ex 24.9 // A parallel plate capacitor carries charge Q and is then disconnected from a battery. The two plates are initially separated by a distance d. Suppose the plates are pulled apart until the separation is 2d. How has the energy stored in this capacitor changed?

$U_i = \frac{1}{2}\frac{Q^2}{C_i}$ $\quad C_i = \varepsilon_0 \frac{A}{d}$ $\quad U_f = \frac{1}{2}\frac{Q^2}{C_f}$ $\quad C_f = \varepsilon_0 \frac{A}{d}$

$U_f = 2 \cdot U_i$ energy stored doubles!

ex 24.10 // The plates of a parallel-plate capacitor have area A, seperation x, and are connected to a battery with voltage V. While connected to the battery, the plates are pulled apart until they are separated by 3x a) What are the initial and final energies stored in the capacitor?

$U_i = \frac{1}{2} C_i V^2$ $\quad C_i = \varepsilon_0 \frac{A}{x}$ $\quad U_i = \frac{1}{2}\varepsilon_0 \frac{A}{x} V^2$ $\quad \Delta U = -\frac{\varepsilon_0 A V^2}{3x}$

$U_f = \frac{1}{2} C_f V^2$ $\quad C_f = \varepsilon_0 \frac{A}{3x}$ $\quad U_f = \frac{1}{6}\varepsilon_0 \frac{A}{x} V^2$

b) How much work is required to pull the plates apart?

$$W = \int_{\ell=x}^{\ell=3x} QE\,d\ell = \frac{\varepsilon_0 A V^2}{2}\int_x^{3x} \frac{d\ell}{\ell^2} = -\frac{\varepsilon_0 A V^2}{2\ell}\Bigg|_{\ell=x}^{\ell=3x} = \frac{\varepsilon_0 A V^2}{2}\cdot\left(-\frac{1}{3x}+\frac{1}{x}\right) = \frac{\varepsilon_0 A V^2}{3x}$$

c) How much energy is exchanged with the battery?

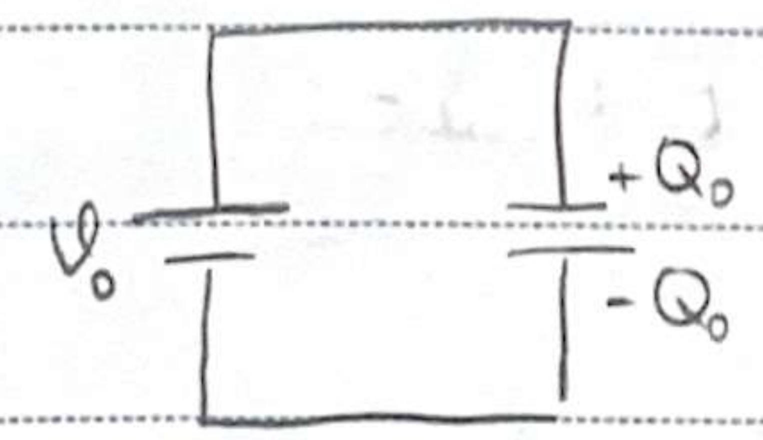
$W = \Delta U_{cap} + \Delta U_{batt}$

$$\Delta U_{batt} = W - \Delta U_{cap} = \frac{\varepsilon_0 A V^2}{3x} + \frac{\varepsilon_0 A V^2}{3x} = \frac{2\varepsilon_0 A V^2}{3x}$$

u = energy density $= \frac{1}{2}\varepsilon_0 E^2$ → energy per unit volume

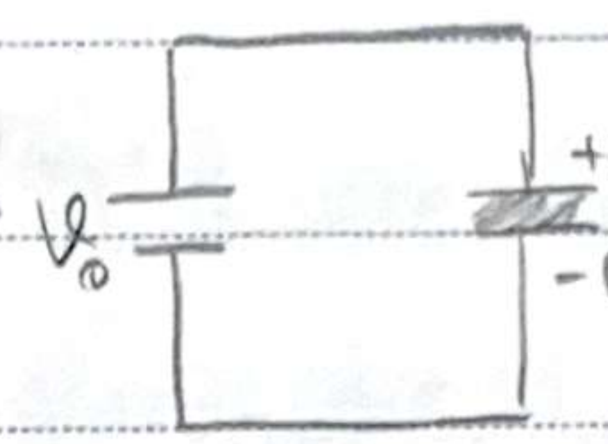
$C = K\varepsilon_0 \frac{A}{d}$ parallel plate capacitor

$\varepsilon = K \cdot \varepsilon_0$



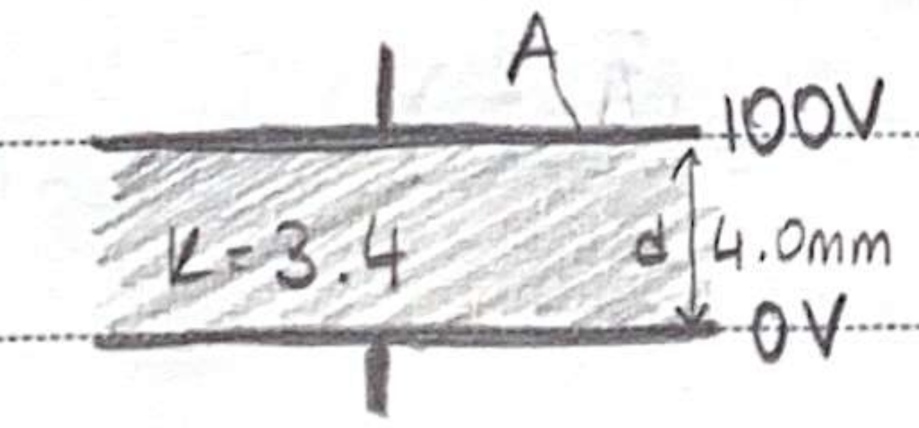
no dielectric

$C_0 = \frac{Q_0}{V_0}$ ⟶ voltage constant



$C = \frac{Q}{V_0} = KC_0$

ex 24.11 After the capacitor (figure) is fully charged, the battery is disconnected. The plates have area $A = 4.0\,m^2$ and are separated by $d = 4.0\,mm$. a) Find the capacitance, the charge on the capacitor, the electric field strength, and the energy stored in the capacitor.



$C = \frac{K\varepsilon_0 A}{d} = \frac{(3.4)(8.85\times10^{-12})(4.0m^2)}{4\times10^{-3}} = \boxed{3\times10^{-8}F}$

$Q = CV = (3\times10^{-8})(100V) = \boxed{3\times10^{-6}C}$

$E = \frac{V}{d} = \frac{100}{4\times10^{-3}} = \boxed{25}$

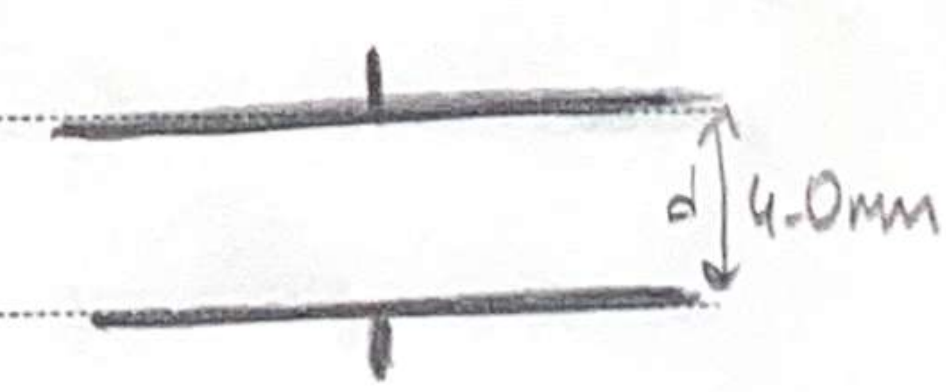
$U = \frac{1}{2}CV^2 = \frac{1}{2}(3\times10^{-8})(100)^2 = 1.5\times10^{-4}J$

→ When dielectric is removed;

b) Find the new values of capacitance, electric field strength, voltage between the plates, and the energy stored in the capacitor

