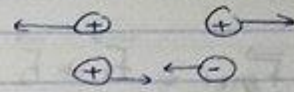
Physics 2 Discussion

$$F = K\frac{q_1 q_2}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

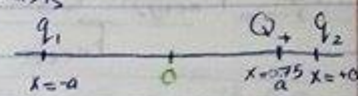
للفراغ



للفراغ $\boxed{\frac{1}{4\pi\varepsilon_0}} = 9\times10^9$

Ch21:

(14) 3 particles $\longrightarrow$ x-axis



(a) Q at $x = +0.750a$ $F_{net} = 0$

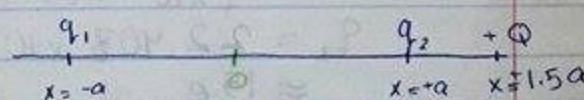
$$|F_1| = |F_2|$$

$$\frac{k\, q_1 \cancel{Q}}{(1.75a)^2} = \frac{k\, q_2 \cancel{Q}}{(0.25a)^2}$$

$$\frac{q_1}{q_2} = \frac{(1.75a)^2}{(0.25a)^2} = 49$$

لما الشحنتين موجبتين أو سالبتين فتكون النسبة بينهما موجبة.

(b) $+Q \Rightarrow x = +1.5a$



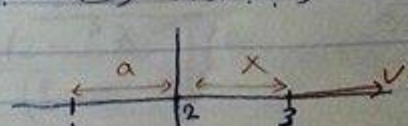
$$|F_1| = |F_2|$$

$$\frac{K\, q_1 \cancel{Q}}{(2.5a)^2} = \frac{K\, q_2 \cancel{Q}}{(0.5a)^2}$$

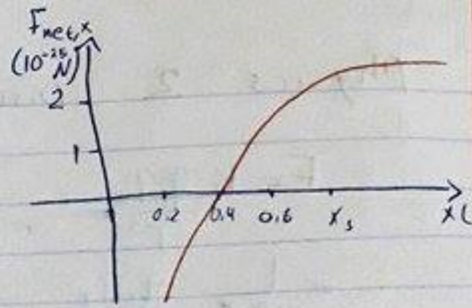
$$\frac{q_1}{q_2} = \frac{-(2.5a)^2}{(0.5a)^2} = -25$$

شحنة موجبة و الأخرى سالبة و لذلك النسبة بينهما سالبة.

(32) $|q_1| = 8e$



$|q_3| = +7e, \; x_s = 0.8\,m$



$F_{2,net} = 1.5 \times 10^{-25}\,N$ as $x \to \infty$

$\vec{F}_{2net} = \vec{F}_1 + \vec{F}_2$

$|F_1| = |F_3|$ at $x = 0.4\,m$

$\frac{Kq_1q_2}{a^2} = \frac{Kq_2q_3}{(0.4)^2}$

$\Rightarrow a = \sqrt{\frac{(0.4)^2 q_1}{q_3}} = 0.43\,m$

* $\lim_{x\to\infty} F_{net,2} = 1.5 \times 10^{-25}\,N$

$\vec{F}_{net,2} = \vec{F}_1 + \vec{F}_3$

$= \frac{K q_1 q_2}{a^2} + \cancel{\frac{K q_2 q_3}{x^2}}$ goes to 0

$\lim_{x\to\infty} \vec{F}_{net,2} = \frac{Kq_1q_2}{a^2}$

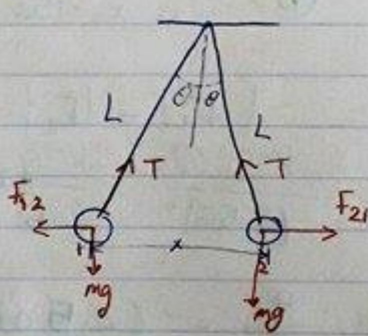
$1.5 \times 10^{-25} = \frac{9\times10^9 \times 8\,e \times q_2}{a^2}$

$q_2 = \frac{1.5\times10^{-25}\,(0.43)(0.43)}{9\times10^9 \times 8 \times 1.6\times10^{-19}}$

$q_2 = 2.408 \times 10^{-18}$

$\approx 15e$

47 a) on particle 2



$T\cos\theta = mg$

$T\sin\theta = F_{21}$

$T = \frac{mg}{\cos\theta}$

$\frac{mg}{\cos\theta}\sin\theta = \frac{K q_1 q_2}{x^2}$

$$x^2 = \frac{1}{4\pi\varepsilon_0} q^2 \frac{\cos\theta}{mg\sin\theta}$$

$$x^2 = \frac{q^2}{4\pi\varepsilon_0\, mg \tan\theta} \qquad \tan\theta \simeq \sin\theta$$

$$x^2 = \frac{q^2}{4\pi\varepsilon_0\, mg \frac{\frac{1}{2}x}{L}}$$

$$x^3 = \frac{q^2 L}{2\pi\varepsilon_0 mg} \longrightarrow x = \left(\frac{q^2 L}{2\pi\varepsilon_0 mg}\right)^{1/3}$$

(b)

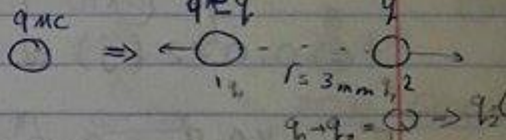
$$mg\tan\theta = \frac{Kq^2}{x^2}$$

$$q = \sqrt{\frac{x^2\, mg\tan\theta}{K}} = \sqrt{\frac{x^3\, 2\pi\varepsilon_0\, mg}{L}}$$

$$= \sqrt{\frac{(5\times10^{-2})^3\ 2\times3.14\times8.85\times10^{-12}\times5\times10^{-3}\times9.8}{120\times10^{-2}}}$$

$$= 1.7\times10^{-8}\,C$$

(54) $F_{12} = \frac{K q_1 q_2}{r^2}$



$$F_{12} = \frac{K(9\times10^{-6} - q)\,q}{(3\times10^{-3})^2}$$

$q_1 + q_2 = $ ⇒ $q_2 (Q - q_1)$

F is maximum when $\frac{dF}{dq} = 0$ ---- $\frac{dF}{dq_1} = 0 \quad \frac{dF}{dq_2} = 0$

$$F_{12} = \frac{K}{r^2}(9\times10^{-6}q - q^2)$$

$$\frac{dF}{dq} = \frac{K}{r^2}(9\times10^{-6} - 2q) \qquad \frac{dF}{dq} = 0 \text{ when } 9\times10^{-6} = 2q$$

$$q = 4.5\times10^{-6}\,C$$

$$F_{12} = \frac{9\times10^9(9\times10^{-6} - 4.5\times10^{-6})\times4.5\times10^{-6}}{(3\times10^{-3})^2} = 20250\ N$$

(69) ${}^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He$ ⇐ مطلوب تعاملم کنوك مێش بخەزرە لو ذرة پشکوله متعادلة

$\downarrow p^+ \qquad \downarrow p^+$

(a) $$F = \frac{K q_1 q_2}{r^2} = \frac{9\times10^9\times(2\times1.6\times10^{-19})(90(1.6\times10^{-19}))}{(9\times10^{-15})^2}$$

$= 512\ N$

(b)

$$F = ma$$

$$512 = 4(1.67\times10^{-27})\,a$$

$$a = 7.66\times10^{28}\ m/s^2$$

10^{-15} فيمتو

10^{-12} بيكو

10^{6} ميجا

$m = m_{2p} + m_{2n}$

$= 4\,m_p$

$= 4\times1.67\times10^{-}$

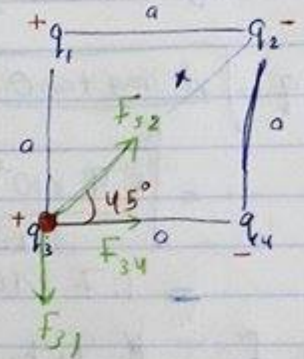
Additional problems:

(11) $q_1 = -q_2 = 100\ nC$

$q_3 = -q_4 = 200\ nC$

$a = 5\ cm$

$x = \sqrt{a^2+a^2} = \sqrt{2}\,a$



$$F_{31} = \frac{K q_3 q_1}{a^2}$$

$$= \frac{9\times10^9 \times 200\times10^{-9} \times 100\times10^{-9}}{(5\times10^{-2})^2}$$

$$= 0.072\,(-\hat{j})\ N$$

$$F_{34} = \frac{K q_3 q_4}{a^2} = \frac{9\times10^9 \times 200\times10^{-9} \times 200\times10^{-9}}{(5\times10^{-2})^2} = 0.144\,\hat{i}$$

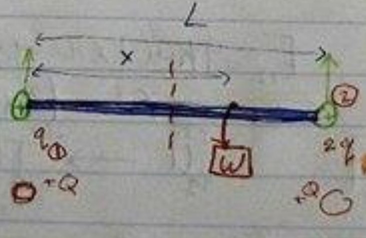
$$F_{32} = \frac{K q_3 q_2}{(\sqrt{2}a)^2} = \frac{9\times10^9 \times 200\times10^{-9} \times 100\times10^{-9}}{(\sqrt{2}\times5\times10^{-2})^2} = 0.036$$

$$F_{3,net} = (F_{34} + F_{32}\cos45)\,\hat{i} + (-F_{31} + F_{32}\sin45)\,\hat{j}$$

$$= (0.144 + 0.0255)\,\hat{i} + (-0.072 + 0.0255)\,\hat{j}$$

$$= 0.169\,\hat{i} - 0.0465\,\hat{j}$$

(50) (a) $F_1 = \dfrac{KQq}{h^2}$



$$F_2 = \frac{KQ\,2q}{h^2}$$

$$\tau_{net}=0 \qquad F_2\frac{L}{2} + -W\left(X-\frac{L}{2}\right) + -F_1\frac{L}{2} = 0$$

$$\frac{KQ\,2q}{h^2}\frac{L}{2} + W\frac{L}{2} - Wx - \frac{KQq}{h^2}\frac{L}{2} = 0$$

$$\frac{KQqL}{2h^2} + W\frac{L}{2} = Wx$$

$$X = \frac{L}{2}\left(\frac{KQq}{Wh^2} + 1\right)$$

(b) $F_{net}=0 \qquad F_2 - W + F_1 = 0$

$$\frac{KQ2q}{h^2} - W + \frac{KQq}{h^2} = 0$$

$$0 = \frac{3KQq}{h^2} - W$$

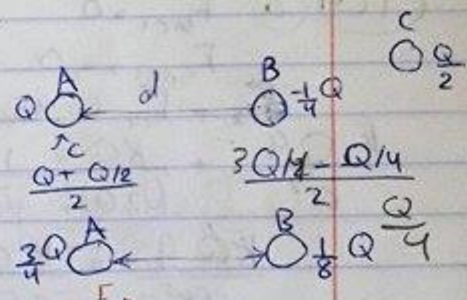
$$W = \frac{K3Qq}{h^2} \Rightarrow h^2 = \frac{3KQq}{W}$$

$$h = \sqrt{\frac{3Qq}{W}}$$

(65) $$F_{AB} = \frac{K\,q_A q_B}{d^2}$$

$$= \frac{9\times10^9 \times \frac{3}{4} \times 2\times10^{-14} \times \frac{1}{\cancel{8}\,4} \times 2\times10^{-14}}{(1.2)^2}$$

$$= 4.38\times10^{-19}\ N$$



(70) $F_{1,net}=0$

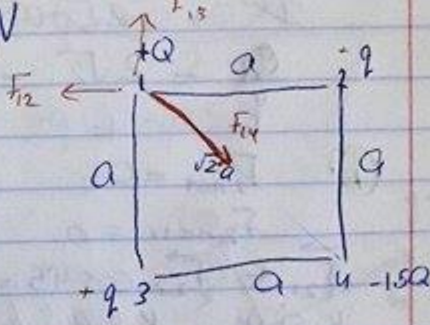
$F_{1x}=0$

$$F_{14}\cos 45 - F_{12} = 0$$

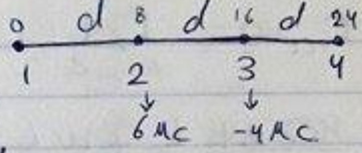
$$\frac{KQ\,1.5Q}{(\sqrt{2}a)^2}\times\frac{1}{\sqrt{2}} - \frac{KQ\,q}{a^2} = 0$$

$$\frac{1.5\,KQ\cancel{Q}}{2\cancel{a^2}}\times\frac{1}{\sqrt{2}} = \frac{K\cancel{Q}q}{\cancel{a^2}}$$

$$\frac{q}{Q} = \frac{3}{4\sqrt{2}} = 0.53$$



47



$$F_{1,net} = 0 \qquad 0 = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14}$$

$$0 = \frac{K q_1 q_2}{d^2} + \frac{K q_1 q_3}{(2d)^2} + \frac{K q_1 q_4}{(3d)^2}$$

$$0 = \frac{K q_1}{d^2}\left(q_2 + \frac{q_3}{4} + \frac{q_4}{9} \right)$$

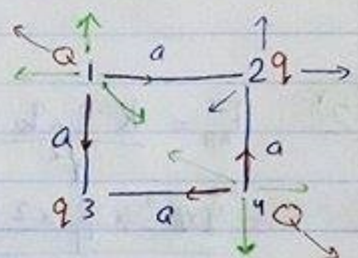
$$q_2 + \frac{q_3}{4} + \frac{q_4}{9} = 0$$

$$6 \times 10^{-6} + \frac{-4 \times 10^{-6}}{4} + \frac{q_4}{9} = 0$$

$$\frac{q_4}{9} = -5 \times 10^{-6}$$

$$q_4 = -45 \times 10^{-6}\ C = -45 \mu C$$

10. a



$$F_{1,net} = 0$$

$$F_{1,net\,x} = 0$$

$$\vec{F}_{12} + \vec{F}_{14} \cos 45 = 0$$

$$\frac{k Q q}{a^2} + \frac{k Q Q}{(\sqrt{2} a)^2} \frac{1}{\sqrt{2}} = 0$$

$$\frac{k \cancel{Q} q}{\cancel{a^2}} = -\frac{k \cancel{Q} Q}{2\sqrt{2}\, a^2}$$

$$\frac{Q}{q} = -2\sqrt{2} = -2.83$$

b

نفرض أن المحصلة على ثنين أيضاً ٠

$$F_{2\,net} = 0$$

$$F_{2,net\,x} = 0$$

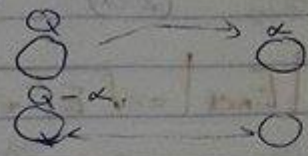
$$\vec{F}_{21} + \vec{F}_{23} \cos 45 = 0$$

$$\frac{k Q q}{a^2} + \frac{k q q}{(\sqrt{2} a)^2} \frac{1}{\sqrt{2}} = 0$$

$$\frac{k Q q}{a^2} = -\frac{k q q}{2\sqrt{2}\, a^2}$$

$$\frac{q}{Q} = -2\sqrt{2} \Rightarrow \frac{Q}{q} = \frac{-1}{2\sqrt{2}}$$

No because the rate of $\frac{Q}{q}$ is not equal in a and b.



35

a) $$F = \frac{K(Q-q)q}{r^2}$$

$$\frac{dF}{dq} = \frac{K}{r^2}(Q-2q) \Rightarrow F_{max} \Rightarrow \frac{dF}{dq} = 0$$

$$Q - 2q = 0 \quad \boxed{\frac{1}{2}Q = q}$$

$$F_{max} = \frac{K\,\frac{1}{2}Q\,\frac{1}{2}Q}{r^2} = \frac{1}{4}\frac{KQ^2}{r^2}$$

b) + c) $$\frac{1}{2}F_{max} = \frac{1}{8}\frac{KQ^2}{r^2}$$

$$\frac{1}{8}\frac{\cancel{K}Q^2}{\cancel{r^2}} = \frac{\cancel{K}(Q-q)q}{\cancel{r^2}}$$

$$\frac{Q^2}{8} = Qq - q^2$$

$$\frac{Q^2}{8} - Qq + q^2 = 0$$

$$c + bx + x^2 = 0$$

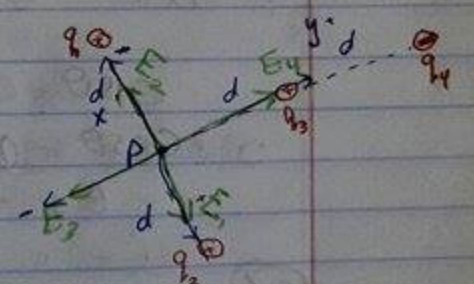
$$q = \frac{+Q \pm \sqrt{Q^2 - 4\frac{Q^2}{8\,2}}}{2} \qquad q = \frac{+Q \pm Q\sqrt{\frac{1}{2}}}{2}$$

$$q = \frac{+Q - 0.7Q}{2} \text{ or } q = \frac{+Q + 0.7Q}{2}$$

$$q = +0.146Q \text{ or } q = +0.85Q$$

Ch22:

8) $q_1 = q_2 = +5e$
$q_3 = +3e$
$q_4 = -12e$ $\quad d = 8\ \mu m$



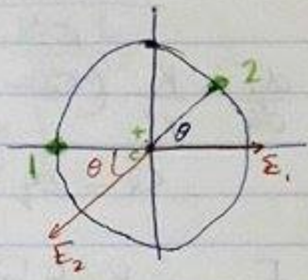
$$|E_1| = |E_2| \Rightarrow E_x = 0$$

$$E_y = E_4 - E_3$$

$$= \frac{Kq_4}{(2d)^2} - \frac{Kq_3}{d^2} = \frac{K(\cancel{12}^{3}e)}{\cancel{4}d^2} - \frac{K\,3e}{d^2} = 0$$

$$|E_{net}| = \sqrt{E_x^2 + E_y^2 + 2E_xE_y\cos\theta}$$

(16)

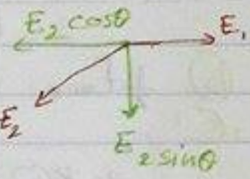


$|E_{net,c}| = 1\times10^5\ N/C$

$q_1 = +2\,\mu C$

$q_2 = +6\,\mu C$

$R = 80.0\ cm$



$$E_x = E_1 - E_2\cos\theta$$

$$= \frac{Kq_1}{R^2} - \frac{Kq_2}{R^2}\cos\theta$$

$$= \frac{K}{R^2}\left[q_1 - q_2\cos\theta\right]$$

قانون المحصلة أسرع

$$E_y = -E_2\sin\theta$$

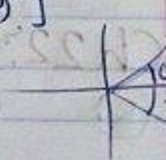
$$= \frac{-Kq_2}{R^2}\sin\theta$$

$$|E_{net,c}|^2 = E_x^2 + E_y^2$$

$$1\times10^{10} = \frac{K^2}{R^4}\left[q_1^2 - 2q_1q_2\cos\theta + \underbrace{q_2^2\cos^2\theta + q_2^2\sin^2\theta}_{q_2^2}\right]$$

$$1\times10^{10} = \frac{K^2}{R^4}\left[q_1^2 - 2q_1q_2\cos\theta + q_2^2\right]$$

$$1\times10^{10} = \frac{(9\times10^9)^2}{(.8)^4}\left[(2\times10^{-6})^2 - 2(2\times10^{-6})(6\times10^{-6}) + (6\times10^{-6})^2\right]$$

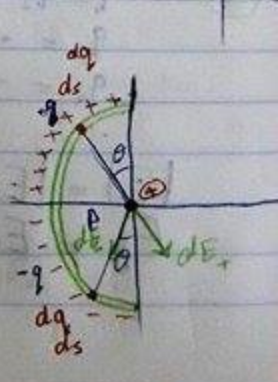


$$\cos\theta = 0.44$$

$$\theta = 63.87^\circ$$

$$\theta = -63.87^\circ$$

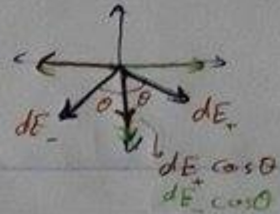
(26)



$+q = +4.5\ pC$

$-q = -4.5\ pC$

$R = 3\ cm$



$$dE_+ = \frac{K\,dq}{R^2}$$

$$\int dE_{net} = \int_0^{\pi/2} 2\,dE_+ \cos\theta$$

$$= \int_0^{\pi/2} 2\,\frac{K}{R^2}\,\lambda R \cos\theta\, d\theta$$

$$= \frac{2\lambda K}{R} \sin\theta \Big|_0^{\frac{\pi}{2}} = \frac{2\lambda K}{R}$$

$$= \frac{2\boxed{\frac{q}{\frac{1}{4}(2\pi R)}}K}{R} = \frac{4qK}{\pi R^2}$$

$$\lambda = \frac{q}{\frac{1}{4}(2\pi R)} = \frac{dq}{ds}$$

$dq = \lambda ds$

$s = R\theta$

$ds = R\,d\theta$

$dq = \lambda R\,d\theta$

$$E = \frac{4qK}{\pi R^2} = \frac{4\,(4.5)\,9\times10^9}{\pi\,(3\times10^{-2})^2} = 57.32 \text{ N/C}$$

$\theta = -90°$ relative to + x-axis $(-\hat{j})$

27

$q = 15$ pC $\quad r = 8.5$ cm

$E_x = 0$ (from symmetry)

$$dE = \frac{K\,dq}{R^2}$$

$$\lambda = \frac{q}{\pi r}$$

$$dE_y = \frac{K\,\lambda\, r\, d\theta}{r^2}\cos\theta$$

$dq = \lambda ds$

$s = \theta r$

$ds = r\,d\theta$

$$E_y = 2\int_0^{\pi} \frac{K\lambda r}{r^2}\cos\theta\, d\theta$$

2 ← بتعويض للقوس الموجب والسالب

$$E_{net} = E_y = 2\frac{K\lambda}{r}\int^{\pi} \cos\theta\, d\theta$$

$p \to 10^{-12}$

$$= \frac{2K\lambda}{r}\sin\theta\Big|_{-\frac{\pi}{2}}^{\frac{\pi}{2}} = \frac{4K}{r}\frac{q}{\pi r} = \frac{4Kq}{\pi r^2}$$

$$E = \frac{4Kq}{\pi r^2} = \frac{4\,(9\times10^9)\,15\times10^{-12}}{\pi\,(8.5\times10^{-2})^2} = 23.8 \text{ N/C}$$

