

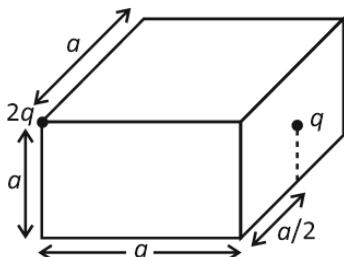
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. There are two point charges, one at vertex and other at face as shown in the cube. Find electric flux through the cube.

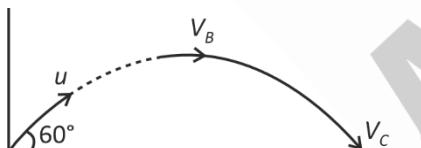


(1) $3q/\epsilon_0$ (2) q/ϵ_0
 (3) $3q/4\epsilon_0$ (4) $5q/\epsilon_0$

Answer (3)

Sol. $\phi = \frac{q_{enc}}{\epsilon_0} = \frac{\frac{2q}{8} + \frac{q}{2}}{\epsilon_0} = \frac{3q}{4\epsilon_0}$

2. If a projectile is being projected with speed v at an angle 60° with horizontal. Find the ratio of speed at highest point (V_B) to the speed at final point (V_C).



(1) 3 : 4 (2) 1 : 3
 (3) 1 : 2 (4) 1 : 12

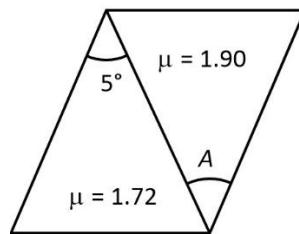
Answer (3)

Sol. $V_C = v$

$$V_B = v \cos 60^\circ = \frac{v}{2}$$

$$\frac{V_B}{V_C} = \frac{1}{2}$$

3. Find A for dispersion without deviation.



(1) 3 (2) 4
 (3) 4.5 (4) 5

Answer (2)

Sol. $A_1 (\mu_1 - 1) = A_2 (\mu_2 - 1)$

$$5(0.72) = A(0.9)$$

$$\Rightarrow A = 4$$

4. For the given set of measurement find relative error.

20.00, 19.75, 18.25, 17.01

(1) 0.12 (2) 0.06
 (3) 0.09 (4) 0.17

Answer (2)

Sol. $\bar{x} = \frac{20.00 + 18.25 + 19.75 + 17.01}{4}$

$$\Rightarrow \bar{x} = 18.75$$

$$\Rightarrow |\Delta \bar{x}| = \frac{1.25 + 0.5 + 1 + 1.74}{4} = 1.12$$

$$\frac{\Delta \bar{x}}{\bar{x}} = \frac{1.12}{18.75} = 0.06$$

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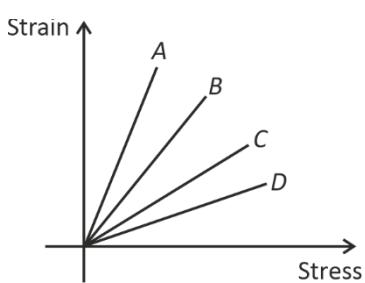
5. Find out the correct energy for the ground state or energy transition. (symbols have usual meaning & $n \rightarrow m$ gives the transition)

(1) H (-6.8 eV) (2) Li²⁺ (-13.6 eV)
 (3) He₂⁺ (40.8 eV) (4) Be₂³⁺ (+13.6 eV)

Answer (3)

Sol. $E_n = 13.6 \frac{z^2}{n^2}$

6. Which of the following material has bigger Young's modulus



(1) A (2) B
 (3) C (4) D

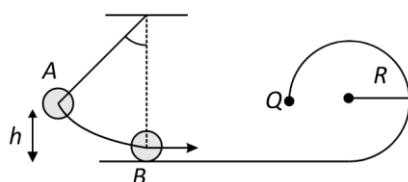
Answer (4)

Sol. Slope = $\frac{\text{Strain}}{\text{Stress}}$

$$Y = \frac{1}{\text{Slope}}$$

Thus D

7. Find h (in m) such that ball B just be able to reach Q after elastic collision with A. Mass of both the bodies are same m. ($R = 10 \text{ cm}$)



(1) $\frac{3}{5}$ (2) $\frac{1}{\sqrt{5}}$
 (3) $\frac{1}{4}$ (4) $\frac{1}{5}$

Answer (3)

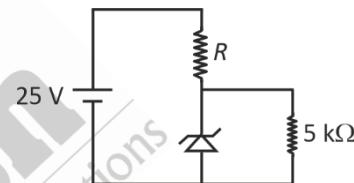
Sol. $V_A = V_B, V_A = \sqrt{5gR}$

$$m_Agh = \frac{1}{2}m_Av_A^2$$

$$h = \frac{5}{2}R$$

$$h = \frac{5}{2}R = \frac{5}{2} \times \frac{1}{10} = \frac{1}{4}$$

8. For the given circuit the breakdown voltage of Zener diode is $V_z = 5$ volts. And it can stand maximum current of $I_z = 5 \text{ mA}$.



Find the value of R .

(1) $\frac{10}{3} \text{ k}\Omega$ (2) $5 \text{ k}\Omega$
 (3) $\frac{15}{4} \text{ k}\Omega$ (4) $8 \text{ k}\Omega$

Answer (1)

Sol. I_1 across $6 \text{ k}\Omega$ is

$$I_1 = \frac{5}{5000} = 1 \text{ mA}$$

So, total $I = 6 \text{ mA}$

$$R = \frac{20}{6} \times 1000 = \frac{10}{3} \text{ k}\Omega$$

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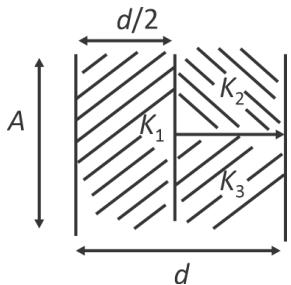
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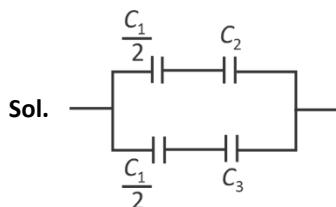
9. Find capacitance of capacitor given below if each plate has area A and separation is d between them.



