

1 - JEE Main Maths 28-Jan 2026 Shift -2

Q1 Solution:

(2)

$$E(X) = \sum x_i P(X_i) = \frac{526k}{15 \times 7} = \frac{263}{15} \Rightarrow k = \frac{7}{2}$$

X	14	15	16	17	18	19	20	21
P(X)	$\frac{2}{15}$	$\frac{1}{15}$	$\frac{2}{15}$	$\frac{1}{5}$	$\frac{1}{15}$	$\frac{2}{15}$	$\frac{1}{5}$	$\frac{1}{15}$

$$P(X < 20) = \sum_{x=14}^{19} P(X) = \frac{11}{15}$$

Q2 Solution:

(4)

[IMAGE 285]

$$CA_1 = a = 4$$

$$CF_1 = ae = 2$$

$$e = \frac{1}{2}$$

$$LR = 2e \left(\frac{a}{e} - ae \right)$$

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

$$= 6$$

Q3 Solution:

(1)

$$S = (1+x)^{1000} + x(1+x)^{999} + x^2(1+x)^{998} + \dots + x^{1000}$$

$$= (1+x)^{1000} \left(\frac{1 - \left(\frac{x}{1+x}\right)^{1001}}{1 - \frac{x}{1+x}} \right)$$

$$= (1+x)^{1001} - x^{1001}$$

$$\text{Required sum} = {}^{1001}C_{499} + {}^{1001}C_{500} = {}^{1002}C_{500}$$

Q4 Solution:

(3)

$$f(x) = \begin{cases} \cos(\pi x) & x \rightarrow 1^- \\ \frac{-\sin(x-1)}{x-1} & x \rightarrow 1^+ \end{cases}$$

$$\text{RHL} = \lim_{x \rightarrow 1} \frac{-\sin(x-1)}{x-1} = -1$$

$$\text{LHL} = \lim_{x \rightarrow 1} \cos(\pi x) = -1, \quad f(1) = -1$$

f(x) is continuous at x = 1

$$f(x) = \begin{cases} \frac{-\sin(x-1)}{-(x-1)} & x \rightarrow -1^- \\ \cos(\pi x) & x \rightarrow -1^+ \end{cases}$$

$$\text{RHL} = \lim_{x \rightarrow -1} \cos(\pi x) = -1$$

$$\text{LHL} = \lim_{x \rightarrow -1} \frac{-\sin(x-1)}{x-1} = \frac{\sin 2}{-2}$$

$f(x)$ is discontinuous at $x = -1$

Q5 Solution:

(1)

$$f(x) = \int \frac{dx}{x^{2/3} + 2x^{1/2}}$$

$$\text{Put } x = t^6 \Rightarrow dx = 6t^5 dt$$

$$= \int \frac{6t^5}{t^4 + 2t^3} dt = 6 \int \frac{(t^2 - 4) + 4}{t + 2} dt$$

$$= 6 \left[\int (t - 2) dt + 4 \int \frac{1}{t + 2} dt \right]$$

$$= 6 \left[\frac{t^2}{2} - 2t + 4 \ln(t + 2) \right] + C$$

$$= 3x^{1/3} - 12x^{1/6} + 24 \ln(x^{1/6} + 2) + C$$

$$f(0) = 24 \ln 2 + C = -26 + 24 \ln 2 \text{ (given)}$$

$$\Rightarrow C = -26$$

Now

$$f(1) = -35 + 24 \ln 3 = a + b \ln 3 \text{ (as given in ques.)}$$

$$\Rightarrow a = -35, b = 24$$

$$\Rightarrow a + b = -11$$

Q6 Solution:

(3)

$$x dy - y dx = x^2 \cot x dx$$

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

$$d\left(\frac{y}{x}\right) = \cot x dx$$

$$\int d\left(\frac{y}{x}\right) = \int \cot x dx$$

$$\frac{y}{x} = \log_e(\sin x) + C$$

$$\text{given } y\left(\frac{\pi}{2}\right) = \frac{\pi}{2} \Rightarrow C = 1$$

$$y = x \left(\log_e(\sin x) + 1 \right)$$

$$y\left(\frac{\pi}{6}\right) = \frac{\pi}{6} \left[-\log_e 2 + 1 \right]$$

$$y\left(\frac{\pi}{4}\right) = \frac{\pi}{4} \left[-\frac{1}{2} \log_e 2 + 1 \right]$$

$$6y\left(\frac{\pi}{6}\right) - 8y\left(\frac{\pi}{4}\right)$$

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

$$= \pi [1 - 2] = -\pi$$

Q7 Solution:

(1)

$$\text{Let } \sin^{-1} \left(\frac{2}{\sqrt{13}} \right) = \theta \text{ \& } \cos^{-1} \left(\frac{3}{\sqrt{10}} \right) = \phi$$

$$\sin \theta = \frac{2}{\sqrt{13}} \text{ \& } \cos \phi = \frac{3}{\sqrt{10}}$$

$$\tan \left(2\theta - 2\phi \right) = \frac{\tan 2\theta - \tan 2\phi}{1 + \tan 2\theta \tan 2\phi}$$

$$\left(\because \tan 2\theta = \frac{2 \tan \theta}{1 - \tan^2 \theta} \right)$$

$$= \frac{\frac{12}{5} - \frac{3}{4}}{1 + \frac{12}{5} \cdot \frac{3}{4}}$$

$$= \frac{33}{56}$$

Q8 Solution:

