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5 STUDENTS IN TOP 10 IN JEE-ADVANCED 2024 OPEN CATEGORY

AIR	Name	Ht. No.
1	RAGHAV SHARMA	242053073*
4	RHYTHM KEDIA	247025176*
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6	RAJDEEP MISHRA	241016176*
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HIGHLIGHTS

- BELOW 100 ALL INDIA OPEN CATEGORY RANKS: **30**
- BELOW 500 ALL INDIA OPEN CATEGORY RANKS: **122**
- BELOW 1000 ALL INDIA OPEN CATEGORY RANKS: **203**
- BELOW 100 ALL INDIA CATEGORY RANKS COUNT: **146**
- BELOW 1000 ALL INDIA CATEGORY RANKS COUNT: **721**
- NUMBER OF QUALIFIED RANKS: **4187+**

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JEE MAIN (JAN) 2025 - SHIFT 2

22-01-2025

Sri Chaitanya IIT Academy., India.

A.P, TELANGANA, KARNATAKA, TAMILNADU, MAHARASHTRA, DELHI, RANCHI

A right Choice for the Real Aspirant

ICON Central Office – Madhapur – Hyderabad

2025_Jee-Main_22-Jan-2025_Shift-02

MATHEMATICS **Max Marks: 100**

(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.

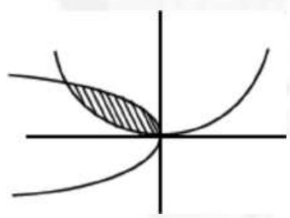
1. The area of the region enclosed by the curves $y = x^2 - 4x + 4$ and $y^2 = 16 - 8x$ is :

1) $\frac{8}{3}$ 2) 8 3) 5 4) $\frac{4}{3}$

Key: 1

Sol : $y = (x-2)^2, y^2 = -8(x-2)$

$y = x^2, y^2 = -8x$ $= \frac{16ab}{3} = \frac{16 \times \frac{1}{4} \times 2}{3} = \frac{8}{3}$



2. Let $f(x) = \int_0^{x^2} \frac{t^2 - 8t + 15}{e^t} dt, x \in R$. Then the numbers of local maximum and local minimum points of f, respectively, are :

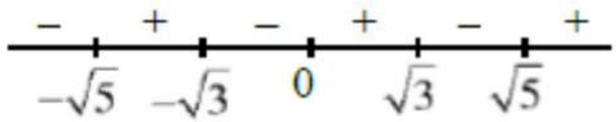
1) 3 and 2 2) 1 and 3 3) 2 and 2 4) 2 and 3

Key: 4

Sol : By using Newtons – Leibnitz Theorem

$f^1(x) = \left(\frac{x^4 - 8x^2 + 15}{e^{x^2}}\right)(2x) - 0$ $= \frac{(x^2-3)(x^2-5)(2x)}{e^{x2}}$

$= \frac{(x-\sqrt{3})(x+\sqrt{3})(x-\sqrt{5})(x+\sqrt{5})(2x)}{e^{x^2}}$



$\therefore$ Maxima at $x \in \{-\sqrt{3}, \sqrt{3}\}$

Minima at $x \in \{-\sqrt{5}, 0, \sqrt{5}\}$

$\therefore$ 2 points of Maxima and 3 points of Minima.

3. Let $A = \{1,2,3,4\}$ and $B = \{1,4,9,16\}$. Then the number of many-one functions $f : A \to B$ such that $1 \in f(A)$ is equal to :

1) 151 2) 127 3) 139 4) 163

KEY : 1

Sol : Total = 4^4

One –one = 4!

Many-one = 256-24=232

Many-one which $1 \notin f(A)$ = 3.3.3.3 = 81 232 – 81 = 151

4. Let α_θ and β_θ be the distinct roots of $2x^2 + (\cos\theta)x - 1 = 0, \theta \in (0, 2\pi)$. If m and M are the minimum and the maximum values of $\alpha_\theta^4 + \beta_\theta^4$, then 16(M+m) equals:

1) 17 2) 25 3) 27 4) 24

KEY : 2

Sol : $\alpha^4 + \beta^4 = (\alpha^2 + \beta^2)^2 - 2\alpha^2\beta^2$

$(\alpha^2 + \beta^2)^2 - 2\alpha^2\beta^2$

$\left[(\alpha+\beta)^2 - 2\alpha\beta\right]^2 - 2(\alpha\beta)^2$ $\therefore\ \alpha + \beta = \frac{-\cos\theta}{2},\ \alpha\beta = \frac{-1}{2}$

$\left[\frac{\cos^2\theta}{4} + 1\right] - 2.\frac{1}{4}$ $\left(\frac{\cos^2\theta}{4} + 1\right)^2 - \frac{1}{2}$

$M = \frac{25}{16} - \frac{1}{2} = \frac{17}{16}$ $\left[\because\ 0 \le \cos^2\theta \le 1\right]$

$m = \frac{1}{2}, 16(M+m) = 25$

5. The sum of all values of $\theta \in [0, 2\pi]$ satisfying $2\sin^2\theta = \cos 2\theta$ and $2\cos^2\theta = 3\sin\theta$ is

1) $\frac{\pi}{2}$ 2) 4π 3) π 4) $\frac{5\pi}{6}$

KEY : 3

Sol : $2\sin^2\theta = \cos 2\theta$

$2\sin^2\theta = 1 - 2\sin^2\theta$

$4\sin^2\theta = 1$

$\sin^2\theta = \frac{1}{4}$

$\sin\theta = \pm\frac{1}{2}$

$2\cos^2\theta = 3\sin\theta$

$2 - 2\sin^2\theta = 3\sin\theta$

$2\sin^2\theta + 3\sin\theta - 2 = 0$

$2\sin^2\theta + 4\sin\theta - \sin\theta - 2 = 0$

$2\sin\theta(\sin\theta + 2) - 1(\sin\theta + 2) = 0$

$\sin\theta = \frac{1}{2} \ \& \ \sin\theta \neq -2$

So common equation satisfy both eq's is $\sin\theta = \frac{1}{2}$

$\therefore \theta = \frac{\pi}{6}, \frac{5\pi}{6}, \therefore \theta \in [0, 2\pi]$ $\therefore sum = \frac{\pi}{6} + \frac{5\pi}{6} = \frac{6\pi}{6} = \pi$.

6. In a group of 3 girls and 4 boys, there are two boys B_1 and B_2. The number of ways, in which these girls and boys can stand in a queue such that all the girls stand together, all the boys stand together, but B_1 and B_2 are not adjacent to each other, is :

1) 72 2) 144 3) 96 4) 120

KEY : 2

Sol : Total – when B_1 and B_2 are together

= 2!(3! 4!) – 2! (3!(3! 2!)) = 144

7. If the system of linear equations : $x + y + 2z = 6$, $2x + 3y + az = a + 1$, $-x - 3y + bz = 2b$, where $a, b \in R$, has infinitely many solutions, then 7a + 3b is equal to :

1) 22 2) 9 3) 16 4) 12

KEY : 3

Sol : $\Delta = \begin{vmatrix} 1 & 1 & 2 \\ 2 & 3 & a \\ -1 & -3 & b \end{vmatrix} = 0$

$\Rightarrow 1[3b+3a]-1[2b+a]+2[-6+3]=0$

$\Rightarrow 3a+3b-2b-a-6=0$

$2a+b=6$...........(1)

Similarly $\Delta_3=0 \Rightarrow \begin{vmatrix} 1 & 1 & 6 \\ 2 & 3 & a+1 \\ -1 & -3 & 2b \end{vmatrix}=0$

$\Rightarrow 1[6b+3(a+1)]-1[4b+a+1]+6[-6+3]=0$

$\Rightarrow 6b+3a+3-4b-a-1-18=0$

$2b+2a-16=0 \Rightarrow a+b-8=0$..........(2)

Solve (1) - (2)

$2a+b=6$
$a+b=8$

$a=-2$

Is substitute in equation (2) b = 10

$\therefore 7a+3b=7(-2)+3(10)=-14+30=16$

8. Let $P(4,4\sqrt{3})$ be a point on the parabola $y^2=4ax$ and PQ be a focal chord of the parabola. If M and N are the foot of perpendiculars drawn from P and Q respectively on the directrix of the parabola, then the area of the quadrilateral PQMN is equal to :

1) $\frac{34\sqrt{3}}{3}$ 2) $17\sqrt{3}$ 3) $\frac{343\sqrt{3}}{8}$ 4) $\frac{263\sqrt{3}}{8}$

KEY : 3

Sol : $(4,4\sqrt{3})$

Lies on $y^2=4ax \quad \Rightarrow 48=4a.4$

$a=3$

$\Rightarrow y^2=12x$ is equation of parabola

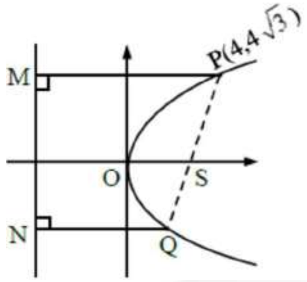
Now the parameter point $P(t_1)=\frac{2}{\sqrt{3}} \Rightarrow$ parameters of Q $\therefore t_2=\frac{-\sqrt{3}}{2}$

Then the point $Q\left(\frac{9}{4},-3\sqrt{3}\right)$

$\therefore$ the area of quadrilateral (trapezium) PQNM

$=\frac{1}{2}MN(PM+QN) \quad =\frac{1}{2}MN(PS+QS)$

$=\frac{1}{2}MN(PQ) \quad =\frac{1}{2}\times 7\sqrt{3}\times\frac{49}{4} \quad =\frac{(343)\sqrt{3}}{8}S.U$



$\because\ 2at_1=4\sqrt{3}\Rightarrow t_1=\frac{2}{\sqrt{3}}\ \therefore\ \frac{SP}{PM}=1\Rightarrow SP=PM \quad \frac{SQ}{QN}=1\Rightarrow SQ=QN$

9. If $\lim_{x\to\infty}\left(\left(\frac{e}{1-e}\right)\left(\frac{1}{e}-\frac{x}{1+x}\right)\right)^x=\alpha$, then the value of $\frac{\log_e\alpha}{1+\log_e\alpha}$ equals :

1) e^2 2) e^{-2} 3) e 4) e^{-1}

KEY : 3

Sol :Given $\propto = lt_{x\to\infty}\left[\left(\frac{e}{1-e}\right)\left(\frac{1}{e}-\frac{x}{1+x}\right)\right]^x$

$\therefore \propto = e^{Limit}=e^L$

Where $L=lt_{x\to\infty}x\left[\left(\frac{e}{1-e}\right)\left(\frac{1}{e}-\frac{x}{1+x}\right)-1\right]$

