1 - JEE Main Maths 24-Jan 2026 Shift -2

Q1 Solution:
(4)

$f\left(t\right) = \frac{-3}{4} + 2t - t^2$

$f\left(t\right)\Big|_{\text{maximum}} = \frac{1}{4} = e \Rightarrow e^2 = \frac{1}{16} \Rightarrow \frac{a^2 - b^2}{a^2} = \frac{1}{16} \quad ...\left(1\right)$

$\because \frac{2b^2}{a} = 30 \Rightarrow b^2 = 15a \quad ...\left(2\right)$

By (1) & (2)

$16\left(a^2 - 15a\right) = a^2 \Rightarrow 15a^2 - 16 \times 15a = 0$

$a = 16$

$b^2 = 240$

$a^2 + b^2 = 256 + 240$

$= 496$

Q2 Solution:
(2)

$40^n = 2^{3n} \times 5^n$

$E_2\left(60!\right) = \left[\frac{60}{2}\right] + \left[\frac{60}{2^2}\right] + \left[\frac{60}{2^3}\right] + \left[\frac{60}{2^4}\right] + \left[\frac{60}{2^5}\right]$

$= 30 + 15 + 7 + 3 + 1 = 56$

$E_5\left(60!\right) = \left[\frac{60}{5}\right] + \left[\frac{60}{5^2}\right]$

$= 12 + 2 = 14$

$40^n = \left(2^3\right)^n \times 5^n = \left(2^3 \times 5\right)^n$

$60! = 2^{56} \times 5^{14} ... = 2^{14} \cdot \left(2^3 \cdot 5\right)^{14}$

$\therefore$ Maximum value of n is 14.

Q3 Solution:
(4)

$\sum y_i = a\sum x_i + \sum b$

$= a\left(1 + 2 + \cdots + 19\right) + 19b$

$\frac{\sum y_i}{19} = \frac{a \cdot 19 \cdot 20}{2 \cdot 19} + b$

$30 = 10a + b \quad ...\left(1\right)$

Variance of $X = \frac{\sum x_i^2}{19} - \left(\frac{\sum x_i}{19}\right)^2$

$= \frac{19 \cdot 20 \cdot 39}{19 \cdot 6} - \left(10\right)^2 = 30$

Variance of $Y = a^2\left(\text{variance of } X\right)$

$750 = a^2 \cdot 30$

$a^2 = 25 \Rightarrow a = \pm 5$

if $a = +5 \Rightarrow b = 30 - 50 = -20$ from (1)

if $a = -5 \Rightarrow b = 30 + 50 = 80$ from (1)

sum of values of $b = 80 - 20 = 60$

option (4)

Q4 Solution:
(2)

Let $\vec{v} = \vec{a} + \lambda\vec{b}$

$\vec{v} = \left(2+\lambda\right)\hat{i} + \left(3\lambda - 1\right)\hat{j} - \left(1+\lambda\right)\hat{k}$

$\frac{\vec{v}\cdot\vec{c}}{\left|\vec{c}\right|} = \frac{1}{\sqrt{14}}$

$\frac{2\left(2+\lambda\right) + 3\lambda - 1 - 3 - 3\lambda}{\sqrt{14}} = \frac{1}{\sqrt{14}}$

$4 + 2\lambda - 4 = 1$

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

$\vec{v} = \frac{5}{2}\hat{i} + \frac{1}{2}\hat{j} - \frac{3}{2}\hat{k}$

$\left|\vec{v}\right| = \sqrt{\frac{25+1+9}{4}} = \frac{\sqrt{35}}{2}$

Q5 Solution:
(4)

Let $a = \frac{4}{7},\ b = \frac{1}{3}$

Multiply N^r and D^r by $\left(a - b\right) = \frac{4}{7} - \frac{1}{3} = \frac{5}{21}$

$\frac{1}{a-b}\left[\left(a^2 - b^2\right) + \left(a^3 - b^3\right) + \left(a^4 - b^4\right) + \cdots\ \infty\right]$

$= \frac{1}{a-b}\left[\frac{a^2}{1-a} - \frac{b^2}{1-b}\right] = \frac{21}{5}\left[\frac{\frac{16}{49}}{1-\frac{4}{7}} - \frac{\frac{1}{9}}{1-\frac{1}{3}}\right]$

$= \frac{21}{5}\left[\frac{16}{21} - \frac{1}{6}\right] = \frac{21}{5}\left[\frac{96-21}{21.6}\right]$

$= \frac{75}{5\cdot 6} = \frac{15}{6} = \frac{5}{2}$

Q6 Solution:
(3)

ADIPRUU

$A \rightarrow \frac{6!}{2!} = 360$

$D \rightarrow \frac{6!}{2!} = 360$

$P \rightarrow \frac{6!}{2!} = 360$

$R \to \frac{6!}{2!} = 360$

$UA \to 5! = 120$

$UDAP \to 3! = 6$

$UDAR \to 3! = 6$

$UDAU \to 3! = 6$

$UDAYPRU \to 1$

$UDAYPUR \to 1$

Total $= 1580$

Q7 Solution:
(1)

$-1 \le \frac{2}{x^2 - 2x - 2} \le 1$

$\frac{1 + x^2 - 2x - 2}{x^2 - 2x - 2} \ge 0 \Rightarrow \frac{(x-1)^2 - 2}{(x-1)^2 - 3} \ge 0$

$\Rightarrow \frac{(x - 1 - \sqrt{2})(x - 1 + \sqrt{2})}{(x - 1 - \sqrt{3})(x - 1 + \sqrt{3})} \ge 0$

$x \in (-\infty, 1 - \sqrt{3}) \cup [1 - \sqrt{2}, 1 + \sqrt{2}] \cup (1 + \sqrt{3}, 0) \quad ...(1)$

$1 - \frac{1}{x^2 - 2x - 2} \ge 0 \Rightarrow \frac{x^2 - 2x - 3}{x^2 - 2x - 2} \ge 0$

$\Rightarrow \frac{(x+1)(x-3)}{(x - 1 - \sqrt{3})(x - 1 + \sqrt{3})} \ge 0$

$x \in (-\infty, -1] \cup (1 - \sqrt{3}, 1 + \sqrt{3}) \cup [3, \infty) \quad ...(2)$

$(1) \cap (2)$

$\Rightarrow x \in (-\infty, -1] \cup [1 - \sqrt{2}, 1 + \sqrt{2}] \cup [3, \infty)$

