JEE (Main)-2025 (Online) Session-2
Memory Based Question with & Solutions
(Physics, Chemistry and Mathematics)
7th April 2025 (Shift-2)

Time: 3 hrs. **M.M.: 300**

IMPORTANT INSTRUCTIONS:

(1) The test is of 3 hours duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains Three Parts. Part-A is Physics, Part-B is Chemistry and Part-C is Mathematics. Each part has only two sections: Section-A and Section-B.

(4) Section - A : Attempt all questions.

(5) Section - B : Attempt all questions.

(6) Section - A (01 - 20) contains 20 multiple choice questions which have only one correct answer. Each question carries +4 marks for correct answer and -1 mark for wrong answer.

(7) Section - B (21 – 25) contains 5 Numerical value based questions. The answer to each question should be rounded off to the nearest integer. Each question carries +4 marks for correct answer and -1 mark for wrong answer.

MEMORY BASED QUESTIONS JEE–MAIN EXAMINATION – APRIL, 2025

(Held On Monday 7th April, 2025) **TIME : 3 : 00 PM to 6 : 00 PM**

PHYSICS

SECTION-A

1. Given below are two statements. One is labelled as Assertion (A) and the other is labelled as reason (R)

Assertion (A): Refractive index of glass is more than air

Reason (R): Optical density of a medium is directly related to its mass density.

In the light of the above statements, choose the correct answer from the options given below

(1) Both (A) and (R) are true and (R) is correct explanation of (A)

(2) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

(3) (A) is true but (R) is false

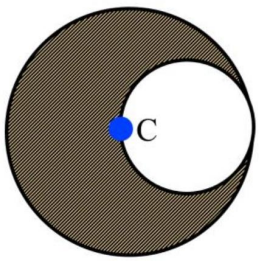
(4) (A) is false but (R) is true

Ans. **(3)**

Sol. Assertion → True

Reason → False

2. The figure shows a circular portion of radius $\frac{R}{2}$ removed from a disc of mass m and radius R. The moment of inertia about an axis passing through the centre C of the disc and perpendicular to the plane is



(1) $\frac{11}{64}mR^2$ (2) $\frac{mR^2}{16}$

(3) $\frac{mR^2}{2}$ (4) $\frac{13}{32}mR^2$

Ans. **(4)**

Sol. $I=\frac{MR^2}{2}+\frac{\left(-\frac{M}{4}\right)\left(\frac{R}{2}\right)^2}{2}+\left(-\frac{M}{4}\right)\left(\frac{R}{2}\right)^2$

$=\frac{mR^2}{2}-\frac{mR^2}{32}-\frac{mR^2}{16}$

$\frac{16mR^2-mR^2-2mR^2}{32}$

$=\frac{13}{32}mR^2$

3. Which of the following quantity has same dimensions as $\sqrt{\frac{\mu_0}{\varepsilon_0}}$?

(1) Resistance (2) Voltage

(3) Capacitance (4) Inductance

Ans. **(1)**

Sol. Ampere's law $B\ell : \mu_0 i$

Gauss' law $\frac{q}{\varepsilon_0}=EA$

$\sqrt{\frac{\mu_0}{\varepsilon_0}}=\left(\frac{1}{\sqrt{\mu_0\varepsilon_0}}\right)\mu_0=C\times\frac{B}{ni}$

$=\frac{C(EL)}{CNi}=\frac{V}{Ni}=R$

4. Give below are two statements. One is labelled as Statement-I and the other is labelled as Statement-II.

Statement-I: A magnetic monopole does not exist.

Statement-II : Magnetic lines are continuous and form closed loops.

In the light of the above statements, choose the correct answer from the options given below :-

(1) Statement-I is correct, statement-II is correct and statement-II is correct explanation of statement-I.

(2) Statement-I is correct, statement-II is correct and statement-II is not the correct explanation of statement-I.

(3) Statement-I is correct and statement-II is incorrect.

(4) Statement-I is incorrect and statement-II is correct.

Ans. **(1)**

Sol. $\oint B\cdot dA=0$

5. Potential energy is not defined for which of the force :-

(1) Gravitational force (2) Restoring force

(3) Friction (4) Electrostatic force

Ans. **(3)**

Sol. Frictional force is Non conservative force

6. The equation of a wave travelling on a string is $y = \sin[20\pi x + 10\pi t]$ where x and t are distances and time in SI units, the minimum distance between two points having zero oscillating speed is :-

(1) 20 cm (2) 5.0 cm

(3) 2.5 cm (4) 10 cm

Ans. **(2)**

Sol. $y = \sin[20\pi x + 10\pi t]$

$\omega = 10\pi$

$k = 20\pi$

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

$$\pi = 20\pi\,\Delta x$$

$$\Delta x = \frac{1}{20}m = 5cm$$

7. For a given physical expression $\sqrt{\frac{2I}{C\epsilon_0}}$ which of the unit matches :-

(1) N/C (2) m/s C

(3) Amp./m (4) N m/C

Ans. **(1)**

Sol. $$I = \frac{W}{m^2}$$

$C = m/s$

$$\varepsilon_0 = \frac{C^2}{Nm^2}$$

$$\sqrt{\frac{2I}{\varepsilon_0 C}} = \sqrt{\frac{W/m^2}{\frac{C^2}{Nm^2}\times m/s}} = \frac{N}{C}$$

8. Match the following :-

(a) Power (P) $[ML^{-3}T^0]$

(b) Mass density (Q) $[ML^2T^{-3}]$

(c) Angular Impulse (R) $[ML^2T^{-1}]$

(S) $[ML^3T^{-2}]$

(1) (a)-(Q), (b)-(P), (c)-(R)

(2) (a)-(Q), (b)-(P), (c)-(S)

(3) (a)-(S), (b)-(P), (c)-(R)

(4) (a)-(P), (b)-(Q), (c)-(R)

Ans. **(1)**

Sol. (a) Power = $[ML^2T^{-3}]$

(b) Mass density = $[ML^{-3}T^0]$

(c) Angular Impulse = $[ML^2T^{-1}]$

9. A helicopter is moving 2 km above the ground horizontally with a speed of 360 km/hr. A packet is dropped from helicopter, find distance between the points where the packet was released to the point where packet lands on the ground

(1) $\sqrt{2}$ km (2) $2\sqrt{2}$ km

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

Ans. **(2)**

Sol. $$R = \sqrt{\frac{2h}{g}}\times u$$

$$= 350\times\frac{5}{18}\times\sqrt{\frac{2\times2000}{10}}$$

$= 100\times20 = 2000m$

= 2 km

Distance between the points = $2\sqrt{2}$ km

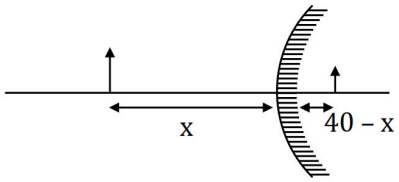
10. A convex mirror is used to produce an image with magnification of $\frac{1}{4}$. If the distance between object and its image is 40 cm, the focal length of the mirror is :-

