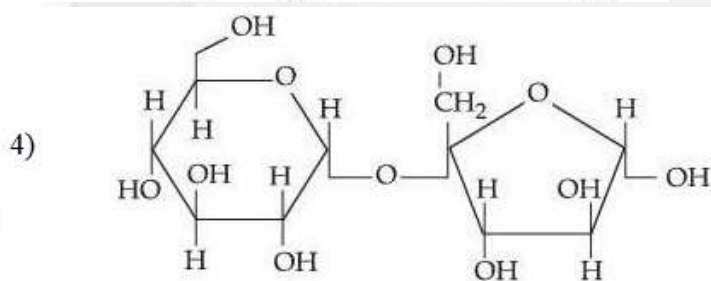
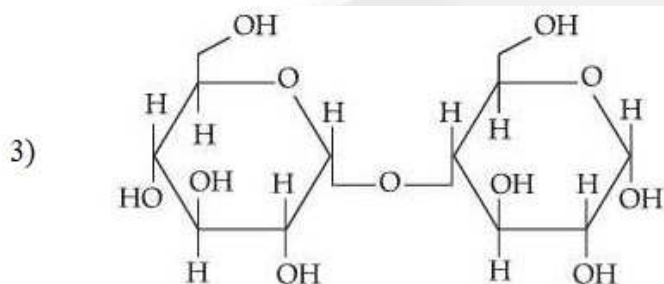
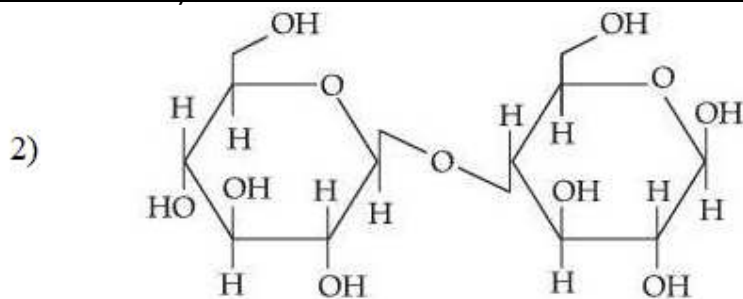
1) C and D only 2) B, D and E only 3) A and D only 4) A, C and E only

Key: 1

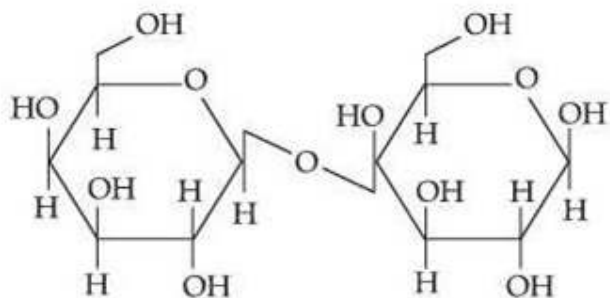


64. Structures of four disaccharides are given below. Among the given disaccharides, the non-reducing sugar is:



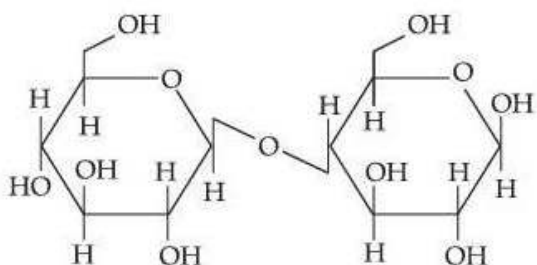


Key: 4

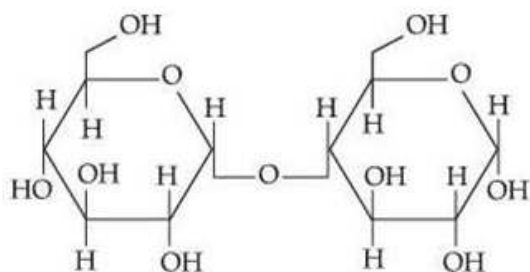


Hemi Acetal (Reducing)