(3)

$$a = 4 - d, \alpha = 4 + d, b = 4 + 2d$$

$$\Rightarrow (4 + d)x^2 - (4 - d)x + 2(4 + d - 8 - 4d) = 0$$

$$\Rightarrow (4 + d)x^2 - (4 - d)x + 2(-4 - 3d) = 0$$

$$\text{Also } \frac{\frac{1}{a} + \frac{1}{b}}{2} = \frac{5}{16}$$

$$\Rightarrow \frac{\frac{1}{4-d} + \frac{1}{4+2d}}{2} = \frac{5}{16}$$

$$\Rightarrow d = 2$$

$$\text{Equation becomes } 6x^2 - 2x - 20 = 0$$

$$3x^2 - x - 10 = 0$$

$$x = 2, -\frac{5}{3}$$

Q9 Solution:

(3)

$$x \in \left(0, \frac{\pi}{2} \right) \Rightarrow y = 1 + 1 + 1 + 1 = 4$$

$$x \in \left(\frac{\pi}{2}, \pi \right) \Rightarrow y = 1 - 1 - 1 - 1 = -2$$

$$x \in \left(\pi, \frac{3\pi}{2} \right) \Rightarrow y = -1 - 1 + 1 + 1 = 0$$

$$x \in \left(\frac{3\pi}{2}, 2\pi \right) \Rightarrow y = -1 + 1 - 1 - 1 = -2$$

$$\therefore \text{Range of } y \text{ is } \{ -2, 0, 4 \}$$

$$\text{Required sum} = -2 + 0 + 4 = 2$$

Q10 Solution:

(4)

$$\cos 2\theta = \frac{3-1-3}{\sqrt{11} \cdot \sqrt{11}} = -\frac{1}{11}$$

[IMAGE 286]

$$1 - 2\sin^2\theta = -\frac{1}{11} \Rightarrow 2\sin^2\theta = \frac{12}{11} \Rightarrow \sin\theta = \sqrt{\frac{6}{11}}$$

$$\therefore \text{Area}(\Delta APB) = \frac{1}{2} \times \sqrt{11} \cdot \frac{\sqrt{5}}{2} \cdot \sqrt{\frac{6}{11}} = \frac{\sqrt{30}}{4}$$

Q11 Solution:

(3)

$$I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{12(3 + [x])}{3 + [\sin x] + [\cos x]} dx$$

$$I = \int_{-\frac{\pi}{2}}^{-1} \frac{12(1) dx}{2} + \int_{-1}^0 \frac{12(2) dx}{2} + \int_0^1 \frac{12(3) dx}{3} + \int_1^{\frac{\pi}{2}} \frac{12(4) dx}{3}$$

$$I = 6\left(\frac{\pi}{2} - 1\right) + 12(0 + 1) + 12(1 - 0) + 16\left(\frac{\pi}{2} - 1\right)$$

$$I = 3\pi - 6 + 12 + 12 + 8\pi - 16$$

$$I = 11\pi + 2$$

Q12 Solution:

(4)

$$|z - 2| \leq 4 \Rightarrow (x - 2)^2 + y^2 \leq 16$$

$$|z - 2| + |z + 2| = 5 \Rightarrow \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$\Rightarrow \frac{4x^2}{25} + \frac{4y^2}{9} = 1$$

[IMAGE 287]

$$\text{Maximum value of } |z_1 - z_2| = 6 + \frac{5}{2} = \frac{17}{2}$$

Q13 Solution:

(2)

[IMAGE 288]

Area bounded between P_1 & P_2 is

$$\int_{-3}^3 \left((x^2 + 27) - (4x^2) \right) dx$$

$$\text{(P.O.I. of } P_1 \text{ \& } P_2 \text{ is } x = \pm 3)$$

$$= 2 \int_0^3 (27 - 3x^2) dx = 2[27x - x^3]_0^3$$

$$= 2[81 - 27] = 108$$

\therefore Area bounded between P_1 & L is 18 sq. units

$$\left(\text{Area between } x^2 = 4ay \text{ \& line } x = my \text{ is } \frac{8a^2}{3m^3} \right)$$

\therefore Area between $x^2 = \frac{y}{4}$ \& $x = \frac{y}{\alpha}$ is

$$\frac{8\left(\frac{1}{16}\right)^2}{3\left(\frac{1}{\alpha}\right)^3} = 18$$

$$\Rightarrow \frac{\frac{8}{16 \cdot 16}}{\frac{3}{\alpha^3}} = 18 \Rightarrow \alpha^3 = 2^6 \cdot 3^3$$

$$\Rightarrow \alpha = 12$$

Q14 Solution:

(2)

[IMAGE 289]

$$\text{drs of PN} = \langle r - 2, 2r - 2, r \rangle$$

$$1(r - 2) + 2(2r - 2) + 1(r) = 0$$

$$6r = 6 \Rightarrow r = 1$$

$$\therefore N \equiv (2, 2, 2)$$

$$\Rightarrow Q \equiv (1, 2, 3)$$

[IMAGE 290]

$$AQ = \sqrt{64 + 49 + 4} = \sqrt{117}$$

$$AM = \frac{|24 + 14 - 4|}{\sqrt{9 + 4 + 4}} = \frac{34}{\sqrt{17}} = 2\sqrt{17}$$

$$\therefore QM = \sqrt{117 - 68} = \sqrt{49} = 7$$

Q15 Solution:

(2)

