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.

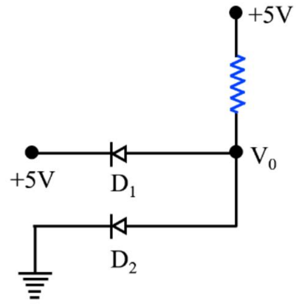
(6) Section - A (01 - 20) contains 20 multiple choice questions which have only one correct answer. Each question carries +4 marks for correct answer and -1 mark for wrong answer.

(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.

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) ρ $\propto A^{1/3}$

(3) ρ $\propto A^3$

(4) ρ $\propto$ A

Ans. **(1)**

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

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

$R^3 \alpha A$

$\rho \rightarrow$ constant

4. A convex lens (f = 30 cm) is in contact with concave lens (f = 20 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. $V = \frac{1}{4\pi\varepsilon_0} \times \frac{\sigma 4\pi R^2}{R} = \frac{\sigma R}{\varepsilon_0}$

$\frac{\sigma_1 R_1}{\varepsilon_0} = \frac{\sigma_2 R_2}{\varepsilon_0}$

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

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 fight

(1) 4 : 1 (2) 2 : 1

(3) $1 : 2\sqrt{2}$ (4) $2\sqrt{2} : 1$

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. $q_{en} = 3\times10^{-2} \times 2\times10^{-9}$

$= 6\times10^{-11}C$

$\phi = \frac{6\times10^{-11}}{\varepsilon_0} = 6\times10^{-11} \times 36\times10^{9} \times \pi$

$= 2.16\pi$

8. A uniform disc of radius r is rotating about an axis passing through diameter with angular speed $800\,rpm$. A torque of magnitude $25\pi\ Nm$ 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. $\omega_0 = 800 \times \frac{2\pi}{60} = \frac{80\pi}{3}\text{rad/s}$

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

$\omega = \omega_0 + \alpha t$

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

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

$R = \sqrt{\frac{400\times3}{13}} = 20\sqrt{\frac{3}{13}}$

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) $\frac{11}{10}°C$ (2) $\frac{20}{21}°C$

(3) $\frac{10}{21}°C$ (4) 0.7°C

Ans. **(3)**

Sol. $mgh = ms\Delta T$

$2000 = 4200 \times \Delta T$

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

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) $4\times10^3\ cm^3$ (2) $4\times10^4\ cm^3$

(3) $2\times10^{-4}\ cm^3$ (4) $4\times10^{-3}\ cm^3$

Ans. **(1)**

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

$2\times10^9 = \frac{4\times10^5}{0.8\times10^{-6}} \times V$

$V = \frac{2}{500}\times10^6 = 4\times10^3 cm^3$

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. $A_{net} = \sqrt{16+4+2\times4\times2\times\left(\frac{-1}{2}\right)} = \sqrt{12} = 2\sqrt{3}$

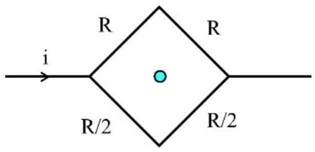
$\tan\phi = \frac{B\sin\theta}{A + B\cos\theta}$

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

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

$\phi = 30° = \frac{\pi}{6}$

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

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

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

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

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

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

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. $F = 6\hat{k}$

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

$a = 3\hat{k}$

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

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

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)**

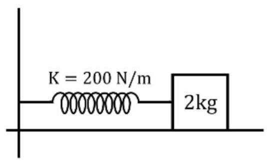
Sol. $I = \frac{mR^2}{2}$

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

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

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

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)**

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 $P \times 10^{11}$ Nm^{-2}, where the value of P is

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

(1) 10 (2) 25

(3) 2.5 (4) 5

Ans. **(4)**

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 nth power of distance travelled. Find the value of n.