Q cannot change
V increases $V = \frac{Q}{C}$
by $K = 3.4$ to $340V$

$E = \frac{V}{d} = \frac{340}{4\times10^{-3}} = 85$



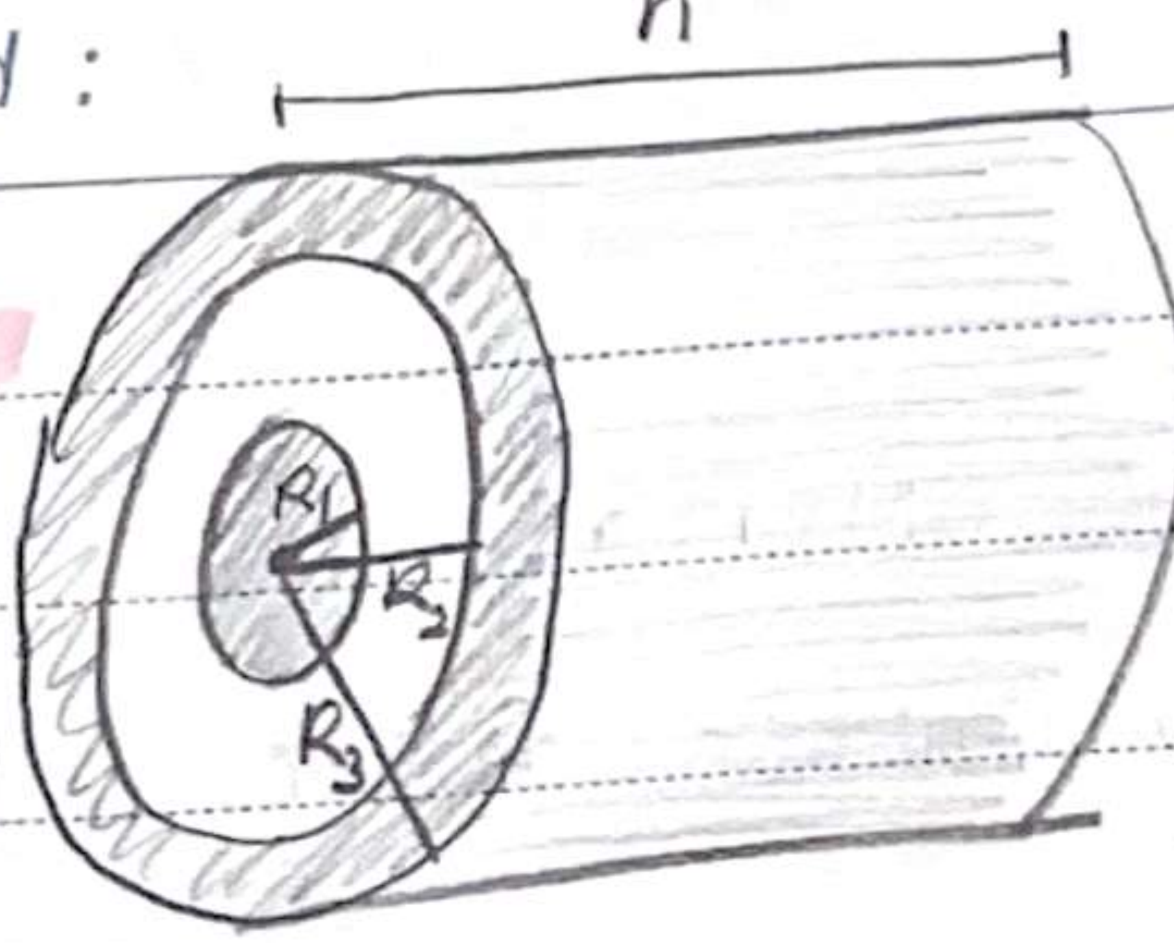
energy stored $= U = \frac{1}{2}CV^2$

$= \frac{1}{2}(8.8\times10^{-9})(340)^2$

$= 5.1\times10^{-4}J$

Record :

22.38



Determine the electric field as a function of the distance r?

a) $0 < r < R_1$? $\oint dA\,E = \frac{Q}{\varepsilon_0}$ $\rho = \frac{Q}{V} \Rightarrow Q = \rho \cdot V$

$E \cdot 2\cancel{\pi} r \cancel{h} = \frac{\rho_E \cdot (\cancel{\pi} r^{\cancel{2}} \cancel{h})}{\varepsilon_0} \Rightarrow \boxed{E = \frac{\rho_E \cdot r}{2\varepsilon_0}}$ //

b) $R_1 < r < R_2$ $\oint dA\,E = \frac{Q}{\varepsilon_0}$

$E \cdot 2\pi r h = \frac{\rho_E \cdot (\pi R_1^2 h)}{\varepsilon_0} \Rightarrow E = \frac{\rho_E R_1^2}{2\varepsilon_0 r}$

c) $R_2 < r < R_3$ $E \cdot 2\cancel{\pi} r \cancel{h} = \frac{\rho_E (\cancel{\pi} R_1^2 \cancel{h}) + \rho_E \cdot (\cancel{\pi} r^2 \cancel{h} - \cancel{\pi} R_2^2 \cancel{h})}{\varepsilon_0}$

$E = \frac{\rho_E \cdot (R_1^2 - R_2^2 +}{2\varepsilon_0 r}$

d) $R_3 < r$ $E\,2\pi r h = \frac{\rho_E (\pi R_1^2 h) + \rho_E \cdot (R_3^2 - R_2^2) h}{\varepsilon_0}$

$E = \frac{\rho_E (R_1^2 - R_2^2 + R}{2\varepsilon_0 r}$

CHAPTER 25

→ The electric field must be zero inside a conductor

→ If charges are moving in a conductor, there is an electric field

$$\boxed{I = \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}}$$

$1A = 1C/s$ $V = I.R$
↳ resistance

25.1 A steady current of 2.5 A exists in a wire for 4 min

a) How much total charge passed by a given point in the circuit?

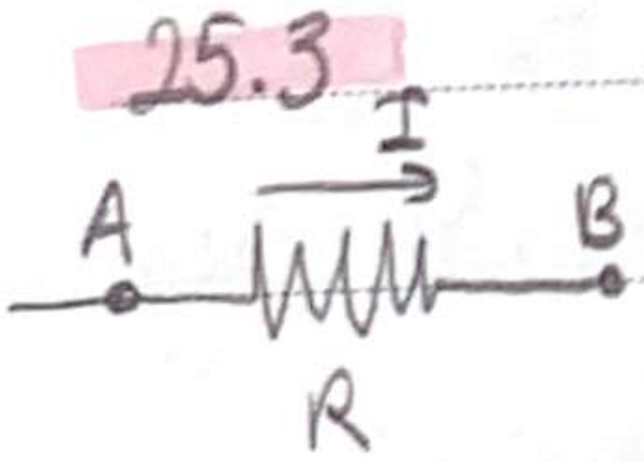
$\Delta t = 4min = 240s$, $I = 2.5A$

$I = \frac{\Delta Q}{\Delta t}$ $\Delta Q = (2.5A)(240s) = 600\,C$

b) How many electrons would this be?

$\frac{600\,C}{1.6 \times 10^{-19}\,C/e} = 3.8 \times 10^{21}$ electrons

25.3



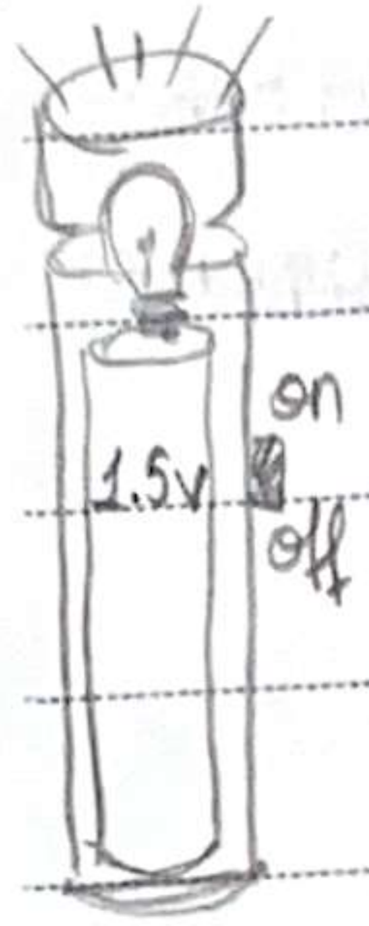
a) Is the potential higher at point A or point B

→ positive charge always from + towards from high to low potential

b) Is the current greater at point A or at point B

→ A is higher than B

25.4



Flashlight bulb draws 300 mA from its 1.5 V battery.

a) What is the resistance of the bulb?

$R = \frac{V}{I} = \frac{1.5\,V}{0.3\,A} = 5\,\Omega$ //

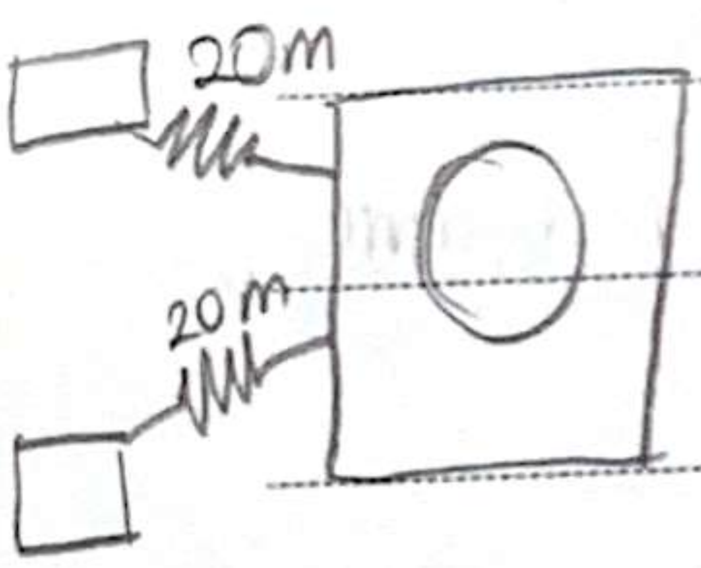
b) If the battery becomes weak and the voltage drops to 1.2V, how would the current change?

