

Answer Key

Other (130 Questions)

Q1. (B)	Q2. (D)	Q3. (A)	Q4. (C)	Q5. (C)
Q6. (A)	Q7. (A)	Q8. (B)	Q9. (A)	Q10. (A)
Q11. (A)	Q12. (D)	Q13. (A)	Q14. (D)	Q15. (A)
Q16. (A)	Q17. (B)	Q18. (A)	Q19. (C)	Q20. (C)
Q21. (B)	Q22. (C)	Q23. (D)	Q24. (D)	Q25. (C)
Q26. (B)	Q27. (B)	Q28. (C)	Q29. (B)	Q30. (A)
Q31. (A)	Q32. (B)	Q33. (A)	Q34. (D)	Q35. (B)
Q36. (C)	Q37. (D)	Q38. (B)	Q39. (B)	Q40. (D)
Q41. (C)	Q42. (D)	Q43. (C)	Q44. (B)	Q45. (A)
Q46. (C)	Q47. (C)	Q48. (C)	Q49. (D)	Q50. (B)
Q51. (D)	Q52. (A)	Q53. (B)	Q54. (B)	Q55. (B)
Q56. (D)	Q57. (D)	Q58. (C)	Q59. (B)	Q60. (A)
Q61. (B)	Q62. (C)	Q63. (C)	Q64. (C)	Q65. (C)
Q66. (D)	Q67. (C)	Q68. (D)	Q69. (A)	Q70. (C)
Q71. (A)	Q72. (D)	Q73. (C)	Q74. (D)	Q75. (A)
Q76. (A)	Q77. (D)	Q78. (D)	Q79. (B)	Q80. (A)
Q81. (C)	Q82. (C)	Q83. (B)	Q84. (A)	Q85. (B)
Q86. (D)	Q87. (C)	Q88. (A)	Q89. (D)	Q90. (D)
Q91. (B)	Q92. (A)	Q93. (D)	Q94. (D)	Q95. (B)
Q96. (B)	Q97. (B)	Q98. (A)	Q99. (C)	Q100.(B)
Q101.(C)	Q102.(B)	Q103.(D)	Q104.(A)	Q105.(A)

Q106.(A)

Q107.(B)

Q108.(A)

Q109.(B)

Q110.(C)

Q111.(C)

Q112.(C)

Q113.(C)

Q114.(A)

Q115.(A)

Q116.(A)

Q117.(C)

Q118.(C)

Q119.(C)

Q120.(A)

Q121.(D)

Q122.(A)

Q123.(D)

Q124.(A)

Q125.(C)

Q126.(D)

Q127.(D)

Q128.(D)

Q129.(A)

Q130.(D)

Solutions

Q1. Solution

Correct Answer: (B)

$$\text{Let, } \vec{a} = 2\hat{j} + 3\hat{k}$$

$$\vec{b} = 4\hat{j} - 3\hat{k}$$

$$\vec{c} = \hat{j} - \hat{k}$$

$$\vec{d} = \hat{i} + \hat{j}$$

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

A normal vector perpendicular to the plane P_1 is $\vec{a} \times \vec{b}$

A normal vector perpendicular to the plane P_2 is $\vec{c} \times \vec{d}$

$$\text{A vector parallel to the line of intersection is } (\vec{a} \times \vec{b}) \times (\vec{c} \times \vec{d}) = (\hat{k} - \hat{j})$$

Let, θ be the acute angle between them then,

$$\cos \theta = \frac{\vec{A} \cdot \vec{e}}{\|\vec{A}\| \|\vec{e}\|} = \frac{(-3)}{\sqrt{2} \times 3} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \theta = \frac{\pi}{4}$$

Q2. Solution

Correct Answer: (D)

Option A: Incorrect. The sign of dual variables depends on the type of constraints in the primal problem. In the standard form, dual variables are associated with constraints, and their sign restrictions vary based on the inequality type. Hence, they are not always guaranteed to be non-negative. Option B: Incorrect. The dual simplex method does not guarantee that it will always generate a basic feasible solution unless specific feasibility and optimality conditions are met. It begins with a dual feasible but primal infeasible solution and works toward primal feasibility. Option C: Incorrect. The dual simplex method is used when the initial solution is optimal for the dual but infeasible for the primal. Simply having a non-optimal basic feasible solution does not necessarily qualify for applying the dual simplex method. Option D: Correct. This is a known computational strategy in linear programming. If the primal has a small number of variables but a large number of constraints, solving the dual problem—which will have fewer constraints and more variables—can often be more computationally efficient.

Q3. Solution**Correct Answer: (A)**

The given differential equation is $\frac{dy}{dx} - y = \cos x - \sin x$

Integrating factor

$$IF = e^{-x}$$

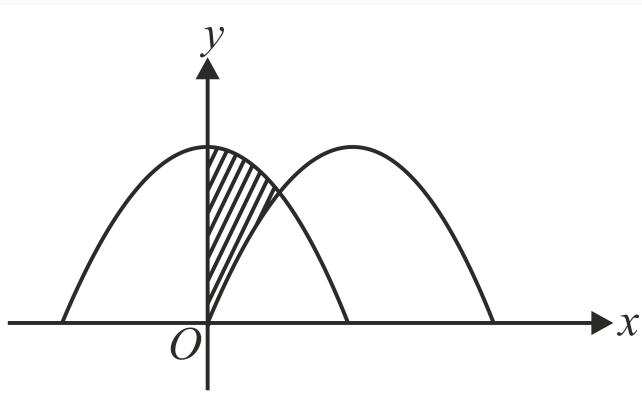
$$\therefore ye^{-x} = \int e^{-x}(\cos x - \sin x)dx$$

Put $-x = t$

$$\Rightarrow ye^{-x} = - \int e^t(\cos t + \sin t)dt$$

Integrating by parts-

$$ye^{-x} = e^{-x} \sin x + C$$



Since, y is bounded when

$$x \rightarrow \infty$$

$$\Rightarrow C = 0$$

$$\therefore y = \sin x$$

$$\text{So, Area} = \int_0^{\pi/4} (\cos x - \sin x)dx = \sqrt{2} - 1$$

Q4. Solution**Correct Answer: (C)**

$$\tan^{-1} \frac{1}{1+2} + \tan^{-1} \frac{1}{1+2\times 3} + \tan^{-1} \frac{1}{1+3\times 4} + \dots + \\ \tan^{-1} \frac{1}{1+(n-1)n} + \tan^{-1} \frac{1}{1+n(n+1)} + \dots + \\ \tan^{-1} \frac{1}{1+(n+19)(n+20)} = \tan^{-1} \frac{n+19}{n+21}$$

We know that, $\Rightarrow \tan^{-1} \frac{n-1}{n+1} + \tan^{-1} \frac{1}{1+n(n+1)} + \tan^{-1} \frac{1}{1+(n+1)(n+2)} + \dots + \frac{1}{1+(n+19)(n+20)} = \tan^{-1} \frac{n+19}{n+21}$

$$\tan^{-1} \frac{1}{1+n(n+1)} + \tan^{-1} \frac{1}{1+(n+1)(n+2)} + \dots + \frac{1}{1+(n+19)(n+20)} = \tan^{-1} \frac{n+19}{n+21} - \tan^{-1} \frac{n-1}{n+1}$$
$$\tan^{-1} \left(\frac{1}{n^2 + n + 1} \right) + \tan^{-1} \left(\frac{1}{n^2 + 3n + 3} \right) + \dots +$$
$$= \tan^{-1} \left(\frac{\frac{n+19}{n+21} - \frac{n-1}{n+1}}{1 + \frac{n+19}{n+21} \times \frac{n-1}{n+1}} \right)$$
$$= \tan^{-1} \frac{1}{1 + (n+19)(n+20)} \frac{20}{n^2 + 20n + 1} = S$$
$$\therefore \tan S = \frac{20}{n^2 + 20n + 1}$$

Q5. Solution

Correct Answer: (C)

We have to find the value of $\cos \frac{7\pi}{8} + \cos \frac{\pi}{4} + \cos \left(\frac{-\pi}{8} \right) - 1$, using $\cos(-\theta) = \cos \theta$,

$$= \cos \frac{7\pi}{8} + \frac{1}{\sqrt{2}} + \cos \frac{\pi}{8} - 1$$

$$= \cos \frac{7\pi}{8} + \frac{1}{\sqrt{2}} + \cos \left(\pi - \frac{7\pi}{8} \right) - 1$$

Using $\cos(\pi - \theta) = -\cos \theta$,

$$= \cos \frac{7\pi}{8} + \frac{1}{\sqrt{2}} - \cos \frac{7\pi}{8} - 1$$

$$= \frac{1}{\sqrt{2}} - 1.$$

Now taking the options

$$(A) 4 \cos \frac{\pi}{16} \cos \frac{3\pi}{4} \cos \frac{5\pi}{8}$$

$$= 2 \left(2 \cos \frac{\pi}{16} \cos \frac{5\pi}{8} \right) \cos \left(\pi - \frac{\pi}{4} \right)$$

Using $2 \cos A \cos B = \cos(A + B) + \cos(A - B)$, $\cos(\pi - \theta) = -\cos \theta$,

$$= 2 \left(\cos \left(\frac{\pi}{16} + \frac{5\pi}{8} \right) + \cos \left(\frac{\pi}{16} - \frac{5\pi}{8} \right) \right) \left(-\cos \frac{\pi}{4} \right)$$

$$= 2 \left(\cos \left(\frac{11\pi}{16} \right) + \cos \left(-\frac{9\pi}{16} \right) \right) \left(-\frac{1}{\sqrt{2}} \right)$$

$$= -\sqrt{2} \left(\cos \left(\frac{11\pi}{16} \right) + \cos \left(\frac{9\pi}{16} \right) \right) \neq \frac{1}{\sqrt{2}} - 1.$$

$$(B) 4 \cos \frac{\pi}{16} \cos \frac{\pi}{8} \cos \frac{5\pi}{8}$$

$$= 2 \left(2 \cos \frac{\pi}{16} \cos \frac{5\pi}{8} \right) \cos \left(\frac{\pi}{8} \right)$$

$$= 2 \left(\cos \left(\frac{\pi}{16} + \frac{5\pi}{8} \right) + \cos \left(\frac{\pi}{16} - \frac{5\pi}{8} \right) \right) \left(\cos \frac{\pi}{8} \right)$$

$$= 2 \left(\cos \left(\frac{11\pi}{16} \right) + \cos \left(\frac{9\pi}{16} \right) \right) \left(\cos \frac{\pi}{8} \right)$$

$$= 2 \cos \left(\frac{11\pi}{16} \right) \cos \left(\frac{\pi}{8} \right) + 2 \cos \left(\frac{9\pi}{16} \right) \cos \left(\frac{\pi}{8} \right)$$

$$= \cos \left(\frac{13\pi}{16} \right) + \cos \left(\frac{9\pi}{16} \right) + \cos \left(\frac{11\pi}{16} \right) + \cos \left(\frac{7\pi}{16} \right)$$

$$= \cos \left(\frac{13\pi}{16} \right) + \cos \left(\frac{9\pi}{16} \right) + \cos \left(\frac{11\pi}{16} \right) + \cos \left(\pi - \frac{9\pi}{16} \right)$$

$$= \cos \left(\frac{13\pi}{16} \right) + \cos \left(\frac{9\pi}{16} \right) + \cos \left(\frac{11\pi}{16} \right) - \cos \left(\frac{9\pi}{16} \right)$$

$$= \cos \left(\frac{13\pi}{16} \right) + \cos \left(\frac{11\pi}{16} \right) \neq \frac{1}{\sqrt{2}} - 1.$$

$$\begin{aligned}
(C) & 4 \cos \frac{\pi}{16} \cos \frac{3\pi}{8} \cos \frac{9\pi}{16} \\
& = 2 \left(2 \cos \frac{9\pi}{16} \cos \frac{\pi}{16} \right) \cos \left(\frac{3\pi}{8} \right) \\
& = 2 \left(\cos \left(\frac{\pi}{16} + \frac{9\pi}{16} \right) + \cos \left(\frac{9\pi}{16} - \frac{\pi}{16} \right) \right) \left(\cos \frac{3\pi}{8} \right) \\
& = 2 \left(\cos \left(\frac{10\pi}{16} \right) + \cos \left(\frac{8\pi}{16} \right) \right) \left(\cos \frac{3\pi}{8} \right) \\
& = 2 \left(\cos \left(\frac{5\pi}{8} \right) + \cos \left(\frac{\pi}{2} \right) \right) \left(\cos \frac{3\pi}{8} \right) \\
& = 2 \left(\cos \left(\frac{5\pi}{8} \right) + 0 \right) \left(\cos \frac{3\pi}{8} \right) \\
& = 2 \cos \left(\frac{5\pi}{8} \right) \cos \left(\frac{3\pi}{8} \right) \\
& = \cos \left(\frac{8\pi}{8} \right) + \cos \left(\frac{2\pi}{8} \right) \\
& = \cos(\pi) + \cos \left(\frac{\pi}{4} \right) = -1 + \frac{1}{\sqrt{2}}.
\end{aligned}$$

Which is same as the simplified form of the question, hence the correct option is (C).

Q6. Solution

Correct Answer: (A)

$$\vec{a} = m\hat{i} + (m+1)\hat{j} + (m+8)\hat{k}$$

Given vectors: $\vec{b} = (m+3)\hat{i} + (m+4)\hat{j} + (m+5)\hat{k}$ Vectors are non-coplanar \Leftrightarrow Scalar triple product $\neq 0$:

$$\vec{c} = (m+6)\hat{i} + (m+7)\hat{j} + (m+8)\hat{k}$$

$$cccm \quad m+1 \quad m+8$$

$$\vec{a} \cdot (\vec{b} \times \vec{c}) = m+3 \quad m+4 \quad m+5 \quad \text{Expand determinant:}$$

$$m+6 \quad m+7 \quad m+8$$

$$= m[(m+4)(m+8) - (m+5)(m+7)]$$

$$- (m+1)[(m+3)(m+8) - (m+5)(m+6)] \quad \text{All } 2 \times 2 \text{ determinants simplify to:}$$

$$+ (m+8)[(m+3)(m+7) - (m+4)(m+6)]$$

$$= m(-3) - (m+1)(-6) + (m+8)(-3)$$

$$= -3m + 6(m+1) - 3(m+8) \quad \text{Since scalar triple product} = -12 \text{ (constant} \neq 0\text{)} \text{ Vectors are non-}$$

$$= -3m + 6m + 6 - 3m - 24 = -12$$

coplanar for all real m.

Q7. Solution**Correct Answer: (A)**

Given

$$\begin{aligned}
& \sin^{-1} \left[\cot \left(\sin^{-1} \sqrt{\left(\frac{2-\sqrt{3}}{4} \right)} + \cos^{-1} \frac{\sqrt{12}}{4} + \sec^{-1} \sqrt{2} \right) \right] \\
&= \sin^{-1} \left[\cot \left\{ \sin^{-1} \left(\frac{\sqrt{3}-1}{2\sqrt{2}} \right) + \cos^{-1} \left(\frac{\sqrt{3}}{2} \right) + \cos^{-1} \left(\frac{1}{\sqrt{2}} \right) \right\} \right] \\
&= \sin^{-1} [\cot(15^\circ + 30^\circ + 45^\circ)] \\
&= \sin^{-1} \{ \cot(90^\circ) \} = \sin^{-1} 0 = 0.
\end{aligned}$$

Q8. Solution**Correct Answer: (B)**

Distance between the line $\vec{r} = 2\hat{i} - 2\hat{j} + 3\hat{k} + \lambda(\hat{i} - \hat{j} + 4\hat{k})$ and the plane $\vec{r} \cdot (\hat{i} + 5\hat{j} + \hat{k}) = 5$ is equation of plane is $x + 5y + z = 5$. ∴ Distance of line from this plane = perpendicular distance of point $(2, -2, 3)$ from the plane i.e. $\frac{2-10+3-5}{\sqrt{1+5^2+1}} = \frac{10}{3\sqrt{3}}$.

