1. (1)

$$\frac{\sin\alpha}{\cos\beta}+\frac{\cos\beta}{\sin\alpha}+\frac{\cos\alpha}{\sin\beta}+\frac{\sin\beta}{\cos\alpha}\Rightarrow\frac{\cos(\alpha-\beta)}{\sin\beta\cos\beta}+\frac{\cos(\alpha-\beta)}{\sin\alpha\cos\alpha}$$

$$=2\cos(\alpha-\beta)\left[\frac{1}{\sin((\alpha+\beta)-(\alpha-\beta))}+\frac{1}{\sin((\alpha+\beta)+(\alpha-\beta))}\right]$$

$$\left[\frac{2\times\frac{2}{3}}{\frac{1}{3}\times\frac{2}{3}-\frac{2\sqrt{2}}{3}-\frac{\sqrt{5}}{3}}+\frac{2\times\frac{2}{3}}{\frac{1}{3}\times\frac{2}{3}+\frac{2\sqrt{2}}{3}.\frac{\sqrt{5}}{3}}\right]=\frac{2\times\frac{2}{3}\times\frac{4}{9}}{\frac{4-40}{81}}$$

$=\frac{48}{-36}=-\frac{4}{3}\Rightarrow$ Required answer is 1

2. (8) $y=\frac{4}{1+x^4}\Rightarrow 10y\left(\sqrt{2}\right)=8$

3. (5) $\int_1^2\log_2\left(x^3+1\right)dx+\int_1^{\log_2 9}\left(2^x-1\right)^{\frac{1}{3}}dx=2\log_2 9-1=\log_2\left(\frac{81}{2}\right)$

GIF of $\log_2\left(\frac{81}{2}\right)=5$

4. (1) $\left(16\left(\log_5 x\right)^3-68\log_5 x\right)\left(\log_5 x\right)=-16$

$\log_5 x=t\Rightarrow 4t^4-17t^2+4=0$

$$t^2=\frac{17\pm\sqrt{17^2-8^2}}{2.4}=\frac{17\pm15}{8}=4,\frac{1}{4}$$

$$\Rightarrow\log_5 x=\pm2,\pm\frac{1}{2}\Rightarrow x=25,\frac{1}{25},\sqrt{5},\frac{1}{\sqrt{5}}$$

Product = 1

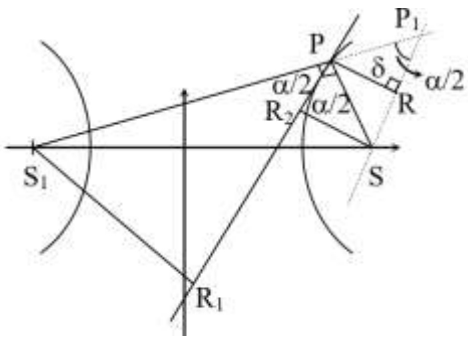
5. (5) $\beta=\lim\limits_{x\to0}\frac{1+x^3-\left(1-\frac{x^3}{3}\right)+\left(1-\frac{x^2}{2}-1\right)x}{x^3}=\frac{5}{6}\Rightarrow 6\beta=5$

6. (3) $|A|^5\left|A^2-(\beta-1)A-\beta\right|=0$

$|A|\neq0\Rightarrow|A^2-(\beta-1)A-\beta|=0\Rightarrow|A+1||A-\beta|=0$

$|A+1|\neq0\Rightarrow|A-\beta|=0\Rightarrow\beta=\frac{1}{3}\Rightarrow9\beta=3$

7. (7)

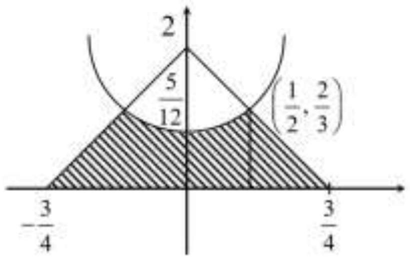


$PR=SR_2=\delta$

$S_1R_1=S_1P\sin\frac{\alpha}{2}=\beta\sin\frac{\alpha}{2}$

$$\frac{\beta\delta}{9}\sin\left(\frac{\alpha}{2}\right)=\frac{SR_2.S_1R_1}{9}=\frac{b^2}{9}=7$$

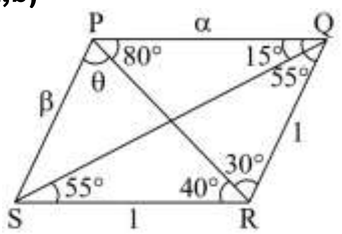
8. (6)



$$9\alpha=9.2\left[\int_0^{\frac{1}{2}}\left(x^2+\frac{5}{12}\right)dx+\frac{1}{2}.\frac{2}{3}.\frac{1}{4}\right]$$

$$=18\left(\frac{1}{24}+\frac{5}{24}+\frac{2}{24}\right)=6$$

9. (a,b)



In $\Delta PQR=\frac{\alpha}{\sin 30^0}=\frac{1}{\sin\theta^0}\Rightarrow\alpha=\frac{1}{2\cos 10^0}\ldots$(i)

In $\Delta PSR=\frac{\beta}{\sin 40^0}=\frac{1}{\sin\theta^0}\Rightarrow\beta\sin\theta^0=\sin 40^0\ldots$(ii)

