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HT. NO. 250310255592
CLASSROOM STUDENT FROM GRADE IX-XII

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D. GNANA RUTVIK SAI
HT. NO. 256055278*

NEET 2025

KAVISH
HT. NO. 250411147966*
CLASSROOM STUDENT

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22-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. If $X=\begin{bmatrix} x \\ y \\ z \end{bmatrix}$ is a solution of the system of equations $AX = B$, Where

$\text{Adj } A=\begin{bmatrix} 4 & 2 & 2 \\ -5 & 0 & 5 \\ 1 & -2 & 3 \end{bmatrix}$ and $B=\begin{bmatrix} 4 \\ 0 \\ 2 \end{bmatrix}$ then $|x+y+z|$ is equal to:

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

Key:3

Sol: $X=A^{-1}B=\left(\frac{adjA}{|A|}\right)B=\pm\frac{1}{10}\begin{pmatrix} 4 & 2 & 2 \\ -5 & 0 & 5 \\ 1 & -2 & 3 \end{pmatrix}\begin{pmatrix} 4 \\ 0 \\ 2 \end{pmatrix}=\pm\frac{1}{10}\begin{pmatrix} 20 \\ -10 \\ 10 \end{pmatrix}=\pm\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}$

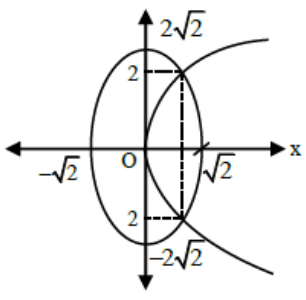
$\therefore |x+y+z|=2$

2. The area of the region $A=\{(x,y):4x^2+y^2\le 8 \text{ and } y^2\le 4x\}$ is:

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

Key: 4

Sol:



$$A=2\int_0^1 2\sqrt{x}dx+2\int_1^{\sqrt{2}}\sqrt{8-4x^2}dx=\frac{8}{3}\left(X^{\frac{3}{2}}\right)_0^1+4\int_1^{\sqrt{2}}\sqrt{2-x^2}dx$$

$$\frac{8}{3}+4\times\frac{1}{2}\left[x\sqrt{2-x^2}+2\sin^{-1}\left(\frac{x}{\sqrt{2}}\right)\right]_1^{\sqrt{2}}$$

$$\frac{8}{3}+2\left[2\times\frac{\pi}{2}-1-2\times\frac{\pi}{4}\right]=\frac{8}{3}+2\pi-2-\pi=\pi+\frac{2}{3}\text{ Sq. unit}$$

3. Let $\mathbf{P}\left(\mathbf{10,2\sqrt{15}}\right)$ be a point on the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$, whose foci are S and S'. If the length of its latus rectum is 8, then the square of the area of $\Delta PSS'$ is equal to:

1) 1462 2) 2700 3) 4200 4) 900

Key:2

Sol: $P\left(10,2\sqrt{15}\right)$ lies on $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$

$\therefore \frac{100}{a^2}-\frac{60}{b^2}=1$.....(1)

Length of latus rectum = 8

$\frac{2.b^2}{a}=8\Rightarrow\boxed{\frac{b^2}{a}=4}$.....(2)

From (1) & (2)

$\frac{100}{a^2}-\frac{60}{4a}=1$

$400-60a=4a^2$

$4a^2+60a-400=0$

$a^2+15a-100=0$

$a=5\ \&\ -20(rejected)$

$\Rightarrow b=\sqrt{20}$

$\therefore$ Hyperbola is $\boxed{\frac{x^2}{25}-\frac{y^2}{20}=1}$

$\therefore$ Focal length $SS^1=2ae=2.5.\left(\sqrt{1+\frac{4}{5}}\right)=6\sqrt{5}$

$\therefore$ Area of $\Delta PSS^1=\frac{1}{2}.6\sqrt{5}.2\sqrt{15}=30\sqrt{3}=A$

$\therefore A^2=2700$

4. Let $S=\left\{z\in \quad : 4z^2+\bar{z}=0\right\}$, then $\sum_{z\in S}|z|^2$ is equal to

1) $\frac{7}{64}$ 2) $\frac{5}{64}$ 3) $\frac{3}{16}$ 4) $\frac{1}{16}$

Key:2

Sol: $4z^2=\bar{z}=0$

Let $z=x+iy$

$4(x+iy)^2+x-iy=0$

$4x^2-4y^2+8xyi+x-iy=0$

$4x^2-4y^2+x=0 \& y(8x-1)=0$

$\Rightarrow y=0$ or $x=\frac{1}{8}$

If $y=0, 4x^2+x=0$

$x=0,\frac{-1}{4}$

$\therefore z_1=0+0.i \qquad |z_1|^2=0$

$z_2=-\frac{1}{4}+0i \qquad |z_2|^2=\frac{1}{16}$

If $x=\frac{1}{8}$

$4\times\frac{1}{64}-4y^2+\frac{1}{8}=0\Rightarrow 4y^2=\frac{3}{16}\Rightarrow y=\pm\frac{\sqrt{3}}{8}$

$\therefore z_3=\frac{1}{8}+\frac{\sqrt{3}}{8}i \qquad |z_3|^2=\frac{1}{64}+\frac{3}{64}=\frac{1}{16}$

$z_4=\frac{1}{8}-\frac{\sqrt{3}}{8}i \qquad |z_4|^2=\frac{1}{64}+\frac{3}{64}=\frac{1}{16}$

$\therefore \sum_{i=1}^{n}|z_i|^2=0+\frac{1}{16}+\frac{1}{16}+\frac{1}{16}=\frac{3}{16}$

5. Let C_r denote the coefficient of x^r in the binomial expansion of $(1+x)^n, n\in N, 0\le r\le n$.

If $P_n=C_0-C_1+\frac{2^2}{3}C_2-\frac{2^3}{4}C_3+\ldots+\frac{(-2)^n}{n+1}C_n$, then the value of $\sum_{n=1}^{25}\frac{1}{P_{2n}}$ equals

1) 675 2) 650 3) 525 4) 580

Key: 1

Sol: $P_n=\sum_{r=0}^{n}\frac{{}^nC_r(-2)^r}{r+1}=\sum_{r=0}^{n}\frac{1}{(n+1)}{}^{n+1}C_{r+1}(-2)^r$

$$=\frac{-1}{2(n+1)}\sum_{r=0}^{n}{}^{n+1}C_{r+1}(-2)^{r+1}=\frac{-1}{2(n+1)}\left[(1-2)^{n+1}-1\right]$$

$$P_n=\frac{1}{2(n+1)}\left[1-(-1)^{n+1}\right]$$

$$P_{2n}=\frac{1}{2(2n+1)}\left[1-(-1)^{2n+1}\right]$$

$$P_{2n}=\frac{1}{2n+1}$$

$$\sum_{n=0}\frac{1}{P_{2n}}=\sum_{n=1}^{25}(2n+1)=3+5+.....+51=\frac{25}{2}[51+3]=25\times 27=675$$

6. Let f and g be functions satisfying $f(x+y)=f(x)f(y)$, $f(1)=7$ and $g(x+y)=g(xy), g(1)=1$, for all $x,y\in N$. If $\sum_{x=1}^{n}\left(\frac{f(x)}{g(x)}\right)=19607$, then n is equal to:

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

Key: 2

Sol: $f(x+y)=f(x).f(y)\Rightarrow f(x)=a^x$

$\left(\ f(1)=7\Rightarrow a^1=7\right)$

So $f(x)=7^x$

Now

$g(x+y)=g(xy)\ \left(put\ y=1\right)\Rightarrow g(x+1)=g(x)$

So $g(1)=g(2)=g(3)=.....=g(n)=1$

Given $\sum_{x=1}^{n}\frac{f(x)}{g(x)}=19607$

$$\sum_{x=1}^{n}\frac{7^x}{1}=19607\Rightarrow 7\left(\frac{7^n-1}{7-1}\right)=19607$$

$$7^n-1=\frac{6}{7}\times 19607$$

$$7^n=16807\Rightarrow n=5$$

7. Let $f(x)=[x]^2-[x+3]-3, x\in R$, where [.] is the greatest integer function. Then

1) $f(x)>0$ only for $x\in[4,\infty)$ 2) $f(x)=0$ for finitely many values of x

3) $f(x)<0$ only for $x\in[-1,3)$ 4) $\int_0^2 f(x)dx=-6$

Key:3

Sol: (3) $\Rightarrow f(x)=0 \Rightarrow [x]=3$ or $[x]=-2$

$\Rightarrow x \in [3,4) \cup [-2,-1) \Rightarrow f(x)=0$ has infinite solutions

$f(x)=[x]^2-[x+3]-3$

$=\left[x^2\right]-[x]-6=([x]-3)([x]+2)$

$(2) \Rightarrow \int_0^2 f(x)\,dx=\int_0^2 \left([x]^2-[x]-6\right)dx$

$\int_0^2 f(x)\,dx=\int_0^2 \left([x]^2-[x]-6\right)dx=\int_0^2 \left([x]^2-[x]\right)dx-12=-12$

$(4) \Rightarrow f(x)<0 \Rightarrow ([x]-3)([x]+2)<0 \Rightarrow -2<[x]<3 \Rightarrow -1 \le [x]<3$

$(1) \Rightarrow f(x)>0 \Rightarrow [x]<-2$ or $[x]>3 \Rightarrow x<-2$ or $x \ge 4 \Rightarrow x \in (-x,-2)0[4,\infty]$

8. Let α,β be the roots of the quadratic equation $12x^2-20x+3\lambda=0, \lambda \in \mathbf{Z}$. If $\frac{1}{2} \le |\beta-\alpha| \le \frac{3}{2}$, then the sum of all possible values of λ is

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

Key:1

Sol: $\frac{1}{2} \le |\alpha-\beta| \le \frac{3}{2}$

$\frac{1}{4} \le |\alpha-\beta|^2 \le \frac{9}{4}$

$\frac{1}{4} \le (\alpha+\beta)^2-4\alpha\beta \le \frac{9}{4}$

$\frac{1}{4} \le \frac{25}{9}-4\times\frac{\lambda}{4} \le \frac{9}{4}$

$-\frac{91}{36} \le -\lambda \le \frac{-19}{36}$

$\frac{19}{36} \le \lambda \le \frac{91}{36}$

$\lambda=1,2$

Sum=3

9. If the mean deviation about the median of the numbers k, 2k, 3k… 1000k is 500, then $\mathbf{k^2}$ is equal to

1) 1 2) 4 3) 16 4) 9

Key:2

Sol: median $= \frac{1001k}{2}=X_M$

$\therefore$ mean deviation about median $= \dfrac{\sum|X_i - X_M|}{n}$

$$= \frac{2\left(\frac{k}{2}+\frac{3k}{2}+\frac{5k}{2}+.....500terms\right)}{1000} = \frac{2.\frac{k}{2}(500)^2}{1000} = \frac{500k}{2} = 500(given)$$

$\therefore k = 2$

$\therefore k^2 = 4$

10. If $\lim\limits_{x\to 0}\dfrac{e^{(a-1)x}+2\cos bx+(c-2)e^{-x}}{x\cos x-\log_e(1+x)} = 2$, then $a^2+b^2+c^2$ is equal to:

