Answer Key

Mathematics (25 Questions)

Q1. (A)	Q2. (A)	Q3. (B)	Q4. (B)	Q5. (B)
Q6. (B)	Q7. (C)	Q8. (C)	Q9. (C)	Q10. (C)
Q11. (C)	Q12. (C)	Q13. (D)	Q14. (C)	Q15. (A)
Q16. (B)	Q17. (C)	Q18. (D)	Q19. (C)	Q20. (D)
Q21. 61	Q22. 3201	Q23. 3	Q24. 15	Q25. 16

Physics (25 Questions)

Q26. (B)	Q27. (A)	Q28. (D)	Q29. (A)	Q30. (B)
Q31. (A)	Q32. (A)	Q33. (A)	Q34. (D)	Q35. (B)
Q36. (C)	Q37. (D)	Q38. (A)	Q39. (B)	Q40. (A)
Q41. (B)	Q42. (B)	Q43. (C)	Q44. (C)	Q45. (B)
Q46. 5	Q47. 10	Q48. 5	Q49. 6	Q50. 5

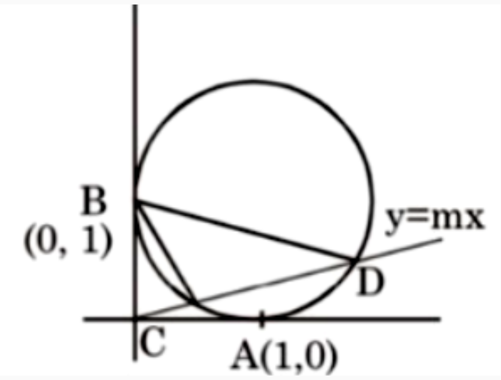
Chemistry (25 Questions)

Q51. (B)	Q52. (A)	Q53. (B)	Q54. (A)	Q55. (B)
Q56. (C)	Q57. (B)	Q58. (A)	Q59. (A)	Q60. (C)
Q61. (A)	Q62. (C)	Q63. (D)	Q64. (B)	Q65. (C)
Q66. (C)	Q67. (C)	Q68. (B)	Q69. (A)	Q70. (B)
Q71. 3	Q72. 10	Q73. 88	Q74. 6	Q75. 12

Solutions

Q1. Solution

Correct Answer: (A)



Equation of circle $(x-1)^2+(y-1)^2=1$

$$CD = 2\sqrt{\frac{2\,m}{m^2+1}}$$

$$ar(BCD) = \frac{\sqrt{2\,m}}{m^2+1}$$

$m^2=\frac{1}{3}; m=\frac{1}{\sqrt{3}}; y=\frac{x}{\sqrt{3}}; x=\sqrt{3}y$

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

$4y^2-(2+2\sqrt{3})y+1=0$

$y_1+y_2=\frac{\sqrt{3}+1}{2}; \lambda=3$

Q2. Solution
Correct Answer: (A)

Given: Data points $x_1 = c$, $x_2 = d$, $x_3 = 6$, $x_4 = 8$, $x_5 = 10$, with mean $\bar{x} = 7$ and variance $\text{Var}(x) = 8$.

The mean equation yields $c + d = 11$, while the variance gives $extVar(x) = \frac{c^2+d^2+36+64+100}{5} - 49 = 8$, simplifying to $c^2 + d^2 = 85$.

From $(c+d)^2 = c^2 + d^2 + 2cd$, we have $121 = 85 + 2cd$, so $cd = 18$. Thus, c and d are roots of $t^2 - 11t + 18 = 0$, giving $t = 2$ or 9. Since $c > d$, it follows that $c = 9$ and $d = 2$.

The transformation $z_n = 2x_n - n$ produces:

$z_1 = 2 \times 9 - 1 = 17$,
$z_2 = 2 \times 2 - 2 = 2$,
$z_3 = 2 \times 6 - 3 = 9$,
$z_4 = 2 \times 8 - 4 = 12$,
$z_5 = 2 \times 10 - 5 = 15$.

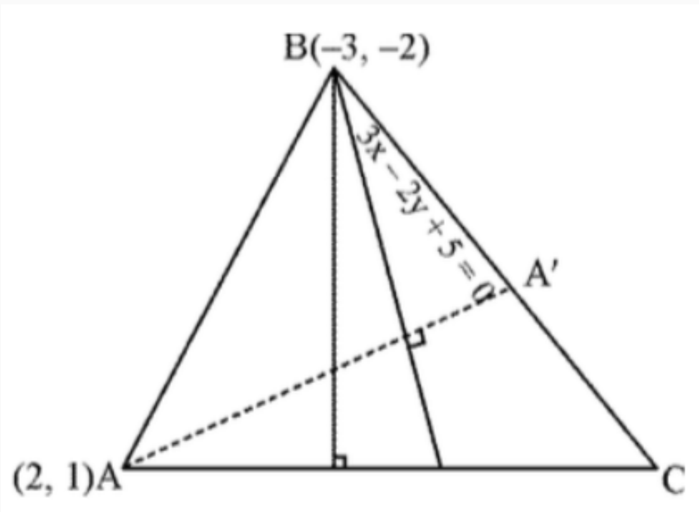
The mean of z is $\bar{z} = \frac{17+2+9+12+15}{5} = 11$.

Variance is computed as $\text{Var}(z) = \frac{(17-11)^2+(2-11)^2+(9-11)^2+(12-11)^2+(15-11)^2}{5} = \frac{36+81+4+1+16}{5} = \frac{138}{5} = 27.6$.

Final Variance: $\boxed{27.6}$

Q3. Solution
Correct Answer: (B)

Image of $A(2, -1)$ w.r.t. $3x - 2y + 5 = 0$, A' is given by $$\frac{x-2}{3} = \frac{y+1}{-2} = -2 \cdot \frac{(6+2+5)}{13} = -2$$
$$A' = (-4, 3)$$



Equation of BC is $$y - 3 = \frac{3+2}{-4+3}(x+4)$$
$$5x + y + 17 = 0$$

Q4. Solution
Correct Answer: (B)

The relation R on the set S of real-valued functions defined on the integers is examined, where $(f, g) \in \mathrm{R}$ if and only if $f(2) = g(3)$ and $f(3) = g(2)$.

Reflexivity: For $(f, f) \in \mathrm{R}$, it must hold that $f(2) = f(3)$. Since this is not true for all functions in S (consider $f(x) = x$ where $f(2) = 2 \neq 3 = f(3)$), the relation is not reflexive.

Symmetry: Suppose $(f, g) \in \mathrm{R}$, so $f(2) = g(3)$ and $f(3) = g(2)$. Interchanging f and g gives $g(2) = f(3)$ and $g(3) = f(2)$, which are the same conditions. Thus, $(g, f) \in \mathrm{R}$, and the relation is symmetric.

Transitivity: Assume $(f, g) \in \mathrm{R}$ and $(g, h) \in \mathrm{R}$, so $f(2) = g(3)$, $f(3) = g(2)$, $g(2) = h(3)$, and $g(3) = h(2)$. Substituting gives $f(2) = h(2)$ and $f(3) = h(3)$, but for $(f, h) \in \mathrm{R}$, we require $f(2) = h(3)$ and $f(3) = h(2)$, which imply $h(2) = h(3)$—a condition not generally satisfied. For example, with $f(x) = x$, $g(x) = 5 - x$, and $h(x) = x$, we have $(f, g) \in \mathrm{R}$ and $(g, h) \in \mathrm{R}$, but $(f, h) \notin \mathrm{R}$ since $f(2) = 2 \neq 3 = h(3)$. The relation is not transitive.

The relation is symmetric but neither reflexive nor transitive, corresponding to option **b**.

Q5. Solution
Correct Answer: (B)

$x^3 - 2x^2 - 1 = 0$ or $\alpha^3 - 1 = 2\alpha^2$

$$\frac{\mathrm{T}_{11} - \mathrm{T}_8}{\mathrm{T}_{10}} = \frac{\alpha^{11} + \beta^{11} + \gamma^{11} - \left[\alpha^8 + \beta^8 + \gamma^8\right]}{\alpha^{10} + \beta^{10} + \gamma^{10}} = \frac{\alpha^8\left(\alpha^3 - 1\right) + \beta^8\left(\beta^3 - 1\right) + \gamma^8\left(\gamma^3 - 1\right)}{\alpha^{10} + \beta^{10} + \gamma^{10}}$$

$$= \frac{2\left(\alpha^{10} + \beta^{10} + \gamma^{10}\right)}{\alpha^{10} + \beta^{10} + \gamma^{10}} = 2$$

Q6. Solution
Correct Answer: (B)

Total points are 11 on L_A (excluding M), 10 on L_B (excluding M), and the intersection point M, giving $11 + 10 + 1 = 22$ points.

Triangles are formed by choosing any three non-collinear points. The total ways to choose three points from 22 is $\binom{22}{3} = 1540$.

Subtract the collinear triples: $\binom{12}{3} = 220$ from line L_A (with 12 points) and $\binom{11}{3} = 165$ from line L_B (with 11 points).

The number of triangles is $1540 - 220 - 165 = 1155$.

1155 triangles can be formed.