→ If the resistance stays same, $I = \frac{V}{R} = \frac{1.2\,V}{5\,\Omega} = 0.24\,A$

$= 240\,mA$

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

25.5



a) If each wire must be 20m long, what diameter copper wire should you use to keep the resistance less than 0.10 Ω per wire? $\rho = 1.68 \times 10^{-18}\,\Omega.m$

$R = \rho \frac{l}{A} \longrightarrow 0.10 = \frac{(1.68 \times 10^{-18}).(20m)}{A} \rightarrow A = 3.4 \times 10^{-6}\,m^2$

$A = \pi r^2 \Rightarrow \boxed{r = 1.04 \times 10^{-3}\,m}$ //

b) If the current to each speaker is 4.0 A, what is the potential difference, or voltage drop, across each wire?

$V = I.R = (4A).(0.10\,\Omega) = 0.4\,V$

$$\rho_T = \rho_0 \left[1 + \alpha (T - T_0)\right]$$

25.7 Suppose at 20.0 °C the resistance of a platinum resistance thermometer is 164.2 Ω. When placed in a particular solution, the resistance is 187.4 Ω. What is the temperature of this solution?

$\rho = \rho_0 [1+\alpha(T-T_0)]$ by multiplying $\frac{l}{A}$ to obtain

$$R = R_0 [1+\alpha(T-T_0)]$$

Where $R_0 = \frac{\rho_0 \cdot l}{A}$, is the resistance of the wire at 20.0°C

$$T = T_0 + \frac{R-R_0}{\alpha R_0} \Rightarrow T = 20° + \frac{187.4\,\Omega - 164.2\,\Omega}{(3.927\times10^{-3}\,(°C)^{-3})(164.2\,\Omega)} = 56°C$$

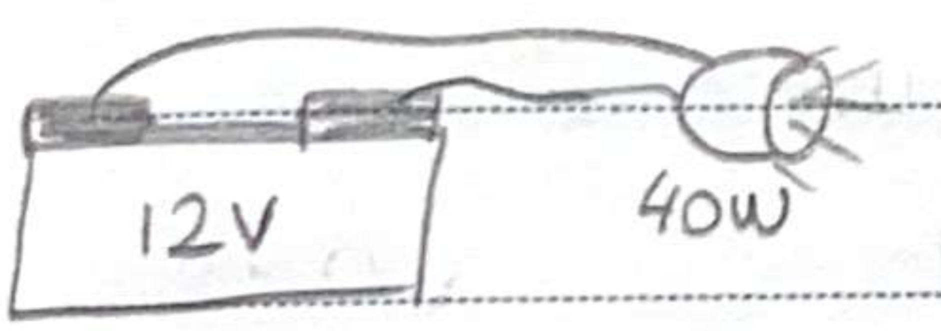
$$P = \frac{dU}{dt} = \frac{dq}{dt} V$$

power

$$P = I.V = I^2.R = \frac{V^2}{R}$$

$1W = 1\frac{J}{s}$

25.8 Calculate the resistance of a 40-W automobile headlight designed for 12 V.



$$P = \frac{V^2}{R} \qquad 40W = \frac{(12V)^2}{R} \Rightarrow \boxed{R = 3.6\,\Omega}$$

25.9 An electric heater draws a steady 15.0 A on a 120 V line. How much power does it require and how much does it cost per mont (30 days) if it operates 3.0 h per day and charges 9.2 cents per kWh?

9.2 = 0.092 \$, $I = 15.0\,A$, $V = 120V$

$$P = I.V = (15A)(120V) = 1800\,W = 1.8\,kW$$

$$\frac{3h}{d} \cdot 30d = 90h \qquad (1.8\,kW)(90h)(0.092\,\$) = 15\,\$$$

Record : / /

25.10 a lighting can trasfer 10^9 J of energy across a potential difference of perhaps 5×10^7 V during a time interval of about 0.2s estimate a) the total amount of charge transferred between cloud and ground? $\Delta U = Q \cdot \Delta V$ $\quad Q = \frac{\Delta U}{\Delta V} = \frac{10^9\ J}{5\cdot10^7\ V} = 20C$

b) The current in the lighning bolt

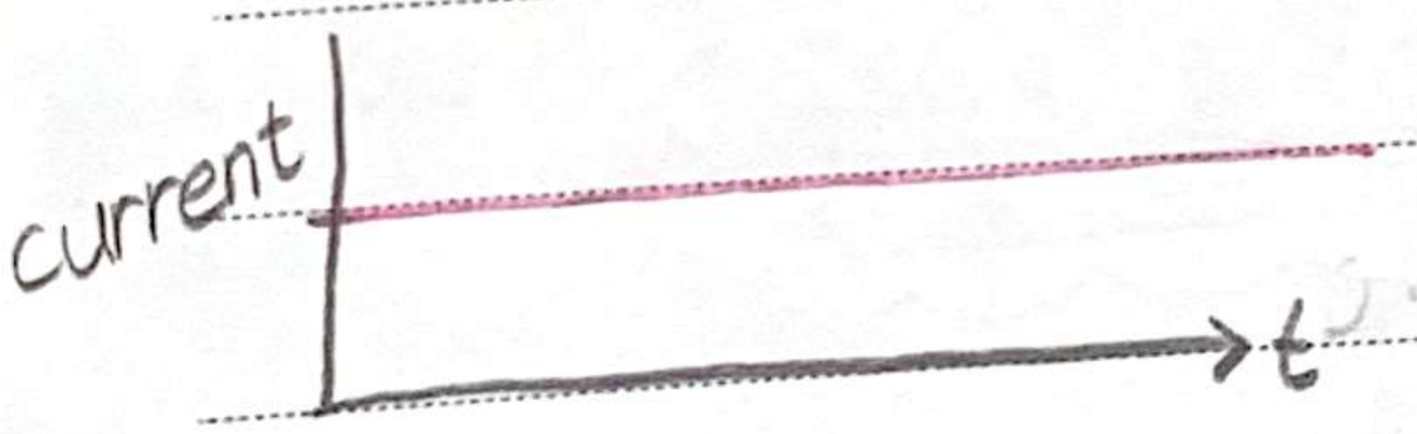
$$I = \frac{\Delta Q}{\Delta t} = \frac{20C}{0.2s} = 100A$$

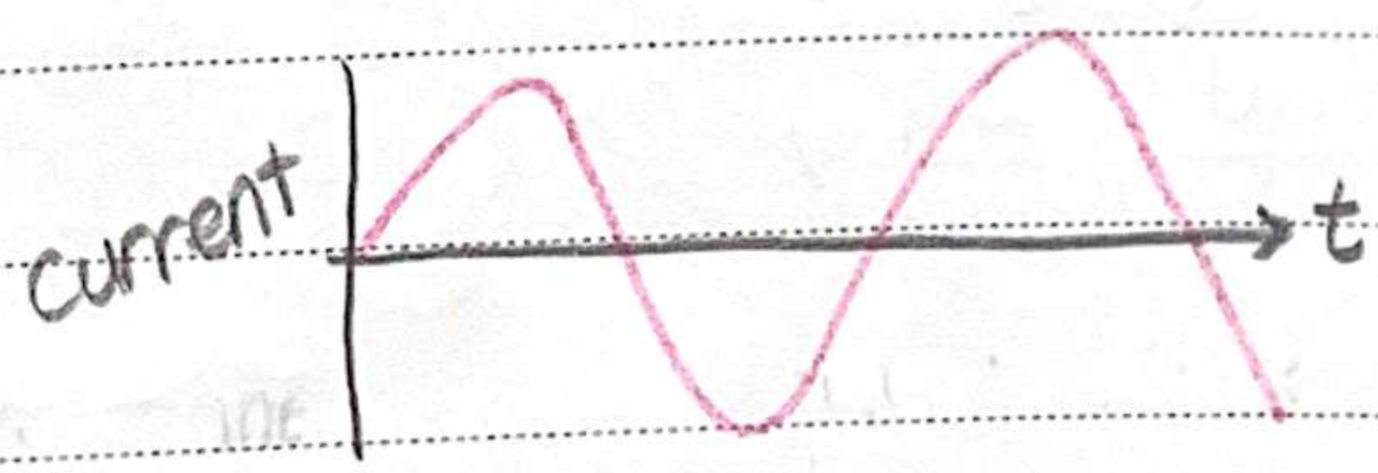
c) the average power delivered

$$P = \frac{\text{energy}}{\text{time}} = \frac{10^9\ J}{0.2s} = 5\cdot10^9 = 5GW$$

