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23-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.

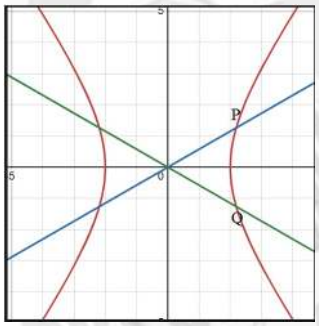
Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. Let PQ be a chord of the hyperbola $\frac{x^2}{4}-\frac{y^2}{b^2}=1$, perpendicular to the x-axis such that OPQ is an equilateral triangle, O being the centre of the hyperbola. If the eccentricity of the hyperbola is $\sqrt{3}$, then the area of the triangle OPQ is

1) $\frac{8\sqrt{3}}{5}$ 2) $2\sqrt{3}$ 3) $\frac{9}{5}$ 4) $\frac{11}{5}$

Key: **1**

Sol:



$P=\left(2\sec\theta,2\sqrt{2}\tan\theta\right), Q=\left(2\sec\theta,-2\sqrt{2}\tan\theta\right)$

$\tan 30^0=\frac{2\sqrt{2}\tan\theta}{2\sec\theta}\Rightarrow\sin\theta=\frac{1}{\sqrt{6}}$

$\Delta=\frac{1}{2}2\left(\sec\theta\right)4\sqrt{2}\tan\theta=4\sqrt{2}\frac{\sin\theta}{\cos^2\theta}=4\sqrt{2}\frac{\frac{1}{\sqrt{6}}}{1-\frac{1}{6}}=\frac{4}{\sqrt{3}}\times\frac{6}{5}=\frac{8\sqrt{3}}{5}$

2. The system of linear equations

$x+y+z=6$

$2x+5y+az=36$

$x+2y+3z=b$

has

1) Infinitely many solutions for $a=8$ *and* $b=14$

2) Unique solution for $a=8$ *and* $b=16$

3) Infinitely many solutions for $a=8$ *and* $b=16$

4) Unique solution for $a=8$ *and* $b=14$

Key: **1**

Sol: $[AD]=\begin{bmatrix}1&1&1&6\\2&5&a&36\\1&2&3&b\end{bmatrix}\begin{matrix}\\R_2-2R_1\\R_3-R_1\end{matrix}$

$$4\begin{bmatrix}1&1&1&6\\0&3&a-2&24\\0&1&2&b-6\end{bmatrix}3R_3-R_2$$

$$4\begin{bmatrix}1&1&1&6\\0&3&a-2&24\\0&0&8-a&3(b-14)\end{bmatrix}$$

$R(A)=R(A_1)\neq 3$

$\therefore a=8\ b=14$

3. If the mean and the variance of the data

Class	4-8	8-12	12-16	16-20
Freaquency	3	λ	4	7

are μ *and* 19 respectively, then the value of $\lambda+\mu$ is

1)18 2)21 3)19 4)20

Key: **3**

Sol:

Class	freq	Mid value	Fi xi	Fi xi
4-8	3	6	18	108
8-12	λ	10	10λ	100λ
12-16	4	14	56	784
16-20	7	18	126	2268
	$N=14+\lambda$		$\sum f_i x_i=200+10\lambda$	$\sum f_i x_i^2=3160+100\lambda$

$$\mu=\frac{200+10\lambda}{14+\lambda}=\frac{200+60}{20}=13$$

$$19=\frac{3160+100\lambda}{14+\lambda}-\left(\frac{200+10\lambda}{14+\lambda}\right)^2$$

$$19\left(196+28\lambda+\lambda^2\right)=\left(3160+100\lambda\right)\left(14+\lambda\right)-\left(40000+4000\lambda+100\lambda^2\right)$$

$$19\lambda^2-28\lambda-516=0$$

$$\lambda=\frac{28\pm\sqrt{784+4.19.516}}{2.19}=\frac{28\pm 200}{2.19}=6,\frac{86}{19}$$

$\lambda+\mu=6+13=19$

4. *If* $z=\frac{\sqrt{3}}{2}+\frac{i}{2}, i=\sqrt{-1}$, *then* $\left(z^{201}-i\right)^8$ is equal to

1) 0 2) 256 3)-1 4)1

Key: **2**

Sol: $z=-i\left(\frac{-1}{2}+i\frac{\sqrt{3}}{2}\right)=-iw$

$z^{201}=-i$

$\left(z^{201}-i\right)^8=\left(-i-i\right)^8=2^8=256$

5. *If* $f(x)=\begin{cases}\frac{a|x|+x^2-2(\sin|x|)(\cos|x|)}{x}, & x\neq 0\\ b, & x=0\end{cases}$

is continuous at $x=0$, *then* $a+b$ *is equal to*

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

Key: **2**

Sol: LHL= $f(0)=RHL$

$\lim\limits_{x\to 0^-}\left(-a+x+\frac{\sin 2x}{x}\right)=b=\lim\limits_{x\to 0^+}\left(a+x-\frac{\sin x}{x}\right)$

$-a+0+2=b=a+0-2$

$a+b=2$

6. *Let* $\frac{\pi}{2}<\theta<\pi$ *and* $\cot\theta=-\frac{1}{2\sqrt{2}}$. *Then the value of*

$\sin\left(\frac{15\theta}{2}\right)(\cos 8\theta+\sin 8\theta)+\cos\left(\frac{15\theta}{2}\right)(\cos 8\theta-\sin 8\theta)$ *is equal to*

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

Key: **2**

Sol: $\tan\frac{\theta}{2}=t,\ \ \frac{1-t^2}{2t}=\frac{-1}{2\sqrt{2}}\Rightarrow t=\sqrt{2}$

$A=8\theta,\ B=\frac{15\theta}{2}\Rightarrow A-B=\frac{\theta}{2}$

$\sin B\cos A+\sin B\sin A+\cos B\cos A-\cos B\sin A$

$=Cos(A-B)-\sin(A-B)=Cos\frac{\theta}{2}-\sin\frac{\theta}{2}=\frac{1-t}{\sqrt{1+t^2}}=\frac{1-\sqrt{2}}{\sqrt{3}}$

7. *Let* $I(x)=\int\frac{3dx}{(4x+6)\left(\sqrt{4x^2+8x+3}\right)}$ *and* $I(0)=\frac{\sqrt{3}}{4}+20$.

If $I\left(\frac{1}{2}\right)=\frac{a\sqrt{2}}{b}+c$, *where* $a,b,c,\in N,\gcd(a,b)=1$, *then* $a+b+c$ *is equal to*

1)31 2)28 3)30 4)29

Key: **1**

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

$$=\frac{3}{2}\int\frac{dx}{\left(\frac{2x+3}{2x+1}\right)^{3/2}(2x+1)^2}\left(t=\frac{2x+3}{2x+1}\Rightarrow dt=\frac{-4}{(2x+1)^2}dx\right)$$

$$=\frac{3}{2}\int\left(\frac{2x+3}{2x+1}\right)^{-3/2}\frac{dx}{(2x+1)^2}=\frac{-3}{8}\frac{\left(\frac{2x+3}{2x+1}\right)^{\frac{-3}{2}+1}}{\frac{-3}{2}+1}+C=\frac{3}{4}\left(\frac{2x+1}{2x+3}\right)^{\frac{1}{2}}+C$$

$$I(0)=20+\frac{\sqrt{3}}{4}\Rightarrow c=20$$

$$I\left(\frac{1}{2}\right)=\frac{3\sqrt{2}}{8}+20$$

$$a+b+c=3+8+20=31$$

8. An equilateral triangle OAB is inscribed in the parabola $y^2=4x$ with the vertex O at the vertex of the parabola. Then the minimum distance of the circle having AB as a diameter from the origin is

1) $2\left(8-3\sqrt{3}\right)$ 2) $4\left(6+\sqrt{3}\right)$ 3) $2\left(3+\sqrt{3}\right)$ 4) $4\left(3-\sqrt{3}\right)$

Key: **4**

Sol: $Tan30=\frac{2t_1}{t_1^2}$

$$\frac{1}{\sqrt{3}}=\frac{2}{t_1}$$

$$t_1=2\sqrt{3}$$

Equation of circle AB as a diameter is

$(x-1)^2+y^2-48=0$ 1

(1) Cut the x-axis at C,D

$$(x-12)^2=\pm4\sqrt{3}$$

$$x=12\pm4\sqrt{3}$$

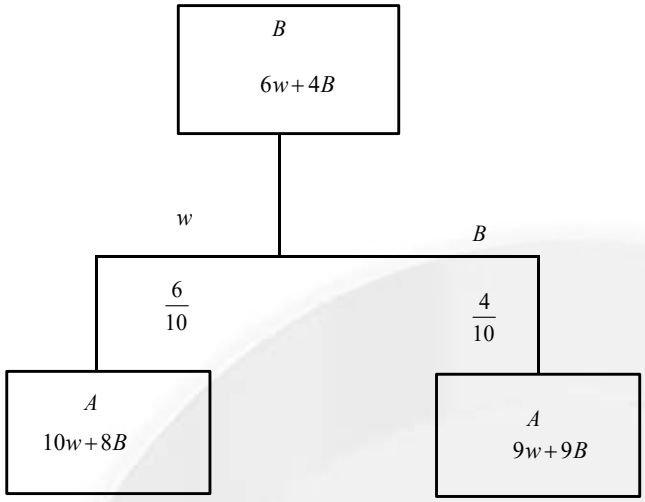
$$c\left(12-4\sqrt{3},0\right),D=\left(12+4\sqrt{3},0\right)$$

$$OC=12-4\sqrt{3}$$

9. Bag A contains 9 white and 8 black balls, while bag B contains 6 white and 4 black balls. One ball is randomly picked up from the bag B and mixed up with the balls in the bag A. Then a ball is randomly drawn from the bag A. If the probability, that the ball drawn is white, is $\frac{p}{q},\gcd(p,q)=1,$ *then* $p+q$ *is equal to*

1)23 2)22 3)21 4)24

Key: **1**



Sol:

E=draw white ball from A after transferring a ball from B

$P(E)=\frac{6}{10}.\frac{10}{18}+\frac{4}{10}.\frac{9}{18}=\frac{96}{180}=\frac{8}{15}=\frac{p}{q}$

$P+Q=23$

10. Let $A=\{0,1,2,....,9\}.Let\ R$ be a relation on A defined by $(x,y)\in R$ if and only if $|x-y|$ is a multiple of 3.

