1 - JEE Main Maths 21-Jan 2026 Shift -1

Q1 Solution:
(2)

$$= \frac{1}{\sin 10°} - \frac{\sqrt{3}}{\cos 10°}$$

$$= \frac{\cos 10° - \sqrt{3}\sin 10°}{\sin 10° \cos 10°}$$

$$= 4\left[\frac{\frac{1}{2}\cos 10° - \frac{\sqrt{3}}{2}\sin 10°}{2\sin 10° \cos 10°}\right]$$

$$= 4\left[\frac{\sin(30° - 10°)}{\sin 20°}\right]$$

$$= 4$$

Q2 Solution:
(3)

$$\left|\vec{c} + \vec{d}\right| = \sqrt{29}$$

$$\vec{c} + \vec{d} = \lambda\left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)$$

$$\lambda = \pm 1$$

$$\lambda(-14 + 6 + 12) = 4\lambda, \quad \lambda_1 = 4, \quad \lambda_2 = -4$$

$$k^2x^2 + \left(k^2 - 5k + 4\right)xy + \left(3k - 2\right)y^2 - 8x + 12y - 4 = 0$$

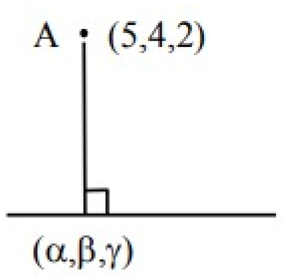
is circle

$$k^2 - 5k + 4 = 0 \Rightarrow k = 1, 4$$

$$k^2 = 3k - 2 \Rightarrow k = 1, 2$$

$$k = 1$$

Q3 Solution:
(1)



$$\vec{r} = \left(-\hat{i} + 3\hat{j} + \hat{k}\right) + \lambda\left(2\hat{i} + 3\hat{j} - \hat{k}\right)$$

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

Any general point P on the line is

$$(2\lambda - 1,\ 3\lambda + 3,\ -\lambda + 1)$$

Let the given point is A (5,4,2).

$\bar{AP}\left(2\lambda - 6\right)\hat{i} + \left(3\lambda - 1\right)\hat{j} + \left(-\lambda - 1\right)\hat{k}$

$\because\ \bar{AP} \perp^r$ Line (L)

$\therefore\ \bar{AP}\cdot\left(2\hat{i} + 3\hat{j} - \hat{k}\right) = 0$

$2(2\lambda - 6) + 3(3\lambda - 1) - 1(-\lambda - 1) = 0$

$\Rightarrow \lambda = 1$

$\therefore \alpha = 1,\ \beta = 6,\ \gamma = 0$

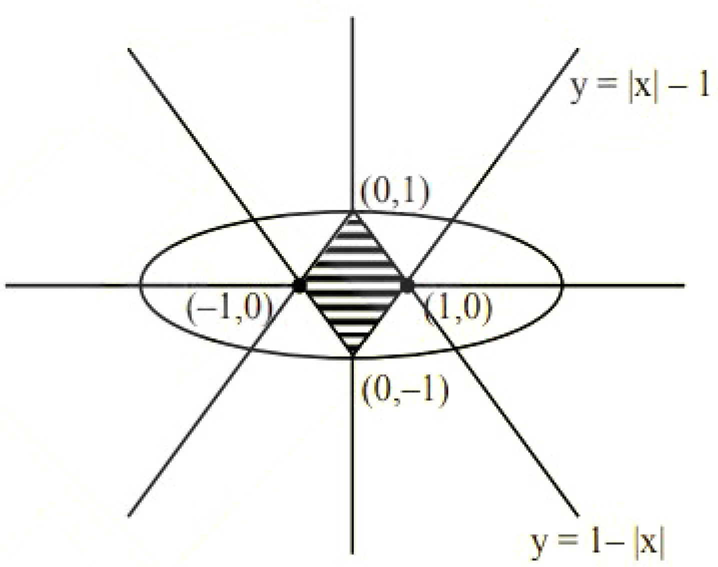
Let the vector $\bar{u} = \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$

$$\bar{u} = \hat{i} + 6\hat{j} + 0\hat{k}$$

and $\bar{w} = 6\hat{i} + 2\hat{j} + 3\hat{k}$

So projection $= \frac{|\bar{u}\cdot\bar{w}|}{|\bar{w}|} = \frac{18}{7}$

Q4 Solution:
(2)



Required area = area of ellipse - shaded area

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

Q5 Solution:
(1)

Number of relation which are reply and sym. both $= 1^4 \times 2^6 = 64$

(a, a) (a, b) (a, c) (a, d)
(b, a) (b, b) (b, c) (b, d)
(c, a) (c, b) (c, c) (c, d)
(d, a) (d, b) (d, c) (d, d)

Q6 Solution:
(3)

$f(x) = \cos^{-1}\left(\frac{2x - 5}{11 - 3x}\right) + \sin^{-1}\left(2x^2 - 3x + 1\right)$

$-1 \le \frac{2x - 5}{11 - 3x} \le 1$

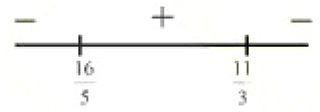
$-1 \le 2x^2 - 3x + 1 \le 1$

$2x^2 - 3x + 2 \geq 0, \quad 2x^2 - 3x \leq 0$

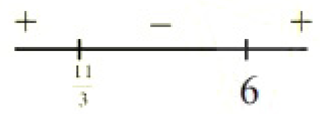
$x \in \left[0, \frac{3}{2}\right] \quad \ldots\ldots\ldots\ldots(\text{i})$

$\frac{2x - 5}{11 - 3x} + 1 \geq 0 \quad \frac{2x - 5}{11 - 3x} - 1 \leq 0$

$\frac{2x - 5 + 11 - 3x}{11 - 3x} \geq 0 \quad \frac{5x - 16}{11 - 3x} \leq 0$



$\frac{6 - x}{11 - 3x} \geq 0$



$x \in \left(- \infty, \frac{16}{5}\right] \cup \left(\frac{11}{3}, \infty \right)$

$x \in \left(- \infty, \frac{11}{3}\right) \cup \left(6, \infty \right)$

Intersection:

$x \in \left(- \infty, \frac{16}{5}\right] \cup \left[6, \infty \right) \quad \ldots.(\text{ii})$

Intersection of (i) & (ii) $x \in \left[0, \frac{3}{2}\right]$

$\alpha = 0, \ \beta = \frac{3}{2} \ \Rightarrow \ \alpha + 2\beta = 3$

Q7 Solution:
(2)

Let e_1 be eccentricity of ellipse

$\Rightarrow e_1 = \sqrt{1 - \frac{16}{36}} = \sqrt{1 - \frac{4}{9}} = \frac{\sqrt{5}}{3}$

So $ae_1 = 6 \cdot \frac{\sqrt{5}}{3} = 2\sqrt{5}$

Now $H: \frac{x^2}{p^2} - \frac{y^2}{q^2} = 1$

$p.e = ae_1$

$p \cdot 5 = 2\sqrt{5}$

$p = \frac{2}{\sqrt{5}} \Rightarrow e^2 = 1 + \frac{q^2}{p^2} \Rightarrow 25 = 1 + \frac{5q^2}{4} \Rightarrow q^2 = \frac{96}{5}$

So length of LR $= \frac{2q^2}{p} = \frac{96}{\sqrt{5}}$

Q8 Solution:
(4)

Let $|x - 1| = t$

$t^2 - 5t + 6 = 0$

$t = 2$ and $t = 3$

$|x - 1| = 2$ and $|x - 1| = 3$

$x - 1 \pm 2$ and $x - 1 = \pm 3$

$x = 1 \pm 2$ and $x = 1 \pm 3$

$\therefore$Roots are $3, -1, 4, -2$

$\therefore$Sum of roots $= 3 + (-1) + 4 + (-2) = 4$

Q9 Solution:
(1)

Mean $(\bar{x}) = 8$ (Given)

$\Rightarrow \frac{2+4+10+x+12+14+y}{7} = 8$

$\Rightarrow x + y = 14 \quad ...(1)$

Variance $(\sigma^2) = 16$ (Given)

$\Rightarrow 16 = \frac{2^2+4^2+10^2+x^2+12^2+14^2+y^2}{7} - 8^2$

$\Rightarrow x^2 + y^2 = 100 \quad ...(2)$

$\because \ (x+y)^2 = x^2 + y^2 + 2xy$

$\Rightarrow xy = 48$ (sum is 14, product is 48)