(1) 12.7 cm (2) 15 cm

(3) 10 cm (4) 10.7 cm

Ans. **(4)**

Sol.



$$m = -\left(\frac{40-x}{-x}\right) = \frac{1}{4}$$

$$160 - 4x = x$$

$$x = 32$$

$$\frac{1}{8} - \frac{1}{32} = \frac{1}{f}$$

$$f = \frac{32}{3}\text{cm}$$

11. An object with mass 500 g moves along x-axis with speed $V = 4\sqrt{x}\ m/s$ then force acting on the object is :-

(1) 5 N (2) 6 N

(3) 8 N (4) 4 N

Ans. **(4)**

Sol. $v = 4\sqrt{x}$

$$a = v\frac{dv}{dx}$$

$$= 4\sqrt{x}\frac{2}{\sqrt{x}} = 8$$

$$F = 4N$$

12. A capillary tube is put in water which is having tube radius of 0.1 mm. Find capillary rise in the tube, If angle of contact = 30°, surface tension of liquid 70 dyne/cm, $\rho_{water} = \frac{1gram}{cm^3}$, g = 9.8 m/sec^2

(1) 21.35 cm (2) 12.37 cm

(3) 15.35 cm (4) 11.37 cm

Ans. **(2)**

Sol. $$h = \frac{2T\cos\theta}{\rho gr} = \frac{2\times 7\times\frac{\sqrt{3}}{2}}{1\times 980\times 0.01} = \frac{1.732}{0.14} = 12.37\text{cm}$$

13. Flux through a plane parallel to x-z plane is 6 SI units. Find area of plane if electric field in the region is $\vec{E} = (\hat{i} + 4\hat{j} + \hat{k})\ 10^3 N/C$.

(1) 2.5×10^{-2} m^2 (2) 2×10^{-3} m^2

(3) 2.5×10^{-3} m^2 (4) 1.5×10^{-3} m^2

Ans. **(4)**

Sol. $\phi = \vec{E}\cdot\vec{A}$

$$6 = \left(2\hat{i} + 4\hat{j} + 6\hat{k}\right)\cdot\left(A\hat{j}\right)\times 10^3$$

$$6 = 4A\times 10^3$$

$$\Rightarrow A = 1.5\times 10^{-3}\,m^2$$

14. **Assertion :** Aeroplane is made of metal to prevent from lighting strike.

Reason : Electric field in cavity inside conductor at equilibrium remain zero.

(1) Both Assertion and Reason are correct

(2) Assertion is correct but Reason incorrect

(3) Assertion is incorrect and Reason is correct

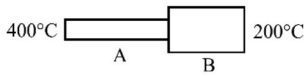
(4) Both are incorrect.

Ans. **(1)**

Sol. Assertion → Correct

Reason → Correct

15. If $\frac{L_A}{L_B} = 2, \frac{K_A}{K_B} = 2, \frac{R_A}{R_B} = \frac{1}{2}$, where L = length of Rod, K = thermal conductivity, R = Radius of cross-section of Rod.



Find temperature of Junction.

(1) 280°C (2) 300°C

(3) 240°C (4) 320°C

Ans. **(3)**

Sol. $$R_A = \frac{L_A}{K_A\pi R_A^2}$$

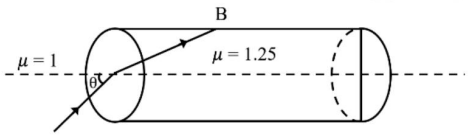
$$R_B = \frac{L_B}{K_B\pi R_B^2}$$

$$\frac{R_A}{R_B} = \frac{L_A}{L_B}\times\frac{K_B}{K_A}\times\frac{R_B^2}{R_A^2} = 2\times\frac{1}{2}\times 4 = 4$$

$$\text{Drop across A} = \frac{4}{5}\times 200 = 160°C$$

$$T = 400 - 160 = 240°C$$

16. The maximum value of θ (as shown in figure) for which total internal reflection can happen at point B is



(1) $\sin^{-1}\left(\frac{3}{4}\right)$ (2) $\cot^{-1}\left(\frac{3}{4}\right)$

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

Ans. **(1)**

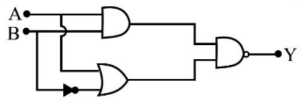
Sol. $\sin\theta_C = \frac{1}{\mu} = \frac{1}{5/4}$

$\theta_C = 53°$

$1\sin\theta = \frac{5}{4} \times \sin i$

$\sin\theta = \frac{5}{4} \times \sin 37° = \frac{5}{4} \times \frac{3}{5} = \frac{3}{4}$

17. Find input A and B for which output Y is zero



(1) A = 1, B = 1 (2) A = 0, B = 0

(3) A = 0, B = 1 (4) A = 1, B = 0

Ans. **(1)**

Sol. $A \rightarrow 1$

$B \rightarrow 1$

18. Distance between plates of capacitor is 0.5 mm, potential difference between plates is 5 volt. Now a dipole is placed between plates of capacitor, having its dipole moment parallel to electric field. Magnitude of one charge of dipole is 2 μC and distance between charges is 0.5 μm. Now dipole is tilted at an angle θ= 30°, then torque acting on the dipole is

(1) 5×10^{-8} Nm (2) 5×10^{-9} Nm

(3) 5×10^{-10} Nm (4) None of these

Ans. **(2)**

Sol. $E = \frac{5 \times 10}{0/5 \times 10^{-3}} = 10^4 V/m$

$\tau = PE\sin 30° = \left(2 \times 10^{-6} \times 0.5 \times 10^{-6}\right) \times 10^4 \times \frac{1}{2}$

$\tau = 5 \times 10^{-9}$ Nm

19. A photon of wavelength λ_1 is incident on a photo-sensitive surface of threshold wavelength λ_0 . The de-Broglie wavelength of fastest photoelectron is :-

(1) $\lambda_1 - \lambda_0$ (2) $\sqrt{\lambda_1^2 - \lambda_0^2}$

(3) $\sqrt{\frac{h}{2mc}\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_0}\right)}$ (4) $\sqrt{\frac{h}{2mc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_0}\right)}}$

Ans. **(4)**

Sol. $KE_{max} = \frac{hc}{\lambda_i} - \frac{hc}{\lambda_0} = hc\left(\frac{1}{\lambda_i} - \frac{1}{\lambda_0}\right)$

$\lambda = \frac{h}{\sqrt{2mKE}} = \frac{h}{\sqrt{2m_e hc\left(\frac{1}{\lambda_i} - \frac{1}{\lambda_0}\right)}}$

$\lambda = \sqrt{\frac{h}{2m_e c\left(\frac{1}{\lambda_i} - \frac{1}{\lambda_0}\right)}}$

SECTION - B

1. An inductor of reactance 50Ω, a capacitor of reactance 50 Ω and a resistor of resistance 100Ω are connected in series with an AC source 10V, 50 Hz. Average power dissipated by the circuit is _____ W.

