(HELD ON THURSDAY 02nd APRIL 2026) **TIME : 9:00 AM TO 12:00 NOON**

MATHEMATICS

TEST PAPER WITH SOLUTION

SECTION-A

1. Let $\alpha, \alpha + 2, \alpha \in \mathbf{Z}$, be the roots of the quadratic equation $x(x + 2) + (x + 1)(x + 3) + (x + 2)(x + 4) + \ldots + (x + n - 1)(x + n + 1) = 4n$ for some $n \in N$.

Then $(n + \alpha)$ is equal to :

(1) 0 (2) 1

(3) 2 (4) 4

Ans. **(3)**

Sol. $nx^2 + x(2 + 4 + 6 + \ldots + 2n) + (1.3 + \ldots + (n-1)(n + 1)) = 4n$

$$nx^2 + n(n+1)x + \frac{n(n-1)(2n+5)}{6} = 4n$$

$$x^2 + (n+1)x + \frac{(n-1)(2n+5)}{6} = 4$$

D must be a perfect square

$$D = \frac{122 - 2n^2}{6} = 20 - \left(\frac{n^2-1}{3}\right)$$

If make perfect square $\Rightarrow \frac{n^2-1}{3} = 16 \Rightarrow n = 7$

So Equation is

$$\Rightarrow x^2 + 8x + \frac{8 \times 15}{6} - 5 = 0$$

$x^2 + 8x + 15 = 0$

$x = -3, -5$

$\alpha = -5, \alpha + 2 = -3$

$\alpha + n = 7 - 5 = 2$

2. Let x and y be real number such that $50\left(\frac{2x}{1+3i} - \frac{y}{1-2i}\right) = 31 + 17i$, $i = \sqrt{-1}$. Then the value of $10(x - 3y)$ is :

(1) 20 (2) 31

(3) 35 (4) 75

Ans. **(4)**

Sol. $50\left(\frac{2x(1-3i)}{10} - \frac{y(1+2i)}{5}\right) = 31 + 17i$

$10x - (30x)i - 10y - 20y\,i = 31 + 17i$

$$\left.\begin{aligned} 10(x-y) &= 31 \\ -30x - 20y &= 17 \end{aligned}\right\}$$

$30x - 30y = 93$

$-10(3x + 2y) = 17$

$x = 0.9, y = -2.2$

$10(x - 3y) = 75$

3. Let $\alpha, \beta \in \mathbf{R}$ be such that the system of linear equations

$x + 2y + z = 5$

$2x + y + \alpha z = 5$

$8x + 4y + \beta z = 18$

has no solution. Then $\frac{\beta}{\alpha}$ is equal to :

(1) –4 (2) 4

(3) 8 (4) –8

Ans. **(2)**

Sol. $x + 2y + z = 5$

$2x + y + \alpha z = 5$

$8x + 4y + \beta z = 18$

for no solution

$$\Delta = \begin{vmatrix} 1 & 2 & 1 \\ 2 & 1 & \alpha \\ 8 & 4 & \beta \end{vmatrix} = 0$$

$\Delta = 1(\beta - 4\alpha) - 2(2\beta - 8\alpha) + 1\,(0) = 0$

$= \beta - 4\alpha - 4\beta + 16\alpha = 0$

$\Rightarrow 4\alpha = \beta$

4. Let $A = \begin{bmatrix} 1 & 2 \\ 1 & \alpha \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 3 \\ \beta & 2 \end{bmatrix}$.

If $A^2 - 4A + I = O$ and $B^2 - 5B - 6I = O$, then among the two statements :

(S1) : $[(B - A)(B + A)]^T = \begin{bmatrix} 13 & 15 \\ 7 & 10 \end{bmatrix}$

and

(S2) : det (adj(A + B)) = – 5,

(1) only (S1) is correct

(2) only (S2) is correct

(3) both (S1) and (S2) are correct

(4) both (S1) and (S2) are wrong

Ans. (2)

Sol. $A = \begin{bmatrix} 1 & 2 \\ 1 & \alpha \end{bmatrix}$

$A^2 - 4A + I = 0$

trace of matrix

$\alpha + 1 = 4$

$\alpha = 3$

$B = \begin{bmatrix} 3 & 3 \\ \beta & 2 \end{bmatrix}$

$B^2 - 5B - 6I = 0$

det. $(B) = 6 - 3\beta = -6$

$3\beta = 12$

$\beta = 4$

$B - A = \begin{bmatrix} 2 & 1 \\ 3 & -1 \end{bmatrix}; B + A = \begin{bmatrix} 4 & 5 \\ 5 & 5 \end{bmatrix}$

$(B - A)(B + A) = \begin{bmatrix} 13 & 15 \\ 7 & 10 \end{bmatrix}$

$\text{adj}(A) = \begin{bmatrix} 3 & -2 \\ -1 & 1 \end{bmatrix}$, $\text{adj}B = \begin{bmatrix} 2 & -3 \\ -4 & 3 \end{bmatrix}$

$\text{adj}(A + B) = \begin{bmatrix} 5 & -5 \\ -5 & 4 \end{bmatrix}$

5. Let A be the set of first 101 terms of an A.P., whose first term is 1 and the common difference is 5 and let B be the set of first 71 terms of an A.P., whose first term is 9 and the common difference is 7. Then the number of elements is $A \cap B$, which are divisible by 3, is :

(1) 4 (2) 5

(3) 6 (4) 7

Ans. (2)

Sol. AP_1 Set A = {1, 6,11,16 ..... 101 terms}

AP_2 Set B = {9, 16 ..... 71 terms}

$D = \text{L.C.M}\ \{d_1, d_2\} = 35$

1^{st} Common term is 16

$16 + (n - 1)\,35 \leq 499$

$n \leq 14.8$

$\Rightarrow n = 14$

$A \cap B$ = {16,51,86,121,156, 191, 226, 261, 296, 331, 366,401,436,471}

terms divisible by '3'

= {51,156,261,366,471}

Ans. 5 terms

6. The number of seven-digit numbers, that can be formed by using the digits 1, 2, 3, 5 and 7 such that each digit is used at least once, is ;

(1) 15400 (2) 17800

(3) 16800 (4) 29400

Ans. (3)

Sol. Exactly one digit repeated $\rightarrow {}^5C_1 \times \frac{7!}{3!} = 4200$

Exactly two digits repeated $\rightarrow {}^5C_2 \times \frac{7!}{2!2!} = 12600$

Total numbers = 16800

7. The number of elements in the set

$S = \left\{(r, k) : k \in \mathbf{Z} \text{ and } {}^{36}C_{r+1} = \frac{6({}^{35}C_r)}{(k^2-3)}\right\}$, is

(1) 2 (2) 4 (3) 8 (4) 16

Ans. (2)

Sol. $\frac{36}{r+1}.{}^{35}C_r = 6.\frac{{}^{35}C_r}{k^2-3}$

$k^2 - 3 = \frac{r+1}{6}$

$k^2 = \frac{r+19}{6}$

$0 \le r \le 35$

$19 \le r + 19 \le 54$

$3.1 \le \frac{r+19}{6} \le 9$

$\therefore k^2 = 4, 9$

$k = \pm 2, \pm 3$

$\therefore (r, k) \Rightarrow (5, \pm 2) \Rightarrow (35, \pm 3)$

$\therefore$ 4

8. If the mean of the data

Class	5-10	10-15	15-20	20-25	25-30	30-35
Frequency	2	k	28	54	k+1	5

is 21, then k is one of the roots of the equation :

(1) $2x^2 - 23x - 10 = 0$

(2) $4x^2 - 35x + 24 = 0$

(3) $2x^2 - 19x - 10 = 0$

(4) $2x^2 - 35x + 98 = 0$

Ans. (3)

Sol.

Class	5-10	10-15	15-20	20-25	25-30	30-35
Freq.	2	k	28	54	k+1	5

mean

$21 = \frac{15 + 12.5k + 490 + 1215 + 27.5 + 27.5k + 162.5}{90 + 2k}$

$1890 + 42k = 1910 + 40k$

$k = 10$

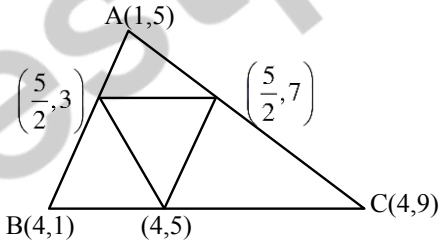
9. Let the mid points of the sides of a triangle ABC be $\left(\frac{5}{2}, 7\right)$, $\left(\frac{5}{2}, 3\right)$ and (4, 5). If its incentre is (h, k), then 3h + k is equal to :

(1) 11 (2) 12

(3) 13 (4) 14

Ans. (3)

Sol.