From equation (i) and (ii)

$$\alpha\beta\sin\theta=\frac{\sin 40^0}{2\cos 10^0}$$

$$4\alpha\beta\sin\theta=\frac{2\sin 40^0}{\sin 80^0}=\frac{2\sin 40^0}{2\sin 40^0\cos 40^0}=\sec 40^0$$

$$\frac{2}{\sqrt{3}}<\sec 40^0<\sqrt{2}$$

10. (a, b, c)

So $\alpha=\sum_{k=1}^{\infty}\left(\frac{1}{2}\right)^{2k}=\frac{\frac{1}{4}}{1-\frac{1}{4}}=\frac{1}{3}$

$$g(x)=2^{7/3}+2^{\frac{1-x}{3}}$$

$$\frac{2^{\frac{x}{3}}+2^{\frac{1-x}{3}}}{2}\geq\left(2^{\frac{x}{3}+\frac{1-x}{3}}\right)^{\frac{1}{2}}\Rightarrow g(x)\geq 2^{\frac{7}{6}}$$

Also $g(x)\leq 1+2^{1/3}$ at x=0,1

11. (a) Let $\omega=I_1+iI_2=(\bar{z})^2+\frac{1}{z^2},I_1,I_2\in$ Integers

$$\Rightarrow|\omega|=\sqrt{I_1^2+I_2^2}=|z|^2+\frac{1}{|z|^2}$$

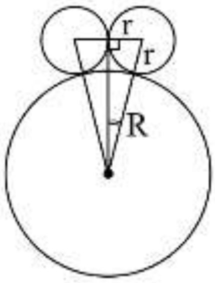
$$\Rightarrow |z|^4 + \frac{1}{|z|^4} = I_1^2 + I_2^2 - 2$$

$$\Rightarrow |z|^8 - \left(I_1^2 + I_2^2 - 2\right)|z|^4 + 1 = 0$$

$$\Rightarrow |z|^4 = \frac{\left(I_1^2 + I_2^2 - 2\right) \pm \sqrt{\left(I_1^2 + I_2^2 - 2\right)^2 - 4}}{2}$$

$$\Rightarrow |z| = \left(\frac{43 \pm 3\sqrt{205}}{2}\right)^{1/4} \text{ where } I_1 = 6, I_2 = 3$$

12. (c, d)



$$\sin\left(\frac{2\pi}{2n}\right) = \frac{r}{R+r} \Rightarrow \frac{R+r}{r} = \frac{1}{\sin\left(\frac{\pi}{n}\right)}$$

$$\frac{R}{r} + 1 = \operatorname{cosec}\frac{\pi}{n} \Rightarrow \frac{R}{r} = \left(\operatorname{cosec}\frac{\pi}{n} - 1\right)$$

For n=4, $\frac{R}{r} = \left(\sqrt{2} - 1\right) \Rightarrow R = r\left(\sqrt{2} - 1\right)$

For n=8, $\frac{R}{r} > \left(\sqrt{2} - 1\right) \Rightarrow R > \left(\sqrt{2} - 1\right)r$

For n=5, $\frac{R}{r} = \left(\operatorname{cosec}36^0 - 1\right) < 1 \Rightarrow R < r$

For n=12, $\frac{R}{r} = \left(\operatorname{cosec}15^0 - 1\right) \Rightarrow \frac{R}{r} = \left(\sqrt{2}\left(\sqrt{3}+1\right) - 1\right) < \sqrt{2}\left(\sqrt{3}+1\right) \Rightarrow R < \sqrt{2}\left(\sqrt{3}+1\right)r$

13. (b, c, d)

$$\vec{a}.\vec{b} = 0$$

$$\Rightarrow 3 + b_2 - b_3 = 0$$

$$\Rightarrow \left|\vec{b}\right| = \sqrt{1 + b_2^2 + b_3^2}$$

$$\Rightarrow \left|\vec{b}\right| = \sqrt{2b_2^2 + 6b_2 + 10} = \sqrt{2\left(b_2\right)\left(b_2 + 3\right) + 10}$$

$$\Rightarrow \left|\vec{b}\right| = \sqrt{2b_2 b_3 + 10}$$

$$\Rightarrow \left|\vec{b}\right| > 10 \qquad \left(\because b_2 b_3 > 0\right)$$

Also, $\vec{c} \times \vec{b} = \vec{a} - \vec{c}$

$$\Rightarrow \left|\vec{c}\right| \le \left|\vec{a}\right| \Rightarrow \left|\vec{c}\right| \le \sqrt{11}$$

If $\vec{a}.\vec{c} = 0 \Rightarrow \left|\vec{c}\right| = 0 \Rightarrow \vec{c} = 0 \Rightarrow \vec{a} = 0$ (which is not possible)

14. (c) $\frac{dy}{dx} = 12y = \cos\left(\frac{\pi x}{12}\right), y(0) = 0$

$$ye^{12x} = \int \cos\left(\frac{\pi x}{12}\right) e^{12x} dx$$

$$ye^{12x}=\frac{e^{12x}}{12^2+\frac{\pi^2}{12^2}}\left[12\cos\left(\frac{\pi x}{12}\right)+\frac{\pi}{12}\sin\left(\frac{\pi x}{12}\right)\right]+c$$

$$\Rightarrow y=\frac{1}{12^2+\frac{\pi^2}{12^2}}\left[12\cos\left(\frac{\pi x}{12}\right)+\frac{\pi}{12}\sin\left(\frac{\pi x}{12}\right)-12e^{-12x}\right]$$