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

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

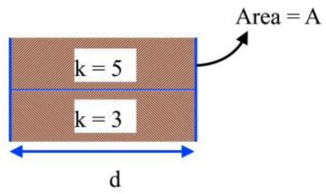
Ans. **(3)**

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) $\frac{4\varepsilon_0 A}{d}$ (2) $\frac{2\varepsilon_0 A}{d}$

(3) $\frac{3\varepsilon_0 A}{d}$ (4) $\frac{8\varepsilon_0 A}{d}$

Ans. **(4)**

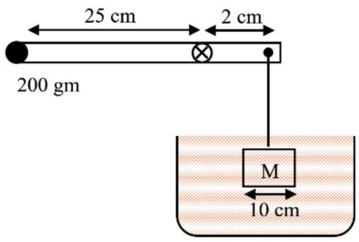
Sol. $$C_1 + C_2 = \frac{5\varepsilon_0 \frac{A}{2}}{d} + \frac{3\varepsilon_0 \frac{A}{2}}{d}$$

$$c_{eq} = \frac{8\varepsilon_0 \frac{A}{2}}{d}$$

as two such capacitor are connected in parallel so c_{eq} will be $\frac{8\varepsilon_0 A}{d}$

SECTION – B

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



Ans. **(7)**

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

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

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

$$M = 3.5kg$$

$$2M = 7kg$$

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; ℓ =0

(3) Last electron enters in 2s subshell

(4) There are $5e^-$ with $\ell = 0$

Ans. **(1)**

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

$n = 2, \ell = 1$

$\Rightarrow$ Total nodes = n – 1 = 2 – 1 = 1

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

(1) $[NiCl_4]^{2-}$ (2) $[Ni(CO)_4]$

(3) SF_6 (4) $[Ni(CN)_4]^{2-}$

Ans. **(3)**

Sol.

$[NiCl_4]^{2-} \Rightarrow sp^3$

$[Ni(CO)_4] \Rightarrow sp^3$

$SF_6 \Rightarrow sp^3d^2$

$[Ni(CN)_4]^{2-} \Rightarrow dsp^2$

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 : $H_2O < H_2S < H_2Se < H_2Te$

Bond dissociation enthalpy: $H_2O > H_2S > H_2Se > H_2Te$

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

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

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

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

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

Ans. **(3)**

Sol. $\mu_{S.O.} = \sqrt{n(n+2)}$ B.M.

n = No. of unpaired electrons

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

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

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

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

$\mu_{S.O.} \Rightarrow Cr^{2+} > Cr^{3+} > Cu^{2+} > Cu^+$

6. A monoatomic gas is stored in a thermally insulated container. The gas is suddenly compressed to $\left(\frac{1}{8}\right)^{th}$ 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

$P_1 = P \quad V_1 = V$

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

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

$\Rightarrow$ For adiabatic process

PV^γ = Constant

$\Rightarrow P_1V_1^\gamma, = P_2V_2^\gamma$

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

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

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

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

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

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

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

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

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

8. An aqueous solution of 0.1 M HA shows depression in freezing point of 0.2°C. If K_f (H_20) = 1.86 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)**

Sol. $HA \rightleftharpoons H^+ + A^-$

$C(1 - \alpha)$ $\quad C\alpha \quad C\alpha$

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

$i = 1 + \alpha$

$\Delta T_f = iK_fM$

$0.2 = i \times 1.86 \times 0.1$

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

$1 + \alpha = 1.075$

$\alpha = 0.075$

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

$\Rightarrow K_a = C\alpha^2$

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

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

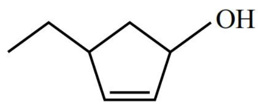
9. Which of the following solution can form minimum boiling azeotrope ?

(1) $C_2H_5OH + H_2O$
(2) n-heptane + n-hexane
(3) $CH_3COOH + C_5H_5N$
(4) $C_2H_5Br + C_2H_5I$

Ans. **(1)**

Sol. $C_2H_5OH + H_2O$ show positive deviation from Raoult's law and thus from thus form minimum boiling azeotrope.

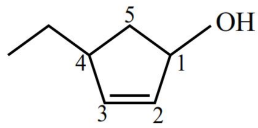
10. Find the IUPAC name of the given compound



(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

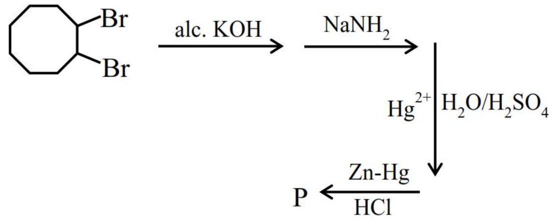
Ans. **(1)**

Sol.

