(HELD ON WEDNESDAY 08th APRIL 2026) **TIME : 3:00 PM TO 6:00 PM**

MATHEMATICS

TEST PAPER WITH SOLUTION

SECTION-A

1. Consider the relation R on the set {–2, –1, 0, 1, 2} defined by $(a, b) \in R$ if and only if $1 + ab > 0$. Then among the statements :

I. The number of elements in R is 17

II. R is an equivalence relation

(1) Only I is true (2) Only II is true

(3) Both I and II are true (4) Neither I nor II is true

Ans. (1)

Sol. Reflexive If $(a, a) \in R$

$\Rightarrow 1 + a^2 > 0$

$\Rightarrow$ It is reflexive relation

Symmetric If $1 + ab > 0 \Rightarrow 1 + ba > 0$

i.e. If $(a, b) \in R$ and $(b, a) \in R$

Therefore it is symmetric relation

Transitive $\because (-2, 0) \in R$ & $(0, 2) \in R$

But $(-2, 2) \notin R$

Hence it is not transitive

$\Rightarrow$ It is not an equivalence relation.

Check Number of elements in R

$\because 1 + ab > 0$

a & b each can be filled by 5 ways

$\therefore$ total elements = 25 But out of these

(–2, –1), (–2, 2), (–1, 2), (1, –2), (2, –2), (2, –1)

(–1, 1) & (1, –1) are not in relation.

2. The number of values of $z \in \mathbb{C}$, satisfying the equations $|z - (4 + 8i)| = \sqrt{10}$ and $|z - (3 + 5i)| + |z - (5 + 11i)| = 4\sqrt{5}$, is :

(1) 0 (2) 2

(3) 1 (4) 4

Ans. (2)

Sol. $|z - (3 + 5i)| + |z - (5 + 11i)| = 4\sqrt{5}$

So, $S_1(3, 5)$ & $S_2(5, 11)$ are two foci of ellipse, where $2ae = S_1S_2 = 2\sqrt{10}$ & $2a = 4\sqrt{5}$

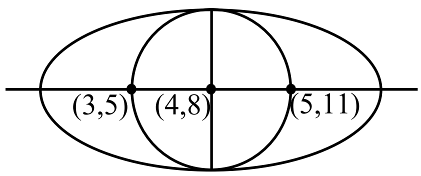
$\Rightarrow a = 2\sqrt{5}$, $e = \dfrac{1}{\sqrt{2}}$ & $b^2 = a^2(1 - e^2)$ gives $b^2 = 10$

& center of an ellipse is mid point of both focus

$\therefore$ center (4, 8)

Equation of circle is $|Z - (4 + 8i)| = \sqrt{10}$

$\Rightarrow$ Ellipse & given circle are concentric & radius of given circle is equal to length of minor axis of given ellipse



$\Rightarrow$ Two points which are common to both.

3. If the system of linear equations :

$x + y + z = 6,$

$x + 2y + 5z = 10,$

$2x + 3y + \lambda z = \mu.$

has infinitely many solutions, then the value of $\lambda + \mu$ equals.

(1) 12 (2) 16

(3) 22 (4) 28

Ans. (3)

Sol. $D = \begin{vmatrix} 1 & 1 & 1 \\ 1 & 2 & 5 \\ 2 & 3 & \lambda \end{vmatrix} = \lambda - 6$

$D_1 = \begin{vmatrix} 6 & 1 & 1 \\ 10 & 2 & 5 \\ \mu & 3 & \lambda \end{vmatrix} = 2\lambda + 3\mu - 60$

$D_2 = \begin{vmatrix} 1 & 6 & 1 \\ 1 & 10 & 5 \\ 2 & \mu & \lambda \end{vmatrix} = 4(\lambda - \mu + 10)$

$D_3 = \begin{vmatrix} 1 & 1 & 6 \\ 1 & 2 & 10 \\ 2 & 3 & \mu \end{vmatrix} = \mu - 16$

For infinite many solution

$D = D_1 = D_2 = D_3 = 0$

$\Rightarrow \lambda = 6 \ \& \ \mu = 16$

$\Rightarrow \lambda + \mu = 22$

4. Let $A = \begin{bmatrix} \alpha & 1 & 2 \\ 2 & 3 & 0 \\ 0 & 4 & 5 \end{bmatrix}$ and

$B = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -5\alpha & 0 \\ 0 & 4\alpha & -2\alpha \end{bmatrix} + \text{adj}(A)$. If $\det(B) = 66$, then $\det(\text{adj}(A))$ equals :

(1) 289 (2) 361

(3) 441 (4) 529

Ans. (3)

Sol. $A = \begin{bmatrix} \alpha & 1 & 2 \\ 2 & 3 & 0 \\ 0 & 4 & 5 \end{bmatrix}$ & $|A| = 5\alpha + 6$

Now $\text{adj}\, A = \begin{bmatrix} 15 & 3 & -6 \\ -10 & 5\alpha & 4 \\ 8 & -4\alpha & 3\alpha - 2 \end{bmatrix}$

$\therefore B = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -5\alpha & 0 \\ 0 & 4\alpha & -2\alpha \end{bmatrix} + \text{adj}(A)$

$B = \begin{bmatrix} 16 & 3 & -6 \\ -10 & 0 & 4 \\ 8 & 0 & \alpha - 2 \end{bmatrix}$

& $|B| = 6(5\alpha + 6) = 66$ (given in question)

$\Rightarrow \alpha = 1$

$\Rightarrow |A| = 21$

$\therefore \det(\text{adj}\, A) = |A|^{(n-1)^2}$

Here $n = 3$

$= 21^2$

$= 441$

5. Let $\alpha = 3 + 4 + 8 + 9 + 13 + 14 + \ldots$ upto 40 terms. If $(\tan\beta)^{\frac{\alpha}{1020}}$ is a root of the equation $x^2 + x - 2 = 0$, $\beta \in \left(0, \frac{\pi}{2}\right)$, then $\sin^2\beta + 3\cos^2\beta$ is equal to :

(1) 2 (2) $\frac{7}{4}$

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

Ans. (1)

Sol. a = (3 + 8 + 13 … upto 20 terms) + (4 + 9 + 14 + … upto 20 terms)

$$= \frac{20}{2}[6+19\times5]+\frac{20}{2}(8+19\times5)$$

= 2040

$$(\tan\beta)^{\frac{2040}{1020}} = \tan^2\beta$$

$$x^2 + x - 2 = 0 < \begin{matrix} 1 \\ -2 \end{matrix}$$

$$\Rightarrow \tan^2\beta = 1 \text{ ; } \sin^2\beta = \frac{1}{2} \text{ \& } \cos^2\beta = \frac{1}{2}$$

$$\sin^2\beta + 3\cos^2\beta = \frac{1}{2}+\frac{3}{2}=\frac{4}{2}=2$$

6. A candidate has to go to the examination centre to appear in an examination. The candidate uses only one means of transportation for the entire distance out of bus, scooter and car. The probabilities of the candidate going by bus, scooter and car, respectively, are $\frac{2}{5}$, $\frac{1}{5}$ and $\frac{2}{5}$. The probabilities that the candidate reaches late at the examination centre are $\frac{1}{5}$, $\frac{1}{3}$ and $\frac{1}{4}$ if the candidate uses bus, scooter and car, respectively. Given that the candidate reached late at the examination centre, the probability that the candidate travelled by bus is :

(1) $\frac{11}{37}$ (2) $\frac{12}{37}$

(3) $\frac{13}{37}$ (4) $\frac{14}{37}$

Ans. (2)

Sol.

$$P(\text{Bus}) = P(B) = \frac{2}{5} \quad \Big| \quad P\left(\frac{\text{late}}{B}\right) = \frac{1}{5}$$

$$P(\text{Scooter}) = P(S) = \frac{1}{5} \quad \Big| \quad P\left(\frac{\text{late}}{S}\right) = \frac{1}{3}$$

$$P(\text{Car}) = P(C) = \frac{2}{5} \quad \Big| \quad P\left(\frac{\text{late}}{C}\right) = \frac{1}{4}$$

$$P\left(\frac{B}{\text{late}}\right) = \frac{\frac{2}{5}\times\frac{1}{5}}{\frac{2}{5}\times\frac{1}{5}+\frac{1}{5}\times\frac{1}{3}+\frac{2}{5}\times\frac{1}{4}} = \frac{12}{37}$$

7. A set of four observations has mean 1 and variance 13. Another set of six observations has mean 2 and variance 1. Then, the variance of all these 10 observations is equal to :

(1) 5.96 (2) 6.14

(3) 6.04 (4) 6.24

Ans. (3)

Sol. Given $\bar{x} = 1, \sigma_1^2 = 13$

$\bar{y} = 2, \sigma_2^2 = 1$

Combined variance = $\frac{n_1\sigma_1^2 + n_2\sigma_2^2}{n_1+n_2} + \frac{n_1n_2}{(n_1+n_2)^2}(\bar{x}-\bar{y})^2$

$$= \frac{4\times13+6\times1}{10}+\frac{4\times6}{10^2}(2-1)^2$$

$$\frac{58}{10}+\frac{24}{100}=\frac{580+24}{100}=\frac{604}{100}=6.04$$

8. If

$$26\left(\frac{2^3}{3}\left({}^{13}C_2\right)+\frac{2^5}{5}\left({}^{12}C_4\right)+\frac{2^7}{7}\left({}^{12}C_6\right)+\ldots+\frac{2^{13}}{13}\left({}^{12}C_{12}\right)\right)$$

$= 3^{13} - \alpha$, then α is equal to :

(1) 45 (2) 48

(3) 51 (4) 54

Ans. (3)

Sol. $(1 + x)^{12} = {}^{12}C_0 + {}^{12}C_1 x + {}^{12}C_2 x^2 + \ldots\ldots + {}^{12}C_{12} x^{12}$

integrating both sides

$$\left(\frac{(1+x)^{13}}{13}\right)_{-2}^{2} = \left({}^{12}C_0 x + {}^{12}C_1\frac{x^2}{2} + {}^{12}C_2\frac{x^3}{3} + \ldots + {}^{12}C_{12}\frac{x^{13}}{13}\right)_{-2}^{2}$$

$$\frac{3^{13}}{13}+\frac{1}{13}=\left({}^{12}C_0 2+{}^{12}C_1\frac{2^2}{2}+{}^{12}C_2\frac{2^3}{3}+\ldots+{}^{12}C_{12}\frac{2^{13}}{13}\right)$$

$$-\left(-{}^{12}C_0.2+{}^{12}C_1\frac{2^2}{2}-{}^{12}C_2.\frac{2^3}{3}+\ldots+{}^{12}C_{12}.\frac{2^{13}}{13}\right)$$

$$=2\left(2.{}^{12}C_0+{}^{12}C_2.\frac{2^3}{3}+{}^{12}C_4.\frac{2^5}{5}+\ldots+{}^{12}C_{12}.\frac{2^{13}}{13}\right)$$

$$3^{13}+1=26\left(2+{}^{12}C_2.\frac{2^3}{3}+{}^{12}C_4.\frac{2^5}{5}+\ldots+{}^{12}C_{12}.\frac{2^{13}}{13}\right)$$

$$3^{13}-51=26\left({}^{12}C_2.\frac{2^3}{3}+{}^{12}C_4.\frac{2^5}{5}+\ldots+{}^{12}C_{12}.\frac{2^{13}}{13}\right)$$