Since problem states $x > y$

$\therefore \ x = 8$ and $y = 6$

Now set $X = \{1, 2, 3, 4, 6, 5\}$

Now we choose two numbers one after another without replacement

Total outcomes $= 6 \times 5 = 30$

We want the probability that the smaller number among the two is less than 4

$P(\text{smaller} < 4) = 1 - P(\text{smaller} \geq 4)$

$= 1 - \frac{6}{30} = \frac{4}{5}$

Q10 Solution:
(4)

$ar \cdot ar^2 \cdot ar^3 = 64$

$a^3r^6 = 64 \Rightarrow ar^2 = 4$

$a + ar^2 + ar^4 = \frac{813}{7}$

$r^2 = 28$

$ar^2 + ar^4 + ar^6 = ?$

$ar^2(1 + r^2 + r^4) = 4(1 + 28 + 784) = 3252$

Q11 Solution:
(3)

$x^2 + x + 1 = 0$

$\Rightarrow x = \omega$ or ω^2

$\therefore \alpha = \omega,\ \beta = \omega^2$

$= (\omega + \omega^2)^4 + (\omega^2 + \omega^4)^4 + (\omega^3 + \omega^6)^4 + \cdots + (\omega^{25} + \omega^{50})^4$

$= \left[(\omega + \omega^2)^4 + (\omega^2 + \omega^4)^4 + (\omega^4 + \omega^8)^4 + \cdots + (\omega^{25} + \omega^{50})^4\right]$
$+\left[(\omega^3 + \omega^6)^4 + (\omega^6 + \omega^{12})^4 + (\omega^9 + \omega^{18})^4 + \cdots + (\omega^{24} + \omega^{48})^4\right]$

$= \underbrace{[1 + 1 + 1 + \cdots + 1]}_{17 \text{ times}} + \underbrace{\left[(1+1)^4 + (1+1)^4 + \cdots + (1+1)^4\right]}_{8 \text{ times}}$

$= 17 + 128$

$= 145$

Q12 Solution:
(1)

Let $T = \lim_{x \to 1} \left(\frac{f(x+2)}{f(3)}\right)^{\frac{18}{(x-1)^2}}$; 1^∞ form

$\Rightarrow T = e^{\lim_{x \to 1} \frac{18}{(x-1)^2}\left(\frac{f(x+2) - f(3)}{f(3)}\right)}$

$\Rightarrow \quad T = e^{\lim_{x \to 1} \frac{18}{(x-1)^2}\left(\frac{f(x+2) - f(3)}{18}\right)}$

$\Rightarrow T = e^{\lim_{x \to 1}\left(\frac{f(x+2) - f(3)}{(x-1)^2}\right)\frac{0}{0}\text{form}}$ apply L' opital

$\Rightarrow T = e^{\lim_{x \to 1}\frac{f'(x+2)}{2(x-1)};\frac{0}{0}\text{form}}$ apply L' opital

$\Rightarrow \quad T = e^{\lim_{x \to 1}\frac{f''(x+2)}{2}}$; $= e^{\frac{4}{2}} = e^2$

$\Rightarrow \log_e(T) = 2$

Q13 Solution:
(3)

$(ax^2 + bx + c)\sum_{r=0}^{26} {}^{26}C_r(-2x)^r$

Coeff. of x^2: $a \cdot {}^{26}C_0(-2)^0 + b \cdot {}^{26}C_1(-2) + c \cdot {}^{26}C_2(-2)^2 = 0$

$\Rightarrow a - 52b + 1300c = 0 \quad ...(1)$

Coeff. of x^3: $a \cdot {}^{26}C_1(-2) + b \cdot {}^{26}C_2(-2)^2 + c \cdot {}^{26}C_3(-2)^3 = 0$

$\Rightarrow -52a + 1300b - 20800c = 0 \quad ...(2)$

Coeff. of $x = -56$

$\Rightarrow b \cdot {}^{26}C_0(-2)^0 + c \cdot {}^{26}C_1(-2)^1 = -56$

$\Rightarrow b - 52c = -56 \quad ...(3)$

After solving (1), (2) & (3)

$a = 1300,\ b = 100,\ c = 3$

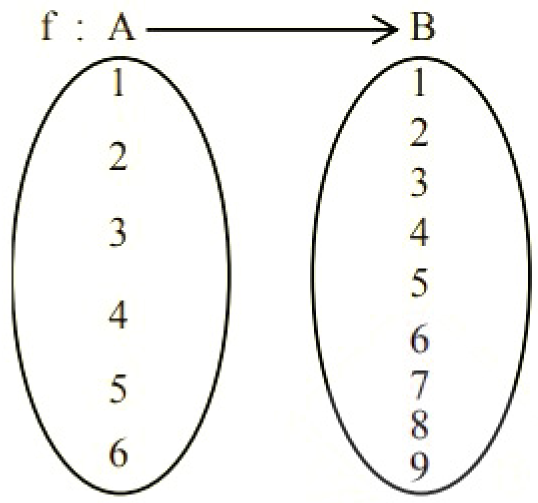
$\Rightarrow a + b + c = 1403$

Q14 Solution:
(1)

$f(i) \neq i$, $f(x)$ is strictly increasing function

$f: A \to B$, where $A = \{1, 2, 3, \dots, 6\}$

$B = \{1, 2, 3, \dots, 9\}$, then number of functions $f: A \to B$ is equal to



$f(i) \neq i$ Case (i) $f(1) = 2 \Rightarrow {}^7C_5 = 21$

Case (ii) $f(1) = 3 \Rightarrow {}^6C_5 = 6$

Case (iii) $f(1) = 4 \Rightarrow {}^5C_5 = 1$

Number of functions from A to B $= 21 + 6 + 1 = 28$

Q15 Solution:
(3)

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

$\vec{b} = 8\hat{i} + 7\hat{j} - 3\hat{k}$

$\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$

$\vec{a} \times \vec{c} = \vec{b} \Rightarrow \left(2c_3 - 2c_2\right)\hat{i} + \left(c_3 + 2c_1\right)\hat{j} - \left(c_2 + 2c_1\right)\hat{k} = 8\hat{i} + 7\hat{j} - 3\hat{k}$

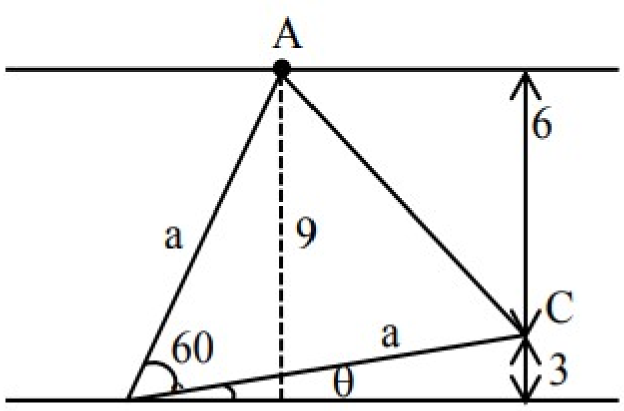
$2c_3 - 2c_2 = 8$, $c_3 + 2c_1 = 7$, $c_2 + 2c_1 = 3$

$\left(c_1\hat{i} + c_2\hat{j} + c_3\hat{k}\right) \cdot \left(\hat{i} + \hat{j} + \hat{k}\right) = 4$

$\Rightarrow c_1 + c_2 + c_3 = 4$, $c_1 = 2$, $c_2 = -1$, $c_3 = 3$

$\left|\vec{a} + \vec{c}\right|^2 = \left|\hat{i} + \hat{j} + 5\hat{k}\right|^2 = 27$

Q16 Solution:
(3)



$\sin\theta = \frac{3}{a}$

$\sin\left(60° + \theta\right) = \frac{9}{a}$

$\frac{\sqrt{3}}{2}\cos\theta + \frac{1}{2}\sin\theta = \frac{9}{a}$

$\sqrt{3}\sqrt{1 - \frac{9}{a^2}} + \frac{3}{a} = \frac{18}{a}$

$a = \sqrt{84}$

Area of $\Delta ABC = \frac{\sqrt{3}}{4}a^2 = \frac{\sqrt{3}}{4} \times 84 = 21\sqrt{3}$

Q17 Solution:
(2)