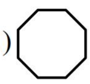


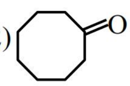
4-ethylcyclopent-2-en-1-ol

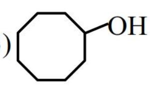
11. Consider the following sequence of reactions given below

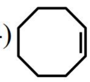


The product P is

(1) 

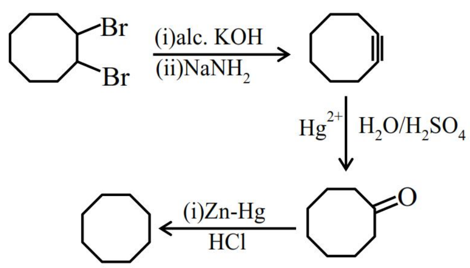
(2) 

(3) 

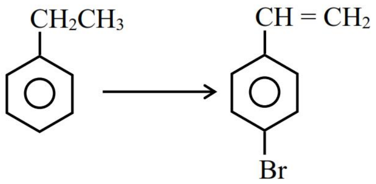
(4) 

Ans. **(1)**

Sol.



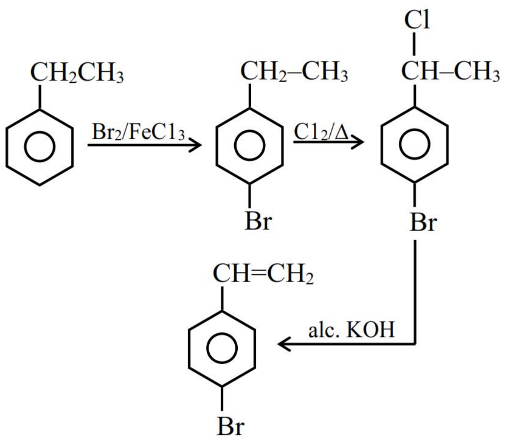
12. The correct sequence of reagents to the added for the following conversion



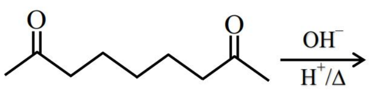
(1) Br_2/Fe; alc. KOH; $C1_2/FeC1_3$
(2) $Br_2/FeC1_3$; $C1_2/\Delta$; alc. KOH
(3) $FeC1_3/Br_2$; alc. KOH; H^+/Δ
(4) $C1_2/FeC1_3$; $Br_2/FeC1_3$; alc. KOH

Ans. **(2)**

Sol.



13.

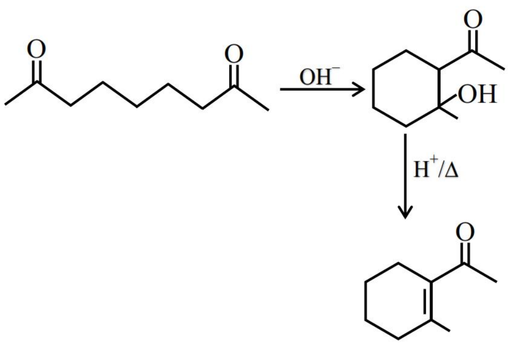


Product

The correct IUPAC name of the product is:-
(1) 1-acetyl-2-methyl cyclohexene
(2) 1-(2-methylcyclohex-l-enyl)ethanone
(3) Cyclooct-2-en-1-one
(4) 2-Cycloocten-I-one

Ans. **(2)**

Sol.



1-(2-methylcyclohex-l-enyl)ethanone

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 –OH
C	Liberate CO_2 with $NaHCO_3$	III	Phenolic –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 –OH
C	Liberate CO_2 with $NaHCO_3$	→	Carboxylic Acid
D	Ceric Ammonium nitrate test	→	Alcoholic –OH

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

	List-1		**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-1		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	$[NiC1_4]^{2-}$	I	sp^3, tetrahedral, 3.87 BM
B	$[Ni(CN)_4]^{2-}$	II	dsp^2, square planar, 0 BM
C	$[CoC1_4]^{2-}$	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

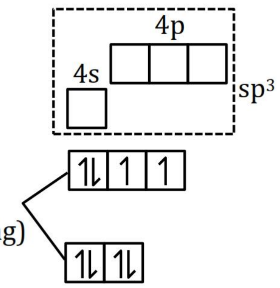
Ans. **(4)**

Sol.

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

$Ni^{2\oplus} \Rightarrow 3d^8$

3d⁸ with Cl⊖ (WFL)
(Tetrahedral splitting)



Unpaired e⊖ (n) = 2

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

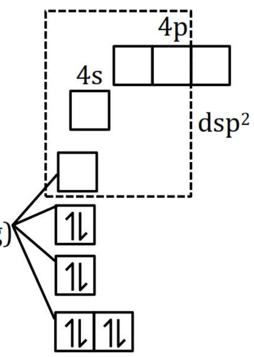
= 2.8 B.M.