Given below are two statements:

Statement-I: $n(R)=36.$

Statement-II: R is an equivalence relation.

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

1) Both statement I and Statement II are incorrect
2) Both statement I and statement II are correct
3) Statement I is correct but statement II is incorrect
4) Statement I is incorrect but Statement II is correct

Key: **4**

Sol: R={ (0,0).…….(9,9),(0,3), (0,6), (0,9), (3,0), (6,0), (9,0), (1,4), (1,7), (4,1) (7,1), (2,5), (5,2), (5,2), (2,8) , (8,2), (3,6), (6,3), (3,9), (9,3), (4,7), (7,4), (5,8), (8,5), (6,9), (9,6),}

n(R) =33

Reflexive: $x\in A\Rightarrow(x,x)\in R$

R is reflexive

Symmetric: $(x,y)\in R\Rightarrow|x-y|=3k$

$|y-x|=3k$

$(y,x)\in R$

R is symmetric

Transitive: $if\ (x,y)\in R\Rightarrow|x-y|=3k$

$x-y=\pm3k$ ……..1

$if\ (y,z) \in R \Rightarrow |y-z| = 3\lambda$

$y - z = \pm 3\lambda$ 2

$1+2 \rightarrow x-2 = \pm 3M$

R is transitive

R is equation

11. *Let* a,b,c be three vectors such that $a \times b = 2(a \times c)$. *If* $|a| = 1, |b| = 4, |c| = 2$, and the angle between b *and* c *is* 60^o, *then* $|a.c|$ is equal to

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

Key: **1**

$\bar{a} \times \bar{b} = 2(\bar{a} \times \bar{c})$

Sol: $2(\bar{a} \times \bar{c}) - (\bar{a} \times \bar{b}) = 0$

$\bar{a} \times (2\bar{c} - \bar{b}) = 0$

$\bar{a} \parallel 2\bar{c} - \bar{b}$

$2\bar{c} - \bar{b} = \lambda \bar{a}$

$(2\bar{c} - \bar{b})^2 = \lambda^2 |\bar{a}|^2$

$4|\bar{c}|^2 + |\bar{b}|^2 - 4\bar{b}.\bar{c} = \lambda^2 |\bar{a}|^2$

$\lambda = \pm 4.$

$2\bar{c} - \bar{b} = 4\bar{a}$

$2\bar{c} - 4\bar{a} = \bar{b}$

$(2\bar{c} - 4a)^2 = |\bar{b}|^2$

$4|\bar{c}|^2 + 16|\bar{a}|^2 - 16\bar{a}.\bar{c} = 16$

$a.c = 1$

12. Consider two sets $A = \{x \in Z : |(|x-3|-3)| \le 1\}$ *and*

$$B = \left\{ x \in \quad -\{1,2\} : \frac{(x-2)(x-4)}{x-1} \log_e (|x-2|) = 0 \right\}.$$

Then the number of onto functions $f : A \rightarrow B$ is equal to

1) 32 2)62 3)79 4)81

Key: **2**

Sol: $||x-3|-3| \le 1$

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

$2 \le |x-3| \le 4.$

$|x-3| \le 4$

$-4 \le x-3 \le 4$

$-1 \le x \le 7$

$2 \le |x-3|$

$x-3 \le -2, x-3 \ge 2$

$x \le 1, x \le 5$

$x \in [-1,1] \cup [5,7]$

$\therefore A = \{-1,0,1,5,6,7\}$

$B = \{3,4\}$

Number of . onto functions from A to B

$= r^n - r_{c_1}(r-1)^n + ... = 2^6 - 2c_1 1 = 62$

13. If the points of intersection of the ellipses $x^2+2y^2-6x-12y+23=0$ *and* $4x^2+2y^2-20x-12y+35=0$ lie on a circle of radius r and centre (a,b), then the value of $ab+18r^2$ is

1)51 2)55 3)53 4)52

Key: **2**

Sol: $s_1 + \lambda s_2 = 0$

$x^2+2y^2-6x-12y+23+\lambda\left(4x^2+2y^2-20x-12y+35\right)=0$

represents a circle

coeff of x^2 = *coeff of* y^2

$1+4\lambda = 2+2\lambda$

$\lambda = 1/2$

$x^2+2y^2-6x-12y+23+1/2\left(4x^2+2y^2-20x-12y+35\right)=0$

$6x^2+6y^2-32x-36y+81=0$

$x^2+y^2-\frac{16}{3}x-6y+\frac{81}{6}=0$

$c=\left(\frac{8}{3},3\right), r=\sqrt{\frac{47}{18}}$

$ab+18r^2 = 8+47 = 55$

14. The number of ways, in which 16 oranges can be distributed to four childrens such that each child gets at least one orange, is

1)455 2)384 3)429 4)403

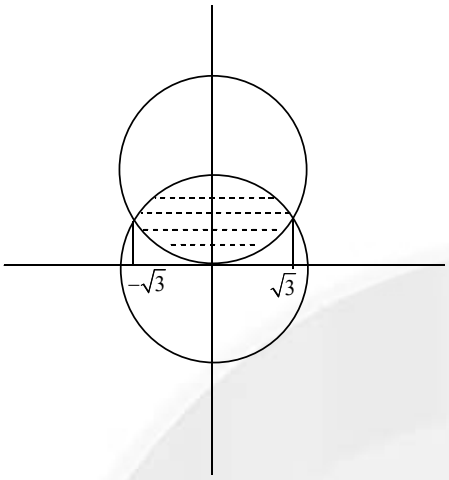
Key: **1**

Sol: Required number of ways $= n-1_{C_{r-1}} = 15_{C_3} = 455$

15. The area of the region enclosed between the circles $x^2+y^2=4$ and $x^2+(y-2)^2=4$ is

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

Key: **4**



Sol:

$$\text{Req area} = \int_{-\sqrt{3}}^{\sqrt{3}} \left\{ \sqrt{4-x^2} - \left(2 - \sqrt{4-x^2}\right) \right\} dx$$

$$= \int_{-\sqrt{3}}^{\sqrt{3}} \left(2\sqrt{4-x^2} - 2\right) dx$$

$$= \frac{2}{3}\left(4\pi - 3\sqrt{3}\right)$$

16. *Let* $a = \hat{i} - 2\hat{j} + 3\hat{k}, b = 2\hat{i} + \hat{j} - \hat{k}, c = \lambda\hat{i} + \hat{j} + \hat{k}$ *and* $v = a \times b$. If $v.c = 11$ and the length of the projection of b *on* c *is* p, *then* $9p^2$ is equal to

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

Key: **3**

$$\bar{v} = \bar{a} \times \bar{b} = \begin{vmatrix} i & j & k \\ 1 & -2 & 3 \\ 2 & 1 & -1 \end{vmatrix} = -i + 7j + 5k$$

Sol: $\bar{v}.\bar{c} = 11$

$\lambda = 1$

$P = \text{The projection of } \bar{b} \text{ on } \bar{c} = \dfrac{\bar{b}.\bar{c}}{|\bar{c}|} = \dfrac{2}{\sqrt{3}}$

$9P^2 = 12$

17. The least value of $\left(\cos^2\theta - 6\sin\theta\cos\theta + 3\sin^2\theta + 2\right)$ *is*

1) $4 + \sqrt{10}$ 2) $4 - \sqrt{10}$ 3) 1 4) -1

Key: **2**

Sol: $f(\theta) = \dfrac{1+\cos 2\theta}{2} - 3(2\sin\theta\cos\theta) + 3\left(\dfrac{1-\cos 2\theta}{2}\right) + 2 = 4 - \cos 2\theta - 3\sin 2\theta$

$\min imum \text{ of } f(\theta) = 4 - \sqrt{10}$

18. The sum of all the real solutions of the equation

$\log_{(x+3)}\left(6x^2 + 28x + 30\right) = 5 - 2\log_{(6x+10)}\left(x^2 + 6x + 9\right)$ *is equal to*

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

Key: **3**

Sol: $\log_{(x+3)}(x+3)(6x+10)=5-2\log_{(6x+10)}^{(x+3)^2}$

$1+\log_{x+3}^{6x+10}=5-4\log_{6x+10}^{x+3}$

$t=\log_{x+3}^{6x+10}$

$1+t=5-\frac{4}{t}$

$(t-2)^2=0$

$t=2$

$\log_{x+3}^{6x+10}=2$

$6x+10=(x+3)^2$

$x^2=1$

$x=\pm 1$

19. *Let* $\sum_{k=1}^{n} a_k=\alpha n^2+\beta n$. *If* $a_{10}=59$ *and* $a_6=7a_1$, *then* $\alpha+\beta$ is equal to