Q9. Solution**Correct Answer: (A)**

$$\begin{aligned}
\text{Let } A &= \lim_{n \rightarrow \infty} \frac{1}{n} [(n+1)(n+2)(n+3)\dots(2n)]^{\frac{1}{n}} \\
&= \lim_{n \rightarrow \infty} \left[\left(1 + \frac{1}{n}\right) \left(1 + \frac{2}{n}\right) \dots \left(1 + \frac{n}{n}\right) \right]^{\frac{1}{n}} \\
\therefore \log A &= \lim_{n \rightarrow \infty} \sum_{r=1}^n \frac{1}{n} \log \left(1 + \frac{r}{n}\right) \\
&= \int_0^1 \log(1+x) dx = [x \log(1+x)]_0^1 - \int_0^1 \frac{x}{1+x} dx \\
&= \log 2 - \int_0^1 \left(1 - \frac{1}{1+x}\right) dx \\
&= \log 2 - [x - \log(1+x)]_0^1 \\
&= \log 2 - [1 - \log 2] \\
&= \log 2 - 1 + \log 2 = \log 4 - 1 \\
\therefore \log A &= \log 4 - 1 \\
\Rightarrow \log \left(\frac{A}{4} \right) &= -1 \Rightarrow \frac{A}{4} = e^1 \\
\Rightarrow A &= \frac{4}{e} \Rightarrow \lim_{n \rightarrow \infty} f(n) = \frac{4}{e}
\end{aligned}$$

Q10. Solution

Correct Answer: (A)

Let: - x = tennis rackets - y = cricket bats Given: - Machine time: $1.5x + 3y \leq 42$ - Craftsman time: $3x + 1y \leq 24$ - Profit: $Z = 20x + 10y$ - $x \geq 0, y \geq 0$ Step 1: Multiply first constraint by 2:
 $3x + 6y \leq 84$ (eq1) Step 2: Solve (1) and (2) Subtract eq2 from eq1:
 $3x + y \leq 24$ (eq2)
 $(3x + 6y) - (3x + y) = 84 - 24 \Rightarrow 5y = 60 \Rightarrow y = 12 \Rightarrow x = 0$ from eq 2 Point A: (0, 12) Other intercepts: - Put $x = 0$ in both: - From eq1: $y = 14$ - From eq2: $y = 24$ - Put $y = 0$ in both: - From eq1: $x = 28$ - From eq2: $x = 8$ Feasible corner points: - (0, 0), (0, 12), (4, 12), (8, 0) (Verified by solving constraints) Step 3: Evaluate profit - (0, 0) : $Z = 0$ - (0, 12) : $Z = 120$ - (4, 12) : $Z = 20 \times 4 + 10 \times 12 = 80 + 120 = 200$ - (8, 0) : $Z = 160$ Maximum profit is Rs. 200 at (4, 12)

Q11. Solution

Correct Answer: (A)

Given that

10 Red roses & 5 Yellow roses.

x is number of garlands that can be formed with all these flowers so that no two yellow roses come together.

i.e., first arranging 10 Red roses in $\frac{9!}{2}$ then in that 10 gaps we can arrange these 5 yellow roses in $\frac{10!}{5!} = 10 \times 9 \times 8 \times 7 \times 6$.

$$\text{So } x = \frac{9!}{2} \times 10P_5$$

y is number of garlands with all these flowers so that all the red roses coming together.

i.e., taking all red roses as one unit and arranging red and yellow roses is $y = \frac{5!}{2} \times (10!)$.

$$\frac{2(x-y)}{10!} = \frac{10P_5}{10} - 5!$$

$$\therefore \frac{2(x-y)}{10!} = \frac{9!}{5!} - 5!$$

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Q12. Solution**Correct Answer: (D)**

Given,

$$\vec{a} \times (\vec{b} \times \vec{c}) = \frac{\vec{b} - \vec{c}}{2}$$

Using the vector triple cross product we have,

$$\vec{a} \times (\vec{b} \times \vec{c}) = (\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c}$$

$$\text{So, } (\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c} = \frac{\vec{b} - \vec{c}}{2}$$

On comparing both sides we get,

$$\vec{a} \cdot \vec{c} = \frac{1}{2}, \vec{a} \cdot \vec{b} = \frac{1}{2}$$

$$\therefore \vec{b} \cdot \vec{d} = \vec{a} \cdot \vec{b}$$

$$\therefore \vec{b} \cdot \vec{d} = \frac{1}{2}$$

Using vector cross-product formulae we have

$$\begin{aligned} & (\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d}) = \vec{a} \cdot (\vec{b} \times (\vec{c} \times \vec{d})) \\ &= \vec{a} \cdot ((\vec{b} \cdot \vec{d})\vec{c} - (\vec{b} \cdot \vec{c})\vec{d}) \quad (\because \vec{b} \cdot \vec{c} = 0) \\ &= (\vec{a} \cdot \vec{c})(\vec{b} \cdot \vec{d}) = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4} \end{aligned}$$

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Q13. Solution**Correct Answer: (A)**

$$\frac{dP}{dx} = 100 - 12\sqrt{x}$$

$$\Rightarrow \int dP = \int (100 - 12\sqrt{x}) dx$$

$$\Rightarrow P = 100x - 8x^{3/2} + C$$

$$\text{Now, } x = 0$$

$$\Rightarrow P = 2000 \Rightarrow C = 2000$$

$$\text{hence, } P = 100x - 8x^{\frac{3}{2}} + 2000$$

$$\therefore x = 25$$

$$P = 2500 - 1000 + 2000$$

$$P = 3500 \sim$$

Q14. Solution**Correct Answer: (D)**

Given, $\frac{z_1 - 2z_2}{2 - z_1\bar{z}_2}$ is unimodular.

$$\Rightarrow \frac{z_1 - 2z_2}{2 - z_1\bar{z}_2} = 1$$

$$\Rightarrow |z_1 - 2z_2| = |2 - z_1\bar{z}_2|$$

Squaring both the sides, we get,

$$|z_1 - 2z_2|^2 = |2 - z_1\bar{z}_2|^2$$

$$\Rightarrow (z_1 - 2z_2)(\bar{z}_1 - 2\bar{z}_2) = (2 - z_1\bar{z}_2)(2 - \bar{z}_1z_2)$$

$$\left(\because |z|^2 = z\bar{z} \right)$$

$$\Rightarrow z_1\bar{z}_1 - 2z_1\bar{z}_2 - 2\bar{z}_1z_2 + 4\bar{z}_2\bar{z}_2$$

$$= 4 - 2\bar{z}_1z_2 - 2z_1\bar{z}_2 + z_1\bar{z}_1z_2\bar{z}_2$$

$$\Rightarrow |z_1|^2 + 4|z_2|^2 = 4 + |z_1|^2|z_2|^2$$

$$\Rightarrow |z_1|^2 - 4 + 4|z_2|^2 - |z_1|^2|z_2|^2 = 0$$

$$\Rightarrow (|z_1|^2 - 4)(1 - |z_2|^2) = 0$$

$$\Rightarrow |z_1| = 2 \text{ or } |z_2| = 1$$

Given, z_2 is not unimodular

$$\therefore |z_1| = 2$$

\therefore Point z_1 lies on a circle of radius 2.

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Q15. Solution**Correct Answer: (A)**

We know that

$$\text{Mean} = np = 4$$

$$\text{variance} = npq = \frac{4}{3}$$

$$\Rightarrow \frac{n pq}{np} = \frac{\left(\frac{4}{3}\right)}{4}$$

$$\Rightarrow q = \frac{1}{3}$$

$$\Rightarrow p = 1 - \frac{1}{3} = \frac{2}{3}$$

So,

$$np = 4$$

$$\Rightarrow n\left(\frac{2}{3}\right) = 4$$

$$\Rightarrow n = 6$$

Now,

$$P(X = 2) = {}^6C_2(p)^2(q)^4$$

$$\Rightarrow P(X = 2) = \frac{6!}{2! \times 4!} \left(\frac{2}{3}\right)^2 \left(\frac{1}{3}\right)^4$$

$$\Rightarrow P(X = 2) = \frac{60}{3^6}$$

$$\Rightarrow P(X = 2) = \frac{20}{243}$$

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Q16. Solution**Correct Answer: (A)**

For $x \geq 0$, $y = e^{-x}$

$$\frac{dy}{dx} = -e^{-x}$$

The equation of tangent at $M(x, y)$ is

$$Y - y = -e^{-x}(X - x) \dots (1)$$

For x axis $Y = 0$

equation (1) becomes $y = e^{-x}(X - x) \Rightarrow X = ye^x + x$

Similarly for y axis $Y = xe^{-x} + y$

This will intersect coordinate axes at $A(x + ye^x, 0)$ and $B(0, y + xe^{-x})$.

Hence ,

the area of the required triangle AOB is $A = \frac{1}{2}(y + xe^{-x})(x + ye^x)$

$$\Rightarrow A = \frac{1}{2}(1+x)^2 e^{-x} (\because y = e^{-x})$$

$$\text{Now, } \frac{dA}{dx} = \frac{1}{2} \left[-(1+x)^2 e^{-x} + 2(1+x)e^{-x} \right]$$

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

$$\frac{d^2A}{dx^2} = \frac{1}{2} [(1-x^2)(-e^{-x}) + e^{-x}(-2x)]$$

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

for maxima and minima

$$\frac{dA}{dx} = 0 \Rightarrow x = 1, -1$$

at $x = 1$, $\frac{d^2A}{dx^2} = \text{negative}$

Therefore, area will be maximum at $x = 1$

Since slope is positive for $0 \leq x \leq 1$, Also

$$\frac{dA}{dx} > 0, \text{ if } 0 \leq x < 1 \text{ and}$$

$$\frac{dA}{dx} < 0 \text{ if } x \geq 1$$

therefore area of triangle OAB will be maximum at $x = 1$

Hence A is maximum when $x = 1$. So

$$y = e^{-1}.$$

Since y is even function other possibility of M is $(1, e^{-1})$.

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Q17. Solution**Correct Answer: (B)**

First 15 even integers are

2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28 and 30

$$\text{Mean } \bar{x} = \frac{2+4+6+8+\dots+30}{15} = 16$$

$$\text{Median } \tilde{x} = \frac{15+1}{2}^{\text{th term}} = 8^{\text{th term}} = 16$$

$$M_1 = \text{mean deviation about mean} = \frac{\sum_{i=1}^n |x_i - \bar{x}|}{n}$$

$$= \frac{|2-16| + |4-16| + |6-16| + |8-16| + \dots + |30-16|}{15}$$

$$= \frac{14+12+10+8+6+4+2+0+2+4+6+8+10+12+14}{15}$$

$$= \frac{112}{15}$$

$$M_2 = \text{mean deviation about median} = \frac{\sum_{i=1}^n |x_i - \tilde{x}|}{n}$$

$$= \frac{|2-16| + |4-16| + |6-16| + |8-16| + \dots + |30-16|}{15}$$

$$= \frac{14+12+10+8+6+4+2+0+2+4+6+8+10+12+14}{15}$$

$$= \frac{112}{15}$$

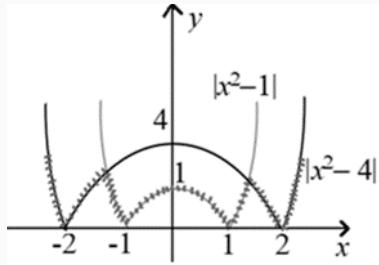
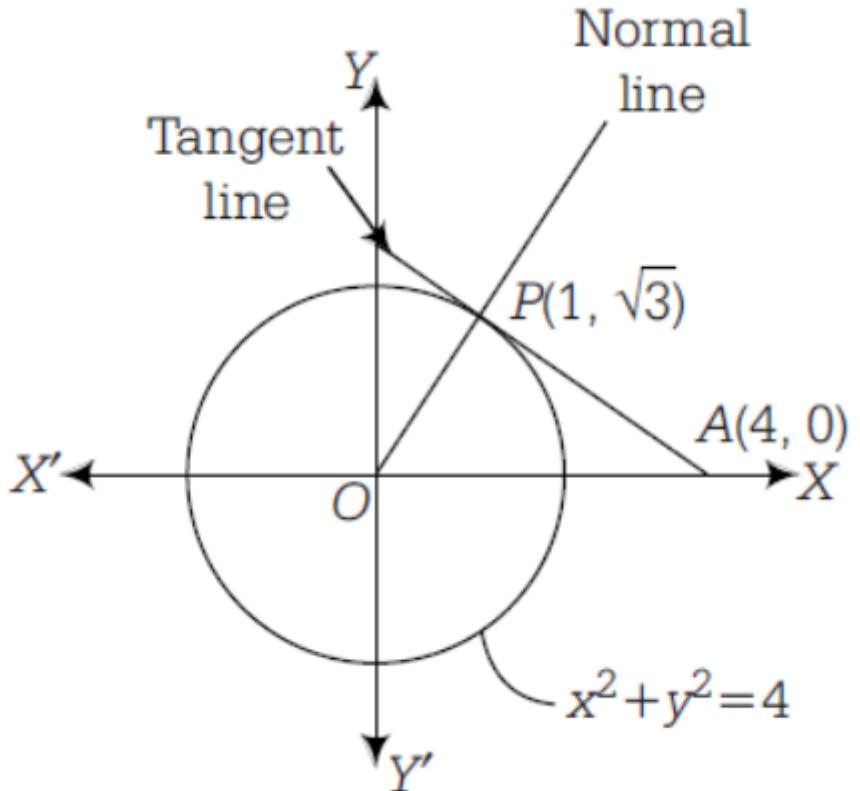
$$\text{So, } M_1 + M_2 = \frac{112}{15} + \frac{112}{15} = \frac{224}{15}$$

\wedge

Q18. Solution**Correct Answer: (A)**

$$\text{Let } I = \int \frac{x^2-1}{x^4+3x^2+1} dx = \int \frac{1-1/x^2}{x^2+3+1/x^2} dx = \int \frac{1-1/x^2}{\left(x^2+\frac{1}{x^2}\right)+3} dx = \int \frac{1-1/x^2}{\left(x+\frac{1}{x}\right)^2-2+3} dx = \int \frac{1-1/x^2}{\left(x+\frac{1}{x}\right)^2+1} dx \text{ Let}$$

$$x + \frac{1}{x} = t \Rightarrow \left(1 - \frac{1}{x^2}\right) dx = dt \Rightarrow I = \int \frac{dt}{t^2+1} = \tan^{-1} t + C = \tan^{-1} \left(x + \frac{1}{x}\right) + C [\because t = x + \frac{1}{x}] \wedge$$