$\therefore\ \alpha=51$

9. A person has three different bags and four different books. The number of ways, in which he can put these books in the bags so that no bag is empty, is

(1) 18 (2) 36

(3) 39 (4) 72

Ans. **(2)**

Sol. B_1 B_2 B_3

1 1 2

No. of ways = $\frac{4!}{2!2!}\times 3!=6\times 6=36$

10. If a straight line drawn through the point of intersection of the lines $4x + 3y - 1 = 0$ and $3x + 4y - 1 = 0$, meet the co-ordinate axes at the points P and Q, then the locus of the mid point of PQ is:

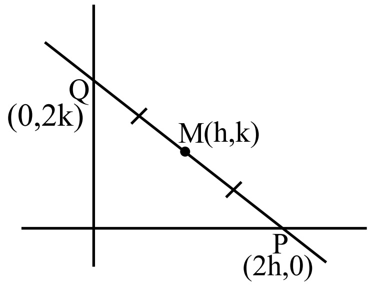
(1) $x+y-7=0$ (2) $x+y-14xy=0$

(3) $2x+y+14xy=0$ (4) $x+2y-14xy=0$

Ans. **(2)**

Sol. Point of intersection of the lines

$3x + 4y = 1$ and $4x + 3y = 1$ is $\left(\frac{1}{7},\frac{1}{7}\right)$



Let the line be $\frac{x}{2h}+\frac{y}{2k}=1$

Satisfy $\left(\frac{1}{7},\frac{1}{7}\right)$

$\frac{1}{14h}+\frac{1}{14k}=1$

$\frac{1}{x}+\frac{1}{y}=14$

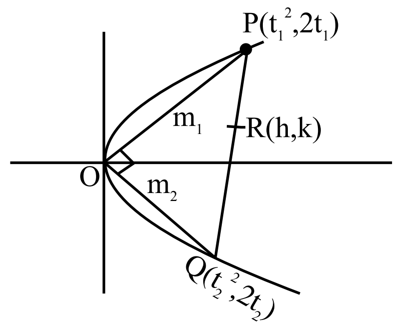
11. Let O be the vertex of the parabola $y^2 = 4x$ and its chords OP and OQ are perpendicular to each other. If the locus of the mid-point of the line segment PQ is a conic C, then the length of its latus rectum is :

(1) 1 (2) 2

(3) 4 (4) 8

Ans. **(2)**

Sol.



$t_1t_2=-4$

$2h=t_1^2+t_2^2$ $2k=2(t_1+t_2)$

$2h=k^2-2t_1t_2$

$2h=k^2+8$

$k^2=2h-8$

$=2((h-4)$

L.R. = 2

12. Let $\alpha = 3\sin^{-1}\left(\frac{6}{11}\right)$ and $\beta = 3\cos^{-1}\left(\frac{4}{9}\right)$, where inverse trigonometric functions take only the principal values.

Given below are two statements:

Statement I : $\cos(\alpha+\beta) > 0$

Statement II : $\cos(\alpha) < 0$

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. $\frac{1}{2} < \frac{6}{11} < \frac{1}{\sqrt{2}}$

$\sin^{-1}\left(\frac{1}{2}\right) < \sin^{-1}\left(\frac{6}{11}\right) < \sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

$\frac{\pi}{6} < 3\sin^{-1}\left(\frac{6}{11}\right) < \frac{\pi}{4}$

$\frac{\pi}{2} < \alpha < \frac{3\pi}{4} \quad \therefore \cos\alpha < 0$

$0 < \frac{4}{9} < \frac{1}{2}$

$\frac{\pi}{3} < \cos^{-1}\left(\frac{4}{9}\right) < \frac{\pi}{2}$

$\pi < 3\cos^{-1}\left(\frac{4}{9}\right) < \frac{3\pi}{2}$

$\pi < \beta < \frac{3\pi}{2}$

Now $\frac{3\pi}{2} < \alpha+\beta < \frac{9\pi}{4}$

$\therefore \cos(\alpha+\beta) > 0$

13. For the function $f(x) = e^{\sin|x|} - |x|$, $x \in \mathbf{R}$, consider the following statements:

Statement I : f is differentiable for all $x \in \mathbf{R}$.

Statement II : f is increasing in $\left(-\pi, -\frac{\pi}{2}\right)$.

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. $f(x) = e^{|\sin x|} - |x|$ is

non-differentiable at $x = \pi$

and for $x \in \left(-\pi, \frac{-\pi}{2}\right)$

$f(x) = e^{-\sin x} + x$

$f'(x) = -e^{-\sin x}\cos x + 1$

for $x \in \left(-\pi, \frac{-\pi}{2}\right) \qquad \cos x < 0$

$\therefore f'(x) > 0$

$\therefore$ f(x) is increasing

14. Let $\vec{a} = 4\hat{i} - \hat{j} + 3\hat{k}$, $\vec{b} = 10\hat{i} + 2\hat{j} - \hat{k}$ and a vector $\vec{c}$ be such that $2(\vec{a}\times\vec{b}) + 3(\vec{b}\times\vec{c}) = \vec{0}$. If $\vec{a}.\vec{c} = 15$, then $\vec{c}\cdot(\hat{i}+\hat{j}-3\hat{k})$ is equal to :

(1) –6	(2) –5
(3) –4	(4) –3

Ans. **(2)**

Sol. $2(\vec{a}\times\vec{b})-3(\vec{c}\times\vec{b})=\vec{0}$

$(2\vec{a}-3\vec{c})\times\vec{b}=\vec{0}$

$\vec{b}\,||\,(2\vec{a}-3\vec{c})$

$2\vec{a}-3\vec{c}=\lambda\vec{b}$

$$\vec{c}=\frac{2\vec{a}-\lambda\vec{b}}{3} \qquad \ldots(1)$$

$\vec{a}.\vec{c}=15$

$$\left(\frac{2\vec{a}-\lambda\vec{b}}{3}\right).\vec{a}=15$$

$$\frac{2|a|^2-\lambda\vec{b}.\vec{a}}{3}=15$$

$2(26)-\lambda(40-2-3)=45$

$$\lambda=\frac{1}{5}$$

$$\Rightarrow \vec{c}.\left(\hat{i}+\hat{j}-3\hat{k}\right)=\frac{\left(2\left(4\hat{i}-\hat{j}+3\hat{k}\right)-\frac{1}{5}\left(10\hat{i}+2\hat{j}-\hat{k}\right).\left(\hat{i}+\hat{j}-3\hat{k}\right)\right)}{3}$$

$$=\frac{2(4-1-9)-\frac{1}{5}(10+2+3)}{3}=-5$$

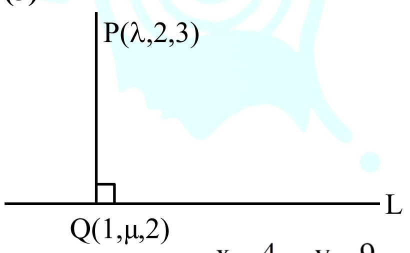
15. Let the foot of perpendicular from the point $(\lambda, 2, 3)$ on the line $\frac{x-4}{1}=\frac{y-9}{2}=\frac{z-5}{1}$ be the point $(1, \mu, 2)$. Then the distance between the lines $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z+4}{6}$ and $\frac{x-\lambda}{2}=\frac{y-\mu}{3}=\frac{z+5}{6}$ is equal to

(1) $\frac{12}{7}$ (2) $\frac{\sqrt{145}}{7}$

(3) $\frac{\sqrt{146}}{7}$ (4) $\frac{\sqrt{143}}{7}$

Ans. (3)

Sol.



$$\frac{x-4}{1}=\frac{y-9}{2}=\frac{z-5}{1}$$

Q(1, μ, 2) satisfies the line L

$$\therefore \frac{1-4}{1}=\frac{\mu-9}{2}=\frac{2-5}{1}$$

$$\Rightarrow -3=\frac{\mu-9}{2}=-3 \qquad \Rightarrow \boxed{\mu=3}$$

D.R. of PQ : $\lambda-1, 2-\mu, 1$

Since PQ $\perp$ L $\Rightarrow (\lambda-1).1+2(2-\mu)+1.1=0$

$$\Rightarrow \boxed{\lambda-2\mu+4=0} \qquad \therefore \boxed{\lambda=2}$$

Now lines : $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z+4}{6}$ &

$$\frac{x-2}{2}=\frac{y-3}{3}=\frac{z+5}{6}$$

i.e. $\vec{r}=\left(\hat{i}+2\hat{j}-4\hat{k}\right)+t_1\left(2\hat{i}+3\hat{j}+6\hat{k}\right)$

& $\vec{r}=\left(2\hat{i}+3\hat{j}-5\hat{k}\right)+t_2\left(2\hat{i}+3\hat{j}+6\hat{k}\right)$

Distance

$$=\frac{\left|\left(\left(\hat{i}+2\hat{j}-4\hat{k}\right)-\left(2\hat{i}+3\hat{j}-5\hat{k}\right)\right)\times\left(2\hat{i}+3\hat{j}+6\hat{k}\right)\right|}{\left|2\hat{i}+3\hat{j}+6\hat{k}\right|}$$

$$=\frac{\left|-9\hat{i}+8\hat{j}-\hat{k}\right|}{7}=\frac{\sqrt{146}}{7}$$

16. The value of the integral

$$\int_0^2 \frac{\sqrt{x\left(x^2+x+1\right)}}{\left(\sqrt{x}+1\right)\left(\sqrt{x^4+x^2+1}\right)}dx \text{ is equal to :}$$

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

(2) $\frac{2}{3}\log_e\left(4+\sqrt{2}\right)$

(3) $\frac{2}{3}\log_e\left(3+2\sqrt{2}\right)$

(4) $\frac{1}{3}\log_e\left(1+6\sqrt{2}\right)$

Ans. (3)

Sol. $I = \int_0^2 \sqrt{\frac{x(x^2+x+1)}{(x+1)(x^2-x+1)(x^2+x+1)}}dx$

$= \int_0^2 \sqrt{\frac{x}{x^3+1}}dx$

$(x^{3/2} = t \Rightarrow \frac{3}{2}x^{1/2}dx = dt)$

$= \frac{2}{3}\int_0^{2^{3/2}} \frac{dt}{\sqrt{t^2+1}}$

$= \frac{2}{3}\left(\ell n(t+\sqrt{t^2+1})\right)_0^{2^{3/2}}$

$= \frac{2}{3}\ell n\left(2^{3/2}+3\right)$

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

$x\sqrt{1-x^2}\,dy + \left(y\sqrt{1-x^2} - x\cos^{-1}x\right)dx = 0,$

$x \in (0, 1)$, $\lim_{x\to 1^-} y(x) = 1$. Then $y\left(\frac{1}{2}\right)$ equals :

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

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

Ans. (1)

Sol. $x\sqrt{1-x^2}dy + \left(y\sqrt{1-x^2} - x\cos^{-1}x\right)dx = 0$

$\Rightarrow \frac{dy}{dx} + \frac{y}{x} = \frac{\cos^{-1}x}{\sqrt{1-x^2}}$

it is L.D.E.