Q7. Solution

Correct Answer: (C)

Let $\theta = \frac{\pi}{4} + x$

$\Rightarrow \quad d\theta = dx$

or $\quad 4\theta = \pi + 4x$

$\Rightarrow \quad \pi - 4\theta = -4x$

$$I = \int_{-\pi/2}^{0} \frac{(-4x)\tan\left(\frac{\pi}{4}+x\right)}{1-\tan\left(\frac{\pi}{4}+x\right)} dx = -4\int_{-\pi/2}^{0} \frac{x(1+\tan x)}{1-\tan x}$$

$$\int_{-\pi/2}^{0} \frac{x(1+\tan x}{1-\tan x} dx = -4$$

$$= 2\int_{-\pi/2}^{0} \frac{x(1+\tan x}{\tan x} \cdot \frac{(1-\tan x)}{(-2)\tan x} dx$$

$$I = x^2\Big]_{-\pi/2}^{0} + \int_{-\pi/2}^{0} \frac{x}{\tan x} dx I = -\frac{\pi^2}{4} + 2\int_{0}^{\pi/2} \frac{t}{\text{tant}} dt$$

$x = -t$

now $\quad I_1 = \int_0^{\pi/2} \underbrace{t}_{I} \underbrace{\cot t}_{II} dt = t\ell n \sin t\Big]_0^{\pi/2} -$

$$\int_0^{\pi/2} \ln \sin t dt I_1 = 0 + \frac{\pi}{2}\ln 2$$

Hence $I = 2 \cdot \frac{\pi}{2}\ln 2 - \frac{\pi^2}{4} = \pi \ln 2 - \frac{\pi^2}{4}$

Q8. Solution

Correct Answer: (C)

We are given the functional equation $h(t) + 5h\left(\frac{40}{t}\right) = 3t$ for all non-zero real numbers t. We need to find the value of $h(4) + h(10)$.

Substitute $t = 4$ into the equation:
$h(4) + 5h\left(\frac{40}{4}\right) = 3(4)$
$h(4) + 5h(10) = 12$

Substitute $t = 10$ into the equation:
$h(10) + 5h\left(\frac{40}{10}\right) = 3(10)$
$h(10) + 5h(4) = 30$

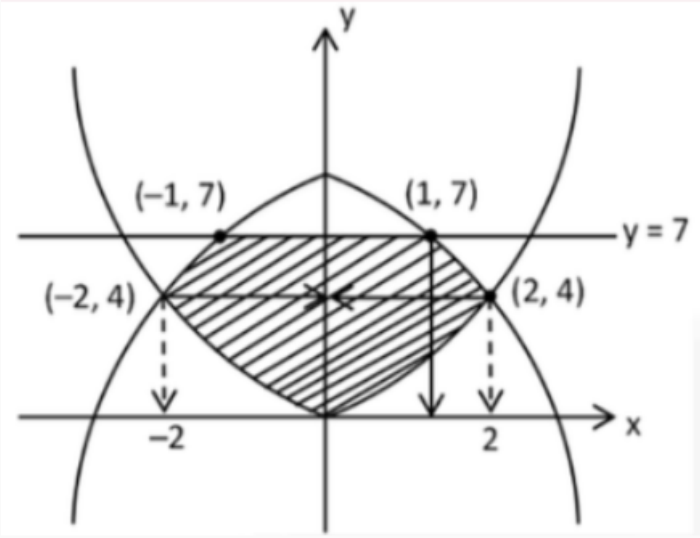
Let $x = h(4)$ and $y = h(10)$, giving the system:
$x + 5y = 12$
$5x + y = 30$

Adding both equations:
$(x + 5y) + (5x + y) = 12 + 30$
$6x + 6y = 42$
$6(x + y) = 42$
$x + y = 7$

Thus, $h(4) + h(10) = \boxed{7}$.

Q9. Solution

Correct Answer: (C)



$y \geq x^2 \quad y \leq 8 - x^2 \quad y \leq 7$

$x^2 = 8 - x^2$

$x^2 = 4$

$x = \pm 2$

$$2\left(1.7 + \int_1^2 (8 - 2x^2)dx\right) - 2\int_0^1 (x^2)dx$$

$$= 2\left[7 + \left(8x - \frac{2x^3}{3}\right)_1^2\right] - 2\left(\frac{x^3}{3}\right)_0^1$$

$$= 2\left[7 + \left(16 - \frac{16}{3}\right) - \left(8 - \frac{2}{3}\right)\right] - 2\left(\frac{1}{3}\right)$$

$$= 2\left[7 + \frac{32}{3} - \frac{22}{3}\right] = 2\left[7 + \frac{10}{3}\right] - \frac{2}{3}$$

$$= \frac{60}{3} = 20.$$

Q10. Solution

Correct Answer: (C)

$a_0 = 1, a_1 = 0$

$a_n = 3a_{n-1} - 2a_{n-2}$

$(a_n - 2a_{n-1}) = (a_{n-1} - 2a_{n-2})$

$\therefore \quad a_n - 2a_{n-1} = \text{ constant } (k)$

$\therefore \quad a_1 - 2a_0 = k \Rightarrow k = -2$

$\therefore a_n = 2a_{n-1} - 2$

$\Rightarrow (a_n - 2) = 2\,(a_{n-1} - 2)$

$\Rightarrow b_n = 2 \cdot b_{n-1}$

$\therefore \quad b_0,\ b_1,\ b_2,\ b_3, \ldots\ldots, b_n$ are in G.P.

$b_n = b_0 \cdot 2^n$

$b_n = (-1) \cdot 2^n$

$a_n - 2 = -2^n$

$a_n = 2 - 2^n$

Q11. Solution

Correct Answer: (C)

$x^2 \leq 9 \quad \ldots(1)$

$\text{and } -1 \leq \log_2\left(\frac{x}{x+1}\right) \leq 1$

$\Rightarrow \frac{x}{x+1} \geq \frac{1}{2} \quad \text{and} \quad \frac{x}{x+1} \leq 2$ by (1), (2) $[-3,-2] \cup [1,3]$ $\therefore$ 5 integers in the domain. .

$\Rightarrow \frac{x-1}{x+1} \geq 0 \quad \text{and} \quad \frac{x+2}{x+1} \geq 0$

$\Rightarrow (-\infty,-1) \cup [1,\infty)$

$\text{and } (-\infty,-2] \cup [-1,\infty) \quad \ldots(2)$

Q12. Solution
Correct Answer: (C)

Line through Q intersecting L_A and L_B

Let line L pass through $Q(1,0,0)$ and intersect L_A at A and L_B at B. Parameterize A on $L_A : x-1 = \frac{y-1}{2} = \frac{z-1}{3} = t$, giving $A(1+t, 1+2t, 1+3t)$.

Parameterize B on $L_B : \frac{x-2}{1} = \frac{y-2}{-1} = \frac{z-2}{1} = s$, giving $B(2+s, 2-s, 2+s)$.

Vectors $\vec{QA} = (t, 1+2t, 1+3t)$ and $\vec{QB} = (1+s, 2-s, 2+s)$ must be parallel for collinearity, so their cross product is zero:

$$\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ t & 1+2t & 1+3t \\ 1+s & 2-s & 2+s \end{vmatrix} = \vec{0}$$

This yields three equations:

$$2s - 2t + 5st = 0$$
$$1 + s + t + 2st = 0$$
$$1 + s + 3st = 0$$

Subtracting the second from the third gives $t(s-1) = 0$, so either $t = 0$ or $s = 1$.

$t = 0$ leads to contradiction, while $s = 1$ gives $t = -\frac{2}{3}$ from $1 + 1 + 3t = 0$.

Thus $A(\frac{1}{3}, -\frac{1}{3}, -1)$ and $B(3, 1, 3)$.

The determinant evaluates to:

$$\begin{vmatrix} 2 & 1 & 0 \\ \frac{1}{3} & -\frac{1}{3} & -1 \\ 3 & 1 & 3 \end{vmatrix} = 2[(-\tfrac{1}{3})(3) - (-1)(1)] - 1[(\tfrac{1}{3})(3) - (-1)(3)] = 2(0) - 1(4) = -4$$

Final answer: $\boxed{-4}$

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Q13. Solution
Correct Answer: (D)

Using the concept of complementary events,

$$P(x=1) + P(x=2) = 1 - P(x=0)$$

$$= 1 - \frac{48}{52} \times \frac{48}{52}$$

$$= 1 - \frac{144}{169} = \frac{25}{169}$$ `

Q14. Solution
Correct Answer: (C)

$d\left(e^{y^2}\sin x\right)+d\left(e^x\cos y^2\right)=0$ $e^y\sin x=e^x\cos y^2+c$ If is through $(0,0)\Rightarrow \mathrm{c}=1$
$e^{y^2}\sin x=-e^{-x}\cos y^2+1$ Put $y=\sqrt{\frac{\pi}{2}}\Rightarrow \sin x=\frac{1}{e^{\pi/2}}\rightarrow 2$ solutions exist `

Q15. Solution
Correct Answer: (A)

Let a, b, and c represent the vertices of an equilateral triangle, with centroid $z_c=\frac{a+b+c}{3}$.

A fundamental property of equilateral triangles gives $(a-z_c)^2+(b-z_c)^2+(c-z_c)^2=0$.

Expanding yields $a^2+b^2+c^2-2z_c(a+b+c)+3z_c^2=0$.

Substituting $a+b+c=3z_c$ produces $a^2+b^2+c^2-6z_c^2+3z_c^2=0$, which simplifies to $a^2+b^2+c^2-3z_c^2=0$.

Final answer: $\boxed{0}$

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Q16. Solution
Correct Answer: (B)

Distinct solutions of $\cos 7x+\cos 5x=\cos x$ **on** $[0,\pi]$

Using the sum-to-product identity, $\cos 7x+\cos 5x=2\cos 6x\cos x$. Substituting yields $2\cos 6x\cos x=\cos x$, which simplifies to $\cos x(2\cos 6x-1)=0$.

This equation holds when $\cos x=0$ or $\cos 6x=\frac{1}{2}$.

For $\cos x=0$, the only solution in $[0,\pi]$ is $x=\frac{\pi}{2}$.

For $\cos 6x=\frac{1}{2}$, let $y=6x$ with $y\in[0,6\pi]$. The solutions are $y=2n\pi\pm\frac{\pi}{3}$ for integer n. Valid y values in $[0,6\pi]$ are $\frac{\pi}{3}$, $\frac{5\pi}{3}$, $\frac{7\pi}{3}$, $\frac{11\pi}{3}$, $\frac{13\pi}{3}$, and $\frac{17\pi}{3}$, giving $x=\frac{y}{6}$ as $\frac{\pi}{18}$, $\frac{5\pi}{18}$, $\frac{7\pi}{18}$, $\frac{11\pi}{18}$, $\frac{13\pi}{18}$, and $\frac{17\pi}{18}$.