$$K_1 = 3 \quad K_2 = 5 \quad K_3 = 2$$

(1) $\frac{123\epsilon_0 A}{40d}$ (2) $\frac{140\epsilon_0 A}{6d}$
 (3) $\frac{120\epsilon_0 A}{30d}$ (4) $\frac{128\epsilon_0 A}{4d}$

Answer (1)



$$C_1 = \frac{6\epsilon_0 A}{d} \quad C_2 = \frac{5\epsilon_0 A}{d} \quad C_3 = \frac{2\epsilon_0 A}{d}$$

$$C_{eq} = \frac{123\epsilon_0 A}{40d}$$

10. A simple pendulum of length 3 m completes 20 oscillations in 10 sec. What is length of another pendulum which completes 40 oscillations in same times

(1) 0.75 m (2) 1.5 m
 (3) 12 m (4) 6 m

Answer (1)

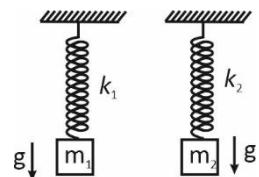
Sol. $T = 2\pi \sqrt{\frac{l}{g_{eff}}}$

$$\frac{Y_2}{Y_4} = \frac{\sqrt{3}}{\sqrt{l}}$$

$$l = \frac{3}{4} \text{ m}$$

11. Find ratio of energy stored in the two springs as shown in figure below

Given: $\frac{K_1}{K_2} = \frac{1}{2}$ and $\frac{m_1}{m_2} = \frac{1}{4}$



(1) $\frac{1}{4}$ (2) $\frac{1}{2}$
 (3) $\frac{1}{8}$ (4) 1

Answer (3)

Sol. Given: $\frac{K_1}{K_2} = \frac{1}{2}$ and $\frac{m_1}{m_2} = \frac{1}{4}$

$$E = \frac{2kq}{r^2} \Rightarrow E_{net} = E\sqrt{3}$$

12. In two different YDSE setup, two different monochromatic wave are used but fringe width on the screen is same. If $\frac{\lambda_1}{\lambda_2} = \frac{1}{2}$ and $\frac{d_1}{d_2} = \frac{2}{1}$, then find the ratio of $\frac{D_1}{D_2}$ (All symbols are standard).

(1) 1 (2) $\frac{1}{2}$
 (3) 2 (4) 4

Answer (4)

Sol. $\Delta\omega = \frac{\lambda D}{d}$

$$\text{So, } \frac{\lambda_1 D_1}{d_1} = \frac{\lambda_2 D_2}{d_2}$$

$$\frac{D_1}{D_2} = \left(\frac{d_1}{d_2} \right) \cdot \left(\frac{\lambda_2}{\lambda_1} \right) = \left(\frac{2}{1} \right) \times \left(\frac{2}{1} \right)$$

$$\frac{D_1}{D_2} = 4$$

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13. A 25 kg mass moving with 30 m/s and another mass 15 kg of same material moving with 10 m/s in opposite direction, collides perfectly inelastically. Find the rise in temperature of the system.

(Given: $C = 5 \times \text{cal/g}^\circ\text{C}$ & 1 cal = 4.2 J)

(1) $\frac{1}{50}^\circ\text{C}$

(2) $\frac{1}{112}^\circ\text{C}$

(3) $\frac{1}{150}^\circ\text{C}$

(4) $\frac{1}{125}^\circ\text{C}$

Answer (1)

Sol. $25 \times 30 - 15 \times 10 = 40 V_f \Rightarrow V_f = 15 \text{ m/s}$

$$K\epsilon_i - K\epsilon_f = \frac{1}{2} 25 \times 900 + \frac{1}{2} \times 15 \times 100 - \frac{1}{2} 40(225) = 7500 \text{ J}$$

$$ms\Delta T = 7500 \Rightarrow \Delta T = \frac{7500}{40 \times 5000 \times 4.2} = \frac{1}{112}^\circ\text{C}$$

14. Two point particles of masses $2m$ and m are attached to ends of a massless rod of length l . Find Angular momentum of this system about an axis passing through their center of mass and perpendicular to the rod if the system is rotating with angular velocity ω about the axis.

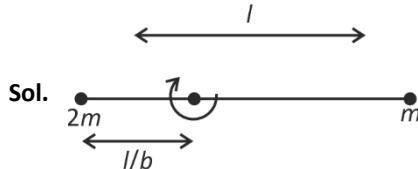
(1) $\frac{2}{3}m\omega l^2$

(2) $\frac{1}{3}m\omega l^2$

(3) $\frac{m\omega l^2}{9}$

(4) $m\omega l^2$

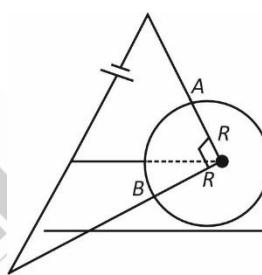
Answer (1)



$$L = 2m\omega \left(\frac{l}{3}\right)^2 + m\omega \left(\frac{20}{3}\right)^2$$

$$L = \frac{2}{9}m\omega l^2 + \frac{4}{9}m\omega l^2 = \frac{2}{3}m\omega l^2$$

15. A uniform wire is bent into the shape of a circle of radius R has resistance per unit length = λ . A battery is connected across point A and B which subtends an angle of 90° at its centre as shown. Find the equivalent resistance of this circuit.