$\therefore$ I.F. $= e^{\int \frac{1}{x}dx} = e^{\ell n\,x} = x$

$\therefore$ solution is $y.x = \int \frac{x\cos^{-1}x}{\sqrt{1-x^2}}dx + C$

$y.x = I_1 + C$ ....(1)

$I_1 = \int \frac{x\cos^{-1}x}{\sqrt{1-x^2}}dx$

Let $\cos^{-1}x = t \Rightarrow x = \cos t$

$-\frac{1}{\sqrt{1-x^2}}dx = dt$

$I_1 = \int -t.\cot dt$

$= -\left(t\sin t + \cos t\right)$

$I_1 = -\left(\sqrt{1-x^2}.\cos^{-1}x + x\right)$ ....(2)

$\therefore y.x = -\left(\sqrt{1-x^2}.\cos^{-1}x + x\right) + C$

$\because \lim_{x\to 1^-} y(x) = 1$

$\therefore 1 = -(0 + 1) + C$

$\Rightarrow C = 2$

$\therefore y.x = -\sqrt{1-x^2}.\cos^{-1}x - x + 2$

$\left(\text{put } x = \frac{1}{2}\right)$

$y\left(\frac{1}{2}\right)\times\frac{1}{2} = -\frac{\sqrt{3}}{2}\times\frac{\pi}{3} - \frac{1}{2} + 2$

$\Rightarrow y\left(\frac{1}{2}\right) = 3 - \frac{\pi}{\sqrt{3}}$

18. Let f : $(1, \infty) \to$ **R** be function defined as $f(x) = \frac{x-1}{x+1}$. Let $f^{i+1}(x) = f\left(f^i(x)\right)$, $i = 1, 2, \ldots, 25$, where $f^1(x) = (x)$. If $g(x) + f^{26}(x) = 0$, $x \in (1, \infty)$, then the area of the region bounded by the curves y = g(x), 2y = 2x – 3, y = 0 and x = 4 is:

(1) $\frac{1}{8} + \log_e 2$ (2) $\frac{1}{4} + \log_e 2$

(3) $\frac{5}{6} + 3\log_e 2$ (4) $\frac{5}{6} + \log_e 2$

Ans. (1)

Sol. $f^2(x) = f(f(x)) = \dfrac{\frac{x-1}{x+1}-1}{\frac{x-1}{x+1}+1} = \dfrac{-1}{x}$

$f^3(x) = f(f^2(x)) = f\left(\dfrac{-1}{x}\right) = \dfrac{1+x}{1-x}$

$f^4(x) = f(f^3(x)) = f\left(f\left(\dfrac{-1}{x}\right)\right) = x$

$f^5(x) = f(f^4(x)) = f(x)$

$f^6(x) = f(f^5(x)) = f(f(x)) = \dfrac{-1}{x}$

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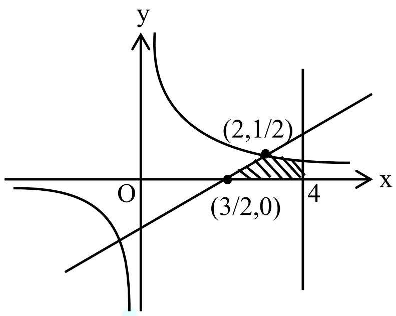
$f^{26}(x) = \dfrac{-1}{x}$

$g(x) = \dfrac{1}{x}$



$x - 3/2 = 1/x \Rightarrow 2x^2 - 3x - 2 = 0$

$\Rightarrow x = -1/2, 2$

Req. area $= \int_2^4 \dfrac{1}{x}dx + \dfrac{1}{2}\times\dfrac{1}{2}\times\dfrac{1}{2}$

$= \dfrac{1}{8} + (\ell nx)_2^4 = \dfrac{1}{8} + \ell n2$

19. Let $f(x) = \begin{cases} \dfrac{1}{3}, & x \le \pi/2 \\ \dfrac{b(1-\sin x)}{(\pi-2x)^2}, & x > \pi/2 \end{cases}$, If f is continuous at $x = \pi/2$, then the value of $\int\limits_0^{3b-6} \left|x^2+2x-3\right| dx$ is :

(1) 5 (2) 2

(3) 3 (4) 4

Ans. **(4)**

Sol. $\lim\limits_{x\to\frac{\pi}{2}} \dfrac{b(1-\cos(\frac{\pi}{2}-x))}{4\left(\frac{\pi}{2}-x\right)^2} = \dfrac{1}{3} \Rightarrow b = \dfrac{8}{3}$

$\int_0^2 \left|x^2+2x-3\right| dx = \int_0^2 \left|(x+3)(x-1)\right| dx$

put $x - 1 = t$

$\int_{-1}^1 \left|(t+4)t\right| dt = \int_{-1}^0 (-t^2-4t)dt + \int_0^1 (t^2+4t)dt$

$\left(\dfrac{-t^3}{3} - 2t^2\right)_{-1}^0 + \left(\dfrac{t^3}{3} + 2t^2\right)_0^1 = 4$

20. Let $\dfrac{x^2}{f\left(a^2+7a+3\right)} + \dfrac{y^2}{f\left(3a+15\right)} = 1$ represent an ellipse with major axis along y-axis, where f is a strictly decreasing positive function on **R**. If the set of all possible values of a is **R** $-[\alpha, \beta]$, then $\alpha^2 + \beta^2$ is equal to :

(1) 28 (2) 40

(3) 61 (4) 24

Ans. **(2)**

Sol. Given ellipse is vertical

$\therefore f(3a + 15) > f(a^2 + 7a + 3)$

$\because f(x)$ is decreasing $\forall x \in R$

$\Rightarrow 3a + 15 < a^2 + 7a + 3$

$\Rightarrow a^2 + 4a - 12 > 0$

$\Rightarrow (a + 2)^2 > 16$

$\Rightarrow |(a + 2)| > 4$

$\Rightarrow a > 2$ or $a < -6$

$\Rightarrow a \in R - [-6, 2]$

$\therefore \alpha = -6, \beta = 2$

$\therefore \alpha^2 + \beta^2 = 36 + 4 = 40$

SECTION-B

21. The sum of squares of all real solution of the equation

$\log_{(x+1)}(2x^2+5x+3) = 4 - \log_{(2x+3)}(x^2+2x+1)$ is equal to _______.

Ans. **(2)**

Sol. $\log_{(x+1)}(2x+3)(x+1) + \log_{(2x+3)}(x+1)^2 = 4$

$1 + \log_{(x+1)}(2x+3) + 2\log_{(2x+3)}(x+1) = 4$

$\log_{x+1}(2x+3) = t \qquad t + \dfrac{2}{t} = 3$

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

for $t = 1 \Rightarrow \log_{(x+1)}(2x+3) = 1 \Rightarrow 2x+3 = x+1$

$\Rightarrow x = -2$ (rejected)

for $t = 2 \Rightarrow 2x+3 = x^2+2x+1 \Rightarrow x^2 = 2$

$\Rightarrow x = \pm\sqrt{2}$

rejecting $x = -\sqrt{2}$, we get $x = \sqrt{2}$

$\therefore$ sum of squares of all the roots = 2

22. If $\displaystyle\int_{\pi/6}^{\pi/4}\left(\cot\left(x-\frac{\pi}{3}\right)\cot\left(x+\frac{\pi}{3}\right)+1\right)dx = \alpha\log_e\left(\sqrt{3}-1\right)$,

then $9\alpha^2$ is equal to _______.

Ans. **(12)**

Sol. $$\int_{\pi/6}^{\pi/4}\left((\cot(x-\frac{\pi}{3})\cot(x+\frac{\pi}{3})+1\right)dx$$

using $\cot(A-B) = \dfrac{\cot B\,\cot A + 1}{\cot B - \cot A}$

$$\Rightarrow \int_{\pi/6}^{\pi/4} -\frac{1}{\sqrt{3}}\left[\cot(x-\frac{\pi}{3}) - \cot(x+\frac{\pi}{3})\right]dx$$

$$\Rightarrow \frac{-1}{\sqrt{3}}\left[\ell n\left|\frac{\sin(x-\frac{\pi}{3})}{\sin(x+\frac{\pi}{3})}\right|\right]_{\frac{\pi}{6}}^{\frac{\pi}{4}}$$

$$= \frac{-1}{\sqrt{3}}\left[\ell n\left|\left(\frac{\sin 15^\circ}{\sin 105^\circ}\right)\right| - \ell n\left|\frac{\sin 30^\circ}{\sin 90^\circ}\right|\right]$$

$$= \frac{-1}{\sqrt{3}}\left[\ell n(\tan 15^\circ) - \ell n\left(\frac{1}{2}\right)\right]$$

$$= \frac{-1}{\sqrt{3}}\left[\ell n\left(2-\sqrt{3}\right) + \ell n 2\right]$$

$$\Rightarrow \frac{-1}{\sqrt{3}}\ell n\left(4-2\sqrt{3}\right) = \frac{-2}{\sqrt{3}}\ell n\left(\sqrt{3}-1\right)$$

$$\therefore \alpha = \frac{-2}{\sqrt{3}} \therefore 9\alpha^2 = 12$$

23. Let a line L_1 pass through the origin and be perpendicular to the lines

$L_2 : \vec{r} = (3+t)\hat{i} + (2t-1)\hat{j} + (2t+4)\hat{k}$ and

$L_3 : \vec{r} = (3+2s)\hat{i} + (3+2s)\hat{j} + (2+s)\hat{k}$, t, s $\in$ **R**. If (a, b, c), a $\in$ **Z**, is the point on L_1 at a distance of $\sqrt{17}$ from the point of intersection of L_1 and L_2, then $(a+b+c)^2$ is equal to _______.