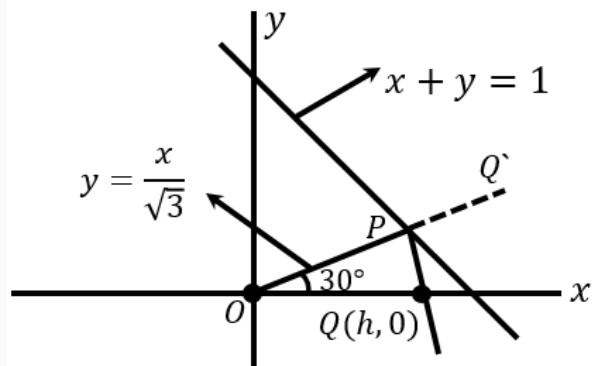
Q19. Solution**Correct Answer: (C)**Using the graph of $y = x^2 - 4$, $y = x^2 - 1$ Clearly, from the graph we can see $f(x)$ is non-differentiable at 6 points. !**Q20. Solution****Correct Answer: (C)**The equations of the tangent and normal to the circle $x^2 + y^2 = 4$ at $P(1, \sqrt{3})$ are $x + \sqrt{3}y = 4$ and $y = \sqrt{3}x$ The tangent meets X -axis at $A(4, 0)$.

$$\therefore \text{Area of } \triangle OAP = \frac{1}{2} \times 4 \times \sqrt{3} = 2\sqrt{3} \text{ sq units ,}$$

Q21. Solution

Correct Answer: (B)

On plotting the diagram of given data we get,



Let $Q(h, 0)$

$\because OP$ reflected by $x + y = 1$

So, the image of Q lies on $y = \frac{x}{\sqrt{3}}$

$$\therefore \frac{x-h}{1} = \frac{y}{1} = \frac{-2(h-1)}{2}$$

$$\Rightarrow x = 1, y = 1 - h$$

Since it lies on $y = \frac{x}{\sqrt{3}}$

$$\therefore 1 - h = \frac{1}{\sqrt{3}}$$

$$\Rightarrow h = 1 - \frac{1}{\sqrt{3}} = \frac{\sqrt{3}-1}{\sqrt{3}}$$

On rationalising the numerator we get,

$$\Rightarrow h = \frac{\sqrt{3}-1}{\sqrt{3}} \times \frac{\sqrt{3}+1}{\sqrt{3}+1}$$

$$\Rightarrow h = \frac{2}{3+\sqrt{3}}$$

Q22. Solution**Correct Answer: (C)**

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

$$y \cos x dx - \sin x dy = y^2 dx$$

$$\frac{ycos x \cdot dx - \sin x \cdot dy}{y^2} = dx$$

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

On integrating, we get,

$$\frac{\sin x}{y} = x + c$$

$$\sin x = xy + cy$$

Q23. Solution**Correct Answer: (D)**

$$\text{As } \vec{a} + \vec{b} = \sqrt{3}$$

Squaring both the sides

$$\vec{a}^2 + \vec{b}^2 + 2\vec{a} \cdot \vec{b} = 3$$

$$1 + 1 + 2 \cdot 1 \cdot 1 \cdot \cos \theta = 3$$

$$2\cos\theta = 1$$

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

$$\theta = 60^\circ$$

\therefore Angle between \vec{a} and \vec{b} is 60°

Now,

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

Squaring both the sides

$$\vec{c}^2 = \vec{a}^2 + 4\vec{b}^2 + 9\vec{a} \times \vec{b}^2 + 4\vec{a} \cdot (\vec{b}) + 3\vec{a} \cdot (\vec{a} \times \vec{b}) + 6\vec{b} \cdot (\vec{a} \times \vec{b})$$

$$\vec{c}^2 = 1 + 4 + 9\sin^2\theta + 4\cos\theta + 0 + 0$$

$$\vec{c}^2 = 5 + 9 \cdot \frac{3}{4} + 4 \cdot \frac{1}{2} = \frac{55}{4}$$

$$\therefore 2\vec{c} = \sqrt{55}$$

Q24. Solution**Correct Answer: (D)**

$\therefore x + y \leq 70$, $x + 2y \leq 100$ and $2x + y \leq 120$ all are satisfied by $(0, 0)$. Hence, we should take common side containing the origin which is represented by fig. 3

Q25. Solution

Correct Answer: (C)

Let $x - [x] = t$

$$\therefore 3t^2 + 2t + a^2 = 0$$

As x is not an integer, $t \neq 0 \therefore a \neq 0$

For a root of x to exist at least one of the roots of t should be between 0 and 1.

$$\begin{aligned} \text{Roots} &= \frac{-2 \pm \sqrt{4 - (4)(-3)a^2}}{-6} \\ &= \frac{-2 \pm \sqrt{4 + 12a^2}}{-6} \\ &= \frac{-1 \pm \sqrt{1 + 3a^2}}{-3} = \frac{1 \mp \sqrt{1 + 3a^2}}{3} \end{aligned}$$

As we observe, one root is surely less than zero,

$$\text{i.e., } \frac{1 - \sqrt{1 + 3a^2}}{3}$$

\therefore For a solution to exist,

$$\frac{1 + \sqrt{1 + 3a^2}}{3} < 1$$

$$\therefore 1 + \sqrt{1 + 3a^2} < 3$$

$$\therefore \sqrt{1 + 3a^2} < 2$$

$$\therefore 1 + 3a^2 < 4$$

$$\therefore 3a^2 < 3$$

$$\therefore a^2 < 1$$

$$\therefore a \in (-1, 0) \cup (0, 1). [\because a \neq 0]$$

Q26. Solution

Correct Answer: (B)

$$\lim_{x \rightarrow 0^+} x^{x^2} = e^{\lim_{x \rightarrow 0^+} x^2 \ln x} = e^L \text{ (say)}$$

$$\begin{aligned} L &= \lim_{x \rightarrow 0^+} \frac{\ln x}{\frac{1}{x^2}} = \lim_{x \rightarrow 0^+} \frac{\frac{1}{x}}{\left(-\frac{2}{x^3}\right)} \text{ (applying L' hospital rule)} \\ &= \lim_{x \rightarrow 0^+} \left(-\frac{x^2}{2}\right) = 0 \end{aligned}$$

$$\text{Hence, } \lim_{x \rightarrow 0^+} x^{x^2} = e^0 = 1$$

$$\text{Similarly, } \lim_{x \rightarrow 0^+} x^x = e^{\lim_{x \rightarrow 0^+} x \ln x} = e^{\lim_{x \rightarrow 0^+} \frac{\ln x}{\frac{1}{x}}}$$

$$= e^{\lim_{x \rightarrow 0^+} \frac{\frac{1}{x}}{\frac{-1}{x^2}}} = e^{\lim_{x \rightarrow 0^+} -x} = e^0 = 1$$

$$\text{Hence, } \lim_{x \rightarrow 0^+} x^{(x^x)} = 0$$

$$\text{Therefore, } \lim_{x \rightarrow 0^+} x^{x^2} + \lim_{x \rightarrow 0^+} x^{(x^x)} = 1$$

Q27. Solution**Correct Answer: (B)**

$$\text{Given, } \tan(\sec^{-1}(\frac{1}{x})) = \sin(\tan^{-1} 2) \Rightarrow \tan\left(\tan^{-1}\frac{\sqrt{1-x^2}}{x}\right) = \sin\left(\sin^{-1}\frac{2}{\sqrt{1+2^2}}\right) \\ (\because \tan^{-1} x = \sin^{-1} \frac{x}{\sqrt{1+x^2}}) \\ \Rightarrow \frac{\sqrt{1-x^2}}{x} = \frac{2}{\sqrt{5}} \\ \Rightarrow \sqrt{5}\sqrt{1-x^2} = 2x \\ \Rightarrow 4x^2 = 5(1-x^2) \\ \Rightarrow x^2 = \frac{5}{9} \\ \Rightarrow x = \frac{\sqrt{5}}{3}$$

Q28. Solution**Correct Answer: (C)**

$$A^3 = A^2 A = (I - 2A)A = A - 2A^2 = A - 2(I - 2A) = 5A - 2I \\ A^4 = A^3 A = (5A - 2I)A = 5A^2 - 2A = 5(I - 2A) - 2A = 5I - 12A \\ A^5 = A^4(A) = (5I - 12A)A = 5A - 12A^2 = 5A - 12(I - 2A) = 29A - 12I$$

Q29. Solution**Correct Answer: (B)**

Given points $A(-1, 2, -3)$, $B(5, 0, -6)$, $C(0, 4, -1)$

Let, the vector AD is the internal bisector of $\angle BAC$, point D lie on the side BC .

$$\text{Now, } AB = \sqrt{(-1-5)^2 + 2^2 + (-3+6)^2} = \sqrt{36+4+9} = 7$$

$$\text{and, } AC = \sqrt{(-1-0)^2 + (2-4)^2 + (-3+1)^2} = \sqrt{1+4+4} = 3$$

We know that, the bisector of angle $\angle BAC$, divides the side BC in ratio $AB : AC$, i.e. $7 : 3$

$$\text{So, the coordinate of } D \text{ is } \left(\frac{3 \times 5 + 7 \times 0}{3+7}, \frac{3 \times 0 + 7 \times 4}{3+7}, \frac{3 \times (-6) + 7 \times (-1)}{3+7} \right) = \left(\frac{3}{2}, \frac{14}{5}, -\frac{5}{2} \right)$$

$$\text{Hence, the vector } \overrightarrow{AD} = \frac{5}{2}\hat{i} + \frac{4}{5}\hat{j} + \frac{1}{2}\hat{k}$$

$$\text{So, the direction cosines are } \frac{\frac{5}{2}}{\sqrt{\left(\frac{5}{2}\right)^2 + \left(\frac{4}{5}\right)^2 + \left(\frac{1}{2}\right)^2}}, \frac{\frac{4}{5}}{\sqrt{\left(\frac{5}{2}\right)^2 + \left(\frac{4}{5}\right)^2 + \left(\frac{1}{2}\right)^2}}, \frac{\frac{1}{2}}{\sqrt{\left(\frac{5}{2}\right)^2 + \left(\frac{4}{5}\right)^2 + \left(\frac{1}{2}\right)^2}}$$

$$\text{i.e. } \frac{25}{\sqrt{714}}, \frac{8}{\sqrt{714}}, \frac{5}{\sqrt{714}}$$

Q30. Solution

Correct Answer: (A)

First term of each sets are $1, 2, 4, 7, \dots$. Let $S = 1 + 2 + 4 + 7 + \dots + T_n$ On subtracting, we get
 $S = 1 + 2 + 4 + \dots + T_n$

$$0 = 1 + 1 + 2 + 3 + \dots - T_n$$

$$T_n = 1 + (1 + 2 + 3 + \dots + (n-1) \text{ terms})$$

$$T_n = 1 + \frac{(n-1)n}{2}$$

$$T_{50} = 1 + \frac{49 \times 50}{2}$$

\Rightarrow First term of 50th set is 1226, therefore series is

$$\therefore T_{50} = 1226$$

$$1226, 1227, \dots 50 \text{ terms } S = \frac{50}{2}[2 \cdot 1226 + 49] = 62525$$

Q31. Solution

Correct Answer: (A)

$$12600 = 2^3 \times 3^2 \times 5^2 \times 7 \text{ Number of divisors which are multiple of 3}$$

$$= (3+1) \cdot 2 \cdot (2+1)(1+1) = 4 \times 2 \times 3 \times 2 \text{ Number of divisors which are multiple of 14}$$

$$\therefore n_1 = 48$$

$$= 3 \times (2+1) \times (2+1) \times 1 = 3 \times 3 \times 3$$

$$\therefore n_2 = 27$$

$$\text{Total} = n_1 + n_2 = 48 + 27 = 75.$$

Q32. Solution

Correct Answer: (B)

$$2\sin^2\theta - \cos 2\theta = 0 \Rightarrow 2\sin^2\theta - (1 - 2\sin^2\theta) = 0 \Rightarrow 2\sin^2\theta - 1 + 2\sin^2\theta = 0$$

$$\Rightarrow 4\sin^2\theta = 1 \Rightarrow \sin\theta = \pm\frac{1}{2} \therefore \theta = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}, \theta \in [0, 2\pi] \therefore \theta = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$$

$$\text{Now } 2\cos^2\theta - 3\sin\theta = 0$$

$$\Rightarrow 2(1 - \sin^2\theta) - 3\sin\theta = 0$$

$$\Rightarrow -2\sin^2\theta - 3\sin\theta + 2 = 0$$

$$\Rightarrow -2\sin^2\theta - 4\sin\theta + \sin\theta + 2 = 0 \quad \text{But } \sin\theta = -2, \text{ is not possible} \therefore \sin\theta = \frac{1}{2}, \Rightarrow \theta = \frac{\pi}{6}, \frac{5\pi}{6}$$

$$\Rightarrow 2\sin^2\theta - \sin\theta + 4\sin\theta - 2 = 0$$

$$\Rightarrow \sin\theta(2\sin\theta - 1) + 2(2\sin\theta - 1) = 0$$

$$\Rightarrow \sin\theta = \frac{1}{2}, -2$$

Hence, there are two common solution, there each of the statement-1 and 2 are true but statement- 2 is not a correct explanation for statement-1.

Q33. Solution

Correct Answer: (A)

$$2 \quad 2a \quad a$$

$$2 \quad 3b \quad b = 0$$

$$2 \quad 4c \quad c$$

$$1 \quad 2a \quad a$$

$$1 \quad 3b \quad b = 0$$

$$1 \quad 4c \quad c$$

$$(3bc - 4bc) - (2ac - 4ac) + (2ab - 3ab) = 0$$

$$-bc + 2ac - ab = 0$$

$$ab + bc = 2ac$$

a, b, c in H.P.

$\Rightarrow \frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ in A.P.

Q34. Solution

Correct Answer: (D)

Given Boolean expression: $\sim(p \vee q) \vee (\sim p \wedge q)$ Step 1: Apply De Morgan's Law: $\sim(p \vee q) = \sim p \wedge \sim q$ So expression becomes: $(\sim p \wedge \sim q) \vee (\sim p \wedge q)$ Step 2: Distribute $\sim p$:

$$\begin{aligned} & \sim p \wedge (\sim q \vee q) \\ (\sim q \vee q) &= \text{True} \Rightarrow \sim p \wedge \text{True} = \sim p \end{aligned}$$

Final Answer: (d) $\sim p$

Q35. Solution

Correct Answer: (B)

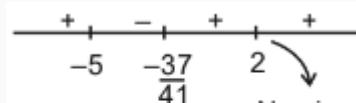
Coefficient of x^{10} in the given expansion

$$\begin{aligned} &= {}^{15}C_{10} + {}^{16}C_{10} + {}^{17}C_{10} + \dots + {}^{30}C_{10} \\ &= \left({}^{10}C_{10} + {}^{11}C_{10} + \dots + {}^{14}C_{10} + {}^{15}C_{10} + \dots + {}^{30}C_{10} \right) - \left({}^{10}C_{10} + {}^{11}C_{10} + \dots + {}^{14}C_{10} \right) \\ &= {}^{31}C_{11} - {}^{15}C_{11} \end{aligned}$$

Q36. Solution

Correct Answer: (C)

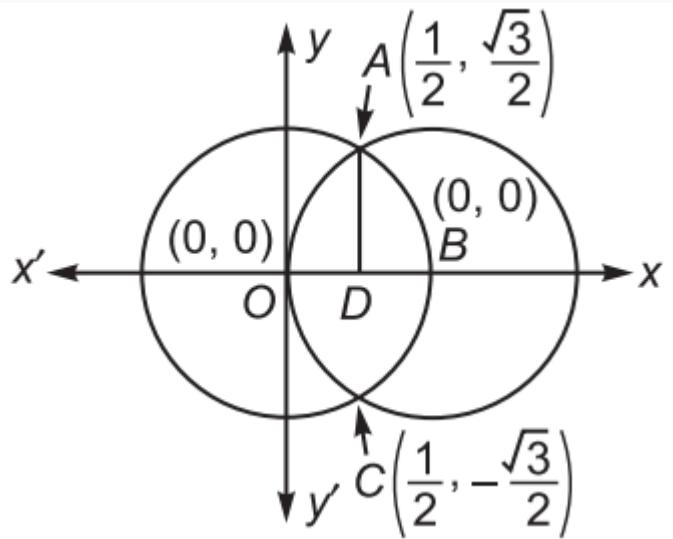
$$\begin{aligned} f(x) &= (x - 2)^{17}(x + 5)^{24} \\ \Rightarrow f'(x) &= 17(x - 2)^{16}(x + 5)^{24} + 24(x - 2)^{17}(x + 5)^{23} \\ &= (x - 2)^{16}(x + 5)^{23}(17x + 85 + 24x - 48) \\ &= (x - 2)^{16}(x + 5)^{23}(41x + 37) \end{aligned}$$