Ans. **(1)**

Sol. $P = VI\cos\Delta\phi$

$Z = \sqrt{100^2} = 100\Omega$

$I_{rms} = \frac{10}{100} = \frac{1}{10} A$

$\tan\Delta\phi = \frac{X_C - X_L}{R} = 0$

$P_{avg} = 1W$

CHEMISTRY

SECTION-A

1. Which of the following is correct order of acidic character of oxides of vanadium?

(1) $V_2O_5 > VO_2 > V_2O_3$

(2) $V_2O_3 > VO_2 > V_2O_5$

(3) $V_2O_5 > V_2O_3 > VO_2$

(4) $VO_2 > V_2O_3 > V_2O_5$

Ans. **(1)**

Sol. For oxides of same element

As. O.S. increases, acidic character increases

So acidic character order $V_2O_5 > VO_2 > V_2O_3$

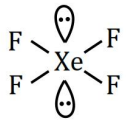
2. Which of the following is the correct Hybridisation of XeF_4?

(1) sp^3d (2) sp^3

(3) sp^3d^2 (4) sp^3d^3

Ans. **(3)**

Sol.



Steric Number = B.P. + l.P.

= 4 + 2 = 6

No. of hybrid orbitals formed = 6

Hybridization = sp^3d^2

3. Consider the following species

(i) $\underline{S}O_2$ (ii) $\underline{N}_3^-$ (iii) $\underline{N}O_2^-$

Find the hybridization of underlined atom.

(1) (i) sp^2 (ii) sp^2 (iii) sp^2

(2) (i) sp^2 (ii) sp (iii) sp^2

(3) (i) sp^3 (ii) sp (iii) sp^2

(4) (i) sp (ii) sp^2 (iii) sp^3

Ans. **(2)**

Sol. (i) $SO^2 \rightarrow sp^2$

(ii) $\underline{N}_3^- \rightarrow sp$

(iii) $\underline{N}O_2^- \rightarrow sp^2$

4. Match the following

	Complex	**Primary Valency**		**Secondary Valency**
(A)	$[Co(en)_2Cl_2]Cl$	(I)	3	6
(B)	$[Pt(NH_3)_2Cl(NO_2)]$	(II)	3	4
(C)	$[Co(SCN)_4]^{-1}$	(III)	2	6
(D)	$[Mg(EDTA)]^2$	(IV)	2	4

(1) A-I, B-II, C-IV, D-III

(2) A-III, B-IV, C-II, D-I

(3) A-III, B-IV, C-I, D-II

(4) A-I, B-IV, C-II, D-III

Ans. **(4)**

Sol.

(A) $\left[Co(en)_2Cl_2\right]Cl \Rightarrow$ Primary valency = 3

Sec. Valency = 6

(B) $\left[Pt(NH_3)_2Cl(NO_2)\right] \Rightarrow$ Primary valency = 2

Sec. Valency = 4

(C) $\left[CO(SCN)_4\right]^{-1} \Rightarrow$ Primary valency = 3

Sec. Valency = 4

(D) $\left[Mg(EDTA)\right]^{2-} \Rightarrow$ Primary valency = 2

Sec. Valency = 6

5. Among the given order, the incorrect order of atomic radii is

(1) $r_{Rb} < r_{Cs}$ (2) $r_{Mg} < r_{Al}$

(3) $r_{Cl} < r_{Br}$ (4) $r_K < r_{Rb}$

Ans. **(2)**

Sol. (1) $r_{Rb} < r_{Cs}$ correct

(2) $r_{Mg} < r_{Al}$ incorrect

(3) $r_{Cl} < r_{Br}$ correct

(4) $r_K < r_{Rb}$ correct

6. If P_A^o = 350 torr and P_B^o = 750 torr and the two volatile liquids (A) and (B) form an ideal solution. X_A and X_B are the respective k mole fraction of (A) and (B) in solution and YA and YB are the respective mole fraction of (A) and (B) in the vapour phase. Which one of the following relation is correct?

(1) $\frac{Y_A}{Y_B} = \frac{X_A}{X_B}$ (2) $\frac{Y_A}{Y_B} < \frac{X_A}{X_B}$

(3) $\frac{Y_A}{Y_B} > \frac{X_A}{X_B}$ (4) $\frac{Y_A}{Y_B} = \frac{X_B}{X_A}$

Ans. **(2)**

Sol. $P_A = P_A^o X_A = P_T \times Y_A$ ....(1)

$P_B = P_B^o X_B = P_T \times Y_B$ ....(2)

Dividing eq. (1) by (2)

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

$$\frac{350 \times X_A}{750 \times X_B} = \frac{Y_A}{Y_B}$$

$$\frac{X_A}{X_B} > \frac{Y_A}{Y_B}$$

7. Match List-I with List-II and select the correct option.

List-I (Solution)		List-II (Properties)	
(A)	Benzene + Toluene	(P)	Show +ve deviation
(B)	Aniline + CH_3COOH	(Q)	$\Delta v_{mix} = 0$
(C)	Water + ethanol	(R)	ΔH_{mix} = –ve
(D)	Acetone + $CHCl_3$	(S)	Form minimum boiling Azeotrope.

(1) A → Q; B → R; C → P,S; D → R

(2) A → S; B → Q; C → P,S; D → R

(3) A → Q; B → P, S; C → R; D → P

(4) A → P; B → S; C → P; D → R

Ans. **(1)**

Sol.

(A) Benzene + Toleune ⇒ Ideal solution ($\Delta V_{mix} = 0$)

(B) Aniline + CH_3COOH ⇒ Negative deviation (ΔH_{mix} = negative)

(C) Water + ethanol ⇒ Positive deviation (Form minimum boiling Azeotrope.)

(D) Acetone + $CHCl_3$ ⇒ Negative deviation (ΔH_{mix} = negative)

8. List-I mentions thermodynamic process of List-II mention property

List-I		List-II	
(A)	Isothermal	(I)	q = 0
(B)	Adiabatic	(II)	$\Delta T = 0$
(C)	Isobaric	(III)	$\Delta V = 0$
(D)	Isochoric	(IV)	$\Delta P = 0$

(1) A → II; B → I; C → IV; D → III

(2) A → I; B → II; C → III; D → IV

(3) A → I; B → IV; C → III; D → II

(4) A → II; B → I; C → III; D → IV

Ans. **(1)**

Sol. (A) Isothermal ⇒ $\Delta T = 0$

(B) Adiabatic ⇒ q = 0

(C) Isobaric ⇒ $\Delta P = 0$

(D) Isochoric ⇒ $\Delta V = 0$

9. In electrolysis of aqueous solution of $AgNO_3$, $Cu(NO_3)_2$, $Hg(NO_3)_2$ and $Au(NO_3)_3$ is carried out, then correct order of deposition of metal cathode give

Metal ion	SRP(V)
Ag^+/Ag	0.79
Cu^{2+}/Cu	0.34
Hg^{2+}/Hg	0.85
Au^{3+}/Au	1.4

(1) Au > Hg > Ag > Cu

(2) Au > Hg > Cu > Ag

(3) Au > Ag > Hg > Cu

(4) Cu > Ag > Hg > Au

Ans. **(1)**

Sol.