Ans. **(4)**

Sol. $L_2 : \dfrac{x-3}{1} = \dfrac{y+1}{2} = \dfrac{z-4}{2} = t$

$L_5 : \dfrac{x-3}{2} = \dfrac{y-3}{2} = \dfrac{z-2}{1} = s$

vector $\perp^{ar}$ to L_2 & L_3

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

$\Rightarrow -2\hat{i} + 3\hat{j} - 2\hat{k}$

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

Now, $L_1 : \frac{x}{2} = \frac{y}{-3} = \frac{z}{2} = \ell$

intersection of L_1 & L_2

$\Rightarrow t + 3 = 2\ell, 2t - 1 = -3\ell, 2t + 4 = 2\ell$

$t + 3 = 2t + 4$

$t = -1$

$\Rightarrow P \equiv (2, -3, 2)$

A point on L_3 is $Q(2s + 3, 2s + 3, s + 2)$

$\Rightarrow PQ^2 = (2s + 1)^2 + (2s + 6)^2 + s^2 = 17$

$\Rightarrow 9s^2 + 28s + 20 = 0$

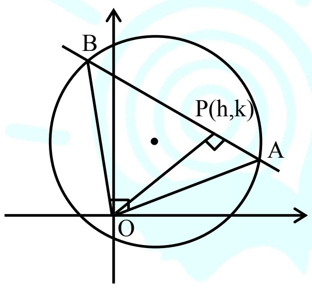
$\Rightarrow (9s + 10)(s + 2) = 0 \Rightarrow s = -2$

$\therefore Q \equiv (-1, -1, 0) \equiv (a, b, c) \Rightarrow (a + b + c)^2 = 4$

24. Consider the circle $C : x^2 + y^2 - 6x - 8y - 11 = 0$. Let a variable chord AB of the circle C subtend a right angle at the origin. If the locus of the foot of the perpendicular drawn from the origin on the chord AB is the circle $x^2 + y^2 - \alpha x - \beta y - \gamma = 0$, then $\alpha + \beta + 2\gamma$ is equal to _______.

Ans. **(18)**

Sol.



$C : x^2 + y^2 - 6x - 8y - 11 = 0$

E^{qn} of chord AB

$$y - k = -\frac{h}{k}(x - h)$$

$hx + ky = h^2 + k^2$ ....(2)

Homogenising the eq^n of the circle

$$x^2 + y^2 - 6x\left(\frac{hx + ky}{h^2 + k^2}\right) - 8y\left(\frac{hx + ky}{h^2 + k^2}\right) - 11\left(\frac{hx + ky}{h^2 + k^2}\right)^2 = 0$$

coeff. of x^2 + coeff of $y^2 = 0$

$$1 - \frac{6h}{h^2 + k^2} - 11.\frac{h^2}{(h^2 + k^2)^2} + 1 - \frac{8k}{h^2 + k^2} - 11.\frac{k^2}{(h^2 + k^2)^2} = 0$$

$2(h^2 + k^2) - 6h - 8k - 11 = 0$

$$x^2 + y^2 - 3x - 4y - \frac{11}{2} = 0$$

$\therefore \alpha + \beta + 2\gamma = 3 + 4 + 11 = 18$

25. Let f be a polynomial function such that

$$\log_2(f(x)) = \left(\log_2\left(2 + \frac{2}{3} + \frac{2}{9} + ...\infty\right)\right).$$

$$\log_3\left(1 + \frac{f(x)}{f\left(\frac{1}{x}\right)}\right),\ x > 0 \text{ and } f(6) = 37. \text{ Then}$$

$\sum_{n=1}^{10} f(n)$ is equal to _______.

Ans. **(395)**

Sol. $$\log_2 f(x) = \log_2\left(\frac{2}{1 - \frac{1}{3}}\right).\log_3\left(1 + \frac{f(x)}{f\left(\frac{1}{x}\right)}\right)$$

$$\log_2 f(x) = \log_2 3.\log_3\left(1 + \frac{f(x)}{f\left(\frac{1}{x}\right)}\right)$$

$$\Rightarrow f(x) = 1 + \frac{f(x)}{f\left(\frac{1}{x}\right)}$$

$$\Rightarrow f(x)\ f\left(\frac{1}{x}\right) = f(x) + f\left(\frac{1}{x}\right)$$

$\Rightarrow f(x) = 1 \pm x^n$ $\quad\Rightarrow f(6) = 37$

$\Rightarrow 1 \pm 6^n = 37$ $\quad\Rightarrow 6^n = 36$

$\Rightarrow n = 2$

$\therefore f(x) = 1 + x^2$

$$\sum_{n=1}^{10}(1 + n^2) = 10 + \frac{10.11.21}{6} = 395$$

(HELD ON WEDNESDAY 08th APRIL 2026) **TIME : 3:00 PM TO 6:00 PM**

PHYSICS	TEST PAPER WITH SOLUTION

SECTION-A

26. A new unit (α) of length is chosen such that it is equal to the speed of light in vacuum. What is the distance between Venus and Earth in terms of α units if light takes 6 min. 40 s to cover this distance ?

(1) 200 α (2) 400 α

(3) 300 α (4) 500 α

Ans. **(2)**

Sol. $\alpha = 3 \times 10^8$ m

Distance = (400) × 3 × 10^8 m = 400α

27. Consider the equation $H = \dfrac{x^p \in^q E^r}{t^s}$

Where H = magnetic field; E = electric field; $\in$ = permittivity, x = distance, t = time. The values of p, q, r and s respectively are :

(1) 1, 1, 1, 1 (2) –1, 1, 2, 1

(3) 1, –1, –2, 1 (4) –1, –2, –2, 1

Ans. **(1)**

Sol. As per the question, considering H as magnetic field

$$[H] = \frac{MLT^{-2}}{LT^{-1}IT} = MI^{-1}T^{-2}$$

$$[E] = \frac{MLT^{-2}}{IT} = MLI^{-1}T^{-3}$$

$$[\in] = \frac{I^2T^2}{MLT^{-2}L^2} = M^{-1}L^{-3}I^2T^4$$

$$MI^{-1}T^{-2} = M^{-q+r}\, L^{p-3q+r}\, I^{2q-r}\, T^{4q-3r-S}$$

$-q + r = 1$

$P - 3q + r = 0$

$2q - r = -1$

$4q - 3r - S = -2$

Solving we get

$q = 0, r = 1$

$p = -1, S = -1$

No option matching

Considering H as magnetic field intensity

$$H = \frac{B}{\mu_0} = Ni \Rightarrow \text{current per unit length} \Rightarrow IL^{-1}$$

$-q + r = 0$	$q = 1$
$p - 3q + r = -1$	$r = 1$
$2q - r = 1$	$p = +1$
$4q - 3r - s = 0$	$s = +1$

Option (1) is matching

Note : As per the question if we consider H as magnetic field, no option is matching but if we consider H as magnetic field intensity then option (1) is matching.

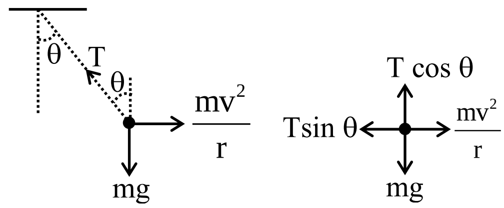
28. A car moving with a speed of 54 km/h takes a turn of radius 20 m. A simple pendulum is suspended from the ceiling of the car. Determine the angle made by the string of the pendulum with the vertical during the turning. (Take g = 10 m/s^2)

(1) $\tan^{-1}(0.5)$ (2) $\tan^{-1}(0.75)$

(3) $\tan^{-1}(1.125)$ (4) $\tan^{-1}(0.25)$

Ans. **(3)**

Sol.



$$\tan\theta = \frac{v^2}{rg} \qquad \left(v = 54 \times \frac{5}{18} = 15\text{m/s}\right)$$

$$\tan\theta = \frac{225}{20 \times 10}$$

$$\tan\theta = \frac{9}{8}$$

$$\theta = \tan^{-1}(1.125)$$

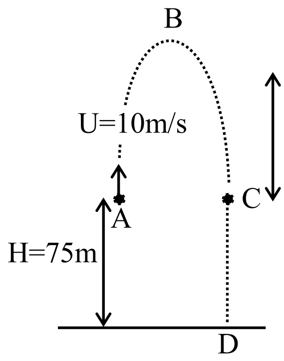
29. A gas balloon is going up with a constant velocity of 10 m/s. When this balloon reached a height of 75 m, a stone is dropped from it and balloon keeps moving up with the same velocity. The height of the balloon when the stone hits the ground is ______ m. (Take $g = 10\ m/s^2$)

(1) 85 (2) 150

(3) 129 (4) 125

Ans. (4)

Sol.



$$h = \frac{u^2}{2g} \Rightarrow \frac{100}{2\times 10} = 5m$$

$$-75 = 10 \times t - \frac{1}{2} \times 10 \times t^2$$

$$t^2 - 2t - 15 = 0$$

$$(t-5)(t+3) = 0 \quad \Rightarrow \quad t = 5$$

Height = 75 + 10 × 5 = 125 m

30. A thin biconvex lens is prepared from the glass ($\mu = 1.5$) both curved surfaces of which have equal radii of 20 cm each. Left side surface of the lens is silvered from outside to make it reflecting. To have the position of image and object at the same place, the object should be placed, from the lens at a distance of _________ cm.

(1) 10 (2) 12.5

(3) 13 (4) 13.5

Ans. (1)

Sol. Combination of lens + mirror

$$f_m = \frac{R}{2} = -10cm \; ; \; f_L = \frac{R}{2(\mu-1)} = 20cm$$

$$\frac{1}{f} = \frac{1}{f_m} - \frac{2}{f_L}$$

$$\frac{1}{f} = \frac{-1}{10} - \frac{2}{20} = -\frac{1}{5}$$

$f = -5$ cm

To form image at the position of object, it should be placed at center of curvature of mirror + lens combination.

$\therefore u = 2f = 2 \times 5 = 10$ cm

31. Two identical bodies, projected with the same speed at two different angles cover the same horizontal range R. If the time of flight of these bodies are 5 s and 10 s, respectively, then the value of R is ________ m. (Take $g = 10\ m/s^2$)

(1) 250 (2) 25

(3) 500 (4) 125

Ans. (1)

Sol. For range to be same, angle of projection must be complementary angles.

$$T_1 = \frac{2u\sin\theta}{g} = 10 \, , \; T_2 = \frac{2u\cos\theta}{g} = 5$$

$$\text{Range} = \frac{2(u\sin\theta)(u\cos\theta)}{g}$$

$$= \frac{2(50)(25)}{10} m = 250 m$$

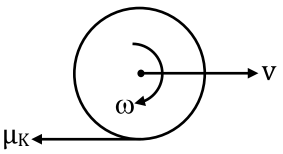
32. A solid cylinder having radius R and length L is slipping on a rough horizontal plane. At time t = 0 the cylinder has a translational velocity $v_0 = 49$ m/s, perpendicular to its axis and a rotational velocity $v_0/4R$ about the centre. The time taken by the cylinder to start rolling is ________ seconds. (coefficient of kinetic friction $\mu_K = 0.25$ and $g = 9.8\ m/s^2$)

(1) 15 (2) 5

(3) 10 (4) 7.5

Ans. (2)

Sol.



$$a=\frac{\mu_K mg}{m}=\mu_K g$$

$$\tau=I\alpha \Rightarrow \mu_K mgR=\frac{MR^2}{2}\times\alpha$$

$$\Rightarrow \alpha=\frac{2\mu_K g}{R}$$

$$\therefore\ v=v_0-\mu_K gt \qquad \ldots \text{(i)}$$

$$\text{Also, } \omega=\omega_0+\frac{2\mu_K gt}{R} \qquad \ldots \text{(ii)}$$

$$\frac{v}{R}=\frac{v_0}{4R}+\frac{2\mu_k gt}{R}$$

Solving Eq. (i) & (ii)

$$\frac{v_0}{4}+2\mu gt=v_0-\mu_k gt$$

$$3\mu gt=v_0-\frac{v_0}{4}$$

$$3\mu gt=\frac{3v_0}{4}$$

$$\Rightarrow t=\frac{v_0}{4\mu_K g}=\frac{49}{4\times\frac{1}{4}\times 9.8}=5\text{sec.}$$

33. A liquid of density 600 kg/m^3 flowing steadily in a tube of varying cross-section. The cross-section at a point A is 1.0 cm^2 and that at B is 20 mm^2. Both the points A and B are in same horizontal plane, the speed of the liquid at A is 10 cm/s. The difference is pressures at A and B points is ________ Pa.