or

$$P = IV = (100A)(5\cdot10^7 V) = 5\ GW$$



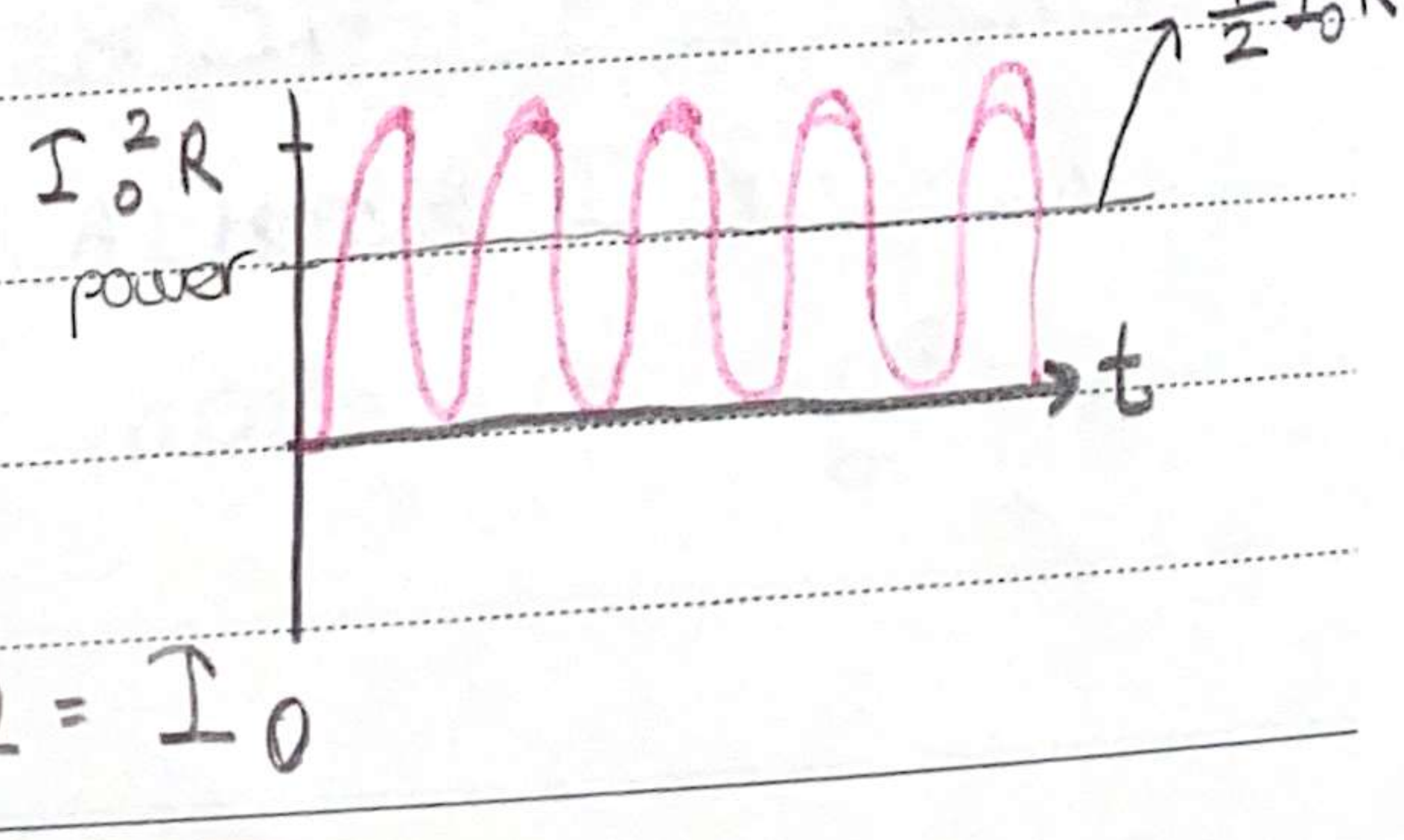


→ When a battery is connected to a circuit the current moves in one direction. This is called direct current (DC)

→ Electric generatiors at electric power plants produces alternating current (AC)

$$V = V_0 \cdot \sin 2\pi f t = V_0 \sin \omega t$$

$$I = \frac{V}{R} = \underbrace{\frac{V_0}{R}}_{I_0} \sin \omega t = I_0 \sin \omega t$$



$$I_{rms} = \sqrt{\overline{I^2}} = \frac{I_0}{\sqrt{2}} = 0.707\, I_0$$

$$V_{rms} = 0.707\, V_0$$

$$I_{rms} \cdot \sqrt{2} = I_0$$

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26.13 a) calculate the resistance and the peak current in a 1000-W hair dryer connected to a 120-V line.

current $I_{rms} = \frac{\bar{P}}{V_{rms}} = \frac{1000\,W}{120\,V} = 8.33\,A$ $\quad I_0 = \sqrt{2}.I_{rms} = \sqrt{2}.(8.33) = 11.8\,A$

resistance $R = \frac{V_{rms}}{I_{rms}} = \frac{120V}{8.33A} = 14.4\,\Omega$

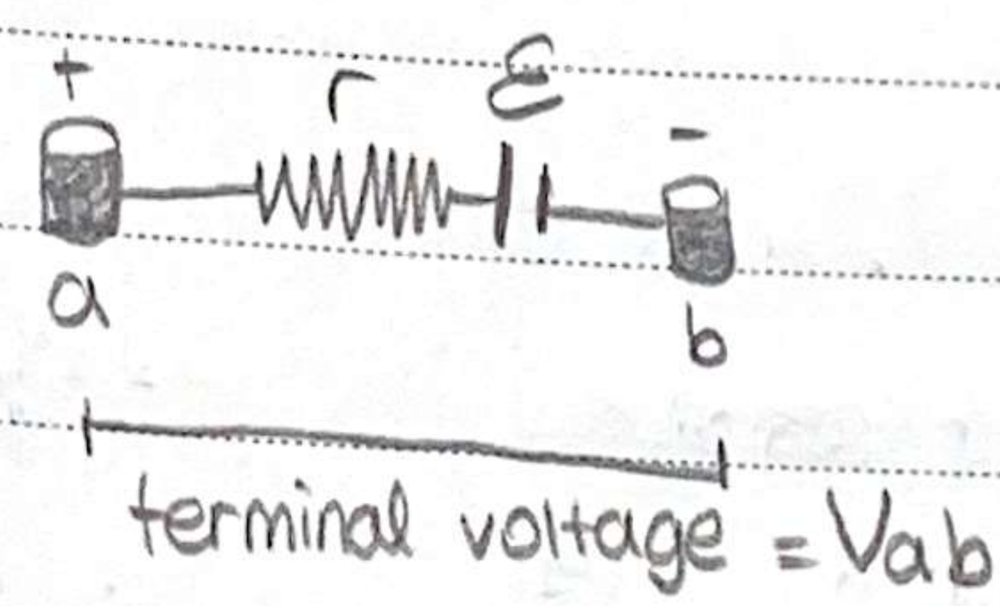
b) What happens if it is connected to a 240-V line in Britain?

the average power $\bar{P} = \frac{V_{rms}^2}{R} = \frac{(240)^2}{(14.4\Omega)} = 4000\,W$

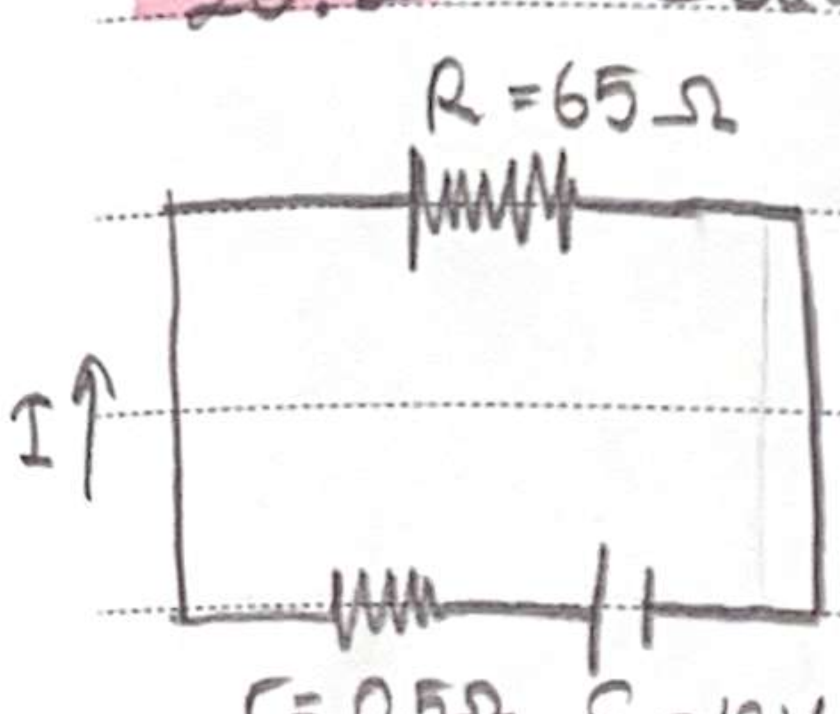
CHAPTER 26

$V_{ab} = \mathcal{E} - Ir$

↳ $V_a - V_b$



26.1 Calculate a) the current at the circuit?



$V_{ab} = \mathcal{E} - Ir = I.R \rightarrow \mathcal{E} = I.(R+r)$

$12V = I.(65.5\Omega)$

$I = 0.183A$

b) the terminal voltage?

