Answer Key

Mathematics (25 Questions)

Q1. (D)	Q2. (C)	Q3. (B)	Q4. (A)	Q5. (A)
Q6. (C)	Q7. (B)	Q8. (B)	Q9. (B)	Q10. (B)
Q11. (C)	Q12. (C)	Q13. (A)	Q14. (B)	Q15. (C)
Q16. (D)	Q17. (A)	Q18. (D)	Q19. (D)	Q20. (B)
Q21. 3	Q22. 1	Q23. 7	Q24. 44	Q25. 1

Physics (25 Questions)

Q26. (C)	Q27. (C)	Q28. (C)	Q29. (A)	Q30. (B)
Q31. (D)	Q32. (A)	Q33. (D)	Q34. (C)	Q35. (A)
Q36. (D)	Q37. (C)	Q38. (D)	Q39. (D)	Q40. (C)
Q41. (C)	Q42. (B)	Q43. (C)	Q44. (A)	Q45. (D)
Q46. 6	Q47. 52	Q48. 10000	Q49. 4	Q50. 2

Chemistry (25 Questions)

Q51. (B)	Q52. (C)	Q53. (A)	Q54. (D)	Q55. (D)
Q56. (B)	Q57. (A)	Q58. (C)	Q59. (D)	Q60. (B)
Q61. (D)	Q62. (D)	Q63. (B)	Q64. (A)	Q65. (C)
Q66. (A)	Q67. (B)	Q68. (C)	Q69. (B)	Q70. (C)
Q71. 17	Q72. 174	Q73. 120	Q74. 4	Q75. 56

Solutions

Q1. Solution

Correct Answer: (D)

Divisible by six means divisible by 2 as well as 3.

(i) Case-1: without $0 \Rightarrow$ ____ $\underline{2/4}$

So, we have to put 2 or 4 in ones place.

$\Rightarrow$ Number of ways $= \underline{4} \times \underline{3} \times \underline{2} \times \underline{1} \times \underline{2} = 2 \times 4! = 48$

(ii) Case-2: 0 at unit place and without 3

____ $\underline{0} \Rightarrow 4 \times 3 \times 2 \times 1 \times 1 = 4! = 24$

(ii) Case-2: 2 or 4 at unit place and without 3

____ $\underline{2/4} \Rightarrow 3 \times 3 \times 2 \times 1 \times 2 = 36$

$\Rightarrow$ Total number of ways $= 48 + 24 + 36 = 108$

Q2. Solution

Correct Answer: (C)

For unique solution $\begin{vmatrix} 1+\alpha & \beta & 1 \\ \alpha & 1+\beta & 1 \\ \alpha & \beta & 2 \end{vmatrix} \neq 0$

Applying $C_1 \to C_1 + C_2 + C_3$, we get

$$\begin{vmatrix} \alpha+\beta+2 & \beta & 1 \\ \alpha+\beta+2 & 1+\beta & 1 \\ \alpha+\beta+2 & \beta & 2 \end{vmatrix} \neq 0$$

$$\Rightarrow (\alpha+\beta+2)\begin{vmatrix} 1 & \beta & 1 \\ 1 & 1+\beta & 1 \\ 1 & \beta & 2 \end{vmatrix} \neq 0$$

$\Rightarrow \alpha + \beta + 2 \neq 0$

Clearly, point $(2,\ 4)$ satisfying the given condition.

Q3. Solution

Correct Answer: (B)

Let us consider $x^3 + (p - x)^3 \geq p \forall x \in R$ $\begin{aligned} &\Rightarrow p^3 - 3p^2x + 3px^2 \geq p \\ &\Rightarrow 3p\left[\left(x - \frac{p}{2}\right)^2 + \frac{p^2 - 4}{12}\right] \geq 0 \end{aligned}$ $\Rightarrow$ for p $< 0 \rightarrow$ no solution for $p = 0 \rightarrow$ solution exist for $p > 0 \rightarrow \frac{p^2-4}{12} \geq 0 \Rightarrow p \in [2, \infty) \cup \{0\}$.

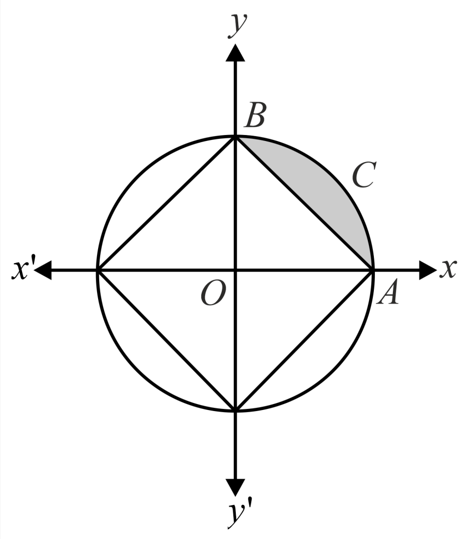
Q4. Solution

Correct Answer: (A)

Given curves are

$\sqrt{|x|} + \sqrt{|y|} = \sqrt{a} \quad \ldots$(i)

and $x^2 + y^2 = a^2 \quad \ldots$(ii)



Now, required areas $=$ 4[shaded area in the first quadrant]

$= 4\left[\frac{\pi a^2}{4} - \int_0^a \left(\sqrt{a} - \sqrt{x}\right)^2 dx\right]$ [from Eqs. (i) and (ii)]

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

$= 4\frac{\pi a^2}{4} - 4\left[ax + \frac{x^2}{2} - \frac{4}{3}\sqrt{a}x^{3/2}\right]_0^a$

$= \left(\pi - \frac{2}{3}\right)a^2$ sq units

Hence, option (a) is correct.

Q5. Solution
Correct Answer: (A)

A chord of a hyperbola is parallel to line $y = 2x + 4$.

Let mid-point of the chord is (h, k)

$\Rightarrow$Equation of the chord is $3hx - 2ky + 4\left(\frac{x+h}{2}\right) - 6\left(\frac{y+k}{2}\right) = 3h^2 - 2k^2 + 4h - 6k$

$\Rightarrow$ $(3h + 2)x + (-2k - 3)y = 3h^2 - 2k^2 + 2h - 3k$

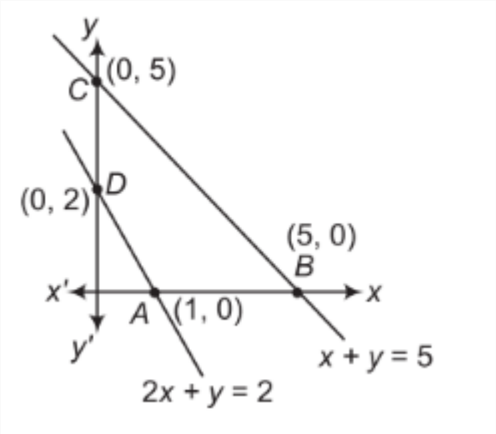
$\Rightarrow$ Slope of the chord is equal to $\frac{3h+2}{2k+3} = 2$

$\Rightarrow$ locus of the mid-points is $3x + 2 = 4y + 6$

$\Rightarrow$ $3x - 4y - 4 = 0$

Q6. Solution
Correct Answer: (C)

Given equations are $2x + y = 2, x = 0, y = 0$ and $x + y = 5$.



The total integral points lies inside the quadrilateral $ABCD$ is
$(1, 1), (1, 2), (2, 1), (2, 2), (1, 3), (3, 1)$

Q7. Solution

Correct Answer: (B)

Let $\overrightarrow{\mathrm{x}}=\lambda\overrightarrow{\mathrm{a}}+\mu\overrightarrow{\mathrm{b}}$ (λ and μ are scalars)

$\overrightarrow{\mathrm{x}}=\hat{\mathrm{i}}\left(2\lambda+\mu\right)+\hat{\mathrm{j}}\left(2\mu-\lambda\right)+\widehat{\mathrm{k}}\left(\lambda-\mu\right)$

Since $\overrightarrow{\mathrm{x}}\cdot\left(3\hat{\mathrm{i}}+2\hat{\mathrm{j}}-\widehat{\mathrm{k}}\right)=0$

$3\lambda+8\mu=0$ .....(1)

Also Projection of $\overrightarrow{x}$ on $\overrightarrow{a}$ is $\frac{17\sqrt{6}}{2}$

$\frac{\overrightarrow{\mathrm{x}}\cdot\overrightarrow{\mathrm{a}}}{\overrightarrow{\mathrm{a}}}=\frac{17\sqrt{6}}{2}$

$6\lambda-\mu=51$ ....(2)

From (1) and (2)

$\lambda=8,\mu=-3$

$\overrightarrow{\mathrm{x}}=13\hat{\mathrm{i}}-14\hat{\mathrm{j}}+11\widehat{\mathrm{k}}$

$\left|\overrightarrow{\mathrm{x}}\right|^2=486$

Q8. Solution

Correct Answer: (B)

Given,

$xdy = \left(\sqrt{x^2+y^2}+y\right)dx$

$\Rightarrow xdy - ydx = \sqrt{x^2+y^2}dx$

$\Rightarrow \dfrac{xdy-ydx}{x^2} = \sqrt{1+\dfrac{y^2}{x^2}} \cdot \dfrac{dx}{x}$

$\Rightarrow \dfrac{d\left(\frac{y}{x}\right)}{\sqrt{1+\left(\frac{y}{x}\right)^2}} = \dfrac{dx}{x}$

Now integrating both side we get,

$\Rightarrow \int \frac{d\left(\frac{y}{x}\right)}{\sqrt{1+\left(\frac{y}{z}\right)^2}} = \int \frac{dx}{x}$

$\Rightarrow \ln\left(\dfrac{y}{x}+\sqrt{\left(\dfrac{y}{x}\right)^2+1}\right) = \ln x + \ln c$

