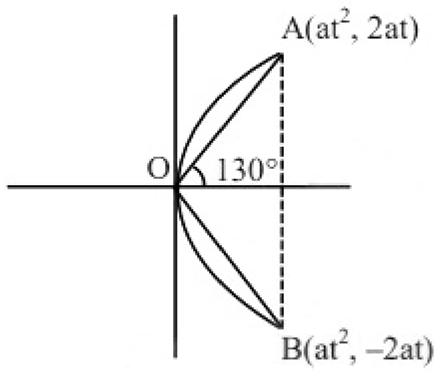
1 - JEE Main Maths 23-Jan 2026 Shift -2

Q1 Solution:
(2)



$M_{OA} = \frac{2t - 0}{t^2 - 0} = \frac{2}{t}$

$\frac{2}{t} = \tan 30°$

$t = 2\sqrt{3}$

Req. Circle: $(x - 12)^2 + y^2 = (4\sqrt{3})^2$

Least distance $= |CP - R|$

$= |2 - 4\sqrt{3}| = 4(3 - \sqrt{3})$

Q2 Solution:
(3)

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

For continuity:

$\lim_{x \to 0^-} f(x) = \lim_{x \to 0^+} f(x) = f(0)$

$\lim_{x \to 0^-} \frac{ah + h^2 - 2(\sin h)\cos h}{-h}$

$= \lim_{x \to 0^+} \frac{ah + h^2 - 2(\sin h)\cos h}{h}$

or $-a + 2 = a - 2 = b$

$2a = 4$

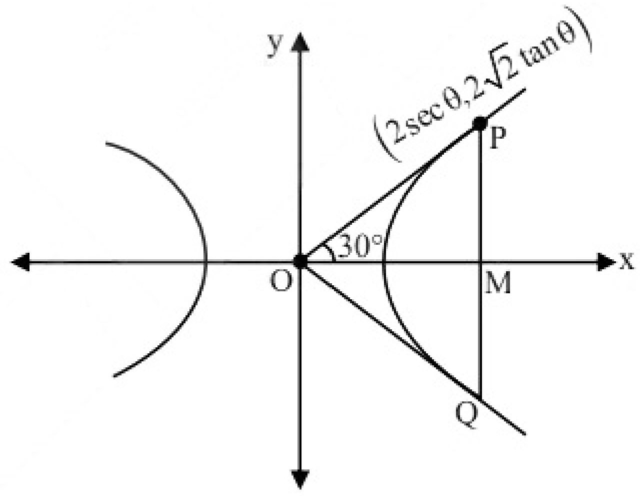
$a = 2,\ b = 0$

$\therefore\ a + b = 2$

Q3 Solution:
(2)

$e = \sqrt{1 + \frac{b}{4}} = \sqrt{3} \Rightarrow b = 8$

$\therefore$ Hyperbola: $\frac{x^2}{4} - \frac{y^2}{8} = 1$



$\frac{PM}{OM} = \tan 30°$

$\Rightarrow \frac{2\sqrt{2}\tan\theta}{2\sec\theta} = \frac{1}{\sqrt{3}} \Rightarrow \sin\theta = \frac{1}{\sqrt{6}}$

Area $= 2 \times \frac{1}{2} \times OM \times MP$

$= 2\sec\theta \times 2\sqrt{2}\tan\theta$

$= 4\sqrt{2}\frac{\sin\theta}{\cos^2\theta}$

$= 4\sqrt{2} \times \frac{1}{\sqrt{6}\left(1 - \frac{1}{6}\right)}$

$= \frac{8\sqrt{3}}{5}$

Q4 Solution:
(3)

Let oranges be identical, then

$x_1 + x_2 + x_3 + x_4 = 16,$ and $x_1, x_2, x_3, x_4 \geq 1$

or $x_1' + x_2' + x_3' + x_4' = 12$

so total number of solutions are

$= {}^{12+3}C_3 = {}^{15}C_3 = 455$

Q5 Solution:
(3)

If $D = \begin{vmatrix} 1 & 1 & 1 \\ 2 & 5 & a \\ 1 & 2 & 3 \end{vmatrix} = 0 \Rightarrow a = 8$

If $D_1 = \begin{vmatrix} 6 & 1 & 1 \\ 36 & 5 & a \\ b & 2 & 3 \end{vmatrix} = 0 \Rightarrow ab - 5b - 12a + 54 = 0$

If $D_2 = \begin{vmatrix} 1 & 6 & 1 \\ 2 & 36 & a \\ 1 & b & 3 \end{vmatrix} = 0 \Rightarrow ab - 6a - 2b - 36 = 0$

If $D_3 = \begin{vmatrix} 1 & 1 & 6 \\ 2 & 5 & 36 \\ 1 & 2 & b \end{vmatrix} = 0 \Rightarrow b = 14$

For $a = 8$ and $b = 14 \Rightarrow D_1, D_2$ are also zero

For $a = 8$ and $b = 14 \Rightarrow D = D_1 = D_2 = D_3 = 0$

$\Rightarrow$ infinitely many solutions.

Q6 Solution:
(3)

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

$\vec{a} \times \left(\vec{b} - 2\vec{c}\right) = 0 \Rightarrow \vec{b} - 2\vec{c} = \lambda\vec{a} \quad ...\left(1\right)$

$\left|\lambda\vec{a}\right|^2 = \left|\vec{b} - 2\vec{c}\right|^2 \Rightarrow \lambda^2 \mid \vec{a}\mid^2 = b^2 + 4c^2 - 4\vec{b} \cdot \vec{c}$

$\lambda^2 = 16 + 16 - 4 \cdot 4 \cdot 2 \cdot \frac{1}{2}$

$\lambda^2 = 16$

$\lambda = \pm 4$

$\because \vec{b} - 2\vec{c} = \pm 4\vec{a}$

Dot with $\vec{c} \Rightarrow \vec{b} \cdot \vec{c} - 2 \mid \vec{c}\mid^2 = \pm 4\left(\vec{a} \cdot \vec{c}\right)$

$4 \cdot 2 \cdot \frac{1}{2} - 2 \cdot 4 = \pm 4\left(\vec{a} \cdot \vec{c}\right)$

$\left|\vec{a} \cdot \vec{c}\right| = 1$

Q7 Solution:
(3)

$z = \cos\frac{\pi}{6} + i\sin\frac{\pi}{6}$

$z^{201} = \cos\left(201\frac{\pi}{6}\right) + i\sin\left(201\frac{\pi}{6}\right) = -i$

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

Q8 Solution:
(2)

$\frac{\pi}{2} < \theta < \pi$ and $\cot\theta = -\frac{1}{2\sqrt{2}}$

$\Rightarrow \sin\left(\frac{15\theta}{2}\right)\left(\cos8\theta + \sin8\theta\right) + \cos\left(\frac{15\theta}{2}\right)\left(\cos8\theta - \sin8\theta\right)$

$\Rightarrow \sin\left(\frac{15\theta}{2}\right)\cos8\theta - \cos\left(\frac{15\theta}{2}\right)\sin8\theta + \sin\left(\frac{15\theta}{2}\right)\sin8\theta + \cos\left(\frac{15\theta}{2}\right)\cos8\theta$