1) 9 2) 7 3) 3 4) 5

Key:2

Sol: $\lim\limits_{x\to 0}\left[1+\dfrac{(a-1)}{1!}x+\dfrac{(a-1)^2}{2!}x^2+.....\infty\right]$

$$\frac{+2\left[1-\frac{(bx)^2}{2!}+.....\infty\right]+(c-2)\left[1-\frac{x^1}{1!}+\frac{x^2}{2!}-.....\infty\right]}{x\left(1-\frac{x^2}{2!}+.....\infty\right)-\left(x-\frac{x^2}{2}+.....\infty\right)}$$

$$\Rightarrow \lim_{x\to 0}\frac{(c+1)+(a-c+1)x+\left[\frac{(a-1)^2}{2}-b^2+\frac{(c-2)}{2}\right]x^2+.....\infty}{\left(\frac{x^2}{2}-\frac{x^3}{2}+.....\infty\right)} = 2$$

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

$a-c+1=0 \Rightarrow a+1+1=0 \Rightarrow a=-2$

$$\frac{\left(\frac{(a-1)^2}{2}-b^2+\frac{(c-2)}{2}\right)}{\left(\frac{1}{2}\right)} = 2$$

$\Rightarrow 9-2b^2-3=2 \Rightarrow 2b^2=4 \Rightarrow b^2=2$

$\therefore a^2+b^2+c^2 = 4+2+1=7$

11. Let n be the number obtained on rolling a fair die. If the probability that the system

$x-ny+z=6$

$x+(n-2)y+(n+1)z=8$

$(n-1)y+z=1$

has a unique solution is $\frac{k}{6}$, then the sum of k and all possible values of n is

1) 24 2) 20 3) 21 4) 22

Key: 4

Sol: $x-ny+z=6$

$x-(n-2)y+(n+1)z=8$

$(n-1)y+z=1$

$\begin{vmatrix}1 & -n & 1\\ 1 & (n-2) & n+1\\ 0 & n-1 & 1\end{vmatrix}=0\Rightarrow n=1,2$ or $n=-1$ (rejected)

For unique solution n= 3,4,5,6

Now P (Probability when system of equations has unique solution)= $\frac{4}{6}$

So k=4

Now required sum = $4+(3+4+5+6)=22$

12. Let the domain of the function

$f(x)=\log_3\log_5\left(7-\log_2\left(x^2-10x+85\right)\right)+Sin^{-1}\left(\left|\frac{3x-7}{17-x}\right|\right)$ be $(\alpha,\beta]$.

Then $\alpha+\beta$ is equal to:

1) 8 2) 9 3) 10 4) 12

Key: 2

Sol: let $x^2-10x+85=\lambda$

$\therefore$ Domain for first term $\lambda>0$.....(1)

& $7-\log_2\lambda>0\Rightarrow\lambda<2^7$.....(2)

& $\log_5(7-\log_2\lambda)>0\Rightarrow\lambda<2^6$.....(3)

$\therefore$ from (1),(2) & (3)

$0<\lambda<2^6$

$0<x^2-10x+85<64\Rightarrow x\in(3,7)$.....$(A)$

& domain for second term $-1\le\frac{3x-7}{x-17}\le1\Rightarrow x\in[-5,6]$.....$(B)$

From (A) & (B), domain of function will be (3,6]

$\Rightarrow\alpha=3,\beta=6\Rightarrow\alpha+\beta=9$

13. Let L be the line $\frac{x+1}{2}=\frac{y+1}{3}=\frac{z+3}{6}$ and let S be set of all points (a,b,c) on L, whose distance from the line $\frac{x+1}{2}=\frac{y+1}{3}=\frac{z-9}{0}$ along the line L is 7. Then $\sum_{(a,b,c)\in s}(a+b+c)$ is equal to

1) 34 2) 40 3) 28 4) 6

Key: 1

Sol: M is the point of intersection of L_1 & L_2

$\Rightarrow 2\lambda-1=2\mu-1, 3\lambda-1=3\mu-1, 6\lambda-3=9\Rightarrow\lambda=2=\mu$

$M(3,5,9)$

Now let point P be $(2K-1,3K-1,6K-3)$ on L_2

Such that PM=7

$\Rightarrow\sqrt{(2K-4)^2+(3K-6)+(6K-12)^2}=7$

$\Rightarrow 49K^2+196-196K=49$

$\Rightarrow K^2+4-4K=1\Rightarrow K^2-4K+3=0\Rightarrow K=1,3$

So points P&Q are $(1,2,3)$ & $(5,8,15)$ So sum of all co-ordinates of P & Q =34

14. Among the statements,

(S1): If $A(5,-1)$ and $B(-2,3)$ are two vertices of a triangle, whose orthocentre is (0, 0) then its third vertex is (-4,-7) and

(S2): If positive numbers 2a,b,c are three consecutive terms of an A.P., then the lines $ax+by+c=0$ are concurrent at (2,-2)

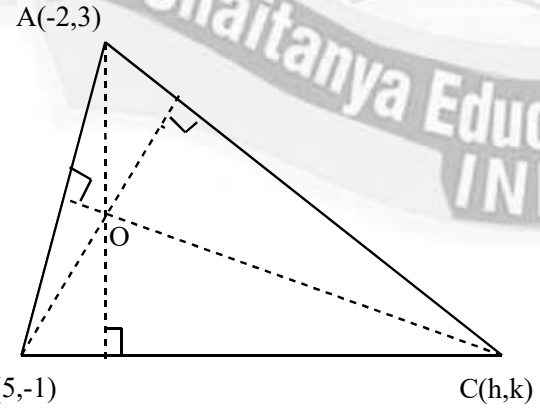
1) Only (S1) is correct 2) Both are correct

3) Only (S2) is correct 4) Both are incorrect

Key: 4

Sol: Solution of statement-I

$m_{AO}.m_{BC}=-1$



$\Rightarrow 2h-3k=13.....(1)$

$\&m_{AB}.m_{OC} = -1$

$\Rightarrow 4k = 7h$.....(2)

$\Rightarrow$ third vertex is (-4,-7)

Solution of statement -2

$2a, b, c \rightarrow A.P$

$b = \dfrac{2a+c}{2} \Rightarrow 2a - 2b + c = 0$

$\therefore$ lines $ax + by + c = 0$ are concurrent then

$\dfrac{x}{2} = \dfrac{y}{-2} = \dfrac{1}{1}$

$x = 2$ and $y = -2$

$\therefore$ Pt. Of concurrency is (2,-2)

$\therefore$ Statement 2 is correct.

15. Let [.] denote the greatest integer function, and let $f(x) = \min\left\{\sqrt{2}x, x^2\right\}$. Let $S = \left\{x \in (-2,2) :\right.$ the function $g(x) = |x|\left[x^2\right]$ is discontinuous at $\left.x\right\}$. Then $\sum\limits_{x \in S} f(x)$ equals

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

Key: 4

Sol: $g(x) = |x|\left[x^2\right]$

Points of discontinuity of g(x) in (-2,2) are $\left(\pm 1, \pm\sqrt{2}, \pm\sqrt{3}\right)$

$\therefore S = \left\{-1, 1, -\sqrt{2}, \sqrt{2}. -\sqrt{3}, \sqrt{3}\right\}$

$f(x) = \min\left\{\sqrt{2x}, x^2\right\}$

$\therefore \sum\limits_{x \in S} f(x) = -\sqrt{2} + 1 - 2 + 2 - \sqrt{6} + \sqrt{6} = 1 - \sqrt{2}$

16. If $y = y(x)$ satisfies the differential equation

$16\left(\sqrt{x + 9\sqrt{x}}\right)\left(4 + \sqrt{9 + \sqrt{x}}\right) \cos y\, dy = (1 + 2\sin y)\, dx, x > 0$ and $y(256) = \dfrac{\pi}{2}, y(49) = \alpha$,

then $2\text{Sin}\,\alpha$ is equal to :

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

Key: 1

Sol: $\int \dfrac{\cos y}{1 + 2\sin y} dy = \int \dfrac{1}{16\left(\sqrt{x + 9\sqrt{x}}\right)\left(4 + \sqrt{9 + \sqrt{x}}\right)} dx$

$$\Rightarrow \frac{1}{2}\int \frac{2\cos y}{1+2\sin y}dy = \int \frac{1}{4t}dt$$

Put $4+\sqrt{9+\sqrt{x}} = t$

$$\Rightarrow \frac{1}{2\sqrt{9+\sqrt{x}}}.\frac{1}{2\sqrt{x}}dx = dt \Rightarrow \frac{1}{4\sqrt{x+9\sqrt{x}}}dx = dt$$

$$\Rightarrow \frac{1}{2}\log|1+2\sin y| = \frac{1}{4}\log|t| + \log c \Rightarrow \sqrt{1+2\sin y} = ct^{1/4} \Rightarrow \frac{1}{4}\log|t| + \log c$$

$$\Rightarrow \sqrt{1+2\sin y} = ct^{1/4} \Rightarrow \sqrt{1+2\sin y} = c\left(4+\sqrt{9+\sqrt{x}}\right)^{1/4}$$

$$\left(256, \frac{\pi}{2}\right) \Rightarrow \sqrt{3} = c\left(\sqrt{3}\right) \Rightarrow c = 1$$

$$(49, \alpha) \Rightarrow \sqrt{1+2\sin\alpha} = (1)8^{1/4}$$

$$\Rightarrow 1+2\sin\alpha = 2\sqrt{2} \Rightarrow 2\sin\alpha = 2\sqrt{2}-1$$

17. The number of elements in the relation $R = \{(x,y): 4x^2 + y^2 < 52, x, y \in \mathbf{Z}\}$ is

1) 89 2)86 3) 77 4) 67

Key: 4

Sol: $4x^2 + y^2 < 52, \quad x, y \in Z$

$0 \quad 0, \pm1, \pm2, \pm3, \pm4, \pm5, \pm6, \pm7 \rightarrow 1\times 15 = 15$

$\pm1 \quad 0, \pm1, \pm2, \pm3 ..... \pm6 \rightarrow 2\times 13 = 26$

$+2 \quad 0, \pm1 \pm2 \pm3 ..... \pm5 \rightarrow 2\times 11 = 22$

$\pm3 \quad 0, \pm1, \pm2, \pm3 \rightarrow 2\times 7 = 14$

Number of elements = 77

18. Let $a = 2\hat{i} - \hat{j} + \hat{k}$ and $b = \lambda\hat{j} + 2\hat{k}$, $\lambda \in Z$ be two vectors, Let $c = a \times b$ and d be a vector of magnitude 2 in yz-plane. If $|c| = \sqrt{53}$, then the maximum possible value of $(c.d)^2$ is equal to :

1) 52 2) 104 3) 26 4) 208

Key: 4

Sol: $\bar{c} = \bar{a} \times \bar{b} = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ 2 & 1 & 1 \\ 0 & \lambda & 2 \end{vmatrix} = (2-\lambda)\bar{i} - \bar{j}(4) + (2\lambda)\bar{k}$

$$|\bar{c}|^2 = 53 \Rightarrow (2-\lambda)^2 + 16 + (2\lambda)^2 = 53 = 5\lambda^2 - 4\lambda - 33 = 0$$

$$\Rightarrow 5\lambda^2 - 15\lambda + 11\lambda - 33 = 0$$

$$\Rightarrow 5\lambda(\lambda-3) + 11(\lambda-3) = 0$$

$\Rightarrow (\lambda-3)(5\lambda+11)=0$

$\Rightarrow \lambda=3, \lambda\neq -\frac{11}{5} \qquad (\ \lambda\in Z)$

$\therefore \bar{c}=(-1,-4,6)$

Let $\therefore \bar{d}=(0,y,z)$

Given $|\bar{d}|=2 \Rightarrow y^2+z^2=4$

$\bar{c}.\bar{d}=0-4y+6z$

$(\bar{c}.\bar{d})^2=(-4y+6z)^2$

$=16y^2+36z^2-48yz$

$=16y^2+36(4-y^2)-48y.\sqrt{4-y^2}$

Let f(y) = $-20y^2+144-48y\sqrt{4-y^2}$

$f^1(y)=-40y-48\left(\sqrt{4-y^2}\right)-48y\left(\frac{1}{2\sqrt{4-y^2}}\right)(-2y)$