$\theta = -90°$ relative to + x-axis $(-\hat{j})$

36

$Q = +(2\times10^6)e \quad R = 2$ cm (disk)

$w = 40$ μm $\quad r = 0.5$ cm (ring)

disk → $\sigma = \frac{Q}{\pi R^2}$

$$= \frac{2\times10^{6}\times1.6\times10^{-19}}{\pi\,(2\times10^{-2})^2} = 2.55\times10^{-10}$$

ring → $q = \sigma \times 2\pi r$

$dq = \sigma \times 2\pi r\,dr$

$dq = 2.55\times10^{-10}\times 2\pi\,(0.5\times10^{-2})\,(40\times10^{-6})$

$dq = 3.2\times10^{-16}$ C

He → $m = 4\times m_p \rightarrow 2p + 2n^0 = q = 2p$

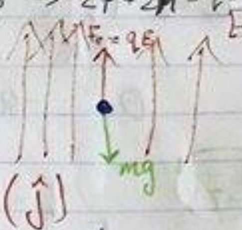
44

$F_E = mg$

$Eq = mg$

$E\;\; 2\times1.6\times10^{-19} = 6.64\times10^{-27}(9.8)$

$E = 2.0335\times10^{-7}$ N/C $(\hat{j})$



48

$E_{disk} = \int_0^R dE_{ring}$

dr (width)
$dA = 2\pi r\,dr$

$$dE_{ring} = \frac{qZ}{4\pi\epsilon_0\left[Z^2+R^2\right]^{3/2}}$$

$$= \frac{\sigma\, 2\pi r\,dr\, Z}{4\pi\epsilon_0\left[Z^2+r^2\right]^{3/2}}$$

$A_{disk} = \pi R^2$

equal $\left\{ \begin{array}{l} \sigma_{disk} = \frac{q}{\pi R^2} \\ \sigma_{ring} = \frac{q}{2\pi r\,dr} \end{array} \right.$

$$E_{disk} = \int_0^R \frac{K\sigma\, 2\pi r\,dr\, Z}{\left[Z^2+r^2\right]^{3/2}}$$

$$= 2ZK\sigma\pi\int_0^R \frac{r\,dr}{\left[Z^2+r^2\right]^{3/2}}$$

let $u = Z^2 + r^2$
$du = 2r\,dr$

$$= \cancel{2}Z\pi K\sigma \int \frac{\cancel{r}\,du}{\cancel{2r}\,u^{3/2}}$$

$$= Z\pi K\sigma \int u^{-3/2}\,du$$

$$= Z\pi K\sigma\, \frac{u^{-1/2}}{-1/2}\Big] = -2Z\pi K\sigma\, \frac{1}{(Z^2+r^2)^{1/2}}\Big|_0^R$$

$$= -2\pi K \sigma Z \left[\frac{1}{\sqrt{Z^2+R^2}} - \frac{1}{Z} \right]$$

$$= \frac{-2\pi}{\underset{2}{\cancel{4}}\pi\epsilon_0} \sigma \left[\frac{Z}{\sqrt{Z^2+R^2}} - 1 \right]$$

$$= \frac{\sigma}{2\epsilon_0} \left[1 - \frac{Z}{\sqrt{R^2+Z^2}} \right]$$

$\sigma = 5\,\mu C$

$\epsilon_0 = 8.85 \times 10^{-12}$

(a) $Z = R \Rightarrow$ $E = \frac{\sigma}{2\epsilon_0} \left[1 - \frac{R}{\sqrt{R^2+R^2}} \right]$

$$= \frac{\sigma}{2\epsilon_0} \left[1 - \frac{1}{\sqrt{2}} \right]$$

$$= 82738.2 \text{ N/C}$$

$F = ma \Rightarrow Eq = ma$ $\quad m = 9.11 \times 10^{-31}$ Kg

$$a = \frac{Eq}{m} = \frac{82738.2 \times 1.6 \times 10^{-19}}{9.11 \times 10^{-31}} = 1.5 \times 10^{16} \text{ m/s}^2$$

(b) $Z = R/100$ $\quad E = \frac{\sigma}{2\epsilon_0} \left[1 - \frac{R/100}{\sqrt{R^2 + \frac{R^2}{10000}}} \right]$

$$= \frac{\sigma}{2\epsilon_0} \left[1 - \frac{\cancel{R/100}}{\sqrt{10001}\,\frac{\cancel{R}}{\cancel{100}}} \right]$$

$$= \frac{\sigma}{2\epsilon_0} \left[1 - \frac{1}{\sqrt{10001}} \right]$$

$$= 279661.16 \text{ N/C}$$

$$a = \frac{Eq}{m} = 4.9 \times 10^{16} \text{ m/s}^2$$

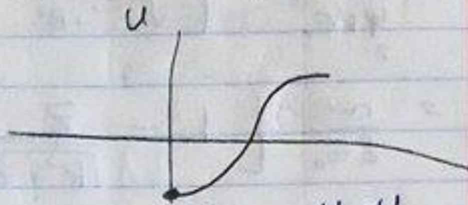
(c) $Z = R/1000$ $\quad E = \frac{\sigma}{2\epsilon_0} \left[1 - \frac{\cancel{R/1000}}{\sqrt{1000001}\,\frac{\cancel{R}}{\cancel{1000}}} \right]$

$$= \frac{\sigma}{2\epsilon_0} \left[1 - \frac{1}{\sqrt{1000001}} \right]$$

$$= 282203.4 \text{ N/C}$$

$$a = \frac{Eq}{m} = 4.956 \times 10^{16} \text{ m/s}^2$$

(d) F_{net} will decrease because the contribution which come closer to cancelling out as the electron reache the middle of the disk. بصير المجال ينتظم أكثر



(58) $E = 50\,N/C$

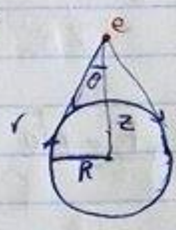
$$U = -\vec{P}\cdot\vec{E}$$

$$U = -PE\cos\theta \qquad \text{when } \theta = 0 \quad U = U_s$$

$$+100\times10^{-28} = +P\ 50\times1$$

$$P = 2\times10^{-28}\ C.m \Rightarrow P = dq$$

(72)



$$dE = \frac{K\,dq}{r^2}$$

$$dE_x = 0 \qquad dE_y = dE_{net} = dE\cos\theta \qquad dq = \lambda\,ds$$

$$dE_y = \frac{K\lambda\,ds\cos\theta}{R^2+Z^2} \qquad \lambda = \frac{q}{2\pi R}$$

$$E_{net} = \int dE_y = \int \frac{K\lambda\,ds}{R^2+Z^2}\cos\theta$$

$$= K\lambda\int\frac{ds}{R^2+Z^2}\,\frac{Z}{\sqrt{R^2+Z^2}}$$

$$= K\lambda\,\frac{Z}{(R^2+Z^2)^{3/2}}\int ds$$

$$= \frac{1}{4\pi\epsilon_0}\,\frac{q}{\cancel{2\pi R}}\,\frac{Z}{(R^2+Z^2)^{3/2}}\ \cancel{2\pi R} \qquad R \gg Z$$

$$E = \frac{qZ}{4\pi\epsilon_0(R^2)^{3/2}} = \frac{qZ}{4\pi\epsilon_0 R^3} \qquad d: Ee = \boxed{\frac{qe}{4\pi\epsilon_0(R^2)^{3/2}}}\ Z$$

constant

$$F = \frac{mV^2}{Z} \qquad Ee = -CZ$$

$$Ee = m\frac{V^2}{Z} \qquad V = wZ \qquad w = \sqrt{\frac{K}{m}}$$

$$\frac{q\cancel{Z}e}{4\pi\epsilon_0 R^3} = m\frac{w^2\cancel{Z^2}}{\cancel{Z}} \qquad w = \sqrt{\frac{qe}{4\pi\epsilon_0 R^3 m}}$$

$$w^2 = \frac{qe}{4\pi\epsilon_0 m R^3} \Longrightarrow w = \sqrt{\frac{q e}{4\pi\epsilon_0 m R^3}}$$

Additional problems:

62

(a) $F = ma$ $\qquad m_e = 9.11\times10^{-31}\ kg$

$$a = \frac{Eq}{m}$$

$$= \frac{2.9\times10^{6}\times1.6\times10^{-19}}{9.11\times10^{-31}} = 5.09\times10^{17}\ m/s^2$$

(b) $V_0 = 0$ $\qquad V_f = \frac{1}{10} S_{light} = 0.1\times3\times10^{8}$

$$V_f = V_0 + at$$

$$3\times10^{7} = 0 + 5.09\times10^{17}\ t$$

$$t = 5.9\times10^{-11}\ sec$$

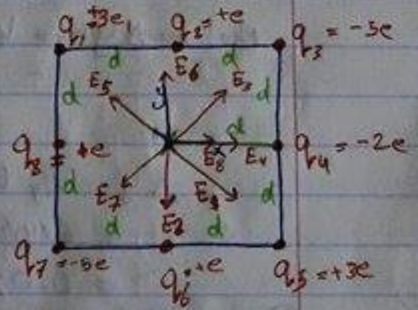
(c) $\Delta x = V_0 t + \frac{1}{2}at^2$

$$\Delta x = \frac{1}{2}(5.09\times10^{17})\times(5.9\times10^{-11})^2 = 8.86\times10^{-4}\ m$$

$$V_f^2 = V_i^2 + 2a\Delta x$$

$$\Delta x = \frac{V_f^2}{2a} = \frac{(3\times10^{7})^2}{2(5.09\times10^{7})} = 8.84\times10^{-4}\ m$$

68



$$\left.\begin{aligned} E_1 &= -E_5 \\ E_3 &= -E_7 \\ E_2 &= -E_6 \end{aligned}\right\} \text{equal in magnitude opposite in direction}$$

$$E_{net} = E_4 + E_8$$

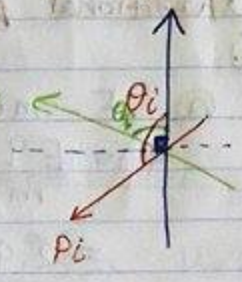
$$= \frac{Kq_4}{d^2} + \frac{Kq_8}{d^2}$$

$$= \frac{K}{d^2}\left[2e + 1e\right]$$

$$= \frac{9\times10^{9}}{(3\times10^{\text{[illegible]}})^2}(3\times1.6\times10^{-19}) = 4.8\times10^{-6}\ \hat{i}\ N/C$$

(76) $\vec{p} = 2.4 \times 10^{-27}$ C.m

$E = 3 \times 10^{6}$ N/C



$U = -\vec{p} \cdot \vec{E}$

$U_f = -pE \cos(90 - 20)$ (θ_f)

$= -2.4 \times 10^{-27} \times 3 \times 10^{6} \times \cos 70$

$= -2.463 \times 10^{-21}$ J

$U_i = -pE \cos(90 + 20)$ (θ_i)

$= +2.463 \times 10^{-21}$ J

$\Delta U = U_f - U_i = -4.926 \times 10^{-21}$ J

(84) $\vec{E} = 2 \times 10^{3}$ N/C

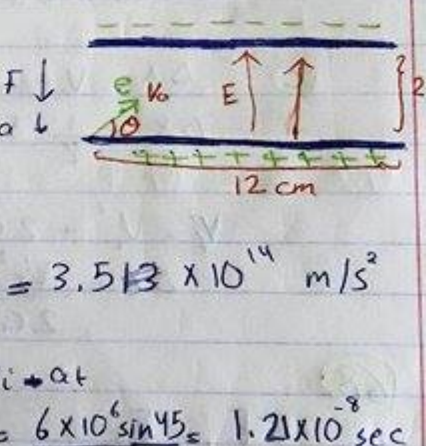
$V_i = 6 \times 10^{6}$ m/s

$\theta = 45°$

$f \Rightarrow (-\hat{j})$

$F = ma$

$Ee = ma$



$a = \dfrac{2 \times 10^{3} \times 1.6 \times 10^{-19}}{9.11 \times 10^{-31}} = 3.51 \times 10^{14}$ m/s²

the maximum hight $\Rightarrow V_{fy} = 0$ $V_f = V_i + at$

$t = \dfrac{+V_{iy}}{+a} = \dfrac{6 \times 10^{6} \sin 45}{3.51 \times 10^{14}} = 1.21 \times 10^{-8}$ sec

$\Delta y = V_{iy} t - \frac{1}{2} a t^2$

$= 6 \times 10^{6} \sin 45 (1.21 \times 10^{-8}) - \frac{1}{2}(3.51 \times 10^{14} \times (1.21 \times 10^{-8})^2$

$= 0.0253$ m $= 2.53$ cm

(a) it : might hit the upper plate

(b) $d_x = V_x t$ t : the time need to be at 2cm high

$\Delta y = V_{iy} t - \frac{1}{2} a t^2$

$2 \times 10^{-2} = 6 \times 10^{6} \sin 45 t - \frac{1}{2}(3.51 \times 10^{14}) t^2$

$1.755 \times 10^{14} t^2 - 4.2 \times 10^{6} t + 2 \times 10^{-2} = 0$

$$t = \frac{-(4.2\times10^{6}) \pm \sqrt{(4.2\times10^{6})^2 - 4(1.755\times10^{14})\times 2\times10^{-2}}}{2(1.755\times10^{14})}$$

$$t = \frac{4.2\times10^{6} \pm 1.9\times10^{6}}{3.51\times10^{14}}$$

$t = 6.553\times10^{-9}$ sec $\qquad t = 17.3\times10^{-9}$ sec

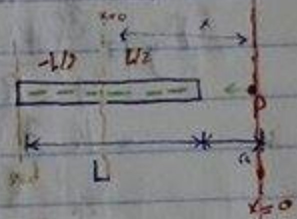
بعد ما يتعامد ينزل

$d_x = V_x t = 6\times10^{6}\cos 45 \times 6.553\times10^{-9} = 0.0278$ m

$= 2.78$ cm

(31) $L = 8.15$ cm

$q = -4.23$ fC $\hookrightarrow 10^{-15}$



(a) λ? $\quad \lambda = \frac{q}{L}$

$$= \frac{4.23\times10^{-15}}{8.15\times10^{-2}} = 5.19\times10^{-14}\ \text{C/m}$$

(b) $dE = \frac{K\,dq}{r^2}$ $\qquad \boxed{\begin{array}{l} dq = \lambda\,dx \\ r^2 = x^2 \end{array}}$

بنحصل على طول الرود ① - ② = $-L$

$$E = \int_{-a}^{-(L+a)} K\frac{\lambda\,dx}{x^2} = K\lambda\int_{-a}^{-(L+a)}\frac{dx}{x^2} = K\lambda\left[\frac{-1}{x}\right]_{-a}^{-(L+a)}$$

$$= K\lambda\left(\frac{-1}{-(L+a)} - \frac{-1}{-a}\right) = -K\lambda\left(\frac{-1}{L+a} + \frac{1}{a}\right)$$

$$= -K\lambda\frac{L}{a(L+a)} = \frac{-Kq}{a(L+a)} = -1.57\times10^{-3}\ \text{N/C}$$

باتجاه $(-\hat{i})$

(d) $E = \frac{-Kq}{a(L+a)} = -1.52\times10^{-8}$ N/C

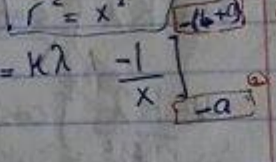
(e) $E = \frac{Kq}{r^2} = \frac{Kq}{a^2} = 1.523\times10^{-8}$ N/C

باتجاه $(-\hat{i})$

(32) $q = 9.25$ pC

$L = 16$ cm

$R = 6$ cm



$$dE = \frac{K\,dq}{r^2} \qquad dq = \lambda\,dx$$

$$dE_x = K\frac{dq}{r^2}\sin\theta \implies E_x = \int dE_x = 0$$
from symmetry

$$dE_y = \frac{K\,dq}{r^2}\cos\theta \qquad r^2 = R^2 + \boxed{\overset{x^2}{\left(\frac{L}{2}\right)^2}}$$

$$dE_y = K\frac{\lambda\,dx}{R^2+x^2}\cos\theta$$

$$E_y = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{K\lambda\,dx}{R^2+x^2}\cos\theta$$

$$= K\lambda\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{dx}{R^2+x^2}\cos\theta$$

$$= K\lambda\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} R\frac{\sec^2\theta\,d\theta}{R^2/\cos^2\theta}\cos\theta$$

$$= K\lambda\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{\sec^2\theta\cos\theta\,d\theta}{R}\cdot\cos^2\theta$$

$$= K\lambda\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{\cancel{\sec^2\theta}\cos\theta}{R}\,d\theta\cdot\frac{1}{\cancel{\sec^2\theta}}$$

$$= \frac{K\lambda}{R}\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\cos\theta\,d\theta = \frac{K\lambda}{R}\sin\theta\Big|_{-\frac{\pi}{2}}^{\frac{\pi}{2}} = \frac{2K\lambda}{R}$$

$$= \frac{2Kq}{LR}$$

$\tan\theta = \frac{x}{R}$

$dx = R\sec^2\theta\,d\theta$

$\cos\theta = \frac{R}{r}$

$r^2 = \frac{R^2}{\cos^2\theta}$

$$E = \frac{2Kq}{LR} = \frac{2(9\times10^9)(9.25\times10^{-12})}{(0.16)(0.06)} = 17.34\ \text{N/C}$$

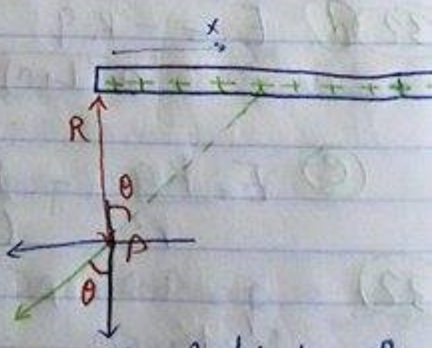
33

$$dE = \frac{K\,dq}{r^2}$$

$$dE_x = \frac{K\,dq}{r^2}\sin\theta$$

$$E_x = \int\frac{K\,dq}{r^2}\sin\theta$$

$$= K\int_0^{\frac{\pi}{2}}\frac{\lambda\,dx}{r^2}\sin\theta$$



$dq = \lambda\,dx$

$r^2 = R^2 + x^2$

$\tan\theta = \frac{x}{R}$

$dx = R\sec^2\theta\,d\theta$

$\cos\theta =$

$r = \frac{R}{\cos}$

$$= K\lambda \int_0^{\frac{\pi}{2}} \frac{R \sec^2\theta \, d\theta}{r^2} \sin\theta$$

$$= K\lambda \int_0^{\frac{\pi}{2}} \frac{\cancel{R} \sec^2\theta \, d\theta}{R^{\cancel{2}} \cos^2\theta} \sin\theta$$

$$= \frac{K\lambda}{R} \int_0^{\frac{\pi}{2}} \cancel{\sec^2\theta} \cancel{\cos^2\theta} \sin\theta \, d\theta = \frac{K\lambda}{R} \int_0^{\frac{\pi}{2}} \sin\theta$$

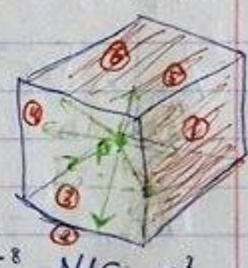
$$= \frac{-K\lambda}{R} \cos\theta \Big|_0^{\frac{\pi}{2}} = \frac{K\lambda}{R} \quad (-\hat{i})$$

from p32 $E_y = \int_0 \frac{K\lambda dx}{r^2} \cos\theta = \frac{K\lambda}{R} \sin\theta \Big|_0^{\frac{\pi}{2}} = \frac{K\lambda}{R} \quad (-\hat{j})$

$$\tan\theta = \frac{E_y}{E_x} = \frac{\cancel{K\lambda}/\cancel{R}}{\cancel{K\lambda}/\cancel{R}} = 1 \quad \boxed{\theta = 45^\circ}$$

Ch23:

5



$$\Phi = \oint \vec{E} \cdot d\vec{A}$$

$$\Phi_{cube} = \frac{q_{enc}}{\epsilon_0}$$

$$= \frac{1.6 \times 10^{-19}}{8.85 \times 10^{-12}} = 1.808 \times 10^{-8} \ \underset{(F)}{\underline{N/C}} \cdot \underset{(A)}{m^2}$$

$\Phi_{cube} = \Phi_1 + \Phi_2 + \Phi_3 + \Phi_4 + \Phi_5 + \Phi_6$ 1, 2, 3, 4, 5, 6 → أوجه المكعب

Φ from every cube $= E \cdot dA$ (equal for all surfaces)

$$\Phi_{cube} = 6 \Phi_2$$

$$1.808 \times 10^{-8} = 6 \Phi_2$$

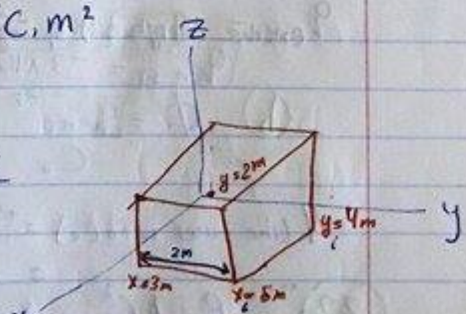
$$\Phi_2 = 3.013 \times 10^{-9} \ N/C \cdot m^2$$

11

$L = 2m \quad x_i = 5m \quad y = 4m$

$E = -3\hat{i} - 4y^2\hat{j} + 3K \ N/C$

q_{enc} ??



$$\Phi_{total} = \frac{q_{enc}}{\epsilon_0}$$

to find ϕ_{total} we need to find ϕ from each surfa

(*) $E_{ثابت} \rightarrow E\int dA = E \cdot A = EA\cos\theta$

الطول × العرض المربع

right : $\phi_r = \oint \vec{E} \cdot d\vec{A} = \oint (-4y^2\hat{j}) \cdot (4\hat{j})$ $\quad d\vec{A} = 4m^2\hat{j}$, $y = 4$

$= -256 \ N/C.m^2$

left : $\phi_l = \oint \vec{E} \cdot d\vec{A} = \oint (-4y^2\hat{j}) \cdot (4)\hat{j}$ $\quad d\vec{A} = -4m^2\hat{j}$, $y = 2$

$= +64 \ N/C.m^2$

top: $\phi_t = \oint \vec{E} \cdot d\vec{A} = \oint (3\hat{k})(4\hat{k})$ $\quad d\vec{A} = 4m^2\hat{k}$

$= 12 \ N/C.m^2$

Bottom: $\phi_B = \oint \vec{E} \cdot d\vec{A} = \oint (3\hat{k})(-4\hat{k})$ $\quad d\vec{A} = -4m^2\hat{k}$

$= -12 \ N/C.m^2$

front : $\phi_f = \oint \vec{E} \cdot d\vec{A} = \oint (-3\hat{i})(4\hat{i})$ $\quad d\vec{A} = 4m^2\hat{i}$

$= -12 \ N/C.m^2$

back : $\phi_b = \oint \vec{E} \cdot d\vec{A} = \oint (-3\hat{i})(-4\hat{i})$ $\quad d\vec{A} = -4m^2\hat{i}$

$= +12 \ N/C.m^2$

وبما أن E ثابتة في $\hat{i}$ و $\hat{k}$ ف t بلغي B و f بلغي b.