$I = \left(\frac{24}{9}, 5\right)$

$\therefore 3h + k = 8 + 5 = 13$

10. Let an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, a < b, pass through the point (4, 3) and have eccentricity $\frac{\sqrt{5}}{3}$. Then the length of its latus rectum is :

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

(3) $\frac{7\sqrt{5}}{3}$ (4) $\frac{8\sqrt{5}}{3}$

Ans. (4)

Sol. $e^2 = 1 - \frac{a^2}{b^2} \Rightarrow \frac{a^2}{b^2} = 1 - e^2 = 1 - \frac{5}{9} = \frac{4}{9}$

$\Rightarrow \frac{a^2}{b^2} = \frac{4}{9}$ …(1)

Passes through (4,3) $\Rightarrow \frac{16}{a^2} + \frac{9}{b^2} = 1$ …(2)

from (1) and (2)

$a^2 = 20$ and $b^2 = 45$

$LR = \frac{2a^2}{b} = \frac{2(20)}{3\sqrt{5}} = \frac{8\sqrt{5}}{3}$

11. If $\sin\left(\frac{\pi}{18}\right)\sin\left(\frac{5\pi}{18}\right)\sin\left(\frac{7\pi}{18}\right) = K$, then the value of $\sin\left(\frac{10K\pi}{3}\right)$ is :

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

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

Ans. (1)

Sol. $K = \sin10° \sin50° \sin70°$

$= \frac{1}{4}\sin30° = \frac{1}{8}$

$\sin10K\frac{\pi}{3} = \sin\left(10 \times \frac{1}{8}.\frac{\pi}{3}\right) = \sin\frac{5\pi}{12} = \frac{\sqrt{3}+1}{2\sqrt{2}}$

12. Let $S = \{x \in [-\pi, \pi] : \sin x (\sin x + \cos x) = a, a \in \mathbf{Z}\}$. Then n(S) is equal to :

(1) 3 (2) 6

(3) 7 (4) 9

Ans. (4)

Sol. $\sin x (\sin x + \cos x) \in \left[\frac{1-\sqrt{2}}{2}, \frac{1+\sqrt{2}}{2}\right]$

2 integer will be there $\Rightarrow a = 0, 1$

If $a = 0$ $\sin(\sin x + \cos x) = 0$

$\Rightarrow \sin x = 0$ or $\sin x + \cos x = 0$

$\boxed{x = -\pi, 0, \pi}$ $= \tan x = -1$

3 solutions $\boxed{x = -\frac{\pi}{4}, \frac{3\pi}{4}}$ 2 solutions

If $a = 1$ $\sin(\sin x + \cos x) = 1$

$\sin^2 x + \sin x \cos x = 1$

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

$1 - \cos2x + \sin2x = 2$

$\text{Sin}2x - \cos2x = 1 \rightarrow$ square

$\text{Sin } 4x = 0$

$4x = -4\pi, -3\pi, \ldots\ldots\ldots, 3\pi, 4\pi$

$x = -\pi, -\frac{3\pi}{4}, -\frac{\pi}{2}, -\frac{\pi}{4}, 0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \pi$

$\Rightarrow x = -\frac{3\pi}{4}, -\frac{\pi}{2}, \frac{\pi}{4}, \frac{\pi}{2}$ 4 solutions

Total 9 solution

13. If the point of intersection of the lines $\frac{x+1}{3} = \frac{y+a}{5} = \frac{z+b+1}{7}$ and $\frac{x-2}{1} = \frac{y-b}{4} = \frac{z-2a}{7}$ lies on xy-plane, then the value of a + b is :

(1) 2 (2) 5

(3) 7 (4) 9

Ans. (3)

Sol. Line (L_1)

$\frac{x+1}{3} = \frac{y+a}{5} = \frac{z+b+1}{7} = r_1$

$\Rightarrow$ General point P on L_1 is

$(3r_1 - 1, 5r_1 - a, 7r_1 - b - 1)$

Line (L_2)

$\frac{x-2}{1} = \frac{y-b}{4} = \frac{z-2a}{7} = r_2$

$\Rightarrow$ General point Q on L_2 is

$(r_2 + 2, 4r_2 + b, 7r_2 + 2a)$

For point of intersection

$3r_1 - 1 = r_2 + 2 \Rightarrow r_2 = 3r_1 - 3$ …(1)

$5r_1 - a = 4r_2 + b$ …(2)

$7r_1 - b - 1 = 7r_2 + 2a$ …(3)

Since point lies on XY plane

$\Rightarrow$ z – coordinate = 0

From L_1 : $7r_1 - b - 1 = 0 \Rightarrow 7r_1 = b + 1$

From L_2 : $7r_2 + 2a = 0 \Rightarrow 2a = -7r_2$

Substitute $r_2 = 3r_1 - 3$

$2a = -7(3r_1 - 3)$

$\Rightarrow a = \frac{-21r_1 + 21}{2}$

Put in equation (2)

$5r_1 - a = 4r_2 + b$

$5r_1 - \left(\frac{-21r_1 + 21}{2}\right) = 4(3r_1 - 3) + (7r_1 - 1)$

$\Rightarrow r_1 = \frac{5}{7}$

$\Rightarrow b = 7r_1 - 1 = 4$

$\Rightarrow a = 3 \therefore a + b = 7$

14. If $\vec{a}$ and $\vec{b}$ are two vectors such that $|\vec{a}| = 2$ and $|\vec{b}| = 3$, then the maximum value of $3\left|(3\vec{a} + 2\vec{b})\right| + 4\left|(3\vec{a} - 2\vec{b})\right|$ is :

(1) 30 (2) 36

(3) 60 (4) 72

Ans. (3)

Sol. $E = 3\sqrt{9a^2 + 4b^2 + 12\vec{a}.\vec{b}} + 4\sqrt{9a^2 + 4b^2 - 12\vec{a}.\vec{b}}$

$= 3\sqrt{36 + 36 + 12 \times 6\cos\theta} + 4\sqrt{36 + 36 - 72\cos\theta}$

$= 3\sqrt{72 + 72\cos\theta} + 4\sqrt{72 - 72\cos\theta}$

$= 18\sqrt{2}\sqrt{1 + \cos\theta} + 24\sqrt{2}\sqrt{1 - \cos\theta}$

$= 18\sqrt{2}\sqrt{2}\cos\frac{\theta}{2} + 24\sqrt{2}\left(\sqrt{2}\sin\frac{\theta}{2}\right)$

$= 36\left(\cos\frac{\theta}{2}\right) + 48\sin\left(\frac{\theta}{2}\right)$

$E_{max} = \sqrt{(36)^2 + (48)^2} = \sqrt{6^4 + 6^2 \times 8^2} = 60$

15. Let a line L passing through the point (1, 1, 1) be perpendicular to both the vectors $2\hat{i} + 2\hat{j} + \hat{k}$ and $\hat{i} + 2\hat{j} + \hat{k}$. If P(a, b, c) is the foot of perpendicular from the origin on the line L, then the value of 34(a + b + c) is :

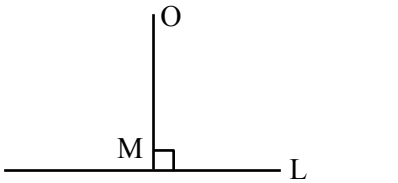
(1) 50 (2) 80

(3) 100 (4) 120

Ans. (3)

Sol. Direction vector of line is

$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 2 \\ 2 & 2 & 1 \end{vmatrix} = -2\hat{i} + 3\hat{j} - 2\hat{k}$



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

So equation of line is

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

let $(2\lambda + 1, -3\lambda + 1, 2\lambda + 1)$ be the foot of perpendicular from (0, 0, 0) upon given line

$\Rightarrow \overrightarrow{OM}.\left(2\hat{i} - 3j + 2\hat{k}\right) = 0$

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

$\Rightarrow \lambda = -\frac{1}{17}$

So $(a, b, c) \equiv \left(\frac{-2}{17} + 1, \frac{3}{17} + 1, \frac{-2}{17} + 1\right)$

$\Rightarrow 34(a + b + c) = 100$

16. If $\lim\limits_{x \to 2} \frac{\sin\left(x^3 - 5x^2 + ax + b\right)}{(\sqrt{x-1} - 1)\log_e(x-1)} = m$, then a + b + m is equal to:

(1) 5 (2) 6

(3) 8 (4) 10

Ans. (2)

Sol. $\because$ Denominator = 0 at x = 2

$\Rightarrow$ Numerator = 0 at x = 2

$\Rightarrow 2^3 - 5(2)^2 + a(2) + b = 0$

$\Rightarrow 2a + b = 12 \quad ... (1)$

$$\therefore m = \lim_{x\to 2} \frac{\frac{\sin(x^3-5x^2+ax+b)}{(x^3-5x^2+ax+b)}\cdot(x^3-5x^2+ax+b)}{\left(\frac{x-1-1}{\sqrt{x-1}+1}\right)\cdot\frac{\log_e(1+(x-2))}{(x-2)}\cdot(x-2)}$$

$$\Rightarrow m = \lim_{x\to 2} 2\left(\frac{x^3-5x^2+ax+b}{(x-2)^2}\right)$$

$$\Rightarrow m = \lim_{x\to 2} 2\left(\frac{3x^2-10x+a}{2(x-2)}\right)$$

$\because$ Denominator = 0 at x = 2

$\Rightarrow$ Numerator = 0 at x = 2

$\Rightarrow 3(2)^2 - 10(2) + a = 0 \Rightarrow a = 8$

put a = 8 in (1), we get b = – 4

$$\therefore m = \lim_{x\to 2} 2\left(\frac{6x-10}{2}\right) \Rightarrow m = 2$$

$\therefore a + b + m = 6$

17. If the curve y = f(x) passes through the point (1, e) and satisfies the differential equation $dy = y(2 + \log_e x)\,dx$, x > 0, then f(e) is equal to :

(1) e^e (2) e^{e^2}

(3) e^{2e} (4) e^{2^e}

Ans. (3)