15. (a) Required number of ways

=coefficient of x^2+ coefficient of xy+coefficient of y^2 in $(3x+3x^2+x^3)^4(2y+y^2)^4$

$\Rightarrow$Required number of ways $=\left(6.3^4+4.3^3\right)\times 2^4+3^4\times 6\times 4+3^4\times 4\times 8\times 4$

=21816

16. (a)

$$M=\begin{bmatrix}\frac{5}{2} & \frac{3}{2}\\ -\frac{3}{2} & -\frac{1}{2}\end{bmatrix}=I+\frac{3}{2}\begin{bmatrix}1 & 1\\ -1 & -1\end{bmatrix}$$

$$A^2=\begin{bmatrix}0 & 0\\ 0 & 0\end{bmatrix}, where A=\begin{bmatrix}1 & 1\\ -1 & -1\end{bmatrix}$$

$$\Rightarrow M^{2022}=\left(I+\frac{3}{2}A\right)^{2022}=I+\frac{3}{2}\times 2022A$$

$$=\begin{bmatrix}3034 & 3033\\ -3033 & -3032\end{bmatrix}$$

17. (c)

$$P\left(\frac{W_1}{G_{12}}\right)=\frac{P\left(\frac{W}{G}\right)}{P(G)}$$

$$=\frac{\frac{5}{16}\cdot\frac{6}{32}}{\frac{5}{16}.1+\frac{8}{16}\cdot\frac{15}{48}+\frac{3}{16}\cdot\frac{12}{16}}=\frac{15}{80+40+36}=\frac{5}{52}$$

18. (b)

$$f(n)=n+\sum_{r=1}^{n}\frac{16r+9n-4nr-3n^2}{4nr+3n^2}$$

$$=\sum_{r=1}^{n}\frac{16r+9n}{4nr+3n^2}$$

$$\lim_{n\to\infty}f(x)=\int_0^1\frac{16x+9}{4x+3}dx$$

$$=\int_0^1 4-\frac{3}{4x+3}dx$$

$$=4-\frac{3}{4}\ln\left(\frac{7}{3}\right)$$

19. (3) $\vec{F}$ is passing through origin, so torque of $\vec{F}$ is zero

So $\vec{L}$ of the particle about O is conserved

So $\vec{L}_0=\left(\frac{1}{\sqrt{2}}\hat{i}+\sqrt{2}j\right)\times(1)\left(-\sqrt{2}\hat{i}+\sqrt{2}j+\frac{2}{\pi}k\right)$

$$=\begin{vmatrix} \hat{i} & j & k \\ \frac{1}{\sqrt{2}} & \sqrt{2} & 0 \\ -\sqrt{2} & \sqrt{2} & \frac{2}{\pi} \end{vmatrix}$$

$$=\hat{i}\left(\frac{2\sqrt{2}}{\pi}\right)-j\left(\frac{2}{\pi\sqrt{2}}\right)+k\left(1+2\right)kg\,m^2s^{-1}$$

$\vec{L}$ at any $\vec{r}=x\hat{i}+yj+zk$ having velocity $\vec{v}=v_x\hat{i}+v_yj+v_zk$

$$\vec{L}=\begin{vmatrix} \hat{i} & j & k \\ x & y & z \\ v_x & v_y & v_z \end{vmatrix}$$

$$=\hat{i}\left(yv_z-zv_y\right)-j\left(xv_z-zv_x\right)+k\left(xv_y-yv_x\right)$$

so $xy_y-yv_x=3$

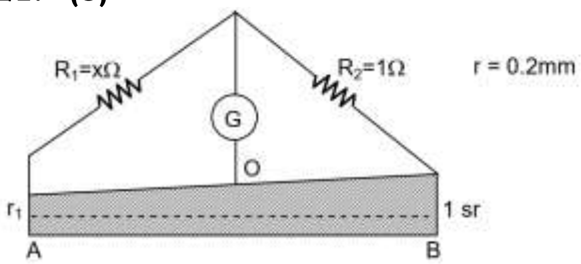
20. (2)

$${}^{230}_{90}Th\rightarrow{}^{214}_{84}P_0+4\,{}^{4}_{2}He+2\beta^-$$

(from consv. Of mass no and charge)

So $\frac{n_\alpha}{n_\beta}=\frac{4}{2}=2$

21. (5)



$$R_{AO}=\int_0^{1/2}\frac{\rho}{\pi}\frac{dx}{\left(r+4rx\right)^2}=\frac{2\rho}{3\pi r^2}$$

$$R_{BO}=\int_{1/2}^{1}\frac{\rho}{\pi}\frac{dx}{\left(r+4r\pi\right)^2}=\frac{2\rho}{15\pi r^2}$$

$$\left(x\right)=\frac{2\rho}{15\pi r^2}=\left(1\right)\frac{2\rho}{3\pi r^2}\Rightarrow x=5$$

22. (4)

$$[B]=[e]^\alpha[M_e]^\beta[h]^\gamma[K]^\delta$$

$$[B]=MT^{-2}I^{-1}$$

$$[e]=I^T$$

$$[h]=ML^2T^{-1}$$

$$[K]=ML^3T^{-4}I^{-2}$$

$$MT^{-2}I^{-1} = [IT]^{\alpha}[M]^{\beta}[ML^2T^{-1}]^{\gamma}[ML^3T^{-4}I^{-2}]^{\delta}$$