Since $\frac{\pi}{2}=\frac{9\pi}{18}$ is not among these, all seven solutions are distinct.

The total number of distinct x values is $\boxed{7}$.

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Q17. Solution

Correct Answer: (C)

$$\frac{1}{x^2}+\frac{1}{f^2(x)}=1$$
$$\Rightarrow f(x)=\frac{x}{\sqrt{x^2-1}}$$
$$\Rightarrow f(f(x))=x$$
$$\Rightarrow f(f(f(x)))=f(x)=\frac{x}{\sqrt{x^2-1}}$$,
$$\Rightarrow \underbrace{\text{fff}\ldots-f(x)}_{\text{10 times}}=x$$
$$\text{So } \int_2^4 \underbrace{\text{fff}\ldots.f(x)}_{\text{10 times}}dx=\left[\frac{x^2}{2}\right]_2^4=\frac{16-4}{2}=6$$

Q18. Solution

Correct Answer: (D)

Check video solution for detailed explanation
$$\begin{aligned} \because\quad & f'(x)=ax(x-1) && \Rightarrow && f'(2)=6 && \Rightarrow && a=3 \\ & f'(x)=3\left(x^2-x\right) && \Rightarrow && f(x)=x^3-\tfrac{3x^2}{2}+C \\ \therefore\quad & f(x)=x^2\left(x-\tfrac{3}{2}\right) \\ & f(2)=2\Rightarrow C=0 \end{aligned}$$.

Q19. Solution

Correct Answer: (C)

Let $(2\lambda-1,3\lambda-2,2\lambda+1)$ be any point on the line Its distance from point $A(4,2,7)$ is $\sqrt{26}$
$$\therefore (2\lambda-5)^2+(3\lambda-4)^2+(2\lambda-6)^2=26$$
$$\Rightarrow \lambda^2-4\lambda+3=0\Rightarrow\lambda=1,3$$
$\therefore B=(1,1,3)$ and $C=(5,7,7)$, ~

So, area of $\triangle ABC=\frac{1}{2}|\overrightarrow{AB}\times\overrightarrow{AC}|=\sqrt{153}$

Q20. Solution

Correct Answer: (D)

$$\frac{T_{r+1}}{T_r}=\frac{1}{3}\quad T_1=a;T_2=\frac{1}{3}a\quad T_3=\frac{1}{3^2}a\ldots\ldots\ldots\ldots T_7=\frac{1}{3^6}a$$
$$\frac{a}{3^6}=\frac{1}{243}\Rightarrow a=3$$
$$T_r\times T_{r+1}=\frac{a}{3^{r-1}}\times\frac{a}{3^r}=\frac{a^2}{3^{2r-1}}=\frac{3^2}{3^{2r-1}}=\frac{1}{3^{2r-3}}$$:
$$\sum_{r=1}^{\infty}T_r\cdot T_{r+1}=3+\frac{1}{3}+\frac{1}{3^3}+\frac{1}{3^5}+\ldots\ldots.\infty$$
$$=\frac{3}{1-\frac{1}{3^2}}=\frac{27}{8}=3.375$$

Q21. Solution

Correct Answer: 61

$|A| = 3abc - a^3 - b^3 - c^3$
$a+b+c = 9. \&ab+bc+ca = 26$ So, $|A| = -27$ Hence $M = 3^{48}$ Now $3^{48} = 9^{24} = (10-1)^{24}$ Now last two digits are 61.

Q22. Solution

Correct Answer: 3201

Given $P(x) = (1-x+x^2)^8 = b_0 + b_1x + b_2x^2 + \ldots + b_{16}x^{16}$, we evaluate $(b_0 + b_2 + b_4 + \ldots + b_{16}) + 10b_1$.

The sum of even coefficients is $S_{\text{even}} = \frac{P(1)+P(-1)}{2}$.
$P(1) = (1-1+1)^8 = 1^8 = 1$,
$P(-1) = (1+1+1)^8 = 3^8 = 6561$,
so $S_{\text{even}} = \frac{1+6561}{2} = 3281$.

The coefficient b_1 is found by differentiation:
$P'(x) = 8(1-x+x^2)^7(-1+2x)$,
so $b_1 = P'(0) = 8(1)^7(-1) = -8$.

The expression becomes $3281 + 10(-8) = 3281 - 80 = 3201$.

$\boxed{3201}$

Q23. Solution

Correct Answer: 3

$$\frac{1}{x^4} - 1 < \left[\frac{1}{x^4}\right] \leq \frac{1}{x^4} \quad \Rightarrow \left(x^{16}+4x^{12}-3x^4\right)\frac{1-x^4}{x^4} < \left(x^{16}+4x^{12}-3x^4\right)\left[\frac{1}{x^4}\right] \leq \frac{x^{16}+4x^{12}-3x^4}{x^4}$$

$$\Rightarrow \lim_{x\to 0}\left(x^{16}+4x^{12}-3x^4\right)\left(\frac{1-x^4}{x^4}\right) < \lim_{x\to 0}\left(x^{16}+4x^{12}-3x^4\right)\left[\frac{1}{x^4}\right] \leq \lim_{x\to 0}\frac{x^{16}+4x^{12}-3x^4}{x^4}$$

$$\Rightarrow -3 < \lim_{x\to 0}\left(x^{16}+4x^{12}-3x^4\right)\left[\frac{1}{x^4}\right] \leq -3$$

$\therefore \quad$ By sandwich theorem, $\lim_{x\to 0}\left(x^{16}+4x^{12}-3x^4\right)\left[\frac{1}{x^4}\right] = -3$ Aliter : $\lim_{x\to 0}\left(x^{16}+4x^{12}-3x^4\right)\left(\frac{1}{x^4} - \left\{\frac{1}{x^4}\right\}\right) \because \quad 0 \leq \left\{\frac{1}{x^4}\right\} < 1$ therefore limit $= -3$

Q24. Solution

Correct Answer: 15

$$|\vec{c}-\vec{a}| = \sqrt{14}$$

$$\Rightarrow |\vec{c}|^2 + |\vec{a}|^2 - 2\vec{c}\cdot\vec{a} = 14 \quad \ldots(i)$$

$$\vec{a}\cdot\vec{c} + 2|\vec{c}| = 0$$

$$\Rightarrow |\vec{a}|\cdot|\vec{c}|\cdot\cos\theta + 2|\vec{c}| = 0$$

$$\Rightarrow |\vec{c}|\cdot(|\vec{a}|\cdot\cos\theta + 2) = 0$$

$$\Rightarrow \cos\theta = -\frac{2}{3}, \text{ given } |\vec{a}| = 3$$

from (i)

$$\Rightarrow |\vec{c}|^2 + 9 - 2|\vec{c}|\cdot|\vec{a}|\cdot\left(-\frac{2}{3}\right) - 14 = 0$$

$$\Rightarrow |\vec{c}|^2 + 4|\vec{c}| - 5 = 0 \Rightarrow |\vec{c}| = 1, -5$$

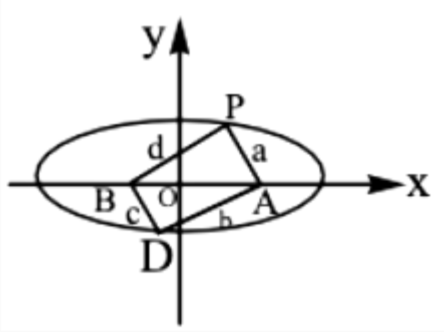
$$\vec{a}\times\vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix} = 2\hat{i} - 2\hat{j} + \hat{k}$$

$$|(\vec{a}\times\vec{b})\times\vec{c}| = |(\vec{a}\times\vec{b})|\cdot|\vec{c}|\cdot\sin\theta$$

$$= 3.1\times\frac{1}{2} = \frac{3}{2}$$

Q25. Solution

Correct Answer: 16



$$PA + PB = 4 \quad \text{(focal property)}$$

$$DA + DB = 4$$

$$\Rightarrow \quad a + b + c + d = 8$$

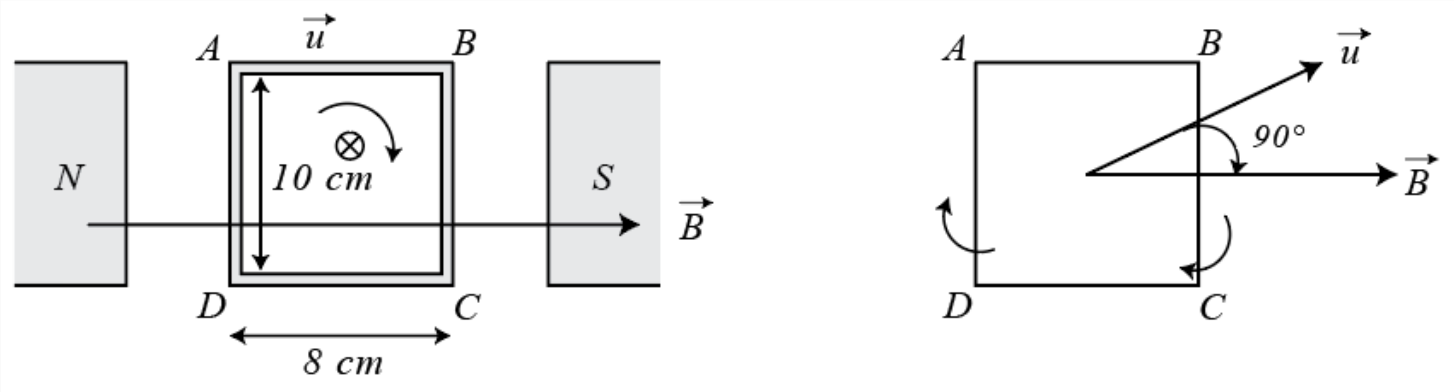
$$A.M. \geq G.M.$$

Now, $\Rightarrow \quad \dfrac{a+b+c+d}{4} \geq (abcd)\dfrac{1}{4}$

$$\Rightarrow \quad abcd \leq 16$$

Q26. Solution

Correct Answer: (B)



$$\begin{aligned}|\vec{\tau}| &= |\vec{\mu} \times \vec{B}| \times 100 \\ &= \mu B \sin 90^\circ \times 100 \\ &= 2(10 \times 8) \times 10^{-4} \times 0.2 \times 100 \\ &= 3.2 \times 10^{-3} \times 100\ \mathrm{N-m} \\ &= 0.0032 \times 100\end{aligned}$$

