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21-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. Let the line L_1 be parallel to the vector $-3i+2j+4k$ and pass through the point $(2,6,7)$, and the line L_2 be parallel to the vector $2i+j+3k$ and pass through the point $(4,3,5)$. If the line L_3 is parallel to the vector $-3i+5j+16k$ and intersects the lines L_1 and L_2 at the points C and D, respectively, then $|CD|^2$ is equal to:

1) 89 2) 312 3) 171 4) 290

Key: 4

Sol: $L_1 : \frac{x-2}{-3}=\frac{y-6}{2}=\frac{z-7}{4}=t$

$L_2 : \frac{x-4}{2}=\frac{y-3}{1}=\frac{z-5}{3}=s$

Any point on L_1 is $C=(-3t+2,2t+6,4t+7)$

Any point on L_2 is $D=(2s+4,s+3,3s+5)$

d.r's of $CD=(2s+3t+2,s-2t-3,3s-4t-2)$

CD is parallel to $-3i+5j+16k$

$\frac{2s+3t+2}{-3}=\frac{s-2t-3}{5}=\frac{3s-4t-2}{16}$

$13s+9t+1=0.....(i)$

$41s+36t+26=0....(2)$

Solve (i) & (2) $s=2;t=-3$

$C=(11,0,-5)$

$D=(8,5,11)$

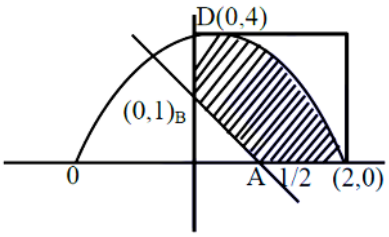
$CD^2=290$

2. If the area of the region $\{(x,y):1-2x\le y\le 4-x^2, x\ge 0, y\ge 0\}$ is $\frac{\alpha}{\beta}, \alpha,\beta\in ?N$, gcd $(\alpha,\beta)=1$, then the value of $(\alpha+\beta)$ is :

1) 73 2) 67 3) 91 4) 85

Key: 2

Sol:



$$\int_0^2 \left(4-x^2\right)dx - \frac{1}{2}\times 1\times\frac{1}{2}$$

3. A random variable X takes values 0,1,2,3 with probabilities $\frac{2a+1}{30}, \frac{8a-1}{30}, \frac{4a+1}{30}$, b respectively, where $a,b \in R$. Let μ and σ respectively be the mean and standard deviation of X such that $\sigma^2+\mu^2=2$. Then $\frac{a}{b}$ is equal to:

1) 3 2) 30 3) 12 4) 60

Key: 4

Sol:

X	0	1	2	3
$p(n)$	$\frac{2a+1}{30}$	$\frac{8a-1}{30}$	$\frac{4a+1}{30}$	b

$$\mu = \Sigma \times p(n) = 0 + \frac{8a-1}{30} + 2\times\frac{4a+1}{30} + 3b = \frac{16a+90b+1}{30}$$

$$\sigma^2 = \Sigma x^2 p(n) - \mu^2 \Rightarrow \sigma^2+\mu^2 = \Sigma x^2 p(n) = 2$$

$$\frac{8a-1}{30} + \frac{4(4a+1)}{30} + 9b = 2$$

$$8a+90b-19=0 \ldots\ldots\ldots (i)$$

$$\Sigma p(n) = 1 \Rightarrow 14a+1+30b = 30$$

$$14a+30b-29=0 \ldots\ldots\ldots (ii)$$

From (i) and (ii)

$$a=2 \quad b=\frac{1}{30} = \frac{a}{b} = 60$$

4. The positive integer n, for which the solutions of the equation $x(x+2)+(x+2)(x+4)+\ldots+(x+2n-2)(x+2n)=\frac{8n}{3}$ are two consecutive even integers, is:

1) 3 2) 9 3) 6 4) 12

Key: 1

Sol: $nx^2+\left(2x+6x+10x+.....+(4n-2)\right)+\left(2.4+4.6+...+(2n-2)2n\right)=\frac{8n}{3}$

$nx^2+2x\left(1+3+5+....+2n-1\right)+\sum_{r=1}^{n}(2r-2)2r=\frac{8n}{3}$

$nx^2+2n^2x+4\left(\frac{n(n+1)(2n-2)}{6}\right)=\frac{8n}{3}$

$3x^2+6nx+4\left(n^2-1\right)=8$

For n=3

$3x^2+18x+24=0$

$x=-2,-4$ (two consecutive even integers)

5. Let $f(x)=x^3+x^2f'(1)+2xf''(2)+f'''(3), x\in R$. Then the value of $f'(5)$ is :

1) $\frac{2}{5}$ 2) $\frac{117}{5}$ 3) $\frac{657}{5}$ 4) $\frac{62}{5}$

Key: 2

Sol: Let $f'(1)=a$

$f'(2)=b$

$f'(3)=c$

$f(x)=x^3+ax^2+bx+c$

$f'(x)=3x^2+2ax+b$

$f'(x)=a=3+2a+b\Rightarrow a+b=3.....(1)$

$f''(x)=6x+2a$

$f''(2)=12+2a=\frac{b}{2}\Rightarrow 4a-b=-24$

$f''(x)=6$

$f''(3)=c=6$

$\Rightarrow a=\frac{-27}{5}, b=\frac{12}{5}$

$f'(5)=75+10a+b$

$=75-54+\frac{12}{5}\ =21+\frac{12}{5}=\frac{117}{5}$

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

$\sec x\frac{dy}{dx}-2y=2+3\sin x, x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right),\ y(0)=-\frac{7}{4}$. Then $y\left(\frac{\pi}{6}\right)$ is equal to :

1) $-3\sqrt{3}-7$ 2) $-\frac{5}{2}$ 3) $-3\sqrt{2}-7$ 4) $-\frac{5}{4}$

Key: 2

Sol: $\frac{dy}{dx}-2\cos x.y=\cos x(2+3\sin x)$

$I.F=e^{-2\sin x}$

$G.S\ y.e^{-2\sin x}=\int e^{-2\sin x}\cos x(2+3\sin x)dx$

Put $\sin x=t$

$\cos x.dx=dt$

$y=e^{-2\sin x}\left(\frac{2+3\sin x}{-2}-\frac{3}{4}\right)+c$

When $x=0,c=0$

When $x=\frac{\pi}{6},\ y=-\frac{5}{2}$

7. If the line $\alpha x+4y=\sqrt{7}$, where $\alpha\in R$, touches the ellipse $3x^2+4y^2=1$ at the point P in the first quadrant, then one of the focal distances of P is :

1) $\frac{1}{\sqrt{3}}+\frac{1}{2\sqrt{5}}$ 2) $\frac{1}{\sqrt{3}}+\frac{1}{2\sqrt{7}}$ 3) $\frac{1}{\sqrt{3}}-\frac{1}{2\sqrt{11}}$ 4) $\frac{1}{\sqrt{3}}-\frac{1}{2\sqrt{5}}$

Key: 2

Sol: $\alpha x+4y-\sqrt{7}=0$ touches $3x^2+4y^2=1$

$\therefore c^2=a^2m^2+b^2$

$\frac{7}{16}=\frac{1}{3}\times\frac{\alpha^2}{16}+\frac{1}{4}\Rightarrow\alpha=3,-3$

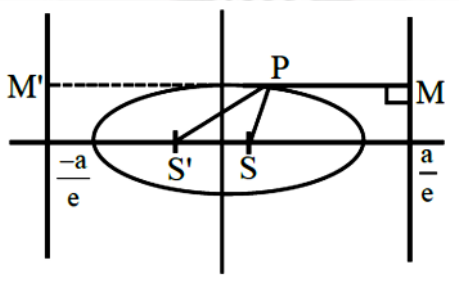
Tangent is $3x+47-\sqrt{7}=0$

Let the point of contact is $P(x_1,y_1)$

$\therefore\frac{3x_1}{3}=\frac{4y_1}{4}=\frac{1}{\sqrt{7}}$

$\therefore P\left(\frac{1}{\sqrt{7}},\frac{1}{\sqrt{7}}\right)$

$ecc.=\sqrt{1-\frac{3}{4}}=\frac{1}{2}$



$PS=e(PM)=e\left(\frac{a}{e}-\frac{1}{\sqrt{7}}\right)=\frac{1}{2}\left(\frac{2}{\sqrt{3}}-\frac{1}{\sqrt{7}}\right)=\frac{1}{\sqrt{3}}-\frac{1}{2\sqrt{7}}$

$PS'=e(PM')=\frac{1}{2}\left(\frac{a}{e}+\frac{1}{\sqrt{7}}\right)=\frac{1}{2}\left(\frac{1}{\sqrt{7}}+\frac{2}{\sqrt{3}}\right)=\frac{1}{\sqrt{3}}+\frac{1}{2\sqrt{7}}$

8. For the matrices $A=\begin{bmatrix}3 & -4\\ 1 & -1\end{bmatrix}$ and $B=\begin{bmatrix}-29 & 49\\ -13 & 18\end{bmatrix}$, if $\left(A^{15}+B\right)\begin{bmatrix}x\\ y\end{bmatrix}=\begin{bmatrix}0\\ 0\end{bmatrix}$, then among the following which one is true ?