$1 = \beta + \gamma + \delta$ (1)

$-2 = \alpha - \gamma - 4\delta$ (2)

$-1 = \alpha - 2\delta$ (3)

$0 = 2\gamma + 3\delta$ (4)

On solving equation (1), (2), (3) and (4), we get

$\alpha = 3$

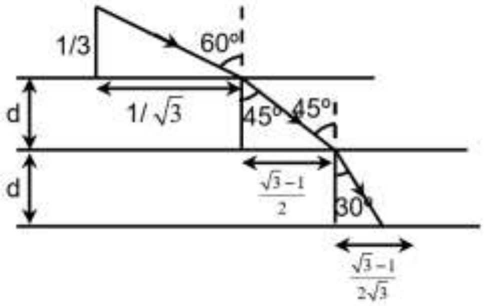
$\gamma = -3$

$\delta = 2$

$\beta = 2$

$\alpha + \beta + \gamma + \delta = 4$

23. (4)



$$1\sin 60^0 = \frac{\sqrt{3}}{2} r$$

$$r = 45^0$$

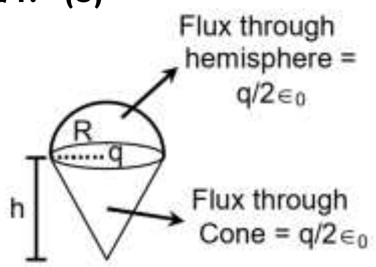
$$\frac{\sqrt{3}}{2}\sin 45^0 = \sqrt{3}\sin r_2$$

$$r_2 = 30^0$$

$$\left(\frac{1}{\sqrt{3}} + \frac{(\sqrt{3}-1)}{2} + \frac{(\sqrt{3}-1)}{2\sqrt{3}}\right) \times n = \frac{8}{\sqrt{3}}$$

n=4

24. (3)



Flux through cone $= \frac{q}{2\epsilon_0} = \frac{nq}{6\epsilon_0}$

$n = 3$

25. (6)

For $l > l_0$, it oscillates with frequency $\frac{1}{2\pi}\sqrt{\frac{k_1}{m}}$

And for $l < l_0$, it oscillates with frequency $\frac{1}{2\pi}\sqrt{\frac{k_2}{m}}$

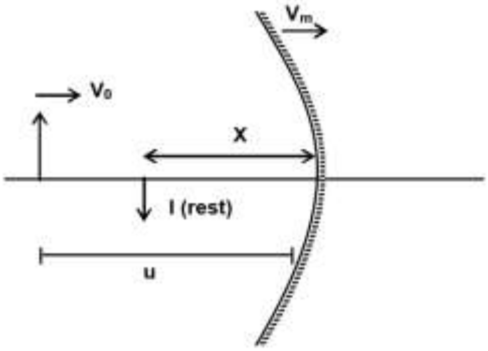
Therefore $T = \pi\sqrt{\frac{m}{k_1}} + \pi\sqrt{\frac{m}{k_2}}$

$= \pi\left[\sqrt{\frac{0.1}{0.009}} + \sqrt{\frac{0.1}{0.016}}\right] = \frac{70}{12}\pi \approx 6\pi$

$6\pi = n\pi$

$n = 6$

26. (3) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$



$\frac{1}{-x} + \frac{1}{-30} = \frac{1}{-10}$

x=15cm

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\frac{1}{-x} + \frac{1}{(-u)} = \frac{1}{f}$

$\frac{1}{x^2}\frac{dx}{dt} + \frac{1}{u^2}\frac{du}{dt} = 0$

$\frac{dx}{dt} = -\left(\frac{x}{u}\right)^2 \frac{du}{dt}$

$(v_m - 0) = -\left(\frac{15}{30}\right)^2 [v_m - v_0]$

$v_m = -\frac{1}{4}[v_m - 15]$

$4v_m + v_m = 15$

$v_m = 3cm/s$

27. (b)

for $r \in [0,1]; \rho = kr$

for $r \in [1, r_B]; \rho = \frac{2k}{r}$

total charge of the configuration is q

$q = \int_0^1 (kr)4\pi r^2 dr + \int_1^{r_B} \frac{2k}{r} 4\pi r^2 dr$

For $r_B = \sqrt{\frac{3}{2}}; q = k\pi + 2k\pi = 3k\pi$

Electric field just outside B is $E = \frac{1}{4\pi \in_0} \frac{(3\pi k)}{r_B^2} = \frac{k}{2 \in_0}$

For $r_B = \frac{3}{2}; q = k\pi + 5\pi k = 6k\pi$

Potential just outside B is $v = \frac{(6\pi k)}{4\pi \in_0 \left(\frac{3}{2}\right)} = \frac{k}{\in_0}$

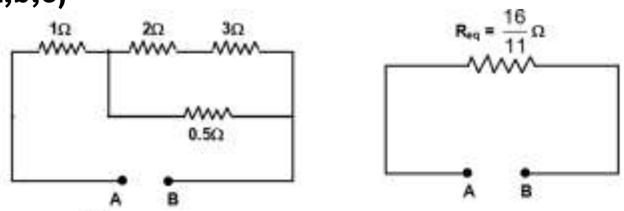
For $r_B = 2; q = k\pi + 12k\pi = 13k\pi$

