

JEE (Main)-2025 (Online) Session-2
Memory Based Question with & Solutions
(Physics, Chemistry and Mathematics)
8th April 2025 (Shift-2)

Time: 3 hrs.

M.M.: 300

IMPORTANT INSTRUCTIONS:

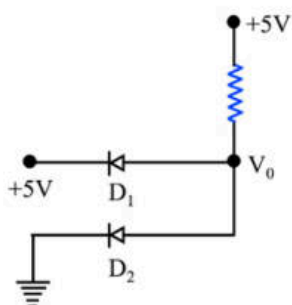
- (1) The test is of 3 hours duration.
- (2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.
- (3) This question paper contains Three Parts. Part-A is Physics, Part-B is Chemistry and Part-C is Mathematics. Each part has only two sections: Section-A 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 Tuesday 8th April, 2025) TIME : 3 : 00 PM to 6 : 00 PM

PHYSICS

SECTION-A

1. Find output voltage in the given circuit



- (1) – 5 volt (2) 10 volt
 (3) Zero (4) + volt

Ans. (3)

Sol. D_1 is reverse biased
 D_2 is forward biased
 $V_0 = 0V$

2. A fractional errors in x , y and z are 0.1 , 0.2 and 0.5 respectively. Find maximum fractional error in $x^{-2}y^{\frac{3}{2}}z^{\frac{-2}{5}}$.

- (1) 0.3 (2) 0.6
 (3) 0.7 (4) 0.2

Ans. (3)

Sol. $\frac{\Delta f}{f} = 2\frac{\Delta x}{x} + \frac{3}{2}\frac{\Delta y}{y} + \frac{2}{5}\frac{\Delta z}{z}$
 $= 2 \times 0.1 + \frac{3}{2} \times 0.2 + \frac{2}{5} \times 0.5$
 $= 0.2 + 0.3 + 0.2 = 0.7$

3. For a nucleus of mass number A and radius R , mass density ρ . Then choose the correct option :-

- (1) ρ is independent of A
 (2) $\rho \propto A^{1/3}$
 (3) $\rho \propto A^3$
 (4) $\rho \propto A$

Ans. (1)

Sol. $\rho = \frac{M}{V} = \frac{A}{\frac{4}{3}\pi R^3} = \frac{A}{\frac{4}{3}\pi A} = \text{constant}$

$$R \propto A^{\frac{1}{3}}$$

$$R^3 \propto A$$

$$\rho \rightarrow \text{constant}$$

4. A convex lens ($f = 30 \text{ cm}$) is in contact with concave lens ($f = 20 \text{ cm}$). Object is placed on the left side at a distance of 20 cm. Find the distance of image.

- (1) 25 cm (2) 15 cm
 (3) 20 cm (4) 10 cm

Ans. (2)

Sol. $\frac{1}{f_{eq}} = \frac{1}{30} - \frac{1}{20}$

$$= \frac{2-3}{60} = -\frac{1}{60}$$

$$f_{eq} = -60\text{cm}$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_{eq}}$$

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{-60}$$

$$\frac{1}{v} = -\frac{1}{60} - \frac{1}{20} = \frac{-1-3}{60} = -\frac{4}{60}$$

$$v = -15\text{cm}$$

5. There are two charged sphere of radius R and $3R$. When the sphere are made to touch each other and then separate, the surface charge density becomes σ_1 and σ_2 respectively. Find $\frac{\sigma_1}{\sigma_2}$

- (1) 9 (2) 3
 (3) $\frac{1}{3}$ (4) $\frac{1}{9}$

Ans. (2)

Sol. $V = \frac{1}{4\pi\epsilon_0} \times \frac{\sigma 4\pi R^2}{R} = \frac{\sigma R}{\epsilon_0}$

$$\frac{\sigma_1 R_1}{\epsilon_0} = \frac{\sigma_2 R_2}{\epsilon_0}$$

$$\frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1} = 3R$$

6. Two balls are projected with same speed at different angles. If maximum height of 1st is 8 times maximum height of 2nd ball. Find the ratio of their time of flight

- (1) 4 : 1 (2) 2 : 1
(3) 1 : 2√2 (4) 2√2 : 1

Ans. (4)

Sol. $H = \frac{(u \sin \theta)^2}{2g}$

$$T = \frac{2u \sin \theta}{g}$$

$$T \propto \sqrt{H}$$

$$\frac{T_1}{T_2} = 2\sqrt{2} : 1$$

7. Given $\lambda = 2 \frac{nC}{m}$ (linear charge density) of wire having charge Q which is passing through body diagonal of a closed cube of side length $\sqrt{3}$ cm. Find flux through the cube.

- (1) 2.16 π (2) 6.84 π
(3) 0.72 π (4) 1.44 π

Ans. (1)

Sol. $q_{en} = 3 \times 10^{-2} \times 2 \times 10^{-9}$
 $= 6 \times 10^{-11} C$
 $\phi = \frac{6 \times 10^{-11}}{\epsilon_0} = 6 \times 10^{-11} \times 36 \times 10^9 \times \pi$
 $= 2.16\pi$

8. A uniform disc of radius r is rotating about an axis passing through diameter with angular speed 800 rpm. A torque of magnitude 25π Nm is applied on the disc for 40 sec. If final angular speed of disc is 2100 rpm. Find radius of the disc if mass is 1 kg.

- (1) $10\sqrt{\frac{5}{2}}$ (2) $15\sqrt{\frac{2}{13}}$
(3) $20\sqrt{\frac{3}{13}}$ (4) $\frac{50}{3}$

Ans. (3)

Sol. $\omega_0 = 800 \times \frac{2\pi}{60} = \frac{80\pi}{3} \text{ rad/s}$

$$25\pi = \frac{1 \times R^2}{4} \times \alpha$$

$$\omega = \omega_0 + \alpha t$$

$$2100 \times \frac{\pi}{30} = \frac{80\pi}{3} + \frac{100\pi}{R^2} \times 40$$

$$\frac{130}{3} = \frac{4000}{R^2}$$

$$R = \sqrt{\frac{400 \times 3}{13}} = 20\sqrt{\frac{3}{13}}$$

9. Water falls from 200 m height. What is increase in temperature when it touches the bottom. (Assume that all the heat goes into same amount of mass which was falling)

- (1) $\frac{11}{10}^\circ C$ (2) $\frac{20}{21}^\circ C$
(3) $\frac{10}{21}^\circ C$ (4) $0.7^\circ C$

Ans. (3)