Hybridization and geometry ⇒ sp^3, tetrahedral

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

$Ni^{2\oplus} \Rightarrow 3d^8$

3d⁸ with CN⊖ (SFL)
(square planar splitting)



Unpaired e⊖ (n) = 0

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

Hybridization and geometry

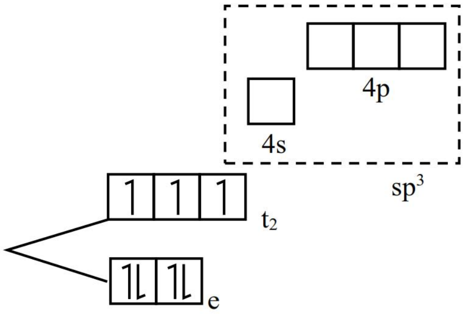
$\Rightarrow$ dsp^2, square planar

(C) $[CoCl_4]^{2-}$

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

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

(tetrahedral splitting)



Unpaired electron (n) = 3

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

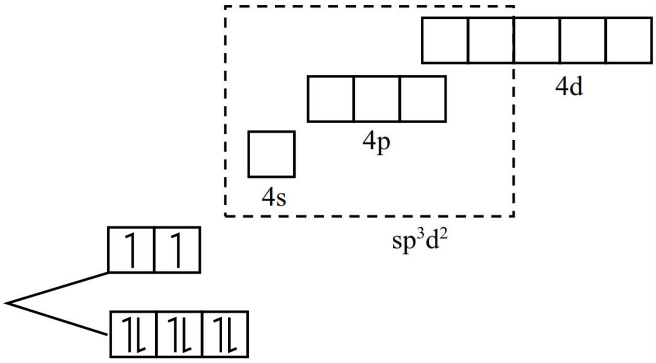
Hybridization and geometry $\Rightarrow$ sp^3 tetrahedral

(D) $[Ni(H_2O)_6]^{2+}$

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

$3d^8$ with H_2O (WFL)

(octahedral splitting)



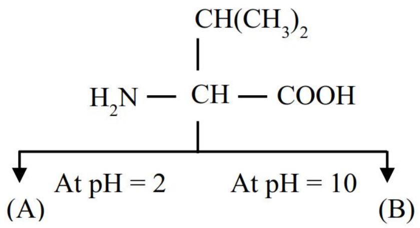
$\Delta_o < p$

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).

(1) (A) = $NH_2—CH(CH(CH_3)_2)—COO^-$
(B) = $NH_2—CH(CH(CH_3)_2)—COOH$

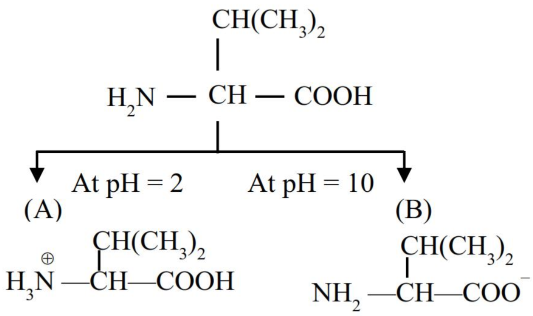
(2) (A) = $NH_2—CH(CH(CH_3)_2)—COO^-$
(B) = $\overset{\oplus}{N}H_3—CH(CH(CH_3)_2)—COOH$

(3) (A) = $H_3\overset{\oplus}{N}—CH(CH(CH_3)_2)—COOH$
(B) = $NH_2—CH(CH(CH_3)_2)—COO^-$

(4) (A) = $H_2N—CH(CH(CH_3)_2)—COOH$
(B) = $\overset{\oplus}{N}H_3—CH(CH(CH_3)_2)—COO^-$

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. $NaI + AgNO_3 \rightarrow AgI + NaNO_3$

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

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

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 eV

|E| = 54.4 eV ≈ 54 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. $T_r = {}^{1016}C_r\,(5)^{\frac{1016-r}{2}}\,7^{\frac{r}{8}}$

$\Rightarrow$ r = 0, 8, 16, 24, ……, 1016

1016 = 0 + (n – 1)8

$\Rightarrow n-1=\dfrac{1016}{8}=127$

So, n = 128.