(1) 18 (2) 144

(3) 36 (4) 72

Ans. (4)

Sol. Using continuity equation,

$$A_1V_1=A_2V_2$$

$$1\times 10=\frac{1}{5}\times V_2$$

$$\Rightarrow V_2=50\text{ cm/s}$$

Using Bernoulli's theorem,

$$P_1+\frac{1}{2}\rho V_1^2=P_2+\frac{1}{2}\rho V_2^2$$

$$P_1-P_2=\frac{1}{2}\rho\left[V_2^2-V_1^2\right]$$

$$=\frac{1}{2}\times 600\left[(50)^2-(10)^2\right]\times 10^{-4}=72\text{ Pa.}$$

34. A spherical liquid drop of radius R acquires the terminal velocity v_1 when falls through a gas of viscosity η. Now the drop is broken into 64 identical droplets and each droplet acquires terminal velocity v_2 falling through the same gas. The ratio of terminal velocities v_1/v_2 is ________.

(1) 4 (2) 0.25

(3) 32 (4) 16

Ans. (4)

Sol. Using volume conservation,

$$\frac{4}{3}\pi R_1^3=64\times\frac{4}{3}\pi R_2^3 \Rightarrow R_2=\frac{R_1}{4}$$

Terminal velocity $v \propto R^2$

$$\frac{v_1}{v_2}\Rightarrow\frac{R_1^2}{R_2^2}\Rightarrow(4)^2=16$$

35. One mole of diatomic gas having rotational modes only is kept is a cylinder with a piston system. The cross-section area of the cylinder is 4 cm^2. The gas is heated slowly to raise the temperature by 1.2 °C during which the piston moves by 25 mm. The amount of heat supplied to the gas is ________J. (Atmospheric pressure = 100 kPa, R = 8.3 J/mol.K) (Neglect mass of the piston)

(1) 24.8 (2) 25

(3) 15.04 (4) 29.98

Ans. (2)

Sol. **I[st] Method**

$Q = \Delta U + W$

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

if $f = 2 \Rightarrow Q = 2nR\Delta T \Rightarrow 2 \times 1 \times 8.3 \times 1.2 = 19.92$

(No option is matching)

if $f = 5 \Rightarrow Q = 3.5nR\Delta T$

$\Rightarrow 3.5 \times 1 \times 8.3 \times 1.2 = 34.86$

(No option is matching)

Method-2

$Q = \Delta U + W$

$$Q = \frac{f}{2}nR\Delta T + P\Delta V$$

if $f = 2$

$\Rightarrow Q = nR\Delta T + P\Delta V$

$= 1 \times 8.3 \times 1.2 + 10^5 \times 25 \times 10^{-3} \times 4 \times 10^{-4}$

$= 10.96$

(No option is matching)

if $f = 5$

$\Rightarrow Q = 2.5nR\Delta T + P\Delta V$

$2.5 \times 1 \times 8.3 \times 1.2 + 10^5 \times 25 \times 10^{-3} \times 4 \times 10^{-4}$

$= 25.9$

(closest is 25)

Note : As $P\Delta V \neq nR\Delta T$, given state is inconsistent

Hence we can opt the most suitable option as (2).

36. Initial pressure and volume of a monoatomic ideal gas are P and V. The change in internal energy of this gas in adiabatic expansion to volume $V_{final} = 27\ V$ is __________ J.

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

(3) $-\frac{4}{3}PV$ (4) $\frac{3}{4}PV$

Ans. **(3)**

Sol. $P_1V_1^{\gamma} = P_2V_2^{\gamma}$

$$\gamma = \frac{5}{3}$$

$$PV^{5/3} = P_2 \times (27V)^{5/3}$$

$$P_2 = \frac{P}{(27)^{5/3}} = \frac{P}{3^5}$$

$$\Delta U \Rightarrow nC_v\Delta T = \frac{nR\Delta T}{(\gamma-1)}$$

$$= \frac{P_2V_2 - P_1V_1}{(\gamma-1)}$$

$$\Rightarrow \frac{\frac{P}{3^5}\times 3^3.V - PV}{\frac{5}{3}-1} \Rightarrow \frac{-PV\left\{1-\frac{1}{9}\right\}}{\frac{2}{3}}$$

$$= -PV \times \frac{8}{9} \times \frac{3}{2}$$

$$\Rightarrow -\frac{4}{3}PV$$

37. The frequency of oscillation of a mass m suspended by spring is v_1. If the length of the spring is cut to half, the same mass oscillates with frequency v_2. The value of $\frac{v_2}{v_1}$ is ________.

(1) 1 (2) 2

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

Ans. **(3)**

Sol. For a spring, $k\ell$ = constant

$$k_1\ell = k_2\frac{\ell}{2} \Rightarrow k_2 = 2k_1$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

$$\Rightarrow \frac{f_1}{f_2} = \sqrt{\frac{k_1}{k_2}}$$

$$\Rightarrow \frac{f_1}{f_2} = \sqrt{\frac{1}{2}} \Rightarrow \frac{f_2}{f_1} = \sqrt{2}$$

38. A monochromatic source of light operating at 15 kW emits 2.5×10^{22} photons/s. The region of an electromagnetic spectrum to which the emitted electromagnetic radiation belongs to ________.
(Take $h = 6.6 \times 10^{-34}$ J.s and $c = 3 \times 10^8$ m/s).

(1) Microwave (2) Infrared
(3) Visible (4) Ultraviolet

Ans. **(4)**

Sol. $\frac{hC}{\lambda} = \frac{15\times10^3}{2.5\times10^{22}}$

$\therefore \lambda = \frac{6.6\times10^{-34}\times3\times10^8\times2.5\times10^{22}}{15\times10^3}$

$\lambda = 3.3 \times 10^{-7}$

39. A current carrying circular loop of radius 2 cm with unit normal $\hat{n} = \frac{\hat{k}+\hat{i}}{\sqrt{2}}$ is placed in a magnetic field, $\vec{B} = B_0(3\hat{i}+2\hat{k})$. If $B_0 = 4 \times 10^{-3}$ T and current $I = 100\sqrt{2}A$, the torque experienced by the loop is ________ Wb.A. ($\pi = 3.14$)

(1) $16\times10^{-5}\hat{k}$ (2) $5024\times10^{-7}\hat{k}$
(3) $5024\times10^{-7}\hat{i}$ (4) $5024\times10^{-7}\hat{j}$

Ans. **(4)**

Sol. $\vec{\tau} = \vec{M}\times\vec{B}$

$\Rightarrow 100\sqrt{2}\times3.14\times4\times10^{-4}\left[\left(\frac{\hat{k}+\hat{i}}{\sqrt{2}}\right)\times\left(3\hat{i}+2\hat{k}\right)\right]B_0$

$\Rightarrow 16\times3.14\times\left[+3\hat{j}-2\hat{j}\right]\times10^{-5}$

$\Rightarrow 50.24\times10^{-5}\hat{j}$

40. A 30 cm long solenoid has 10 turns per cm and area of 5 cm². The current through the solenoid coil varies from 2 A to 4 A is 3.14 s. The e.m.f. induced in the coil is $\alpha \times 10^{-5}$ V. The value α is ________.

(1) 60 (2) 12
(3) 120 (4) 34

Ans. **(2)**

Sol. $\varepsilon = -\frac{Ldi}{dt} = -\mu_0 n^2 A\ell\frac{di}{dt}$

$= -4\pi\times10^{-7}\times10^6\times5\times10^{-4}\times0.3\times\frac{2}{\pi}$

$\Rightarrow -12\times10^{-5}$

41. Two point charges $q_1 = 3\mu C$ and $q_2 = -4\mu C$ are placed at points $(2\hat{i}+3\hat{j}+3\hat{k})$ and $(\hat{i}+\hat{j}+\hat{k})$ respectively. Force on charge q_2 is ________ N.

$\left(\text{Take } \frac{1}{4\pi\epsilon_0} = 9\times10^9 \text{ SI Units}\right)$

(1) $(12\hat{i}+24\hat{j}+24\hat{k})\times10^{-3}$
(2) $(4\hat{i}+8\hat{j}+8\hat{k})\times10^{-3}$
(3) $(3\hat{i}+6\hat{j}+6\hat{k})\times10^{-3}$
(4) $(-4\hat{i}-8\hat{j}-8\hat{k})\times10^{-3}$

Ans. **(2)**

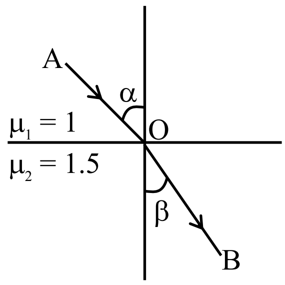
Sol. $\vec{r} = \vec{r}_2 - \vec{r}_1 \Rightarrow -\hat{i}-2\hat{j}-2\hat{k}$

Force $\Rightarrow \frac{kq_1q_2}{r^3}\vec{r}$

$\Rightarrow \frac{9\times10^9\times(3)(+4)\times10^{-12}}{27}\left(\hat{i}+2\hat{j}+2\hat{k}\right)$

$\Rightarrow 4\times10^{-3}\left[\hat{i}+2\hat{j}+2\hat{k}\right]$

42. Light ray incident along a vector $\overrightarrow{AO}\left(\overrightarrow{AO} = 2\hat{i}-3\hat{j}\right)$ emerges out along vector $\overrightarrow{OB}\left(\overrightarrow{OB} = C\hat{i}-4\hat{j}\right)$ as shown in the figure below. The value of C is ________.