$L=Lt_{x\to\infty}x\left[\left(\frac{e}{1-e}\right)\left(\frac{1}{e}-\frac{x}{1+x}-\left(\frac{1-e}{e}\right)\right)\right]$

$L=\left(\frac{e}{1-e}\right)\left[lt_{x\to\infty}x\left(1-\frac{x}{1+x}\right)\right]$

$=\left(\frac{e}{1-e}\right)lt_{x\to\infty}x\left(\frac{1+x-x}{1+x}\right)$

$=\left(\frac{e}{1-e}\right)lt_{x\to\infty}x\left(\frac{1}{1+x}\right)=\left(\frac{e}{1-e}\right)(1)$

$\therefore \alpha=e^L=e^{\left(\frac{e}{1-e}\right)}\Rightarrow \log\propto\alpha=\left(\frac{e}{1-e}\right)(1)=\frac{e}{1-e}\alpha$

$\therefore$ The Req value $=\frac{\log_e\alpha}{1+\log_e\alpha}=\frac{\frac{e}{1-e}}{1+\frac{e}{1-e}}=\frac{e}{1}=e$

10. For a 3×3 matrix M, let trace (M) denote the sum of all the diagonal elements of M. Let A be a 3×3 matrix such that $|A|=\frac{1}{2}$ and trace (A) = 3. If $B=adj\left(adj\left(2A\right)\right)$, then the value of $|B|+trace\ \left(B\right)$ equals:

1) 280 2) 132 3) 174 4) 56

KEY : 1

Sol : $|A|=\frac{1}{2}$, trace(A) = 3, $B=adj\left(adj\left(2A\right)\right)=|2A|^{n-2}\left(2A\right)$

$n=3, B=|2A|\left(2A\right)=2^3.|A|\left(2A\right)=8A$

$|B|=|8A|=8^3.|A|=2^8=256$

trace(B) = 8 trace(A) = 24

$|B|+trace\left(B\right)=280$

11. If $x=f\left(y\right)$ is the solution of the differential equation

$\left(1+y^2\right)+\left(x-2e^{\tan-1}y\right)\frac{dy}{dx}=0, y\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ with $f\left(0\right)=1$, then $f\left(\frac{1}{\sqrt{3}}\right)$ is equal to :

1) $e^{\pi/3}$ 2) $e^{\pi/6}$ 3) $e^{\pi/4}$ 4) $e^{\pi/12}$

KEY : 2

Sol : $\frac{dx}{dy}+\frac{x}{1+y^2}=\frac{2e^{\tan-1y}}{1+y^2}$

$I.F.=e^{\tan^{-1}y}$

$xe^{\tan^{-1}y}=\int\frac{2\left(e^{\tan^{-1}y}\right)^2dy}{1+y^2}$

Put $\tan^{-1}y=t,\frac{dy}{1+y^2}=dt$

$xe^{\tan^{-1}y}=\int 2e^{2t}dt$

$xe^{\tan^{-1}y}=e^{2\tan-1}y+c$

$x=e^{\tan^{-}y}+ce^{-\tan^{-1}y}$

$\because\ y=0, x=1$

$1=1+c\Rightarrow c=0$

$y=\frac{1}{\sqrt{3}}, x=e^{\pi/6}$

12. Let the curve $z(1+i)+\bar{z}(1-i)=4, z\in C$, divide the region $|z-3|\le 1$ into two parts of areas α and β. Then $|\alpha-\beta|$ equals :

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

KEY : 3

Sol : Let $z=x+iy$

$z(1+i)+\bar{z}(1-i)=4, z\in c$

$(x+iy)(1+i)+(x-iy)(1-i)=4$

$x+xi+iy-y+x-xi-iy-y=4$

$2x-2y=4 \Rightarrow x-y=2---(1)$

And $|z-3|\le 1$

$|x+iy-3|\le 1$

$\Rightarrow (x-3)^2+y^2\le 1$

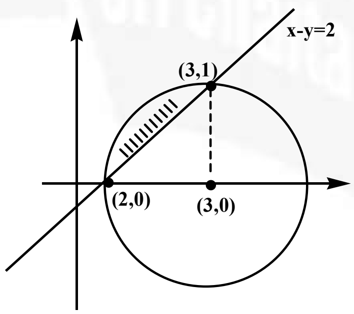
$\therefore$ Area of shaded region $\alpha=\frac{\pi.1^2}{4}-\frac{1}{2}.1.1=\frac{\pi}{4}-\frac{1}{2}$

Area of unshaded region inside the circle

$\beta=\frac{3\pi}{4}.1^2+\frac{1}{2}.1.1=\frac{3\pi}{4}+\frac{1}{2}$

$\therefore$ difference of area $A=|\alpha-\beta|=\left|\left(\frac{3\pi}{4}+\frac{1}{2}\right)-\left(\frac{\pi}{4}-\frac{1}{2}\right)\right|$

$A=\frac{\pi}{2}+1$



13. If $\int e^x\left(\frac{x\sin^{-1}x}{\sqrt{1-x^2}}+\frac{\sin^{-1}x}{\left(1-x^2\right)^{3/2}}+\frac{x}{1-x^2}\right)dx=g(x)+C$, where C is the constant of integration, then $g\left(\frac{1}{2}\right)$ equals :

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

KEY : 1

Sol : $\because \frac{d}{dx}\left(\frac{x\sin^{-1}x}{\sqrt{1-x^2}}\right)=\frac{\sin^{-1}x}{\left(1-x^2\right)^{3/2}}+\frac{x}{1-x^2}$

$\Rightarrow \int e^x\left(\frac{x\sin^{-1}x}{\sqrt{1-x^2}}+\frac{\sin^{-1}x}{\left(1-x^2\right)^{3/2}}+\frac{x}{1-x^2}\right)dx$

$=e^x.\frac{x\sin^{-1}x}{\sqrt{1-x^2}}+c=g(x)+C$

Note : assuming $g(x)=\frac{xe^x\sin^{-1}x}{\sqrt{1-x^2}}$

$g(1/2)=\frac{e^{1/2}}{2}.\frac{\frac{\pi}{6}\times 2}{\sqrt{3}}=\frac{\pi}{6}\sqrt{\frac{e}{3}}$

14. Let $\vec{a}$ and $\vec{b}$ be two unit vectors such that the angle between them is $\frac{\pi}{3}$. If $\lambda\vec{a}+2\vec{b}$ and $3\vec{a}-\lambda\vec{b}$ are perpendicular to each other, then the number of values of λ in $[-1,3]$ is :

1) 2 2) 3 3) 1 4) 0

KEY : 4

Sol : $\cos\theta=\frac{\bar{a}.\bar{b}}{|\bar{a}||\bar{b}|}$, $\because |\bar{a}|=|\bar{b}|=1$ & $(\bar{a},\bar{b})=\frac{\pi}{3}$ $\bar{a}.\bar{b}=\frac{1}{2}$

Now $\left(\lambda\bar{a}+2\bar{b}\right).\left(3\bar{a}-\lambda\bar{b}\right)=0$

$3\lambda\bar{a}.\bar{a}-\lambda^2\bar{a}.\bar{b}+6\bar{a}.\bar{b}-2\lambda\bar{b}.\bar{b}=0$

$3\lambda-\frac{\lambda^2}{2}+3-2\lambda=0$ $\lambda^2-2\lambda-6=0$

$\lambda=1\pm\sqrt{7}$ $\Rightarrow$ number of values = 0

15. Let a line pass through two distinct points P(-2, -1, 3) and Q, and be parallel to the vector $3\hat{i}+2\hat{j}+2\hat{k}$. If the distance to the point Q from the point R(1, 3,3) is 5, then the square of the area of ΔPQR is equal to :

1) 140 2) 136 3) 144 4) 148

KEY : 2

Sol : $\therefore \overline{PQ}$ Parallel to $\overline{3i}+\overline{2j}+\overline{2k}$

R (1,3,3)

P (-2,-1,-3)

$\therefore Q(3\lambda-2, 2\lambda-1, 2\lambda+3)$

But $|\overline{QR}|=5$

$\Rightarrow \sqrt{(3\lambda-3)^2+(2\lambda-4)^2+(2\lambda)^2}=5$

$\Rightarrow 9\lambda^2+9-18\lambda+4\lambda^2+16-16\lambda+4\lambda^2=25$

$\Rightarrow 17\lambda^2-34\lambda=0 \Rightarrow 17\lambda(\lambda-2)=0$

$\therefore \lambda \neq 0 \; Then \; \lambda=2$

$\therefore The\, are\; P(-2,-1,3), Q(4,3,7), R(1,3,3)$

$\therefore Area\, of\, \triangle PQR=[PQR]=\frac{1}{2}|\overline{PQ\times PR}|$

$$\Delta=\frac{1}{2}\begin{vmatrix} i & j & k \\ 6 & 4 & 4 \\ 3 & 4 & 0 \end{vmatrix}=\begin{vmatrix} i & j & k \\ 3 & 2 & 2 \\ 3 & 4 & 0 \end{vmatrix}$$

$\Delta=\bar{i}[0-8]-\bar{j}[0-6]+\bar{k}[12-6]$ $=|8i+6j+6k|$

$\therefore \Delta=\sqrt{64+36+36}=\sqrt{136}$ $\therefore \Delta^2=136$

16. Let α,β,γ and δ be the coefficients of x^7, x^5, x^3 and x respectively in the expansion of $\left(x+\sqrt{x^3-1}\right)^5+\left(x-\sqrt{x^3-1}\right)^5, x>1$. If u and v satisfy the equations $\alpha u+\beta v=18, \gamma u+\delta v=20$, then u + v equals:

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

KEY : 2

Sol : $\left(x+\sqrt{x^3-1}\right)^5+\left(x-\sqrt{x^3-1}\right)^5$

$= 2\left\{ {}^5C_0.x^5 + {}^5C_2.x^3\left(x^3-1\right) + {}^5C_4.x\left(x^3-1\right)^2 \right\}$

$= 2\left\{5x^7 + 10x^6 + x^5 - 10x^4 - 10x^3 + 5x\right\}$

$\alpha = coeff\ \ of\ \ x^7 = 10$

$\beta = coeff\ \ of\ \ x^5 = 2$

$\gamma = coeff\ \ of\ \ x^3 = -20$

$\delta = coeff\ \ of\ \ x = 10$

10u +2v =18

-20u +10v = 20

$\Rightarrow u = 1, v = 4$

$\therefore$ u + v =5

17. Let $E : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b$ and $H : \frac{x^2}{A^2} - \frac{y^2}{B^2} = 1$. Let the distance between the foci of E and the foci of H be $2\sqrt{3}$. If a–A=2, and the ratio of the eccentricities of E and H is $\frac{1}{3}$, then the sum of the lengths of their latus rectums is equal to