1)12 2)5 3)3 4)7

Key:**2**

Sol: $a_1=\alpha+\beta$

$a_1+a_2=4\alpha+2\beta$

$a_2=3\alpha+\beta$

$d=2\alpha$

$a_6=7(\alpha+\beta)$

$\alpha+\beta+5.2\alpha=7(\alpha+\beta)$

$4\alpha=6\beta$

$\alpha=\frac{3}{2}\beta$

$a_{10}=59$

$\alpha+\beta+9.2\alpha=59$

$19\alpha+\beta=59$

$\frac{57\beta}{2}+\beta=59$

$\beta=2 \quad \alpha=3$

$\alpha+\beta=5$

20. Let $A(1,2)$ *and* $C(-3,-6)$ be two diagonally opposite vertices of a rhombus, whose sides AD and BC are parallel to the line $7x-y=14$. *If* $B(\alpha,\beta)$ *and* $D(\gamma,\delta)$ are the other two vertices, then $|\alpha+\beta+\gamma+\delta|$ is equal to

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

Key: **2**

Sol: Mid point of AC=mid point of BD $B+D=A+C\Rightarrow\left(\frac{\alpha+\gamma}{2},\frac{\beta+\delta}{2}\right)=\left(\frac{1-3}{2},\frac{2-6}{2}\right)$

$|\alpha+\beta+\gamma+\delta|=|1-3+2-6|=6$

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 $A=\begin{bmatrix}0 & 2 & -3\\ -2 & 0 & 1\\ 3 & -1 & 0\end{bmatrix}$ and B be a matrix such that $B(I-A)=I+A$. Then the sum of the diagonal elements of B^TB is equal to_____.

Key: **3**

Sol: A *is skew symmetric matrix.*

$A^T=-A$

$(I-A)^T B^T=(I+A)^T$

$(I+A)B^T=I-A$

$B(I-A)B^T=B^T(I+A)=I-A$

$B^TB=(I-A)(I-A)^{-1}=I$

$Trace\left(B^TB\right)=3$

22. The number of elements in the set $S=\left\{x: x\in[0,100] and \int_0^x t^2\sin(x-t)dt=x^2\right\}$ is ____.

Key: **16**

Sol: $\sin x\int_0^x t^2\cos t dt-\cos x\int_0^x t^2\sin t\,dt=x^2$

$\sin x\left(t^2\sin t+2t\cos t-2\sin t\right)_0^x-\cos x\left(-t^2\cos t+2t\sin t+2\cos t\right)_0^x=x^2$

$x^2-2+2\cos x=x^2$

$\cos x=1$

$x=0,2\pi,4\pi....30\pi$

$No.of\ solution=16$

23. If the image of the point $P(a,2,a)$ *in the line* $\frac{x}{2}=\frac{y+a}{1}=\frac{z}{1}$ *is* Q, and the image of Q in the line $\frac{x-2b}{2}=\frac{y-a}{1}=\frac{z+2b}{-5}$ *is* P, *then* $a+b$ *is equal to* _____.

Key: **3**

Sol: *foot of perpendicular from* P *on* L_1 *is* R

$R=(2\lambda,\lambda-a,\lambda)$

$d.r.\ of\ PR=(2\lambda-a,\lambda-2-a,\lambda-a)$

$2(2\lambda-a)+1(\lambda-a-2)+1(\lambda-a)=0$

$6\lambda=4a+2$

PR *is perpendicular to* L_2

$\therefore 2(2\lambda-a)+1(\lambda-a-2)-5(\lambda-a)=0$

$a=1$

$$\begin{vmatrix} x & y+a & z \\ 2 & 1 & 1 \\ 2 & 1 & -5 \end{vmatrix}=0$$

$x-2y-2a=0$

$(2b,a,-2b)$ *will satisfy it.*

$2b-2a-2a=0$

$b=2a$

$b=2$

$\Rightarrow a+b=2+1=3$

24. If the solution curve $y=f(x)$ of the differential equation $(x^2-4)y'-2xy+2x(4-x^2)^2=0, x>2$, passes through the point $(3,15)$, then the local maximum value of f is_____.

Key: **16**

Sol: $y^1+\left(\frac{-2x}{x^2-4}\right)y=-2x(x^2-4)$

$I.F=e^{-\int\frac{2x}{x^2-4}dx}=\frac{1}{x^2-4}$

$G.S\ \ y\left(\frac{1}{x^2-4}\right)=\int\left(-2x(x^2-4)\right)\frac{1}{x^2-4}dx$

$\frac{y}{x^2-4}=-x^2+c$

Passes through $(3,15)$

$c=12$

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

$=16-(x^2-8)^2\le 16$

25. Let S denote the set of 4-digit numbers $abcd$ such that $a>b>c>d$ and P denoted the set of 5-digit numbers having product of its digits equal to 20. Then $n(S)+n(P)$ is equal to_____.

Key: **260**

Sol: $n(S)={}^{10}C_4=210$

For 5 *digit no.*

2 possibilities

$(5,4,1,1,1)\ \&\ (5,2,2,1,1)$

then $n(p)=\frac{5!}{2!2!}+\frac{5!}{3!}=30+20=50$

$n(s)+n(p)=210+50=260$

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 body of mass 14 kg initially at rest explodes and breaks into three fragments of masses in the ratio 2:2:3. The two pieces of equal masses fly off perpendicular to each other with a speed of 18 m/s each. The velocity of the heavier fragment is.. m/s

1) $12\sqrt{2}$ 2) 12 3) $10\sqrt{2}$ 4) $24\sqrt{2}$

Key: 1

$$0=\sqrt{2}p+P^1V^1$$

Sol: $\sqrt{2}\times 4\times 18=6V^1$

$$V=12\sqrt{2}$$

27. A parallel plate capacitor with plate separation 5 mm is charged by a battery. On introducing a mica sheet of 2mm and maintaining the connections of the plates with the terminals of the battery, It is found that it draws 25% more charge from the battery. The dielectric constant of mica is

1)1.0 2) 2.5 3) 1.5 4) 2.0

Key: 4

Sol: $C=\dfrac{\varepsilon_0 A}{d}$

$$Q=C_{eff}V=1.25CV$$

$$C_{eff}=\frac{5KC}{3K+2}$$

$$\frac{5KC}{3K+2}=1.25C=\frac{5}{4}$$

$$K=2$$

28. One mole of an ideal diatomic gas expands from volume V to 2V isothermally at a temperature 27^0C and does W joule of work. If the gas undergoes same magnitude of expansion adiabatically from 27^0C doing the same amount of work W, the its final temperature will be (close to)….^{0}C. $(\log_e 2=0.693)$

1) -189 2) -56 3) -117 4) -30

Key: 2

Sol: W isothermal = W adiabatic

$$1\times R\times 300\ln(2)=\frac{nR(300-T)}{\left(\frac{7}{5}-1\right)}$$

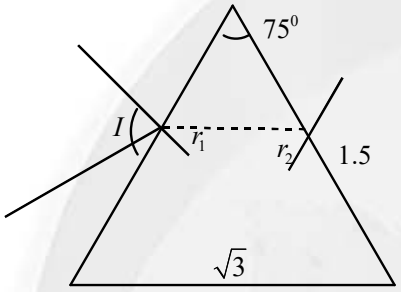
$$T=216.82k \qquad T=-56.17^0C$$

29. A prism of angle 75^0 and refractive index $\sqrt{3}$ is coated with thin film of refractive index 1.5 only at the back exit surface. To have total internal reflection at the back exit surface the incident angle must be.... $\left(\text{Sin}15^0 = 0.25 \text{ and } \sin 25^0 = 0.43\right)$

1) $< 15^0$ 2) 15^0 3) *between* 15^0 *and* 20^0 4) $> 25^0$

Key: 1,2,3

Sol:



For TIR

$r_2 = \sin^{-1}\left(\frac{1.5}{\sqrt{3}}\right)$

$r_2 = 60^0$

$r_1 + r_2 = A$

$r_1 = 15$

$1\sin A = \sqrt{3}\sin 15^0 = \sqrt{3} \times \frac{1}{4}$

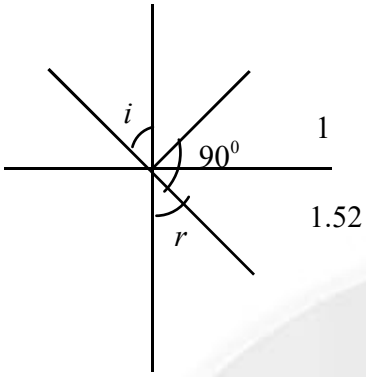
$= \frac{\sqrt{3}}{4}$

$I \le 25^0$

30. When an unpolarised light falls at a particular angle on a glass plate (placed in air), it is observed that the reflected beam is linearly polarized. The angle of refracted beam with respect to the normal is... ($\tan^{-1}(1.52) = 57.7^0$, refractive indices of air and glass are 1.00 and 1.52 respectively)