$\therefore \alpha + \beta + \gamma + \delta = 4$

Q8 Solution:
(1)

$f(x) = |lnx| - |x - 1|$

$= \begin{cases} lnx - (x-1) & x \ge 1 \\ -lnx + (x-1) & 0 < x < 1 \end{cases}$

$= \begin{cases} lnx - x + 1 & x \ge 1 \\ -lnx + x - 1 & 0 < x < 1 \end{cases}$

$f'(x) = \begin{pmatrix} \frac{1}{x} - 1 & x \ge 1 \\ -\frac{1}{x} + 1 & 0 < x < 1 \end{pmatrix}$

$f'(1^+) = f'(1^-) = 0 \Rightarrow f(x)$ is differentiable $\forall x > 0$

$f'(x) < 0 \;\; \forall x > 1$

$f'(x) < 0 \;\; \forall 0 < x < 1$

$\Rightarrow f(x)$ is decreasing $\forall x \in (0, \infty)$

Option (1)

Q9 Solution:
(1)

$m = \frac{9 \times 10 \times 19}{6} = 15 \times 19$

$3f\left(x\right) + 2f\left(\frac{15}{x}\right) = 5x$

Replace x by $\frac{15}{x}$

$3f\left(\frac{15}{x}\right) + 2f\left(x\right) = \frac{75}{x}$

$9f\left(x\right) - 4f\left(x\right) = 15x - \frac{150}{x}$

$5f\left(x\right) = 15x - \frac{150}{x}$

$f\left(x\right) = 3x - \frac{30}{x}$

$f\left(5\right) = 15 - \frac{30}{5} = 9$

$f(2) = 6 - 15 = -9$

$f(5) - f(2) = 18$

Q10 Solution:
(2)

$$\begin{vmatrix} 2p_{11} & 2^2p_{12} & 2^3p_{13} \\ 2^2p_{21} & 2^3p_{22} & 2^4p_{23} \\ 2^3p_{31} & 2^4p_{32} & 2^5p_{33} \end{vmatrix} = 2^{10}$$

$$= 2^2 \cdot 2 \cdot 2^3 \begin{vmatrix} p_{11} & p_{12} & p_{13} \\ 2p_{21} & 2p_{22} & 2p_{23} \\ 2^2p_{31} & 2^2p_{32} & 2^2p_{33} \end{vmatrix} = 2^{10}$$

$$= 2^9 \begin{vmatrix} p_{11} & p_{12} & p_{13} \\ p_{21} & p_{22} & p_{23} \\ p_{31} & p_{32} & p_{33} \end{vmatrix} = 2^{10} \Rightarrow |P| = 2$$

$|\text{adj}(\text{adj}(P))| = |P|^{(n-1)^2} = |P|^4 = 2^4 = 16$

Q11 Solution:
(1)

$x^4 - ax^2 + 9 = 0 \quad ...(1)$

let $x^2 = t$

$t^2 - at + 9 = 0 \quad ...(2)$

For roots of equation (1) to be real & distinct, roots of equation (2) must be positive & distinct.

(i) $D > 0 \Rightarrow a^2 - 36 > 0 \Rightarrow a \in (-\infty, -6) \cup (6, \infty)$

(ii) $\frac{-b}{2a} > 0 \Rightarrow \frac{a}{2} > 0 \Rightarrow a > 0$

(iii) $f(0) > 0 \Rightarrow 9 > 0 \Rightarrow a \in \mathbb{R}$

By (i) ∩ (ii) ∩ (iii)

$\therefore \alpha \in (6, \infty)$

$\therefore$ least integral value of $\alpha = 7$

Q12 Solution:
(2)

$$\sqrt{2} = \frac{\begin{vmatrix} -1 & 1 & 3 \\ \alpha & -1 & -\alpha \\ \alpha & 2 & 2\alpha \end{vmatrix}}{\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \alpha & -1 & -\alpha \\ \alpha & 2 & 2\alpha \end{vmatrix}}$$

$$\sqrt{2} = \frac{-1(-2\alpha + 2\alpha) - 1(2\alpha^2 + \alpha^2) + 3(2\alpha + \alpha)}{|\hat{i}(-2\alpha + 2\alpha) - \hat{j}(2\alpha^2 + \alpha^2) + \hat{k}(2\alpha + \alpha)|}$$

$$\sqrt{2} = \frac{-3\alpha^2 + 9\alpha}{\sqrt{9\alpha^4 + 9\alpha^2}}$$

$$\sqrt{2} = \frac{-\alpha + 3}{\sqrt{\alpha^2 + 1}}$$

$\Rightarrow 2\alpha^2 + 2 = \alpha^2 + 9 - 6\alpha$

$\alpha^2 + 6\alpha - 7 = 0$

$(\alpha + 7)(\alpha - 1) = 0$

$\alpha = -7, 1$

sum $= -7 + 1 = -6$

option (2)

Q13 Solution:
(1)

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

$\Rightarrow (2\vec{a} + 3\vec{b}) \times \vec{c} = 0 \Rightarrow \vec{c} = \lambda(2\vec{a} + 3\vec{b})$

$\Rightarrow \vec{c} = \lambda(7\hat{i} - 13\hat{j} + 19\hat{k})$

Now $(\vec{a} - \vec{b}) \cdot \vec{c} = \lambda(7 + 52 + 38) + 97\lambda = -97$

$\Rightarrow \lambda = -1$

Now $\vec{c} = -7\hat{i} + 13\hat{j} - 19\hat{k}$

$\Rightarrow \vec{c} \times \hat{k} = -7\hat{j} + 13\hat{i} \Rightarrow |\vec{c} \times \hat{k}|^2 = 7^2 + 13^2 = 218$