$\Rightarrow \sin\left(\frac{15\theta}{2} - 8\theta\right) + \cos\left(\frac{15\theta}{2} - 8\theta\right)$

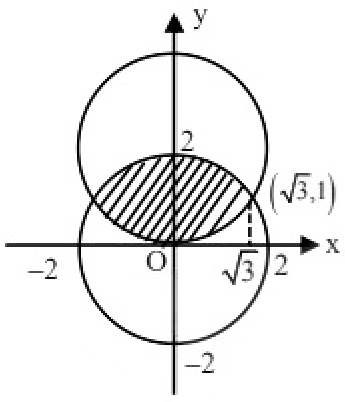
$\Rightarrow \cos\frac{\theta}{2} - \sin\frac{\theta}{2} = -\sqrt{1 - \sin\theta} \quad \left(\frac{\pi}{4} < \frac{\theta}{2} < \frac{\pi}{2}\right)$

$\Rightarrow$ given $\cot\theta = -\frac{1}{2\sqrt{2}}, \ \sin\theta = \frac{2\sqrt{2}}{3}$

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

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

Q9 Solution:
(1)



$A = 2\int_0^{\sqrt{3}} \left[\sqrt{4 - x^2} - \left(2 - \sqrt{4 - x^2}\right)\right]dx$

$= 2\int_0^{\sqrt{3}} \left(2\sqrt{4 - x^2} - 2\right)dx$

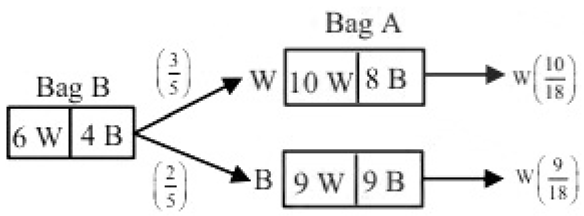
$= 4\int_0^{\sqrt{3}} \left(\sqrt{4 - x^2} - 1\right)dx$

$= 4\left[\frac{1}{2}\left(x\sqrt{4 - x^2} + 4\sin^{-1}\frac{x}{2}\right) - x\right]_0^{\sqrt{3}}$

$= 4\left[\frac{1}{2}\left(\sqrt{3} + 4 \cdot \frac{\pi}{3}\right) - \sqrt{3}\right] = 4\left[\frac{2\pi}{3} - \frac{\sqrt{3}}{2}\right]$

$= \frac{8\pi}{3} - 2\sqrt{3}$ (Sq. units)

Q10 Solution:
(1)



$\therefore\ P\left(\text{Drawn ball is white}\right) = \frac{3}{5} \times \frac{10}{18} + \frac{2}{5} \times \frac{9}{18}$

$= \frac{48}{90} = \frac{8}{15} = \frac{p}{q}$

$\therefore\ p + q = 23$

Q11 Solution:
(4)

$\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + \hat{j} - \hat{k}$, $\vec{c} = \lambda\hat{i} + \hat{j} + \hat{k}$, and $\vec{v} = \vec{a} \times \vec{b}$. If $\vec{v} \cdot \vec{c} = 11$

$\vec{v} = \left(\vec{a} \times \vec{b}\right) = \left(-\hat{i} + 7\hat{j} + 5\hat{k}\right)$

$\vec{v} \cdot \vec{c} = 11 = \left(-\hat{i} + 7\hat{j} + 5\hat{k}\right) \cdot \left(\lambda\hat{i} + \hat{j} + \hat{k}\right) = 11$

$\Rightarrow -\lambda + 7 + 5 = 11$

$\Rightarrow \lambda = 1$

Length of projection of $\vec{b}$ on $\vec{c} = \vec{b} \cdot \hat{c}$

$\Rightarrow \left|\left(2\hat{i} + \hat{j} - \hat{k}\right) \cdot \frac{\left(\hat{i} + \hat{j} + \hat{k}\right)}{\sqrt{3}}\right| = \frac{2 + 1 - 1}{\sqrt{3}} = p = \frac{2}{\sqrt{3}}$

$\Rightarrow 9p^2 = 9\left(\frac{4}{3}\right) = 12$

Q12 Solution:
(2)

Number of form $3K = 4$

Number of form $3K + 1 = 3$

Number of form $3K + 2 = 4$

$4 \times 4 + 3 \times 3 + 3 \times 3 = 34$ relations

$\Rightarrow xRy \Rightarrow yRx$

$\Rightarrow (x - y) = 3\lambda, \ (y - z) = 3\mu$

$\Rightarrow (x - z) = 3(\lambda + \mu)$

R is reflexive, symmetric and transitive S_2 is true

Ans. S_1 is false but S_2 is true

Q13 Solution:
(1)

Let $4x + 6 = \frac{1}{t} \Rightarrow x = \frac{\frac{1}{t} - 6}{4}$

$4dx = -\frac{dt}{t^2}, \quad \left\{ \frac{x + 1 = \frac{1}{t} - 2}{4} \right.$

$$\int \frac{3dx}{(4x + 6)\sqrt{4(x + 1)^2 - 1}}$$

$$= \int \frac{3(-dt)}{4t^2 \cdot \frac{1}{t}\sqrt{4\left(\frac{1/t - 2}{4}\right)^2 - 1}}$$

$$= -\frac{3}{4}\int \frac{dt}{t\sqrt{\frac{(1 - 2t)^2}{4t^2} - 1}}$$

$$= -\frac{3}{4}\int \frac{dt(2t)}{t\sqrt{1 - 4t}}$$

$$= -\frac{3}{2}\int \frac{dt}{\sqrt{1 - 4t}} = -\frac{3}{2}\left(\frac{\sqrt{1 - 4t}}{\frac{1}{2} \times -4}\right) + C$$

$$= \frac{3}{4}\sqrt{1 - 4t} + C \quad \because t = \frac{1}{4x + 6}$$

$$= \frac{3}{4}\sqrt{1 - 4\left(\frac{1}{4x + 6}\right)} + C$$

$$= \frac{3}{4}\sqrt{\frac{4x + 6 - 4}{4x + 6}} + C$$

$$I(x) = \frac{3}{4}\sqrt{\frac{4x + 2}{4x + 6}} + C$$

$$I(0) = \frac{3}{4}\sqrt{\frac{2}{6}} + C = \frac{\sqrt{3}}{4} + C$$

$\Rightarrow C = 20$

Hence $I\left(x\right) = \frac{3}{4}\sqrt{\frac{4x+2}{4x+6}} + 20$

$I\left(\frac{1}{2}\right) = \frac{3}{4}\sqrt{\frac{4}{8}} + 20$

$= \frac{3}{4\sqrt{2}} + 20 = \frac{3\sqrt{2}}{8} + 20$

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

Q14 Solution:
(4)

By family of curve equation of circle will be

$\Rightarrow S_1 + \lambda S_2 = 0$

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

$\Rightarrow$ for circle coeff of x^2 = coeff of y^2

$\Rightarrow \lambda = \frac{1}{2}$

So equation of circle is

$\Rightarrow x^2 + y^2 - \frac{16}{3}x - 6y + \frac{27}{2} = 0$

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

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

Q15 Solution:
(1)