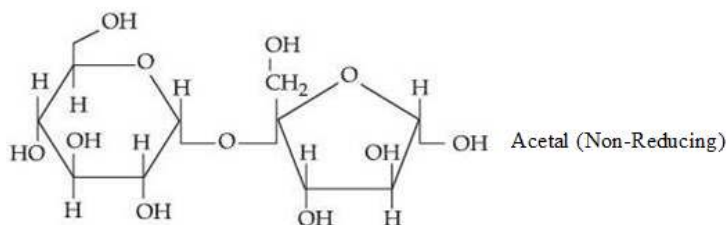
Sol:



Hemi Acetal (Reducing)



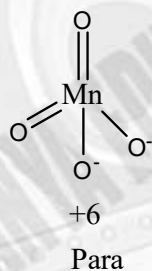
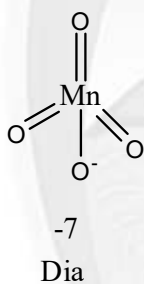
Hemi Acetal (Reducing)



65. Consider the following statements about manganite and permanganate ions. Identify the correct statements.
- The geometry of both manganate and permanganate ions is tetrahedral.
 - The oxidation states of Mn in manganate and permanganate are +7 and +6, respectively.
 - Oxidation of Mn(II) salt by peroxodisulphate gives manganate ion as the final product.
 - Manganate ion is paramagnetic and permanganate ions is diamagnetic.
 - Acidified permanganate ion reduces oxalate, nitrite and iodide ions.
- Choose the correct answer from the options given below:

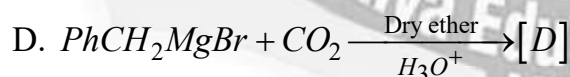
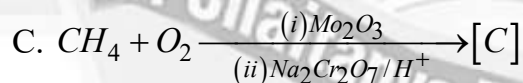
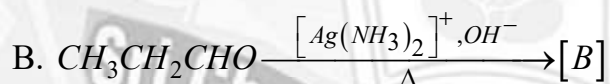
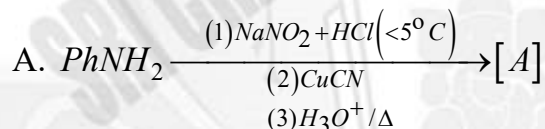
- 1) A, C and D only 2) A, D and E only 3) A, B and C only 4) A and D only

Key: 2



Sol:

66. The correct order of acidic strength of the major products formed in the given reaction, is:

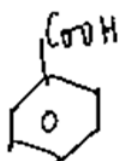


Choose the correct answer from the options given below:

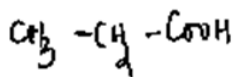
- 1) $C > B > A > D$ 2) $A > D > C > B$ 3) $C > A > D > B$ 4) $A > D > B > C$

Key: 3

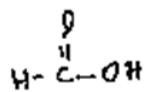
Sol:



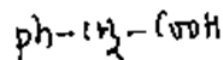
A



B



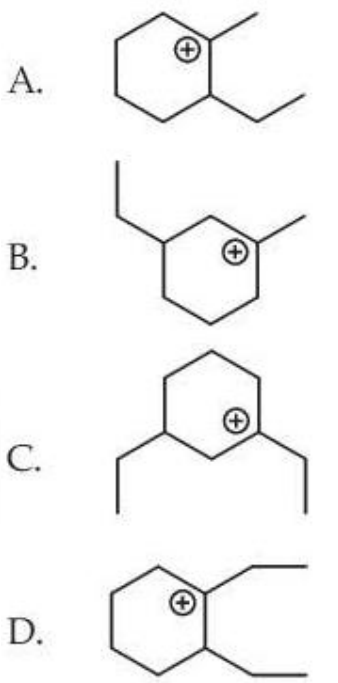
C



D

Acidic order: C > A > D > B

67. The cyclic cations having the same number of hyperconjugation are:



Choose the correct answer from the options given below:

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

Key: 2

Sol: $A \rightarrow 6\alpha, B \rightarrow 7\alpha, C \rightarrow 6\alpha, D \rightarrow 5\alpha$

68. Match List – I with List – II according to shape.

List – I

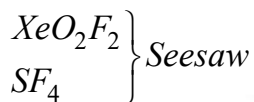
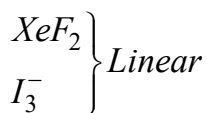
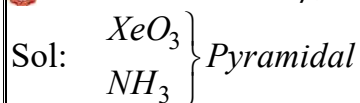
List – II