Sol. $mgh = ms\Delta T$

$$2000 = 4200 \times \Delta T$$

$$\Delta T = \frac{20}{42} = \frac{10}{21}^\circ C$$

10. Bulk modulus of a liquid is 2×10^9 Pa initial and final pressure are 1 atm and 5 atm respectively. Find initial volume of the liquid if change in volume is 0.8 cm^3 :-

- (1) $4 \times 10^3 \text{ cm}^3$ (2) $4 \times 10^4 \text{ cm}^3$
(3) $2 \times 10^{-4} \text{ cm}^3$ (4) $4 \times 10^{-3} \text{ cm}^3$

Ans. (1)

Sol. $\beta = \frac{-\Delta\phi}{\frac{\Delta V}{V}}$

$$2 \times 10^9 = \frac{4 \times 10^5}{0.8 \times 10^{-6}} \times V$$

$$V = \frac{2}{500} \times 10^6 = 4 \times 10^3 \text{ cm}^3$$

11. The amplitude and phase of the wave when two travelling waves given as $y_1(x, t) = 4\sin(\omega t - kx)$ and $y_2(x, t) = 2\sin\left(\omega t - kx - \frac{2\pi}{3}\right)$ are superimposed.

- (1) $\sqrt{3}, \frac{\pi}{6}$ (2) $2\sqrt{3}, \frac{\pi}{6}$
 (3) $6, \frac{\pi}{3}$ (4) $6, \frac{2\pi}{3}$

Ans. (2)

Sol. $A_{\text{net}} = \sqrt{16 + 4 + 2 \times 4 \times 2 \times \left(\frac{-1}{2}\right)} = \sqrt{12} = 2\sqrt{3}$

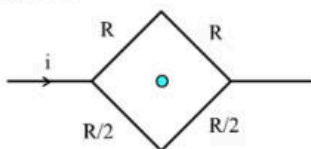
$$\tan \phi = \frac{B \sin \theta}{A + B \cos \theta}$$

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

$$= \frac{\sqrt{3}}{3} = \frac{1}{\sqrt{3}}$$

$$\phi = 30^\circ = \frac{\pi}{6}$$

12. Find magnetic field at center of square having side length a :-



- (1) $\frac{\sqrt{2}\mu_0 i}{3\pi a}$ (2) $\frac{\sqrt{5}\mu_0 i}{7\pi a}$
 (3) $\frac{\sqrt{2}\mu_0 i}{\pi a}$ (4) $\frac{\mu_0 i}{\pi a}$

Ans. (1)

Sol. $\frac{i_1}{i_2} = \frac{1}{2}$

$$i_1 = \frac{i}{3}$$

$$i_2 = \frac{2i}{3}$$

$$B_1 = \frac{\mu_0}{4\pi} \frac{2i}{\frac{a}{2}} 2 \sin 45^\circ \times 2 = \frac{2\sqrt{2}\mu_0 i}{3\pi a}$$

$$B_2 = \frac{\mu_0}{4\pi} \frac{i}{\frac{a}{2}} 2 \sin 45^\circ \times 2 = \frac{\sqrt{2}\mu_0 i}{3\pi a}$$

$$B_{\text{net}} = \frac{\sqrt{2}\mu_0 i}{3\pi a}$$

13. A force of $6\hat{k}$ is applied for $\frac{5}{3}$ seconds on a body of mass 2 kg. If initial velocity of body was $3\hat{i} + 4\hat{j}$. Then find final velocity of the body.

- (1) $3\hat{i} + 4\hat{j} + 5\hat{k}$ (2) $3\hat{i} + \hat{j} + 5\hat{k}$
 (3) $3\hat{i} + 2\hat{j} - 3\hat{k}$ (4) $3\hat{i} + 4\hat{j} - 5\hat{k}$

Ans. (1)

Sol. $F = 6\hat{k}$

$$t = \frac{5}{3}$$

$$a = 3\hat{k}$$

$$u = 3\hat{i} + 4\hat{j}$$

$$\vec{v} = (3\hat{i} + 4\hat{j}) + (3\hat{k}) \times \frac{5}{3} = 3\hat{i} + 4\hat{j} + 5\hat{k}$$

14. A rod of linear mass density ' λ ' and length ' L ' is bent into the form of a ring of radius R . Moment of inertia of ring about any of its diameter is

- (1) $\frac{\lambda L^3}{12}$ (2) $\frac{\lambda L^3}{4\pi^2}$
 (3) $\frac{\lambda L^2}{12}$ (4) $\frac{\lambda L^3}{8\pi^2}$

Ans. (4)

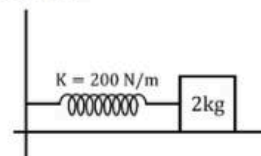
Sol. $I = \frac{mR^2}{2}$

$$I = \frac{(\lambda \ell) R^2}{2}$$

$$I = \frac{(\lambda \ell)}{2} \left(\frac{\ell}{2\pi}\right)^2$$

$$I = \frac{\lambda \ell^3}{8\pi^2}$$

15. Natural length of spring is 2 m. Spring is released when it is compressed by 1m. Then what is the velocity of block when it is at x distance from the mean position :-



- (1) $10\sqrt{1-x^2}$ (2) $5\sqrt{1-x^2}$
 (3) $5\sqrt{1+x^2}$ (4) $10\sqrt{1+x^2}$

Ans. (1)

Sol. $\frac{1}{2} K(1)^2 = \frac{1}{2} Kx^2 + \frac{1}{2} mv^2$

$$100 = 100x^2 + v^2$$

$$v^2 = 100(1 - x^2)$$

$$v = 10\sqrt{1 - x^2}$$

16. A concavo-convex lens of refractive index 1.5 and the radii of curvature of its surface are 30 cm and 20 cm respectively. The concave surface is upwards and is filled with a liquid of refractive index 1.3. The focal length of the liquid-glass combination will be :-

- (1) $\frac{500}{11}$ cm (2) $\frac{700}{11}$ cm
(3) $\frac{800}{11}$ cm (4) $\frac{600}{11}$ cm

Ans. (4)

$$\text{Sol. } \frac{1}{f_1} = (1.3 - 1) \left(\frac{1}{\infty} - \frac{1}{-30} \right)$$

$$\frac{1}{f_1} = \frac{0.3}{30} = \frac{0.6}{60}$$

$$\frac{1}{f_2} = (1.5 - 1) \left(\frac{-1}{30} + \frac{1}{20} \right)$$

$$\frac{1}{f_2} = 0.5 \left(\frac{-2 + 3}{60} \right) = \frac{0.5}{60}$$

$$f_{eq} = \frac{600}{11}$$

17. A 3 m long wire of radius 3 mm shows an extension of 0.1 mm when loaded vertically by a mass of 50 kg in an experiment to determine young's modulus. The value of young's modulus of the wire as per this experiment is $P \times 10^{11} \text{ Nm}^{-2}$, where the value of P is

(Take $g = 3\pi \text{ m/s}^2$) :-

- (1) 10 (2) 25
(3) 2.5 (4) 5

Ans. (4)

$$\text{Sol. } \frac{50 \times 3\pi}{\pi \times 9 \times 10^{-6}} = \frac{Y \times 0.1 \times 10^{-3}}{3}$$

$$Y = 500 \times 10^9 = 5 \times 10^{11}$$

18. An electron is released in the field generated by a non-conducting sheet of uniform surface charge density σ . The rate of change of de-Broglie wavelength associated with electron waves as n th power of distance travelled. Find the value of n.