$A: \left|\,|x-3| - 3\,\right| \leq 1$

$\Rightarrow -1 \leq |x-3| - 3 \leq 1$

$\Rightarrow 2 \leq |x-3| \leq 4$

$\Rightarrow 2 \leq (x-3) \leq 4$ or $-4 \leq (x-3) \leq -2$

$\Rightarrow 5 \leq x \leq 7$ or $-1 \leq x \leq 1$

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

$B \Rightarrow x = 4$, $|x-2| = 1 \Rightarrow x = 3$ or 1 (reject)

$\Rightarrow B = \{3, 4\}$

Number of onto functions from A to $B = 2^6 - 2 = 62$

Q16 Solution:
(4)

$a_n = S_n - S_{n-1}$

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

$(1)\ a_{59} \Rightarrow 19\alpha + \beta = 59$

$(2)\ a_6 = 7a_1 \Rightarrow 11\alpha + \beta = 7(\alpha + \beta)$

$\Rightarrow 2\alpha = 3\beta$

$\alpha = 3,\ \beta = 2$

$\alpha + \beta = 5$

Q17 Solution:
(1)

$\log_{x+3}\left[(x+3)(6x+10)\right] = 5 - 2\log_{6x+10}(x+3)^2$

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

Let $\log_{x+3}(6x+10) = A$

$\Rightarrow A + \frac{4}{A} = 4$ or $A = 2$

$\Rightarrow \log_{x+3}(6x+10) = 2$

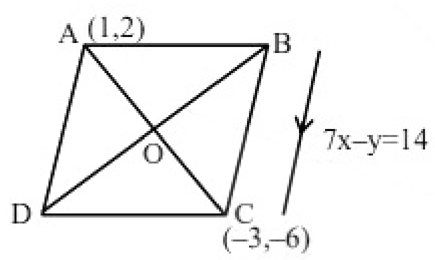
$\Rightarrow 6x + 10 = (x+3)^2$

$\Rightarrow 6x + 10 = x^2 + 9 + 6x$

$\Rightarrow x^2 = 1,\ x = \pm 1$

So sum of roots $= 0$

Q18 Solution:
(1)



Given the points of B and D are (α, β) and (γ, δ) and midpoint of A and C is $(-1, -2)$

So $\frac{\alpha+\gamma}{2} = -1$ and $\frac{\beta+\delta}{2} = -2$

$|\alpha + \gamma + \beta + \delta| = 6$

Q19 Solution:
(4)

$\mu = \frac{\sum f_i x_i}{\sum f_i} = \frac{18 + 10\lambda + 56 + 126}{14 + \lambda}$

$= \frac{200 + 10\lambda}{\lambda + 14} = 10 + \left(\frac{60}{\lambda + 14}\right)$

$\lambda + 14$ is a multiple of $60 \Rightarrow \lambda = 1, 6$ or 16

$\sigma^2 = \frac{\sum f_i x_i^2}{\lambda + 14} - \mu^2$

$\sigma^2 = \frac{6^2(3) + 10^2(\lambda) + 14^2(4) + 18^2(7)}{\lambda + 14} - \mu^2$

for $\lambda = 6,\ \mu = 10 + 3 = 13$

$\lambda + \mu = 19$

Q20 Solution:
(1)

$$f\left(\theta\right) = \frac{1 + \cos 2\theta}{2} - 3\sin 2\theta + 3\left(\frac{1 - \cos 2\theta}{2}\right) + 2$$

$$f(\theta) = 4 - 3\sin 2\theta - \cos 2\theta$$

$$f(\theta) \in \left[4 - \sqrt{10},\ 4 + \sqrt{10}\right]$$

Q21 Solution:
(16)

$$\left(x^2 - 4\right)y' - 2xy = -2x\left(x^2 - 4\right)^2$$

$$\Rightarrow \frac{d}{dx}\left(\frac{y}{x^2 - 4}\right) = -2x$$

$$\Rightarrow y = \left(-x^2 + C\right)\left(x^2 - 4\right)$$

for $x = 3,\ y = 15 \Rightarrow C = 12$

$$\Rightarrow y = \left(-x^2 + 12\right)\left(x^2 - 4\right)$$

$$y' = 0 \Rightarrow x = 2\sqrt{2}$$

$$y_{\text{local max}} = \left(\left(2\sqrt{2}\right)^2 - 4\right)\left(-\left(2\sqrt{2}\right)^2 + 12\right)$$

$$= 16$$

Q22 Solution:
(3)

$$A^T = -A$$

$$B = \left(I + A\right)\left(I - A\right)^{-1}$$

$$B^T = \left(\left(I - A\right)^{-1}\right)^T\left(I + A\right)^T$$

$$B^T = \left(I - A^T\right)^{-1}\left(I + A^T\right)$$

$$B^T = \left(I + A\right)^{-1}\left(I - A\right)$$

$$B^TB = \left(I + A\right)^{-1}\left(I - A\right)\left(I + A\right)\left(I - A\right)^{-1}$$

$$= \left(I + A\right)^{-1}\left(I + A\right)\left(I - A\right)\left(I - A\right)^{-1}$$

$$= I$$

$$\text{tr}\left(B^TB\right) = 3$$

Q23 Solution:
(260)

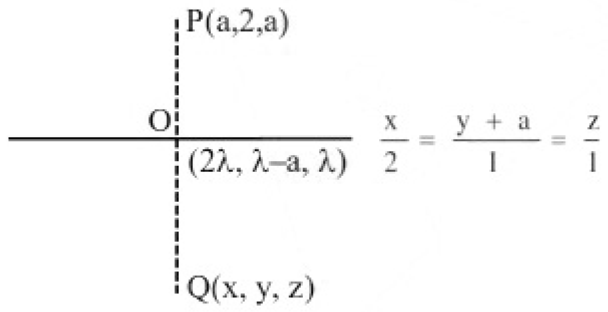
For $n\left(s\right) = {}^{10}C_4 = 210$

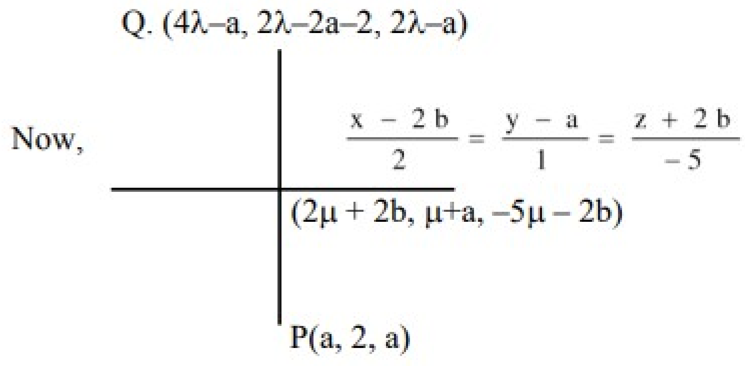
$$\left(5, 4, 1, 1, 1\right),\ \left(5, 2, 2, 1, 1\right)$$