Metal ion	SRP(V)
Ag^+/Ag	0.79
Cu^{2+}/Cu	0.34
Hg^{2+}/Hg	0.85
Au^{3+}/Au	1.4

Higher the SRP higher the tendency to get reduced on cathode.

10. How many of the following coordination compounds having same coordination number and paramagnetic in nature?

$K_3[Fe(CN)_6]$, $K_4[Fe(CN)_6][Cu(NH_3)_4]SO_4$, K_2HgI_4, $[Ni(H_2O)_6]^{2+}$

(1) 2 (2) 3 (3) 1 (4) 4

Ans. **(1)**

Sol.

	C.No.
$K_3[Fe(CN)_6]$ Fe^{+3} : $3d^5$ Paramagnetic	6
$K_4[Fe(CN)_6]$ Fe^{+2} : $3d^6$ Diamagnetic	6
$[Cu(NH_3)_4]SO_4$ Cu^{+2} : $3d^9$ Square planar Paramagnetic	4
$K_2[HgI_4]$ Hg^{+2} : $5d^{10}$ tetrahedral diamagnetic	4
$[Ni(H_2O)_6]^{+2}$ Ni^{+2} : $3d^8$ Paramagnetic	6

11. Hydration energy of K^+ is –x kJ/mol and of Cl^- is –y kJ/mol and lattice energy of KCl is –Z kJ/mol then what is the heat of dissolution of KCl?

(1) Z – (x + y) (2) –Z – (x + y)

(3) Z + x + y (4) –Z + (x + y)

Ans. **(1)**

Sol

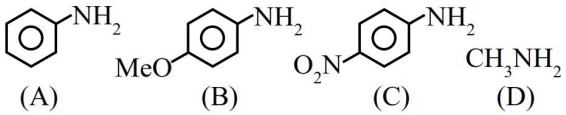
$$K^+_{(g)} + Cl^-_{(g)} \rightarrow KCl_{(s)} : L.E. = -Z \text{ kJ/mol}$$

$\Delta H_{Sol.} = -x$ kJ/mol ↓ $K^+_{(aq)}$ + $\Delta H_{Sol.} = -y$ kJ/mol ↓ $Cl^-_{(aq)}$

$\Delta H_{dissolution}$ ←

$$\Delta H_{dissolution} = Z + (-x - y)$$
$$= Z - (x + y)$$

12. The correct order to basic strength of the following molecules is



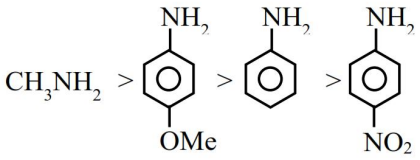
(A) (B) (C) (D)

(1) A > B > C > D (2) B > C > D > A

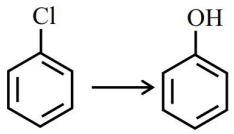
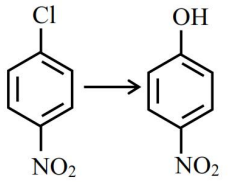
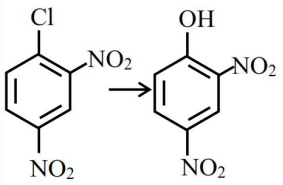
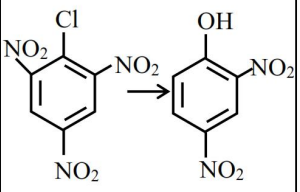
(3) D > B > A > C (4) B > A > C > D

Ans. **(3)**

Sol. Basic strength



13. Match the following List-I with List-II:

List-I (Reactions)		List-II (Reaction Temperature)	
(A)		(I)	Slight Warming
(B)		(II)	368 K
(C)		(III)	443 K
(D)		(IV)	623 K

Choose the correct answer from the options given below:

(1) A-II, B-III, C-I, D-IV

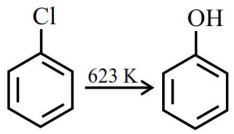
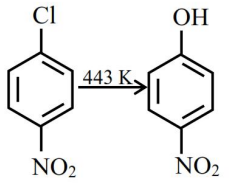
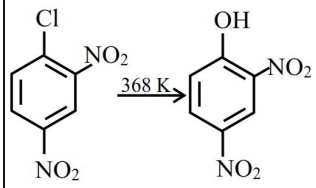
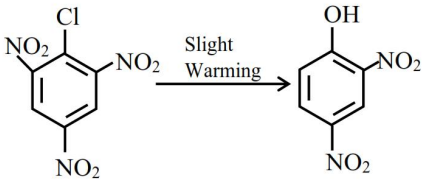
(2) A-IV, B-III, C-II, D-I

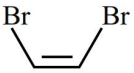
(3) A-I, B-II, C-III, D-IV

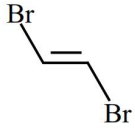
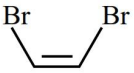
(4) A-II, B-IV, C-III, D-I

Ans. **(2)**

Sol.

(Reactions)	
(A)	
(B)	
(C)	
(D)	

14. Assertion :  has more dipole moment than 

Reason :  has more boiling point than 

Choose the correct option.

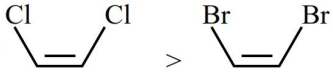
(1) Both Assertion and Reason are correct, Reason is correct explanation of Assertion.

(2) Both Assertion and Reason are correct, Reason is not correct explanation of Assertion.

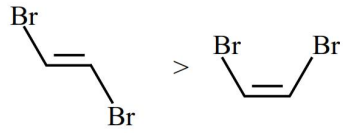
(3) Assertion is correct, Reason is incorrect.

(4) Assertion is incorrect, Reason is correct.

Ans. **(3)**

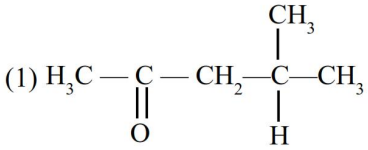
Sol. Dipole moment 

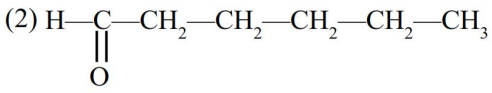
Due to more E.N. of Cl as compare to Br:

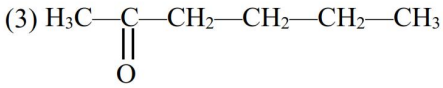
B.P. 

