FLT-03

1. (B) $\frac{\pi P r^4}{3 Q l}$ vol. flow rate $Q = \left(\frac{P}{l}\right) \cdot \frac{\pi r^4}{\eta 8}$ $Q = \frac{P}{\frac{8 \eta l}{\pi r^4}}$ $Q = \frac{\Delta P}{R_{viscous}}$

2. (D) If $\vec{A} \perp \vec{B}$ then $\vec{A} \cdot \vec{B} = 0$

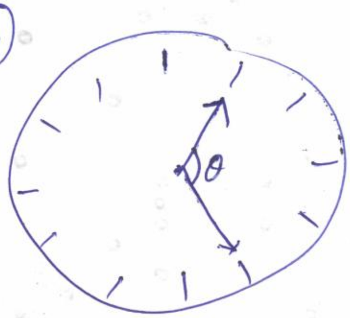
$(2\hat{i} + 3\hat{j} + 2\hat{k}) \cdot (4\hat{i} - 4\hat{j} + \alpha\hat{k}) = 0$

$8 - 12 + 2\alpha = 0$

$2\alpha = 4$

$\alpha = 2$

3. (b)



$\theta = 120^\circ$

$\Delta S = 2a \sin(\theta/2)$

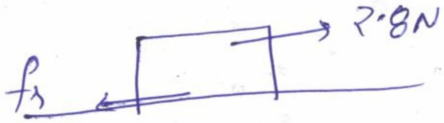
$= 2 \times 6 \times \sin 30^\circ = 6\sqrt{3}$ h.

4. (a) $R_{max} = 16$ Km   If $\theta = 30^\circ$

$\frac{u^2}{g} = 16$ Km $H_m = \frac{u^2 \sin^2\theta}{2g} = \frac{u^2}{g} \cdot \frac{\sin^2 30}{2}$

$= 16 \times \frac{1}{8} = 2$ Km

5. (D) $m = 2$ Kg

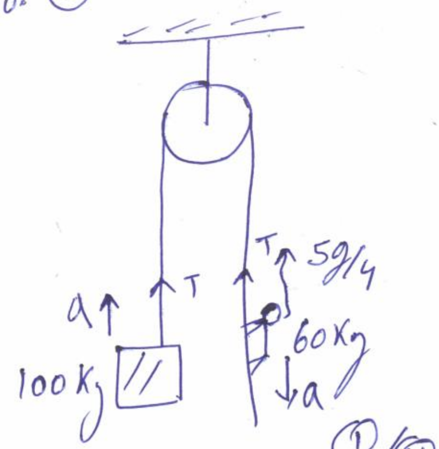


$f_{r\,max} = \mu m g$ $(f_r)_{req} = 2 \cdot 8$ N

$= 0 \cdot 54 \times 2 \times 10$ so only 2·8N will act.

$= \underline{10 \cdot 8 N}$

6. (c)



$T - 100g = 100a \quad —(I)$

$T - 60g = 60\left(\frac{5g}{4} - a\right) \quad —(II)$

$T - 60g = 75g - 60a$

$T - 135g = -60a \quad —(III)$

(I)/(III)

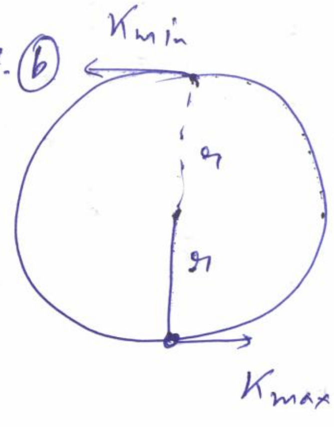
$\frac{T - 100g}{T - 135g} = \frac{5}{-3}$

$-3T + 300g = 5T - 675g$

$975g = 8T$

$\left(T = \frac{975g}{8}\right) = \underline{1218\,N.}$

7. (b)



Due to Energy Conservation

$K_{max} = K_{min} + mg(2r)$

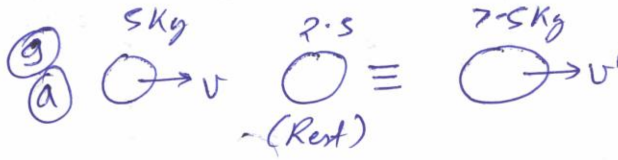
$K_{max} - K_{min} = 1 \times 10 \times 2 = 20J.$

8. (a) $W = \frac{1}{2} m v^2$

$25 = \frac{1}{2} \times 2 \times v^2$

$v = 5 m/s$

9. (a)



$\frac{1}{2} \times 7.5 \times (v')^2 = 5$

$(v')^2 = \frac{10}{7.5} = \frac{4}{3}$

$v' = \frac{2}{\sqrt{3}}$

by Conservation of momentum.