For $n\left(p\right) = \frac{5!}{3!} + \frac{5!}{2!2!} = 50$

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

Q24 Solution:
(3)





$\frac{2\lambda - a + a}{2} = -5\mu - 2b$

and $\frac{a + 4\lambda - a}{2} = 2\mu + 2b$

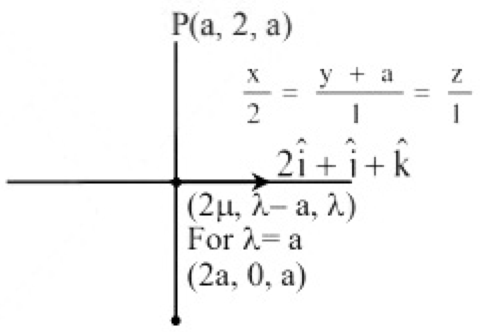
and $\frac{2\lambda - 2a - 2 + 2}{2} = \mu + a$

$\Rightarrow \lambda - \mu = b$

$\lambda - \mu = 2a$

$\lambda + 5\mu = -2b$

$\Rightarrow b = 2a$ and $\lambda = a,\ \mu = -a$



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

$2a - 2 = 0$

$a = 1$

$b = 2a = 2 \times 1 = 2$

$a + b = 1 + 2 = 3$

Q25 Solution:
(16)

$\int_0^x t^2 \sin\left(x - t\right) dt = x^2$

Use by parts

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

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

$\cos x = 1$

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

Total Elements $= 16$

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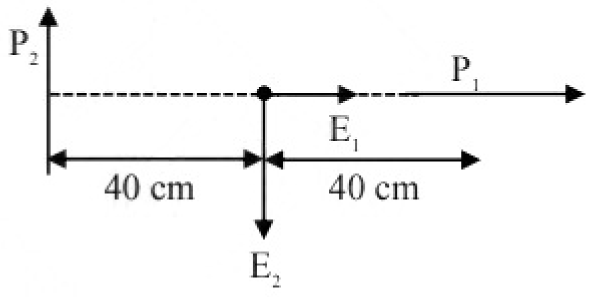
Q26 Solution:
(1)



$\vec{E}_2 = -\frac{KP_2}{r^3}$; $\vec{E}_1 = -\frac{2KP_1}{r^3}$

$P_1 = 2 \times 10^{-6} \times 10^{-2} = 2 \times 10^{-8}$

$P_2 = 4 \times 10^{-6} \times 10^{-2} = 4 \times 10^{-8}$

$\vec{E}_{\text{net}} = \frac{2 \times 9 \times 10^9 \times 2 \times 10^{-8}}{(0.4)^3}\hat{i} - \frac{9 \times 10^9 \times 4 \times 10^{-8}}{(0.4)^3}\hat{j}$

$\vec{E}_{\text{net}} = \frac{9 \times 10^9 \times 4 \times 10^{-8}}{(0.4)^3}\left(\hat{i} - \hat{j}\right)$

$\left|\vec{E}_{\text{net}}\right| = \frac{9 \times 10^4}{16}\sqrt{2}$

Q27 Solution:
(4)

For isothermal process

$W_{\text{isothermal}} = nRT ln\left(\frac{V_2}{V_1}\right)$

$= 1 \cdot R \cdot 300 \cdot ln(2)$

$= 300R(0.693) \quad \cdots (1)$

Now for adiabatic process,

It is given work done in isothermal = work done in adiabatic

$W_{\text{adiabatic}} = \frac{nR(T_1 - T_2)}{\gamma - 1} \qquad \cdots \left(2\right)$

$(1) = (2)$

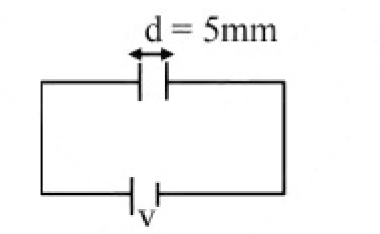
$\frac{nR(300 - T_{\text{final}})}{1.4 - 1} = 300R\left(0.693\right)$

$T_{\text{final}} = 216.84\text{K}$

$= -56.3°\text{C}$

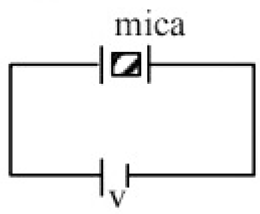
Q28 Solution:

(1)



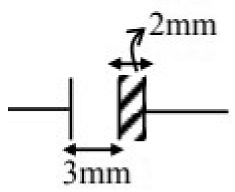
$C = \frac{\epsilon_0 A}{d}$

$Q_1 = CV$



$Q_2 = (c_{eq})\,v$

$Q_2 = 1.25\,cv$



$$c_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{\frac{\varepsilon_0 A}{3} \times \frac{K\varepsilon_0 A}{2}}{\frac{\varepsilon_0 A}{3} + \frac{K\varepsilon_0 A}{2}}$$

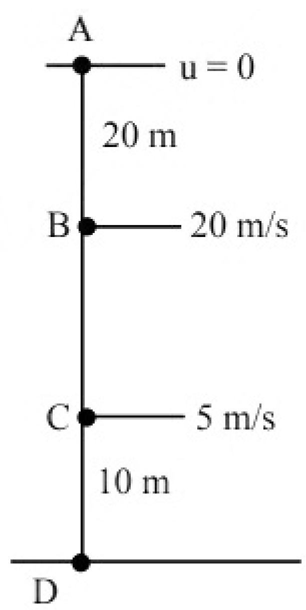
$$c_{eq} = \frac{(\varepsilon_0 A)^2 \left(\frac{K}{6}\right)}{\varepsilon_0 A \left(\frac{2+3K}{6}\right)} \Rightarrow C_{eq} = \frac{K\varepsilon_0 A}{2+3K}$$

$$1.25 \times \frac{\varepsilon_0 A}{5} = \frac{K\varepsilon_0 A}{2+3K} \Rightarrow 0.25\left(2+3K\right) = K$$

$$2 + 3K = 4K \Rightarrow K = 2$$

Q29 Solution:

(4)



A to B

$x_1 = \frac{1}{2} \times 10 \times 2^2 = 20\text{m}$

$V = 0 + 10 \times 2$

B to C

$5^2 = 20^2 - 2\left(3\right)x_2$

$x_2 = \frac{375}{6}$

$x_2 = 62.5$

C to D

$x_3 = 10\text{m}$

$H = x_1 + x_2 + x_3 = 92.5$

Q30 Solution:
(3)

$V_T = \frac{2r^2 g}{9\eta}\left(\rho_b - \rho_\ell\right)$

$V_T = \frac{2}{9} \cdot \frac{(1)^2 \times 10}{10}\left(10.5 - 1.5\right)$

$V_T = 2$ cm/sec.