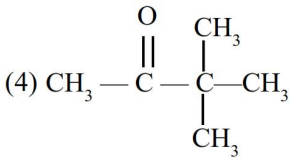
$\mu = 0$ $\mu \neq 0$

15. Which of the following compounds molecular formula $C_6H_{12}O$. Positively to 2,4-DNP test and Tollen's regent test

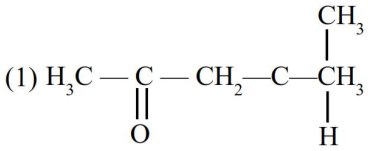
(1) 

(2) 

(3) 

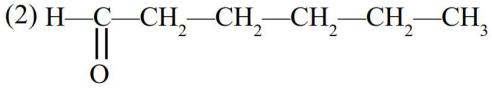
(4) 

Ans. **(2)**

Sol. (1) 

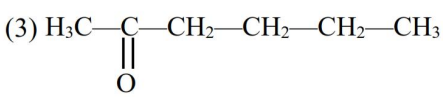
Positive 2,4-DNP

Negative Tollen's test

(2) 

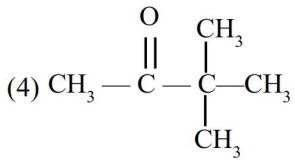
Positive 2,4-DNP

Positive Tollen's test

(3) 

Positive 2,4-DNP

Negative Tollen's test

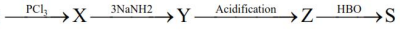
(4) 

Positive 2,4-DNP

Negative Tollen's test

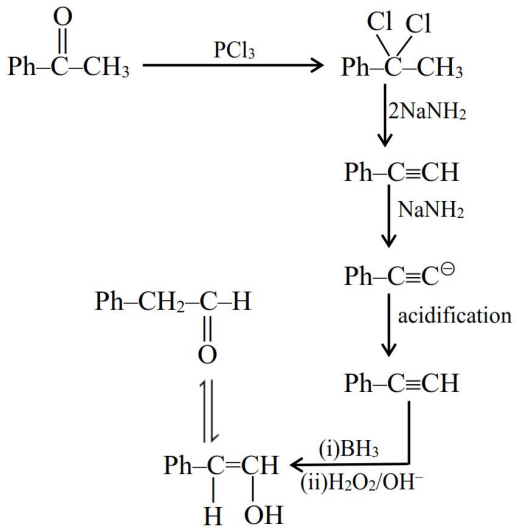
SECTION-B

16. Find the number of sp^2 carbons in the final product 's'.

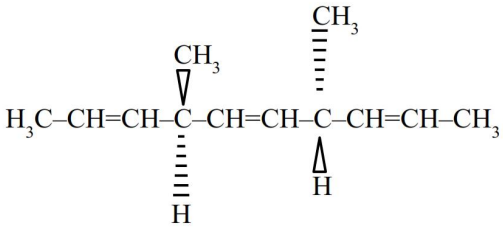


Ans. **(7)**

Sol.



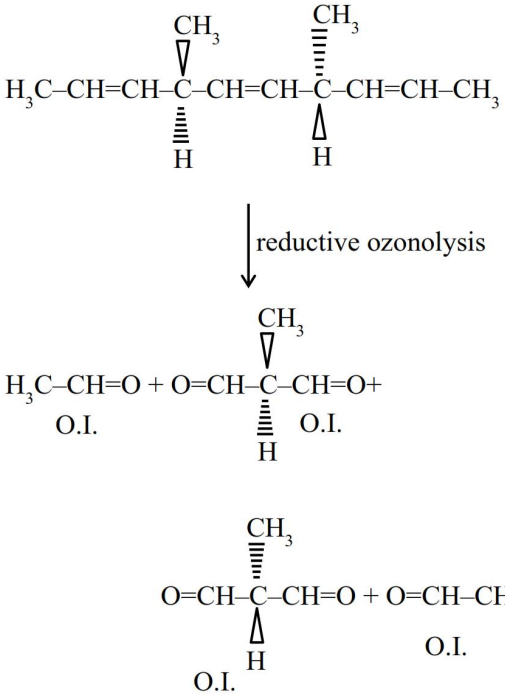
17. Consider the following molecule



Number of optically active molecule(s) formed after complete reductive ozonolysis of above compound is

Ans. **(0)**

Sol.



18. Consider the following oxides

V_2O_5, Cr_2O_3, Mn_2O_7, V_2O_3

Number of oxides which are acidic is x.

Consider the following complex compound $[Co(NH_2CH_2CH_2NH_2)_3]_2(SO_4)_3$

The primary valency of complex is y

The value of x + y is

Ans. **(4)**

Sol. Acidic oxide $\Rightarrow Mn_2O_7$

Amphoteric oxide $\Rightarrow V_2O_5, Cr_2O_3$

Basic oxide $\Rightarrow V_2O_3$

x = no. of acidic oxide = 1

$[Co(NH_2CH_2CH_2NH_2)_3]_2(SO_4)_3 \Rightarrow CO^{3+}$

Primary valency = oxidation state of CMA = 3

y = 3

x + y = 1 + 3 = 4

19. Total number of ions having $3d^5$ electronic configuration.

Fe^{+2}, Co^{+2}, Mn^{+2}, Fe^{+3}, Cu^{+}, Cr^{+}

Ans. **(3)**

Sol. Mn^{+2}, Fe^{+3}, Cr^{+}

20. Consider the reaction given below:

$C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O.$

If 174 g of butane reacts with 320 g of O_2. Find the volume of H_2O formed in ml. (given density of H_2O is 1 g/ml)

Ans. **(138)**

Sol. $C_4H_{10(g)} + \frac{13}{2}O_{2(g)} \longrightarrow 4CO_{2(g)} + 5H_2O(\ell)$

$n_{C_4H_{10}} = \frac{174}{58} = 3 \quad n_{O_2} = \frac{320}{32} = 10$

Stoichiometric ratio

$\frac{3}{1} \qquad \frac{10}{\frac{13}{2}} = \frac{20}{13} = 1.53$

L.R.

$\frac{13}{2}$ mol O_2 produces moles of H_2O = 5

1 mol O_2 produces moles of $H_2O = \frac{5}{13/2} = \frac{10}{13}$

10 mol O_2 produces moles of $H_2O = \frac{10}{13} \times 10 = \frac{100}{13}$

Mass of H_2O produced $= \frac{100}{13} \times 18 = 138.46 \approx 138$

Volume of H_2O produced $= 138 \times 1$ ml

= 138 ml

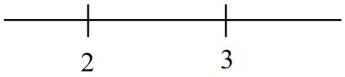
MATHEMATICS

1. If $x|x-3|+3|x-2|+1=0$, then the number of real solution is

(1) 1 (2) 2 (3) 4 (4) 6

Ans. **(1)**

Sol. $x|x-3|+3|x-2|+1=0$



In $(-\infty, 2)$

$-x^2+3x-3(x-2)+1=0$

$-x^2+7=0$

$x=\pm\sqrt{7}$ but $x=-\sqrt{7}$ only

In [2, 3]

$-x(x-3)+3(x-2)+1=0$

$-x^2+3x+3x-5=0$

$x^2-6x+5=0$

$x=1,5$

Hence no solution in [2, 3]

In $(3, \infty)$

$x(x-3)+3(x-2)+1=0$

$x^2-5=0$

$x=\pm\sqrt{5}$

Hence no solution in $(3, \infty)$

2. $Re\left(\frac{2z+i}{z+i}\right)+Re\left(\frac{2\bar{z}-i}{\bar{z}-i}\right)=2$ is a circle of radius r and centre (a, b), then $\frac{15ab}{r^2}$ is equal to

