1 - JEE Main Maths 22-Jan 2026 Shift -2

Q1 Solution:

(4)

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

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

$$\frac{1}{2\sqrt{9+\sqrt{x}}} \times \frac{dx}{2\sqrt{x}} = 1dx$$

$\frac{1}{2}\ln\left|1+2\sin y\right| = \int \frac{4dt}{16t} + C$

$\frac{1}{2}\ln\left|1+2\sin y\right| = \frac{1}{4}\ln\left|4+\sqrt{9+\sqrt{x}}\right| + C$

$\frac{1}{2}\ln\left(2\sin y+1\right) = \frac{1}{4}\ln\left|4+\sqrt{9+\sqrt{x}}\right| + C$

Substituting $\left(256, \frac{\pi}{2}\right)$

$\frac{1}{2}\ln 3 = \frac{1}{2}\ln 3 + C$ $\qquad C = 0$

Substituting $(49, \alpha)$

$\frac{1}{2}\ln\left(2\sin\alpha+1\right) = \frac{1}{4}\ln 8$

$\ln\left(2\sin\alpha+1\right) = \frac{1}{2}\ln 8$

$\ln(2\sin\alpha+1) = \ln(2\sqrt{2})$

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

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

Q2 Solution:

(2)

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

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

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

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

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

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

$\lambda = 1, 2$

$\text{Sum} = 3$

Q3 Solution:

(4)

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

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

$\because$ length of latus rectum $= 8$

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

From (1) & (2)

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

$400 - 60a = 4a^2$

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

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

$a = 5$ & -20 (rejected)

$\Rightarrow b = \sqrt{20}$

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

$\therefore$ Focal length $S_1S_2 = 2ae = 2 \cdot 5\left(\sqrt{1 + \frac{4}{5}}\right) = 6\sqrt{5}$

$\therefore$ Area of $\Delta PS_1S_2 = \frac{1}{2} \cdot 6\sqrt{5} \cdot 2\sqrt{15} = 30\sqrt{3} = A$

$\therefore A^2 = 2700$

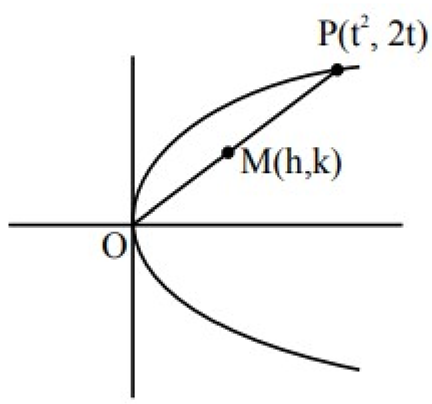
Q4 Solution:
(2)

$y^2 = 4x$

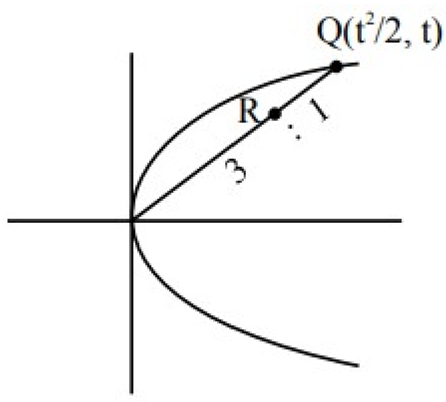
Locus of mid point of OP

$M(h, k) \Rightarrow h = \frac{t^2}{2}, k = t$

$\Rightarrow k^2 = 2h \Rightarrow y^2 = 2x$



$S: y^2 = 2x$



R(h, k)

$\Rightarrow h = \frac{\frac{3t^2}{2}}{4}, \; k = \frac{3t}{4}$

$t^2 = \frac{8h}{3}, \; t = \frac{4k}{3}$

$\Rightarrow \frac{16k^2}{9} = \frac{8h}{3} \Rightarrow 2k^2 = 3h$

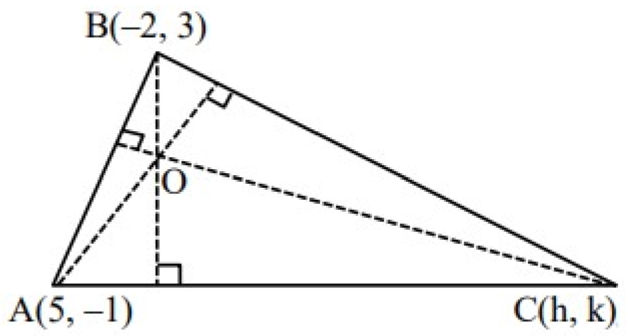
Locus of R: $2y^2 = 3x$

Q5 Solution:
(1)

Solution of statement-1

$m_{AO} \cdot m_{BC} = -1$

$B(-2, 3)$



$\Rightarrow 5h - k + 13 = 0 \quad ...(1)$

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

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

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

$\therefore$ Statement 1 is correct.

Solution of statement-2

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

$b = \frac{2a + c}{2}$

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

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

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

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

$\therefore$ Point of concurrency is $(2, -2)$

$\therefore$ Statement 2 is correct.