$\Rightarrow \dfrac{y+\sqrt{y^2+x^2}}{x} = cx$

$\Rightarrow y+\sqrt{y^2+x^2} = cx^2$

Now given when $x=1, y=0 \Rightarrow 0+1=c \Rightarrow c=1$

So equation of curve is $y+\sqrt{x^2+y^2}=x^2$

Now at $x=2, y=\alpha$

So putting the value in curve we get, $2+\sqrt{4+\alpha^2}=4$

$\Rightarrow 4+\alpha^2 = 16+\alpha^2 = 8\alpha$

$\Rightarrow \alpha = \dfrac{3}{2}$

Q9. Solution

Correct Answer: (B)

$a^{\left(\frac{1}{a}+\frac{1}{2a}+\frac{1}{4a}+\ldots\ldots\infty\right)} \cdot 2^{\frac{1}{2a}+\frac{1}{4a}+\frac{1}{8a}+\ldots\ldots\infty} = \dfrac{8}{27}$ and $\frac{1}{2a}+\frac{2}{4a}+\frac{3}{8a}+\ldots\ldots\ldots\infty = \frac{2}{a}$ (use AGP)

now $\dfrac{1}{a}\left(1+\dfrac{1}{2}+\dfrac{1}{2^2}+\ldots\ldots\ldots\right) = \dfrac{2}{a}$

$\therefore \quad a^{\frac{1}{a}} \cdot 2^{\frac{1}{a}} = \frac{8}{27} = \left(\frac{1}{3}\right)^3 \cdot 2^3 \Rightarrow a = \frac{1}{3}$

Q10. Solution

Correct Answer: (B)

$g(x) = \frac{2(\sin x - \sin^n x)+|\sin x - \sin^n x|}{2(\sin x - \sin^n x)-|\sin x - \sin^n x|}$ for $0<n<1, \sin x < \sin^n x$, so $g(x)=\frac{1}{3}$ and for $n>1, \sin x > \sin^n x$, so $g(x)=3 \therefore$ for $\mathrm{n}>1, \mathrm{f(x)}=3,\ \mathrm{g(x)}=3 \therefore f(x)$ is continuous and differentiable at $x=\frac{\pi}{2}$ and for $0<n<1$ $f(x) = \begin{cases} \left[\frac{1}{3}\right]=0 & x \in \left(0,\frac{\pi}{2}\right)\cup\left(\frac{\pi}{2},\pi\right) \\ 3, & =\frac{\pi}{2} \end{cases}$ $\therefore f(x)$ is not continuous at $x=\frac{\pi}{2}$. Hence $f(x)$ is also not differentiable at $x=\frac{\pi}{2}$.

Q11. Solution

Correct Answer: (C)

Since, total vertices of a cube is 8. So, total ways of selection of 3 vertices out of 8 vertices are ${}^8C_3$.

So, $n(S) = {}^8C_3 = 56$

Now, equilateral triangle will be formed by joining the face diagonal.

So, favourable cases i.e., $n(E) = 8$

According to classical definition of the probability, we get

$p(E) = \frac{n(E)}{n(S)}$

$\Rightarrow p(E) = \frac{8}{56} = \frac{1}{7}$

Hence, the required value of a is 7.

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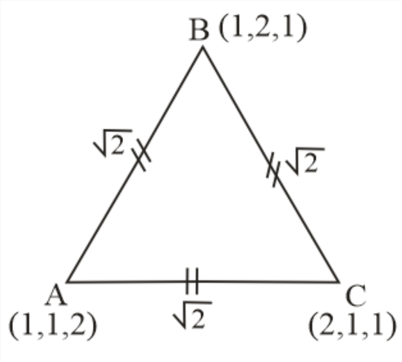
Q12. Solution
Correct Answer: (C)



$AB = \sqrt{(1-1)^2 + (2-1)^2 + (1-2)^2}$

$AB = \sqrt{2}$ units

Similarly, $BC = \sqrt{2}$ units and $CA = \sqrt{2}$ units.

Hence, ΔABC is an equilateral triangle.

Hence, the distance of the orthocentre O from the sides is equal to the distance of the incentre from the sides, that is, the inradius of the triangle.

Since, in an equilateral triangle, the orthocentre and incentre coincides.

$\therefore l_1 = l_2 = l_3 =$ inradius $\Rightarrow r = \frac{\Delta}{s} = \frac{\frac{\sqrt{3}}{4}\left(\sqrt{2}\right)^2}{\frac{3}{2}\left(\sqrt{2}\right)} = \frac{1}{\sqrt{6}}$

$\Rightarrow (l_1 + l_2 + l_3) = \frac{3}{\sqrt{6}}$

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Q13. Solution
Correct Answer: (A)

for f to be one-one $f'(x) > 0$ and $f'(x) < 0$ for all x

clearly f is continuous at $x = 0$ and $f(0) = -1$

$x \leq 0, f'(x) = 2(x + m)$ for $x < 0$

$f'(x)$ can not be > 0 for $\forall x < 0$ if $m > 0$

$\therefore \mathrm{f}'(\mathrm{x}) < 0$ for $\forall \mathrm{m} \leq 0$

but $\quad \mathrm{m} \neq 0$ as for $\mathrm{x} > 0$, f is constant and $\forall \mathrm{m} < 0, \mathrm{f}'(\mathrm{x}) < 0, \forall \mathrm{x} > 0$ `

Q14. Solution

Correct Answer: (B)

$$\begin{array}{ll} a_1 = a_3 - 2d & a_5 = a_3 + 2d \\ a_3 = -4 & a_3\left(a_3{}^2 - 4d^2\right) = 80 \\ & 16 - 4d^2 = -20 \\ & d = \pm 3 \\ d = 3 & (\because \text{ increasing A.P}) \end{array}$$

Q15. Solution

Correct Answer: (C)

$$\mathrm{f}(\mathrm{x}) = \log\left(\frac{1-\mathrm{x}}{1+\mathrm{x}}\right)$$

$$\therefore \mathrm{f}(-\mathrm{x}) = \log\left(\frac{1+\mathrm{x}}{1-\mathrm{x}}\right) = -\log\left(\frac{1-\mathrm{x}}{1+\mathrm{x}}\right) = -\mathrm{f}(\mathrm{x})$$

$\therefore$ It is an odd function

(2) $\mathrm{f}(\mathrm{x}) = \log\left(\mathrm{x} + \sqrt{\mathrm{x}^2+1}\right) \Rightarrow \mathrm{f}(-\mathrm{x}) = \log\left(-\mathrm{x} + \sqrt{\mathrm{x}^2+1}\right)$

$$f(x) + f(-x) = \log\left(x + \sqrt{x^2+1}\right) + \log\left(-x + \sqrt{x^2+1}\right)$$

$$= \log\left\{\left(x + \sqrt{x^2+1}\right)\left(-x + \sqrt{x^2+1}\right\} = \log\left(x^2 + 1 - x^2\right)\right.$$

$$= \log(1) = 0 \quad \therefore \mathrm{f}(-\mathrm{x}) = -\mathrm{f}(\mathrm{x})$$

$\therefore$ It is an odd function

(3) $\mathrm{f}(\mathrm{x}) = \frac{\mathrm{x}}{\mathrm{e}^{\mathrm{x}}-1} + \frac{\mathrm{x}}{2} + 1;$

$$f(-x) = \frac{-x}{e^{-x}-1} - \frac{x}{2} + 1 = \frac{-xe^x}{1-e^x} - \frac{x}{2} + 1$$

$$\mathrm{f}(\mathrm{x}) - \mathrm{f}(-\mathrm{x}) = \left\{\frac{\mathrm{x}}{\mathrm{e}^{\mathrm{x}}-1} + \frac{\mathrm{x}}{2} + 1\right\} - \left\{\frac{-\mathrm{xe}^{\mathrm{x}}}{1-\mathrm{e}^{\mathrm{x}}} - \frac{\mathrm{x}}{2} + 1\right\}$$

$$\frac{x\left(1-e^x\right)}{e^x - 1} + x = -x + x = 0$$

$$\therefore \mathrm{f}(-\mathrm{x}) = \mathrm{f}(\mathrm{x})$$

Hence, it is an even function

(4) $\mathrm{f}(\mathrm{x}) = \mathrm{e}^{2\mathrm{x}} + \sin\mathrm{x}$

$$f(-x) = e^{-2x} + \sin(-x) = e^{-2x} - \sin x \neq \pm f(x)\,.$$

Q16. Solution
Correct Answer: (D)

From the given condition

$^nC_r : {}^nC_{r+1} : {}^nC_{r+2} = 2 : 15 : 70$

$\Rightarrow \frac{^nC_r}{^nC_{r+1}} = \frac{2}{15}$ and $\frac{^nC_{r+1}}{^nC_{r+2}} = \frac{15}{70}$

$\Rightarrow \frac{\left(\frac{n!}{(n-r)!.r!}\right)}{\left(\frac{n!}{(n-r-1)!.(r+1)!}\right)} = \frac{2}{15}$ and $\frac{\left(\frac{n!}{(n-r-1)!.(r+1)!}\right)}{\left(\frac{n!}{(n-r-2)!.(r+2)!}\right)} = \frac{15}{70}$

$\Rightarrow \frac{(n-r-1)!.(r+1)1}{(n-r)!.r!} \frac{2}{15}\ and\ \frac{(n-r-2)!.(r+2)!}{(n-r-1)!.(r+1)!} = \frac{3}{14}$

$\Rightarrow \frac{(n-r-1)!.(r+1).r!}{(n-r).(n-r-1)!.r!} = \frac{2}{15}$ and $\frac{(n-r-2)!.(r+2).(r+1)!}{(n-r-1).(n-r-2)!.(r+1)!} = \frac{3}{14}$