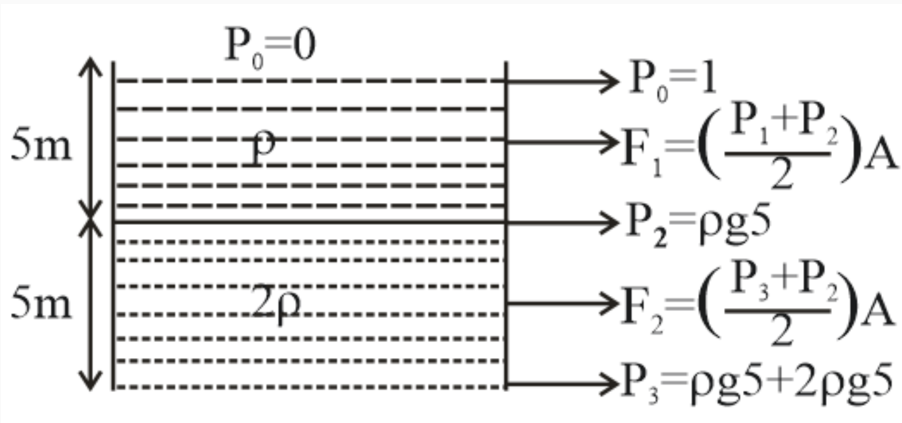
Q27. Solution

Correct Answer: (A)

$f_0 - f_c = 2$ Or $\frac{v}{2l} - \frac{v}{4l} = 2$ or $\frac{v}{4l} = 2$ Or $\frac{v}{l} = 8$ When length of open organ pipe is halved and that of closed organ pipe is doubled, the beat frequency will be: $f_0' - f_c' = \frac{v}{l} - \frac{v}{8l} = \frac{7}{8}\frac{v}{l} = \frac{7}{8} \times 8 = 7$

Q28. Solution

Correct Answer: (D)



$\frac{F_1}{F_2} = \frac{1}{4}$

Q29. Solution
Correct Answer: (A)

The fringe width β in Young's double-slit experiment is given by $\beta = \frac{\lambda D}{d}$, where λ is the wavelength, D is the slit-screen distance, and d is the slit separation.

When the slit separation increases to $2.5d$, the new fringe width becomes $\beta' = \frac{\lambda D}{2.5d} = \frac{1}{2.5}\beta = 0.4\beta$.

The percentage change is calculated as $\frac{\beta' - \beta}{\beta} \times 100\% = \frac{0.4\beta - \beta}{\beta} \times 100\% = -60\%$.

The fringe width decreases by 60%.

Answer: a

Q30. Solution
Correct Answer: (B)

If mass of a gas is constant then there is variation in density of gas with the variation of temperature and pressure because the molar volume of the gas goes on changing because $\rho = \frac{\mathrm{M}}{\mathrm{V}}$
We know, from Ideal gas law $\mathrm{p} = \frac{\rho \mathrm{RT}}{\mathrm{M}}$
For point A, $\mathrm{p} = \frac{\rho_0 \mathrm{RT}_0}{\mathrm{M}} \Rightarrow \mathrm{M} = \frac{\rho_0 \mathrm{RT}_0}{\mathrm{p}}$
For point B, $3\mathrm{p} = \frac{\rho \mathrm{R}(2\ \mathrm{T}_0)}{\mathrm{M}} = \frac{\rho \mathrm{R}(2\ \mathrm{T}_0)}{\rho_0 \mathrm{RT}_0} \times \mathrm{p}$
[By Eq. (i)]
$\Rightarrow \rho = \frac{3\rho_0}{2}$

Q31. Solution
Correct Answer: (A)

Young's double-slit interference involves two sources with intensities I_1 and I_2 in the ratio $1:16$, so $\frac{I_1}{I_2} = \frac{1}{16}$. Let $I_1 = k$ and $I_2 = 16k$ for a constant k.

The resultant intensity at any point is $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$, where ϕ is the phase difference.

Maximum intensity occurs at constructive interference ($\cos\phi = 1$):
$I_{\max} = (\sqrt{I_1} + \sqrt{I_2})^2 = (\sqrt{k} + 4\sqrt{k})^2 = 25k$

Minimum intensity occurs at destructive interference ($\cos\phi = -1$):
$I_{\min} = (\sqrt{I_1} - \sqrt{I_2})^2 = (\sqrt{k} - 4\sqrt{k})^2 = 9k$

The ratio is $\frac{I_{\max}}{I_{\min}} = \frac{25k}{9k} = \frac{25}{9}$.

The final answer is $\boxed{\text{a}}$

Q32. Solution
Correct Answer: (A)

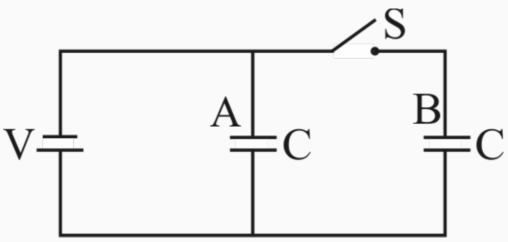
Check video solution for detailed explanation $\lambda_{Lyman} < \lambda_{Balmer}$

$\therefore$ A is false

$And\ 2\pi r_n = n\lambda$

Hence B is true

Q33. Solution
Correct Answer: (A)

Initial energy $(E_i) = 2 \times \left(\frac{1}{2} CV^2\right)$ 

when switch S is opened and dielectric is introduced the new capacitance (C_1) of either capacitor will be $= 3\mathrm{C}$ and after opening the switch S the potential across capacitor A is V volt but potential across B will now change (Think !). So final potential across capacitor B is $\mathrm{V}_1(\text{sup})$ is given by $\Rightarrow \quad \begin{array}{c} \mathrm{q_B = CV = C_1\,V_1} \\ \mathrm{V_1 = \dfrac{V}{3}\ volt} \end{array}$ Therefore, final energy of A $= \frac{1}{2}(3\mathrm{C})\mathrm{V}^2$ And final energy of B $= \frac{1}{2}(3\mathrm{C})\left(\frac{\mathrm{V}}{3}\right)^2 \therefore$ Total final energy $(\mathrm{E}_q) = \frac{3}{2}\mathrm{CV}^2 + \frac{1}{6}\mathrm{CV}^2 = \frac{5}{3}\mathrm{CV}^2 \Rightarrow \quad \frac{\mathrm{E_i}}{\mathrm{E_f}} = \frac{3}{5}$.

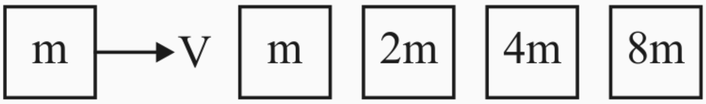
Q34. Solution
Correct Answer: (D)

Let the power source be P and it is placed at O. 

Then, intensity at A and B would be given by $I_A = \frac{P}{4\pi\times 1^2}$ and $I_B = \frac{P}{4\pi\times 2^2}$ Since, int ensity $\propto$ (Amplitude) $\times(\text{ Frequency })^2$ (here, amplitude means displacement amplitude) The frequency is same at both the points. $\frac{(Amp)_A}{(Amp)_B} = \sqrt{\frac{I_A}{I_B}} = \sqrt{\frac{2^2}{1^2}} = 2 : 1$

Q35. Solution

Correct Answer: (B)



Inelastic collision

$\mathrm{mv}=16\ \mathrm{mv}^1$

$\Delta\mathrm{K}$ loss $=\frac{1}{2}\mathrm{mv}^2-\frac{1}{2}(16\mathrm{M})\left(\frac{\mathrm{v}}{16}\right)^2$

$=\frac{1}{2}\mathrm{mv}^2-\frac{1}{2}\mathrm{M}\frac{\mathrm{v}^2}{16}$

$=\frac{1}{2}\mathrm{mv}^2\left(\frac{15}{16}\right)$

$\%\ \Delta\mathrm{K}$ loss $=\frac{\frac{1}{2}\mathrm{mv}^2\left(\frac{15}{16}\right)}{\frac{1}{2}\mathrm{MV}^2}\times 100=\frac{15}{16}\times 100=93.75\ \%$

Q36. Solution

Correct Answer: (C)

Given,

A ball is projected with an initial speed of $u=100\ \mathrm{m\ s^{-1}}$ at an angle 30° above the horizontal.

The Vertical component of initial velocity is $u_y=u\sin(30^\circ)=100\left(\frac{1}{2}\right)=50\ \mathrm{m\ s^{-1}}$

The ball hits the point A on the cliff after $t=5$ s.

The height of the cliff will be

$h=u_y t-\frac{1}{2}gt^2=50(5)-\frac{1}{2}(10)(5)^2$

$\therefore\ h=125$ m.