Q6 Solution:
(4)

$x - ny + z = 6$

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

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

$$\begin{vmatrix} 1 & -n & 1 \\ 1 & (n-2) & n+1 \\ 0 & n-1 & 1 \end{vmatrix} \neq 0$$

$\Rightarrow n^2 - 3n + 2 \neq 0$

$n \neq 1, 2$

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

Now $P\left(\text{probability when system of equations has unique solution}\right) = \frac{4}{6}$

So $k = 4$

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

Q7 Solution:
(2)

$X = A^{-1}B = \left(\frac{\text{adj } A}{|A|}\right)B$

$$= \pm \frac{1}{10}\begin{pmatrix} 4 & 2 & 2 \\ -5 & 0 & 5 \\ 1 & -2 & 3 \end{pmatrix}\begin{pmatrix} 4 \\ 0 \\ 2 \end{pmatrix}$$

$$= \pm \frac{1}{10}\begin{pmatrix} 20 \\ -10 \\ 10 \end{pmatrix} = \pm \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}$$

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

Q8 Solution:
(1)

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

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

$\therefore (PS)^2 + (PS')^2 - PS \cdot PS' = 37$

$(PS + PS')^2 - 3PS \cdot PS' = 37$

$100 - 3PS \cdot PS' = 37$

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

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

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

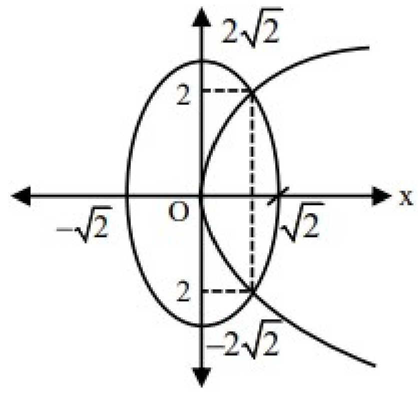
$\frac{16}{25}\alpha^2 = 4$

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

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

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

Q9 Solution:
(3)



$A = \int_0^2 2\sqrt{x}\, dx + 2\int_1^{\sqrt{2}} \sqrt{8 - 4x^2}\, dx$

$= \frac{8}{3}\left[x^{3/2}\right]\int_0^1 + 4\int_1^{\sqrt{2}} \sqrt{2 - x^2}\, dx$

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

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

$= \frac{8}{3} + 2\pi - 2 - \pi$

$= \pi + \frac{2}{3}$ sq. units

Q10 Solution:
(3)

Let $x^2 - 10x + 85 = \lambda$

$\therefore$ Domain for first term

$\lambda > 0 \quad ...(1)$

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

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

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

$0 < \lambda < 2^6$

$0 < x^2 - 10x + 85 < 64$

$\Rightarrow x \in (3, 7) \quad ...(A)$

& domain for second term $-1 \le \frac{3x - 7}{x - 17} \le 1$

$\Rightarrow x \in [-5, 6] \quad ...(B)$

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

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

$\Rightarrow \alpha + \beta = 9$

Q11 Solution:
(4)

$\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$

$\vec{b} = \lambda\hat{j} + 2\hat{k}, \quad \lambda \in \mathbb{Z}$

$\vec{c} = \vec{a} \times \vec{b} = \left(-2-\lambda\right)\hat{i} - 4\hat{j} + 2\lambda\hat{k}$

$\left|\vec{c}\right| = \sqrt{53}$

$\Rightarrow 5\lambda^2 + 4\lambda - 33 = 0$

$\lambda = 2.2 \text{ or } -3$

$\Rightarrow \lambda = -3$

$\vec{c} = \hat{i} - 4\hat{j} - 6\hat{k}$

let $\vec{d} = y\hat{j} + z\hat{k}$

$\left|\vec{d}\right| = 2$

$\Rightarrow y^2 + z^2 = 4$

$\left(\vec{c}\cdot\vec{d}\right)^2 = \left(4y + 6z\right)^2 \le \left(\sqrt{4^2 + 6^2} \times \sqrt{y^2 + z^2}\right)^2 \le 208$

Q12 Solution:
(2)

$f\left(x+y\right) = f\left(x\right)\ f\left(y\right) \Rightarrow f\left(x\right) = a^x$

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

So $f\left(x\right) = 7^x$

Now

$g\left(x+y\right) = g\left(xy\right)\ \left(\text{put } y = 1\right)$

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

so $g\left(1\right) = g\left(2\right) = g\left(3\right) = \cdots = g\left(n\right) = 1$

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

$\sum_{x=1}^{n} \frac{7^x}{1} = 19607$

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

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

$7^n = 16807$

$\Rightarrow n = 5$

Q13 Solution:
(2)

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

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

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

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

$\therefore \sum_{x \in S} f\left(x\right) = -\sqrt{2} + 1 - 2 + 2 - \sqrt{6} + \sqrt{6}$

$= 1 - \sqrt{2}$

Q14 Solution:
(1)

$$P_n = \sum_{r=0}^{n} \frac{{}^{n}C_r(-2)^r}{r+1} = \sum_{r=0}^{n} \frac{1}{n+1} \; {}^{n+1}C_{r+1}(-2)^r$$

$$= \frac{-1}{2(n+1)} \sum_{r=0}^{n} \; {}^{n+1}C_{r+1}(-2)^{r+1}$$

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

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

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

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

$$\sum_{n=1}^{25} \frac{1}{P_{2n}} = \sum_{n=1}^{25} \left(2n+1 \right)$$

$$= 3 + 5 + \cdots + 51$$

$$= \frac{25}{2} \left(51 + 3 \right)$$

$$= 25 \times 27 = 675$$

Q15 Solution:
(4)

$4x^2 + y^2 < 52 \quad , \quad x, y \in \mathbb{Z}$

↓ ↓

$0 \quad 0, \pm 1, \pm 2, \pm 3, \pm 4, \pm 5, \pm 6, \pm 7 \rightarrow 1 \times 15 = 15$

$\pm 1 \quad 0, \pm 1, \pm 2, \pm 3, \ldots \ldots, \pm 6 \rightarrow 2 \times 13 = 26$

$\pm 2 \quad 0, \pm 1, \pm 2, \pm 3, \ldots \ldots, \pm 5 \rightarrow 2 \times 11 = 22$

$\pm 3 \quad 0, \pm 1, \pm 2, \pm 3 \rightarrow 2 \times 7 = 14$

Number of elements $= 15 + 26 + 22 + 14 = 77$

Q16 Solution:
(1)