$5\cdot v + 0 = (7.5)\, v'$

$5v = (7.5)\cdot \frac{2}{\sqrt{3}}$

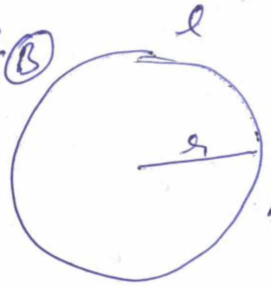
$v = \sqrt{3}$ m/s.

$KE = \frac{1}{2}\times 5 \times 3 = 7.5\,J$.

10. (C) Internal gravitational force does not change the state of COM. if initially it's in rest then it will remain in rest.

11. (B) $u_{MF} = \frac{1}{2\mu_0}B^2$ $\quad u_{EF} = \frac{1}{2}\epsilon_0 E^2$

12. (B)

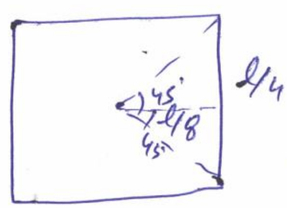


$2\pi r = l$

$r = \frac{l}{2\pi}$

$B_1 = \frac{\mu_0 I}{2r} = \frac{\mu_0 I\cdot 2\pi}{2\cdot l}$

$B_1 = \frac{\mu_0 \pi I}{l}$



$B_2 = \frac{\mu_0 I}{4\pi(l/8)}\left[\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}\right]\times 4$

$B_2 = \frac{\mu_0 I}{\pi l/2}\left[\sqrt{2}\right]\times 4$

$B_2 = \frac{\mu_0 I\, 8\sqrt{2}}{\pi l}$

$\frac{B_1}{B_2} = \frac{\mu_0 \pi I}{l \cdot \frac{\mu_0 I\cdot 8\sqrt{2}}{\pi l}}$

$= \frac{\pi^2}{8\sqrt{2}}$

13. (D) $B = \frac{\mu_0 N I}{2\pi r}$ (vacuum)

$B = \frac{\mu_0 \mu_r N I}{2\pi r}$ (medium)

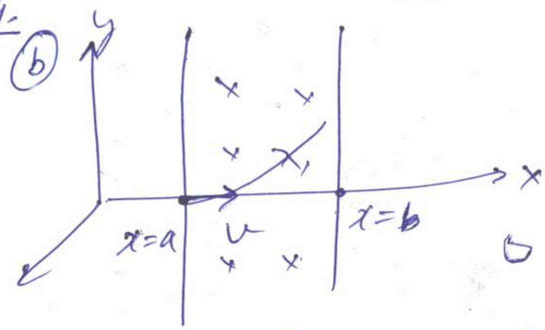
$1 = \frac{2\times 10^{-7}\mu_r \times \cancel{400}^{100}\cdot 2\times 10}{0.4/2\pi}$

$\mu_r = \frac{1}{2\times 10^{-7}\times 2000\times 2\pi}$

$= \frac{10^4}{8\pi} = \frac{\cancel{10000}^{1250}}{\cancel{8}\pi} = \frac{1250}{\pi}$

≈ 400.

14. (b)



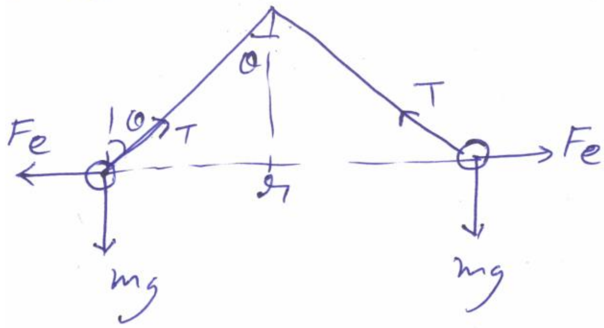
if Particle can just enter the region $x > b$

then $r > (b-a)$

$\frac{mv}{qB} > (b-a)$

$v > \frac{qB(b-a)}{m}$.