1) 42.6^0 2) 39.6^0 3) 32.3^0 4) 36.3^0

Key: 3



Sol:

$$\text{Tan}\, I = \frac{1.52}{1}$$

$$I = 57.7^0$$

$$r = 90^0 - 57.7^0$$

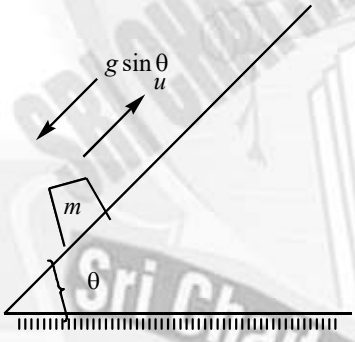
$$r = 32.3^0$$

31. A block is sliding down on an inclined plane of slope θ and at an instant t=0 this block is given an upward momentum so that it starts moving up on the inclined surface with velocity u. The distance (S) travelled by the block before its velocity become zero, is…(g=gravitational acceleration)

1) $\frac{u^2}{4g\sin\theta}$ 2) $\frac{2u^2}{g\cos\theta}$ 3) $\frac{u^2}{\sqrt{2}g\cos\theta}$ 4) $\frac{u^2}{2g\cos\theta}$

Key: BONUS

Sol:



On applying third equation of motion $0^2 = u^2 - 2(g\sin\theta).S \Rightarrow S = \frac{u^2}{2g\sin\theta}$

NTA KEY : 1

Remark :

Topic : Newton's law of motion

gf frictions present then only

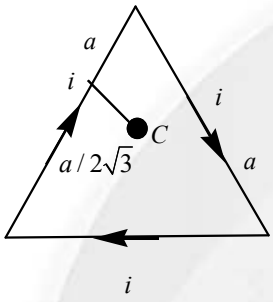
Option (1) can be correct answer (Id 444792479)

32. The current passing through a conducting loop in the form of equilateral triangle of side $4\sqrt{3}\,cm$ is 2A. The magnetic field at its centroid is $\alpha\times10^{-5}T$. The value of α is…….(given $\mu_0=4\pi\times10^{-7}\,SI\,units$)

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

Key: 2

Sol:



As magnetic field due to finite wire is

$$B=\frac{\mu_0 i}{4\pi r}\left[\sin\alpha_1+\sin\alpha_2\right]$$

$$\Rightarrow B=\frac{\mu_0 i}{4\pi\left(\frac{9}{2\sqrt{3}}\right)}\left[\sin60^0+\sin60^0\right]$$

$$\Rightarrow B=\frac{\mu_0 i}{4\pi a}(6)$$

here

$\mu_0=4\pi\times10^{-7}\,s.i\,units,\ a=4\sqrt{3}\times10^{-2}\,m, i=2amp$

$so\ B_{net}=3B=\frac{18\mu_0 i}{4\pi a}=\frac{18\times10^{-7}\times2}{4\sqrt{3}\times10^{-2}}$

$\mathbf{B}_{net}=3\sqrt{3}\times10^{-5}$

$So\ \alpha=3\sqrt{3}$

33. A small metallic sphere of diameter 2 mm and density 10.5 g/cm^3 is dropped in glycerine having viscosity 10 Poise and density 1.5g/cm^3 respectively. The terminal velocity attained by the sphere is…cm/s $\left(\pi=\frac{22}{7}\,and\,g=10m/s^2\right)$

1) 3.0 2) 2.0 3) 1.5 4) 1.0

Key: 2

Sol: As terminal velotiy

$$V_T=\frac{2}{9}\frac{r^2\left(\rho_s-\rho_l\right)g}{\eta}\Rightarrow V_T=\frac{2\times0.01\times10^{-6}\times\left(10.5-1.5\right)\times10^3\times10}{9\times10}=2cm/\sec$$

34. A circular loop of radius 7 cm is placed in uniform magnetic field of 0.2T directed perpendicular to plane of loop. The loop is converted into a square loop in 0.5s. The EMF induced in the loop is….mV.

1) 13.2 2) 1.32 3) 6.6 4) 8.25

Key: 2

Sol: As length of wire remains same, so

$2\pi r = 4l$

$\Rightarrow 2\times\frac{22}{7}\times 7cm = 4\times l \Rightarrow l = 11cm$

$change\,in\,area\ \Delta A = l^2 - \pi r^2$

$\Delta A = \left(121 - \frac{22}{7}\times 49\right)\times 10^{-2}$

$\Delta A = -0.33m^2$

$avg.\ emf\ induced, E_{avg} = \left|\frac{\Delta\varphi}{\Delta t}\right| = \left|\frac{B.\Delta A}{\Delta t}\right|$

$\Rightarrow E_{avg} = \frac{0.2\times 0.33}{0.5} = 1.32mV$

35. To compare EMF of two cells using potentiometer the balancing lengths obtained are 200cm and 150cm. The least count of scale is 1cm. The percentage error in the ratio of EMFs is…

1) 1.75 2) 1.65 3) 1.45 4) 1.55

Key: Bonus

$Let\,say\ x = \frac{E_2}{E_1} = \frac{L_2}{L_1}$

Sol: $\frac{\Delta x}{x} = \frac{\Delta L_2}{L_2} + \frac{\Delta L_1}{L_1}$

$\%\,error\ in\ x = \frac{\Delta L_2}{L_2}\times 100 + \frac{\Delta L_1}{L_1}\times 100 = \left(\frac{1}{200} + \frac{1}{150}\right)\times 100 = 0.5 + 0.67 = 1.17\%$

NTA KEY : 4

Remark :

Topic : Experimental Physics (Id 444792476)

36. The internal energy of a monoatomic gas is 3nRT. One mole of helium is kept in a cylinder having internal cross section area of $17cm^2$ and fitted with a light movable frictionless piston. The gas is heated slowly by suppling 126J heat. If the temperature rises by 4^0C, then the piston will move …cm. (Atmospheric pressure = $10^5 Pa$)

1) 1.55 2) 1.45 3) 15.5 4) 14.5

Key: 3

Sol: process is isobaric

$\Delta Q = 126$

$\Delta U = 3nR\Delta T = 100$

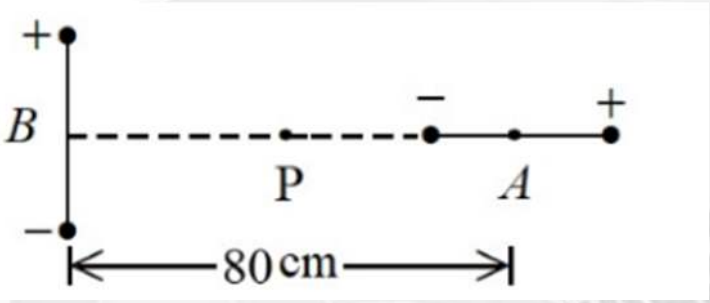
$P\Delta V = 26$

$PA\Delta x = 26$

$10^5 \times 17 \times 10^{-4} \Delta x = 26$

$\Delta x = 0.155m$

37. Two shorts dipoles (A,B), A having charges $\pm 2\mu C$ and length 1cm and B having charges $\pm 4\mu C$ and length 1cm are placed with their centres 80cm apart as shown in the figure. The electric field at a point P, equi-distant from the centres of both dipoles is……..N/C.



1) $4.5\sqrt{2} \times 10^4$ 2) $\frac{9}{16}\sqrt{2} \times 10^4$ 3) $9\sqrt{2} \times 10^4$ 4) $\frac{9}{16}\sqrt{2} \times 10^5$

Key: 2

$\Delta Q = 126$

$E = \frac{kp_2}{r^3}\left(-\hat{j}\right) + \frac{2kp_1}{r^3}\hat{i}$

Sol:

$|E| = \sqrt{4p_1^2 + p_2^2}\frac{K}{r^3}$

$|E| = \sqrt{2} \times \frac{9}{16} \times 10^4$

38. A paratrooper jumps from an aeroplane and opens a paracliute after 2s of free fall and starts deaccelerating with $3m/s^2$. At 10m height from ground, while descending with the help of parachute, the speed of paratrooper is 5m/s. The initial height of the airplane is… m. $\left(g = 10m/s^2\right)$

1) 92.5 2) 20 3) 82.5 4) 62.5

Key: 1

A

B

C

D

Sol:

$AB = h_1, BC = h_2, CD = 10m$

$v_1 = gt = 20m/s$

$h_1 = \frac{1}{2}gt^2 = 20m$

$5^2 - v_1^2 = 2as = 2(-3)(h_2)$

$h_2 = 62.5m$

Total height

$20 + 62.5 + 10 = 92.5$

39. An air bubble of volume 2.9cm^{3}rises from the bottom of a swimming pool of 5m deep. At the bottom of the pool water temperature is 17^{0}C. The volume of the bubble when it reaches the surface, where the water temperature is 27^{0}C, is …..cm^3. (g=10m/s^2, density of water =10^{3}kg/m^3. And 1 atm pressure is 10^5 Pa)

1) 4.2 2) 2.0 3) 4.5 4) 3.0

Key: 3

Sol:

$PV = nRT$

$\left[10^5 + \rho g h_1\right]2.9cc = nR(273+17)$

$\left[10^5 \times 1.5\right]2.9cc = nR(290).....(i)$

$PV = nRT$

$10^5 \times V = nR(273+27)$

$10^5 V = nR(300).....(ii)$

Dividing

$\frac{1.5 \times 2.9}{V} = \frac{2.9}{3}$

$V = 4.5cc$

40. Suppose a long solenoid of 100cm length, radius 2cm having 500turns per unit length, carries a current $I = 10\sin(\omega t)A$, where $\omega = 1000 rad/s$. A circular conducting loop (B) of radius 1cm coaxially slided through the solenoid at a speed $v = 1cm/s$. The r.m.s current through the loop when the coil B is inserted 10cm inside the solenoid is $\alpha/\sqrt{2}\mu A$. The value of α is…..[Resistance of the loop$=10\Omega$]