(1) $\frac{3\pi}{4}\lambda R$

(2) $\frac{\pi}{2}\lambda R$

(3) $\frac{3\pi}{8}\lambda R$

(4) $\frac{\pi}{4}\lambda R$

Answer (3)

Sol. $R_1 = \lambda \frac{3\pi R}{2}; R_2 = \frac{\lambda\pi}{2}R$

$$R_{\text{eq}} = \frac{\frac{\lambda\pi}{2}R \frac{3\pi}{2}R}{\frac{\lambda\pi}{2}R + \lambda \frac{3\pi}{2}R} = \frac{\lambda^2 \frac{3\pi^2}{4}R^2}{\lambda \times 2\pi R}$$

$$R_{\text{eq}} = \frac{3\pi}{8}\lambda R$$

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CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. The correct order of ionisation energy of Cl, S, P, Al, Si is

- (1) Cl > P > S > Si > Al
- (2) P > Cl > S > Al > Si
- (3) Cl > S > P > Si > Al
- (4) Cl > Al > Si > P > S

Answer (1)

Sol. kJ/mol

$$\text{Cl} \Rightarrow 1256$$

$$\text{S} \Rightarrow 999$$

$$\text{P} \Rightarrow 1012$$

$$\text{Al} \Rightarrow 577$$

$$\text{Si} \Rightarrow 786$$

2. Consider the statements below :

Statement I : $[\text{CoBr}_4]^{2-}$ absorbs lesser energy than $[\text{CoCl}_4]^{2-}$.

Statement II : $[\text{CoCl}_4]^{2-}$ has higher crystal field splitting energy than $[\text{CoBr}_4]^{2-}$.

- (1) Both statement I and statement II are correct
- (2) Both statement I and statement II are incorrect
- (3) Statement I correct and statement II incorrect
- (4) Statement I incorrect and statement II correct

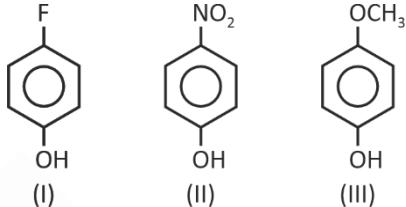
Answer (1)

Sol. Order of ligand strength $\text{Cl}^- > \text{Br}^-$

$[\text{CoCl}_4]^{2-}$ absorb more energy than $[\text{CoBr}_4]^{2-}$

$[\text{CoCl}_4]^{2-}$ has more CFSE value due to strength of ligand.

3. Arrange in increasing order of acid strength.



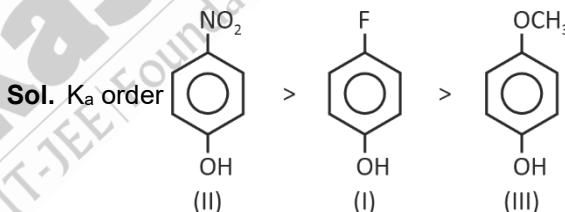
$$(1) (II) > (I) = (III)$$

$$(2) (I) > (II) > (III)$$

$$(3) (II) > (I) > (III)$$

$$(4) (II) = (I) > (III)$$

Answer (3)



4. Which of the following undergo nitration at fastest rate?

$$(1) \text{C}_6\text{H}_5\text{NO}_2$$

$$(2) \text{C}_6\text{H}_5\text{CH}_3$$

$$(3) \text{C}_6\text{H}_5\text{COOH}$$

$$(4) \text{C}_6\text{H}_5\text{Br}$$

Answer (2)

Sol. Methyl group is activating group

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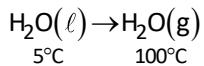
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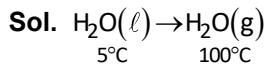
5. For the following change,



Select the correct answer:

- (1) $q = +ve, w = +ve, \Delta H = +ve$
- (2) $q = -ve, w = -ve, \Delta H = +ve$
- (3) $q = +ve, w = -ve, \Delta H = +ve$
- (4) $q = -ve, w = -ve, \Delta H = -ve$

Answer (3)

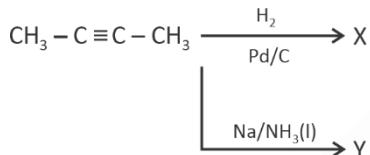


$\rightarrow \because$ expansion $w = -ve$.

\rightarrow It is heat absorbing, so, $q = +ve$.

$$\Delta H = +ve$$

6. Consider the following reaction

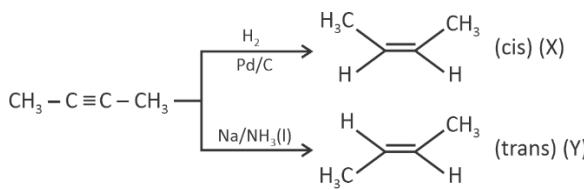


Choose the correct option.

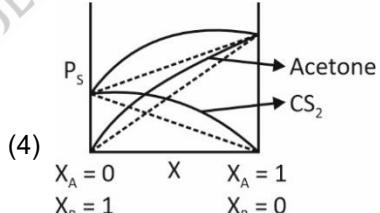
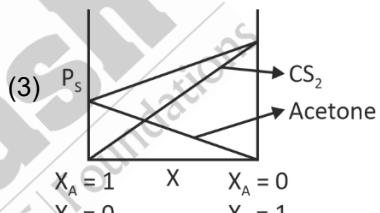
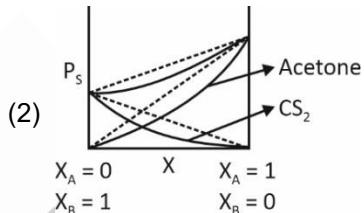
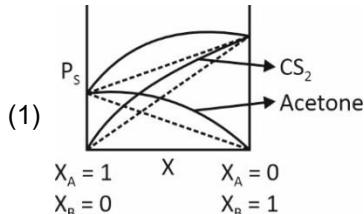
- (1) $\text{X} \Rightarrow \text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$
 $\text{Y} \Rightarrow \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ (cis)
- (2) $\text{X} \Rightarrow \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ (cis)
 $\text{Y} \Rightarrow \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ (trans)
- (3) $\text{X} \Rightarrow \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ (cis)
 $\text{Y} \Rightarrow \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ (cis)
- (4) $\text{X} \Rightarrow \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ (trans)
 $\text{Y} \Rightarrow \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ (cis)

Answer (2)

Sol.