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

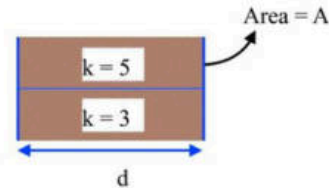
Ans. (3)

$$\text{Sol. } \lambda = \frac{h}{mv}$$

$$\frac{d\lambda}{dt} = -\frac{h}{mv^2} \frac{dv}{dt} = \frac{-ha}{mv^2} = \frac{-ha}{m2ax} \propto x^{-1}$$

$$v^2 = 0^2 + 2ax$$

19. If two such capacitor are connected in parallel. Find equivalent capacitance of the system



- (1) $\frac{4\epsilon_0 A}{d}$ (2) $\frac{2\epsilon_0 A}{d}$
(3) $\frac{3\epsilon_0 A}{d}$ (4) $\frac{8\epsilon_0 A}{d}$

Ans. (4)

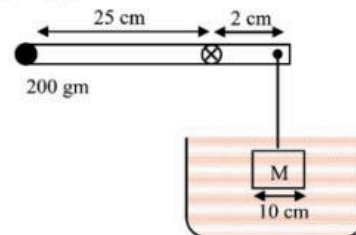
$$\text{Sol. } C_1 + C_2 = \frac{5\epsilon_0 \frac{A}{2}}{d} + \frac{3\epsilon_0 \frac{A}{2}}{d}$$

$$C_{eq} = \frac{8\epsilon_0 \frac{A}{2}}{d}$$

as two such capacitor are connected in parallel so C_{eq} will be $\frac{8\epsilon_0 A}{d}$

SECTION - B

1. If the system is in equilibrium find the value of 2M (in kg)



Ans. (7)

$$\text{Sol. } \frac{1}{4} = \frac{1}{50} (mg - 10^3 \times 10^{-3} g)$$

$$\frac{1}{2} = \frac{1}{50} (M - 1)g$$

$$\frac{5}{2} = M - 1$$

$$M = 3.5 \text{ kg}$$

$$2M = 7 \text{ kg}$$

CHEMISTRY

SECTION-A

1. Consider the last electron of element having atomic no. 9 & choose the correct option
 (1) Sum of total nodes = 1.
 (2) $n = 2$; $\ell = 0$
 (3) Last electron enters in 2s subshell
 (4) There are $5e^-$ with $\ell = 0$

Ans. (1)

Sol. $F \Rightarrow 1s^2 2s^2 2p^5$

$$n = 2, \ell = 1$$

$$\Rightarrow \text{Total nodes} = n - 1 = 2 - 1 = 1$$

2. Which of the following has sp^3d^2 hybridization?

- (1) $[\text{NiCl}_4]^{2-}$ (2) $[\text{Ni}(\text{CO})_4]$
 (3) SF_6 (4) $[\text{Ni}(\text{CN})_4]^{2-}$

Ans. (3)

Sol. $[\text{NiCl}_4]^{2-} \Rightarrow sp^3$
 $[\text{Ni}(\text{CO})_4] \Rightarrow sp^3$
 $\text{SF}_6 \Rightarrow sp^3d^2$
 $[\text{Ni}(\text{CN})_4]^{2-} \Rightarrow dsp^2$

3. Atomic number of element with lowest first ionization enthalpy is

- (1) 32 (2) 19 (3) 35 (4) 87

Ans. (4)

Sol.

At. No.	Element
32	Ge
19	Cl
35	Br
87	Fr

 Lowest I.E. = Fr

4. Consider the following statement.

Statement I : H_2Se is more acidic than H_2Te

Statement II : H_2Se has higher bond dissociation Enthalpy than H_2Te

In light of the above statement, choose correct option:

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

Ans. (3)

Sol. Hydrides of Oxygen family –

Acidic strength : $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$

Bond dissociation enthalpy: $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{Te}$

5. Correct decreasing order of spin only magnetic moment values is

(1) $\text{Cr}^{3+} > \text{Cr}^{2+} > \text{Cu}^{2+} > \text{Cu}^+$

(2) $\text{Cr}^{3+} > \text{Cr}^{2+} > \text{Cu}^+ > \text{Cu}^{2+}$

(3) $\text{Cr}^{2+} > \text{Cr}^{3+} > \text{Cu}^{2+} > \text{Cu}^+$

(4) $\text{Cr}^{2+} > \text{Cr}^{3+} > \text{Cu}^+ > \text{Cu}^{2+}$

Ans. (3)

Sol. $\mu_{s.o.} = \sqrt{n(n+2)} \text{ B.M.}$

$n = \text{No. of unpaired electrons}$

$\text{Cr}^{2+} = 3d^4$; $n = 4$

$\text{Cr}^{3+} = 3d^3$; $n = 3$

$\text{Cu}^{2+} = 3d^9$; $n = 1$

$\text{Cu}^+ = 3d^{10}$; $n = 0$

$\mu_{s.o.} \Rightarrow \text{Cr}^{2+} > \text{Cr}^{3+} > \text{Cu}^{2+} > \text{Cu}^+$

6. A monoatomic gas is stored in a thermally insulated container. The gas is suddenly compressed to $\left(\frac{1}{8}\right)^{\text{th}}$ of its initial volume. Find ratio of final pressure to initial pressure.