$\phi_{total} = -256 + 64 + \cancel{12} - \cancel{12} - \cancel{12} + \cancel{12}$

$= -192 \ N.m^2/C$

$q_{enc} = \phi \cdot \epsilon_0 = -192 \times 8.85 \times 10^{-12} \simeq -1.6992 \times 10^{-9}$

$\simeq -1.7 \ nC$ نانو

(21)

حسب قانون غاوس التدفق في s_1 = صفر

(a) $\vec{\phi} = \frac{q_{enc}}{\epsilon_0}$ $\quad s_1$ $\quad \Rightarrow q_{enc} = 0$

$q_{enc} = +q_1 + q_{on\,s_1} \Rightarrow 0 = 3\times10^{-6} + q_{on\,s_1}$

$\boxed{q_{on\,s_1} = -3\times10^{-6} \ C}$

(b) $\phi = \frac{q_{enc}}{\epsilon_0}$ $\quad s_2$

بتعرض مجموع الشحنتين q_2 و q_1

q (the outer surface) $= +3\times10^{-6} + 10\times10^{-6}$

$= 1.3 \times 10^{-5}$

(32) $\rho = Ar^2 \quad A = 2.5 \ \mu C/m^5$

$r_1 = 3cm \quad r_2 = 5cm \quad R = 4 \ cm$

(a) (1) $\dfrac{q_{enc}}{\epsilon_0} = \oint \vec{E} \cdot d\vec{A}$

$\dfrac{r^4 \pi A L}{2\epsilon_0} = E \oint d\vec{A}$

$\boxed{\text{inside the cylinder Draw cylinder with } V = r^2 \pi L}$

$\dfrac{r^{\cancel{4}\,3} \cancel{\pi} A \cancel{L}}{2\epsilon_0} = E(2\cancel{\pi} \cancel{r} \cancel{L})$ → سطح الاسطوانة

⇒ to find q_{enc} ⇒ $\rho = \dfrac{q}{V} = Ar^2$

$\rho = \dfrac{dq}{dV}$ ⇒ $dq = \int_0^r \rho\, dV$ $\quad V = \pi r^2 L$

جزء الشحنة

$\rho = \dfrac{q}{V} = \dfrac{dq}{dV}$

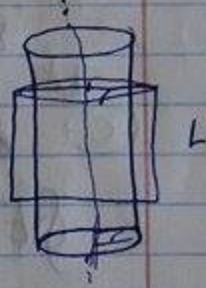
$q_{enc} = \int_0^r \rho\, dV \qquad dV = 2\pi r L\, dr$

$= \int_0^r A r^2\, 2\pi r L\, dr$

$q_{enc} = 2A \dfrac{r^4 \pi L}{\cancel{4}\,2} = \dfrac{r^4}{2} \pi A L$

$E = \dfrac{Ar^3}{4\epsilon_0} = \dfrac{2.5 \times 10^{-6} \times (3 \times 10^{-2})^3}{4 \times 8.85 \times 10^{-12}} = 1.91\ N/C$

(b) (2) E at $r = 5$ cm



$q_{enc} = \int_0^R A r^2\, 2\pi r\, dr\, L$

$= AL2\pi \left.\dfrac{r^4}{4}\right]_0^R = AL\cancel{2}\pi \dfrac{R^4}{\cancel{4}\,2}$

$\dfrac{q_{enc}}{\epsilon_0} = \oint \vec{E} \cdot d\vec{A}$

$\dfrac{\pi A L R^4}{2\epsilon_0} = E \oint d\vec{A}$

$\dfrac{R^4 \cancel{\pi} A \cancel{L}}{2\epsilon_0} = E(2\cancel{\pi} r \cancel{L})$

$E = \dfrac{A R^4}{4\epsilon_0 r} = 3.62\ N/C$

(53) $R = 5.6\,cm$

$\rho = \frac{14.1\, r}{R}\ pC/m^3$ $\qquad pC = 10^{-12} C$

$\rho = \frac{q}{V} = \frac{dq}{dV}$

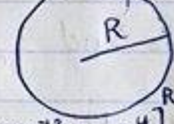
$dq = \rho\, dV \qquad V = \frac{4}{3}\pi R^3$

$dV = 4\pi r^2\, dr$

(a) $\rho = \frac{dq}{\cancel{4\pi r^2}} = \frac{14.1 \times 10^{-12}\ r}{R}$

$dq = 14.1 \times 10^{-12} \times 4\pi \frac{r^2}{R} r\, dr$

$Q = \int_0^R 14.1 \times 10^{-12} \times 4\pi r^3\, dr$



$Q = \frac{4}{R} \times 14.1 \times 10^{-12} \pi \int_0^R r^3\, dr = \frac{4}{R} 14.1 \times 10^{-12} \pi \left.\frac{r^4}{4}\right]_0^R$

$Q = \frac{\cancel{4} \times 14.1 \times 10^{-12} \pi}{\cancel{R}} \frac{R^{\cancel{4}\,3}}{\cancel{4}} =$

$Q = 7.78 \times 10^{-15}\ C$

(b) $r = 0$

$E = \frac{1}{4\pi\epsilon_0} \frac{q_{enc}}{r^2}$ $\qquad$ when $r=0$ $q_{enc} = 0$

$E = 0$

(c) $r = R/2$

$\oint_{R/2} E \cdot dA = \frac{q_{enc}}{\epsilon_0}$ $\qquad q_{enc} = \frac{\pi (14.1 \times 10^{-12})}{R} \left(\left. r^4 \right]_0^{R/2} \right)$

$E \oint dA = \frac{q_{enc}}{\epsilon_0}$ $\qquad = 4.8595 \times 10^{-16}\ C$

$\oint dA = 4\pi r^2$ $\qquad E = \frac{q_{enc}}{4\pi\epsilon_0 r^2} = \frac{4.8595 \times 10^{-16} \times 9 \times 10^9}{(0.056/2)^2}$ $\qquad r = \frac{0.056}{2}$

$= 5.578 \times 10^{-3}\ N/C$

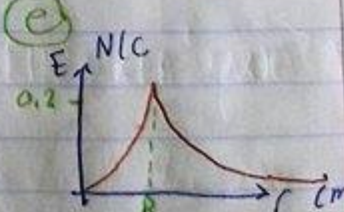
(d) $r = R$?

$\oint E\, dA = \frac{q_{enc}}{\epsilon_0}$

$E(4\pi R^2) = \frac{q_{enc}}{\epsilon_0}$

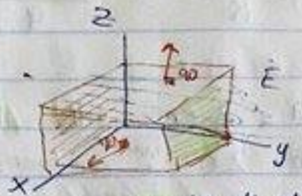
$E = \frac{q_{enc}}{4\pi\epsilon_0 R^2} = 0.02233\ N/C$

(e)



Additional problems:

(1) $l = 1.4\ m$



(a) $\vec{E} = 3y\hat{j}\ N/C$

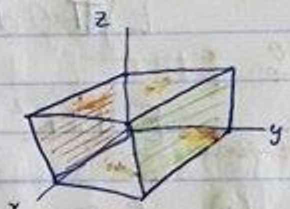
$\phi = \oint E.dA$ ① $dA = (1.4)^2\ \hat{j}$

$= \int 3y\hat{j} . (1.4)^2 \hat{j} \Rightarrow$ $y = 1.4$

$= 8.232\ N.m^2/C$ ② $y = 0,\ \phi = \int E.dA = 0$

(b) $\phi = \dfrac{q_{enc}}{\epsilon_0}$

$q_{enc} = 8.232 \times 8.85 \times 10^{-12} = 72.85 \times 10^{-12}\ C$



(c) $E = -4\hat{i} + (6+3y)\hat{j}\ N/C$

$\phi_{top} = \phi_{bottom} = 0$

$\phi_{front} = -\phi_{back} \Rightarrow$ $\phi_{front} = \oint -4\hat{i}\ (1.4)^2\hat{i} = -7.84$

$\phi_{back} = \int -4\hat{i}\ (1.4)^2 - \hat{i} = 7.84$

* $\phi_{right} = \oint E.dA$ $\longrightarrow$ $dA = (1.4)^2\ \hat{j}$

$= \int (6+3y)\hat{j} (1.4)^2\ \hat{j}$ $y = 1.4$

$= \int (6+4.2)\hat{j} . (1.4)^2 \hat{j} = 19.992\ N.m^2/C$

* $\phi_{left} = \oint E\, dA$ $\longrightarrow$ $dA = (1.4)^2\ -\hat{j}$

$= \int (6+3y)\hat{j} . (1.4)^2 - \hat{j}$ $y = 0$

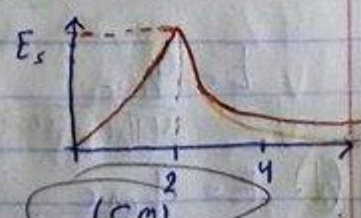
$= \int 6\hat{j} . (1.4)^2 - \hat{j}) = -11.76$

$\phi_{total} = 8.232\ N.m^2/C$

* بجبر أوزع ĵ وآخذ بس اللي بتغير لأنو الباقي
بلغي بعض و بجمعي ثم نفس الفرع الأول

(d) $\phi = \dfrac{q_{enc}}{\epsilon_0} \Rightarrow q_{enc} = 72.85 \times 10^{-12}\ C$

(44) $E_s = 5 \times 10^7\ N/C$



$E_s = \dfrac{q}{4\pi\epsilon_0 R^2}$

$R = 2 \times 10^{-2}\ m$

$$q = \frac{E_s R^2}{K} = \frac{(5\times10^7)(2\times10^{-2})^2}{9\times10^9} = 2.22\times10^{-6}\ C$$
$$= 2.22\ \mu C$$

(49) $a = 2\ cm$ solid sphere
$b = 2a$ inner r ← conducting shell
$c = 2.4a$ outer r
$q_1 = +5\ fC$ $f = 10^{-15}$

$$\phi = \oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0}$$
$$\int E\cos\theta\, dA = \frac{q_{enc}}{\epsilon_0}$$
$$E\int \cos\theta\, dA = \frac{q_{enc}}{\epsilon_0}$$
$0 = \theta$
$1 = \cos\theta$
$$E\, 4\pi r^2 = \frac{q_{enc}}{\epsilon_0} \Rightarrow \boxed{E = \frac{q_{enc}}{4\pi\epsilon_0 r^2}}$$
مساحة سطح الكرة

(a) $r = 0 \rightarrow q_{enc} = 0 \rightarrow E = 0$

(b) $r = a/2$ $r = 1cm$

q_{enc} in asphere with raduis = 1 cm
$$\rho_a = \frac{q}{\frac{4}{3}\pi a^3} = \frac{5\times10^{-15}}{\frac{4}{3}\pi(2\times10^{-2})^3} = 1.493\times10^{-10}\ C/m^3$$

q_{enc} in sphere with $r = 1cm$ = $\rho \times V_{sphere} = 1.493\times10^{-10} \times \frac{4}{3}\pi(1\times10^{-2})^3$
$= 6.25\times10^{-16}\ C$

$$E = \frac{q_{enc}}{4\pi\epsilon(1\times10^{-2})^2} = 0.05625 = 5.63\times10^{-2}\ N/C$$

(c) $r = a$
$$E = \frac{q_{enc}}{4\pi\epsilon_0 r^2} = \frac{5\times10^{-15}}{4\pi\epsilon_0(2\times10^{-2})^2} = 0.1125 = 11.25\times10^{-2}\ N$$

(d) $$E = \frac{q_{enc}}{4\pi\epsilon_0 r^2} = \frac{5\times10^{-15}}{4\pi\epsilon_0(3\times10^{-2})^2} = 0.05\ N/C$$
$r = 1.5a = 3cm$

(e) $r = 2.3a = 4.6\,cm$

* inside the conductor $E = 0$ since $q = 0$

(f) $r = 3.5a = 7\,cm$

$$E = \frac{q_{enc}}{4\pi\epsilon_0 r^2} = \frac{q_1 + q_2}{4\pi\epsilon_0 r^2} = 0 \qquad q_2 = -q_1$$

(g) $$\phi_{\text{for the inner surface}} = \frac{q_{enc}}{\epsilon_0}$$

$$0 = \frac{q_{enc}}{\epsilon_0}$$

$$q_{enc} = 0 \Longrightarrow q_{1\,\text{sphere}} + q_{\text{for the inner surface}} = 0$$

$$5\times10^{-15} + q_{inner} = 0$$

$$q_{inner} = -5\times10^{-15}\ C$$

(h) $$\phi_{\text{for the outer surface}} = \frac{q_{enc}}{\epsilon_0}$$

$$0 = \frac{q_{enc}}{\epsilon_0}$$

$$q_{enc} = 0 \Longrightarrow q_{1\,\text{sphere}} + q_{inner} + q_{outer} = 0$$

$$5\times10^{-15} + -5\times10^{-15} + q_{outer} = 0$$

$$q_{outer} = 0$$

(76) (a) $$\rho = \frac{q}{\pi r^2 L}$$

$$\phi = \frac{q_{enc}}{\epsilon_0}$$

$$\oint E.dA = \frac{q_{enc}}{\epsilon_0}$$

$$E\int \underbrace{\cos\theta\, dA} = \frac{\rho \pi r^2 L}{\epsilon_0}$$

مساحة سطح الاسطوانة

$$E\,2\pi \cancel{r} \cancel{L} = \frac{\rho \pi r^{\cancel{2}} \cancel{L}}{\epsilon_0}$$

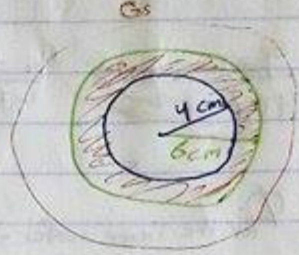
$$E = \frac{\rho r}{2\epsilon_0}$$

(b) $\oint E \cdot dA = \frac{q_{enc}}{\epsilon_0} \leftarrow q$

$$E(2\pi r L) = \frac{\rho \pi R^2 L}{\epsilon_0}$$

$$E = \frac{\rho R^2}{2\epsilon_0 r}$$

ch21 problem 21:



$\rho = b/r$

$b = 3\,\mu C/m^2$

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0}$$

$$E 4\pi r^2 = \frac{q_{enc}}{\epsilon_0}$$

$$\frac{\sigma}{\epsilon_0} 4\pi r^2 = \frac{q_{enc}}{\epsilon_0}$$

21, 32, 53

$$\rho = \frac{q}{V} = \frac{dq}{dV} \qquad V = \pi R^3 \frac{4}{3} \qquad dV = \pi r^2$$

$$dq = 4\rho \pi r^2 dr$$

$$q = \int_{0.04}^{0.06} 4 \rho \pi r^2 dr$$

$$= \int_{0.04}^{0.06} 4 \frac{b}{r} \pi r^2 dr$$

$$= 4\pi b \int_{0.04}^{0.06} r\,dr = 4\pi b \left. \frac{r^2}{2} \right|_{0.04}^{0.06}$$

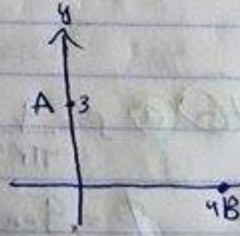
$$= 2\pi b \left((0.06)^2 - (0.04)^2 \right)$$

$$= 3.768 \times 10^{-8}\ C$$

Ch24:

(7) $E_z = E_x = 0 \qquad E_y = 4x$

$$V = -\int_i^f E\,dx = -2x^2$$



$V_B = -2(x_B)^2 = -2(4)^2 = -32V$

$V_A = -2(x_A)^2 = -2(0)^2 = 0$

$V_B = -\int 4x\,dx =$

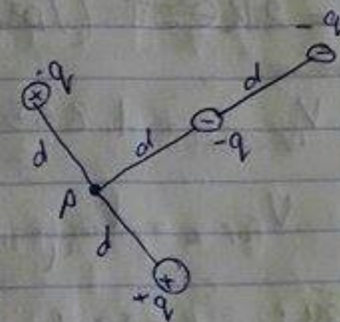
$V_A = -\int_i^f \vec{E} \cdot d\vec{s} = 0$

$V_B - V_A = -32\ V$

(17)

$U_{a..}$

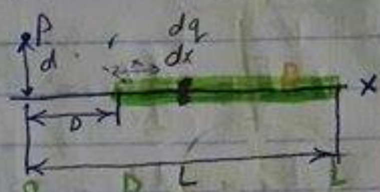
$V_\infty = 0$ $\quad q = 5\ fC \quad d = 4\,cm$



$$V = \frac{kq}{d} + \frac{kq}{d} + \frac{k(-q)}{d} + \frac{k(-q)}{2d}$$

$$V = \frac{kq}{2d} = 5.625\times10^{-4}\ V$$

(26)



$\lambda = 1\ \mu C/m$

$d = D = L/4$

$dV = \frac{k\,dq}{r}$

$V = k\int \frac{dq}{r}$ $\qquad \lambda = \frac{q}{L}$ $\qquad dq = \lambda\, dx$

$$V = k\int_D^L \frac{\lambda\, dx}{\sqrt{d^2+(D+x)^2}} \qquad r = \sqrt{d^2+(D+x)^2}$$

$$V = k\lambda \int_D^L \frac{dx}{\sqrt{d^2+(D+x)^2}}$$

$$= k\lambda \ln x + \sqrt{d^2+x^2}\Big]_D^L$$ ← 640 ص (24-35)

$$= 9\times10^9\,(1\times10^{-6})\left(\ln L+\sqrt{d^2+L^2} - \ln D+\sqrt{d^2+D^2}\right)$$

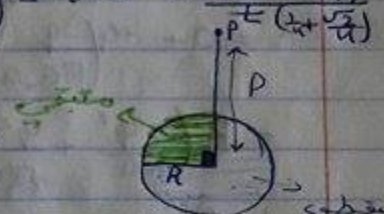
$$= 9\times10^9\,(1\times10^{-6})\left(\ln \frac{L+\sqrt{(L/4)^2+L^2}}{L/4+\sqrt{(L/4)^2+(L/4)^2}}\right) = 9\times10^3 \ln \frac{L\left(1+\frac{\sqrt{17}}{4}\right)}{L\left(\frac{1}{4}+\frac{\sqrt{2}}{4}\right)}$$

$= 10.92\times10^3$ Volt

(31)

$R = 64\ cm$

$\sigma = 7.73\ fC/m^2 \quad D = 25.9\ cm$



$$V = k\int \frac{dq}{r} \qquad \sigma = \frac{q}{\pi R^2} \qquad dq = \sigma\, 2\pi R\, dr$$

$$= k\int \frac{\sigma\, 2\pi r\, dr}{\sqrt{D^2+r^2}} \qquad u = D^2+r^2 \qquad du = 2r\, dr$$

$$= k\sigma\pi \int_0^R \frac{\cancel{2r}\ du}{\cancel{2r}\ u^{1/2}}$$

$$= 2k\sigma\pi\, u^{1/2}\Big]_0^R = 2k\sigma\pi \sqrt{D^2+r^2}\Big]_0^R$$

$$= 2K\sigma\pi\left(\sqrt{D^2+R^2} - \sqrt{D^2+0}\right) = 2K\sigma\pi\left(\sqrt{D^2+R^2} - D\right)$$

بعد تعويض الأرقام

$$V_{\text{for a disk}} = 1.885 \times 10^{-4}\ V$$

$$V_{\text{for a}} = \frac{V_{\text{for the disk}}}{4} = 4.7 \times 10^{-5}\ V$$

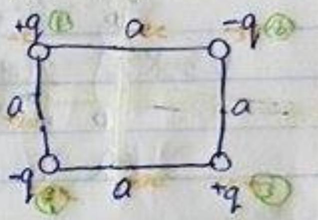
(39) $V_s = 500\,V$

$$E_x = \frac{-dV}{dx} = -\text{slope} = -\left(\frac{500-0}{0-0.2}\right) = 2500\ N/C$$

$$E_y = \frac{-dV}{dy} = -\text{slope} = -\left(\frac{-300-0}{0-0.3}\right) = -1000\ N/C$$

$$F = eE$$
$$= -4\times10^{-16}\,\hat{i} + +1.6\times10^{-16}\,\hat{j} \quad N$$

(43) $q = 2.3\,pC$
$a = 64\,cm$



$$W = W_{1\,\infty\to} + W_{2\,\infty\to} + W_{3\,\infty\to} + W_{4\,\infty\to}$$

$$= 0 + U_{12} + U_{13} + U_{23} + U_{14} + U_{24} + U_{34}$$

$$= 0 + {+q}\left(\frac{-q}{4\pi\epsilon_0 a}\right) + {+q}\left(\frac{+q}{4\pi\epsilon_0\sqrt{2}a}\right) + {+q}\left(\frac{-q}{4\pi\epsilon_0 a}\right) + {+q}\left(\frac{-q}{4\pi\epsilon_0\sqrt{2}a}\right) + {-q}\left(\frac{-q}{4\pi\epsilon_0\sqrt{2}a}\right) + {-q}$$

$$= K\left(\frac{-q^2}{a} + \frac{q^2}{\sqrt{2}a} + \frac{-q^2}{a} + \frac{-q^2}{a} + \frac{+q^2}{\sqrt{2}a} + \frac{-q^2}{4\pi\epsilon_0 a}\right)$$

$$= \frac{K}{a}q^2\left(-4 + \frac{2}{\sqrt{2}}\right) = \cancel{-1.1796\times10^{-13}\ J}$$
$$= -1.913\times10^{-13}\ J$$