$\Rightarrow \frac{r+1}{n-r} = \frac{2}{15}$ and $\frac{r+2}{n-r-1} = \frac{3}{14}$

$\Rightarrow 17r = 2n - 15$ and $17r = 3n - 31$

$\Rightarrow 3n - 31 = 2n - 15, \Rightarrow n = 16$ and $r = 1$

Hence, average $= \frac{^nC_r + {}^nC_{r+1} + {}^nC_{r+2}}{3}$

$= \frac{^{16}C_1 + {}^{16}C_2 + {}^{16}C_3}{3}$

$= 232. :$

Q17. Solution

Correct Answer: (A)

$\because f(x)=\frac{4}{\sin x}+\frac{1}{1-\sin x}$

$\Rightarrow f'(x)=-\frac{4\cos x}{\sin^2 x}+\frac{\cos x}{(1-\sin x)^2}$

For critical points: $f'(x)=0$

$$\Rightarrow -\frac{4\cos x}{\sin^2 x}+\frac{\cos x}{(1-\sin x)^2}=0$$

$$\Rightarrow -\cos x\left[\frac{4(1-\sin x)^2+\sin^2 x}{\sin^2 x(1-\sin x)^2}\right]=0$$

$\Rightarrow 4(1-\sin x)^2+\sin^2 x=0$

$\Rightarrow 3\sin^3 x-8\sin x+4=0$

$\Rightarrow (3\sin x-2)(\sin x-2)=0$

$\Rightarrow 3\sin x-2=0$ or $\sin x=2($ not possible$)$

$$\Rightarrow \sin x=\frac{2}{3}$$

So, the only critical value is $x=\sin^{-1}\left(\frac{2}{3}\right)$

$\therefore f(x)$ has extremum at $x=\sin^{-1}\left(\frac{2}{3}\right)$

So, the extreme value is

$$f\left(\sin^{-1}\frac{2}{3}\right)=\frac{4}{\sin\left(\sin^{-1}\frac{2}{3}\right)}+\frac{1}{1-\sin\left(\sin^{-1}\frac{2}{3}\right)},$$

$$=4\times\frac{3}{2}+3=9$$

Q18. Solution

Correct Answer: (D)

Using $C_1\rightarrow C_1+C_2+C_3$, we get

$$\Delta(x)=f(x)\begin{vmatrix}1 & 2\cos^4 x & \sin^2 2x\\ 1 & 3+2\cos^4 x & \sin^2 2x\\ 1 & 2\cos^4 x & 3+\sin^2 2x\end{vmatrix}$$

where $f(x)=3+2\sin^4 x+2\cos^4 x+\sin^2 2x$

$=3+2\left(\sin^4 x+\cos^4 x+2\sin^2 x\cos^2 x\right)$

$=3+2\left(\cos^2 x+\sin^2 x\right)^2=5$

Applying $C_2\rightarrow C_2-\left(2\cos^4 x\right)C_1$ and $C_3\rightarrow C_3-\left(\sin^2 2x\right)C_1$, we get

$$\Delta(x)=5\begin{vmatrix}1 & 0 & 0\\ 1 & 3 & 0\\ 1 & 0 & 3\end{vmatrix}=45$$

Thus, $\int_{-\pi/2}^{\pi/2} x\Delta(x)dx=45\int_{-\pi/2}^{\pi/2} xdx=0$.

Q19. Solution

Correct Answer: (D)

$P \equiv (\log a, \log a)$

$\Rightarrow \log^2 a = \log a$

$\log a = 1$

$P \equiv (1, 1)$

focal distance of P $= 1 + \frac{1}{4} = \frac{5}{4}$ ~

Q20. Solution

Correct Answer: (B)

$\tan^{-1}\left(\frac{\left\{\frac{1}{(2x+1)}\right\}+\left\{\frac{1}{(4x+1)}\right\}}{1-\left\{\frac{1}{(2x+1)}\right\}\cdot\left\{\frac{1}{(4x+1)}\right\}}\right) = \tan^{-1}\frac{2}{x^2}$

$\tan^{-1}\left(\frac{6x+2}{8x^2+6x}\right) = \tan^{-1}\frac{2}{x^2}$

Therefore, $\frac{3x+1}{4x^2+3x} = \frac{2}{x^2}$

$x^2(3x+1) = 2\left(4x^2+3x\right)$

$3x^3 - 7x^2 - 6x = 0$

$x\left(3x^2 - 7x - 6\right) = 0$

$x(x-3)(3x+2) = 0$

We take $x = 3, 0$ because when $x = -\frac{2}{3}$, LHS of the given equation will be negative whereas $\tan^{-1}\left(\frac{2}{x^2}\right)$ is positive.

Hence, the number of values $= 2.$:

Q21. Solution

Correct Answer: 3

Coordinates of P, Q, R are $(r_1, -r_1+1, 2r_1-2), (2r_2, r_2+1, r_2-2), (-r_3, -r_3+1, r_3-2)$ respectively.
It must satisfy the equation, hence $r_1 = \frac{3}{2}, r_2 = \frac{-3}{2}, r_3 = +1$. So points P, Q, R are
$\left(\frac{3}{2}, -\frac{1}{2}, 1\right), \left(-3, -\frac{1}{2}, \frac{-7}{2}\right)$ (–1,0,–1) respectively.

$\overrightarrow{PQ} = -\frac{9}{2}\hat{i} - \frac{9}{2}\widehat{k}$

$\overrightarrow{PR} = \frac{-5}{2}\hat{i} + \frac{1}{2}\hat{j} - 2\widehat{k}$

Area $= \frac{1}{2}\left|\overrightarrow{PQ} \times \overrightarrow{PR}\right|$

$= \left|\frac{1}{8}\right|\begin{vmatrix} i & \hat{j} & \widehat{k} \\ -9 & 0 & -9 \\ -5 & 1 & -4 \end{vmatrix}$

$= \frac{1}{8}\left|9\hat{i} \quad +9\hat{j} \quad -9\widehat{k}\right| = \frac{9\sqrt{3}}{8}$ sq. units

Q22. Solution

Correct Answer: 1

$I=\int\sqrt{\frac{x-5}{x-7}}\,dx$

Multiplying and dividing by $\sqrt{x\ -\ 5}$

$I\ =\int\frac{x-5}{\sqrt{x^2-12x+35}}dx$

$I=\frac{1}{2}\int\frac{2x-10}{\sqrt{x^2-12x+35}}dx$

$I\ =\frac{1}{2}\int\frac{2x-12+2}{\sqrt{x^2-12x+35}}dx$

$I\ =\frac{1}{2}\int\frac{2x-12}{\sqrt{x^2-12x+35}}dx+\int\frac{dx}{\sqrt{x^2-12x+36-1}}$

$I=I_1\ +\ I_2\qquad\qquad\ldots\ldots(\mathrm{i})$

now

$I_1=\frac{1}{2}\int\frac{2x-12}{\sqrt{x^2-12x+35}}dx$

taking

$x^2-12x+35=t$

$(2x-12)dx=dt$ substituting in I_1

$I_1\ =\frac{1}{2}\int\frac{dt}{\sqrt{t}}$

$I_1\ =\frac{1}{2}\times\frac{t^{\frac{1}{2}}}{\frac{1}{2}}+c$

$I_1=\sqrt{t}+c$

$I_1=\sqrt{x^2-12x+35}+C_1$

Similarly

$I_2=\int\frac{dx}{\sqrt{x^2-12x+36-1}}$

$I_2=\int\frac{dx}{\sqrt{(x-6)^2-1}}$

by using formula

$\left\{\int\frac{dx}{\sqrt{x^2-a^2}}=\log\left(\left|x\ +\ \sqrt{x^2+a^2}\right|\right)+c\right\}$

$I_2=\log\left|x-6+\sqrt{x^2-12x+35}\right|+C_2$

Substituting the values in equation (i)

$I=\frac{1}{2}2\sqrt{x^2-12x+35}+C_1+\int\frac{dx}{\sqrt{(x-6)^2-1}}+C_2$

$= \sqrt{x^2 - 12x + 35} + \log\left|x - 6 + \sqrt{x^2 - 12x + 35}\right| + C$
$\Rightarrow A = 1$

Q23. Solution
Correct Answer: 7

$\left(\frac{2+\sin x}{y+1}\right)\frac{dy}{dx} = -\cos x$

$\Leftrightarrow \frac{dy}{y+1} = \frac{-\cos x}{2+\sin x}dx$

Integrating, we get

$\log(y+1) = -\log(2+\sin x) - \log k$
$\Rightarrow k(y+1)(2+\sin x) = 1$

$y(0) = 1 \Rightarrow k = \frac{1}{4}$

$\Rightarrow (y+1)(2+\sin x) = 4$

At $x = \frac{\pi}{2}$

$(y+1)(3) = 4$

$\Rightarrow y\left(\frac{\pi}{2}\right) = \frac{1}{3}$

$\Rightarrow 6y\left(\frac{\pi}{2}\right) + 5 = 7$

Q24. Solution
Correct Answer: 44

Given $A = \{1,\ 2,\ 3,\ 4,\ 5\}$

$f:\ A \rightarrow A$ (into function)

$f(i) \neq i,\ \forall\, i \in\ A$

Now number of injective functions for which

$f(i) \neq i$ are: $5!\left(\frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!}\right)$