$V_{ab} = \mathcal{E} - Ir = 12V - (0.183A)(0.5\Omega)$

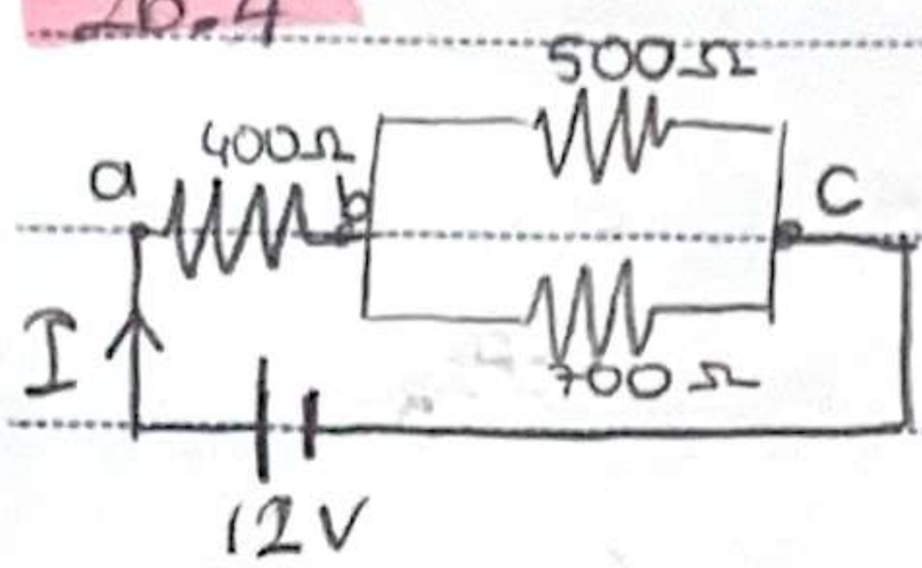
$V_{ab} = \boxed{11.9V}$ ///

c) the power dissipated in the resistor R and in the batterys internal resistance r?

$P_R = I^2.R = (0.183A)^2.(65\Omega) = 2.18\,W$

$P_r = I^2.r = (0.183A)^2.(0.5\Omega) = 0.02W$

26.4



How much current is drawn from the battery?

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{500} + \frac{1}{700} \longrightarrow R_p = 290$

$R_{eq} = 400\Omega + 290\Omega = 690\Omega$

Total current $I = \frac{V}{R} = \frac{12V}{690\Omega} = 0.0174A = 17mA$

26.5 What is the current through the 500Ω resistor? (Same picture)

$I = 17mA$ $\quad V_{ab} = I.R = (17.10^{-3}A)(400\Omega) = 7V$

$V_{bc} = 12V - 7V = 5V$ $\quad I_1 = \frac{V_{bc}}{R_1} = \frac{5V}{500\Omega} = 10mA$

$I_2 = \frac{V_{bc}}{R_1} = \frac{5V}{700\Omega} = 7mA$

Question A 75W, 110V bulb is connected in parallel with a 25W, 110V bulb. What is the net resistance? $P = \frac{V^2}{R}$, $\frac{1}{R} = \frac{P}{V^2}$

$$\frac{1}{R_{eq}} = \left(\frac{1}{R_{75}} + \frac{1}{R_{25}}\right) = \left(\frac{75}{110^2} + \frac{25}{110^2}\right) \Rightarrow R_{eq} = \frac{110^2}{100} = \boxed{121\ \Omega}$$

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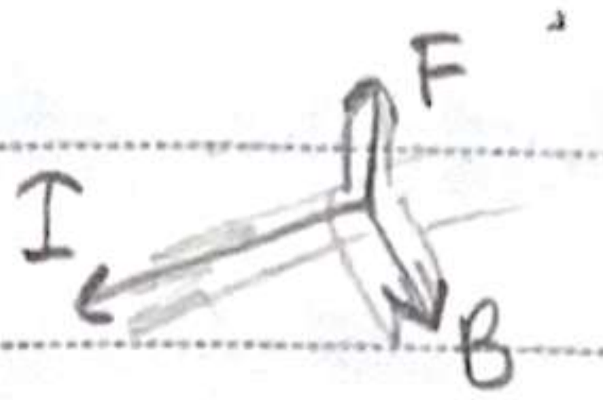
CHAPTER 27

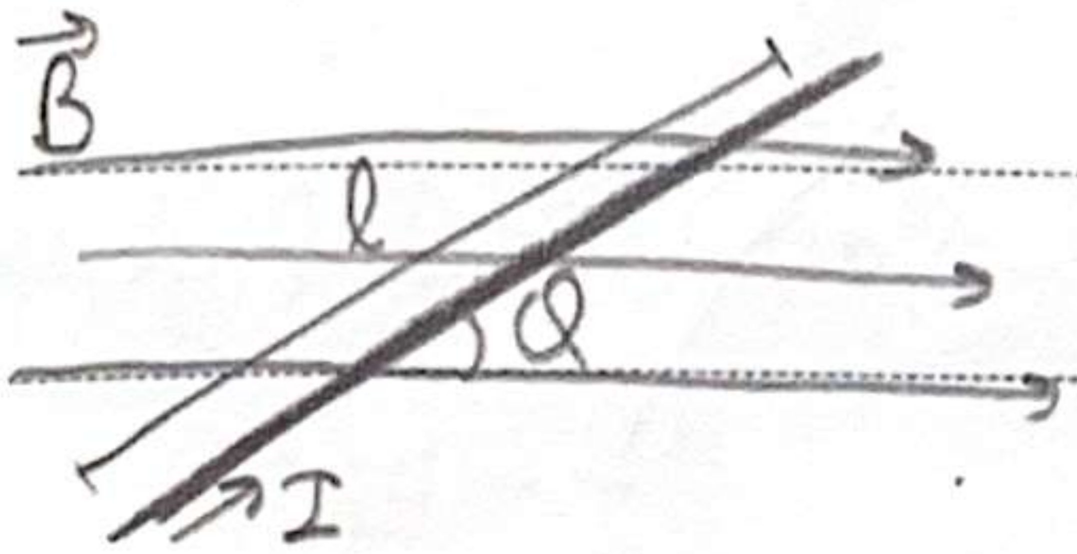


$\boxed{F = I . \ell . B \sin Q}$ $F = I . \ell . B$

$1T = \frac{1N}{A.m}$

$1G = 10^{-4} T$

27.1 A wire carrying a 30-A current has length $\ell = 12cm$ between the pole, $Q = 60°$. The magnetic field is 0.90T. What is the magnitude of the force on the wire?

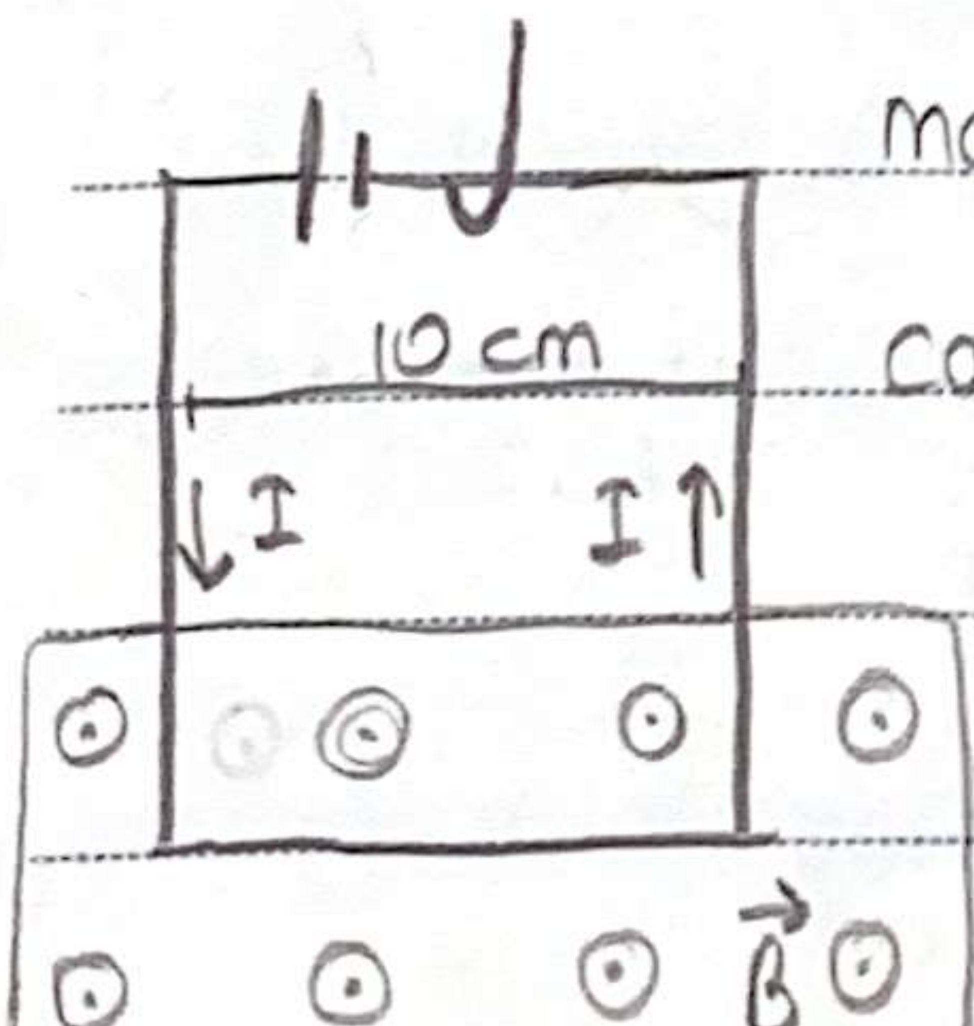


$I = 30A$, $Q = 60°$, $B = 0.90T$, $\ell = 0.12m$

$F = B . I . \ell \sin Q = (0.90)(30)(0.12)(\sin 60)$

$F = 2.8N$

27.2 The loop hangs from a balance which measures a downward magnetic force of $F = 3.48 \times 10^{-2} N$, when the wire carries a current $I = 0.245 A$. What is the magnitude of the magnetic field B?