Sol. $$\frac{dy}{dx} = y(2+\ell nx)$$

$$\int\frac{dy}{y} = \int(2+\ell nx)\,dx$$

$$\ell ny = 2x + x\ell nx - x + C$$

$$\ell ny = x + x\ell nx + C$$

Since it passes through (1,e)

$1 = 1 + 0 + C \Rightarrow C = 0$

$\ell ny = x + x\ell nx$

$f(x) = y = e^{x + x\ln x}$

$\Rightarrow f(e) = e^{e+e} = e^{2e}$

18. The number of critical points of the function $f(x) = \begin{cases} \left|\frac{\sin x}{x}\right| & , \ x \neq 0 \\ 1 & , \ x = 0 \end{cases}$ in the interval $(-2\pi, 2\pi)$ is equal to:

(1) 1 (2) 3

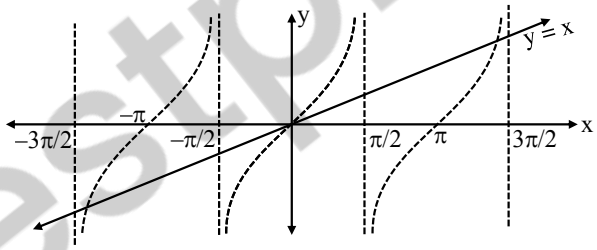
(3) 5 (4) 7

Ans. (3)

Sol. $\lim_{x\to 0}\left|\frac{\sin x}{x}\right| = 1 = f(0) \rightarrow f(x)$ is continuous

Now $\frac{d}{dx}\left(\frac{\sin x}{x}\right) = \frac{x\cos x - \sin x}{x^2}$

$\Rightarrow f'(x) = 0 \Rightarrow \tan x = x$



3 solution in $(-2\pi, 2\pi)$

also f'(0) does not exist at $x = -\pi, \pi$

total 5 points

19. Let [·] denote the greatest integer function. Then the value of $\int_0^3 \left(\frac{e^x + e^{-x}}{[x]!}\right)dx$ is:

(1) $e^2 + e^3 - \frac{1}{e^2} - \frac{1}{e^3}$

(2) $\frac{1}{2}\left(e^2 + e^3 - \frac{1}{e^2} - \frac{1}{e^3}\right)$

(3) $e^2 + e^3 - \frac{1}{2e^2} - \frac{1}{2e^3}$

(4) $\frac{1}{2}(e^2 + e^3) - \frac{1}{e^2} - \frac{1}{e^3}$

Ans. (2)

Sol. $\int_0^1 \frac{e^x+e^{-x}}{1}dx + \int_1^2 \frac{e^x+e^{-x}}{1}dx + \int_2^3 \frac{e^x+e^{-x}}{2}dx$

$\int_0^2 e^x dx + \int_0^2 e^{-x}dx + \frac{1}{2}\int_2^3 (e^x+e^{-x})dx$

$(e^2-1) + \frac{(e^{-2}-1)}{-1} + \frac{1}{2}\left((e^3-e^2)-(e^{-3}-e^{-2})\right)$

$\frac{e^3+e^2}{2} + 1 - 1 - \frac{e^{-2}}{2} - \frac{e^{-3}}{2}$

$\frac{e^3+e^2-e^{-2}-e^{-3}}{2}$

20. Let y = y(x) be the solution curve of the differential equation $(1+\sin x)\frac{dy}{dx} + (y+1)\cos x = 0$, $y(0) = 0$. If the curve $y = y(x)$ passes through the point $\left(\alpha, \frac{-1}{2}\right)$, then a value of α is :

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{4}$

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

Ans. **(4)**

Sol. $\int \frac{dy}{y+1} = -\int \frac{\cos x}{1+\sin x}dx$

$\Rightarrow \ell n(y+1) = -\ell n(1+\sin x) + C$

$\because y(0) = 0 \Rightarrow C = 0$

$\Rightarrow y+1 = \frac{1}{1+\sin x}$

passes through $\left(\alpha, -\frac{1}{2}\right)$

$\Rightarrow \sin x = 1$

$\Rightarrow x = \frac{\pi}{2}$ (as per options)

SECTION-B

21. If the domain of the function $f(x) = \sqrt{\log_{(0.6)}\left(\left|\frac{2x-5}{x^2-4}\right|\right)}$ is $(-\infty, a] \cup \{b\} \cup [c,d) \cup (e,\infty)$, then the value of $a+b+c+d+e$ is _____.

Ans. **(4)**

Sol. For domain $\log_{0.6}\left|\frac{2x-5}{x^2-4}\right| \geq 0$

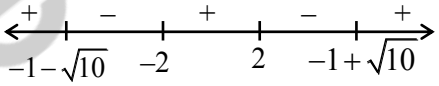
$\left|\frac{2x-5}{x^2-4}\right| \leq 1 \quad \& \quad x \neq \frac{5}{2}$ ..... (1)

$-1 \leq \frac{2x-5}{x^2-4} \leq 1$

$\frac{2x-5}{x^2-4} + 1 \geq 0$

$\frac{x^2+2x-9}{x^2-4} \geq 0$

$\frac{(x+1)^2-10}{(x-2)(x+2)} \geq 0$



$x \in \left(-\infty, -1-\sqrt{10}\right] \cup (-2,2) \cup \left[-1+\sqrt{10}, \infty\right)$ .....(2)

$\frac{2x-5}{x^2-4} - 1 \leq 0$

$\frac{2x-5-x^2+4}{x^2-4} \leq 0$

$\frac{x^2-2x+1}{x^2-4} \geq 0$

$\frac{(x-1)^2}{(x-2)(x+2)} \geq 0$

$x \in (-\infty,-2) \cup (2,\infty) \cup \{1\}$ ....(3)

$(1) \cap (2) \cap (3)$

$x \in \left(-\infty, -1-\sqrt{10}\right] \cup \{1\} \cup \left[-1+\sqrt{10}, \frac{5}{2}\right) \cup \left(\frac{5}{2}, \infty\right)$

$a+b+c+d+e = -2+1+5 = 4$

22. If $\sum_{k=1}^{n} a_k = 6n^3$, then $\sum_{k=1}^{6}\left(\frac{a_{k+1}-a_k}{36}\right)^2$ is equal to ____.

Ans. **(91)**

Sol. $a_1 + a_2 + ... + a_n = 6n^3$.

$a_1 + a_2 + ... + a_n + a_{n+1} = 6(n+1)^3$

$a_{n+1} = 6(n+1)^3 - 6n^3$

$= 6\left((n+1)-n\right)\left((n+1)^2 + n^2 + n(n+1)\right)$

$a_{n+1} = 6(1)\left(3n^2+3n+1\right)$

$a_n = 6\left(3(n-1)^2 + 3(n-1) + 1\right)$

$= 6\left(3(n^2 - 2n + 1 + n - 1) + 1\right)$

$= 6\left(3(n^2 - n) + 1\right)$

$a_n = 6\,(3n^2 - 3n + 1)$

$$\sum_{k=1}^{6}\left(\frac{6(3k^2+3k+1)-6(3k^2-3k+1)}{36}\right)^2$$

$$\sum_{k=1}^{6}\left(\frac{36k}{36}\right)^2 = \sum_{k=1}^{6} k^2 = \frac{6\times 7\times 13}{6} = 91$$

23. Let a, b, c $\in \{1,2,3,4\}$. If the probability, that $ax^2 + 2\sqrt{2}\,bx + c > 0$ for all $x \in \mathbf{R}$, is $\frac{m}{n}$, gcd (m,n) = 1, then m + n is equal to _____.

Ans. **(81)**

Sol. $8b^2 - 4ac < 0 \Rightarrow 2b^2 < ac$

b	a	c		
1	1	3,4	$\rightarrow$	2
1	2	2,3,4	$\rightarrow$	3
1	3	1,2,3,4	$\rightarrow$	4
1	4	1,2,3,4	$\rightarrow$	4
2	3	3,4	$\rightarrow$	2
2	4	3,4	$\rightarrow$	2
				17

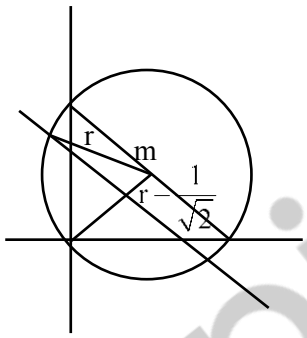
Required probability $= \frac{17}{64} \equiv \frac{m}{n}$

$\therefore\ m + n = 17 + 64 = 81$

24. Let a circle C have its centre in the first quadrant, intersect the coordinate axes at exactly three points and cut off equal intercepts from the coordinate axes. If the length of the chord of C on the line x + y = 1 is $\sqrt{14}$, then the square of the radius of C is _____.

Ans. **(8)**

Sol.



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

$$r^2 = \frac{7}{2} + r^2 - \sqrt{2}r + \frac{1}{2}$$

$\sqrt{2}r = 4$

$r = 2\sqrt{2}$

$r^2 = 8$

25. If $\alpha = \int_0^{2\sqrt{3}} \log_2\left(x^2+4\right)dx + \int_2^4 \sqrt{2^x - 4}\,dx$, then α^2 is equal to _____.