Q37. Solution

Correct Answer: (D)

Terminal velocity is achieved when Boyant force = d rag force (mass neglegible)

$\Rightarrow \rho_w\left(\frac{4}{3}\pi R^3\right)\cdot g=6\pi\eta R v$

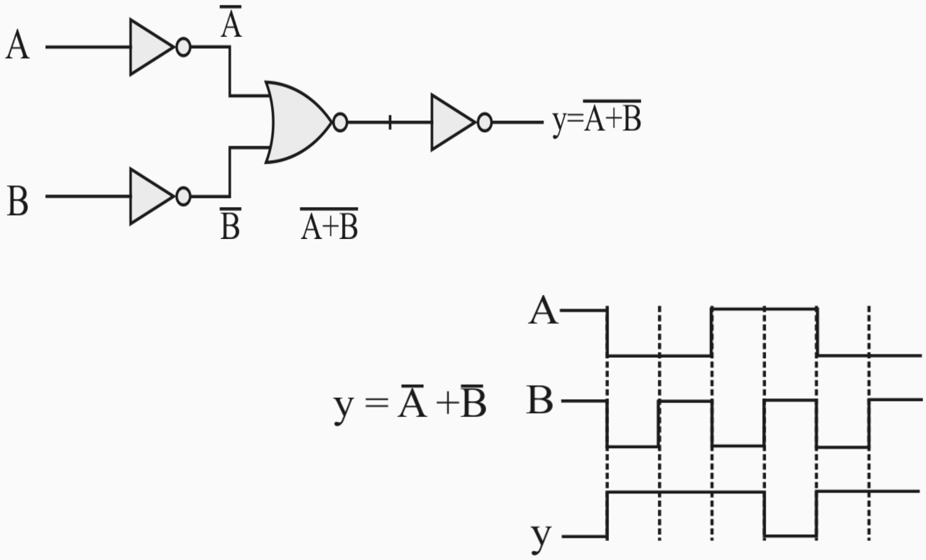
$\Rightarrow v=\frac{2\rho_w\cdot R^2\cdot g}{9\eta}$

$\Rightarrow v=4\ \mathrm{cm/s}$

$\Rightarrow t=\frac{20}{4}=5\mathrm{sec}$

Q38. Solution

Correct Answer: (A)



Q39. Solution

Correct Answer: (B)

$x^2 = at^2 + 2bt + c$

$2xv = 2at + 2b$

$xv = at + b$

$v^2 + ax = a$

$ax = a - \left(\frac{at+b}{x}\right)^2$

$a = \frac{a\left(at^2+2bt+c\right)-(at+b)^2}{x^3}$

$a = \frac{ac^{-2}}{x^3}$

$a \; \alpha \; x^{-3}$

Q40. Solution

Correct Answer: (A)

The maximum instantaneous current I_0 is found from the RMS current I_{rms}, which relates to average power P_{avg} and RMS voltage V_{rms} by $P_{avg} = V_{rms}I_{rms}$ when power factor is unity.

Given $P_{avg} = 150\text{W}$ and $V_{rms} = 240\text{V}$, we compute $I_{rms} = \frac{150}{240} = \frac{5}{8} = 0.625\text{A}$.

For sinusoidal AC, $I_{rms} = \frac{I_0}{\sqrt{2}}$, so $I_0 = I_{rms}\sqrt{2} = 0.625 \times 1.414 \approx 0.88\text{A}$.

This matches option **a**.

Q41. Solution
Correct Answer: (B)

Surface tension is force per unit length, with force dimensions $[MLT^{-2}]$ and length $[L]$, yielding $\tau = \frac{[MLT^{-2}]}{[L]} = [MT^{-2}]$.
Thus, (A) matches (III).

Planck's constant relates energy $E = [ML^2T^{-2}]$ to frequency $\nu = [T^{-1}]$, giving $h = \frac{E}{\nu} = \frac{[ML^2T^{-2}]}{[T^{-1}]} = [ML^2T^{-1}]$.
Thus, (B) matches (IV).

Thermal conductivity k appears in $Q = kA\frac{dT}{dx}t$, with heat $Q = [ML^2T^{-2}]$, area $A = [L^2]$, temperature gradient $\frac{dT}{dx} = [KL^{-1}]$, and time $t = [T]$.
This yields $k = \frac{[ML^2T^{-2}]}{[L^2][KL^{-1}][T]} = [MLT^{-3}K^{-1}]$.
Thus, (C) matches (I).

Energy density is energy per volume: $\frac{[ML^2T^{-2}]}{[L^3]} = [ML^{-1}T^{-2}]$.
Thus, (D) matches (II).

The correct pairing is option $\boxed{b}$.

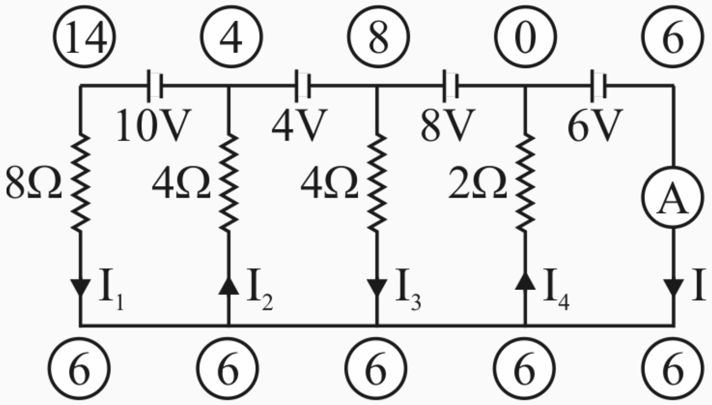
Q42. Solution
Correct Answer: (B)

Equation of the parabola given in the graph is

$$\begin{aligned}
& \mathrm{y}^2 = 4\mathrm{ax} \\
& (\mathrm{T}_0)^2 = 4\mathrm{a}\left(\frac{1}{\mathrm{V}_0}\right) \\
\Rightarrow \quad & \mathrm{T}_0^2\,\mathrm{V}_0 = \text{ constant} \\
& \mathrm{T}_0\,\mathrm{V}_0^{1/2} = \text{ constant} \qquad \left[\text{for an adiabatic process } \mathrm{TV}^{\gamma-1} = \text{ constant}\right] \\
\therefore \quad & \gamma - 1 = 1/2 \Rightarrow \gamma = \frac{3}{2} \\
& \frac{\mathrm{V}_{\text{rms}}}{\mathrm{V}_{\text{nound}}} = \frac{\sqrt{\left(\frac{3\mathrm{RT}}{\mathrm{M}}\right)}}{\sqrt{\frac{\gamma\mathrm{RT}}{\mathrm{M}}}} = \sqrt{\frac{3}{\gamma}} = \sqrt{2}
\end{aligned}$$

Q43. Solution

Correct Answer: (C)



The current through ammeter

$$\begin{aligned} I &= I_4 - I_3 + I_2 - I_1 \\ &= \left(\frac{6-0}{2}\right) - \left(\frac{8-6}{4}\right) + \frac{(6-4)}{4} - \frac{(14-6)}{8} \\ &= 3 - \frac{1}{2} + \frac{1}{2} - 1 = 3 - 1 = 2\text{ A} \end{aligned}$$

Q44. Solution

Correct Answer: (C)

Let so be the total displacement of the particle till it stops in time $t0$. Then average velocity

$V_{as} = \frac{S_0}{t_0}$

$\Rightarrow m\left(v \cdot \frac{dv}{ds}\right) = -kv^n \Rightarrow v^{1-n}dv = -\frac{k}{m}ds \Rightarrow \int_{v_0}^{0} v^{1-n}dv = -\frac{k}{m}\int_0^{s_0} ds$

V 0 $=$ initial velocity of particle

$$S_0 = \frac{mv_0^{2-n}}{k(2-n)}$$

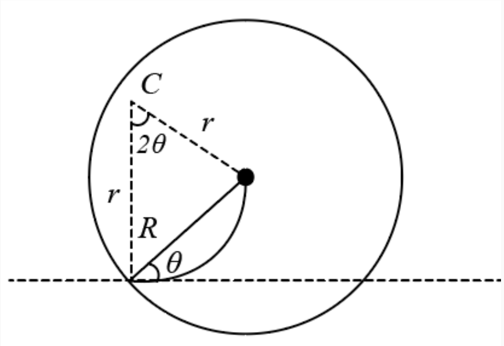
Or

or $m\left(\frac{dv}{dt}\right) = -kv^n$

or to $= \frac{mv_0^{1-n}}{k(1-n)} \quad V_{av} = \left(\frac{1-n}{2-n}\right)V_0 = \frac{V_0}{3} \quad \therefore n = \frac{1}{2}$

Q45. Solution

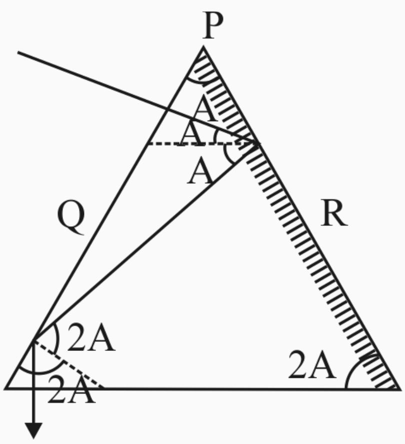
Correct Answer: (B)



$$r = \frac{R}{2\sin\theta}$$
$$\frac{mv_0}{qB} = \frac{R}{2\sin\theta}$$
$$v_0 = \frac{qBR}{2m\sin\theta}$$

Q46. Solution

Correct Answer: 5



$$\frac{\pi}{2} - \frac{A}{2} + \frac{\pi}{2} - 2A = \frac{\pi}{2}$$
$$\frac{5A}{2} = \frac{\pi}{2}$$
$$A = \frac{\pi}{5} = 36^\circ$$