$=-40y-48\left(\frac{4-y^2-y^2}{\sqrt{4-y^2}}\right)$

$f^1(y)=0 \Leftarrow 40y=96\left(\frac{y^2-2}{\sqrt{4-y^2}}\right)$

$\Rightarrow 5y\sqrt{4-y^2}=12(y^2-2)$

$\Rightarrow 25y^2(4-y^2)=144(y^4+4-4y^2)$

$=169y^4-676y^2+576=0$

$=169y^4-208y^2-468y^2+576=0$

$\Rightarrow 13y^2(13y^2-16)-36(13y^2-16)=0$

$\Rightarrow y^2=\frac{16}{13}(or)\frac{36}{13}$

$\Rightarrow y=\pm\frac{4}{\sqrt{13}}(or)\pm\frac{6}{\sqrt{13}}$

$\therefore$ Maximum of $(\bar{c}.\bar{d})^2=208$

19. Let the locus of the mid-point of the chord through the origin O of the parabola $y^2 = 4x$ be curve S. Let P be any point on S. Then the locus of the point, which internally divides OP in ratio 3:1, is:

1) $3y^2 = 2x$ 2) $2y^2 = 3x$ 3) $2x^2 = 3y$ 4) $3x^2 = 2y$

Key: 2

Sol: Let $M(x_1, y_1)$ be the locus of the midpoint of the chord of the parabola $y^2 = 4x$

$\therefore$ Equation of the chord is $S_1 = S_{11} \Rightarrow yy_1 - 2(x + x_1) = y_1^2 - 4x_1$

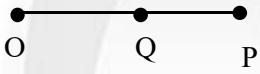
It passes through 0(0,0)

$\therefore -2x_1 = y_1^2 - 4x_1$

Locus of M is $y^2 = 2x$

Let $P\left(\frac{1}{2}t^2, t\right)$ be a point on this locus

3:1



$$Q(x,y) = \left(\frac{\frac{3t^2}{2} + 0}{4}, \frac{3t + 0}{4}\right) \Rightarrow \left(\frac{3t^2}{8}, \frac{3t}{4}\right)$$

$$\Rightarrow t^2 = \frac{8x}{3}, t = \frac{4y}{3} \Rightarrow \frac{16y^2}{9} = \frac{8x}{3} \Rightarrow 2y^2 = 3x$$

20. Let S and S' be the foci of the ellipse $\frac{x^2}{25} + \frac{y^2}{9} = 1$ and $P(\alpha, \beta)$ be a point on the ellipse in the first quadrant. If $(SP)^2 + (S'P)^2 - SP.S'P = 37$, then $\alpha^2 + \beta^2$ is equal to:

1) 17 2) 11 3) 13 4) 15

Key: 4

Sol: P lies on ellipse $\Rightarrow \frac{\alpha^2}{25} + \frac{\beta^2}{9} = 1$

$PS + PS' = 2a \Rightarrow PS + PS' = 10$

$(PS)^2 + (PS')^2 - PS.PS' = 37$

$(PS + PS') - 3PS.PS' = 37$

$100 - 3PS.PS' = 37$

$3PS.PS' = 63 \Rightarrow PS.PS' = 21$

$PS \& PS'$ are $\left(5 \pm \frac{4}{5}.\alpha\right)$

$\therefore PS.PS' = 25 - \frac{16}{25}\alpha^2 = 21$

$\frac{16}{25}\alpha^2 = 4$

$\alpha = \frac{5}{2} \Rightarrow \alpha^2 = \frac{25}{4}$

$\therefore \beta^2 = \frac{27}{4}$

$\therefore \alpha^2 + \beta^2 = \frac{52}{4} = 13$

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 [.] be the greatest integer function. If $\alpha = \int_0^{64} \left(x^{1/3} - \left[x^{1/3}\right]\right) dx$, then

$\frac{1}{\pi}\int_0^{\alpha\pi} \left(\frac{\sin^2\theta}{\sin^6\theta + \cos^6\theta}\right) d\theta$ is equal to _____

Key: 36

Sol: $\int_0^{64} X^{\frac{1}{3}} dx = \frac{3}{4}.\left[X^{\frac{4}{3}}\right]_0^{64} = 192 \&$

$\int_0^{64} \left[X^{1/3}\right] dx = \int_0^{1} \left[X^{1/3}\right] dx + \int_1^{8} \left[X^{1/3}\right] dx + \int_8^{27} \left[X^{1/3}\right] dx \int_{27}^{64} \left[X^{1/3}\right] dx = 156$

So $\alpha = 192 - 156 = 36$

Now $E = \frac{1}{\pi}\int_0^{36\pi} \frac{\sin^2\theta}{\sin^6\theta + \cos^6\theta} d\theta = \frac{36}{\pi}.2\int_0^{\pi} \frac{\sin^2\theta}{\sin^6\theta + \cos^6\theta} d\theta$

$\Rightarrow E = \frac{36}{\pi}\int_0^{\pi/2} \frac{\sin^2\theta}{\sin^6\theta + \cos^6\theta} d\theta$

Let $J = \int_0^{\pi/2} \frac{\sin^2\theta}{\sin^6\theta + \cos^6\theta} d\theta$.....(1)

Applying King $J = \int_0^{\pi/2} \frac{\cos^2\theta}{\sin^6\theta + \cos^6\theta} d\theta$.....(2)

Now $2J=\int_0^{\pi/2}\frac{1}{\sin^6\theta+\cos^6\theta}d\theta$ (add (1) & (2)) $=\int_0^{\pi/2}\frac{\sec^6\theta}{\tan^6\theta+1}d\theta$

Put $\tan\theta=\lambda$

$\int_0^{\infty}\frac{\left(1+\lambda^2\right)^2}{\lambda^4-\lambda^2+1}d\lambda$

$\int_0^{\infty}\frac{1+\frac{1}{\lambda^2}}{\lambda^2-1+\frac{1}{\lambda^2}}d\lambda=\pi$

$\Rightarrow J=\frac{\pi}{2}$

$E=\frac{36}{\pi}.2J=36$

22. Let a vector $a=\sqrt{2}\hat{i}-\hat{j}+\lambda\hat{k},\lambda>0,$ make an obtuse angle with the vector $b=-\lambda^2\hat{i}+4\sqrt{2}\hat{j}+4\sqrt{2}\hat{k}$ and an angle $\theta,\frac{\pi}{6}<\theta<\frac{\pi}{2}$, with positive z-axis. If the set of all possible values of λ is $(\alpha,\beta)-\{\gamma\}$, then $\alpha+\beta+\gamma$ is equal to___

Key: 5

Sol: $a\hat{\ }\hat{k}\in\left(\frac{\pi}{6},\frac{\pi}{2}\right)$

$\frac{\lambda}{\sqrt{\left(2+1+\lambda^2\right)}}\in\left(0,\frac{\sqrt{3}}{2}\right)\Rightarrow 0<\frac{\lambda}{\sqrt{3+\lambda^2}}<\frac{\sqrt{3}}{2}$

$\lambda>0\,\&\,\lambda\in(-3,3)\Rightarrow\lambda\in(0,3).....(1)$

$a\hat{\ }b$ is obtuse

$a.b<0\Rightarrow-\sqrt{2}\lambda^2-4\sqrt{2}+4\sqrt{2}\lambda<0$

$\Rightarrow\lambda^2-4\lambda+4>0\Rightarrow(\lambda-2)^2>0$

$\Rightarrow\lambda\in R-\{2\}.....(2)$

$(1)\,\&\,(2)\Rightarrow\lambda\in(0,3)-\{2\}\Rightarrow\alpha+\beta+\gamma=5$

23. Let S be the set of first 11 natural numbers. Then the number of elements in $A=\{B\subseteq S:n(B)\geq 2$ and the product of all elements of B is even$\}$ is _____

Key: 1979

Sol: $A=\{1,2,3.....11\}$

$\therefore n(B)\geq 2$ & product of all elements in B is even

Case (i): n(B) =2 $\Rightarrow {}^{11}C_2 - {}^{6}C_2$

$n(B)=3 \Rightarrow {}^{11}C_3 - {}^{6}C_3$

$n(B)=4 \Rightarrow {}^{11}C_4 - {}^{6}C_4$

$n(B)=5 \Rightarrow {}^{11}C_5 - {}^{6}C_5$

$n(B)=6 \Rightarrow {}^{11}C_6 - {}^{6}C_6$

$n(B)=7 \Rightarrow {}^{11}C_7$

:

:

$n(B)=11 \Rightarrow {}^{11}C_{11}$

$\therefore$ number of sets $B = \sum_{r=2}^{11} {}^{11}C_r - \sum_{r=2}^{6} {}^{6}C_r = 2^{11} - (12) - (2^6 - 7) = 2048 - 64 - 5 = 1979$

Alternate sol.

Total subsets = 2^{11}

No. of subsets having odd terms only = 2^6

No. Of subsets having one term only & also having even terms = 5

Req. Ways $= 2^{11} - 2^6 - 5 = 1979$

24. Let $\cos(\alpha+\beta) = -\frac{1}{10}$ and $\sin(\alpha-\beta) = \frac{3}{8}$, where $0 < \alpha < \frac{\pi}{3}$ and $0 < \beta < \frac{\pi}{4}$. If $\tan 2\alpha = \frac{3(1-r\sqrt{5})}{\sqrt{11}(s+\sqrt{5})}$, $r, s \in \mathbf{N}$, then $r+s$ is equal to _____

Key: 20

Sol: $\tan 2\alpha = \tan\left[(\alpha+\beta)+(\alpha-\beta)\right]$

$$\tan 2\alpha = \frac{\tan(\alpha+\beta)+\tan(\alpha-\beta)}{1-\tan(\alpha+\beta).\tan(\alpha-\beta)}$$

$$\tan 2\alpha = \frac{\left(-\sqrt{99}+\frac{3}{\sqrt{55}}\right)}{1-\left(\sqrt{99}\right)\left(\frac{3}{\sqrt{55}}\right)}$$

$$\tan 2\alpha = \frac{-3\sqrt{11}+\frac{3}{\sqrt{5}\times\sqrt{11}}}{1+\frac{9\sqrt{11}}{\sqrt{5}\times\sqrt{11}}}$$

$$\tan 2\alpha = \frac{3\left(1-11\sqrt{5}\right)}{\sqrt{11}\left(9+\sqrt{5}\right)}$$

$r = 11, s = 9$

$r + s = 20$

25. Suppose a, b, c are in A.P. and $a^2, 2b^2, c^2$ are in G.P. If $a < b < c$ and $a + b + c = 1$, then $9\left(a^2 + b^2 + c^2\right)$ is equal to _____

Key: 9

Sol: $a = b - d, c = b + d, \Rightarrow b = \frac{1}{3} \Rightarrow 4b^4 = a^2c^2$

$4b^4 = \left[(b-d)(b+d)\right]^2$

$$\frac{4}{81} = \left(\frac{1}{9} - d^2\right)^2 \Rightarrow \frac{4}{81} = \frac{1}{81} - \frac{2d^2}{9} + d^4 \Rightarrow d^4 - \frac{2d^2}{9} - \frac{1}{27} = 0 \Rightarrow 27d^4 - 6d^2 - 1 = 0$$

$d^2 = 1/3 \Rightarrow d = +\frac{1}{\sqrt{3}}$ (as a>b>c)

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

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. Given below are two statements:

Statement-I: A satellite is moving around earth in the orbit very close to the earth surface. The time period of revolution of satellite depends upon the density of earth

Statement-II: The time period of revolution of the satellite is $T = 2\pi\sqrt{\frac{R_e}{g}}$ (for satellite very close to the earth surface), where R_e radius of earth and g acceleration due to gravity.