1) $x=16, y=3$ 2) $x=11, y=2$ 3) $x=18, y=11$ 4) $x=5, y=7$

Key: 2

Sol: $A=\begin{bmatrix}3 & -4\\ 1 & -1\end{bmatrix}$, $B=\begin{bmatrix}23 & 49\\ 45 & 21\end{bmatrix}$

Characteristic equation of A,

$(3-\lambda)(-1-\lambda)+4=0$

$(\lambda-3)(\lambda+1)+4=\lambda^2-2\lambda+=0$

$\Rightarrow A^2-2A+I=0$

$A^2=2A-I, A^3=2A^2-A=2(2A-I)-A=3A-2I$

$A^4=4A^2+I-4A=4(2A-I)-4A+I$

$=4(2A-I)-3A=5A-4I$

$\left(A^5\right)^3=(5A-4I)^3$

$=125A^3-3\times 25A^2(4)+3(5A)\left(4^2\right)-64I$

$=125(3A-2I)-300(2A-I)+240A-64I$

$=A(375-600+240)+I(-250+300-64)$

$=15A-14I$

$\Rightarrow A^{15}+B=15A-14I+B$

$=\begin{bmatrix}2 & -11\\ 1 & -11\end{bmatrix}$ $\left(A^{15}+B\right)\begin{bmatrix}x\\ y\end{bmatrix}=\begin{bmatrix}0\\ 0\end{bmatrix}\Rightarrow 2x=11y$

9. If the system of equations

$3x+y+4z=3$

$2x+\alpha y-z=-3$

$x+2y+z=4$

has no solution, then the value of α is equal to :

1) 23 2) 4 3) 13 4) 19

Key: 4

Sol: $\Delta=\begin{vmatrix}3 & 1 & 4\\ 2 & \alpha & -1\\ 1 & 2 & 1\end{vmatrix}$

$\det(\Delta)=0$

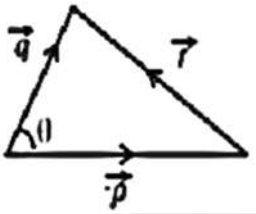
$\alpha=19$

10. For a triangle ABC, let $p = BC, q = CA$ and $r = BA$. If $|p| = 2\sqrt{3}, |q| = 2$ and $\cos\theta = \frac{1}{\sqrt{3}}$, where θ is the angle between p and q, then $\left|p \times \left(q - 3r\right)\right|^2 + 3|r|^2 + 3|r|^2$ is equal to :

1) 340 2) 410 3) 220 4) 200

Key: 4

Sol:



$\Rightarrow r = q + p$

$|r| = \sqrt{q^2 + p^2 + 2pq\cos\theta}$

$|r|^2 = 4 + 12 + 2 \times \sqrt{3} \times 2 \times \frac{1}{\sqrt{3}}$

$|r|^2 = 24$

$\left|p \times \left(q - 3\left(q - p\right)^2\right)\right|^2 + 3|r|^2 = \left|-2p \times q\right|^2 + 3|r|^2$

$= 4 \times |p||q|^2 \sin^2\theta + 3 \times 24 = 4 \times 12 \times 4 \times \left(\frac{2}{3}\right) + 72 = 128 + 72 = 200$

11. Let $a_1, \frac{a_2}{2}, \frac{a_3}{2^2}, ..., \frac{a_{10}}{2^9}$ be a G.P . of common ratio $\frac{1}{\sqrt{2}}$. If $a_1 + a_2 + ... + a_{10} = 62$, then a_1 is equal to :

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

Key: 4

Sol: $\frac{a_2}{2a_1} = \frac{a_3}{2a_2} = \frac{a_4}{2a_3} = ... = \frac{a_{10}}{2a_9} = \frac{1}{\sqrt{2}}$

$\therefore a_1, a_2, a_2, ...a_{10}$ are in G.P .With common ratio $\sqrt{2}$

$\therefore \sum_{i=1}^{10} a_i = \frac{a_1\left(\left(\sqrt{2}\right)^{10} - 1\right)}{\sqrt{2} - 1} = 62 \Rightarrow a_1 = 2\left(\sqrt{2} - 1\right)$

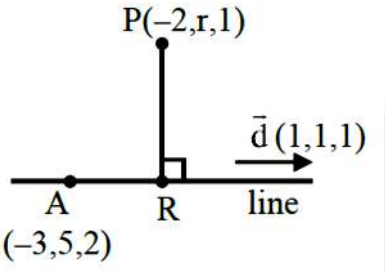
12. Let the line L pass through the point $(-3, 5, 2)$ and make equal angles with the positive coordinate axes. If the distance of L from the point $(-2, r, 1)$ is $\sqrt{\frac{14}{3}}$, then the sum of all possible values of r is :

1) 6 2) 10 3) 12 4) 16

Key: 2

Sol: Equation line is : $\frac{x+3}{1}=\frac{y-5}{1}=\frac{z-2}{1}=\lambda$

$\therefore$ General point R on line is $r(\lambda-3,\lambda+5,\lambda+2)$



$PR=(\lambda-1,\lambda+5-r,\lambda+1)$

Now $PR=.d=0$

$\Rightarrow(\lambda-1)1+(\lambda+5-r)1+(\lambda+1)1=0$

$\Rightarrow 3\lambda+5=0$

$\Rightarrow\lambda=\frac{r-5}{3}$

$\therefore R\equiv\left(\frac{r-5}{3}-3,\frac{r-5}{3}+5,\frac{r-5}{3}+2\right)$

$\therefore R\equiv\left(\frac{r-14}{3},\frac{r+10}{3},\frac{r+1}{3}\right)$

Now $PR=\sqrt{\frac{14}{3}}\Rightarrow(PR)^2=\frac{14}{3}$

$\Rightarrow\left(\frac{r-14}{3}+2\right)+\left(\frac{r+10}{3}-r\right)^2+\left(\frac{r+1}{3}-1\right)^2=\frac{14}{3}$

$\Rightarrow\frac{(r-8)^2}{9}+\frac{(10-2r)^2}{9}+\frac{(r-2)^2}{9}=\frac{14}{3}$

$\Rightarrow\left(r^2-16r+64\right)+\left(100+4r^2-40r\right)+\left(r^2-4r+4\right)=42$

$\Rightarrow 6r^2-60r+126=0$

$\Rightarrow r^2-10r+21=0$

$\Rightarrow r=3,7$

Sum of possible value of r is =10

13. Let α and β be the roots of the equation $x^2+2ax+(3a+10)=0$ such that $\alpha<1<\beta$. Then the set of all possible values of a is :

1) $(-\infty,-2)\cup(5,\infty)$ 2) $(-\infty,-3)$ 3) $\left(-\infty,\frac{-11}{5}\right)$ 4) $\left(-\infty,\frac{-11}{5}\right)\cup(5,\infty)$

Key: 3

Sol: $\alpha<1<\beta$

$f(1)<0$

$\Rightarrow 1+2a+(3a+10)<0$

$\Rightarrow 5a+11<0$

$a<\frac{-11}{5}$

$\therefore a\in\left(-\infty,\frac{-11}{5}\right)$

14. The largest $n\in N$, for which 7^n divides 101!, is:

1) 18 2) 19 3) 16 4) 15

Key: 3

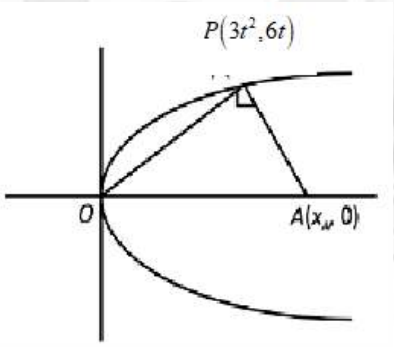
Sol: Exponent of 7 in 101! $=\left[\frac{101}{7}\right]+\left[\frac{101}{7^2}\right]+.....$ (Where [.] is G.I.F.)= 14+12=16

15. Let $y^2=12x$ be the parabola with its vertex at O. Let P be point on the parabola and A be a point on the x-axis such that $\angle OPA=90^0$.Then the locus of the centroid of such triangles OPA is:

1) $y^2-9x+6=0$ 2) $y^2-6x+4=0$ 3) $y^2-4x+8=0$ 4) $y^2-2x+8=0$

Key: 4

Sol:



$m_{op}m_{PA}=-1\ \frac{6t}{3t^2}\times\frac{6t}{3t^2-x}=-1$

$12=-3t^2+x$

$x=12+3t^2$

$h=\frac{x+3t^2+0}{3}\ ;\ k=\frac{0+0+6t}{3}$

$3h=12+6th2;\ k=2t$

$h=4+2t^2\ ;\ k=2t$

Substitute t & replace h by x & k by y

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

16. Let $A=\{2,3,5,7,9\}$. Let R be the relation on A defined by xRy if and only if $2x\le 3y$. Let l be the number of elements in R, and m be the minimum number

of elements required to be added in R to make it a symmetric relation. Then $l+m$ is equal to:

1) 23 2) 21 3) 25 4) 27

Key: 3

Sol: For $x=2$

$4\le 3y \quad y\in\{2,3,5,7,9\}$

$(2,2)(2,3)(2,5)(2,7)(2,5)$

For $x=3$

$6\le 3y \quad y\in\{2,3,5,7,9\}$

$(3,2)(3,3)(3,5)(3,7)(3,5)$

For $x=5$

$10\le 3y \; y\in\{5,7,9\}$

$(5,5)(5,7)(5,5)$

For $x=7$

$14\le 3y \quad y\in\{5,7,9\}$

$(7,5)(7,7)(7,9)$

For $x=9$

$18\le 3y \quad y\in\{7,9\}$

$(9,7)(9,9)$

$R=5+5+3+3+2=18$

$(2,3)\in R$ but $(3,2)\in R$ (symmetric)