Q31 Solution:
(2)

induced EMF $= \frac{d\phi}{dt}$

circumference $\simeq 14\pi$

side length of square loop $= \frac{14\pi}{4} = \frac{7\pi}{2}$

$\Delta\phi = B\left(A_1 - A_2\right)$

$= \left(0.2\right)\left[\left(\frac{7\pi}{2}\right) \times \frac{7\pi}{2} - 49\pi\right] \times 10^{-4}$

$= 0.2\left(\frac{49\pi^2}{4} - 49\pi\right) \times 10^{-4}$

$\Delta\phi = 0.2 \times 33.07 \times 10^{-4}$

$\Delta\phi = 6.614 \times 10^{-4}$

EMF $= \frac{6.614 \times 10^{-4}}{\frac{1}{2}}\text{V} = 13.23 \times 10^{-4}\text{V}$

EMF $= 1.32\text{mV}$

Q32 Solution:
(4)

$\varepsilon = \lambda\ell$

Potential gradient

$\varepsilon_1 = \lambda\ell_1$

$\varepsilon_2 = \lambda\ell_2$

$y = \frac{\varepsilon_1}{\varepsilon_2} = \frac{\ell_1}{\ell_2}$

$\frac{\Delta y}{y} = \frac{\Delta\ell_1}{\ell_1} + \frac{\Delta\ell_2}{\ell_2}$

$\frac{\Delta y}{y} = \frac{1}{200} + \frac{1}{150}$

$\frac{\Delta y}{y} \times 100 = \left(\frac{1}{200} + \frac{1}{150}\right) \times 100$

$= \left(\frac{3+4}{600}\right) \times 100 = \frac{7}{6} = 1.16\%$

Q33 Solution:
(3)

EMF induced $\varepsilon = A\frac{dB}{dt} = A\mu_0 n\frac{di}{dt}$

$\varepsilon = A\mu_0 n i_0 \omega \cos\omega t$

current induced $i = \frac{\varepsilon}{R} = \frac{\pi r^2 \mu_0 n i_0 \omega}{R}\cos\omega t$

So $i = \frac{\pi r^2 \mu_0 n i_0 \omega}{\sqrt{2}R}$

$= \frac{\pi \times 10^{-4} \times 4\pi \times 10^{-7} \times 500 \times 10 \times 10^{3}}{\sqrt{2} \times 10}$

$= \frac{20\pi^2}{\sqrt{2}} \times 10^{-6}$

$= \frac{197}{\sqrt{2}}\mu A$

Q34 Solution:
(4)

For an air bubble rising in water, the number of moles remain constant

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$\frac{(P_{\text{atm}} + \rho g h) 2.9 \text{cm}^3}{290 \text{K}} = \frac{(P_{\text{atm}}) V_2}{300}$

$V_2 = 4.5 \text{cm}^3$

Q35 Solution:
(1)

$\frac{C}{V} = \mu = \sqrt{\varepsilon_r \mu_r}$

$\frac{C}{V} = \sqrt{\frac{3 \times 2}{1}} = \frac{\sqrt{6}}{1}$

Q36 Solution:
(1)

$\Delta U = 3nR\Delta T$

$\Delta U = 3 \times 1 \times \frac{25}{3} \times 4 = 100 \text{Joule}$

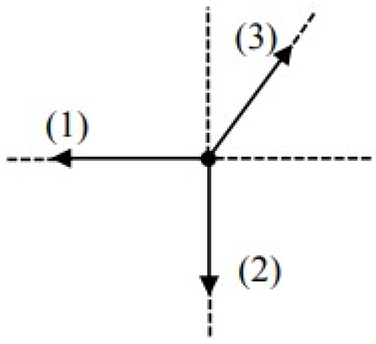
$\Delta Q = 126$

$W = 26 = P\Delta V$

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

$\Delta x = \frac{26}{170} = 15.3$

Q37 Solution:
(3)



Apply C.O.M

$M_1V_1 + M_2V_2 + M_3V_3 = 0$

$2(-18i) + 2(-18j) + 3V_3 = 0$

$V_3 = 12i + 12j$

$|V_3| = 12\sqrt{2}\,\text{m/s}$

Q38 Solution:
(1)

Horizontal displacement of Q is more than P.

$$X_Q > X_P$$

Horizontal component of velocity is same

So $t_P = \frac{X_P}{V}$

$t_Q = \frac{X_Q}{V}$

$t_Q > t_P$

Q39 Solution:
(3)

Isobars are nuclei that have the same mass number.

${}_1^3H$ & ${}_2^3He$ have same mass number.

Q40 Solution:
(3)

Gate 1 : At bottom there is an OR gate with inputs n & m
output = n + m

Gate 2 : A NAND gate, its input are direct n & the output of OR gate (n + m)

out put $z = \overline{n.(n+m)}$

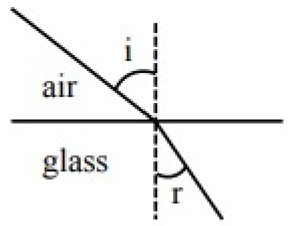
since $n.(n + m) = (n.n) + (n.m)$

$= n + n.m = n(1 + m) = n$

$\therefore$ output $z = \overline{n.(n+m)} = \overline{n}$

n	m	$z = \overline{n}$
0	0	1
0	1	1
1	1	0
1	0	0

Q41 Solution:
(2)



$\tan i = \frac{\mu_2}{\mu_1} = \frac{\mu_g}{\mu_a}$

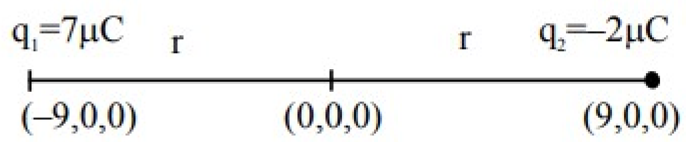
$\tan i = 1.52$

$i = 57.7°$

$r = 90° - i$

$r = 32.3°$

Q42 Solution:
(2)



$dV = -\vec{E} \cdot d\vec{r}$

$\int_0^V dV = -\int_\infty^r \frac{A}{r^2} dr$

$V = -\left[\frac{-A}{r}\right]_\infty^r \Rightarrow V = \frac{A}{r}$

$U = U_{\text{self}} + U_{\text{interaction}}$

$= q_1 V_1 = q_2 V_2 + \frac{kq_1q_2}{2r}$

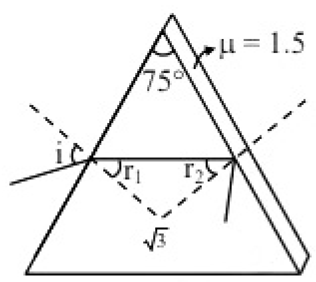
$= 7 \times 10^{-6} \cdot \frac{A}{9 \times 10^{-2}} - 2 \times 10^{-6} \cdot \frac{A}{9 \times 10^{-2}} - \frac{9 \times 10^9 \times 14 \times 10^{-12}}{2 \times 9 \times 10^{-2}}$

$= \frac{5 \times 10^{-6} \times 9 \times 10^5}{9 \times 10^{-2}} - 7 \times 10^{-1}$

$= 50 \quad 0.7$

$= 49.3\text{J}$

Q43 Solution:
(4)