7. A binary solution is formed by mixing Acetone (A) and CS_2 (B). The variation of vapour pressure v/s mole fraction will be



Answer (1)

Sol. $P_{\text{CS}_2}^0 \approx 510 \text{ mmHg}$

$$P_{\text{Acetone}}^0 \approx 310 \text{ mmHg}$$

CS_2 and Acetone shows positive deviation

$$P_S > P_A^0 X_A + P_B^0 X_B$$

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8. Match the List-I with List-II and choose the correct option :

	List-I		List-II
(a)	2 nd orbit of He ⁺ ion	(i)	-1.96×10^{-17} J
(b)	3 rd orbit of H-atom	(ii)	-2.42×10^{-19} J
(c)	1 st orbit of Li ²⁺ ion	(iii)	-2.178×10^{-18} J
(d)	2 nd orbit of Li ²⁺ ion	(iv)	-4.9×10^{-18} J

(1) (a)-(iii); (b)-(ii); (c)-(i); (d)-(iv)
 (2) (a)-(iii); (b)-(ii); (c)-(iv); (d)-(i)
 (3) (a)-(iv); (b)-(iii); (c)-(ii); (d)-(i)
 (4) (a)-(i); (b)-(ii); (c)-(iii); (d)-(iv)

Answer (1)

Sol. $E_n = -2.178 \times 10^{-18} \frac{z^2}{n^2}$ J

(a) $z = 2, n = 2$
 (b) $z = 1, n = 3$
 (c) $z = 3, n = 1$
 (d) $z = 3, n = 2$

9. Given below are two statements.

Statement I: Sublimation is a purification technique that is used to separate those solid substances which changes from solid to vapour state without passing through liquid state.

Statement II: If external atmospheric pressure is reduced, then boiling point of substance is decreased.

In the light of the above statements, choose the correct option.

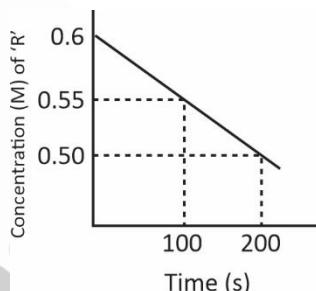
(1) Both statement I and statement II are correct
 (2) Both statement I and statement II are incorrect
 (3) Statement I is correct but statement II is incorrect
 (4) Statement I is incorrect but statement II is correct

Answer (1)

Sol. Sublimable compounds are those compounds which changes from solid to vapour state without passing through liquid state.

Boiling point depends on external atmospheric pressure.

10. Consider the following graph of concentration vs time, of a reaction, $R \rightarrow P$



Find half-life of reaction.

(1) 600 s
 (2) 200 s
 (3) 300 s
 (4) 100 s

Answer (1)

Sol. The graph shows straight line for concentration vs time.

For zero order

$$A_t = -kt + A_0$$

At, $t = 100$ s, conc. = 0.55

At $t = 200$ s, conc. = 0.5

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$$k = \frac{\text{Change in concentration}}{\text{Change in time}}$$

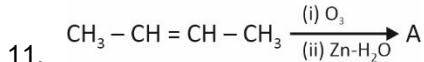
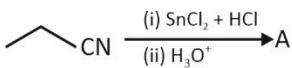
$$= \frac{0.5 - 0.55}{200 - 100} = \frac{0.05}{100}$$

$$k = 5 \times 10^{-4} \text{ ms}^{-1}$$

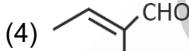
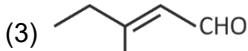
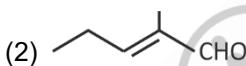
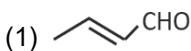
$$t_{\frac{1}{2}} = \frac{A_0}{2k}$$

$$= \frac{0.6}{2 \times 5 \times 10^{-4}}$$

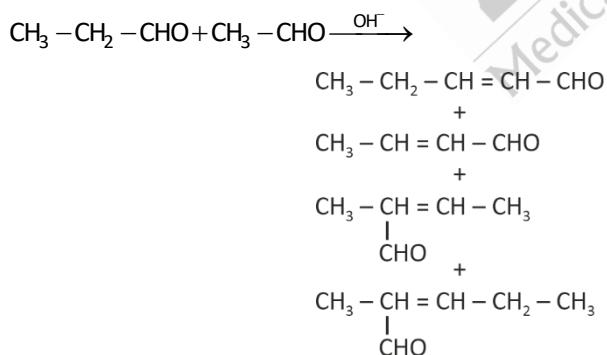
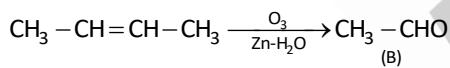
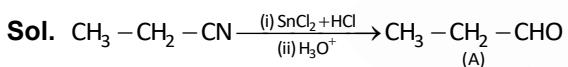
$$= \frac{6000}{100} = 600 \text{ s}$$



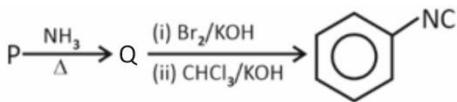
A and B are mixed and treated with dil. base to give mixture of products. Choose the incorrect product.



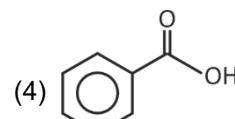
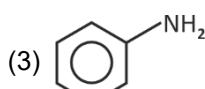
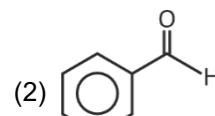
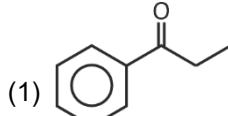
Answer (3)



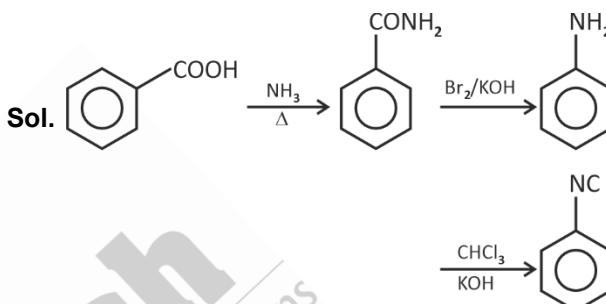
12. Consider the following reaction :