$= 44.$

Q25. Solution
Correct Answer: 1

Ellipse $16x^2 + 25y^2 = 400$
$\Rightarrow \frac{x^2}{25} + \frac{y^2}{16} = 1$
Let the points on ellipse be P $(5\cos\theta_1, 4\sin\theta_1)$ and $Q\,(5\cos\theta_2, 4\sin\theta_2)$. Circle described on PQ as diameter touches x-axis $(3, 0)$. Then
$$5\left(\frac{\cos\theta_1 + \cos\theta_2}{2}\right) = 3 \text{ and } 4\left(\frac{\sin\theta_1 + \sin\theta_2}{2}\right) = r$$
$$\Rightarrow \frac{4}{5}\tan\left(\frac{\theta_1 + \theta_2}{2}\right) = \frac{r}{3}$$
$$\Rightarrow \tan\left(\frac{\theta_1 + \theta_2}{2}\right) = \frac{5r}{12}$$
$$\Rightarrow \text{ Slope of } PQ = -\frac{4}{5}\cot\frac{\theta_1 + \theta_2}{2}$$
$$= -\frac{48}{25r} = -1$$
Therefore, $1/|\mathrm{m}| = 1$

Q26. Solution
Correct Answer: (C)

$\frac{X-(-125)}{500} = \frac{Y-(-70)}{40}$
For $Y = 50 \quad X = 1375.0^\circ X$

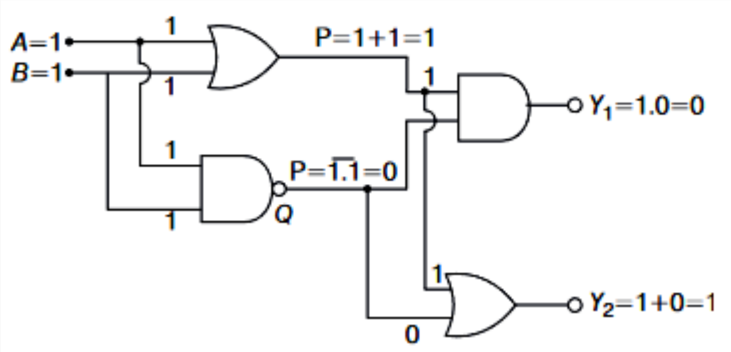
Q27. Solution
Correct Answer: (C)

We know that,
Range of projectile
$R = \frac{u^2 \sin 2\theta}{g}$
As range is maximum, $\theta = 45^\circ$
$R_{\max} = \frac{u^2 \sin 2 \times 45}{g} = \frac{u^2}{g}$
Flight time of projectile,
$T = \frac{2u \sin 45^\circ}{g}$
$$\text{or } = \frac{2u}{\sqrt{2}\cdot g} = \frac{\sqrt{2}\cdot u}{g}$$
$$\text{or } u = \frac{Tg}{\sqrt{2}}$$
Putting these value of u in Eq. (i), we get
$$R_{\max} = \frac{1}{g}\left(\frac{Tg}{\sqrt{2}}\right)^2$$
$$R_{\max} = \frac{1}{2}gT^2$$

Q28. Solution

Correct Answer: (C)

The logical circuit can be explained as,



So, $Y_1 = 0$ and $Y_2 = 1$

Hence, the correct option is (c).

Q29. Solution

Correct Answer: (A)

As ratio of slit widths = Ratio of intensities

$\therefore \frac{I_1}{I_2} = \frac{9}{4}$ or $\frac{a_1^2}{a_2^2} = \frac{9}{4}$ or $\frac{a_1}{a_2} = \frac{3}{2}$

$a_{max.} = a_1 + a_2 = 3 + 2 = 5$; $a_{min.} = 3 - 2 = 1$

$\frac{I_{max.}}{I_{min.}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2} = \frac{(3+2)^2}{(3+2)^2} = \frac{25}{1}$

Q30. Solution

Correct Answer: (B)

For a Diatomic gas the total heat given is $\Delta Q_{AB} + \Delta Q_{BC}$

ΔQ_{AB}(Isochoric Process) $= nC_V\Delta T$

$$= \frac{P_f V_f - P_i V_i}{\gamma - 1} = \frac{2P_0 V_0 - P_0 V_0}{\frac{7}{5} - 1} = \frac{P_0 V_0}{\left(\frac{2}{5}\right)} = \frac{5}{2} P_0 V_0 = 2.5 P_0 V_0$$

ΔQ_{BC} (Isothermal Process)

$Q_{BC} = nRT\ell n\frac{V_f}{V_i} \quad = PV\ell n\frac{V_f}{V_i}$

$= 2P_0 \times V_0 \ln\left(\frac{2 V_0}{V_0}\right) = 2P_0 V_0 \ell n 2 = 1.4 P_0 V_0$

$\Rightarrow \Delta Q_{total} = 3.9 P_0 V_0$

Q31. Solution

Correct Answer: (D)

Magnetic field strength in a solenoid is given by $B=\mu_0 n i$

where, $\mu_0=$ permeability of free space,

$n=$ number of turns per unit length and $i=$ current flowing through solenoid.
So, it is clear that magnetic field strength B in a solenoid depends on n and i only, it does not depends on diameter of solenoid. Therefore, statements 1 and 2 are correct.

Q32. Solution

Correct Answer: (A)

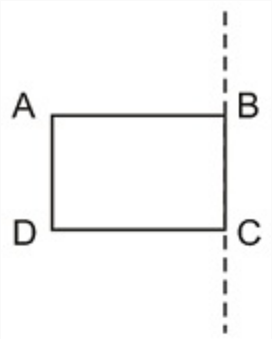
$\mathrm{e}\left(3 \mathrm{~V}_0\right)=\frac{\mathrm{hc}}{300}-\frac{\mathrm{hc}}{\lambda_0}$

$e\left(V_0\right)=\frac{h c}{600}-\frac{h c}{\lambda_0}$

$\lambda_0=1200 \mathrm{~nm}$

Q33. Solution

Correct Answer: (D)



$\frac{AB}{BC}=2 \therefore AB=\mathrm{DC}=\frac{l}{3}$

and $BC=AD=\frac{l}{6}$.

Similarly, $m_{\mathrm{AB}}=m_{\mathrm{DC}}=\frac{m}{3}$ and $m_{\mathrm{BC}}=m_{\mathrm{AD}}=\frac{m}{6}$.

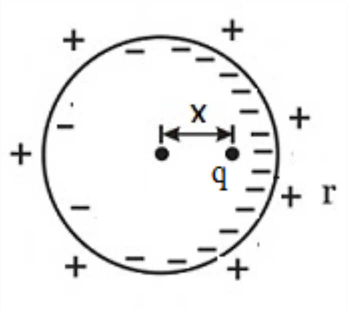
Now, $I=2 I_{\mathrm{AB}}+I_{\mathrm{AD}}+I_{\mathrm{BC}}$

$=2\left\{\frac{m}{3}\left(\frac{l}{3}\right)^2 \cdot \frac{1}{3}\right\}+\left(\frac{m}{6}\right)\left(\frac{l}{3}\right)^2+0$

$=\frac{189}{4374} m l^2=\frac{7}{162} m l^2$.

Q34. Solution

Correct Answer: (C)



Charge induced near the surface closer to the charged particle will be more and hence sphere will be attracted to the charge q. Hence net force is towards left.

Q35. Solution

Correct Answer: (A)

In conductor, there are free electrons moving with high speed corresponding to the temperature known as thermal speed of that conductor for that particular temperature.
But their directions are random, such that their total velocities or net velocity of all the electrons within the conductor is zero.
Therefore, net magnetic field due to total electrons is also zero and consequently net magnetic force is also zero on any conductor.

Q36. Solution

Correct Answer: (D)

The phase of a particle executing SHM is defined as the state of a particle as regard to its position and direction of motion at any instant of time. In the given curve, phase is same when $\mathrm{t}=1 \mathrm{~s}$ and $\mathrm{t}=5 \mathrm{~s}$. Also phase is same when $\mathrm{t}=2 \mathrm{~s}$ and $\mathrm{t}=6 \mathrm{~s}$.

Q37. Solution
Correct Answer: (C)

Since the object is very far away from the lens, the rays can be approximated to parallel rays. Hence, the image is formed at focus.

To find out the magnified area we know that,

$A_{\mathrm{i}}=A_{\mathrm{o}}\times m^2$

where $A_{\mathrm{o}},\ A_{\mathrm{i}},\ m$ are area of object, area of image, areal magnification respectively.

For a lens magnification is given by square of ratio of image to object distance,

So $m=\frac{500\times10^3}{50\times10^{-2}}=10^6$

Substituting this value in above equation we get,

$A_{\mathrm{i}}=\left(10^6\right)^2A=10^{12}A$

Q38. Solution
Correct Answer: (D)

$\mathrm{W_{CRD}}=\mathrm{Q}\left(\mathrm{V_D}-\mathrm{V_C}\right)$
$=\mathrm{Q}\left[\mathrm{V_D}-0\right]$
$(\because$ potential at centre of dipole is zero $)$
$=\left[\frac{\mathrm{kq}}{3\mathrm{~L}}-\frac{\mathrm{kq}}{\mathrm{L}}\right]\mathrm{Q}$
$\mathrm{W_{CRD}}=-\frac{\mathrm{kqQ}}{\mathrm{L}}\times\frac{2}{3}=-\frac{\mathrm{qQ}}{6\pi\varepsilon_0\mathrm{~L}}$

Q39. Solution
Correct Answer: (D)

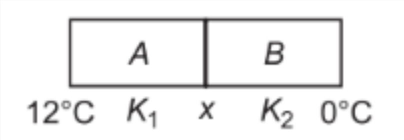
Infrared - Muscular treatment
Radio wave - Broadcasting
X Rays - To detect fracture
Uv Rays $\rightarrow$ Absorbed ozone layer

Q40. Solution
Correct Answer: (C)