$r_1 + r_2 = 75°$

For TIR at back surface

$\sqrt{3} \sin r_2 = \frac{3}{2} \sin 90°$

$r_2 > 60°$

$r_1 < 15°$

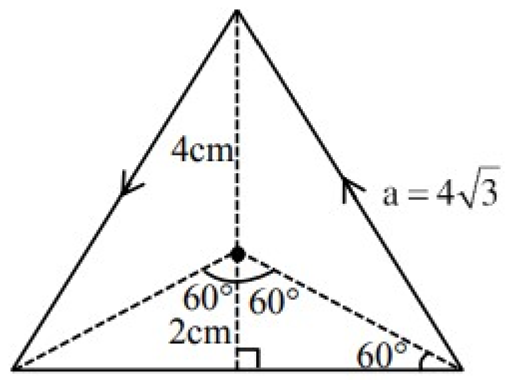
$\sin i = \sqrt{3}\sin 15°$

$\sin i = 1.73 \times 0.25$

$\sin i = 0.433$

$i = 25° \Rightarrow i < 25°$

Q44 Solution:
(3)

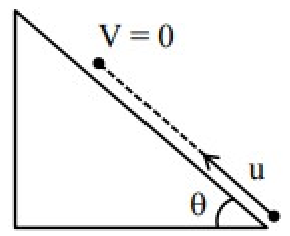


$B = \frac{\mu_0}{4\pi} \times \frac{I}{d}\left[\sin 60° + \sin 60°\right] \times 3$

$B = 10^{-7} \times \frac{2}{2 \times 10^{-2}}\left(\frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{2}\right) \times 3$

$= \sqrt{3} \times 10^{-5} \times 3 = 3\sqrt{3} \times 10^{-5}$

Q45 Solution:
(4)



$a = -g\sin\theta$

$V^2 = U^2 + 2as$

$0 = u^2 - 2g\sin\theta \cdot s$

$s = \frac{u^2}{2g\sin\theta}$

Q46 Solution:
(109)

$M = \sigma\pi R^2$

$\sigma\pi R^2 = 16m$

$m = \frac{\sigma\pi R^2}{16}$

$I_{\text{system}} = \frac{MR^2}{2} - 2\left(\frac{mR^2}{2 \times 16} + \frac{9mR^2}{16}\right)$

$= \frac{MR^2}{2} - 2 \times \frac{19mR^2}{32}$

$= \frac{MR^2}{2} - \frac{19}{16}mR^2$

$= \frac{MR^2}{2} - \frac{19}{256}MR^2$ because $m = \frac{M}{16}$

$= \frac{(128 - 19)MR^2}{256}$

$= \frac{109MR^2}{256}$

Q47 Solution:
(819)

$V = \sqrt{\frac{\gamma RT}{M}}$

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

$\frac{V_0}{2V_0} = \sqrt{\frac{273}{T_2}}$

$\frac{1}{4} = \frac{273}{T_2}$

$T_2 = 4 \times 273 = \alpha + 273$

$\alpha = 3 \times 273$

$\alpha = 819°C$

Q48 Solution:
(16)

$m = \frac{f}{f + u}$

$m_1 = -m_2$

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

$f - 8 = 24 - f$

$2f = 32$

$f = 16\text{cm}$

Q49 Solution:
(1)

$T = (ML^{-3})^a L^b (ML^{-1}T^{-1})^c (ML^{-3})^d$

$T = M^{a + c + d} L^{-3a - c - 3d + b} T^{-c}$

on comparing

$c = -1;\ \ a + c + d = 0;\ \ -3a - c - 3d + b = 0$

$b = 2;\ \ a + d = 1$

$b + c = 1$

Q50 Solution:
(228)

Total number of U-235 atoms is

$47\text{g} = \frac{47}{235}$ moles $= \frac{1}{5}$ moles

$\therefore$ Total energy released $= \frac{1}{5} \times 6 \times 10^{23} \times 190\,\text{MeV}$

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

3 - JEE Main Chemistry 23-Jan 2026 Shift -2

Q51 Solution:
(4)

Organic compound $= 0.2425$ gm

AgCl obtained $= 0.5253$ gm

In Carius method for estimation of halogen, amount of AgCl obtained is 0.5253 gm from 0.2425 gm of organic c

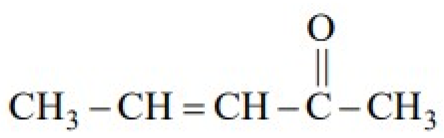
Hence percentage of Cl.

Percentage of Cl $= \frac{35.5}{143.5} \times \frac{0.5253}{0.2425} \times 100$

$= 53.58\%$

Q52 Solution:
(3)

(A) NaOCl + KI → NaCl + KOI
(B) Incorrect statement

(C)  gives iodoform reaction.

(D) Incorrect statement
(E) Incorrect statement

Q53 Solution:
(4)

(A) $Co^{3+} : 3d^6$
$NH_3 \Rightarrow$ S.F.L
Hybridisation $\Rightarrow d^2sp^3$, Inner orbital complex

(B) $Mn^{3+} : 3d^4$
$Cl^- \Rightarrow$ W.F.L
Hybridisation $\Rightarrow sp^3d^2$, Outer orbital complex

(C) $Co^{3+} : 3d^6$
$F^- \Rightarrow$ W.F.L
Hybridisation $\Rightarrow sp^3d^2$, Outer orbital complex

(D) $Fe^{3+} : 3d^5$
$F^- \Rightarrow$ W.F.L
Hybridisation $\Rightarrow sp^3d^2$, Outer orbital complex

(E) $Ni^{2+} : 3d^8$

$CN^- \Rightarrow$ S.F.L

Hybridisation $\Rightarrow dsp^2$, Inner orbital complex

Q54 Solution:

(3)

DNA & RNA are chiral molecules due to presence of chiral 2-deoxy-Ribose & Ribose sugar unit respectively.

Q55 Solution:

(2)

$Na^+ : 1s^2\ 2s^2\ 2p^6$ (fully filled electronic configuration)

$Mg^+ : 1s^2 2s^2 2p^6 3s^1$

IE_2 of Na > IE_2 of Mg

Size of $O^{2-} > F^-$

Q56 Solution:

(1)

$KE_{max} = E - \phi$

$(KE_{max})_1 = 6 - \phi_1 \quad \ldots . (1)$

$(KE_{max})_2 = 6 - \phi_2 \quad \ldots . (2)$

By eq. (1) divide eq. (2)

$\frac{(KE_{max})_1}{(KE_{max})_2} = \frac{2.642}{1} = \frac{6 - \phi_1}{6 - \phi_2}$

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

$\phi_1 = 2.3$ eV

$\phi_2 = 4.6$ eV

Q57 Solution:

(4)

(1) If C_1 is at anode $\Rightarrow$ cell reaction

$M^+(C_2) \rightarrow M^+(C_1)$

$E_{cell} = -0.059 \log \frac{C_1}{C_2}$

$\therefore\ E_{cell} > 0 \Rightarrow C_1 < C_2$

(2) If C_1 is at cathode

$M^+(C_1) \rightarrow M^+(C_2)$

$E_{cell} = -0.059 \log \frac{C_2}{C_1} > 0$

$C_2 < C_1$

Q58 Solution:
(2)

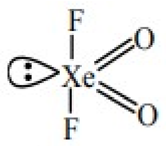
$PbO_2 + Pb \rightarrow 2PbO$

Pb^{2+} is more stable hence reaction will be spontaneous. So $\Delta G_r°(1)$ is negative.