$\frac{dy}{dx} + \frac{y}{x^2 + 1} = \frac{\tan^{-1}x}{x^2 + 1}$

I.F. $= e^{\tan^{-1}x}$

$y \times e^{\tan^{-1}x} = \int e^{\tan^{-1}x} \cdot \frac{\tan^{-1}x}{1 + x^2}dx$

$y \times e^{\tan^{-1}x} = \tan^{-1}x\left(e^{\tan^{-1}x}\right) - e^{\tan^{-1}x} + c$

$y\left(0\right) = 1 \Rightarrow c = 2$

$y\left(1\right) = \frac{2}{e^{\pi/4}} + \frac{\pi}{4} - 1$

Q18 Solution:
(4)

$= 2\pi\int_0^{\pi/6} \frac{1}{1 - \sin\left(x + \frac{\pi}{6}\right)}dx$ let $x + \frac{\pi}{6} = t \Rightarrow dx = dt$

$= 2\pi\int_{\pi/6}^{\pi/3} \frac{dt}{1 - \sin t} = 2\pi\int_{\pi/6}^{\pi/3} \frac{1 + \sin t}{\cos^2 t}dt$

$= 2\pi\left[\int_{\pi/6}^{\pi/3} \sec^2 t\,dt + \int_{\pi/6}^{\pi/3} \sec t \tan t\,dt\right]$

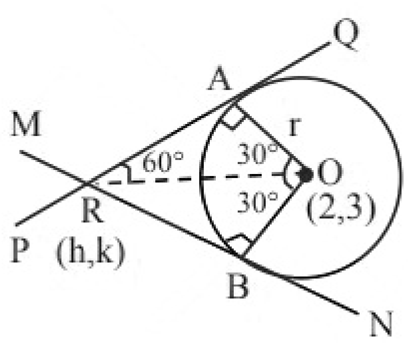
$= 2\pi\left[(\tan t)_{\pi/6}^{\pi/3} + (\sec t)_{\pi/6}^{\pi/3}\right]$

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

$= 2\pi\left[\sqrt{3} + 2 - \sqrt{3}\right] = 4\pi$

Q19 Solution:
(1)

Given Circle



$x^2 + y^2 - 4x - 6y - 3 = 0$

$C(2, 3)$ and $r = 4$

$\cos 30° = \frac{r}{OR} = \frac{4}{OR}$

$\Rightarrow OR = \frac{8}{\sqrt{3}}$

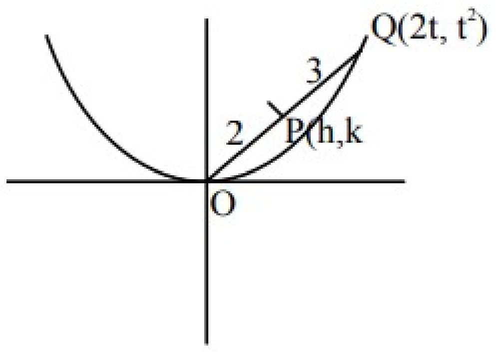
Now

$OR^2 = (h - 2)^2 + (k - 3)^2$

$\Rightarrow 3(x^2 + y^2) - 12x - 18y - 25 = 0$

Q20 Solution:
(3)

$h = \frac{4t}{5}$



$k = \frac{2t^2}{5} = \frac{2}{5}\left(\frac{5h}{4}\right)^2$

$8k = 5h^2$

$\Rightarrow 5x^2 = 8y$

$T = S_1$

$5(xx_1) - 4(y + y_1) = 5x_1^2 - 8y_1$

$5x - 4(y + 2) = 5 - 8 \cdot 2$

$5x - 4y + 3 = 0$

Q21 Solution:
(1333)

$S = \{1, 2, 3, \ldots, 50\}$

$p = (6^m + 9^n)$ is divisible by 5

No. of ways

$6^m = (5\lambda + 1)^m = 5k + 1$

$9^n = (10 - 1)^n = 10\mu - 1$ if n is odd

$\Rightarrow n$ must be odd

$10\mu + 1$ if n is even

$\Rightarrow$ No. of ways $= 50 \times 25 = 1250$

$q \Rightarrow (m + n)$ is square of a prime

	$m+n=4$	$m+n=9$	$m+n=25$	$m+n=49$
No. of	↓	↓	↓	↓
ways	3	8	24	48

$q = 3 + 8 + 24 + 48 = 83$

$= p + q = 1250 + 83 = 1333$

Q22 Solution:
(225)

$\text{Tr}(A) = 4 \Rightarrow \alpha + 2 = 4 \Rightarrow \alpha = 2$

$\text{Tr}(B) = 3 \Rightarrow \beta + 1 = 3 \Rightarrow \beta = 2$

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

$A^3 = 4A^2 - 2A = 16A - 8I - 2A = 14A - 8I$

$= \begin{bmatrix} 28 & 28 \\ 14 & 28 \end{bmatrix} + \begin{bmatrix} -8 & 0 \\ 0 & -8 \end{bmatrix}$

$= A^3 = \begin{bmatrix} 20 & 28 \\ 14 & 20 \end{bmatrix}$

$B^2 - 3B + I = 0$

$B^2 = 3B - I$

$\Rightarrow B^3 = 3B^2 - B = 3\left(3B - I\right) - B = 8B - 3I$

$B^3 = \begin{bmatrix} 8 & 8 \\ 8 & 16 \end{bmatrix} + \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix} = \begin{bmatrix} 5 & 8 \\ 8 & 13 \end{bmatrix}$

$A^3 - B^3 = \begin{bmatrix} 20 & 28 \\ 14 & 20 \end{bmatrix} - \begin{bmatrix} 5 & 8 \\ 8 & 13 \end{bmatrix} = \begin{bmatrix} 15 & 20 \\ 6 & 7 \end{bmatrix}$

$\Rightarrow \left|A^3 - B^3\right| = 105 - 120 = -15$

$\Rightarrow \left|\text{adj}\left(A^3 - B^3\right)\right| = \left|A^3 - B^3\right| = -15$

$\Rightarrow |\text{adj}\left(A^3 - B^3\right)|^2 = 225$

Q23 Solution:
(2)

$a_{n+1} - \frac{1}{2}a_n = \frac{n^2 - 2n - 1}{n^2(n+1)^2} = \frac{2n^2 - (n+1)^3}{n^2(n+1)^2}$

$\Rightarrow a_{n+1} - \frac{1}{2}a_n = \frac{2}{(n+1)^2} - \frac{1}{n^2}$

For $n = 1$,

$a_2 - \frac{1}{2}a_1 = \frac{2}{2^2} - \frac{1}{1^2}$

$2\left[a_3 - \frac{1}{2}a_2 = \frac{2}{3^2} - \frac{1}{2^2}\right]$

$2^2\left[a_4 - \frac{1}{2}a_3 = \frac{2}{4^2} - \frac{1}{3^2}\right]$

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

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

Adding,

$$a_{n+1} = \frac{2}{(n+1)^2} - \frac{1}{2^n} \quad \Rightarrow \quad a_n = \frac{2}{n^2} - \frac{1}{2^{n-1}}$$

$$\Rightarrow \left|\sum_{n=1}^{\infty}\left(a_n - \frac{2}{n^2}\right)\right| = \left|\sum_{n=1}^{\infty} - \frac{1}{2^{n-1}}\right| = 2$$

Q24 Solution:
(17)

$$6\int_0^{\pi} |2\sin 2x\cos x + \sin 2x| dx$$

$$= 6\int_0^{\pi} \left|4\sin x\cos^2 x + 2\sin x\cos x\right| dx$$

$$I = 12\int_0^{\pi} \left|\sin x\left(2\cos^2 x + \cos x\right)\right| dx$$

Put $\cos x = t, \;\; -\sin x dx = dt$

$$I = -12\int_1^{-1} \left|2t^2 + t\right| dt$$

$$I = 12\left(\int_{-1}^{-\frac{1}{2}}\left(2t^2 + t\right)dt + \int_{-\frac{1}{2}}^{0} -\left(2t^2 + t\right)dt + \int_0^1\left(2t^2 + t\right)dt\right)$$

$$I = 17$$

Q25 Solution:
(1)

Given quadratic equation has equal roots, thus

$$D = 0 \Rightarrow \left(f'(x)\right)^2 = f''\left(x\right) \cdot f\left(x\right)$$

$$\frac{f'(x)}{f(x)} = \frac{f''(x)}{f'(x)}$$

Integrate,

$$ln(f(x)) = ln(f'(x)) + \ln C \Rightarrow f(x) = c \;\; f'(x)$$

Put $x = 0$,

$$1 = c \cdot 2 \Rightarrow c = \frac{1}{2}$$

Now, $2f(x) = f'(x)$

$$\Rightarrow \frac{f'(x)}{f(x)} = 2$$

Integrate,

$$ln(f(x)) = 2x + d$$

$$\Rightarrow d = 0$$

$$\Rightarrow ln\left(f\left(x\right)\right) = 2x \Rightarrow f\left(x\right) = e^{2x}$$

Now let $g\left(x\right) = f\left(lnx - x\right) = e^{2(lnx - x)}$

$$\therefore \;\; g'\left(x\right) = 2e^{2(lnx - x)}\left(\frac{1}{x} - 1\right) \geq 3$$

$$\Rightarrow \frac{1-x}{x} \geq 0$$

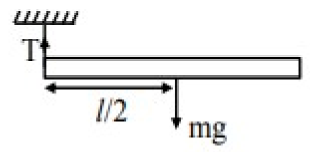
$$\Rightarrow x \in (0, 1]$$

$$\Rightarrow \alpha = 0, \; \beta = 1$$

$\alpha + \beta = 1$.