$[X]=\left[\frac{M^{-1}L^3T^{-2}\times ML^2T^{-1}}{L^3T^{-3}}\right]^{1/2}=[L]$

Q41. Solution
Correct Answer: (C)

The given situation can be shown as



Rate of flow of heat will be equal in both the slabs
$\therefore (12 - x)K_1 = K_2(x - 0)$
$12 - x = 2x \quad \left(\because K_1 = \frac{K_2}{2}\right)$
$x = 4^\circ\mathrm{C}$
The temperature difference across slab
$A = (12 - x) = (12 - 4)$
$= 8^\circ\mathrm{C}$

Q42. Solution
Correct Answer: (B)

Given, inclination of inclined plane,
$\theta = \sin^{-1}(0.42) \Rightarrow \sin\theta = 0.42$
Acceleration due to gravity,
$g = 10\ \mathrm{m/s^2}$
Acceleration of rolling solid sphere on the inclined plane without slipping is given by
$a = \frac{g\sin\theta}{1 + \frac{I}{MR^2}}$
where, $I =$ moment of inertia
$M =$ mass of sphere
$R =$ radius of sphere
But $\quad I = \frac{2}{5}MR^2$
$\therefore a = \dfrac{g\sin\theta}{\frac{2}{MR^2}} = \dfrac{5}{7}g\sin\theta$
$1 + \dfrac{5}{MR^2}$
$= \dfrac{5}{7} \times 10 \times 0.42 = 3\ \mathrm{m/s^2}$

Q43. Solution
Correct Answer: (C)

According to Brewster's law, the light reflected from the top of glass slab gets polarised. The light refracted into the glass slab and the light emerging from the glass slab is only partially polarised. Therefore, when a polaroid is held in the path of emergent light at P, and rotated about an axis passing through the centre and perpendicular to plane of polaroid, the intensity of light shall go through a minimum but not zero for two orientations of the polaroid.

Q44. Solution

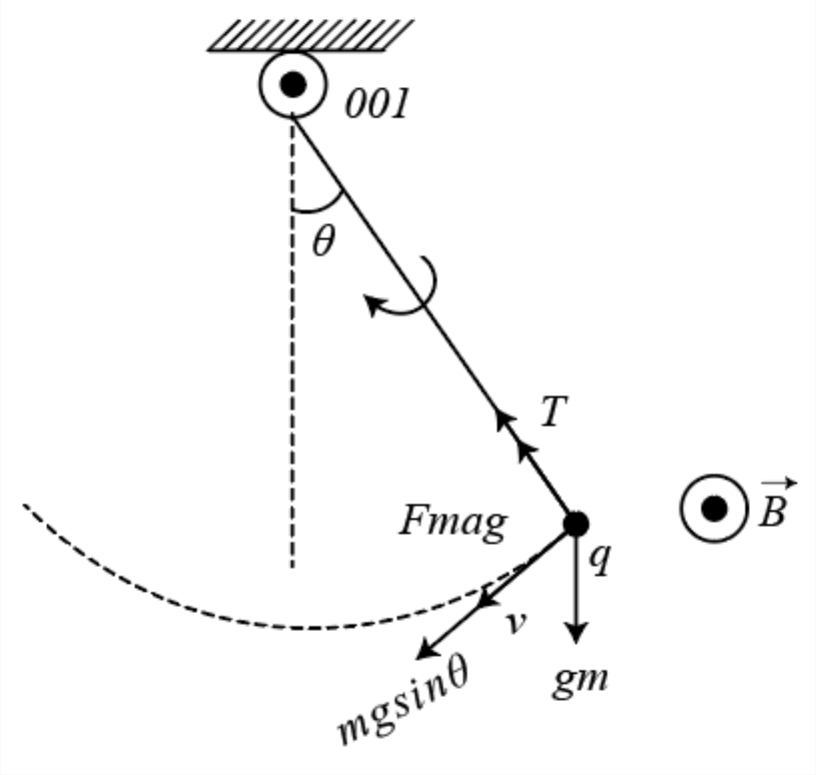
Correct Answer: (A)

1. Assertion: "When a bottle of cold carbonated drink is opened, a slight fog forms around the opening."
- When a carbonated drink is bottled, the space above the liquid (headspace) is under high pressure, containing carbon dioxide (and possibly some water vapor).
- Upon opening, this pressurized gas suddenly escapes into the surrounding atmosphere.
2. Reason: "Adiabatic expansion of the gas causes lowering of temperature and condensation of water vapours."
- Adiabatic expansion refers to a process in which a gas expands without exchanging heat with its surroundings.
- When the bottle is opened, the pressurized gas inside expands rapidly (a near-adiabatic expansion), causing a sharp drop in temperature of the escaping gas.
- Because the temperature drops, the water vapor in the surrounding air (or in the escaping gas itself) cools to the point of condensation, creating a visible fog or mist around the opening.

Hence, the reason correctly explains the assertion: the sudden (adiabatic) expansion leads to lower temperature, which causes water vapor to condense, forming the "fog."

Q45. Solution

Correct Answer: (D)



$$\tau_{\text{res}} = (\text{mg} \sin\theta)\ell$$
$$= \underbrace{(\text{mge})}_{c}\theta$$

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

$$F_{mag} = q \vee B$$

Q46. Solution

Correct Answer: 6

$\angle ABC = \pi - 2(\hat{i} - \hat{r})$

$2\angle ABC = \angle AOC[\text{ half angle theorem}]$

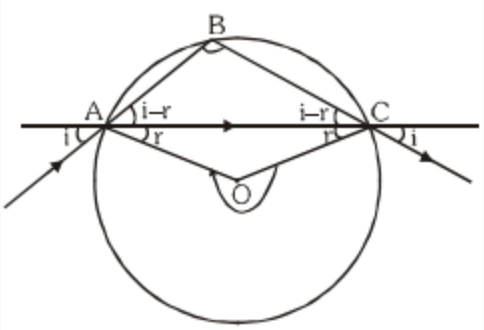
$2\pi - 4\hat{i} + 4r = (\pi + 2r)$

$2\hat{i} - r = \frac{\pi}{z} \Rightarrow r = 2\hat{i} - \frac{\pi}{2}$

$1 \sin \hat{i} = \mu \sin \hat{\mathrm{r}}$

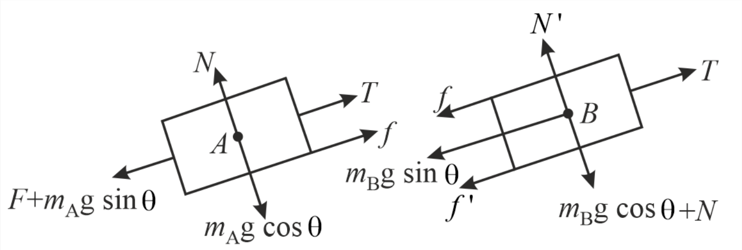
$\sin \hat{i} = \mu \sin \left(2\hat{\mathrm{i}} - \frac{\pi}{2}\right)$

$\sin \hat{i} = \frac{\sqrt{3}}{2} \Rightarrow \hat{i} = \frac{\pi}{3} \Rightarrow \frac{2\pi}{6} \Rightarrow k = 6$



Q47. Solution
Correct Answer: 52

FBD of Block A and B.



By Newton's II law of motion,

For Block A,
$m_A g \sin \theta + F - T - f = m_A a \quad \ldots$(i)

Kinetic frictional force on A, $\quad f = \mu_k m_A g \cos \theta \quad \ldots$(ii)

For Block B,
$T - m_B g \sin \theta - f - f' = m_B a \quad \ldots$(iii)

Kinetic frictional force on B, $\quad f' = \mu_k . N' \ldots$(iv)

$= \mu_k (m_A g \cos \theta + m_B g \cos \theta)$

Solving above equations, then
$a_A = 5.2 \ \mathrm{ms}^{-2}$

Q48. Solution
Correct Answer: 10000

The Bulk modulus k
$k = -\frac{p}{\Delta V / V}$
Where, $p =$ Pressure
$\Delta V =$ Change in volume
$V =$ Volume of liquid
From (i)
$\frac{p}{k} = -\frac{\Delta V}{V} = \frac{\Delta p}{p}$
$\Rightarrow \quad p = \frac{k \Delta p}{p}$
$\Delta p = 0 \cdot 01\% = 0 \cdot 01/100$
$$p = \frac{k}{10000}$$

Q49. Solution
Correct Answer: 4

Magnetic fields at the centre of the coils are equal.

$\therefore \quad \frac{\mu_0 I_1}{2r_1} = \frac{\mu_0 I_2}{2r_2}$

$\therefore \quad \frac{\mathrm{I}_1}{\mathrm{I}_2} = \frac{\mathrm{r}_1}{\mathrm{r}_2} = \frac{2\mathrm{r}}{\mathrm{r}}$ ....(given $r_1 = 2r_2$)

$\therefore \quad \frac{\mathrm{I}_1}{\mathrm{I}_2} = 2$...(ii)

The resistance through the coil, $\mathrm{R} \propto l$

Here, $l = 2\pi\mathrm{r}$

$\therefore \quad \frac{\mathrm{R}_1}{\mathrm{R}_2} = \frac{2\pi\mathrm{r}_1}{2\pi\mathrm{r}_2} = 2$...(ii)

$\therefore \quad \frac{\mathrm{V}_1}{\mathrm{V}_2} = \frac{\mathrm{I}_1\mathrm{R}_1}{\mathrm{I}_2\mathrm{R}_2} = 2 \times 2 = 4$

[From (i) and (ii)]

Q50. Solution
Correct Answer: 2

Escape velocity is given by,

$$\mathrm{v}_\mathrm{c} = \sqrt{\frac{2\mathrm{GM}}{\mathrm{R}}}$$

$$= \sqrt{\frac{2\mathrm{G}}{\mathrm{R}} \times \frac{4}{3}\pi\mathrm{R}^3\rho} = \sqrt{\frac{8\mathrm{G}}{3}\pi\mathrm{R}^2\rho} = \sqrt{\frac{8\mathrm{G}\pi\rho}{3}} \times \mathrm{R}$$

As the planets have the same density;

$\mathrm{V}_\mathrm{e} \propto \mathrm{R}$

$\therefore \quad \frac{\mathrm{V}_\mathrm{P}}{\mathrm{V}_\mathrm{E}} = \frac{\mathrm{R}_\mathrm{P}}{\mathrm{R}_\mathrm{E}} = \frac{2\mathrm{R}}{\mathrm{R}} = 2$

$\therefore \quad \frac{\mathrm{V}_\mathrm{P}}{\mathrm{V}_\mathrm{E}} = 2$

$\therefore \quad \mathrm{X} = 2$

Q51. Solution
Correct Answer: (B)

Higher the value of $(\mathrm{n}+\mathrm{l})$ higher will be energy.