1) 10 2) 8 3) 9 4) 7

KEY : 2

Sol : Given $E : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, (a>b), foci are $s\left(ae, 0\right) \& s'\left(-ae, 0\right)$

Similarly $H : \frac{x^2}{A^2} - \frac{y^2}{B^2} = 1$, foci are $s\left(Ae', 0\right) \& s'\left(-Ae', 0\right)$

$\Rightarrow 2ae = 2\sqrt{3}\ \ \&\ \ 2Ae' = 2\sqrt{3}$

$ae = \sqrt{3}......(1)\ \&\ \ \ Ae^1 = \sqrt{3}......(2)$

$ae = Ae' \qquad \Rightarrow \frac{e}{e^1} = \frac{A}{a}$

but $\frac{e}{e^1} = \frac{1}{3} \qquad \frac{1}{3} = \frac{A}{a} \Rightarrow a = 3A.......(3)$

$\because\ \ a - A = 2\ \ (\text{given})\ \ a = \frac{a}{3} = 2 \Rightarrow \frac{3a-a}{3} = 2 \Rightarrow \frac{2a}{3} = 2 \Rightarrow a = 3$

$\therefore\ \ 3 - 2 = A \Rightarrow A = 1\ \ \because\ \ Ae' = \sqrt{3} \Rightarrow 1.e' = \sqrt{3} \Rightarrow e' = \sqrt{3}$

$b^2 = a^2\left(1-e^2\right) \qquad b^2 = 9\left[1 - \frac{1}{3}\right] \qquad b^2 = 9\left[\frac{2}{3}\right] = 6$

Also $B^2 = A^2\left[(e')^2 - 1\right] = B^2 = 2$

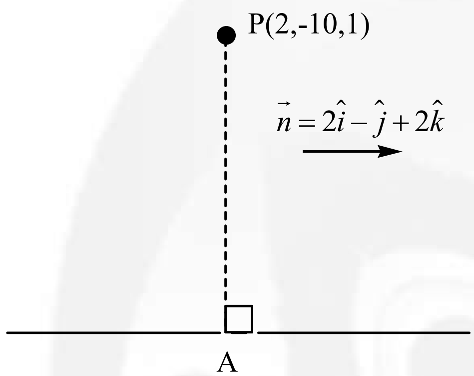
Sum of LR $LR = \frac{2b^2}{a} + \frac{2B^2}{A} = 4 + 4 = 8$

18. The perpendicular distance, of the line $\frac{x-1}{2} = \frac{y+2}{-1} = \frac{z+3}{2}$ from the point P(2, -10, 1), is :

1) $5\sqrt{2}$ 2) 6 3) $4\sqrt{3}$ 4) $3\sqrt{5}$

KEY : 4

Sol :



$\frac{x-1}{2} = \frac{y+2}{-1} = \frac{z+3}{2} = \lambda$

$\frac{x-1}{2} = \lambda$, $y+2 = -\lambda$, $z = 2\lambda - 3$

$x = 1 + 2\lambda$ $y = -2 - \lambda$

$\overline{PA}.\bar{n} = 0 \Rightarrow 2(2\lambda - 1) + (-1)(8 - \lambda) + 2(2\lambda - 4) = 0$

$\Rightarrow 4\lambda - 2 - 8 + \lambda + 4\lambda - 8 = 0 \Rightarrow 9\lambda = 18$

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

$\therefore Point\ A(5, -4, 1)$

$\therefore PA = \sqrt{3^2 + 6^2 + 0} = \sqrt{9 + 36} = \sqrt{45} = 3\sqrt{5}$

19. If A and B are two events such that $P(A \cap B) = 0.1$, and $P(A|B)$ and $P(B|A)$ are the roots of the equation $12x^2 - 7x + 1 = 0$, then the value of $\frac{P(\bar{A} \cup \bar{B})}{P(\bar{A} \cap \bar{B})}$ is :

1) $\frac{9}{4}$ 2) $\frac{4}{3}$ 3) $\frac{5}{3}$ 4) $\frac{7}{4}$

KEY : 1

Sol : $12x^2 - 7x + 1 = 0$

$x=\frac{1}{3},\frac{1}{4}$

Let $P\left(\frac{A}{B}\right)=\frac{1}{3}$ & $P\left(\frac{B}{A}\right)=\frac{1}{4}$

$\frac{P(A\cap B)}{P(B)}=\frac{1}{3}$ & $\frac{P(A\cap B)}{P(A)}=\frac{1}{4}$ $\Rightarrow P(B)=0.3$ & $P(A)=0.4$

$P(A\cup B)=P(A)+P(B)-P(A\cap B)$ $=0.3+0.4-0.1=0.6$

Now $\frac{P(\bar{A}\cup\bar{B})}{P(\bar{A}\cap\bar{B})}=\frac{P(\overline{A\cap B})}{P(\overline{A\cup B})}=\frac{1-P(A\cap B)}{1-P(A\cup B)}=\frac{1-0.1}{1-0.6}=\frac{9}{4}$

20. Suppose that the number of terms in an A.P. is $2k, k\in N$. If the sum of all odd terms of the A.P. is 40, the sum of all even terms is 55 and the last term of the A.P. exceeds the first term by 27, then k is equal to

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

KEY : 4

Sol : Given $a_1, a_2, a_3........a_{2k}$ are in A.P

But $\sum_{r=1}^{k} a_{2r-1}=40, \sum_{r=1}^{k} a_{2r}=55$

But $a_{2k}-a_1=27$

$a_1=a_{2r}-27$ $\therefore \frac{K}{2}\left[2a_1+(k-1)2d\right]=40$ & $\therefore \frac{K}{2}\left[2a_2+(k-1)2d\right]=55$

$$\frac{k\left[a_1+(k-1)d\right]}{\frac{k}{2}\left[2a_2+(k-1)2d\right]}=\frac{40}{55}$$

$\frac{\left[a_1+(k-1)d\right]}{\left[a_2+(k-1)2d\right]}=\frac{8}{11}\Rightarrow d=\frac{27}{2k-1}$ $\therefore a_1=\frac{40}{k}-(k-1)d=\frac{55}{k}-kd$

$d=\frac{15}{k}\Rightarrow\frac{27}{2k-1}\times\frac{15}{k}\Rightarrow ak=5(2k-1)$ $\therefore k=5$

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..

21. Let $y=f(x)$ be the solution of the differential equation $\frac{dy}{dx}+\frac{xy}{x^2-1}=\frac{x^6+4x}{\sqrt{1-x^2}},-1<x<1$ such that $f(0)=0$. If $6\int_{-1/2}^{1/2} f(x)dx=2\pi-\alpha$ then α^2 is equal to ______.

KEY : 27

Sol : I.F $e^{\frac{-1}{2}\int\frac{2x}{1-x^2}}=\sqrt{1-x^2}$

$$y\times\sqrt{1-x^2}=\int\frac{x^6+4x}{\sqrt{1-x^2}}\times\sqrt{1-x^2}\,dx$$

$$y\times\sqrt{1-x^2}=\frac{x^7}{7}+\frac{4x^2}{2}+c$$

Given y(0)=0 $\quad y\sqrt{1-x^2}=\frac{x^7}{7}+2x^2 \quad y=\frac{\frac{x^7}{7}+2x^2}{\sqrt{1-x^2}}$

Now $6\int_{\frac{-1}{2}}^{\frac{1}{2}}\frac{\frac{x^7}{7}+2x^2}{\sqrt{1-x^2}}\,dx \quad =6\int_{\frac{-1}{2}}^{\frac{1}{2}}\frac{\frac{x^7}{7}}{\sqrt{1-x^2}}+6\int_{\frac{-1}{2}}^{\frac{1}{2}}\frac{2x^2}{\sqrt{1-x^2}}dx$

Odd function + even function

$$=24\int_0^{\frac{1}{2}}\frac{x^2}{\sqrt{1-x^2}}dx \quad put\ x=\sin\theta, dx=\cos\theta d\theta \quad =24\int_0^{\frac{\pi}{6}}\frac{1-\cos 2\theta}{2}d\theta$$

$$=12\left[\frac{\pi}{6}-\frac{\sqrt{3}}{4}\right] \quad =2\pi-3\sqrt{3} \quad \propto^2=\left(3\sqrt{3}\right)^2=27$$

22. If $\sum_{r=1}^{30}\frac{r^2\left({}^{30}C_r\right)^2}{{}^{30}C_{r-1}}=\alpha\times 2^{29}$, then α is equal to _______.

KEY : 465

Sol : $S=\sum_{r=1}^{30}r^2\frac{30c_r}{30c_{r-1}}\times 30c_r \quad =\sum_{r=1}^{30}r^2\frac{30-r+1}{r}\times\frac{30}{r}\times 29c_{r-1}$

$$=\sum_{r=1}^{30}(31-r)\times 30\times 29c_{r-1} \quad \sum_{r=1}^{30}930.29c_{r-1}-30\sum_{r=1}^{30}r.29c_{r-1}$$

$$930\ 2^{29}-30\sum_{r=1}^{30}(r-1+1)29c_{r-1}$$

$$930\ 2^{29}-30\left(\sum_{r=2}^{30}(r-1)\frac{29}{r-1}28c_{r-2}+2^{29}\right) \quad =930\ 2^{29}-30\times 29\times 2^{28}-30\ 2^{29}$$

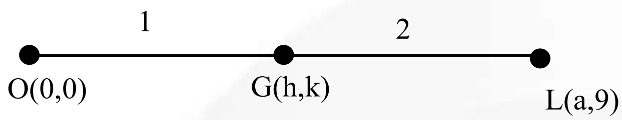
$$=930\ 2^{29}-15\times 29\times 2^{29} \quad =2^{29}(900-435)$$

$$=2^{29}(465) \quad =\propto\ 2^{29}\ \propto=465.$$

23. Let $A(6,8), B(10\cos\alpha, -10\sin\alpha)$ and $C(-10\sin\alpha, 10\cos\alpha)$, be the vertices of a triangle. If L(a, 9) and G(h, k) be its orthocenter and centroid respectively, then $(5a-3h+6k+100\sin 2\alpha)$ is equal to ______,

KEY : 145

Sol : All the three points A,B,C (i.e on the circle $x^2+y^2=100$ so circumstance is $(0,0)$



$\frac{a+0}{3}=h \Rightarrow a=3h$

And $\frac{9+0}{3}=k \Rightarrow k=3$

Also centroid $\frac{6+10\cos\propto-10\sin\propto}{3}=h$

$\Rightarrow 10(\cos\propto-\sin\propto)=3h-6$ _________(1)

And $\frac{8+10\cos\propto-10\sin\propto}{3}=k$

$10(\cos\propto-\sin\propto)=3k-8=3(3)-8=1$ _______(2)

On squaring

$100(1-\sin\propto)=1$

$100\sin\propto=99$

From Eq (1) and (2) we get $h=\frac{7}{3}$

Now $5a-3h+6k+100\sin^2\propto$

$15h-3h+6k+100\sin^2\propto$

$=12\times\frac{7}{3}+18+99$ =145.

