FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – IX
PAPER –2
TEST DATE: 14-05-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

Section – A

1. B

Sol. Using symmetry equivalent resistance is $\frac{8}{5}R$

2. A

Sol. $\frac{1}{f_1} = \left(\frac{\mu_1}{\mu_w} - 1\right)\left(\frac{2}{R}\right)$

$\frac{1}{f_2} = \left(\frac{\mu_2}{\mu_w} - 1\right)\left(-\frac{2}{R}\right)$

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

$\frac{2}{R} = \frac{2}{R}\left\{\frac{\mu_1 - \mu_2}{\mu_W}\right\}$

$(\mu_W) = (\mu_1 - \mu_2)$

$(\mu_1 - \mu_2) = \frac{4}{3}$

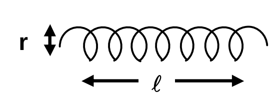
$2\mu_2 - \mu_2 = \frac{4}{3}$

$\mu_2 = \frac{4}{3}$

$\mu_1 = \frac{8}{3}$

3. A

Sol. $L = \frac{\mu_0 N^2 \pi r^2}{\ell}$



Where N is total number of turns

Let total length of wire is ℓ_0.

Then $L = \dfrac{\mu_0 (2\pi r.N)^2 .\pi r^2}{4\pi\ell} = \dfrac{\mu_0 \ell_0^2}{4\pi\ell}$ …(i)

$R = \rho\dfrac{\ell_0}{A} = \rho.\dfrac{\ell_0^2}{V} = \dfrac{\rho\ell_0^2}{(m/d)} = \dfrac{\rho d.\ell_0^2}{m}$

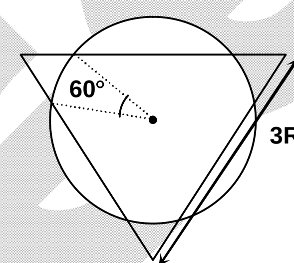
V is volume of the wire.

$\ell_0^2 = \dfrac{mR}{\rho d}$ …(ii)

From (i) and (ii) $\tau = \dfrac{L}{R} = \dfrac{\mu_0 m}{4\pi\rho d\ell}$.

4. C

Sol. $\phi = \dfrac{\left[\sigma\left(\dfrac{\pi}{3}R\cdot R\right)\times 3\right]}{\varepsilon_0} = \dfrac{\sigma\pi R^2}{\varepsilon_0}$



