

SOLUTIONS & ANSWERS FOR AIEEE-2010 VERSION – A

[PHYSICS, CHEMISTRY & MATHEMATICS]

PART – A – PHYSICS

1. The initial shape of the wavefront of the ----

Ans: Planar

Sol: Initially parallel, cylindrical beam will have planar wavefront.

2. The speed of light in the medium is

Ans: Minimum on the axis of the beam

Sol: Intensity is maximum along the axis \Rightarrow refractive index maximum along the axis \Rightarrow speed minimum along the axis.

3. As the beam enters the medium -----

Ans: Converge

Sol: Intensity is maximum at the centre and decreases with increasing radius \Rightarrow light energy getting concentrated near centre \Rightarrow beam is converging..

4. The speed of daughter nuclei -----

Ans: $c\sqrt{\frac{2\Delta m}{M}}$

Sol: Mass lost = (Δm)
Energy released = $(\Delta m)c^2$
By conservation of momentum and energy each has energy $\frac{1}{2} M v^2$

$$\therefore \frac{1}{2} M v^2 = \frac{1}{2} (\Delta m) c^2 \Rightarrow v = c\sqrt{\frac{2\Delta m}{M}}$$

5. The binding energy per nucleon for the -----

Ans: $E_2 > E_1$

Sol: In radioactive decay, the parent nucleus decays to a more stable daughter nuclei.
 $\therefore E_2 > E_1$

6. Statement – 1

When ultraviolet light is incident on a photocell, its stopping potential -----

Ans: Statement – 1 is true, Statement-2 is false.

Sol: $h\nu = KE_{\max} + \phi$

\therefore if $h\nu$ increases, KE_{\max} increases

\therefore Stopping potential increases

Photoelectrons have various speeds.

7. Statement – 1:

Two particles moving in the same direction do not -----

Ans: Statement -1 is true, Statement – 2 is true; Statement-2 is the correct explanation of Statement-1

Sol: Linear momentum is conserved and initial momentum is not zero \Rightarrow final momentum is not zero \Rightarrow particles have speed after collision \Rightarrow Particles have some K.E after collision.

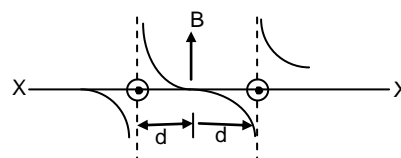
8. The figure shows the position – time ($x - t$) graph of ---

Ans: 0.8 Ns

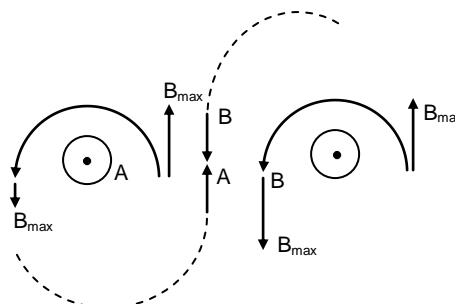
Sol: Impulse = change in momentum
 $= mv_2 - mv_1$
 $= 0.4 \times (-1) - 0.4 \times 1 = -0.8 \text{ Ns}$

9. Two long parallel wires are at a distance 2d apart. They carry -----

Ans:



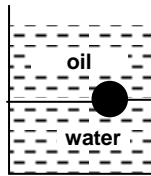
Sol:



Hence graph (2) is correct.

10. A ball is made of a material of density ρ where ---

Ans:



Sol: Since ρ_{water} is greater than ρ_{oil} , ρ_{oil} should be above water.

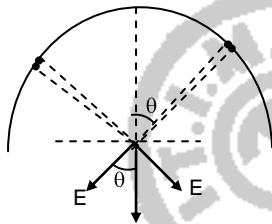
$\rho > \rho_{\text{oil}}$ it should sink in oil and float in water.

Hence Answer 3.

11. A thin semicircular ring of radius r has positive charge q ----

Ans: $-\frac{q}{2\pi^2\epsilon_0 r^2} \hat{j}$

Sol:



Taking symmetrical elements of charge as shown the $\sin\theta$ components cancel out. The $\cos\theta$ components add upto

$$2 \int_0^{\pi/2} \frac{K dq}{r^2} \cos\theta$$

$$= 2 \int_0^{\pi/2} K \left(\frac{q}{\pi r} \right) r d\theta \frac{\cos\theta}{r^2}$$

$$= 2 \cdot \frac{1}{4\pi\epsilon_0} \frac{q}{\pi r^2} \int_0^{\pi/2} \cos\theta d\theta$$

$$= -\frac{q}{2\pi^2\epsilon_0 r^2} \hat{j}$$

12. A diatomic ideal gas is used in a Carnot engine as the working substance ----

Ans: 0.75

Sol: In the adiabatic part of the cycle

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$= T_2 (32 V_1)^{\gamma-1}$$

$$\therefore \frac{T_1}{T_2} = (32)^{\gamma-1} = (32)^{7/5-1} = (32)^{2/5}$$

$$= 4 \Rightarrow T_1 = 4 T_2$$

$$\eta = \frac{T_1 - T_2}{T_1} = \frac{3}{4} = 0.75$$

13. The respective number of significant figures for the numbers ----

Ans: 5, 1, 2

14. The combination of gates shown below ----

Ans: OR gate

Sol: $\overline{\overline{A} \cdot \overline{B}} = A + B$

OR gate

15. If a source of power 4 kW produces 10^{20} photons / second, the ----

Ans: X - rays

Sol: Energy of a photon = $\frac{4000}{10^{20}} \text{ J}$

$$= \frac{4000}{10^{20}} \times \frac{1}{1.6 \times 10^{-19}} \text{ eV}$$

$$= 250 \text{ eV}$$

$$\Rightarrow \frac{1242}{250} \text{ nm} \cong 5 \text{ nm (X- rays)}$$

16. A radioactive nucleus (initial mass number A and atomic number Z) emits ----

Ans: $\frac{A-Z-4}{Z-8}$

Sol: ${}_Z X^A \rightarrow {}_{Z-8} Y^{A-12} + 3\alpha + 2\beta^+$

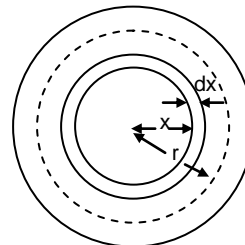
No. of neutrons = $A - 12 - (Z - 8)$

$\therefore \text{Ratio} = \frac{A-Z-4}{Z-8}$

17. Let there be a spherically symmetric charge distribution with charge ----

Ans: $\frac{\rho_0 r}{4\epsilon_0} \left[\frac{5}{3} - \frac{r}{R} \right]$

Sol:



$$\rho_x = \rho_0 \left(\frac{5}{4} - \frac{x}{R} \right) 4\pi x^2 dx$$

Total charge upto r is

$$\rho_r = \int_0^r \rho_0 \left(\frac{5}{4} - \frac{x}{R} \right) 4\pi x^2 dx$$

$$= 4\pi\rho_0 \int_0^r \left(\frac{5}{4} - \frac{x}{R} \right) x^2 dx$$

$$= 4\pi\rho_0 \left[\frac{5}{4} \left[\frac{x^3}{3} \right]_0^r - \left[\frac{x^4}{4R} \right]_0^r \right]$$

$$= 4\pi\rho_0 \left[\frac{5}{4} \frac{r^3}{3} - \frac{r^4}{4R} \right]$$

Gauss's law is

$$E \cdot 4\pi r^2 = \frac{4\pi\rho_0}{\epsilon_0} \left[\frac{5}{4} \frac{r^3}{3} - \frac{r^4}{4R} \right]$$

$$\Rightarrow E = \frac{\rho_0 r}{4\epsilon_0} \left[\frac{5}{3} - \frac{r}{R} \right]$$