(47) $r = 1\,cm$ $\quad q = 1.6\times10^{-15}\,C$

$$(U+K)_\infty = (U+K)_s$$
$$0+0 = -E\cdot q_e + \frac{1}{2}mV^2$$
$$E\,q_e\cos 0 = \frac{1}{2}mV^2$$

$$\frac{qe}{4\pi\epsilon_0 r} = \frac{1}{2}mv^2$$

$m_e = 9.11\times10^{-31}$ kg

$q_e = 1.6\times10^{-19}$ c

$q = 1.6\times10^{-15}$ c

$$V = \sqrt{\frac{2qe}{4\pi\epsilon_0 r m}} = 22490.39 \approx 2.25\times10^4 \text{ m/s}$$

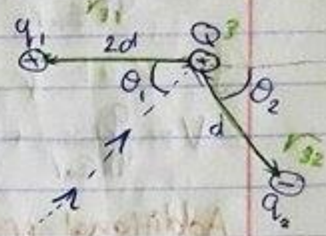
(50)

$$W = Q\left(\frac{-q_2}{4\pi\epsilon_0 r_{32}}\right) + Q\left(\frac{+q_1}{4\pi\epsilon_0 r_{31}}\right)$$

$$= Q\left(\frac{-q_1/2}{4\pi\epsilon_0 d}\right) + Q\left(\frac{+q_1}{4\pi\epsilon_0 2d}\right)$$

$$= \frac{-Qq_1}{4\pi\epsilon_0 2d} + \frac{Qq_1}{4\pi\epsilon_0 2d}$$

$$= 0$$



(66) $E(r) = \frac{1}{4\pi\epsilon_0}\frac{q_{enc}}{r}$

$R_1 = 0.5m$ $R_2 = 1m$

$q_1 = +3\,\mu C$ $q_2 = +1\,\mu C$

ⓐ E at r = 4m

$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0}$$

$$E\,4\pi r^2 = \frac{q_{enc}}{\epsilon_0} \Rightarrow E = \frac{q_{enc}}{4\pi\epsilon_0 r^2} = \frac{q_1+q_2}{4\pi\epsilon_0 r^2} = 2250 \text{ V/m}$$

ⓑ E at r = 0.7 m

$$E = \frac{q_{enc}}{4\pi\epsilon_0 r^2} = \frac{q_1}{4\pi\epsilon_0 r^2} = 55102 \text{ V/m}$$

ⓒ E at r = 0.2 m

$$E = \frac{q_{enc}}{4\pi\epsilon_0 r^2} \Rightarrow q_{enc} = 0 \quad E = 0$$

$$V(r) - V(r') = \int_{r}^{r'} E(r)\,dr$$

ⓓ V at r = 4 m

$$V = -\int_i^f E\cdot ds = -E\int_i^f ds = -E\,d = 9000 \text{ V}$$

(e) V at $r = 1m$

$$V = \frac{q_1 + q_2}{4\pi\epsilon_0 r} = \boxed{36000\,V}$$

(f) V at $r = 0.7m$

$$V = \frac{q_1}{4\pi\epsilon_0 r} + \frac{q_2}{4\pi\epsilon_0 R} = \boxed{47571.43\,V}$$

(g) V at $r = 0.5$

$$V = \frac{q_1}{4\pi\epsilon_0 r} + \frac{q_2}{4\pi\epsilon_0 R} = 63000\,V$$

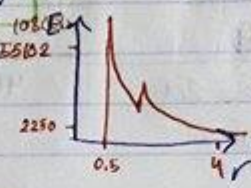
(h) V at $r = 0.2m$

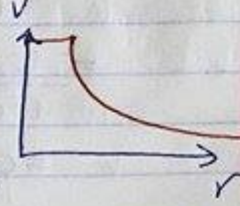
$$V = \frac{q_1}{4\pi\epsilon_0 R_1} + \frac{q_2}{4\pi\epsilon_0 R_2} = 63000$$

(i) V at $r = 0$

$$V = \frac{q_1}{4\pi\epsilon R_1} + \frac{q_2}{4\pi\epsilon_0 R_2}$$
$$= 63000\,V$$

(j)





Additional problems:

(15) $q = 30\ pC$
$V = 500\,V$

(a)

$$V_f - \cancel{V_i} = -\int_i^f E \cdot ds$$

$$V_f = -\int_i^f \frac{q}{4\pi\epsilon_0 r^2}\,dr \qquad \text{or} \qquad \boxed{V = \frac{kq}{r}}$$

$$V_f = +\frac{q}{4\pi\epsilon_0} \frac{r^{-1}}{\cancel{-1}}\Big]_i^f$$

$$V_f = \frac{q}{4\pi\epsilon_0 r} \Rightarrow r = \frac{q}{4\pi\epsilon_0 V} = 5.4 \times 10^{-4}\ m$$

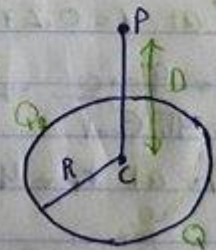
(b) $U = qV$ $\qquad V = \frac{kq}{r}$ $\qquad V = \frac{4}{3}\pi r^3$
$= 6.6 \times 10^{-10}$

$$V_f = \frac{2q}{4\pi\epsilon_0 r_{..}}$$

$V_{..} = 13.2 \times 10^{-10}$
$r_{..} = 6.81 \times 10^{-4}\ m$

$$= 792.95\ V$$

(25) $R = 8.2\ cm$ $\quad Q_1 = 42\ pC$ $\quad Q_2 = -6Q_1$
$D = 6.71\ cm$



$$V_f - V_i = -\int_i^f \vec{E} \cdot \vec{ds}$$

$$V_f = -\int_i^f \vec{E} \cdot \vec{ds}$$

(a) at c

$$V = \frac{1}{4\pi\epsilon_0}\left(\frac{Q_1}{R} + \frac{-6Q_1}{R}\right) = -2.3 \ V$$

(b) at point p

$$V = \frac{1}{4\pi\epsilon_0}\left(\frac{Q_1}{\sqrt{R^2+D^2}} + \frac{-6Q_1}{\sqrt{R^2+D^2}}\right) = -1.784 \ V$$

(45)

$q = 3.1 \ \mu C$

$m = 20 \ mg \rightarrow$ mili gram

$r_1 = 0.9 \ mm \qquad r_2 = 2.5 \ mm$

$$(K+U)_i = (K+U)_f$$

$$0 + \frac{qq}{4\pi\epsilon_0 r_1} = \frac{1}{2}mv^2 + \frac{qq}{4\pi\epsilon_0 r_2}$$

$$\frac{1}{2}mV^2 = \frac{qq}{4\pi\epsilon_0 r_1} - \frac{qq}{4\pi\epsilon_0 r_2}$$

$$\frac{1}{2}mV^2 = \frac{qq}{4\pi\epsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$\frac{1}{2}mV^2 = 61.504$$

$$\frac{1}{2}(20\times10^{-6})\,V^2 = 61.504$$

$$V = 2480 \ m/s$$

(67) $r = 15 \ cm \qquad q = 3\times10^{-8} \ C$

(a) $E = \dfrac{q}{4\pi\epsilon_0 r^2} = 12000 \ N/C$

(b) $V = \dfrac{q}{4\pi\epsilon_0 r} = 1800 \ V$

(c) $\rightarrow$ decrease by 500 V $\Rightarrow$ $V = 1300 \ V$ or $\boxed{\Delta V = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_n} - \frac{1}{r}\right)}$

$$V = \frac{q}{4\pi\epsilon_0 r}$$

$r = \dfrac{q}{4\pi\epsilon_0 V} \Rightarrow r = 0.2077 \ m = 20.77 \ cm \qquad \Delta r = 20.77 - 15$

$= 5.77 \ cm$

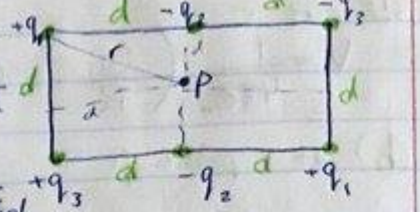
$= 5.77\times10^{-2} \ m$

$r^2 = d^2 + \left(\frac{d}{2}\right)^2$

$r^2 = 5/4 d^2$

$r = \sqrt{5/4}\, d$

(92)



$$V = \frac{+q_1}{4\pi\epsilon_0\sqrt{5/4}d} + \frac{-q_2}{4\pi\epsilon_0 d/2} + \frac{-q_3}{4\pi\epsilon_0\sqrt{5/4}d}$$

$$+ \frac{+q_3}{4\pi\epsilon_0\sqrt{5/4}d} + \frac{-q_2}{4\pi\epsilon_0 d/2} + \frac{+q_1}{4\pi\epsilon_0\sqrt{5/4}d}$$

$$= \frac{1}{4\pi\epsilon_0 d}\left[\frac{q_1}{\sqrt{5/4}} + \frac{-q_2}{2} + \frac{-q_2}{2} + \frac{q_1}{\sqrt{5/4}}\right]$$

$$= \frac{9\times10^9}{2.54\times10^{-2}}\left[\frac{3\times10^{-15}}{\sqrt{5/4}} + \frac{-2\times10^{-15}}{1/2} + \frac{-2\times10^{-15}}{1/2} + \frac{3\times10^{-15}}{\sqrt{5/4}}\right]$$

$q_1 = 3\,fc$

$q_2 = 2\,fc$

$q_3 = 3\,fc$

$d = 2.54\,c$

$$= \frac{9\times10^9}{2.54\times10^{-2}} \times -2.366\times10^{-15}$$

$$= -9.331\times10^{-4}\ V$$

(102) $K_{Ep} = 3.5\ MeV$

(a)

$$(K+U)_i = (K+U)_f$$

$$3.5\,MeV + 0 = 0 + U_f$$

$$U_f = 3.5\,MeV$$

$$U = \frac{q_1 q_2}{4\pi\epsilon_0 r} = 3.5\times1.6\times10^{-13}$$

$$\frac{9\times10^9\times1.6\times10^{-19}\times82\times1.6\times10^{-19}}{r_p} = 5.6\times10^{-13}$$

$$r_p = 3.37\times10^{-14}\ m = 33.7\ fm$$

MeV = million electron Volt = $10^6\times1.6\times10^{-19}$

Note: a lead nucleus has a net charge of $82e \Rightarrow q_2 = 82e$

(b)

$$K_{E\alpha} = 3.5\,MeV$$

$$(K+U)_i = (K+U_f)$$

$$3.5\,MeV + 0 = 0 + U_f$$

$$U = \frac{q_1 q_2}{4\pi\epsilon_0 r} = 3.5\times1.6\times10^{-13}$$

$$\frac{9\times10^9\times2\times1.6\times10^{-19}\times82\times1.6\times10^{-19}}{r_\alpha} = 5.6\times10^{-13}$$

$$r_\alpha = 6.74\times10^{-14}\ m = 67.4\ fm$$

$$\frac{r_\alpha}{r_p} = \frac{67.4\times10^{-15}}{33.7\times10^{-15}} = 2$$

(36) $V = 1500\,x^2$

ⓐ at $x = 1.8$ cm $\Rightarrow E = \frac{-dV}{dx} = -3000\,x$

$= -3000\,(1.8\times10^{-2})$

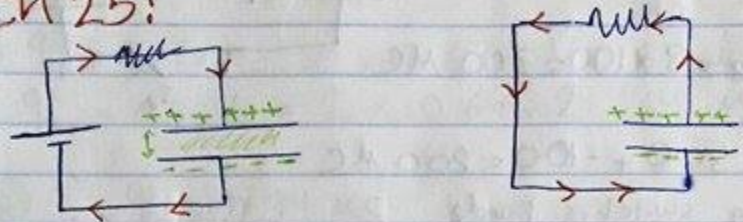
$= -54$ V/m

الإشارة للاتجاه فقط   الـ magnitude

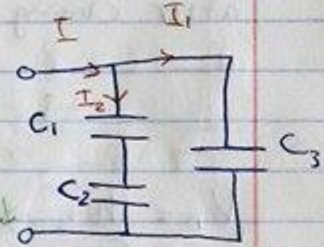
ⓑ the direction is $(-\hat{i})$ or toward plate $\underline{1}$.

من الأعلى جهد (x)

ch 25:



(10) $C_1 = 10\,\mu F$, $C_2 = 8\,\mu F$, $C_3 = 4\,\mu F$



$Q = CV$, $I = \frac{dq}{dt}$

1, 2 توالي (لا تفرع)

$q_1 = q_2$

$V_{12} = V_1 + V_2$

$\frac{q_{12}}{C_{12}} = \frac{q_1}{C_1} + \frac{q_2}{C_2}$ $q_{12} = q_1 = q_2$

$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2}$

12, 3 توازي (تفرع)

$V_{12} = V_3$

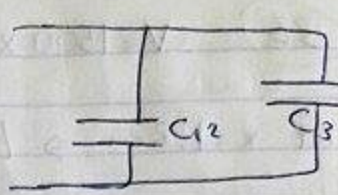
$q_{eq} = q_{12} + q_3$ $V_{eq} = V_{12} = V_3$

$C_{eq}\cancel{V_{eq}} = C_{12}\cancel{V_{12}} + C_3\cancel{V_3}$

$C_{eq} = C_{12} + C_3$

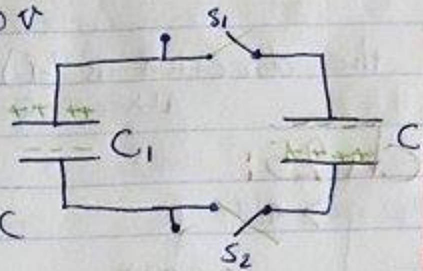
$C_{12} \Rightarrow C_{12} = \frac{C_1 C_2}{C_1 + C_2} = \frac{80}{18} = 4.44\ \mu F$

$$C_{eq} = C_{12} + C_3$$
$$= 4.44 + 4$$
$$= 8.44 \ \mu F$$



(21) $C = \dfrac{q}{V}$ $\quad C_1 = 1 \mu F,\ C_2 = 3 \mu F,\ V_1 = 100 V$

$V_1 = -V_2 = -100 V$



(a) $q_1 = C_1 V_1$
$= 1 \times 100 = {}^-100 \mu C$

$q_2 = C_2 V_2 = 3 \times 100 = 300 \mu C$

$q_{tot} = 300 + -100 = 200 \mu C$

after closing switches 1 and 2

$$V_1 = V_2 = V_{ab}$$
$$\frac{q_1'}{C_1} = \frac{q_2'}{C_2} = \frac{q_{tot}}{C_{eq}}$$

$V_{ab} = \dfrac{q_{tot}}{C_{eq}} \Rightarrow \quad C_{eq} = C_1 + C_2 = 1 + 3 = 4 \mu F$

$$\boxed{V_{ab} = \frac{200 \mu C}{4 \mu F} = 50 V}$$

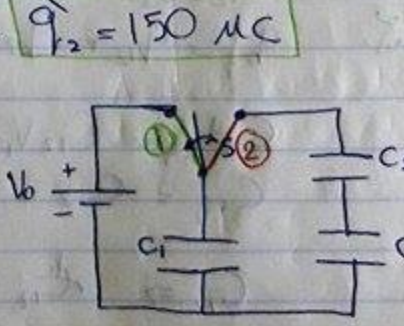
(b) $V_1 = \dfrac{q_1'}{C_1} = 50$

$\dfrac{q_1'}{1 \mu F} = 50 \quad \Rightarrow \boxed{q_1' = 50 \mu C}$

(c) $V_2 = \dfrac{q_2'}{C_2} = 50$

$q_2' = 3 \mu F \times 50 \Rightarrow \boxed{q_2' = 150 \mu C}$

(28) $V_0 = 16 V$
$C_1 = 4 \mu F$
$C_2 = 6 \mu F$
$C_3 = 3 \mu F$



$$q_{tot} = C_1 V_1$$
$$= 4 \times 16 = 64\ \mu C$$

$$C_{23} = \frac{3 \times 6}{3+6} = \frac{18}{9} = 2\ \mu F$$

after ②

$$V_{23} = V_1 = V_{eq}$$
$$\frac{q'_{23}}{C_{23}} = \frac{q'_1}{C_1} \Rightarrow \frac{q_{tot}}{C_{eq}} = \frac{64\ \mu C}{6} = 10.67\ V$$

ⓐ $q'_1 = C_1 V_1 = 4 \times 10.67 = 42.68\ \mu C$

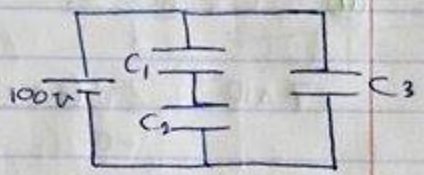
$q'_{23} = C_{23} V_{23} = 2 \times 10.67 = 21.34\ \mu C$

ⓑⓒ $q'_2 = q'_3 = 21.34\ \mu C$

(34)

$V = 100\ V$

$C_1 = 10\ \mu F$, $C_2 = 5\ \mu F$, $C_3 = 2\ \mu F$



ⓐ $q_3 \Rightarrow$ $q_3 = C_3 V_3$

$= 2 \times 100 = 200\ \mu C$

ⓑ $V_3 \Rightarrow$ $V_3 = V = 100\ V$

ⓒ $U_3 \Rightarrow$ $U_3 = \frac{1}{2} q V = \frac{1}{2} C V^2 = 0.01\ J$

ⓓ $q_1 \Rightarrow$ $q_1 = q_2 = q_{12}$

$q_{12} = C_{12} V_{12}$ $\quad C_{12} = \frac{50}{15} = 3.33$

$= 3.33 \times 100$

$= 333\ \mu C$

$q_1 = 333\ \mu C$

ⓔ $V_1 \Rightarrow$ $V_1 = \frac{q_1}{C_1} = \frac{333}{10} = 33.3\ V$

ⓕ $U_1 \Rightarrow$ $U_1 = \frac{1}{2} C_1 V_1^2 = 0.0055\ J$

ⓖ $q_2 \Rightarrow$ $q_2 = q_{12} = 333\ \mu C$

ⓗ $V_2 \Rightarrow$ $V_2 = \frac{q_2}{C_2} = \frac{333}{5} = 66.6\ V$

(i) $U_2 = \frac{1}{2} C_2 V_2^2$

$= \frac{1}{2}(5)(66.6)^2$

$= 0.011\ J$

$C \leftarrow \mu F \Rightarrow \times 10^{-6} F$

(47) $K = 2.8$

$\vec{E} = 18 \frac{MV}{m}$

$C_0 = \frac{\epsilon_0 A}{d}$ $\quad C = \frac{\epsilon_0 K A}{d}$

$\oint E \cdot dA = \frac{q_{enc}}{\epsilon_0}$

$E A = \frac{q_{enc}}{\epsilon_0}$

$E = \frac{q_{enc}}{\epsilon_0 A} \rightarrow V = \frac{q_{enc} d}{\epsilon_0 A} \rightarrow C = \frac{q}{V} = \frac{\epsilon_0 A}{d}$

$C = \frac{K \epsilon_0 A}{d}$

$7 \times 10^{-8} = \frac{2.8(8.85 \times 10^{-12}) A \rightarrow ?}{? \leftarrow d}$

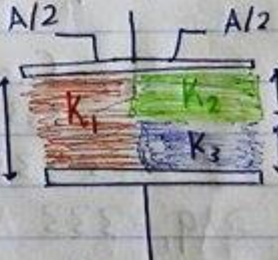
$V = Ed$

ممكن معرفة من الوحدة $d = \frac{V}{E} = \frac{4 \times 10^3}{18 \times 10^6} = 2.2 \times 10^{-4}\ m$

$\frac{MV}{m}$

$A = \frac{7 \times 10^{-8} \times 2.2 \times 10^{-4}}{2.8 \times 8.85 \times 10^{-12}} = 0.62\ m^2$

(50) $K_1 = 21,\ K_2 = 42,\ K_3 = 58$



$C = \frac{K \epsilon_0 A}{d}$

① $C_1 = \frac{K_1 \epsilon_0 A/2}{2d}$

$= \frac{K_1 \epsilon_0 A}{4d} = 1.63 \times 10^{-11}\ F$

$A = 12.5\ cm^2 = 12$

$2d = 7.12\ mm = 7.12$

$K = \frac{\epsilon}{\epsilon_0}$

② $C_2 = \frac{K_2 \epsilon_0 A/2}{d}$

$= \frac{K_2 \epsilon_0 A}{2d} = 6.5 \times 10^{-11}\ F$

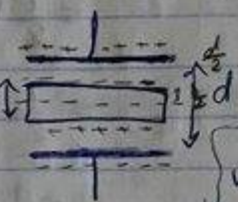
③ $C_3 = \frac{K_3 \epsilon_0 A/2}{d} = 8.97 \times 10^{-11}$ F

(2,3) series $\quad C_{23} = \frac{C_2 C_3}{C_2 + C_3} = \frac{58.305 \times 10^{-22}}{15.47 \times 10^{-11}} = 3.77 \times 10^{-11}$ F

(23,1) parallel

$$C_{eq} = C_{23} + C_1$$
$$= (3.77 + 1.63) \times 10^{-11} = 5.4 \times 10^{-11} \text{ F}$$