Q14 Solution:
(1)

$$\lim_{t \to x} \frac{2tf(x) - x^2 f'(t)}{-1} = 3$$

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

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

$$\text{I.F.} = e^{\int \frac{-2}{x}dx} = e^{-2\log_e x} = \frac{1}{x^2}$$

$$y \cdot \frac{1}{x^2} = \int \frac{3}{x^4}dx$$

$$\frac{y}{x^2} = -\frac{1}{x^3} + c \Rightarrow y = cx^2 - \frac{1}{x} = f\left(x\right)$$

$$f(1) = 2 = c - 1 \Rightarrow c = 3$$

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

$$f\left(2\right) = 12 - \frac{1}{2} \Rightarrow 2f\left(2\right) = 23$$

Q15 Solution:
(4)

$$f(0) = a$$

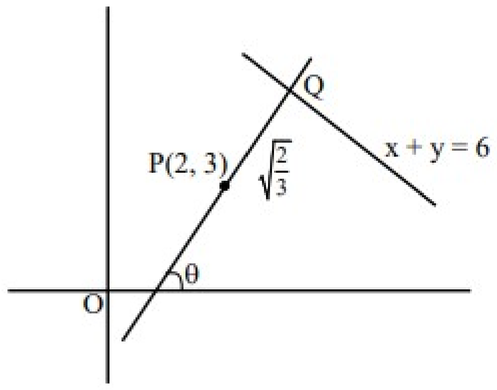
$$\text{RHL} = \lim_{x \to 0^+} \frac{\sin x(1 - \cos x)}{x^3} = \frac{1}{2}$$

$$\text{LHL} = \lim_{x \to 0^-} \left(b^2 \sin\frac{\pi}{2}\left[\frac{\pi}{2}\left(\sin x + \cos x\right)\cos x\right]\right) = b^2$$

$$\therefore \quad a = \frac{1}{2}, \ b^2 = \frac{1}{2}$$

$$\text{so } \left(a^2 + b^2\right) = \frac{1}{4} + \frac{1}{2} = \frac{3}{4}$$

Q16 Solution:
(1)



$$\text{Let } Q \text{ is } \left(\sqrt{\frac{2}{3}}\cos\theta + 2, \ \sqrt{\frac{2}{3}}\sin\theta + 3\right)$$

$$\text{so}, x + y = 6$$

$$\sqrt{\frac{2}{3}}\left(\cos\theta + \sin\theta\right) + 5 = 6$$

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

$$1 + \sin 2\theta = \frac{3}{2}$$

$$\sin 2\theta = \frac{1}{2}$$

$$2\theta = \frac{\pi}{6}, \ \frac{5\pi}{6}$$

$$\theta = \frac{\pi}{12}, \ \frac{5\pi}{6}$$

$$\text{So } \theta_1 + \theta_2 = \frac{\pi}{2}$$

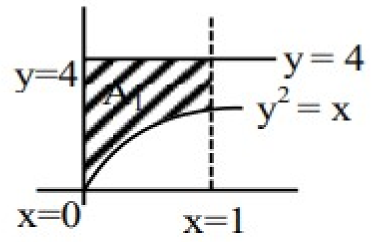
Q17 Solution:
(3)

at $\alpha = 0 \Rightarrow f(0)$

$x = 0,\ x = 1,\ y^2 = x$

$y = |0 \cdot x - 5| - |1 - 0 \cdot x| + 0 \cdot x^2$

$y = 4$



$A_1 = \int_0^1 \left(4 - \sqrt{x}\right) dx$

$= 4x - \frac{x^{3/2}}{3/2}\Big|_0^1$

$= 4 - \frac{2}{3}\left(1\right) = \frac{10}{3}$

at $\alpha = 1 \Rightarrow f(1)$

$x = 0,\ x = 1,\ y^2 = x$

$y = |x - 5| - |1 - x| + x^2,\ x \in (0, 1)$

$y = 5 - x - (1 - x) + x^2$

$y = 4 + x^2$

[IMAGE 245]--------

$A_2 = \int_0^1 \left[\left(4 + x^2\right) - \sqrt{x}\right] dx$

$= 4x + \frac{x^3}{3} - \frac{x^{\frac{3}{2}}}{\frac{3}{2}}\Big|_0^1$

$= 4 + \frac{1}{3} - \frac{2}{3} = \frac{11}{3}$

$|f(0) + f(1)| = |A_1 + A_2| = \left|\frac{10}{3} + \frac{11}{3}\right| = \left|\frac{21}{3}\right| = 7$

option (3)

Q18 Solution:
(4)

Parametric point P on $x^2 = 4y$ is $P\left(2t, t^2\right)$

$\therefore$ mirror image of P in $x - y = 1$ is

$Q \equiv \left(2t - \frac{2.1.\left(2t - t^2 - 1\right)}{2},\ t^2 + \frac{2.2(1).\left(2t - t^2 - 1\right)}{2}\right)$

$Q \equiv \left(t^2 + 1,\ 2t - 1\right) \equiv (h, k)$

$\therefore$ locus of Q is $x = \frac{(y+1)^2}{4} + 1$ which is the required parabola.

$\therefore (y + 1)^2 = 4(x - 1)$

$\therefore a = 1,\ b = 4,\ c = 1$

$\therefore a + b + c = 6$

Q19 Solution:
(2)

$$f\left(x\right) = \int \frac{\left(\frac{7}{x^8} + \frac{9}{x^{10}}\right)}{\left(\frac{1}{x^9} + \frac{1}{x^7} + 2\right)^2} dx$$

Put $t = \frac{1}{x^9} + \frac{1}{x^7} + 2 \Rightarrow \frac{dt}{dx} = \frac{-9}{x^{10}} - \frac{7}{x^8}$

$f\left(x\right) = \int \frac{-dt}{t^2} = \frac{1}{t} + C$

$f\left(x\right) = \frac{1}{\frac{1}{x^9} + \frac{1}{x^7} + 2} + C$

$= \frac{x^9}{1 + x^2 + 2x^9} + C$

Given $f\left(1\right) = \frac{1}{4} = \frac{1}{4} + C \Rightarrow C = 0$

$f\left(x\right) = \frac{x^9}{1 + x^2 + 2x^9}$

$$f'\left(x\right) = \frac{\left(1 + x^2 + 2x^9\right) - 9x^8 - x^9\left(2x + 18x^8\right)}{\left(1 + x^2 + 2x^9\right)^2}$$

$f'\left(x\right) = \frac{36 - 20}{16} = 1$

$$A = \begin{pmatrix} 0 & 0 & 1 \\ 4 & 1 & 1 \\ \alpha^2 & \frac{1}{4} & 1 \end{pmatrix}$$