5. A, D

Sol. $K_1 = 8K + \left(25K\cos^2 37^\circ\right)2$

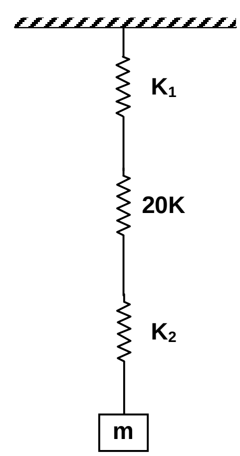
$K_1 = 40K$

$K_2 = 40K + \left(50K\cos^2 53^\circ\right)$

$K_2 = 40K$

$K_{equ} = 10K$

$T = 2\pi\sqrt{\dfrac{m}{10K}}$



6. A, B, D

Sol. $E_k = 5.23$ eV , W = 7.52 eV

Ionization energy of H atom = 13.6 eV

(A) Energy of photon = 5.23 + 7.52 = 12.75 eV

(B) $E_n = -\dfrac{Rhc}{n^2} = -\dfrac{13.6}{n^2}$ eV

$E_1(n = 1) = -13.6$ eV

$E_2(n = 2) = -3.4$ eV

$E_3(n = 3) = -1.51$ eV

$E_4(n = 4) = -0.85$ eV

$E_4 - E_1 = -0.85 + 13.6 = 12.75$ eV

So, the transition is from 4 to 1

(C) $L = \frac{nh}{2\pi}$

$L_1(n = 4) = \frac{4h}{2\pi}$

$L_2(n = 1) = \frac{h}{2\pi}$

$\Delta L = \frac{3h}{2\pi}$

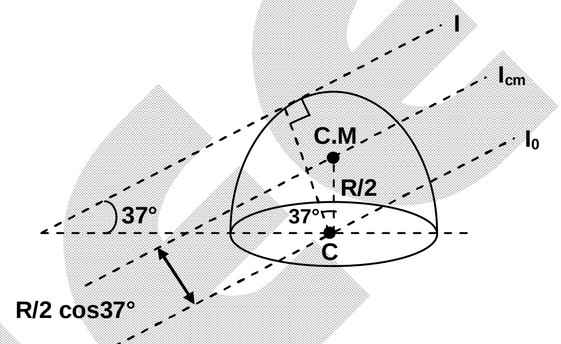
7. A, C

Sol. $I = I_{cm} + m\left(R - \frac{R}{2}\cos 37°\right)^2$

$= \left[I_0 - m\left(\frac{R}{2}\cos 37°\right)^2\right] + mR^2\left(1 - \frac{2}{5}\right)^2$

$= \left(\frac{2}{3} - \frac{4}{25} + \frac{9}{25}\right)mR^2$

$= \frac{13}{15}mR^2$



8. A, B, C

Sol. $\Delta x = S_1P - S_2P$

$d\cos\theta = n\lambda$ …(i)

$\Delta x_{max} = d = 10\lambda$

$n\lambda = 10\lambda$

$n = 10$

from equation (i) for the 4th bright ring

$10\lambda \cos\theta = 6\lambda$

$\cos\theta = \frac{3}{5}$

$\theta = 53°$

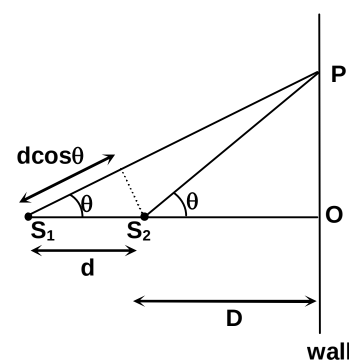
$\cos\theta = \frac{3}{5} = \frac{D}{\sqrt{D^2 + y^2}}$

$9D^2 + 9y^2 = 25D^2$

$y = \frac{8}{3}m$

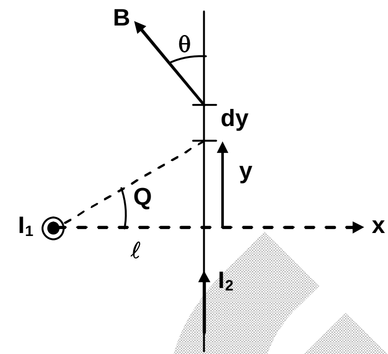
For dark ring path difference is

$\frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \frac{7\lambda}{2}, \frac{9\lambda}{2}, \frac{11\lambda}{2}, \frac{13\lambda}{2}, \frac{15\lambda}{2}, \frac{17\lambda}{2}, \frac{19\lambda}{2},$



9. B, C

Sol. $F = \int BI_2 dy \sin\theta$



$$F = \int \frac{\mu_0 I_1}{2\pi\sqrt{\ell^2 + y^2}} I_2 dy \left(\frac{y}{\sqrt{\ell^2 + y^2}}\right)$$

$$= \frac{\mu_0 I_1 I_2}{2\pi} \int_{-3\ell/4}^{4\ell/3} \frac{y dy}{\ell^2 + y^2}$$

$$= \frac{\mu_0 I_1 I_2}{4\pi} \ln\left(\frac{16}{9}\right) = \frac{\mu_0 I_1 I_2}{4\pi} \ln\left(\frac{16}{9}\right)$$