$(2,5)\in R$ but $(5,2)\notin R$ Add$(5,2)$

$(2,7)\in R$ but $(7,2)\notin R$ Add$(7,2)$

$(2,9)\in R$ but $(9,2)\notin R$ Add$(9,2)$

$(3,5)\in R$ but $(5,3)\notin R$ Add$(5,3)$

$(3,7)\in R$ but $(7,3)\notin R$ Add$(7,3)$

$(3,9)\in R$ but $(9,3)\notin R$ Add$(9,3)$

$(5,7)\in R$ but $(7,5)\in R$

$(5,9)\in R$ but $(9,5)\notin R$ Add$(9,5)$

$(7,9)\in R$ but $(9,7)\in R$

18+7=25

17. Let one end of a focal chord of the parabola $y^2=16x$ be $(16,16)$. If $P(\alpha,\beta)$ divides this focal chord internally in the ratio 5:2, then the minimum value of $\alpha+\beta$ is equal to:

1) 7 2) 5 3) 22 4) 16

Key: 1

Sol: If $P(\alpha,\beta)$ divides focal chord internally in 5:2

If $A(t_1)\&B(t_2)$ are ends of focal chord $A(16,16)$

$t_1t_2=-1$

$2t_2=-1$

$t_2=-\frac{1}{2}$

$B=(1,-4)$

$P(\alpha,\beta)=\left(\frac{37}{7},\frac{12}{7}\right)$ or $\left(\frac{82}{7},\frac{72}{7}\right)$

Minimum of $\alpha+\beta=\frac{37}{7}+\frac{12}{7}=7$

18. Let $f:R\to R$ be a twice differentiable function such that $f''(x)>0$ for all $x\in R$ and $f'(a-1)=0$, where a is a real number. Let $g(x)=f\left(\tan^2x-2\tan x+a\right),0<x<\frac{\pi}{2}$.

Consider the following two statements :

(I) g is increasing in $\left(0,\frac{\pi}{4}\right)$ (II) g is deceasing in $\left(\frac{\pi}{4},\frac{\pi}{2}\right)$

Then,

1) Only (I) is True 2) Neither (I) nor (II) is True

3) Only (II) is True 4) Both (I) and (II) are True

Key: 2

Sol: $g(x)=f\left((\tan x-1)^2+a-1\right)$

$g'(x)=f'\left((\tan x-1)^2+a-1\right).2(\tan x-1).\sec^2x....(i)$

Given $f''(x)>0\ \forall x\in R$

$\therefore f'(x)$ is increasing function

Case (i) $0<x<\frac{\pi}{4}$

$0<\tan x>1$

$-1<\tan x-1<0$

$0<(\tan x-1)^2<1$

$a-1<(\tan x-1)^2+(a-1)<a$

$\therefore f'\left((\tan x-1)^2+a-1\right)>f'(a-1)=0$

From (i) $g'(x)=(+)(-)(+)=-ve$

$g(x)$ is decreasing in $\left(0,\frac{\pi}{4}\right)$

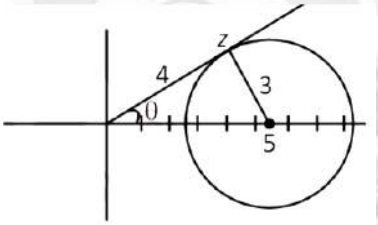
Similarly we can prove that $g(x)$ is increasing in $\left(\frac{\pi}{4},\frac{\pi}{2}\right)$

19. Let Z be the complex number satisfying $|z-5|\le 3$ and having maximum positive principal argument . Then $34\left|\frac{5z-12}{5iz+16}\right|^2$ is equal to;

1) 16 2) 12 3) 20 4) 26

Key: 3

Sol:



$\Rightarrow \arg(z)=\sin^{-1}\left(\frac{3}{5}\right)\tan^{-1}\left(\frac{3}{4}\right)\Rightarrow z=|z|^{i\theta}$

$=4\times(\cos\theta+i\sin\theta)=4\times\left(\frac{4}{5}+i\frac{3}{5}\right)$

$=\frac{16}{5}+\frac{12i}{5}\qquad\Rightarrow 5z=16+12i$

$5zi=16i-12$

$\left(\frac{5z-12}{5zi+16}\right)=\frac{(4+12i)}{(4+16i)}=\frac{(1+3i)}{(1+4i)}$

$\Rightarrow\left(\frac{5z-12}{5zi+16}\right)=\frac{\sqrt{10}}{\sqrt{17}}$

$34\left(\frac{5z-12}{5zi+16}\right)^2=34\times\frac{10}{17}=20$

20. Let $A=\{x:|x^2-10|\le 6\}$ and $B=\{x:|x-2|>1\}$. Then

1) $A\quad B=[-4,-2]\quad[3,4]$ 2) $A-B=[2,3)$

3) $B-A=(-\infty,-4)\quad(-2,1)\quad(4,\infty)$ 4) $A\quad B=(-\infty,1]\quad(2,\infty)$

Key: 3

Sol: $A = x \in [-4,-2] \quad [2,4]$

$B = (-\infty,1) \quad (3,\infty)$

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 P is a point on the circle $x^2 + y^2 = 4$, Q is a point on the straight line $5x + y + 2 = 0$ and $x - y + 1 = 0$ is the perpendicular bisector of PQ, then 13 times the sum of abscissa of all such points P is …….

Key:2

Sol: $P(x_1 y_1)$ and point $Q(x_2, y_2)$

Mid point of PQ $M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$

Substitute M into $x - y + 1 = 0$

$x_1 + x_2 - y_1 - y_2 + 2 = 0..(i)$

Slope of PQ is Perpendicular to slope of bisector line

So, slope of $PQ = -1$

$y_2 = x_1 - x_2 + y_1.....(ii)$

$Q(x_2, y_2)$ lie on $5x + y + 2 = 0$

So, $5x_2 + y_2 + 2 = 0.....(iii)$

Substitute (iii) in (i)

$x_2 = \frac{-x_1 - y_1 - 2}{4}....(iv)$

Substitute (iii) in (ii)

$x_2 = y_1 - 1.....(v)$

From (iv) and (v)

$x_1 = 2 - 5y$

(x_1, y_1) lie on circle

$x_1^2 + y_1^2 = 4$

Pt $x_1 = 2 - 5y_1$

$y_1 = 0, -\frac{10}{13}$

So, $x_1 = 2, \frac{-24}{13}$

So, $2 + \left(-\frac{24}{13}\right) = \frac{2}{13}$

So, $13 \times \frac{2}{13} = 2$

22. If $\left(\frac{1}{{}^{15}C_0}+\frac{1}{{}^{15}C_1}\right)\left(\frac{1}{{}^{15}C_1}+\frac{1}{{}^{15}C_2}\right)...\left(\frac{1}{{}^{15}C_{12}}+\frac{1}{{}^{15}C_{13}}\right)=\frac{\alpha^{13}}{{}^{14}C_0\,{}^{14}C_1...{}^{14}C_{12}}$, then 30α is equal to ……

Key: 32

Sol: $\frac{1}{{}^{n}C_r}+\frac{1}{{}^{n}C_{r+1}}=\frac{{}^{n}C_{r+1}+{}^{n}C_r}{{}^{n}C_r.{}^{n}C_{r+1}}=\frac{{}^{n+1}C_{r+1}}{{}^{n}C_r.{}^{n}C_{r+1}}=\frac{\frac{n+1}{r+1}+{}^{n}C_r}{{}^{n}C_r.{}^{n}C_{r+1}}=\frac{(n+1)}{(r+1).\frac{n}{r+1}.{}^{n-1}C_r}=\frac{n+1}{n.{}^{n+1}C_r}$

$\therefore\left(\frac{1}{15C_0}+\frac{1}{15C_1}\right)\left(\frac{1}{15C_1}+\frac{1}{15C_2}\right)...\left(\frac{1}{15C_{12}}+\frac{1}{15C_{13}}\right)=\frac{16}{15.{}^{14}C_0}.\frac{16}{15.{}^{14}C_1}.\frac{16}{15.{}^{14}C_{12}}=\frac{\left(\frac{16}{15}\right)^{13}}{{}^{14}C_0.{}^{14}C_1.{}^{14}C_2...{}^{14}C_{12}}$

$\therefore\alpha=\frac{16}{15}$

$\therefore 30\alpha=32$

23. Let $[.]$ denote the greatest integer function and $f(x)=\lim_{n\to\infty}\frac{1}{n^3}\sum_{k=1}^{n}\left[\frac{k^2}{3^x}\right]$. Then $12\sum_{j=1}^{\infty}f(j)$ is equal to

Key: 2

Sol: $f(x)=\lim_{x\to\infty}\left(\frac{1}{n^3}.\sum_{k=1}^{n}\left[\frac{k^2}{3^x}\right]\right)=\lim_{n\to\infty}\frac{1}{n^3}.\sum_{k=1}^{n}\left(\frac{k^2}{3^x}\right)-\lim_{n\to\infty}\frac{1}{n^3}.\sum_{k=1}^{n}\left\{\frac{k^2}{3^x}\right\}$

$f(x)=\lim_{n\to\infty}\frac{1}{n^3}\times\frac{n(n+1)(2n+1)}{6\times 3^x}-0\Rightarrow f(x)=\frac{1}{3^{x+1}}$