Q47. Solution

Correct Answer: 10

Height of liquid in column is $h = \frac{2T\cos\theta}{r\rho g}$

$\therefore$ Mass of liquid in column $= \pi^2 h\rho$

$(\because \quad \text{Mass} = \text{volume} \times \text{density})$

$\therefore \quad m = \pi r^2 \left(\frac{2T\cos\theta}{r\rho g}\right)\rho$

$\therefore \quad m = \left(\frac{2\pi T\cos\theta}{g}\right) r$

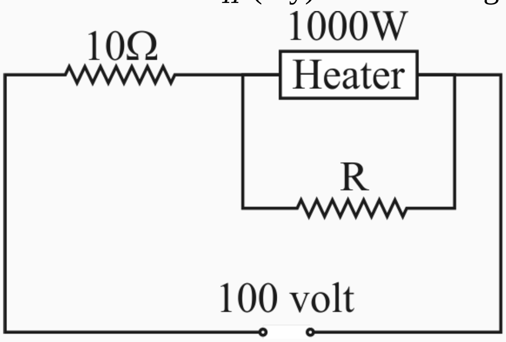
$\therefore \quad m \propto r \quad$ or $\quad \frac{m_1}{m_2} = \frac{r_1}{r_2}$

or $\frac{5}{m_2} = \frac{r}{2r} \quad$ or $\quad m_2 = 10\ \text{g}$

Q48. Solution

Correct Answer: 5

The resistance R_H (say) of the heating filament of the heater is $R_H=\frac{V^2}{P}=\frac{(100\text{ volt })^2}{1000\text{ watt}}=10\text{ ohm}$



A part I' of I passes through the heater and the rest into R. Now $I'=\frac{V'}{R_H}=\frac{25\text{volt}}{10\text{ohm}}=2.5\text{Amp}$ Therefore, current in R is $=I-I'=7.5-2.5=5.0$ A The potential difference across R is $V'=25\text{Volt}$
$R_H=\frac{V'}{I-I'}=\frac{25\text{volt}}{5.0\text{Amp}}=5\text{ohm}$

Q49. Solution

Correct Answer: 6

$\frac{hc}{\lambda_1}+\frac{hc}{\lambda_2}=RchZ^2\left(\frac{1}{1^2}-\frac{1}{n^2}\right)$
Put $\lambda_1=1026.7\text{Å}$ and $\lambda_2=304\text{ Å}$
$Z=2$ for He^+ ion
On solving for n
$n=6$

Q50. Solution

Correct Answer: 5

Given $Q=x^{2/5}y^{-1}t^{-1/2}z^3\ \frac{\Delta Q}{Q}\times 100=\frac{2}{5}\frac{\Delta x}{x}\times 100+\frac{\Delta y}{y}\times 100+\frac{1}{2}\frac{\Delta t}{t}\times 100+3\frac{\Delta z}{z}\times 100$
$=\frac{2}{5}\times 2.5+2+\frac{1}{2}\times 1+3\times 0.5=5\%$

Q51. Solution

Correct Answer: (B)

The principle of conductometric titration is based on the fact that during the titration one of the ions is replaced by other and invariably these two ions differ in the ionic conductivity.

In the conductometric titration of 0.05 M H_2SO_4 with 0.1 M NH_4OH, initially the fast moving H^+ ion get neutralised as H_2O and is replaced by slow moving NH_4^+ ion up to neutralisation point. After neutralisation point, weak electrolyte NH_4OH is added gradually, which do not affect the conductance.

Q52. Solution
Correct Answer: (A)

$\mathrm{pH} = \mathrm{pk_a} + \log\left[\frac{\mathrm{Salt}}{\mathrm{Acid}}\right]$ $(\because [\mathrm{Salt}]=[\mathrm{Anion}])$

$\Rightarrow 6 = 5 + \log \ \frac{\mathrm{Salt}}{\mathrm{Acid}}$

$\Rightarrow 1 = \log \frac{\mathrm{Salt}}{\mathrm{Acid}}$

$\Rightarrow \log 10 = \log \frac{\mathrm{Salt}}{\mathrm{Acid}}$

$\frac{\mathrm{Salt}}{\mathrm{acid}} = \frac{10}{1}$

Q53. Solution
Correct Answer: (B)

Vitamins are organic compounds essential for normal growth and nutrition, required in small dietary quantities as they cannot be synthesized by the body.
They are classified by solubility: **fat-soluble vitamins** (A, D, E, K) are absorbed with fats and stored in tissues, while **water-soluble vitamins** (C and B-complex including B_1, B_2, B_3, B_5, B_6, B_7, B_9, B_{12}) are not significantly stored and are excreted in urine.

Analyzing the options:

Option (a) contains Vitamin B_1, Vitamin C, and Vitamin B_6—all water-soluble.

Option (b) contains Vitamin A, Vitamin D, and Vitamin K—all fat-soluble.

Option (c) contains Vitamin C (water-soluble), Vitamin B_{12} (water-soluble), and Vitamin E (fat-soluble)—a mixture.

Option (d) contains Vitamin B_2 (water-soluble), Vitamin A (fat-soluble), and Vitamin C (water-soluble)—also a mixture.

Only option (b) lists exclusively fat-soluble vitamins.

Q54. Solution
Correct Answer: (A)

Lothar Meyer arranged elements in increasing order of atomic weight, not atomic number. Newlands' Law of Octaves was based on atomic weight, making Statement II correct and Statement I incorrect.

Q55. Solution

Correct Answer: (B)

$$\text{Angular momentum} = \frac{nh}{2\pi} \qquad 3.1652 \times 10^{-34} = \frac{n \times 6.626 \times 10^{-34}}{2\pi} \quad n = 3 \qquad \because \bar{v} = R.Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Q56. Solution

Correct Answer: (C)

Primary standards must possess high purity, stability in air, high molecular weight, and ready solubility without reacting with the solvent. Substances lacking these properties require standardization and are unsuitable for direct weighing.

Concentrated sulfuric acid (H_2SO_4) is a hygroscopic liquid, making accurate mass determination impossible.

Anhydrous sodium carbonate (Na_2CO_3) is hygroscopic and requires careful drying before use.

Hydrated ferrous ammonium sulfate ($Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$) is efflorescent and oxidizes readily.

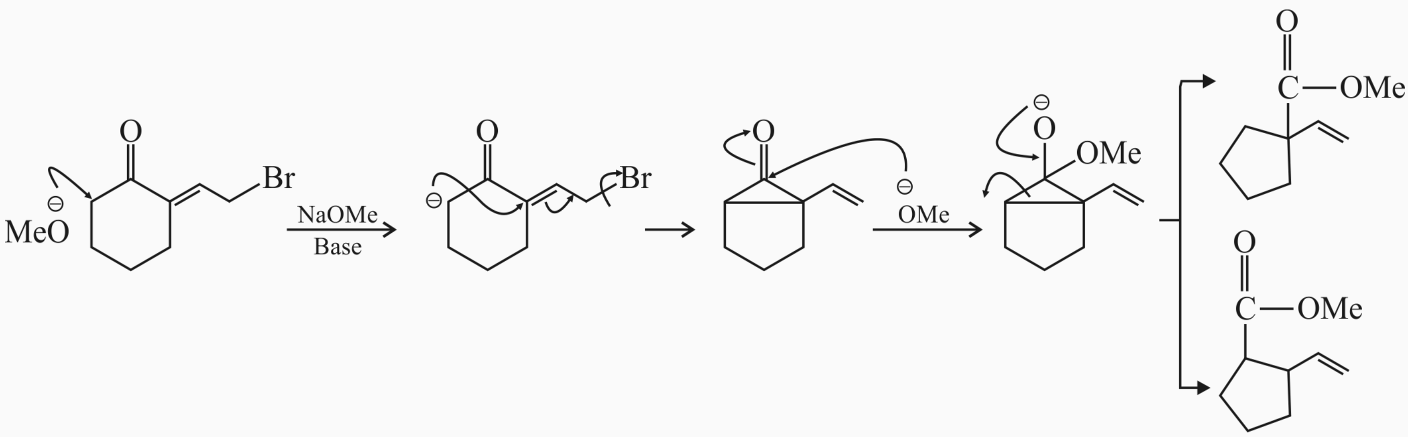
Potassium hydrogen phthalate meets all criteria for a primary standard.

Substances I, II, and III are inappropriate for direct weighing.

$\boxed{\text{C}}$

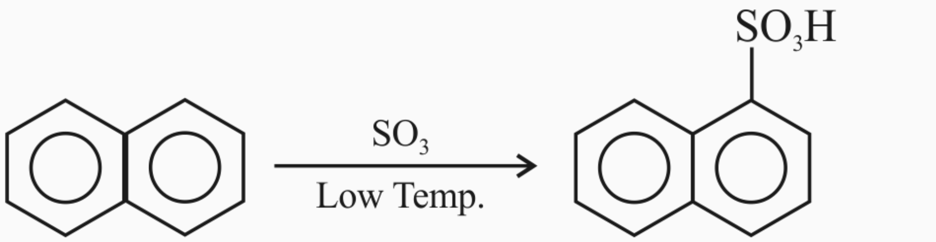
Q57. Solution

Correct Answer: (B)

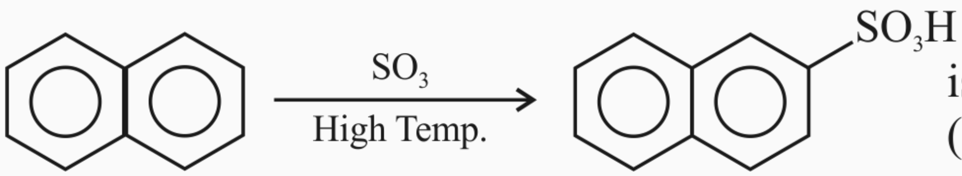


Q58. Solution

Correct Answer: (A)



is Kcp
(More stable σ-complex carbocation)



is Tcp
(More stable product)

Q59. Solution

Correct Answer: (A)

The anode reaction involves hydrogen oxidation: $\mathrm{H_2}(g) \rightarrow 2\mathrm{H}^+(aq) + 2\mathrm{e}^-$

The cathode reaction involves bromine reduction: $\mathrm{Br_2}(aq) + 2\mathrm{e}^- \rightarrow 2\mathrm{Br}^-(aq)$

The overall cell reaction becomes: $\mathrm{H_2}(g) + \mathrm{Br_2}(aq) \rightarrow 2\mathrm{H}^+(aq) + 2\mathrm{Br}^-(aq)$