2 - JEE Main Physics 21-Jan 2026 Shift -1

Q26 Solution:
(2)



$mg\frac{l}{2} = \frac{ml^2}{3}\alpha$

$\alpha = \frac{3g}{2l} \quad \ldots (1)$

$mg - T = ma_c$

$T = mg - ma_c$

$= mg - m\left(\frac{l}{2}\alpha\right)$

$= mg - m\left(\frac{l}{2} \cdot \frac{3g}{2l}\right)$

$T = \frac{mg}{4}$

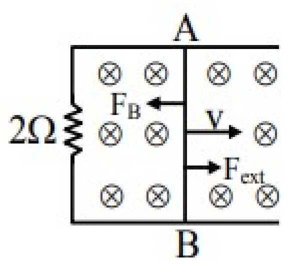
Q27 Solution:
(4)

To maintain constant speed

$F_{\text{ext}} = F_B$

$\Rightarrow \ F_{\text{ext}} = ilB$

$= \left(\frac{vBl}{R}\right) lB$



$= \frac{B^2 l^2 v}{R}$

$= \frac{(0.1)^2 \times (1)^2 \times 1.5}{2}$

$= 7.5 \times 10^{-3}$ N

Q28 Solution:
(4)

Water flow rate $= 5\ \ell\ /\ \text{min} = \frac{5}{60}\text{kg/s}$

$\therefore$ Power of heater $= \frac{dm}{dt} S \Delta T = \frac{1}{12} \times 4200 \times 60$ W

$\therefore$ Let rate of consumption of gas be x g/s.

$\therefore \ x \times 5.0 \times 10^4 = \frac{1}{12} \times 4200 \times 60$

$\Rightarrow \quad x = 4200 \times 10^{-4} = 0.42 \text{ g/s}$

Q29 Solution:
(3)

From continuity equation

$A_A V_A = A_B V_B \Rightarrow 6V_A = 3V_B \Rightarrow V_B = 2V_A$

Applying Bernoulli's equation between A & B,

$$P_A + \frac{1}{2}\rho V_A^2 = P_B + \frac{1}{2}\rho V_B^2$$

$$\Rightarrow \rho g \times 0.05 = \frac{1}{2}\rho\left[V_B^2 - V_A^2\right] = \frac{1}{2}\rho\left(3V_A^2\right)$$

$$\Rightarrow V_A = \sqrt{\frac{2g \times 0.05}{3}} \text{ m/s} = \frac{1}{\sqrt{3}} \text{ m/s} = \frac{100}{\sqrt{3}} \text{ cm/s}$$

$$\Rightarrow \text{Volume flow rate} = A_A V_A = \frac{6 \times 100}{\sqrt{3}} \text{cm}^3 / \text{sec}$$

$$= 200\sqrt{3} \text{ cm}^3 / \text{sec}$$

Q30 Solution:
(2)

Area of the loop = 1 m^2

$B = \sin(100t)$

$\therefore \quad \phi = BA = \sin\left(100t\right)$

$\therefore \quad \frac{d\phi}{dt} = 100\cos\left(100t\right)$

$\therefore \quad P = \frac{V^2}{R} = \frac{10^4 \cos^2\left(100t\right)}{100}$

$\therefore \quad$ Thermal energy dissipated in 1 time period

$$= \int_0^T P\,dt = \int_0^T 100\cos^2\left(100t\right) dt$$

$$T = \frac{2\pi}{100} = \frac{\pi}{50} \text{ sec}$$

$$\therefore \quad Q = 100 \int_0^{\pi/50} \cos^2\left(100t\right) dt$$

$$= 100 \int_0^{\pi/50} \frac{1 + \cos(200t)}{2} dt$$

$$= 100\left[\frac{\pi}{100}\right] = \pi$$

Q31 Solution:
(2)

Energy conservation

$K_i + U_i = K_f + U_f$

$7.7 \times 10^6 \times 1.6 \times 10^{-19} + 0$

$$= 0 + \frac{9 \times 10^9 \left(1.6 \times 10^{-19}\right)\left(79 \times 1.6 \times 10^{-19}\right)}{r}$$

$r = 2.95 \times 10^{-14}$

Q32 Solution:
(3)

Energy of a satellite in a circular orbit is given as

$E = \frac{-GM_E m}{2r}$; $r =$ radius of circular orbit

Required energy to be supplied $= \Delta E = E_f - E_i$

$$\Delta E = \left(\frac{-GM_E m}{2(3R_E)}\right) - \left(\frac{-GM_E m}{2(1.5R_E)}\right)$$

$$= \frac{GM_E m}{6R_E}$$

Now, $g = \frac{GM_E}{R_E^2} \Rightarrow \frac{GM_E}{R_E} = gR_E$

$\therefore \quad \Delta E = \frac{1}{6} gmR_E$

$$= \frac{1}{6} \times 10 \times 100 \times 6 \times 10^6$$

$$= 1000 \times 10^6$$

$\alpha = 1000$

Q33 Solution:
(3)

$\omega_1 = 3 \times 10^{15}$ rad/sec

$\omega_2 = 12 \times 10^{15}$ rad/sec

$\because \ \nu = \frac{\omega}{2\pi}$

$E_{\text{photon}} = h\nu = 6.6 \times 10^{-34} \times 1.91 \times 10^{15}$

$$= 1.26 \times 10^{-18} \text{ J}$$

$E_{\max} = \frac{1.26 \times 10^{-18}}{1.6 \times 10^{-19}} \approx 7.9 \text{ eV}$

$K_{\max} = E_{\max} - \phi_0$

$$= 7.9 - 2.8$$

$K_{\max} = 5.1 \text{ eV}$

Q34 Solution:
(1)

For parallel combination of spring,

$K_{\text{eq}} = K_1 + K_2 = 30 \text{ N/m}$

$\Delta K_{\text{eq}} = \Delta K_1 + \Delta K_2 = 0.2 + 0.3 = 0.5 \text{ N/m}$

$\therefore \quad \%$ Error in $K = \frac{0.5}{30} \times 100 = 1.67\%$

Q35 Solution:
(1)

$\vec{F} = 4t^3\hat{i} - 3t\hat{j}$

$\vec{a} = \frac{\vec{F}}{m} = t^3\hat{i} - \frac{3}{4}t\hat{j}$

$a_x = t^3$ $\qquad$ $a_y = -\frac{3}{4}t$

$\frac{dv_x}{dt} = t^3$ $\qquad$ $\frac{dv_y}{dt} = -\frac{3}{4}$

$\int_{v_x = 0}^{v_{x_2}} dv_x = \int_{t=0}^{t=2} t^3 dt$ $\qquad$ $\int_0^{v_{y_2}} dv_y = \int_0^2 -\frac{3}{4}t dt$

$v_{x_2} - 0 = \left[\frac{t^4}{4}\right]_0^2$ $\qquad$ $v_{y_2} = -\frac{3}{4}\left[\frac{t^2}{2}\right]_0^2$

$v_{x_2} = 4$ $\qquad$ $v_{y_2} = \frac{-3}{2}$

$$\vec{v}_2 = 4\hat{i} - \frac{3}{2}\hat{j}$$

$v_x = \frac{t^4}{4}$ $\qquad$ $v_y = -\frac{3}{8}t^2$

$\int_0^{x_2} dx = \int_0^2 \frac{t^4}{4} dt$ $\qquad$ $\int_0^{y_2} dy = \int_0^2 \frac{-3}{8}t^2 dt$