10. B, C

Sol. Let maximum displacement of centre of mass is h

$$mgh = \frac{1}{2}2kh^2 + \frac{1}{2}k(2h)^2$$

$$h = \frac{mg}{3k}$$

For the velocity centre of mass

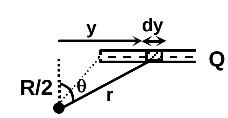
$$\frac{mgh}{2} = \frac{1}{2}2k\left(\frac{h}{2}\right)^2 + \frac{1}{2}kh^2 + \frac{1}{2}\left(\frac{3}{2}mv^2\right)$$

$$v = \frac{g}{3}\sqrt{\frac{m}{k}}$$

Section – B

11. 8

Sol. equilibrium of elemental part dy



$$dpA_2 = \frac{GMr\rho A_2 dy \sin\theta}{R^3}$$

$$\int_{P_0}^{P} dp = \int_{3R/8}^{\sqrt{3}R/2} \frac{GM\rho y dy}{R^3}$$

$$P = P_0 + \frac{39GM\rho}{128R} \qquad \ldots(i)$$

Using Bernoulli theorem

$$P = P_0 + \frac{1}{2}\rho v^2 \qquad \ldots(ii)$$

From (i) and (ii)

$$v = \frac{1}{8}\sqrt{\frac{39GM}{R}}$$

12. 5

Sol. $v_{max} = A\omega \sin\phi$

$$\frac{6\lambda}{2} = 1.2 \Rightarrow \lambda = 0.4 \text{ m}$$

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{320}{0.2}} = 40\,m/s$$

$$v = f\lambda \Rightarrow f = \frac{40}{0.4} = 100\ Hz$$

$$\omega = 2\pi f = 2\pi(100) = 200\pi$$

$$\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{(0.4)}\left(\frac{1}{30}\right) = \frac{2\pi}{12} = \frac{\pi}{6}$$

$$v_{max} = (0.25\times10^{-2})(200\pi)\sin\left(\frac{\pi}{6}\right) = \frac{0.50}{2}\pi = 0.25\pi\ m/s = 25\ cm/s$$

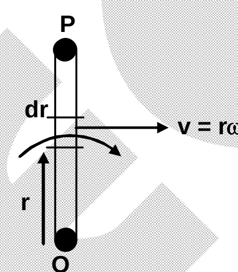
13. 3

Sol.
$$E = \int B(r)(dr)(r\omega)$$

$$= \int_0^{\ell} B_0\left(1+\frac{r^2}{\ell^2}\right)(dr)(r\omega)$$

$$= B_0\omega\int_0^{\ell}\left(r+\frac{r^3}{\ell^2}\right)(dr)$$

$$= \frac{3}{4}B_0\omega\ell^2 = 0.75B_0\omega\ell^2$$



14. 1

Sol. For the first container work done

$W_1 = nRT\ell n2$ …(i)

For the second container work done

$$W_2 = \frac{nR(T-T_f)}{\gamma-1}\quad \left[T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}\right]$$

$$W_2 = \frac{nRT(1-2^{1-\gamma})}{\gamma-1} \quad \text{…(ii)}$$

$W_1 = W_2$

$(\gamma-1)\ell n2 = 1-2^{1-\gamma}$

Hence, $x + y + z = 1 + 1 - \gamma + \gamma - 1 = 1$

15. 5

Sol. Time of flight $T = \frac{2(80)}{10} = 16$ s

Let t_0 is the time when ball collide with the wall. Then,

$60t_0 = v_0(16 - t_0)$ …(i)

$v_0 \rightarrow$ horizontal component of velocity of ball after the collision

$v_2 - v_1 = e(u_1 - u_2)$

$$10 - v_0 = \frac{1}{2}(60-10)$$

$v_0 = -15$ m/s …(ii)

from (i) and (ii)

$$t_0 = \frac{16}{5} = 3.2\ sec$$

So, separation = $50 \times 3.2 = 160$ m

16. 6

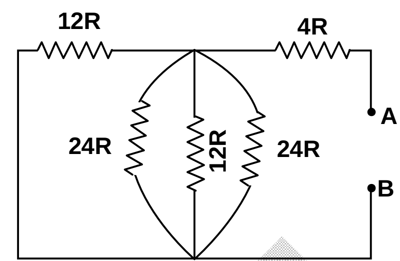
Sol. Equivalent resistance across AB

$R_{AB} = 8R$

Equivalent capacitance across AB

$C_{AB} = 3C$

$\tau = (8R)(3C) = 24RC$



17. 5

Sol. For A, $1V = \frac{2S}{8} = 0.25$ mm

Least count of A = $1 - 0.25 \times 3 = 0.25$ mm

For B, $1V = \frac{3S}{5} = 0.6$ mm

Least count of B = $2 - 0.6 \times 3 = 0.2$

Difference = $0.25 - 0.2 = 0.05$ mm

18. 3

Sol. In case I:

$$P - P_0 = \frac{4T}{r}$$

Now radius 'r' increases to '3r' due to charge on the soap bubble

$P_1V_1 = P_2V_2$

$$P\frac{4}{3}\pi r^3 = P_2\frac{4}{3}\pi(3r)^3$$

$$P_2 = \frac{P}{27}$$

In case II:

$$P_2 + \frac{\sigma_1^2}{2\varepsilon_0} - P_0 = \frac{4T}{3r}$$, where σ_1 is final charge density ($\sigma_1 = \sigma/9$)

$$\frac{P}{27} + \frac{\sigma^2}{162\varepsilon_0} - P_0 = \frac{P - P_0}{3}$$

$$\therefore\ P = \left(\frac{\sigma^2}{48\varepsilon_0} - \frac{9}{4}P_0\right)$$

Chemistry

PART – II

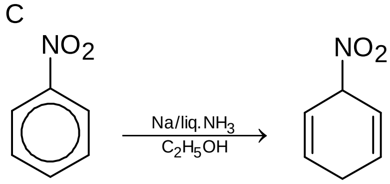
Section – A

19. D

Sol. It is an example of anti elimination via E_2 mechanism. Hence, meso gives trans alkene.

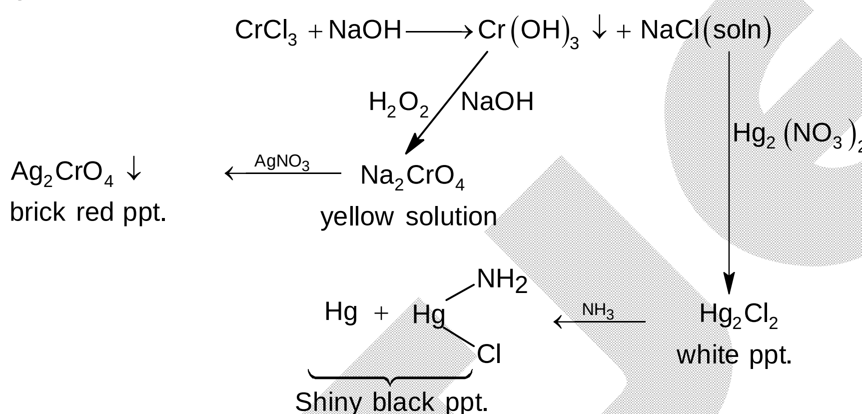
20. C

Sol.



21. C

Sol.