15. (a)



$T\cos\theta = mg$

$T\sin\theta = F_e = \frac{Q\,Q}{4\pi\epsilon_0 r^2}$

$\tan\theta = \frac{F_e}{mg}$

after immersing in a medium of density σ, the 'θ' remains same.

$T\cos\theta = \frac{mg}{RD}\left(1-\frac{1}{RD}\right)$ $\quad T\sin\theta = \frac{F_e}{K}$

$\tan\theta = \cancel{mg}\ \frac{F_e \cdot RD}{K\cdot mg(RD-1)} = \frac{F_e}{mg}$

$\frac{RD}{RD-1} = K \qquad (RD = \rho/\sigma)$

$K = \frac{\rho/\sigma}{\rho/\sigma - 1} = \frac{\rho}{\rho-\sigma}$

16. (a)

$dQ = \frac{Q}{L}\cdot dx$

$dF = \frac{kq\cdot dQ}{x^2} = kq\cdot\frac{Q}{L}\cdot\frac{dx}{x^2}$

$F = \frac{kqQ}{L}\int_d^{(d+L)} x^{-2}\,dx$

$F = \frac{kqQ}{L}\left[\frac{x^{-1}}{-1}\right]_d^{d+L}$

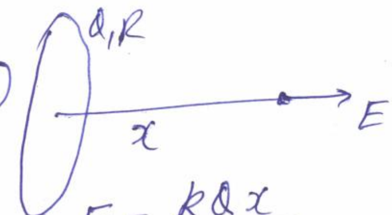
$F = -\frac{kqQ}{L}\left[\frac{1}{x}\right]_d^{d+L}$

$F = -\frac{kqQ}{L}\left[\frac{1}{d+L}-\frac{1}{d}\right]$

$F = -\frac{kqQ}{L}\left[\frac{d-d-L}{d(d+L)}\right]$

$F = \frac{kqQ}{d(d+L)}$

17. (B)



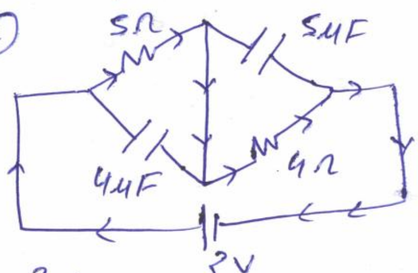
$E = \frac{kQx}{(R^2+x^2)^{3/2}}$

E is maximum at $x = R/\sqrt{2}$

$E = \frac{kQ\cdot R/\sqrt{2}}{(R^2+R^2/2)^{3/2}} = \frac{kQR/\sqrt{2}}{\left(\frac{3R^2}{2}\right)^{3/2}}$

$= \frac{kQR/\cancel{\sqrt{2}}}{\frac{3\sqrt{3}}{2\cancel{\sqrt{2}}}\cdot R^3} = \frac{2}{3\sqrt{3}}\frac{kQ}{R^2}$

18 (C)



$I = \frac{2}{9}A$

ΔV across $4\mu F = 5\times\frac{2}{9} = \frac{10}{9}$ volt.

Energy in $4\mu F$

$$U_4 = \frac{1}{2}\times(4\times10^{-6})\times\left(\frac{10}{9}\right)^2$$

ΔV across $5\mu F = 4\times\frac{2}{9} = 8/9$ volt

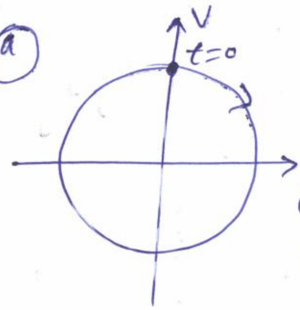
Energy in $5\mu F$

$$U_5 = \frac{1}{2}\times(5\times10^{-6})\times\left(\frac{8}{9}\right)^2$$

$$\frac{U_5}{U_4} = \frac{\cancel{\frac{1}{2}}(5\times\cancel{10^{-6}})(64/\cancel{81})}{\cancel{\frac{1}{2}}(4\times\cancel{10^{-6}})\left(\frac{100}{\cancel{81}}\right)} = \frac{5}{4}\times\frac{\overset{16}{\cancel{64}}}{\underset{20}{\cancel{100}}} = \frac{4}{5}$$