$|A| = \left|1 - \alpha^2\right| = 3$

$1 - \alpha^2 = 3,\ -3 \Rightarrow \alpha^2 = -2,\ 4$

Value of $\alpha^2 = 4$

$B = \text{ adj }\left(\text{ adj } A\right)$

$|B| = 81 = |A|^4 \Rightarrow |A| = 3$

Q20 Solution:
(4)

a_1, a_2, a_3, a_4 as $a - 3d,\ a - d,\ a + d,\ a + 3d$

where $d = \frac{\ell}{2}$

$\because a_1 + a_2 + a_3 + a_4 = 48 \Rightarrow 4a = 48 \Rightarrow a = 12$

$\&\ a_1 a_2 a_3 a_4 + \ell^4 = 361 \Rightarrow \left(a^2 - 9d^2\right)\left(a^2 - d^2\right) + 16d^4 = 361$

$\Rightarrow \left(144 - 9d^2\right)\left(144 - d^2\right) + 16d^4 = 361$

$\Rightarrow 25d^4 - 1440d^2 + (144)^2 = 361$

$\left(5d^2 - 144\right)^2 = 19^2$

$\therefore 5d^2 - 144 = 19 \text{ or } -19$

$d^2 = \frac{163}{5}$ or $d^2 = \frac{125}{5} = 25$

$d = \sqrt{\frac{163}{5}}$ or $d = 5$

$\therefore \ell = 2\sqrt{\frac{163}{5}}$ or $\ell = 10$

(rejected)

$\because$ common difference is an integer

$\therefore$ largest term $= 12 + 15 = 27$

Q21 Solution:
(15)

$S = \{a, b, c, d, e\}$

$P(S)$ contains $2^5 = 32$ elements

both set A and set B are subsets of $P(S)$

Every element has 4 choices

A	B
✓	✓
✓	×
×	✓
×	×

Favourable cases $= 3^5$

Total cases $= 4^5$

$P = \frac{3^5}{4^5} = \frac{3^5}{2^{10}}$

$m = 5,\ n = 10$

$m + n = 15$

Q22 Solution:
(5)

$|z|^2 = 2^3 \cdot 5^2 \cdot 13 \cdot 17$

$\prod_{r=1}^{n}\left(1 + r^2\right) = 2^3 \cdot 5^2 \cdot 13 \cdot 17 = (2) \cdot (5) \cdot (2 \cdot 5) \cdot (17) \cdot (2 \cdot 13) = 2 \cdot 5 \cdot 10 \cdot 17 \cdot 26$

so $n = 5$

Q23 Solution:
(4)

$\frac{\tan(x + 100°)}{\tan x} = \tan\left(x + 50°\right)\tan\left(x - 50°\right)$

$\frac{\sin(x + 100°)\cos x}{\cos(x + 100°)\sin x} = \frac{\sin(x + 50°)\sin(x - 50°)}{\cos(x + 50°)\cos(x - 50°)}$

Apply C & D

$\frac{\sin(2x + 100°)}{\sin 100°} = \frac{\cos 100°}{-\cos 2x}$

$2\sin(2x + 100°)\cos 2x + \sin 200° = 0$

$\sin(4x+100°)+\sin100°+\sin200°=0$

$\sin(4x+100°) = -2\sin150°\cos50°$

$\sin(4x+100°) = -\cos50° = \sin(-40°)$

$\therefore 4x+100° = n\pi + (-1)^n \cdot (-40°)$

$x = \frac{n\pi + (-1)^{n+1}\left(40°\right) - 100°}{4}$

$\therefore x = 30°,\ 55°,\ 120°,\ 145°$ in $(0, \pi)$

$\therefore$ no. of solutions $= 4$

Q24 Solution:
(9)

Let $P \equiv (2\cos\theta, 2\sin\theta)$

$\therefore$ coordinates of $Q = \left(4\cos\theta + 1, 6\sin\theta + 3\right)$

$\therefore$ locus of Q is $\left(\frac{x-1}{4}\right)^2 + \left(\frac{y-3}{6}\right)^2 = 1$

$\therefore e^2 = 1 - \frac{16}{36} = \frac{5}{9}$

$\therefore \frac{5}{e^2} = 9$

Q25 Solution:
(2)

$f\left(x\right) = e^x + \int_0^1 yf\left(y\right)dy + xe^x \int_0^1 f\left(y\right)dy$

$f(x) = e^x + A + Bxe^x$

$A = \int_0^1 yf\left(y\right)dy = \int_0^1 y\left(A + e^y + Bye^y\right)dy$

$A = \frac{A}{2} + 0 - \left(-1\right) + B\left(e - 1\right)$

$\frac{A}{2} + B\left(1 - e\right) = 1$

$B = \int_0^1 f\left(y\right)dy$

$B = \int_0^1 \left(e^y + A + Bye^y\right)dy$

$B = (e-1) + A + B(0 - (-1))$

$B = e - 1 + A + B \Rightarrow A = 1 - e$

$f(x) = e^x + A + Bxe^x$

$f(0) = 1 + A = 1 - e + 1 = 2 - e$

$e + f(0) = 2$

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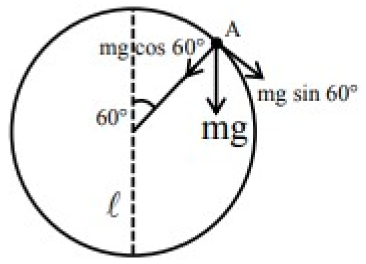
Q26 Solution:
(3)

$LC = 1MSD - 1MSD = 1MSD - \frac{48}{50}MSD$

$= \frac{2}{50}MSD = \frac{2}{50} \times 0.05mm = 0.002mm$

Q27 Solution:
(3)



$T + mg\cos60° = \frac{mV^2}{\ell}$

$T = 0$

$V^2 = \frac{g\ell}{2}$ where V is the speed at point A

M.E.C.