(1) 1.6 (2) 0.16
(3) 11.6 (4) 16

Ans. **(1)**

Sol. $1\left(AO\times\hat{j}\right)\Rightarrow\left(OB\times\hat{j}\right)\times1.5$

$$\frac{2\hat{k}}{\sqrt{13}}=\frac{3}{2}\left[\frac{C\hat{k}}{\sqrt{C^2+16}}\right]$$

$$\therefore\frac{4}{13}=\frac{9C^2}{4\left(C^2+16\right)}\Rightarrow16C^2+256=117C^2$$

$256=101\ C^2$

$C=1.59\approx1.6$

43. K_1 and K_2 be the maximum kinetic energies of photoelectrons emitted from a surface of a given material for the light of wavelength λ_1 and λ_2, respectively. If $\lambda_1=\ 2\ \lambda_2$ then the work function of material is given by :

(1) K_2+2K_1 (2) $2K_2-K_1$

(3) K_1-2K_2 (4) K_2-2K_1

Ans. **(4)**

Sol. $2K_1=\frac{2hC}{\lambda_1}-2\phi$ … (i)

$K_2=\frac{2hC}{\lambda_1}-\phi$ … (ii)

Solving (i) & (ii), we get

$K_2-2K_1=\phi$

44. Two radioactive substances A and B of mass numbers 200 and 212 respectively, shows spontaneous α-decay with same Q value of 1 MeV. The ratio of energies of α-rays produced by A and B is ________.

(1) $\frac{2548}{2650}$ (2) $\frac{2706}{2646}$

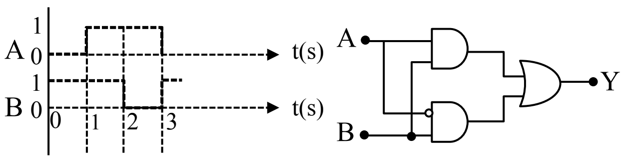
(3) $\frac{2597}{2600}$ (4) $\frac{2862}{2499}$

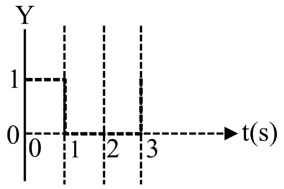
Ans. **(3)**

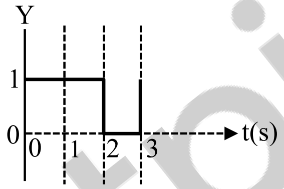
Sol. $k_\alpha=\left(\frac{A-4}{A}\right)Q$

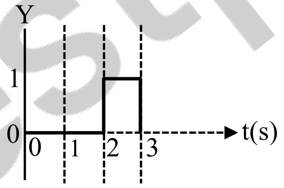
$$\therefore\frac{k_{\alpha_1}}{k_{\alpha_2}}=\frac{196}{200}\times\frac{212}{208}=\frac{2597}{2600}$$

45. The output Y for the given inputs A and B to the circuit is :



(1)


(2)


(3)


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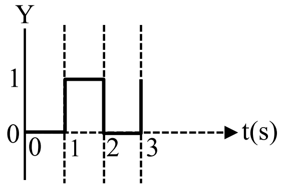
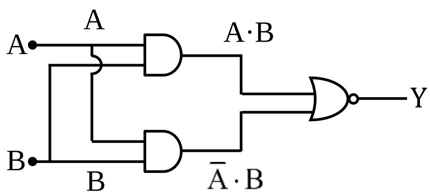


Ans. **(2)**

Sol.


$A\cdot B+\bar{A}\cdot B\Rightarrow\left(A+\bar{A}\right)\cdot B=B$

Note : In lower gate, input is taken from A as $\bar{A}$ due to node given in the figure.

SECTION-B

46. A parallel plate capacitor is having separation between plates 0.885 mm. It has a capacitance of 1 μF when the space between the plates is filled with an insulating material of resistivity 1×10^{13} Ωm and resistance 17.7×10^{14} Ω. Relative permittivity of the insulating material is $\alpha \times 10^7$. The value of α is _________.

(Take permittivity of free space $= 8.85 \times 10^{-12}$ F/m)

Ans. **(2)**

Sol. $RC = \rho K \in_0$

$$K = \frac{RC}{\rho\varepsilon_0} = \frac{17.7\times10^{14}\times10^{-6}}{10^{13}\times8.85\times10^{-12}} = 2 \times 10^7$$

47. Some distance star is to be observed by some telescope of diameter of objective lens a, at an angular resolution of 3.0×10^{-7} radian. If the wavelength of light from the star reaching the telescope is 500 nm, the minimum diameter of the objective lens of the telescope is _________ cm. (Nearest integer)

Ans. **(203)**

Sol. $\theta = \dfrac{1.22\lambda}{b}$

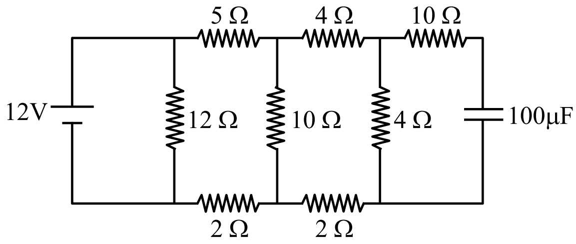
$$3\times10^{-7} = \frac{1.22\times5\times10^{-7}}{b} \Rightarrow b = 203.33\text{cm}$$

48. A 5 mg particle carrying a charge of $5\pi \times 10^{-6}$ C is moving with velocity of $(3\hat{i}+2\hat{k})\times10^{-2}\,m/s$ in a region having magnetic field $\vec{B} = 0.1\,\hat{k}\ Wb/m^2$. It moves a distance of α meter along $\hat{k}$ when it completes 5 revolutions. The value of α is ________.

Ans. **(2)**

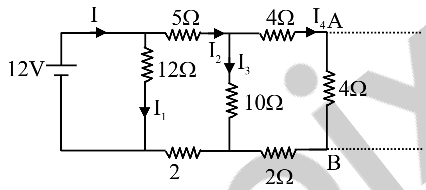
Sol. $$5\left(\frac{2\pi m}{qB}\right)v \Rightarrow \frac{5\times2\times\pi\times5\times10^{-6}\times2\times10^{-2}}{5\pi\times10^{-6}\times0.1} = 2m$$

49. The stored charge in the capacitor in steady state of the following circuit is _________ μC.



Ans. **(200)**

Sol. At steady state,



$$I = \frac{E}{R_{eq}} = \frac{12}{6} = 2A$$

$I_1 = I_2 = 1A$

$$I_3 = I_4 = \frac{1}{2}A$$

$$V_{AB} = \frac{1}{2}\times4 = 2V$$

Charge on capacitor

$Q = CV_{AB} = 100 \times 2 = 200$ μC

50. Two masses of 3.4 kg and 2.5 kg are accelerated from an initial speed of 5 m/s and 12 m/s, respectively. The distances traversed by the masses in the 5^{th} second are 104 m and 129 m, respectively. The ratio of their momenta after 10 s is $\frac{x}{8}$. The value of x is _________.

Ans. **(9)**

Sol. $$S = u + \frac{a}{2}(2n-1) \Rightarrow 104 = 5 + \frac{a}{2}(9) \Rightarrow a = 22\ m/s^2$$

$$129 = 12 + \frac{a}{2}\times9 \Rightarrow a = 26\ \ m/s^2$$

$$\frac{p_1}{p_2} = \frac{(5+22\times10)3.4}{(12+26\times10)(2.5)} = \frac{225\times(3.4)}{272\times2.5} = \frac{9}{8}$$

(HELD ON WEDNESDAY 08th APRIL 2026) **TIME : 3:00 PM TO 6:00 PM**

CHEMISTRY | TEST PAPER WITH SOLUTION

SECTION-A

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

List-I Mass of substance		**List-II** Number of atoms	
A.	1.8 mg water	I.	$2 \times 10^{-4} \times N_A$
B.	9.8 mg sulphuric acid	II.	$1.5 \times 10^{-4} \times N_A$
C.	1.8 mg carbon	III.	$3 \times 10^{-4} \times N_A$
D.	5.85 mg salt (NaCl)	IV.	$7 \times 10^{-4} \times N_A$

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

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

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

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

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

Ans. (3)

Sol. **(A)** No. of atoms in 1.8 mg water

$= \frac{1.8\times10^{-3}}{18} \times N_A \times 3 = 3 \times 10^{-4} N_A$

(B) No. of atoms in 9.8 mg H_2SO_4

$= \frac{9.8\times10^{-3}}{98} \times N_A \times 7 = 7 \times 10^{-4} \times N_A$

(C) No. of atoms in 1.8 mg carbon

$= \frac{1.8\times10^{-3}}{12} \times N_A = 1.5 \times 10^{-4} \times N_A$

(D) No. of atoms in 5.85 mg NaCl

$= \frac{5.85\times10^{-3}}{58.5} \times N_A \times 2 = 2 \times 10^{-4} N_A$

Correct match : A-III, B-IV, C-II, D-I

52. Given below are two statements :

Given : Molar mass of C, H, O, Cl are 12, 1, 16 and 35.5 g mol^{-1}, respectively.

Statement I : In 30%(w/w) solution of methanol in CCl_4 (at T K), the mole fraction of CCl_4 is equal to 0.33.

Statement II : Mixture of methanol and CCl_4 shows positive deviation deviation from Raoult's law.

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

(1) Both **Statement I** and **Statement II** are ture

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

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

(4) **Statement I** is false but **Statement II** are ture

Ans. (1)

Sol. (i) Let wt of solution = 100 g

wt of methanol = 30 g

wt of CCl_4 = 100 – 30 = 70 g

mole fraction of $CCl_4 = \frac{n_{CCl_4}}{n_{CCl_4} + n_{CH_3OH}} = \frac{\frac{70}{154}}{\frac{70}{154} + \frac{30}{32}}$

$= 0.3267 \approx 0.33$

(ii) CCl_4 & methanol is mixture of positive deviation from Raoult's law.

So, statement (I) & statement (II) are correct.

53. Bromine trifluoride autoionizes to form $BrF_2^{\oplus}$ and $BrF_4^{\ominus}$. The shapes of the cation and anion are respectively _____, and _____.

(1) bent, square planar

(2) linear, square planar

(3) bent, see-saw

(4) linear, tetrahedral

Ans. (1)

Sol. $BrF_2^{\oplus} \Rightarrow sp^3$

[Bond pair = 2, lone pair = 2]

$\Rightarrow$ bent

$BrF_2^{\oplus} \Rightarrow sp^3d^2$

[Bond pair = 4, lone pair = 2]

$\Rightarrow$ square planar

54. Which of the following are **not correct** ?

A. For water, magnitude of K_b is more than the magnitude of K_f.

B. The elevation in boiling point of water when a non-volative solute is added to it is larger in magnitude than its depression in freezing point.

C. Osmotic pressure measurement is preferred over any other colligative property to determine molar mass of proteins and polymers.