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

$(1)\ f(x) > 0 \Rightarrow [x] \in (-\infty, -2) \cup (3, \infty)$

$\Rightarrow x \in (-\infty, -2) \cup [4, \infty)$

$(2)\ f(x) < 0 \Rightarrow [x] \in (-2, 3)$

$\Rightarrow x \in [-1, 3)$

option (2) is correct

$$\left(3\right)\ \int_0^2 f\left(x\right) dx = \int_0^1 \left(0 - 0 - 6\right) dx + \int_1^2 \left(1 - 1 - 6\right) dx$$

$$= -6 - 6$$

$= -12$

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

infinitely many solutions

Q17 Solution:
(4)

$4z^2 + \bar{z} = 0$

Let $z = x + iy$

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

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

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

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

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

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

$\therefore z_1 = 0 + 0i, \quad |z_1|^2 = 0$

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

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

$4 \cdot \frac{1}{64} - 4y^2 + \frac{1}{8} = 0$

$\Rightarrow 4y^2 = \frac{3}{16} \Rightarrow y = \pm\frac{\sqrt{3}}{8}$

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

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

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

Q18 Solution:
(3)

M is the point of intersection of L_1 and L_2

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

$\Rightarrow \lambda = 2 = \mu$

$\Rightarrow M(3,5,9)$

Now let point P be $(2K-1, 3K-1, 6K-3)$ on L_2, such that $PM = 7$

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

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

$\Rightarrow K^2 + 4 - 4K = 1$

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

$\Rightarrow K = 1, 3$

So points P and Q are $(1, 2, 3)$ and $(5, 8, 15)$

So sum of all coordinates of P and $Q = 34$

Q19 Solution:

(1)

$$\lim_{x \to 0} \frac{\left(1 + \left(a - 1\right)x + \frac{(a-1)^2 x^2}{2!}\right) + 2\left(1 - \frac{b^2 x^2}{2!}\right) + \left(c - 2\right)\left(1 - x + \frac{x^2}{2!}\right)}{x\left(1 - \frac{x^2}{2!}\right) - \left(x - \frac{x^2}{2} \ldots\right)} = 2$$

$$\lim_{x \to 0} \frac{\left(1 + 2 + c - 2\right) + x\left(a - 1 - c + 2\right) + x^2\left(\frac{(a-1)^2}{2} - b^2 + \left(\frac{c-2}{2}\right)\right)}{\frac{x^2}{2!} - \frac{x^3}{2!} + \cdots} = 2$$

For which

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

$\because \quad a - c = -1 \Rightarrow a = -2$

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

$\frac{9}{2} - b^2 - \frac{3}{2} = 1 \Rightarrow b^2 = 2$

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

Q20 Solution:

(2)

$\because$ median $= \frac{1001k}{2} = X_M$

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

$= \frac{2\left(\frac{k}{2} + \frac{3k}{2} + \frac{5k}{2} + \cdots \text{ 500 terms}\right)}{1000}$

$= \frac{2 \cdot \frac{k}{2}(500)^2}{1000}$

$= \frac{500k}{2} = 500 \ \left(\text{given}\right)$

$\therefore k = 2$

$\therefore k^2 = 4$

Q21 Solution:

(1979)

$A = \{1, 2, 3, \ldots, 11\}$

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

Case (i):

$n\left(B\right) = 2 \Rightarrow {}^{11}C_2 - {}^{6}C_2$

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

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

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

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

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

$\vdots$

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

$\therefore$ number of set $B = \sum_{r=2}^{11} {}^{11}C_r - \sum_{r=2}^{6} {}^{6}C_r$

$= 2^{11} - \left(1 + 11\right) - \left(2^6 - 7\right)$

$= 2048 - 64 - 5$

$= 1979$

Alternate Solution:

Total subsets $= 2^{11}$

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

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

Required ways $= 2^{11} - 2^6 - 5 = 1979$

Q22 Solution:
(9)

$a = b - d,\ c = b + d \ \Rightarrow\ b = \frac{1}{3}$

$\Rightarrow 4b^4 = a^2c^2$

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

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

$\Rightarrow \left(\frac{1}{9} - d^2\right) = \pm\frac{2}{9}$

$d^2 = \frac{1}{3} \ \Rightarrow\ d = \pm\frac{1}{\sqrt{3}}\ \left(\text{as } a < b < c\right)$

$\therefore\ \ 9\left(a^2 + b^2 + c^2\right)$

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

$= 9\left[\frac{1}{3} + \frac{2}{3}\right] = 3 + 6 = 9$

Q23 Solution:
(36)

$\because \int_0^{64} x^{\frac{1}{3}} dx = \frac{3}{4}\left[x^{\frac{4}{3}}\right]_0^{64} = 192$

and

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

So $\alpha = 192 - 156 = 36$

Now

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

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

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

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

Applying King property,

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

Now

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

$$= \int_0^{\pi/2} \frac{\sec^6\theta}{\tan^6\theta + 1} d\theta$$

$$= \int_0^{\infty} \frac{1 + \lambda^2}{\lambda^4 - \lambda^2 + 1} d\lambda$$

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

$$= \pi$$

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

$$\Rightarrow E = \frac{36 \cdot 2}{\pi} \times J = 36$$

Q24 Solution:
(20)

$$\tan 2\alpha = \tan[(\alpha + \beta) + (\alpha - \beta)]$$

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

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

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

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

$r = 11, \ s = 9$

$r + s = 20$

Q25 Solution:
(5)

$$\frac{\vec{a} \cdot \hat{k}}{|\vec{a}|} = \cos\theta = \frac{\lambda}{\sqrt{3 + \lambda^2}} = \cos\theta$$

$\Rightarrow 0 < \frac{\lambda}{\sqrt{3+\lambda^2}} < \frac{\sqrt{3}}{2}$

$\Rightarrow \lambda > 0 \;\&\; 4\lambda^2 < 9 + 3\lambda^2 \Rightarrow \lambda^2 < 9$

$\Rightarrow \lambda \in (0,3) \quad ...(1)$

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

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

$\Rightarrow \lambda \neq 2 \quad ...(2)$

From (1) and (2)