$x_2 - 0 = \left[\frac{t^5}{20}\right]_0^2$ $\qquad$ $y_2 - 0 = \frac{-3}{8}\left[\frac{t^3}{3}\right]_0^2$

$x_2 = \frac{8}{5}$ $\qquad$ $y_2 = -1$

$$\vec{r} = \frac{8}{5}\hat{i} - \hat{j}$$

Q36 Solution:
(3)

Work done by external agent :

$W_{\text{ext}} = \Delta U;$

$\Delta U \rightarrow$ Change in potential energy in taking the charge from initial to final configuration

$\Rightarrow \quad W_{\text{ext}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_f} - \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_i}$

Now, $r_f = \sqrt{(2-0)^2 + (2-0)^2 + (1-0)^2} = 3 \text{ m}$

$r_i = \sqrt{(4-0)^2 + (4-0)^2 + (2-0)^2} = 6 \text{ m}$

$\therefore \quad W_{\text{ext}} = \left(9 \times 10^9\right) \times \left(10^{-8} \times 2 \times 10^{-6}\right)\left[\frac{1}{3} - \frac{1}{6}\right]$

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

$= 30 \times 10^{-6} \text{ J}$

Q37 Solution:
(3)

$d\sin\theta = \left(\mu - 1\right)t$

$d\left[\frac{x}{D}\right] = \left(\mu - 1\right)t$

$t = \frac{xd}{D\left(\mu - 1\right)}$

$= \frac{(0.2)(0.1)}{50(1.5-1)}$

$t = 8 \times 10^{-4} \text{ cm}$

Q38 Solution:
(4)

$$\ell_{\text{final}} = \ell_0\left(1+\alpha_A \Delta T\right) + \ell_0\left(1+\alpha_B \Delta T\right)$$

$$= \ell_0\left[2+\left(\alpha_A+\alpha_B\right)\Delta T\right]$$

$$= 60\left[2+\left(36\times 10^{-6}\right)\times 70\right]$$

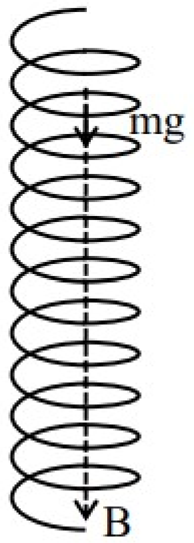
$$= 60[2+0.0025]$$

$$= 120.15\text{ cm}$$

Q39 Solution:
(2)

Since the solenoid is placed vertically, the magnetic field inside the solenoid will be either along $-y$ or $+y$ axis.

$\Rightarrow$ Particle will gain velocity along $-y$ axis.



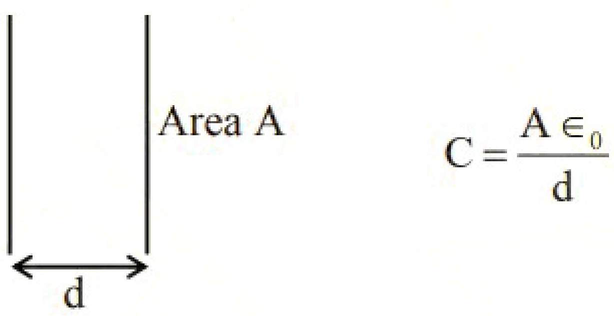
$\Rightarrow \vec{F}_B = q\left(\vec{v}\times\vec{B}\right)$

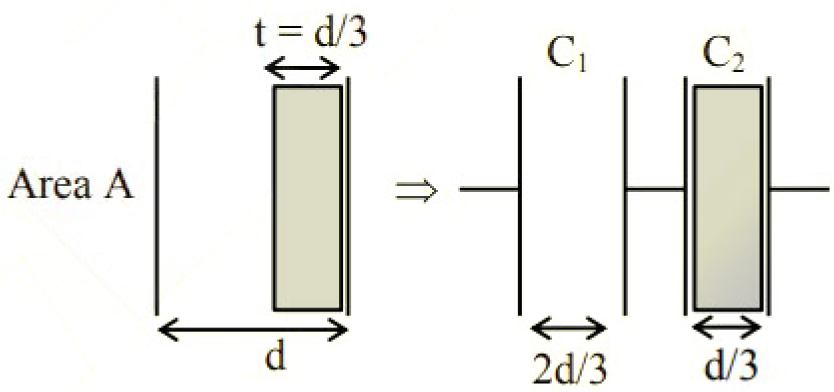
$\Rightarrow \vec{F}_B = 0$

$\Rightarrow \vec{F}_{\text{net}} = m\vec{g}$

$\Rightarrow a_{\text{net}} = g$

Q40 Solution:
(3)





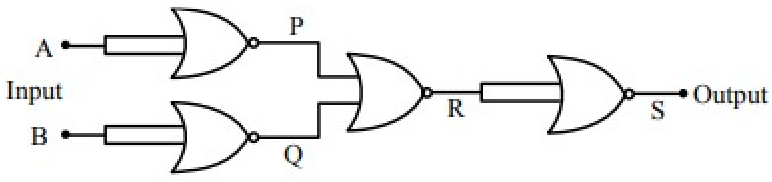
$C_1 = \frac{3A\varepsilon_0}{2d} \qquad C_2 = \frac{3A\varepsilon_0\times K}{d}$

$C_1 = \frac{3}{2}C \qquad C_2 = 3KC$

$C_{eq} = \frac{C_1C_2}{C_1 + C_2} = \frac{\frac{3}{2}C \times 3KC}{\frac{3}{2}C + 3KC}$

$C_{eq} = \frac{\frac{9}{2}KC^2}{\frac{3}{2}C\left(2K+1\right)} = \frac{3KC}{2K+1}$

Q41 Solution:
(4)



$P = \overline{A}$

$Q = \overline{B}$

$R = \overline{\overline{A} + \overline{B}} = \overline{\overline{AB}} = AB$

$S = \overline{AB} \qquad \Rightarrow$ NAND Gate

Q42 Solution:
(2)

$\hat{B} = \hat{c} \times \hat{E}$

$\Rightarrow \ \hat{c} = \hat{i}$ because phase of electric field is function of x.

$\Rightarrow \ \hat{E} = \hat{j}$ (given)

$\Rightarrow \ \hat{B} = \hat{i} \times \hat{j} = \hat{k}$

$|B| = \frac{|E|}{c} = \frac{69 \times 0.6 \times 10^3}{1.8 \times 10^{11}} = \frac{69}{3 \times 10^8}$

$|B| = 2.9 \times 10^{-7}$

$\overrightarrow{B_2} = 2.9 \times 10^{-7} \sin\left(0.6 \times 10^3 x - 1.8 \times 10^{11} t\right)$

(phase is same as that of electric field)

Q43 Solution:
(1)

Slope of potential energy v/s position curve gives negative of force.

$\therefore \ F_{BC} > F_{AB} > F_{DE} > F_{CD}$

Q44 Solution:
(1)

Given $L_A = 2.5$ m, $L_B = 1.5$ m, $T = 500$ N

$v_A = \sqrt{\frac{T}{\mu_A}} = \sqrt{\frac{500}{2 \times 10^{-4}}} = 5\sqrt{10} \times 10^2$ m/s

$v_B = \sqrt{\frac{T}{\mu_B}} = \sqrt{\frac{500}{4 \times 10^{-4}}} = 5\sqrt{5} \times 10^2$ m/s

$t_1 = \frac{L_A}{v_A} = \frac{2.5}{5\sqrt{10}} \times 10^{-2}$ s

$t_2 = \frac{L_B}{v_B} = \frac{1.5}{5\sqrt{5}} \times 10^{-2}$ s

$\therefore \quad \frac{t_1}{t_2} = \frac{2.5}{5\sqrt{10}} \times \frac{5\sqrt{5}}{1.5} = \frac{5}{3} \times \frac{1}{\sqrt{2}} = \frac{1.66}{1.41} = 1.18$

Q45 Solution:

(1)

$\Rightarrow \quad [P] = \left[\frac{A}{Bt^2}\right] \quad .....(1)$

$\Rightarrow \quad [h] = [Bt] \quad .....(2)$

$\Rightarrow \quad [B] = \left[\frac{h}{t}\right] = \left[\frac{L}{T}\right] = [LT^{-1}]$