18. In a series LCR circuit $R = 200 \Omega$ and the voltage and the frequency of the main supply -----

Ans: 242 W

Sol: Since the lag by removing the capacitance is equal to the lead by removing the inductor $X_C = X_L$.

The circuit is in resonance condition.

$$\text{Power dissipated is } \frac{V^2}{R} = \frac{20^2}{200}$$

$$= 242 \text{ W}$$

19. In the circuit shown below, the key K is closed at $t = 0$. -----

$$\text{Ans: } \frac{V}{R_2} \text{ at } t = 0 \text{ and } \frac{V(R_1 + R_2)}{R_1 R_2} \text{ at } t = \infty$$

Sol: At the instant of switching on there is no current through L. Therefore current at $t = 0$ is $\frac{V}{R_2}$

At $t = \infty$, $V_L = 0$

$$R_{\text{eff}} = \frac{R_1 R_2}{R_1 + R_2} \Rightarrow I = \frac{V(R_1 + R_2)}{R_1 R_2}$$

20. A particle is moving with velocity -----

$$\text{Ans: } y^2 = x^2 + \text{constant}$$

$$\text{Sol: } \vec{v} = K(\hat{i} + \hat{x}_j)$$

$$\frac{d\vec{r}}{dt} = Ky \hat{i} + Kx \hat{j}$$

$$\Rightarrow \vec{r} = Kyt\hat{i} + Kxt\hat{j} + C$$

$$\Rightarrow r^2 = K^2 y^2 t^2 + K^2 x^2 t^2 + \text{constant}$$

$$(x^2 + y^2) = K^2 y^2 t^2 + K^2 x^2 t^2 + \text{constant}$$

$$y^2 [1 - K^2 t^2] = x^2 [K^2 t^2 - 1] + \text{constant}$$

$$y^2 = \frac{x^2 [K^2 t^2 - 1]}{1 - K^2 t^2} + \text{constant}$$

$$= -x^2 + \text{current} = x^2 + \text{constant}$$

$$\therefore y^2 = x^2 + \text{constant}$$

21. Let C be the capacitance of a capacitor discharging through -----

$$\text{Ans: } \frac{1}{4}$$

$$\text{Sol: } Q = R_0 e^{-t/RC}$$

$$\frac{Q_1^2}{2C} = \frac{Q_0^2}{2C} \cdot \frac{1}{2}$$

$$\Rightarrow Q_1 = \frac{Q_0}{\sqrt{2}}$$

$$\therefore \frac{Q_0}{\sqrt{2}} = Q_0 e^{-t_1/\tau}$$

$$\frac{1}{\sqrt{2}} = e^{-t_1/\tau}$$

$$\sqrt{2} = e^{t_1/\tau} \quad \ln \sqrt{2} = \frac{t_1}{\tau}$$

$$\Rightarrow \frac{1}{2} \log_e 2 = \frac{t_1}{\tau} \quad \text{---(1)}$$

$$\frac{Q_0}{4} = Q_0 e^{-t_2/\tau} \Rightarrow \frac{1}{4} = e^{-t_2/\tau}$$

$$\Rightarrow 2 \log_e 2 = \frac{t_2}{\tau} \quad \text{---(2)}$$

$$\frac{(i)}{(ii)} \Rightarrow \frac{t_1}{t_2} = \frac{1}{4}$$

22. A rectangular loop has a sliding connector PQ of length ℓ and -----

$$\text{Ans: } I_1 = I_2 = \frac{B\ell v}{3R}, I = \frac{2B\ell v}{3R}$$

Sol: Motional emf, $\epsilon = B\ell v$

$$R_{\text{effective (external)}} = R \parallel R = \frac{R}{2}$$

Internal resistance = R

$$\text{Total resistance} = R + \frac{R}{2} = \frac{3R}{2}$$

$$\therefore I = \frac{\epsilon}{\left(\frac{3R}{2}\right)} = \frac{2\epsilon}{3R} = \frac{2B\ell v}{3R}$$

$$I_1 = I_2 = \frac{I}{2} = \frac{B\ell v}{3R}$$

Aliter

$$IR + I_1 R = B\ell v \quad \text{--- (i)}$$

$$IR + I_2 R = B\ell v \quad \text{--- (ii)}$$

$$(i) - (ii) \Rightarrow I_1 R - I_2 R = 0 \Rightarrow I_1 = I_2$$

$$I = I_1 + I_2 = 2I_2$$

$$\therefore (ii) \Rightarrow 3 I_2 R = B\ell v$$

$$\Rightarrow I_2 = \frac{B\ell v}{3R}$$

$$I_1 = I_2 = \frac{B\ell v}{3R}; I = \frac{2B\ell v}{3R}$$

23. The equation of a wave on a string of linear mass density 0.04

Ans: 6.25 N

Sol: $y = 0.02 \sin \left[\frac{2\pi t}{0.04} - \frac{2\pi x}{0.50} \right]$

Compare with $y = A \sin (\omega t - kx)$

$$\Rightarrow \omega = \frac{2\pi}{0.04} \text{ and } k = \frac{2\pi}{0.50}$$

$$\therefore v = \frac{\omega}{k} = \frac{0.5}{0.04} = 12.5 \text{ m s}^{-1}$$

But $v = \sqrt{\frac{T}{\mu}} \Rightarrow T = v^2 \mu$

$$\therefore T = (12.5)^2 \times 0.04 = 6.25 \text{ N}$$

24. Two fixed frictionless inclined planes making an angle -----

Ans: 4.9 m s^{-2} in the vertical direction.