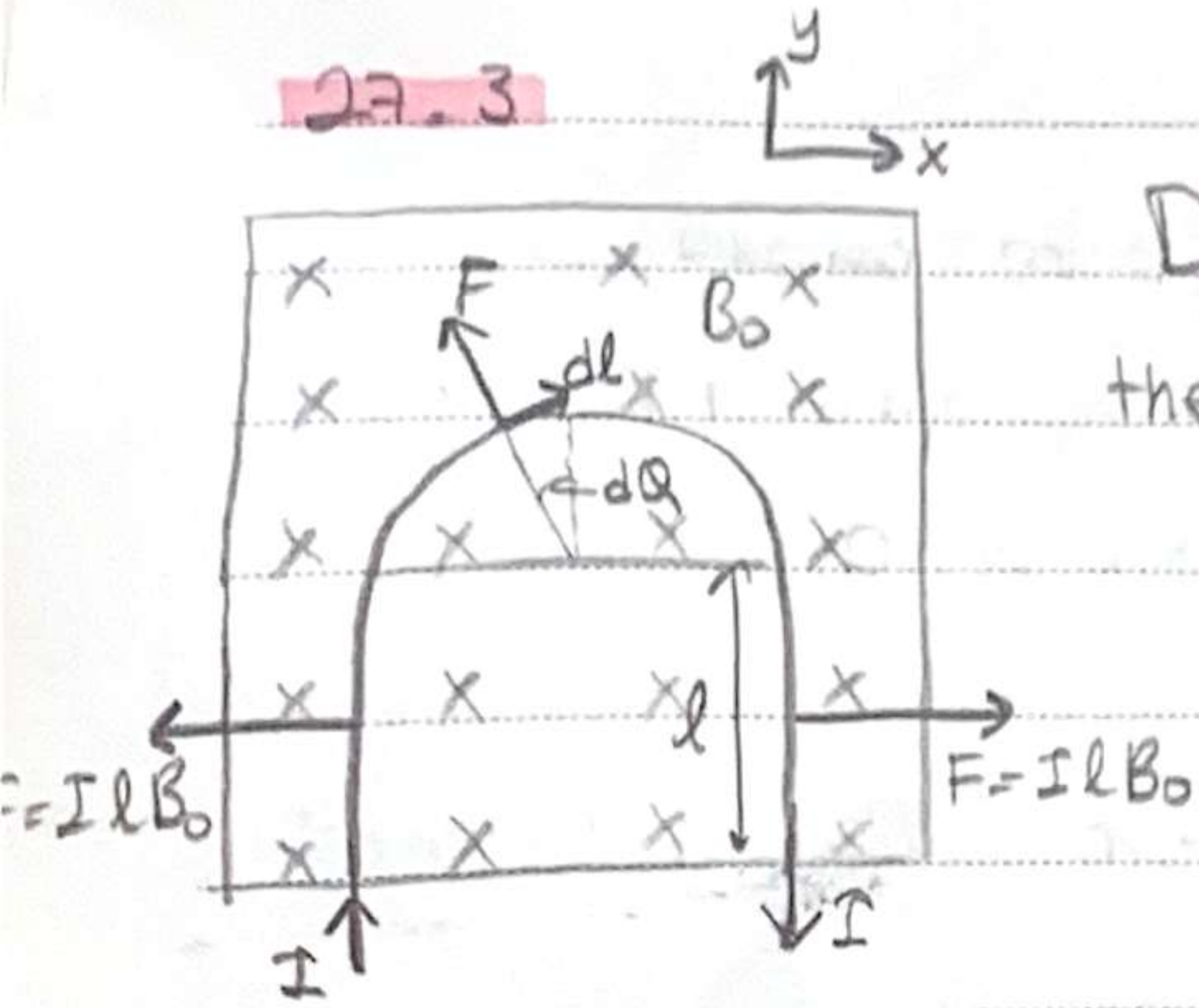


$F = B . I . \ell . \sin Q$ $(Q = 90°)$

$(3.48 \times 10^{-2}) = B . (0.245)(1.10^{-1})(\sin 90)$

$B = 1.42 T$

27.3



Determine the net force on the wire due to the magnetic field $\vec{B_0}$

→ forces on the two streight sections, they cancel

$dl = R \cdot d\theta$

$dF = I \cdot B_0 \cdot R \cdot d\theta$ → the angle between dl and B is $90°$

with direction vertically upward along the y-axis ← $F = \int_0^{\pi} dF \sin\theta = I \cdot B_0 R \int_0^{\pi} \sin\theta \, d\theta = -I B_0 R \cos\theta \Big|_0^{\pi}$

$= 2 I B_0 R$

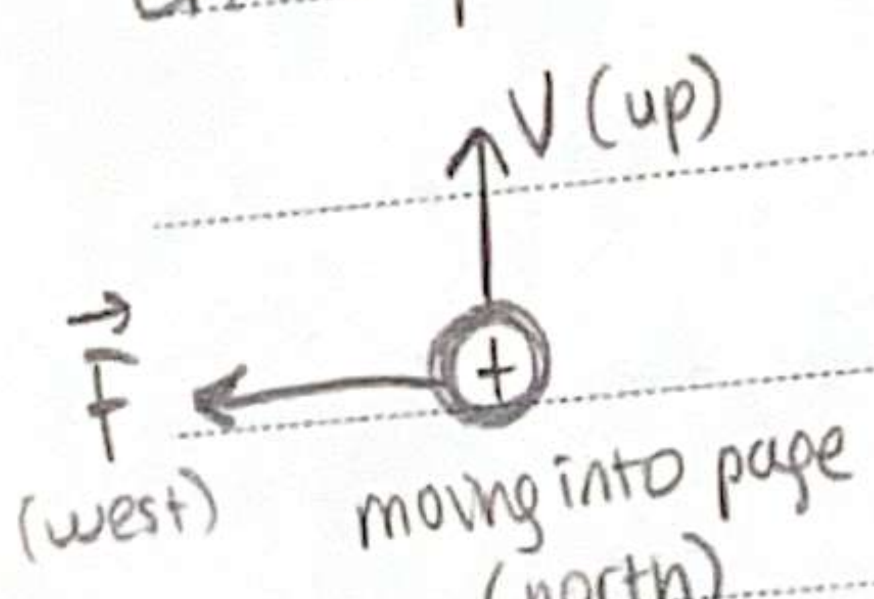
$$F = q\vec{V} \cdot B$$

27.4 A negative charge $-Q$ is placed at rest near a magnet. Will the charge begin to move? Will it feel a force? What if the charge were positive, $+Q$?

$F = qVB \quad V = 0 \quad F = 0$

Magnetic fields exert a force only on moving charges.

27.5 A magnetic field exerts a force of 8×10^{-14} N toward to west on a proton moving vertically upward at a speed of 5×10^6 m/s. Determine the magnitude and direction of the magnetic field in this region. ($q = +e = 1.6 \times 10^{-19}$ c)



$F = qVB$

$8 \times 10^{-14} = (1.6 \times 10^{-19})(5 \times 10^6) B$

$B = 0.1 T$

Record :

/ /

27.7 An electron travels at 2×10^7 m/s in a plane perpendicular to a uniform 0.010 T magnetic field. Describe its path quantitatively.