24. Let the distance between two parallel lines be 5 units and a point P lie between the lines at a unit distance from one of them. An equilateral triangle PQR is formed such that Q lies on one of the parallel lines, while R lies on the other. Then $(QR)^2$ is equal to ________.

KEY : 28

Sol : $PR = Co\sec\theta, PQ = 4\sec(30+\theta)$

For equilateral

$d = PR = PQ \Rightarrow \cos(\theta + 30^o) = 4\sin\theta$

$\Rightarrow \frac{\sqrt{3}}{2}\cos\theta - \frac{1}{2}\sin\theta = 4\sin\theta \qquad \Rightarrow Tan\theta = \frac{1}{3\sqrt{3}}$

$QR^2 = d^2 = \csc^2\theta = 28$

25. Let A ={1,2,3}. The number of relations on A, containing (1, 2) and (2, 3), which are reflexive and transitive but not symmetric, is __________.

KEY : 3

Sol : $(1,2) \in R(2,3) \in R \Rightarrow (1,3) \in R$

For reflexive $(1,1)(2,2)(3,3) \in R$

Now $(2,1)(3,2)(3,1)$

$(3,1)$ cannot be taken

R_1: (2,1)taken and (3,2) not taken

R_2 (3,2)taken and (2,1) not taken

R_3 :Both not taken

$\therefore$ 3 relations are possible.

PHYSICS

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 force $\vec{F} = 2\hat{i} + b\hat{j} + \hat{k}$ is applied on a particle and it undergoes a displacement $\hat{i} - 2\hat{j} - \hat{k}$. What will be the value of b, if work done on the particle is zero.

1) 2 2) 0 3) $\frac{1}{2}$ 4) $\frac{1}{3}$

Ans: 3

Sol : $W = \vec{F}.\vec{S} = 0$

$\left(2\hat{i} + b\hat{j} + \hat{k}\right).\left(\hat{i} - 2\hat{j} - \hat{k}\right) = 0$

$2 - 2b - 1 = 0$

$b = 1/2$

27. Given below are two statements. One is labeled as Assertion (A) and the other is labeled as Reason (R) .

Assertion (A) : A simple pendulum is taken to a planet of mass and radius, 4 times and 2 times, respectively, then the Earth . The time period of the pendulum remains same on earth and the planet .

Reason (R) : The mass of the pendulum remains unchanged at earth and the other planet . In the light of the above statements , choose the correct answer from the options given below :

1) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

2) (A) is false but (R) is true

3) Both (A) and (R) are true and (R) is the correct explanation of (A)

4) (A) is true but (R) is false

Ans: 1

Sol : $T = 2\pi\sqrt{\frac{L}{g}}$ and $g = \frac{GM}{R^2}$

$$\frac{g_1}{g_2} = \frac{M_1}{M_2} \times \left(\frac{R_2}{R_1}\right)^2$$

$$= \frac{\cancel{M}}{4\cancel{M}} \times \left(\frac{2\cancel{R}}{\cancel{R}}\right)^2 = \frac{1}{\cancel{4}} \times \frac{\cancel{4}}{1} = 1$$

$g_1 = g_2$

$\therefore$ Time period depends on length of pendulum and acceleration due to gravity (g) and it is independent of mass of pendulum .

28. The torque due to the force $\left(2\hat{i}+\hat{j}+2\hat{k}\right)$ about the origin, acting on a particle whose position vector is $\left(\hat{i}+\hat{j}+\hat{k}\right)$, would be

1) $\hat{j}+\hat{k}$ 2) $\hat{i}-\hat{k}$ 3) $\left(\hat{i}-\hat{i}+\hat{k}\right)$ 4) $\hat{i}+\hat{k}$

Ans : 2

Sol : $\bar{\tau}=\bar{r}\times\bar{F}$ $\bar{F}=2i+j+2k$

$\bar{r}=i+j+k$ $\tau=\begin{vmatrix} i & -j & k \\ 1 & 1 & 1 \\ 2 & 1 & 2 \end{vmatrix}$

$=i(2-1)-j(2-2)+k(1-2)$

$=\hat{i}-o-\hat{k}$ $=\hat{i}-\hat{k}$

29. For a diatomic gas, if $\gamma_1=\left(\frac{C_p}{C_v}\right)$ for rigid molecules and $\gamma_2=\left(\frac{C_p}{C_v}\right)$ for another diatomic molecules, but also having vibrational modes, Then, which one of the following options is correct ?

(C_p and C_v are specific heats of the gas at constant pressure and volume

1) $\gamma_2=\gamma_1$ 2) $\gamma_2>\gamma_1$ 3) $2\gamma_2=\gamma_1$ 4) $\gamma_2<\gamma_1$

Ans : 4

Sol : $\gamma=1+\frac{2}{f}$ $\frac{for\ Diatomic}{f=5}$ $\gamma_1=1+\frac{2}{5}=\frac{7}{5}=1.4\rightarrow(1)$

If vibrational model are taken into account , f=7

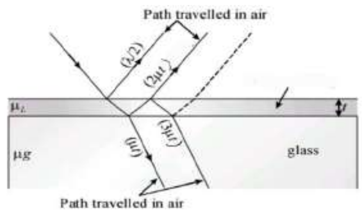
$\gamma_2=1+\frac{2}{7}=\frac{9}{7}=1.28$ $\gamma_2=1.3\rightarrow(2)$ $\therefore\ \gamma_2<\gamma_1$

30. A transparent film of refractive index, 2.0 is coated on a glass slab of refractive index, 1.45. What is the minimum thickness of transparent film to be coated for the maximum transmission of Green light of wavelength 550 nm. [Assume that the light is incident nearly perpendicular to the glass surface.]

1) 68.7 nm 2)275 nm 3) 94.8 nm 4) 137.5

Ans : 4

Sol :



Path difference for transmission $\Delta = 2\mu t$

For max transmission $2\mu t = n\lambda \ (n = 1,2,3....)$

$t = \frac{\lambda}{2\mu}$ $t_{\min} = \frac{550nm}{2\times 2} = \frac{550}{4}$ $t_{\min} = 137.5nm$

31. Given are statements for certain thermodynamic variables,

A) Internal energy, volume (V) and mass (M) are extensive variables.

B) Pressure (P) , temperature (T) and density (p) are intensive variables .

C) Volume (V), temperature (T) and density (p) are intensive variables.

D) Mass (M), temperature (T) and internal energy are extensive variables.

Choose the correct answer from the options given below :

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

Ans : 3

Sol : Extensive variable depends on the size or mass if the system

Ex : Volume , Total, mass, extropy, internal energy neat capacity .

Intensive variables do not depends on the size or mass of the system.

Ex : Temperature pressure, specific heat capacity density etc .

32. Which one of the following is the correct dimensional formula for the capacitance in F ? M. L, T and C stand for unit of mass, length time and charge ,

1) $[F] = [C^2M^{-2}L^2T^2]$
2) $[F] = [C^2M^{-1}L^{-2}T^2]$
3) $[F] = [CM^{-2}L^{-2}T^{-2}]$
4) $[F] = [CM^{-1}L^{-2}T^2]$

Ans : (2)

Sol : Capacity (C)= $\frac{q}{V} = \frac{q}{W/q} = \frac{q^2}{W}$ $= \frac{C^2}{ML^2T^{-2}} = [C^2M^{-1}L^{-2}T^2]$

33. A ball of mass 100 g is projected with velocity 20 m/s at 60^0 with horizontal. The decrease in kinetic energy of the ball during the motion from point of projection to highest point is

1) 15J 2) 20J 3) Zero 4) 5J

Ans : 1

Sol : A^{+}point of projection

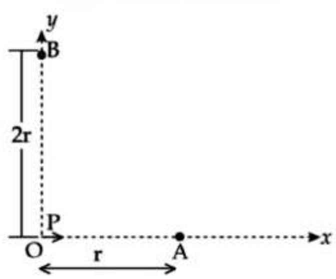
$KE = \frac{1}{2}mv^2$ $= \frac{1}{2} \times 100 \times 10^{-3} \times 20 \times 20$

$KE = 20J \rightarrow (1)$ $\frac{at\ highest\ point}{u =_u\ x = u\cos 60^0}$ $= \frac{20}{2} = 10ms^{-1}$

$KE = \frac{1}{2} \times 100 \times 10^{-3} \times 100$ $= \frac{10}{2} = 5J$

$\Delta KE = 20 - 5 = 15J$

34. For a short dipole placed at origin O, the dipole moment P is along x-axis , as shown in the figure. If the electric potential and electric field at A are V_0 and E_0 , respectively then the correct combination of the electric potential and electric field, respectively, at point B on the y-axis is given by



1) Zero and $\frac{E_0}{16}$ 2) Zero and $\frac{E_0}{8}$ 3) V_0 and $\frac{E_0}{4}$ 4) $\frac{V_0}{2}$ and $\frac{E_0}{16}$

Ans : 1

Sol : $\overrightarrow{E_0} = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3} \rightarrow (1)$ $E = \frac{1}{4\pi\varepsilon_0}\frac{p}{(2r)^3}$

$E = \frac{1}{4\pi\varepsilon_0}\frac{p}{8r^3} \times \frac{2}{2}$ $E = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3} \times \frac{1}{16}$

$E_B = \frac{E_0}{16} \rightarrow (2)$ $\frac{Potentaial}{v = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}}$

$at\ B\ , \theta = 90^0$ $v_B = 0$

35. Given below are two statements . One is labeled as Assertion (A) and the other is labeled as Reason (R) .

Assertion (A) : In young's double slit experiment, the fringes produced by red light are closer as compared to those produced by blue light.