Sol: Acceleration of A along the plane, $a = g \sin \theta = g \sin^2 60^\circ$

Component of acceleration of A in the vertical direction,

$$a_v = a \sin \theta = g \sin^2 60^\circ$$

$$\therefore (a_v)_A = g \sin^2 60^\circ$$

Similarly $(a_v)_B = g \sin^2 30^\circ$

$$\therefore (a_v)_{AB} = (a_v)_A - (a_v)_B$$

$$= g [\sin^2 60^\circ - \sin^2 30^\circ]$$

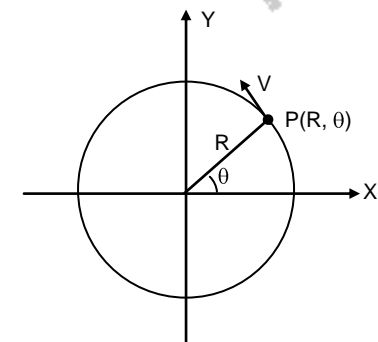
$$= 9.8 \left[\frac{3}{4} - \frac{1}{4} \right]$$

$$= 4.9 \text{ m s}^{-2} \text{ in the vertical direction.}$$

25. For a particle in uniform circular motion, the acceleration -----

Ans: $-\frac{V^2}{R} \cos \theta \hat{i} - \frac{V^2}{R} \sin \theta \hat{j}$

Sol:



$$a_c = \frac{V^2}{R}$$

$$(a_c)_x = -\frac{V^2}{R} \cos \theta \hat{i}$$

$$(a_c)_y = -\frac{V^2}{R} \sin \theta \hat{j}$$

$$\therefore \vec{a}_c = -\frac{V^2}{R} \cos \theta \hat{i} - \frac{V^2}{R} \sin \theta \hat{j}$$

26. A small particle of mass m is projected at an angle θ -----

Ans: $-\frac{mv_0gt^2}{2} \cos \theta \hat{k}$

Sol: $\vec{L} = \vec{r} \times \vec{p} \Rightarrow \vec{L}$ is in the $-\hat{k}$ direction

$$\vec{x} = tv_0 \cos \theta \hat{i}$$

$$\vec{y} = \left[tv_0 \sin \theta - \frac{1}{2} gt^2 \right] \hat{j}$$

$$\vec{r} = v_0 t \cos \theta \hat{i} + t \left(v_0 \sin \theta - \frac{gt}{2} \right) \hat{j}$$

$$\vec{v} = v_x \hat{i} + v_y \hat{j}$$

$$= v_0 \cos \theta \hat{i} + (v_0 \sin \theta - gt) \hat{j}$$

$$\vec{p} = mv = mv_0 \cos \theta \hat{i} + m \left(v_0 \sin \theta - gt \right) \hat{j}$$

$$\vec{L} = \vec{r} \times \vec{p}$$

$$= \left[v_0 t \cos \theta \hat{i} + t \left(v_0 \sin \theta - \frac{gt}{2} \right) \hat{j} \right] \times$$

$$\left[mv_0 \cos \theta \hat{i} + m \left(v_0 \sin \theta - gt \right) \hat{j} \right]$$

$$=$$

$$mv_0 t \cos \theta \left(v_0 \sin \theta - gt \right) \hat{k} - tmv_0 \cos \theta \left[v_0 \sin \theta - \frac{gt}{2} \right] \hat{k}$$

$$= \left[mv_0^2 t \sin \theta \cos \theta - mv_0 gt^2 \cos \theta \right] \hat{k}$$

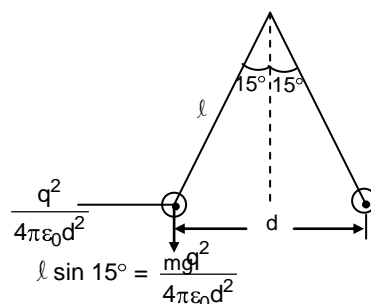
$$- \left[mv_0^2 t \sin \theta \cos \theta - \frac{mv_0 gt^2}{2} \right] \hat{k}$$

$$= -\frac{mv_0 gt^2}{2} \cos \theta \hat{k}$$

27. Two identical charged spheres are suspended by strings of

Ans: 2

Sol:



$$l \sin 15^\circ = \frac{mg}{4\pi\epsilon_0 d^2}$$

$$l \cos 15^\circ = mg$$

$$\tan 15^\circ = \frac{q^2}{mgd^2 4\pi\epsilon_0} \quad \text{---- (i)}$$

$$\text{In liquid } g' = g \left[1 - \frac{\sigma}{\rho} \right] = g \left[1 - \frac{0.8}{1.6} \right] = \frac{g}{2}$$

$$\epsilon = \epsilon_0 K$$

$$\text{Again } \tan 15^\circ$$

$$= \frac{q^2}{mg'd^2 4\pi\epsilon} = \frac{2q^2}{mgd^2 4\pi\epsilon_0 K} \quad \text{-----(ii)}$$

$$\text{From (i) and (ii) } \frac{2q^2}{4\pi\epsilon_0 K mgd^2} = \frac{q^2}{mgd^2 4\pi\epsilon_0}$$

$$\Rightarrow \frac{2}{K} = 1 \Rightarrow K = 2$$

$$= \frac{b}{2a} \cdot x^6$$

$$\therefore x = \left(\frac{2a}{b} \right)^{1/6} \text{ at equilibrium}$$

$$U_{(x)} = \infty = 0$$

$$U_{\text{at equilibrium}} = \frac{a}{\left(\frac{2a}{b} \right)^{12/6}} - \frac{b}{\left(\frac{2a}{b} \right)^{6/6}}$$

$$= \frac{ab^2}{4a^2} - \frac{b^2}{2a} = -\frac{b^2}{4a}$$

$$\therefore D = 0 - \left(-\frac{b^2}{4a} \right) = \frac{b^2}{4a}$$

28. A point P moves in counter-clockwise direction on a circular path as shown ----

Ans:

$$\text{Sol: } S = t^3 + s$$

$$\text{Speed } v = \frac{ds}{dt} = 3t^2$$

$$\text{At } t = 2 \text{ s, } v = 12 \text{ m s}^{-1}$$

$$a_c = \frac{v^2}{r} = \frac{12^2}{20} = 7.2 \text{ m s}^{-2}$$

Tangential acceleration,

$$a_t = \frac{dv}{dt} = 6t$$

$$\text{At } t = 2 \text{ s, } a_t = 6 \times 2 = 12 \text{ m s}^{-2}$$

$$\therefore a = \sqrt{a_c^2 + a_t^2} = \sqrt{7.2^2 + 12^2}$$

$$= \sqrt{51.84 + 144}$$

$$= \sqrt{195.84}$$

$$\cong 14 \text{ m s}^{-2}$$

29. The potential energy function for the force between two atoms ----

$$\text{Ans: } 0 - \left(-\frac{b^2}{4a} \right) = \frac{b^2}{4a}$$

$$\text{Sol: } U_{(x)} = \frac{a}{x^{12}} - \frac{b}{x^6}$$

$$F = -\frac{dU}{dx} = -[-12ax^{-13} + 6bx^{-7}]$$

$$= 12ax^{-13} - 6bx^{-7}$$

$$\text{At equilibrium, } F = 0 \Rightarrow 0$$

$$= 12ax^{-13} - 6bx^{-7}$$

$$\therefore 12ax^{-13} = 6bx^{-7}$$

$$1 = \frac{6b}{12a} \cdot \frac{x^{-7}}{x^{-13}}$$

30. Two conductors have the same resistance at 0 °C but their temperature

Ans:

Sol: In series

$$R_0 = R_1 + R_2$$

$$R_t = R_1' + R_2'$$

$$= R_1 + R_1\alpha_1 t + R_2 + R_2\alpha_2 t$$

$$= (R_1 + R_2) + t[R_1\alpha_1 + R_2\alpha_2] \quad \text{----- (i)}$$

$$\text{But } R_t = R_0 + R_0\alpha t$$

$$= (R_1 + R_2) + (R_1 + R_2)\alpha t \quad \text{----- (ii)}$$

From (i) & (ii)

$$\alpha = \frac{R_1\alpha_1 + R_2\alpha_2}{R_1 + R_2}$$

$$= \frac{\alpha_1 + \alpha_2}{2} \quad \left(R_1 = R_2 \right)$$

In parallel

$$R_0 = \frac{R}{2}$$

$$R_t = \frac{\frac{R}{2} + \alpha_1 t \frac{R}{2} + \alpha_2 t \frac{R}{2}}{\frac{R}{2} + \alpha_1 t + \alpha_2 t}$$

$$= \frac{R(\alpha_1 t + \alpha_2 t)}{2 + \alpha_1 t + \alpha_2 t} \quad \text{----(ii)}$$

$$\text{But } R_t = \frac{R}{2} + \alpha t \quad \text{--- (i)}$$

From (i) & (ii) (1 + \alpha t)

$$= \frac{2 + \alpha_1 t + \alpha_2 t}{2 + \alpha_1 t + \alpha_2 t}$$

$$\alpha t = \frac{2 + \alpha_1 t + \alpha_2 t + \alpha_1 \alpha_2 t^2}{2 + \alpha_1 t + \alpha_2 t} - 1$$

$$= \frac{\alpha_1 t + \alpha_2 t + \alpha_1 \alpha_2 t^2}{2 + \alpha_1 t + \alpha_2 t}$$

$$= \frac{t(\alpha_1 + \alpha_2 + \alpha_1 \alpha_2 t)}{2 + \alpha_1 t + \alpha_2 t}$$

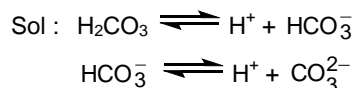
$$\Rightarrow \alpha = \frac{\alpha_1 + \alpha_2 + \alpha_1 \alpha_2 t}{2 + \alpha_1 t + \alpha_2 t}; \text{ At } t = 0,$$

$$\alpha = \frac{\alpha_1 + \alpha_2}{2}$$

PART B – CHEMISTRY

31. In aqueous solution the ionization constants

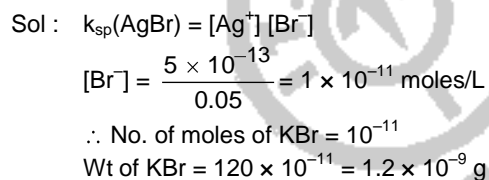
Ans : The concentration of H^+ and HCO_3^- are approximately equal.



Since the k_2 value is very low compared to that of k_1 , the H^+ obtainable from HCO_3^- is negligibly small.

32. Solubility product of silver bromide is 5.0×10^{-13}

Ans : 1.2×10^{-9} g



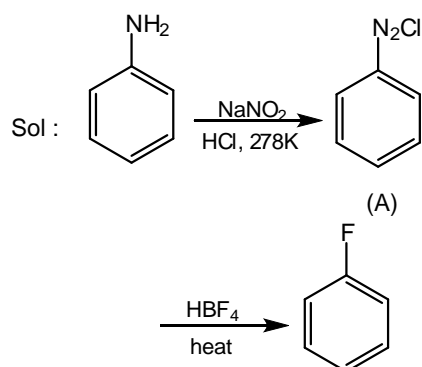
33. The correct sequence which shows decreasing order of

Ans : $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$

Sol : For isoelectronic species the radii decreases with increase in atomic number.

34. In the chemical reactions,

Ans : benzene diazonium chloride and fluorobenzene



35. If 10^{-4} dm^3 of water is introduced into a 1.0 dm^3 flask at 300 K,

Ans : 1.27×10^{-3} mol

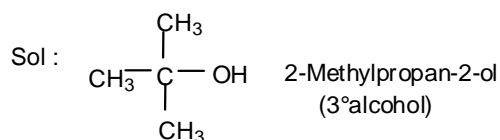
Sol : $PV = nRT$

$$n = \frac{3170(\text{Pa}) \times 1 \times 10^{-3} (\text{m}^3)}{8.314 (\text{JK}^{-1}\text{mol}^{-1}) \times 300(\text{K})}$$

$$= 1.27 \times 10^{-3} \text{ mol}$$

36. From amongst the following alcohols the one that would react fastest with.....

Ans : 2-Methylpropan-2-ol



Order of reactivity of alcohols with con.HCl/ZnCl₂ (Lucas reagent) is $3^\circ > 2^\circ > 1^\circ$

37. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change

Ans : 0.0558 K

$$\text{Sol : } \Delta T_f = i \times k_f \times m$$

$$= 3 \times 1.86 \times 0.01$$

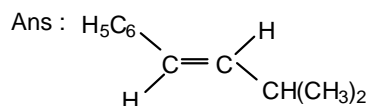
$$= 0.0558 \text{ K}$$

38. Three reactions involving $H_2PO_4^-$ are given below:.....

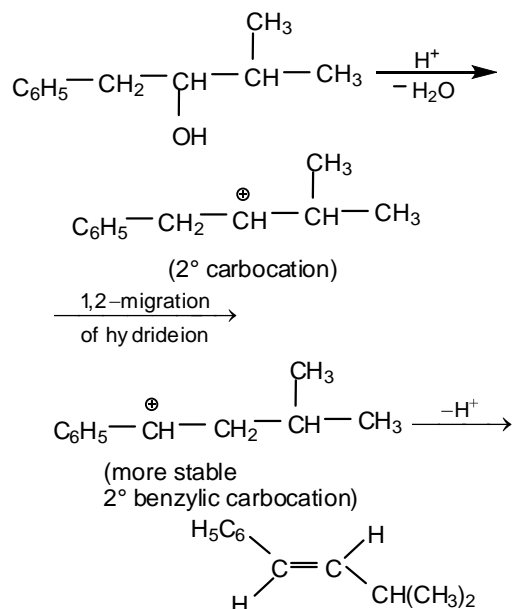
Ans : (ii) only

Sol : $H_2PO_4^-$ act as H^+ donor in reaction (ii).