Let point of intersection $R(h, k)$

$$m_{BR} = m_{BP} \Rightarrow \frac{k}{h+2} = \frac{2\sin\alpha}{2\cos\alpha + 2} \Rightarrow \frac{k}{h+2} = \tan\frac{\alpha}{2}$$

$$m_{AR} = m_{AQ} \Rightarrow \frac{k}{h-2} = \frac{2\sin\beta}{2\cos\beta - 2} = \frac{\sin\beta}{\cos\beta - 1} = -\cot\frac{\beta}{2}$$

$$\frac{\alpha}{2} - \frac{\beta}{2} = \frac{\pi}{4}$$

$$\tan\left(\frac{\alpha}{2} - \frac{\beta}{2}\right) = \tan\frac{\pi}{4} = 1$$

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

$$\frac{\frac{k}{h+2} + \frac{h-2}{k}}{1 + \left(\frac{k}{h+2}\right)\left(\frac{2-h}{k}\right)} = 1$$

$$\Rightarrow \frac{k^2 + h^2 - 4}{\frac{4}{h+2}} = 1$$

$$\Rightarrow \frac{h^2 + k^2 - 4}{4k} = 1$$

$$\Rightarrow x^2 + y^2 - 4y - 4 = 0$$

Q16 Solution:

(4)

$$\text{Statement 1: } f(x) = \frac{x}{1 + |x|}$$

$$f(x) = \begin{cases} \frac{x}{1+x} & x \geq 0 \\ \frac{x}{1-x} & x < 0 \end{cases}$$

[IMAGE 291]

$f(x)$ is one-one

Statement 2: $f(x) = \frac{x^2 + 4x - 30}{x^2 - 8x + 18}$, $f(0) = \frac{-30}{18} = \frac{-5}{3}$

$$\frac{-5}{3} = \frac{x^2 + 4x - 30}{x^2 - 8x + 18}$$

On solving $x = 0, -1$

$$\Rightarrow f(0) = f(-1) = \frac{-5}{3}$$

$\therefore f(x)$ is many-one

Q17 Solution:

(3)

[IMAGE 292]

Coordinates of centroid of triangle ABC are

$$\frac{2}{3}(t_1^2 + t_2^2 + 1) = \frac{7}{3} \Rightarrow t_1^2 + t_2^2 = \frac{5}{2}$$

$$\frac{4}{3}(t_1 + t_2) = \frac{4}{3} \Rightarrow t_1 + t_2 = 1$$

$$(t_1 + t_2)^2 = t_1^2 + t_2^2 + 2t_1t_2 \Rightarrow t_1t_2 = -\frac{3}{4}$$

$$(t_1 - t_2)^2 = (t_1 + t_2)^2 - 4t_1t_2 = 4$$

$$(BC)^2 = 4(t_1^2 - t_2^2)^2 + 16(t_1 - t_2)^2$$

$$\Rightarrow (BC)^2 = 80$$

Q18 Solution:

(3)

Equation of hyperbola: $\frac{y^2}{\lambda^2} - \frac{x^2}{16} = 1$

Equation of ellipse: $\frac{x^2}{144} + \frac{y^2}{169} = 1$

$$e = \sqrt{1 - \frac{144}{169}} = \frac{5}{13}$$

Focus $\Rightarrow (0, 5)$

$$\Rightarrow \lambda \sqrt{1 + \frac{16}{\lambda^2}} = 5$$

$$\Rightarrow \lambda^2 + 16 = 25 \Rightarrow \lambda = 3$$

Eccentricity of hyperbola = $\sqrt{1 + \frac{16}{\lambda^2}} = \frac{5}{3}$

Length of latus rectum of hyperbola = $\frac{2(16)}{3} = \frac{32}{3}$

$$24(e + \ell) = 24\left(\frac{5}{3} + \frac{32}{3}\right) = 8 \times 37 = 296$$

Q19 Solution:

(3)

$$S = \frac{6}{3^{26}} + \frac{10}{3^{25}} \left[\frac{6^{25} - 1}{6 - 1} \right]$$

$$S = \frac{6}{3^{26}} + \frac{10}{3^{25}} \left[\frac{6^{25} - 1}{5} \right]$$

$$S = \frac{2}{3^{25}} + 2 \left[\frac{2^{25}}{3^{25}} - \frac{1}{3^{25}} \right]$$

$$S = 2^{26}$$

Q20 Solution:

(1)

Statement I :

[IMAGE 293]

Statement II: $R = (7 + 4\sqrt{3})^{25} = I + f$

$$R' = (7 - 4\sqrt{3})^{25} = f'$$

$$\therefore R + R' = 2 \left[{}^{25}C_0 7^{25} + {}^{25}C_2 7^{23} (4\sqrt{3})^2 + \dots \right]$$

$$I + f + f' = \text{even integer}$$

$$\therefore I = \text{odd integer}$$

$$\because 0 < f + f' < 2 \Rightarrow f + f' = 1$$

\Rightarrow Both the statements are correct

Q21 Solution:

(976)

$$\begin{aligned} S &= \sum \frac{r}{(r^2 + r + 1)(r^2 - r + 1)} \\ &= \frac{1}{2} \sum_{r=1}^{25} \left(\frac{1}{r^2 - r + 1} - \frac{1}{r^2 + r + 1} \right) \\ &= \frac{1}{2} \left[\left(\frac{1}{1} - \frac{1}{3} \right) + \left(\frac{1}{3} - \frac{1}{7} \right) + \dots + \left(\frac{1}{601} - \frac{1}{651} \right) \right] \\ &= \frac{1}{2} \left[1 - \frac{1}{651} \right] \\ &= \frac{1}{2} \left[\frac{650}{651} \right] = \frac{325}{651} \end{aligned}$$

$$\frac{p}{q} = \frac{325}{651} \Rightarrow p + q = 976$$

Q22 Solution:

(170)

$$\frac{x-43}{3} = \frac{y-\alpha}{-1} = \frac{z-\beta}{0} \Rightarrow P_1(43 + 3\lambda, \alpha - \lambda, \beta)$$

$$\frac{x-4}{2} = \frac{y}{0} = \frac{z+1}{3} \Rightarrow P_1(2\mu + 4, 0, 3\mu - 1)$$

$$\therefore \mu = \frac{3\lambda + 39}{2}, \alpha = \lambda, \beta = \frac{9\lambda - 115}{2}$$

$$P(43, \alpha, \beta), P_1(43 + 3\alpha, 0, \beta)$$

$$(PP_1)^2 = 1690 = 10\alpha^2 \Rightarrow \alpha = 13, \beta = 1$$

$$\therefore \alpha^2 + \beta^2 = 170$$

Q23 Solution:

(0)

$$A = I + \begin{bmatrix} 2 & -4 \\ 1 & -2 \end{bmatrix}, \text{ let } M = \begin{bmatrix} 2 & -4 \\ 1 & -2 \end{bmatrix}$$

$$M^2 = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \Rightarrow M^3 = M^4 = \dots = M^{100} = 0$$

$$A^{100} = (I + M)^{100} = \sum_{r=0}^{100} \binom{100}{r} M^r \cdot I$$

$$A^{100} = I + 100M = I + 100B$$

$$\therefore M = B \Rightarrow M^{100} = B^{100} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Q24 Solution:

(9)

$$f(x) = 1 - 2x + e^x \int_0^x e^{-t} f(t) dt$$

$$e^{-x} f(x) = (1 - 2x) e^{-x} + \int_0^x e^{-t} f(t) dt$$

$$e^{-x} f'(x) - e^{-x} f(x) = -2e^{-x} + (1 - 2x) e^{-x} (-1) + e^{-x} f(x)$$

$$f'(x) - 2f(x) = 2x - 3$$

$$\frac{dy}{dx} - 2y = 2x - 3$$

$$\Rightarrow ye^{-2x} = \int e^{-2x} (2x - 3) dx$$

On solving we get $f(x) = 1 - x$

$$g(x) = \int_0^x (3-t)^{15} (t-4)^6 (t+12)^{17} dt$$

$$g'(x) = (3-x)^{15} (x-4)^6 (x+12)^{17}$$

$$= - (x-3)^{15} (x-4)^6 (x+12)^{17}$$

[IMAGE 294]

Local maxima $\Rightarrow q = 3$

Local minima $\Rightarrow p = -12 = |p + q| = 9$

Q25 Solution:

(210)

$${}^7C_3 \times 3! = \frac{7 \times 6 \times 5}{1 \times 2 \times 3} \times 3! = 210$$

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Q26 Solution:

(1)

[IMAGE 295]

$$V_A = \frac{V}{2}$$

$$V_B = \frac{V}{2 \cdot I_R} \times R = \frac{V}{2 \cdot 1}$$

$$\therefore V_A - V_B = V \left[\frac{1}{2} - \frac{1}{2 \cdot 1} \right]$$

$$V_A - V_B = \frac{0.1}{2 \times 2.1} \times 40$$

$$V_A - V_B = \frac{4}{4.2} = 0.95$$

Q27 Solution:

(3)

$$x = 0 \Rightarrow t = 0, \frac{\sqrt{3}}{2}$$

$$v = 12t^2 - 3$$

At turning point, $v = 0$

$$t = \frac{1}{2} \Rightarrow x = \frac{4}{8} - \frac{3}{2} = -1$$

$$a = 24t \text{ (always positive)}$$

Q28 Solution:

(2)

$$R_\alpha = R_0 \alpha^{1/3}$$

$$R_\beta = R_0 \beta^{1/3}$$

$$\frac{R_\alpha}{R_\beta} = \left(\frac{\alpha}{\beta} \right)^{1/3} = \frac{1}{2}$$

Q29 Solution:

(2)

$$\frac{\Delta K}{K} = \frac{2\Delta T}{T} + \frac{\Delta m}{m}$$

$$T = \frac{60}{50} = 1.2 \text{ sec}$$

$$\Delta T = \frac{2}{50}$$

$$\therefore \frac{\Delta K}{K} = \frac{2 \times 2}{50 \times 1.2} + \frac{10 \times 10^{-3}}{10} = 0.0676$$

$$\therefore \% \text{ Error} = 6.76\%$$

Q30 Solution:

(3)

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$$

$$\vec{p} = m\vec{v}$$

$$\vec{L} = m(\vec{r} \times \vec{v})$$

$$= (x\hat{i} + y\hat{j} + z\hat{k}) \times m(v_x\hat{i} + v_y\hat{j} + v_z\hat{k})$$

When sign of \vec{r} changes, \vec{L} remains same.

Q31 Solution:

(2)

$$\begin{aligned}\lambda &= \frac{k_B T}{\sqrt{2} \pi \sigma^2 P} \\ &= \frac{1.38 \times 10^{-23} \times (273 + 41) \times 100}{\sqrt{2} \times 3.14 \times (5 \times 10^{-10})^2 \times 1.38 \times 10^5} \\ &= 2\sqrt{2} \times 10^{-8}\end{aligned}$$

Q32 Solution:

(2)

Solid cylinder

[IMAGE 296]

B_{\max} at surface

B_{\min} at axis

Q33 Solution:

(2)

$$\delta_{\min} = 2i - A \Rightarrow i = \delta_{\min} = A$$

$$\text{Also, } \mu = \frac{\sin\left(\frac{\delta_{\min} + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\Rightarrow \mu = \frac{\sin A}{\sin \frac{A}{2}} = 2\cos\left(\frac{A}{2}\right)$$

$$1 < \mu < 2 \quad \dots (1)$$

$$\delta_{\min} = 2i - A$$

$$A = 2i - A \Rightarrow i = A$$

$i < 90^\circ$ (grazing incidence)

$$A < 90^\circ$$

$$\mu = 2\cos\left(\frac{A}{2}\right), A < 90^\circ$$

$$\mu > \sqrt{2} \quad \dots (2)$$

from (1) & (2)

$$\sqrt{2} < \mu < 2$$

Q34 Solution:

(3)

$$(A) \quad \eta = \frac{F dr}{A dv} = \frac{[MLT^{-2}][L]}{[L^2][LT^{-1}]} = [ML^{-1}T^{-1}]$$

$$(B) \quad S = \frac{F}{L} = \frac{[MLT^{-2}]}{[L]} = [MT^{-2}]$$

$$(C) \quad P = \frac{F}{A} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$$

$$(D) E = S \times A = [MT^{-2}][L^2] = [ML^2T^{-2}]$$

Q35 Solution:

(1)

$$\hat{B} = \hat{C} \times \hat{E} = \hat{k} \times \hat{j} = -\hat{i}$$

$$\therefore \vec{B} = \frac{54}{3 \times 10^8} \sin(kz - \omega t) (-\hat{i})$$

$$= -1.8 \times 10^{-7} \sin(kz - \omega t) \hat{i}$$

Q36 Solution:

(1)

$$V_{\text{sound}} = \sqrt{\frac{Y}{\rho}}$$

$$\frac{\Delta V}{V} \times 100 = \frac{1}{2} \left(\frac{\Delta Y}{Y} \times 100 \right) - \frac{1}{2} \left(\frac{\Delta \rho}{\rho} \times 100 \right)$$

$$= \frac{1}{2} \times 1 - \frac{1}{2} \times 0.5$$

$$\frac{\Delta V}{V} \times 100 = \frac{1}{4}$$

$$\Delta V = \frac{1}{4} \times \frac{V}{100}$$

$$\Delta V = 1 \text{ m/s}$$

$$V_{\text{final}} = 400 + 1 = 401 \text{ m/s}$$

Q37 Solution:

(2)

[IMAGE 297]

$$mg \sin \theta - ma_0 \cos \theta = ma$$

$$a = g \sin \theta - a_0 \cos \theta$$

Now using,

$$S = ut + \frac{1}{2} a_{\text{down}} t^2$$

$$\frac{L}{\cos \theta} = \frac{1}{2} (g \sin \theta - a_0 \cos \theta) t^2$$

$$t = \sqrt{\frac{2L}{g \sin \theta \cos \theta - a_0 \cos^2 \theta}}$$

$$t = \sqrt{\frac{4L}{g \sin 2\theta - a_0 (1 + \cos 2\theta)}}$$

Q38 Solution:

(1)

For series combination

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$\therefore C_{\text{eq}}$ is less than C_1 & C_2 .

Note: In statement C, capacitor is assumed to be completely filled with dielectric then on decreasing thickness of dielectric capacitance will increase.

Q39 Solution:**(1)**

$$P = \frac{nhc}{\lambda}$$

$$6 \times 10^{-3} = \frac{n \times 6.63 \times 10^{-34} \times 3 \times 10^8}{663 \times 10^{-9}}$$

$$n = 2 \times 10^{16} \text{ photons}$$

Q40 Solution:**(2)**

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_{\text{net}}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{v} + \frac{1}{30} = (1.5 - 1) \left(\frac{1}{15} - \frac{1}{\infty} \right) + (1.2 - 1) \left(\frac{1}{\infty} + \frac{1}{12} \right)$$

$$\frac{1}{v} + \frac{1}{30} = \frac{1}{30} + \frac{1}{60}$$

$$v = 60$$

$$m = \frac{v}{u} = \frac{60}{-30} = -2$$

Q41 Solution:**(4)**

If either A or B is zero, in that case current flows and $v_c = 0$.

Hence the gate will be AND gate.

Q42 Solution:**(4)**

Here from voltage, question refers to potential. We can measure potential difference between two points but not potential at any point.

Note: If the potential of reference point is known then we can measure potential as well.

Q43 Solution:**(2)**

Least count will be 0.01 mm.

Q44 Solution:**(1)**

$$\mu = \frac{m_1 m_2}{m_1 + m_2} = \frac{1 \times 0.2}{1.2}$$

$$\mu = \frac{1}{6}$$

$$\omega = \sqrt{\frac{k}{\mu}} = \sqrt{\frac{150}{1/6}} = 30$$

Q45 Solution:**(4)**

Static electric field lines do NOT form closed loops (they start on positive and end on negative charges), making statement A false.

Q46 Solution:

(30)

[IMAGE 298]

$$mg \times 3 = \frac{1}{2} \cdot \frac{mR^2}{2} \cdot \omega^2 + \frac{1}{2}mv^2 \dots (i)$$

$$\& v = \omega R \dots (ii)$$

From equation (i) & (ii)

$$g \times 3 = \frac{3}{4}v^2$$

$$\text{K.E. of flywheel} = \frac{1}{2} \times \frac{mR^2}{2} \times \omega^2 = \frac{1}{4}mv^2$$

$$= \frac{1}{4} \times 3 \times 40 = 30 \text{ Joule}$$

Q47 Solution:

(384)

$$|f_A - f_B| = 4$$

$$|f_A - 380| = 4$$

So, $f_A = 384 \text{ Hz}$ or 376 Hz

On loading with wax f_A decreases

So, $f_A = 384 \text{ Hz}$

Q48 Solution:

(429)

$$y = n \frac{\lambda D}{d}$$

$$y_1 = y_2$$

$$n_1 \lambda_1 \frac{D}{d} = n_2 \lambda_2 \frac{D}{d}$$

$$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{550}{650} = \frac{11}{13}$$

$$y = 11 \times \frac{\lambda_1 D}{d} = \frac{11 \times 650 \times 10^{-9} \times 1.2}{2 \times 10^{-3}}$$

$$y = 429 \times 10^{-5}$$

Q49 Solution:

(300)

Work done = Area bounded by cycle

$$= \frac{1}{2} \times 3 \times 200 = 300 \text{ J}$$

Q50 Solution:

(314)

$$\frac{1}{2}Li_{\text{rms}}^2 = 16 \Rightarrow L = 8$$

$$i^2R = 32 \Rightarrow R = 8$$

$$X_L = \omega L = 2 \times 3.14 \times 50 \times 8$$

$$= 800 \times 3.14$$

$$R = 8$$

$$\frac{X_L}{R} = 314$$

3 - JEE Main Chemistry 28-Jan 2026 Shift -2

Q51 Solution:

(1)

[IMAGE 299]

Q52 Solution:

(1)

Correct order of

(i) Boiling point : HF > HI > HBr > HCl

(ii) Melting point : HI > HF > HBr > HCl

Q53 Solution:

(4)

$$\log_{10} K = -\frac{\Delta H^\circ}{2.303RT} + \frac{\Delta S^\circ}{2.303R}$$

$$\text{y-intercept} = \frac{\Delta S^\circ}{2.303R}$$

$$\text{Slope} = -\frac{\Delta H^\circ}{2.303R}$$

Ans. (4) is correct.

Q54 Solution:

(4)

$$\% S = \frac{32}{233} \times \frac{0.4813}{0.314} \times 100$$

$$= 21.052\%$$

Ans. (4) 21.05%

Q55 Solution:

(2)

XeF₂ & I₃: 2 bond pair, 3 lone pair ; Linear

XeOF₄ & BrF₅: 5 bond pair, 1 lone pair ; Square pyramidal

XeO₂F₂ & SF₄: 4 bond pair, 1 lone pair ; See-saw

XeO₃ & NH₃: 3 bond pair, 1 lone pair ; Pyramidal

Q56 Solution:

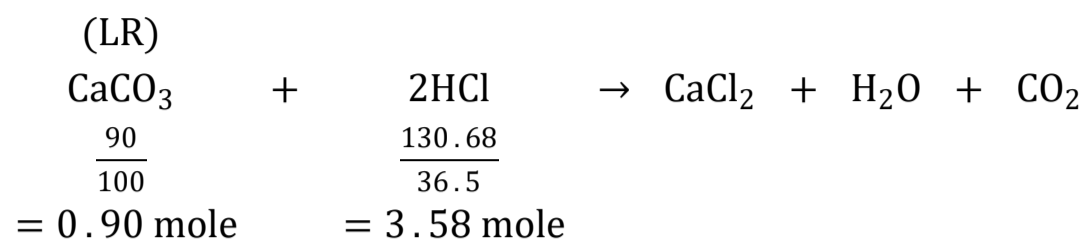
(2)

Density of HCl solution (d) = 1.13 g/mL

$V = 300$ mL

Wt. of HCl solution = 339 g

Wt. of HCl = $339 \times \frac{38.55}{100} = 130.68$ g



Moles of HCl remained = 1.78 mole

Mass of HCl remained = 64.97 g

Q57 Solution:

(2)

2° Amine are insoluble with Hinsberg reagent.

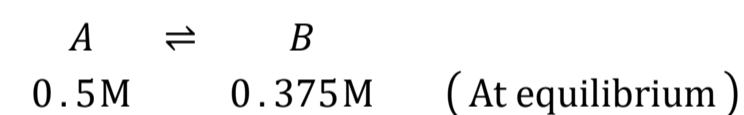
Ph-NH-CH₃, Me-NH-Me,

Ph-NH-CH₂-CH₂-CH₃, Ph-NH-Ph

Ans. (2) 4

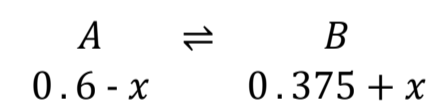
Q58 Solution:

(2)



$$K_{eq} = \frac{[B]_{eq}}{[A]_{eq}} = \frac{0.375}{0.5} = 0.75$$

Now 0.1 mole of A is added so reaction will move in forward direction.



$$K_{eq} = 0.75 = \frac{0.375 + x}{0.6 - x}$$

$$0.45 - 0.75x = 0.375 + x$$

$$1.75x = 0.075$$

$$x = \frac{0.075}{1.75} = \frac{3}{70} = 0.043$$

Moles of A = $0.6 - 0.043 = 0.557$

Moles of B = $0.375 + 0.043 = 0.418$

Ans. (2) is correct.

Q59 Solution:

(4)

[IMAGE 300]

Ans. – (4) A & C

Q60 Solution:

(4)

(1) Wavelength of A = 400 nm

(2) Wavelength of B $(\lambda) = \frac{c}{\nu} = \frac{3 \times 10^8}{10^{16}} = 3 \times 10^{-8} = 30 \times 10^{-9} = 30 \text{ nm}$

(3) Wavelength of C $(\lambda) = \frac{1}{\bar{\nu}} = \frac{1}{10^4} = 10^{-4} \text{ cm} = 10^{-6} \text{ m} = 1000 \text{ nm}$

Here $\lambda_C > \lambda_A > \lambda_B$

Energy $(E) \propto \frac{1}{\lambda}$

So $E_B > E_A > E_C$

Ans. (4) is correct.