Hence, $\underset{(4)}{3\mathrm{p}} < \underset{(5)}{3\mathrm{d}} < \underset{(5)}{4\mathrm{p}} < \underset{(7)}{4\mathrm{d}}$

If $(\mathrm{n}+\mathrm{l})$ same, then higher the value of, higher will be energy.

Q52. Solution
Correct Answer: (C)

$[\mathrm{Ni}\,(\mathrm{CN})_4]^{2-}$ Square planar
The electrons are paired in 3d orbitals because CN^- is strong field ligand.Hence the hybridisation will be dsp^2

$[\mathrm{Ni}\,(\mathrm{CO})_4]$ Tetrahedral
CO is strong field ligand. First the unpaired electrons will pair and then the electrons from 4s orbital will go in 3d orbital. Now 4s and 4p is empty hence it will be sp^3 hybridised.

$[\mathrm{NiCl}_4]^2$ is paramagnetic in nature due to presence of 2 unpaired electrons.
Ni^{2+} ion has $3\mathrm{d}^8$ electronic configuration. It undergoes sp^3 hybridisation which results in tetrahedral geometry.

Q53. Solution
Correct Answer: (A)

$CO_3^{2-} \rightarrow sp^2 \rightarrow \%s = 33.33\%$

$XeF_4 \rightarrow sp^3d^2 \rightarrow \%s = 16.67\%$

$I_3^- \rightarrow sp^3d \rightarrow \%\,s = 20\%$

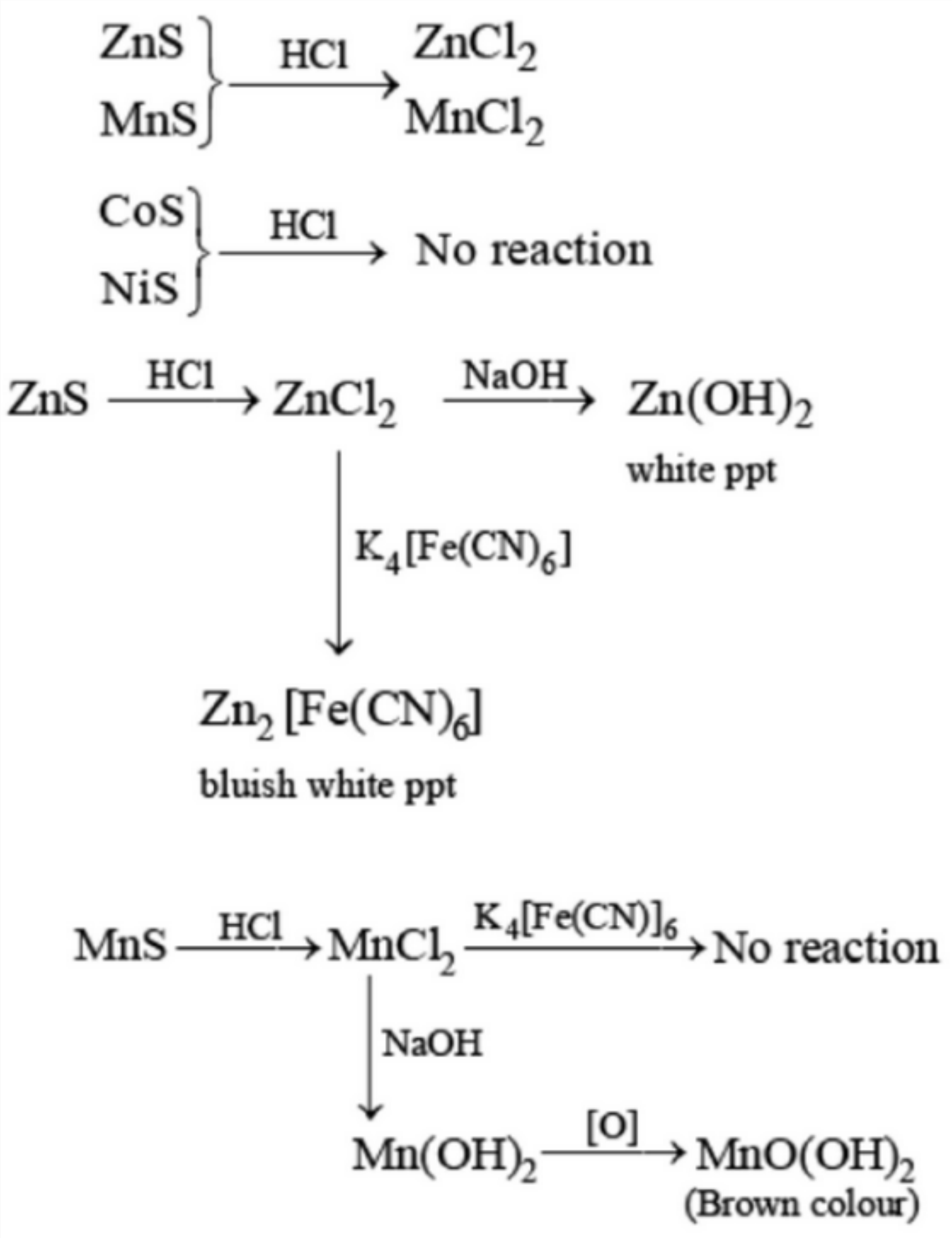
$NCl_3 \rightarrow sp^3 \rightarrow \%\,s = 25\%$

$BeCl_2 \rightarrow sp \rightarrow \%\,s = 50\%$

Q54. Solution

Correct Answer: (D)

In presence of HCl



The above reaction path is confirming the presence of Zn^{2+} ion.

Q55. Solution
Correct Answer: (D)

All the elements of Group 16 form hydrides of the type H_2E (E = O, S, Se, Te, Po). Their acidic character increases from H_2O to H_2Te.

Boiling point depends on the size and intermolecular forces.

As the size of the central atom increases boiling point should increase,but H_2O has greater boiling point than the other hydrides due to intermolecular hydrogen bonding.

The correct order of boiling points of 16th group hydrides is $H_2O > H_2Te > H_2Se > H_2S$The most volatile hydride of 16th group is H_2S

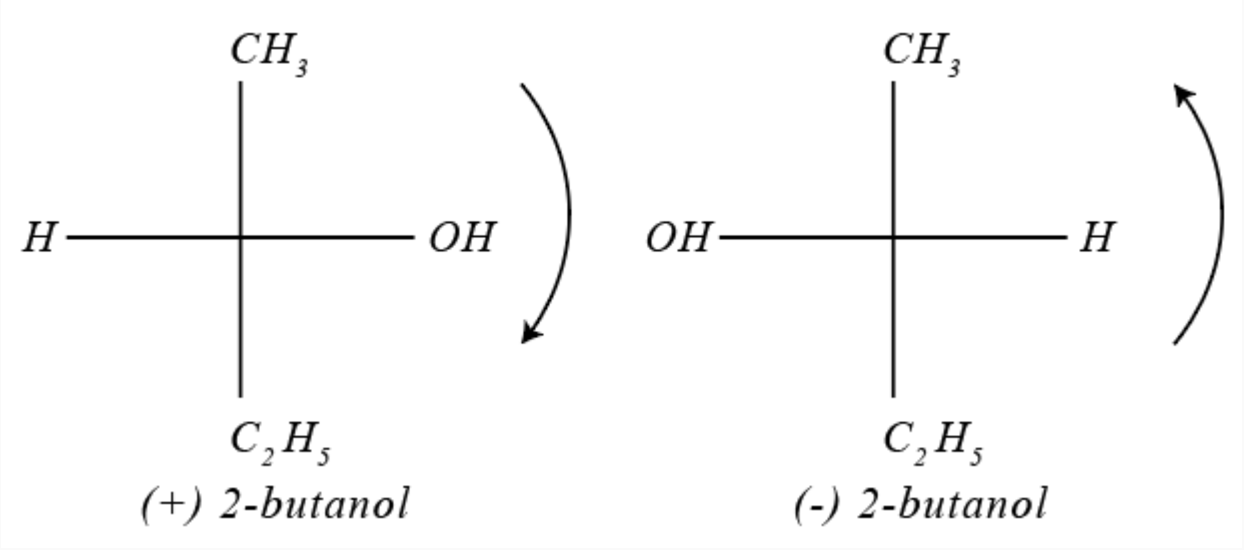
Q56. Solution
Correct Answer: (B)

$$\underset{\text{acetaldehyde}}{CH_3CHO} \xrightarrow{\text{Tautomerisation}} \underset{\text{vinyl alcohol}}{CH_2 = CH - OH}$$

Thus, these two are tautomers.

Eclipsed and staggered ethane are two conformations of ethane.