$$= 0.8$$

19 (a)



at $t=0$

i is zero & V is max

after $T/4$

$i \to$ max $\quad V=0$

at $T/2$

$i=0 \quad V = -$ve max

at $3T/4$

$i = -$ve max $\quad V=0$

So current is following voltage

so current lags the voltage by $90°$.

20 (a) Just after pressing the key current through inductor is zero so 8Ω & 6Ω are in series here

$$I_1 = \frac{10}{14} = \frac{5}{7}A.$$

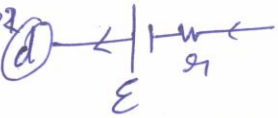
21. (c) $I = neAV_d$

$$I = ne\pi r^2 v$$

$$I' = ne\left(\frac{\pi r^2}{4}\right)\cdot 2v$$

$$\frac{I'}{I} = \frac{1}{2}$$

22 (d)



$$\Delta V = \mathcal{E} - ir$$

but $r \propto i$

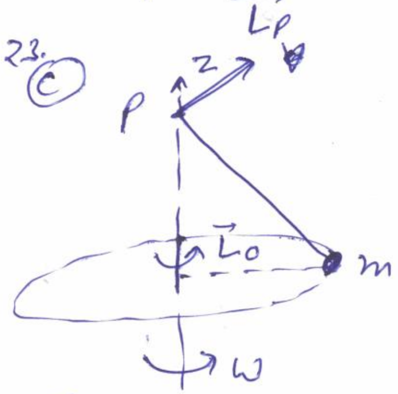
$$r = Ki$$

$$\Delta V = \mathcal{E} - i(Ki)$$

$$\Delta V = \mathcal{E} - Ki^2$$

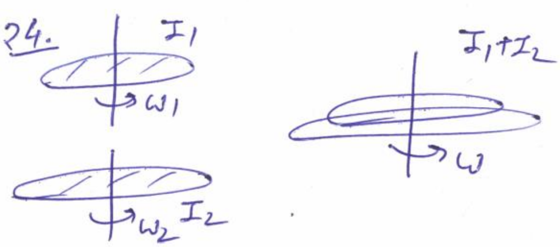
parabola opening downwards

23. (c)



$\vec{L_0}$ remains constant but $\vec{L_P}$ varies with time.

24.



$$I_1\omega_1 + I_2\omega_2 = (I_1+I_2)\omega$$

$$\text{loss in KE} = \frac{1}{2}I_1\omega_1^2 + \frac{1}{2}I_2\omega_2^2 - \frac{1}{2}(I_1+I_2)\omega^2$$

$$= \frac{1}{2}\left(I_1\omega_1^2 + I_2\omega_2^2 - (I_1+I_2)\left(\frac{I_1\omega_1+I_2\omega_2}{I_1+I_2}\right)^2\right)$$

$$= \frac{1}{2}\left[I_1\omega_1^2 + I_2\omega_2^2 - \frac{I_1^2\omega_1^2 - I_2^2\omega_2^2 - 2I_1I_2\omega_1\omega_2}{(I_1+I_2)}\right]$$

$$= \frac{1}{2}\left[\frac{\cancel{I_1^2\omega_1^2} + I_1I_2\omega_2^2 + I_1I_2\omega_1^2 + \cancel{I_2^2\omega_2^2} - \cancel{I_1^2\omega_1^2} - \cancel{I_2^2\omega_2^2} - 2I_1I_2\omega_1\omega_2}{(I_1+I_2)}\right]$$

$$= \frac{1}{2}\frac{I_1I_2}{I_1+I_2}(\omega_1-\omega_2)^2$$

25. (D)