$12\sum_{j=1}^{\infty}f(j)=12\left(\frac{1}{3^2}+\frac{1}{3^3}+\frac{1}{3^4}+.....\right)=12\left(\frac{\frac{1}{9}}{1-\frac{1}{3}}\right)=\frac{12}{9-3}=2$

24. If $\int_0^1 4\cot^{-1}\left(1-2x+4x^2\right)dx=a\,\tan^{-1}(2)-b\log_e(5)$, where $a.b\in N$, then $(2a+b)$ is equal to…

Key: 9

Sol: $4\int_0^1 Tan^{-1}\left(\frac{1}{1-2x+4x^2}\right)dx$

$4\int_0^1 Tan^{-1}\left(\frac{2x-(2x-1)}{1+2x+(2x-1)}\right)dx$

$I=4\int_0^1 Tan^{-1}2x.dx-4\int_0^1 Tan^{-1}(2x-1)dx.....(i)$

$4\int_0^1 Tan^{-1}2x.dx-4\int_0^1 Tan^{-1}\left(2(1-x)-1\right)dx$

$I=4\int_0^1 Tan^{-1}2x.dx+4\int_0^1 Tan^{-1}(2x-1)dx.....(ii)$

(i)+(ii) $2I=8\int_0^1 Tan^{-1}2x.dx$

By integration by parts $I = 4Tan^{1}2 - \log 5$

$\therefore 2a+b = 8+1 = 9$

25. Let the maximum value of $\left(\sin^{-1}x\right)^2 + \left(\cos^{-1}x\right)^2$ for $x \in \left[-\frac{\sqrt{3}}{2}, \frac{1}{\sqrt{2}}\right]$ be $\frac{m}{n}\pi^2$, where $\gcd(m,n)=1$. Then $m+n$ is equal to …….

Key: 65

Sol: $\frac{-\sqrt{3}}{2} \le x \le \frac{1}{\sqrt{2}}$

$$-\frac{\pi}{3} \le \sin^{-1}x \le \frac{\pi}{4}$$

$$-\frac{\pi}{3} - \frac{\pi}{4} \le \sin^{-1}x - \frac{\pi}{4} \le 0$$

$$-\frac{7\pi}{12} \le \sin^{-1}x - \frac{\pi}{4} \le 0$$

$$0 \le \left(\sin^{-1}x - \frac{\pi}{4}\right)^2 \le \frac{49\pi^2}{144}$$

$$\frac{\pi^2}{16} \le \left(\sin^{-1}x - \frac{\pi}{4}\right)^2 + \frac{\pi^2}{16} \le \frac{49\pi^2}{144} + \frac{\pi^2}{16}$$

$$\frac{\pi^2}{16} \le \left(\sin^{-1}x - \frac{\pi}{4}\right)^2 + \frac{\pi^2}{16} \le \frac{58\pi^2}{144}$$

$$\frac{\pi^2}{8} \le 2\left(\sin^{-1}x - \frac{\pi}{4}\right)^2 + \frac{\pi^2}{8} \le \frac{29\pi^2}{36}$$

PHYSICS **Max Marks: 100**

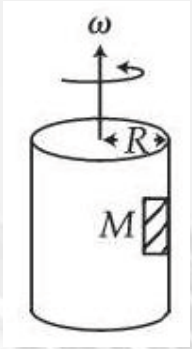
SECTION-I

(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.

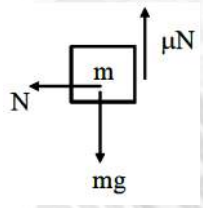
26. A large drum having radius R is spinning around its axis with angular velocity ω as shown in the figure. The minimum value of ω so that body of mass M remains stuck to the inner wall of the drum taking the coefficient of friction between drum surface and mass M as μ is



1) $\sqrt{\frac{g}{2\mu R}}$ 2) $\sqrt{\frac{2g}{\mu R}}$ 3) $\sqrt{\frac{g}{\mu R}}$ 4) $\sqrt{\frac{\mu g}{R}}$

Key: 3

Sol:

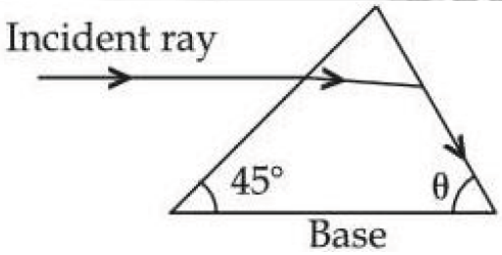


$N = M\omega^2 R$ and $Mg = \mu N$

$\mu \times M\omega^2 R = Mg$

$\omega = \sqrt{\frac{g}{\mu R}}$.

27. As shown in the diagram, when the incident ray is parallel to base of the prism the emergent ray grazes along the second surface.

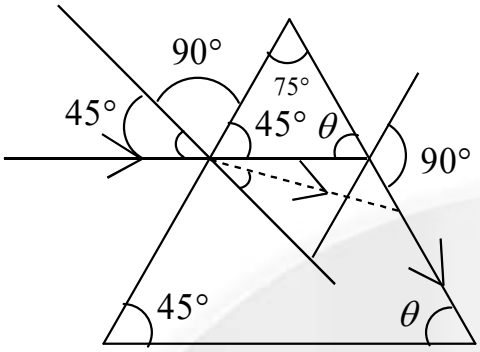


If refractive index of the material of prism is $\sqrt{2}$, the angle θ of prism is

1) 45° 2) 90° 3) 60° 4) 70°

Key: 3

Sol:



$\mu = \sqrt{2}$

$i_C = r_2 = 45°$

$r_1 = 30°$

$r_1 + r_2 = A = 75°$

$\therefore \theta = 180° - 75° - 45° = 60°$

28. Keeping significant figures in view physical quantities 52.01 m, 153.2 m and 0.123 m is

1) 205.33 m 2) 205.333 m 3) 205.3 m 4) 205 m

Key: 3

Sol: 52.01+153.2+0.123 = 205.333

29. The r.m.s. speed of oxygen molecules at $47°C$ is equal to that of hydrogen molecules kept at _____$°C$. (mass of oxygen molecule/mass of hydrogen molecule = 32/2)

1) -235 2) -20 3) -100 4) -253

Key: 4

Sol: $V_{rms} = \sqrt{\frac{3RT}{M}}$

$V_{rmsO_2} = V_{rmsH_2}$

$T_{O_2} = 273 + 47 = 320K$

$\sqrt{\frac{3RT_{O_2}}{M_{O_2}}} = \sqrt{\frac{3RT_{H_2}}{M_{H_2}}}$

$\frac{T_2}{M_{O_2}} = \frac{T_{H_2}}{M_{H_2}}$

$\frac{320}{32} = \frac{T_{H_2}}{2}$

$T_{H_2} = 20K$

$T_{H_2} = -253^0 C$

30. A capacitor C is first charged fully with potential difference of V_0 and disconnected from battery. The charged capacitor is connected across an inductor having inductance L. In t sec 25% of initial energy in the capacitor is transferred to inductor. The value of t is _____ sec.

1) $\frac{\pi\sqrt{LC}}{2}$ 2) $\pi\sqrt{\frac{LC}{2}}$ 3) $\frac{\pi\sqrt{LC}}{6}$ 4) $\frac{\pi\sqrt{LC}}{3}$

Key: 3

Sol: $U_{c_f} = 75\%U_{c_i}$

$Q_F^2 = \frac{3}{4}Q_I^2$

$Q_i \cos\omega t = \frac{\sqrt{3}}{2}Q_i \Rightarrow t = \frac{T}{12}$

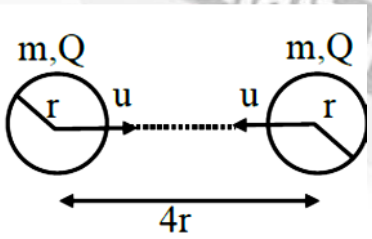
$t = \frac{\pi}{6}\sqrt{LC}$.

31. Consider two identical metallic spheres of radius R each having charge Q and mass m. Their centres have an initial separation of 4 R. Both spheres are given and initial speed u towards each other. The minimum value of u, so that they can just touch each other is (Take $k = \frac{1}{4\pi \in_0}$ and assume $kQ^2 > Gm^2$ where G is the gravitational constant)

1) $\sqrt{\frac{kQ^2}{2mR}\left(1-\frac{Gm^2}{kQ^2}\right)}$ 2) $\sqrt{\frac{kQ^2}{4mR}\left(1+\frac{Gm^2}{kQ^2}\right)}$ 3) $\sqrt{\frac{kQ^2}{4mR}\left(1-\frac{Gm^2}{kQ^2}\right)}$ 4) $\sqrt{\frac{kQ^2}{2mR}\left(1-\frac{Gm^2}{2kQ^2}\right)}$

Key: 3

Sol: Using energy conservation



$(2)\left(\frac{1}{2}mu^2\right) - \frac{Gm^2}{4r} + \frac{KQ^2}{4r} = -\frac{Gm^2}{2r} + \frac{KQ^2}{2r}$

$u = \sqrt{\frac{1}{4mr}\left(KQ^2 - Gm^2\right)}$

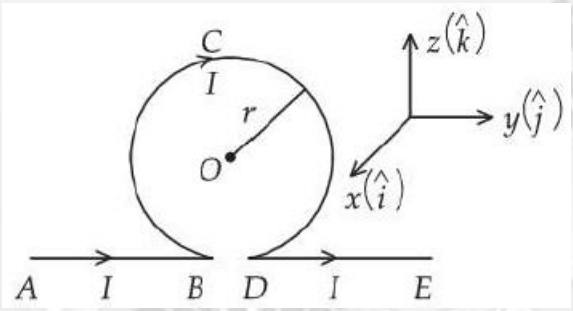
32. Two cars A and B each of mass $10^3\ kg$ are moving on parallel tracks separate by distance of 10 m, in same direction with speeds 72 km/h and 36 km/h. The magnitude of angular momentum of car A with respect to car B is _____ Js.