1) 80 2) 100 3) 197 4) 280

Key: 3

Sol:

$B = \mu_0 nI$

$B = 4\pi \times 10^{-7} \times 500 \times 10\sin\omega t$

$B = 2\pi \times 10^{-3}\sin\omega t$

$\phi = B\pi r^2$

$\phi = 2\pi \times 10^{-3}\pi\left(10^{-2}\right)^2 \sin\omega t$

$\phi = 2\times10^{-6}\sin\omega t \ \left[taking\ \pi^2 = 10\right]$

$E = 2\times10^{-3}\cos\omega t$

$I = \frac{E}{R} = 2\times10^{-4}\cos\omega t$

$I_{rms} = \frac{2}{\sqrt{2}}\times10^{-4} = \frac{200}{\sqrt{2}}\mu A\ (Approx)$

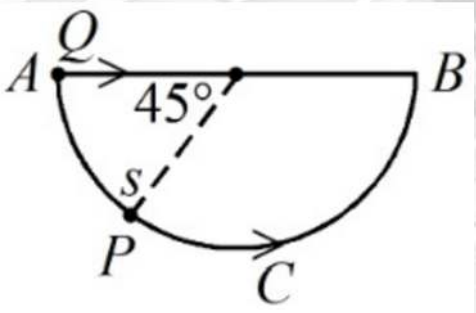
41. Which of the following pair of nuclei are isobars of the element ?

1) ${}^{3}_{1}H$ and ${}^{3}_{2}He$ 2) ${}^{2}_{1}H$ and ${}^{3}_{1}H$ 3) ${}^{198}_{80}Hg$ and ${}^{197}_{79}Au$ 4) ${}^{236}_{92}U$ and ${}^{238}_{92}u$

Key: 1

Sol: Atomic mass should be same

42. A bead P sliding on a frictionless semi-circular string (ACB) and it is at point S at t=0 and at this instant the horizontal component of its velocity is v. Another bead Q of the same mass as P is ejected from point A at t=0 along the horizontal string AB, with the speed v, friction between the beads and the respective strings may be neglected in both cases. Let t_P and t_Q be the respective times taken by beads P and Q to reach the point B, then the relation between t_P and t_Q is.

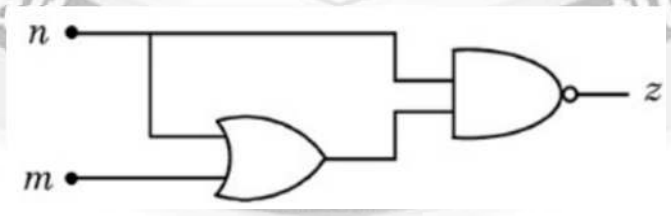


1) $t_P = t_Q$ 2) $t_P > t_Q$ 3) $t_P < t_Q$ 4) $t_P > 1.25t_Q$

Key: 3

Sol: For P horizontal velocity is always greater or equal to v hence $t_p < t_q$

43. For the given logic gate circuit. Which of the following is the correct truth table?



	n	m	z
	0	0	1
1)	0	1	1
	1	1	0
	1	0	0

	n	m	z
	0	0	0
2)	0	1	1
	1	1	0
	1	0	1

	n	m	z
	0	0	1
3)	0	1	0
	1	1	1
	1	0	0

	n	m	z
	0	0	1
4)	0	1	0
	1	1	0
	1	0	0

Key: 1

Sol: $Z=\overline{n(n+m)}$

n	m	$Z=\overline{n(n+m)}$
0	0	1
0	1	1
1	1	0
1	0	0

44. The ratio of speeds of electromagnetic waves in vacuum and a medium, having dielectric constant k=3 and permeability of $\mu=2\mu_0$ is. $(\mu_0 = permeability\,of\,vacuum)$

1) $\sqrt{6}:1$ 2) $36:1$ 3) $3:2$ 4) $6:1$

Key: 1

Sol: $\mu=\dfrac{C}{V}=\dfrac{\dfrac{1}{\sqrt{\mu_0 \in_0}}}{\dfrac{1}{\sqrt{\mu \in}}}=\sqrt{\mu_r \in_r}$

$\mu=\sqrt{2\times 3}=\sqrt{6}$

45. Two charges $7\mu C$ and $-2\mu C$ are placed at (-9,0,0) cm and (9,0,0) cm respectively in an external field $E=\dfrac{A}{r^2}\bar{r}$, Where $A=9\times10^5\,N/Cm^2$. Considering the potential at infinity is 0, the electrostatic energy of the configuration is…….J.

1) -90.7 2) 1.4 3) 49.3 4) 24.3

Key: 3

$U=\dfrac{kq_1q_2}{r}+q_1v_1+q_2v_2$

Sol: $U=\dfrac{9\times10^9\times7\times10^{-6}\times(-2)\times10^{-6}}{18\times10^{-2}}+7\times10^{-6}\times\dfrac{9\times10^5}{9\times10^{-2}}+-2\times10^{-6}\times\dfrac{9\times10^5}{9\times10^{-2}}$

$U=-7\times10^{-1}+70-20$

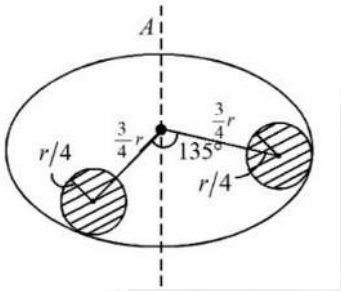
$U=49.3J$

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. Suppose there is a uniform circular disc of mass M kg and radius r m shown in figure. The shaded regions are cut out from the disc. The moment of inertia of the remainder about the axis A of the disc is given by $\frac{x}{256}Mr^2$ .The value of x is…



Key: 109

Sol: $$I=\frac{Mr^2}{2}-\left[\left(\frac{\frac{M}{16}\frac{r^2}{16}}{2}+\frac{M}{16}\left(\frac{3}{4}r\right)^2\right)\right]\times 2$$

$$I=\frac{109}{256}Mr^2$$

47. The size of the images of an object, formed by a thin lens are equal when the object is placed at two different positions 8cm and 24cm from the lens. The focal length of the lens is……cm.

Key: 16

Sol: $m=\frac{f}{f+u}$ *here* $m_1=-m_2$

$$\frac{f}{f-8}=\frac{-f}{f-24}$$

$$f-24=-f+8$$

$$2f=32$$

$$f=16cm$$

48. The velocity of sound in air is doubled when the temperature is raised from 0^0C to α^0C. The value of α is……

Key: 819

Sol: $\frac{V_2}{V_1}=\sqrt{\frac{T_2}{T_1}}$

$$\frac{2V}{V}=\sqrt{\frac{\alpha+273}{273}}$$

$$4\times 273-273=\alpha$$

$$\alpha=3\times 273$$

$$\alpha=819^0 c$$

49. The average energy released per fission for the nucleus of $^{235}_{92}U$ is 190MeV. When all the atoms of 47g pure $^{235}_{92}U$ undergo fission process, the energy released is $\alpha\times 10^{23}\,MeV$. The value of α is… (Avogadro number $=6\times 10^{23}\,per\,mole$)

Key: 228

$$235amu\rightarrow 190MeV$$

$$47gm\rightarrow ?$$

Sol:
$$=\frac{47gm\times 190MeV}{235\times\frac{1}{6\times 10^{23}}gm}$$

$$=\frac{47\times 6}{235}\times 190\times 10^{23}MeV$$

$$=228\times 10^{23}MeV$$

50. A ball of radius r and density ρ dropped through a viscous liquid of density σ and viscosity η attains its terminal velocity at time t, given by $t=A\rho^a r^b\eta^c\sigma^d$, where A is a constant and a,b,c and d are integers. The value of $\frac{b+c}{a+d}$ is.

Key: 1

$$t=Ap^a r^b\eta^c\sigma^d$$

Sol:
$$[T]=\left[ML^{-3}\right]^{a+d}[L]^b\left[ML^{-1}T^{-1}\right]^c$$

$$\therefore\frac{b+c}{c+d}=\frac{2-1}{1}=1$$

CHEMISTRY **Max Marks: 100**

SECTION-I
(SINGLE CORRECT ANSWER TYPE)

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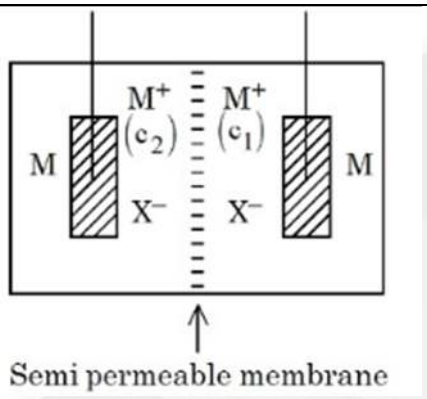
51.



Consider the above electrochemical cell where a metal electrode (M) is undergoing redox reaction by forming $M^+\left(M \rightarrow M^+ + {}^+ e\right)$. *The cation* M^+ is present in two different concentrations c_1 *and* c_2 as shown above. Which of the following statement is correct for generating a positive cell potential?