(+)2-butanol and (-)2-butanol are enantiomers as these are non-superimposable mirror images.



$$\underset{\text{(methyl-n-propylamine)}}{CH_3NHC_3H_7}$$
$$\underset{\text{(diethylamine)}}{C_2H_5NHC_2H_5}$$

Due to difference in the nature of alkyl groups attached to the same functional group, these are called metamers.

Q57. Solution
Correct Answer: (A)

The negative value of standard reduction potential (SRP) indicates that the reactant is more stable than product while for positive (SRP) it is vice-versa.

$\mathrm{Cr}^{3+}+\mathrm{e}^{-} \longrightarrow \mathrm{Cr}^{2+}, \mathrm{E}^{\theta}=-0.41$ volts and $\mathrm{Mn}^{3+}+\mathrm{e}^{-} \longrightarrow \mathrm{Mn}^{2+}, \mathrm{E}^{\ominus}=+1.51$ volts.

This shows that Cr^{2+} is unstable and has a tendency to acquire more stable Cr^{3+}state by acting as a reducing agent. On the other hand $\mathrm{Mn}^{3+}$is unstable and is reduced to more stable Mn^{2+}state which has d^{5} configuration.

Q58. Solution
Correct Answer: (C)

$$\mathrm{SO}_2+\frac{1}{2} \mathrm{O}_2 \rightleftharpoons \mathrm{SO}_3$$

$$\begin{aligned} K_1 &= \frac{[\mathrm{SO}_3]}{[\mathrm{SO}_2][\mathrm{O}_2]^{1/2}} \\ 2 \mathrm{SO}_3 &\rightleftharpoons 2 \mathrm{SO}_2+\mathrm{O}_2 \\ \mathrm{K}_2 &= \frac{[\mathrm{SO}_2]^2\,[\mathrm{O}_2]}{[\mathrm{SO}_3]^2} \end{aligned}$$

From Eqs. (i) and (ii)

$$\begin{aligned} K_2 &= \frac{1}{K_1^2} \\ K_2 &= \frac{1}{\left(5 \times 10^{-2}\right)^2}=\frac{1}{25 \times 10^{-4}} \\ &= \frac{100 \times 10^2}{25} \\ &= 4 \times 10^2 \text{ atm} \end{aligned}$$

Q59. Solution

Correct Answer: (D)

$CoCl_2 + H_2S \rightarrow CoS \downarrow + 2HCl$

$3CoS + 6HCl + 2HNO_3 \rightarrow 3CoCl_2 + 2NO + 3S + 4H_2O \quad (aquaregia)$

$KNO_2 + CH_3COOH \rightarrow CH_3COOK + HNO_2$

$CoCl_2 + 2KNO_2 \rightarrow Co(NO_2)_2 + 2KCl$

$Co(NO_2)_2 + 2HNO_2 \rightarrow Co(NO_2)_3 + NO + H_2O$ Lab Manual Reference:

$Co(NO_2)_3 + 3KNO_2 \rightarrow K_3[Co(NO_2)_6]$

Oxidation number of cobalt in this compound is $+3$.

Cobalt sulphide dissolves in aqua regia in the same manner as nickel sulphide. When the aqueous solution of the residue obtained after treatment with aqua regia is treated with a strong solution of potassium nitrite after neutralisation with ammonium hydroxide and the solution is acidified with dil. acetic acid, a yellow precipitate of the complex of cobalt named potassium hexanitritocobaltate (III) is formed.

$CoS + HNO_3 + 3HCl \longrightarrow CoCl_2 + NOCl + S + 2H_2O$

$$CoCl_2 + 7KNO_2 + 2CH_3COOH \longrightarrow \underset{\substack{\text{Potassium} \\ \text{hexanitritocobaltate(III)} \\ \text{(Yellow precipitate)}}}{K_3[Co(NO_2)_6]} + 2KCl + 2CH_3COOK + NO + H_2O$$

Q60. Solution

Correct Answer: (B)

Molarity $= \frac{\text{mass} \times 1000}{\text{molecular weight} \times \text{volume of solution}}$

Molecular weight of ethyl alcohol,

$C_2H_5OH = 12 \times 2 + 5 + 16 + 1$

$= 24 + 22 = 46 gmol^{-1}$

On substituting the values, we get

$0.5M = \frac{\text{mass} \times 1000}{46 \times 100}$

Mass $= \frac{0.5 \times 46}{10} = 2.3g$

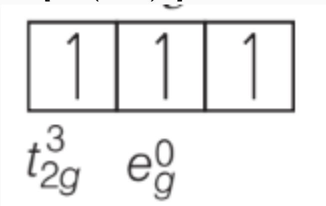
$\therefore$ Volume of ethyl alcohol required.

$V = \frac{\text{mass of ethyl alcohol}}{\text{density of ethyl alcohol}} = \frac{2.3g}{1.15g/cc} = 2cc$

Q61. Solution

Correct Answer: (D)

(I) $[Cr(CN)_6]^{3-}, Cr^{3+} \Rightarrow 3d^3 \therefore$ CN is a strong field ligand.

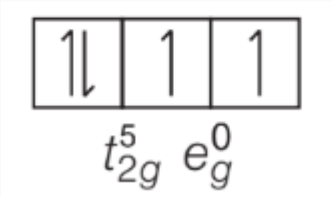


$\therefore$ Number of unpaired $e^- = 3$

$\Rightarrow N = \sqrt{n(n+2)} = \sqrt{3(3+2)} = \sqrt{15}\text{BM}$

(II) $[Mn(CN)_6]^{3-}; Mn^{3+} \Rightarrow 3d^4$

$\because$ CN is a strong field ligand.

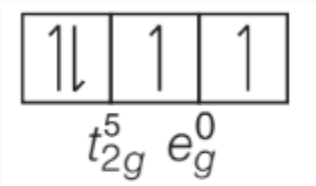


$\therefore$ Number of unpaired $e^- = 2$

$\Rightarrow \quad N = \sqrt{2(2+2)} = \sqrt{8}\text{BM}$

(III) $[Fe(CN)_6]^{3-}; Fe^{3+} \rightarrow 3d^5$

$\because$ CN is a strong field ligand.

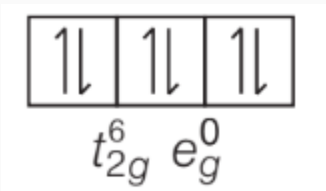


$\therefore$ Number of unpaired $e^- = 2$

$N = \sqrt{2(2+2)} = \sqrt{8}\text{BM}$

(IV) $[Co(CN)_6]^{3-}, Co^{3+} \longrightarrow 3d^6$

$\because$ CN^- is a strong field ligand.



$\therefore$ Number of unpaired $e^- = 0$

$\Rightarrow \quad N = 0$

Hence, minimum value of magnetic moment is for $[Co(CN)_6]^{3-}$.

Q62. Solution
Correct Answer: (D)

The correct order of covalent character is $NaCl < LiCl < MgCl_2 < BeCl_2$. The covalent character depends on small size as well as more + ve charge on cation.

Q63. Solution
Correct Answer: (B)

In the given reaction :

$X \rightarrow Y \rightarrow Z$

When reaction is started, only X will be continuously converting into Y. So, concentration of X will continuously decrease. Therefore, curve III should be of X.

Compound Y is being formed from X as well as it is converting into Z. So, its concentration will first increase upto certain time then after reaching to a maxima, it will start decreasing. Therefore, curve II should be of Y.

Compound Z is being only formed from Y. So, concentration of Z will continuously increase. Therefore, curve I should be of Z.

Q64. Solution
Correct Answer: (A)

(A) (iii), Anhydrous $ZnCl_2+$ conc HCl called, i.e. as reagent and used to distinguish between $1^{\circ}, 2^{\circ}, 3^{\circ}$ alcohols.
(B) (iv), $Zn - Hg/HCl$ called clemmensen reagent and used in conversion of carbonyl into alkane.
(C) (ii), Tollen's reagent $\left[Ag(NH_3)_2\right]^{+}$used as oxidising reagent.
(D) (i), Stiphen reagent $SnCl_2 + HCl$ used in reduction of nitrogen compounds.

Q65. Solution
Correct Answer: (C)

T' is final temperature.
$q \; = \Delta E - W$
$= C_V(T' - T) + P_{ext}(2 - 1)$
$= C_V(T' - T) + 1 \text{ L atm}$
$q \; = \frac{3}{2}R\,(T' - T) + 1 \text{ L atm} = 0$
$T' - T = -\frac{2}{3}\frac{1}{R}$
$T' = T - \frac{2}{3R}$
$= T - \frac{2}{3 \times 0.082}$