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

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

Key: (2)

Sol: Statement -1 is correct

Explanation: $T = 2\pi\sqrt{\frac{R_e}{g}}$

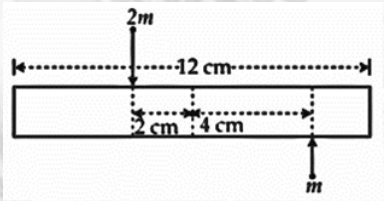
$$T = 2\pi\sqrt{\frac{R_e}{\frac{4}{3}\pi G\rho Re}}$$

$$T = Z\pi\sqrt{\frac{3}{4\pi g\rho}}$$

Statement – 2 is correct

$$T = 2\pi\sqrt{\frac{Re}{g}}$$

27. A uniform bar of length 12 *cm* and mass 20 *m* lies on a smooth horizontal table. Two-point masses *m* and 2*m* are moving in opposite direction with same speed of *v* and in the same plane as the bar, as showing figure. These masses strike the bar simultaneously and got stuck to it. After collision the entire system is rotating with the angular frequency ω. The ratio of *v* and ω is:



1) 33 2) 32 3) $2\sqrt{88}$ 4) 66

Key: (1)

Sol: Using angular momentum conservation about com of rod $L_i = L_f$

$$m \times v \times 4 + 2m \times v \times 2 = \left(\frac{20\ m\ (12)^2}{12} + m \times 4^2 + 2m \times 2^2\right)\omega$$

$$8mv = (240m + 24m)\ \omega$$

$$8v = 264\omega$$

$$\frac{v}{\omega} = 33$$

28. A Laser beam has intensity of $4.0 \times 10^{14}\ W/m^2$. The amplitude of magnetic field associated with beam is …… T. (Take $\in_0 = 8.85 \times 10^{-12} C^2/Nm^2$ and $c = 3 \times 10^8\ m/s$)

1) 5.5 2) 18.3 3) 1.83 4) 2.0

Key: (3)

Sol: $I = \left(\frac{B^2}{2\mu 0}C\right) = 4 \times 10^{14}$

$$B^2=\frac{2\mu_0}{c}\times 4\times 10^{14}$$

$$B^2=\frac{2\times 4\pi\times 10^{-7}\times 4\times 10^{14}}{3\times 10^8}$$

$$B^2=\frac{3.2\pi}{3} \qquad B^2=\frac{32\pi}{3}\times 10^{-1}$$

$$B=1.83T$$

29. The smallest wavelength of Lyman series is 91 nm. The difference between the largest wavelengths of *Paschen* and *Balmer* series is nearly …… nm.

1) 1784 2) 1875 3) 1217 4) 1550

Key: (3)

Sol: For Lyman Series $\frac{1}{\lambda}=R(\frac{1}{1^2}-\frac{1}{\infty^2})\Rightarrow\lambda=\frac{1}{R}=91nm$

For Balmer services $\rightarrow$Largest Wavelength

$(n_1=2\ \&\ n_2=3)$

$$\frac{1}{\lambda_B}=R(\frac{1}{2^2}-\frac{1}{3^2})=\frac{5R}{36}$$

$$\lambda_B=\frac{36}{5R}=\frac{36}{5}\times 91=655.2$$

$$\therefore\lambda_B=655.2nm$$

For Paschen series $\rightarrow$Largest Wavelength

$(n_1=3\ \&\ n_2=4)$

$$\frac{1}{\lambda_P}=R(\frac{1}{3^2}-\frac{1}{4^2})=\frac{7R}{144}$$

$$\lambda_P=\frac{144}{7R}=\frac{144}{7}\times 91$$

$$\lambda_P=1872nm$$

$$\lambda_P-\lambda_B=1216.8nm$$

$$\lambda_P-\lambda_B=1217nm\ (nearly)$$

30. In an open organ pipe v_3 and v_6 are 3rd and 6th harmonic frequencies, respectively. If $v_6-v_3=2200$ Hz then length of the pipe is _____ mm. (Take velocity of sound in air is 330 m/s).

1) 225 2) 275 3) 250 4) 200

Key: (2)

Sol: $f=n\frac{V_0}{2L}(For\ open\ pipe)$

$$\frac{6V_0}{2L}-\frac{3V_0}{2L}=2200$$

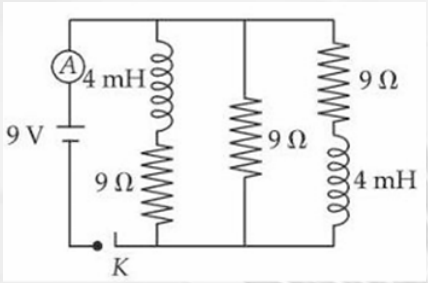
$$\frac{3\times 330}{2L}=2200$$

$$\frac{3}{2L}\times 3=20 \Rightarrow L=\frac{9}{40}m$$

$$\therefore L=\frac{9\times 1000}{40}=\frac{900}{4}mm$$

$$L=225mm$$

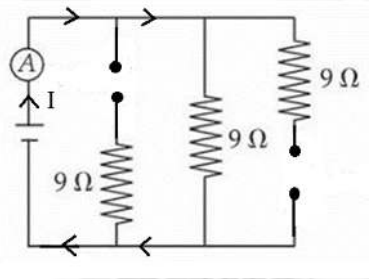
31. Figure shows the circuit that contains three resistances (9 Ω each) and two inductors (4 mH each). The reading of ammeter at the moment switch K is turned ON, is ____ A.



1) 1 2) 3 3) Zero 4) 2

Key: (1)

Sol:



At t = 0 all inductors act as open circuit $I=\frac{9}{9}=1$ A

32. The wavelength of light, while it is passing through the water of 540 nm. The refractive index of water is $\frac{4}{3}$. The wavelength of the same light when it is passing through a transparent medium having refractive index of $\frac{3}{2}$ is _____ nm

1) 380 2) 840 3) 480 4) 540

Key: (3)

Sol: $\lambda\alpha\frac{1}{\mu}\Rightarrow\frac{\lambda_1}{\lambda_2}=\frac{\mu_2}{\mu_1}$

$$\therefore\frac{\lambda_1}{\lambda_2}=\frac{3/2}{4/3}=\frac{9}{8}$$

$$\lambda_2=\frac{8}{9}\lambda_1$$

$\therefore \lambda_2 = \frac{8}{9} \times 540$

$\lambda_2 = 480\,nm$

33. An electric power line having total resistance of 2Ω, delivers 1kW of power at 250 V. The percentage efficiency of transmission line is_____

1) 96.9 2) 100 3) 86.5 4) 92.5

Key: 1

Sol: Total current $i = \frac{1000}{250} = 4A$

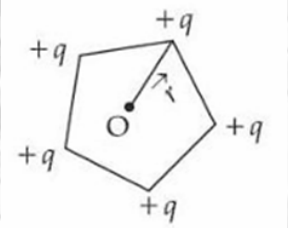
$i^2RW = 4^2 x2 = 32W$

$(\text{power dissipated in } 2\Omega)$

$\therefore$ % wastage $= \frac{32}{1000} \times 100 = 3.2\%$

$\therefore \eta = (100 - 3.2)\% = 96.8\%$

34. Five positive charges each having charge q are placed at the vertices of a pentagon as shown in the figure. The electric potential (V) and the electric field (E) at the centre O of the pentagon due to these five positive charges are:



1) $V = \frac{5q}{4\pi\varepsilon_0 r}$ and $E = 0$

2) $V = \frac{5q}{4\pi\varepsilon_0 r}$ and $E = \frac{5\sqrt{3}q}{8\pi\varepsilon_0 r^2}\hat{r}$

3) $V = 0$ and $E = 0$

4) $V = \frac{5q}{4\pi\varepsilon_0 r}$ and $E = \frac{5q}{4\pi\varepsilon_0 r^2}\hat{r}$

Key: 1

Sol: $V = \left(\frac{5kq}{r}\right) = \frac{5q}{4\pi \in_0 R}$

$\left|\vec{E}\right| = 0$ (As it is a regular pentagon)

35. Three small identical bubbles of water having same charge on each coalesce to form a bigger bubble. Then the ratio of the potentials on one initial bubble and that on the resultant bigger bubble is:

1) $1:3^{1/3}$ 2) $3^{2/3}:1$ 3) $1:2^{2/3}$ 4) $1:3^{2/3}$

Key: 4

Sol: Let each water bubble has a radius r.

Then $V_i = \frac{Kq}{r}(\text{on one bubble})$

$V_f = \frac{K3q}{R} = \frac{3Kq}{R}$

From volume conservation, it yields, $3\left(\frac{4}{3}\pi r^3\right) = \frac{4}{3}\pi R^3$

$R = (3)^{\frac{1}{3}r}$

$\therefore \frac{V_i}{V_f} = \frac{Kq/r}{k3q/R} = \frac{1}{3^{2/3}}$

$V_i : V_f = 1 : 3^{2/3}$

36. In parallax method for the determination of focal length of a concave mirror, the object should always be placed:

1) Between the focus (F) and the centre of curvature (C) of the mirror ONLY
2) Between the pole (P) and the focus (F) of the concave mirror ONLY
3) Beyond the centre of curvature (C) of the mirror ONLY
4) At any point beyond the focus (F) of the mirror

Key: 1 & 3

Sol: Between the focus (f) & the center of curvature of the mirror(c) For more magnification (3) Beyond the centre of curvature of the mirror.

37. Given below are two statements:

Statement I: An object moves from position r_1 to position r_2 under a conservative force field F. The work done by the force is $W = -\int_{r_1}^{r_2} F.dr.$

Statement II: Any object moving from one location to another location can follow infinite number of paths. Therefore, the amount of work done by the object changes with the path it follows for a conservative force.

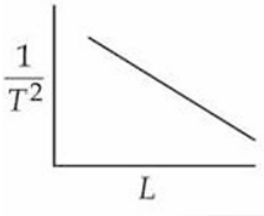
In the light of the above statements, choose the correct answer from the options given below:

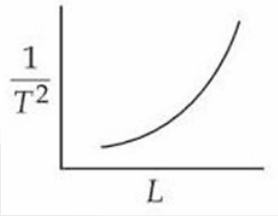
1) Both statement I and statement II are false
2) Both statement I and statement II are true
3) Statement I is false but statement II is true
4) Statement I is true but statement II is false

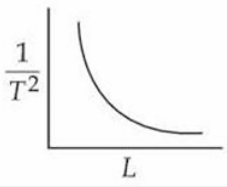
Key: 1

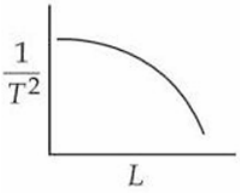
Sol: Both statement-1 & statement-2 are false work done in a closed path if it's O, the work force associated with this force is conservative & work done is $W = \int_{r_1}^{r_2} F.dr$ which is independent of path.

38. Using a simple pendulum experiment g is determined by measuring its time period T. Which of the following plots represent the correct relation between the pendulum length L & time period T?