A. XeO_3 I. BrF_5 B. XeF_2 II. NH_3 C. XeO_2F_2 III. $[\text{I}_3]^-$ D. XeOF_4 IV. SF_4

Choose the correct answer from the options given below:

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

Key: 1

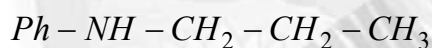
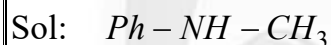


69. Total number of alkali insoluble solid sulphonamides obtained by reaction of given amines with Hinsberg's reagent is _____.

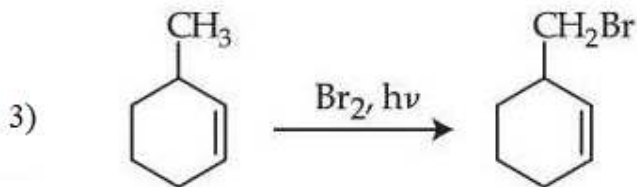
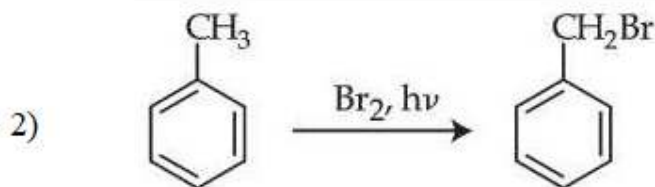
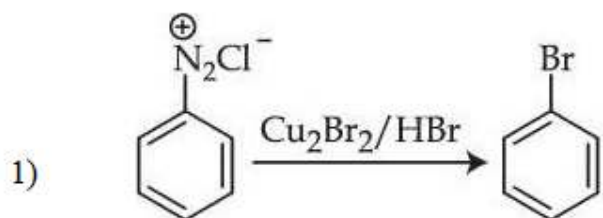
Aniline, N-Methylaniline, Methanamine, N, N – Dimethylmethanamine, N-Methyl Methanamine, Phenylmethanamine, N-propylaniline, N-phenylaniline, N, N-Dimethylaniline, Allyl amine, Isopropyl amine

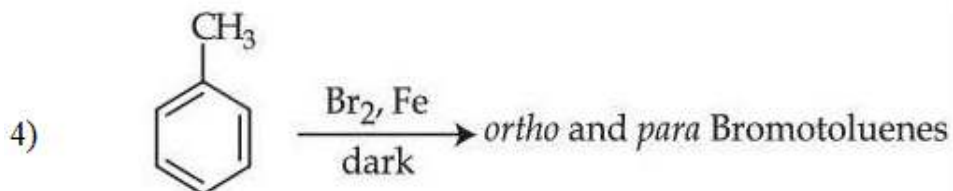
- 1) 4 2) 8 3) 5 4) 2

Key: 1

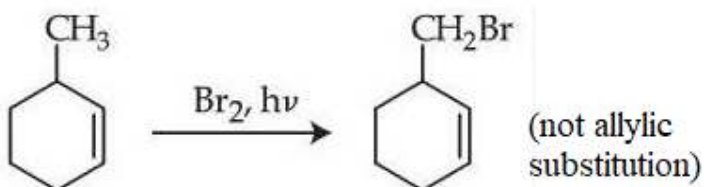


70. Which of the following reaction is NOT correctly represented?





Key: 3



Sol:

SECTION-II

(NUMERICAL VALUE TYPE)

This section contains 5 Numerical Value Type Questions. The Answer should be within 0 to 9999. If the Answer is in Decimal then round off to the Nearest Integer value (Example i.e. If answer is above 10 and less than 10.5 round off is 10 and If answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

71. $A \rightarrow B$ (first reaction) $C \rightarrow D$ (second reaction)

Consider the above two first-order reactions. The rate constant for first reaction at 500 K is double of the same at 300K. At 500 K, 50% of the reaction becomes complete in 2 hour. The activation energy of the second reaction is half of that of first reaction. If the rate constant at 500 K of the second reaction becomes double of the rate constant of first reaction at the temperature; then rate constant for the second reaction at 300 K is _____ $\times 10^{-1} \text{ hour}^{-1}$ (nearest integer).