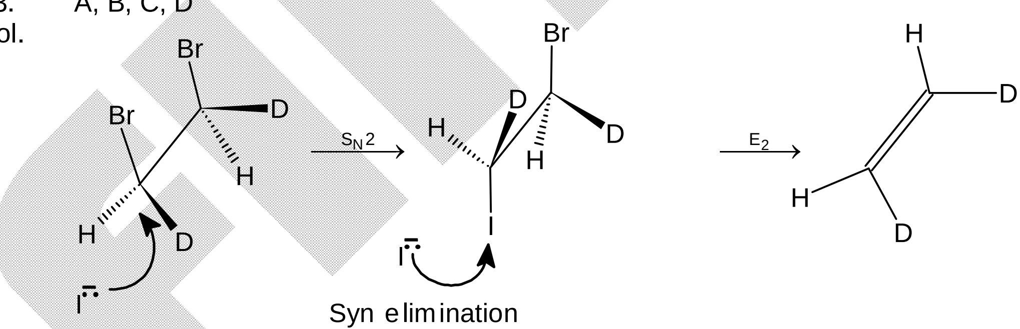
22. A

Sol. Nodal plane in 5d orbital are

$n - \ell - 1 = 5 - 2 - 1 = 2$

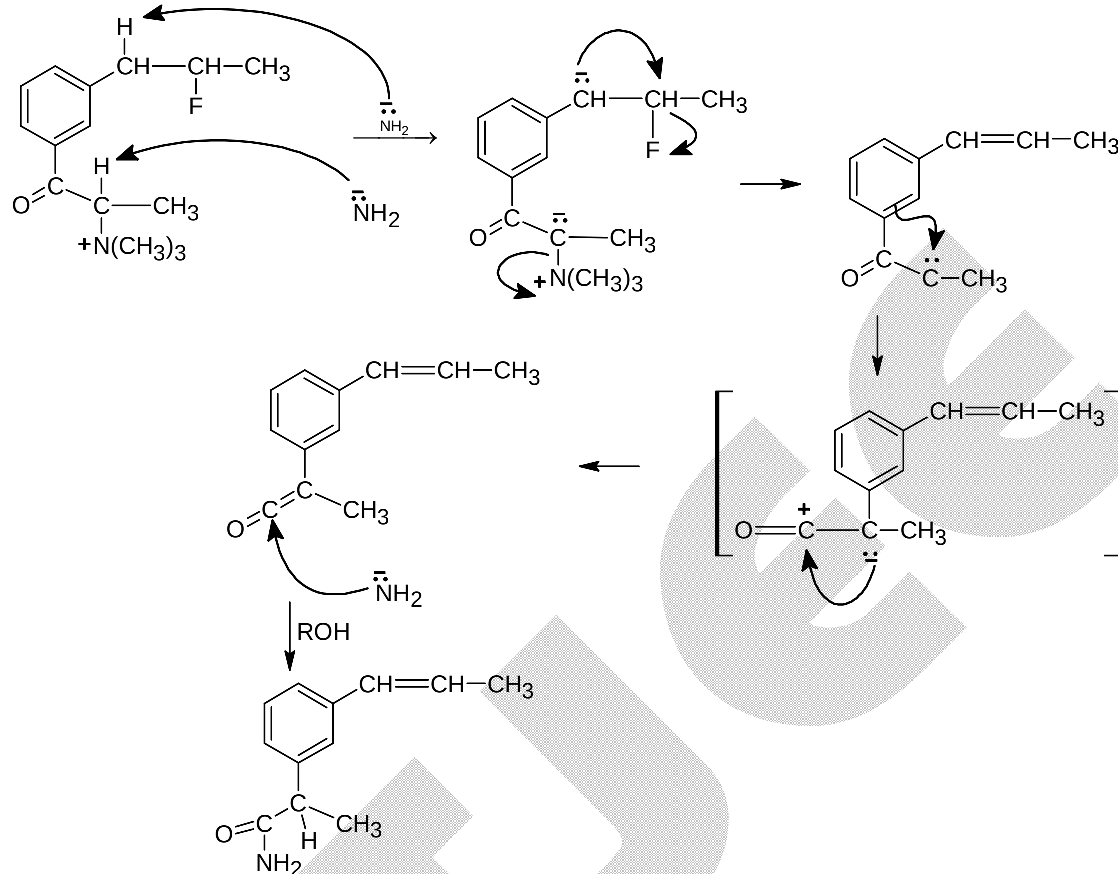
23. A, B, C, D

Sol.



24. A, B, C, D

Sol.



25. A, B, C

Sol. $P_Q = P_{NH_3} = \frac{8}{2} = 4$

$\therefore K_{eq}(I) = 4 \times 4 = 16\ cm^2\ Hg$

$P_z = P_{NH_3} = \frac{26}{2} = 13$

$\therefore K_{eq}(II) = 13 \times 13 = 169$

$P(s) \rightleftharpoons Q(g) + NH_3(g)$

$C - x \quad x \quad x + B$

$Y(s) \rightleftharpoons Z(g) + NH_3(g)$

$A - B \quad B \quad B + x$

$\therefore P_{Total} = x + B + (x + B)$

Also, $x(x + B) = 16$

$B(x + B) = 169$

By adding $(x + B)^2 = 185$

$\therefore (x + B) = 13.60$

$\therefore P_{Total} = 2(x + B) = 27.20$

26. A, C

Sol. Moles of HCl $= \frac{200 \times 0.9}{1000} = 0.18$

Moles of $Ba(OH)_2 = \frac{200 \times (0.45 \times 2)}{1000} = 0.18$

Thus, $[H^+] = [OH^-]$ hence no reactant is left unreacted.