1) 

2) 

3) 

4) 

Key: 3

$$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow T^2 = 4\pi^2\frac{l}{g}$$

$$\frac{l}{g} = \frac{T^2}{4\pi^2} \Rightarrow \frac{l}{T^2} = \frac{g}{4\pi^2}$$

$\left(\frac{l}{T^2}\right)l =$ CONSTANT (RECTANGULAR HYPERBOLA)

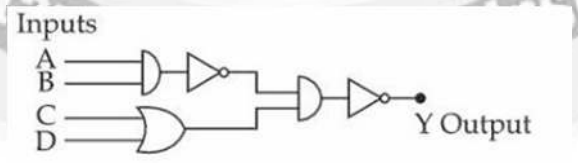
39. When a part of a straight capillary tube is placed vertically in liquid, the liquid raises upto certain height h. If the inner radius of the capillary tube, density of the liquid and surface tension of the liquid decrease by 1% each, then the height of the liquid in the tube will change by …….%

1) - 3 2) + 1 3) + 3 4) – 1

Key: 2

Sol: $$H = \frac{2T\cos\theta}{\rho g r} \Rightarrow \frac{dh}{h} = \frac{dT}{T} - \frac{d\rho}{\rho} - \frac{dr}{r} = -1\% + 1\% + 1\% = +1\%$$

40. The correct truth table for the given input data of the following logic gate is:



1)

Inputs				Output
A	B	C	D	Y
1	1	0	1	0
0	0	1	1	0
1	0	1	0	1
1	1	1	1	1

2)

Inputs				Output
A	B	C	D	Y
1	1	0	1	1
0	0	1	1	0
1	0	1	0	0
1	1	1	1	1

3)

Inputs				Output
A	B	C	D	Y
1	1	0	1	1
0	0	1	1	0
1	0	1	0	1
1	1	1	1	0

4)

Inputs				Output
A	B	C	D	Y
1	1	0	1	0
0	0	1	1	1
1	0	1	0	1
1	1	1	1	1

Key: 2

Sol: $Y = \left(\overline{A.B}\right).\left(C + D\right)$

$Y = A.B + \overline{C + D}$

INPUT				OUTPUT
A	B	C	D	Y
1	1	0	1	1
0	0	1	1	0
1	0	1	0	0
1	1	1	1	1

41. Consider two boxes containing ideal gases A and B such that their temperatures, pressures and number densities are same. The molecular size of A is half of that of B and mass of molecules A is four times that of B. If the collision frequency in gas B is 32×10^{18} /s then collision frequency in gas A is _____/s.

1) 4×10^8 2) 8×10^8 3) 2×10^8 4) 32×10^8

Key: 1

$P, T, N = \text{same}$

collision frequency

$z \propto \frac{d^2}{\sqrt{m} =}$

Sol: $Z_B = 32 \times 10^{8/3}$

$\frac{Z_A}{Z_B} = \frac{{d_A}^2 / \sqrt{m_A}}{{d_B}^2 / \sqrt{m_B}} = \left(\frac{d_A}{d_B}\right)^2 = \sqrt{\frac{m_B}{m_A}}$

$\frac{Z_A}{32 \times 10^8} = (1/2)^2 \times \sqrt{\frac{1}{4}\frac{m_A}{m_B}} = 4 \times 10^8 / s$

42. If $\in$,E and t represent the free space permittivity, electric field and time respectively, then the unit of $\frac{\in E}{t}$ will be :

1) Am^2 2) A/m^2 3) Am 4) A/m

Key: 2

$\frac{\in .E}{t} = \frac{F/m \times N/C}{S}$

Sol: $\in .E = \frac{C}{m^2}$

$m^2 = A$

43. Given below are two statements:

Statement-I: For a mechanical system of many particles total kinetic energy is the sum of kinetic energies of all the particles.

Statement-II: The total kinetic energy can be the sum of kinetic energy of the center of mass w.r.t. to the origin and the kinetic energy of the all the particles w.r.t. the center of mass as the reference.

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

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

Key: 1

Sol: Both statements are true (1&2) correct explanation

44. Which of the following are true for a single slit diffraction?

A. Width of central maxima increases with increasing in wavelength keeping slit width constant

B. Width of central maxima increases with decrease in wavelength keeping slit width constant

C. Width of central maxima increases with decrease in slit width at constant wavelength.

D. Width of central maxima increases with increase in slit width at constant wavelength.

E. Brightness of central maxima increases for decrease in wavelength at constant slit width

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

Key: 3

Sol: $\beta = \frac{\lambda D_2}{a}$

A, C are true

(A) $\beta \propto \lambda$

(C) $\beta \propto \frac{1}{d}$

(E) Shorter wave length's distance length.

45. Light is incident on a metallic plate having work function $110 \times 10^{-20}\ J$. If the produced photoelectrons have zero kinetic energy then the angular frequency of the incident light is ……. rad/s. $\left(h = 6.63 \times 10^{-30}\ J/s\right)$

1) 1.04×10^{16} 2) 1.66×10^{15} 3) 1.04×10^{13} 4) 1.66×10^{16}

Key: 3

Sol: $w = \frac{2\pi E}{h}$ $KE = W = 110 \times 10^{-20} J$

$$= \frac{2 \times 3.14 \times 110 \times 10^{-20}}{6.6 \times 10^{-34}} = 104 \times 10^{14} = 1.04 \times 10^{16} \text{ rad/sec}$$

46. A conducting circular loop is rotated about is diameter at a constant angular speed of 100 rad/s in a magnetic field of 0.5 T perpendicular to the axis of rotation. When the loop is rotated by 30^0 from the horizontal position, the induced EMF is 15.4 mV. The radius of the loop is _____ mm.

(Take $\pi = \frac{22}{7}$)

Key: 14

$E(t) = BA\omega\sin(\omega t) = 15.4\times10^{-3}V$

Sol: $0.5\times\frac{22}{7}xr^2\times100\times\frac{1}{2} = 15.4\times10^{-3}V$

$\Rightarrow r = 14mm$

47. A capacitor P with capacitance $10\times10^{-6}F$ is fully charged with a potential difference of 6.0 V and disconnected from the battery. The charged capacitor P is connected across another capacitor Q with capacitance $20\times10^{-6}F$. The charge on capacitor Q when equilibrium is established will be $\alpha\times10^{-5}C$ (assume capacitor Q does not have any charge initially), the value of α is _____

Key: 40

$C_P = 10\mu F \quad Q = 60\mu c$

$C_Q = 20\mu F$

Sol: $Q\propto C \Rightarrow \frac{Q_P}{Q_Q} = \frac{C_P}{C_Q} = \frac{10}{20}$

$\frac{Q_P}{Q_Q} = \frac{1}{2} \Rightarrow Q_Q = 40\mu C.$

48. An insulated cylinder of volume $60\ cm^3$ is filled with a gas at 27^0C and 2 atmospheric pressure. Then the gas is compressed making the final volume as $20\ cm^3$ while allowing the temperature to rise to 77^0C. The final pressure is _____ atmospheric pressure.

Key: 7

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\quad P_1 = 2, T_1 = 300, V_1 = 60$

Sol: $\quad P_2 = ?,\ T_2 = 350,\ \ V_2 = 20$

$\Rightarrow P_2 = \frac{P_1V_1}{T_1}.\frac{T_2}{V_2} = 7$

49. A cylindrical conductor of length 2 m and area of cross-section $0.2\,mm^2$ carries an electric current of 1.6 A when its ends are connected to a 2V battery. Mobility of electrons

in the conductor is $\alpha \times 10^{-3}\ m^2$ / V. s. The value of α is: (electron concentration = $5 \times 10^{28} / m^3$ and electron charge = 1.6×10^{-19} C)

Key: 1

$l = 2\,m$

$A = 0.2\ mm^2$

$i = 1.6A$

Sol: $V = 2v$

$n = 5 \times 10^{28} / m^3$

$$V_d = \frac{i}{neA}$$

$$\frac{V_d}{E} = \frac{V_d.l}{V} = \frac{i}{neA}.\left(\frac{1}{v}\right) = \mu = 1 \times 10^{-3} m^2 / v.s$$

50. Two masses m and 2m are connected by a light string going over a pulley (disc) of mass 30 m with radius $r = 0.1\ m$. The pulley is mounted in a vertical plane and it is free to rotate about its axis. The 2m mass is released from rest and its speed when it has descended through a height of 3.6 m is _____ m/s. (Assume string does not slip and $g = 10\ m/s^2$)

Key: 2

Sol: Loss of Gravitational potential energy of 2 m

$$2m.10.36 = \frac{1}{2} \times 2m \times v^2 + \frac{1}{2} \times m \times v^2 + m \times 10(3.6) + \frac{1}{2} \times 30m.\frac{r^2}{2}.\frac{v^2}{r^2}$$

$$36m = mv^2 + \frac{mv^2}{2} + \frac{1}{2} \times 30m \times \frac{v^2}{2}$$

$$36 = 9v^2 \Rightarrow v = 2\,m/s$$

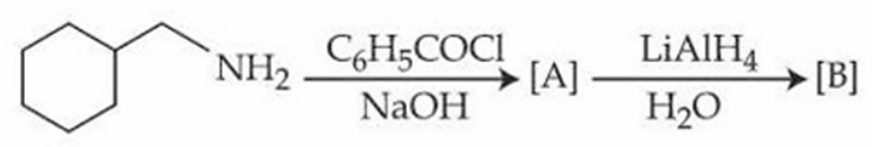
CHEMISTRY

Max Marks: 100

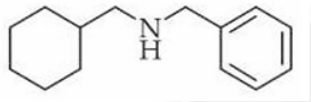
SECTION-I
(SINGLE CORRECT ANSWER TYPE)

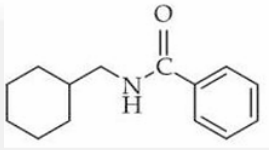
This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

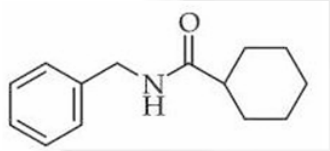
Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

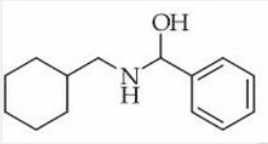
51. 