Reason (R) : The fringe width is directly proportional to the wavelength of light. In the light of the above statements, choose the correct answer to the options given below :

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) (A) is false but (R) is true

3) (A) is true but (R) is false

4) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

Ans : 2

Sol : $\beta = \frac{\lambda D}{d}$ $\therefore \beta \alpha \lambda$

36. An electron projected perpendicular to a uniform magnetic field B moves in a circle. If Bohr's quantization is applicable, then the radius of the electronic orbit in the first excited state is :

1) $\sqrt{\frac{h}{2\pi eB}}$ 2) $\sqrt{\frac{2h}{\pi eB}}$ 3) $\sqrt{\frac{h}{\pi eB}}$ 4) $\sqrt{\frac{4h}{\pi eB}}$

Ans : 3

Sol : $mvr = \frac{nh}{2\pi}$ $\frac{mv^2}{r} = qvB$

$r = \frac{mv}{qb}$ $r = \frac{nh}{2\pi r}qb$ $r^2 = \frac{nh}{2\pi qB}$

For first excited state =n=2 $r = \sqrt{\frac{2h}{2\pi eB}}$ $r = \sqrt{\frac{h}{\pi eB}}$

37. A series LCR circuit is connected to an alternating source of emf E. The current amplitude at resonant frequency is I_0. If the value of resistance R becomes twice of its initial value then amplitude of current at resonance will be

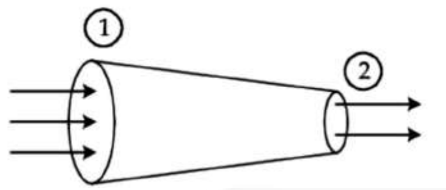
1) $2I_0$ 2) $\frac{I_0}{2}$ 3) I_0 4) $\frac{I_0}{\sqrt{2}}$

Ans : 2

Sol : $I_m = \dfrac{v_m}{\sqrt{R^2 + \left(X_L - X_C\right)^2}}$

At Resonance $X_L = X_C$ $\quad I_m = \dfrac{v_m}{R} = I_0 \quad I_m = \dfrac{v_m}{2R} = \dfrac{I_0}{2}$

38.



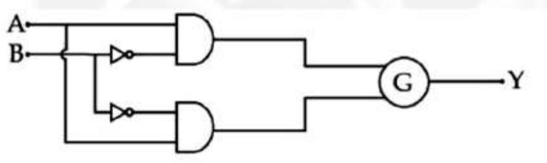
A tube of length L is shown in the figure. The radius of cross section at the point (1) is 2 cm and at the point (2) is 1 cm, respectively. If the velocity of water entering at point (1) is 2 m/s, then velocity of water leaving the point (2) will be

1)8 m/s 2) 4 m/s 3) 6 m/s 4) 2 m/s

Ans : 1

Sol : $A_1V_1 = A_2V_2 \quad \pi(2)^2(2) = \pi(1)^2 V_2 \quad 8 = v_2$

39.



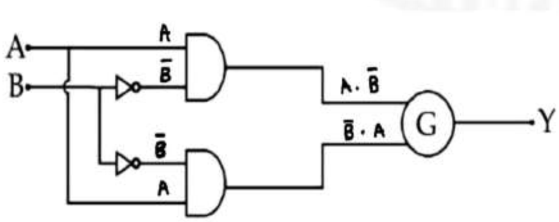
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

To obtain the given truth table, following logic gate should be placed at G:

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

Ans : No Option

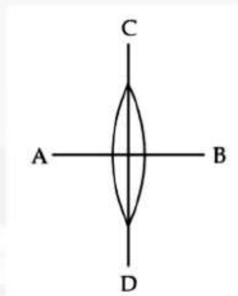
Sol :



A	B	$\bar{B}$	$A.\bar{B}$	$\bar{B}.A$	AND	OR	NAND	NOR
0	0	1	0	0	0	0	1	1
0	1	0	0	0	0	0	1	1
1	0	1	1	1	1	1	0	0
1	1	0	0	0	0	0	1	1

The output is not match with the following options.

40. A symmetric thin biconvex lens is cut into four equal parts by two panes AB and CD as shown in figure. If the power of original lens is 4D then the power of a part of the divided lens is



1) 8D   2) 2D   3) D   4) 4D

Ans : 2

Sol : $P = \frac{1}{f} = 4D$

$P^1 = \frac{1}{2f}$ $= \frac{4}{2}D$ $= 2D$

41. The maximum percentage error in the measurement of density of wire is

$$\begin{bmatrix} \text{Given,} & \text{mass of wire} = (0.60 \pm 0.003)\,\text{g} \\ & \text{radius of wire} = (0.50 \pm 0.01)\,\text{cm} \\ & \text{length of wire} = (10.00 \pm 0.05)\,\text{cm} \end{bmatrix}$$

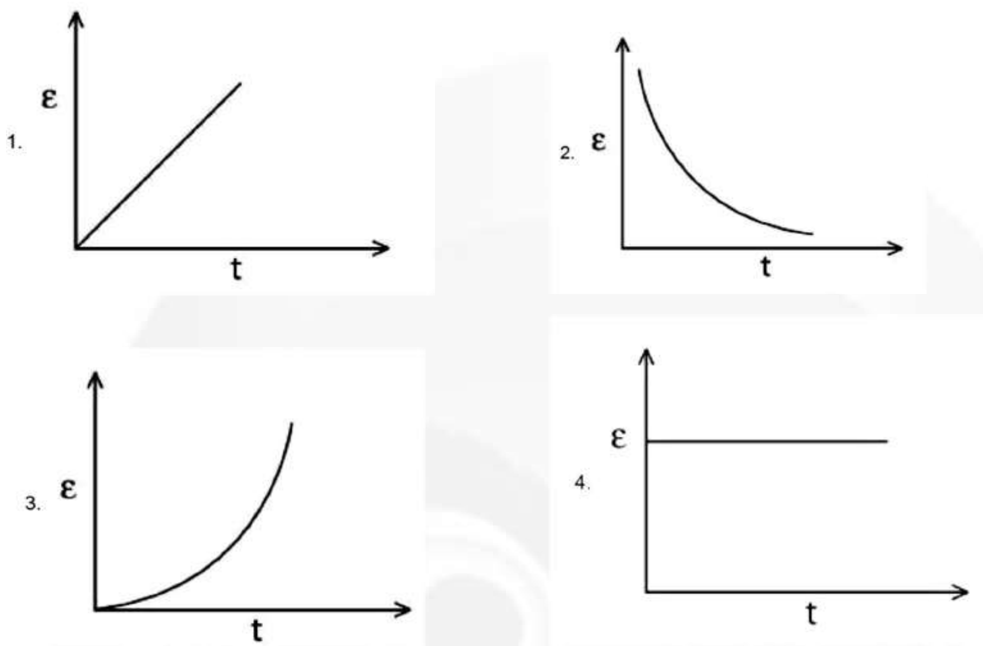
1) 5   2) 7   3) 8   4) 4

Ans : 1

Sol : $\rho = \frac{m}{v} = \frac{m}{\pi r^2 l}$ $\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 2\left(\frac{\Delta r}{r}\right) + \frac{\Delta l}{l}$

$= \frac{0.003}{0.60} + 2\left(\frac{0.01}{0.5}\right) + \left(\frac{0.05}{10}\right) = 0.005 + 0.04 + 0.005$ $= 0.05$ $= 5\%$

42. A rectangular metallic loop is moving out of uniform magnetic field region to a field region with a constant speed. When the loop is partially inside the magnate field, the plot of magnitude of induced emf (ε) with time (t) is given by



Ans : 4

Sol : $\varepsilon = -\frac{d\phi}{dt}$ $\therefore \phi = BA$

$\varepsilon = -B\left(\frac{dA}{dt}\right)$

$\frac{dA}{dt} = cons\tan t \ and \ B = cons\tan t$ $\therefore \varepsilon$ is also constant .

43. A light source of wavelength λ illuminates a metal surface and electrons are ejected with maximum kinetic energy of 2 eV. If the same surface is illuminated by a light source of wavelength $\frac{\lambda}{2}$, then the maximum kinetic energy of ejected electrons will be (The work function of metal is 1 eV)

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

Ans : 1

Sol : $E = K_m + \phi$

$E = 2eV + 1eV$

$\Rightarrow E = 3eV$

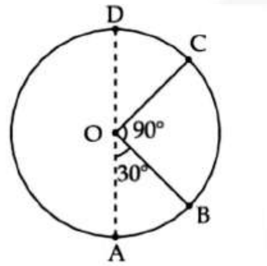
$E \alpha \frac{1}{\lambda}$

$\frac{E_2}{E} = \frac{\lambda_1}{\lambda_2} = \frac{\lambda}{\frac{\lambda}{2}} = 2, E_2 = 2E = 6ev$

$E_2 - 2E = 6eV$

$KE_2 = E_2 - \phi = 6 - 1 = 5eV$

44. A body of mass 100g is moving in circular path of radius 2 m on vertical plane as shown in figure. The velocity of the body at point A is 10 m/s . The ratio of its kinetic energies at point B and C is :



(Take acceleration due to gravity as 10 m/s^2)

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

Ans: 4

Sol : For position $= \sqrt{v^2 - 2gl(1-\cos\theta)}$

If $\theta = 30^0$ $v_B = \sqrt{100 - 2(10)(2)(1-\cos 30^0)}$

$= \sqrt{100 - 40\left(1 - \sqrt{3/2}\right)}$ $= \sqrt{100 - 20\left(2-\sqrt{3}\right)}$

$v_B^2 = 100 - 40 + 20\sqrt{3}$ $v_B^2 = 60 + 20\sqrt{3}$

For position ' C'

$v_c = \sqrt{100 - 2(10)(2)(1-\cos 120^0)}$ $= \sqrt{100 - 40\left(1 + \frac{1}{2}\right)}$

$= \sqrt{100 - 40(3/2)}$ $= \sqrt{100-60}$ $= \sqrt{40}$

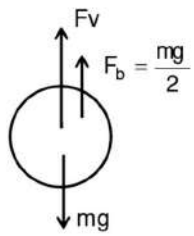
$v_c^2 = 40$ $\frac{KE_B}{KE_C} = \frac{v_B^2}{v_c^2} = \frac{60+20\sqrt{3}}{40}$ $= \frac{3+\sqrt{3}}{2}$

45. A small rigid spherical ball of mass M is dropped in a long vertical tube containing glycerine . The velocity of the ball becomes constant after some time. If the density of glycerine is half of the (consider g as acceleration due to gravity)

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

Ans : 1

Sol :



$f_V + f_B = Mg$

$f_V = Mg - F_B \qquad = Mg - \rho_L (V) g$

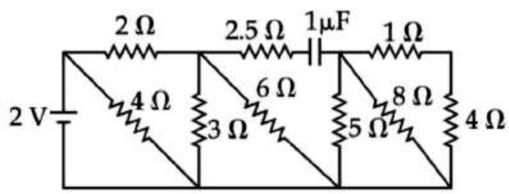
$= Mg - \frac{\rho}{2} vg \qquad = Mg - \frac{Mg}{2} \qquad = \frac{Mg}{2}$

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).**

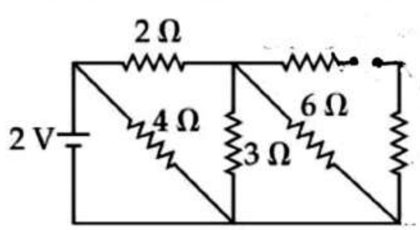
Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases.