$\lambda \in (0,3) - \{2\}$

$\therefore \alpha = 0,\ \beta = 3,\ \gamma = 2$

$\Rightarrow \alpha + \beta + \gamma = 5$

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Q26 Solution:
(3)

$\frac{\mu_1}{\mu_2} - \frac{v_2}{v_1} = \frac{\lambda_2}{\lambda_1}\Big|, \quad v = f\lambda$

$\frac{\mu_1}{\mu_2} = \frac{\lambda_2}{\lambda_1}$

$\frac{\mu_B}{3/2} = \frac{\lambda}{540}$

$\lambda = \left(\frac{4 \times 2 \times 540}{3 \times 3}\right)$

$\lambda = 480 \text{ nm}$

Q27 Solution:
(4)

$f = n\left(\frac{V_0}{2L}\right)$

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

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

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

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

$L = 0.225\text{m}$

$L = 225\text{mm}$

Q28 Solution:
(3)

$T = 2\pi\sqrt{\frac{R^3}{GM}}$

$\because \quad M = \rho \cdot \frac{4}{3}\pi R^3$

$\therefore T = 2gp\sqrt{\frac{1}{G\rho\frac{4}{3}\pi}}$

Statement I is correct.

And $\therefore \frac{GM}{R^2} = g$

$\therefore T = 2\pi\sqrt{\frac{R}{g}}$

Statement II is correct

Ans. (3)

Q29 Solution:
(4)

Using volume conservation

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

$R = 3^{1/3} r$

$\frac{V_i}{V_f} = \frac{\frac{kq}{r}}{\frac{k(3q)}{R}} = \frac{R}{3r} = \frac{3^{1/3} r}{3r} = \frac{1}{3^{2/3}}$

Q30 Solution:
(4)

$\beta_{cm} = \frac{2\lambda D}{a}$

(A) Correct $\beta \propto \lambda$

(B) Incorrect

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

(D) Incorrect

(E) Correct

Statement A, C & E are correct.

No option matching

Q31 Solution:
(2)

Electric potential $\Rightarrow V = \frac{5kq}{R}$

As regular polygon $\Rightarrow \vec{E} = 0$

Q32 Solution:
(1)

$P_{\text{out}} = 1000\text{W}$

$P = VI$

$1000 = 250 \times I$

$I = 4\text{A}$

$P_{\text{loss}} = I^2R = (4)^2 \times 2 = 3200$

$P_{\text{net}} = 1000 + 32 = 103200$

$\eta = \left(\frac{P_{\text{out}}}{P_{\text{net}}}\right) \times 100 = \frac{1000}{1032} \times 100 = 96.9\%$

Q33 Solution:
(3)

Statement-I : Incorrect

Correct equation is $W = \int_{r_1}^{r_2} \vec{F} \cdot d\vec{r}$

Statement-II : Incorrect

Q34 Solution:
(3)

$h = \frac{2T\cos\theta}{\rho g r}$

$\frac{\Delta h}{h}\% = \frac{\Delta T}{T}\% - \frac{\Delta \rho}{\rho}\% - \frac{\Delta r}{r}\%$

$\frac{\Delta h}{h}\% = 1 + 1 + 1$

$\frac{\Delta h}{h} = +1\%$

Q35 Solution:
(2)

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

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

$\frac{1}{T^2} = \frac{g}{4\pi^2\ell}$

Q36 Solution:
(4)

Collision frequency $\left(Z\right) = \sqrt{2}\pi d^2 N\sqrt{\frac{8RT}{\pi M}}$

Temp, N are same

$Z \propto \frac{d^2}{\sqrt{M}}$

$d_A = \frac{d_B}{2}$

$M_A = 4M_B$

$\frac{Z_A}{Z_B} = \frac{d_A^2}{\sqrt{M_A}} \times \frac{\sqrt{M_B}}{d_B^2} = \left(\sqrt{\frac{M_B}{M_A}}\right)\left(\frac{d_A}{d_B}\right)^2$

$= \left(\sqrt{\frac{1}{4}}\right)\left(\frac{1}{2}\right)^2$

$\frac{Z_A}{Z_B} = \frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$

$\Rightarrow Z_A = \frac{32 \times 10^8}{8} = 4 \times 10^8 s^{-1}$

Q37 Solution:
(1)

$n = 4$ ________________________

$n = 3$ ________________________ Paschen

$n = 2$ ________________________ Balmer

$n = 1$ ________________________ Lyman

Smallest wavelength of Lyman

$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right)$

$R = \frac{1}{\lambda} = \frac{1}{91}\text{nm}^{-1}$

λ_{max} for Balmer series

$n_1 = 2 \rightarrow n_2 = 3$

$\frac{1}{\lambda_B} = R\left(\frac{1}{4} - \frac{1}{9}\right)$

$\frac{1}{\lambda_B} = \frac{1}{91}\left(\frac{5}{36}\right)$

$\lambda_B = \left(\frac{91 \times 36}{5}\right) = 655.2\text{nm}$

λ_{max} Paschen

$n_1 = 3 \rightarrow n_2 = 4$

$\frac{1}{\lambda_p} = \frac{1}{91}\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = \frac{1}{91}\left(\frac{7}{144}\right)$

$\lambda_p = \left(\frac{91 \times 144}{7}\right) = 1872\text{nm}$

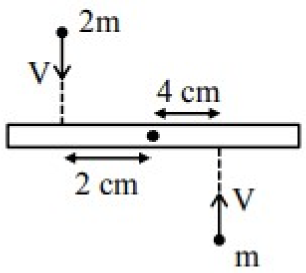
$\Delta\lambda = \lambda_p - \lambda_B$

$\Delta\lambda = 1872 - 655.2$

$\Delta\lambda = 1216.8$

$\Delta\lambda \approx 1217$

Q38 Solution:
(2)



Using angular momentum conservation about COM of rod:

$L_i = L_f$

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

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

$$8V = 264\omega$$

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

Q39 Solution:
(2)

Image should be real. So object should be placed beyond focus.