Ans. **(192)**

Sol. As we know that

$$\int_a^b f(x)\,dx + \int_{f(a)}^{f(b)} f^{-1}(x)\,dx = bf(b) - af(a)$$

$\therefore\ \alpha = \left(2\sqrt{3}\right)(4) - (0)(2)$

$= 8\sqrt{3}$

$\Rightarrow \alpha^2 = 192$

(HELD ON THURSDAY 02nd APRIL 2026) **TIME : 9:00 AM TO 12:00 NOON**

PHYSICS

TEST PAPER WITH SOLUTION

SECTION-A

26. The dimensional formula of $\frac{1}{2}\in_0 E^2$ ($\in_0$ = permittivity of vacuum and E = electric field) is $M^aL^bT^c$. The value of $2a-b+c=$ _____.

(1) 0 (2) 1

(3) –1 (4) 2

Ans. (2)

Sol. $\frac{1}{2}\in_0 E^2$ = Energy density

$$\therefore \left[\frac{1}{2}\in_0 E^2\right] = \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$$

$\therefore$ a = 1, b = –1, c = – 2

$\therefore$ 2a – b + c = 2 + 1 – 2 = 1

27. The diameter of a wire measured by a screw gauge of least count 0.001 cm is 0.08 cm. The length measured by a scale of least count 0.1 cm is 150 cm. When a weight of 100 N is applied to the wire, the extension in length is 0.5 cm, measured by a micrometer of least count 0.001 cm. The error in the measured Young's modulus is $\alpha \times 10^9$ N/m^2. The value of α is_____.

(Ignore the contribution of the load to Young's modulus error calculation)

(1) 1.3 (2) 1.65

(3) 0.13 (4) 0.25

Ans. (2)

Sol. $Y = \frac{F\ell}{A\Delta\ell}$

$$\therefore \frac{\Delta Y}{Y} = \frac{\Delta F}{F} + \frac{\Delta\ell}{\ell} + 2\frac{\Delta d}{d} + \frac{\Delta(\Delta\ell)}{\Delta\ell}$$

$$\left[A = \pi\frac{d^2}{4} \Rightarrow \frac{\Delta A}{A} = \frac{2\Delta d}{d}\right]$$

Since F is known exactly $\Rightarrow \Delta F = 0$

$$\frac{\Delta Y}{Y} = \frac{0.1}{150} + \frac{2\times 0.001}{0.08} + \frac{0.001}{0.5} = 0.0277$$

$\therefore \Delta Y = 0.0277\ Y$

$$Y = \frac{100\times 1.5}{\frac{\pi}{4}\left(\frac{0.08}{100}\right)^2 \times 0.5\times 10^{-2}} = 5.97\times 10^{10}\ \text{N/m}^2$$

$\therefore \Delta Y = 0.0277 \times 5.97 \times 10^{10}\ \text{N/m}^2 = 1.65 \times 10^9\ \text{N/m}^2$

28. The velocity of a particle is given as $\vec{v} = -x\hat{i} + 2y\hat{j} - z\hat{k}\ m/s$. The magnitude of acceleration at point (1, 2, 4) is _____ m/s^2.

(1) $\sqrt{6}$ (2) 9

(3) $\sqrt{33}$ (4) 0

Ans. (2)

Sol. $\vec{v} = -x\hat{i} + 2y\hat{j} - z\hat{k}$

$$\vec{a} = \frac{d\vec{v}}{dt} = -\frac{dx}{dt}\hat{i} + 2\frac{dy}{dt}\hat{j} - \frac{dz}{dt}\hat{k}$$

$$= -(-x)\hat{i} + 2(2y)\hat{j} - (-z)\hat{k} = x\hat{i} + 4y\hat{j} + z\hat{k}$$

$\therefore$ $\vec{a}$ at $(1,2,4) = \hat{i} + 8\hat{j} + 4\hat{k}$

$\therefore |\vec{a}| = 9\ m/s^2$

29. The position of an object having mass 0.1 kg as a function of time t is given as $\vec{r}=\left(10t^2\hat{i}+5t^3\hat{j}\right)$m. At t = 1 s, which of the following statements are **correct**?

A. The linear momentum $\vec{p}=\left(2\hat{i}+1.5\hat{j}\right)$kg.m/s.

B. The force acting on the object $\vec{F}=\left(2\hat{i}+3\hat{j}\right)$N.

C. The angular momentum of the object about its origin $\vec{L}=15\hat{k}$Js.

D. The torque acting on the object about its origin $\vec{\tau}=20\,\hat{k}$ Nm.

Choose the **correct** answer from the option given below.

(1) A, B and C only

(2) B, C and D only

(3) A, C and D only

(4) A, B and D only

Ans. (4)

Sol. Given $\vec{r}=10t^2\hat{i}+5t^3\hat{j}\Rightarrow\vec{r}_{t=1}=10\hat{i}+5\hat{j}$

$$\vec{v}=\frac{d\vec{r}}{dt}=20t\hat{i}+15t^2\hat{j}\Rightarrow\vec{v}_{t=1sec}=20\hat{i}+15\hat{j}$$

$$\vec{a}=\frac{d^2\vec{r}}{dt^2}=20\hat{i}+30t\hat{j}\Rightarrow\vec{a}_{t=1sec}=20\hat{i}+30\hat{j}$$

$$\therefore\ \vec{P}=m\vec{v}=2\hat{i}+1.5\hat{j}$$

$$\vec{F}=m\vec{a}=2\hat{i}+3\hat{j}$$

$$\vec{\tau}=\vec{r}\times\vec{F}=20\hat{k}$$

$$\vec{L}=\vec{r}\times\vec{P}=5\hat{k}$$

30. A planet (P_1) is moving around the star of mass 2M in the orbit of radius R. Another planet (P_2) is moving around another star of mass 4M in a orbit of radius 2R. Ratio of time periods of revolution of P_2 and P_1 is _____.

(1) $\frac{1}{2}$ (2) 2

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

Ans. (2)

Sol. From Kepler's law,

$$T^2=\frac{4\pi^2}{GM_S}r^3$$

$$\therefore\ T_{P_1}=\frac{2\pi}{\sqrt{G(2M)}}R^{3/2}$$

$$T_{P_2}=\frac{2\pi}{\sqrt{G(4M)}}(2R)^{3/2}$$

$$\therefore\ \frac{T_{P_2}}{T_{P_1}}=\frac{(2)^{3/2}}{\sqrt{4}}\times\frac{\sqrt{2}}{1}=\frac{2\sqrt{2}\times\sqrt{2}}{2}=2$$

31. A particle is rotating in a circular path and at any instant its motion can be described as $\theta=\frac{5t^4}{40}-\frac{t^3}{3}$. The angular acceleration of the particle after 10 seconds is _____ rad/s^2.

(1) 150 (2) 120

(3) 130 (4) 170

Ans. (3)

Sol. $\theta=\frac{5t^4}{40}-\frac{t^3}{3}$

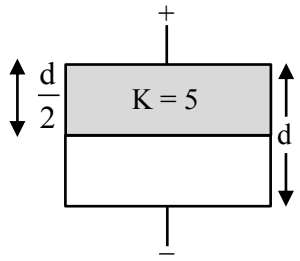
$$\frac{d\theta}{dt}=\frac{5}{40}\left(4t^3\right)-\frac{3t^2}{3}=\frac{t^3}{2}-t^2$$

$$\alpha=\frac{d^2\theta}{dt^2}=\frac{3t^2}{2}-2t$$

at t = 10

$$\alpha=\frac{3}{2}(10)^2-2\times10=130\ \text{rad/sec}^2$$

32. A parallel plate air capacitor has a capacitance C. When it is half filled as show in figure with a dielectric constant K = 5, the percentage increase in the capacitance is _____.



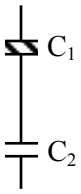
(1) 33.34 (2) 66.67

(3) 200 (4) 400

Ans. (2)

Sol. Initial capacitance

$$C_i = \frac{A\in_0}{d} = C$$



Final capacitance

$$C_1 = \frac{A\in_0 \times 5}{\frac{d}{2}} = 10C$$

$$C_2 = \frac{A\in_0}{\frac{d}{2}} = 2C$$

$$C_f = \frac{C_1C_2}{C_1+C_2} = \frac{10\times 2}{10+2}C = \frac{5}{3}C$$

$$\% \text{ increase} = \frac{\frac{5}{3}C - C}{C}\times 100 = 66.67$$

33. Heat is supplied to a diatomic gas at constant pressure. Then the ratio of ΔQ : ΔU : ΔW is_____.

(1) 2 : 3 : 5

(2) 5 : 3 : 2

(3) 2 : 5 : 7

(4) 7 : 5 : 2

Ans. (4)

Sol. $\Delta Q_P = nC_P\Delta T = \frac{7}{2}nR\Delta T$

$\Delta U = nC_v\Delta T = \frac{5}{2}nR\Delta T$

$W = nR\Delta T$

$\Delta Q : \Delta U : W :: 7 : 5 : 2$

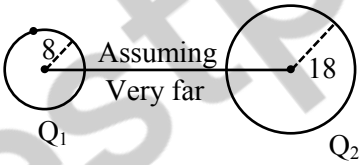
34. Two charged conducting spheres S_1 and S_2 of radii 8 cm and 18 cm are connected to each other by a wire. After equilibrium is established, the ratio of electric fields on S_1 and S_2 spheres are E_{S1} and E_{S2} respectively. The value of $\frac{E_{S1}}{E_{S2}}$ is _____.

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

(3) $\frac{4}{9}$ (4) $\frac{9}{4}$

Ans. (4)

Sol.