No sign change at $x = 2$
 $\Rightarrow f(x)$ has neither a maximum nor a minimum at $x = 2$

Q37. Solution

Correct Answer: (D)



Intersection point of two circles

$$x^2 + y^2 = 1 \dots \text{(i)} \quad (x-1)^2 + y^2 = 1 \dots \text{(ii)}$$

(ii) is given by $(x-1)^2 + (1-x^2) = 1$

$$\Rightarrow x^2 + 1 - 2x - x^2 = 0 \Rightarrow x = \frac{1}{2}$$

From Eq. (i), $\frac{1}{4} + y^2 = 1 \Rightarrow y^2 = 1 - \frac{1}{4} \Rightarrow y = \pm \frac{\sqrt{3}}{2}$

Point $A\left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$ and $C\left(\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$ So, Area of region $OABC$ = $2 \times$ Area of region $OABDO$

$$= \text{Area of } OADO + \text{Area of } ABDA = \int_0^{1/2} \sqrt{1-(x-1)^2} dx + \int_{1/2}^1 \sqrt{1-x^2} dx$$

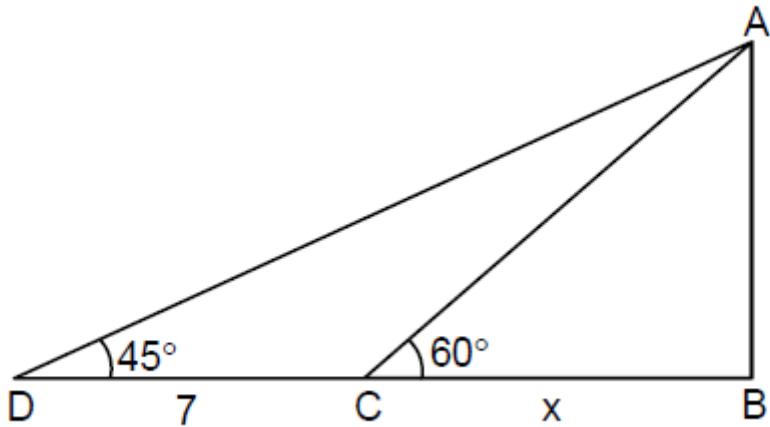
$$= \left[\frac{1}{2} \cdot (x-1) \sqrt{1-(x-1)^2} + \frac{1}{2} \sin^{-1} \left(\frac{x-1}{1} \right) \right]_0^{1/2} + \left[\frac{1}{2} x \sqrt{1-x^2} + \frac{1}{2} \sin^{-1} \left(\frac{x}{1} \right) \right]_{1/2}^1$$

$$= \left[-\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{\sqrt{3}}{2} + \frac{1}{2} \sin^{-1} \left(\frac{-1}{2} \right) - \frac{1}{2} \cdot 0 - \frac{1}{2} \sin^{-1}(-1) \right] + \left[\frac{1}{2} \cdot 0 + \frac{1}{2} \sin^{-1}(1) - \frac{1}{4} \cdot \frac{\sqrt{3}}{2} - \frac{1}{2} \sin^{-1} \left(\frac{1}{2} \right) \right]$$

$$= \left(-\frac{\sqrt{3}}{8} \right) - \frac{1}{2} \sin^{-1} \left(\frac{1}{2} \right) + \frac{1}{2} \sin^{-1}(1) + \frac{1}{2} \sin^{-1}(1) - \frac{\sqrt{3}}{8} - \frac{1}{2} \sin^{-1} \left(\frac{1}{2} \right) = \sin^{-1}(1) - \sin^{-1} \left(\frac{1}{2} \right) - \frac{\sqrt{3}}{4}$$

$$= \frac{\pi}{2} - \frac{\pi}{6} - \frac{\sqrt{3}}{4} = \left(\frac{\pi}{3} - \frac{\sqrt{3}}{4} \right)$$

from Eq. (i), Area of region $OABC$ = $2 \times \left(\frac{\pi}{3} - \frac{\sqrt{3}}{4} \right) = \left(\frac{2\pi}{3} - \frac{\sqrt{3}}{2} \right)$

Q38. Solution**Correct Answer: (B)**

$$BD = AB = 7 + x$$

$$\text{Also } AB = x \tan 60^\circ = x\sqrt{3}$$

$$\therefore x\sqrt{3} = 7 + x$$

$$x = \frac{7}{\sqrt{3} - 1}$$

$$AB = \frac{7\sqrt{3}}{2}(\sqrt{3} + 1)$$

Q39. Solution**Correct Answer: (B)**

$\frac{1}{2}, \frac{1}{h_1}, \frac{1}{h_2}, \dots, \frac{1}{h_{20}}, \frac{1}{6}$ are in A.P.

$$\Rightarrow \frac{1}{6} = \frac{1}{2} + 21d \Rightarrow \frac{\frac{1}{6} - \frac{1}{2}}{21} = d$$

$$\Rightarrow d = -\frac{1}{63}$$

$$\Rightarrow \frac{1}{h_{18}} = \frac{1}{2} + 18d = \frac{1}{2} + 18 \left(-\frac{1}{63} \right) = \frac{1}{2} - \frac{2}{7}$$

$$\frac{1}{h_{18}} = \frac{3}{14} \Rightarrow h_{18} = \frac{14}{3}$$

Also, $2, a_1, a_2, \dots, a_{20}, 6$ are in A.P.

$$\Rightarrow 6 = 2 + 21D \Rightarrow D = \frac{4}{21}$$

$$\Rightarrow a_3 = 2 + 3D = 2 + 3 \times \frac{4}{21} = \frac{18}{7}$$

$$\Rightarrow a_3 h_{18} = \frac{18}{7} \times \frac{14}{3} = 12$$

Q40. Solution**Correct Answer: (D)**

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

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

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

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

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

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

(iii) Case-3: without 3 and 2 or 4 at ones place

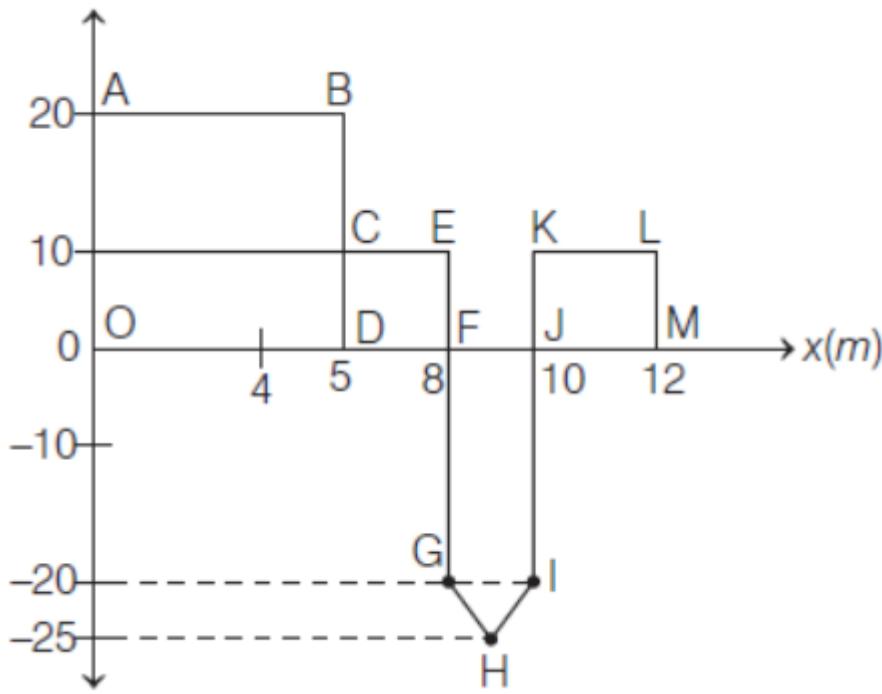
$$\underline{\quad} \underline{\quad} \underline{\quad} \underline{2/4} \Rightarrow 3 \times 3 \times 2 \times 1 \times 2 = 36$$

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

Q41. Solution

Correct Answer: (C)

The area under the force displacement curve give the amount of work done.



$$W = \Delta KE$$

∴ At $x = 8 \text{ m}$,

$$W = \text{Area ABDO} + \text{Area CEF}$$

$$= 20 \times 5 + 10 \times 3 = 130 \text{ J} \quad \dots (i)$$

Using Eq. (i)

$$\Rightarrow 130 = \frac{1}{2}mv^2 = \frac{1}{2} \times \frac{500}{1000}v^2$$

$$\Rightarrow v = 2\sqrt{130} = 22.8 \text{ ms}^{-1} \approx 23 \text{ ms}^{-1}$$

At $x = 12 \text{ m}$

$$W = \text{Area ABDO} + \text{Area CEF} + \text{Area FGHIJ}$$

From work-energy theorem, + Area KLMJ

$$W = 20 \times 5 + 10 \times 3 + (-20 \times 2) + \left(\frac{1}{2} \times -5 \times 2 \right)$$

$$+ 10 \times 2 \quad [\because \text{Area FGHIJ} = \text{Area FGIJ} + \text{Area GHI}]$$

$$= 100 + 30 - 40 - 5 + 20 = 105 \text{ J}$$

Using Eq. (i)

$$\therefore 105 = \frac{1}{2} \times \frac{1}{2} \times v^2$$

$$\Rightarrow v = 2\sqrt{105} \simeq 20.6 \text{ ms}^{-1}$$

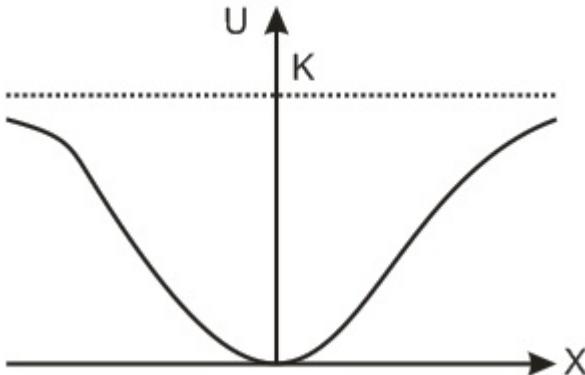
Q42. Solution

Correct Answer: (D)

$$U(x) = k \left(1 - e^{x^2}\right)$$

It is an exponentially increasing graph of potential energy (U) with x^2 . Therefore, U versus x graph will be as shown. At origin.

Potential energy U is minimum (therefore, kinetic energy will be maximum) and force acting on the particle is zero because



$$F = -\frac{dU}{dx}$$

$$= -(\text{slope of } U - x \text{ graph}) = 0.$$

Therefore, origin is the stable equilibrium position. Hence, particle will oscillate simple harmonically about $x = 0$ for small displacements. Therefore, correct option is (For small displacements from $x = 0$, the motion is simple harmonic).

(At points away from the origin, the particle is in unstable equilibrium), (For any finite non-zero value of x, there is a force directed away from the origin) and (If its total mechanical energy is $k/2$ it has its minimum kinetic energy at the origin) options are wrong due to following reasons,

(At points away from the origin, the particle is in unstable equilibrium) At equilibrium position $F = -\frac{dU}{dx}$

$$= 0 \text{ the slope of } U - x$$

graph should be zero and from the graph we can see that slope is zero at $x = 0$ and $x = \pm\infty$.

Now among these equilibriums stable equilibrium position is that where U is minimum (Here $x = 0$). Unstable equilibrium position is that where U is maximum (Here none).

Neutral equilibrium position is that where U is constant (Here $x = \pm\infty$).

Therefore, option ((At points away from the origin, the particle is in unstable equilibrium)) is wrong.

(For any finite non-zero value of x, there is a force directed away from the origin) For any finite non-zero value of x, force is directed towards the origin because origin is in stable equilibrium position. Therefore, option ((For any finite non-zero value of x, there is a force directed away from the origin)) is incorrect

(If its total mechanical energy is $k/2$ it has its minimum kinetic energy at the origin) At origin, potential energy is minimum, hence kinetic energy will be maximum. Therefore, option ((If its total mechanical energy is $k/2$ it has its minimum kinetic energy at the origin)) is also wrong

Q43. Solution

Correct Answer: (C)

$$\begin{aligned} P + \frac{1}{2}\rho V^2 &= P_0 + \frac{1}{2}\rho v^2 \\ \left[\frac{F}{A} + P_0 \right] + \frac{1}{2}\rho V^2 &= P_0 + \frac{1}{2}\rho v^2 \\ \frac{F}{A} + \frac{1}{2}\rho \left[\frac{av}{A} \right]^2 &= \frac{1}{2}\rho v^2 \\ \frac{F}{A} &= \frac{1}{2}\rho v^2 \left[1 - \frac{a^2}{A^2} \right] \end{aligned}$$

$$v = \sqrt{\frac{2F}{\rho A \left[1 - \frac{a^2}{A^2} \right]}}$$

$$a^2 \ll A^2 \quad v = \sqrt{\frac{2F}{\rho A}}$$

Q44. Solution

Correct Answer: (B)



According to law of conservation of linear momentum,
total momentum before collision = total momentum after collision

Here $m_1 = m_2 = m = M$,

$$\Rightarrow mv_1 - mv_2 = 0 \dots (1)$$

where v_1 – final velocity of m

v_2 – final velocity of M

from the definition of coefficient of restitution, $e = \frac{v_2 - v_1}{u_1 - u_2}$

$$\Rightarrow \frac{v_1 + v_2}{2u} = \frac{1}{3} \dots (2)$$

from equations (1) and (2), we get,

$$\Rightarrow v_1 = \frac{u}{3}, \quad v_2 = \frac{u}{3}$$

$$(K.E.)_{in} = 2\left(\frac{1}{2}mu^2\right) = mg\ell$$

$$(K.E.)_{final} = 2\left(\frac{1}{2}m\frac{u^2}{9}\right) = \frac{mu^2}{9}$$

$$\text{Let height attained by A after collision is } \ell' \Rightarrow mg\ell' = \frac{mu^2}{9} \Rightarrow \ell' = \frac{\ell}{9}$$

Q45. Solution**Correct Answer: (A)**

A) In the process of lifting a bucket from a well, the man does positive work, as the force and displacement are in the same direction. B) In the process of lifting a bucket from a well, gravitational force does negative work, as the force and displacement are in opposite directions. C) Friction does negative work on a block sliding down an incline, as it acts opposite to the motion. D) Work done by the applied force is non-zero, as it balances friction to maintain uniform velocity. E) Air resistance does negative work on an oscillating pendulum, as it acts opposite to the direction of motion.