1) 2×10^5 2) 3.6×10^5 3) 10^5 4) 3×10^5

Key: 3

Sol: $L = m.V_{rel}r_{\perp} = 1000\times\left(36\times\frac{5}{18}\right)\times10 = 10^5$

33. An infinitely long straight wire carrying current I is bent in a planer shape as shown in the diagram. The radius of the circular part is r. The magnetic field at the centre O of the circular loop is

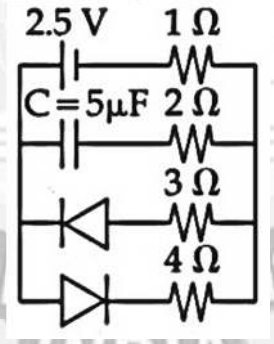


1) $\frac{\mu_0}{2\pi}\frac{I}{r}(\pi-1)\hat{i}$ 2) $-\frac{\mu_0}{2\pi}\frac{I}{r}(\pi-1)\hat{i}$ 3) $-\frac{\mu_0}{2\pi}\frac{I}{r}(\pi+1)\hat{i}$ 4) $\frac{\mu_0}{2\pi}\frac{I}{r}(\pi+1)\hat{i}$

Key: 2

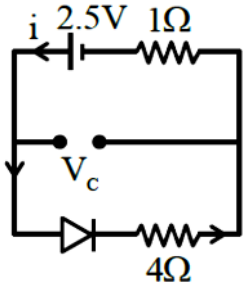
Sol: $B = -\frac{\mu_0 I}{2r}+\frac{\mu_0 I}{2\pi r} = -\frac{\mu_0}{2\pi}\frac{I}{r}(\pi-1)\hat{i}$.

34. The charge stored by the capacitor C in the given circuit in the steady state is _____ μC.



1) 7.5 2) 10 3) 12.5 4) 5

Key: 2



Sol: in steady state

$i = 2.5/5 = 0.5A$

$V_c = 4 \times 0.5$

$V_c = 2V$

Charge $Q = CV_C = 5 \times 2 = 10\mu C$

35. The kinetic energy of simple harmonic oscillator is oscillating with angular frequency of 176 rad/sec. The frequency of the simple harmonic oscillator is _____Hz. $(\pi = 22/7)$

1) 88 2) 176 3) 28 4) 14

Key: 4

$\omega = 176$

Sol: $f = \frac{\omega}{2} = \frac{176 \times 7}{4 \times 22} = 14$

36. A river of width 200m flowing from west to east with a speed 18 km/h. A boat moving with speed of 36 km/h in still water, is made to travel 1 round trip (bank to bank of the river). Minimum time taken by the boat for this journey and also displacement along the river bank are _____ and _____ respectively.

1) 40 s and 200 m 2) 40 s and 0 m 3) 40 s and 100 m 4) 20 s and 100 m

Key: 1

Sol: $t = \frac{400}{10} = 40s$

$x = 5 \times 40 = 200$.

37. A spherical body of radius r and density σ falls freely through a viscous liquid having density ρ and viscosity η and attains a terminal velocity v_0. Estimated maximum error in the quantity η is (ignore errors associated with σ, ρ *and* g, gravitational acceleration)

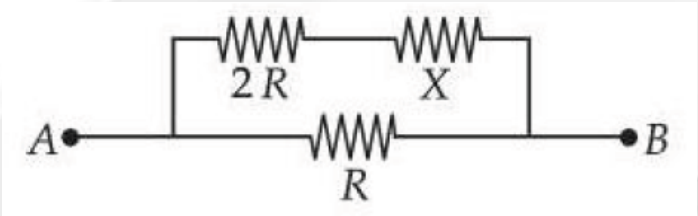
1) $2\left[\frac{\Delta r}{r} + \frac{\Delta V_0}{V_0}\right]$ 2) $2\left[\frac{\Delta r}{r} - \frac{\Delta V_0}{V_0}\right]$ 3) $2\frac{\Delta r}{r} - \frac{\Delta V_0}{V_0}$ 4) $\frac{2\Delta r}{r} + \frac{\Delta V_0}{V_0}$

Key: 4

Sol: $V_0 = \frac{2}{9}(\rho_s - \rho_l)\frac{r^2 g}{\eta}$ (Here v_0 is terminal velocity) $\Rightarrow \eta = \frac{2}{9}(\rho_s - \rho_l)\frac{r^2 g}{\eta}$

$\therefore \frac{\Delta\eta}{\eta} = \frac{2\Delta r}{r} + \frac{\Delta V_0}{V_0}$.

38. Two known resistance of $R\Omega$ and $2R\Omega$ and one unknown resistance $X\Omega$ are connected in a circuit as shown in the figure. If the equivalent resistance between points A and B in the circuit is $X\Omega$, then value of X is _____ Ω.



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

Key: 4

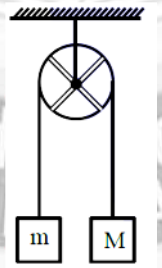
Sol: $\frac{(2R+x)R}{3R+x}$

$2R^2 + xR = 3Rx + x^2$

$x^2 + 2Rx - 2R^2 = 0$

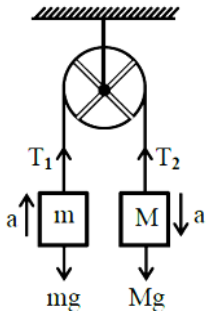
$x = \frac{-2R \pm \sqrt{4R^2 + 8R^2}}{2} = \frac{-2R \pm 2\sqrt{3}R}{2} = R\left(\sqrt{3}-1\right)$

39. The pulley shown in the figure is made using a thin rim and two rods of equal length to the diameter of rim. The rim and each rod have a mass of M. Two blocks of mass M *and* m are attached to two ends of a light string passing over the pulley, which is hinged to rotate freely in vertical plane about its center. The magnitudes of the acceleration experienced by the block is _____ (Assume no slipping of string on pulley)



1) $\frac{(M-m)g}{M+m}$ 2) $\frac{(M-m)g}{2M+m}$ 3) $\frac{(M-m)g}{\left[\left(\frac{13}{6}\right)M+m\right]}$ 4) $\frac{(M-m)g}{\left[\left(\frac{8}{3}\right)M+m\right]}$

Key: 4



Sol:

$Mg - T_2 = Ma.....(1)$

$T_1 - mg = ma.....(2)$

$(T_2 - T_1)r = I\frac{a}{r}.....(3)$

$(1)+(2)+(3)$

$(M-m)g = \left(M + m + \frac{I}{r^2}\right)a$

Here $I = Mr^2 + \frac{M \times (2r)^2}{12} \times 2$

On substituting I value in above equation we will get $\frac{(M-m)g}{\left[\left(\frac{8}{3}\right)M + m\right]}$

40. Given below are two statements:

Statement 1: In Young's double slit experiment, the angular separation of fringes will increase as the screen is moved away from the plane of the slits.

Statement II: In a Young's double slit experiment, the angular separation of fringes will increase when monochromatic source is replaced by another monochromatic source of higher wavelength.

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

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

Key: 2

Sol: $\theta = \frac{\lambda}{d}$.

41. A battery with EMF E and internal resistance r is connected across a resistance R. The power consumption in R will be maximum when:

1) $R=\sqrt{2}\,r$ 2) $R=r$ 3) $R=2r$ 4) $R=\frac{r}{2}$

Key: 2

Sol: Conceptual.

42. A body of mass 2 kg is moving along x direction such that its displacement as function of time is given by $x(t)=at^2+\beta t+\gamma m,$ where $\alpha=1m/s^2,\beta=1m/s$ *and* $\gamma=1m$. The work done on the body during the time interval $t=2s$ *to* $t=3s$, is _____ J.

1) 49 2) 12 3) 24 4) 42

Key: 3

Sol: $v=\frac{dx}{dt}=2t+1$

$a=2;F=ma$

$F=2\times2=4N$

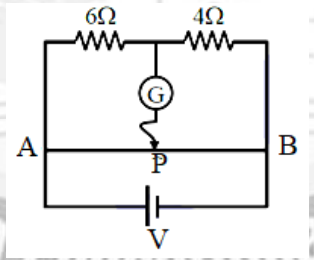
$X_{(t=2\text{sec})}=2^2+2+1=7$

$X_{(t=3\text{sec})}=3^2+3+1=13$

Displacement $=\Delta x=13-7=6$

Work done by force $=F\times x=4\times6=24J$.

43. The total length of potentiometer wire AB *is* $50cm$ in the arrangement as shown in the figure. If P is the point where the galvanometer shows Zero reading then length of AP is _____ cm.



1) 20 2) 15 3) 30 4) 25

Key: 3

Sol: $\frac{6}{4}=\frac{x}{50-x}$

$\frac{3}{2}=\frac{x}{50-x}$

$150-3x=2x$

$x = \frac{150}{5} = 30\,cm$.