1) *If* c_1 *is present at anode, then* $c_1 = c_2$. 2) *If* c_1 *is present at cathode, then* $c_1 < c_2$.

3) *If* c_1 *is present at cathode, then* $c_1 > c_2$. 4) *If* c_1 *is present at anode, then* $c_1 > c_2$.

Key: 3

Sol: *Cathode* $\rightarrow$ *reduction*

Anode $\rightarrow$ *Oxidation*

$$\underset{(Cathode)}{M^+} + M \rightarrow \underset{(Anode)}{M^+} + M$$

$$E_{cell} = E^0_{Cell} - 0.06\log\frac{M_{Anode}}{M_{Cathode}} = 0.06\log\frac{M_{cathode}}{M_{Anode}}$$

$$M_{cathode} > M_{Anode}$$

52. Identify the INCORRECT statements from the following:

A. Notation ${}^{24}_{12}Mg$ represents 24 protons and 12 neutrons.

B. Wavelength of a radiation of frequency $4.5\times10^{15}\,S^{-1}$ *is* $6.7\times10^{-8}\,m$.

C. One radiation has wavelength $= \lambda_1(900nm)$ *and energy* $= E_1$. *Other* radiation has wavelength $= \lambda_2(300nm)$ *and energy* $= E_2$. $E_1 : E_2 = 3:1$.

D. Number of photons of light of wavelength 2000 pm that provides 1 J of energy is 1.006×10^{16}.

Choose the correct answer from the options given below:

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

Key: 1

Sol: $E = \frac{hc}{\lambda}$

$v = \frac{c}{\lambda}$

$\frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1}$

53. Identify the CORRECT set of details from the following:

A. $\left[Co\left(NH_3\right)_6\right]^{3+}$: *Inner orbital complex*; d^2sp^3 *hybridized*

B. $\left[MnCl_6\right]^{3-}$: *Outer orbital complex*; sp^3d^2 *hybridized*

C. $\left[CoF_6\right]^{3-}$: *Outer orbital complex*; d^2sp^3 *hybridized*

D. $\left[FeF_6\right]^{3-}$: *Outer orbital complex*; sp^3d^2 *hybridized*

E. $\left[Ni\left(CN\right)_4\right]^{2-}$: *Inner orbital complex*; sp^3 *hybridized*

Choose the correct answer from the options given below:

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

Key: 2

Sol: $Co^{+3} \rightarrow 4s^0\,3d^6\left(NH_3\right) \rightarrow inner$

$Mn^{+3} \rightarrow 4s^0\,3d^4\left(Cl\right) \rightarrow outer$

$Co^{+3} \rightarrow 4s^0\,3d^6\left(Cl\right) \rightarrow outer$

$Fe^{+3} \rightarrow 4s^0\,3d^5\left(F\right) \rightarrow outer$

$Ni^{+2} \rightarrow 4s^0\,3d^8\left(CN\right) \rightarrow dsp^2$

54. Elements X and Y belong to group 15. The difference between the electronegativity values of 'X' and phosphorus is higher than that of the difference between phosphorus and 'Y'. 'X' & 'Y' are respectively

1) *As & Sb* 2) *Bi & N* 3) *As & Bi* 4) *N & As*

Key: 4

Sol: $E.N : N > P > As > Sb$

$So\ X = N$

$Y = As$

55. The oxidation state of chromium in the final product in the reaction between KI and

acidified $K_2Cr_2O_7$ solution is:

1) +3 2) +6 3) +4 4) +2

Key: 1

Sol: $Cr^{+6} \rightarrow Cr^{+3}$ *on reduction*

56. Given below are two statements:

Statement I: The second ionisation enthalpy of Na larger than the corresponding ionisation enthalpy of Mg.

Statement II: the ionic radius of O^{2-} is larger than that of F^-.

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

1) Both statement I and statement II are true

2) Statement I is false but Statement II is true

3) Statement I is true but Statement II is false

4) Both Statement I and Statement II are false

Key: 1

Sol: **Statement-I:** True due to octet configuration of Na^+

Statement-II: True as isoelectronic species size α charge

57. which of the following statements are TRUE about Haloform reaction?

A. Sodium hypochlorite reacts with KI to give KOI.

B. KOI is a reducing agent.

C. $\alpha,\beta-$*unsaturated methylketone* $\left(CH_3-CH=CH-\overset{\overset{O}{\|}}{C}-CH_3\right)$ will give iodoform reaction.

D. Isopropyl alcohol will not give iodoform test.

E. Methanoic acid will give positive iodoform test.

Choose the correct answer from the options given below:

1) $B,D\,\&\,E\,Only$ 2) $A\,\&\,C\,Only$ 3) $A,C\,\&\,E\,Only$ 4) $A,B\,\&\,C\,Only$

Key: 2

Sol: **A)** $NaOCl + KI \rightarrow NaCl + KOI$

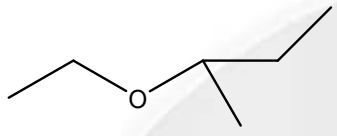
B) KOI is an oxidising agent, Since it release nascent oxygen

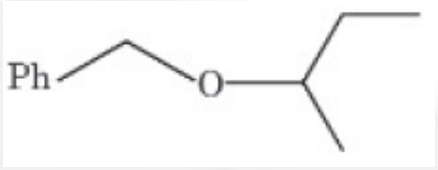
C) It has end methyl group, so it will give iodoform test

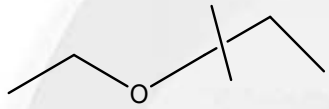
D) Isopropyl alcohol will give iodoform test

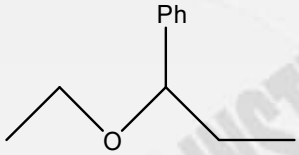
E) Methanoic acid does not give iodoform test

58. A mixed ether (P), when heated with excess of hot concentrated hydrogen iodide produces two different alkyl iodides which when treated with aq. *NaOH* give compounds (Q) and (R) Both (Q) and (R) give yellow precipitate with *NaOI*. Identify the mixed ether(P):

1) 

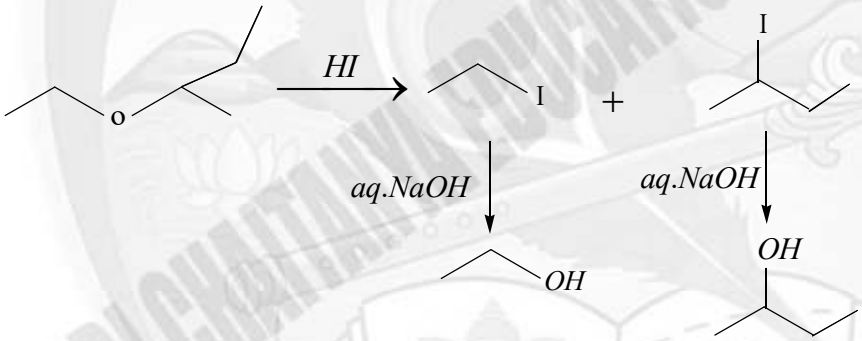
2) 

3) 

4) 

Key:1

Sol: By verifying options,



Both have end methyl group, So both will give Iodofrom (Yellow precipitate with NaOI)

59. Given below are two statements:

Statement I: $(CH_3)_3\overset{\oplus}{C}$ is more stable than $\overset{\oplus}{C}H_3$ as nine hyperconjugation interactions are possible in $(CH_3)_3\overset{\oplus}{C}$.

Statement II: $\overset{\oplus}{C}H_3$ is less stable than $(CH_3)_3\overset{\oplus}{C}$ as only three hyperconjugation interactions are possible in $\overset{\oplus}{C}H_3$.

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

1) Both statement I and statement II are true

2) Statement I is false but statement II is true

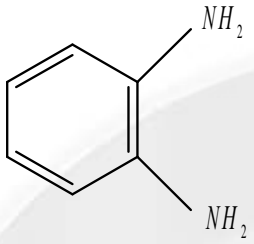
3) Both statement I and statement II are false

4) Statement I is true but statement II is false

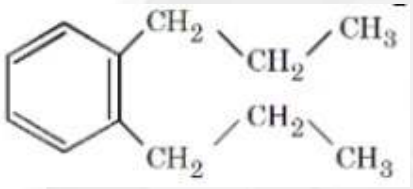
Key: 4

Sol: The condition for hyper conjugation is atleast $1\ \alpha - H$, i.e, atleast 1 H atom on adjacent C to positive charge

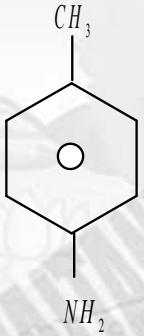
60. Given below are two statements:



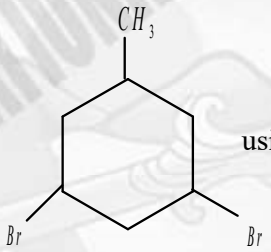
Statement I: can be synthesized from



using simpler reagents in the order i) Acidic $KMnO_4$ ii) Ammonia iii) Bromine and alkali



can be converted into



using regents

Statement II:

In the order i) Bromine $-H_2O$ ii) $NaNO_2 / HC1(0-5\ C)$ iii) Aq. H_3PO_2.