$\Delta_r H^o = (0.18)(-56.2 \text{ kJ mol}^{-1})$

$= -10.116 \text{ kJ}$

$\Delta H_{caloremeter} = C_P \Delta T$

$= 450 \times \Delta T$

$\Delta H_{solution} = m.s.\Delta T = 400 \times 4.184 \times \Delta T$

$\Delta H_{total} = 450\Delta T + 1673.6\Delta T$

$10.116 \times 10^3 = 2123.6\Delta T$

$\Delta T = \frac{10116}{2123.6} = 4.7636 \simeq 4.76$

$T_2 = 4.76 + 21 = 25.76^o C$

27. A, B, C, D

Sol. $AlCl_3.6H_2O + SOCl_2 \xrightarrow{\Delta} AlCl_3 + HCl \uparrow + SO_2 \uparrow$

$Al_2O_3 + Coke + Cl_2 \xrightarrow{\Delta} AlCl_3 + CO \uparrow$

$Al + Cl_2 (dry) \xrightarrow{\Delta} AlCl_3$

$Al + HCl(dry, gas) \xrightarrow{\Delta} AlCl_3 + H_2 \uparrow$

28. B, D

Sol. Ag^+ and Mg^{2+} don't give coloured bead.

Section – B

29. 2

Sol. Molality = m, molarity = M, density = d, molar mass of solute m'

$m = \frac{1000M}{1000d - Mm'}$

$2.273 = \frac{1000 \times 4.0}{1000d - 4 \times 60}$

$d = 2.0 \text{ gm/ml}$

30. 2

Sol. $a - 2R = 1.35$

$\sqrt{3}a = 4R$

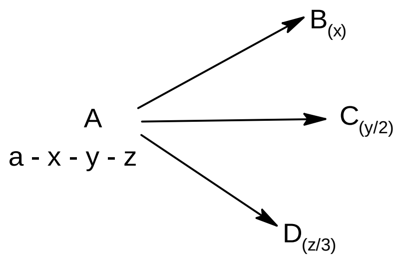
$a - \frac{1.73}{2}a = 1.35$

$\therefore a = \frac{1.35}{0.135} = 10 \text{ Å} = 10 \times 10^{-8} \text{ cm}$

$$\text{Density} = \frac{z \times m}{a^3 \times N_{av}}$$
$$= \frac{2 \times 600}{\left(10 \times 10^{-8}\right) \times 6 \times 10^{23}} = 2\ \text{gm/ml}$$

31. 8

Sol.



$$\therefore \frac{-d[A]}{dt} = \frac{dx}{dt} + \frac{dy}{dt} + \frac{dz}{dt}$$
$$= \frac{d[B]}{dt} + \frac{1}{2}\frac{d[C]}{dt} + \frac{1}{3}\frac{d[z]}{dt}$$
$$= \lambda_1[A] + 2\lambda_2[A] + 3\lambda_3[A]$$
$$\lambda = \left(60 \times 10^{-3}\right) + 2\left(25 \times 10^{-3}\right) + 3 \times 5 \times 10^{-3}$$
$$\lambda = 125 \times 10^{-3}$$
$$t_{avg.} = \frac{1}{\lambda} = \frac{1}{125 \times 10^{-3}} = 8\ \text{sec.}$$

32. 3

Sol. $T = \frac{\Delta H}{\Delta S} = \frac{27.6 \times 10^3}{100} = 276\ K \Rightarrow 3^o C$

33. 2

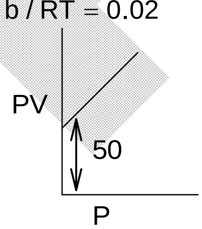
Sol. $0.58 = 0.521 + \frac{0.059}{n}\log 10^{-2}$