D. The dimerised form of benzoic acid in benzene is $C_6H_5-\overset{\overset{\large O}{\|}}{C}-OH \ldots\ldots O=\overset{\overset{\large OH}{|}}{C}-C_6H_5$

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

(1) A and B only

(2) A and D only

(3) A, B and D only

(4) A, C and D only

Ans. **(3)**

Sol. (A) K_b for water = $0.512 \dfrac{°C-Kg}{mol}$

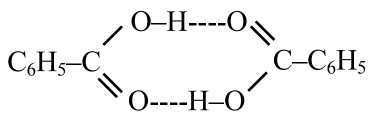
K_f for water = $1.86 \dfrac{°C-Kg}{mol}$

So, $K_b < K_f$ for water

(B) Since, $K_b < K_f$ so $\Delta T_b < \Delta T_f$ [same equimolal solution]

(C) Osmotic pressure is used to determine molar mass of protiens & polymers

(D) dimerised form of benzoic acid in benzene



option (A), (B) & (D) are incorrect

55. Consider the following reactions in which all the reactants and products are present in gasesous state

$2xy \rightleftharpoons x_2 + y_2 \quad K_1 = 2.5 \times 10^5$

$xy + \frac{1}{2}z_2 \rightleftharpoons xyz \quad K_2 = 5 \times 10^{-3}$

The value of K_3 for the equilibrium

$\frac{1}{2}x_2 + \frac{1}{2}y_2 + \frac{1}{2}z_2 \rightleftharpoons xyz$ is :

(1) 2.5×10^{-3} (2) 2.5×10^{3}

(3) 1.0×10^{-5} (4) 5×10^{-3}

Ans. **(3)**

Sol. $x_2 + y_2 \rightleftharpoons 2xy, \quad K' = \dfrac{1}{K_1} = \dfrac{1}{2.5\times10^5} = \dfrac{1}{25\times10^4}$

$\frac{1}{2}x_2 + \frac{1}{2}y_2 \rightleftharpoons xy, \ K'' = \left(\dfrac{1}{25\times10^4}\right)^{1/2} = \dfrac{1}{5\times10^2} \quad \ldots\ldots(1)$

$xy + \frac{1}{2}z_2 \rightleftharpoons xyz, \ K_2 = 5 \times 10^{-3} \quad \ldots\ldots\ (2)$

On adding equation (1) & (2)

$\frac{1}{2}x_2 + \frac{1}{2}y_2 + \frac{1}{2}z_2 \rightleftharpoons xyz,$

$K_3 = \dfrac{1}{5\times10^2}\times5\times10^{-3} = 1 \times 10^{-5}$

56. Given at 298 K : $E^{\ominus}_{Fe^{2+}/Fe} = X$ Volt

$E^{\ominus}_{Fe^{3+}/Fe} = Y$ Volt

The $E^{\ominus}_{Fe^{3+}/Fe^{2+}}$ in Volt at 298 K is given by :

(1) 2X – 3Y (2) 3Y – 2X

(3) 3Y + 2X (4) Y + X

Ans. **(2)**

Sol. (i) $Fe^{+2}(aq) + 2e^- \rightarrow Fe(s)$ ……. $\Delta G_1°$

(ii) $Fe^{+3}(aq) + 3e^- \rightarrow Fe(s)$ ……. $\Delta G_2°$

(iii) $Fe^{+3}(aq) + e^- \rightarrow Fe^{+2}(aq)$……. $\Delta G_3°$

iii = ii – i

$-1 \times F \times E°_{Fe^{3+}/Fe^{2+}} = -3 \times F \times y - (-2 \times F \times x)$

$E°_{Fe^{3+}/Fe^{2+}} = 3y - 2x$

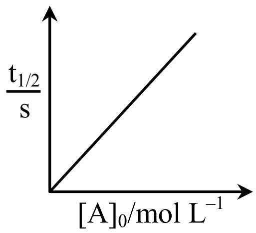
Option (2) is correct

57. Given below are two statements :

$R = 8.314\ J\ K^{-1}\ mol^{-1}$ and 1 cal = 4.2 J

Statement I : When Ea = 12.6 kcal/mol, the room temperature rate constant is doubled by a 10°C increase in temperature (298 K to 308 K)

Statement II : For a first order reaction $A \rightarrow B$,



Here $[A]_0$ is the initial concentration of A and $t_{1/2}$ is half-life of reaction.

In the light of the above statements, choose the **correct** answer from the option 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** are false

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

Ans. **(3)**

Sol. S-I : $\ell n\left(\frac{K_2}{K_1}\right) = \frac{12.6 \times 10^3}{\left(\frac{8.314}{4.2}\right)}\left[\frac{10}{298 \times 308}\right]$

$\Rightarrow \ell n\left(\frac{K_2}{K_1}\right) = 0.693$

$\Rightarrow \frac{K_2}{K_1} = 2$

S-II : For 1st order

$t_{1/2} = \frac{\ell n 2}{K}$; $t_{1/2} \propto [A]^0$ = constant.

Statement-I is true but statement-II is false.

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

List-I Electronic configuration of neutral atom (where n = 2)		**List-II** 1st Ionization Energy ($kJ\ mol^{-1}$)	
A.	ns^2	I.	2080
B.	ns^2np^1	II.	899
C.	ns^2np^3	III.	800
D.	ns^2np^6	IV.	1402

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

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

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

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

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

Ans. **(1)**

Sol. (A) $2s^2 \Rightarrow Be$

(B) $2s^2\ 2p^1 \Rightarrow B$

(C) $2s^22p^3 \Rightarrow N$

(D) $2s^22p^6 \Rightarrow Ne$

IE order : B < Be < N < Ne

A-II, B-III, C-IV, D-I

59. Find the **correct** statements related to group 15 hydrides.

A. Reducing nature increases from NH_3 to BiH_3

B. Tendency to donate lone pair of electrons decreases from NH_3 to BiH_3

C. The stability of hydrides decreases from NH_3 to BiH_3

D. HEH bond angle decreases from NH_3 to SbH_3 (E = Elements of group 15)

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

(1) A and B only (2) B and C only

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

Ans. **(3)**

Sol. (1) Reducing nature : $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

(2) Lone pair definition tendency :

$NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

(3) Stability of Hydrides :

$NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

(4) HEH bond angle : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

60. Given below are two statements :

Statement I : The number of pairs among $[Ti^{4+}, V^{2+}]$, $[V^{2+}, Mn^{2+}]$, $[Mn^{2+}, Fe^{3+}]$ and $[V^{2+}, Cr^{2+}]$ in which both ions are coloured is 3.

Statement II : The number pairs among $[La^{3+}, Yb^{2+}]$, $[Lu^{3+}, Ce^{4+}]$ and $[Ac^{3+}, Lr^{3+}]$ ions in which both are diamagnetic is 3.

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

(1) Both **Statement I** and **Statement II** are correct

(2) Both **Statement I** and **Statement II** are incorrect

(3) **Statement I** is correct but **Statement II** are incorrect

(4) **Statement I** is incorrect but **Statement II** are correct

Ans. (1)

Sol. Ti^{+4} is colourless due to d^0 configuration

$\therefore$ statement 1 is correct

La^{+3}, Yb^{+2}, Lu^{+3}, Ce^{+4}, Al^{+3} & Lr^{+3} all are diamagnetic

$\therefore$ Statement 2 is correct.

61. Given below are two statements for catalytic properties of transition metals :

Statement I : First row transition metals which act as catalyst utilise their 3d electrons only for formation of bonds between reactant molecules and atoms on the surface of catalyst.

Statement II : There is increase in the concentration of reactants on the surface of catalyst which strengthens the bonds in reacting molecules.

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

(1) Both **Statement I** and **Statement II** are correct

(2) Both **Statement I** and **Statement II** are incorrect

(3) **Statement I** is correct but **Statement II** are incorrect

(4) **Statement I** is incorrect but **Statement II** are correct

Ans. (2)

Sol. First row transition metals utilize 3d and 4s electrons for bonding on the catalyst surface.

$\therefore$ Statement 1 is incorrect

Adsorption increases reactant concentration on the catalyst surface and weakens bonds facilitating formation of activated complex and lowering activation energy.

$\therefore$ Statement 2 is incorrect

62. Given below are two statements :

Statement I : Vapours of the liquid with higher boiling point condense before vapours of the liquid with lower boiling points in fractional distillation.

Statement II : The vapours rising up in the fractionating column become richer in high boiling component of the mixture.

In the light of the above statements, choose the **correct** answer from the option 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** are false

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

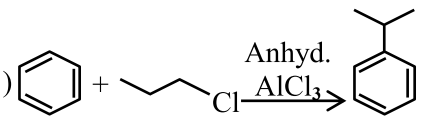
Ans. (3)

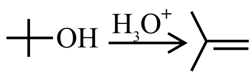
Sol. Statement I : True

Statement II : False

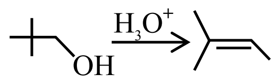
Reason - As vapours rise, they become richer in the lower-boiling component, not high-boiling component.

63. The major product of which of the following reaction is not obtained by rearrangement reaction?

(1) 

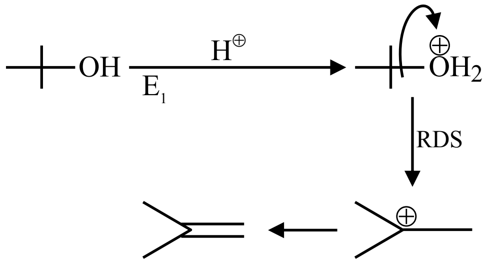
(2) 

(3) $CH_3(CH_2)_4CH_3 \xrightarrow[HCl]{\text{Anhyd. } AlCl_3} CH_3-\underset{\displaystyle CH_3}{\underset{|}{C}}H(CH_2)_2CH_3$

(4) 

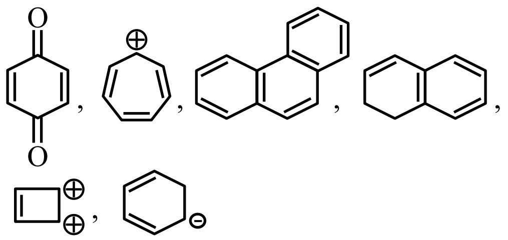
Ans. (2)

Sol.



Product obtained without rearrangement.

64. The total number of aromatic compounds/species from the following is

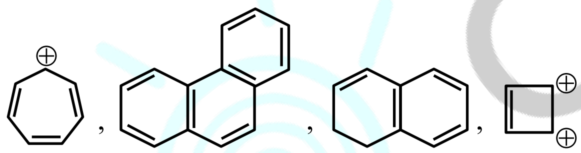


(1) 6 (2) 4

(3) 3 (4) 5

Ans. (2)

Sol. Aromatic compounds are



65. n-Butane on monochlorination under photochemical conditions gives an optically active compound "P". "P" on further chlorination gives dichloro compounds.