Q46. Solution**Correct Answer: (C)**

$$\text{In hydrogen atom } E_n = -\frac{Rhc}{n^2}$$

where m is the mass of the electron. Here, the electron has been replaced by a particle whose mass is double of an electron. Therefore, energy in n^{th} orbit for this hypothetical atom will be given by

$$E_n = -\frac{2Rhc}{n^2}$$

The longest wavelength λ_{\max} (or minimum energy) photon will correspond to the transition of the particle from $n = 3$ to $n = 2$

$$\frac{hc}{\lambda_{\max}} = E_3 - E_2 = 2Rhc \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$$

$$\text{This gives, } \lambda_{\max} = \frac{18}{5R}$$

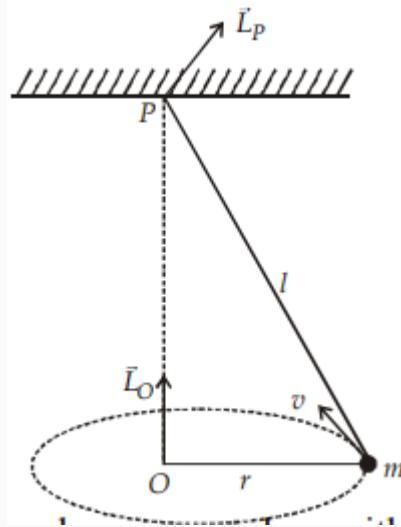
Q47. Solution**Correct Answer: (C)**

When blue glass is heated at high temperature, it absorbs all the radiation of higher wavelength except blue. If it is taken inside a dimly-lit room, it emits all the radiation of higher wavelength, hence it looks brighter as compared to the red piece.

Q48. Solution

Correct Answer: (C)

For all locations of m the angular momentum of the mass m about O i.e., L_o is $mr^2\omega$ and is directed toward $+z$ direction. The angular momentum of mass m about P i.e., L_p is mvl and is directed for the given location of m as shown in the figure. For different location of m , the direction of \vec{L}_P remains changing.



Q49. Solution

Correct Answer: (D)

To convert pulsating dc into steady dc both of mentioned method are correct.

Q50. Solution

Correct Answer: (B)

A spherometer is a device that does just as the name suggests: it measures a sphere. But what exactly would you measure on a sphere? You could measure its diameter or the circumference of a great circle, the surface area, or the radius. But all of these measurements will change proportionally to the radius R of the sphere. Any surface that is curved has a radius of curvature, the radius of the sphere that approximates the surface locally. Thus, a spherometer can measure the radius of curvature of an item such as a lens and curved mirrors that are spherical.

Q51. Solution

Correct Answer: (D)

In the P-V indicator diagram, the processes B to C and D to A are isochoric, i.e., while going from B to C and going from D to A, the volume does not change, i.e.,

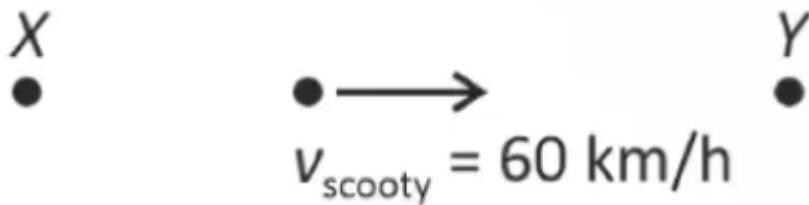
$$V = \text{constant}$$

Therefore,

$$dV = 0$$

$$\Rightarrow dW = PdV = 0$$

So, work is not done in B to C and D to A

Q52. Solution**Correct Answer: (A)**

$X \rightarrow Y$ Let velocity of bus = v km/hr Relative velocity of bus w.r.t. scooty = $(v - 60)$ Distance between 2

$$(v - 60)30 = vT \quad \dots (1)$$

$$(v - 60)30 = (v + 60)10$$

consecutive buses = vT $Y \rightarrow X$

Equating (1) and (2) $\therefore v = 120$ km/hr

$$(v + 60)10 = vT \quad \dots (2)$$

$$T = 15 \text{ min}$$

Q53. Solution**Correct Answer: (B)**

- A. Microwaves → IV. Aircraft navigation (Microwaves are used in radar systems, essential in aircraft navigation)
 - B. UV rays → III. Lasik eye surgery (Excimer lasers using UV rays are used in Lasik surgery)
 - C. Infra-red rays → I. Physiotherapy (Infrared rays are commonly used in heat therapy for pain relief)
 - D. X-rays → II. Treatment of cancer (X-rays, especially high-energy ones, are used in radiotherapy for cancer treatment)
- Correct match: Option (2): A-IV, B-III, C-I, D-II

Q54. Solution**Correct Answer: (B)**

Average intensity along the string

$$\langle I \rangle = 2\pi^2 f^2 A^2 \rho v$$

$$\frac{I_1}{I_2} = \left(\frac{f_1 A_1}{f_2 A_2} \right)^2 = \left(\frac{T_2 A_1}{T_1 A_2} \right)^2 = \left(\frac{1}{2} \times 3 \right)^2 = \frac{9}{4}$$

Q55. Solution**Correct Answer: (B)**

$$1 \text{ AU} = 1.496 \times 10^{11} \text{ m}$$

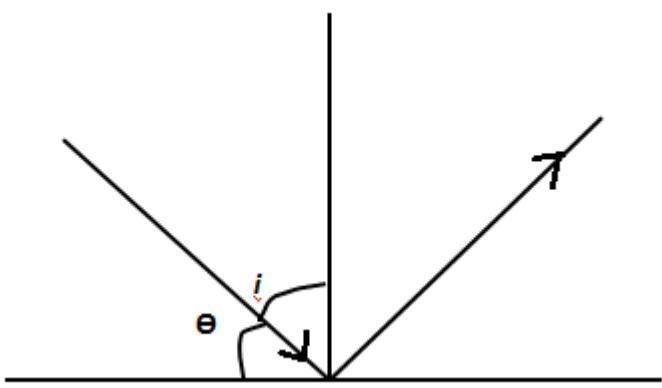
$$1 \text{ par sec} = 3.08 \times 10^{16} \text{ m} \quad \text{So, Au} < \text{ly} < \text{Per sec}$$

$$1 \text{ light year} = 9.46 \times 10^{15} \text{ m}$$

Q56. Solution

Correct Answer: (D)

Bragg's relation $n\lambda = 2d \sin\theta$ for having an intensity maximum for diffraction pattern.



But as the angle of incidence is given,

$n\lambda = 2d \cos i$ is the formula for finding a peak.

Q57. Solution

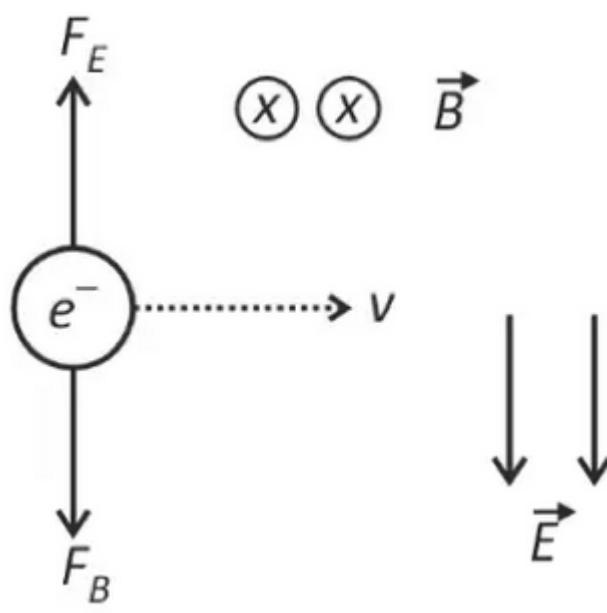
Correct Answer: (D)

According to Gauss law,

$$\Rightarrow \phi = \int \vec{E} \cdot d\vec{S} = \frac{q_{\text{enclosed}}}{\epsilon_0}.$$

Total electric flux will be,

$$\phi = \frac{\sigma \times \text{Area}_{\text{enclosed}}}{\epsilon_0} = \frac{\sigma \pi (R^2 - x^2)}{\epsilon_0}.$$

Q58. Solution**Correct Answer: (C)**

For no deflection of electron, $\vec{F}_B = \vec{F}_E$

$$-e(\vec{v} \times \vec{B}) = -e\vec{E}$$

$$\Rightarrow \vec{E} = \vec{v} \times \vec{B} \Rightarrow \vec{E} \perp \vec{B}$$

$$E = vB = \frac{c}{100} \times 9 \times 10^{-4}$$

$$= \frac{3 \times 10^8}{100} \times 9 \times 10^{-4}$$

$$= 27 \times 10^2 \text{ V m}^{-1}$$

Q59. Solution**Correct Answer: (B)**

Modulation is the phenomenon of superimposing a low audio frequency information signals (called the modulation signals) on a high-frequency wave (called, the carrier wave). When we modulate the amplitude of the carrier wave to transmit the information, it is known as amplitude modulation.

Q60. Solution**Correct Answer: (A)**

$$t_{\text{rough}} = 2t_{\text{smooth}}$$

$$a_{\text{smooth}} = g \sin \theta$$

$$t \propto \frac{1}{\sqrt{a}} \Rightarrow t_{\text{smooth}} \propto \frac{1}{\sqrt{g \sin \theta}}$$

$$a_{\text{rough}} = g \sin \theta - \mu_k g \cos \theta$$

$$\frac{t_{\text{rough}}}{t_{\text{smooth}}} = \frac{\sqrt{\sin \theta}}{\sqrt{\sin \theta - \mu_k \cos \theta}} = 2$$

$$\frac{\sin \theta}{\sin \theta - \mu_k \cos \theta} = 4 \Rightarrow \frac{\frac{1}{\sqrt{2}}}{\frac{1}{\sqrt{2}} - \mu_k \times \frac{1}{\sqrt{2}}} = 4$$

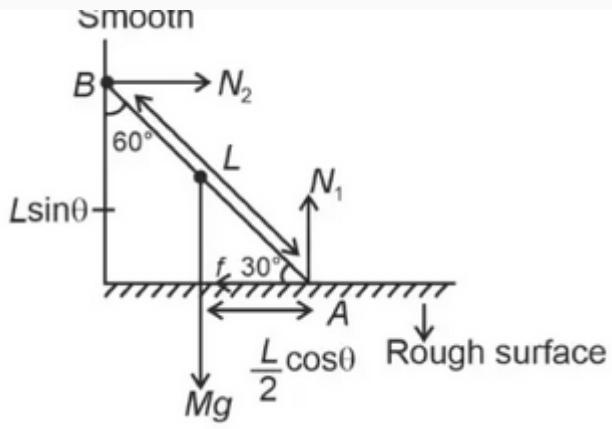
$$\text{Squaring both sides } \Rightarrow 1 - \mu_k = \frac{1}{4}$$

$$\begin{aligned} \mu_k &= \frac{3}{4} \\ &= 0.75 \end{aligned}$$

Q61. Solution**Correct Answer: (B)**

At a given temperature, molecules of gas may have speeds in a range of zero to infinity. The Maxwell's distribution curve is $(\frac{dN}{dv})$ vs (v) curve. (N) is the total number of molecules of a gas and (v) is speed of a molecule at a given temperature. The maxima of the curve give the most probable speed of the molecules of gas. Root mean square speed gives a general idea about the speed of a molecule. The area under the Maxwell's curve gives the total number of molecules of the gas and is given as:

$$N = \int_0^{\infty} \frac{dN}{dv} dv$$

Q62. Solution**Correct Answer: (C)**

For translational equilibrium $\frac{Mg}{2} \cot \theta = N_2 = f$ For rotational equilibrium Torque about $A, Mg \frac{L}{2} \cos \theta = N_2 L \sin \theta$

$$\frac{Mg}{2} \cot \theta = N_2 = f$$

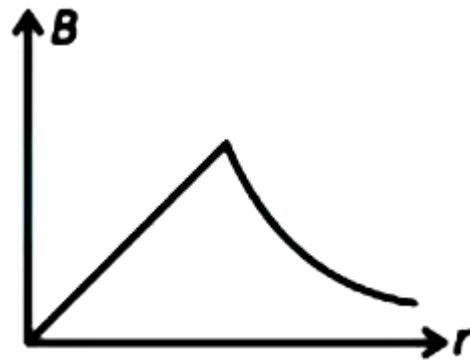
$$\frac{Mg}{2} \cot 30^\circ = f$$

$$\frac{Mg}{2} \sqrt{3} = N_2$$

$$100\sqrt{3} = f$$

Q63. Solution**Correct Answer: (C)**

Let the surface charge density be $\sigma = q/A$ Given $dq/dt = \text{constant} \Rightarrow d/dt(q/A) = \text{constant}$
 $\Rightarrow (1/A) \times dq/dt = \text{constant}$ It means displacement current is constant. This system will act like a cylindrical



wire. The graph of magnetic field (B) vs radius (r) is:

Q64. Solution**Correct Answer: (C)**

We know frequency of a closed end an column $n_1 = \frac{v}{4l_1}$ We know frequency of a open end an column $n_2 = \frac{v}{2l_2}$ Given, $l_1 = 32 \text{ cm}$, $I_2 = 66 \text{ cm}$ and $n_1 - n_2 = 8 \text{ heat /s}$ So, $n_1 = \frac{v}{4 \times 32} = \frac{v}{128}$ and

$$\frac{v}{128} - \frac{v}{132} = 8$$

$$v = 8448 \times 4$$

$$v = 33792$$

$$\text{Hence, } n_1 = \frac{33792}{128}$$

$$n_2 = \frac{v}{2 \times 66} = \frac{v}{132} \text{ In given condition, } n_1 = 264 \text{ Hz}$$

and

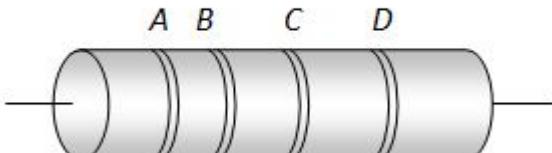
$$n_2 = \frac{33792}{132}$$

$$n_2 = 256 \text{ Hz}$$

Q65. Solution**Correct Answer: (C)**

Colour band *A* and *B* indicate the first two significant figures of resistance in "ohm", while the *C* band gives the decimal multiplier i.e., the number of zeros that follows the two significant figures *A* and *B*.

The last band *D* indicates the tolerance in percentage about the indicated value or in another word it represents the percentage accuracy of the indicated value.



According to given color-coding, the values of colors are

Green \rightarrow 5, Black \rightarrow 0 Red \rightarrow 10^2 Silver \rightarrow 10% tolerance

so, resistance is $R = 50 \times 10^2 \pm 10\%$

The maximum current is

$$I^2R = P$$

$$I^2 = \frac{2}{50 \times 10^2} = 4 \times 10^{-4} \text{ A}$$

$$I = 2 \times 10^{-2} \text{ A} = 20 \text{ mA}$$

Q66. Solution**Correct Answer: (D)**

Sample *X* is undoped. Sample *Y* is pentavalent as energy level is close to conduction band. Sample *Z* is trivalent as energy level is close to valence band.

Q67. Solution**Correct Answer: (C)**

(a) \rightarrow p, q (b) \rightarrow p, r (c) \rightarrow p, s (d) \rightarrow p, q, r

Q68. Solution**Correct Answer: (D)**

From the work-energy theorem, the total energy of the satellite will be conserved, and it is given by the following relation,

$$dK = -dU + W_{\text{air friction}}$$

$W_{\text{air friction}} = -\frac{GMm}{2R^2} \times \Delta R$; will be the correct answer.