- (1) 8 (2) 16 (3) 4 (4) 32

Ans. (4)

Sol. Adiabatic process

$$P_1 = P \quad V_1 = V$$

$$P_2 = ? \quad V_2 = \left(\frac{V}{8}\right)$$

$$\Rightarrow \text{For monoatomic gas } (\gamma) = \frac{5}{3} = 1.67$$

$\Rightarrow$ For adiabatic process

$$PV^\gamma = \text{Constant}$$

$$\Rightarrow P_1 V_1^\gamma = P_2 V_2^\gamma$$

$$\Rightarrow PV^{(5/3)} = P_2 \left(\frac{V}{8}\right)^{5/3}$$

$$P_2 = P \times 2^5 = 32 P$$

$$\frac{P_2}{P_1} = 32$$

7. For a first order reaction, the ratio of time required is $\frac{t_1}{t_2}$, if t_1 is time consumed when reactant reaches $\frac{1}{4}$ th of initial concentration and t_2 is the time when it reaches $\frac{1}{8}$ th of initial concentration

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

Ans. (1)

Sol. For first order reaction

$$t = \frac{2.303}{K} \log \frac{[A_0]}{[A_t]}$$

$$t_1 = \frac{2.303}{K} \log \frac{[A_0]}{\frac{1}{4}[A_0]} \quad \dots(1)$$

$$t_2 = \frac{2.303}{K} \log \frac{[A_0]}{\frac{1}{8}[A_0]} \quad \dots(2)$$

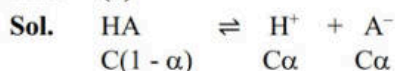
$$\frac{t_1}{t_2} = \frac{\log 4}{\log 8} \Rightarrow \frac{2\log(2)}{3\log(2)}$$

$$\frac{t_1}{t_2} = \frac{2}{3}$$

8. An aqueous solution of 0.1 M HA shows depression in freezing point of 0.2°C . If $K_f(\text{H}_2\text{O}) = 1.86 \text{ K kg mol}^{-1}$ and assuming molarity = molality, find the dissociation constant of HA.

(1) 4.50×10^{-5} (2) 6.25×10^{-3}
(3) 5.625×10^{-4} (4) 2.65×10^{-4}

Ans. (3)



$$i = \frac{\text{C} - \text{C}\alpha + \text{C}\alpha + \text{C}\alpha}{\text{C}}$$

$$i = 1 + \alpha$$

$$\Delta T_f = iK_f m$$

$$0.2 = i \times 1.86 \times 0.1$$

$$i = \frac{2}{1.86} \Rightarrow 1.075$$

$$1 + \alpha = 1.075$$

$$\alpha = 0.075$$

$$K_a = \frac{\text{C}\alpha^2}{1-\alpha} \quad (1-\alpha \approx 1)$$

$$\Rightarrow K_a = \text{C}\alpha^2$$

$$\Rightarrow K_a = 0.1 \times (0.075)^2$$

$$K_a = 5.625 \times 10^{-4}$$

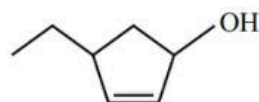
9. Which of the following solution can form minimum boiling azeotrope ?

- (1) $\text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{O}$
(2) n-heptane + n-hexane
(3) $\text{CH}_3\text{COOH} + \text{C}_5\text{H}_5\text{N}$
(4) $\text{C}_2\text{H}_5\text{Br} + \text{C}_2\text{H}_5\text{I}$

Ans. (1)

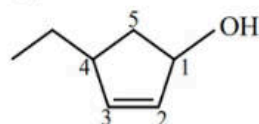
Sol. $\text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{O}$ show positive deviation from Raoult's law and thus form minimum boiling azeotrope.

10. Find the IUPAC name of the given compound



- (1) 4-ethylcyclopent-2-en-1-ol
(2) 3-ethylcyclopent-1-en-2-ol
(3) 5-ethylcyclopent-1-en-3-ol
(4) 1-ethylcyclopent-2-en-4-ol

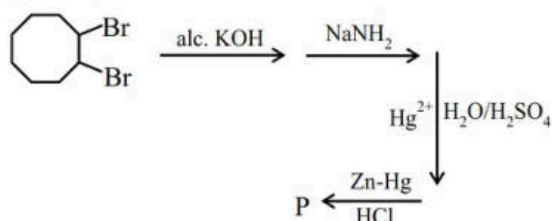
Ans. (1)



Sol.

4-ethylcyclopent-2-en-1-ol

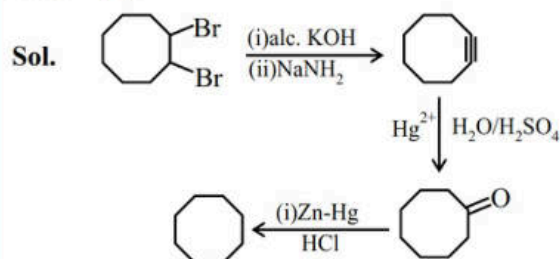
11. Consider the following sequence of reactions given below



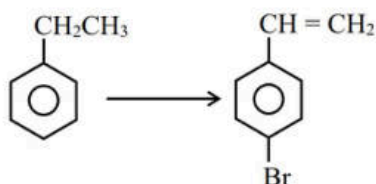
The product P is

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

Ans. (1)

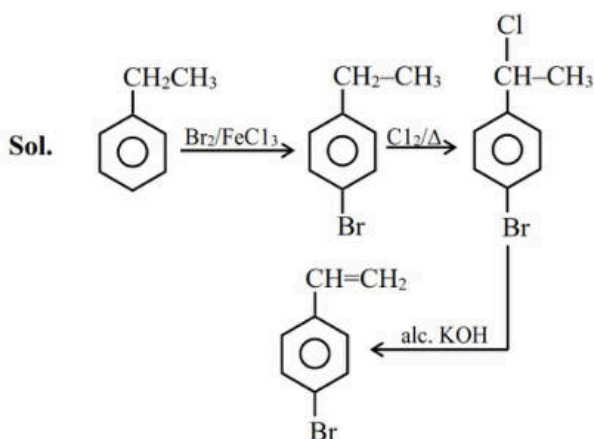


12. The correct sequence of reagents to be added for the following conversion



- (1) Br_2/Fe ; alc. KOH ; $\text{Cl}_2/\text{FeCl}_3$
 (2) $\text{Br}_2/\text{FeCl}_3$; Cl_2/Δ ; alc. KOH
 (3) $\text{FeCl}_3/\text{Br}_2$; alc. KOH ; H^+/Δ
 (4) $\text{Cl}_2/\text{FeCl}_3$; $\text{Br}_2/\text{FeCl}_3$; alc. KOH

Ans. (2)