$V_1 = V_2$

$$\frac{kQ_1}{8} = \frac{kQ_2}{18} \quad \left\{v_{surface} = \frac{kQ}{R}\right\}$$

$$\frac{Q_1}{Q_2} = \frac{4}{9}$$

$$\frac{E_{S_1}}{E_{S_2}} = \frac{kQ_1}{r_1^2}\frac{r_2^2}{kQ_2} \quad \left\{E_{surface} = \frac{kQ}{R^2}\right\}$$

$$= \frac{Q_1}{Q_2}\left(\frac{r_2}{r_1}\right)^2 = \frac{4}{9}\times\left(\frac{9}{4}\right)^2 = \frac{9}{4}$$

35. The equation of a plane progressive wave is given by $y = 5\cos\pi\left(200t - \frac{x}{150}\right)$ where x and y are in cm and t is in second. The velocity of the wave is _____m/s

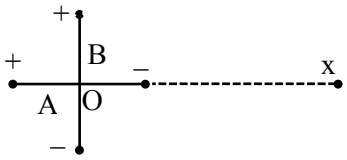
(1) 120 (2) 150

(3) 200 (4) 300

Ans. (4)

Sol. $v = \frac{\text{coeff of t}}{\text{coeff of x}} = \frac{200}{\frac{1}{150}\times 100} = 300\text{m/s}$

36. Two short electric dipoles A and B having dipole moment p_1 and p_2 respectively are placed with their axis mutually perpendicular as shown in the figure. The resultant electric field at a point x is making an angle of 60° with the line joining points O and x. The ratio of the dipole moments p_2/p_1 is _____.



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

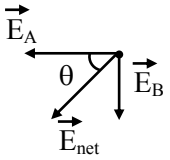
(2) $2\sqrt{3}$

(3) $\frac{1}{\sqrt{3}}$

(4) $\sqrt{3}$

Ans. (2)

Sol.



$$\vec{E}_A = \frac{2kP_1}{x^3}\left(-\hat{i}\right) \{\text{Axial point}\}$$

$$\vec{E}_B = \frac{kP_2}{x^3}\left(-\hat{j}\right) \{\text{Equatorial point}\}$$

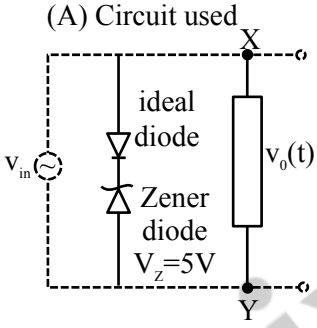
$$\text{Now : } \tan\theta = \frac{|\vec{E}_B|}{|\vec{E}_A|}$$

$$\Rightarrow \tan 60° = \frac{P_2}{2P_1}$$

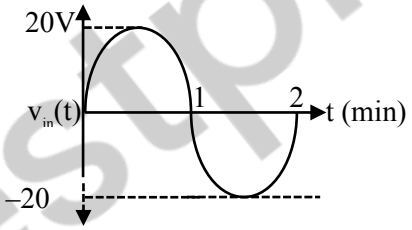
$$\Rightarrow \frac{P_2}{P_1} = 2\sqrt{3}$$

37. For the given circuit (shown in part (A)) the time dependent input voltage $v_{in}(t)$ and corresponding output $v_o(t)$ are shown in part (B) and part (C), respectively. Identify the components that are used in the circuit between points X and Y.

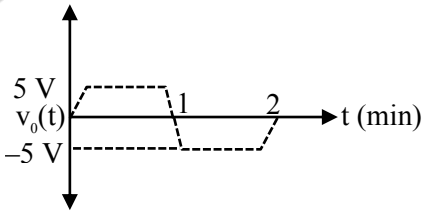
(A) Circuit used

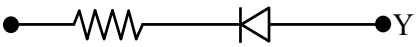


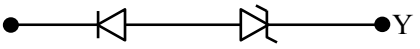
Part(B) : Input voltage

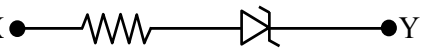


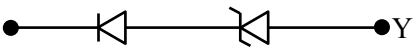
Part(C) : Output voltage



(1) 

(2) 

(3) 

(4) 

Ans. (2)

Sol. **For the +ve half cycle of input**

Middle branch has ideal diode in forward bias and Zener diode in reverse bias Thus, we get constant 5V output due to Zener breakdown. For this situation component between x & y should act as open circuit.

For –ve half cycle of input

middle branch has ideal diode in reverse bias, which makes it open branch without any current. for this situation component between x & y should give a constant –5V output due to Zener breakdown.

(Note : The input side must contain some resistance else V_{in} is equal to V_{out} for every cases)

38. When a coil is placed in a time dependent magnetic field the power dissipated in it is P. The number of turns, area of the coil and radius of the coil wire are N, A and r respectively. For a second coils number of turns, area of the coil and radius of the coil wire are 2N, 2A and 3r respectively. When the first coil is replaced with second coil the power dissipated in it is $\sqrt{2}\,\alpha P$. The value of α is_____.

(1) 36 (2) $128\sqrt{2}$

(3) 16 (4) 64

Ans. **(1)**

Sol. Power dissipated : $P = \dfrac{\varepsilon^2}{R}$

Induced emf $\varepsilon = -NA\dfrac{dB}{dt}$

Resistance of coil : $R = \rho\dfrac{\ell}{\pi r^2}$

Now : $\ell = N(2\pi R_{coil})$

Also : $A = \pi R_{coil}^2 \Rightarrow R_{coil} = \sqrt{\dfrac{A}{\pi}}$

Thus ; $R = \dfrac{\rho N(2\pi)}{\pi r^2}\sqrt{\dfrac{A}{\pi}}$

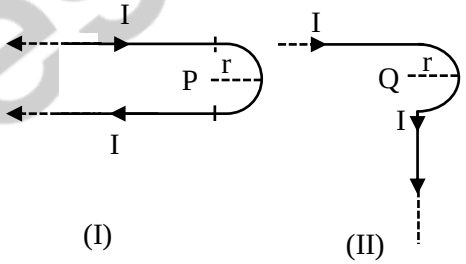
$$P = \frac{N^2A^2\left(\frac{dB}{dt}\right)^2}{\frac{2\rho N}{r^2}\sqrt{\frac{A}{\pi}}} \Rightarrow P \propto NA^{3/2}r^2 \quad .....(1)$$

$P' \propto (2N)(2A)^{3/2}(3r)^2$ .....(2)

$$\frac{(2)}{(1)}:\frac{P'}{P} = 36\sqrt{2} \Rightarrow P' = \left(\sqrt{2}\right)(36)P$$

Thus : $\alpha = 36$

39. Two identical long current carrying wires are bent into the shapes shown in the following figures. If the magnitude of magnetic fields at the centres P and Q of a semicircular arc are B_1 and B_2 respectively, then the ratio $\dfrac{B_1}{B_2}$ is _____.



(I) (II)

(1) $\dfrac{2+\pi}{1+\pi}$ (2) $\dfrac{1+\pi}{1-\pi}$

(3) $\dfrac{2+\pi}{1-\pi}$ (4) $\dfrac{1+\pi}{2-\pi}$

Ans. **(1)**

Sol. $B_1 = \dfrac{\mu_0 I}{4\pi r}\times 2 + \dfrac{\mu_0 I}{4r} = \dfrac{\mu_0 I}{4r}\left(\dfrac{2}{\pi}+1\right)$

$B_2 = \dfrac{\mu_0 I}{4\pi r} + \dfrac{\mu_0 I}{4r} = \dfrac{\mu_0 I}{4r}\left(\dfrac{1}{\pi}+1\right)$

$\dfrac{B_1}{B_2} = \dfrac{2+\pi}{1+\pi}$

40. For a thin symmetric prism made of glass (refractive index 1.5), the ratio of incident angle and minimum deviation will be _____.

(1) 3 : 4 (2) 3 : 2

(3) 2 : 1 (4) 1 : 2

Ans. (2)

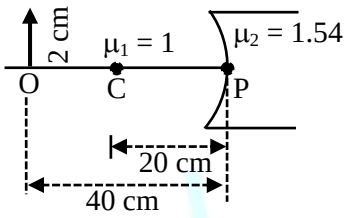
Sol. We have for thin prism minimum deviation : $\delta_m = (\mu - 1)A$

$\Rightarrow \delta_m = (1.5-1)A \qquad \Rightarrow \delta_m = \dfrac{A}{2}$

Also, $i = \dfrac{A+\delta_m}{2} \Rightarrow i = \dfrac{A+\frac{A}{2}}{2} \Rightarrow i = \dfrac{3A}{4}$

Thus $\dfrac{i}{\delta_m} = \dfrac{3}{2}$

41. Refer the figure given below. μ_1 and μ_2 are refractive indices of air and lens material. The height of image will be _____cm.