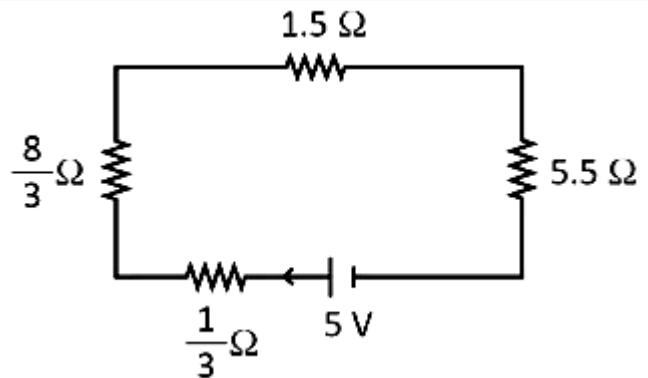
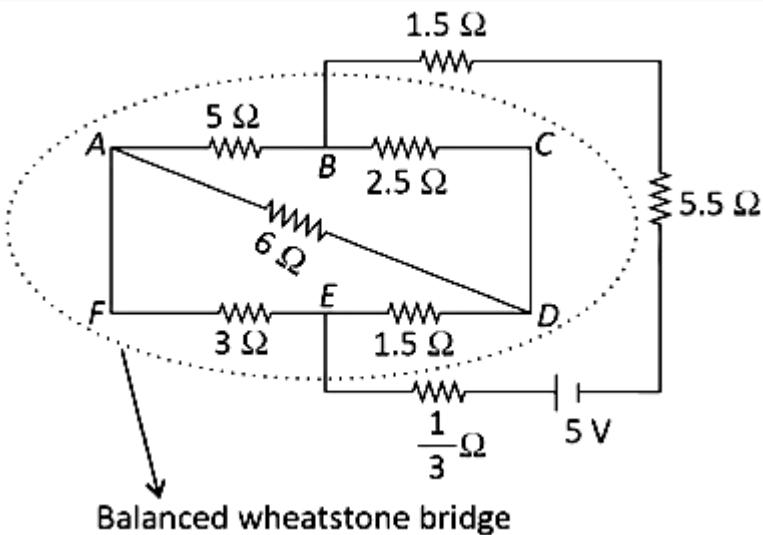
Q69. Solution**Correct Answer: (A)**

Statement (C) is correct because, the magnetic field outside the toroid is zero and they form closed loops inside the toroid itself. Statement (E) is correct because we know that superconductors are materials inside which the

$$\mu_r = 1 + \chi$$

net magnetic field is always zero and they are perfect diamagnetic. $\chi = -1$ For superconductors.

$$\mu_x = 0$$

Q70. Solution**Correct Answer: (C)**

\therefore its equivalent $R' = \frac{4 \times 8}{12} = \frac{8}{3} \Omega$ Circuit can be redrawn as

$$R_{\text{eq}} = \frac{8}{3} + \frac{1}{3} + 1.5 + 5.5 \\ = 10 \Omega$$

$$i = \frac{V}{R_{\text{eq}}} = \frac{5}{10} = 0.5 \text{ A}$$

Q71. Solution**Correct Answer: (A)**at t=0, P₀ 0 0at t=30 min. (P₀-x) 2x $\frac{x}{2}$ at t=60 min. (P₀-y) 2y $\frac{y}{2}$

$$\therefore P_0 = 50\text{mmHg}$$

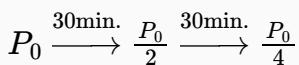
$$\therefore \text{after 30 min.} \Rightarrow (P_0 - x) + 2x + \frac{x}{2} = 87.5$$

$$P_0 + \frac{3}{2}x = 87.5$$

$$\frac{3}{2}x = 37.5; x = 25\text{mmHg}$$

$$P_0 = 50; P_{30\text{min}} = 25\text{mmHg}$$

That mean 30 min. is Half life of reaction.



at t= 60 min

$$P_{N_2O_5} = \frac{P_0}{4} \Rightarrow \frac{50}{4} = 12.5\text{mmHg}$$

$$P_0 - y = 12.5 \Rightarrow 50 - y = 12.5$$

$$y = 37.5\text{mmHg}$$

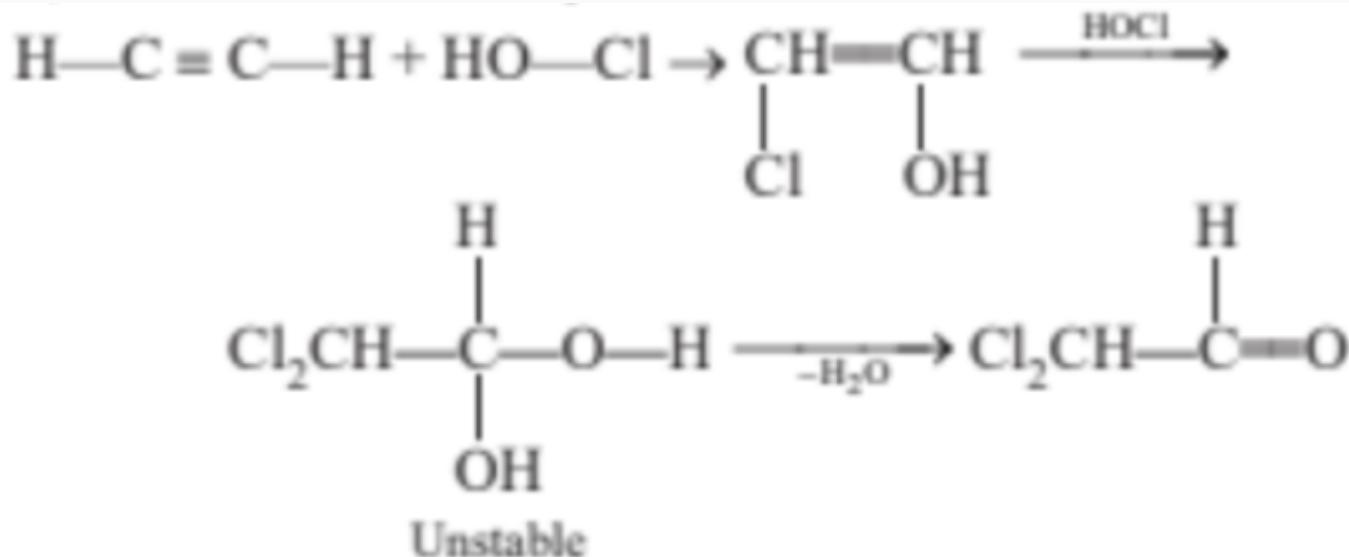
$$\text{Total P after 60 min.} \Rightarrow (P_0 - y) + 2y + \frac{y}{2} \Rightarrow 50 \times \frac{3}{2} \times 37.5$$

$$= 106.25\text{mmHg}$$

Q72. Solution**Correct Answer: (D)**

Aspirin is a non-narcotics analgesic . Rest are correct facts about aspirin.

Q73. Solution**Correct Answer: (C)**For the first reaction $6KOH + 3I_2 \rightarrow 5KI + KIO_3 + 3H_2O$ 3 mole I₂ gives = 1 moles KIO₃ 1 mole I₂ gives = $\frac{1}{3}$ moles KIO₃ Therefore, option (3) is the correct answer.

Q74. Solution**Correct Answer: (D)****Q75. Solution****Correct Answer: (A)**

The electrostatic precipitator is based on the principle of attraction of opposite charges.

The particulate matter is introduced to a chamber with a high negative voltage, which negatively charges ions. These ions collide with the particulate matter and transfer the charge, making them negatively charged. Now, these charged particles are attracted to the positively charged electrode and are collected on it.

Electrostatic precipitators apply energy only to the particulate matter without impeding the flow of gases.

Q76. Solution**Correct Answer: (A)**

Spectrochemical series: A list of ligands ordered in ligand strength and a list of metal ions based on oxidation number, group, and identity.

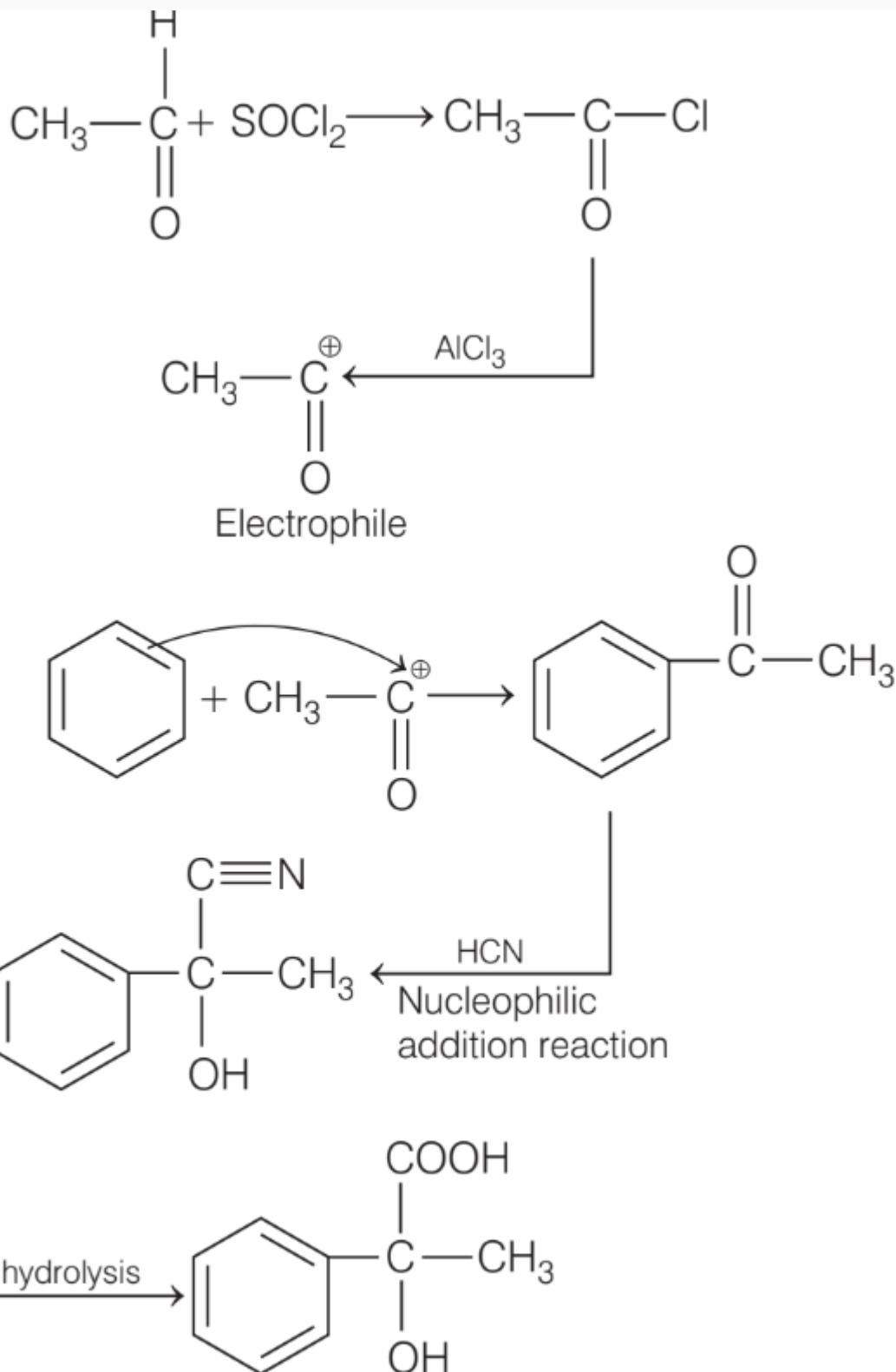
Using the concept of spectrochemical series, the ligands arranged in increasing order of crystal field strength are,



If in a complex, at least one ligand is strong field ligand, in this case, all ligands are considered as strong field ligand.

Q77. Solution

Correct Answer: (D)



Hence, option (d) is correct.

Q78. Solution**Correct Answer: (D)**

Comparing the slope and intercept of the given equation with the following Arrhenius equation :

$$\log k = -\frac{E_a}{2303RT} + \log A \text{ Hence, } \log A = 6 \text{ i.e. } A = 10^6 \text{ s}^{-1}$$

Q79. Solution**Correct Answer: (B)**

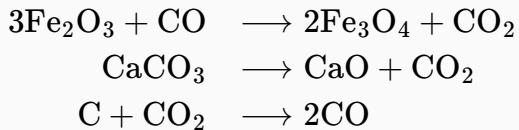
Gutta-Percha is a trans-1, 4-polyisoprene polymer. As this is trans in nature, it has zig-zag chains fitting. Natural rubber is cis-1, 4-polyisoprene polymer. Therefore, Gutta-Percha is a geometrical isomer of natural rubber. It is not elastic in nature.

Q80. Solution**Correct Answer: (A)**

The correct IUPAC name for the given compound is Spiro[2.2]pentane. Therefore, the answer is option 1.

Q81. Solution**Correct Answer: (C)**

Bordeaux mixture consists of copper sulphate (CuSO_4) and lime [$\text{Ca}(\text{OH})_2$].

Q82. Solution**Correct Answer: (C)**

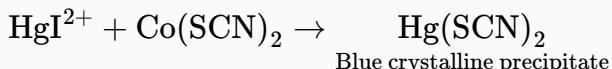
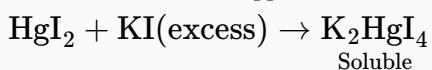
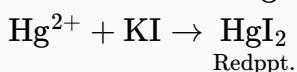
The reaction takes place in blast furnace are $\text{CaO} + \text{SiO}_2 \longrightarrow \text{CaSiO}_3$ in blast furnace.



thence, the action

**Q83. Solution****Correct Answer: (B)**

Here metal ion is Hg^{2+} and the reactions are as follows



Q84. Solution**Correct Answer: (A)**

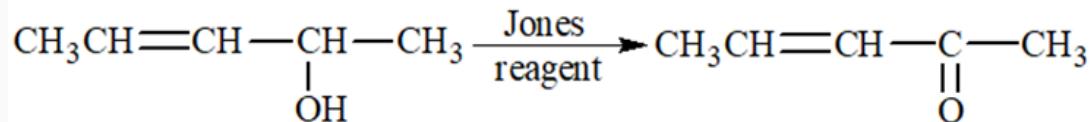
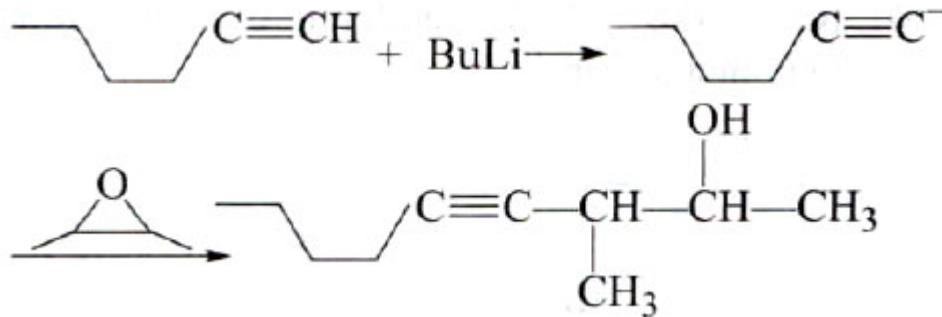
Enthalpy of neutralization of strong acid and strong base is -13.7 kcal/mol

$$\Delta H = -13.7 + 0.7$$

$$= -13.0 \text{ kcal}$$

Q85. Solution**Correct Answer: (B)**

Jones reagent oxidises 1° alcohol to aldehyde further it oxidised in carboxylic acid and 2° alcohols to ketones without affecting C = C doubled bond.

**Q86. Solution****Correct Answer: (D)****Q87. Solution****Correct Answer: (C)**

As A approaches BC, a strong repulsion between any filled shells of electrons will develop between the two species.

Because the like charges repel and as the shells are filled, charge density will be high and more repulsion.