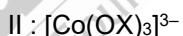
The structure of 'P' is



Answer (4)



13. Consider the two complexes

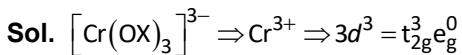


Find the ratio of CFSE of I to II complex (neglect pairing energy and consider Δ_o for both complexes to be x)

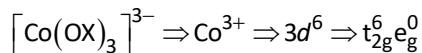
$$(1) 2 \quad (2) \frac{1}{2}$$

$$(3) \frac{1}{3} \quad (4) \frac{2}{3}$$

Answer (2)



$$\text{CFSE} = 3 \times (-0.4) \Delta_o = -1.2 \Delta_o$$



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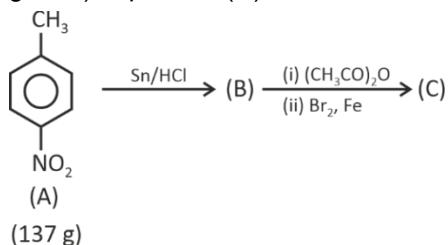


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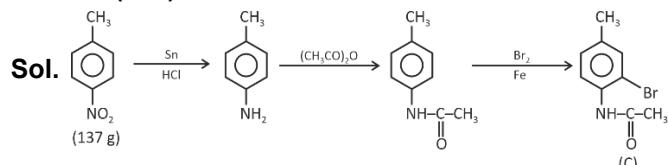


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21. In the reaction sequence, what is the mass (in grams) of product (C) formed?



Answer (228)



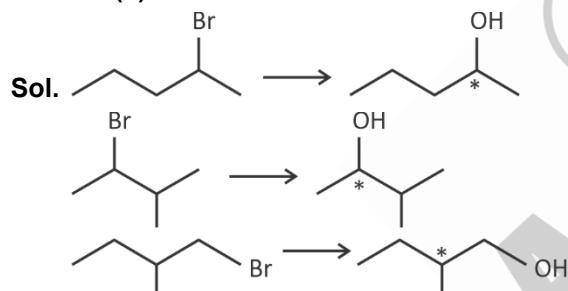
$$\text{moles of (A)} = \frac{137}{137} = 1 \text{ mole.}$$

$$\text{moles of (C) formed} = 1 \text{ moles}$$

$$\text{mass of (C)} = 1 \times 228 = 228 \text{ (g)}$$

22. $\text{C}_5\text{H}_{11}\text{Br}$ reacts with aq. KOH without rearrangement. How many optically active compounds are formed.

Answer (3)



23. x g of pure Cl_2 is reacted with $\text{Ba}(\text{OH})_2$ to form $\text{Ba}(\text{ClO}_3)_2$. $\text{Ba}(\text{OH})_2$ concentration is 1 M and volume is 25 mL. Find x .

Answer (2)



$$1 \text{ M} \times 25 \text{ mL}$$

$$= 25 \text{ m mol}$$

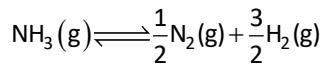
$$6 \text{ mol of } \text{Ba}(\text{OH})_2 \text{ reacted with } 6 \text{ mol } \text{Cl}_2$$

$$25 \text{ m mol of } \text{Ba}(\text{OH})_2 \text{ reacted with } 25 \text{ m mol of } \text{Cl}_2$$

$$\text{mol of } \text{Cl}_2 \text{ reacted} = 25 \times 10^{-3} \text{ mol}$$

$$\text{mass of } \text{Cl}_2 = 25 \times 10^{-3} \times 71 = 1.775 \text{ g} \approx 2 \text{ g}$$

24. For the reaction,



$$\text{Total pressure at equilibrium} = \sqrt{3} \text{ atm}$$

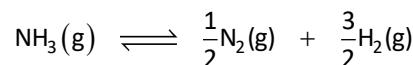
$$K_p = 9 \text{ atm}$$

$$\alpha = x \times 10^{-1}$$

$$\text{Use } \sqrt{2} = 1.41$$

Find x . (Report to nearest integer)

Answer (9)



Sol. $t=0 \quad P$

$$t=t_{\text{eq}} \quad P - \alpha P \quad \frac{\alpha P}{2} \quad \frac{3\alpha P}{2}$$

$$P + \alpha P = \sqrt{3} \quad \dots(1)$$

$$9 = K_p = \frac{\left(\frac{3\alpha P}{2}\right)^{3/2} \left(\frac{\alpha P}{2}\right)^{1/2}}{P(1-\alpha)} \quad \dots(2)$$

$$P(1+\alpha) = \sqrt{3} \Rightarrow P = \frac{\sqrt{3}}{1+\alpha}$$

$$\Rightarrow 9 = \frac{\left[\frac{3\alpha \times \sqrt{3}}{2(1+\alpha)}\right]^{3/2} \left[\frac{\alpha \times \sqrt{3}}{1+\alpha}\right]^{1/2}}{\frac{\sqrt{3}}{1+\alpha}[1-\alpha]}$$

$$= \frac{\left[\frac{3\sqrt{3}}{2}\right]^{3/2} [\sqrt{3}]^{1/2} \left[\frac{\alpha}{1+\alpha}\right]^{3/2} \left[\frac{\alpha}{1+\alpha}\right]^{1/2}}{(\sqrt{3}) \left(\frac{1-\alpha}{1+\alpha}\right)}$$

$$\text{Solving } \alpha = 0.86$$

$$= 8.6 \times 10^{-1}$$

25.