The final product [B] is:

1) 

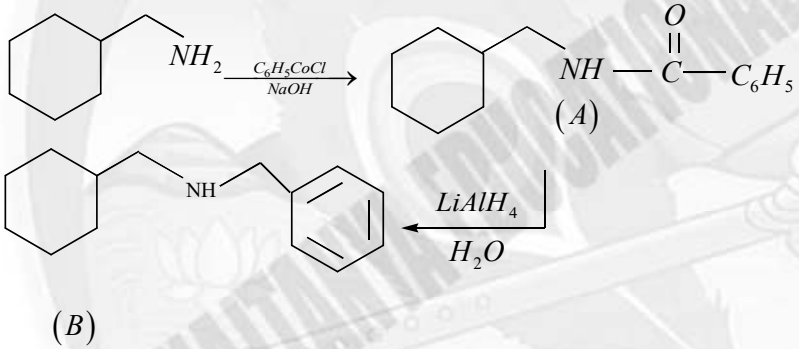
2) 

3) 

4) 

Key: 1

Sol:



52. When 1 g of compound (X) is subjected to Kjeldahl's method for estimation of nitrogen, 15 mL 1 M H_2SO_4 was neutralized by ammonia evolved. The percentage of nitrogen in compound (X) is:

1) 42 2) 0.21 3) 0.42 4) 21

Key: 1

Sol: Equivalents of H_2SO_4 = Equivalents of ammonia

$$= \frac{1.5\times1\times2}{1000} = moles\ of\ ammonia \times 1$$

= moles of Ammonia = moles of Nitrogen

$$= \text{weight of nitrogen} = \frac{15\times1\times2}{1000}\times14 = 0.42$$

$$\% \text{ of Nitrogen} = \frac{\text{weight of nitrogen}}{\text{weight of organic compound}}\times100 = \frac{0.42}{1}\times100 = 42\%$$

53. Which of the following mixture gives a buffer solution with pH = 9.25?

Given: $pK_b\left(NH_4OH\right) = 4.75$

1) 0.4 M $NH_4OH(1L) + 0.1$ M $HCl\ (1L)$

2) 0.2 M $NH_4OH(0.4\ L) + 0.1\ M\ HCl\ (1L)$

3) 0.2 M $NH_4OH(0.5\ L) + 0.1\ M\ HCl\ (0.5\ L)$

4) 0.5 M $NH_4OH(0.2\ L) + 0.2\ M\ HCl\ (0.5\ L)$

Key: 3

Sol: $NH_4OH + HCl \rightarrow NH_4Cl + H_2O$

$0.2M \times 0.5lit\ \ 0.1 \times 0.5$

100 milli moles 50 milli moles 50 milli moles

100 – 50 = 50 millimoles

$$POH = pkb + \log\frac{[salt]}{[Base]}$$

$$POH = 4.75$$

$$PH = 14 - 4.75 = 9.25$$

54. At T (K), 100 g of 98% H_2SO_4 (w/w) aqueous solution is mixed with 100 g of 49% H_2SO_4 (w/w) aqueous solution. What is the mole fraction of H_2SO_4 in the resultant solution? (Given: Atomic mass H = 1 u; S = 32 u; O = 16 u) (Assume that temperature after mixing remains constant)

1) 0.663 2) 0.9 3) 0.337 4) 0.1

Key: 3

Sol: 98% H_2SO_4 means 98 gm of H_2SO_4 & 2gm of H_2O

49% H_2SO_4 means 49 gm of H_2SO_4 & 51gm of H_2O

Total mass of solute = 98 + 49=147 gm

Total mass of solvent = 2 + 51=53 gm

No. of moles of $H_2SO_4 = \frac{147}{98} = 1.5\ moles\ of\ H_2SO_4$

No. of moles of $H_2O = \frac{53}{18} = 2.94\ moles\ of\ H_2O$

$$X_{H_2SO_4} = \frac{1.5}{1.5 + 2.94} = \frac{1.5}{4.44} = 0.337$$

55. Given below are two statements:

Statement I: Elements 'X' and 'Y' are the most and least electronegative elements, respectively among N, As, Sb and P. The nature of the oxides X_2O_3 and Y_2O_3 is acidic and amphoteric, respectively

Statement II: BCl_3 is covalent in nature and gets hydrolysed in water. It produces $\left[B(OH)_4\right]^-$ and $\left[B(H_2O)_6\right]^{3+}$ in aqueous medium.

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 false

3) Both statement I and statement II are true

4) Statement I is false but statement II is true

Key: 1

Sol: Statement-1

Electronegativity of 15th group

$\underset{(3.0)}{N} > \underset{(2.1)}{p} > \underset{(2.0)}{As} > \underset{(1.9)}{Sb} = \underset{(1.9)}{Bi}$

Most Electronegative – nitrogen - N_2O_3

Least Electronegative - $Sb \& Bi$

Sb_2O_3 – Amphoteric Nature

Bi_2O_3 – Basic Nature

Statement-2

$BCl_3 + 3H_2O \rightarrow \underset{BoricAcid}{H_3BO_3} + 3HCl$

It produces Boric Acid

$\therefore$ Statement -2 is incorrect.

56. Consider the following reduction processes:

$Al^{3+} + 3e^- \rightarrow Al(s), E^0 = -1.66\,V$

$Fe^{3+} + e^- \rightarrow Fe^{2+}, E^0 = +0.77\,V$

$Co^{3+} + e^- \rightarrow Co^{2+}, E^0 = +1.81\,V$

$Cr^{3+} + 3e^- \rightarrow Cr(s), E^0 = -0.74\,V$

The tendency to acts as reducing agent decreases in the order:

1) $Al > Cr > Fe^{2+} > Co^{2+}$ 2) $Al > Cr > Co^{2+} > Fe^{2+}$

3) $Al > Fe^{2+} > Cr > Co^{2+}$ 4) $Cr > Fe^{2+} > Al > Co^{2+}$

Key: 1

Sol: More Negative the reduction potential values, that act as strong reducing agent

$Al^{+3} / Al = -1.60V$ $Fe^{3+} / Fe^{2+} = +0.77\,V$

$Co^{+3} / Co^{2+} = +1.81V$ $Cr^{+3} / Cr = -0.7V$

Decreasing order of reducing nature $Al > Cr > Fe^{+2} > Co^{+2}$

57. $\left[Ni(PPh_3)_2 Cl_2\right]$ is a paramagnetic complex. Identify the INCORRECT statements about this complex.

A. The complex exhibits geometrical isomerism

B. The complex is white in colour

C. The calculated spin-only magnetic moment of the complex is 2.84 BM

D. The calculated CFSE (Crystal Field Stabilization Energy) of Ni in this complex is $-0.8\Delta_0$

E. The geometrical arrangement of ligands in this complex is similar to that in $Ni(CO)_4$.

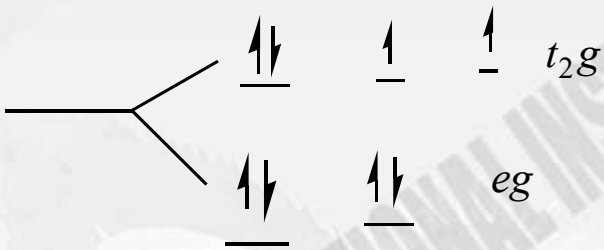
Choose the correct answer from the options given below:

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

Key: 4

Sol: $\left[Ni(pph_3)_2Cl_2\right] \Rightarrow$ oxidations state of Ni is +2

$Ni^{+2} = 3d^8$



It is tetrahedral complex, paramagnetic nature

It is blue colour complex

$CFSE$ for d^8 is $-1.2\Delta_0$ irrespective of ligand

Tetrahedral complexes do not show geometrical isomerism

A, B, D incorrect

58. Correct statements regarding Arrhenius equation among the following are:

A. Factor $e^{-Ea/RT}$ corresponds to fraction of molecules having kinetic energy less than Ea.

B. At a given temperature, lower the Ea, faster is the reaction

C. Increase in temperature by about $10^0 C$ doubles the rate of reaction

D. Plot of log k vs $\frac{1}{T}$ gives a straight line with slope = $-\frac{Ea}{R}$

Choose the correct answer from the options given below:

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

Key: 2

Sol: * The factor $e^{-Ea/RT}$ in the Arrhenius equation represents the fraction of molecules with kinetic energy greater than activation Energy

* Plot of $\log K$ Vs $\frac{1}{T}$ gives a straight line with slope $\frac{-Ea}{2.303R}$

B,C are correct

59. $\mathbf{A + 2B \rightarrow AB_2}$

36.0 g of 'A' (Molar mass : 60 g mol^{-1}) and 56.0 g of 'B' (Molar mass : 80 g mol^{-1}) are allowed to react. Which of the following statements are correct?

A. 'A' is the limiting reagent B. 77.0 g of AB_2 is formed

C. Molar mass of AB_2 is 140 g mol^{-1}

D. 15.0 g of A is left unreacted after the completion of reaction

Choose the correct answer from the options given below:

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

Key: 3

Sol: $A+2B \rightarrow AB_2$

(A) Moles of (A) & (B) $=\frac{36}{60}$ & $\frac{56}{80}=0.6$ mole (A) & 0.7 mole (B)

Baked on stoichiometric ration 'B' is limiting reagent

(B) 2 moles of B $\rightarrow$ produces 1 mole of AB_2

$0.7 \rightarrow (x)$

$x=\frac{0.7}{2}=0.35$ mole of AB_2

Weight of formed AB_2 = 0.35xmol. wt of AB_2

0.35 x 220 = 77 g

(C) Molar mass of AB_2 is A–60, B–80

$\therefore 220$

(D) 1 mole of A $\rightarrow$ reacts with 2 moles of B

(x) $\leftarrow$ 0.7 moles of B

$x=\frac{0.7}{2}=0.35$ (Required of A)

$\therefore 0.6-0.35=0.25$ mole of A is left

$\therefore 0.25\times 60=15$ g of 'n' is left

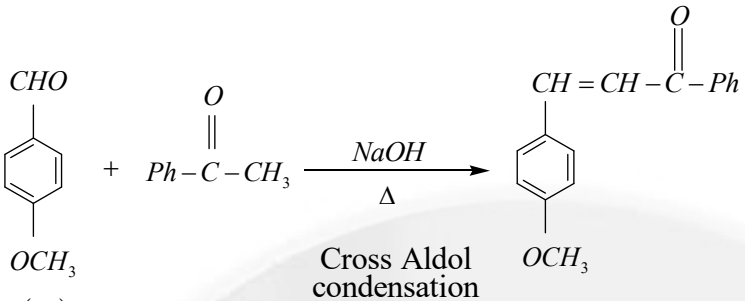
$\therefore$ B, D Correct

60. The compound A, $C_8H_8O_2$ reacts with acetophenone to form a single product via cross-aldol condensation. The compound A on reaction with conc. NaOH forms a substituted benzyl alcohol as one of the two products. The compound A is:

1) 4-methoxy benzaldehyde 2) 4-hydroxy benzylaldehyde

3) 4-methyl benzoic acid 4) 2-hydoxy acetophenone

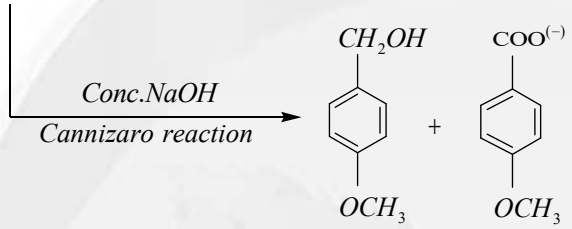
Key: 1



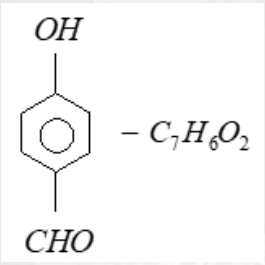
Cross Aldol condensation

(A)

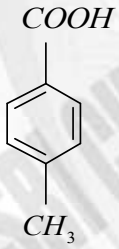
4 - Methoxy bentaldehyde



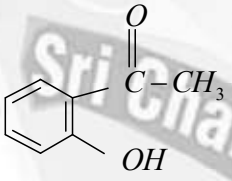
Sol: (1)



(2) does not match with molecular formula



(3) Not Aldehyde & Ketone does not give Aldol (or) Cannizaro reactions



(4) do not undergoes canizzaro due to presence of $\alpha - Hydrogen$

61. The energy of first (lowest) Balmer line of H atom is x J. The energy (in J) of second Balmer line of H atom is:

1) x^2 2) $\frac{x}{1.35}$ 3) $1.35\,x$ 4) $2x$

Key: 3

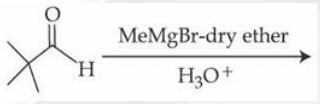
Sol: First line of Balmer $\Delta E_1 = RH\ hc\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = RH\ hc\left[\frac{5}{36}\right]$

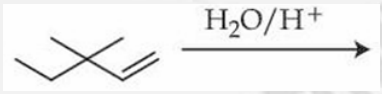
Second line of Balmer $\Delta E_2 = RH\ hc\left[\frac{1}{2^2}-\frac{1}{4^2}\right] = RH\ hc\left[\frac{3}{16}\right]$

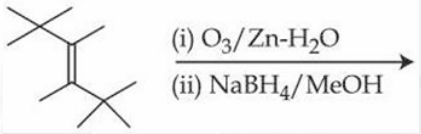
$$\frac{\Delta E_2}{\Delta E_1} = \frac{\frac{3}{11}}{\frac{5}{36}} = \frac{3\times 36}{16\times 5} = \frac{108}{80} = \frac{27}{20}$$

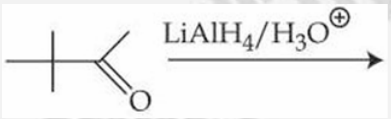
The energy of 2nd line = $\frac{27}{20}x = 1.35x$

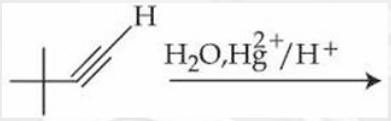
62. 3, 3-Dimethyl-2-butanol cannot be prepared by:

A. 