39. The main product of the following reaction is



Sol :



40. The energy required to break one mole of Cl – Cl bonds in Cl₂ is 242 kJ mol⁻¹.....

Ans : 494 nm

$$\begin{aligned}
 \text{Sol : } E &= \frac{242 \times 10^3}{6.02 \times 10^{23}} \text{ J molecule}^{-1} \\
 E &= \frac{h \times c}{\lambda} \\
 \therefore \lambda &= \frac{6.626 \times 10^{-34} \text{ (Js)} \times 3 \times 10^8 \text{ (ms}^{-1}\text{)}}{\left(\frac{242 \times 10^3}{6.02 \times 10^{23}}\right) \text{ (J molecule}^{-1}\text{)}} \\
 &= 0.494 \times 10^{-6} \text{ m} \\
 &= 494 \text{ nm}
 \end{aligned}$$

41. 29.5 mg of an organic compound containing nitrogen was digested according to Kjeldahl's method

Ans : 23.7

$$\begin{aligned}
 \text{Sol : } \% \text{ of N} &= \frac{14 \times (V_1 - V_2) N_1 \times 100}{w \times 1000} \\
 &= \frac{14 \times (20 - 15) \times 0.1 \times 100}{0.0295 \times 1000} = 23.7
 \end{aligned}$$

42. Ionisation energy of He+ is 19.6 × 10⁻¹⁸ J atom⁻¹. The energy

Ans : -4.41 × 10⁻¹⁷ J atom⁻¹

$$\text{Sol : } E \propto \frac{z^2}{n^2}$$

$$\begin{aligned}
 E_{\text{Li}^{2+}} &= \frac{9}{4} \times E_{\text{He}^+} \\
 &= \frac{9}{4} \times -19.6 \times 10^{-18} \text{ J atom}^{-1} \\
 &= -4.41 \times 10^{-17} \text{ J atom}^{-1}
 \end{aligned}$$

43. On mixing, heptane and octane form an ideal solution. At 373 K, the vapour pressures

Ans : 72.0 kPa

$$\text{Sol : } n_A = \frac{25}{100} = 0.25$$

$$n_B = \frac{35}{114} = 0.31$$

$$x_A = \frac{0.25}{0.56} = 0.45$$

$$\begin{aligned}
 p &= p_A^0 \cdot x_A + p_B^0 \cdot x_B \\
 &= 105 \times 0.45 + 45 \times 0.55 \\
 &= 72 \text{ kPa}
 \end{aligned}$$

44. Which one of the following has an optical isomer?

Ans : [Co(en)₃]³⁺

Sol : [Co(en)₃]³⁺ is chiral.

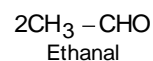
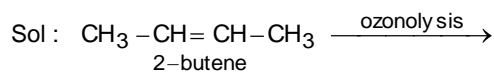
45. Consider the following bromides:.....

Ans : B > C > A

Sol : Order of S_N1 reactivity is related to the relative stability of carbocation formed by ionisation (B) gives allylic secondary carbocation, (C) gives secondary carbocation and (A) gives primary carbocation on ionisation.

46. One mole of a symmetrical alkene on ozonolysis gives two moles of an aldehyde

Ans : 2-butene



Molecular mass : 44 u

47. Consider the reaction:
 $\text{Cl}_2(\text{aq}) + \text{H}_2\text{S}(\text{aq}) \rightarrow \text{S}(\text{s}) + 2\text{H}^+(\text{aq}) + 2\text{Cl}^-(\text{aq})$

Ans : A only

Sol : Slow step is the rate determining step.
 According to A; rate = $K[\text{Cl}_2][\text{H}_2\text{S}]$
 According to B; rate = $\frac{K[\text{Cl}_2][\text{H}_2\text{S}]}{[\text{H}^+]}$

48. The Gibbs energy for the decomposition of Al_2O_3 at 500°C is as follows:.....

Ans : 2.5 V

Sol : $\Delta G = -nFE$
 $\frac{3}{2} \times 966 \times 10^3 (\text{J}) = 6 \times 96500 \times E$
 $E = 2.5 \text{ V}$

49. The correct order of increasing basicity of the given conjugate bases

Ans : $\text{RCO}\bar{\text{O}} < \text{HC}\equiv\bar{\text{C}} < \bar{\text{N}}\text{H}_2 < \bar{\text{R}}$

Sol : Acidic strength of the corresponding conjugate acid is
 $\text{CH}_3 - \text{COOH} > \text{CH}\equiv\text{CH} > \text{NH}_3 > \text{CH}_4$
 Hence the basicity of the conjugate base must be the reverse.

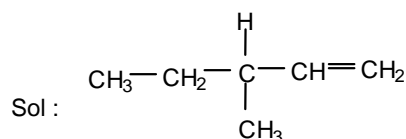
50. The edge length of a face centered cubic cell of an anionic substance is 508 pm.....

Ans : 144 pm

Sol : $2(r_{(+)} + r_{(-)}) = a$
 $r_{(+)} + r_{(-)} = \frac{508}{2} = 254$
 $r_{(-)} = 254 - 110 = 144 \text{ pm}$

51. Out of the following, the alkene that exhibits optical isomerism is

Ans : 3-methyl-1-pentene



3-Methyl-1-pentene

It contains a chiral carbon atom.

52. For a particular reversible reaction at temperature T , ΔH and ΔS were found to be

Ans : $T > T_e$

Sol : At equilibrium, $\Delta H = T_e \Delta S$
 $\therefore \Delta G = \Delta H - T \Delta S$
 $= \Delta S (T_e - T)$
 ΔG will be negative when $T > T_e$.

53. Percentages of free space in cubic close packed structure and in body centered

Ans : 26% and 32%

Sol : For ccp and bcc percentages of free space are 26% and 32% respectively.

54. The polymer containing strong intermolecular forces e.g. hydrogen bonding

Ans : nylon-6, 6

Sol : Nylon-6,6 is a fibre having strong intermolecular forces due to hydrogen bonding.

55. At 25°C , the solubility product of $\text{Mg}(\text{OH})_2$ is 1.0×10^{-11} . At which pH, will Mg^{2+} ions start precipitating

Ans : 10

Sol : $K_{sp}[\text{Mg}(\text{OH})_2] = [\text{Mg}^{2+}][\text{OH}^-]^2$

$$\therefore [\text{OH}^-]^2 = \frac{10^{-11}}{10^{-3}} = 10^{-8}$$

$$[\text{OH}^-] = 10^{-4}$$

$$\text{pOH} = 4$$

$$\text{pH} = 10$$

56. The correct order of $E_{\text{M}^{2+}/\text{M}}^0$ values with negative sign for the four successive elements

Ans : $\text{Mn} > \text{Cr} > \text{Fe} > \text{Co}$

Sol : $\text{Mn} > \text{Cr} > \text{Fe} > \text{Co}$

Standard reduction potential values of

$$\text{Mn}^{2+}/\text{Mn} = -1.18 \text{ V}$$

$$\text{Cr}^{2+}/\text{Cr} = -0.91 \text{ V}$$

$$\text{Fe}^{2+}/\text{Fe} = -0.44 \text{ V}$$

$$\text{Co}^{2+}/\text{Co} = -0.28 \text{ V}$$

57. Biuret test is not given by

Ans : carbohydrates

Sol : Biuret test is not answered by carbohydrates.