70) $b = 3$ mm, $A = 2.4$ cm^2, $d = 5$ mm



$\boxed{C_1 = \frac{\epsilon_0 A}{\frac{d}{2} - \frac{b}{2}} \quad C_2 = \frac{\epsilon_0 A}{\frac{d}{2} - \frac{b}{2}} \quad \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} \quad C_{eq} = \frac{\epsilon_0 A}{d - b}}$

$\boxed{C = \frac{q}{V} \quad U = \frac{1}{2} qV = \frac{1}{2}\frac{q^2}{C} = \frac{1}{2} CV^2}$

ⓐ $C = \frac{\epsilon_0 A}{(d-b)}$

$$= \frac{(8.85 \times 10^{-12})\ 2.4 \times 10^{-4}}{(5-3) \times 10^{-3}} = 1.062 \times 10^{-12} \text{ F}$$

ⓑ $\frac{U_b}{U_a} = \frac{q^2/2C_b}{q^2/2C_a} = \frac{C_a}{C_b} = \frac{\frac{\epsilon_0 A}{(d-b)}}{\frac{\epsilon_0 A}{d}} = \frac{d}{d-b} = \frac{5 \times 10^{-3}}{(5-3) \times 10^{-3}}$

$= 2.5$

ⓒ $W_s = \Delta U = U_a - U_b$

$$= \frac{1}{2}\frac{q^2}{C_a} - \frac{1}{2}\frac{q^2}{C_b}$$
$$= \frac{q^2}{2}\left(\frac{1}{C_a} - \frac{1}{C_b}\right)$$
$$= \frac{q^2}{2}\left(\frac{(d-b)}{\epsilon_0 A} - \frac{d}{\epsilon_0 A}\right)$$
$$= -\frac{q^2}{2}\frac{b}{\epsilon_0 A} = -8.164 \text{ J}$$

ⓓ $W < 0$, so the slab is sucked in

71)

ⓐ $C = \frac{\epsilon_0 A}{(d-b)} = 1.062$ pF depends on geometry

$U = \frac{1}{2} CV^2$

ⓑ $\frac{U_b}{U_a} = \frac{(1/2) C_b V^2}{(1/2) C_a V^2} = \frac{\frac{\epsilon_0 A}{d}}{\frac{\epsilon_0 A}{d-b}} = \frac{b-d}{d} = 0.4$

(c) $W_s = \Delta U = U_a - U_b$

$$= \frac{1}{2} C_a V^2 - \frac{1}{2} C_b V^2$$

$$= \frac{1}{2} V^2 (C_a - C_b)$$

$$= \frac{1}{2} V^2 \left(\frac{\epsilon_0 A}{d-b} - \frac{\epsilon_0 A}{d} \right)$$

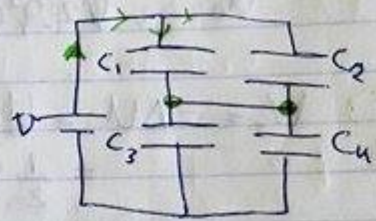
$$= \frac{1}{2} V^2 \epsilon_0 A \left(\frac{1}{2\times10^{-3}} - \frac{1}{5\times10^{-3}} \right)$$

$$= 2.3 \times 10^{-9} \text{ J}$$

(d) ~~sucked in~~

additional problems:

(59)



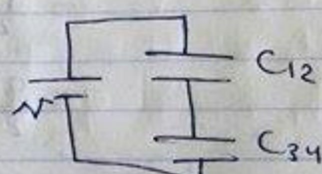
$V = 12$ V

$C_1 = C_4 = 2\ \mu F$, $C_2 = 4\ \mu F$

$C_3 = 1\ \mu F$

$C_{12} = 6\ \mu F$

$C_{34} = 3\ \mu F$



$$C_{eq} = \frac{6 \times 3}{6+3} = 2\ \mu F$$

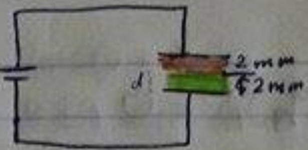
$$C_{eq} = \frac{q_{tot}}{V} \Rightarrow q_{tot} = C_{eq} V = 24\ \mu C$$

$$V_{34} = \frac{q_{tot}}{C_{34}} = \frac{24}{3} = 8 \text{ V}$$

$$V_{34} = V_4 = 8$$

$$\frac{q_{34}}{C_{34}} = \frac{q_4}{C_4} = 8 \qquad q_4 = 2 \times 8 = 16\ \mu C$$

(65)



$A = 2 \times 10^{-2}$ m , $V = 7$ V

$k_1 = 3$

$k_2 = 4$

Connected in series $\quad C_{eq} = \dfrac{C_1 C_2}{C_1 + C_2}$

$C_1 = \dfrac{K \epsilon_0 A}{d}$

$= \dfrac{3\,(8.85 \times 10^{-12})\, 2 \times 10^{-2}}{2 \times 10^{-3}}$

$= 2.655 \times 10^{-10}$ F

$C_2 = \dfrac{K \epsilon_0 A}{d}$

$= \dfrac{4 \times (8.85 \times 10^{-12}) \times 2 \times 10^{-2}}{2 \times 10^{-3}}$

$= 3.54 \times 10^{-10}$ F

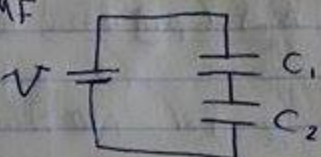
$C_{eq} = \dfrac{C_1 C_2}{C_1 + C_2} = 1.52 \times 10^{-10}$ F

$q = C_{eq} \times V$

$= 1064 \times 10^{-9}$

$= 1.064$ nC

(72) $V = 400$ V , $C_1 = 2$ MF , $C_2 = 8$ MF



(a) $q_1 = q_{tot} = C_{eq} V$

$= (1.6)(400)$

$= 640\ \mu C$

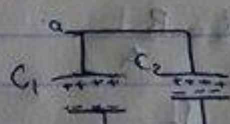
$C_{eq} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$

$= \dfrac{C_1 C_2}{C_1 + C_2} = \dfrac{16}{10} = 1.6$ MF

(b) $V_1 \Rightarrow V_1 = \dfrac{q_1}{C_1} = \dfrac{640}{2} = 320$ V

(c) $q_2 = q_1 = q_{tot} = 640\ \mu C$

(d) $V_2 \Rightarrow V_2 = \dfrac{q_2}{C_2} = \dfrac{640}{8} = 80$ V



(e) $2 q_{tot} = q_1' + q_2'$

$V_1' = V_2' = V_{ab}$

$\dfrac{q_1'}{C_1} = \dfrac{q_2'}{C_2} = \dfrac{q_{tot}}{C_{eq}}$

$V_{ab} = \dfrac{\cancel{2}640}{10} = 128$ V

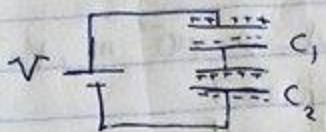
$q_1' = 128 \times 2 = 256\ \mu C$

(f) $V_1 = 128$ V

(g) $q_2' = 128 \times 8 = 1024\ \mu C$

(h) $V_2 = 128$ V

(i) $q_{tot} = 0$



(j) $V_1 = 0$

(k) $q_2 = 0$

(l) $V_2 = 0$

(74)

$$C = \frac{K\varepsilon_0 A}{d}$$

ε_0 → constant

A the same for all sheets

d → thickness

$\frac{K}{d}$ for mica $= 54000\ m^{-1}$ ⇐ when connecting in parallel mica should be placed to give the greatest C

$\frac{K}{d}$ for glass $= 3500\ m^{-1}$

$\frac{K}{d}$ for parraffin $= 200\ m^{-1}$

Ch 26:

(16) $I = 50A$ $R = 0.15\ \Omega/Km$

$density_C = 8960\ Kg/m^3$ $density_{AL} = 2600\ Kg/m^3$

(a) $J_c = \frac{I}{A} = \frac{50}{1.1267} = 443726.98 \approx 4 \times 10^5\ A/m^2$

$R = \frac{\rho L}{A}$

$\frac{R}{L} = \frac{\rho_c}{A}$ $\rho_c = 1.69 \times 10^{-8}\ \Omega.m$

$\frac{0.15}{1000}\ \frac{\Omega}{m} = \frac{1.69 \times 10^{-8}}{A}$

$A = 1.1267 \times 10^{-4}\ m^2$

(b) $\lambda = m/L = \frac{density * V}{L} = density * A$

$= 8960 \times 1.1267 \times 10^{-4}$

$\simeq 1.0095 \ \ Kg/m$

(c) $J_{AL} = \frac{I}{A} = \frac{50}{1.83\times10^{-4}} = 27.32\times10^{4}$

$\simeq 2.7\times10^{5} \ \ A/m^2$

$R = \frac{\rho L}{A}$

$\rho_{Al} = 2.75\times10^{-8} \ \Omega.m$

$\frac{R}{L} = \frac{\rho}{A} \Rightarrow A = \frac{\rho}{\frac{R}{L}} = \frac{2.75\times10^{-8}}{\frac{0.15}{1000}} = 1.83\times10^{-4} \ \ m^2$

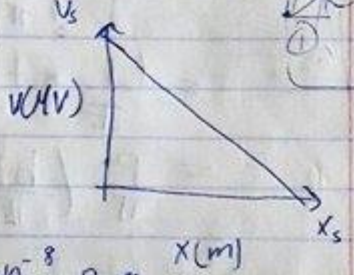
(d) $\lambda = m/L = \frac{density * V}{L} = density * A$

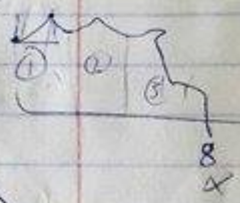
$= 2600 \times 1.83 \times 10^{-4}$

$\simeq 0.4758 \ \ Kg/m$

(28) $V_s = 12 \ \mu V$

$X_s = 3 \ m \qquad r = 2.2 \ mm$





$? \ I = \frac{V}{R?}$

$R = \frac{\rho L}{A} \qquad \rho_c = 1.69\times10^{-8} \ \Omega.m$

$= \frac{1.69\times10^{-8} \times 3}{(2.2\times10^{-3})^2 \ (3.14)} = 3.34 \times 10^{-3} \ \Omega$

$I = \frac{V}{R} = \frac{12\times10^{-6}}{3.34\times10^{-3}} = 3.59\times10^{-3} \ A$

طريقة أخرى

$E = \frac{-dV}{dx} = -slope$

$E = \rho J = \rho \frac{i}{A}$

$i = \frac{AE}{\rho} \qquad A = \pi r^2$

(35) $\rho = 731 \ \Omega.m \qquad a = 2 \ mm \quad b = 2.3 mm \quad L = 1.94 \ cm$

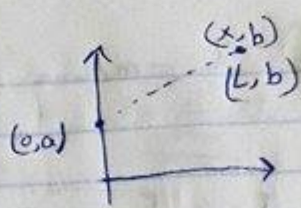
$R = \frac{V}{I}$

$= \frac{-1}{I} \int_0^L$

$E = \rho J = \rho \frac{I}{A} = \rho \frac{I}{\pi r^2}$

$r = mx + c$

at $x = 0 \quad r = a \Rightarrow \boxed{c = a}$



$$m = \frac{b-a}{L-0} = \frac{b-a}{L}$$

$$r = \frac{b-a}{L} x + a$$

$$E = \frac{\rho I}{\pi \left(\frac{b-a}{L} x + a\right)^2}$$

let $u = \frac{b-a}{L} x + a$

$\frac{du}{dx} = \frac{b-a}{L}$

$$R = \frac{-1}{I} \int_0^L E \, dx$$

$$= \frac{-1}{I} \int_0^L \frac{\rho I}{\pi \left(\frac{b-a}{L} x + a\right)^2} dx$$

$$= \frac{+1}{\cancel{I}} * \frac{+\rho \cancel{I}}{\pi} \left(\frac{L}{b-a}\right) \frac{1}{\pi \left(\frac{b-a}{L} x + a\right)} \Bigg|_0^L$$

$$= \frac{\rho}{\pi} \left(\frac{L}{b-a}\right) \left[\frac{1}{(b - \cancel{a} + \cancel{a})} - \frac{1}{a}\right]$$

$$= \frac{\rho}{\pi} \left(\frac{1}{b} - \frac{1}{a}\right) \frac{L}{b-a}$$

$$= \frac{731}{\pi} \left(\frac{1}{2.3 \times 10^{-3}} - \frac{1}{2 \times 10^{-3}}\right) \left(\frac{1.94 \times 10^{-2}}{0.3 \times 10^{-3}}\right) = 981819.4406$$

$$= 981 \text{ K}\Omega$$

(46) $A = 2.4 \times 10^{-6} \, m^2 \quad L = 4 \, m \quad I = 2 \, A \quad t = 30$

(a) $E = \rho J \qquad \rho_c = 1.69 \times 10^{-8} \, \Omega . m$

$$E = \rho \frac{I}{A} = \frac{1.69 \times 10^{-8} \times 2}{2.4 \times 10^{-6}} = 1.41 \times 10^{-2} \text{ N/C } (V/m)$$

(b) $P = I^2 R$

$= (2)^2 \frac{\rho L}{A} = 0.11267$ watt

Energy $= P * t$

$= 0.11267 \times 30 \times$

$= 202,806$ Joul

(74) $J = 2.6 \times 10^6 \, A/m^2 \qquad L = 5 \, m$

the density of conduction electrons $= 8.49 \times 10^{28} \, m^{-3}$

$$J = e\,n\,V_d$$

$$2.6\times10^{6} = (1.6\times10^{-19})\,(8.49\times10^{28})\,V_d$$

$$V_d = 1.914\times10^{-4}\ \text{m/s}$$

$$V = \frac{L}{t} \Rightarrow t = \frac{L}{V} = \frac{5}{1.914\times10^{-4}} = 2.6\times10^{4}\ \text{sec}$$

$$t = \frac{2.6\times10^{4}}{3600} = 7.2\ \text{hour}$$

Additional problems:

(47) $V = 75$

$A = 2.6\times10^{-6}$ m

$\rho = 5\times10^{-7}\ \Omega.\text{m}$ $\qquad P = 5000$ W

(a) $P = I^2 R$

$$P = \frac{V^2}{R^2}\cancel{R} \qquad R = \frac{\rho L}{A}$$

$$R = \frac{V^2}{P} = 1.125\ \Omega \Rightarrow L = \frac{RA}{\rho}$$

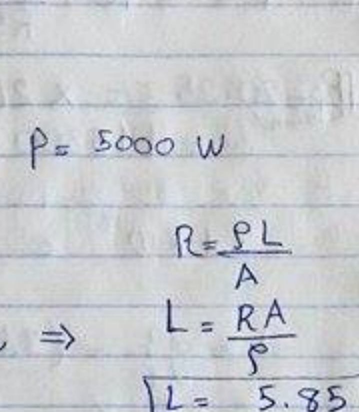
$$\boxed{L = 5.85\ \text{m}}$$

(b) $V = 100$ V

$$R = \frac{V^2}{P} = 2\ \Omega \Longrightarrow L = \frac{RA}{\rho}$$

$$\boxed{L = 10.4\ \text{m}}$$

(51) $L_c = 1$ m



$\rho_c = 2\times10^{-6}\ \Omega.\text{m}$

$R = \frac{1\ \text{mm}}{2}$

$L_D = 1$ m

$\rho_D = 1\times10^{-6}\ \Omega.\text{m}$ $\qquad I = 2$ A

$R = \frac{0.5\ \text{mm}}{2}$

(a) $$V_{12} = I R_c = 2\,(\overset{2.55}{\cancel{0.637}}) = \overset{5.1\ V}{\cancel{1.274}}\ V$$

$$R_c = \frac{\rho_c L_c}{A_c} = \frac{2\times10^{-6}\times1}{(0.5\times10^{-3})^2\,(3.14)} = \overset{2.55}{\cancel{0.637}}\ \Omega$$

(b) $$V_{23} = I R_D = I\left(\frac{\rho_D L_D}{A_D}\right) = 2\left(\overset{5.1}{\frac{1\times10^{-6}\times1}{(0.25\times10^{-3})^2\,(3.14)}}\right) = \overset{10.2\ V}{\cancel{2.55}}\ V$$

(c)

$P_{12} = I^2 R_c = 4\,(\overset{2.55}{\cancel{0.637}}) = \overset{10.2\ W}{\cancel{2.548}}\ w$

$P_{23} = I^2 R_D = 4\,(\overset{5.1}{\cancel{1.275}}) = \overset{20.4\ W}{\cancel{5.1}}\ w$

(69) $t = 2h \quad R = 400\ \Omega \quad V = 90\ V$

$$P = I^2 R = \frac{V^2}{R^{\cancel{2}}} \cancel{R} = \frac{V^2}{R} = 20.25\ \text{watt} \quad (J/s$$

$P_{consumed} = 20.25\ J/s \times 2(3600)$
$= 145800\ J$

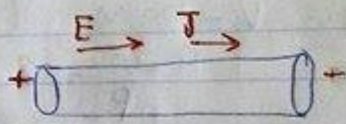
(76) $3.1 \times 10^{18}\ e \quad 1.1 \times 10^{18}$ protons

(a)

$$I = \frac{dq}{dt} = \frac{(3.1 \times 10^{18} + 1.1 \times 10^{18}) \times 1.6 \times 10^{-19}}{s}$$

$= 0.672\ A$

(b)



Ch27:

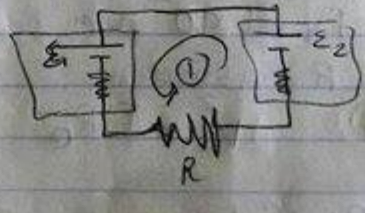
(10) $I = 1.5\ mA \quad \mathcal{E}_1 = 2V \quad \mathcal{E}_2 = 3V \quad r_1 = r_2 = 3\ \Omega$

(a) $I = \frac{\mathcal{E}}{r + R}$

أو كيرشوف

$\mathcal{E}_2 - \mathcal{E}_1$

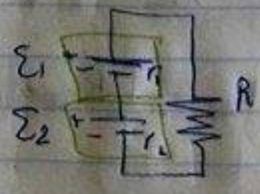
$1.5 \times 10^{-3} = \frac{3 - 2}{6 + R}$



$6 + R = 666.67$
$R = 660.67\ \Omega$

(b) $P = I^2 R$
$= (1.5 \times 10^{-3})^2 \times 660.67$
$= 1.5 \times 10^{-3}$ watt

(17)



$\mathcal{E}_1 = 12\ V \quad \mathcal{E}_2 = 12V$

$r_1 = 0.016\ \Omega \quad r_2 = 0.012\ \Omega$

$$I = \frac{\varepsilon_1 + \varepsilon_2}{R + r_1 + r_2}$$

$$IR + \cancel{I r_1} + I r_2 = \cancel{\varepsilon_1} + \varepsilon_2$$

$$I(R + r_2) = \varepsilon_2$$

$$750(R + 0.012) = 12$$

$$R = 0.004\ \Omega$$

$r_1 > r_2$

$\varepsilon_1 - I r_1 = 0$

$\varepsilon_1 = I r_1$

$I = \frac{\varepsilon_1}{r_1} = \frac{12}{0.016} = 750\text{A}$

اللي معرفش تصنيع صحيح

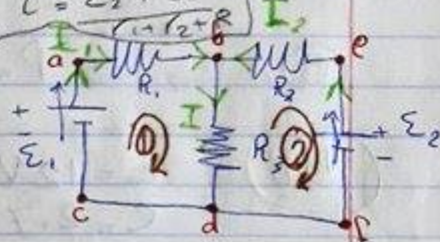
ها كتبها في داخلها

$$\boxed{\begin{array}{l} \varepsilon_1 = i r_1 \\ i = \dfrac{\varepsilon_2 + \varepsilon_1}{r_1 + r_2 + R} \end{array}}$$

b) ε_1 since $r_1 > r_2$

41) $\varepsilon_1 = 3V \quad \varepsilon_2 = 1\ V$

$R_1 = 4\ \Omega \quad R_2 = 2\ \Omega \quad R_3 = 5\ \Omega$



① $\sum V_{abcda} = 0$

$$3 - 4I_1 - 5I_3 = 0$$

$$4I_1 + 5I_3 = 3 \text{ — ①}$$

② $\sum V_{befdb} = 0$

$$2I_2 - 1 + 5I_3 = 0$$

$$2I_2 + 5I_3 = 1 \text{ — ②}$$

at point b $\quad I_1 + I_2 = I_3$ —— ③

1 − 2 $\quad (4I_1 - 2I_2 = 2)^{\times 5}$

3 in 2 $\quad (7I_2 + 5I_1 = 1)^{\times -4}$

$$20I_1 - 10I_2 = 10$$

$$-28I_2 - 20I_1 = -4$$

$$-38I_2 = 6$$

$\boxed{I_2 = -0.158\ A}$

$-7\times(9I_1 + 5I_2 = 3)$

$5(7I_2 + 5I_1 = 1)$

$-63I_1 - \cancel{35I_2} = 21 -$

$\cancel{35I_2} + 25I_1 = 5$

$-38I_1 = -16$

$I_1 = 0.421$

$I_2 = 3 - 9I_1$

$= 0.158$

$20I_1 - 10(-0.158) = 10$

$\boxed{I_1 = 0.421 \text{ Amp}}$

$I_3 = 0.421 + -0.158 = 0.263 \text{ A}$

(a) $P_{R_1} = I_1^2 R_1 = (0.421)^2 (4) = 0.7089$ watt

(b) $P_{R_2} = R_2 I_2^2 = 2(0.158)^2 = 0.05$ watt

(c) $P_{R_3} = R_3 I_3^2 = 5(0.263)^2 = 0.346$ watt

(d) $\varepsilon_1 \Rightarrow P = \varepsilon_1 I_1 = 1.263$ watt $\qquad P = iV$

(e) $\varepsilon_2 \Rightarrow P = \varepsilon_2 I_2 = -0.158$ watt $\qquad P = i$

$P = iV - i_2^2 r_2$ [illegible]