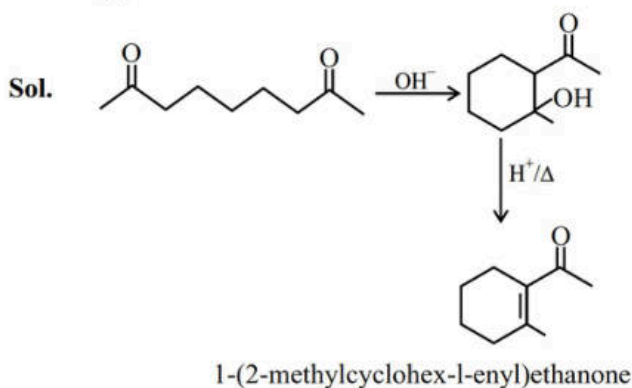


13. $\xrightarrow[\text{H}^+/\Delta]{\text{OH}^-}$ Product

The correct IUPAC name of the product is:-

- (1) 1-acetyl-2-methyl cyclohexene
 (2) 1-(2-methylcyclohex-1-enyl)ethanone
 (3) Cyclooct-2-en-1-one
 (4) 2-Cycloocten-1-one

Ans. (2)



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

List-I		List-II	
A	dil. KMnO_4	I	Unsaturation test
B	FeCl_3 test	II	Alcoholic $-\text{OH}$
C	Liberate CO_2 with NaHCO_3	III	Phenolic $-\text{OH}$
D	Ceric Ammonium nitrate test	IV	Carboxylic Acid

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

Ans. (3)

Sol.

List-I		List-II	
A	dil. KMnO_4	→	Unsaturation test
B	FeCl_3 test	→	Phenolic $-\text{OH}$
C	Liberate CO_2 with NaHCO_3	→	Carboxylic Acid
D	Ceric Ammonium nitrate test	→	Alcoholic $-\text{OH}$

15. Match list-I with list-II and choose the correct option.

	List-I		List-II
(a)	Nucleophile	(i)	Tetrahedral shape
(b)	Electrophile	(ii)	Planar and sp^2 hybridized
(c)	Carbocation	(iii)	Species that accepts electron
(d)	Carbanion	(iv)	Species that donate electron

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

Ans. (2)

Sol.

	List-I		List-II
(a)	Nucleophile	→	Species that donate electron
(b)	Electrophile	→	Species that accepts electron
(c)	Carbocation	→	Planar and sp^2 Hybridized
(d)	Carbanion	→	Tetrahedral shape

16. On combustion of 0.21 g of an organic compound containing C, H and O gave 0.127 g H_2O and 0.307 g CO_2 . The percentage of H and O in the given organic compound respectively are

- (1) 7.55 and 43.85 (2) 6.72 and 53.41
(3) 6.72 and 39.87 (4) 53.41 and 39.60

Ans. (2)

Sol. $C_xH_yO_z + O_2 \longrightarrow CO_2 + H_2O$

$$\%C = \frac{12}{44} \times \frac{\text{wt. of } CO_2}{\text{wt. of organic compound}} \times 100$$

$$\Rightarrow \frac{12}{44} \times \frac{0.307}{0.21} \times 100 \Rightarrow 39.87\%$$

$$\%H = \frac{2}{18} \times \frac{\text{wt. of } H_2O}{\text{wt. of organic compound}} \times 100$$

$$\frac{2}{18} \times \frac{0.127}{0.21} \times 100$$

$$\%O = 100 - (\%H + \%C)$$

$$\Rightarrow 53.4\%$$

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

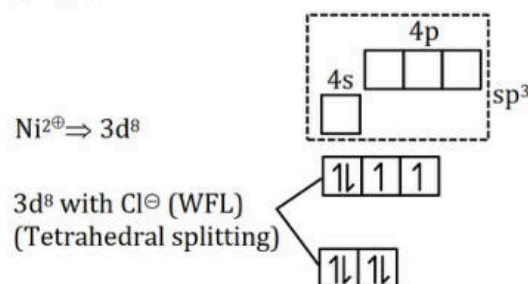
List-I (Complex)		List-II (Characteristics)	
A	$[NiCl_4]^{2-}$	I	sp^3 , tetrahedral, 3.87 BM
B	$[Ni(CN)_4]^{2-}$	II	dsp^2 , square planar, 0 BM
C	$[CoCl_4]^{2-}$	III	sp^3d^2 , octahedral, 2.82 BM
D	$[Ni(H_2O)_6]^{2+}$	IV	sp^3 , tetrahedral, 2.82 BM

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

Ans. (4)

Sol.

(A) $[NiCl_4]^{2-}$

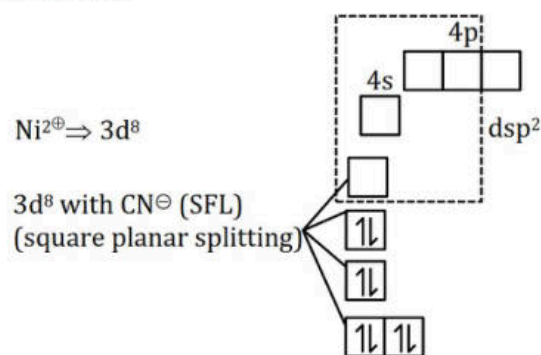


Unpaired e^- (n) = 2

$$\mu_{s.o} = \sqrt{n(n+2)} \text{ B.M.} \\ = 2.8 \text{ B.M.}$$

Hybridization and geometry $\Rightarrow sp^3$, tetrahedral

(B) $[Ni(CN)_4]^{2-}$



Unpaired e^- (n) = 0

$$\mu_{s.o} = 0 \text{ B.M.}$$

Hybridization and geometry

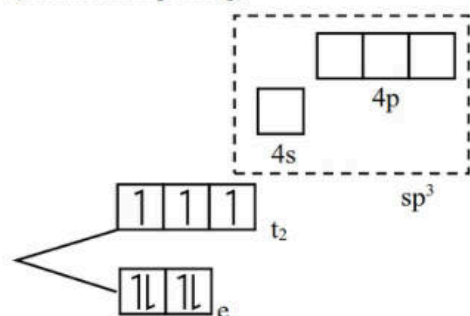
$\Rightarrow dsp^2$, square planar

(C) $[\text{CoCl}_4]^{2-}$

$\text{Co}^{2+} = 3d^7$

Co^{2+} , $3d^7$ with Cl^- (WFL)

(tetrahedral splitting)



Unpaired electron (n) = 3

$\mu_{s.o.} = 3.9$ B.M.