$\frac{1}{2}mu^2 = mg\left(\ell + \ell\cos60°\right) + \frac{1}{2}mV^2$

$u^2 = 3g\ell + \frac{g\ell}{2}$

$u = \sqrt{\frac{7g\ell}{2}}$

Q28 Solution:
(2)

$Mg = F_b$

$dAHg = \rho Ahg$

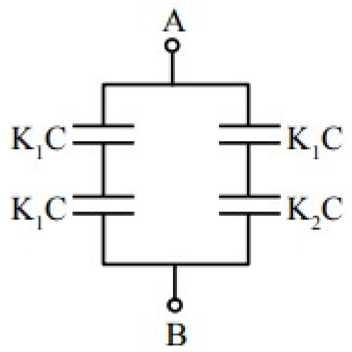
$600 \times 8cm = 900 \times h$

$h = \frac{16}{3}cm$

$h = 5.3cm$

Q29 Solution:
(1)

For C_A:

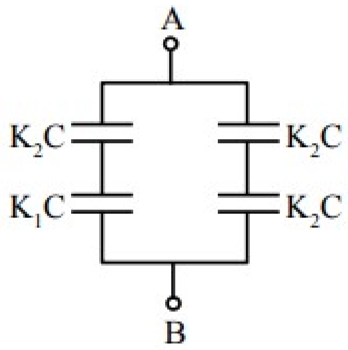


Let $\frac{\varepsilon_0 A}{d} = C$

$\therefore \quad C_A = \frac{K_1C}{2} + \frac{K_1K_2C}{K_1 + K_2}$

$= K_1C\left[\frac{K_1 + 2K_2}{2\left(K_1 + K_2\right)}\right]$

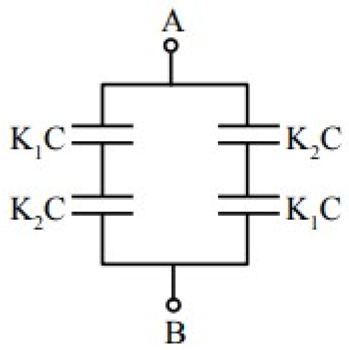
For C_B:



$C_B = \frac{K_2C}{2} + \frac{K_1K_2C}{K_1 + K_2}$

$= K_2C\left[\frac{K_1 + 2K_2}{2(K_1 + K_2)}\right]$

For C_C:



$C_C = \frac{2K_1K_2C}{K_1 + K_2}$

$C_A > C_C > C_B$

Q30 Solution:
(3)

$V \to 8V \Rightarrow R \to 2R$

$\Rightarrow A \to 4A$

$\Rightarrow I \to \frac{I_0}{4}$

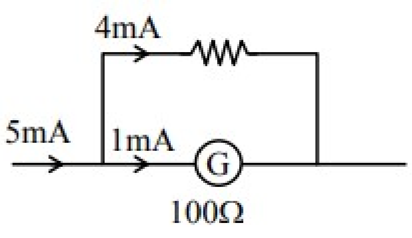
Q31 Solution:
(4)

$\Delta Q = nC_v\Delta T$ (isochoric)

$= \frac{C_v}{R}nR\Delta T = \frac{C_v}{R}(P_2 - P_1)V$

$= \frac{21}{8.3} \times (30 - 21.7) \times 1 = 21\text{J}$

Q32 Solution:
(4)



$G = 100\Omega$

$i_g = 1\text{mA}$

$i = 5\text{mA}$

$r_s = \frac{G}{\left(\frac{i}{i_g} - 1\right)}$

$= \frac{100}{\left(\frac{5}{1} - 1\right)} = 25\Omega$

Q33 Solution:
(4)

$d = 2\text{mm}$

$D = 10\text{m}$

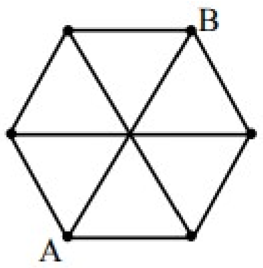
$\lambda = 6000\text{Å}$

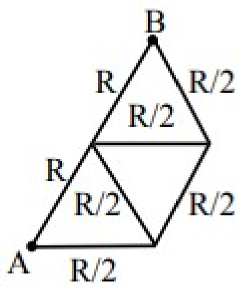
$y = \frac{d}{2}$ $\left(\text{in front of one slit}\right)$

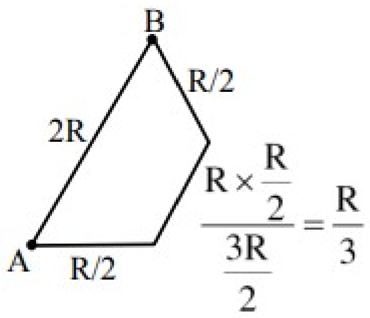
$I = 4I_0\cos^2\left(\frac{2\pi}{\lambda} \cdot \frac{y}{D} \cdot d\right)$

$\Rightarrow\ I = I_0$

Q34 Solution:
(2)







$R_{\text{eq}} = \frac{2R \times \frac{4R}{3}}{2R + \frac{4R}{3}} = \frac{8R^2}{10R} = \frac{4}{5}R$

Q35 Solution:
(3)

[IMAGE 253]

$T\sin 30° = \frac{m}{2}g$

$T\cos 30° = T_0$

$\tan 30° = \frac{mg}{2T_0}$

$T_0 = \frac{\sqrt{3}}{2}mg$

Q36 Solution:
(2)

$P = +5D$

$\frac{1}{f} = 5 \Rightarrow f = 20\text{cm}$

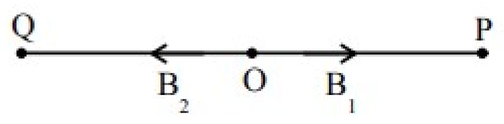
$\Rightarrow$ If object is between f and $2f$, image will be beyond $2f$ and magnified.

$\Rightarrow$ If object is beyond $2f$, image will be between f and $2f$ and diminished.

Hence reading of P_3 are incorrect.

Q37 Solution:
(2)

$B_{\text{net}} = B_1 - B_2$



$= \frac{4\mu_0 iR^2}{2\left(R^2 + R^2\right)^{3/2}} - \frac{\mu_0 iR^2}{2\left(R^2 + R^2\right)^{3/2}}$

$= \frac{3\mu_0 i}{4\sqrt{2}R}$

Q38 Solution:
(4)

$m = -3 = \frac{v}{u}$

$v = -3u$

$|v| - |u| = 40$

$u = 20\text{cm}$

$v = 60\text{cm}$

$\therefore \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\frac{1}{-60} + \frac{1}{-20} = \frac{1}{f}$

$f = -15\text{cm}$

Q39 Solution:
(4)

$q\left(3.2\right) = \frac{hc}{\lambda} - \phi \cdots \left(1\right)$

$q\left(0.7\right) = \frac{hc}{2\lambda} - \phi \cdots \left(2\right)$

Eq. (1) - Eq. (2)