58. The time for half life period of a certain reaction $A \rightarrow$ Products is 1 hour. When the initial concentration of the reactant 'A',.....

Ans : 0.25 h

Sol : For a zero order reaction, $t_{1/2} \propto a$
 $2.0 \text{ mol L}^{-1} \rightarrow 1.0 \text{ mol L}^{-1}; t_{1/2} = 1 \text{ hour}$
 $0.5 \text{ mol L}^{-1} \rightarrow 0.25 \text{ mol L}^{-1};$
 $t_{1/2} = 0.25 \text{ hour}$

59. A solution containing 2.675 g of $\text{CoCl}_3 \cdot 6\text{NH}_3$ (molar mass = 267.5 g mol^{-1}) is passed through a cation exchanger.

Ans : $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$

Sol : No. of moles of $\text{AgCl} = \frac{4.78}{143.5} \approx 0.03$
 i.e., 0.01 moles of the compound gives 0.03 moles of AgCl
 \therefore No. of moles of Cl^- per unit = 3
 \therefore Formula of the complex is $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$

60. The standard enthalpy of formation of NH_3 is $-46.0 \text{ kJ mol}^{-1}$. If the enthalpy of formation of H_2 from its atoms is -436 kJ mol^{-1} and that of N_2 is -712 kJ mol^{-1}

Ans : $+352 \text{ kJ mol}^{-1}$

Sol : $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
 $2 \times -46 = +712 + 3 \times +436 - (6 \times \text{N} - \text{H})$
 $\text{N} - \text{H} = +352 \text{ kJ mol}^{-1}$

PART - C - MATHEMATICS

61. Consider the following relations :
 $R = \{(x, y) | x, y \text{ are real numbers and } \dots\}$

Ans: S is an equivalence relation but R is not an equivalence relation.

Sol: $x R y = x = wy \Rightarrow x R_x$
 \therefore R is reflexive
 $x R_y \Rightarrow x = wy$ and $y R_x \Rightarrow y = w'x$
 where $w' = \frac{1}{w}$, this is possible only

if $w \neq 0$
 $\text{ie } x R_0 \Rightarrow 0 R_x \text{ ie; } R \text{ is not symmetric}$
 $\therefore R \text{ is not an equivalence relation.}$
 $\frac{m}{n} S \frac{p}{q} \Rightarrow mq = pn$
 $\therefore \frac{m}{n} S \frac{m}{n}$ exists by the definition so S is reflexive .
 $\frac{m}{n} S \frac{p}{q} \Rightarrow mq = pn \Rightarrow pn = mq \Rightarrow \frac{p}{q} S \frac{m}{n}$
 $\therefore S \text{ is symmetric.}$

Again, $\frac{m}{n} S \frac{p}{q}, \frac{p}{q} S \frac{r}{s} \Rightarrow mq = pn \text{ and } ps = qr$
 ie; $mq.ps = pn.qr \Rightarrow ms = nr \Rightarrow \frac{m}{n} S \frac{r}{s}$
 $\therefore S \text{ is transitive}$
 $\therefore S \text{ is an equivalence relation but is not an equivalence relation.}$

62. The number of complex numbers z such that $|z - 1| = |z + 1| = \dots$

Ans: 1

Sol: z is a point equidistant from 3 given points.
 $\therefore z$ is the centre of the circle passing through 1, -1, i.

63. If α and β are the roots of the equation $x^2 - x + 1 = 0$,

Ans: 1

Sol: $-\omega - \omega^2$
 $\alpha^{2009} = (-\omega)^{2009}$
 $= -\omega^{2007} \cdot \omega^2$
 $= -\omega^2$
 $\beta^{2009} = (-\omega^2)^{2009}$
 $= -\omega^{4018}$
 $= -\omega^{4017} \times \omega$
 $= -\omega$
 $-\omega^2 - \omega = -(\omega^2 + \omega) = 1.$

64. Consider the system of linear equations :

$$\begin{aligned} x_1 + 2x_2 + x_3 &= 3 \\ 2x_1 + 3x_2 + x_3 &= 3 \end{aligned}$$

Ans: No solution.

Sol: $A = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 3 & 1 \\ 3 & 5 & 2 \end{bmatrix} \Rightarrow |A| = 0$

$$Ax_1 = \begin{bmatrix} 3 & 2 & 1 \\ 3 & 3 & 1 \\ 1 & 5 & 2 \end{bmatrix} \Rightarrow |Ax_1| \neq 0.$$

\therefore The given system has no solutions.

65. There are two urns. Urn A has 3 distinct red balls

Ans: 108

Sol: A \Rightarrow 3 distinct red balls
 B \Rightarrow 9 distinct blue balls
 ${}^3C_2 \times {}^9C_2 = 3 \times 36 = 108$.

66. Let $f : (-1, 1) \rightarrow \mathbf{R}$ be a differentiable function with

Ans: -4

Sol: $g(x) = [f(2f(x) + 2)]^2$
 $g'(x) = 2f(2f(x) + 2) \times 2f'(x)$
 $g'(0) = 2f(2f(0) + 2) \times 2f'(0)$
 $= 4 \times 1 \times f(2 - 2)$
 $= 4f(0)$
 $= -4$.

67. Let $f : \mathbf{R} \rightarrow \mathbf{R}$ be a positive increasing function with $\lim_{x \rightarrow \infty} \frac{f(x)}{f(x)} = 1$

Ans: 1

Sol: Given $\lim_{x \rightarrow \infty} \frac{f(x)}{f(x)} = 1$
 since $f(x)$ is an increasing function,
 $\lim_{x \rightarrow \infty} \frac{f(x)}{f(x)}$ is also equal to 1.

68. Let $p(x)$ be a function defined on \mathbf{R} such that $p'(x) = p'(1-x)$,

Ans: 21

Sol: $f(x) = p(x) + p(1-x)$
 $f'(x) = p'(x) - p'(1-x) = 0$ (given)
 $\therefore f(x) = k$ constant
 when $x = 0$, $p(0) + p(1) \Rightarrow k = 42$
 $p(x) + p(1-x) = 42$
 $\therefore \int_0^1 p(x) dx + \int_0^1 p(1-x) dx = 42$
 $\therefore 2 \int_0^1 p(x) dx = 42$
 $\therefore \int_0^1 p(x) dx = 21$.