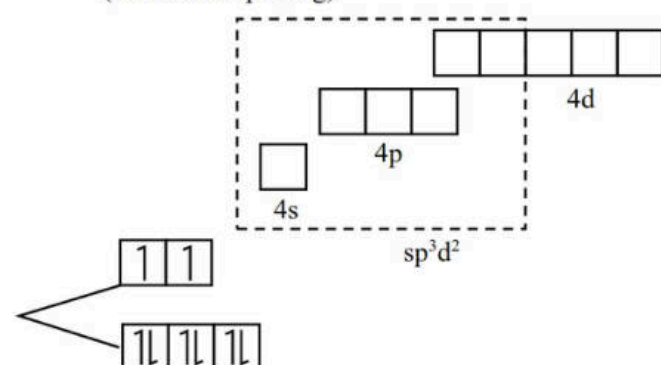
Hybridization and geometry $\Rightarrow sp^3$ tetrahedral

(D) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$

$\text{Ni}^{2+} = 3d^8$

$3d^8$ with H_2O (WFL)

(octahedral splitting)



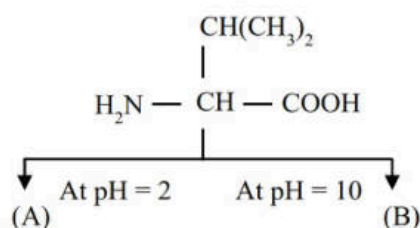
$\Delta_o < p$

Unpaired electron (n) = 2

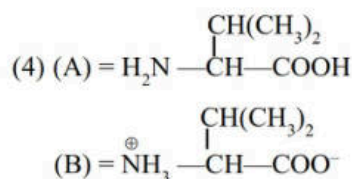
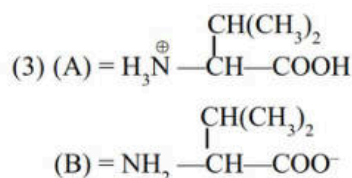
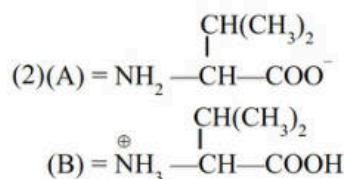
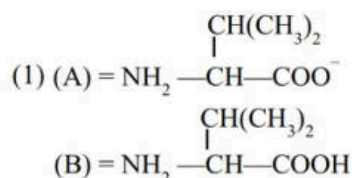
$\mu_{s.o.} = 2.8$ B.M.

Hybridisation and geometry $\Rightarrow sp^3d^2$, octahedral

18. Consider the following amino acid.

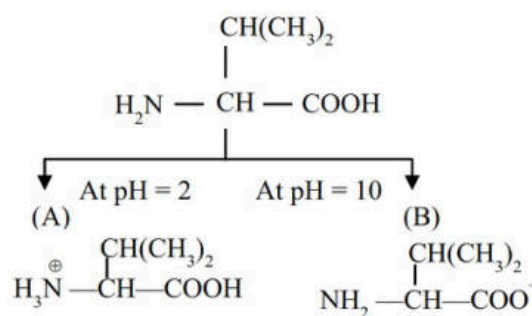


Which of the following option contain correct for structure of (A) and (B).



Ans. (3)

Sol.



SECTION-B

19. 20 ml of NaI reacts with excess of AgNO_3 to give 4.74gm of AgI . Find molarity of NaI .

Ans. (1)

Sol. $\text{NaI} + \text{AgNO}_3 \rightarrow \text{AgI} + \text{NaNO}_3$

$$n = \frac{\text{wt.}}{\text{M.wt}}$$

$$n = \frac{4.74}{235} = 0.02 \text{ mol}$$

$$\text{Molarity of NaI} = \frac{n}{V}$$

$$= \frac{0.02}{20 \times 10^{-3}} = \frac{2 \times 10^{-2}}{2 \times 10^{-2}} = 1\text{M}$$

- 20.** The energy of an electron in first Bohr orbit of H-atom is -13.6 eV .

Find the magnitude of energy of an electron in first excited state of Be^{3+} ion in eV.

Ans. (54)

Sol. $E = -13.6 \left(\frac{Z^2}{n^2} \right)$

For Be^{3+} ion $z = 4$ & first excited state ($n = 2$)

$$E = -13.6 \times \frac{(4)^2}{(2)^2}$$

$$E = -13.6 \times \frac{4 \times 4}{2 \times 2}$$

$$E = -54.4 \text{ eV}$$

$$|E| = 54.4 \text{ eV} \approx 54 \text{ eV}$$

MATHEMATICS

1. The number of rational terms in the binomial expansion of $\left(5^{\frac{1}{2}} + 7^{\frac{1}{8}}\right)^{1016}$ is

(1) 127 (2) 128 (3) 129 (4) 130

Ans. (2)

Sol. $T_r = {}^{1016}C_r (5)^{\frac{1016-r}{2}} (7^{\frac{1}{8}})^r$
 $\Rightarrow r = 0, 8, 16, 24, \dots, 1016$
 $1016 = 0 + (n-1)8$
 $\Rightarrow n-1 = \frac{1016}{8} = 127$
 So, $n = 128$.

2. If $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \dots \infty = \frac{\pi^4}{90}$, $\frac{1}{1^4} + \frac{1}{3^4} + \frac{1}{5^4} + \dots \infty = \alpha$ and $\frac{1}{2^4} + \frac{1}{4^4} + \frac{1}{6^4} + \dots \infty = \beta$, then $\frac{\alpha}{\beta}$ is equal to

(1) 14 (2) 15 (3) 18 (4) 23

Ans. (2)

Sol. $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \dots = \frac{\pi^4}{90}$
 Consider
 $\frac{1}{2^4} + \frac{1}{4^4} + \frac{1}{6^4} + \dots$
 $\frac{1}{2^4} \left(\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \dots \right) = \frac{1}{2^4} \times \frac{\pi^4}{90} = \beta$
 $\alpha + \beta = \frac{\pi^4}{90}$
 So, $\alpha = \frac{\pi^4}{90} - \frac{1}{2^4} \times \frac{\pi^4}{90}$
 $= \frac{\pi^4}{90} \left(\frac{15}{16} \right)$
 $\Rightarrow \frac{\alpha}{\beta} = 15$

3. There are 12 points in a plane such that no three of them are collinear except 5 which are on same line, then the number of triangles that can be formed from any 3 points from these 12 points is equal to

(1) 210 (2) 220 (3) 230 (4) 240

Ans. (1)

Sol. ${}^{12}C_3 - {}^5C_3$
 $\Rightarrow 220 - 10$
 $\Rightarrow 210$

4. Two lines $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ and $\frac{x-\lambda}{3} = \frac{y-3}{4} = \frac{z-4}{5}$ has shortest distance $\frac{1}{\sqrt{6}}$. If λ_1, λ_2 are values of λ , then radius of circle passing through $(0,0)$, (λ_1, λ_2) , (λ_2, λ_1) is equal to