B. 

C. 

D. 

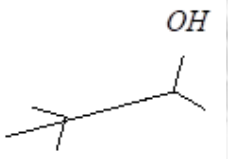
E. 

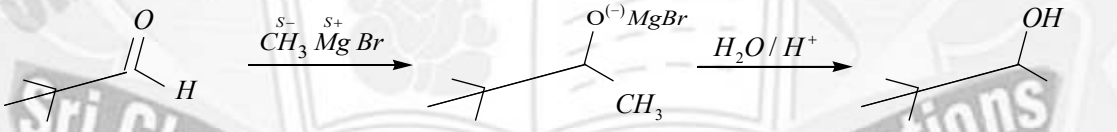
Choose the correct answer from the options given below:

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

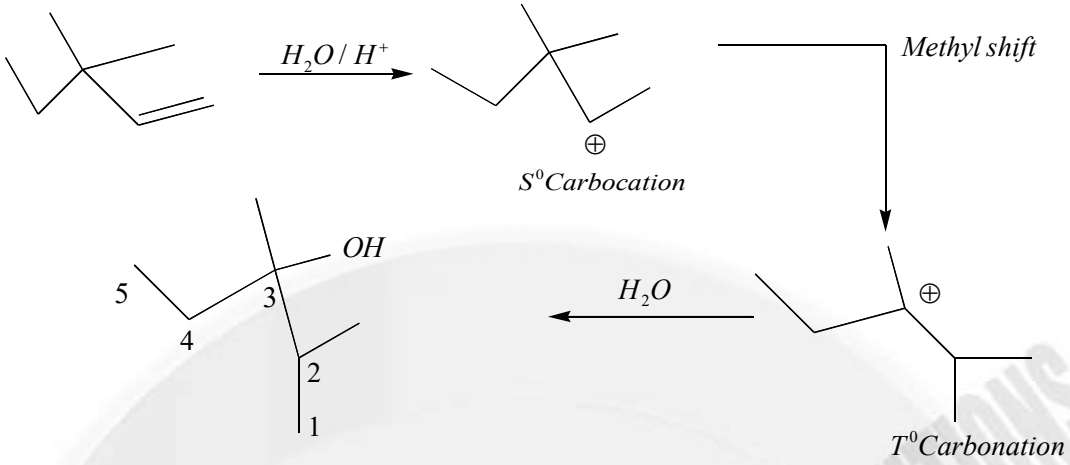
Key: (2)

Sol: 3,3–dimethyl–2–butanol

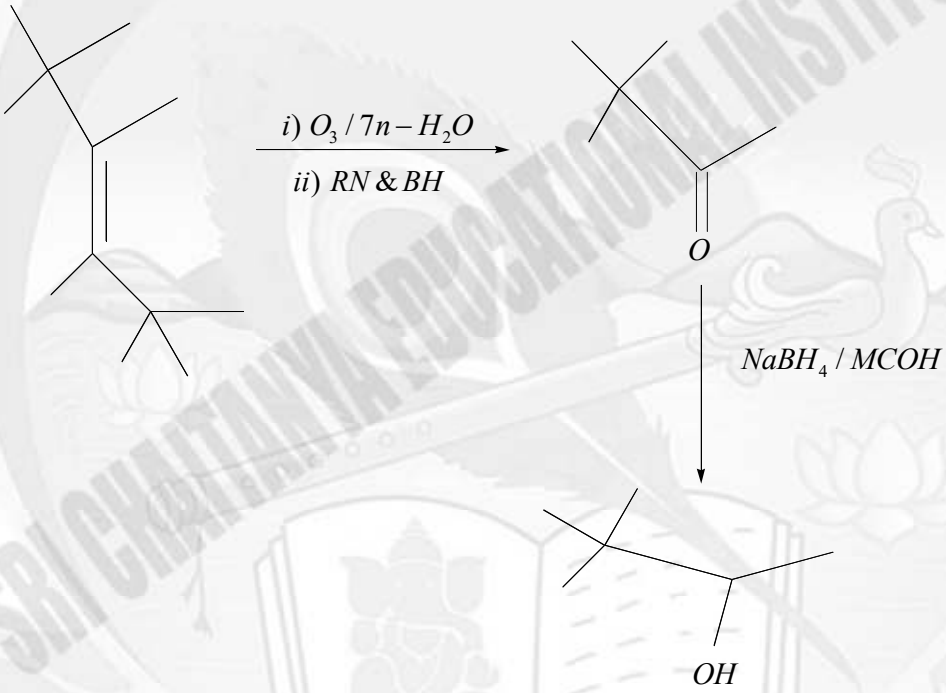


(A) 

3,3 – dimethyl – 2 – butanol

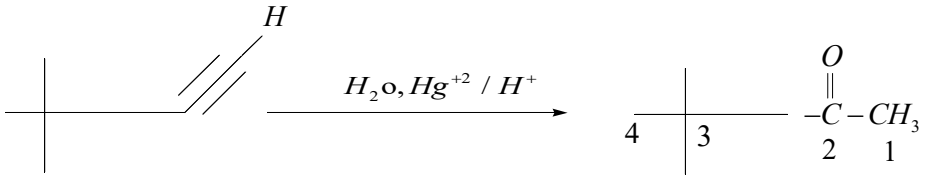


(B) 2,3 – dimethyl pentan – 3 – ol



(C) 3,3 – dimethyl – 2 – butanol

(D) 3,3 – dimethyl – 2 – butanol



3,3–dimethyl Butan – 2 – one

(E)

$\therefore$ B,E are correct

63. Among H_2S, H_2O, NF_3, NH_3 and $CHCl_3$, identify the molecule (X) with lowest dipole moment value. The number of lone pairs of electrons present on the central atom of the molecule (X) is:

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

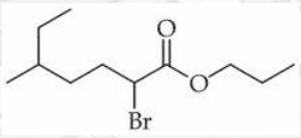
Key: (4)

Sol:

Molecule	H_2S	H_2O	NF_3	NH_3	$CHCl_3$
Dipole moment	0.95	1.85	0.23	1.47	1.04

$\therefore NF_3$ has least dipole moment & has one lone pair of electrons

64. The IUPAC name of the following compound is:

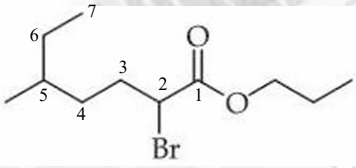


1) n-propyl-1-bromo-4-methylhexanoate 2) n-propyl-2-bromo-5-methylheptanoate

3) 2-bromo-5-methylpropanoate 4) 2-bromo-5-methylhexylpropanoate

Key: (2)

Sol:



IUPAC name of ethers – Alkyl Alkanoate

n-propyl-2-bromo-5-methylheptanoate

65. Given below are two statements:

Statement I: C< O < N< F is the correct order in terms of first ionization enthalpy values.

Statement II: S>Se > Te> Po > O is the correct order in terms of the magnitude of electron gain enthalpy values.

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 II are false

4) Statement I is false but Statement II is true

Key: (2)

Sol: Statement-I: Ionization energy of 2nd period

	C	N	O	F
I.E / K.J/ mol	1086	1402	1314	1681

$\therefore$ C < O < N < F IS CORRECT

Statement – II: Magnitude of electron gain enthalpy

Group – 16 :	O	S	Se	Te	Po
Δ_{eg} / K.J/ mol	-141	-200	-195	-190	-174

$\therefore$ Both statements are correct

66. Match LIST-I with LIST-II.

	LIST-I		LIST-II
	Reaction Of Glucose with		Product Formed
A	Hydroxylamine	I.	Gluconic acid
B	Br_2 water	II.	Glucose pentacetate
C	Excess acetic anhydride	III.	Saccharic acid
D	Concentrated HNO_3	IV.	glucoxime

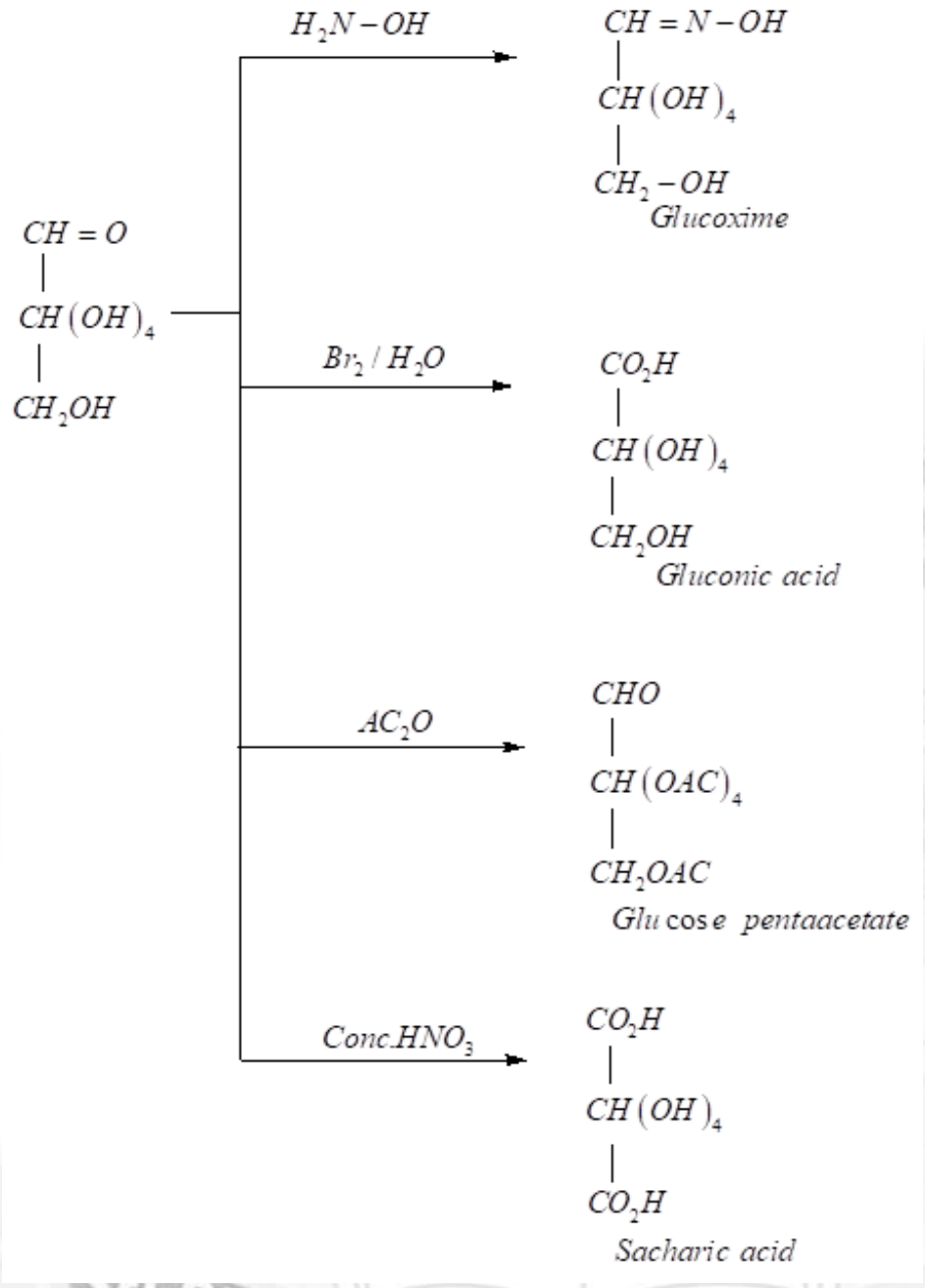
Choose the correct answer from the options given below:

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

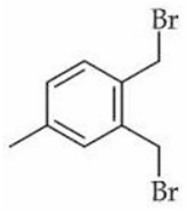
3) A-IV, B-I, C-II, D-III 4) A-IV, B-III, C-II, D-I

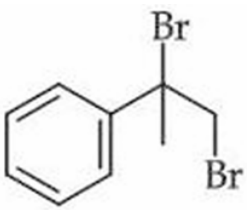
Key: 3

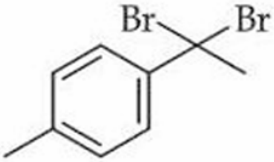
Sol:

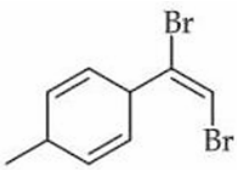


67. The dibromo compound [P] (molecular formula : $C_9H_{10}Br_2$) when heated with excess sodamide followed by treatment with dilute HCl gives [Q]. On warming [Q] with mercuric sulphate and dilute sulphuric acid yield [R] which gives positive Iodoform test but negative Tollen's test. The compound [P] is:

1) 

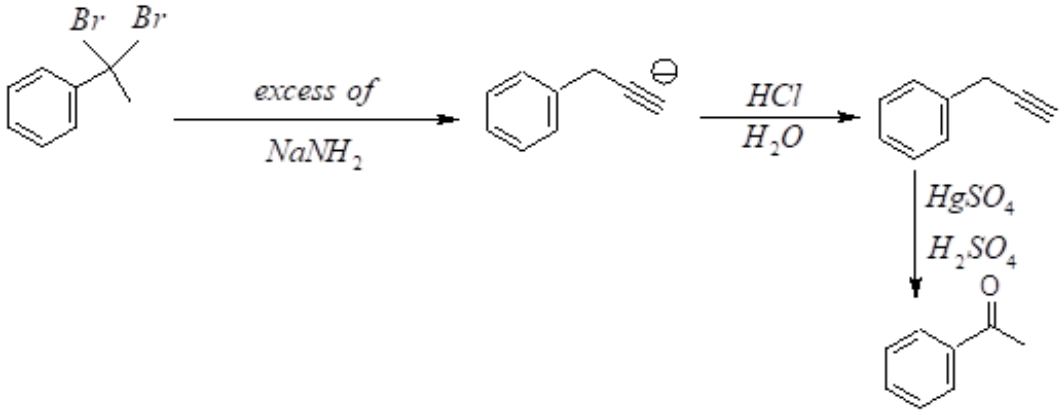
2) 

3) 

4) 

Key: 3

Sol:



68. Given below are two statements:

Statement I: The first ionization enthalpy of Cr is lower than that of Mn

Statement II: The second and third ionization enthalpies of Cr are higher than those of Mn.

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

Key: 2

Sol:

$IE_1(Cr) = 653\,KJ/mol$

$IE_2(Cr) = 1592\,KJ/mol$

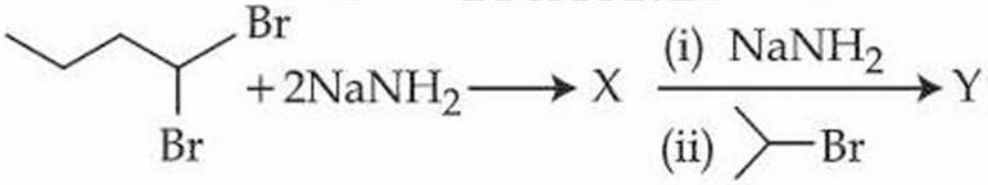
$IE_3(Cr) = 2990$

$IE_1(Mn) = 717$

$IE_2(Mn) = 1509$

$IE_3(Mn) = 3260$

69. Consider the following reaction:

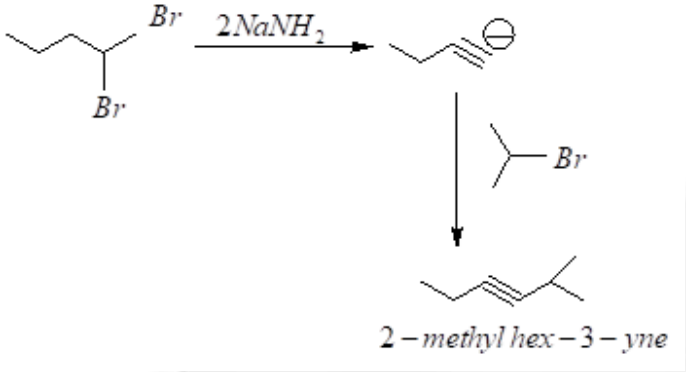


The product Y formed is:

1) 2-methylhex-2-yne
2) Isopropylbut-1-yne
3) 5-methylhex-2-yne
4) 2-methylhex-3-yne

Key: 4

Sol:



70. Identify the correct statements:

A. Hydrated salts can be used as primary standard

B. Primary standard should not undergo any reaction with air

C. Reactions of primary standard with another substance should be instantaneous and stoichiometric.

D. Primary standard should not be soluble in water

E. Primary standard should have low relative molar mass

Choose the correct answer from the options given below:

1) A,B and E only 2) A,B and C only

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

Key: 1

Sol: A) Hydrated Salt can be primary standard

B) Primary standard should not react with air

E) Primary standard should have low relative molar mass are correct

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. Among the following oxides of 3d elements, the number of mixed oxides are _____

$Ti_2O_3, V_2O_4, Cr_2O_3, Mn_3O_4, Fe_3O_4, Fe_2O_3, Co_3O_4$

Ans: 3

Sol: $Mn_3O_4 \Rightarrow 2MnO, MnO_2$

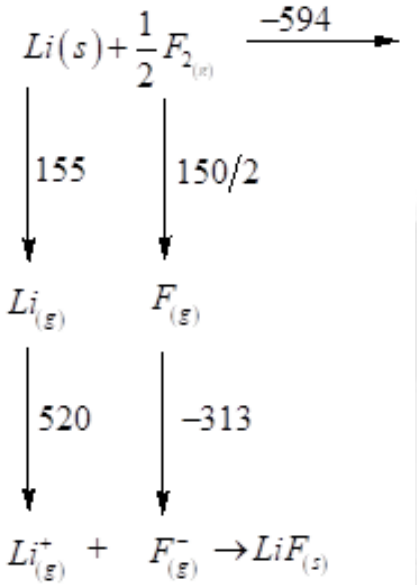
$Fe_3O_4 \Rightarrow FeO, Fe_2O_3$

$Co_3O_4 \Rightarrow CoO, Co_2O_3$

72. If the enthalpy of sublimation of Li is $155\ kJ\,mol^{-1}$, enthalpy dissociation of F_2 is $150\ kJ\ mol^{-1}$, ionization enthalpy of Li is $520\ kJ\ mol^{-1}$, electron gain enthalpy of F is $-313\ kJ\ mol^{-1}$, standard enthalpy of formation of LiF is $-594\ kJ\ mol^{-1}$. The magnitude of lattice enthalpy of LiF is _____ $kJ\ mol^{-1}$ (Nearest integer).

Ans: 1031

Sol:



$$-594 = 155 + 520 + \frac{150}{2} - 313 + L.E \Rightarrow L.E = -1031$$ ANS: 103.

73. Consider the following electrochemical cell:

$$\mathrm{Pt}\left|\mathrm{O_2(g)(1\ bar)}\right|\mathrm{HCl(aq)}\,||\,\mathrm{M^{2+}(aq.1.0\ M)}|\,\mathrm{M(s)}$$

The pH above which, oxygen gas would start to evolve at anode is _____ (nearest integer).

Given: $E^0_{M^{2+}/M} = 0.994$ V, $E^0_{O_2/H_2O} = 1.23$ V } standard reduction potential

and $\frac{RT}{F}(2.303) = 0.059$ V at the given condition

Ans: 4

Sol: For spontaneity $E_{cell} > 0$

$$E_{Oxi}(Anode) = -E_{Red}(Cathode)$$

$$H_2O \rightarrow 2H^+ + \tfrac{1}{2}O_2 + 2e^-$$

$$E_{cell} = E^0_{cell} - \frac{0.059}{2}\log\left[\frac{\left[H^+\right]^2 \times PO_2^{1/2}}{1}\right]$$

$$-0.994 = -1.23 + 0.059 \times p^H$$

$$p^H = 4$$

74. Consider $A \xrightarrow{k_1} B$ and $C \xrightarrow{k_2} D$ are two reactions. If the rate constant (k_1) of the $A \rightarrow B$ reaction can be expressed by the following equation $\log_{10} k = 14.34 - \frac{1.5\times10^4}{T/K}$ and activation energy of $C \rightarrow D$ reaction (Ea_2) is $\frac{1}{5}$th of the $A \rightarrow B$ reaction(Ea_1), then the value of (Ea_2) is _____ kJ mol^{-1} (Nearest Integer)

Ans: 57

Sol: For $A \rightarrow B$ $\log k = \log A - \frac{Ea_1}{2.303RT} \rightarrow (1)$

Given $\log_{10}^{K} = 14.34 - \frac{105\times10^4}{T/k} \rightarrow (2)$

Compare (1) & (2)

$\frac{Ea_1}{2.303R} = 1.5\times10^4 \Rightarrow Ea_1 = 1.5\times10^4 \times 2.303 \times 8.314$

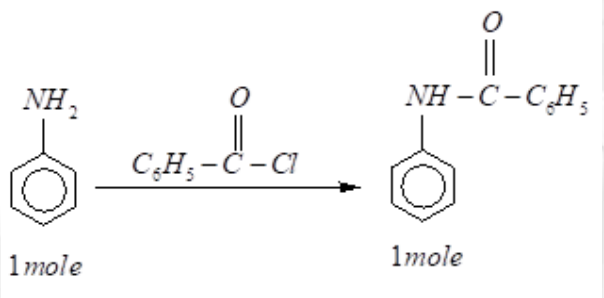
$Ea_1 = 287.207\,KJ$

For $C \rightarrow D$ $\Rightarrow Ea_2 = 1/5 \times Ea_1 \Rightarrow Ea_2 = 57.44\,KJ \Rightarrow Ea_2 = 57$ (Nearest integer)

75. The mass of benzanilide obtained from the benzoylation reaction of 5.8 g of aniline, if yield of product is 82%, is _____ g (nearest integer). (Given molar mass in g mol^{-1} H : 1, C : 12, N : 14, O:16)

Ans: 10

Sol:



Given 5.8 grams (0.0623 mole)

Product is 82% yield then mole of

$product = \frac{0.0623\times82}{100} \Rightarrow 0.051\,mole$

Mass of product=0.051x197=10.047

Ans: 10 (Nearest integer)

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

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