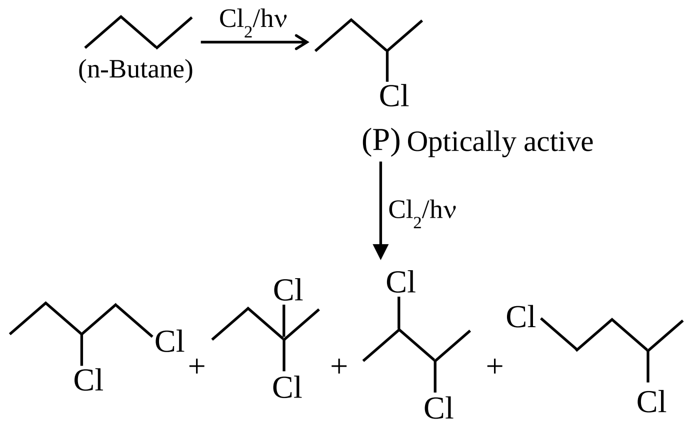
The number of dichloro compounds obtained (ignore stereoisomers) is :

(1) 3 (2) 4

(3) 5 (4) 6

Ans. (2)

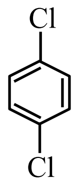
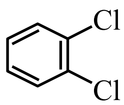
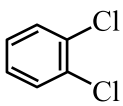
Sol.



Total dichloro products (excluding stereoisomers) = 4

66. Given below are two statements :

Statement-I : Due to increase in van der Waals forces, the order of boiling points is $CH_3CH_2CH_2I > CH_3CH_2I > CH_3I$.

Statement-II : As  is more symmetric, its melting point is higher than , however its boiling point is lower than 

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. **Statement I :** True

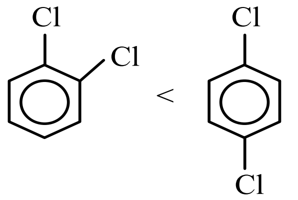
Order of boiling point :

$CH_3CH_2CH_2I > CH_3CH_2I > CH_3I$

Vanderwaals forces increases due to increase in molecular weight

Statement 2: True

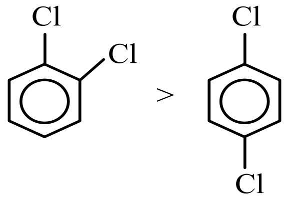
Order of melting point :-



(more symmetric)

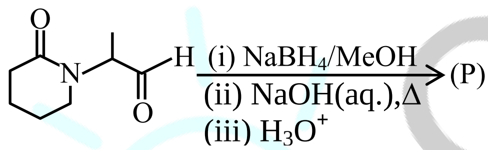
Boiling point order :-

(Boiling point $\propto \mu$)

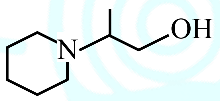


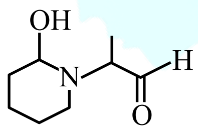
$(\mu \neq 0)$ $(\mu = 0)$

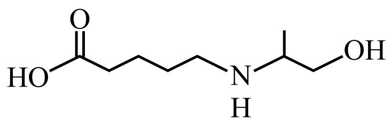
67. Consider the following reaction.

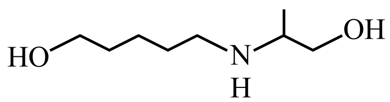


The major product (P) formed is :

(1) 

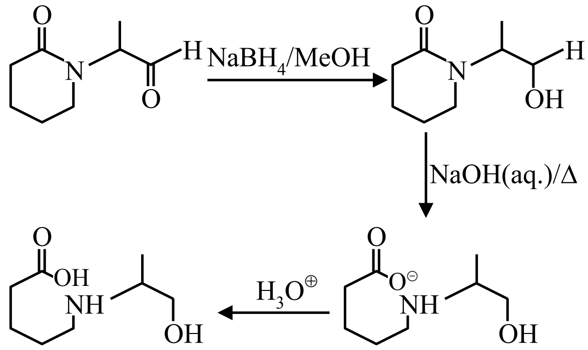
(2) 

(3) 

(4) 

Ans. **(3)**

Sol.



68. Which statements are **True**?

A. In Hoffmann bromamide degradation, 4 moles of NaOH and 2 moles of Br_2 are consumed per mole of an amide

B. Hoffmann bromamide reaction is not given by alkyl amides.

C. Primary amines can be synthesized by Hoffmann bromamide degradation.

D. Secondary amide on reaction with Br_2 and NaOH will give secondary amine.

E. The by-products of Hoffmann degradation are Na_2CO_3, NaBr and H_2O.

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

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

(3) C and E only (4) C, D and E only

Ans. **(3)**

Sol. Hoffmann bromamide degradation reaction –

$$\underset{1^\circ \text{ Amide}}{R-\overset{O}{\overset{\|}{C}}-NH_2} + 4NaOH + Br_2 \longrightarrow \underset{1^\circ \text{ Amine}}{R-NH_2} + Na_2CO_3 + 2NaBr + 2H_2O$$

Statement (A) – False

Statement (B) – False

Statement (C) – True

Statement (D) – False

Statement (E) – True

69. The **incorrect** statement from the following with respect to carbohydrates is :

(1) All monosaccharides are reducing sugars.

(2) The monosaccharide units obtained from hydrolysis of oligosaccharides are always the same.

(3) Starch and cellulose are typical examples of polysaccharides, which are very high molecular weight compounds of more than ten monosaccharide units.

(4) Open chain and cyclic structures co-exist at equilibrium that are responsible for certain properties as in the case of D-(+)-glucose.

Ans. (2)

Sol. The monosaccharide units obtained from hydrolysis of oligosaccharides may be or may not be same.

Example :

$$\text{Lactose} \xrightarrow{H_3O^{\oplus}} \underbrace{\text{Glucose} + \text{Galactose}}_{\text{different monosaccharide units}}$$

$$\text{Maltose} \xrightarrow{H_3O^{\oplus}} \underbrace{\text{Glucose} + \text{Glucose}}_{\text{same monosaccharide units}}$$

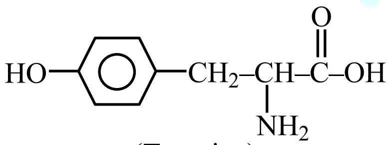
70. Which of the following amino acid will give violet coloured complex with neutral ferric chloride solution?

(1) Threonine (2) Serine

(3) Tyrosine (4) Cysteine

Ans. (3)

Sol.



(Tyrosine)

Tyrosine amino acid will give violet coloured complex with neutral $FeCl_3$ solution because it contains phenolilc group.

SECTION-B

71. Number of paramagnetic complexes among the following is ________.

$[MnBr_4]^{2-}$, $[NiCl_4]^{2-}$, $[Ni(CN)_4]^{2-}$, $[Ni(CO)_4]$, $[CoF_6]^{3-}$, $[Fe(CN)_6]^{4-}$, $[Mn(CN)_6]^{3-}$, $[Ti(CN)_6]^{3-}$, $[Cu(H_2O)_6]^{2+}$, $[Co(C_2O_4)_3]^{3-}$

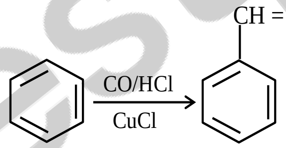
Ans. (6)

Sol. $[MnBr_4]^{2-}$, $[NiCl_4]^{2-}$, $[CoF_6]^{3-}$, $[Mn(CN)_6]^{3-}$, $[Ti(CN)_6]^{3-}$, $[Cu(H_2O)_6]^{2+}$ are paramagnetic.

72. 'x' is the product which is obtained from benzene by reacting it with carbon monoxide and hydrogen chloride in the presence of cuprous chloride. 'y' is the major product obtained from the benzene by reacting it with ethanoyl chloride in the presence of anhydrous $AlCl_3$. Product (major) obtained by heating x and y in the presence of alkali is z. Total number of π (pi) electrons in z is _______.

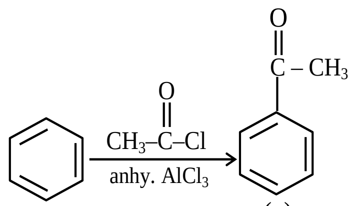
Ans. (16)

Sol.



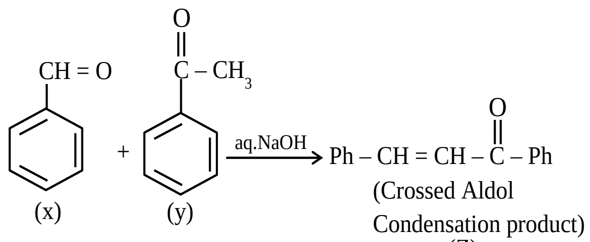
(x)

(Gattermann Koch reaction)



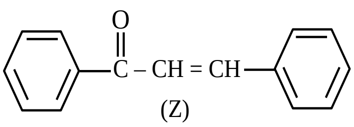
(y)

(Friedal Craft acylation)



(Crossed Aldol Condensation product)
(Z)

Total number of pi (π) electrons in 'z' = 16 π electrons



(Z)

73. Consider two radiations of wavelengths :

1. $\lambda_1 = 2000Å$
2. $\lambda_2 = 6000Å$

The ratio of the energies of these two radiations $\left(\frac{E_1}{E_2}\right)$ is ________. (Nearest integer)

Ans. **(3)**

Sol. $E_{photon} = \frac{hc}{\lambda}$

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

$$\Rightarrow \frac{E_1}{E_2} = \frac{6000}{2000}$$

$$\Rightarrow \frac{E_1}{E_2} = 3$$

74. Consider the reaction :

$2H_2S(g) + 3O_2(g) \rightarrow 2H_2O(l) + 2SO_2(g)$

The magnitude of enthalpy change for the reaction in kJ mol^{-1} is _______. (Nearest integer)

Given : $\Delta_f H^{\ominus}(H_2S) = -20.1$ kJ mol^{-1}

$\Delta_f H^{\ominus}(H_2O) = -286.0$ kJ mol^{-1}

$\Delta_f H^{\ominus}(SO_2) = -297.0$ kJ mol^{-1}

Ans. **(1126)**

Sol. $\Delta_r H° = \Sigma\Delta H_f°(\text{product}) - \Sigma\Delta H_f°(\text{Reactant})$

$\Delta_r H° = 2 \times \Delta H_f°(SO_2,g) + 2 \times \Delta H_f°(H_2O,\ell)$

$-2 \times \Delta H_f°(H_2S,g)$

$\Delta_r H° = 2 \times (-297) + 2 \times (-286) - 2(-20.1)$

$= -594 - 572 + 40.2$

$\Delta_r H° = -1125.8$ kJ/mol.

$|\Delta_r H°| = 1125.8$ kJ/mol.

75. Solid carbon, CaO and $CaCO_3$ are mixed and allowed to attain equilibrium at T K.

$CaCO_3 \rightleftharpoons CaO(s) + CO_2(g)$ $Kp_1 = 0.08$ atm

$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$ $Kp_2 = 2$ atm

The partial pressure of CO is _____ $\times 10^{-1}$ atm.

Ans. **(4)**

Sol. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$, $K_{P_1} = 0.08$ atm

$K_{P_1} = P_{CO_2} = 0.08$ atm

$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$, $K_{P_2} = 2$

$$K_{P_2} = \frac{P_{CO}^2}{P_{CO_2}} = 2$$

$$\frac{P_{CO}^2}{0.08} = 2$$

$P_{CO}^2 = 16 \times 10^{-2}$

$P_{CO} = 4 \times 10^{-1}$