44. Surface tension of two liquids (having same densities). T_1 *and* T_2 are measured using capillary rise method utilising two tubes of inner radius r_1 *and* r_2 where $r_1 > r_2$. The measure liquid heights in these tubes are h_1 *and* h_2 respectively. (ignore weight of liquid about the lowest point of meniscus). The heights h_1 *and* h_2 and surface tension T_1 *and* T_2 satisfy the relation.

1) $h_1 < h_2$ *and* $T_1 = T_2$ 2) $h_1 > h_2$ *and* $T_1 = T_2$

3) $h_1 = h_2$ *and* $T_1 = T_2$ 4) $h_1 > h_2$ *and* $T_1 < T_2$

Key: 1

Sol: $h \propto \frac{1}{r}$.

45. The energy of an electron in an orbit of Bohr's atom is $-0.04E_0\ eV$ where E_0 is the ground state energy. If L is the angular momentum of electron in this orbit and h is planks constant then $\frac{2\pi L}{h}$ is _____.

1) 2 2) 6 3) 5 4) 4

Key: 3

Sol: Angular momentum $L = \frac{nh}{2\pi}$

$n = \frac{2\pi L}{h}$

Energy $E = \frac{-13.6}{n^2}.z^2 = -0.04 \times \left(\frac{+13.6}{1}.z^2\right)$

$n^2 = 25$

$n = 5$

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. A diatomic gas $(\gamma = 1.4)$ does $100\,J$ of work when it is expanded isobarically. Then the heat given to the gas is _____ J.

Key: 350

Sol: $w = 100J = nR\Delta T$ for isobaric process .

$Q = nC_p\Delta T = \left(\frac{f}{2} + 1\right)nR\Delta T$

$\frac{7}{2}(100) = 350\,Joule$

47. A particle having electric charge $3\times10^{-19}C$ *and mass* $6\times10^{-27}kg$ is accelerated by applying an electric potential of $1.21V$. Wave length of the matter wave associated with the particle is $\alpha\times10^{-12}m$. The value of α is _____. (Take Planck's constant $= 6.6\times10^{-34}J.s$)

Key: 10

Sol: $\lambda = \frac{h}{\sqrt{2mqV}}$

$\lambda = \frac{6.6\times10^{-34}}{\sqrt{2\times18\times10^{-46}\times1.21}}$

$\lambda = 10^{-11}m = 10\times10^{-12}m$

$\alpha = 10$

48. The terminal velocity of a metallic ball of radius 6 mm in a viscous fluid 20 cm/s. The terminal velocity of another ball of same material and having radius 3mm in same fluid will be _____ cm/sec.

Key: 5

Sol: We know

Terminal velocity α (radius)^2

$\frac{(v_T)_1}{(v_T)_2} = \left(\frac{6}{3}\right)^2$

$(v_T)_2 = \frac{(v_T)_1}{4} = 5\,cm/\sec$

49. In a Young's double slit experiment setup, the two slits are kept 0.4 mm apart and screen is placed at 1m from slits. If a thin transparent sheet of thickness $20\,\mu m$ is introduced in front of one of the slits then center bright fringe shifts by 20 mm on the screen. The refractive index of transparent sheet is given by $\frac{\alpha}{10}$, where α is _____.

Key: 14

Sol: $\frac{Y}{D}.t = t(\mu-1)$

$\mu = \left(\frac{Yd}{Dt}+1\right) = \left(\frac{20\times10^{-3}\times4\times10^{-4}}{1\times20\times10^{-6}}\right)+1 = \frac{4}{10}+1 \Rightarrow \mu = \frac{14}{10}$

50. An electromagnetic wave of frequency 100 MHz propagates through a medium of conductivity, $\sigma = 10\,mho/m$. The ratio of maximum conduction current

density to maximum displacement current density is _____.

$$\left[Take \frac{1}{4\pi \in_0} = 9 \times 10^9 \, Nm^2 / C^2 \right]$$

Key: 1800

Sol: $i_c = A.\sigma E = A\sigma E_0 \sin(\omega t - kx)$

$$i_d = A\varepsilon_r \varepsilon_0 \frac{\partial E}{\partial t}$$

$$= A\varepsilon_r \varepsilon_0 E_0 \omega \cos(\omega t - kx)$$

$$= \frac{i_{c\max}}{i_{d\max}} = \frac{\sigma}{\varepsilon_r \varepsilon_0 \omega}$$

$$= \frac{10}{8.85 \times 10^{-12} \times 100 \times 10^6} = 1800.$$

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. Aqueous HCl reacts with $MnO_2(s)$ to form $MnCl_2(aq), Cl_2(g)$ and $H_2O(l)$. What is the weight (in g) of Cl_2 liberated when 8.7 g of $MnO_2(s)$ reacted with excess aqueous HCl solution? (Given Molar mass in $g\ mol^{-1}$ $Mn = 55, Cl = 35.5, O = 16, H = 1$)

1) 7.1 2) 17.1 3)14.2 4) 3.55

Key: 1

Sol: $\underset{0.1 moles}{MnO_2} + 4HCl \rightarrow \underset{0.1 moles}{MnCl_2} + Cl_2 + 2H_2O$ $\quad \frac{8.7}{87.}$ Excess $= 0.1$ mole

Wt. of Cl_2 obtained $= 0.1 \times 71 = 7.1\,g$

52. Consider the following data:

$\Delta_f H^{\ominus}$ (methane, g) $= -X\,kJ\,mol^{-1}$

Enthalpy of sublimation of graphite $= Y\,kJ\,mol^{-1}$

Dissociation enthalpy of $H_2 = Z\ kJ\,mol^{-1}$

The bond enthalpy of $C-H$ bond is given by

1) $\frac{X+Y+2Z}{4}$ 2) $\frac{X+Y+4Z}{2}$ 3) $X+Y+Z$ 4) $\frac{-X+Y+Z}{4}$

Key: 1

Sol: $C(s)+2H_2(g) \rightarrow CH_4(g)$

$-x = (\Delta H_{sub}$ of carbon$) + 2\times(\text{B.E. of H-H}) - 4\times(\text{B.E. of } C\text{-H})$

$-x = y + 2z - 4(\text{B.E. of C-H})$

$\text{B.E of C-H} = \frac{y+2z+x}{4}$

53. Consider the following spectral lines for atomic hydrogen:

A) First line of Paschen series B) Second line of Balmer series

C) Third line of Paschen series D) Fourth line of Bracket series

The correct arrangement of the above lines in ascending order of energy is:

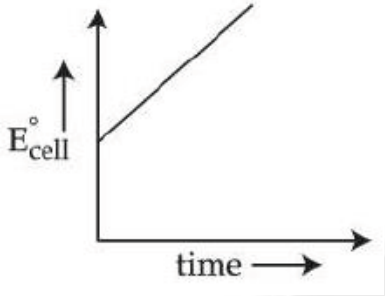
1) $D < A < C < B$ 2) $C < D < B < A$ 3) $A < B < C < D$ 4) $D < C < A < B$

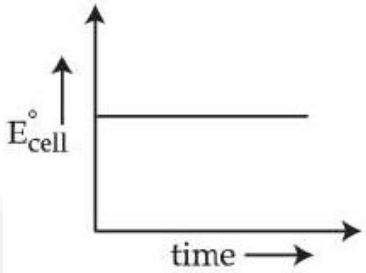
Key: 1

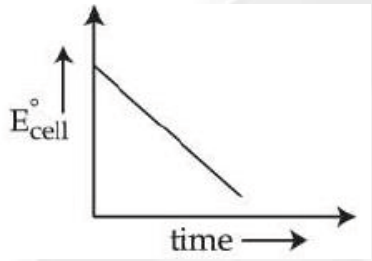
Sol: $\Delta E = 13.6Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

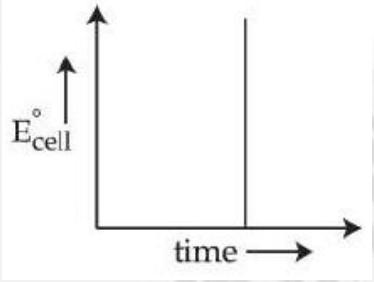
Series	n_1	n_2
1^{st} line of (Paschen)	3	4
2^{nd} line of (Balmer)	2	4
3^{rd} line of (Paschen)	3	6
4^{th} line of (Bracket)	4	8

54. For a closed circuit Daniell cell, which of the following plots is the accurate one at a given temperature ?

1) 

) 

3) 

4) 

Key: 2

Sol: E^0_{cell} remain constant with time

55. Decomposition of A is a first order reaction at T(K) and is given by $A(g) \rightarrow B(g)+C(g)$.

In a closed 1 L vessel, 1 bar A(g) is allowed to decompose at T(K). After 100 minutes, the total pressure was 1.5 bar. What is the rate constant $(in\ \text{min}^{-1})$ of the reaction ? $(\log 2 = 0.3)$

1) 6.9×10^{-4} 2) 6.9×10^{-3} 3) 6.9×10^{-1} 4) 6.9×10^{-2}

Key: 2

Sol: $A_g + B_g + C_g$

$1 \quad - \quad -$

$1-P \quad P \quad P$

$P_{total} = 1+P$

$1.5 = 1+P$

$P = 0.5$

$K = \frac{1}{100}\ln\frac{1}{0.5} = \frac{0.693}{100} = 6.9\times10^{-3}\ \text{min}^{-1}$

56. Given below are two statements

Statement –I: The correct order in terms of atomic/ ionic radii is $Al > Mg > Mg^{2+} > Al^{3+}$

Statement –II : The correct order in terms of the magnitude of electron gain enthalpy is $Cl > Br > S > O$. In the light of the above statements, choose the correct answer from the options given below:

1) Both statement I and II are correct. 2) Both statement I and II are false.