Ans. **(0)**

Sol. Since $\mathrm{Re}(z)+\mathrm{Re}(\bar{z})=2\mathrm{Re}(z)$

hence $2\mathrm{Re}\left(\frac{2z+i}{z+i}\right)=2$

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

$2x^2 + 2y^2 + 3y + 1 = x^2 + 2y + 1 + y^2$

$x^2 + y^2 + y = 0$

centre $\left(0,-\frac{1}{2}\right)$

$$\frac{2z+i}{z+i}$$

$$=\frac{2x+i(2y+1)}{x+i(y+1)}$$

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

$$\frac{15ab}{r^2}=0$$

3. Let $\vec{a}$ and $\vec{b}$ be the vectors of the same magnitude such that $\frac{|\vec{a}+\vec{b}|+|\vec{a}-\vec{b}|}{|\vec{a}+\vec{b}|-|\vec{a}-\vec{b}|}=\sqrt{2}+1$,

then the value of $\frac{|\vec{a}+\vec{b}|^2}{|\vec{a}|^2}$ is equal to

Ans. $2+\sqrt{2}$

Sol. $$\frac{|\vec{a}+\vec{b}|+|\vec{a}-\vec{b}|}{|\vec{a}+\vec{b}|-|\vec{a}-\vec{b}|}=\frac{\sqrt{2}+1}{1}$$

Using componendo and dividendo

$$\Rightarrow \frac{2|\vec{a}+\vec{b}|}{2|\vec{a}-\vec{b}|}=\frac{\sqrt{2}+2}{\sqrt{2}}$$

$$\Rightarrow |\vec{a}+\vec{b}|=|1+\sqrt{2}||\vec{a}-\vec{b}|$$

$$\Rightarrow \frac{|\vec{a}+\vec{b}|^2}{|\vec{a}-\vec{b}|^2}=\left(1+\sqrt{2}\right)^2$$

$$=3+2\sqrt{2}$$

$$\Rightarrow \frac{a^2+a^2+2a^2\cos\theta}{a^2+a^2-2a^2\cos\theta}=3+2\sqrt{2}$$

$$\Rightarrow \frac{4}{4\cos\theta}=\frac{4+2\sqrt{2}}{2+2\sqrt{2}}$$

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

$$\Rightarrow \frac{|\vec{a}+\vec{b}|^2}{|\vec{a}|^2}=\frac{a^2+a^2+2a^2\frac{1}{\sqrt{2}}}{a^2}$$

$$=2+\sqrt{2}$$

4. Let $f(x) = \frac{5-x}{x^2-3x+2}$, if range of $f(x)$ is $(-\infty, \alpha] \cup [\beta, \infty)$. Then $\alpha^2 + \beta^2$ equals to

Ans. **(194)**

Sol. $y = \dfrac{5-x}{x^2-3x+2}$

$\Rightarrow x^2y - 3xy + 2y - 5 + x = 0$

$\Rightarrow x^2y + x(1-3y) + 2y - 5 = 0$

solution must satisfy $y \neq 0$ and $D \geq 0$

$D \geq 0 \Rightarrow (1-3y)^2 - 4y(2y-5) \geq 0$

$\Rightarrow 1 + 9y^2 - 6y - 8y^2 + 20y \geq 0$

$\Rightarrow y^2 + 14y + 1 \geq 0$

solution for $y^2 + 14y + 1 = 0$ are $\dfrac{-14 \pm \sqrt{192}}{2} = \dfrac{-14 \pm 8\sqrt{3}}{2}$

$= -7 \pm 4\sqrt{3}$

So, $y \in \left(-\infty -7-4\sqrt{3}\right] \cup \left[-7+4\sqrt{3}, \infty\right)$

So, $\alpha^2 + \beta^2 = \left(-7-4\sqrt{3}\right)^2 + \left(-7+4\sqrt{3}\right)^2 = 194.$

5. Let $f(x)$ be a polynomial of degree 4 such that it has $x = 4,5$ as extremas. If $\lim\limits_{x\to 0} \frac{f(x)}{x^2} = 5$, then $f(2) =$

Ans.

Sol. $\lim\limits_{x\to 0} \dfrac{f(x)}{x^2} = 5$

$\lim\limits_{x\to 0} \dfrac{f(x)}{x^2} = \lim\limits_{x\to 0} \dfrac{ax^4 + bx^3 + cx^2 + dx + e}{x^2}$

$\Rightarrow c = 5$ and $d = e = 0$

$f(x) = ax^4 + bx^3 + 5x^2$

$f'(x) = 4ax^3 + 3bx^2 + 10x = 0$

$\Rightarrow x(4ax^2 + 3bx + 10) = 0$

$\Rightarrow x\left(\dfrac{x^2}{2} - \dfrac{9x}{2} + 10\right) = 0$

$\Rightarrow a = \dfrac{1}{8}$ and $b = \dfrac{-3}{2}$

So, $f(2) = \dfrac{1}{8}(2)^4 - \dfrac{3}{2}(2)^3 + 5(2)^2$

$= 2 - 12 + 20 = 10$

6. Let p denote no. of $\Delta's$ possible from the vertices of n sided regular polygon & q denote no. of quadrilateral possible from the same. If $p + q = 126$, then eccentricity of $\dfrac{x^2}{16} + \dfrac{y^2}{n} = 1$ is

Ans. $\dfrac{1}{\sqrt{2}}$

Sol. According to question

${}^{n}C_3 + {}^{n}C_4 = 126$

$\Rightarrow {}^{n+1}C_4 = 126 \Rightarrow {}^{9}C_4 \Rightarrow n + 1 = 9 \Rightarrow n = 8$

So, the ellipse is $\frac{x^2}{16}+\frac{y^2}{8}=1$

$e=\sqrt{1-\frac{8}{16}}=\frac{1}{\sqrt{2}}$

7. A box contains 19 unbiased coins and 1 biased coin with both faces head. If a coin is randomly chosen out of this box and tossed, if the head appears, then the probability that the unbiased coin was selected

(1) $\frac{1}{6}$ (2) $\frac{1}{3}$ (3) $\frac{1}{5}$ (4) $\frac{19}{21}$

Ans. **(4)**

Sol. Required probability $= \dfrac{\frac{19}{20}\times\frac{1}{2}}{\frac{19}{20}\times\frac{1}{2}+\frac{1}{20}\times 1}=\frac{19}{21}$

8. If $f(\theta)=\frac{\tan(\tan\theta)-\tan(\sin\theta)}{\tan\theta-\sin\theta}$ is continuous at $\theta=0$, then the valueof $f(\theta)$ at $\theta=0$ is equal to

Ans. **(1)**

Sol. $f(0)=\lim\limits_{\theta\to 0} f(\theta)=\lim\limits_{\theta\to 0}\dfrac{\tan(\tan\theta)-\tan(\sin\theta)}{\tan\theta-\sin\theta}$