Q40 Solution:
(4)

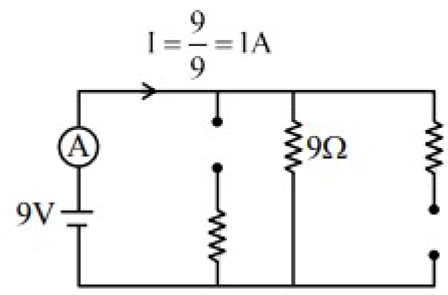
$$KE = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$$KE = \frac{1}{2}\left(m_1 + m_2\right)v_{cm}^2 + \frac{1}{2}\frac{m_1m_2}{m_1 + m_2}|\vec{v}_1 - \vec{v}_2|^2$$

So Ans. is (4)

Q41 Solution:
(3)

Just after closing the switch, inductor will behave as open circuit,



Q42 Solution:
(2)

$$\phi = h\nu$$

$$\nu = \frac{\phi}{h}$$

$$\omega = 2\pi\nu = \frac{2\pi\phi}{h} = \frac{2 \times 3.14 \times 110 \times 10^{-2}}{6.63 \times 10^{-34}}$$

$$\omega = 1.04 \times 10^{16} \text{ rad/sec}$$

Q43 Solution:
(2)

$$\frac{\varepsilon E}{t} = \frac{\varepsilon}{t}\frac{1}{4\pi\varepsilon}\frac{q}{r^2}$$

$$\Rightarrow \frac{AT}{TL^2} = \left(AL^{-2}\right)$$

$$\Rightarrow \text{A/m}^2$$

Q44 Solution:
(4)

$I = \frac{1}{2}\ \varepsilon_0 E_0^2 \cdot C$

$\therefore E_0 = \sqrt{\frac{2I}{\varepsilon_0 C}}$

& $\frac{E_0}{B_0} = C$

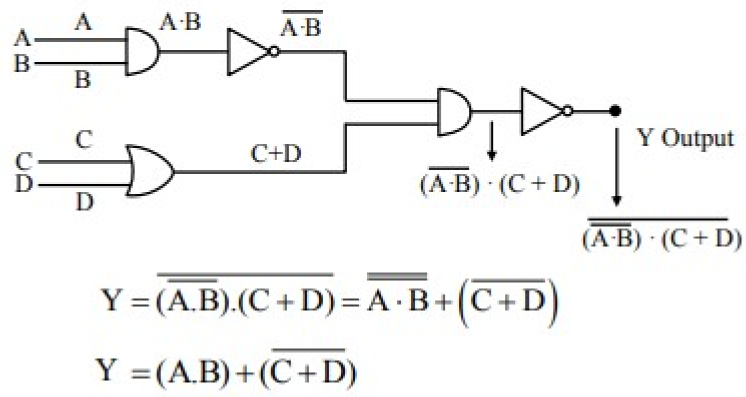
$\therefore\ B_0 = \frac{E_0}{C} = \frac{1}{C}\sqrt{\frac{2I}{\varepsilon_0 C}}$

$\therefore\ B_0 = \frac{1}{3\times 10^8}\sqrt{\frac{2\times 4\times 10^{14}}{8.85\times 10^{-12}\times 3\times 10^8}}$

$B_0 = \frac{10}{3}\sqrt{\frac{8}{8.85\times 3}}$

$B_0 = 1.83\ \mathrm{T}$

Q45 Solution:
(3)



Q46 Solution:
(14)

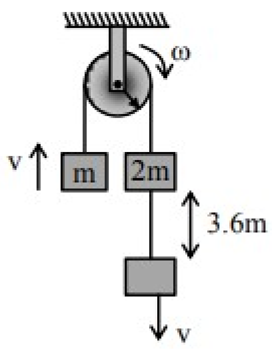
$E = B\omega A \sin\omega t$

$15.4\times 10^{-3} = \frac{1}{2}\times 100\times \frac{22}{7}r^2\times \frac{1}{2}$

$r = \sqrt{\frac{15.4\times 28\times 10^{-5}}{22}}$

$R = 14\ \mathrm{mm}$

Q47 Solution:
(2)



Using energy conservation

$\frac{1}{2}mv^2 + \frac{1}{2}\left(2m\right)v^2 + \frac{1}{2}\left(\frac{30mR^2}{2}\right)\frac{v^2}{R^2} = mgh$

$9mv^2 = mgh$

$v = \sqrt{\frac{gh}{9}} = \sqrt{\frac{10\times 3.6}{9}}$

$v = \sqrt{4} = 2\text{m/s}$

Q48 Solution:
(7)

$PV = nRT$

$\frac{P_1 V_1}{RT_1} = \frac{P_2 V_2}{RT_2}$

$\frac{2 \times 10^5 \times 60}{300} = \frac{P_2 \times 20}{350}$

$P_2 = \frac{2 \times 10^5 \times 7 \times 3}{6}$

$P_2 = 7 \times 10^5 = 7 \text{ atm}$

Q49 Solution:
(1)

$V_d = \mu E = \mu \frac{V}{\ell}$

$I = neAV_d$

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

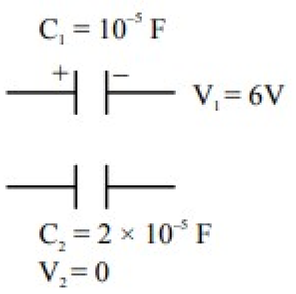
$\mu = \frac{Il}{NneA}$

$\mu = \frac{1.6 \times 3}{2 \times 5 \times 10^{26} \times 1.6 \times 10^{-19} \times 2 \times 10^{-7}}$

$\mu = 1 \times 10^{-3} \text{ m}^2 \text{ / V s}$

$\alpha = 1$

Q50 Solution:
(4)