For $r_B = \frac{5}{2}; q = k\pi + 21k\pi = 22\pi k$

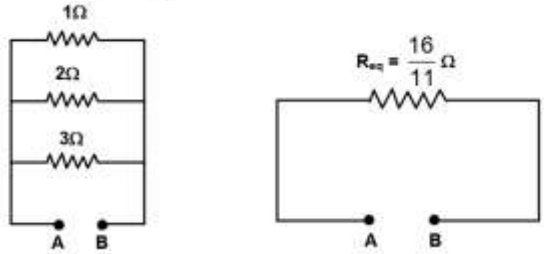
Mag. Of E just outside B is $\frac{1}{4\pi \in_0} \frac{(22\pi k)}{\left(\frac{25}{4}\right)} = \frac{22}{25} \frac{k}{\in_0}$

28. (a,b,c)

(1)



(2)



If 6v voltage source connected to both circuit

$P\alpha \frac{1}{R}$ voltage constant

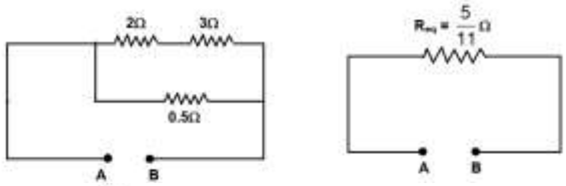
$R_1 > R_2 \quad P_1 < P_2$

If 2 Amp current source connected

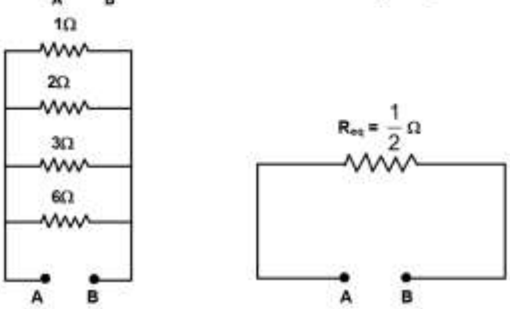
$P\alpha R$

$P_1 > P_2$

(1)



(2)



$P_1 = \frac{6^2}{\left(\frac{16}{11}\right)} \; Q_1 = \frac{6^2}{\left(\frac{5}{11}\right)}$

$Q_1 > P_1$

$P = i^2 R \quad R_2 > R_1 \; \therefore Q_2 > Q_1$

29. (c, d)
(Conducting)
Isothermal process T=constant
PV = constant

$$P_1V_1 = P_2V_2$$

$$\left(P_1 + \frac{4T}{R_1}\right)\frac{4}{3}\pi R_1^3 = \left(P_2 + \frac{4T}{R_2}\right)\frac{4}{3}\pi R_2^3$$

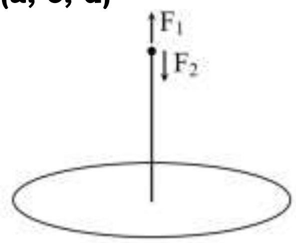
$$\left(\frac{R_1}{R_2}\right)^3 = \frac{P_2 + \frac{4T}{R_2}}{P_1 + \frac{4T}{R_1}}$$

Adiabatic process PV^r =constant $PT^{-5/2}$=const
(Insulating)

$$\frac{P_1^1}{P_2^1} = \left(\frac{T_2}{T_1}\right)^{5/2}$$

$$\left(\frac{T_2}{T_1}\right)^{5/2} = \left(\frac{P_1 + \frac{4T}{R_1}}{P_2 + \frac{4T}{R_2}}\right)$$

30. (a, c, d)



$$\vec{F}_1 = \frac{q\sigma}{2\in_0}\left(1 - \frac{Z}{\sqrt{R^2 + Z^2}}\right)k$$

$$\vec{F}_2 = -ck$$

$\beta = \frac{1}{4} \therefore \frac{1}{4} = \frac{2c\varepsilon_0}{q\sigma}$ (Given)

$\frac{q\sigma}{2\varepsilon_0} = 4c$ ...(1)

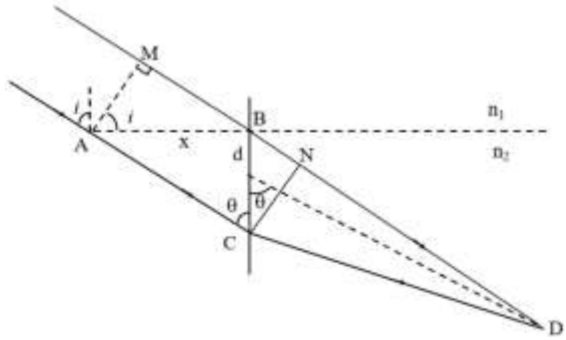
For equilibrium at $z = Z_0$

$F_1 = F_2 \Rightarrow \frac{q\sigma}{2\varepsilon_0}\left(1 - \frac{Z}{\sqrt{R^2 + Z^2}}\right) =$ c from equation (1)

$$\Rightarrow \left(1 - \frac{Z}{\sqrt{R^2 + Z^2}}\right) = \frac{1}{4} \Rightarrow \frac{Z}{\sqrt{R^2 + Z^2}} = \frac{3}{4} \Rightarrow Z = \sqrt{\frac{9}{7}}R \approx 1.13R$$