(1) 1 (2) 0.5

(3) 1.2 (4) 0.25

Ans. (1)

Sol. $\dfrac{\mu_2}{v} - \dfrac{\mu_1}{\mu} = \dfrac{\mu_2 - \mu_1}{R}$

$\dfrac{1.54}{v} - \dfrac{1}{(-40)} = \dfrac{1.54-1}{-20}$

$\dfrac{1.54}{v} = -\dfrac{1}{40} - \dfrac{0.54}{20}$

$\dfrac{1.54}{v} = \dfrac{-2.08}{40}$

$v = -29.61$ cm

$\dfrac{h_i}{h_0} = \dfrac{\mu_1 v}{\mu_2 u} = \dfrac{1(-29.61)}{1.54(-40)} = 0.48$

$h_i = 0.48 \times 2 = 0.96 \approx 1$cm

42. For a certain metal, when monochromatic light of wavelength λ is incident, the stopping potential for photoelectrons is $3V_0$. When the same metal is illuminated by light of wavelength 2λ, then the stopping potential becomes V_0. The threshold wavelength for photoelectric emission for the given metal is $\alpha\lambda$.The value of α is _____.

(1) 1 (2) 4

(3) 2 (4) 3

Ans. (2)

Sol. $\dfrac{hc}{\lambda} - \phi = 3eV_0$ .....(i)

$\dfrac{hc}{2\lambda} - \phi = eV_0$ .....(ii)

$\dfrac{hc}{\lambda} - \phi = 3\left[\dfrac{hc}{2\lambda} - \phi\right]$

$\phi = \dfrac{hc}{4\lambda}$

$\dfrac{hc}{\lambda_0} = \dfrac{hc}{4\lambda}$

$\lambda_0 = 4\lambda$

$\alpha = 4$

43. An electromagnetic wave travelling in x-direction is described by field equation $E_y = 300 \sin\omega\left(t - \dfrac{x}{c}\right)$. If the electron is restricted to move in y-direction only with speed of 1.5×10^6 m/s then ratio of maximum electric and magnetic forces acting on the electron is _____.

(1) 200 (2) 150

(3) 400 (4) 300

Ans. (1)

Sol. $E_y = 300 \sin\ \omega\left(t - \dfrac{x}{v}\right)$

$F_M = qvB$ .....(i)

$F_e = qE$ .....(ii)

$\dfrac{F_e}{F_m} = \dfrac{qE}{qvB} = \dfrac{E}{vB} = \dfrac{c}{v} = \dfrac{3\times10^8}{1.5\times10^6} = 200$

44. Angular momentum of an electron in a hydrogen atom is $\frac{3h}{\pi}$, then the energy of the electron is ____eV.

(1) – 1.51 (2) – 0.85

(3) – 0.38 (4) – 0.28

Ans. **(3)**

Sol. $L = \frac{nh}{2\pi}$

$\frac{3h}{\pi} = \frac{nh}{2\pi}$

$n = 6$

$E = \frac{-13.6}{n^2} eV$

$= \frac{-13.6}{6^2} \approx -0.38$ eV

45. A liquid drop of diameter 2 mm breaks into 512 droplets. The change in surface energy is $\alpha \times 10^{-6}$ J. The value of α is _____. (Take surface tension of liquid = 0.08 N/m)

(1) 10 (2) 7

(3) 8 (4) 11

Ans. **(2)**

Sol. $V_1 = V_2$

$\frac{4}{3}\pi R^3 = 512\left(\frac{4}{3}\pi r^3\right)$

$R = (512)^{1/3} r$

$1 = 8r$

$r = \frac{1}{8}$ mm

$\Delta SE = SE_2 - SE_1$

$= 512\left[T \times 4\pi r^2\right] - \left[T \times 4\pi R^2\right]$

$= 4\pi T[512r^2 - R^2]$

$= 4\pi(0.08)\left[512\left(\frac{1}{8}\right)^2 - 1^2\right] \times 10^{-6} \approx 7 \times 10^{-6}$

$\alpha = 7$

SECTION-B

46. In single slit diffraction pattern, the wavelength of light used is 628 nm and slit width is 0.2 mm, the angular width of central maximum is $\alpha \times 10^{-2}$ degrees. The value of α is_____.

Ans. **(36)**

Sol. Angular width of central maxima $\theta_{cm} = \frac{2\lambda}{d}$

$= \frac{2 \times 628 \times 10^{-9}}{0.2 \times 10^{-3}}$ rad.

$= (628 \times 10^{-5}) \times \frac{180}{\pi}$ degrees

$\approx 36 \times 10^{-2}$ degrees

$\therefore$ Answer : $\alpha = 36$

47. A vessel contains 0.15 m^3 of a gas at pressure 8 bar and temperature 140°C with $c_p = 3R$ and $c_v = 2R$. It is expanded adiabatically till pressure falls to 1 bar. The work done during this process is ____k J. (R is gas constant)

Ans. **(120)**

Sol. $r = \frac{C_P}{C_V} = \frac{3}{2}$

$\because P_1V_1^{\gamma} = P_2V_2^{\gamma}$

$\Rightarrow V_2 = \left(\frac{P_1}{P_2}\right)^{1/\gamma} V_1$

$\Rightarrow V_2 = \left(\frac{8}{1}\right)^{2/3} \times 0.15$

$\Rightarrow V_2 = 0.6\ m^3$

$\because W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$

$= \left(\frac{8 \times 0.15 - 1 \times 0.6}{1.5 - 1}\right) \times 10^5 = 1.2 \times 10^5$

$\Rightarrow W = 120$ kJ

48. 1 μC charge moving with velocity $\vec{v}=\left(\hat{i}-2\hat{j}+3\hat{k}\right)m/s$ in the region of magnetic field $\vec{B}=\left(2\hat{i}+3\hat{j}-5\hat{k}\right)T$. The magnitude of force acting on it is $\sqrt{\alpha}\times10^{-6}N$. The value of α is ____.

Ans. **(171)**

Sol. $\vec{F}=q\left(\vec{v}\times\vec{B}\right)$

$$=1\times10^{-6}\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\1&-2&3\\2&3&-5\end{vmatrix}$$

$$=10^{-6}\left[\hat{i}+11\hat{j}+7\hat{k}\right]$$

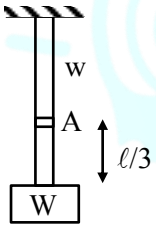
$$\Rightarrow \vec{F}=\sqrt{171}\times10^{-6}N$$

$\therefore \alpha = 171$

49. A uniform wire of length l of weight w is suspended from the roof with a weight of W at the other end. The stress in the wire at $\frac{l}{3}$ distance from the top is $\left(\frac{W}{A}+\frac{2}{\gamma}\frac{w}{A}\right)$, where, A is the cross sectional area of the wire. The value of γ is_____.

Ans. **(6)**

Sol.



$$\sigma=\frac{T}{A}=\frac{W+\frac{w}{3}}{A}$$

$$\Rightarrow \sigma=\frac{W}{A}+\frac{2}{6}\frac{w}{A}$$

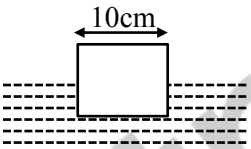
$\therefore \gamma = 6$

50. A tube is filled with water and a wooden cube 10 cm × 10cm ×10cm is placed in the water. The wooden cube is found to float on the water with a part of it submerged in water. When a metal coin is placed on the wooden cube, the submerged part is increased by 3.87 cm. The mass of the metal coin is ____ gram.

(Take water density as $1g/cm^3$ and density of wood as $0.4\ g/cm^3$)

Ans. **(387)**

Sol.



Weight of coin = Additional upthrust

$$\Rightarrow m_c g=\rho_\ell V_{add} g$$

$$\Rightarrow m_c=1\times3.87\times(10)^2$$

$$\Rightarrow m_c = 387 \text{ gram}$$

(HELD ON THURSDAY 02nd APRIL 2026) **TIME : 9:00 AM TO 12:00 NOON**

CHEMISTRY

TEST PAPER WITH SOLUTION

SECTION-A

51. The mass of iron converted into Fe_3O_4 by the action of 18 g of steam is :

(Given : Molar mass of H, O and Fe are 1, 16 and 56 g mol^{-1} respectively)

Assume iron is present in excess :

(1) 2.1 g (2) 4.2 g

(3) 21 g (4) 42 g

Ans. (4)

Sol. $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

$n_{steam} = \frac{18}{18} = 1$

n_{Fe} required $= \frac{3}{4}$

mass of Fe required $= \frac{3}{4} \times 56$

$= 42$ gm

52. What is the energy (in J $atom^{-1}$) required for the following process ?

$Li^{2+}(g) \rightarrow Li^{3+}(g) + e^-$

(Take the ionization energy for the H atom in the ground state as 2.18×10^{-18} J $atom^{-1}$)

(1) 8.72×10^{-18}

(2) 1.962×10^{-18}

(3) 1.962×10^{-17}

(4) 6.54×10^{-17}

Ans. (3)

Sol. $E_{Li^{2+}} = E_H \times z^2$

$= 2.18 \times 10^{-18} \times (3)^2$

$= 1.962 \times 10^{-17}$ J $atom^{-1}$

53. Given below are two statements :

Statement (I) : The correct sequence of bond lengths in the following species is :

$O_2^+ < O_2 < O_2^- < O_2^{2-}$

Statement (II) : The correct sequence of number of unpaired electrons in the following species is :

$O_2 > O_2^+ > O_2^- > O_2^{2-}$

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) Both **Statement I** and **Statement II** are false

(3) **Statement I** is true but **Statement II** is false

(4) **Statement I** is false but **Statement II** is true

Ans. (3)

Sol.