69. A person is to count 4500 currency notes.

Ans: 34 minutes

Sol: In the first 9 minutes the person counts
 $9 \times 150 = 1350$ notes
 Total left notes = $4500 - 1350$
 $= 3150$
 He counts in A.P with $d = (-2)$ and $a = 150$

$\therefore 3150 = \frac{n}{2} [100 + (n-1) \times (-2)]$
 $= n[150 - n + 1]$
 $3150 = 151n - n^2$
 $\therefore n^2 - 151n + 3150 = 0$
 $\Rightarrow n = \frac{252}{2}$ or $\frac{50}{2}$
 $n = 25$
 \therefore Total time = $25 + 9 = 34$
 $= 34$ mts.

70. The equation of the tangent to the curve

$$y = x + \frac{4}{x^2}, \dots\dots$$

Ans: $y = 3$

$$\text{Sol: } y = x + \frac{4}{x^2}$$

$$\frac{dy}{dx} = 0 \Rightarrow 1 - \frac{8}{x^3} = 0$$

$$\Rightarrow x = 2$$

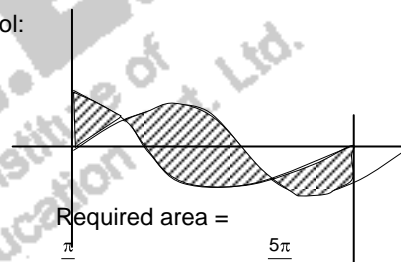
$$\therefore y = 3$$

\therefore Equation of tangent $y = 3$.

71. The area bounded by the curves $y = \cos x$ and $y = \sin x$

Ans: $4\sqrt{2} - 2$

Sol:



Required area =

$$\int_0^{\pi/4} (\cos x - \sin x) dx + \int_{\pi/4}^{5\pi/4} (\sin x - \cos x) dx$$

$$+ \int_{5\pi/4}^{2\pi} (\cos x - \sin x) dx$$

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

$$= 4\sqrt{2} - 2.$$

72. Solution of the differential equation $\cos x dy = y (\sin x - y) dx$,

Ans: $\sec x = (\tan x + c)y$

Sol: Consider $dy = y(\sin x - y)dx$

$$\text{consider } \frac{dy}{y} = y \sin x - y^2$$

$$\frac{dy}{dx} = y \tan x - y^2 \sec x$$

$$\frac{dy}{dx} - y \tan x = -y^2 \sec x$$

$$\frac{-1}{y^2} \frac{dy}{dx} + \frac{1}{y} \tan x = \sec x$$

$$z = \frac{1}{y} \Rightarrow \frac{dz}{dx} = \frac{-1}{y^2} \frac{dy}{dx}$$

$$\therefore \frac{dz}{dx} + z \tan x = \sec x$$

$$\therefore \text{I. F } e^{\int \tan x dx} = \sec x$$

$$\therefore z \sec x = \int \sec^2 x dx = \tan x + C$$

$$\frac{\sec x}{y} = \tan x + C$$

$$\therefore \sec x = y(\tan x + C).$$

73. Let $\vec{a} = \hat{j} - \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} - \hat{k}$

Ans: $-i + j - 2k$

Sol: $(a \times b) + c = 0$

$$a \times (a \times b) + a \times c = 0$$

$$(a \cdot b)a - (a \cdot a)b + a \times c = 0$$

$$3j - 3k - 2b - 2i - j - k = 0$$

$$\therefore 2b = -2i + 2j - 4k$$

$$\therefore \vec{b} = -i + j - 2k$$

74. If the vectors $\vec{a} = \hat{i} - \hat{j} + 2\hat{k}$,

Ans: $(-3, 2)$

Sol: $\vec{a} \cdot \vec{c} = 0$

$$\Rightarrow \lambda - 1 + 2\mu = 0$$

$$\Rightarrow \lambda + 2\mu = 1 \text{ -----(1)}$$

$$\vec{b} \cdot \vec{c} = 0$$

$$\Rightarrow 2\lambda + 4 + \mu = 0$$

$$\therefore 2\lambda + \mu = -4 \text{ -----(2)}$$

$$\therefore \text{Solving } \lambda = -3 \text{ and } \mu = 2$$

75. If two tangents drawn from a point P to the parabola $y^2 = 4x$ are at right angles,

Ans: $x = -1$

Sol: Locus of p is directrix of $y^2 = 4x$

$$\therefore x = -1$$

76. The line L given by $\frac{x}{5} + \frac{y}{b} = 1$ passes

Ans: 1

Sol: $\frac{x}{5} + \frac{y}{b} = 1$ passes through (13, 32)

$$\Rightarrow = -20$$

$$\therefore \text{Equation is } 4x - y = 20. \text{ It is parallel to}$$

$$\frac{x}{c} + \frac{y}{3} = 1$$

$$\therefore c = \frac{-3}{4}. \text{ ie; equation of line k becomes}$$

$$4x - 3y = -3.$$

\therefore The distance between them

$$= \frac{|20 - (-3)|}{\sqrt{16+1}}$$

$$= \frac{23}{\sqrt{17}}.$$

77. A line AB in three-dimensional space makes.....

Ans: 60°

Sol: $\cos^2 45 + \cos^2 120 + \cos^2 \theta = 1$

$$\frac{1}{2} + \frac{1}{4} + \cos^2 \theta = 1$$

$$\cos^2 \theta = 1 - \frac{3}{4} = \frac{1}{4}$$

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

$$\therefore \theta = 60^\circ.$$

78. Let S be a non-empty subsets of R.

Ans: Every rational number $x \in S$ satisfies $x \leq 0$

Sol: "There is a rational number $x \in S$ such that $x > 0$ " means that "There exist some positive rational number in S". Then its negation becomes "All rational numbers in S are negative".

That is

"Every rational number $x \in S$ satisfies $x \leq 0$ ".