Key: 3

Sol: $A \rightarrow B$

$$K_{500} = 2K_{300}$$

$$t_{50\%} = 2$$

$$K_{500} = \frac{0.693}{2}$$

$$K_{300} = \frac{0.693}{4}$$

 $C \rightarrow D$

$$E_{a_{C \rightarrow D}} = E_{a_{A \rightarrow B}} = 112.5R$$

$$K_{500}^{C \rightarrow D} = 2K_{500}^{A \rightarrow D} = 2 \times \frac{0.693}{2} = 0.693 \log_2 = \frac{E_a}{R} \left[\frac{200}{300 \times 500} \right] \text{ Solving } K_{300}^{C \rightarrow D} = 3$$

$$E_a^{A \rightarrow B} = 225R$$

$$E_a^{C \rightarrow D} = 112.5R$$

$$A \rightarrow B$$

$$K_{500} = 2K_{300}$$

$$t_{500} = 2$$

$$K_{500}^{A \rightarrow B} = \frac{0.693}{2}$$

$$K_{300}^{A \rightarrow B} = \frac{0.693}{4}$$

$$C \rightarrow D$$

$$E_a^{C \rightarrow D} = E_a^{A \rightarrow B} = \frac{112.5R}{2}$$

$$K_{500}^{C \rightarrow D} = 2K_{500}^{A \rightarrow B} = 2 \times \frac{0.693}{2} = 0.693$$

$$K_{300}^{C \rightarrow D} = ?$$

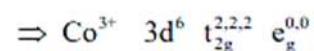
72. The number of isoelectronic species among Sc^{3+} , Cr^{2+} , Mn^{3+} , Co^{3+} and Fe^{3+} is 'n'. If 'n' moles of $AgCl$ is formed during the reaction of complex with formula $CoCl_3(en)_2NH_3$ With excess of $AgNO_3$ solution, then the number of electrons present in the t_{2g} orbital of the complex is _____.

Key: 6

Cr^{2+} and Mn^{3+} are isoelectronic

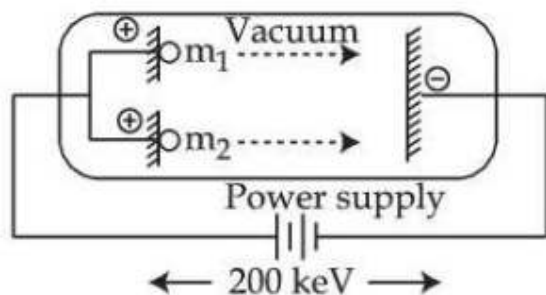
$$n = 2$$

Complex is : $[Co(en)_2NH_3Cl]Cl_2$



Sol:

73. Two positively charged particles m_1 and m_2 have been accelerated across the same potential difference of 200 keV as shown below.



[Given mass of $m_1 = 1$ amu and $m_2 = 4$ amu]

The de Broglie wavelength of m_1 will be x times of m_2 . The value of x is _____ (nearest integer)

Key: 2

Sol:

$$\lambda_d = \frac{h}{\sqrt{2m \text{K.E.}}}$$

Here KE is same i.e. 200 keV

$$\text{So } \lambda_d \propto \frac{1}{\sqrt{m}}$$

$$\frac{(\lambda_d)_{m_1}}{(\lambda_d)_{m_2}} = \sqrt{\frac{m_2}{m_1}} = \sqrt{4} = 2$$

$$(\lambda_d)_{m_1} = 2(\lambda_d)_{m_2}$$

So $x = 2$.

74. For strong electrolyte Λ_m increases slowly with dilution and can be represented by the equation $\Lambda_m = \Lambda_m^\circ - AC^{\frac{1}{2}}$

Molar conductivity values of the solutions of strong electrolyte AB at 18°C are given below:

$c \text{ [molL}^{-1}\text{]}$	0.04	0.09	0.16	0.25
$\Lambda_m \text{ [S cm}^2 \text{ mol}^{-1}\text{]}$	96.1	95.7	95.3	94.9

The value of constant A based on the above data $\left[\text{in S cm}^2 \text{ mol}^{-1} / (\text{mol/L})^{1/2} \right]$ unit is