$n \Rightarrow 2$

34. 5

Sol. $Z = 1 + \frac{Pb}{RT}$

$b/RT = 0.02$



$PV = nRT = 50$

$\therefore 2RT = 50$

$RT = 25$

$\therefore b = 0.02 \times 25 = 0.5$
Excluded volume for 10 moles = 10 × 0.5 = 5

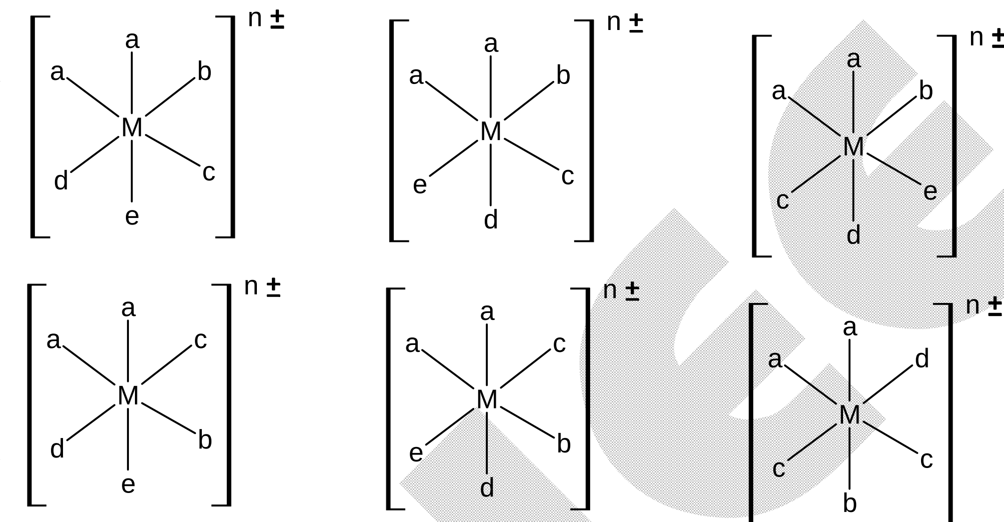
35. 4

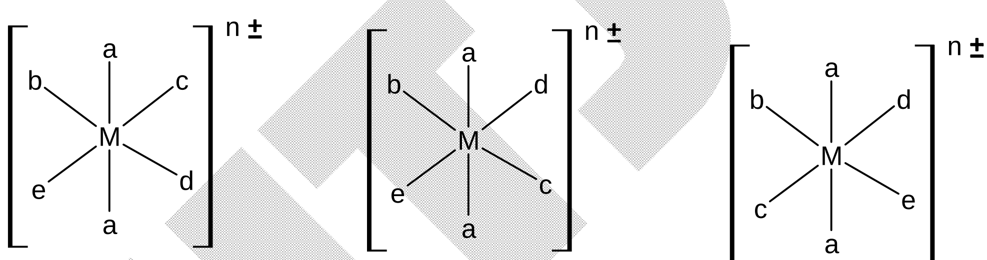
Sol. $Ni + 4CO \longrightarrow \left[Ni(CO)_4\right]$

36. 2

Sol.

Cis





Trans

$\therefore \frac{6}{3} = 2$

Mathematics PART – III

Section – A

37. D

Sol. $3 \times 3! \times 6! \times 4 \times 2 - 3 \times 3! \times 2! \times 4! = 119 \times (3!)^2 \times 4!$

38. A

Sol. Let $P(-1, y_1)$, $A(t_1)$ and $B(t_2)$, then $t_1t_2 = -1$, $t_1 + t_2 = y_1$

If circumcentre be (h, k), then $h = \frac{t_1^2 + t_2^2}{2}$ and $k = y_1$

$\Rightarrow 2h = y_1^2 + 2 \Rightarrow$ locus is $y^2 = 2x - 2$

39. D

Sol. At-least 2 of α, β, γ must be equal. So, number of elements equals ${}^9C_2 \cdot {}^2C_1 \cdot 3 + {}^9C_1$