Standard cell potential: Using standard reduction potentials $E^\circ(\mathrm{Br_2}/\mathrm{Br}^-) = 1.07\ \mathrm{V}$ and $E^\circ(\mathrm{H}^+/\mathrm{H_2}) = 0.00\ \mathrm{V}$, we calculate $E^\circ_{\text{cell}} = 1.07\ \mathrm{V} - 0.00\ \mathrm{V} = 1.07\ \mathrm{V}$

Hydrogen consumption: Hydrogen is oxidized at the anode, not the cathode

Anode reaction: The given reaction $\mathrm{Br_2} + 2\mathrm{e}^- \rightarrow 2\mathrm{Br}^-$ describes reduction at the cathode

Concentration effect: Increasing $[\mathrm{H}^+]$ at the anode increases the reaction quotient $Q = \frac{[\mathrm{H}^+]^2[\mathrm{Br}^-]^2}{P_{\mathrm{H_2}}[\mathrm{Br_2}]}$, which decreases cell potential according to the Nernst equation $E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{RT}{nF}\ln Q$

The standard cell potential of $1.07\ \mathrm{V}$ represents a fundamental characteristic derived directly from standard reduction potentials

Q60. Solution
Correct Answer: (C)

Identifying d^4 configurations in coordination compounds

The oxidation state of the central metal ion determines its d-electron count.
For $[Mn(H_2O)_6]^{3+}$, water is neutral, so Mn has oxidation state $+3$.
Neutral Mn ($Z = 25$) is $[Ar]3d^5 4s^2$, so Mn^{3+} is $[Ar]3d^4$.

For $[Cr(NH_3)_6]Cl_2$, ammonia is neutral, so Cr has oxidation state $+2$.
Neutral Cr ($Z = 24$) is $[Ar]3d^5 4s^1$, so Cr^{2+} is $[Ar]3d^4$.

For $[Fe(CN)_6]^{3-}$, cyanide is -1, so Fe has oxidation state $+3$.
Neutral Fe ($Z = 26$) is $[Ar]3d^6 4s^2$, so Fe^{3+} is $[Ar]3d^5$.

For $[Co(en)_3]Cl_3$, ethylenediamine is neutral, so Co has oxidation state $+3$.
Neutral Co ($Z = 27$) is $[Ar]3d^7 4s^2$, so Co^{3+} is $[Ar]3d^6$.

For $[V(CO)_6]$, carbonyl is neutral, so V has oxidation state 0.
Neutral V ($Z = 23$) is $[Ar]3d^3 4s^2$, so it remains d^3.

Only $[Mn(H_2O)_6]^{3+}$ and $[Cr(NH_3)_6]Cl_2$ yield d^4 configurations.

Q61. Solution
Correct Answer: (A)

The percentage by mass of nitrogen is determined from the nitrogen gas collected over water. The partial pressure of dry nitrogen is $P_{N_2} = P_{\text{total}} - P_{H_2O} = 710\,\text{mm}\backslash\text{,Hg} - 16\,\text{mm}\backslash\text{,Hg} = 694\,\text{mm}\backslash\text{,Hg}$.

Converting to atmospheres and volume to liters: $P_{N_2} = \frac{694}{760}\,\text{atm}$, $V = 0.065\,\text{L}$.

Using the ideal gas law at $T = 295\,\text{K}$: $n_{N_2} = \frac{P_{N_2}V}{RT} = \frac{(694/760)\times 0.065}{0.0821\times 295} = 0.0024515\,\text{mol}$.

The mass of nitrogen is $m_N = n_{N_2} \times 28.00 = 0.068642\,\text{g}$.

The percentage by mass is $\frac{0.068642}{0.45} \times 100\% = 15.25\%$, which corresponds to option **a**.

Q62. Solution
Correct Answer: (C)

The balanced chemical equation for the complete combustion of propane is:

$\mathrm{C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)}$

Molar masses are $\mathrm{C_3H_8} = 44\ \mathrm{g\ mol^{-1}}$, $\mathrm{O_2} = 32\ \mathrm{g\ mol^{-1}}$, and $\mathrm{H_2O} = 18\ \mathrm{g\ mol^{-1}}$.

Given masses: 88.0 kg $\mathrm{C_3H_8}$ and 400.0 kg $\mathrm{O_2}$. Converting to moles:

$\frac{88.0 \times 10^3\ \mathrm{g}}{44\ \mathrm{g\ mol^{-1}}} = 2.0 \times 10^3\ \mathrm{mol\ C_3H_8}$

$\frac{400.0 \times 10^3\ \mathrm{g}}{32\ \mathrm{g\ mol^{-1}}} = 12.5 \times 10^3\ \mathrm{mol\ O_2}$

The stoichiometric requirement for $2.0 \times 10^3\ \mathrm{mol\ C_3H_8}$ is $5 \times 2.0 \times 10^3 = 10.0 \times 10^3\ \mathrm{mol\ O_2}$. Since $12.5 \times 10^3\ \mathrm{mol\ O_2}$ is available, $\mathrm{C_3H_8}$ is the limiting reactant.

From the balanced equation, 1 mol $\mathrm{C_3H_8}$ produces 4 mol $\mathrm{H_2O}$, so:

$2.0 \times 10^3\ \mathrm{mol} \times 4 = 8.0 \times 10^3\ \mathrm{mol\ H_2O}$

Mass of water formed: $8.0 \times 10^3\ \mathrm{mol} \times 18\ \mathrm{g\ mol^{-1}} = 144 \times 10^3\ \mathrm{g} = 144\ \mathrm{kg}$

With density $1\ \mathrm{kg\ L^{-1}}$, volume is $\frac{144\ \mathrm{kg}}{1\ \mathrm{kg\ L^{-1}}} = 144\ \mathrm{L}$.

Q63. Solution
Correct Answer: (D)

(i) Starch-Polymer of α-D-glucose (ii) glycogen-Polymer of α-D-glucose (iii) Cellulose-Polymer of β-D-glucose $\rightarrow$ On hydrolysis of abvoe polymer for long time they gives their respective monomer unit. But for prolong treatement both forms of glucose $(\alpha \& \beta)$ are interconvertible into one qnother, hence in mixture, β-D-glucose present in all 3 (A, B & C) mixture

Q64. Solution
Correct Answer: (B)

Oxidizing agents accept electrons and are reduced. The strength of an oxidizing agent correlates with the instability of its high oxidation state, which drives reduction to a more stable form.

Chromium and molybdenum are both in Group 6. The +6 oxidation state becomes more stable down the group due to larger atomic size and more diffuse d-orbitals, enabling stronger covalent bonding with oxygen.

Molybdenum, being below chromium, stabilizes the +6 state more effectively than chromium. Thus, MoO_3 is less prone to reduction and is a weaker oxidizing agent, while CrO_3, with a less stable +6 state, readily accepts electrons and acts as a stronger oxidizing agent.

Option (b) correctly identifies the greater stability of Mo(+6) relative to Cr(+6) as the key factor.

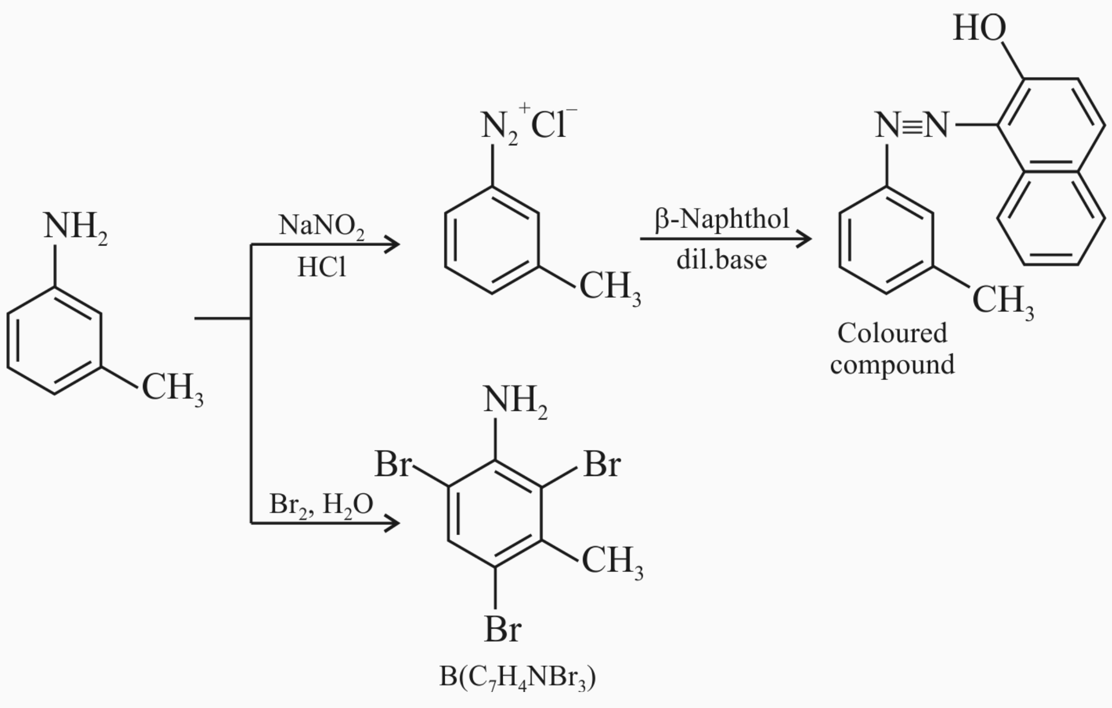
$\boxed{b}$

Q65. Solution
Correct Answer: (C)

Those compounds which are cyclic, conjugate, planar and follow Huckel rule are called aromatic compounds. Huckel's rule states that only planar, fully conjugated monocyclic polyenes having $4n + 2\,\pi$ electrons, where n is an integer, that is, $n = 0, 1, 2, 3, 4, \text{ etc.}$,

I. II and IV are aromatic compounds [contain 6π - electrons].

Q66. Solution
Correct Answer: (C)



Q67. Solution
Correct Answer: (C)

$\pi = \mathrm{i\ C\ R\ T.}$

$10.8 = \mathrm{i} \times 0.10 \times 0.082 \times 298$

$\mathrm{i} = \frac{10.8}{0.10 \times 0.082 \times 298} = \frac{10.8}{2.4436} = \frac{10.8}{2.4438}$

$=\ 4.42$ (experimental value)

$$\underset{0 \cdot 1\mathrm{M}}{\mathrm{FeSO_4.(NH_4)_2SO_4}} \longrightarrow \underset{01\mathrm{M}}{\mathrm{Fe^{2+}_{aq}}} + \underset{0 \cdot 2\mathrm{M}}{\mathrm{2SO^{2-}_{4aq}}} + \underset{0 \cdot 2\mathrm{M}}{\mathrm{2NH^{+}_{4aq}}}$$

i (expected)$= \frac{0 \cdot 5\mathrm{M}}{0 \cdot 1\mathrm{M}} = 5$

Q68. Solution
Correct Answer: (B)

Atomic radius of gallium versus aluminum

Due to poor shielding by d-electrons in gallium, its effective nuclear charge is higher than aluminum's, resulting in a smaller atomic radius: $r_{\mathrm{Al}} = 143\ \mathrm{pm} > r_{\mathrm{Ga}} = 135\ \mathrm{pm}$. Statement I is correct.