$=\lim\limits_{\theta\to 0}\dfrac{\frac{\sin(\tan\theta-\sin\theta)}{\cos(\tan\theta)\cdot\cos(\sin\theta)}}{(\tan\theta-\sin\theta)}=1$

9. Let a random variable X take values 0, 1, 2, 3 with $P(X=0)=P(X=1)=p$ and $P(X=2)=P(X=3)$ and $E(X^2)=2E(X)$, then the value of $8p-1$ is equal to

Ans. **(2)**

Sol. $2p + 2q = 1$

$p+q=\frac{1}{2}$

$E(x^2)=\sum\limits_{i=0}^{3}x_i^2P(x_i)=0\cdot p+1\cdot p+4\cdot q+9\cdot q = p + 13q$

$E(x)=\sum\limits_{i=0}^{3}x_iP(x_i)=0\cdot p+1\cdot p+2q+3q = p+5q$

$\Rightarrow p + 13q = 2(p + 5q)$

$\Rightarrow p = 3q$

So, $q=\frac{1}{8}$ & $p=\frac{3}{8}$

So, $8p-1=2$

10. Let a_n be the n^{th} term of an A. P. If $S_n = a_1 + a_2 + a_3 + \cdots + a_n = 700$, $a_6 = 7$ and $S_7 = 7$, then a_n is equal to

Ans. **(64)**

Sol. $S_n = 700 \Rightarrow \frac{n}{2}\left[2a+(n-1)d\right] = 700$ …(i)

$a_6 = 7 \Rightarrow a+5d = 7$ …(ii)

$S_7 = 7 \Rightarrow \frac{7}{2}\left[2a+6d\right] = 7$

$\Rightarrow 2a+6d = 2$ …(iii)

Solving (ii) & (iii)

a = –8, d = 3

$\frac{n}{2}\left[-16+3n-3\right] = 700$

$\Rightarrow 3n^2 - 19n - 1400 = 0$

$\Rightarrow (3n+56)(n-25) = 0$

$\therefore n = 25$

$\therefore a_{25} = a+24d$

$= -8+24\times 3$

$= -8+72$

$= 64$

11. Let $y = y(x)$ and $(1+x^2)y' - 2xy = (x^4+2x^2+1)\cos x$. If $y(0) = 1$, then $\int_{-3}^{3} y(x)dx$ is equal to

(1) 10 (2) 15 (3) 20 (4) 24

Ans. **(4)**

Sol. $\left(1+x^2\right)y' - 2xy = \left(x^2+1\right)^2 \cos x$

$y' - \frac{2x}{1+x^2}y = \left(1+x^2\right)\cos x$

$P = \frac{-2x}{1+x^2}, Q = \left(1+x^2\right)\cos x$

I.F. $= e^{-\int \frac{2x}{1+x^2}dx} = e^{-\ell n\left(1+x^2\right)} = \frac{1}{1+x^2}$

$y \times \frac{1}{1+x^2} = \int \cos x dx$

$\frac{y}{1+x^2} = \sin x + c \Rightarrow y = \left(1+x^2\right)(\sin x + c)$

$c = 1$

$y = \left(1+x^2\right)(\sin x + 1)$

$I = \int_{-3}^{3} \left\{\left(1+x^2\right)\sin x + \left(1+x^2\right)\right\} dx$

$= 2\int_{0}^{3} \left(1+x^2\right)dx = 2\left(\frac{x^3}{3}+x\right)\Big|_0^3$

$= 2(9+3) = 24$

12. The sum of series ${}^2C_1 \cdot (1 \times 2) + {}^3C_2 \cdot (2 \times 3) + {}^4C_3 \cdot (3 \times 4) + \cdots + {}^{19}C_{18} \cdot (18 \times 19)$ is S, then $\frac{S}{295}$ is equal to

(1) 103 (2) 104 (3) 107 (4) 114

Ans. **(4)**

Sol. $S = 2 \cdot (1 \times 2) + 3(2 \times 3) + 4(3 \times 9) + \ldots.. + 19\,(18 \times 19)$

$$S = \sum_{r=1}^{18} r(r+1)^2 \Rightarrow S = \sum_{r=1}^{18} r(r+1)(r+2-1)$$

$$\Rightarrow S = \sum_{r=1}^{18} r(r+1)(r+2) - \sum_{r=1}^{18} r(r+1)$$

$$\Rightarrow S = \frac{1}{4}\sum_{r=1}^{18}\left[r(r+1)(r+2)(r+3-(r-1))\right] - \frac{1}{3}\sum_{r=1}^{18} r(r+1)(r+2-(r-1))$$

$$= \frac{1}{4} \times 18 \times 19 \times 20 \times 21 - \frac{1}{3} \times 18 \times 19 \times 20$$

$$S = 18 \times 19 \times 20\left[\frac{21}{4} - \frac{1}{3}\right]$$

$$S = 18 \times 19 \times 20 \times \frac{59}{12} = 6 \times 19 \times 295$$

$$\frac{S}{295} = 6 \times 19 = 114$$

13. Let the length of a latus rectum of an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ be 10. If its eccentricity is the minimum value of the function $f(t) = t^2 + t + \frac{11}{12}$, $t \in \mathbb{R}$, then $a^2 + b^2$ is equal to

Ans. **(126)**

Sol. $\frac{2b^2}{a} = 10 \Rightarrow b^2 = 5a$

$$e = f(t)\big|_{\min} = t^2 + t + \frac{11}{12}\bigg|_{t=\frac{-1}{2}} = \frac{1}{4} - \frac{1}{2} + \frac{11}{12}$$

$$= \frac{3-6+11}{12} = \frac{8}{12}$$

$$\Rightarrow \sqrt{1 - \frac{b^2}{a^2}} = \frac{2}{3}$$

$$\Rightarrow 1 - \frac{b^2}{a^2} = \frac{4}{9} \Rightarrow \frac{b^2}{a^2} = \frac{5}{9} \Rightarrow b^2 = \frac{5a^2}{9}$$

$$\Rightarrow 5a = \frac{5a^2}{9} \Rightarrow a = 9 \text{ ; So, } b^2 = 45$$

Hence, $a^2 + b^2 = 81 + 45 = 126$.