$V = \frac{C_1 V_1 + C_2 V_2}{C_1 + C_2} = \frac{10^{-5} \times 6 + 0}{3 \times 10^{-5}}$

$V = 2 \text{ volt}$

$Q_2 = C_2 V = 2 \times 10^{-5} \times 2 = 4 \times 10^{-5} \text{ C}$

3 - JEE Main Chemistry 22-Jan 2026 Shift -2

Q51 Solution:
(2)

$\text{pOH} = pK_b + \log\left(\frac{\text{Salt}}{\text{Base}}\right)$

$4.75 = 4.75 + \log\left(\frac{\text{Salt}}{\text{Base}}\right)$

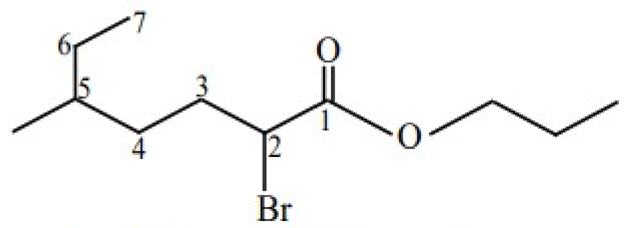
Millimoles of [Salt] = millimoles of [Base]

Option (D):

NH_4OH	+	HCl	→	NH_4Cl	+	H_2O
$0.2M,\ 0.5L$		$0.1M,\ 0.5L$				
100 mmole		50 mmole				
50 mmole		-		50 mmole		

Millimoles of NH_4OH = millimoles of NH_4Cl

Q52 Solution:
(4)



Propyl-2-Bromo-5-Methylheptanoate

Q53 Solution:
(2)

eq. of H_2SO_4 = eq. of Ammonia

$\Rightarrow \frac{15 \times 1 \times 2}{1000} = \text{moles of ammonia} \times 1$

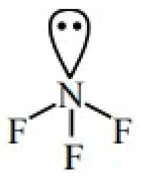
$\Rightarrow$ Moles of ammonia = moles of 'N'

$\Rightarrow \text{Weight of nitrogen} = \frac{15 \times 1 \times 2}{1000} \times 14 = 0.42$

$\%$ weight of 'N' $= \frac{0.42}{1} \times 100 = 42\%$

Q54 Solution:
(3)

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



Number of lone pair on central atom = 1

Q55 Solution:
(3)

Electronegativity order : N > P > As > Sb

↑ ↑

Most electronegative Least electronegative

X = N $X_2O_3 = N_2O_3$ (Acidic)

Y = Sb $Y_2O_3 = Sb_2O_3$ (Amphoteric)

Statement-I is true

$BCl_3 + 3H_2O \rightarrow B(OH)_3 + 3HCl$

Statement-II is false

Q56 Solution:
(4)

Reducing power $\propto \frac{1}{\text{Reduction potential}}$

Q57 Solution:
(1)

	A	+	$2B$	$\longrightarrow$	AB_2
Mole	$\frac{36}{60}$		$\frac{56}{80}$		
	0.6 mole		0.7 mole		
	0.25 mole		-		0.35 mole

(A) Molecular wt. of AB_2 is

$60 + 2 \times 80 = 220$ g/mol

(B) LR is AB.

(C) Wt. of A remaining $= 0.25 \times 60 = 15$ g

(D) Wt. of AB_2 formed $= 0.35 \times 220 = 77$ g

Q58 Solution:
(2)

C < O < N < F

$2p^2$ $2p^4$ $2p^3$ $2p^5$ $\longrightarrow$

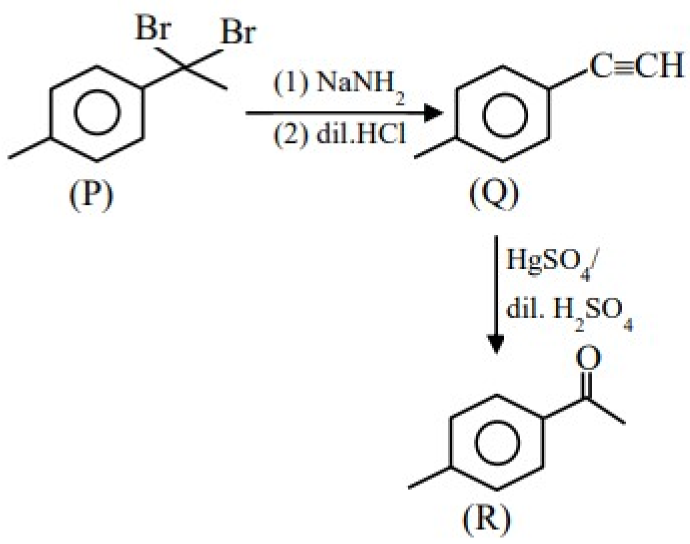
$Z_{eff}\uparrow$ I. E. $\uparrow$

Statement-I is correct

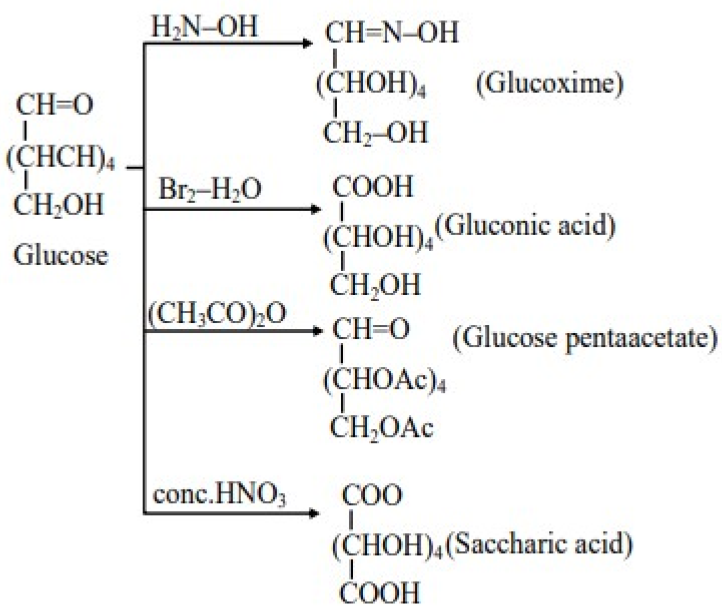
	S	>	Se	>	Te	>	Po	>	O
$\lvert\Delta_{eg}H\rvert$	200		195		190		174		141 (in kJ/mol)

Statement-II is correct.