First ionization energy order

The ionization energies (in kJ/mol) are $\mathrm{In} = 558$, $\mathrm{Al} = 577$, $\mathrm{Ga} = 579$, $\mathrm{Tl} = 589$, $\mathrm{B} = 801$, matching the given order. Statement II is correct.

Electronegativity trend

Electronegativity values are $\mathrm{B} = 2.04$, $\mathrm{Al} = 1.61$, $\mathrm{Ga} = 1.81$, $\mathrm{In} = 1.78$, $\mathrm{Tl} = 1.62$. The increase from Al to Ga violates monotonic decrease. Statement III is incorrect.

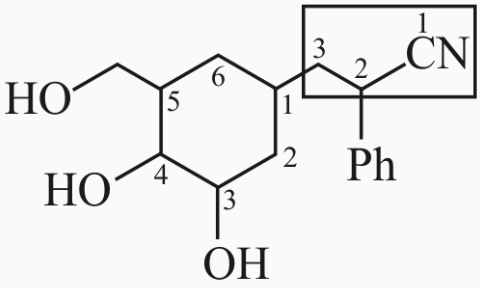
Density progression

Densities (in g/cm^3) increase consistently: $\mathrm{B} = 2.34$, $\mathrm{Al} = 2.70$, $\mathrm{Ga} = 5.91$, $\mathrm{In} = 7.31$, $\mathrm{Tl} = 11.85$. Statement IV is correct.

Statements I, II, and IV are correct.

$\boxed{\mathrm{b}}$

Q69. Solution
Correct Answer: (A)



Principal function group = cyanide
Suffix - Nitrile
Word root - prop
IUPAC Name: 3-(3,4-dihydroxy-5-hydroxy methyl cyclohexyl)-2-phenyl propane nitrile

Q70. Solution
Correct Answer: (B)

Analysis of Statements

Statement I: The Arrhenius equation $k = Ae^{-E_a/RT}$ is an empirical relationship describing temperature dependence of rate constants. It applies to both elementary and complex reactions, where E_a represents apparent activation energy for complex cases. This statement is incorrect.

Statement II: The pre-exponential factor A and activation energy E_a are treated as temperature-independent constants in the standard Arrhenius form. While advanced theories suggest slight temperature dependence for A, this approximation holds for practical purposes. This statement is correct.

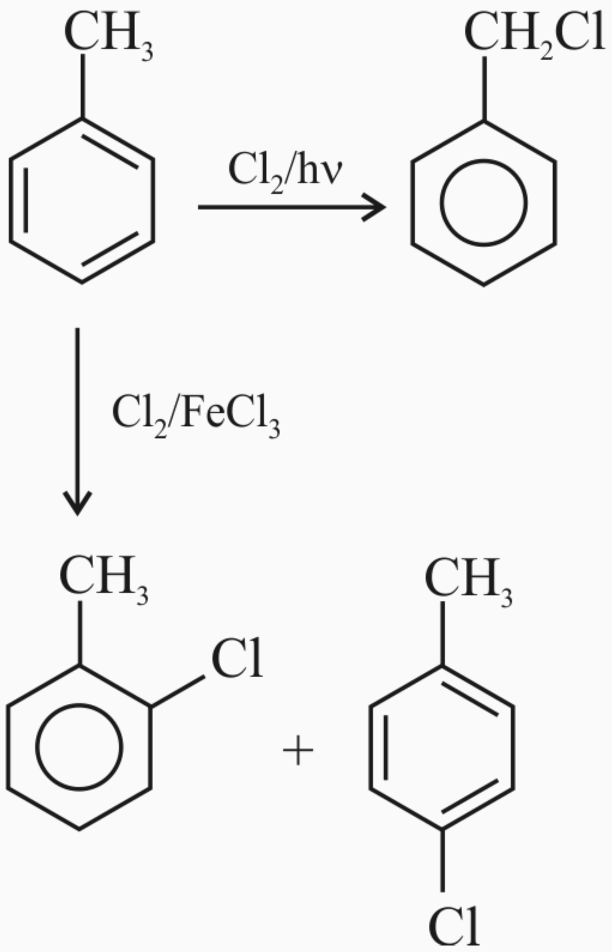
Statement III: From $k = Ae^{-E_a/RT}$, higher E_a makes the exponent more negative, reducing the exponential term and consequently decreasing k. A smaller rate constant corresponds to a slower reaction rate. This statement is correct.

Statement IV: The units of A match those of k, which vary with reaction order: s^{-1} for first-order, $Lmol^{-1}s^{-1}$ for second-order, and generally $(concentration)^{1-n}s^{-1}$ for nth-order reactions. Units are not always s^{-1}. This statement is incorrect.

Statements II and III are correct.

Q71. Solution

Correct Answer: 3



x is

Q72. Solution

Correct Answer: 10

$\Delta U_{AB} = 10J$

$W_{AB} = 0$ (Isochoric)

$\Delta U_{AB} = Q_{AB} + W_{AB}$

$Q_{AB} = 10J$

Q73. Solution

Correct Answer: 88

$N \equiv N+\frac{1}{2}(O=O) \rightarrow N=N=O ; \Delta H f(\text { cal })=?$

$\Delta H=\sum[B D E(R)-B D E(P)]$

$\Delta H f(\text { cal })=\left(946+\frac{498}{2}\right)-(418+607)$

$\Delta H f(\text { cal })=170 \mathrm{KJ} / \mathrm{mole}$

$\Delta H f(\text { Expt })=82 \mathrm{KJ} / \mathrm{mole}$

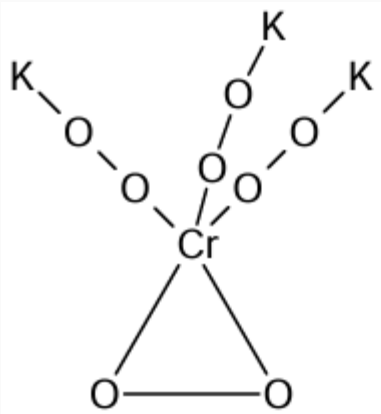
$\text { Resonance Energy }=\Delta H f(\mathrm{cal})-\Delta H f(\text { Expt })$

$\mathrm{RE}=170-82$

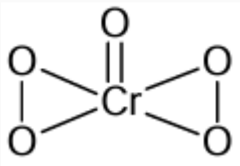
$\mathrm{RE}=88 \mathrm{KJ} / \mathrm{mole}$

Q74. Solution

Correct Answer: 6



$\text { Total peroxide linkage }=4$

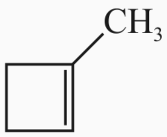


Total peroxide linkage = 2 $\therefore$ Sum of peroxide linkage $=2+4=6$.

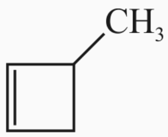
Q75. Solution

Correct Answer: 12

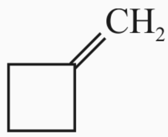
Cyclopentene



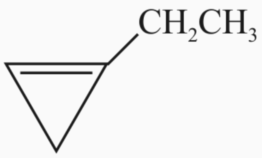
1-Methylcyclobutane



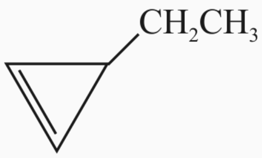
3-Methylcyclobutane
(two enantiomers)



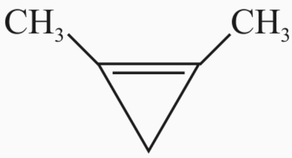
Methylenecyclobutane



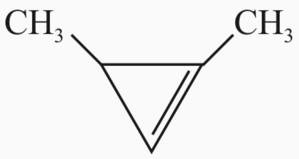
1-Ethylcyclopropene



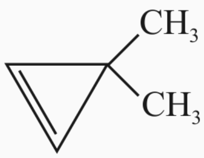
3-Ethylcyclopropene



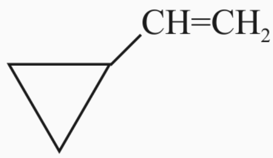
1,2-Dimethylcyclopropene



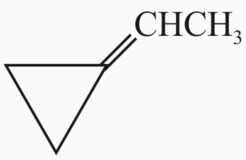
1,3-Dimethylcyclopropene
(two enantiomers)



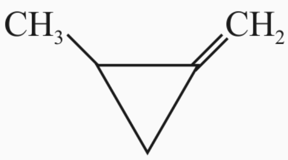
3,3-Dimethylcyclopropene



Cyclopropylethene



Ethylidenecyclopropane



2-Methyl-1-methylene-
cyclopropane
(two enantiomers)