(58) $\varepsilon = 12 V \qquad R = 1.4 M\Omega$

$C = 2.7 \mu F$

(a) $\tau = RC = 1.4 \times 10^6 \times 2.7 \times 10^{-6}$

$= 3.78$ sec

(b) $q_{max} = \varepsilon C$

$= 12(2.7 \times 10^{-6})$

$= 32.4 \mu C$

(c) $Q(t) = \varepsilon C(1 - e^{-t/\tau})$

$16 \times 10^{-6} = 12(2.7 \times 10^{-6})(1 - e^{-t/\tau})$

$0.49 = 1 - e^{-t/\tau}$

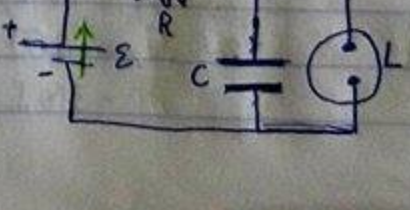
$+0.51 = +e^{-t/\tau}$

$\frac{-t}{\tau} = \ln 0.51$

$\frac{-t}{3.78} = -0.673 \qquad t = 2.54 \text{ sec}$

(62) $\varepsilon = 95 V \qquad C = 0.15 \mu F$

$V_L = 75 V$



$Q(t) = C\mathcal{E}(1-e^{-t/RC}) \rightarrow V_c = \frac{Q(t)}{C}$

$I(t) = \frac{\mathcal{E}}{R} e^{-t/RC}$

$V(t) = \mathcal{E}(1-e^{-t/RC})$

2 flashes per second
for 1 flashe → 0.5 sec

$V_L = \mathcal{E}(1-e^{-t/RC})$

$75 = 95(1-e^{-t/RC})$

$0.79 = 1-e^{-t/RC}$

$e^{-t/RC} = 0.21$

t for one flash = 0.5 s

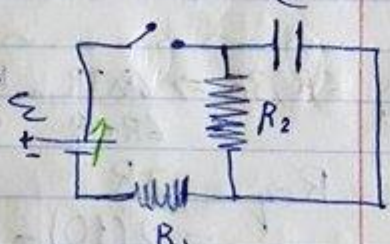
$\frac{-t}{RC} = \ln 0.21$

$R = \frac{-0.5}{-1.56(0.15\times10^{-6})}$

$= 2.137 \times 10^{6}\ \Omega$

65 $R_1 = 10\ K\Omega$ $R_2 = 15\ K\Omega$

$C = 0.4\ \mu F$ $\mathcal{E} = 20\ V$ $t = 4ms$



steady state ⇒ $V_{R_2} = V_c$

$I_{max} = \frac{\mathcal{E}}{R_1+R_2} = \frac{20}{25\times10^3} = 0.8\times10^{-3}$ Amp

$V_{R_2} = I R_2 = 0.8\times10^{-3} \times 15\times10^{3} = 12\ V$ $V_c = 12\ V$

⇒ switch opened (Discharging) $\left(\frac{q(t) = q_0 e^{-t/RC}}{C}\right) \Rightarrow V(t) = V_0\ e^{-t/RC}$

$V(4) = 12 e^{-4\times10^{-3}/(15\times10^3\times0.4\times10^{-6})}$

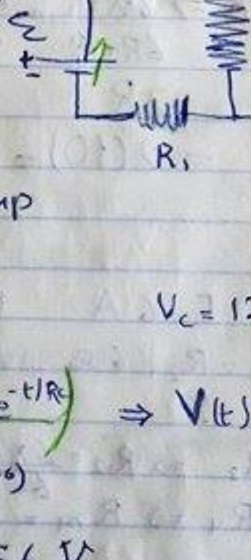
$= 12(0.513) = 6.156\ V$

$I = \frac{V}{R} = \frac{6.156}{15000} = 4.104\times10^{-4}$ Amp

Additional problems:

78 $\mathcal{E} = 5\ V$ $r = 2\ \Omega$

$R_1 = 5\ \Omega$ $R_2 = 4\ \Omega$ $R_A = 0.1\ \Omega$

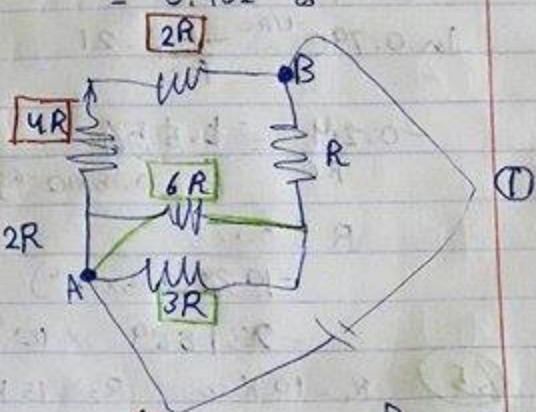


$$I = \frac{\mathcal{E}}{r + R_1 + R_2 + R_A} = 0.4504\,A$$

$$I = \frac{\mathcal{E}}{r + R_1 + R_2} = 0.4545$$

$$E = \frac{\Delta I}{I} = \frac{0.4545 - 0.4504}{0.4545} = 9.02 \times 10^{-3} = 0.902\ \%$$

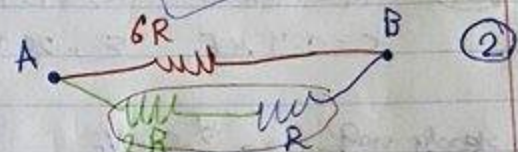
89) $R = 10\ \Omega$



① $2R, 4R \Rightarrow 2R + 4R = 6R$

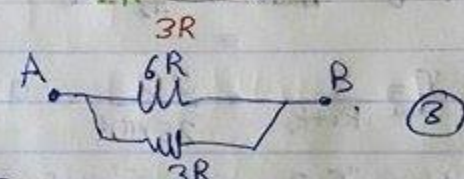
$6R, 3R \Rightarrow \frac{6R \times 3R}{6R + 3R} = \frac{18R^2}{9R} = 2R$

② $2R, R \Rightarrow 2R + R = 3R$



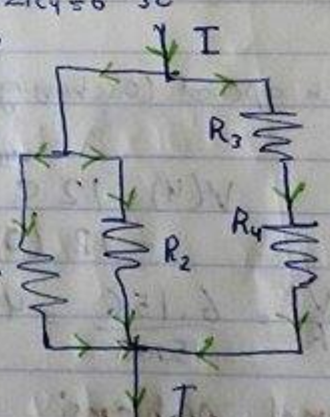
③ $6R, 3R \Rightarrow \frac{6R \times 3R}{6R + 3R} = \frac{18R^2}{9R}$

$$R_{eq} = 2R = 2(10) = 20\ \Omega$$



92) $I = 6\,A$ $\quad R_1 = R_2 = 2R_3 = 2R_4 = 6\ \Omega$

$R_1 = R_2 = 6\ \Omega \quad R_3 = R_4 = 3\ \Omega$



$R_1, R_2 \Rightarrow R_{12} = \frac{6 \times 6}{6 + 6} = \frac{36}{12} = 3\ \Omega$

$R_3, R_4 \Rightarrow R_{34} = 3 + 3 = 6\ \Omega$

$R_{12}, R_{34} \Rightarrow R_{eq} = \frac{6 \times 3}{6 + 3} = 2\ \Omega$

$V_{eq} = I\,R_{eq} = 6 \times 2 = 12\ V$

$$I_{12} = \frac{V}{R_{12}} = \frac{12}{3} = 4\,A \qquad I_1 = \frac{V_1}{R_1} = \frac{12}{6} = 2\,A$$

ch 28:

(5) e , $B = B_x \hat{i} + 3B_x \hat{j}$

$V = 2\hat{i} + 4\hat{j}$

$F = 6.4 \times 10^{-19}\ N\ \hat{k}$

$$\vec{F} = q\vec{V} \times \vec{B}$$

$$6.4 \times 10^{-19}\hat{k} = -1.6 \times 10^{-19} (2\hat{i} + 4\hat{j}) \times (B_x\hat{i} + 3B_x\hat{j})$$

$$-4\hat{k} = 6B_x\hat{k} + -4B_x\hat{k}$$

$$-4\hat{k} = 2B_x\hat{k}$$

$$B_x = -2 \text{ tesla}$$

(7) $V_i = 12\hat{j} + 15\hat{k}$ km/s $*1000$

$a = 2 \times 10^{12}\ m/s^2\ \hat{i}$

$B = 400\,\mu T\ \hat{i}$ $*10^{-6}$

$\vec{V} \times \vec{B} = (12\hat{j} - 15\hat{k})(400\hat{i})$
$= -4800\hat{k} + 6000\hat{j}$
$= (-4.8\hat{k} + 6.0\hat{j}) \times 10^{-4}$
$\times 10^{3}$
$= -4.8\hat{k} + 6\hat{j}$

$$F_{net} = F_E + F_B = ma$$

$$q\vec{E} + q(\vec{V} \times \vec{B}) = ma$$

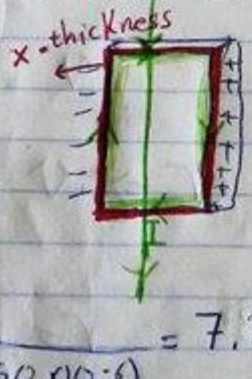
$$-1.6 \times 10^{-19} (\vec{E} + -4.8\hat{k} - 6\hat{j}) = 9.11 \times 10^{-31} (2 \times 10^{12})\hat{i}$$

$$\vec{E} + (-4.8\hat{k} + 6\hat{j}) = -11.387\hat{i}$$

$$\vec{E} = -11.387\hat{i} - 6\hat{j} + 4.8\hat{k} \quad N/C \text{ or } V/m$$

(13) $\vec{B} = 0.65\,T$, $i = 23\,A$, $n = 8.47 \times 10^{28}\ e/m^3$

$x = 150\,\mu m$ $y = 4.5\,mm$



$$n = \frac{IB}{eVl}$$

$$V = \frac{iB}{nel}$$

$$= \frac{(23)(0.65)}{(8.47 \times 10^{28})(1.6 \times 10^{-19})(150 \times 10^{-6})} = 7.35 \times 10^{-6}\ V$$

(17) $q = +2e$ mass $= 4\,u$ $u = 1.661 \times 10^{-27}$ kg

$r = 4.5\ cm$ $B = 1.2\ T$

(a) $\frac{mV^2}{r} = qBV$

$V = \frac{rqB}{m}$

$= \frac{(4.5 \times 10^{-2})\ 2 \times 1.6 \times 10^{-19} \times 1.2}{4\ (1.661 \times 10^{-27})}$

$= 2600842.86$

$\approx 2.6 \times 10^{6}\ m/s$

(b) $T = \frac{2\pi r}{V}$

$= 1.087 \times 10^{-7}$ sec.

(c) $K_E = \frac{1}{2} m V^2$

$= 2.246 \times 10^{-14}\ J$

$= \frac{2.246 \times 10^{-14}}{1.6 \times 10^{-19}} = 140354.5 = 1.4 \times 10^{5}\ eV$

(d) $K = \frac{1}{2} mV^2 = qV$

$V = \frac{K\,(eV)}{2e} = \frac{K}{2} \cong 7 \times 10^{4}\ V$

or $\Rightarrow V = \frac{K(J)}{2e} = \frac{2.246 \times 10^{-14}}{2(1.6 \times 10^{-19})} = 7 \times 10^{4}\ V$

(23) $r = \frac{mV}{qB}$

$V = 1.3 \times 10^{6}\ m/s$
$r = 0.35\ m$
$m = 9.11 \times 10^{-31}\ Kg$
$q = 1.6 \times 10^{-19}\ C$

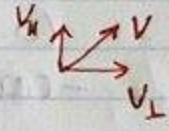
$B = \frac{mV}{qr} = 2.11 \times 10^{-5}\ T$

(29) $B = 0.3\,T$ $\quad \Delta y = 6\,\mu m$ $\quad F = 2\times10^{-15}\,N$

Helical
$V_{\parallel}$ $\quad V_{\perp}$

$\Delta y = V_{\parallel} T$

$\Delta y = V_{\parallel}\left(\dfrac{2\pi m}{qB}\right)$



$6\times10^{-6} = V_{\parallel}\left(\dfrac{2\pi\ 9.11\times10^{-31}}{1.6\times10^{-19}\times0.3}\right)$

$V_{\parallel} = 50340.146$ m/s

$= 50.3$ Km/s

$F = qV_{\perp}B$

$2\times10^{-15} = 1.6\times10^{-19}\ V_{\perp}\times0.3$

$V_{\perp} = 41666.67$ m/s

$= 41.7$ Km/s

$V = \sqrt{V_{\perp}^2 + V_{\parallel}^2} = 65.3$ Km/s

(42) $l = 2$ $\quad \theta = 60$ $\quad i = 3.5\,A$

(a) $4\hat{k}$ T?

$F_{Bx} = 0$ from symmetry

$F_{B_1} = i L B \sin\theta$

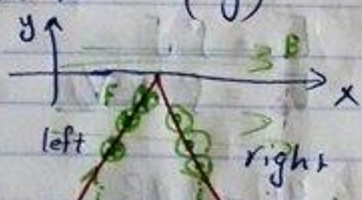
$= 3.5(2)(4)\sin 30 \rightarrow y\text{-}B$

$= 14\ N$ for L_1

for the wire $\Rightarrow F_B = 2F_{B_1} = 28\ N$ $\quad (+\hat{j})$

(b) $F_B = \underset{(-\hat{k})}{F_{B\,left}} + \underset{(+\hat{k})}{F_{B\,right}}$

$= 0$



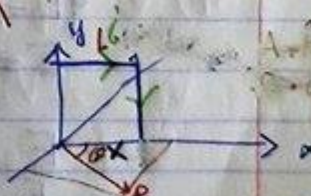
(49) 20 turns $\quad$ 10 cm – 5 cm $\quad$ (L, x)

$i = 0.1\,A$ $\quad \theta = 30$ $\quad B = 0.5\,T$

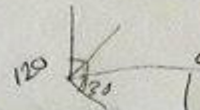
$\tau = NiBA = \vec{M}\times\vec{B}$

$\vec{M} = Ni\vec{A}$

$= 20\times0.1\times10\times10^{-2}\times5\times10^{-2}$



$B\times A = \hat{k}\times\hat{i}$
$= -\hat{j}$



or

$\vec{M} = 0.01\,(-\hat{k})$

$\vec{B} = 0.5\cos 30\,\hat{i} + 0.5\sin 30\,\hat{k}$

$= 0.43\hat{i} + 0.25\hat{k}$ tesla

$\tau = \vec{M} \times \vec{B}$

$= MB\sin 120^\circ$

$= NIAB\sin 120$

$= 20\,(0.1)(0.5)$

$= -4.3\times10^{-3}$

$\vec{\tau} = (0.01\,{-\hat{k}}) \times (0.43\hat{i} + 0.25\hat{k})$

$= -0.0043\,\hat{j}$

(66) $q = +e$, m, $B = B\hat{i}$, $V_0 = V_{0x}\hat{i} + V_{0y}\hat{j}$

$F = q\,\vec{V}\times\vec{B}$ $\qquad \vec{V} = V_x\hat{i} + V_y\hat{j} + V_z\hat{k}$

$= q\,(V_x\hat{i} + V_y\hat{j} + V_z\hat{k}) \times (B\hat{i})$

$= q\,(V_zB\hat{j} - V_yB\hat{k})$

$$\boxed{F_b = q\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ V_x & V_y & V_z \\ B & 0 & 0 \end{vmatrix} = q\,[V_zB\hat{j} - V_yB\hat{k}]}$$

$F = q(V_zB\hat{j} - V_yB\hat{k}) = ma = m\left(\frac{dV_x}{dt}\hat{i} + \frac{dV_y}{dt}\hat{j} + \frac{dV_z}{dt}\hat{k}\right)$

* $\frac{dV_x}{dt} = 0 \Rightarrow V_x = \text{constant} = V_{0x}$
* $\frac{dV_y}{dt} = \frac{q}{m}BV_z \Rightarrow \frac{d^2V_y}{dt^2} = \omega\frac{dV_z}{dt} = -\omega^2 V_y$
* $\frac{dV_z}{dt} = \frac{-q}{m}BV_y$

$V_y(t) = A\sin(\omega t) + B\cos(\omega t) \Rightarrow V_y(t) = V_{y0}\cos$

$V(t) = V_{0x}\hat{i} + V_{0y}\cos(\omega t)\hat{j} - V_{0y}\sin(\omega t)\hat{k}$

(78)

(a) $\frac{E}{E_c} = \frac{B}{ne\rho}$ $\qquad \rho$ resistivity

$E_c = \rho J$

$E_c = \rho neV_d$ — (1)

$qE = qVB$

$E = VB$ — (2)

$\frac{E}{E_c} = \frac{VB}{\rho neV_d} \Rightarrow \frac{E}{E_c} = \frac{B}{\rho ne}$

(b) $\frac{E}{E_c} = \frac{B}{\rho e n}$

$= \frac{0.65}{(1.69 \times 10^{-8})(1.6 \times 10^{-19})(8.47 \times 10^{28})}$

$= 2.838 \times 10^{-3}$

Additional problems:

(67) $r = 15$ cm $N = 6$ turns, $i = 2$ A, $B = 70$ mT

(b) $\tau = |\vec{M} \times \vec{B}|$ $M = NiA$

$= 6\,(2)\,(r^2 \pi)\; 70 \times 10^{-3} \sin 90$  τ عمودي على B يعني عمودي

$= 0.84\,(15 \times 10^{-2})^2\, \pi$

$= 0.059346$ (a) after 15 minutes

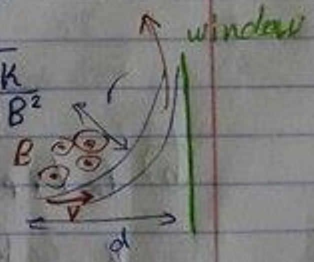
$\approx 5.9 \times 10^{-2}$ N.m

(72) (a) $F = qvB = e\, V \times B$ let B be $\perp$ to V

$F = \frac{mV^2}{r}$

$eVB = \frac{mV^2}{r}$ $K = \frac{1}{2} mV^2$

$r = \frac{mV}{eB} \Rightarrow$ but $V = \sqrt{\frac{2K}{m}}$



$r = \frac{m}{eB}\sqrt{\frac{2K}{m}} = \sqrt{\frac{m^{\cancel{2}}\, 2K}{e^2 B^2\, \cancel{m}}} = \sqrt{\frac{2mK}{e^2 B^2}}$

to prevent the beam from hitting the plate r must be less than d

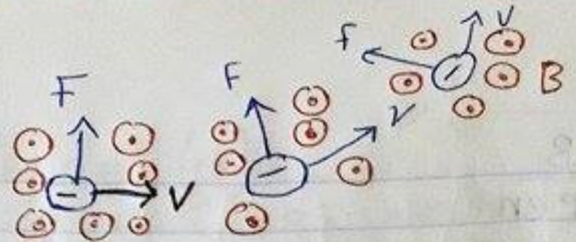
$r \le d$ $\sqrt{\frac{2mK}{e^2 B^2}} \le d$

$\frac{1}{B}\sqrt{\frac{2mK}{e^2}} \le d$

$\frac{1}{d}\sqrt{\frac{2mK}{e^2}} \le B$

$\sqrt{\frac{2mK}{e^2 d^2}} \le B$

(b)



B is outward ⊙

(75) $d \Rightarrow q = +e \quad m = 2u$, $\alpha \Rightarrow q = +2e \quad m = 4u$

$p \Rightarrow q = +e \quad m = 1u$

$K_d = K_\alpha = K_p$

let $m_p = M$
$m_d = 2M$
$m_\alpha = 4M$

(a) r_d / r_α?

$K_d = K_\alpha$

$\cancel{\frac{1}{2}}(2M) V_d^2 = \cancel{\frac{1}{2}}(4M) V_\alpha^2$

$V_d^2 = 2 V_\alpha^2 \Rightarrow V_d = \sqrt{2} V_\alpha$

$\frac{mV^2}{r} = qVB$

$r = \frac{mV}{qB}$

$\frac{r_d}{r_\alpha} = \frac{m_d V_d}{q_d B} \cdot \frac{q_\alpha B}{m_\alpha V_\alpha}$

$= \frac{(2M)\sqrt{2}\cancel{V_\alpha}}{\cancel{e}\cancel{B}} \cdot \frac{2\cancel{e}\cancel{B}}{(4M)\cancel{V_\alpha}}$

$\boxed{\frac{r_d}{r_\alpha} = \sqrt{2} = 1.4}$

(b) r_α / r_p?