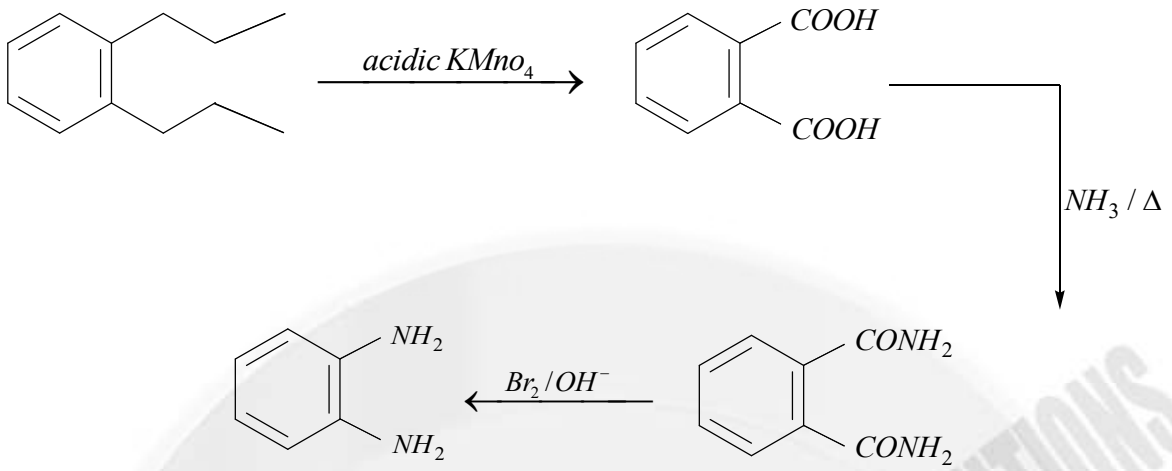
In the light of the above statements, choose the correct answer from the options given below

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

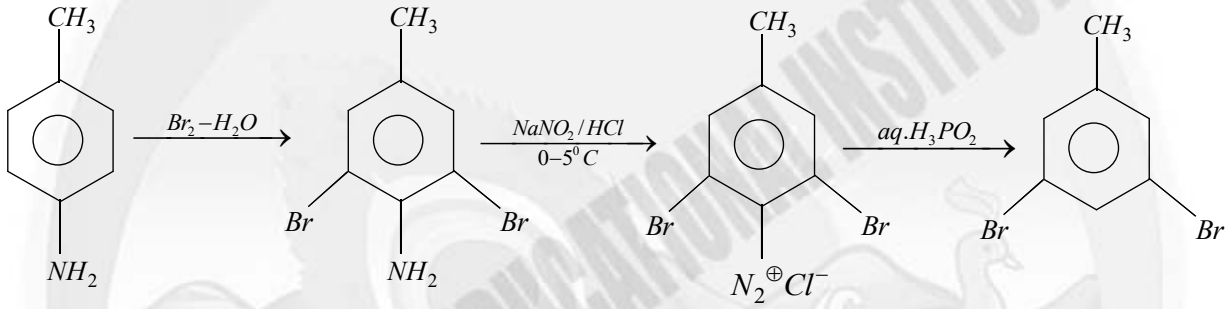
Key: 2

Sol:

Statement-I:



Statement-II:



61. In Carius method 0.2425 g of an organic compound gave 0.5253 g silver chloride.

The percentage of chlorine in the organic compound is

1) 53.58% 2) 34.79% 3) 37.57% 4) 87.65%

Key:1

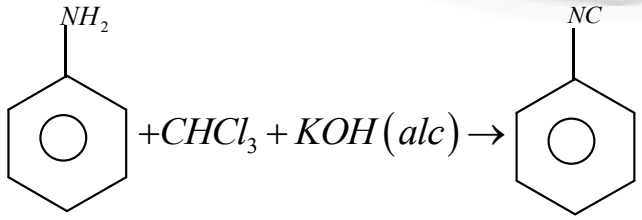
Sol: $\%Cl = \frac{35.5}{143.5} \times \frac{wt\ of\ AgCl}{wt\ of\ O.C} \times 100 = \frac{35.5}{143.5} \times \frac{0.5253}{0.2425} \times 100 = 53.58\%$

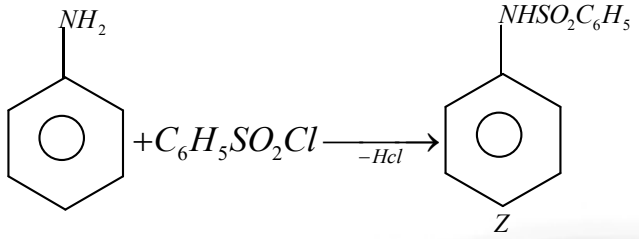
62. A student has been given a compound "x" of molecular formula- C_6H_7N.'x' is sparingly soluble in water. However, on addition of dilute mineral acid 'x' becomes soluble in water 'x' when treated with $CHCl_3$ and $KOH\left(alc\right)$, 'y' is produced. 'y' has a specific unpleasant smell. On treatment with benzenesulphonyl chloride 'x' gives a compound 'z' which is soluble in alkali. The number of different "H" atoms present in 'z' is:

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

Key:1

Sol: $MF = C_6H_7N$





63. Both human DNA and RNA are chiral molecules. The chirality in DNA and RNA arises due to the presence of

1) D-sugar component 2) L-sugar component

3) Chiral phosphate unit 4) Base unit

Key: 1

Sol: Chirality in DNA and RNA arises

Due to the presence of D-sugar component

64. It is noticed that Pb^{2+} is more stable than Pb^{4+} but Sn^{2+} is less stable than Sn^{4+}. Observe the following reactions.

$PbO_2 + Pb \rightarrow 2PbO; \Delta_r G\ (1)$

$SnO_2 + Sn \rightarrow 2SnO; \Delta_r G\ (2)$

Identify the correct set from the following

1) $\Delta_r G\ (1) > 0\,; \Delta_r G\ (2) < 0$ 2) $\Delta_r G\ (1) < 0\,; \Delta_r G\ (2) > 0$

3) $\Delta_r G\ (1) < 0\,; \Delta_r G\ (2) < 0$ 4) $\Delta_r G\ (1) > 0\,; \Delta_r G\ (2) > 0$

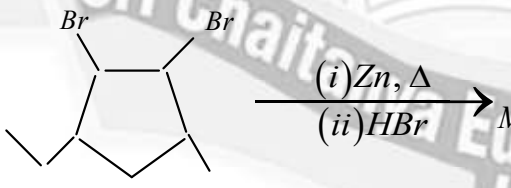
Key: 2

Sol: $\overset{+4}{P}bO_2 + Pb \rightarrow 2\overset{+2}{P}bO$

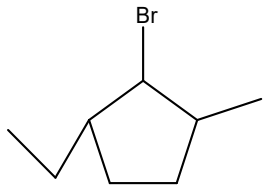
It as spontaneous $\Delta G^0(1) < 0$

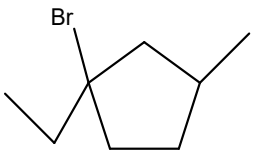
$\overset{+4}{S}nO_2 + Sn \rightarrow 2\overset{+2}{S}nO$ **It as non- spontaneous** $\Delta G^0(2) < 0$

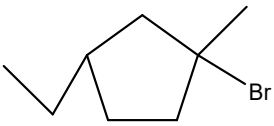
65.

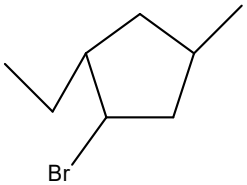


Identify (P)

1) 

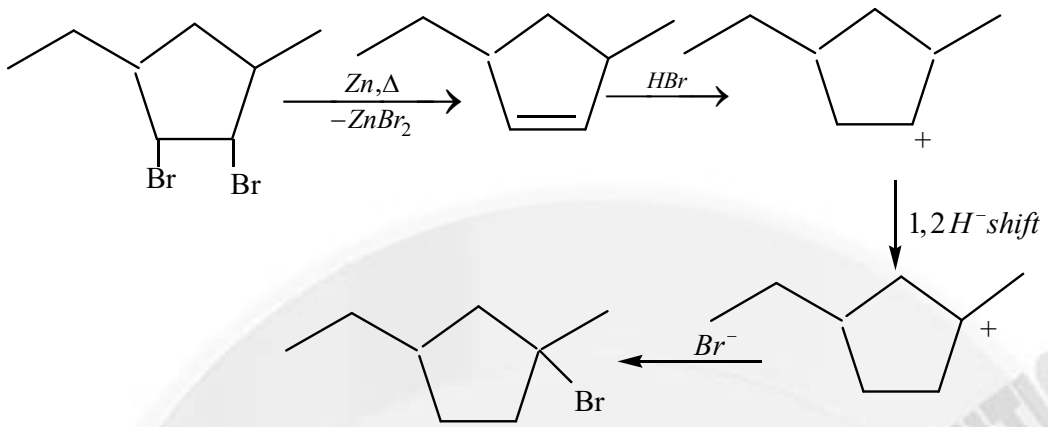
2) 

3) 

4) 

Key: 3

Sol:



66. Observe the following reactions at T(K).

$I. A \rightarrow products$

$II. 5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$

Both the reactions are started at 10.00am .The rates of these reactions at 10.10am are same. The value of $-\frac{\Delta[Br^-]}{\Delta t}$ at 10.10 am is $2\times10^{-4} mol\,L^{-1}\,\text{min}^{-1}$. The concentration of A at 10.10 am is $10^{-2} mol\ L^{-1}$. What is the first order rate constant (in min^{-1}) of reaction I?