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

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

Ans. **(2)**

Sol. $\dfrac{1}{1^4}+\dfrac{1}{2^4}+\dfrac{1}{3^4}+.....+=\dfrac{\pi^4}{90}$

Consider

$\dfrac{1}{2^4}+\dfrac{1}{4^4}+\dfrac{1}{6^4}+...$

$\dfrac{1}{2^4}\left(\dfrac{1}{1^4}+\dfrac{1}{2^4}+\dfrac{1}{3^4}+....\right)=\dfrac{1}{2^4}\times\dfrac{\pi^4}{90}=\beta$

$\alpha+\beta=\dfrac{\pi^4}{90}$

So, $\alpha=\dfrac{\pi^4}{90}-\dfrac{1}{2^4}\times\dfrac{\pi^4}{90}$

$=\dfrac{\pi^4}{90}\left(\dfrac{15}{16}\right)$

$\Rightarrow \dfrac{\alpha}{\beta}=15$

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

$\frac{x-\lambda}{3}=\frac{y-3}{4}=\frac{z-4}{5}$ …(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 (λ, 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)

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

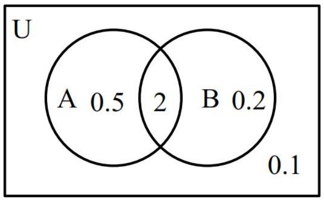
$$r=\frac{abc}{4\Delta}=\frac{20\sqrt{2}}{4\times 4}=\frac{5\sqrt{2}}{4}$$

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.



$$P\left(B / A\cup B^C\right)=\frac{P\left(B\cap\left(A\cup B^C\right)\right)}{P\left(A\cup B^C\right)}$$

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

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, $I = \pi^2 \int_{-1}^{3/2} |x \sin \pi x| dx$

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

$$= \pi^2 \left\{ 2\int_{0}^{1} x \sin \pi x dx - \int_{-1}^{32} x \sin \pi x dx \right\}$$

Consider

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

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

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

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

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

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

$$= 3\pi + 1$$

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

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

Ans. **(3)**

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

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

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)

So, |A| = 8

Required value = $= \left|adj\left(adj\left(3A\right)\right)\right| = 2^m.3^n$

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

$= \left(3^3\right)^4.\left(2^3\right)^4 = 3^{12}.2^{12}$

So, $m+n=24$

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

$g(x) = e^x$

$f\left(f\left(x\right)\right) = f(x) - 1 = x - 1 - 1 = x - 2$

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

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

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

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

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

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

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

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

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

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 $x^2 - 2\left|x-3\right| - 5 = 0$

For x ≤ 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 $x \geq 3$

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

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

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

$\Rightarrow x = 1$ (rejected)

Now, solving

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

Let $|x - 2| = t$

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

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

$\Rightarrow t = -2$ (not possible)

& $t = 1$

$|x - 2| = 1$

$\Rightarrow x = 1, 3$

Sum of the square of roots $= 1^2 + 3^2 + (-1 + 2\sqrt{3})^2 + (-1 - 2\sqrt{3})^2$

$= 36$

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

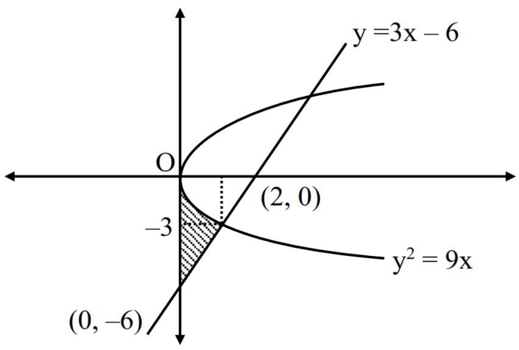
$(3x - 6)^2 = 9x$

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

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

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

$x = 1, 4$



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

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

$\Rightarrow 6A = 15.$

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. $\cot^{-1}\left(\frac{|\sec 2|+1}{\tan 2}\right)-\cot^{-1}\left(\frac{|\sec 2|-1}{\tan 2}\right)$

$=\cot^{-1}\left(\frac{\cos 2-1}{\sin 2}\right)-\cot^{-1}\left(\frac{-1-\cos 2}{\sin 2}\right)$

$=\cot^{-1}(-\tan 1)-\cot^{-1}(-\cot 1)$

$=\pi-\cot^{-1}(\tan 1)-(\pi-\cot^{-1}\cot 1)$

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

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

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

(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. $\lim_{n\to 0}\frac{\tan^{=1}x+\ell n\sqrt{\frac{1+x}{1-x}}-2x}{x^5}$

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

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

Statement -2

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

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