$K_\alpha = K_p$

$\cancel{\frac{1}{2}}(4M) V_\alpha^2 = \cancel{\frac{1}{2}} M V_p^2$

$V_p = 2 V_\alpha$

$\frac{r_\alpha}{r_p} = \frac{m_\alpha V_\alpha}{q_\alpha B} \cdot \frac{q_p B}{m_p V_p} = \frac{4M \cancel{V_\alpha}}{2\cancel{e} \cancel{B}} \cdot \frac{\cancel{e}\cancel{B}}{M\, 2\cancel{V_\alpha}}$

$\boxed{\frac{r_\alpha}{r_p} = 1}$

(85) $V = -2\hat{i} + 4\hat{j} - 6\hat{k}$ m/s $B = 2\hat{i} - 4\hat{j} + 8\hat{k}$ mT

(a) $\vec{F} = q\, \vec{V} \times \vec{B}$

$= q\,(-2\hat{i} + 4\hat{j} - 6K) \times (2\hat{i} - 4\hat{j} + 8K) \times 10^{-3}$

$= 1.6 \times 10^{-19} (8\hat{i} + 4\hat{j}) \times 10^{-3}$

$= 12.8 \times 10^{-22}\,\hat{i} + 6.4 \times 10^{-22}\,\hat{j}$ (N)

$\vec{V} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2 & 4 & -6 \\ 2 & -4 & 8 \end{vmatrix}$

$= (32 - 24)\hat{i} - (-16 - -12)\hat{j} + (8 - 8)\hat{k}$

$= 8\hat{i} + 4\hat{j}$

(b) $V \perp F$ the angle $= 90°$

or $V.F = |V||F| \cos\theta$

$\cos\theta = \dfrac{V.F}{|V||F|} = \dfrac{(-25.6 + 25.6) \times 10^{-22}}{|V|\,|F|} = 0$

$\cos\theta = 0$ $\theta = 90°$

(c) V, B

$V.B = |V|\,|B| \cos\theta$

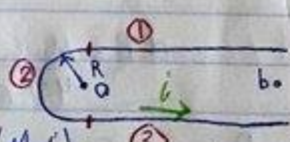
$\cos\theta = \dfrac{V.B}{|V||B|} = \dfrac{(-2\hat{i} + 4\hat{j} - 6\hat{k})\,(2\hat{i} - 4\hat{j} + 8\hat{k}) \times 10^{-3}}{\sqrt{2^2 + 4^2 + 6^2}\ \sqrt{2^2 + 4^2 + 8^2} \times 10^{-3}}$

$= \dfrac{-4 - 16 - 48}{\sqrt{56}\ \sqrt{84}} = \dfrac{-68}{\sqrt{56}\ \sqrt{84}} = \dfrac{-68}{68.6} \approx -1$

$\cos\theta = -1$ $\theta = 180°$

Ch29:

(5) $i = 10$ A $R = 5\,mm = 5 \times 10^{-3}\,m$



(a) $\vec{B}_{at\,a} = \vec{B}_1 + \vec{B}_2 + \vec{B}_3$

$= \frac{1}{2}\left(\dfrac{\mu_0 i}{2\pi R}\right) + \dfrac{\mu_0 i\,(\pi)}{4\pi R} + \frac{1}{2}\left(\dfrac{\mu_0 i}{2R}\right)$

$= \dfrac{\mu_0 i}{2\pi R} + \dfrac{\mu_0 i}{4R} = 4 \times 10^{-4} + 6.28 \times 10^{-4}$ $\mu_0 = 4\pi \times 10^{-7}\ \frac{T.m}{A}$

$= 10.28 \times 10^{-4}$

$\approx 1 \times 10^{-3}$ T   (b) outward

(a) $\vec{B}_{at\ b} = \vec{B}_1 + \vec{B}_3$

$$= \left(\frac{\mu_0 i}{2\pi R}\right) + \left(\frac{\mu_0 i}{2\pi R}\right)$$

$$= \frac{\mu_0 i}{\pi R} = 8 \times 10^{-4}\ T$$

we suppose that the distance between a and b is 10 times larger than R so B is produced from 2 infinite wires and we can ignore the effect of the semi-circle

(b) outward

(7) $a = 13.5$ cm $\quad b = 10.7$ cm

$\theta = 74 \quad i = 0.411$ A

(a) $\vec{B}_{at\ p} = \cancel{\vec{B}_{mi}} + \vec{B}_{mo} + \cancel{\vec{B}_{on}} + \vec{B}_{ni}$

$$= \frac{\mu_0 i (0.41\pi)}{4\pi\ a}(-\hat{k}) + \frac{\mu_0 i (0.41\pi)}{4\pi\ b}(\hat{k})$$

$\theta = \frac{74}{180} \times \pi = 0.41\pi$

$$= \frac{\mu_0 i (0.41\pi)}{4\pi}\left(\frac{-1}{a} + \frac{1}{b}\right)\hat{k}$$

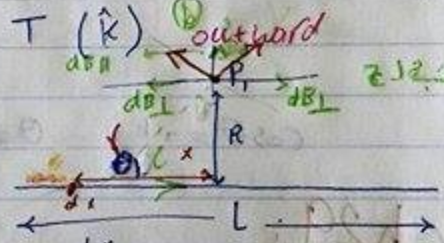
$$= \frac{\cancel{4\pi} \times 10^{-7}\ (0.411)\ (0.41\pi)}{\cancel{4\pi}}\left(\frac{-1}{13.5 \times 10^{-2}} + \frac{1}{10.7 \times 10^{-2}}\right)$$

$$= 1.029 \times 10^{-7}\ T\ (\hat{k})$$

(b) outward

(13) $R = 13.1$ cm $\quad L = 18$ cm

$i = 58.2$ mA



$$dB = \frac{\mu_0 i\ \hat{r} \times d\vec{s}}{4\pi r^2}$$

$\hat{r} = 1$

$B_\perp = 0$ from symmetry

$$B_\parallel = \int \frac{\mu_0 i \sin\theta}{4\pi r^2} dx$$

$r^2 = x^2 + R^2$

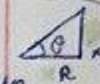
$\sin\theta = \frac{R}{\sqrt{x^2 + R^2}}$

$$= \frac{\mu_0 i}{4\pi}\int_{-L/2}^{L/2} \frac{\cancel{x}\, R}{(x^2 + R^2)^{3/2}}\, dx$$

يمكن حل التكامل بهذه الطريقة

$x = R\tan\theta$

$dx = R\sec^2\theta\, d\theta$



$\int \frac{dx}{(x^2+R^2)^{3/2}} = \int \frac{R\sec^2\theta\, d\theta}{((R\tan\theta)^2+R^2)^{3/2}}$

$= \int \frac{\cancel{R}\sec^2\theta\, d\theta}{R^3(\tan^2\theta+1)^{3/2}} = \int \frac{\sec^2\theta\, d\theta}{R^2 \sec^3\theta}$

$\frac{1}{R^2}\int \frac{d\theta}{\sec\theta} = \frac{1}{R^2}\int \cos\theta\, d\theta$

$= \frac{1}{R^2}\sin\theta$

$= \frac{1}{R^2}\frac{x}{\sqrt{x^2+R^2}}$

$$= \frac{\mu_0 i R}{4\pi}\int_{-L/2}^{L/2} \frac{dx}{(x^2+R^2)^{3/2}}$$

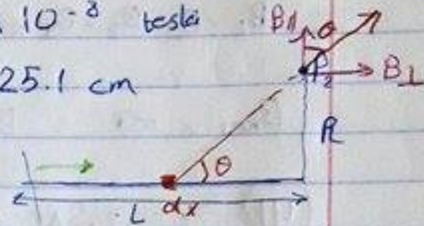
$$= \frac{\mu_0 i R}{4\pi}\left.\frac{1}{R^2}\frac{x}{(x^2+R^2)^{1/2}}\right]_{-L/2}^{L/2}$$

$$= \frac{\mu_0 i}{4\pi R}\left(\frac{L/2}{(L^2/4+R^2)^{1/2}} - \frac{-L/2}{(L^2/4+R^2)^{1/2}}\right) = \frac{\mu_0 i}{4\pi R}\frac{L}{(L^2/4+R^2)^{1/2}}$$

$$= \frac{4\pi 10^{-7} \times 58.2\times10^{-3} \times .18}{4\pi\,(.131)\,((.18)^2/4 + (.131)^2)^{1/2}}$$

$$= 5.03 \times 10^{-8} \text{ tesla}$$

(17) $L = 13.6$ cm, $i = 0.693$ A, $R = 25.1$ cm



$$B_{\perp} = \int_0^L \frac{\mu_0 i \sin\theta\, dr}{4\pi r^2}$$

$$= \frac{\mu_0 i}{4\pi}\int_{-L}^{0}\frac{\sin\theta\, dr}{r^2}$$

$$= \frac{4\pi\times10^{-7} i}{4\pi}\int_{-L}^{0}\frac{R\, dx}{(x^2+R^2)^{3/2}}$$

$$= 10^{-7} i R \int_{-L}^{0}\frac{dx}{(x^2+R^2)^{3/2}}$$

$$= 10^{-7} i R \left.\frac{1}{R^2}\frac{x}{(x^2+R^2)^{1/2}}\right]_{-L}^{0}$$

$$= 10^{-7}\frac{i}{R}\left(\frac{0}{R} - \frac{-L}{(L^2+R^2)^{1/2}}\right)$$

$$= 10^{-7}\left(\frac{0.693}{0.251}\right)\left(\frac{0.136}{((0.136)^2+(0.251)^2)^{1/2}}\right)$$

$$= 1.315 \times 10^{-7} \text{ tesla}$$

$dr = dx$

$\sin\theta = \frac{R}{r} = \frac{R}{\sqrt{x^2+R^2}}$

$r^2 = x^2 + R^2$

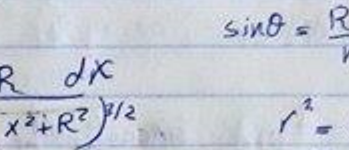
$2r\,dr = 2x\,dx$

$dr = \frac{2x}{2r}dx$

(23) $V_p = -200$ m/s $\hat{j}$

$i = 350$ mA

$d = 2.89$ cm



$F = q\vec{V}\times\vec{B}$

$= 1.6\times10^{-19}(-200\,\hat{j} \times 2.422\times10^{-6}\,\hat{k})$

$= -7.75 \times 10^{-23}\ (\hat{i})$ (N)

$B = \frac{\mu_0 i}{2\pi d} = \frac{\cancel{4\pi}^{\,2}\times10^{-7}(350\times10^{-3})}{\cancel{2\pi}(2.89\times10^{-2})}$

$= 2.422 \times 10^{-6}$ Tesla

outward at C ($\hat{k}$)

(29) $a = 20\ cm$

1, 4 out of the page

2, 3 into the page

$i = 20 A$

$$a^2 + a^2 = (2d)^2$$

$$2a^2 = 4d^2$$

$$d = \sqrt{\frac{a^2}{2}} = \frac{a}{\sqrt{2}} = \frac{20 \times 10^{-2}}{\sqrt{2}} = 0.14\ m$$

$$B_1 = B_2 = B_3 = B_4 = \frac{\mu_0 i}{2\pi d} = \frac{10^{-7} \times 4\pi \times 20}{2\pi\ (0.14)} = 2.857 \times 10^{-5}\ T$$

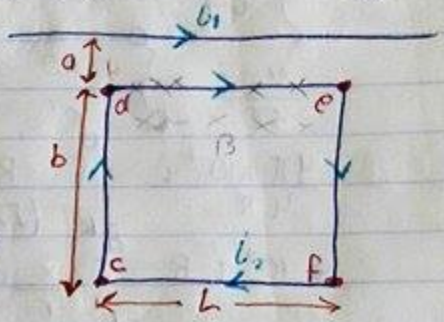
$B_{net\ x} = 0 \qquad B_{net\ y} = 4 B_1 \cos 45$

$$= 8.08 \times 10^{-5}\ \text{Tesla}\ (\hat{j})$$

(41) $i_1 = 30\ A$, $i_2 = 20\ A$

$a = 1\ cm \quad b = 8\ cm$

$L = 30\ cm$



$F_{cd} = F_{ef}$ since $B_{cd} = B_{ef}$

يحل على التكامل على طول القطعة من d الى c : B ← ⊗ , F ← $-i$

من e الى f : B ← ⊙ , F ← $+i$

$$F_{de} = \frac{\mu_0 i_1 i_2 L}{2\pi r} = \frac{\mu_0 i_1 i_2 L}{2\pi a}\ (+\hat{j})\ N$$

$$F_{cf} = \frac{\mu_0 i_1 i_2 L}{2\pi r} = \frac{\mu_0 i_1 i_2 L}{2\pi\ (a+d)}\ (-\hat{j})$$

$$F_{net} = F_{de} + F_{cf} + \cancel{F_{cd}} + \cancel{F_{ef}} = \frac{\mu_0 i_1 i_2 L}{2\pi a}\ \hat{j} + \frac{\mu_0 i_1 i_2 L}{2\pi (a+d)} (-\hat{j})$$

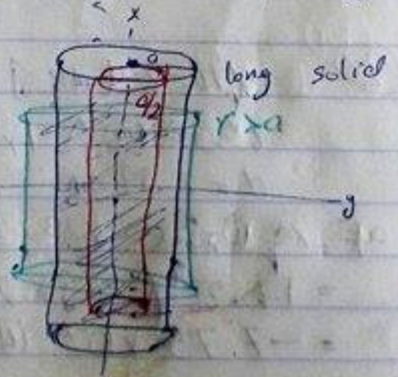
$$= 3.6 \times 10^{-3}\ \hat{j} - 4 \times 10^{-4}\ \hat{j} = 3.2 \times 10^{-3}\ \hat{j}$$

(47) $J = J_0 \frac{r}{a}$ $\qquad a = 3.1\ mm$

$J_0 = 310\ A/m^2$

long solid

$$B = \frac{\mu_0 i_{enc}}{2\pi r}$$



$$i_{enc} = \int_0^r \vec{J} \cdot d\vec{A} \qquad A = \pi r^2 \quad dA = 2\pi r\, dr$$

$$= \int_0^r J_0 \frac{r}{a}\ 2\pi r\ dr\ \cos 0$$

$$= \frac{J_0}{a} 2\pi \int_0^r r^2 dr = \frac{J_0}{a} 2\pi \frac{r^3}{3} = \frac{2 J_0 \pi r^3}{3 a}$$

ⓐ $r = 0 \Rightarrow i_{enc} = \frac{2 J_0}{3 a} \pi r^3 = 0 \Rightarrow B = \frac{\mu_0 i_{enc}}{2\pi r} = 0$

ⓑ $r = a/2 \Rightarrow i_{enc} = \frac{2}{3} \frac{J_0}{a} \pi \left(\frac{a}{2}\right)^3$

$$= \frac{J_0 \pi a^2}{3 (4)} = 7.79 \times 10^{-4} A$$

$$B = \frac{\mu_0 i_{enc}}{2\pi r} = \frac{4\cancel{\pi} \times 10^{-7} (7.79 \times 10^{-4})}{2\cancel{\pi} \left(\frac{3.1 \times 10^{-2}}{2}\right)} = 1.005 \times 10^{-7} \text{ tesla}$$

ⓒ $r = a \Rightarrow i_{enc} = \frac{2 J_0 \pi r^3}{3 a}$

$$= \frac{2 J_0 \pi a^{\cancel{3}\, 2}}{3 \cancel{a}} = 6.24 \times 10^{-3} A$$

$$B = \frac{\mu_0 i_{enc}}{2\pi r} = \frac{\overset{2}{4\pi} \times 10^{-7} (6.24 \times 10^{-3})}{2\pi (3.1 \times 10^{-2})} = 4.03 \times 10^{-7} \text{ tesla}$$

*ملاحظة: إذا طلب B على مسافة > a يتم تكامل التيار على الفترة 0 ← a حيث يتواجد التيار و تعوض المسافة المعطاة في قانون B بدل r

مثال B at $r = 2a$

$i_{enc} = \frac{2 J_0 \pi r^3}{3 a}$ → a ← 0 لا يوجد تيار خارج

$B = \frac{\mu_0 i_{enc}}{2\pi r}$ → 2a ← بعد النقطة عن المركز

(57)

$N = 300$ turns

$d = 5 \text{ cm} \rightarrow r = 2.5 \times 10^{-2}$ m $\qquad B = 5 \mu T$

$i = 4$ A

ⓐ $\vec{\mu} = NI A = NI \pi r^2$

$$= 300 (4) \pi (2.5 \times 10^{-2})^2$$

$$= 2.355 \text{ A.m}^2$$

ⓑ $B = \frac{N \mu_0 I R \, 2\pi R}{2 \, 4\pi (R^2 + z^2)^{3/2}}$ $\qquad A = \pi R^2 \qquad \vec{\mu} = N I A$

$5 \times 10^{-6} = \frac{\mu_0 \vec{\mu}}{2\pi z^3}$ $\qquad \boxed{\begin{matrix} z >> d \\ z >> R \end{matrix}}$

$$5\times10^{-6} = \frac{\cancel{4}^{\,2}\pi\times10^{-7}(2.355)}{\cancel{2\pi}\, z^3}$$

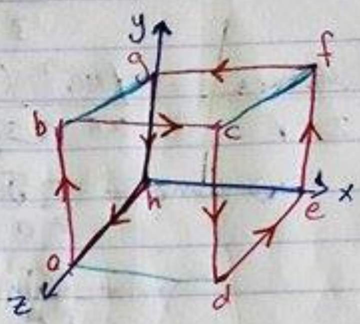
$$z^3 = \frac{2\times2.355\times10^{-7}}{5\times10^{-6}} = 0.0942$$

$$z = \sqrt[3]{0.0942} = 0.455 \text{ m}$$

$$z = 45.5 \text{ cm}$$

(63)

$I = 6\,A$ Length = 10 cm



(a) $\vec{\mu} = NIA$

① $\vec{\mu}_{bcfgb} = (1)(6)(0.1)^2$

$= 0.06 \text{ A.m}^2\ \hat{j}$

② $\vec{\mu}_{abgha} = (1)(6)(0.1)^2$

$= 0.06 \text{ A.m}^2\ -\hat{i}$

③ $\vec{\mu}_{cdefc} = (1)(6)(0.1)^2$

$= 0.06 \text{ A.m}^2\ +\hat{i}$

$\vec{\mu}_{net} = \vec{\mu}_{①} + \vec{\mu}_{②} + \vec{\mu}_{③}$

$= 0.06\,\hat{j} + \cancel{0.06(-\hat{i})} + \cancel{0.06\,\hat{i}}$

$= 0.06\,\hat{j}$

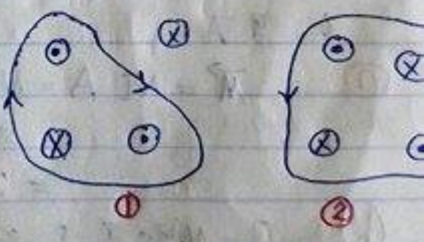
(b) $\vec{B}_{net}$ at $(0, 5\,m, 0)$

$5\,m >> 0.1\,m$

$$B = \frac{\mu_0 \mu}{2\pi d^3} = \frac{\cancel{4}^{\,2}\pi\times10^{-7}\times0.06}{\cancel{2\pi}\,(5)^3} = 9.6\times10^{-11}\ T$$

Additional problems:

(45)



(a) $I = 2\,A$

$\oint \vec{B}\cdot d\vec{s} = \mu_0 I_{enc}$

$= \mu_0(2-2-2)$

$= \mu_0(-2)$

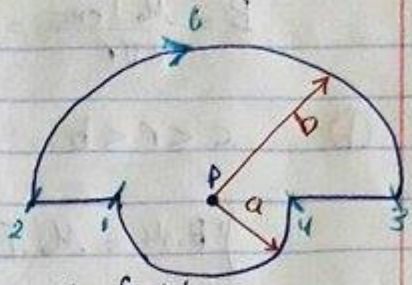
$= 4\pi\times10^{-7}(-2) = -25.12\times10^{-7}\ T.m$

(b) $\oint \vec{B}\cdot d\vec{s} = \mu_0 I_{enc}$

$= \mu_0(2-2+2-2) = 0$

(62) $i = 56.2$ mA

$a = 5.72$ cm $\quad b = 8.57$ cm



$$B_{arc} = \frac{\mu_0 I (R\theta)}{4\pi R^2}$$

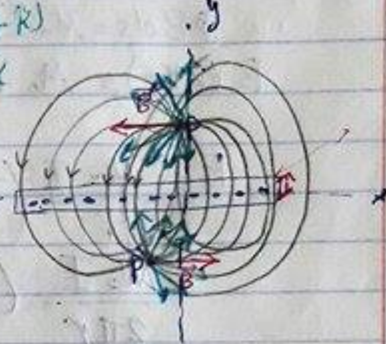
$1 \to 2, 3 \to 4$ $\theta = 0$ or 180 $\sin\theta = 0 \Rightarrow$ no magnatic field

$$2 \to 3 \quad B = \frac{\mu_0 I \cancel{R} \cancel{\pi}}{4 \cancel{\pi} R^{\cancel{2}}_{\to b}} = \frac{4\pi \times 10^{-7} (56.2\times10^{-3})}{4 (8.57\times10^{-2})} = 2.06\times10^{-7}\ \mathrm{T}\ -\hat{k}$$

$$4 \to 1 \quad B = \frac{\mu_0 I \cancel{R} \cancel{\pi}}{4 \cancel{\pi} R^{\cancel{2}}_{\to a}} = \frac{4\pi \times 10^{-7} (56.2\times10^{-3})}{4 (5.72\times10^{-2})} = 3.085\times10^{-7}\ \mathrm{T}\ -\hat{k}$$

$$\vec{B}_{net} = 2.06\times10^{-7}(-\hat{k}) + 3.085\times10^{-7}(-\hat{k})$$
$$= 5.145\times10^{-7}\ \mathrm{T}\ -\hat{k}$$

(81)



$$\lambda = \frac{I}{l} = \frac{AJ}{\Delta X} = J\Delta y$$

$\Delta X \times \Delta y = A$

(a) $\oint \vec{B}\cdot d\vec{s} = \mu_0 I$

$\oint \vec{B}\cdot d\vec{s} = \mu_0 \int \vec{J}\cdot d\vec{A}$

$B_{y\,net} = 0$ from symmetry

$B_n\ p \Rightarrow -\hat{i} \qquad B_n\ p' \Rightarrow +\hat{i}$

(b)

$\oint B\cdot ds = \mu_0 \int \vec{J}\cdot d\vec{A}$ $\qquad \lambda = J\Delta y$

$\int B\, dx = \mu_0 \int \frac{\lambda}{\Delta y}\, dA$ $\qquad \frac{I}{\Delta X} = J\Delta y$

$BX = \mu_0 \int \frac{\lambda}{\cancel{\Delta y}} \Delta X\, \cancel{y}\, dX$ $\qquad A = xy$

$dA = \Delta X\, y$

2 vectors with x axis $\leftarrow 2B\cancel{X} = \mu_0 \lambda \cancel{\Delta X}$

$$B = \frac{1}{2}\mu_0 \lambda$$

(87)

long coaxial cable

(a) $r < c$

$\oint B\cdot ds = \mu_0 I_{enc}$

$B\, 2\pi r = \mu_0 I_{enc}$

$$B = \frac{\mu_0 I_{enc}}{2\pi r} = \frac{\mu_0 I r^2}{2\pi \cancel{r} c^2} = \frac{\mu_0 I r}{2\pi c^2}$$

$$J = \frac{I}{\pi c^2} \rightarrow \text{constant}$$

$$I_{enc} = J \cdot A = \frac{I}{\cancel{\pi} c^2}(\cancel{\pi} r^2) = \frac{I}{c^2} r^2$$