79. Let $\cos(\alpha + \beta) = \frac{4}{5}$ and

Ans: $\frac{56}{33}$

Sol: $\tan 2\alpha = \tan(\alpha + \beta + \alpha - \beta)$

$$= \frac{\tan(\alpha + \beta) + \tan(\alpha - \beta)}{1 - \tan(\alpha + \beta) \tan(\alpha - \beta)}$$

$$= \frac{\frac{3}{4} + \frac{5}{12}}{1 - \frac{3}{4} \times \frac{5}{12}}$$

$$= \frac{56}{33}.$$

80. The circle $x^2 + y^2 = 4x + 8y + 5$

Ans: $-35 < m < 15$

Sol: Perpendicular distance from

$$(2, 4) < \text{Radius}$$

$$\frac{|6 - 16 - m|}{\sqrt{25}} < 5$$

$$= \frac{|-10-m|}{5} < 5$$

$$= |10 - m| < 25$$

$$-25 < 10 + m < 25$$

$$-35 < m < 15.$$

81. For two data sets, each of size 5.....

Ans: $\frac{11}{2}$

Sol: $\sigma^2 = \frac{n_1\sigma_1^2 + n_2\sigma_2^2 + n_1d_1^2 + n_2d_2^2}{n_1 + n_2}$,
 $\bar{x} = \frac{n_1\bar{x}_1 + n_2\bar{x}_2}{n_1 + n_2}$

since $n_1 = n_2$ we get

$$\sigma^2 = \frac{\sigma_1^2 + \sigma_2^2 + d_1^2 + d_2^2}{2} \quad \bar{x} = \frac{\bar{x}_1 + \bar{x}_2}{2}$$

$$d_1^2 = (2 - 3)^2 = 1 \quad \bar{x} = \frac{2+4}{2} = 3$$

$$d_2^2 = (4 - 3)^2 = 1$$

$$\therefore \sigma^2 = \frac{4+5+1+1}{2} = \frac{11}{2}$$

82. An urn contains nine balls of which.....

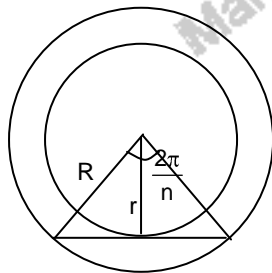
Ans: $\frac{2}{7}$

Sol: Three balls without replacement can be done in = $\frac{3 \times 4 \times 2}{{}^9C_3}$
 $= \frac{2}{7}$.

83. For a regular polygon, let r and R be the.....

Ans: There is a regular polygon with $\frac{r}{R} = \frac{2}{3}$

Sol: Let n sided regular polygon is inscribed in a circle. From the figure it is clear that



$$\therefore \cos\left(\frac{\pi}{n}\right) = \frac{r}{R}$$

There an possible integer value corresponding to $\frac{1}{2}$, $\frac{1}{\sqrt{2}}$ and $\frac{\sqrt{3}}{2}$

But $\cos\theta = \frac{2}{3} \Rightarrow \frac{\pi}{4} = \cos^{-1}\left(\frac{2}{3}\right)$
 $\Rightarrow n$ is not an integer.

84. The number of 3×3 non-singular matrices.....

Ans: at least 7

Sol: Consider $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$. The 1 on the non

diagonal position can be shifted to 5 more positions. Further we can consider

$$\begin{pmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix} \therefore \text{at least 7 matrices are there.}$$

85. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined by.....

Ans: -1

Sol: Since function has local minimum it must be continuous at $x = -1$

$$\therefore \lim_{x \rightarrow -1^+} f(x) = \lim_{x \rightarrow -1^-} f(x)$$

$$1 = k + 2$$

$$\therefore k = -1.$$

86. Four numbers are chosen at random.....

Ans: Statement 1 is true, Statement 2 is false.

Sol: If four chosen numbers form an AP, the common differences can be $\pm 1, \pm 2, \pm 3, \pm 4, \pm 5$ or ± 6 . (e.g. 1, 7, 13, 19 is an AP with common difference 6)

\therefore Statement 2 is not true.

87. Let $S_1 = \sum_{j=1}^{10} j (-1)^j {}^{10}C_j$, $S_2 = \sum_{j=1}^{10} j {}^{10}C_j$

Ans: Statement 1 is true, Statement 2 is false.

Sol: $S_1 = \sum_{j=1}^{10} j (-1)^j {}^{10}C_j$

$$S_2 = \sum_{j=1}^{10} j {}^{10}C_j$$

$$S_3 = \sum_{j=1}^{10} j^2 {}^{10}C_j$$

$$S_1 - S_3 = \sum_{j=1}^{10} (j - j^2) {}^{10}C_j$$

$$= - \sum_{j=1}^{10} j {}^{10}C_j$$

$$= -S_2$$

$$S_1 + S_2 = S_3.$$

$$\frac{10!}{j!(10-j)!} j \binom{10}{j-1}$$

$$\frac{10!}{(-2)!(10-j)!} = 9 \times 10 \times \frac{8!}{(-2)!(10-j)!}$$

$$\sum_{j=1}^{10} j \binom{10}{j-1} C_j = 90 \sum_{j=1}^{10} {}^8 C_{j-2}$$

$$= 90 \times 2^8.$$

88. Statement 1 : The point A (3, 1, 6) is the mirror image.....

Ans: Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for statement 1

Sol: A (3, 1, 6)
 B = (1, 3, 4)
 Midpoint of AB is (2, 2, 5)
 $2 - 2 + 5 = 5$
 Statement 2 is true
 D. R's of AB are [2, -2, 2] or [1, -1, 1]
 \Rightarrow which represent the D.R's of normal to the plane $x - y + z = 5$
 \Rightarrow Statement 1 is true
 We used statement 2 to prove statement 1.

89. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be a continuous function.....

Ans: Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for statement 1

Sol: $f(x) = \frac{1}{e^x + 2e^{-x}} \Rightarrow f(x) > 0$

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

$$f'(x) = 0$$

$$e^x = \frac{2}{e^x}$$

$$\Rightarrow e^{2x} = 2 \Rightarrow x = \frac{1}{2} \log 2$$

Checking the sign of $f'(x)$ as x crosses $\frac{1}{2} \log 2$, we note that $f(x)$ is maximum at $x = \frac{1}{2} \log 2$.

$$\text{Maximum value of } f(x) = \frac{1}{\sqrt{2} + 2 \times \frac{1}{\sqrt{2}}}$$

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

Statement 2 is true

$$\frac{1}{2\sqrt{2}} = \frac{\sqrt{2}}{4} = \frac{1.414}{4} = 0.3535$$

Since $f(x)$ is continuous in \mathbb{R} , $f(x)$ has to assume all values between 0 and 0.3535

Since $\frac{1}{3}$ is a number lying between 0 and 0.3535, statement 1 is also true.

90. Let A be a 2×2 matrix with non-zero.....

Ans: Statement 1 is true, Statement 2 is false.

Sol: Let $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$

$A^2 = I \Leftrightarrow |A| = \pm 1 \Rightarrow$ Statement 2 is NOT true.

$$A^2 = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} a & b \\ c & d \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} a^2 + bc & a + d \cdot b \\ a + d \cdot c & bc + d^2 \end{pmatrix}$$

$$\begin{cases} a^2 + bc = 1 \\ d^2 + bc = 1 \end{cases} \quad (1)$$

$$\begin{cases} a + d \cdot b = 0 \\ a + d \cdot c = 0 \end{cases} \quad (2)$$

Since b or $c \neq 0$

$$a + d = 0 \Rightarrow a = -d$$

$$\therefore \text{Tr}(A) = 0$$

Statement - 1 is true.