3) Statement I is correct and II is false. 4) Statement I is false and II is correct .

Key: 4

Sol: Correct order of size is $Mg > Al > Mg^{2+} > Al^{3+}$

Third period electron gain enthalpy will be more than second period.

57. Given below are two statements

Statement I : The correct order in terms of bond dissociation energy order is : $Cl_2 > Br_2 > F_2 > I_2$

Statement II: The correct trend in the covalent character of the metal halides is $[SnCl_4 > SnCl_2], [PbCl_4 > PbCl_2]$ *and* $[UF_4 > UF_6]$

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

1) Both statement I and II are true 2) Both statement I and II are false.

3) Statement I is true but Statement II is false. 4) Statement I is false but Statement II is true.

Key:3

Sol: Bond energy order is $Cl_2 > Br_2 > F_2 > I_2$

$[UF_4 < UF_6]$ due to more positive charge on U.

58. On heating a mixture of common salt and $K_2Cr_2O_7$ in equal amount along with concentrated H_2SO_4 in a test tube, a gas is evolved . Formula of the gas evolved and oxidation state of the central metal atom in the gas respectively are :

1) CrO_2Cl_2 and $+6$ 2) $Cr_2O_2Cl_2$ and $+6$ 3) $Cr_2O_2Cl_2$ and $+3$ 4) CrO_2Cl_2 and $+5$

Key: 1

Sol: Chromyl chloride test : Product is deep red vapours of CrO_2Cl_2 in which oxidation state of Cr is +6.

59. The correct increasing order of $C-H(A), C-O(B), C=O(C)$ & $C \equiv N(D)$ bonds in terms of covalent bond length is :

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

Key: 3

Sol: $C-H$ $107\ pm$

$C \equiv N$ $116\ pm$

$C \equiv O$ $143\ pm$

$C \equiv O$ $121\ pm$

Data based (From NCERT)

60. Given below are some of the statements about Mn and Mn_2O_7. Identify the correct statements.

A) Mn forms the oxide Mn_2O_7, in which Mn is in its highest oxidation state.

B) Oxygen stabilizes the Mn in higher oxidation states by forming multiple bonds with Mn.

C) Mn_2O_7 is an ionic oxide.

D) The structure of Mn_2O_7 consists of one bridged oxygen.

Choose the correct answer from the options given below :

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

Key:4

Sol: Mn higher oxidation state will be +7, Mn is form multiple bond with oxygen, Mn_2O_7 is 1 bridge bond.

61. Given below are two statements:

Statement I : Crystal field stabilization Energy (CFSE) of $\left[Cr(H_2O)_6\right]^{2+}$ is greater than that of $\left[Mn(H_2O)_6\right]^{2+}$

Statement II : Potassium ferricyanide has a greater spin – only magnetic moment than sodium ferrocyanide.

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

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

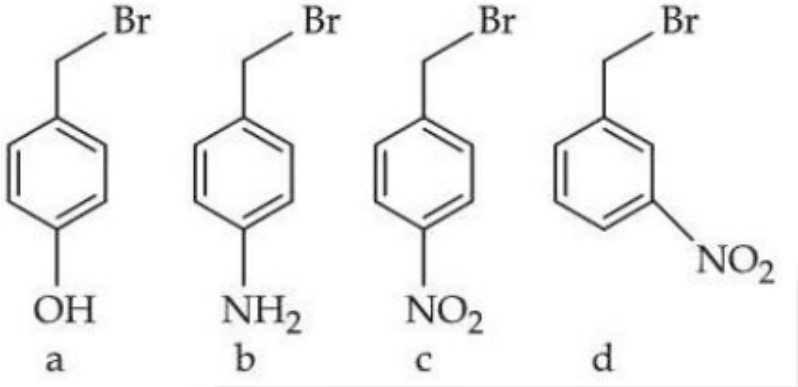
Key: 1

Sol: $\left[Mn(H_2O)_6\right]^{2+}$ is more stable than $\left[Cr(H_2O)_6\right]^{2+}$

For : $K_3\left[Fe(CN)_6\right], \mu = \sqrt{1(1+2)} = \sqrt{3}$ B.M

For $K_4\left[Fe(CN)_6\right], \mu = \sqrt{0}$B.M

62. The correct order of reactivity of the following benzyl halides towards reaction with KCN is:



1) a > b > c > d 2) b > a > c > d 3) a > b > d > c 4) b> a > d > c

Key: 4

Sol: This is S_N1 reaction.

Rate of S_N1 reaction α stability of carbocation

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

List-I (Reagent)		**List-II Reaction name (Involving aldehydes)**	
A	$H_2, Pd-BaSO_4$	I	Etard reaction
B	$SnCl_2, HCl$	II	Rosenmund reduction
C	CrO_2Cl_2, CS_2	III	Gattermann Koch reaction
D	$CO, HCl, Anhyd.AlCl_3$	IV	Stephen reaction

Choose the correct answer from the options given below

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

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

Key: 4

Sol: Based on NCERT data

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

List-I (Pair of Compounds)		**List-II (Type of Isomers)**	
A.	2-Methylpropene and but-1-ene	I	Stereoisomers
B.	Cis-but-2-ene and trans – but-2-ene	II	Position isomers
C.	2-Butanol and diethyl ether	III	Chain isomers
D.	But-1-ene and but-2-ene	IV	Functional isomers

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

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

Key: 1

Sol: 2-Methylpropene and but-1-ene → Chain isomers

Cis-but-2-ene and trans – but-2-ene $\rightarrow$Stereoisomers (Geometrical Isomers)

2-Butanol and diethyl ether $\rightarrow$ Functional isomers

But-1-ene and but-2-ene$\rightarrow$ Position isomers

65. The correct statements are:

A) Activation energy for enzyme catalysed hydrolysis of sucrose is lower than that of acid catalysed hydrolysis

B) During denaturation, secondary and tertiary structures of a protein are destroyed but primary structure remains intact.

C) Nucleotides are joined together by glycosidic linkage between C_1 *and* C_4 carbons of the pentose sugar

D) Quaternary structure of proteins represents overall folding of the polypeptide chain

Choose the correct answer from the options given below :

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

Key: 2

Sol: The activation energy (E_a) for enzyme – catalysed hydrolysis of sucrose (using sucrose) is significantly lower – approximately $2.15 kJ\ mol^{-1}$ compared to $6.22\ kJ\ mol^{-1}$ for acid catalysed hydrolysis.

The primary structure, which is the sequence of amino acids held together by strong covalent peptide bonds, remain intact.

66. The correct order of the rate of the reaction for the following reaction with respect to nuclophiles is: $CH_2Br + Nu^- \rightarrow CH_3Nu + Br^-$

1) $^-OH > PhO^- > CH_3COO^- > ClO_4^-$ 2) $PhO^- > ^-OH > CH_3COO^- > ClO_4^-$

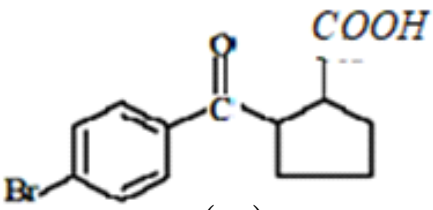
3) $ClO_4^- > CH_3COO^- > ^- OH > PhO^-$ 4) $CH_3COO^- > PhO^- > ^- OH > ClO_4^-$

Key: 1

Sol: Based on strength of nucleophile (More stable anion is less nucleophilc).

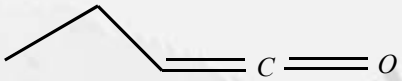
67. Given below are two statements:

Statement – I : Compound (X), shown below, dissolves in $NaHCO_3$ solution and has two chiral carbon atoms



(X)

Statement –II : Compound (Y), shown below, has two carbons with sp^3 hybridization, one carbon with sp^2 and one carbon with sp hybridization



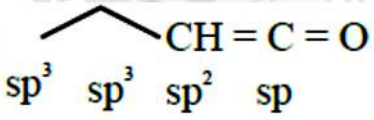
(Y)

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

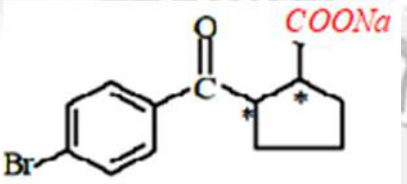
1) Statement I is false but Statement II is true
2) Statement I is true but Statement II is false
3) Both Statement I and Statement II are false
4) Both Statement I and Statement II are true

Key:3

Sol: Both Statements are correct



So there are $2sp^3, 1sp^2$ and 1 sp hybridised carbon in the given compound.