Q66. Solution

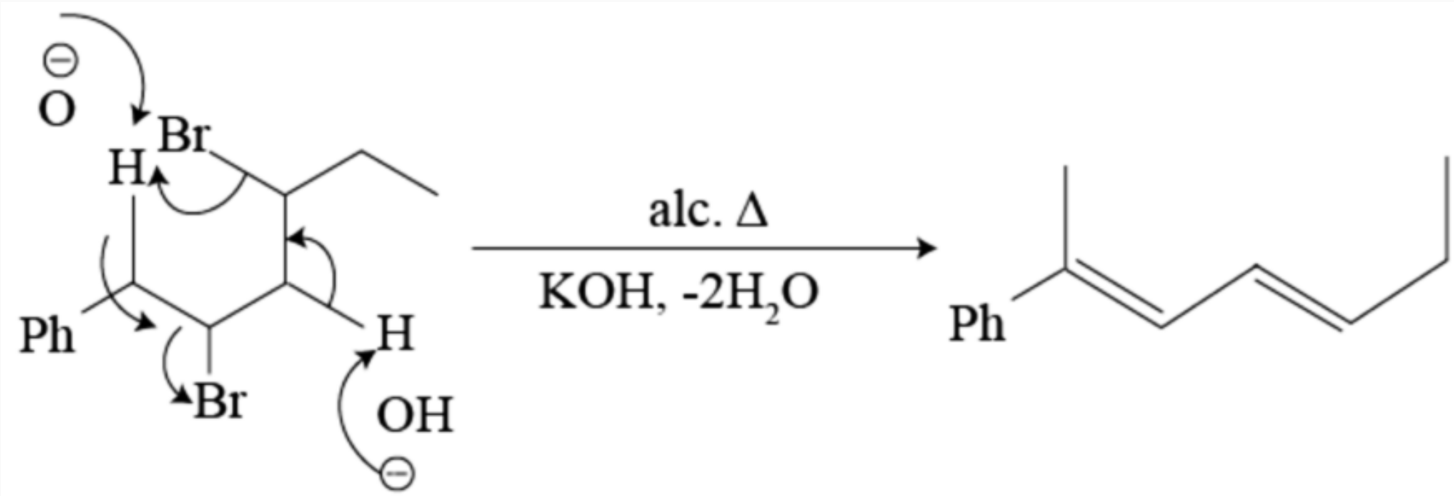
Correct Answer: (A)

(i) Electron affinity of second period p-block element is less than third period p-block element due to small size of second period p-block element, due to small size electron density is more and upcoming electron face extra repulsion, so energy release is less. Hence, EA order: $\mathrm{F} < \mathrm{Cl}$.

(ii) Down the group electron affinity decreases due to size increases. EA order: $\mathrm{S} > \mathrm{Se}$ $\mathrm{Li} > \mathrm{Na}$. Ionization energy is reverse of electron afinity

Q67. Solution

Correct Answer: (B)



This product is highly stable conjugate di-ene system with benzene ring also so it is formed here as major product.

Q68. Solution

Correct Answer: (C)

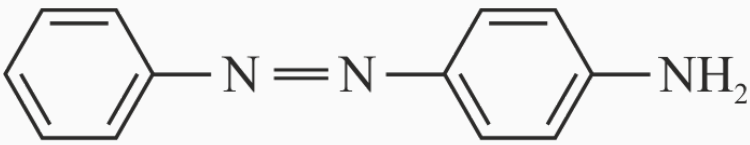
$$\text{(i)}\quad \mathrm{CH_3\,CH_2\,Cl} \xrightarrow{\text{NaCN}} \mathrm{CH_3\,CH_2\,C \equiv N} \xrightarrow[\text{Ni}/\mathrm{H_2}]{\text{reduction}} \mathrm{CH_3\,CH_2\,CH_2\,NH_2}$$

Chloroethane propanenitrile (A) (B) $\text{propan} - 1 - \text{amine}$

$$\text{(ii)}\quad \mathrm{C_6H_5\,NH_2} \xrightarrow{\mathrm{NaNO_2}/\mathrm{HCl}} \mathrm{C_6H_5 - N_2^+\,Cl^-} \xrightarrow[\mathrm{OH^-}]{\mathrm{C_6H_5\,NH_2}}$$

Benzene diazonium

Chloride (C)



(D)

Q69. Solution

Correct Answer: (B)

S1. No. Name of Vitamins	Sources	Deficiency diseases
1. Vitamin A	Fish liver oil, carrots, butter and milk	Xeropthalmia (hardening of cornea of eye) Night blindness
2. Vitamin B_1 (Thjamine)	Yeast, milk, green vegetables and cereals	Beri beri (loss of appetite, retarded growth)
3. Vitamin B_2 (Riboflavin)	Milk, eggwhite, liver, kidney	Cheilosis (fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin.
4. Vitamin B_6 (Pyridoxine)	Yeast, milk, egg yolk, cereals and grams	Convulsions
5. Vitamin B_{12}	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
6. Vitamin C	Citrus fruits, amla and green leafy vegetables	Scurvy (bleeding gums)
7. Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
8. Vitamin E	Vegetable oils like wheat germ oil, sunflower oil, etc.	Increased fragility of RBCs and muscular weakness
9. Vitamin K	Green leafy vegetables	Increased blood clotting time

Q70. Solution

Correct Answer: (C)

$n_{H^+} = \frac{400\times0.2}{1000} \times 2 = 0.16$

$n_{OH^-} = \frac{600\times0.1}{1000} = 0.06(\text{ Limiting Reagent})$

Now we can apply, $q = ms\,\Delta\,T$

$0.06 \times 57.1 \times 10^3$

$= (1000 \times 1.0) \times 4.18 \times \Delta T$

$\therefore \Delta T = 0.8196\ K$

$= 81.96 \times 10^{-2}\ K \approx 82 \times 10^{-2}\ K$

Q71. Solution

Correct Answer: 17

$$n_{N_2} = \frac{PV}{RT}$$
$$= \frac{(725 - 25)40 \times 10^{-3}}{760 \times 0.082 \times 300}$$
$$n_{N_2} = \frac{28}{760 \times 24.6}$$
$$w_{N_2} = \frac{28 \times 28}{760 \times 24.6}\ \text{g of } N_2$$
$$\text{Weight of } N_2 = \frac{28 \times 28}{760 \times 24.6}\text{gm}$$
$$\%N_2 = \frac{28 \times 28}{\frac{1}{660\times24.6}} \times \frac{1}{0.25} \times 100$$
$$= 16.77\%$$

Q72. Solution
Correct Answer: 174

When a non-volatile solute is added in a pure solvent, the freezing point of the solution decreases. This decrease in the freezing point is known as depression in freezing point.

Here,

Weight of solute, $\mathrm{W_B} = 8\ \mathrm{g}$

Weight of solvent, $\mathrm{W_A} = 92\ \mathrm{g} = 0.092\,\mathrm{kg}$

Molal freezing point depression constant, $\mathrm{K_f} = 1.85\ ^{\circ}\mathrm{C}\ \mathrm{mol}^{-1}$

Depression in freezing point, $\Delta \mathrm{T_f} = \mathrm{K_f m} \Rightarrow \Delta \mathrm{T_f} = \mathrm{K_f} \times \frac{\mathrm{W_B}}{\mathrm{M_B}} \times \frac{1}{\mathrm{W_A}} \Rightarrow \mathrm{M_B} = \frac{1.85 \times 8}{0.925 \times 0.092} = 173.9$

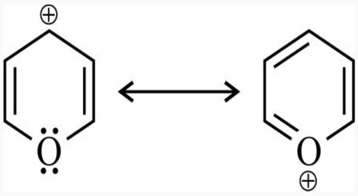
Hence, the molar mass of nicotine = $174\ \mathrm{g\ mol}^{-1}$.

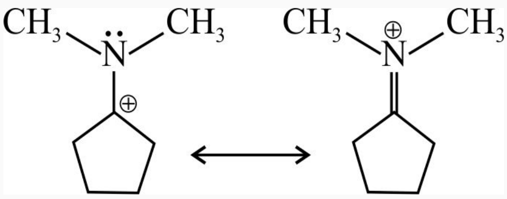
Q73. Solution
Correct Answer: 120

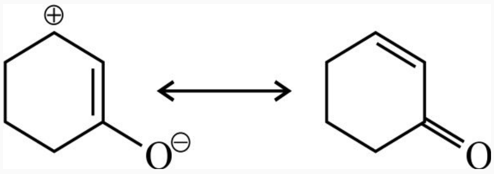
$$\mathrm{k} = \mathrm{Ae}^{-\mathrm{Ea}/R \times 600}$$
$$\mathrm{k^c} = \mathrm{Aee}^{-\frac{(\mathrm{Ea}-20)}{\mathrm{R} \times 500}}$$
$$\mathrm{k} = \mathrm{k^c}$$
$$\frac{\mathrm{Ea}}{\mathrm{R} \times 600} = \frac{(\mathrm{Ea} - 20)}{\mathrm{R} \times 500}$$
$$\frac{\mathrm{Ea}}{6} = \frac{\mathrm{Ea} - 20}{5}$$
$$\frac{5}{6}\mathrm{Ea} = \mathrm{Ea} - 20$$
$$20 = \mathrm{Ea} - \frac{5}{6}\mathrm{Ea}$$
$$\mathrm{Ea} = 20 \times 6$$
$$\mathrm{Ea} = 120\ \mathrm{kJ/mol}$$

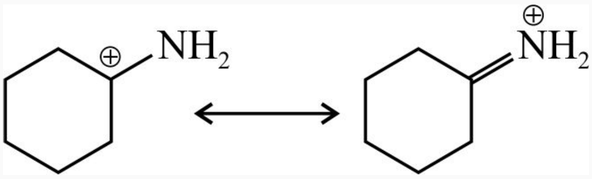
Q74. Solution

Correct Answer: 4

1. 

2. 

3. 

4. 

Q75. Solution

Correct Answer: 56

$3Fe_2O_3(\text{ s}) \rightarrow 2Fe_3O_4 + \frac{1}{2}O_2$

$3 \text{ mol} \qquad\qquad\qquad\qquad 0.5 \text{ mol}$

$3 \times 160 \text{ gm} \qquad\qquad\qquad \frac{1}{2} \times 32\text{gm}$

$\text{loss of } 16 \text{ gm } O_2 \text{ by } 480 \text{ gm } FeO_3$

$\text{loss of } 0.04 \text{ gm } O_2 \rightarrow 0.04 \times \frac{480}{16} Fe_2O_3$

$= 1.2 \text{ gm } Fe_2O_3$

$\% \text{ by mass of Fe} = \frac{0.84}{1.5} \times 100 = 56\%$

CIPHΞR the goat 🫡