$SnO_2 + Sn \rightarrow 2SnO$

Sn^{2+} is less stable, so reaction will be non-spontaneous hence $\Delta G_r°(2)$ is positive.

Q59 Solution:
(1)

(A) 

See-saw

(B) Xe has 7 electron pair in its valence shell

(C) O–Xe–O bond angle is close to 120°

(D) F–Xe–F bond angle is close to 180°

(E) Xe has 14 valence electrons in XeO_2F_2

Q60 Solution:
(3)

Element	EN
N	3.0
P	2.1
As	2.0
Sb	1.9
Bi	1.9

X = Nitrogen (N)

Y = Arsenic (As)

Q61 Solution:
(4)

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

(B) $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{4.5 \times 10^{15}} = 6.67 \times 10^{-8}$ m

(C) $\frac{E_1}{E_2} = \frac{hc / \lambda_1}{hc / \lambda_2} = \frac{\lambda_2}{\lambda_1}$

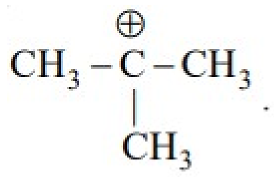
$\frac{E_1}{E_2} = \frac{300}{900} = \frac{1}{3}$ (false)

(D) No. of photons $= \frac{\text{Energy}}{hc / \lambda} = 10^{16}$ (True)

Q62 Solution:
(4)

$K_2Cr_2O_7 + KI \xrightarrow{H^+} I_2 + Cr^{3+}$

Q63 Solution:
(4)

S-1: $\left(CH_3\right)_3C^+ > \overset{+}{C}H_3$; due to hyperconjugation interaction 

S-2 : False

Q64 Solution:
(2)

At $t = 10$ minutes

Rate of reaction $= -\frac{1}{5}\frac{\Delta[Br^-]}{\Delta t} = \frac{1}{5} \times \left(2 \times 10^{-4}\right) = 4 \times 10^{-5}$

For reaction $A \rightarrow P$

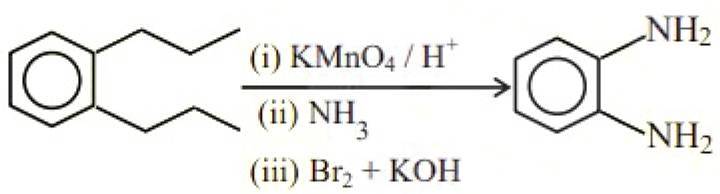
at $t = 10$ minutes

Rate of reaction $= 4 \times 10^{-5} = k\left[A\right]$

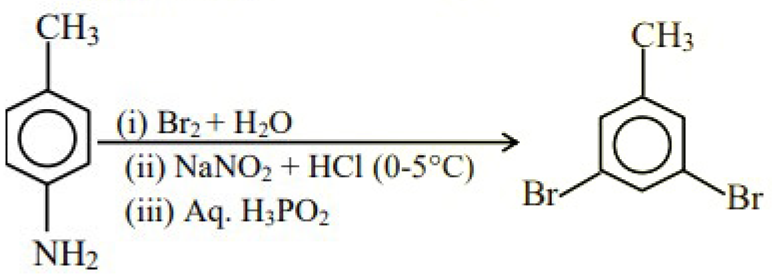
$k = 4 \times 10^{-3}\ \text{min}^{-1}$

Q65 Solution:
(1)

Statement-**I**

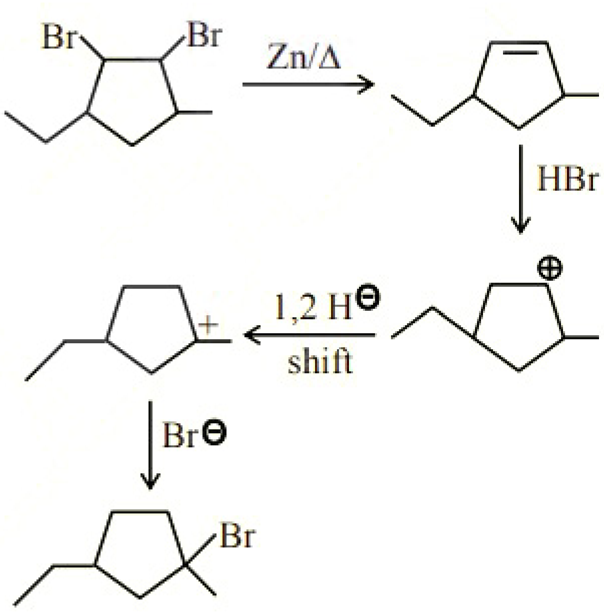


Statement-**II**



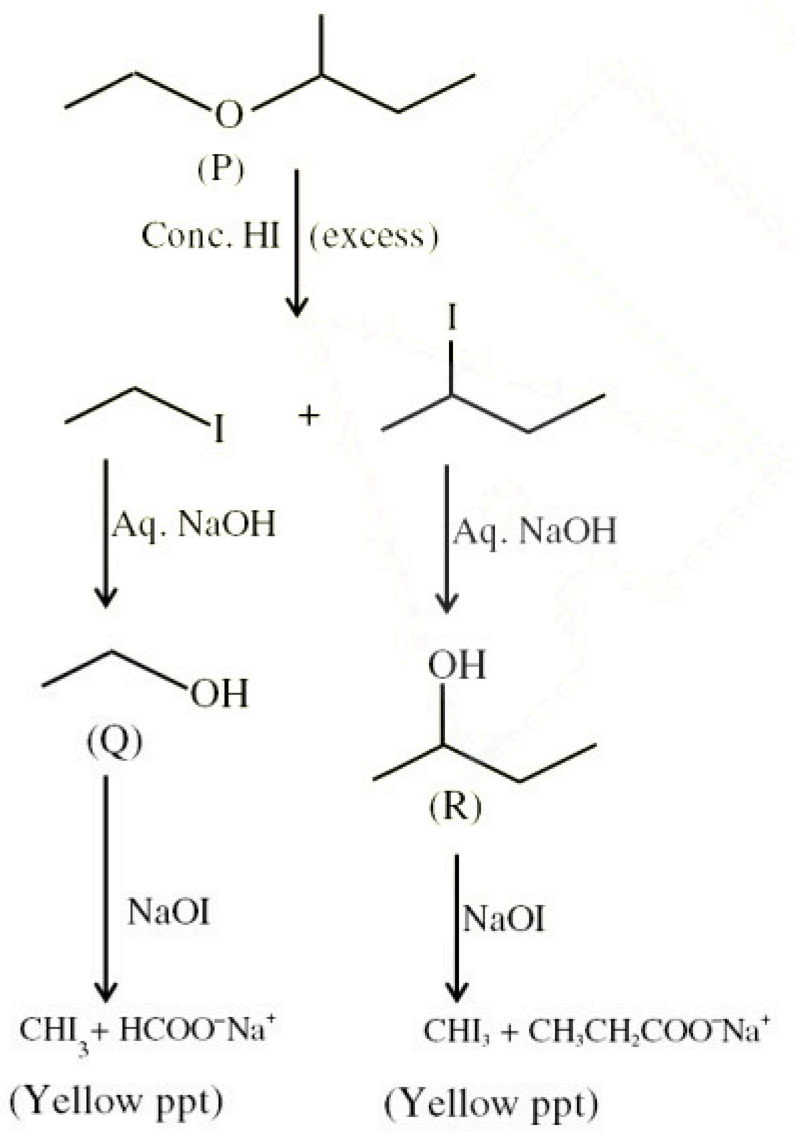
Both statement (I) and (II) are true.