_____.

Key: 4

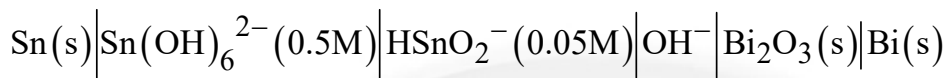
$$\text{Sol: } \Lambda_m = \Lambda_m^\circ - A\sqrt{C}$$

$$96.1 = \Lambda_m^\circ - A\sqrt{0.04}$$

$$95.7 = \Lambda_m^\circ - A\sqrt{0.09}$$

Solving, $A = 4$

75. A volume of x mL of 5 M NaHCO_3 solution was mixed with 10 mL of $2\text{ M H}_2\text{CO}_3$ solution to make an electrolytic buffer. If the same buffer was used in the following electrochemical cell to record a cell potential of 235.3 mV , then the value of $x =$ _____ mL (nearest integer).



Consider upto one place of decimal for intermediate calculations

$$\left[\begin{array}{l} \text{Given:} \quad E^\circ_{\text{HSnO}_2^- | \text{Sn(OH)}_6^{2-}} = -0.9\text{V} \\ E^\circ_{\text{Bi}_2\text{O}_3 | \text{Bi}} = -0.44\text{V} \\ pK_a(\text{H}_2\text{CO}_3) = 6.11 \\ \frac{2.303RT}{F} = 0.059\text{V} \\ \text{Antilog}(1.29) = 19.5 \end{array} \right]$$

Key: 1

Sol: $E^\circ = +0.9 - 0.44 = 0.46$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{6} \log \left(\frac{(0.05)^3}{(0.5)^3 (\text{OH}^-)^3} \right)$$

$$0.2353 = 0.46 - 0.14 \times 3 \log \left(\frac{0.1}{\text{OH}^-} \right) \quad -0.2247 = -0.03 \log \left(\frac{0.1}{\text{OH}^-} \right)$$

$$7.49 = (\log(0.1) - \log(\text{OH}^-)) \quad 7.49 = [-1 + P^{\text{OH}}]$$

$$P^{\text{OH}} = 8.49 \quad P^{\text{H}} = 14 - 8.49$$

$$P^{\text{H}} = 5.51$$

$$P^{\text{H}} = P^{\text{Ka}} + \log \left[\frac{\text{HCO}_3^-}{\text{H}_2\text{CO}_3} \right]$$

$$5.51 = 6.11 + \log \left[\frac{5x}{20} \right]$$

$$-0.6 = \log \left(\frac{x}{4} \right), -2 \log 2 = \log \left(\frac{x}{4} \right)$$

$$\log \left(\frac{1}{4} \right) = \log \left(\frac{x}{4} \right) \quad \frac{1}{4} = \frac{x}{4}, x = 1$$



TOPPERS ARE NOT BORN, THEY'RE MADE @ SRI CHAITANYA

SEIZES 3 RANKS IN TOP 10 IN JEE MAIN 2025 (ALL-INDIA OPEN CATEGORY)