46. The net current flowing in the given circuit is _________A .



Ans : 1

Sol :

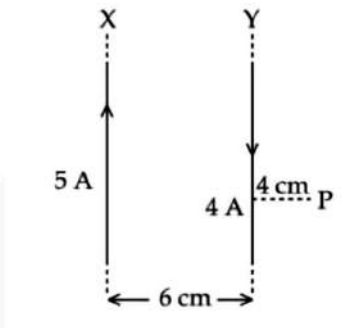


$\frac{3\times 6}{3+6} = \frac{18}{9} = 2\Omega$

$2+2 = 4\Omega \qquad \frac{4\times 4}{4+4} = \frac{16}{8} = 2\Omega$

current $I = \frac{2}{2} = 1A$

47. Two long parallel wires X and Y, separated by a distance of 6 cm, carry currents of 5A and 4 A, respectively, in opposite direction as shown in the figure. Magnitude of the resultant magnetic field at point P at a distance of 4 cm from wire Y is $x \times 10^{-5} T$. The value of x is __________ . Take permeability of free space as $\mu_0 = 4\pi \times 10^{-7} SI$ units .



Ans : 1

Sol : $B_x = \frac{\mu_0 i}{2\pi r}$ $= \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 10 \times 10^{-2}}$

$B_x = 10^{-5} \rightarrow (1)$ inward

$B_y = \frac{\mu_0 i}{2\pi r} = \frac{4\pi \times 10^{-7} \times 4}{2\pi \times 4 \times 10^{-2}}$ $B_y = 2 \times 10^{-5} \rightarrow (2)$ outward

$B_{net} = B_y - B_x$ $= 2 \times 10^{-5} - 10^{-5}$ $B_{net} = 1 \times 10^{-5} T$ $x = 1$

48. A parallel plate capacitor of area $A = 16 cm^2$ and separation between the plates 10 cm, is charged by a DC current. Consider a hypothetical plane surface of area $A_0 = 3.2 Cm^2$ inside the capacitor and parallel to the plates. At an instant, the current through the circuit is 6A. At the same instant the displacement current through A_0 is ___________mA.

Ans: 1200

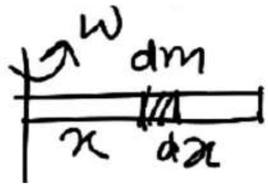
$I_d = \varepsilon_0 A \frac{dE}{dt}$ $= \varepsilon_a A_0 \frac{d}{dt}\left(\frac{q}{A\varepsilon_0}\right)$ $I_D = \frac{A_0}{A}\left(\frac{dq}{dt}\right)$

$I_D = \frac{A_0}{A} I_C$ $I_D = \frac{3.2}{16}(6)$ $= 0.2(6)$ $= 1.2$ Amp $=1200$ mA.

49. A tube of length 1m is filled completely with an ideal liquid of mass 2 M, and close at both ends. The tube is rotated uniformly in horizontal plane about one of its ends. If the force exerted by the liquid at the other end is F the angular velocity of the tube is $\sqrt{\frac{F}{\alpha M}}$ in SI unit. The value of α is ___________

Ans : 1

Sol :



$$\int_0^F dF = \int_0^L (dm)x\omega^2 \qquad dm = \rho A(dx)x\omega^2$$

After integration we can write

$$F = 2m\omega^2 \frac{l}{2}\{l=1\} \qquad \Rightarrow F = m\omega^2 \qquad \Rightarrow \omega = \sqrt{\frac{F}{m}} \text{ So } \alpha = 1$$

50. A proton is moving undeflected in a region of crossed electric and magnetic fields at a constant speed of $2\text{x}10^5\,\text{ms}^{-1}$. When the electric field is switched off, the proton moves along a circular path of radius 2 cm. The magnitude of electric field $x \times 10^4\ N/C$. The value of x is _________

Take the mass of proton $=1.6\text{x}10^{-27}\,\text{kg}$.

Ans : 2

Sol : $r = \frac{mv}{qB}$

$$B = \frac{mV}{qr} = \frac{1.67\times10^{-27}\times2\times10^5}{1.6\times10^{-19}\times2\times10^{-2}}$$

$$B \Rightarrow 0.1T$$

$$E = VB = 2\times10^5\times0.1$$

$$E = 2\times10^4\,V/m = \alpha\times10^4\,V/m \Rightarrow \alpha = 2$$

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. Given below are two statements :

Statement (I) : An element in the extreme left of the periodic table forms acidic oxides.

Statement (II) : Acid is formed during the reaction between water and oxide of a reactive element present in the extreme right of the periodic table .

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

1) Both Statement I and Statement II are false

2) Statement I is false but Statement II is true

3) Both Statement I and Statement II are true

4) Statement I is true but statement II is false

Ans : (2)

Sol : **Statement –I** : False but **Statement- II** is true .On moving left to right in periodic table non-metallic character increase and we know that non-metal oxides are acidic in nature .

Non metallic character ↑ Acidic strength of oxide ↑

52. The maximum covalency of a non-metallic group 15 element 'E' with weakest E-E bond is :

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

Ans (3)

Sol : N – N < P – P : single (σ)bond strength .

Due to L.P – L. P replusion

And maximum possible covalency of nitrogen is 4

53. Density of 3 M NaCl solution is 1.25 g/mL. The molality of the solution is :

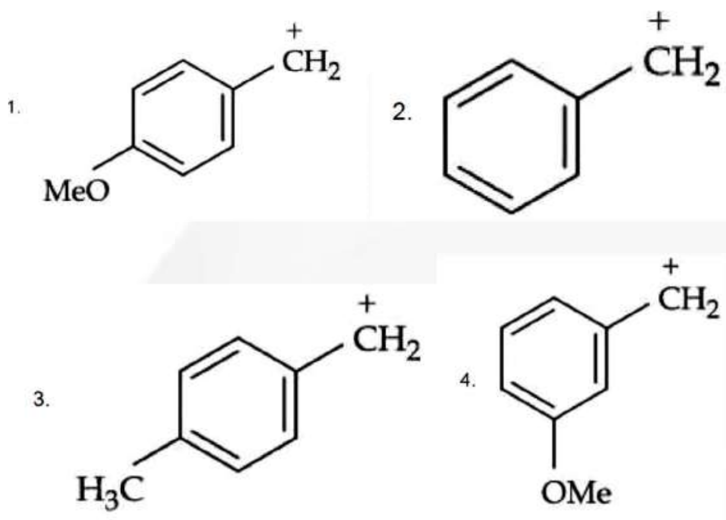
1) 2m 2)1.79 m 3) 2.79 m 4) 3m

Ans : (3)

Sol : 3M NaCl, $d_{sol} = 1.25$ gm/mol

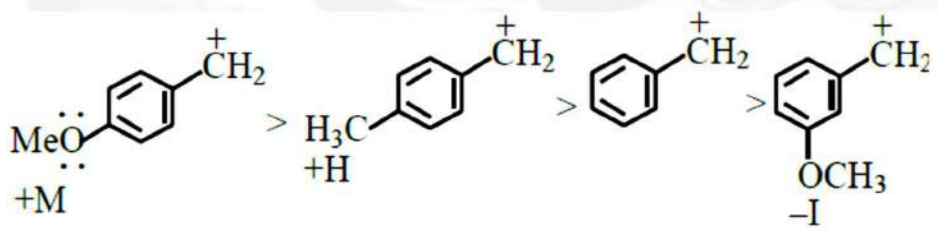
$$\text{Molality} = \frac{M \times 1000}{1000d - M \times M_W} \qquad = \frac{3000}{1250 - 175.5} = 2.79$$

54. The most stable carbocation from the following is :

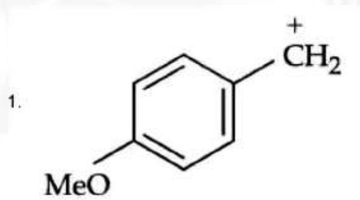


Ans : (1)

Sol :



Due to + M effect of –OMe at para position



Will be most among these .

55. Identify the homoleptic complex (es) that is /are low spin.

A) $\left[Fe(CN)_5 NO\right]^{2-}$ B) $\left[CoF_6\right]^{3-}$ C) $\left[Fe(CN)_6\right]^{4-}$ D) $\left[Co(NH_3)_6\right]^{3+}$ E) $\left[Cr(H_2O_6)\right]^{2+}$

Choose the correct answer form the options given below :

1) (A) and (C) only

2) (C) and (D) only

3) (B) and (E) only

4) (C) only

Ans (2)

Sol : (A) $\left[Fe(CN)_5 NO\right]^{2-} \rightarrow$ Heteroleptic, Fe^{+2} , $3d^6$

$t_{2g}^6 e_g^0, d^2sp^3$, Low spin (3d series +SFL)

(B) $[CoF_6]^{3-} \rightarrow$ Homoleptic , sp^3d^2 , high spin .

Co^{+3}, $3d^6$ (3d series +WFL)

(C) $\left[Fe(CN)_6\right]^{4-} \rightarrow$ Homoleptic Fe^{+2} , $3d^6$ d^2sp^3 , t_{2g}^6 eg^0 Low Spin

(3d series +SFL)

(D) $\left[Co(NH_3)_6\right]^{3+} \rightarrow$Homoleptic, Co^{+3} $3d^6$, d^2sp^3,

$t_{2g}^6 eg^0$ Low spin (3^{rd} series +SFL)

(E) $\left[Cr(H_2O_6)\right]^{2+} \rightarrow$ Homoleptic Cr^{+2} $3d^4$, d^2sp^3 , High spin t_{2g}^3 e_g^1

(3^{rd} series +WFL)

56. Given below are two statements :

Statement (I) : A spectral line will be observed for $a\,2p_x \rightarrow 2p_y$ transition .

Statement (II) : $2p_x$ and $2p_y$ are degenerate orbitals .

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) Both Statement I and Statement III are false

4) Statement I is false but Statement II is true

Ans (4)

Sol : No spectral line will be observed for a $a\,2p_x \rightarrow 2p_y$ transition because $2p_x$ and $2p_y$ orbitals are degenerate orbitals.

57. Given below are two statements :

Statement (I): Corrosion is an electrochemical phenomenon in which pure metal acts as an anode and impure metal as a cathode .

Statemetn (II):The rate of corrosion is more in alkaline medium than in acidic medium .

In the light of the above statement, choose the

Correct answer from the options given below :

1) Statement I is false but Statement II is true

2) Both Statement I and Statement II are true

3) Both Statement I and Statement II are false

4) Statement I is true but Statement II is false

Ans : (4)

Sol : **Statement I**:Corrosion is an example of electrochemical phenomenon.