$q\left(2.5\right) = \frac{hc}{2\lambda}$

$2.5 = \left(\frac{hc}{e}\right)\left(\frac{1}{2\lambda}\right)$

$2.5 = \frac{12400}{2\lambda}$

$\lambda = \frac{12400}{5} Å$

$\lambda = 2480$ Å

$\lambda = 2.48 \times 10^{-7}$ m

Q40 Solution:
(4)

$f_{5 \text{ closed}} = f_{1 \text{ open}}$

$\frac{5v}{4L_{\text{closed}}} = \frac{v}{2L_{\text{open}}}$

$\frac{L_{\text{closed}}}{L_{\text{open}}} = \frac{5}{2}$

$x = 2$

Q41 Solution:
(1)

$\text{BE}_{\text{He}^4} - \text{BE}_{\text{He}^3} = 20\text{MeV} \quad \cdots (1)$

$\text{BE}_{\text{He}^5} - \text{BE}_{\text{He}^4} = -0.9\text{MeV} \quad \cdots (2)$

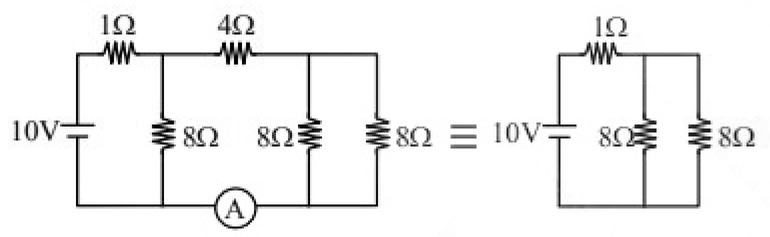
From eq (1) & (2)

$\text{BE}_{\text{He}^4} > \text{BE}_{\text{He}^5} > \text{BE}_{\text{He}^3}$

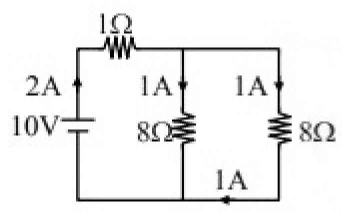
$X_4 > X_5 > X_3$

Q42 Solution:
(1)

In steady state

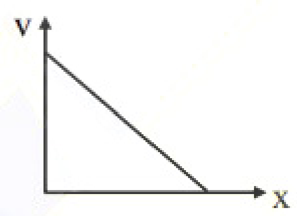


I = 2A



Ammeter reading is 1A.

Q43 Solution:
(2)



Eq. of V vs x from graph

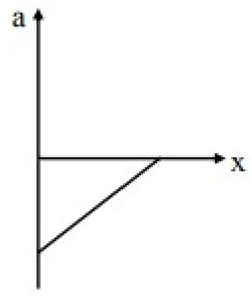
$V = C_1 - C_2 x$

$a = V\frac{dV}{dx}$

$= (C_1 - C_2 x) \times (-C_2)$

$a = C_2^2 x - C_1 C_2$

∴ graph is straight line with positive slope and negative intercept



Q44 Solution:
(4)

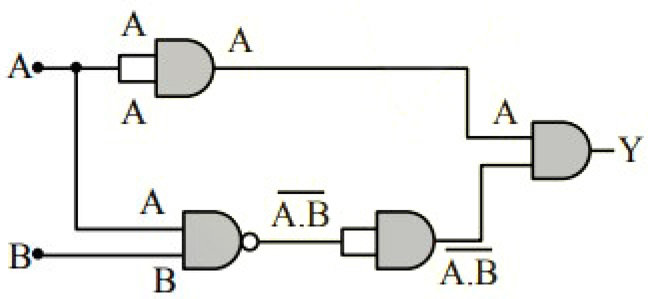
$mg\frac{\ell}{6} = \frac{1}{2}I\omega^2$

Here $I = \frac{m\ell^2}{12} + \frac{m\ell^2}{36} = \frac{m\ell^2}{9}$

$mg\frac{\ell}{6} = \frac{m\ell^2}{18}\omega^2 \Rightarrow \omega^2 = \frac{3g}{\ell}$

$\omega = \sqrt{\frac{3g}{\ell}}$

Q45 Solution:
(1)



$y = A.\ \overline{A.B}$
$= A.\left(\overline{A} + \overline{B}\right) = 0 + A\overline{B}$

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	0

Q46 Solution:
(481)

For a constant volume process, the heat supplied (Q) is given by the formula:

$Q = nC_v\Delta T$

Where:

1. n = number of moles of the gas.
2. C_v = molar specific heat capacity at constant volume.
3. ΔT = change in temperature $= 50°C - 20°C = 30°C = 30K$

We are given the molar specific heat at constant pressure, $C_p = \frac{7}{2}R$. Using Mayer's relation $\left(C_p - C_v = R\right)$:

$$C_v = C_p - R$$

$$\Rightarrow C_v = \frac{7}{2}R - R = \frac{5}{2}R$$

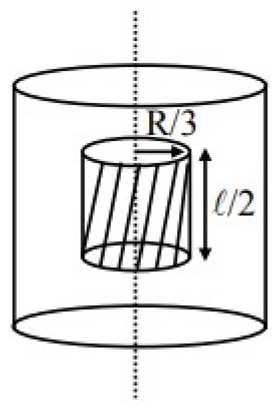
Using the formula of heat,

$$300 = n \times \left(\frac{5}{2} \times 8.314\right) \times 30$$

$$n = \frac{300 \times 2}{5 \times 8.314 \times 30} \approx 0.481 \text{ moles}$$

So, the amount of the gas is 0.481 moles. As the molar mass of the gas is not given in the question, we can't determine the mass of the gas directly.