1
ALL INDIA RANK
OPEN CATEGORY
Ajcy Reddy Vangala
Appl. No. 250310254844*

1
ALL INDIA RANK
OPEN CATEGORY
Devdutta Majhi
Appl. No. 2503102301085*

10
All India Rank Open Category
295
300
Marks
Saksham Jindal
Appl. No. 250310236696*

Secured 31 ranks in Top 100 All INDIA Open Category

12
RANK
SAURAV
Appl. No. 250310254844*

22
RANK
LAKSHYA SHARMA
Appl. No. 250310034153*

31
RANK
BANDARI RUSHMITH
Appl. No. 250310395238

32
RANK
BHAVESH JAYANTHI
Appl. No. 250310289939

33
RANK
UJJWAL KESARI
Appl. No. 250310008960*

36
RANK
PRADESH GANDHI S
Appl. No. 250310788252*

39
RANK
S SAI RISHANTH REDDY
Appl. No. 250310965519

41
RANK
PRASANNA KS
Appl. No. 250310326957

43
RANK
KLLIBOINA MUNI SAI
Appl. No. 250310488636

44
RANK
GORRE NITHIN REDDY
Appl. No. 250310551436

53
RANK
U RAMA CHARAN REDDY
Appl. No. 250310289702

56
RANK
ARNAV NIGAM
Appl. No. 25031028448

60
RANK
SAMUDRA SARKAR
Appl. No. 250310173442*

61
RANK
SOHAN KALIDAS CHELEKAR
Appl. No. 250310202114*

64
RANK
BUDUMURU VIKRAM RAJA
Appl. No. 250310322700

66
RANK
SHAGANTI THIRISHUL
Appl. No. 250310500036

70
RANK
LAXIBHARAV MENDE
Appl. No. 250310248080

71
RANK
D CHETAN RAO
Appl. No. 250310635984

73
RANK
V PRAVAS REDDY
Appl. No. 250310253376

75
RANK
P SAI SURYA KARTHIK
Appl. No. 250310407861

76
RANK
YAGHI KUMAR
Appl. No. 250310204405*

81
RANK
P PRANAYA SAI MUKESH
Appl. No. 250310308114

89
RANK
ADITYA SINGH
Appl. No. 250310151728

91
RANK
JAY A GARWAL
Appl. No. 250310122371*

94
RANK
V ESWAR KARTHIK
Appl. No. 250310235425

96
RANK
SAKSHAM GARG
Appl. No. 250310026726*

97
RANK
RANVEER SINGH VIRDE
Appl. No. 250310790734

BELOW 100 ALL INDIA OPEN CATEGORY RANKS **31**

BELOW 500 ALL INDIA OPEN CATEGORY RANKS **95**

BELOW 10 ALL INDIA CATEGORY RANK HOLDERS **10**

BELOW 100 ALL INDIA CATEGORY RANK HOLDERS **98**

BELOW 1000 ALL INDIA CATEGORY RANK HOLDERS **579**

TOTAL QUALIFIED RANKS FOR JEE ADVANCED-2025 **22,094**



LEADING BY MILES SRI CHAITANYA DOMINATES
JEE ADVANCED 2025

29 Ranks in Top 100 in All-India Open Category



4 Students in Top 11 in JEE-Advanced 2025, All India Open Category

16 RANK DEVDUTTA MAJHI HT. No. 255053116*	18 RANK DHARMANA GHANA RUTVIK SAI HT. No. 256955278	19 RANK VANGALA AJAY REDDY HT. No. 256131009	23 RANK AKSH GOGI HT. No. 252071075*	26 RANK P HEMA SAI SURYA KARTHIK HT. No. 255033006	27 RANK SARKARSAMUDRA HT. No. 252071105*
30 RANK OM PRAKASH BEHERA HT. No. 252021018*	32 RANK SUNKARA SAI RISHANTH REDDY HT. No. 256165327	34 RANK DHRUBA JYOTHI PANJA HT. No. 252048248*	35 RANK BHAVESH JAYANTHI HT. No. 251043080	36 RANK ADVAY MAYANK HT. No. 252104113*	37 RANK KARMANYA GUPTA HT. No. 252081477*
42 RANK MD ANAS HT. No. 252046210*	45 RANK RAMIT GOYAL HT. No. 257001113*	52 RANK MAULIK JAIN HT. No. 252079407*	54 RANK GARV HT. No. 252056188*	59 RANK LARISSA HT. No. 252079071*	60 RANK ARYAN BALABADRULA HT. No. 256132077
63 RANK SAMYAJYOTI BISWAS HT. No. 255058465*	64 RANK AARUSH ANAND HT. No. 251006178*	72 RANK RUSHMITH BANDARI HT. No. 256168048	78 RANK KORIKANA RASAGNYA HT. No. 256057046	87 RANK LAKSHYA SHARMA HT. No. 252070079*	91 RANK AVANEESH BANSAL HT. No. 251113130*
95 RANK KAVYA ABGARWAL HT. No. 252079121*					

BELOW 100 ALL INDIA OPEN CATEGORY RANKS	29	BELOW 500 ALL INDIA OPEN CATEGORY RANKS	113	BELOW 1000 ALL INDIA OPEN CATEGORY RANKS	205	BELOW 1000 ALL INDIA CATEGORY RANKS COUNT	745	NUMBER OF QUALIFIED RANKS	4,212
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