(b) $c < r < b$

$$\oint B \cdot ds = \mu_0 I_{enc}$$

$$B(2\pi r) = \mu_0 I$$

$$B = \frac{\mu_0 I}{2\pi r}$$

(c) $b < r < a$

$I = I$ suppose that I in c +, I in a and b − but they are oppisite

$$\oint B \cdot ds = \mu_0 I_{enc}$$

$$B(2\pi r) = \mu_0 \left(-\frac{I(r^2 - b^2)}{(a^2 - b^2)} + I\right)$$

$$B = \frac{\mu_0 I}{2\pi r}\left(\frac{-r^2 + \cancel{b^2} + a^2 - \cancel{b^2}}{a^2 - b^2}\right)$$

$$= \frac{\mu_0 I}{2\pi r}\left(\frac{a^2 - r^2}{a^2 - b^2}\right)$$

$$J = \frac{I}{A} = \frac{I}{\pi a^2 - \pi b^2}$$

$$J = \frac{I}{\pi(a^2 - b^2)}$$

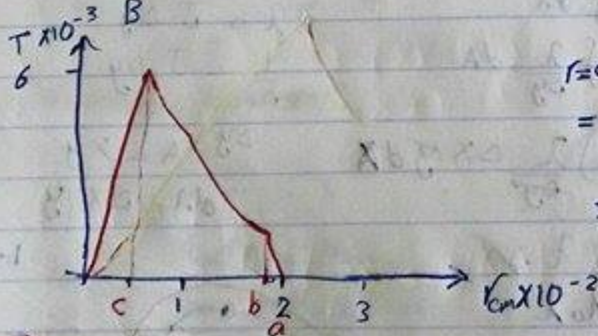
$$I_{enc} = JA = \frac{I}{\cancel{\pi}(a^2 - b^2)} \cancel{\pi} ($$

(d) $r > a$

$B = 0$ since $I_{enc} = I + -I = 0$

(f) $a = 2$ cm $b = 1.8$ $c = 0.4$ cm $i = 120$ A

$0 < r < 3$ cm



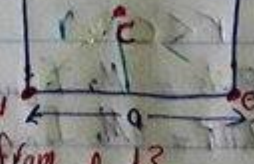
أكبر قيمة تحدث عند $r = c$

$$= \frac{4\pi \times 10^{-7}(120)}{2\pi(0.4 \times 10^{-2})}$$

$$= 6 \times 10^{-3} \text{ T}$$

(89)

$$r = \frac{a}{2}$$



$$B_{de} = \frac{\mu_0 i}{4\pi R} \frac{L}{(L^2/4 + R^2)^{1/2}} \Longrightarrow \text{from p } 13$$

$$= \frac{\mu_0 i \quad a}{4\pi (a/2) \left(a^2/4 + (a/2)^2\right)^{1/2}} = \frac{2\mu_0 i \quad a}{2 \cdot 4\pi a \left(\sqrt{2a^2/4}\right)}$$

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

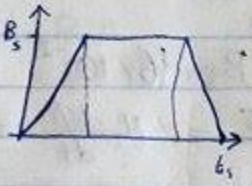
B from 4 wires $= \cancel{4}\,2 \times \left(\frac{\mu_0 i \sqrt{2}}{2\pi a}\right)$

$$\boxed{\vec{B}_{net} = \frac{2\sqrt{2}\,\mu_0 i}{\pi a}}$$

Ch30:

(4) $r = 12$ cm $\quad R = 8.5\ \Omega$

$B_s = 0.5$ T $\quad t_s = 6$ s



$$\varepsilon_{ind} = -N\frac{d\phi}{dt} = -N\frac{d(BA\cos\theta)}{dt}$$

$$= -N\pi r^2 \frac{dB}{dt}$$

(a) $0 \rightarrow 2$ $\quad \frac{dB}{dt} = \text{slope} = \frac{B_s - 0}{2-0} = \frac{0.5}{2} = 0.25$ T/s

$$\varepsilon_{ind} = -(1)\pi(12\times10^{-2})^2(0.25)$$
$$= -0.011304 \text{ V}$$

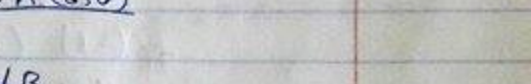
(b) $2 \rightarrow 4$ $\quad \frac{dB}{dt} = \text{slope} = 0 \Rightarrow \varepsilon_{ind} = 0$

(c) $4 \rightarrow 6$ $\quad \frac{dB}{dt} = \text{slope} = \frac{0 - B_s}{6-4} = \frac{-0.5}{2} = -0.25$ T/s

$$\varepsilon_{ind} = -(1)\pi(12\times10^{-2})^2(-0.25)$$
$$= 0.011304 \text{ V}$$

(9) $A = 6.8\ \text{mm}^2$ $\quad n = 854$ turns/cm $\quad I = 1.28$ A

$\omega = 212$ rad/s



$\Phi_{loop} = \Phi_{solenoid}$ $\quad B_{inside\ loop} = B_{inside\ solenoid}$ $\quad A_{solenoid} = A_{loop}$

$B_{solenoid} = \mu_0 n i = 4\pi\times10^{-7}\,\frac{(854)}{1\times10^{-2}}(1.28) = 13.7$ Tesla

$\Phi_{loop} = BA = 13.7 \times 6.8\times10^{-6} = 9.316\times10^{-7}$ weber

$$\varepsilon_{ind} = -N_{loop}\frac{d\phi}{dt} = -N_{loop}\frac{d(BA\cos\theta)}{dt}$$

$= -NBA \; -\sin\theta \frac{d\theta}{dt} = NBA \sin\theta \frac{d\theta}{dt}$ $\qquad w = \frac{d\theta}{dt}$

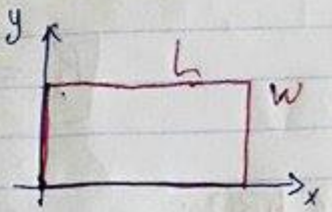
amplitude of emf

$= \mathcal{E}_{max} = N \Phi \,(1)\, w$

$= (1)(9.316 \times 10^{-7})\,(212)$

$= 1.975 \times 10^{-4}$ Volt

(12)



$L = 50\,cm \qquad w = 20\,cm$

* $B = (4 \times 10^{-2}\; T/s)\; y\hat{k}$

(a) $\mathcal{E} = 0$ there is no chage in Φ_B

$\frac{d\phi}{dt} = 0$

(b) none

* $B = (6 \times 10^{-2}\; T/s)\; t\hat{k}$

(c) $\mathcal{E}_i = -N\frac{d\Phi}{dt} = -N \frac{d(BA\cos\theta)}{dt}$

$= -N A \cos 0 \frac{dB}{dt} \qquad \frac{dB}{dt} = 6 \times 10^{-2}\, T/s\; \hat{k}$

$= (-1)(50 \times 10^{-2} \times 20 \times 10^{-2})(1) \times 6 \times 10^{-2}$

$= -6 \times 10^{-3}$ Volt.

(d) clockwise ($\mathcal{E}_{ind}$ will oppose the change in B)

* $B = (8 \times 10^{-2}\; T/m.s)\; yt\hat{k}$

يتغير عادي

$\boxed{\begin{array}{l} \Phi_B = B.A = B \times L \times W \cos 0 \\ \Phi_B = \int B L w \, dy = \int_0^{0.2} 0.08\, y \\ = 0.04t \left.\frac{y^2}{2}\right]_0^{0.2} = \\ \frac{d\Phi}{dt} = 8 \times 10^{-4} \end{array}}$

(e) $\mathcal{E} = -N\frac{d\phi}{dt} = -N \frac{d\phi}{dt}$

$= -N \frac{d\Phi}{dt}$

$= -(1)(8 \times 10^{-4})$

$= -8 \times 10^{-4}$ Volt

يتغير المجال B مع الارتفاع واي والزمن t

(f) clockwise

* $B = (3 \times 10^{-2}\; T/m.s)\; xt\hat{j}$

(g) $\mathcal{E} = -\frac{N\,d\phi}{dt} \qquad \Phi_B = B.A$

$= BA\cos\theta \qquad \theta = 90$

$\hat{j} \; \hat{k} = 0$

$= (-1)\, 0 = 0$

(h) none

* $B = (5 \times 10^{-2}\; T/m.s)\; yt\hat{i}$

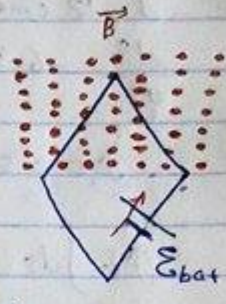
(i) $\mathcal{E} = \frac{-N\, d\phi}{dt}$

$= 0$

$\phi = B.A$
$= B\,A\cos\theta$ $\theta = 90$
$= 0$

(j) none

(15) side = 2m
emf $\mathcal{E} = 20$ V
$B = 0.042 - 0.87\,t$ tesla



(a) $\mathcal{E}_{ind} = -N \frac{d\phi}{dt}$

$= -N \frac{d(2B)}{dt}$

$= -N\,(2)\,\frac{dB}{dt}$

$= -2N\,(-0.87)$

$= -2(1)(-0.87)$

$= 1.74$ Volt

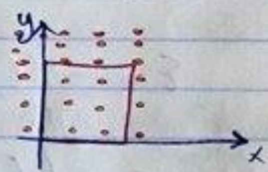
$\phi = B.A$
$= B\,A\cos\theta$ $A = \frac{A_{square}}{2}$
$= B\,\frac{(2)^2}{2}$ $\theta = 0$
$= 2B$

$\frac{dB}{dt} = d(0.042 - 0.87t)$
$= -0.87$

$\mathcal{E}_{net} = \mathcal{E}_{bat} + \mathcal{E}_{ind} = 20 + 1.74$
$= 21.74$ Volt

(b) the current $(I)_{net}$ is counterclockwise.

(27) sides length = 2 cm
$B = 4t^2 y$ T



At $t = 2.5$ s

(a) $\phi = \int B.dA$
$= \int 4t^2 y\; x\,dy$
$= 4t^2 x \int y\,dy$
$= 4t^2 (2\times10^{-2}) \left.\frac{y^2}{2}\right]_0^{2\times10^{-2}}$

$= 1.6\times10^{-5}\,t^2 - 0 = 1.6\times10^{-5}\,t^2$ weber

$\mathcal{E}_{ind} = -N\frac{d\phi}{dt} = -(1)\;1.6\times10^{-5}\,(2t)$

$\mathcal{E}(t) = -3.2\times10^{-5}\,t$ volt at $t = 2.5\,s$, $\mathcal{E}_{ind} = -3.2\times10^{-5}(2.5)$

$= -8\times10^{-5}$ Volt

(b) clockwise.

(37) $d = 12\,cm$ $B = 30\,mT$ $r = 6\,cm$

i↑ $\frac{dB}{dt} = 6.5\,\frac{mT}{s}$

(a) $\oint E\,ds = \frac{-d\phi}{dt}$ $a = 2.2\,cm < r$

$E\int ds = -\frac{d(BA\cos\theta)}{dt}$ $A = \pi a^2$, $\int ds = 2\pi a$

$E(2\pi a) = A\,\frac{-dB}{dt}$

$E = \frac{\pi a^2}{2\pi a}\,\frac{-dB}{dt}$

$= \frac{-a}{2}\,\frac{dB}{dt}$

$= -\frac{(2.2\times10^{-2})}{2}\times6.5\times10^{-3} = 7.15\times10^{-5}$ V/m

(b) $\oint E\,ds = -\frac{d\phi}{dt}$ $b = 8.2\,cm > r$

$E(2\pi b) = -\pi r^2\,\frac{dB}{dt}$ $A = \pi r^2$, $\int ds = 2\pi b$

$E = \frac{-\pi r^2}{2\pi b}\,\frac{dB}{dt}$

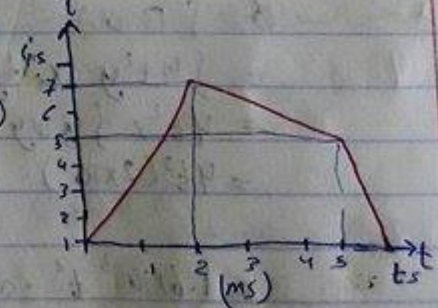
$= -\frac{(6\times10^{-2})^2}{2(8.2\times10^{-2})}\times6.5\times10^{-3} = 1.427\times10^{-4}$ V/m

(46) $L = 4.6\,H$

$i_s = 8A$ $t_s = 6\,ms$

$r = 12\,\Omega$

(A)



$\mathcal{E}_{ind} = -N\,\frac{d\phi}{dt} = L\,\frac{di}{dt}$

magnitude
يعني مطلوب
الحلول بدون
إشارة

ⓐ $0 \to 2\,ms$ $\mathcal{E} = -L \frac{di}{dt}$

$= -4.6 \left(\frac{7-0}{(2-0)\times10^{-3}} \right) = -16100$

$\approx -1.6 \times 10^4\ V$

$\mathcal{E} = 1.6 \times 10^4\ V$

ⓑ $2 \to 5\,ms$ $\mathcal{E} = -L \frac{di}{dt}$

$= -4.6 \left(\frac{5-7}{(5-2)\times10^{-3}} \right) = +3066.67$

$\approx +3.06 \times 10^3\ V$

$\mathcal{E} = 3.06 \times 10^3\ V$

ⓒ $5 \to 6\,ms$ $\mathcal{E} = L \frac{di}{dt}$

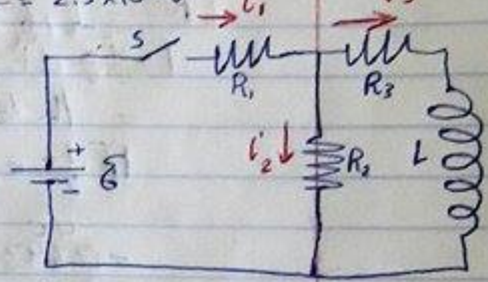
$= -4.6 \left(\frac{0-5}{(6-5)\times10^{-3}} \right) = +23000$

$\approx +2.3 \times 10^4\ V$

$\mathcal{E} = 2.3 \times 10^4\ V$

(54) $\mathcal{E} = 100\,V$ $L = 3.5\,H$

$R_1 = 10\,\Omega$ $R_2 = 20\,\Omega$ $R_3 = 30\,\Omega$



ⓐ $i_1 = \frac{\mathcal{E}}{\Sigma R}$

$= \frac{100}{20+10} = 3.3\,A$

ⓑ $i_2 = i_1 = 3.3\,A$

i in $L = 0$ $\xrightarrow{so}$ i in $R_3 = 0$

ⓒ a long time late $\to$ L will be as a wire $\to I = I_{max}$

$I = \frac{\mathcal{E}}{\Sigma R}$

$R_{23} = \frac{R_2 R_3}{R_2 + R_3} = 12\,\Omega$

$= \frac{100}{12+10} = 4.545\,A$

$i_1 = I = 4.545\,A$

ⓓ $V_{R_{23}} = I R$

$= (4.545)\,12 = 54.54\,V$

$I_{R_2} = \frac{V_{R_2}}{R_2} = \frac{54.54}{20} = 2.727\,A = i_2$

ⓔ when the switch is just opened $i_1 = 0$

ⓕ " " " $i_2 \to$

$i_2 = i_3 = i_{max}$ in R_3

$$= \frac{V_{R_3}}{R_3} = \frac{54.54}{30} = 1.818 \text{ A}$$

(g) after along time i_L will disappear $i_1 = 0$

(h) " " " " " $i_2 = 0$

(63) $\tau_L = 37$ ms

* $U = P * t \Rightarrow \frac{U}{t}$
* $U = \frac{1}{2} L I^2$
* $\tau_L = \frac{L}{R}$
* $I = I_{max}(1 - e^{-t/\tau_L})$

$I = \frac{\varepsilon}{R}(1 - e^{-t/\tau_L})$

* $\frac{dI}{dt} = \frac{\varepsilon}{R} \cdot \frac{-1}{\tau_L} e^{-t}$

$= \frac{\cancel{\varepsilon}}{\cancel{R}} \cdot \frac{\cancel{R}}{L} e^{-t/}$

$= \frac{\varepsilon}{L} e^{-t/\tau}$

t when $P_R = P_L$

$$I^2 R = L I \frac{dI}{dt}$$

$$\frac{\varepsilon}{\cancel{R}}(1 - e^{-t/\tau_L})\cancel{R} = \cancel{L}\left(\frac{\varepsilon}{\cancel{L}} e^{-t/\tau_L}\right)$$

$$1 - e^{-t/\tau_L} = e^{-t/\tau_L}$$

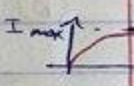
$$1 = 2e^{-t/\tau_L}$$

$$\ln \frac{1}{2} = \frac{-t}{\tau_L}$$

$$-0.693 = \frac{-t}{37 \times 10^{-3}}$$

$$t = 0.0256 \text{ sec}$$

$$= 25.6 \text{ ms}$$



time rate for energy = P, t=0 the battery is connected ⇒ $i_0 = 0$

Additional problems:

(51) i: 1 A → 10 mA in 1 sec. $L = 10$ H

R ??

$$\varepsilon_{ind} = L \frac{dI}{dt} = 10 \left(\frac{0.01 - 1}{1}\right) = -9.9 \text{ Vo}$$

$$I = I_{max} e^{-t/\tau_L}$$

$$0.01 = 1 \; e^{-1/\tau_L}$$

$$-4.605 = \frac{-1}{\tau_L} \Rightarrow \tau_L = \frac{1}{4.605} = \frac{L}{R}$$

$$\frac{1}{4.605} = \frac{10}{R}$$

$$R = 46.05 \; \Omega$$

(53) $L = 6.3\ \mu H \qquad R = 1.2\ K\Omega$

(a) $\mathcal{E} = 14\ V$

$$I = I_{max}(1 - e^{-t/\tau}) \qquad \tau = \frac{L}{R}$$

$$\frac{80}{100}\cancel{I_{max}} = \cancel{I_{max}}(1 - e^{-t/\tau}) \qquad = \frac{6.3\times10^{-6}}{1.2\times10^{3}}$$

$$0.8 = 1 - e^{-t/\tau} \qquad = 5.25\times10^{-9}$$

$$e^{-t/\tau} = 0.2$$

$$\frac{-t}{\tau} = -1.609$$

$$t = 1.609\,(5.25\times10^{-9})$$

$$= 8.45\times10^{-9}\ s$$

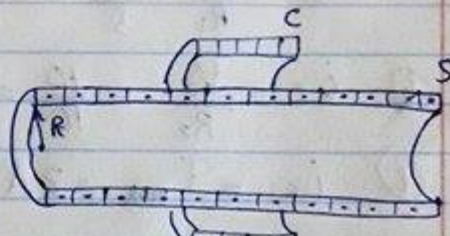
(b) i at $t = 1\tau_L$

$$I = I_{max}(1 - e^{-t/\tau_L})$$

$$= \frac{\mathcal{E}}{R}(1 - e^{-1\tau_L/\tau_L})$$

$$= \frac{14}{1.2\times10^{3}}(1 - e^{-1}) = 7.37\times10^{-3}\ A$$

(76)



$$\Phi_c = \Phi_s = B.A$$

$$= \mu_0 n i\,(\pi R^2)$$

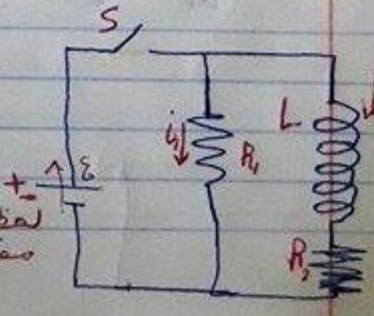
(a) $\mathcal{E}_{ind} = N\,\Phi = L\,I$

$$N \mu_0 n\, I\, \pi R^2 = L\, I$$

$$L = \mu_0 n N \pi R^2$$

$$M = \mu_0 \pi R^2 n N$$

(b) because $\Phi_c = \Phi_s = B_s . A_s$ (no magnetic field out of the solenoid). $\Phi = B_s(\pi R_s^2)$.



(79) $\mathcal{E} = 10\ V \quad R_1 = 5\ \Omega \quad R_2 = 10\ \Omega \quad L = 5\ H$

(a) $i_1 = \frac{\mathcal{E}}{R_1} = \frac{10}{5} = 2\ A$

لحظة إغلاق المفتاح يكون التيار في المحث صفر كأن الدارة مفتوحة

(b) $i_2 = 0$

(c) $i_s = i_1 = 2\text{ A}$

(d) $V_2 = i_2 R_2 = 0$

(e) $V_L = 10\text{ V}$

(f) $\frac{di_2}{dt} \Rightarrow \quad \mathcal{E} = L\frac{di_2}{dt}$

$$10 = 5\frac{di_2}{dt}$$

$$\frac{di_2}{dt} = 2\text{ A/s}$$

(g) a long time late $\rightarrow I = I_{max}$

$$I_{max} = \frac{\mathcal{E}}{\Sigma R} = \frac{10}{\frac{10}{3}} = 3\text{A}$$

$R_{12} = \frac{R_1 R_2}{R_1 + R_2} = \frac{5 \times 10}{15} = \frac{10}{3}$

$i_1 = \frac{V_1}{R_1} = \frac{10}{5} = 2\text{ A}$

note: after a long time $V_L = 0$ since $\frac{di}{dt} = 0$, $\mathcal{E} = L\frac{di}{dt} = 0$

(h) $i_2 = \frac{V_2}{R_2} = \frac{10}{10} = 1\text{ A}$

(i) $i_s = I_{max} = 3\text{A}$

(j) $V_2 = 10\text{ V}$

(k) $V_L = 0$

(l) $\frac{di_2}{dt} = \frac{V_L}{L} = 0$