In which pure metal act as anode and impure metal (rusted meal) act as cathode.

Statement II: Corrosion is more favourable in acid medium than alkaline so rate of corrosion is high is acid medium then alkaline .

58. Given below are two Statement :

Statement (I) : Nitrogen, sulphur, halgen and phosphorus present in an organic compound are detected by Lassaigne's Test .

Statement (II) : The elements present in the compound are converted from covalent form into ionic form by fusing the compound with Magnesium in Lassaigne's test .

In the light of the above statements, choose the

Correct answer from the options given below :

1) Statement I if true but Statement II is false

2) Both Statement I and Statement II are true

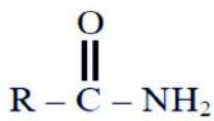
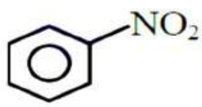
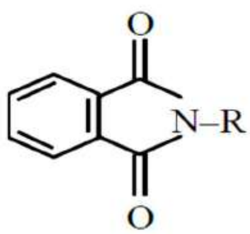
3) Statement I is false but Statement II is true

4) Both Statement I and Statement II are false

Ans (1)

Sol : The elements present in the compound are converted from covalent form into ionic form by fusing the compound with sodium in Lassigne's test

59. Match the Compounds (List –I) with the appropriate Catalyst/Reagents (List-II) for their reduction into corresponding amines .

List-I (Compounds)		List-II (Catalyst/Reagents)	
(A)		(I)	NaOH (aqueous)
(B)		(II)	H_2/Ni
(C)	$R-C\equiv N$	(III)	$LiAlH_4$, H_2O
(D)		(IV)	Sn, HCl

Choose the correct answer from the options given below :

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

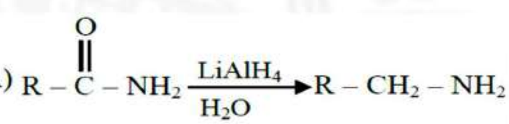
2) (A) – (III) , (B) – (IV) , (C) – (II) , (D) –(I)

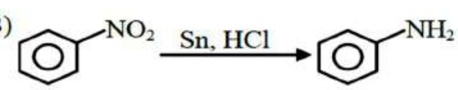
3) (A) – (III) , (B) – (II) , (C) – (IV) , (D) –(I)

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

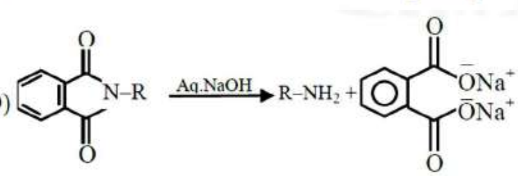
Ans : (2)

Sol :

(A) 

(B) 

(C) $R-C\equiv N \xrightarrow{H_2/Ni} R-CH_2NH_2$

(D) 

60. The molar solubility (s) of zirconium phosphate with molecular formula $\left(Zr^{4+}\right)_3\left(PO_4^{3-}\right)_4$ is given

1) $\left(\frac{K_{sp}}{9612}\right)^{\frac{1}{3}}$ 2) $\left(\frac{K_{sp}}{8435}\right)^{\frac{1}{7}}$ 3) $\left(\frac{K_{sp}}{6912}\right)^{\frac{1}{7}}$ 4) $\left(\frac{K_{sp}}{5348}\right)^{\frac{1}{6}}$

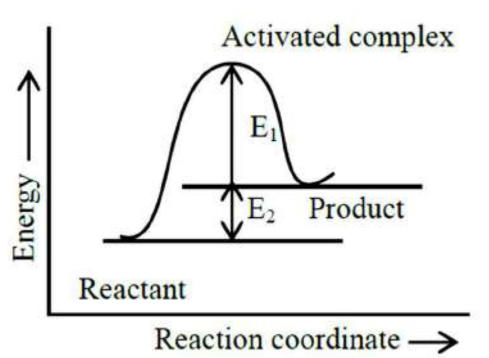
Ans (3)

Sol : $Zr_3\left(PO_4\right)_4(S) \rightleftharpoons 3Zr^{+4}(aq) + 4PO_4^{-3}(aq)$

$-$ $3s$ $4s$

$K_{sp} = (3s)^3(4s)^4 = 6912s^7$ $s = \left(\frac{K_{sp}}{6912}\right)^{1/7}$.

61. Consider the given figure and choose the correct option :



1) Activation energy of both forward and back ward reaction is $E_1 + E_2$ and reactant is more stable than product .

2) Activation energy of forward reaction is $E_1 + E_2$ and product is more stable than reactant .

3) Activation energy of backward reaction is E_1 and product is more stable than reactant

4) Activation energy of forward reaction is $E_1 + E_2$ and product is less stable than reactant .

Ans :(4)

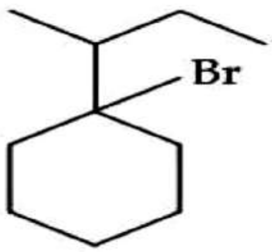
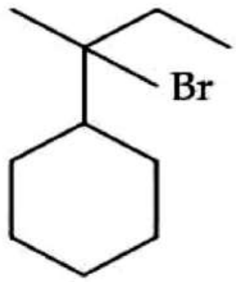
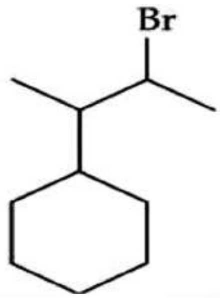
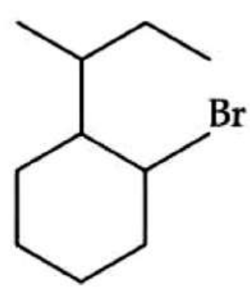
Sol : Activation energy of forward reaction $= E_1 + E_2$

Energy of product > Energy of reactant

stability

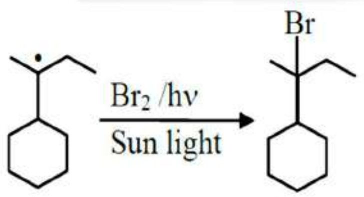
Reactant > Product

62. When sec-butylcyclohexane reacts with bromine in the presence of sunlight, the major product is :

1)  2)  3)  4) 

Ans : (2)

Sol :



Formation of more stable free radical intermediate

63. Arragne the following compound in increasing order of their dipole moment :

HBr, H_2s, NF_3 and $CHCl_3$

1) $NF_3 < HBr < H_2S < CHCl_3$ 2) $H_2S < HBr < NF_3 < CHCl_3$

3) $CHCl_3 < NF_3 < HBr < H_2S$ 4) $HBr < H_2S < NF_3 < CHCl_3$

Ans : (1)

Sol : Increasing order of Dipole moment

$$NF_3 < HBr < H_2S < CHCl_3$$
$$\mu = 0.24D \;\; 0.79D \;\; 0.95D \;\; 1.04D$$

It is NCERT Data Based

64. The alkane from below having two secondary hydrogens is :

1) 2,2,4,4 –Tetramethylhexane

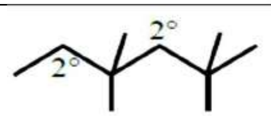
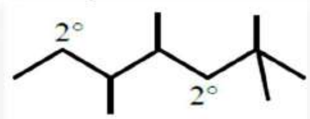
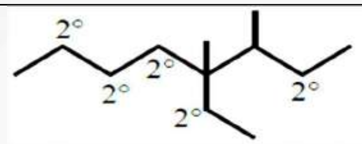
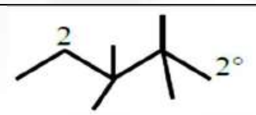
2) 2,2,4,5 –Tetramethylheptane

3) 4 –Ethyl -3,4 –dimethylocatane

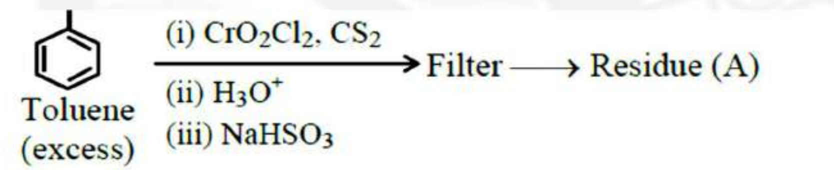
4) 2,2,3,3 – Tetramethylpentane

Ans : (4)

Sol :

	Alkane		$2^0 H$
1			10
2			4
3			2
4			4

65.

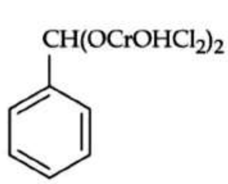


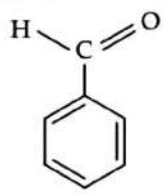
Residue (A) +HCl (dil.) $\rightarrow$ Compound (B)

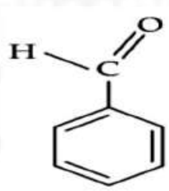
Structure of residue (A) and compound (B)

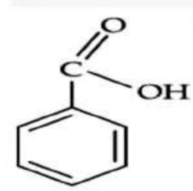
Formed respectively is :

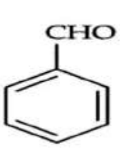
[A] [B]

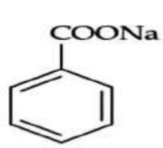
1) 

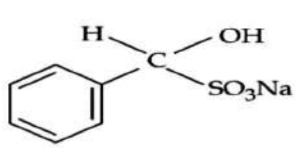


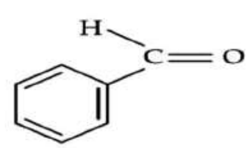
2) 



3) 

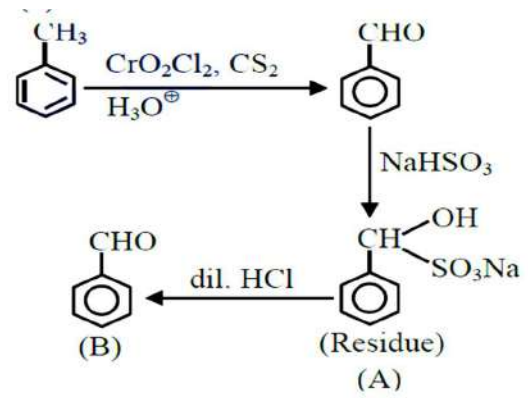


4) 

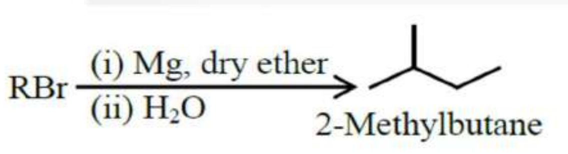


Ans : (4)

Sol :



66.