Q59 Solution:
(2)



Q60 Solution:
(4)



Q61 Solution:
(4)

Total weight of H_2SO_4

$$= \left(100 \times \frac{98}{100}\right) + \left(100 \times \frac{49}{100}\right) = 147 \text{ gm}$$

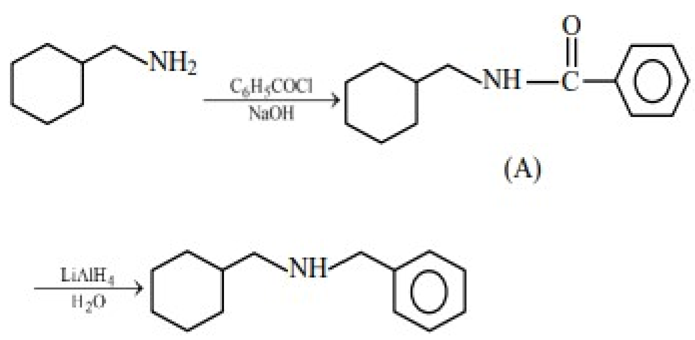
Total weight of $H_2O = 200 - 147 = 53$ gm

$$\text{Mole fraction of } H_2SO_4 = \frac{\frac{147}{98}}{\left(\frac{147}{98} + \frac{53}{18}\right)} = 0.337$$

Q62 Solution:
(1)

Primary standard must be soluble for standard solution formation.

Q63 Solution:
(2)

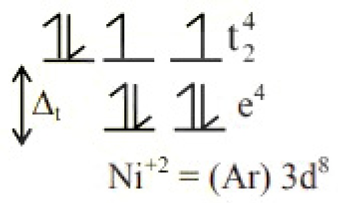


Q64 Solution:
(2)

$[Ni(PPh_3)_2Cl_2]$

Given : Paramagnetic complex hence it must be tetrahedral so

Crystal field splitting :



(A) Tetrahedral complex does not show geometrical isomerism.

(B) Complex is blue in colour

(C) Calculated spin only magnetic moment of the complex is 2.84 B.M.

(D) C.F.S.E. $= -0.6\Delta_t(4) + 0.4\Delta_t(4)$

$= -0.8\Delta_t$ (not $-0.8\Delta_o$)

(E) $Ni(CO)_4$ is also tetrahedral

Hence only A, B, D correct.

Q65 Solution:
(1)

Transition of first Balmer line

$n_1 = 2;\ n_2 = 3$

$\Delta E = x = 13.6(1)^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$ ....(i)

Transition of 2nd Balmer line

$n_1 = 2;\ n_2 = 4$

$\Delta E = 13.6(1)^2\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$ ....(ii)

Divide Eq. (ii) by Eq. (i)

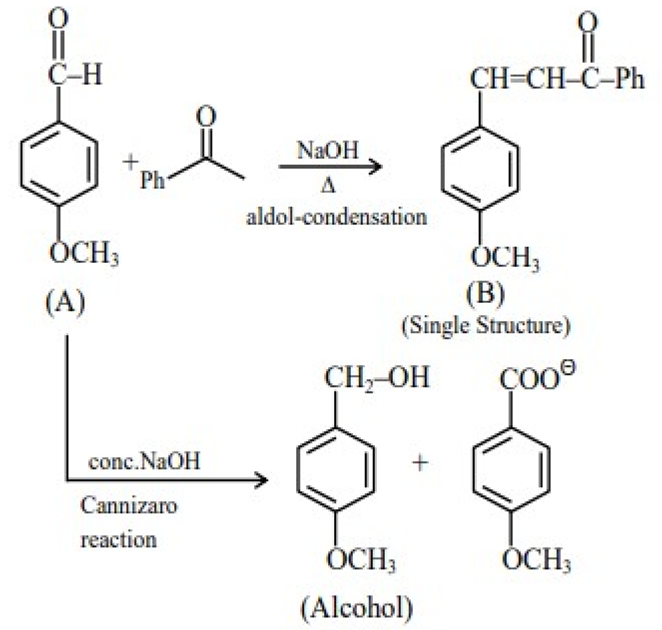
$\frac{\Delta E}{x} = \frac{\frac{1}{4} - \frac{1}{16}}{\frac{1}{4} - \frac{1}{9}}$

$\frac{\Delta E}{x} = \frac{\frac{3}{16}}{\frac{5}{36}}$

$\frac{\Delta E}{x} = \frac{27}{20}$

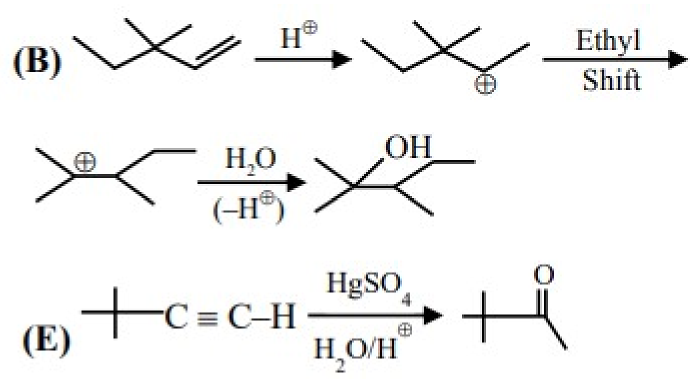
$\Delta E = 1.35x$

Q66 Solution:
(2)



(On cross aldol reaction, a single structure is obtained but it can show geometrical isomerism).