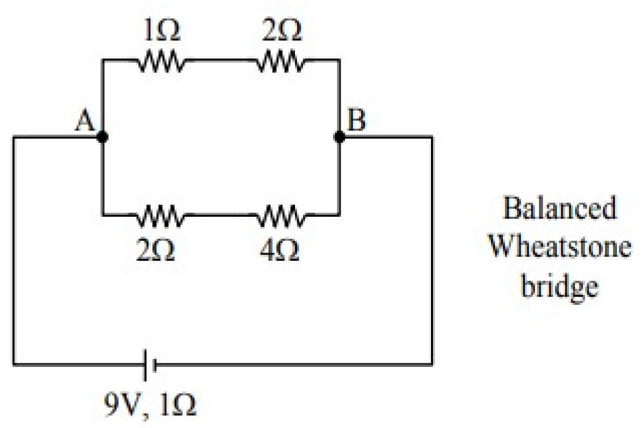
Putting B in equation (1)

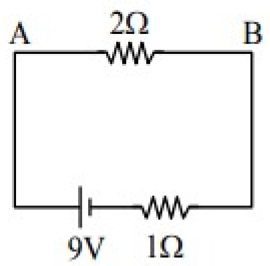
$[ML^{-1}T^{-2}] = \left[\frac{A}{LT^{-1} \times T^2}\right]$

$[A] = [ML^0T^{-1}]$

Q46 Solution:

(1080)





$i = \frac{9}{3} = 3\text{A}$

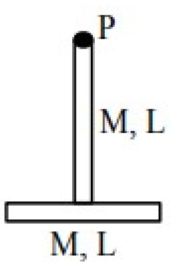
$\therefore \quad H_{AB} = i^2 R_{AB} t$

$= (3)^2 \times 2 \times 60 = 1080\text{J}$

Q47 Solution:

(17)

$I = \frac{ML^2}{3} + \left(\frac{ML^2}{12} + ML^2\right)$



$= \frac{4ML^2 + ML^2 + 12ML^2}{12}$

$I = \frac{17}{12}ML^2$

$\therefore \quad x = 17$

Q48 Solution:
(100)

$m = \frac{lD}{f_0 f_e}$

$= \frac{32}{2} \times \frac{25}{4}$

$m = 100$

Q49 Solution:
(500)

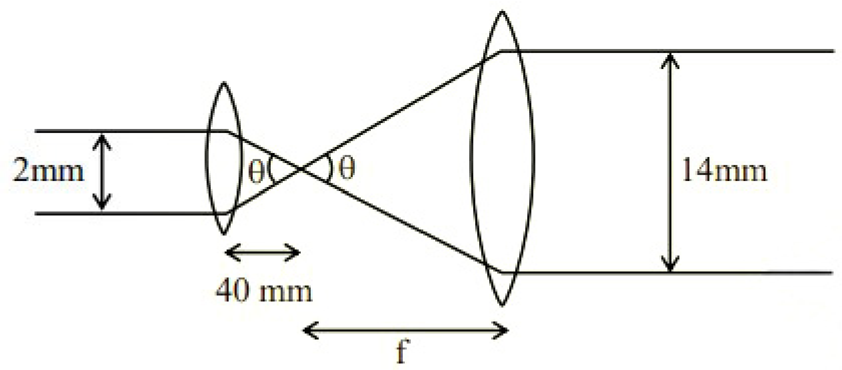
$\Delta U = nC_V \Delta T$

$= n(C_P - R)\Delta T$

$= 10(7 - 2)(40 - 30)$

$\Delta U = 500$

Q50 Solution:
(280)

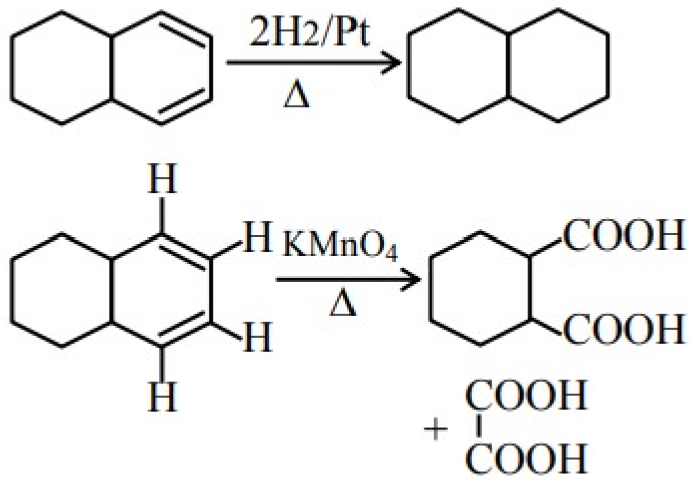


$\frac{40}{2} = \frac{f}{14}$

$\Rightarrow \quad f = 280\text{mm}$

3 - JEE Main Chemistry 21-Jan 2026 Shift -1

Q51 Solution:
(2)



Q52 Solution:
(4)

$$Ca_{(s)} + 2HCl_{(g)} \rightarrow CaCl_{2(s)} + H_{2(g)}$$

$\frac{14}{40}$ excess - -

= 0.35 mole 0.35 mole 0.35 mole

Volume of $H_{2(g)}$ evolved $= 0.35 \times 22.4 = 7.84$ L

(4) is wrong because weight of $CaCl_2 = 0.35 \times 111 = 38.85$ g

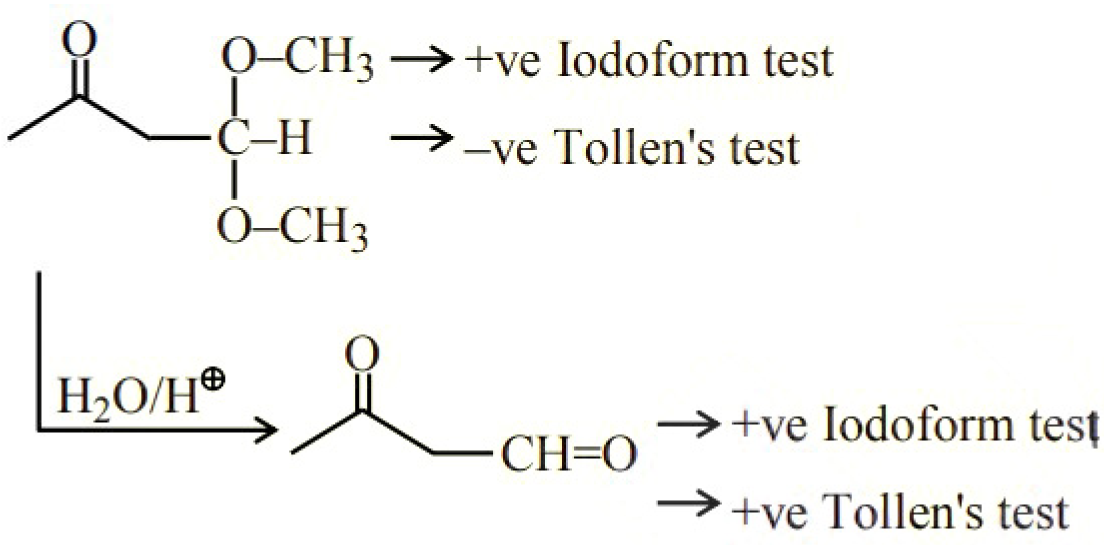
Q53 Solution:
(4)

$$\underset{\text{(Hot solution)}}{PbCl_2} + K_2CrO_4 \rightarrow \underset{(A)}{PbCrO_4} + 2KCl$$

$$PbCrO_4 + 4NaOH\ (\text{excess}) \rightarrow \underset{(B)}{Na_2[Pb(OH)_4]} + Na_2CrO_4$$

$$PbSO_4 + 4CH_3COONH_4 \rightarrow \underset{(X)}{(NH_4)_2[Pb(CH_3COO)_4]} + (NH_4)_2SO_4$$

Q54 Solution:
(2)



Q55 Solution:
(4)

$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For 1st line of Lyman series in H-atom

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

$\frac{1}{\lambda} = \frac{3R}{4}$

For 2nd line of Balmer series of He^+

$\frac{1}{\lambda'} = R(2)^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$

$\frac{1}{\lambda'} = \frac{3R}{4}$

As λ and λ' are equal, so frequency of these lines will also be equal.