Q88. Solution**Correct Answer: (A)**

Those pollutants that cannot be converted into a simpler and harmless form by nature are known as non-biodegradable pollutants.

An example of a non-biodegradable pollutant is DDT.

Q89. Solution**Correct Answer: (D)**

With NaCl only Ag⁺ precipitates $\text{Ag}^+ + \text{NaCl} \downarrow + \text{Na}^+$

With NaI, Cu⁺² precipitates $2\text{Cu}^{+2} + 4\text{I}^- \rightarrow \text{Cu}_2\text{I}_2 \downarrow + \text{I}_2$

With Na₂S, Ni⁺² precipitates $\text{Ni}^{+2} + \text{Na}_2\text{S} \rightarrow \text{NiS} \downarrow + 2\text{Na}^+$

Q90. Solution**Correct Answer: (D)**

-Collagen is the most abundant protein in the animal world and Ribulose bisphosphate carboxylase-oxygenase (RUBISCO) is the most abundant protein in the whole of the biosphere.

-Collagen is the most abundant protein in the human body

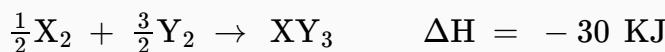
-Rubisco found in the stroma of chloroplast and has Bifunctional activity (carboxylase and oxygenase)

-Low CO₂ high O₂ → Rubisco perform oxygenase activity.

-High CO₂ low O₂ → Rubisco perform carboxylase activity

Q91. Solution**Correct Answer: (B)**

So from this question we know that enthalpy for the reaction is -30 KJ



So we know from the concept of standard entropies is

$$\Delta S = \Delta S(P) - \Delta S(R)$$

$$\Delta S = \Delta S(\text{XY}_3) - \frac{3}{2} \Delta S(\text{Y}_2) - \frac{1}{2} \Delta S(\text{X}_2)$$

$$\Delta S = 50 - \frac{3}{2} \times 40 - \frac{1}{2} \times 60$$

$$\Delta S = -40 \text{ JK}^{-1} \text{ mol}^{-1}$$

So according to the second law of thermodynamics

$$\Delta G = \Delta H - T \Delta S$$

For equilibrium the free Gibb's energy is $\Delta G = 0$

$$\Delta H = T \Delta S$$

$$T = \frac{\Delta H}{\Delta S}$$

$$T = \frac{-30 \times 10^3 \text{ J}}{-40 \text{ JK}^{-1}}$$

So the value of temperature is

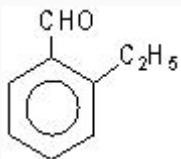
$$T = 750 \text{ K}$$

Q92. Solution

Correct Answer: (A)

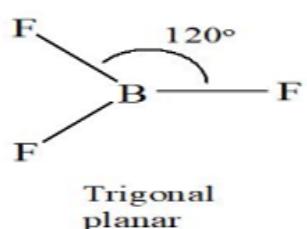
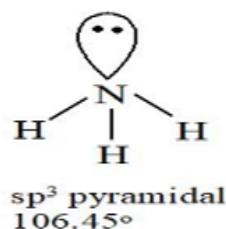
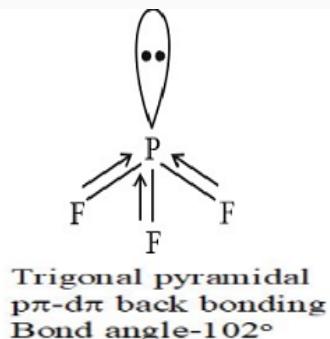
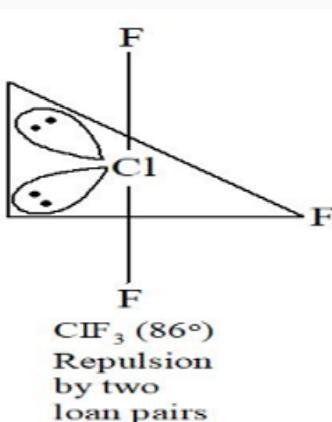
1. X forms 2, 4-DNP derivatives, it shows that it is a carbonyl compound ($C=O$).
2. It reduces Tollen's reagent, it shows that it has an aldehyde group.
3. It undergoes Cannizaro reaction, that also shows the presence of an aldehyde having no α -hydrogen.
4. On vigorous oxidation, it produces 1, 2-benzenedicarboxylic acid. It shows that groups are present at 1,2-position on benzene ring.

Thus, the correct structure of the compound X is



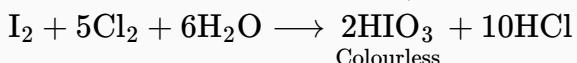
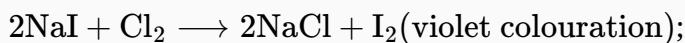
Q93. Solution

Correct Answer: (D)



Q94. Solution

Correct Answer: (D)



Q95. Solution**Correct Answer: (B)**

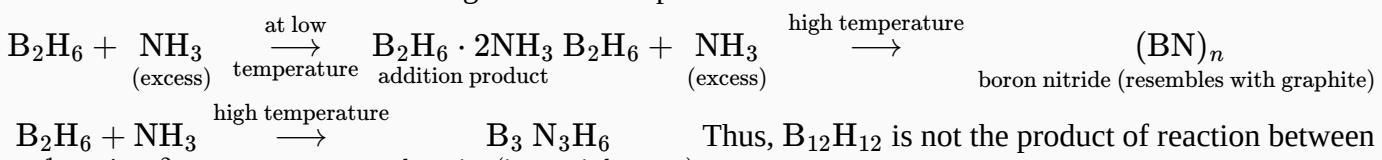
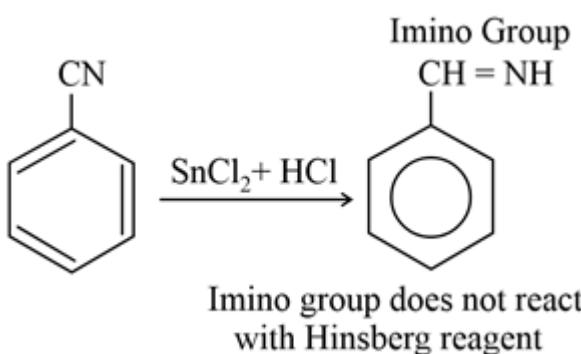
$$\text{b.p. of water} = 100^\circ\text{C}; K_f = 1.86 \text{ kg mol}^{-1}$$

$$\text{b.p. of urea in water} = 100.18^\circ\text{C}; K_b = 0.512 \text{ kg mol}^{-1}$$

$$\begin{aligned}\Delta T_f &= K_f m \dots (1) \Rightarrow \Delta T_b = 0.18 \\ \Delta T_b &= K_b m \dots (2) \quad \text{f.p. of water} = 0^\circ\text{C} \\ \Rightarrow \frac{\Delta T_f}{\Delta T_b} &= \frac{K_f}{K_b} \dots (3) \quad f.p. \text{ of urea in water} = -T^\circ\text{C} \\ &\Rightarrow \Delta T_f = T \\ &\Rightarrow \text{from eq. (3)} \\ &\quad \frac{T}{0.18} = \frac{1.86}{0.512} \\ &\Rightarrow T = 0.6539 \\ &\Rightarrow f.p. \text{ of urea in water} = -0.654^\circ\text{C}\end{aligned}$$

Q96. Solution**Correct Answer: (B)**

Diborane reacts with ammonia and gives different products under different reaction conditions as

**Q97. Solution****Correct Answer: (B)**

Primary and secondary amine can react with Hinsberg's reagent.

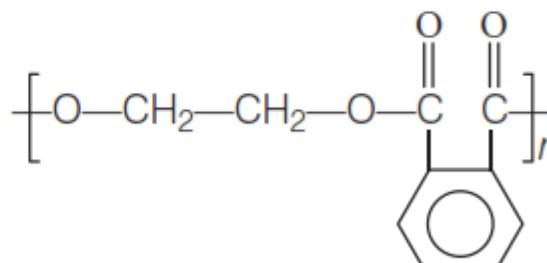
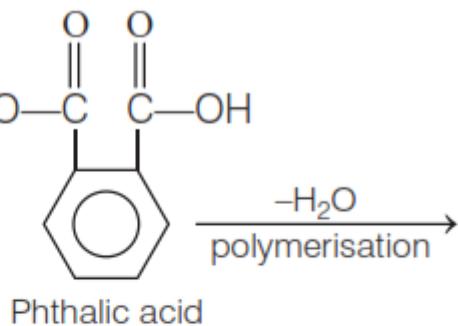
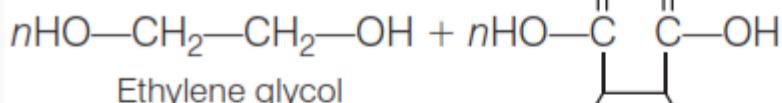
Q98. Solution**Correct Answer: (A)**

$$\text{pH} = \text{pK}_a + \log \frac{[\text{salt}]}{[\text{Acid}]}$$

$$[\text{Acid}] = [\text{CH}_3\text{COOH}] = \frac{10 \times 1}{100} = 0.1\text{M}$$

$$[\text{Salt}] = [\text{CH}_3\text{COO}^-] = \frac{20 \times 0.5}{100} = 0.1\text{M}$$

$$\Rightarrow \text{pH} = 4.76 + \log \frac{0.1}{0.1} \\ = 4.76$$

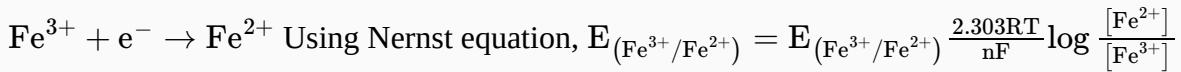
Q99. Solution**Correct Answer: (C)****138. (c)**

Glyptal (polyethylene glycol phthalate)

Glyptal a polyester, is formed by ethylene glycol and phthalic acid formed by step growth polymerisation as shown in the above reaction. Step-growth polymerisation refers to a type of polymerisation mechanism in which bi-functional or multifunctional monomers react to form first dimers, then trimers longer oligomers and eventually long chain polymers. Hence, the correct option is (3).

Q100. Solution

Correct Answer: (B)



Here, n = 1, $[\text{Fe}^{2+}] = 2M$, $[\text{Fe}^{3+}] = 0.02M$,

$$\frac{2.303RT}{F} = 0.059, E^\circ = 0.771 \text{ V } (\text{Fe}^{3+}/\text{Fe}^{2+})$$

$$E_{(\text{Fe}^{3+}/\text{Fe}^{2+})} = 0.771 - 0.059 \log \frac{2}{0.02}$$

$$E_{(\text{Fe}^{3+}/\text{Fe}^{2+})} = 0.653 \text{ V}$$

Q101. Solution

Correct Answer: (C)

The Higgs discovery confirmed part of the Standard Model but simultaneously underscored its incompleteness (e.g., dark matter, gravity). This dual outcome mandates a "multi-pronged approach" combining continued high-energy collider research (like HL-LHC) with complementary avenues such as astrophysical observations. Option (C) concisely summarizes this balanced and diversified future direction.

Q102. Solution

Correct Answer: (B)

The philosopher did get up because It was his turn to keep watch.

Q103. Solution

Correct Answer: (D)

'amenities' means 'pleasing acts' and 'courtesies' means 'polite behaviour'. Therefore correct synonym is courtesies.

Q104. Solution

Correct Answer: (A)

- QUIXOTIC (adjective): Extravagantly chivalrous or romantic; visionary, impractical, or impracticable. It refers to someone who is foolishly idealistic and impractical, often pursuing noble but unrealistic goals. Let's look at the options:

- (A) Pragmatic: Dealing with things sensibly and realistically in a way that is based on practical rather than theoretical considerations. This is directly opposite to being impractical or idealistic to an extreme.
- (B) Idealistic: Characterized by idealism; often unrealistic. This is a synonym or very close in meaning to quixotic.
- (C) Chivalrous: Courteous and honorable, especially toward women (often used in a broader sense of being noble and brave). This is a characteristic sometimes associated with quixotic behavior, but not an antonym.
- (D) Romantic: Conducive to or characterized by romance; idealistic, often in a dreamy or impractical way. This is also a synonym or very close in meaning.

Q105. Solution

Correct Answer: (A)

Fragment IV: more resources on health, education and skill development.

Here, usage of the verb 'on' is erroneous here as the correct preposition that follows the verb 'invest' is 'in' and not 'on'.

Ex. He invested his money **in** stocks.

Correct fragment: more resources **in** health, education and skill development.

Option A is hence the correct answer.

Q106. Solution

Correct Answer: (A)

Voice tells us whether a subject of the verb in a sentence receives or performs any action. An active voice is when the subject of the verb is a performer and passive voice is when the subject of the verb is the recipient. But, words like 'go', 'come', 'sit', 'eat', etc are example of intransitive verbs. Sentences, which have intransitive verb(s), cannot be converted into passive voice.

Q107. Solution

Correct Answer: (B)

- Arsonist is someone who intentionally sets property on fire. - Pyromaniac is someone with a psychological disorder involving a compulsion to start fires - not necessarily for criminal intent. - Incendiary refers to a device or attack designed to cause fires, or a person who stirs up conflict - but it's broader. - Saboteur is someone who deliberately destroys or obstructs something, typically for political or military advantage.

Q108. Solution

Correct Answer: (A)

Prepositions are words that link the nouns, pronouns and phrases to other words in a sentence for the purpose of indicating direction, place, time, relationship etc.

'To' is one of the prepositions.

'To' is a preposition that can be used to indicate time, destination or direction, approximate numbers etc. 'To' is also used after the nouns, verbs and the adjectives. 'To' as a preposition also indicates the recipient of action. In the option, 'His leniency to his subordinates landed him in great difficulties', 'to' is placed after the abstract noun 'leniency'. The sentence conveys the meaning that, as he was lenient, he faced many problems. Here, 'to' as a preposition indicates the word 'subordinates', who are the recipient of his lenient action.

Hence, the correct sentence is 'His leniency to his subordinates landed him in great difficulties' is the right option.

Q109. Solution

Correct Answer: (B)

The first sentence talks about the fact that only few investors have idea about bitcoins and other cryptocurrencies (which seems an attractive investment area), so, the finance ministry has warned the potential investors about it. Sentence E will follow the first sentence because it says that 'bitcoin not only shot up well over by 1000%....' which justifies 'attractive investment area' and forms a link. Now we are left with only option (b) and (d) to choose from. When we consider the sentence, F, we can see that this line seems to be a part, somewhere in the middle of the paragraph, also, the first line starts with a warning, therefore, it must justify the consequences of the investment in bitcoins and other cryptocurrencies which is justified by sentence C. Hence, option (b) is the correct choice.

Q110. Solution

Correct Answer: (C)

"Slur" which means 'insult' and "glorious" which means 'great' are not appropriate for the respective blanks. Option A, thus, can be eliminated.

If honest politicians are available in "abundance", then the country would not be in a "sad" state; which rules out option B. Similarly "lack" of honest politicians cannot be the reason for "progressive" state of the county. This rules out option D as well.

In option E, "sparse" will not be the grammatically correct choice for the first blank and thus can be eliminated too.

Option C is apt as both the words fill in the blanks in a logically and grammatically correct way. "Shortage" means 'a lack of' and "miserable" means 'wretchedly poor or unhappy'.

Option C is hence the correct answer.