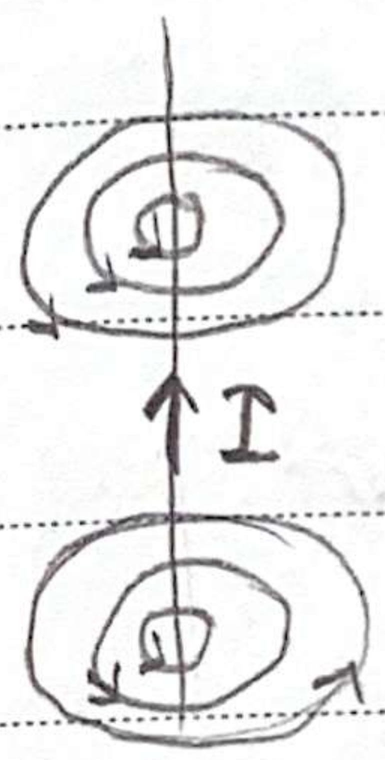
$e = 1.6\times10^{-19}$, $m = 9.1\times10^{-31}$ $\quad a = \frac{v^2}{r}$ $\quad \sin\theta = \sin 90 = 1$,

$v = 2\times10^7$, $B = 0.01\,T$ $\quad F = m.a$

$F = qvB \rightarrow q.v.B = m.\frac{v^2}{r} \Rightarrow r = \frac{mv}{qB} = 1.1\times10^{-2}\,m$

27.10 bu soruyu çözmüş ama oku çünkü çoooooook uzuuuuuun

CHAPTER 28

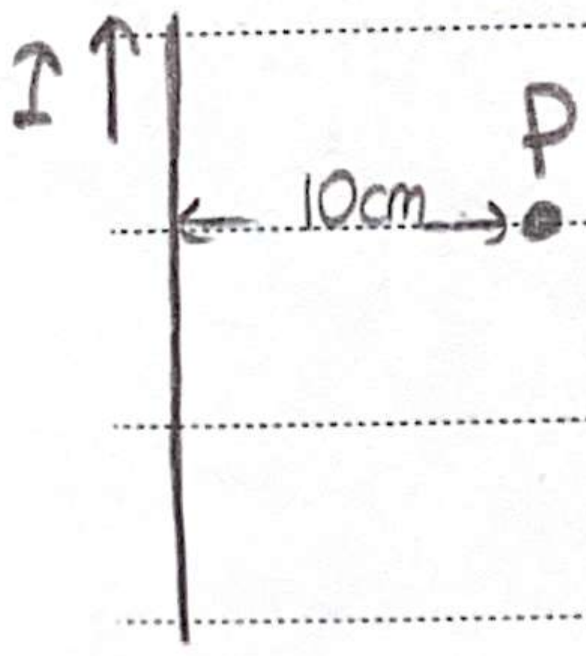


$$B = \frac{\mu_0 . I}{2\pi r}$$

$\mu_0 = 4\pi\times10^{-7}$ Tm/A

↳ the permeability of free

28.1 An electric wire in the wall of a building carries a dc current of 25 A vertically upward. What is the magnetic field due to this current at a point P 10 cm due north of the ware



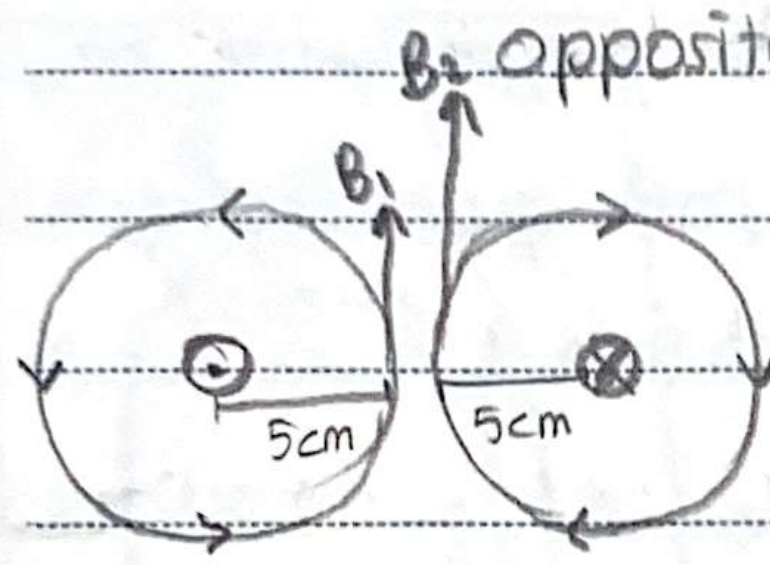
$I = 25A$, $r = 0.1\,m$

$B = \frac{\mu . I}{2\pi r} = \frac{(4\cancel{\pi}\times10^{-7})(25A)}{2\cancel{\pi}\,(0.1m)} \Rightarrow B = 5\times10^{-5}\,T$

B is into the page

Express

28.2 Two parallel straight wires 10 cm apart carry currents in opposite directions. Current $I_1 = 5\,A$ and $I_2 = 7\,A$.



Determine the magnitude and direction of the magnetic field halfway between the two wires.

$I_1 = 5A$, $I_2 = 7A$, $r = 0.05m$

$$B_1 = \frac{\mu_0 \cdot I_1}{2\pi r} = \frac{(4\pi \times 10^{-7})(5A)}{2\pi\,(0.05)} = 2 \times 10^{-5}\,T$$

$$B_2 = \frac{\mu_0 \cdot I_2}{2\pi r} = \frac{(4\pi \times 10^{-7})(7A)}{2\pi\,(0.05)} = 2.8 \times 10^{-5}\,T$$

$B = B_1 + B_2$

$B = 4.8 \times 10^{-5}\,T$ upward

28.4 The two wires of a 2m long appliance cord are 3.00mm apart and carry a current of 8A dc. Calculate the force one wire exerts on the other.

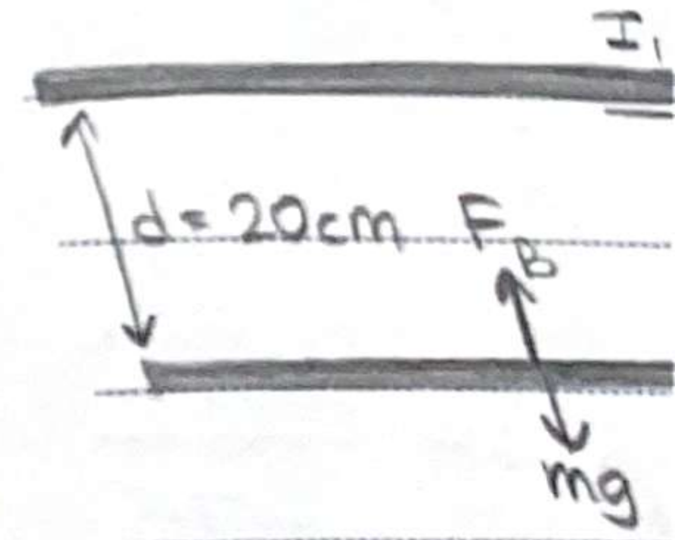
$I_1 = I_2 = 8A$, $l = 2m$, $d = 3 \times 10^{-3}\,m$

$F = I.B.l$

$$F = I_1 \cdot \frac{I_2 \cdot \mu_0}{2\pi d} \cdot l_2 = \frac{(4\pi \times 10^{-7})(8A)(2m)}{2\pi\,(3 \times 10^{-3})} = 8.5 \times 10^{-3}\,N$$

28.5 The low

I_1

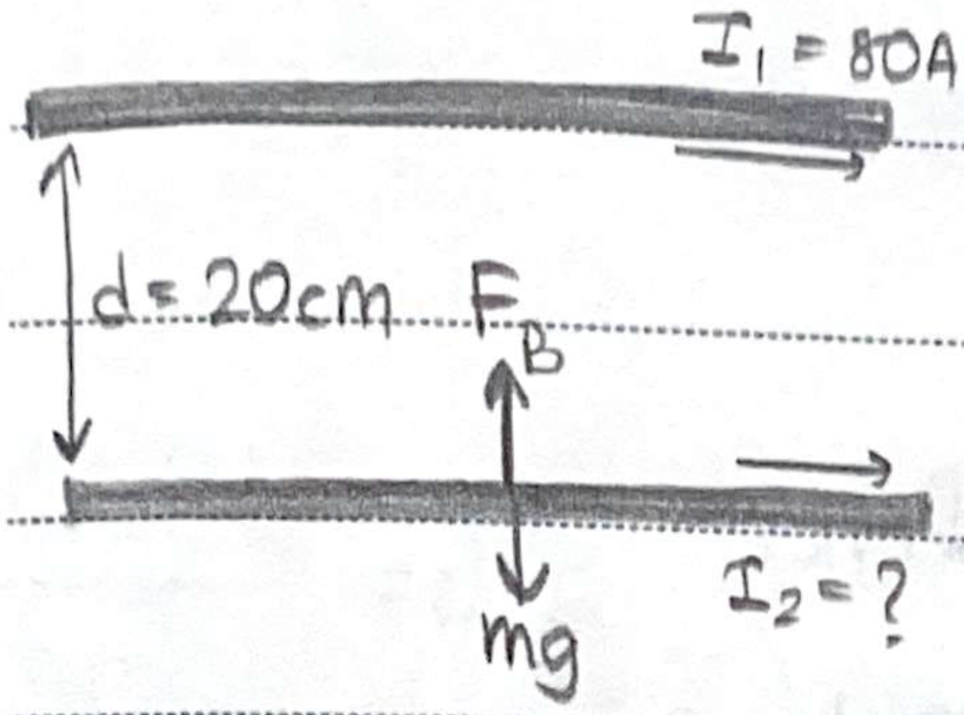


on wire 2

|F

Amp

28.5 The lower wire has a mass of 0.12 g per meter of length.



$F_2 = ?$ so that it doesnt fall due to gravity?