Q47 Solution:
(162)



Original mass (M)

The removed mass (m)

$$m = \rho \times \pi \left(\frac{R}{3}\right)^2 \times \frac{L}{2}$$

$$= \frac{\rho . \pi R^2 L}{18} = \frac{M}{18}$$

$$I' = \frac{1}{2} \cdot \frac{M}{18} \cdot \frac{R^2}{9} = \frac{1}{324}MR^2$$

$$\frac{I}{I'} = \frac{\frac{1}{2}MR^2}{\frac{1}{324}MR^2} = 162$$

Q48 Solution:
(11304)

$$W = \Delta u$$

$$= S \times \left(8\pi r_2^2 - 8\pi r_1^2\right)$$

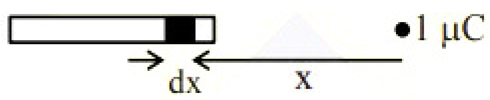
$$= 0.04 \times 2 \times \frac{22}{7}\left(147\right) \times 10^{-4}$$

$$W = 3696 \times 10^{-6} \text{J}$$

$$3696 = 15000 - x$$

$$x = 11304 \mu \text{J}$$

Q49 Solution:
(90)



$F = \int dF = \int_{2\text{cm}}^{12\text{cm}} \frac{kq\lambda dx}{x^2} = kq\lambda\left(\frac{1}{2\times10^{-2}} - \frac{1}{12\times10^{-2}}\right)$

$F = \left(9\times10^{9}\right)\left(10^{-6}\right)\left(\frac{24\times10^{-6}}{10^{-1}}\right)\left(\frac{5}{12}\right)\times10^{2}$

$= 9\times24\times\frac{5}{12} = 90\text{N}$

Q50 Solution:
(6)

In case I

$\frac{2}{3} = \frac{\ell}{(100-\ell)}$ ....(1)

$\ell = 40\text{cm}$

In case II

$\frac{2}{R} = \frac{\ell+10}{100-(\ell+10)}$

Put $\ell = 40\text{cm}$ & solve

$R = 2\Omega$

$\therefore \frac{3x}{3+x} = 2$

$x = 6\Omega$

3 - JEE Main Chemistry 24-Jan 2026 Shift -2

Q51 Solution:
(3)

II, IV & V are secondary alcohol.

Q52 Solution:
(1)

$CH_4(g) \rightarrow C(g) + 4H(g);\ \Delta_r H = x$ kJ/mol

$C_2H_6(g) \rightarrow 2C(g) + 6H(g);\ \Delta_r H = y$ kJ/mol

$1000x = 4\times\varepsilon_{C-H}$

$1000y = 1\times\varepsilon_{C-C} + 6\times\varepsilon_{C-H}$

$\varepsilon_{C-C} = \left(y - \frac{3x}{2}\right)\times1000 = \frac{hc}{\lambda}\cdot N_A$

(λ') wavelength of photon $= \frac{hcN_A}{[4y-6x]\times250}$

Q53 Solution:
(3)

Species	Bond order	Magnetic Nature
O_2^+	2.5	Paramagnetic
O_2^-	1.5	Paramagnetic
O_2^+	2.5	Paramagnetic
N_2^-	2.5	Paramagnetic
N_2^{2-}	2	Paramagnetic

Q54 Solution:
(2)

To identify Ba^{2+} & Ca^{2+}

Reagent $(NH_4)_2CO_3 + NH_4Cl$ is used $BaCO_3$ & $CaCO_3$ are obtained as precipitates.

Q55 Solution:
(2)

Wavelength of light absorbed increases as C.F.S.E of complex decreases.

$[Co(CN)_6]^{3-}$ has maximum CFSE

$[CoF_6]^{3-}$ has least CFSE

Ligand field strength ↑ ; C.F.S.E ↑

Correct wavelength order:

V > II > IV > I > III

Q56 Solution:
(1)

$$\begin{array}{lccccc} & P_2(g) & + & Q_2(g) & \rightleftharpoons & 2PQ(g) \\ t = t_{eq} & 2 \text{ mole} & & 2 \text{ mole} & & 2 \text{ mole} \end{array}$$

$K_{eq} = \frac{2^2}{2.2} = 1$

Now 1 mole of each P_2 and Q_2 is added

So reaction will move in forward direction

$$\begin{array}{lccccc} & P_2(g) & + & Q_2(g) & \rightleftharpoons & 2PQ(g) \\ t = t'_{eq} & 3 - x & & 3 - x & & 2 + 2x \end{array}$$

$K_c = 1 = \frac{(2+2x)^2}{(3-x)(3-x)}$

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

$2 + 2x = 3 - x$

$x = \frac{1}{3}$

At new equilibrium:

Moles of $P_2 = \frac{8}{3} = 2.67$

Moles of $Q_2 = \frac{8}{3} = 2.67$

Moles of $PQ = \frac{8}{3} = 2.67$

Q57 Solution:
(3)

$n_1 \rightarrow$ lower energy level

$n_2 \rightarrow$ higher energy level

$n_1 + n_2 = 4,\ \ n_2 = 3$

$n_2 - n_1 = 2,\ \ n_1 = 1$

Rydberg's formula:

$\frac{1}{\lambda} = R_H Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\frac{1}{\lambda} = R_H (3)^2 \left[\frac{1}{1^2} - \frac{1}{3^2}\right]$

$\frac{1}{\lambda} = 8R_H$

$\lambda = \frac{1}{8R_H}$

$\lambda = \frac{1}{8 \times 1.1 \times 10^5}$

$\lambda = \frac{1000}{8.8} \times 10^{-8}$ cm

$\lambda = 113.63 \times 10^{-8}$ cm

$\lambda \approx 1.14 \times 10^{-6}$ cm

Q58 Solution:
(1)

Statement I : False

$R - NC \xrightarrow{H_3O^+} R - NH_2 + HCOOH$

Statement II : True

$R - CN \xrightarrow{H_3O^+} RCOOH \xrightarrow{SOCl_2} RCOCl \xrightarrow{NH_3} RCONH_2 \xrightarrow{NaOCl / OH^-} RNH_2 \xrightarrow{CHCl_3 + KOH} R - NC$

Q59 Solution:
(4)

Gly ala val
Gly val ala
Val gly ala
Val ala gly
Ala val gly
Ala gly val

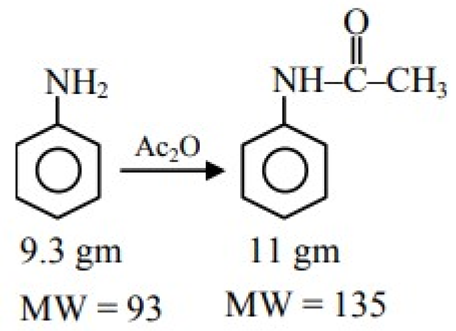
Total tri peptides = 6

Q60 Solution:
(4)

Lightest element of Group 7 $\Rightarrow$ Mn

$K_2MnO_4 \Rightarrow$ Green

Q61 Solution:
(3)



$n = \frac{9.3}{93} = 0.1 \quad n = \frac{11}{135} = 0.08148$

$\%$ yield $= \frac{0.08148}{0.1} \times 100 = 81.5\%$

Q62 Solution:
(1)

$\frac{Y_A}{Y_B} = \frac{P_A^0}{P_B^0} \cdot \frac{X_A}{X_B}$

$\frac{0.8}{0.2} = \frac{55}{15} \times \frac{X_A}{X_B}$

$\frac{X_A}{X_B} = \frac{60}{55} = \frac{12}{11}$

$X_A = \frac{12}{23} = 0.5217$

Q63 Solution:
(2)

Statement I : False
Cross aldol can give 2 or 4 products

Statement II : False
Benzaldehyde & Acetone both react with semicarbazide.