Ans. $\frac{5\sqrt{2}}{4}$

Sol. $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4} \dots(i)$

$\frac{x-\lambda}{3} = \frac{y-3}{4} = \frac{z-4}{5} \dots(ii)$

$$\vec{n}_1 \times \vec{n}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & 4 \\ 3 & 4 & 5 \end{vmatrix}$$

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

L_1 passing through point $(1, 2, 3)$ and L_2 passing through point $(\lambda, 3, 4)$

According to question

$$d = \frac{|-(\lambda-1)+2-1|}{\sqrt{6}} = \frac{1}{\sqrt{6}}$$

$$|-\lambda+1+2-1| = 1$$

$$|-\lambda+2| = 1$$

$$\lambda - 2 = \pm 1$$

$$\lambda = 3, 1$$

Circle passing through points $(0, 0)$ $(1, 3)$ $(3, 1)$

$$\text{then area } \frac{1}{2} \begin{vmatrix} 0 & 0 & 1 \\ 1 & 3 & 1 \\ 3 & 1 & 1 \end{vmatrix} = \frac{|(1-9)|}{2} = 4$$

$$r = \frac{abc}{4\Delta} = \frac{20\sqrt{2}}{4 \times 4} = \frac{5\sqrt{2}}{4}$$

5. Probability of event A is 0.7 and event B is 0.4, $P(A \cap B^c) = 0.5$, then the value of $P(B|A \cup B^c)$ is equal to

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

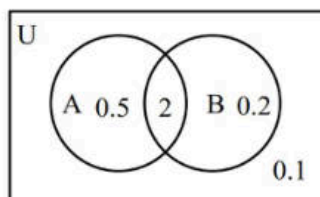
(2) $\frac{1}{2}$

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

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

Ans. (1)

Sol.



$$P(B|A \cup B^c) = \frac{P(B \cap (A \cup B^c))}{P(A \cup B^c)}$$

$$= \frac{P(B \cap A)}{0.8} = \frac{0.2}{0.8} = \frac{1}{4}$$

6. Evaluate : $\int_{-1}^{\frac{3}{2}} |\pi^2 x \sin(\pi x)| dx$
 (1) $4\pi + 1$ (2) $3\pi + 1$ (3) $5\pi + 1$ (4) $6\pi + 1$

Ans. (2)

Sol. Let, $I = \pi^2 \int_{-1}^{\frac{3}{2}} |x \sin \pi x| dx$

$$= \pi^2 \left\{ \int_{-1}^1 x \sin \pi x dx - \int_1^{\frac{3}{2}} x \sin \pi x dx \right\}$$

$$= \pi^2 \left\{ 2 \int_0^1 x \sin \pi x dx - \int_{-1}^{\frac{3}{2}} x \sin \pi x dx \right\}$$

Consider

$$\int x \sin \pi x dx$$

$$= -x \cdot \frac{1}{\pi} \cos \pi x + \int 1 \cdot \frac{1}{\pi} \cos \pi x dx$$

$$= -\frac{x}{\pi} \cos \pi x + \frac{\sin \pi x}{\pi^2}$$

$$I = \pi^2 \left\{ 2 \left(-\frac{x}{\pi} \cos \pi x + \frac{\sin \pi x}{\pi^2} \right)_0^1 - \left(-\frac{x}{\pi} \cos \pi x + \frac{\sin \pi x}{\pi^2} \right)_1^{\frac{3}{2}} \right\}$$

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

$$= \pi^2 \left\{ \frac{3}{\pi} + \frac{1}{\pi^2} \right\}$$

$$= 3\pi + 1$$

7. The product of last 2 digits of $(1919)^{19}$ is equal to
 (1) 45 (2) 54 (3) 56 (4) 63

Ans. (4)

Sol. $(1919)^{19} = (1920 - 1)^{19}$
 $= {}^{19}C_{18} (1920)(-1)^{18} + {}^{19}C_{19} (1920)^0 (-1)^{19} + 100\lambda$
 $= 19 \times 1920 - 1 + 100\lambda$
 $= 36480 - 1 + 100\lambda$
 $= 36479 + 100\lambda$
 So, product of last two digits = $7 \times 9 = 63$

8. If $A = \begin{bmatrix} 2 & 2+p & 2+p+q \\ 4 & 6+2p & 8+3p+2q \\ 6 & 12+3p & 20+6p+3q \end{bmatrix}$, then the value of $\det(\text{adj}(\text{adj}(3A))) = 2^m \cdot 3^n$, then $m + n$ is equal to

- (1) 18 (2) 20 (3) 24 (4) 36

Ans. (3)

Sol. Applying $R_3 \rightarrow R_3 - 3R_1$

And then applying $R_2 \rightarrow R_2 - 2R_1$

We get,

$$\begin{vmatrix} 2 & 2+p & 2+p+q \\ 0 & 2 & 4+p \\ 0 & 6 & 14+3p \end{vmatrix}$$

$$= 2(28 + 6p - 24 - 6p)$$

$$\text{So, } |A| = 8$$

$$\text{Required value} = |\text{adj}(\text{adj}(3A))| = 2^m \cdot 3^n$$

$$= |3A|^{(3-1)^2}$$

$$= (3^3)^4 \cdot (2^3)^4 = 3^{12} \cdot 2^{12}$$

$$\text{So, } m+n = 24$$

9. $f(x) = x - 1$ & $g(x) = e^x$ for $x \in \mathbb{R}$. If $\frac{dy}{dx} = \left(e^{-2\sqrt{x}} g(f(f(x))) - \frac{y}{\sqrt{x}} \right)$, $y(0) = 0$, then $y(1)$ is equal to

(1) $\frac{e-1}{e^4}$

(2) $\frac{2e-1}{e^3}$

(3) $\frac{1-e^2}{e^4}$

(4) $\frac{1-e^3}{e^4}$

Ans. (1)

Sol. $f(x) = x - 1$

$$g(x) = e^x$$

$$f(f(x)) = f(x) - 1 = x - 1 - 1 = x - 2$$

$$\frac{dy}{dx} = e^{-2\sqrt{x}} \cdot e^{x-2} - \frac{y}{\sqrt{x}}$$

$$\frac{dy}{dx} + \frac{y}{\sqrt{x}} = e^{x-2\sqrt{x}-2}$$

$$I.f. = e^{\int \frac{1}{\sqrt{x}} dx} = e^{2\sqrt{x}}$$

$$y \cdot e^{2\sqrt{x}} = \int e^{x-2} dx$$

$$y \cdot e^{2\sqrt{x}} = e^{x-2} + C$$

$$\text{at } x=0, y=0 \Rightarrow C = -e^{-2}$$

$$ye^{2\sqrt{x}} = e^{x-2} - e^{-2}$$

$$\text{at } y(1) \cdot e^2 = e^{-1} - e^{-2} = \frac{1}{e} - \frac{1}{e^2} = \frac{e-1}{e^2}$$

$$y(1) = \frac{e-1}{e^4}$$

10. Sum of the squares of the roots of $|x-2|^2 + |x-2| - 2 = 0$ and $x^2 - 2|x-3| - 5 = 0$ is equal to

(1) 24

(2) 26

(3) 30

(4) 36

Ans. (4)