Species	Bond order	unpaired electrons
$O_2^{\oplus}$	2.5	1
O_2	2	2
O_2^-	1.5	1
O_2^{2-}	1	0

54. Consider the following data

(i) $2Al(s) + 6HCl(aq) \rightarrow Al_2Cl_6(aq) + 3H_2(g) +$ 1200 kJ/mol.

(ii) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g) +$ 164 kJ/mol.

(iii) $HCl(g) + aq \rightarrow HCl(aq) +$ 83 kJ/mol.

(iv) $Al_2Cl_6(s) + aq \rightarrow Al_2Cl_6(aq) +$ 663 kJ/mol.

The enthalpy of formation of anhydrous solid Al_2Cl_6 is :

(1) –648 kJ mol^{-1} (2) –1350 kJ mol^{-1}

(3) –2002 kJ mol^{-1} (4) –1527 kJ mol^{-1}

Ans. (4)

Sol. $2Al(s) + 6HCl(aq) \rightarrow Al_2Cl_6(aq) + 3H_2(g)$

$\Delta_rH_1 = -1200$ kJ/mol

$[H_2(g) + Cl_2(g) \rightarrow 2HCl(g)] \times 3$

$\Delta_rH_2 = -163 \times 3$ kJ/mol

$[HCl(g) + aq \rightarrow HCl(aq)] \times 6$

$\Delta_rH_3 = -83 \times 6$ kJ/mol

$Al_2Cl_6(aq) \rightarrow Al_2Cl_6(s) + aq.\ \Delta_rH_4 = +663$ kJ/mole

$2Al(s) + 3Cl_2 \rightarrow Al_2Cl_6(s) \quad \Delta_fH$

$\Delta_fH = \Delta_rH_1 + \Delta_rH_2 + \Delta_rH_3 + \Delta_rH_4$

$= -1200 - 163 \times 3 - 83 \times 6 + 663$

$= -1527$ kJ/mole

55. 19.5 g of fluoro acetic acid (molar mass = 78 g mol^{-1}) is dissolved in 500g of water at 298 K. The depression in the freezing point of water was 1°C. What is K_a of fluoro acetic acid ?

(For water, $K_f = 1.86$ K kg mol^{-1}). Assume molarity and molality to have same values.

(1) 10^{-6} (2) 4×10^{-4}

(3) 3×10^{-5} (4) 3×10^{-3}

Ans. **(4)**

Sol. $\Delta T_f = iK_fm$

$$\text{no. of moles} = \frac{19.5}{78} = \frac{1}{4}\text{mole}$$

$$1 = i \times 1.86 \times \frac{1/4}{1/2}$$

$$i = \frac{2}{1.86}$$

$i = 1 + (n-1)\alpha$

$i = 1 + \alpha$

$$\alpha = \frac{2}{1.86} - 1 = 0.075$$

$$K_a = \frac{C\alpha^2}{1-\alpha}$$

$$= \frac{1}{2} \times \frac{(0.075)^2}{(1-0.075)}$$

$= 3 \times 10^{-3}$

56. The solubility product constants of Ag_2CrO_4 and AgBr are 32x and 4y respectively at 298 K.

The value of $\left(\frac{\text{molarity of } Ag_2CrO_4}{\text{molarity of AgBr}}\right)$ can be expressed as :

(1) $\frac{2\sqrt[3]{x}}{y}$ (2) $2\sqrt{\frac{x}{y}}$

(3) $\sqrt{\frac{x}{y}}$ (4) $\frac{\sqrt[3]{x}}{\sqrt{y}}$

Ans. **(4)**

Sol. For $Ag_2C_2O_4$

$4S_1^3 = 32x$

$\Rightarrow S_1 = 2x^{1/3}$

For AgBr

$S_2^2 = 4y$

$\Rightarrow S_2 = 2y^{1/2}$

Ratio $\left(\frac{S_1}{S_2}\right) = \frac{\sqrt[3]{x}}{\sqrt{y}}$

57. An electrochemical cell is constructed using half cells in the direction of spontaneous change

$Fe(OH)_2(s) + 2e^- \rightarrow Fe(s) + 2OH^-(aq)\ \ E^0 = -0.88V$

and $AgBr(s) + e^- \rightarrow Ag(s) + Br^-(aq)\ \ E^0 = +0.07V$

Which of the following option is **correct** ?

(1) Overall reaction $Fe(s) + 2OH^{-1}(aq) + 2AgBr(s) \rightleftharpoons Fe(OH)_2(s) + 2Ag(s) + 2Br^-(aq)$

(2) $E^0_{cell} = -0.95V$

(3) Fe is reduced in the electrochemical cell

(4) E^0_{cell} is an extensive property

Ans. **(1)**

Sol. Overall reaction

$Fe(s) + 2OH^-(aq) + 2AgBr(s) \rightleftharpoons Fe(OH)_2(s) + 2Ag(s) + 2Br^-(aq)$

$E^o_{cell} = E^o_{R(cathode)} - E^o_{R(anode)}$

$= 0.07 - (-0.88) = 0.95$ V

58. $t_{100\%}$ is the time required for the 100% completion of the reaction while $t_{1/2}$ is the time required for 50% of the reaction to be completed. Which of the following option correctly represents the relation between $t_{100\%}$ and $t_{1/2}$ for zero and first order reactions respectively ?

(1) $t_{100\%} = (t_{1/2})^2$ and $t_{100\%} = (t_{1/2})^{-\infty}$

(2) $t_{100\%} = 2t_{1/2}$ and $t_{100\%} = (t_{1/2})^{\infty}$

(3) $t_{100\%} = 2t_{1/2}$ and $t_{100\%} = (2t_{1/2})^2$

(4) $t_{100\%} = (t_{1/2})^{\infty}$ and $t_{100\%} = 2t_{1/2}$

Ans. **(2)**

Sol. **Zero –order**

$$t_{100\%} = \frac{a}{k};\ t_{1/2} = \frac{a}{2k}$$

$$t_{100\%} = 2\,t_{1/2}$$

Ist order

$$t_{100\%} = \infty$$

$$t_{1/2} = \frac{\ell n 2}{k}$$

$$t_{100\%} = (t_{1/2})^{\infty}$$

59. Given below are two statements :

Statement (I) : The first ionisation enthalpy of the elements Na, Mg, Cl and Ar follows the order Na > Mg > Cl > Ar

Statement (II) : Among Ca, Al, Fe and B, the third ionisation enthalpy is very high for Ca.

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) Both **Statement I** and **Statement II** are false

(3) **Statement I** is true but **Statement II** is false

(4) **Statement I** is false but **Statement II** is true

Ans. **(4)**

Sol. (i) Na < Mg < Cl < Ar → I^{st} ionization energy

(ii) Among B, Ca, Al, Fe

Ca has maximum 3^{rd} ionization energy among given due to inert gas configuration.

60. Given below are two statements :

Statement (I) : Oxidising power of halogens decreases in the order $F_2 > Cl_2 > Br_2 > I_2$, which is the basis of "Layer test".

Statement (II) : "Layer test" to identify Br_2 and I_2 in aqueous solution involves the oxidation of bromide or iodide into Br_2 or I_2 respectively with Cl_2, which is a type of displacement redox reaction.

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) Both **Statement I** and **Statement II** are false

(3) **Statement I** is true but **Statement II** is false

(4) **Statement I** is false but **Statement II** is true

Ans. **(1)**

Sol. (I) $F_2 > Cl_2 > Br_2 > I_2$ (Oxidizing power order)

(II) $NaBr + Cl_2\text{-water} \rightarrow Br_2 + NaCl$

$NaI + Cl_2\text{-water} \rightarrow I_2 + NaCl$

61. Which of the following sets includes all the species that will change the orange colour of $K_2Cr_2O_7$ in acidic medium ?

(1) Fe^{2+}, Sn^{2+}, I^-, S^{2-}

(2) S^{2-}, Fe^{3+}, I^-, $C_2O_4^{2-}$

(3) Fe^{2+}, NO_2^-, SO_2, Sn^{4+}

(4) Fe^{3+}, SO_4^{2-}, S^{2-}, Sn^{4+}

Ans. **(1)**

Sol. $\text{Reducing agent} + KmnO_4 \xrightarrow[\text{medium}]{\text{acidic}} Mn^{+2} + \text{Product}$

Given Reducing Agent

$Fe^{+2} \rightarrow Fe^{+3}$

$Sn^{+2} \rightarrow Sn^{+4}$

$I^- \rightarrow I_2$

$S^{-2} \rightarrow S$

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

List – I **Chromium (III) Complexes (en = ethylene diamine)**		**List – II** $\Delta_0(cm^{-1})$	
A.	$[Cr(CN)_6]^{3-}$	I.	15,060
B.	$[CrF_6]^{3-}$	II.	17,400
C.	$[Cr(H_2O)_6)]^{3+}$	III.	22,300
D.	$[Cr(en)_3]^{3+}$	IV.	26,600

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

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

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

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

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

Ans. (4)

Sol. CFSE is proportional to strength of ligand followed by chelation.

CN^- is stronger ligand than en

$CN^- > en > H_2O > F^-$

63. Given below are two statements :

Statement (I) : 1,2,3-Trihydroxypropane can be separated from water by simple distillation.

Statement (II) : An azotropic mixture cannot be separated by fractional distillation.

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) Both **Statement I** and **Statement II** are false

(3) **Statement I** is true but **Statement II** is false

(4) **Statement I** is false but **Statement II** is true

Ans. (4)

Sol. Glycerol is separated by distillation under reduced pressure.