Q111. Solution

Correct Answer: (C)

Relationships: 1. Frog ⊂ Amphibian: All frogs are amphibians. 2. Carnivorous ∩ Frog ≠ ∅ : Most frogs are carnivorous. 3. Carnivorous ∩ Amphibian ≠ ∅ : Some amphibians are carnivorous. 4. Carnivorous ⊈ Amphibian: Not all carnivorous animals are amphibians. Optimal Venn Diagram: The diagram must show: - A smaller circle (Frog) entirely within a larger circle (Amphibian). - A third circle (Carnivorous) overlapping with the larger 'Amphibian' circle, thus also inherently overlapping with the 'Frog' circle, and extending beyond the 'Amphibian' circle. Option (c) accurately depicts this: an innermost circle (Frog) within a middle circle (Amphibian), and an outermost circle (Carnivorous) intersecting the middle circle. The final answer is *C*

Q112. Solution

Correct Answer: (C)

To find "males chartered accountants who are NEITHER tax-payers NOR full-time employees," we need the region common to the Pentagon (Males) and the Oval (Chartered Accountants), but outside the Square (Tax-payers) and the Triangle (Full-time employees). 1. Males (Pentagon) \cap Chartered Accountants (Oval): The numbers in this overlapping region are 22, 8, 17, 11. 2. Exclude Tax-payers (Square): Numbers 8 and 17 are in the Square. 3. Exclude Full-time employees (Triangle): Numbers 8, 17, and 11 are in the Triangle. The only number from the initial intersection (22, 8, 17, 11) that is not in the Square or the Triangle is 22. The final answer is 22.

Q113. Solution

Correct Answer: (C)

Given :- a_bc_a_bcda_ccd_bcd_ By checking options and substituting accordingly. 1.

$a, a, b, c, c, d \rightarrow aabca - abbcd - acccd - cbcdd$ 2. $a, c, b, d, b, d \rightarrow aabcc - abbcd - adccd - bbcd$ 3. $a, d, b, b, a, d \rightarrow aabcd - abbcd - abccd - abcdd$ 4. $a, d, b, b, d, d \rightarrow aabcd - abbcd - abccd - dbcd$ - Option (3) gives a cyclic pattern of aabcd - abbcd - abccd - abcdd. Hence, ' a,d, b, b, a, d' is the correct answer.

Q114. Solution

Correct Answer: (A)

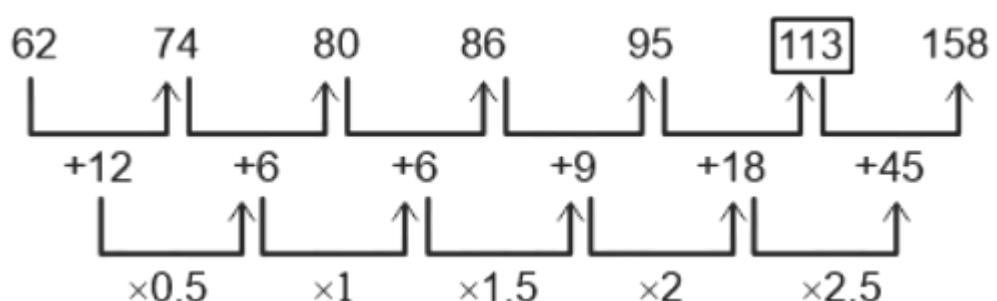
4.....8.....21.....59.....146.....314

Pattern:+4.....+13.....+38.....+87.....+168

$$\dots\dots\dots + 3^2 \dots\dots\dots + 5^2 \dots\dots\dots + 7^2 \dots\dots\dots + 9^2$$

Q115. Solution

Correct Answer: (A)



The logic followed here is :-

Hence, the correct answer is "113".

Q116. Solution

Correct Answer: (A)

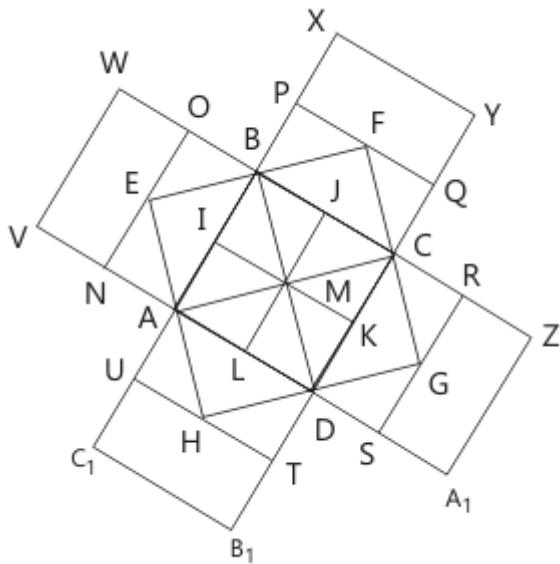
The arcs which are given in the figures ,if we consider them to be facing out and facing inside, we can notice all the possibilities in the given figures and following the sequence of pattern, we can get to know the answer.

Q117. Solution**Correct Answer: (C)**

When the sheet in fig. (X) is folded, then one of the faces of the cube formed will be of the form and this face will lie opposite the face bearing a square. Also, one of the blank faces lies opposite another blank face and the third blank face lies opposite the face bearing an '=' sign. Clearly, all the three blank faces cannot appear adjacent to each other. So, the cube shown in fig. (2) which has all the three blank faces adjacent to each other cannot be formed. Hence, only the cubes shown in figures A, C and D can be formed.

Q118. Solution**Correct Answer: (C)**

The figure may be labelled as shown.



The squares composed of two components each are BJMI, CKMJ , DLMK and AIML i.e. 4 in number.

The squares composed of three components each are EBMA, BFCM, MCGD and AMDH i.e. 4 in number.

The squares composed of four components each are VWBA, XYCB, ZA₁DC and B₁C₁AD i.e. 4 in number.

The squares composed of seven components each are NOJL, PQKI, RSLJ and TULK i.e. 4 in number.

There is only one square i.e. ABCD composed of eight components.

There is only one square i.e. EFGH composed of twelve components.

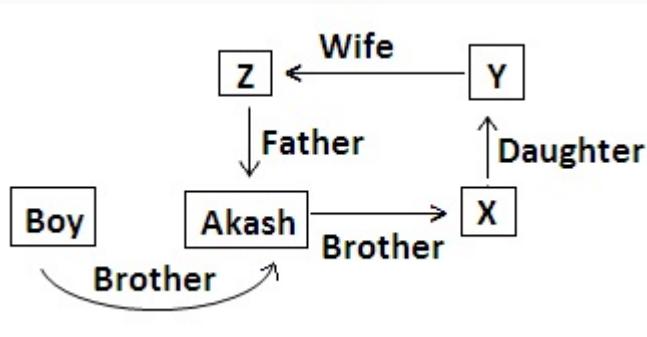
\therefore Total number of squares in the figure = $4 + 4 + 4 + 4 + 1 + 1 = 18$.

Hence, option C is correct.

Q119. Solution

Correct Answer: (C)

According to the given question,



Father's wife of Akash is his mother. The daughter of his mother is his sister. His sister has two brothers one of whom is Akash and the other is the man he is referring to as the boy in the blue shirt.

Hence, the boy in the blue shirt is the younger brother of Akash.

So, the correct answer is an option (C).

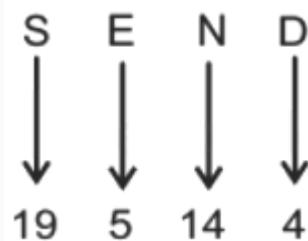
Q120. Solution

Correct Answer: (A)

Between x and $(x + 1)$ o'clock, the 2 hands are in opposite directions at $(5x + 30) \left(\frac{12}{11}\right)$ min past x . So, between 3 and 4, 2 hands will be in opposite directions at $(53 + 30) \left(\frac{12}{11}\right) = (45) \left(\frac{12}{11}\right) = \frac{540}{11} = 49 \left(\frac{1}{11}\right)$ min past 3.

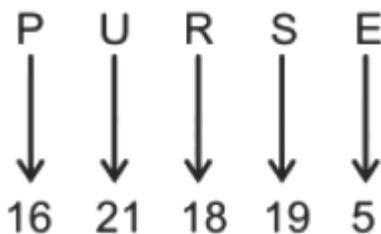
Q121. Solution

Correct Answer: (D)



Logic is: Sum of the place value of the letters × Number of letters in the word

$$\text{SEND} = 19 + 5 + 14 + 4 = 42 \times 4 = 168 \text{ Similarly, PURSE} = 16 + 21 + 18 + 19 + 5 = 79 \times 5 = 395$$



Hence, '395' is the correct answer.

Q122. Solution

Correct Answer: (A)

money is not health → pot lot hot got

need and want money → mop tmp put pot

health makes whole happy → zen lot nup kot

need makes want money → zen mop pot tmp

'need' = either 'mop' or 'tmp' 'whole' = either 'nup' or 'kot' 'more' = not given, so something new. Hence possible code for 'need whole more' is 'xi nup mop'.

Q123. Solution

Correct Answer: (D)

Let's decode the meanings: - Farrago - A confused mixture; hodgepodge. - Olio - A miscellaneous collection; also a stew. - Gallimaufry - A jumble or confused medley. - Susurrus - A soft, whispering or rustling sound. Now the analysis: - (a), (b), and (c) all refer to mixtures or jumbles - i.e., collections of diverse things. - (d) Susurrus refers to sound, specifically a gentle murmuring or rustling. Correct Answer: (d) Susurrus Because it relates to sound, whereas all others refer to confused mixtures or collections.

Q124. Solution**Correct Answer: (A)**

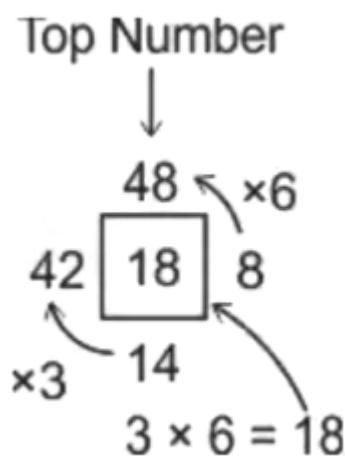
From the option A, we get the required word.

Matrix - I					Matrix - II				
0	1	2	3	4	5	6	7	8	9
0					5				
1				N	6				
2					7				
3					8	T			
4		K			9			I	

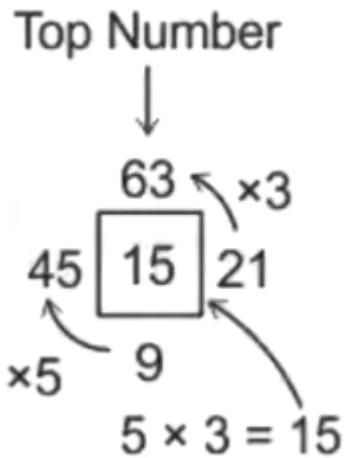
Hence, Option A is correct.

Q125. Solution

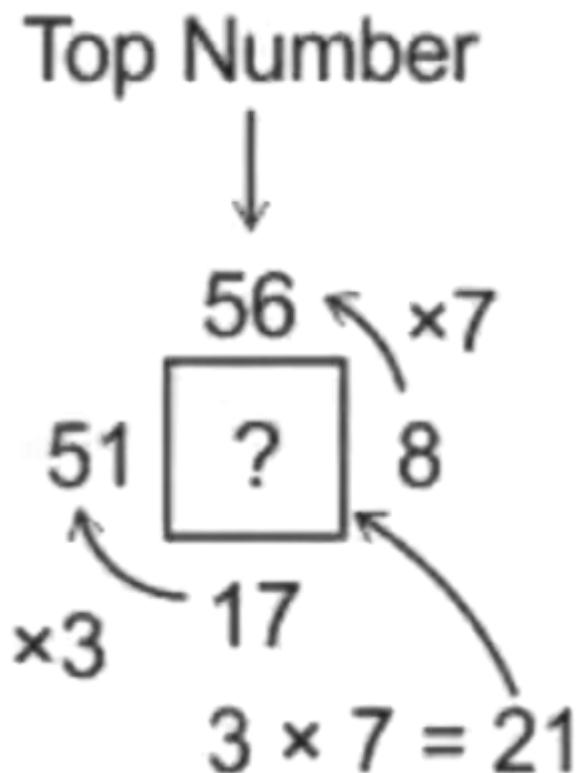
Correct Answer: (C)



The logic followed here is: Top Number 48:



Top number 63:



Similarly, Top number 56:

Middle number (?) = 21. Hence, the correct answer is "21".

Q126. Solution**Correct Answer: (D)****Statements:**

Some caps are hats.

Some hats are shirts.

Many shirts are ties.

Conclusions:

- I. Some caps are ties.
- II. Not a single cap is tie.

Checking Conclusion I and II together : 'Some caps are ties' and 'Not a single cap is tie'

Clearly, all the statements are I type, we can't define a relationship between classes that exist in two different statements.

Similarly, we can't define a relationship between the classes 'cap' and 'tie' either.

But, C1 is an I type statement and C2 an E type, and they together form an E+I combination. Clearly, either C1 or C2 follows.

Hence, option D is correct.

Q127. Solution**Correct Answer: (D)**

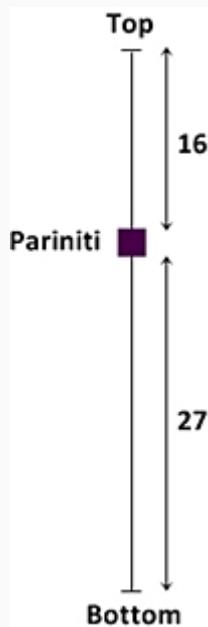
Word: MYTHOLOGICAL

Word	M	Y	T	H	O	L	O	G	I	C	A	L
After Interchanging	L	A	C	I	G	O	L	O	H	T	Y	M

Word formed after interchanging: (left end) LACIGOLOHTYM (right end) Clearly, ' O ' is 8th from the left end of the new word.

Q128. Solution**Correct Answer: (D)**

As given in the figure, there are 16 girls above Pariniti and 27 girls below her among the girls who went into the final round.



$$\text{Total girls who made it to the final} = 16 + \text{Pariniti} + 27 = 44$$

$$\text{Therefore, total girls who enrolled in the contest} = 44 + 7 + 7 = 58$$

Q129. Solution**Correct Answer: (A)**

- Alphabet positions are being used. - Consonants are encoded from the left. - Vowels are encoded from the right.

Let us break down CARAMEL: Word: CARAMEL We write the alphabet positions (from the image and logic):

Letter	Type	Code
C	Consonant	3
A	Vowel	26
R	Consonant	18
A	Vowel	26
M	Consonant	13
E	Vowel	22
L	Consonant	12

Now arrange the code: - As per the pattern, we write all codes in order of the

word itself. - So the final code becomes: → CARAMEL → 3261826132212 Thus, the code for CARAMEL is: 3261826132212

Q130. Solution**Correct Answer: (D)**

The code for VITAMIN using the below mentioned logic is

$$(V+T+M+N) - (I+A+I) = (22+20+13+14) - (9+1+9)$$

$$69 - 19 = 50$$

Hence option E is correct.

Common Explanation:**Reference:**

Word	STRANGE	EFFECT	DREAM
Code	72	25	29

Inference:

Let us analyze the logic behind the codes assigned to the above mentioned words.

STRANGE is coded as 72, here the logic is that Difference of sum of numerical value of consonants and sum of numerical value of vowels is taken.

The numeric value of the letters are calculated by considering A as 1 and Z as 26.

$$(S+T+R+N+G) - (A+E)$$

$$(19+20+18+14+7) - (1+5)$$

$$78 - 6 = 72.$$

Likewise code for EFFECT is $(F+F+C+T) - (E+E)$

$$(6+6+3+20) - (5+5) = 25$$

Similarly , code for DREAM is $(D+R+E+A+M) - (E+E)$

$$35 - 6 = 29$$