26. (D) $V_0 = \sqrt{gR}$

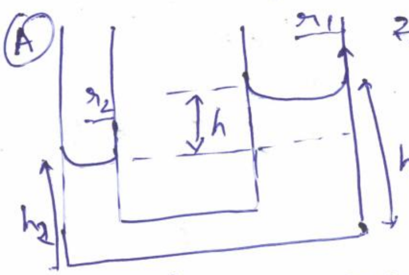
$V_e = \sqrt{2gR}$ so $V_e = \sqrt{2}\, V_0$

27. (B) $\Delta l = \dfrac{Fl}{YA}$

$$\frac{\Delta l_S}{\Delta l_B} = \frac{5mg \cdot l_S \quad Y_B \pi r_B^2}{Y_S \pi r_S^2 \cdot 3mg \cdot l_B}$$

$$= \frac{5}{3}\left(\frac{l_S}{l_B}\right) \frac{1}{\left(\frac{Y_S}{Y_B}\right)\left(\frac{r_S}{r_B}\right)^2} = \frac{5\,q}{3\,p^2 \cdot r}$$

28. (A) $\cancel{2\pi r_1 T - 2\pi r_2 T}$ =



$2\pi r_1 T = \pi r_1^2 h_1 \rho g \qquad 2\pi r_2 T = \pi r_2^2 h_2 \rho g$

$\dfrac{2T}{r_1} = h_1 \rho g$ —(I) $\quad \dfrac{2T}{r_2} = h_2 \rho g$ —(II)

(II) − (I) $\quad 2T\left(\dfrac{1}{r_2} - \dfrac{1}{r_1}\right) = (h_2 - h_1)\rho g$

$$T = \frac{h \rho g \cdot r_1 r_2}{2(r_1 - r_2)}$$

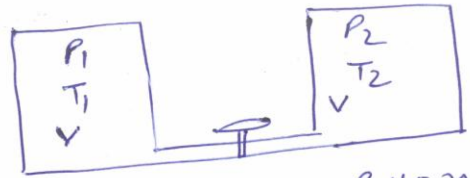
29. (C) A (32°C) $m\, s_A$ → 28°C ← B (24°C) $m\, s_B$

Heat Given = Heat taken

$m s_A (4) = m s_B (4)$.

$\dfrac{s_A}{s_B} = \dfrac{1}{1}$.

30. (D)



$P_1 V = n_1 R T_1 \qquad P_2 V = n_2 R T_2$

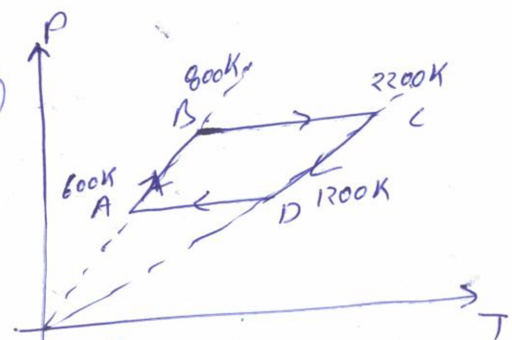
$P(2V) = nRT$

$\dfrac{P}{T} = \dfrac{(n_1+n_2)R}{2V}$

$\dfrac{P}{T} = \dfrac{R}{2V}\left[\dfrac{P_1 V}{R T_1} + \dfrac{P_2 V}{R T_2}\right] = \dfrac{P_1}{2T_1} + \dfrac{P_2}{2T_2}$

$\dfrac{P}{T} = \dfrac{P_1 T_2 + P_2 T_1}{2 T_1 T_2}$ (D)

31. (C)



$n = 6$ moles

AB & CD are isochoric so

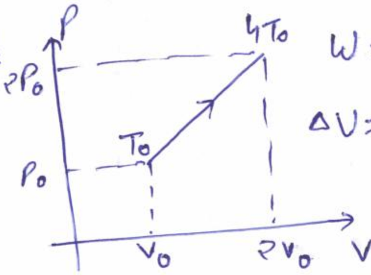
$W = 0$

$W_{BC} = nR\Delta T = 6 \times R \times (1400)$

$W_{DA} = nR\Delta T = 6 \cdot R \cdot (-600)$

$W_{net} = 6R(800) = 4800R = 40\,kJ$

32. (B)



$W = \frac{1}{2}(3P_0) \cdot V_0 = \frac{3}{2} P_0 V_0$

$\Delta U = n \frac{3R}{2}(3T_0)$

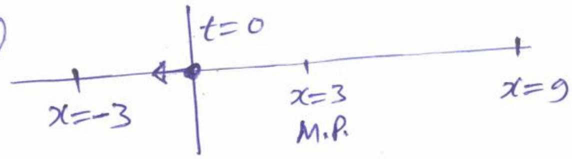
$= \frac{9}{2} nRT_0 = \frac{9}{2} P_0 V_0$

$\Delta Q = \Delta U + W = 6 P_0 V_0$.