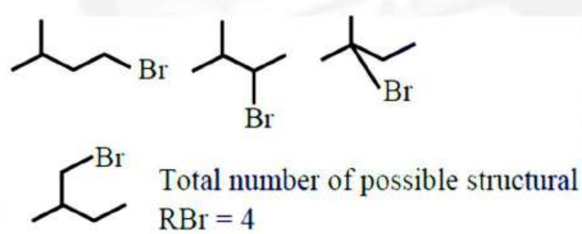


The maximum number of RBr producing 2 –methylbutane by above sequence of reactions is ________ (Consider the structural isomers only)

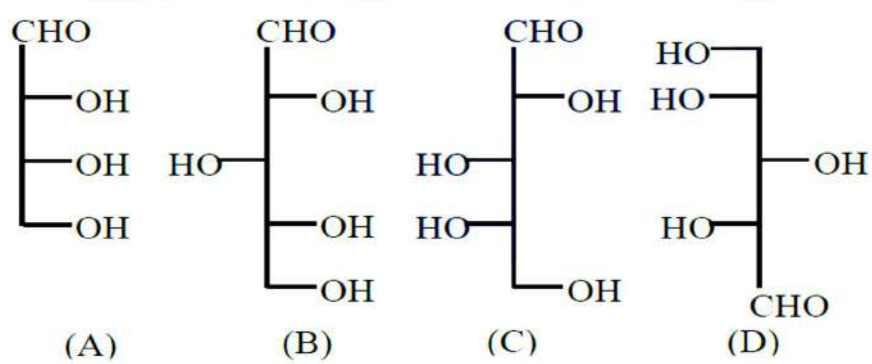
1) 4 2)3 3) 5 4) 1

Ans : (1)

Sol :



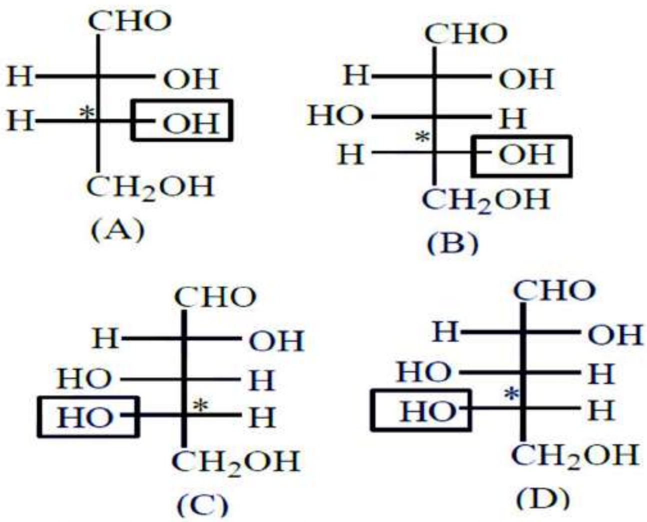
67. Identify the number of structure/s form the following . Which can be correlated to –D glyceraldehydes .



1) Three 2) One 3) Two 4)Four

Ans : (1)

Sol :



In A, B, D * -OH group in right hand side then D-configuration is assign

68 . The correct order of the following complexes in terms of their crystal field stabilization energies is :

1) $\left[Co(en)_3\right]^{3+} < \left[Co(NH_3)_6\right]^{3+} < \left[Co(NH_3)_6\right]^{2+} < \left[Co(NH_3)_4\right]^{2+}$

2) $\left[Co(NH_3)_4\right]^{2+} < \left[Co(NH_3)_6\right]^{2+} < \left[Co(NH_3)_6\right]^{3+} < \left[Co(en)_3\right]^{3+}$

3) $\left[Co(NH_3)_6\right]^{2+} < \left[Co(NH_3)_6\right]^{3+} < \left[Co(NH_3)_4\right]^{2+} < \left[Co(en)_3\right]^{3+}$

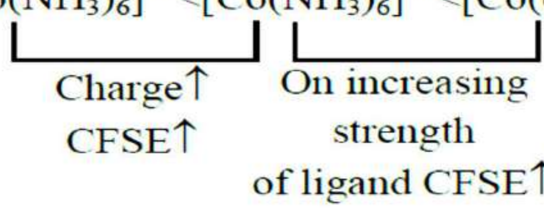
4) $\left[Co(NH_3)_4\right]^{2+} < \left[Co(NH_3)_6\right]^{2+} < \left[Co(en)_3\right]^{3+} < \left[Co(NH_3)_6\right]^{3+}$

Ans : (2)

Sol :

Order of CFSE

$[Co(NH_3)_4]^{+2} < [Co(NH_3)_6]^{+2} < [Co(NH_3)_6]^{+3} < [Co(en)_3]^{+3}$



SFL : $NH_3 <$ en

69. The species which does not undergo disproportionation reaction is :

1) ClO_2^- 2) ClO^- 3) ClO_4^- 4) ClO_3^-

Ans : (3)

Sol : $ClO_4^- \rightarrow X + \{(-2)\times 4\} = -1 \Rightarrow X = +7$

Chlorine is in its maximum oxidation state, so disproportionation not possible in ClO_4^-

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

	List-I (Partial Derivatives)		**List-II (Thermodynamic Quantity)**
A	$\left(\frac{\partial G}{\partial T}\right)_P$	**I**	Cp
B	$\left(\frac{\partial H}{\partial T}\right)_P$	**II**	-S
C	$\left(\frac{\partial G}{\partial P}\right)_T$	**III**	Cv
D	$\left(\frac{\partial U}{\partial T}\right)_V$	**IV**	V

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

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

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

Ans: (2)

Sol : $(A) dG = Vdp - SdT$

Constant pressure

$dG = -SdT$

$$\left(\frac{\partial G}{\partial T}\right)_p = -S$$

(B) dH=$(dq)_p = nCpdT$

$$\left(\frac{\partial H}{\partial T}\right)_P = C_P$$

(C) dG= Vdp –SdT

At constant temperature

dG =Vdp

$$\left(\frac{\partial G}{\partial P}\right)_T = V$$

$$(D) dU - nC_v dT = (q)_v$$

$$\left(\frac{\partial U}{\partial T}\right)_v = C_V$$

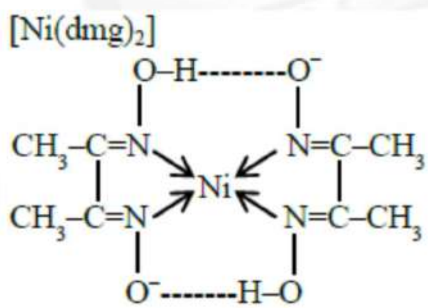
SECTION-II (NUMERICAL VALUE TYPE)

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 complex of Ni^{2+} ion and dimethyl glyoxime contains……… number of Hydrogen (H) atoms.

Key: 14.

Sol:



Number of H-atom = 14.

72. Niobium (Nb) and Ruthenium (Ru) have 'X' and 'Y' number of electrons In their respective '4d' orbitals. The value of X+Y is ……

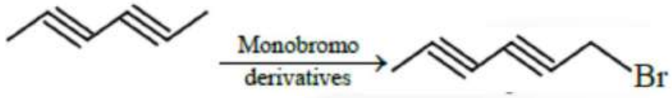
Key: 11.

Sol: $Z = 41 \rightarrow Nb$ (Niobium) : $[Kr]\ 4d^4\,5s^1$, Number of electron in 4d = 4 = x.

$Z = 44 \rightarrow Ru$ (Ruthenium) **:** $[Kr]\ 4d^7\,5s^1$,Number of electron in 4d = 7 = y. x+y=11.

73. The compound with molecular formula C_6H_6, which gives only one monobromo derivative and takes up 4 moles of hydrogen per mole for complete hydrogenation has …….π electrons.

Key: 8.

Sol: 

 $+ \ 4H_2 \rightarrow Hexane$

So number of π electrons=8.

74. Consider the following cases of standard enthalpy of reaction $(\Delta H_r^o in\, kJ\, mol^{-1})$

$$C_2H_6(g)+\frac{7}{2}O_2(g)\rightarrow 2CO_2(g)+3H_2O(l)\Delta H_1^o=-1550$$

$$C(graphite)+O_2(g)\rightarrow CO_2(g)\Delta H_2^o=-393.5$$

$$H_2(g)+\frac{1}{2}O_2(g)\rightarrow HO_2(l)\Delta H_3^o=-286$$

The magnitude of $\Delta H^o_{f\ C_2H_{6(g)}}$ is …… kJ mol^{-1} (Nearest Integer).

Key: 95.

Sol: $2C(graphite)+3H_2(g)\rightarrow C_2H_6(g) \quad \Delta H_f=?$

$$C_2H_6(g)+\frac{7}{2}O_2(g)\rightarrow 2CO_2(g)+3H_2O(l)\Delta H_1^o=-1550$$

$$C(graphite)+O_2(g)\rightarrow CO_2(g)\Delta H_2^o=-393.5$$

$$H_2(g)+\frac{1}{2}O_2(g)\rightarrow HO_2(l)\Delta H_3^o=-286$$

$$\Delta H_f^o=2\Delta H_2+3\Delta H_3-\Delta H_1=95kJ/mole.$$

75. 20mL of 2M NaOH solution is added to 400mL of 0.5M NaOH solution. The final concentration of the solution is …… $\times 10^{-2}M$.(Nearest integer).

Key: 57.

Sol: $M_F=\frac{M_1V_1+M_2V_2}{V_1+V_2}=\frac{2\times 20+0.5\times 400}{420}=0.571M$ $\quad 57.1\times 10^{-2}M \quad =57.$

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SEIZES 4 RANKS IN TOP 10 IN ALL-INDIA RANKS
300 300 MARKS
ALL INDIA RANK 3 RANK
THOTAMSETTY NIKILESH
APPL.No. 240310813888*
300 300 MARKS
ALL INDIA RANK 6 RANK
HIMANSHU THALOR
APPL.No. 240310580429*
300 300 MARKS
ALL INDIA RANK 9 RANK
REDDI ANIL
APPL.No.240310238514
SECURED 25 RANKS IN TOP 100
ALL INDIA OPEN CATEGORY
Sri Chaitanya - Nagpur DLP Student
1 RANK G N NIRMALKUMAR Appl.No. 240310385062*
9 RANK REDDI ANIL Appl.No. 240310238514*
14 RANK K C BASAVA REDDY Appl.No. 240310618179*
20 RANK THOTAMSETTY NIKILESH Appl.No. 240310813888*
21 RANK A V TANISH REDDY Appl.No. 240310807613
22 RANK HIMANSHU THALOR Appl.No. 240310580429*
26 RANK VEDANT SAINI Appl.No. 240310182830
28 RANK P MEET VIKRAMBHAI Appl.No. 240310157524*
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