Q56 Solution:
(4)

Statement-I

SF_4 (See-saw)

XeF_4 (square planar),

$[PtCl_4]^{2-}$ (square planar),

$[NiCl_4]^{2-}$ (Tetrahedral),

$[Ni(CN)_4]^{2-}$ (square planar),

SeF_4 (See-saw)

NH_4^+ (Tetrahedral)

Statement-II

NO_2 (seven electrons on N)

BeH_2 (four electrons on Be)

BF_3 (six electrons on B)

$AlCl_3$ (six electrons on Al)

Q57 Solution:
(2)

$$\frac{n_{BaSO_4} \times 32}{W_{(\text{unknown comp.})}} \times 100$$

$$= \frac{1.2 \times 32}{233} \times \frac{100}{0.75} = 21.97\%$$

Q58 Solution:
(1)

$[Cu(NH_3)_4]^{2+} \Rightarrow d^9,\ dsp^2$ one unpaired electron

$[Ni(en)_3]^{2+} \Rightarrow d^8,\ sp^3d^2$ two unpaired electrons

$[Ni(NH_3)_6]^{2+} \Rightarrow d^8,\ sp^3d^2$ two unpaired electrons

$[Mn(H_2O)_6]^{2+} \Rightarrow d^5,\ sp^3d^2$ five unpaired electrons

$[Ni(CO)_4]$ (diamagnetic)

$[NiCl_4]^{2-}$ (paramagnetic)

$[Ni(CN)_4]^{2-}$ (diamagnetic)

Q59 Solution:
(2)

· Histidine does contain heterocyclic ring.

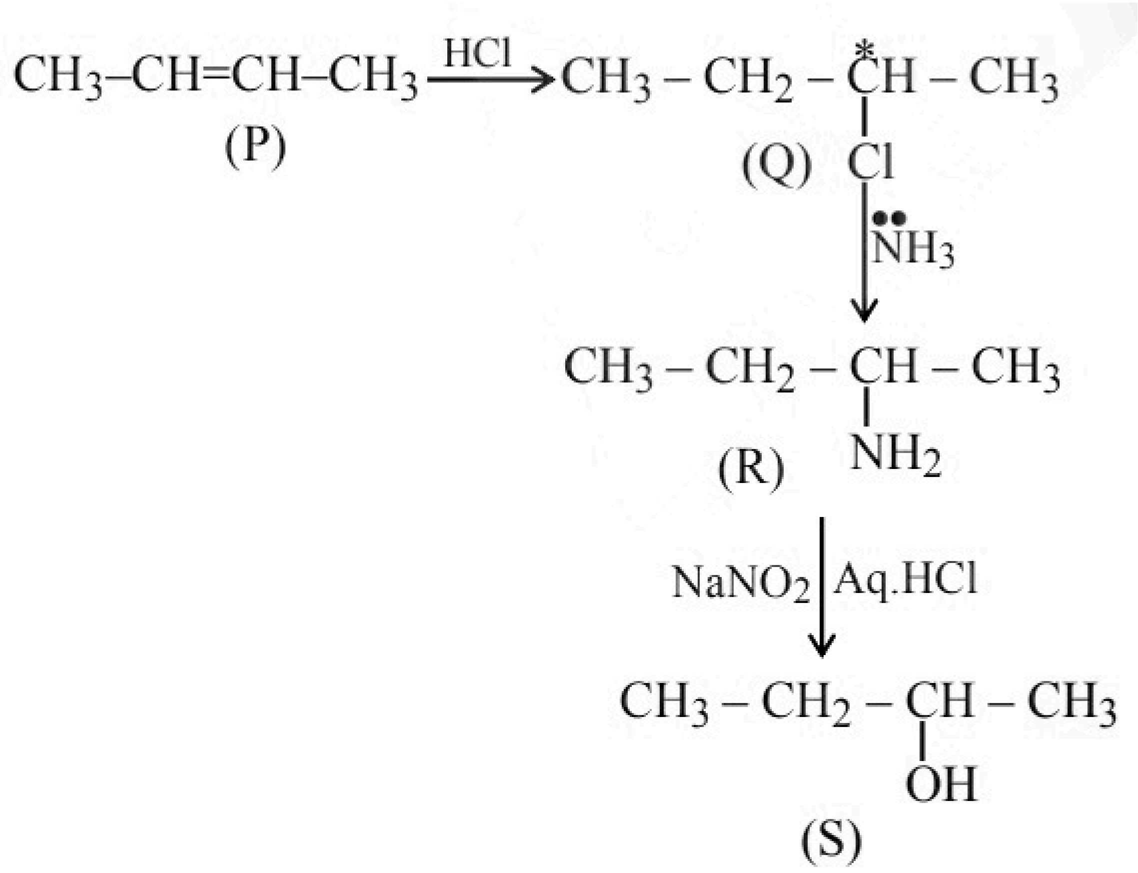
· Proline is a five membered cyclic ring amino acid.

· Cysteine has characteristic feature of side chain as $CH_2 - SMe$.

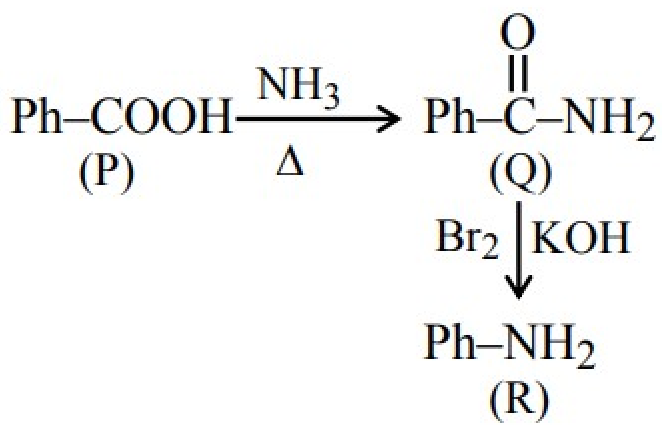
Q60 Solution:
(4)

$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$

Q61 Solution:
(4)



Q62 Solution:
(1)



Q63 Solution:
(4)

⇒ SiO_2, CO_2, GeO, GeO_2 are acidic in nature.

SnO, SnO_2, PbO, PbO_2 are amphoteric in nature.

⇒ BF_3 is Lewis acid according to Lewis octet theory and has sp^2 hybridization with trigonal planar geometry and it can accept lone pair from ammonia to form adduct.

Q64 Solution:
(4)

$(\Delta T_b)_{PQ} = K_b m$

$1.176 = 5 \times \frac{1}{M_1} \times \frac{1000}{50}$

$M_1 = 85.03$

$(\Delta T_b)_{PQ_2} = 5 \times \frac{1}{M_2} \times \frac{1000}{50} = 0.689$

$M_2 = 145.13$

Let molar mass of P & Q are M_P and M_Q respectively

$M_P + M_Q = 85.03$

$M_P + 2M_Q = 145.13$

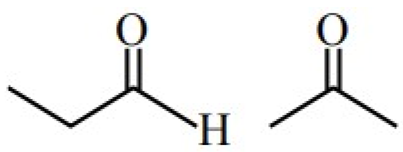
$M_P = 24.93 \approx 25$

$M_Q = 60.1 \approx 60$

Q65 Solution:
(2)

Area under the P v/s V curve, is equal to magnitude of work.
In option (2) work done is zero while in remaining options net work done is negative due to expansion.
NTA has given the answer without considering the negative sign that is considered only magnitude.

Q66 Solution:
(2)



are Functional isomer

$CH_3–CH=CH–CH_3$ & $CH_3–CH_2–CH=CH_2$

Are Positional isomer

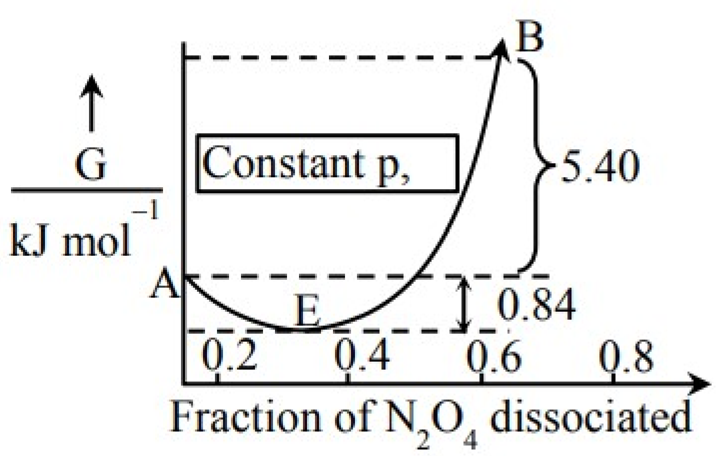
$CH_3–CH_2–O–CH_2–CH_3$ & $CH_3–CH_2–CH_2–O–CH_3$

are Metamer

$CH_3–CH=CH–CH_3$ does not have optical isomer


Chain isomer

Q67 Solution:
(2)



(A) $\Delta_r G° = G_B° - G_A° = +ve$

(B) $\Delta_r G° = +ve$, N_2O_4 will partially dissociate into NO_2.