40. D

Sol. $\frac{10 \times 4 + 30 \times 5 + 60 \times 5 + 100 \times 5 + 180}{20} <$ Average Marks $< \frac{10 + 30 \times 4 + 60 \times 5 + 100 \times 5 + 180 \times 5}{20}$

$\Rightarrow$ Average marks $\in (58.5, 91.5)$

41. A, C, D

Sol. If $f(x) = f(y) \Rightarrow x = y \Rightarrow f$ is one-one
By IVT, f is strictly increasing or strictly decreasing
But if $f(x) < f(y) \Rightarrow x < y \ \forall x, y$
$\Rightarrow$ f is always strictly increasing function
Case-I: If $f(x) > x \Rightarrow fff(x) > x$ (contradiction)
Case-II: If $f(x) < x \Rightarrow fff(x) < x$ (contradiction)
$\Rightarrow f(x) = x$ is the only solution

42. A, D

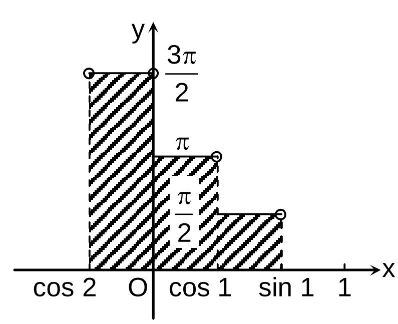
Sol. As can be seen in graph area

$= -\frac{3\pi}{2}\cos 2 + \pi \cos 1 + \frac{\pi}{2}(\sin 1 - \cos 1)$

$\Rightarrow a = \frac{\pi}{2} = b$

$c = 0, \ d = -\frac{3\pi}{2}$

$e = 0$



43. B, D

Sol. $0 \in$ Domain of R
R^{-1}, R are not reflexive, symmetric but are transitive relations

44. A, C

Sol. f(r) is an increasing function but not differentiable at all points where $\sin^{-1}(\sin x)$ is not differentiable

$f(r) = \frac{\pi r^2}{2} \Rightarrow r = 0, 2\pi, 4\pi, ...$

Critical points don't form a geometric progression

45. D
Sol. $\vec{x} \div (\vec{y} \div \vec{z}) = (\vec{x} \div \vec{y}) \div \vec{z}$ if $\vec{x} \times (\vec{y} \times \vec{z}) = (\vec{x} \times \vec{y}) \times \vec{z}$
$\vec{x}, \vec{y}, \vec{x} \div \vec{y}$ are coplanar if $\vec{x} \times \vec{y} = \vec{0}$

46. B, C
Sol. Shortest distance of point from given line = $\frac{2\left(\sqrt{2}-1\right)}{\sqrt{3}}$
The given point is on angle bisector of the planes so $r = \frac{2\left(\sqrt{2}-1\right)}{\sqrt{3}\left(\sqrt{2}+1\right)} = \frac{2}{\sqrt{3}}\left(3-2\sqrt{2}\right)$

Section – B

47. 8
Sol. k = 52 × 100 × 34

48. 9
Sol. $P = \frac{4! \times 9 \times 2 \times 1 \times \frac{36!}{(9!)^4\, 4!} \times 4!}{\frac{52!}{(13!)^4\, 4!} \times 4!}$

49. 5
Sol. Sum is ${}^{3n}C_{2n}$

50. 4
Sol. $x_{P_3} = x_{P_7} = x_{P_{11}} = ... = x_{P_{2023}}$

51. 1
Sol. Circumcircle of GHI is S

52. 9
Sol. Square can always be inscribed in the ellipse

53. 6
Sol. Let sides be a, b, c, then $A = 2\sum ab$, V = abc
Using AM – GM inequality $V \le \left(\frac{A}{6}\right)^{\frac{3}{2}}$

54. 6
Sol. $\left(z^4 - 1\right)\left(z^6 - 2z^3 + 2\right) = 0 \Rightarrow z = 1, -1, i, -i, \sqrt{2}e^{\pm i\frac{\pi}{4}}, \sqrt{2}e^{\pm i\frac{\pi}{4}}\omega, \sqrt{2}e^{\pm i\frac{\pi}{4}}\omega^2$