Q66 Solution:
(4)



Q67 Solution:

(4)



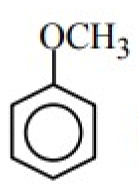
Q68 Solution:

(4)

$$R-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 \text{ or } R-\underset{\underset{\displaystyle OH}{|}}{CH}-CH_3$$

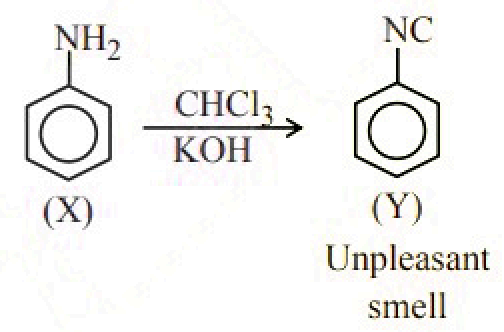
$$\xrightarrow[+I_2]{NaOH} R-CO\overset{\ominus}{O}\overset{\oplus}{Na}+\underset{\substack{\text{Yellow}\\ \text{ppt}}}{CHI_3}\downarrow$$

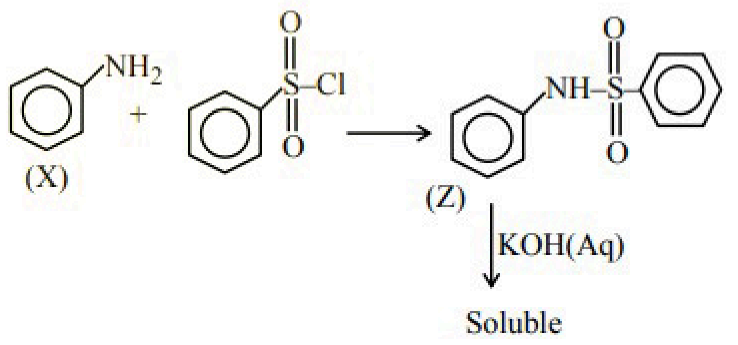
(A) CH_3-OH & $\underset{\underset{\displaystyle OH}{|}}{CH_3-CH_2}$

 & $CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$

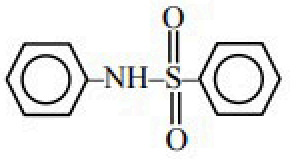
Q69 Solution:

(1)





Number of different H atom in



is 7.

Q70 Solution:
(1)

$$\begin{array}{ccc} A & \rightarrow & nB \\ 0.05 & & 0 \\ 0.04 & & 0.01\times n \end{array}$$

$0.01\times n=0.03$

$n=3$

Q71 Solution:
(200)

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

$P_s=P_A{}^{\circ}X_A+P_B{}^{\circ}X_B$

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

$3P_A{}^{\circ}+P_B{}^{\circ}=2000\quad ....(1)$

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

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

$P_s=520=P_A{}^{\circ}\times\frac{4}{5}+P_B{}^{\circ}\times\frac{1}{5}$

$4P_A{}^{\circ}+P_B{}^{\circ}=2600\quad ...(2)$

By equation (2) - equation (1)

$P_A{}^{\circ}=600$ mm Hg

$P_B{}^{\circ}=200$ mm Hg

Q72 Solution:
(2)

In $\left[Ni\left(CO\right)_4\right]$, $Ni^0: 3d^8 4s^2$

Hybridisation state : sp^3

Unpaired electron $= 0$

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

Hybridisation state : sp^3

Unpaired electron $= 2$

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

Hybridisation state : dsp^2

Unpaired electron $= 0$

In $\left[Ni\left(CN\right)_4\right]^{2-}$, $Ni^{2+}: 3d^8$

Hybridisation state : dsp^2

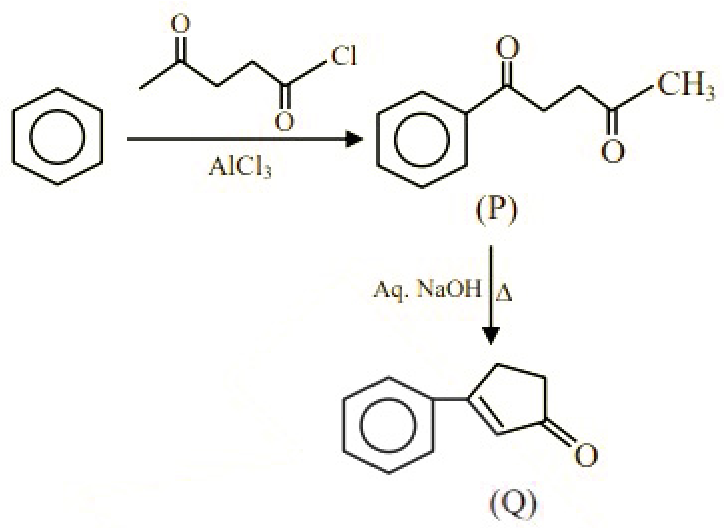
Unpaired electron $= 0$

In $\left[Pt\left(NH_3\right)_2Cl_2\right]$, $Pt^{2+}: 5d^8$

Hybridisation state : dsp^2

Unpaired electron $= 0$

Q73 Solution:
(10)



Molecular mass of Q is $= 157$

% of oxygen in product 'Q' is $= \frac{16}{157} \times 100 = 10.19\%$

Q74 Solution:
(375)

Number of equivalents of $Cr_2O_7^{2-}$ = Number of equivalents of Mohr's salt

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

$x = 375$

Q75 Solution:
(15)

$X_2(g) + Y_2(g) \rightleftharpoons 2Z(g)$

$K_c = \frac{(9)^2}{3 \times 3} = 9$

Now 10 moles of Z are added then reaction will move in backward direction.

$X_2(g) + Y_2(g) \rightleftharpoons 2Z(g)$

$3 + X \quad 3 + X \quad 19 - 2X$

$K_c = \frac{(19 - 2X)^2}{(3 + X)(3 + X)} = 9$

$\frac{19 - 2X}{3 + X} = 3$

$19 - 2X = 9 + 3X$

$10 = 5X$

$X = 2$

At equilibrium $\Rightarrow$ moles of Z $= 19 - 2 \times 2 = 15$ moles