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MATHEMATICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. A rectangle is formed by lines $x = 0$, $y = 0$, $x = 3$, $y = 4$. A line perpendicular to $3x + 4y + 6 = 0$ divides the rectangle into two equal parts, then the distance of the

line from $\left(-1, \frac{3}{2}\right)$ is

(1) 2

(2) $\frac{17}{10}$

(3) $\frac{6}{5}$

(4) $\frac{8}{5}$

Answer (2)

Sol. Concept : line passes through centre of the rectangle \equiv

$\left(\frac{3}{2}, 2\right)$

$\Rightarrow 4x - 3y = C$ passes through $\left(\frac{3}{2}, 2\right)$

$\Rightarrow C = 0$

\Rightarrow distance of $\left(-1, \frac{3}{2}\right)$ from $4x - 3y = 0$ is $\frac{|-4 - \frac{9}{2}|}{5} = \frac{17}{10}$

2. Let $A = \{-2, -1, 0, 1, 2, 3, 4\}$ and R be a relation R , such that $R = \{(x, y) : (2x + y) \leq -2, x \in A, y \in A\}$

Let l = number of elements in R

m = minimum number of elements to be added in R to make it reflexive

n = minimum number of elements to be added in R to make it symmetric, then $(l + m + n)$ is

(1) 10

(2) 17

(3) 11

(4) 14

Answer (2)

Sol. $R = \{(x, y) : 2x + y \leq -2, x \in A, y \in A\}$

$A = \{-2, -1, 0, 1, 2, 3, 4\}$

$R = \{(-2, 2), (-2, 1), (-2, 0), (-2, -1), (-2, -2), (-1, 0), (-1, -1), (-1, -2), (0, -2)\}$

$l = 9$

$m = 5$

$n = \{(-2, 1), (-2, 2), (-1, 0)\} = 3$

3. Number of 4 letter words with or without meaning formed from the letters of the word PQRSSSTTUVV is

(1) 1232 (2) 1400

(3) 1422 (4) 1162

Answer (3)

Sol. Case A : The word is ABCD

$$\Rightarrow {}^7C_4 \cdot 4! = 840$$

Case B: The word is AAAB

$$\Rightarrow (SSS) \times ({}^6C_1) \Rightarrow {}^6C_1 \cdot \frac{4!}{3!} = 24$$

Case C : The word is AABB

$$\Rightarrow {}^3C_2 \cdot \frac{4!}{2!2!} = 18$$

Case (D) : The word is AABC

$$\Rightarrow ({}^3C_1) \cdot ({}^6C_2) \cdot \frac{4!}{2!} = 3 \times 15 \times 12 = 540$$

Answer 1422

4. The area (in square units) bounded by the curve $f(x) = \max\{\sin x, \cos x\}$ and x -axis between $x = 0$ and $x = \frac{3\pi}{2}$ is A sq. unit. Then, the value of $A + A^2$ is

(1) $8 - 2\sqrt{2}$ (2) $8 + 2\sqrt{2}$

(3) $6 - 2\sqrt{2}$ (4) $6 + 2\sqrt{2}$

Answer (1)

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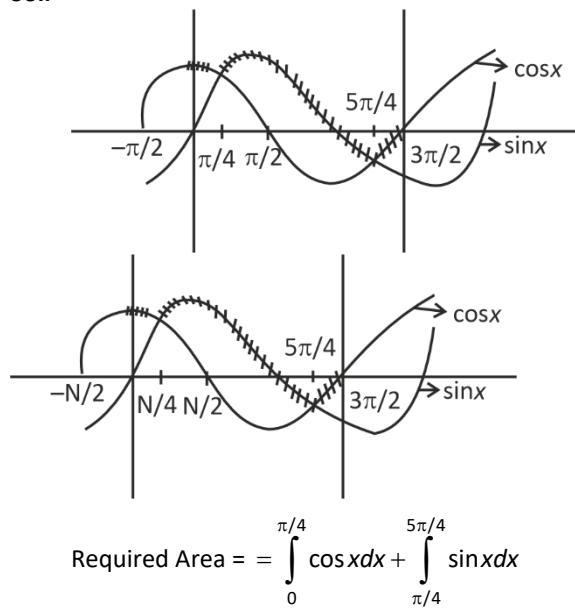


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Sol.



$$\begin{aligned}
 &+ \int_{5\pi/4}^{3\pi/2} \cos x dx \\
 &= [\sin x]_0^{\pi/4} + [-\cos x]_{\pi/4}^{5\pi/4} + [\sin x]_{5\pi/4}^{3\pi/2} \\
 &= \frac{1}{\sqrt{2}} - \left[\frac{-1}{\sqrt{2}} - \frac{1}{\sqrt{2}} \right] + \left[-1 + \frac{1}{\sqrt{2}} \right] \\
 &= \frac{1}{\sqrt{2}} + \sqrt{2} - 1 + \frac{1}{\sqrt{2}}
 \end{aligned}$$

$$A = 2\sqrt{2} - 1$$

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

$$= 2\sqrt{2} - 1 + 8 + 1 - 4\sqrt{2} = 8 - 2\sqrt{2} \text{ sq. unit}$$

5. The value of $\frac{^{100}C_{50}}{51} + \frac{^{100}C_{51}}{52} + \dots + \frac{^{100}C_{100}}{101}$ is

(1) $\frac{2^{100}}{100}$ (2) $\frac{2^{101}}{101}$
 (3) $\frac{2^{100}}{101}$ (4) $\frac{2^{101}}{100}$

Answer (3)

Sol. $(1+x)^{100} = {}^{100}C_0 + {}^{100}C_{1x} + {}^{100}C_{2x^2} + \dots + {}^{100}C_{100x^{100}}$

$$\sum_{r=50}^{100} \frac{{}^{100}C_r}{r+1} = \frac{1}{101} \sum_{r=50}^{100} {}^{101}C_{r+1}$$

$$\begin{aligned}
 &\Rightarrow \frac{1}{101} \sum_{r=51}^{100} {}^{101}C_r \\
 &\Rightarrow \frac{2^{100}}{101}
 \end{aligned}$$

6. For given vectors $\vec{a} = -\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{b} = 2\hat{i} - \hat{j} + \hat{k}$ where $\vec{c} = \vec{a} \times \vec{b}$ and $\vec{d} = \vec{c} \times \vec{b}$. Then the value of $(\vec{a} - \vec{b}) \cdot \vec{d}$ is