Q61 Solution:

(1)

[IMAGE 301]

Ans. : (1) C, D

Q62 Solution:

(4)

Presence of NO_2 group in benzene ring deactivates the ring towards electrophilic substitution reaction due to $-M$ effect and activates the ring towards nucleophilic substitution.

Ans. \rightarrow (4) B & C

Q63 Solution:

(2)

[IMAGE 302]

Q64 Solution:

(2)

Structure (1) given is of sucrose which is non reducing.

For non reducing sugar compound should have acetal linkage not hemi acetal linkage.

[IMAGE 303]

Q65 Solution:

(2)

$$\Delta T_b = i \cdot k_b \cdot m$$

For dilute solution ($M = m$)

	Molarity	$i \times m$
(I)	$M_{\text{glucose}} = \frac{2.2}{180} \times \frac{1000}{125} = 0.098$	0.098×1
(II)	$M_{\text{CaCl}_2} = \frac{1.9}{111} \times \frac{1000}{250} = 0.068$	0.068×3
(III)	$M_{\text{urea}} = \frac{9}{60} \times \frac{1000}{500} = 0.3$	0.3×1
(IV)	$M_{\text{Al}_2(\text{SO}_4)_3} = \frac{20.5}{342} \times \frac{1000}{750} = 0.08$	0.08×5

Order of $\Delta T_b = \text{Al}_2(\text{SO}_4)_3 > \text{Urea} > \text{CaCl}_2 > \text{Glucose}$

So order of BP = $\text{Al}_2(\text{SO}_4)_3 > \text{Urea} > \text{CaCl}_2 > \text{Glucose}$

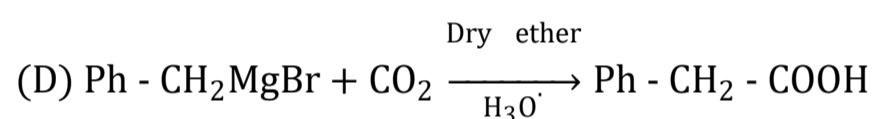
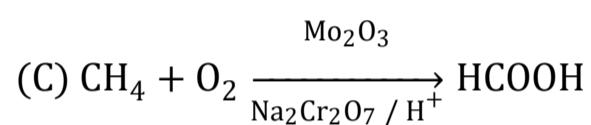
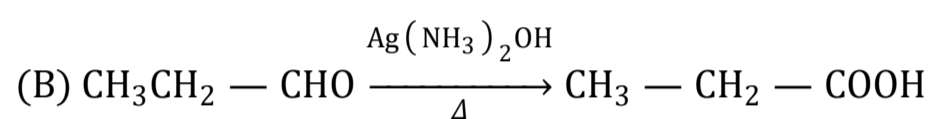
So Answer will be $\text{I} < \text{II} < \text{III} < \text{IV}$

Q66 Solution:

(2)

Correct order of acidic strength of major product formed in the given reaction is

[IMAGE 304]



Ans. (2) $\text{C} > \text{A} > \text{D} > \text{B}$

Q67 Solution:

(2)

Manganate ion $\rightarrow \text{MnO}_4^{2-}$

Permanganate ion $\rightarrow \text{MnO}_4^-$

(A) Both are tetrahedral (d^3s Hybridisation)

(B) MnO_4^- (+7 oxidation state)

MnO_4^{2-} (+6 oxidation state)

(C) $\text{Mn}^{2+} + \text{S}_2\text{O}_8^{2-} \rightarrow \text{MnO}_4^-$ (Permanganate ion)

(D) $\text{MnO}_4^- \rightarrow$ Diamagnetic

$\text{MnO}_4^{2-} \rightarrow$ Paramagnetic

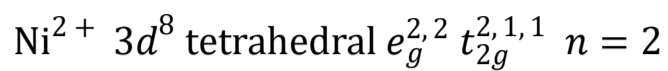
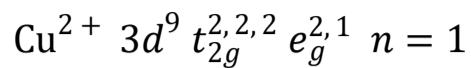
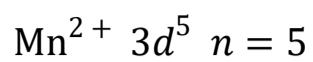
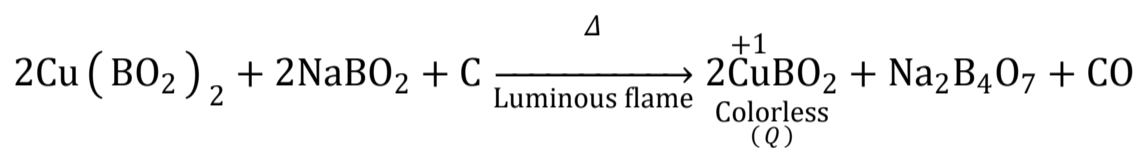
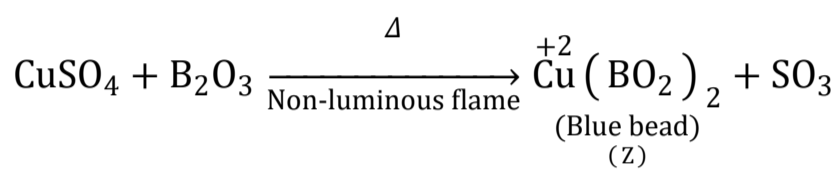
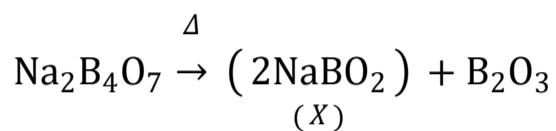
(E) It is oxidising agent

Q68 Solution:

(4)