Z>1.13R: $F_2 > F_1$ Particle reaches origin
Z<1.13R; $F_1 > F_2$ Particle reaches back to $z = Z_0$

31. (a,b)



Path difference

$$\Delta r = (MB + BN) - AC$$

$$\Delta r = (n_1 x \sin i + n_2 d \cos\theta) - \frac{n_2 d}{\cos\theta}$$

$$\Delta r = n_1 (d \tan\theta)\frac{n_2}{n_1}\sin\theta + n_2 d\cos\theta - \frac{n_2 d}{\cos\theta} \quad (\because x = d\tan\theta; n_1 \sin i = n_2 \sin\theta)$$

$$\Delta r = \frac{n_2 d \sin^2\theta}{\cos\theta} + n_2 d\cos\theta - \frac{n_2 d}{\cos\theta}$$

$$\Delta r = \frac{n_2 d\left[\sin^2\theta + \cos^2\theta - 1\right]}{\cos\theta} = 0$$

32. (b, c, d)

Volume of gas at B is

$$V_B = \left(\frac{100}{300}\right)^{3/5}(0.8) = 0.4 m^3$$

$$W_{AB} = \frac{P_A V_A - P_B V_B}{\gamma - 1} = -60 kJ$$

$$W_{BC} = P_B V_B \ln 2 = 84 kJ$$

$$W_{CA} = 0$$

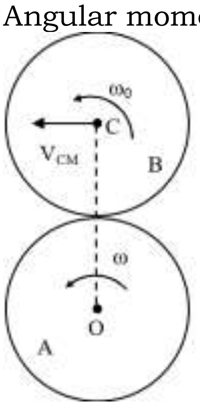
33. (b)

$$V_{CM} = 2R\omega$$

At point of contact

$$V_{CM} = \omega_0 R \Rightarrow \omega_0 = 2\omega$$

Angular momentum of disk B with respect to center of A is



$$L = \left(\frac{MR^2}{2}\right)(\omega_0) + M(2R\omega)(2R)$$

$$= \left(\frac{MR^2}{2}\right)(2\omega) + 4MR^2\omega$$

$$L = 5MR^2\omega \therefore n = 5$$

34. (a)

$$6e = \frac{hc}{\lambda} - \phi_0$$

$$0.6e = \frac{hc}{4\lambda} - \phi_0$$

Solving the above 2 equations, we get (a)

35. (None)

$$L.C. = \frac{0.5}{100} = .005mm$$

I $\quad 4 \times 0.25 + (20-4) \times .005 \rightarrow 1.08mm$

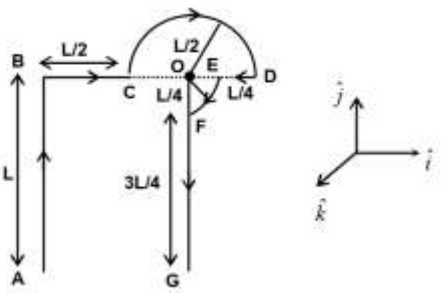
II $\quad 4 \times 0.25 + (16-4) \times .005 \rightarrow 1.06mm$

$$d_m = \frac{1.06 + 1.08}{2} = 1.07$$

$$\Delta d_m = \frac{.01 + .01}{2} = .01$$

$$d = (1.07 \pm .01) mm$$

36. (c)



$$\vec{B}_{Net} = \vec{B}_{AB} + \vec{B}_{BC} + \vec{B}_{CD} + \vec{B}_{DE} + \vec{B}_{EF} + \vec{B}_{FG}$$

$$\vec{B}_{AB} = \vec{B}_{DE} = \vec{B}_{FG} = 0$$

$$\vec{B}_{AB} = \frac{\mu_0 I}{4\pi L} \sin 45^0 \left[-k\right]$$

$$\vec{B}_{CD} = \frac{\mu_0 I}{4\left(\frac{L}{2}\right)} \left[-k\right]$$

$$\vec{B}_{EF} = \frac{\mu_0 I}{8\left(\frac{L}{4}\right)} \left[-k\right] \Rightarrow (C)$$

37. (6)

$$\underset{1}{H_2SO_4} \longrightarrow \underset{1}{H^+} + \underset{1}{HSO_4^-}$$

$$Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}$$

0 $\quad$ 0.036 $\quad$ 0.018

$$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$$

1 $\quad$ 1 $\quad$ 0.018 $\quad$ ($Q > K_C$ so the reaction will go in backward direction)

$(1+a)$ $\quad$ $(1-a)$ $\quad$ $(0.018-a)$

≈ 1 $\quad$ ≈ 1

Now, $0.012 = \dfrac{1 \times (0.018 - a)}{1}$

a=0.006

$$\left[SO_4^{2-}\right] = 0.018 - 0.006 = 1.2 \times 10^{-2} M$$

$PbSO_4(s) \rightleftharpoons Pb^{2+}(aq) + SO_4^{2-}(aq)$

$\quad\quad s \quad\quad (0.012+s) \approx 0.012$

$s = \frac{1.6\times10^{-8}}{0.012} = 1.33\times10^{-6}$

$\therefore y = 6$

38. (5) $\frac{P^0 - P_s}{P^0} = iX_B$

$\frac{60-59.724}{60} = i\times\frac{0.1}{0.1+100}$

$\frac{0.276}{60} = i\times\frac{0.1}{100.1} = i\times\frac{1}{1000}$

$i = \frac{276}{60} = 4.6$

$i = 1+(n-1)\alpha$

$4.6 = 1+(n-1)0.9$

n=5

39. (7) Let λ_m^0 the molar conductance by Z_mX_n

For the graph

$339 = \lambda_m^0 - b\sqrt{c}$

$339 = \lambda_m^0 - b\times0.01$ ... (1)