(1) -35 (2) 53
 (3) -52 (4) 25

Answer (1)

Sol. $\vec{a} = -\hat{c} + \hat{j} + 2\hat{k}$

$$\vec{b} = 2\hat{c} - \hat{j} + \hat{k}$$

$$\vec{c} = \vec{a} \times \vec{b} = 3\hat{c} + 5\hat{j} - \hat{k}$$

$$\vec{d} = \vec{c} \times \vec{b}$$

Now

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

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

$$= -[\vec{a} \vec{b} \vec{c}]$$

$$= -35$$

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{c} & \hat{j} & \hat{k} \\ -1 & 1 & 2 \\ 2 & -1 & 1 \end{vmatrix} = 3\hat{c} + 5\hat{j} - \hat{k}$$

$$\text{And } [\vec{a} \vec{b} \vec{c}] = \begin{vmatrix} -1 & 1 & 2 \\ 2 & -1 & 1 \\ 3 & 5 & -1 \end{vmatrix} = 35$$

$$\Rightarrow -[\vec{a} \vec{b} \vec{c}] = -35$$

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7. The line $y = x + 1$ intersects the ellipse $\frac{x^2}{2} + \frac{y^2}{1} = 1$ at A and B . Find the angle subtended by segment AB and centre of ellipse is

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

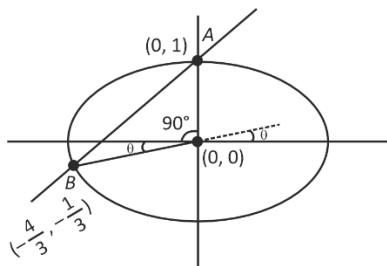
(2) $\frac{\pi}{2} - \tan^{-1}\left(\frac{1}{4}\right)$

(3) $\frac{\pi}{2} + 2\tan^{-1}\left(\frac{1}{4}\right)$

(4) $\frac{\pi}{4} + \tan^{-1}\left(\frac{1}{4}\right)$

Answer (1)

Sol.



$y = x + 1$ intersects $\frac{x^2}{2} + y^2 = 1$

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

$\Rightarrow x = 0, -\frac{4}{3}$

\Rightarrow Points A and B are

$(0, 1), \left(-\frac{4}{3}, -\frac{1}{3}\right)$

$\theta = \tan^{-1}\left(\frac{-1}{\frac{3}{-4}}\right) = \tan^{-1}\left(\frac{1}{4}\right)$

$\Rightarrow \angle AOB = \frac{\pi}{2} + \tan^{-1}\left(\frac{1}{4}\right)$

8. Find $\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{dx}{1 + (\tan 2x)^{1/3}}$

(1) $\frac{\pi}{24}$

(2) $\frac{\pi}{12}$

(3) $\frac{\pi}{6}$

(4) $\frac{\pi}{48}$

Answer (2)

Sol. $I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{1}{1 + (\tan 2x)^{1/3}} dx \quad \dots(1)$

$$\Rightarrow I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{1}{1 + \tan\left(2\left(\frac{5\pi}{24} + \frac{\pi}{24} - 4\right)\right)^{1/3}} dx$$

$$I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{1}{1 + \tan\left(\frac{\pi}{2} - 2x\right)^{1/3}} dx \quad \dots(2)$$

From equation (1) and (2)

$$2I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{(\tan(2x))^{1/3} + 1}{1 + (\tan 2x)^{1/3}} dx$$

$$= (x)\Big|_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \Rightarrow I = \frac{1}{2} \times \frac{4\pi}{24} = \frac{\pi}{12}$$

9. The number of solutions of $13\cos 2\theta + 8\cos \theta - 3\sqrt{3} = 0$ if $\theta \in [-3\pi, 2\pi]$ is

(1) 4

(2) 3

(3) 0

(4) 5

Answer (4)

Sol. $13[2\cos^2 \theta - 1] + 8\cos \theta - 3\sqrt{3} = 0$

$26\cos^2 \theta + 8\cos \theta - 13 - 3\sqrt{3} = 0$

$$\cos \theta = \frac{-8 \pm \sqrt{64 + 4 \times 26(13 + 3\sqrt{3})}}{52}$$

$$= \frac{-8 \pm \sqrt{1416 + 312\sqrt{3}}}{52} \approx 0.69$$

\therefore 5 Solution

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10. For the differential equation $x^4 dy + (4x^3 y + \sin x)dx = 0$ it is given that $y\left(\frac{\pi}{2}\right) = 0$. Then the value of $\pi^4 y\left(\frac{\pi}{3}\right)$ is equal to

(1) $\frac{9}{2}$ (2) $\frac{81}{2}$
 (3) $\frac{27}{2}$ (4) $\frac{243}{2}$

Answer (2)**Sol.** $x^4 dy + (4x^3 y + \sin x)dx = 0$

$$\frac{dy}{dx} + \frac{4x^3}{x^4} y = \frac{-\sin x}{x^4}$$

$$\frac{dy}{dx} + \frac{4}{x} y = \frac{-\sin x}{x^4}$$

$$\text{IF} = e^{\int \frac{4}{x} dx} = e^{\ln x^4} = x^4$$

$$x^4 \frac{dy}{dx} + 4x^3 y = -\sin x$$

$$\frac{d}{dx}(x^4 y) = -\sin x$$

$$\Rightarrow x^4 + y = \cos x + C$$

$$y\left(\frac{\pi}{2}\right) = 0$$

$$\Rightarrow C = 0$$

$$\therefore x^4 y = \cos x \Rightarrow y = \frac{\cos x}{x^4}$$

$$y\left(\frac{\pi}{3}\right) = \frac{\cos\left(\frac{\pi}{3}\right)}{\left(\frac{\pi}{3}\right)^4} = \frac{\frac{1}{2}}{\frac{\pi^4}{81}} = \frac{81}{2\pi^4}$$

$$\pi^4 y\left(\frac{\pi}{3}\right) = \frac{81}{2}$$

11. If coefficients of x , x^2 and x^3 are in arithmetic progression of the binomial expansion of $(1 + x^2)^2 (1 + x)^n$, $n \in \mathbb{N}$. Then sum of all values of n is