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

Key: 1

Sol: $\frac{1}{5}\frac{d[Br^-]}{dt} = \frac{d[A]}{dt} = K[A]$

$\frac{1}{5}\times2\times10^{-4} = K\times[10^{-2}]$

$K = 4\times10^{-3}$

67. Iodoform test can differentiate between

A. Methanol and Ethanol B. CH_3COOH and CH_3CH_2COOH

C. Cyclohexene and cyclohexanone D. Diethyl ether and Pentan -3- one

E. Anisole and acetone

Choose the correct answer from the options given below.

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

Key: 3

Sol: Iodoform test can differentiate between

(A) $CH_3OH(-ve)\ and\ C_2H_5OH(+ve)$

(E) $C_6H_5OCH_3(-ve)\ and\ CH_3-\overset{O}{\overset{\|}{C}}-CH_3(+ve)$

68. The work functions of two metals (M_A and M_B) are in the 1:2 ratio. When these metals are exposed to photons of energy 6 eV, the kinetic energy of liberated electrons of M_A:M_B is in the ratio of 2.642:1. The work function (in eV) of M_A and M_B are respectively.

1) 1.5, 3.0 2) 2.3, 4.6 3) 3.1, 6.2 4) 1.4, 2.8

Key: 2

Sol: $E = \phi + K.E$

$K.E_B = 6 - \phi_B$

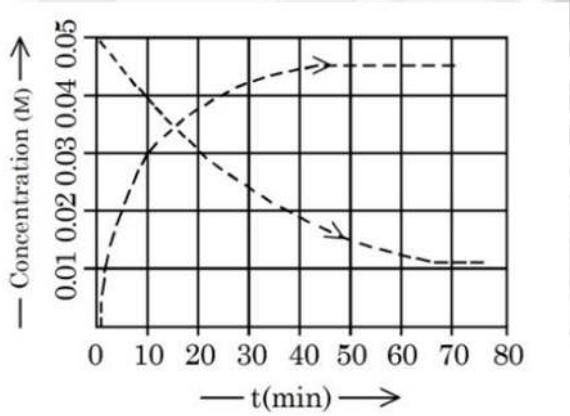
$\frac{K.E_A}{K.E_B} = \frac{6-\phi_A}{6-\phi_B}$ $\qquad \phi_B = 2\phi A$

$\frac{2.642}{1} = \frac{6-\phi_1}{6-2\phi_1}$

$\phi_1 = 2.3$

$\phi_2 = 4.6$

69.



Given above is the concentration vs time plot for a dissociation reaction $A \rightarrow nB$.

Based on the data of the initial phase of the reaction (initial 10 min), the value of n is…..

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

Key: 1

Sol: $A \rightarrow nB$

$f = 0 \quad 0.05 \quad 0$

$0.05 - x \quad nx$

$f = 10 \quad 0.05 - x = 0.04$

$x = 0.01$

From Graph $nx = 0.03$

$n = 3$

70. Which statements are NOT TRUE about ?

A. It has a see-saw shape

B. Xe has 5 electron pairs in its valence shell in XeO_2F_2.

C. The O-Xe-O bond angle is close to 180^0

D. The F-Xe-F bond angle is close to 180^0

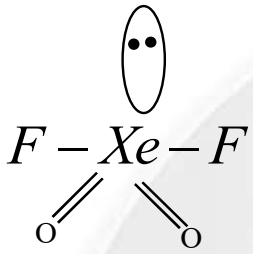
E. Xe has 16 valence electrons in XeO_2F_2

Choose the correct answer from the options given below

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

Key: 4

Sol:



SECTION-II
(NUMERICAL VALUE TYPE

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

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

71. $X_2(g)+Y_2(g) \quad 2Z(g)$

$X_2(g)$ *and* $Y_2(g)$ are added to a 1 L flask and it is found that the system attains the above equilibrium at $T(K)$ with the number of moles of $X_2(g), Y_2(g)$ *and* $Z(g)$ being 3, 3 and 9 mol respectively (equilibrium moles). Under this condition of equilibrium,

10 *mol of* $Z(g)$ is added to the flask and the temperature is maintained at $T(K)$. Then the number of moles of $Z(g)$ in the flask when the new equilibrium is established is _____. (Nearest integer)

Key: 15

Sol: $Keq = \frac{9^2}{3\times 3} = 9$

$x_2 + y_2 \quad 2Z$

At Equibrium $(3+x)\ (3+x)\ \ (19-2x)$

$Keq = 9 = \frac{(19-2x)^2}{(3+x)^2}$

$3(3+x) = 19-2x$

$9+3x+2x = 19$

$x = 2, z = 19-2x = 15$

72. Total number of unpaired electrons present in the central metal atoms/ions of $\left[Ni(CO)_4\right], \left[NiCl_4\right]^{2-}, \left[PtCl_2(NH_3)_2\right], \left[Ni(CN)_4\right]^{2-}$ *and* $\left[Pt(CN)_4\right]^{2-}$ is _____.

Key: 2

Sol: In $\left[Ni(CO)_4\right], Ni^0 : 3d^{10}4s^0 4p^0$

Hybridisation state: $sp^3, n=0$

In $\left[NiCl_4\right]^{2-}, Ni^{2+} : 3d^8 4s^0$

Hybridisation state: $sp^3, n=2$

In $\left[PtCl_4\right]^{2-}, Pt^{2+} : 5d^8$ square planar $\left(dsp^2\right)$

Hybridisation state: $dsp^2, n=0$

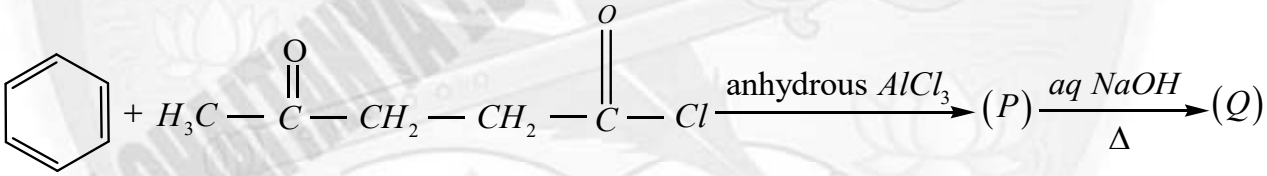
In $\left[PtCl_4\right]^{2-}$ $5d^8$ square planar

Hybridisation state: $dsp^2, n=0$

In $n=3$ square planar

Hybridisation state: $dsp^2, n=0$

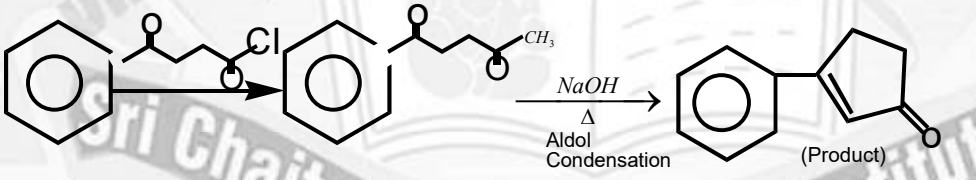
73. Consider the following reaction of benzene.



In compound (Q), the percentage of oxygen is _____ %. (Nearest integer)

Key: 10

Sol:



Molecular mass of product $= 158$

Mass% of oxygen $= \frac{16}{158} \times 100 = 10.13\%$

74. Two liquids A and B form an ideal solution. At 320K, the vapour pressure of the solution. Containing 3 mol of A and 1 mol of B is $500\ mm\ Hg$. At the same temperature, if 1 mol of A is further added to this solution, vapour pressure of the solution increases by $20\ mm\ Hg$. Vapour pressure (in mm Hg) of B in pure state is _____. (Nearest integer)

Key:200

Sol: $X_A = \frac{3}{4}, X_B = \frac{1}{4}$

$P_S = P_A^0 X_A + P_B^0 X_B$

$500 = P_A^0 \times \frac{3}{4} + P_B^0 \times \frac{1}{4}$

$3P_A^0 + P_B^0 = 2000.....(1)$

Now 1 moles of A is further added so $n_A = 4$ moles, $n_B = 1$ mole

$X'_A = \frac{4}{5}, X'_B = \frac{1}{5}$

$P_S = 520 = P_A^0 \times \frac{4}{5} + P_B^0 \times \frac{1}{5}$

$4P_A^0 + P_B^0 = 2600....(2)$

By equation (2)-Equation (1)

$P_A^0 = 600 mmHg$

$P_B^0 = 200 mmHg$

75. $200\,cc$ of $x \times 10^{-3} M$ potassium dichromate is required to oxidise $750\,cc$ of $0.6M$ Mohr's salt solution in acidic medium. Here $x =$ _____.

Key:375

Sol: $Cr_2O_7^{2-} + Fe^{2+} \rightarrow 2Cr^{3+} + Fe^{3+}$

$n_f = 6 \qquad n_f = 1$

$V = 200\ cm^2 \quad V = 750\ cm^2$

$x \times 10^{-3} M \quad 0.6M$

Milli eq. of $K_2Cr_2O_7 =$ milli eq. of $FeSO_4$

$6 \times x \times 10^{-3} \times 200 = 1 \times 0.6 \times 750$

$x = 375$

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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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