$336 = \lambda_m^0 - b\times0.04$ ... (2)

On solving, we get, $\lambda_m^0 = 340$

Now, $25m+100p = 250$ ... (3)

100m+80n=440 ... (4)

50m+80n=340 ... (5)

On solving (3), (4) and (5)

We get, m=2,n=3,p=2

40. (2) $Xe + O_2F_2 \rightarrow \underset{(P)}{XeF_2} + O_2$

$2\underset{(P)}{XeF_2} + 2H_2O \rightarrow 2Xe + 4HF + O_2$

Per mol of P, 2 moles of HF will be formed

41. (6)

$AgNO_3 \rightarrow Ag + NO_2\uparrow + \frac{1}{2}O_2\uparrow$

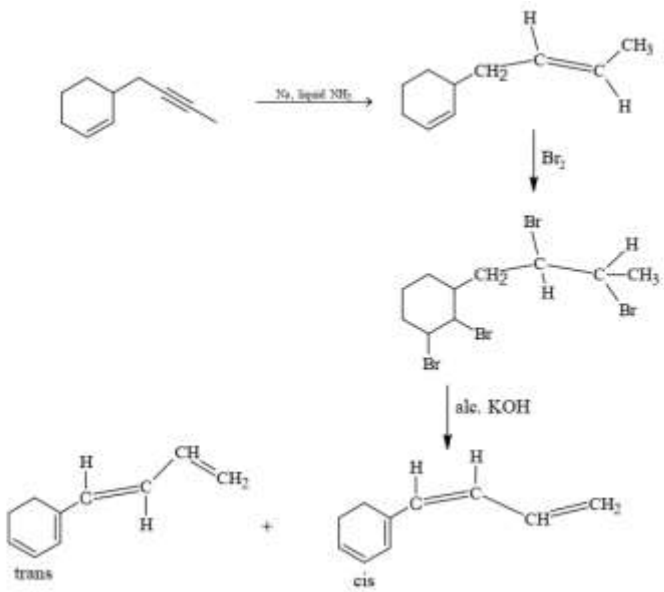
$NO_2 \rightarrow$ One unpaired electron

$O_2 \rightarrow$ Two unpaired electrons

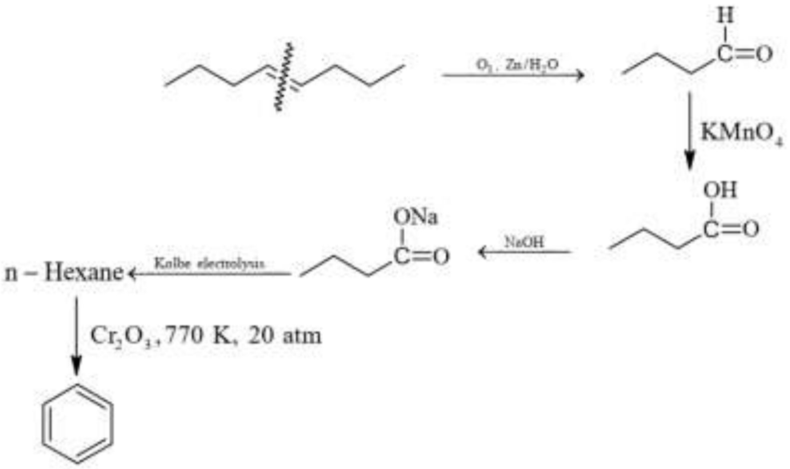
$\sigma1s^2 < \sigma1s^{*2} < \sigma2s^2 < \sigma2s^{*2} < \sigma2p_z^2 < \pi2p_x^2 = \pi2p_y^2 < \pi2p_x^{*1} = \pi2p_y^{*1}$

Number of antibonding electron in $O_2 = 6$

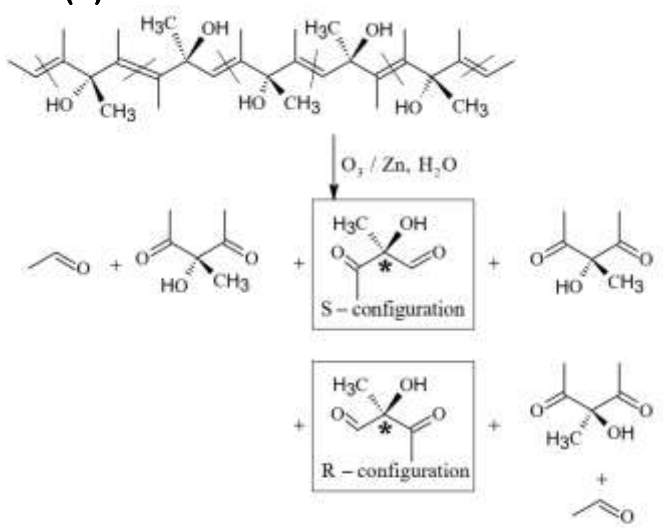
42. (2)



43. (0)



44. (2)



Only 2-chiral molecules are formed.