(1) 9 (2) 7
 (3) 8 (4) 10

Answer (1)**Sol.** Coefficient of x in

$$(1 + 2x^2 + x^4) (1 + x)^4$$

$${}^n C_1$$

Coefficient of x^2 is

$${}^n C_2 + 2 \cdot {}^n C_0$$

Coefficient of x^3 is

$${}^n C_3 + 2 \cdot {}^n C_1$$

⇒ since they are in A.P.

$$\Rightarrow \left({}^n C_1\right) + \left({}^n C_3 + 2 \cdot {}^n C_1\right) = 2 \left({}^n C_2 + 2 \cdot {}^n C_0\right)$$

$$\Rightarrow {}^n C_3 + 3 \cdot n = 2 \cdot \left({}^n C_2 + 2\right)$$

$$\Rightarrow \frac{n(n-1)(n-2)}{6} + 3n = 2(n(n-1) + 4)$$

$$\Rightarrow (n^2 - n)(n-2) + 18n = 6n^2 - 6n + 24$$

$$\Rightarrow n^3 - 3n^2 + 20n = 6n^2 - 6n + 24$$

$$\Rightarrow n^3 - 9n^2 + 26n - 24 = 0$$

$$n = 2, 3, 4$$

$$\Rightarrow \text{sum of all } n = 2 + 3 + 4 = 9$$

12. Let $f(x) = \int \frac{e^x (2-x^2)}{\sqrt{1+x} (1-x)^{\frac{3}{2}}} dx$, with $f(0) = 0$, then $f\left(\frac{1}{2}\right)$ is

$$(1) \sqrt{2e} + 1 \quad (2) \sqrt{2e} - 1$$

$$(3) \sqrt{3e} + 1 \quad (4) \sqrt{3e} - 1$$

Answer (4)

$$\text{Sol. } f(x) = \int e^x \left[\frac{1}{\sqrt{1-x^2} (1-x)} + \frac{(1-x^2)}{\sqrt{1-x^2} (1-x)} \right] dx$$

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$$P(1, 3, 5)$$

$$AP = \sqrt{(1-1)^2 + (6-3)^2 + (3-5)^2}$$

$$= \sqrt{9+4}$$

$$= \sqrt{13}$$

$$\text{Area } (\Delta ABC) = \frac{1}{2} \times 10 \times \sqrt{13}$$

$$= 5\sqrt{13}$$

16.

17.

18.

19.

20.

SECTION - B

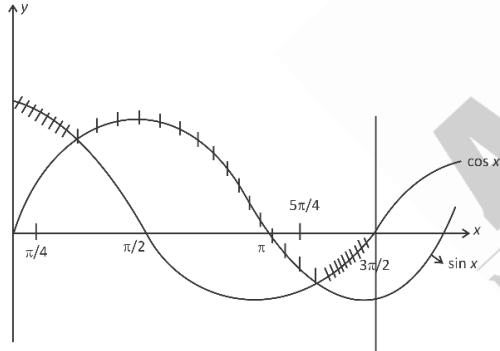
Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. The area (in square units) bounded by the curve $f(x) = \text{Max}\{\sin x, \cos x\}$ and x-axis between $x = 0$ and $x = \frac{3\pi}{2}$ is

A. Then, the value of $A + A^2$ is

Answer (3)

Sol.



$$\text{Required area} = \int_0^{\pi/4} \cos x \, dx + \int_{\pi/4}^{\pi} \sin x \, dx$$

$$\begin{aligned} & + \int_{\pi}^{5\pi/4} (-\sin x) \, dx + \int_{5\pi/4}^{3\pi/2} (-\cos x) \, dx \\ & = [\sin x]_0^{\pi/4} + [-\cos x]_{\pi/4}^{\pi} + [\cos x]_{\pi}^{5\pi/4} - [\sin x]_{5\pi/4}^{3\pi/2} \end{aligned}$$

$$= \frac{1}{\sqrt{2}} \left[1 + \frac{1}{\sqrt{2}} \right] + \left[-\frac{1}{\sqrt{2}} + 1 \right] - \left[-1 + \frac{1}{\sqrt{2}} \right]$$

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

$$= 3$$

22. The mean and variance of the 8 observations $-10, -7, -1, x, y, 16, 2, 9$ are $\frac{7}{2}$ and $\frac{293}{4}$ respectively. Then, the mean of $x, y, x+y+1, |x-y|$ is

Answer (11)

$$\text{Sol. Mean} = \frac{7}{2}$$

$$\frac{-10 - 7 - 1 + x + y + 16 + 2 + 9}{8} = \frac{7}{2}$$

$$\Rightarrow x + y + 9 = 28$$

$$\Rightarrow \boxed{x + y = 19}$$

$$\text{Var} = \frac{293}{4}$$

$$\frac{100 + 49 + 1 + x^2 + y^2 + 256 + 4 + 8}{8} - \frac{49}{4} = \frac{293}{4}$$

$$\frac{491 + x^2 + y^2}{8} = \frac{342}{4} \times 2$$

$$x^2 + y^2 = 193$$

$$\Rightarrow (x, y) = (7, 12) \text{ or } (12, 7)$$

$$\text{Mean} = \frac{x + y + x + y + 1 + (x - y)}{4}$$

$$= \frac{19 + 20 + 5}{4}$$

$$= 11$$

23.

24.

25.



Our Problem *Solvers* shine bright in **JEE 2025**

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AIR 36



RUJUL
GARG
AIR 41



ARUSH
ANAND
AIR 64



SHREYAS
LOHIYA
AIR 6
Uttar Pradesh Topper
100th in Overall



KUSHAGRA
BAINGAHA
AIR 7
Uttar Pradesh Topper
100th in Overall



HARSSH
A GUPTA
AIR 15
Telangana Topper
100th in Overall



and many more...

JEE (MAIN)