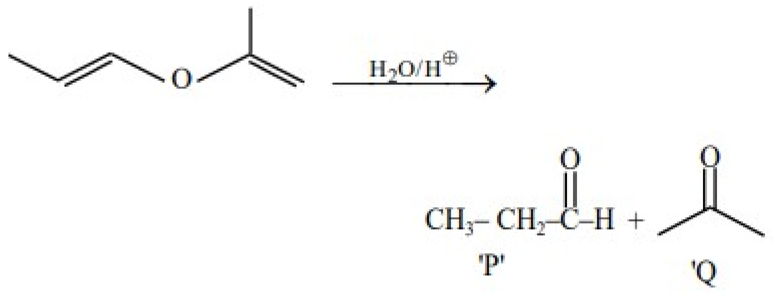
Q64 Solution:
(2)

To compare second ionization potential, configuration of mono-cation is observed

C^+	N^+	O^+	F^+
$[He]2s^2 2p^1$	$[He]2s^2 2p^2$	$[He]2s^2 2p^3$ Half-filled stable	$[He]2s^2 2p^4$

2nd IE order: $O > F > N > C$

Q65 Solution:
(3)



'P' and 'Q' can be differentiated by Fehling's test.

P gives positive Fehling test

Q gives negative Fehling test

Q66 Solution:
(1)

Statement B & D are not true

Q67 Solution:
(1)

C^{13} is not radioactive

C^{14} is radioactive

Q68 Solution:
(2)

	Cl_2	+	2KOH	→	KCl	+	KClO	+	H_2O
$t=0$	1 mole		4 mole						
t_f	0		2 mole		1 mole		1 mole		

$[OH^-] = 1M$

$\left[Cl^-\right] = \frac{1}{2}M$

$\left[ClO^-\right] = \frac{1}{2}M$

Q69 Solution:
(4)

$P_{N_2} = K_H \cdot X_{N_2}$

$P_{N_2} = 0.8 \times 10 = 8 \text{ atm}$

$8 \times 760 = 6.5 \times 10^7 \times X_{N_2}$

$X_{N_2} = \frac{8 \times 760}{6.5 \times 10^7}$

$X_{N_2} = 9.35 \times 10^{-5}$

Q70 Solution:
(1)

Both Statements are correct.

Q71 Solution:
(3)

$$\left[Cr(H_2O)_5Cl\right]Cl_2 \cdot H_2O \quad + \quad AgNO_3 \quad \rightarrow \quad 2AgCl$$

$$\frac{2.75}{266.5} \qquad\qquad -$$

$$= 0.0103 \text{ moles} \qquad\qquad 0.02063 \text{ mole}$$

Mass of AgCl $= 0.02063 \times 143.5 = 2.96$ g

Q72 Solution:
(6)

$1.4\ dm^3$ (or 1.4 mL) occupied by 1 g

$\therefore$ Molecular weight of Q $= \frac{22.4}{1.4} = 16$

$\therefore$ Q is CH_4 gas and Grignard reagent is CH_3MgBr

$$CH_3MgBr \xrightarrow[(ii)\ H_3O^+]{(i)\ CO_2\ (dry\ \ ice)} CH_3COOH$$

(Molecular weight 60)

$\therefore$ Weight of 0.1 mole of $CH_3COOH = 6$

Q73 Solution:
(73)

	$C_xH_yO_z$	+ O_2 →	CO_2	+ H_2O
$t = 0$	0.25 gm			
t_{eq}	-		0.18 gm	0.15 gm

Mass of 'C' $= \frac{0.18}{44} \times 12 = 0.049 \approx 0.05$ gm

Mass of 'H' $= \frac{0.15}{18} \times 2 = 0.016 \approx 0.017$ gm

Mass of 'O' $= 0.25 - 0.05 - 0.017 = 0.1833$ gm

Mass % of 'O' $= \frac{0.1833}{0.25} \times 100 = 73.32\%$

Q74 Solution:
(102)

$t_{1/2} = \frac{ln2}{K}$

$K = \frac{ln2}{245}$

$t = \frac{1}{K} ln\frac{a_0}{a_t}$

$t_{25\%} = \frac{1}{K} ln\frac{4}{3}$

$t_{25\%} = \frac{1}{\frac{ln2}{245}} ln\frac{4}{3}$

$t_{25\%} = 245 \cdot \frac{ln\frac{4}{3}}{ln2} = 245\left[\frac{2\log2 - \log3}{\log2}\right]$

$= 245\left[\frac{2 \times 0.3010 - 0.4771}{0.3010}\right] = 101.66$ day

Q75 Solution:
(2)

$$K_a(\mathrm{HQ}) = C_1\alpha_1^2 \qquad \alpha_1 = \frac{\lambda_m(\mathrm{HQ})}{\lambda_m^{\infty}(\mathrm{HQ})}$$

$$K_a(\mathrm{HZ}) = C_2\alpha_2^2 \qquad \alpha_2 = \frac{\lambda_m(\mathrm{HZ})}{\lambda_m^{\infty}(\mathrm{HZ})}$$

$$\frac{K_a(\mathrm{HQ})}{K_a(\mathrm{HZ})} = \frac{C_1}{C_2}.\left(\frac{\alpha_1}{\alpha_2}\right)^2 = \frac{0.18}{0.02}\left[\frac{\lambda_m(\mathrm{HQ})}{\lambda_m^{\infty}(\mathrm{HZ})}\right]^2$$

$$\frac{K_a(\mathrm{HQ})}{K_a(\mathrm{HZ})} = 9\times\left(\frac{1}{30}\right)^2 = \frac{1}{100}$$

$$\mathrm{p}K_a(\mathrm{HQ}) - \mathrm{p}K_a(\mathrm{HZ}) = 2$$