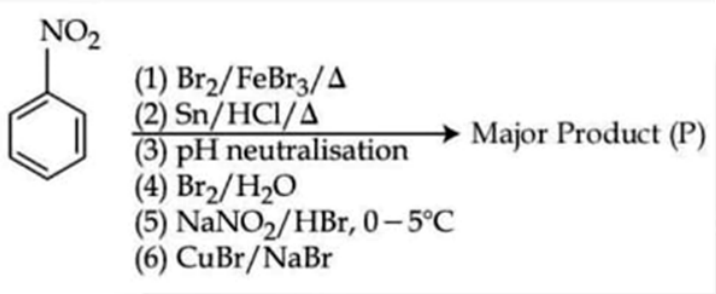
68. By usual analysis 1.00 g of compound (X) gave 1.79 g of magnesium pyrophosphate. The percentage of phosphorus in compound (X) is: (nearest integer) (Give molar mass in $g\ mol^{-1}; O = 16, Mg = 24, P = 31$)

1) 50 2) 20 3) 30 4) 40

Key: 1

Sol: % of $P = \frac{^{n}Mg_2P_2O_7 \times 2 \times 31}{W_{(\text{unknown compound})}} \times 100 = \frac{\left(\frac{1.79}{222}\right) \times 2 \times 31}{1} \times 100 = 50\ \%$

69.

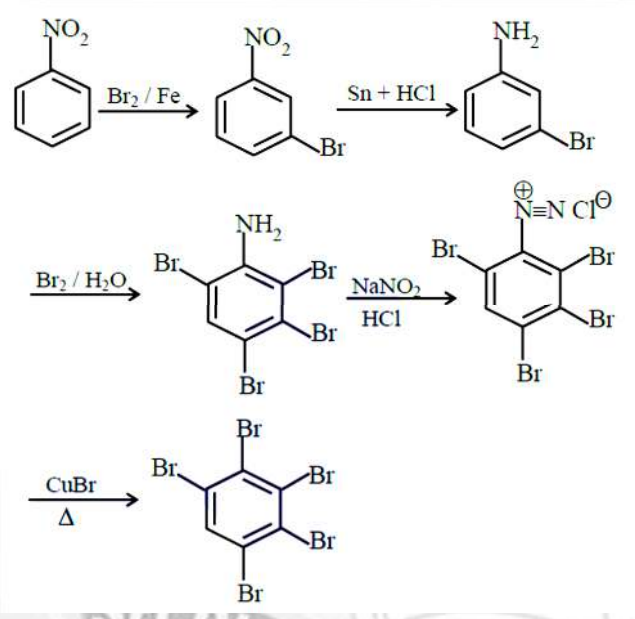


Consider the above sequence of reactions. The number of bromine atom(s) in final product (P) will be?

1) 5 2) 6 3) 3 4) 1

Key: 1

Sol:



Number of Br atom in major product (P) =5

70. Given below are four compounds:

a) n-propyl chloride b) iso-propyl chloride

c) sec-butyl chloride d) neo – pentyl chloride

Percentage of carbon in the one which exhibits optical isomerism is :

1) 46 2) 40 3) 52 4) 56

Key: 3

Sol: $C_4H_9Cl = \frac{48}{92.5} \times 100 = 51.89$

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. The osmotic pressure of a living cell is 12 atm at 300 K. The strength of sodium chloride solution that is isotonic with the living cell at this temperature is $\_ g\,L^{-1}$. (Nearest integer)

Given: $R = 0.08\,L\ atm\ K^{-1}\ mol^{-1}$

Assume complete dissociation of $NaCl$

(Given: Molar mass of Na & Cl are $23 \& 35.5\ g\ mol^{-1}$ respectively.)

Key: 15

Sol: $\pi = iCRT$

$$12 = 2 \times C \times 0.08 \times 300$$

$$C = \frac{1}{4}\text{mole/L}$$

$$Conc. = \frac{1}{4} \times 58.5\ g/L = 14.625\,g/L = 14.625 \times 10^{-2}\ g/L$$

72. The first and second ionization constants of H_2X are 2.5×10^{-8} and 1.0×10^{-13} respectively. The concentration of X^{2-} in $0.1\,M\ H_2X$ solution is $\_\_\_\_\_ \times 10^{-15} M$. (nearest integer)

Key: 100

Sol:

$$\underset{0.1-x}{H_2X} \rightleftharpoons \underset{x+y}{H^+} + \underset{x-y}{HX^-}$$

$$2.5 \times 10^{-8} = \frac{(x+y)(x-y)}{0.1-x}$$

$$\underset{x-y}{HX^-} \rightleftharpoons \underset{x+y}{H^+} + \underset{y}{X^{2-}}$$

$$1 \times 10^{-13} = \frac{(x+y)(y)}{x-y}$$

Approximate: $K_{a_1} >> K_{a_2} \Rightarrow$ So $x >> y$

$$x + y \approx x, x - y \approx x$$

$$10^{-13} = \frac{x.y}{x} \qquad y = 10^{-13}$$

$$\left[X^{2-}\right] = 10^{-13}$$

$$\left[X^{2-}\right] = 100 \times 10^{-15}$$

73. A substance "X" (1.5g) dissolved in 150 g of a solvent "Y" (molar mass = $300\ g\ mol^{-1}$) led to an elevation of the boiling point by 0.5 K. The relative lowering in the vapour pressure of the solvent "Y" is ___ $\times 10^{-2}$. (nearest integer) [Given: K_b of the solvent = $5.0K\ kg\ mol^{-1}$]

Assume the solution to be dilute and no association or dissociation of X takes place in solution.

Key: 3

Sol: $\Delta T_b = ik_b m \qquad 0.5 = 5 \times im$

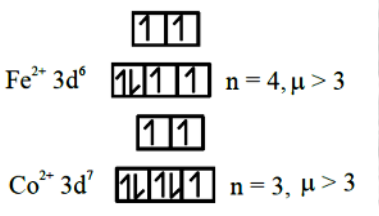
$$\frac{P_0 - P_s}{P_0} = \frac{im \times M_{solvent}}{1000} = 0.1 \times \frac{300}{1000} = 0.03 = 3 \times 10^{-2}$$

74. Identify the metal ions among Co^{2+}, Ni^{2+}, Fe^{2+}, V^{3+} and Ti^{2+} having a spin – only magnetic moment value more than 3.0 BM. The sum of unpaired electrons present in the high spin octahedral complexes formed by those metal ions is :

Key: 7

Sol: $V^{3+}\ 3d^3$, $Ti^{2+}\ 3d^2$, $Ni^{2+}\ 3d^8$, $Fe^{2+}\ 3d^6$, $Co^{2+}\ 3d^7$

Only Fe^{2+} and Co^{2+} can form high spin octahedral complex .



$\therefore$ Number of unpaired electrons = 4+3+7

75. MX is a sparingly soluble salt that follows the given solubility equilibrium at 298 K.

$$MX(s) \rightleftharpoons M^+(aq) + X^-(aq);\ K_{sp} = 10^{-10}$$

If the standard reduction potential for $W = -\int_{r_1}^{r_2} F.dr.$ is $\left(E^{\Theta}_{M^+/M}\right) = 0.79V$, then the value of the standard reduction potential for the metal / metal insoluble salt electrode $E^{\Theta}_{X^-/MX(s)/M}$ is _____ mV. (nearest integer)

(Given: $\frac{2.303RT}{F} = 0.059V$)

Key:200

Sol: $E^0_{Cl^-/AgCl/Ag} = E^0_{Ag^+/Ag} - \frac{0.059}{1}\log\frac{1}{K_{sp}} = 0.79 - 0.059 \times 1log10^{10} = 0.79 - 0.59$ =0.2 volt=200 millivolt.

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33 RANK

UJJWAL KESARI

Appl. No. 250310008860*

36 RANK

PRADISH GANDHI S

Appl. No. 250310788252*

39 RANK

S SAI RISHANTH REDDY

Appl. No. 250310585519

41 RANK

PRASANNA KS

Appl. No. 250310328957

43 RANK

KOLLIBOINA MUNI SAI

Appl. No. 250310488636

44 RANK

GORRE NITHIN REDDY

Appl. No. 250310551436

53 RANK

U RAMA CHARAN REDDY

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56 RANK

ARNAV NIGAM

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60 RANK

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61 RANK

SOHAN KALIDAS CHELEKAR

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64 RANK

BUDUMURU VIKRAM RAJA

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66 RANK

SHAGANTI THRISHUL

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70 RANK

LAXIBHARGAV MENDE

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D CHETAN RAO

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73 RANK

V PRAVAS REDDY

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75 RANK

P SAI SURYA KARTHIK

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76 RANK

YASH KUMAR

Appl. No. 250310204405*

81 RANK

P PRANAYA SAI MUKESH

Appl. No. 250310606114

89 RANK

ADITYA SINGH

Appl. No. 250310151728

91 RANK

JAY AGARWAL

Appl. No. 250310122371*

94 RANK

V ESWAR KARTHIK

Appl. No. 250310238425

96 RANK

SAKSHAM GARG

Appl. No. 250310026726*

97 RANK

RANVEER SINGH VIRDE

Appl. No. 250310790734

BELOW 100	31	BELOW 500	95	BELOW 10	10
BELOW 100	98	BELOW 1000	579	TOTAL QUALIFIED RANKS FOR JEE ADVANCED-2025	22,094

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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 GNANA RUTVIK SAI HT. No. 256056278	19 RANK VANGALA AJAY REDDY HT. No. 256131009	23 RANK AKSH GOGI HT. No. 252071075*	26 RANK P HEMA SAI SURYA KARTHIK HT. No. 256033006	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. 255058456*	64 RANK AARUSH ANAND HT. No. 251006176*	72 RANK RUSHMITH BANDARI HT. No. 256188048	78 RANK KORIKANA RASAGNYA HT. No. 256057046	87 RANK LAKSHYA SHARMA HT. No. 252070079*	91 RANK AVANEESH BANSAL HT. No. 251113138*	95 RANK KAVYA AGGARWAL HT. No. 252078121*

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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