14. Let α and β be roots of the equation $\left[(t+2)^{\frac{1}{7}}-1\right]x^2+\left[(t+2)^{\frac{1}{6}}-1\right]x+\left((t+2)^{\frac{1}{21}}-1\right)=0.$

If $\lim\limits_{t\to-1}\alpha=a$ and $\lim\limits_{t\to-1}\beta=b$, then $72(a+b)^2$ is equal to

(1) 36 (2) 49 (3) 75 (4) 98

Ans. **(4)**

Sol. $$a+b=\lim_{x\to-1}-\frac{\left[(t+2)^{\frac{1}{6}}-1\right]}{\left[(t+2)^{\frac{1}{7}}-1\right]}$$

$$=\lim_{h\to0}-\frac{\left[(1+h)^{\frac{1}{6}}-1\right]}{\left[(1+h)^{\frac{1}{7}}-1\right]}$$

$$=\lim_{h\to0}-\frac{\left[\frac{h}{6}\right]}{\frac{h}{7}}=\frac{-7}{6}$$

So, $72(a+b)^2=72\times\frac{49}{36}=98$

15. If the equation of the line passing through the point $\left(0,\ -\frac{1}{2},\ 0\right)$ and Perpendicular to the lines

$\vec{r}=\lambda(\hat{\imath}+a\hat{\jmath}+b\hat{k})$ and $\vec{r}=(\hat{\imath}-\hat{\jmath}-6\hat{k})+\mu(-b\hat{\imath}+a\hat{\jmath}+5\hat{k})$ is $\frac{x-1}{-a}=\frac{y+4}{d}=\frac{z-c}{-4}$,

then $a+b+c+d$ is equal to

(1) 10 (2) 12 (3) 13 (4) 14

Ans. **(4)**

Sol. $\vec{\ell}=(1,a,b)\times(-b,a,5)$

$=(5a-ab,-b^2-5,a+ab)$

$\Rightarrow\frac{5a-ab}{-a}=\frac{-b^2-5}{d}=\frac{a+ab}{-4}$

$\Rightarrow\frac{b-5}{1}=\frac{-b^2-5}{d}=\frac{a+ab}{-4}$

So, $20-4b=a+ab\Rightarrow20=a+ab+4b$ …(i)

$\Rightarrow\frac{0-1}{-a}=\frac{-\frac{1}{2}+4}{d}=\frac{0-c}{-4}\Rightarrow\frac{1}{a}=\frac{7}{2d}=\frac{c}{4}$ …(ii)

So, $d=\frac{7}{2}a$ $\qquad b-5=\frac{-b^2-5}{\frac{7a}{2}}\Rightarrow7ab=35a-2b^2-10$ …(iii)

$\Rightarrow a=\frac{20-4b}{1+b}$

$$\Rightarrow b-5=\frac{-b^2-5}{\frac{7a}{2}} \Rightarrow b-5=\frac{-2\ b^2+5}{7a}$$

$$\Rightarrow 7a=-2\frac{\left(b^2+5\right)}{b-5}=\frac{2b^2+10}{5-b}$$

On solving b = 3, a = 2, d = 7, c = 2

$\Rightarrow$ a + b + c + d = 14

16. Let $A=\{(\alpha,\ \beta)\in\mathbb{R}\times\mathbb{R}:|\alpha-1|\le 4 \text{ and } |\beta-5|\le 6\}$ and

$B=\{(\alpha,\beta)\in\mathbb{R}\times\mathbb{R}:16(\alpha-2)^2+9(\beta-6)^2\le 144\}$, then

(1) Neither $A\subset B$ nor $B\subset A$

(2) $A\subset B$

(3) $A\cup B=\{(x,y):-4\le x\le 4,-1\le y\le 1\}$

(4) $B\subset A$

Ans. **(2)**

Sol. For α

$$-4\le\alpha-1\le 4$$

$$-3\le\alpha\le 5$$

For β

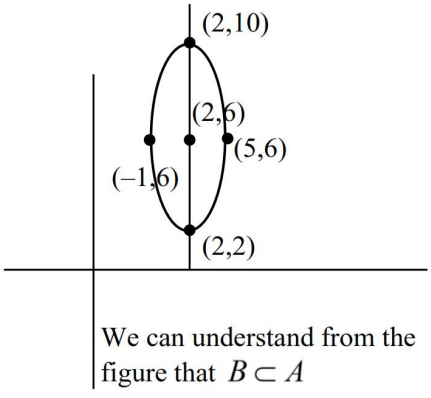
$$|\beta-5|\le 6$$

$$\Rightarrow -6\le\beta-5\le 6$$

$$-1\le\beta\le 11$$

$$16(\alpha-2)^2+9(\beta-6)^2\le 144$$

$$\Rightarrow \frac{(\alpha-2)^2}{9}+\frac{(\beta-6)^2}{16}\le 1$$



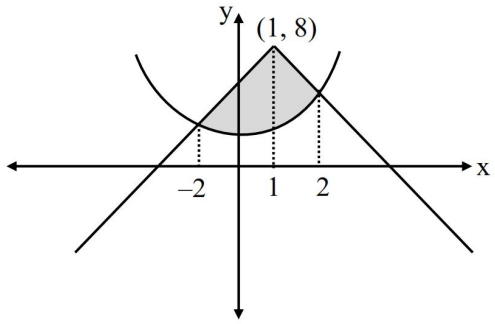
We can understand from the figure that $B\subset A$

17. If the area of the region $\{(x, y): 1 + x^2 \leq y \leq \min\{x + 7, 11 - 3x\}\}$is A, then $3A$ is equal to

(1) 46 (2) 47 (3) 49 (4) 50

Ans. **(4)**

Sol.



$x + 7 = 11 - 3x$

$\Rightarrow x = 1$

and $1 + x^2 = x + 7$

$\Rightarrow x^2 - x - 6 = 0$

$\Rightarrow (x + 5)(x - 2) = 0$

$x = -5, 2$

$$Area = \int_{-2}^{1}\left(7 - x^2 + x\right)dx + \int_{1}^{2}\left(11 - 3x - x^2 - 1\right)dx = \frac{50}{3}$$

18. The number of solutions of the equation $\cos 2\theta \cos\frac{\theta}{2} + \cos\frac{5\theta}{2} = 2\cos^3\frac{5\theta}{2}$ in $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ is

Ans. **(7)**

Sol. $$\cos 2\theta \cos\left(\frac{\theta}{2}\right) + \cos\frac{5\theta}{2} = 2\cos^3 = \frac{5\theta}{2}$$

$$\Rightarrow \frac{1}{2}\left(2\cos 2\theta \cos\frac{\theta}{2}\right) + \cos\frac{5\theta}{2} = \frac{1}{2}\left(\cos\frac{15\theta}{2} + 3\cos\frac{5\theta}{2}\right)$$

On solving,

$$\Rightarrow \cos\frac{3\theta}{2} = \cos\frac{15\theta}{2}$$

$$\Rightarrow \frac{3\theta}{2} = 2n\pi \pm \frac{15\theta}{2}$$

$$\Rightarrow \cos\frac{15\theta}{2} - \cos\frac{3\theta}{2} = 0$$

$$\Rightarrow 2\sin 3\theta \cdot \sin\frac{9\theta}{2} = 0$$

$$3\theta = n\pi \quad \text{and} \quad \frac{9\theta}{2} = m\pi$$

$$\Rightarrow \theta = \frac{n\pi}{3} \quad \text{and} \quad \theta = \frac{2m\pi}{9}$$

$$\Rightarrow -\frac{\pi}{3}, \frac{\pi}{3}, 0 \quad \text{and} \quad -\frac{4\pi}{9}, -\frac{2\pi}{9}, \frac{4\pi}{9}, \frac{2\pi}{9}$$