Least metallic = F, valence electrons = 7

Most metallic = P, valence electrons = 5

Q69 Solution:**(4)****Q70 Solution:****(3)****Q71 Solution:****(4)**

Using equation: $\Lambda_m = \Lambda_m^0 - A\sqrt{c}$

$$96.1 = \Lambda_m^0 - A\sqrt{0.04}$$

$$96.1 = \Lambda_m^0 - A \times 0.2 \dots (1)$$

$$95.7 = \Lambda_m^0 - A\sqrt{0.09}$$

$$95.7 = \Lambda_m^0 - A \times 0.3 \dots (2)$$

From eq. (1) and eq. (2)

$$A = 4$$

Q72 Solution:**(2)**

$$\lambda_d = \frac{h}{\sqrt{2m\text{K.E.}}}$$

Here K.E. is same i.e. 200 keV

$$\text{So } \lambda_d \propto \frac{1}{\sqrt{m}}$$

$$\frac{(\lambda_d)_{m_1}}{(\lambda_d)_{m_2}} = \sqrt{\frac{m_2}{m_1}} = \sqrt{4} = 2$$

$$(\lambda_d)_{m_1} = 2(\lambda_d)_{m_2}$$

$$\text{So } x = 2$$

Q73 Solution:**(5)**

k_1

For $A \rightarrow B$

$$\ln(2) = \frac{E_{a1}}{R} \left[\frac{1}{300} - \frac{1}{500} \right]$$

$$E_{a1} = \frac{\ln 2 \times R \times 1500}{2}$$

$$E_{a2} = \frac{E_{a1}}{2} = \frac{\ln 2 \times R \times 1500}{4}$$

$$(k_1)_{\text{at } 500K} = \frac{\ln 2}{2}$$

$$(k_2)_{\text{at } 500K} = \ln 2$$

k_2

Now for $C \rightarrow D$

$$\ln \left[\frac{(k_2)_{\text{at } 500K}}{(k_2)_{\text{at } 300K}} \right] = \left(\frac{\ln 2 \times R \times 1500}{4} \right) \times \frac{1}{R} \times \left[\frac{1}{300} - \frac{1}{500} \right]$$

$$(k_2)_{\text{at } 300K} = \frac{\ln 2}{\sqrt{2}} = 0.49$$

$$(k_2)_{\text{at } 300K} = 4.9 \times 10^{-1}$$

Ans is 5.

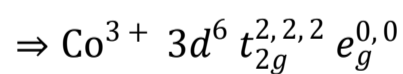
Q74 Solution:**(6)**

Sc^{3+}	18
Cr^{2+}	22
Mn^{3+}	22
Co^{3+}	24
Fe^{3+}	23

Cr^{2+} and Mn^{3+} are isoelectronic

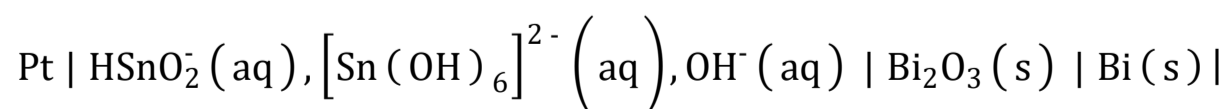
$$n = 2$$

Complex is: $[\text{Co}(\text{en})_2\text{NH}_3\text{Cl}]\text{Cl}_2$

**Q75 Solution:****(78)**

We have considered

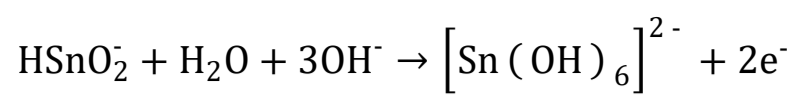
$$E^\circ_{[\text{Sn}(\text{OH})_6]^{2-} / \text{HSnO}_2} = -0.9\text{V}$$



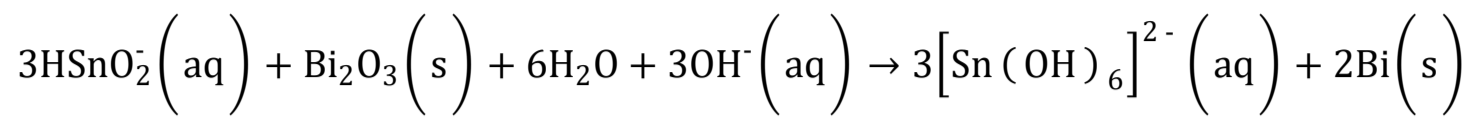
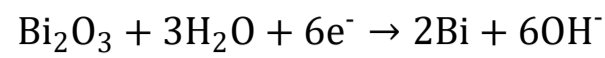
$$0.5\text{M} \quad 0.05\text{M}$$

$$E^\circ_{\text{cell}} = +0.9 - 0.44 = 0.46\text{V}$$

Oxidation Half:



Reduction half:



$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.059}{6} \log \left(\frac{(0.5)^3}{(0.05)^3 \times [\text{OH}^-]^3} \right)$$

$$0.2353 = 0.46 - \frac{0.059}{6} \times 3 \log \left(\frac{10}{[\text{OH}^-]} \right)$$

$$\log \left(\frac{10}{[\text{OH}^-]} \right) = \frac{2 \times 0.2247}{0.059} = 7.6$$

$$1 + \text{pOH} = 7.6$$

$$\text{pOH} = 6.6$$

$$\text{pH} = 14 - 6.6 = 7.4$$

$$\text{pH} = \text{p}K_{a1} + \log \frac{[\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]}$$

$$7.4 = 6.11 + \log \left(\frac{5x}{20} \right)$$

$$1.29 = \log \left(\frac{x}{4} \right)$$

$$\frac{x}{4} = 19.5$$

$$x = 78$$