33. (C) $11 \cdot 2\pi\sqrt{\dfrac{l_1}{g}} = 9 \cdot 2\pi\sqrt{\dfrac{l_2}{g}}$

$121\, l_1 = 81\, l_2 \qquad$ so $\dfrac{l_1}{l_2} = \dfrac{81}{121}$

34. (B)



$T = \frac{1}{2}s$

MP is $x=3$ so

eq. of SHM should be

$x = 3 + A\sin(\omega t + \phi)$

hence Ans is (B) part.

35. (B)

$\left(\frac{v}{4l_c}\right)3 = 2\left(\frac{v}{2l_0}\right)$

$\frac{l_c}{l_0} = \frac{3}{4}$

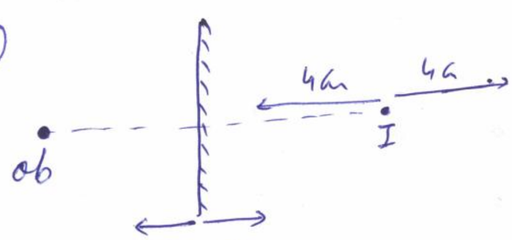
36. (A) $X = A\sin(kz + \omega t)$

$X = 1.\sin\left(\frac{2\pi}{\lambda}z + 2\pi f.t\right)$

$X = 1\sin\left(\frac{2\pi}{\pi}.z + 2\pi.\frac{1}{\pi}.t\right)$

$X = 1.\sin(2z + 2t)$

37. (C)



Amplitude of SHM of the image $= 4a$.

38. (B) $\delta_{min} = 38°$

$\delta = 44°$ if $i = 42°$ or $62°$

$\delta = (i + e) - A$ $\quad 44° = (42 + 62) - A$

$A = 60°$

$\delta_{min} = 2i - A$

$38 = 2i - 60$

$2i = 98$

$i = 49°$

39. (D) CM will shift downward so fringe pattern will shift downward but fringe width will remain same.

40. (B) $I_P = 4I_0$ (maximum)

$I_Q = 4I_0\cos^2\left(\frac{\pi}{4}\right)$ $\qquad \Delta\phi = \frac{2\pi}{\lambda}.\frac{\lambda}{4} = \frac{\pi}{2}$

$I_Q = 4I_0\frac{1}{2} = 2I_0$

$\frac{I_P}{I_Q} = \frac{2}{1}$

41. (A) Photoelectric effect & Compton effect support Quantum nature.

42. (B) $_{90}Th^{232} \longrightarrow {}_{82}Pb^{208}$

no. of α particle $= \frac{232-208}{4} = \frac{24}{4} = '6'$

Reduction in Z due to 6 'α' particle

$= 90 - 6\times2 = 90 - 12 = 78$

but actual Z is 82 so 4 β^- particle will also emit.

Hence 6α & 4β.

43. (B) $n = \frac{100}{(hc/\lambda)} = \frac{100\times5000\times10^{-10}}{6.6\times10^{-34}\times3\times10^{8}}$

$= \left(\frac{5}{6.6\times3}\right)\times10^{-5+26}$

$n = \left(\frac{5}{6.6\times3}\right)\times10^{21}$

$n \simeq 10^{20}$

~~Shekhar Tandan~~

44

(B)

$_{Z}X^{A}$

$v' \leftarrow Y^{A-4}$ $\quad$ $\alpha^{4} \rightarrow v$

$m_1 v_1 = m_2 v_2$

$(A-4)\, v' = 4v$

$v' = \left(\frac{4v}{A-4}\right)$

45. Davisson - Germer Experiment

(B) is the direct evidence of wave nature of electrons.