Q67 Solution:
(2)



Q68 Solution:
(3)

Fact based.

Q69 Solution:
(3)

$\mathrm{Cr} = (\mathrm{Ar})3d^5 4s^1$

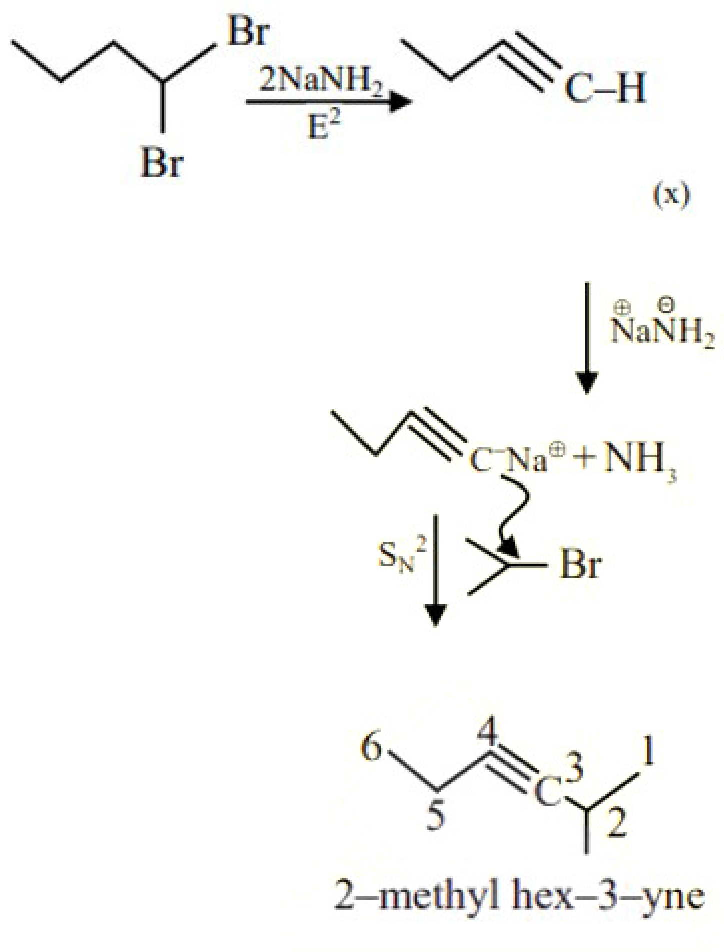
$\mathrm{Mn} = (\mathrm{Ar})3d^5 4s^2$

$IE_1(\mathrm{Cr}) < IE_1(\mathrm{Mn})$

$IE_2(\mathrm{Cr}) > IE_2(\mathrm{Mn})$

$IE_3(\mathrm{Cr}) < IE_3(\mathrm{Mn})$

Q70 Solution:
(3)



Q71 Solution:
(4)

For spontaneity $E_{\text{cell}} > 0$

At limiting condition :

$E_{\text{oxi}}(\text{anode}) = -E_{\text{red}}(\text{cathode})$

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

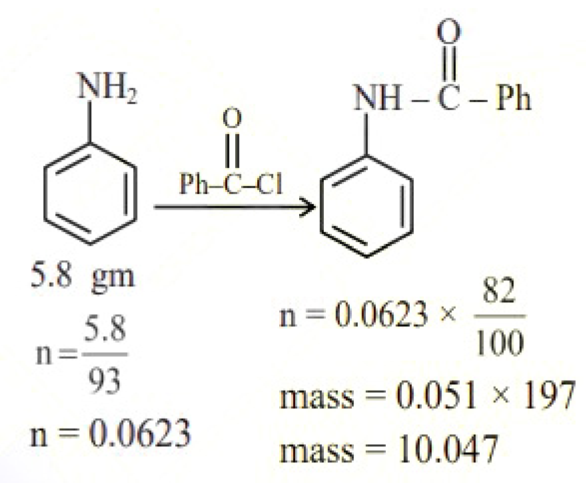
$$E = E° - \frac{0.059}{2}\log\left[\frac{[H^+]^2 \times P_{O_2}^{1/2}}{1}\right]$$

$-0.997 = -1.23 + 0.059 \times \text{pH}$

$\text{pH} = 3.94$

$\text{pH} \approx 4$

Q72 Solution:
(10)



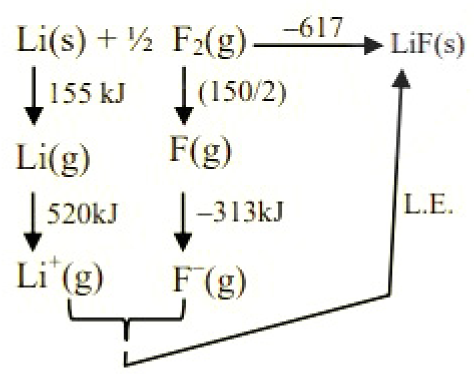
Q73 Solution:
(3)

$Mn_3O_4 = MnO \cdot Mn_2O_3$

$Fe_3O_4 = FeO \cdot Fe_2O_3$ — Only three mixed oxides

$Co_3O_4 = CoO \cdot Co_2O_3$

Q74 Solution:
(1031)



$-594 = 155 + 520 + \frac{150}{2} - 313 + \left(\text{L.E.}\right)$

$\text{L.E.} = -1031 \text{ kJ mol}^{-1}$

Q75 Solution:
(57)

$\frac{E_{a1}}{2.303R} = 1.5 \times 10^4$

$E_{a1} = 1.5 \times 10^4 \times 2.303 \times 8.314$

$E_{a1} = 28.7207 \times 10^4 \text{ J}$

$E_{a1} = 287.207 \text{ kJ}$

$E_{a2} = \frac{E_{a1}}{5} = \frac{287.207}{5} = 57.44 \text{ kJ}$