64. Given below are two statements :

Statement (I) : Benzyl chloride reacts faster in S_N1 mechanism than ethyl chloride.

Statement (II) : Ethyl carbocation intermediate is less stabilized by hyperconjugation than benzyl carbocation by resonance.

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) Both **Statement I** and **Statement II** are false

(3) **Statement I** is true but **Statement II** is false

(4) **Statement I** is false but **Statement II** is true

Ans. (1)

Sol. Rate of $SN^1 \propto$ Stability of carbocation

Order of stability of carbocation :

$Ph-\overset{\oplus}{C}H_2 > CH_3-\overset{\oplus}{C}H_2$

Hyperconjugation in $CH_3-\overset{\oplus}{C}H_2$

Resonance in $Ph-\overset{\oplus}{C}H_2$

65. In IUPAC nomenclature, the **correct** order of decreasing priority of functional group is :

(1) $-CONH_2$, $>C=O$, $-CHO$, $-NH_2$, $-C\equiv C-$

(2) $-CONH_2$, $-COOCH_3$, $-CHO$, $-NH_2$, $-OH$

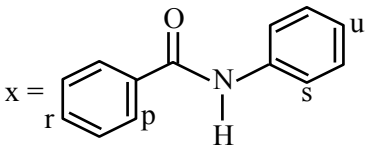
(3) $-CONH_2$, $-CHO$, $>C=O$, $-NH_2$, $-C\equiv C-$

(4) $-CONH_2$, $-CHO$, $-CN$, $-NH_2$, $-C\equiv C-$

Ans. (3)

Sol. Theory based

66. For the given molecule, "x", the preferred site for the attack of the electrophile is :



(1) Predominantly at "r"

(2) "r" and "u"

(3) "p" and "s"

(4) Predominantly at "u"

Ans. (4)

Sol. U is predominant site towards attack of electrophile because of +M nature of nitrogen.

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

	List-I **Mixture of Compounds**		**List-II** **Reagent used to distinguish**
A.	Diethyl amine + Ethyl amine	I.	Bromine water
B.	Acetaldehyde + Acetone	II.	$CHCl_3$ + KOH, Δ
C.	Ethanol + Phenol	III.	Neutral $FeCl_3$
D.	Benzoic acid + Cinnamic acid	IV.	Ammonical silver nitrate

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

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

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

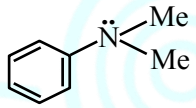
(3) A-II, B-IV, C-I, D-III

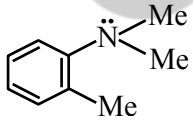
(4) A-II, B-IV, C-III, D-I

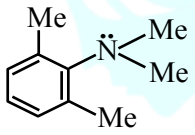
Ans. **(4)**

Sol.
- Phenol gives violet colour with neutral $FeCl_3$ not ethanol.
- 1° amine gives positive test with $CHCl_3$/KOH not 2° amine.
- Aldehyde gives positive test with ammonical silver nitrate not ketone.
- Cinnamic acid gives bromine water test.

68. Consider the three aromatic molecules (P, Q and R) whose structures have been given below :

P. 

Q. 

R. 

The **correct** order regarding the reactivity of these compounds with $Ph–\underset{(+)}{N}\equiv N\ Cl^{(-)}$ under optimum but slightly acidic medium is :

(1) P > Q > R (2) R > P > Q

(3) R > Q > P (4) P > R > Q

Ans. **(1)**

Sol. Rate of ESR ∝ nucleophilicity of benzene ring.

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

	List-I **Vitamin**		**List-II** **Name**
A.	Vitamin B_1	I.	Pyridoxine
B.	Vitamin B_2	II.	Ascorbic acid
C.	Vitamin B_6	III.	Thiamine
D.	Vitamin C	IV.	Riboflavin

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

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

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

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

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

Ans. **(3)**

Sol. Theory based

70. A salt with few drops of conc. HCl gives apple green colour in flame test. The group precipitate of the salt is dissolved in acetic acid and treated with K_2CrO_4 to give yellow precipitate. When the sodium carbonate extract of the salt solution is heated with conc. HNO_3 and ammonium molybdate, it resulted a canary yellow precipitate. The cation and anion present in the salt are respectively.

(1) Ca^{2+} and SO_4^{2-} (2) Ba^{2+} and PO_4^{3-}

(3) Mn^{2+} and PO_4^{3-} (4) Ba^{2+} and SO_4^{2-}

Ans. **(2)**

Sol. (i) Ba^{+2} gives apple green colour while Ca^{+2} and Sr^{+2} gives brick red and crimson red in flame test.

(ii) $Ba^{+2} + CrO_4^{2-} \rightarrow \underset{\text{Yellow ppt}}{BaCrO_4}$

(iii) $PO_4^{3-} + \text{Conc } HNO_3 + (NH_4)_2MoO_4 \longrightarrow \underset{\text{Canery yellow ppt}}{(NH_4)_3[P(Mo_3O_{10})_4]}$

SECTION-B

71. 5.33 g of $CrCl_3 \cdot 6H_2O$, which is a 1 : 3 electrolyte, is dissolved in water and is passed through a cation exchanger. The chloride ions in the eluted solution, on treatment with $AgNO_3$ results in 8.61 g of AgCl. The ratio of moles of complex reacted and moles of AgCl formed is _____ $\times 10^{-2}$. (Nearest integer)

[Molar mass in g mol^{-1} Cr : 52, Ag : 108, Cl : 35.5, H : 1, O : 16]

Ans. **(33)**

Sol. $[Cr(H_2O)_6]Cl_3 + \underset{\text{excess}}{AgNO_3} \rightarrow \underset{\text{ppt}}{3AgCl(s)}$

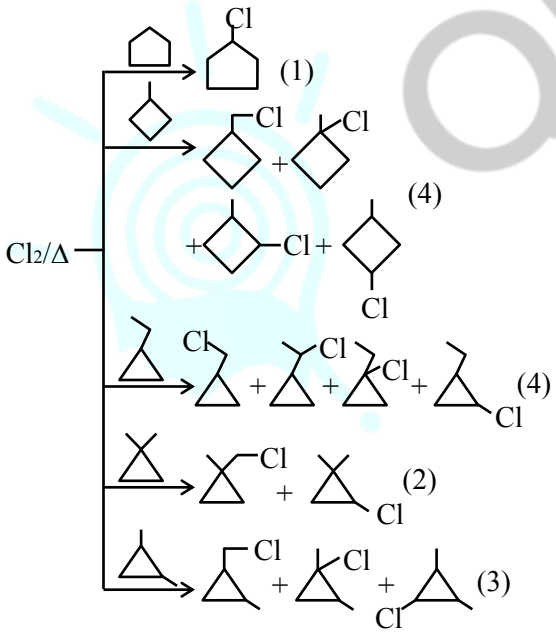
$$\frac{\text{no. of moles of complex reacted}}{\text{no. of moles of AgCl precipitated}} \times 100$$

$$= \frac{1}{3} \times 100 = 33.3$$

72. Consider the isomers of hydrocarbon with molecular formula C_5H_{10}. These isomers do not decolourise $KMnO_4$ solution. These isomers are subjected to chlorination with chlorine in presence of light to give monochloro compounds. The total number of monochloro compounds (structural isomers only) formed is _____.

Ans. **(14)**

Sol.



1 + 4 + 4 + 2 + 3 = 14

73. One mole of an alkane (x) requires 8 mole oxygen for complete combustion. Sum of number of carbon and hydrogen atoms in the alkane (x) is _____.

Ans. **(17)**

Sol. $C_nH_{2n+2} + \left(\frac{3n+1}{2}\right)O_2 \rightarrow nCO_2 + (n+1)\,H_2O$

$$1 \qquad \left(\frac{3n+1}{2}\right)$$

$$\frac{3n+1}{2} = 8 \Rightarrow 3n + 1 = 16$$

$$\Rightarrow 3n = 15$$

$$n = 5$$

So alkane is $C_5H_{12} \Rightarrow 17$

74. For reaction A $\rightarrow$ P, rate constant k = 1.5×10^3 s^{-1} at 27°C. If activation energy for the above reaction is 60 kJ mol^{-1}, then the temperature (in °C) at which rate constant, k = 4.5×10^3 s^{-1} is _____. (Nearest integer)

Given : log 2 = 0.30, log 3 = 0.48, R = 8.3 J K^{-1} mol^{-1}, ln 10 = 2.3

Ans. **(41)**

Sol. $$\ell n\left(\frac{K_2}{K_1}\right) = \frac{E_a}{R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$$

$$\ell n\left(\frac{4.5\times10^3}{1.5\times10^3}\right) = \frac{60\times10^3}{8.3}\left[\frac{T_2 - 300}{300.T_2}\right]$$

$$\ell n3 = \frac{60\times10^3}{8.3}\left[\frac{T_2 - 300}{300.T_2}\right]$$

$\Rightarrow T_2 = 314.4$ K

$\Rightarrow t = 41.4$°C

75. At the transition temperature T, A $\rightleftharpoons$ B and $\Delta G^0 = 105 - 35 \log T$ where A and B are two states of substance X. The transition temperature in °C when pressure is 1 atm is _____. (Nearest integer)

Ans. **(727)**

Sol. $\Delta G° = 0$ (eqm. at standard pressure)

$105 - 35 \log T = 0$

$\log T = 3$

$T = 1000$ K

$T = 727$°C