45. (b,c) As per the law of multiple proporation, if P and Q form two or more compounds, then the ratio of the masses of one of the element (P) that combines with fix mass of Q bear a simple whole number ratio.

Now

Compound	% of P	% of Q
1	50	50
2	44.4	55.6
3	40	60

OR

Compound	% of P	% of Q
1	50	50
2	40	50
3	33.33	50

(a) Given that formula of compound 3 is P_3Q_4 and that of compound 2 is P_3Q_5

Then compound $3 \Rightarrow P_{15/4}Q_5$

Compound $2 \Rightarrow P_3Q_5$

So, ratio of masses of P in 3 and 2 which combines with fixed mass of

$Q = \frac{15}{4} : 3 = \frac{5}{4}$

But from table 2, ratio of masses of P in 3 and 2 $= \frac{33.33}{40} = \frac{5}{6}$

Since two ratio are not same, so option (a) is incorrect.

(b) Empirical formula of compound

P	$\frac{40}{20} = 2$	$\frac{3}{2}$
Q	$\frac{60}{45} = \frac{4}{3}$	1

So, empirical formula of compound 3 is P_3Q_2

(c) Compound $2 \Rightarrow$ PQ or P_4Q_4

Compound $3 \Rightarrow P_5Q_4$

So, ratio of masses of P in 2 and 3 which combines with fix mass of Q is =4:5 which resembles table 2.

(d) Empirical form of compound should be PQ_2 and not P_2Q

46. (b, c, d)

(a) $\Delta S = nF\left(\frac{\partial E_{cell}}{\partial T}\right)$

$= nF \times \frac{R}{F} = nR = 2R(\because n = 2)$

Incorrect statement.

(b) E_{cell} for the given cell is +ve

$\therefore \Delta G = -ve$

Since, $\Delta s = nF\left[\frac{\partial E_{cell}}{\partial T}\right]$

$\therefore \Delta S = +ve$

Correct statement.

(c) Correct statement because racemization involves formation of a racemic mixture

(d) Correct statement because number of particles are increasing

47. (b,c)

$$B_2H_6 + \underset{(excess)}{NH_3} \xrightarrow{High\,temperature} (BN)_x$$

$$B_2O_3 + NH_3 \xrightarrow{\Delta} B_2O_3.2NH_3 \xrightarrow{\Delta} (BN)_x + H_2O$$

$$2B + 2NH_3 \xrightarrow{High\,temperature} 2BN + 3H_2$$

Since, Boron is not a compound, so option (a) is not correct.

48. (a, b, c)

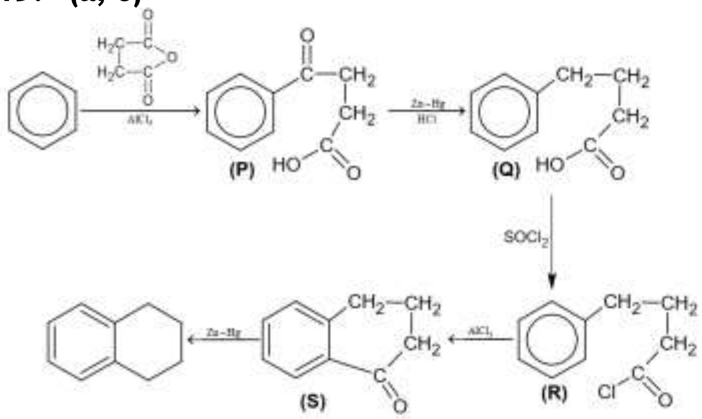
(i) $CaCO_3 \xrightarrow{\Delta} CaO + CO_2 \uparrow$

$\underset{Gangue}{SiO_2} + \underset{Flux}{CaO} \rightarrow \underset{slag}{CaSiO_3} \downarrow$

(ii) Pig iron contains 4% of carbon.

(iii) $C(s) + CO_2(g) \rightarrow 2CO(g)$

49. (a, c)



50. (b, c)

(i) Polymerization of chloroprene gives synthetic rubber

(ii) PVC is thermoplastic polymer

(iii) Ethene at 350-570K temperature and 1000-2000 atm pressure in presence of peroxide initor yields low density polythene.

51. (b)

$X = 8 \times \frac{1}{8} + 6 \times \frac{1}{2} + \frac{1}{2} \times 8$

=1+3+4=8

$2r = \frac{\sqrt{3}}{4}a;$

$r = \frac{\sqrt{3}}{8}a$

Packing fraction= $\frac{\text{number of atoms x volume of one atom}}{\text{volume of unit cell}} \times 100\%$

$= \frac{8 \times \frac{4}{3} \times 3.14 \times \left(\frac{\sqrt{3}}{8}a\right)^3}{a^3} \times 100\%$

=35%

52. (c)

$ClO_3^- + Cl^- \rightarrow ClO_2$

$2ClO_2 + 2O_3 \rightarrow Cl_2O_6 + 2O_2$

53. (c) $Pb(NO_3)_2 + 2NaCl \rightarrow PbCl_2 \downarrow$

$PbCl_2 + 2HCl \rightarrow [PbCl_4]^{-2}$

54. (c) Lobry-de-Bruyn-Van Ekenstin rearrangent]