(C) For reverse reaction

It is partially completed as there is equilibrium at E.

(D) For 1 mole N_2O_4; $\Delta_r G° = -0.84$ kJ mol^{-1}

(E) For 2 mole NO_2; $\Delta_r G° = -5.4 - 0.84$

$$= -6.24 \text{ kJ mol}^{-1}$$

Q68 Solution:
(3)

$$C_xH_{y\,(g)} + \left(x + \frac{y}{4}\right)O_{2\,(g)} \longrightarrow xCO_{2\,(g)} + \frac{y}{2}H_2O_{(\ell)}$$

$t = 0$	80	264	0	-
$t = t_{\text{final}}$	-	$264 - 80\left(x + \frac{y}{4}\right)$	$80x$	-

$264 - 80\left(x + \frac{y}{4}\right) + 80x = 224$

$264 - \frac{80y}{4} = 224$

$40 = \frac{80y}{4} \Rightarrow y = 2$

$264 - 80\left(x + \frac{y}{4}\right) = 64$

$264 - 80\left(x + \frac{1}{2}\right) = 64$

$264 - 80x - 40 = 64$

$x = 2$

Q69 Solution:
(3)

⇒ On moving left to right in a period IE increases and from top to bottom in a group IE decreases.

F > P > S > B (IE order)

⇒ On moving left to right in a period metallic and basic character decreases.

K > Mg > Al > B (Metallic character order)

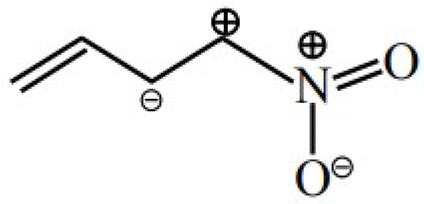
⇒ On moving top to bottom in a group metallic and basic character increases.

$K_2O > Na_2O > MgO > Al_2O_3$

⇒ EA : Group 17 > Group 16 > Group 15

Cl > F > S > P

Q70 Solution:
(4)



This resonating structure having +ve charge on adjacent atoms so it is least stable.

Q71 Solution:
(6)

$\text{pH} = 5$

$\left[H^{+}\right] = 10^{-5} = \left[\text{HX}\right].\alpha$

$= \left[\text{HX}\right] \cdot \frac{\Lambda_m}{\Lambda_m^{\infty}}$

$\Lambda_m = \frac{k \times 1000}{[\text{HX}]}$

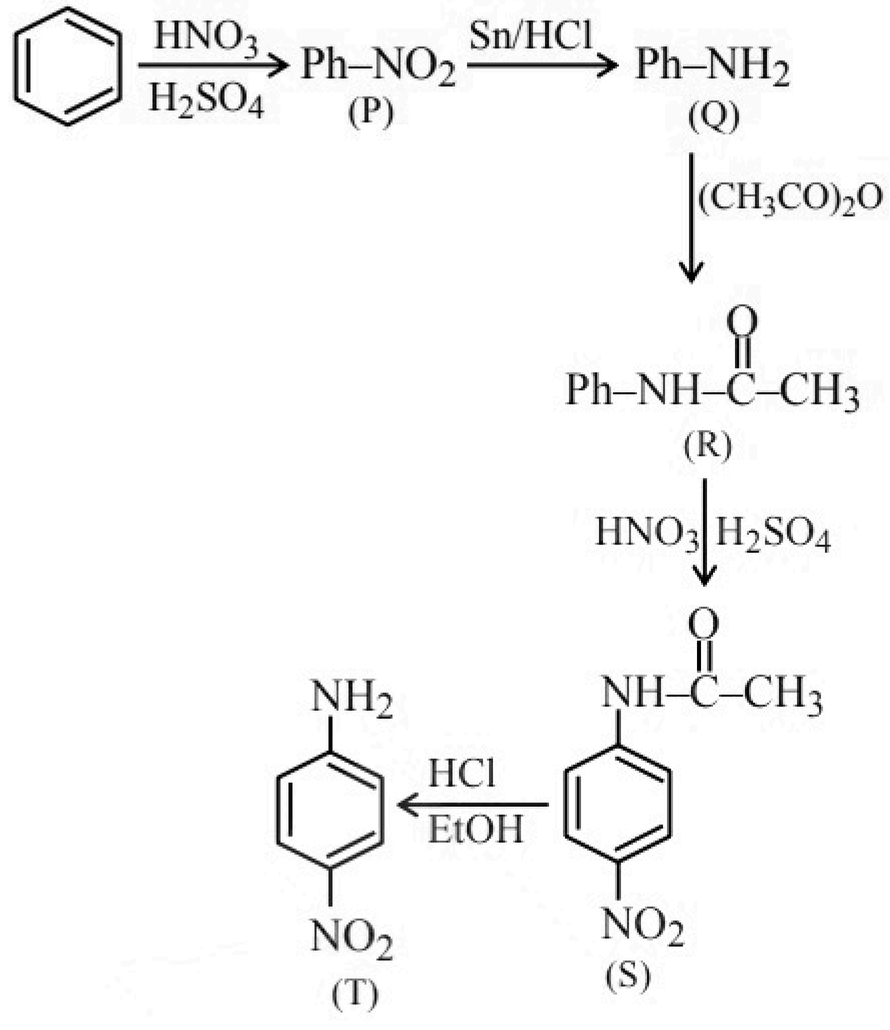
$K = G \cdot G^{*} = 4 \times 10^{-5} \times \frac{15}{1} = 6 \times 10^{-4} \text{S.cm}^{-1}$

$\left[H^{+}\right] = 10^{-5} = \left[\text{HX}\right] \times \frac{6 \times 10^{-4} \times 1000}{\Lambda_m^{\infty} \times [\text{HX}]}$

$\Lambda_m^{\infty} = 60000 \text{ S.cm}^2 \text{mol}^{-1}$

$\Lambda_m^{\infty} = 6 \text{ S.m}^2 \text{mol}^{-1}$

Q72 Solution:
(20)



$\text{Mol. wt} = 6 \times 12 + (6 \times 1) + (2 \times 14) + (2 \times 16) = 138$

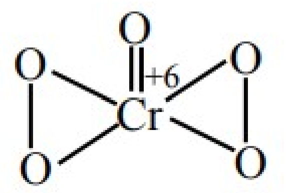
$\% N = \frac{28}{138} \times 100 = 20.29\%$

Q73 Solution:
(13)

$A \rightarrow \mathrm{CrO_2Cl_2}$

$B \rightarrow \mathrm{Na_2CrO_4}$

$C \rightarrow \mathrm{CrO_5}$



$X = 2,\ \ Y = 5$ and $Z = 6$

Q74 Solution:
(70)

$$\mathrm{A_2 + B_2 \xrightarrow{500\ \ K} 2AB} \quad \log K = 2.2$$

$$\Delta H° = (2 \times 32) - (6 + x) = (58 - x)\ \mathrm{kJ}$$

$$\Delta S° = (2 \times 222) - (146 + 280) = 18\ \mathrm{J}$$

$$\Delta G° = -RT\ln K$$

$$\Delta G° = -\frac{8.314 \times 500 \times 2.2 \times 2.303}{1000}$$

$$\Delta G° = -21.06$$

$$\Delta H° - T\Delta S° = -21.06$$

$$58 - x - 500\left(\frac{18}{1000}\right) = -21.06$$

$$x = 70.06\ \mathrm{kJ/mol}$$

Q75 Solution:
(8)

$$\mathrm{A} \xrightarrow{R^{x_n}(1)} \text{product } E_1$$

$$\mathrm{B} \xrightarrow{R^{x_n}(2)} \text{product } E_2$$

Assuming 'A' same for both reaction.

$$\ln k_1 = \ln A - \frac{E_1}{300R}$$

$$\ln k_2 = \ln A - \frac{E_2}{300R}$$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_1 - E_2}{300R} = \frac{20 \times 1000}{300R}$$

$$= 8.032$$