Sol. Solving $x^2 - 2|x-3| - 5 = 0$

For $x \leq 3$

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

$$\Rightarrow x^2 + 2x - 11 = 0$$

$$\Rightarrow x = \frac{-2 \pm \sqrt{4 + 44}}{2 \times 1}$$

$$= -1 \pm 2\sqrt{3}$$

For $x \geq 3$

$$x^2 - 2(x - 3) - 5 = 0$$

$$\Rightarrow x^2 - 2x + 1 = 0$$

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

$$\Rightarrow x = 1 \quad (\text{rejected})$$

Now, solving

$$|x - 2|^2 + |x - 1| - 2 = 0$$

$$\text{Let } |x - 2| = t$$

$$\Rightarrow t^2 + t - 2 = 0$$

$$\Rightarrow (t + 2)(t - 1) = 0$$

$$\Rightarrow t = -2 \quad (\text{not possible})$$

$$\& t = 1$$

$$|x - 2| = 1$$

$$\Rightarrow x = 1, 3$$

$$\begin{aligned} \text{Sum of the square of roots} &= 1^2 + 3^2 + (-1 + 2\sqrt{3})^2 + (-1 - 2\sqrt{3})^2 \\ &= 36 \end{aligned}$$

11. Let the area of the region bounded by $(x, y) = \{0 \leq 9x \leq y^2, y \geq 3x - 6\}$ be A . Then $6A$ is equal to

Ans. (15)

Sol. $y^2 = 9x, y = 3x - 6$

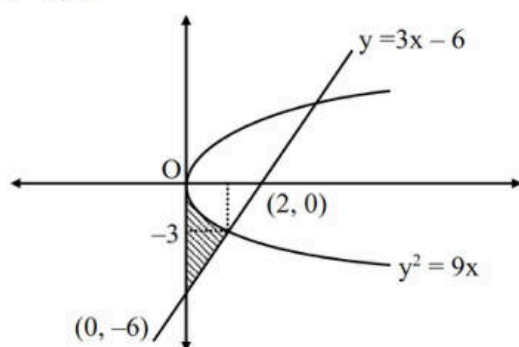
$$(3x - 6)^2 = 9x$$

$$9x^2 - 36x + 36 = 9x$$

$$9x^2 - 45x + 36 = 0$$

$$x^2 - 5x + 4 = 0$$

$$x = 1, 4$$



$$\text{Bounded area} = \left| \int_0^1 (3x - 6) dx - \int_0^1 (-3\sqrt{x}) dx \right|$$

$$A = \frac{5}{2}$$

$$\Rightarrow 6A = 15.$$

12. Value of $\cot^{-1}\left(\frac{\sqrt{1+\tan^2 2}+1}{\tan 2}\right) - \cot^{-1}\left(\frac{\sqrt{1+\tan^2 2}-1}{\tan 2}\right)$ is equal to

(1) $\frac{\pi}{2} + \frac{5}{2}$

(2) $\frac{\pi}{2} - \frac{3}{2}$

(3) $2 - \frac{\pi}{2}$

(4) $3 + \frac{\pi}{2}$

Ans. (3)

Sol.
$$\begin{aligned} & \cot^{-1}\left(\frac{|\sec 2|+1}{\tan 2}\right) - \cot^{-1}\left(\frac{|\sec 2|-1}{\tan 2}\right) \\ &= \cot^{-1}\left(\frac{\cos 2-1}{\sin 2}\right) - \cot^{-1}\left(\frac{-1-\cos 2}{\sin 2}\right) \\ &= \cot^{-1}(-\tan 1) - \cot^{-1}(-\cot 1) \\ &= \pi - \cot^{-1}(\tan 1) - (\pi - \cot^{-1} \cot 1) \\ &= \pi - \left(\frac{\pi}{2} - 1\right) + 1 = 2 - \frac{\pi}{2} \end{aligned}$$

13. If $f(x)$ is a positive function $I_1 = \int_{-\frac{1}{2}}^1 2xf(2x(1-2x))dx$ and $I_2 = \int_{-1}^2 f(x(1-x))dx$, then $\frac{I_2}{I_1}$ is equal to

Ans. (2)

Sol.
$$I_1 = \int_{-\frac{1}{2}}^1 2xF(2x(1-2x))dx$$

Put $2x = t \Rightarrow dx = \frac{1}{2} dt$

$$I_1 = \frac{1}{2} \int_{-1}^2 tF(t(1-t))dt$$

$$I_1 = \frac{1}{2} I_2$$

$$\Rightarrow \frac{I_2}{I_1} = 2$$

14. Consider two statements

Statement 1 : $\lim_{x \rightarrow 0} \frac{\tan^{-1} x + \ln \sqrt{\frac{1+x}{1-x}} - 2x}{x^5} = \frac{2}{5}$

Statement 2 : The $\lim_{x \rightarrow 1} x^{\left(\frac{2}{1-x}\right)}$ is equal to e^2 & can be solved by the method $e^{\lim_{x \rightarrow 1} f(x)(g(x)-1)}$

(1) Only statement 1 is correct

(2) Only statement 2 is correct

(3) Both statements are correct

(4) Both statements are incorrect

Ans. (1)

Sol.
$$\lim_{x \rightarrow 0} \frac{\tan^{-1} x + \ln \sqrt{\frac{1+x}{1-x}} - 2x}{x^5}$$

$$\lim_{x \rightarrow 0} \frac{\left(x - \frac{x^3}{3} + \frac{x^5}{5} - \dots\right) + \frac{1}{2} \left(x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \frac{x^5}{5} + \dots\right) - \frac{1}{2} \left(-x - \frac{x^2}{2} - \frac{x^3}{3} - \dots\right) - 2x}{x^5}$$

$$= \frac{1}{5} + \frac{1}{5} = \frac{2}{5}$$

Statement -2

$$\Rightarrow \lim_{x \rightarrow 1} x^{\left(\frac{2}{1-x}\right)}$$

$$\Rightarrow \lim_{x \rightarrow 1} e^{\frac{2}{1-x}(x-1)} = e^{-2}$$