$I_1 = 80A$, $d = 0.2m$

→ the magnetic field must be upward

⇒ the current in the two wires must be same direction

$$F_G = F_B$$

$$F_G = mg = (0.12 \times 10^{-3} \tfrac{kg}{m})(1m)(9.8) \Rightarrow F_G = 1.18 \times 10^{-3} N$$

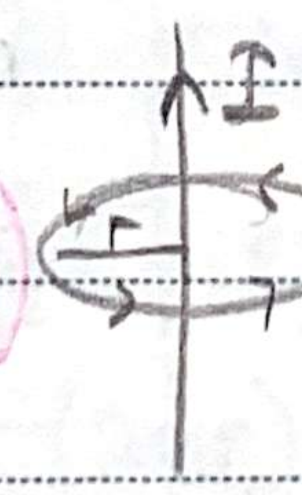
on wire 2 → $F = \dfrac{\mu_0 I_1 I_2 l}{2\pi d}$ $\qquad I_2 = \dfrac{F \cdot 2\pi d}{\mu_0 I_1} = \dfrac{(1.18 \ldots)\, 2\pi (0.2)}{l(1)(4\pi \times 10^{-7})(80)} \Rightarrow I_2 = 15A$

$|F_1 I_1 = I_2 = 1A$ $\qquad \dfrac{F}{l} = \dfrac{\mu_0}{2\pi} \cdot \dfrac{I_1 I_2}{d} = 2 \cdot 10^{-7}\ N/m$

$d = 1m$ $\qquad 1C = 1A.s$

Amperes Law

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 \cdot I_{encl}$$

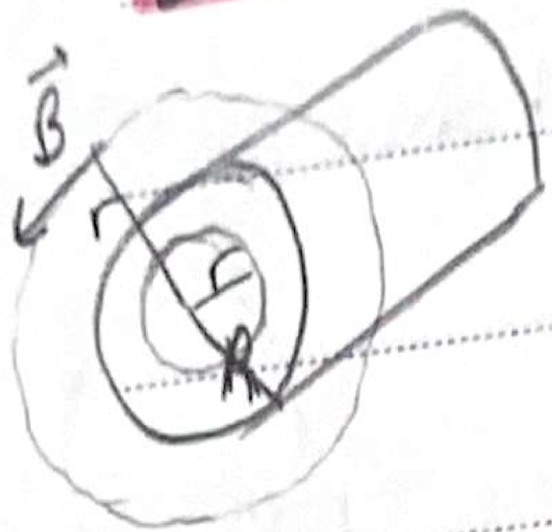


B is tangent to dl at every point

$$B = \frac{\mu_0 \cdot I}{2\pi r}$$ } for straight wire

Record :

28.6 Determine the magnetic field due to this current at



a) points outside the conductor $(r>R)$

For $r>R$

$\oint \vec{B}\,d\vec{l} = B.(2\pi r) = \mu_0 . I_{encl}$

$I_{encl} = I \Rightarrow B.(2\pi r) = \mu_0 . I$

$B = \dfrac{\mu_0 . I}{2\pi r}$

b) points inside the conductor $(r<R)$

πR^2	I
πr^2	I_{encl}

$I_{encl} = \dfrac{I . \pi r^2}{\pi R^2} = \dfrac{I . r^2}{R^2}$

$\oint \vec{B}\,dl = \mu_0 . I_{encl}$

$B.(2\pi r) = \mu_0 . \dfrac{I . r^2}{R^2}$

not : tam merkezde field = 0

$B = \dfrac{\mu_0 . I . r}{2\pi R^2}$

c) If $R = 2.0$ mm and $I = 60A$, what is B at $r = 1.0$ mm, $r = 2.0$ mm and $r = 3.0$ mm ?

For $r = 1$mm, $R = 2$mm

$B = \dfrac{\mu_0 . I . r}{2\pi R^2}$

$B = \dfrac{(4\pi \times 10^{-7} Tm/A)(60A)(1\times10^{-3} m)}{2\pi . (2\times10^{-3} m)^2}$

$\boxed{B = 3\times10^{-3}\,T}$

For $r = 2$mm, $R = 2$mm, $r = R$

$B = \dfrac{\mu_0 . I . r}{2\pi R^2} = \dfrac{\mu_0 . I}{2\pi R}$

$B = \dfrac{(4\pi \times 10^{-7})(60)}{2\pi(2\times10^{-3})} = \boxed{6\times10^{-3}\,T}$

For 3.00m, $R = 2$mm

$B = \dfrac{\mu_0 . I}{2\pi r} = \dfrac{(4\pi \times 10^{-7})(60)}{2\pi(3\times10^{-3})} = \boxed{4\times10^{-3}\,T}$

Express

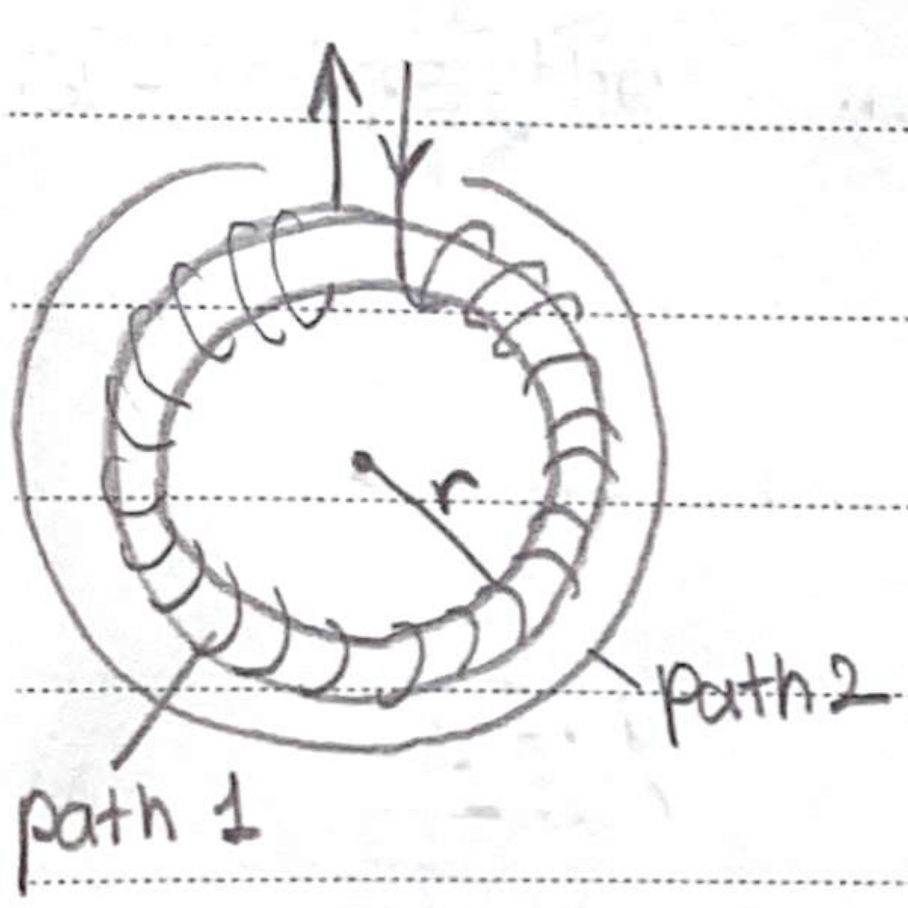
$n = \frac{N}{l}$ $B = \mu_0 . n . I$ } n = number of loops per unit leng

28.9 A thin 10cm long solenoid used for fast electromechanical switching has a total of 400 turns of wire and carries a current of 2.0 A. Calculate the field inside near the center.

$n = \frac{400}{0.1m} = 4 \times 10^3 m^{-1}$ $B = \mu_0 . n . I = (4\pi \times 10^{-7})(4 \times 10^3)(2)$

$\boxed{= 1 \times 10^{-2} T}$

28.10 Use Amperes law to determine the magnetic field



a) inside

⇒ If there is N coils, each carrying current I so,

★ $I_{encl} = N . I$

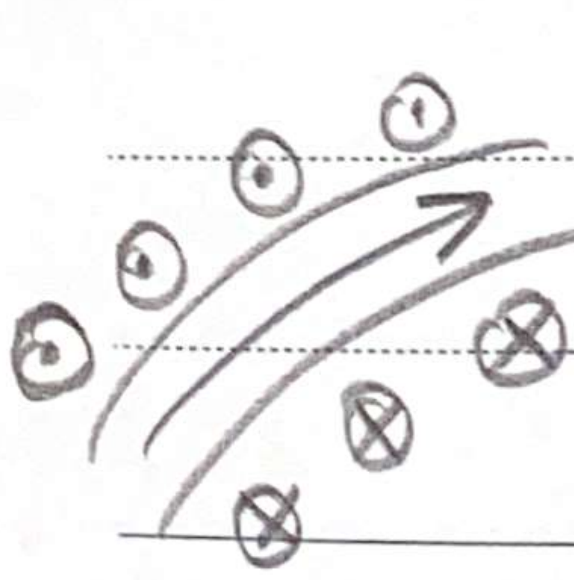
$\oint \vec{B} \vec{dl} = \mu_0 . I_{encl}$

$B . (2\pi r) = \mu_0 . N . I$

$B = \frac{\mu_0 . I . N}{2\pi r}$

b) outside a toroid, which is like a solenoid bent into the shape of a circle as shown.

⇒ By choosing path 2, This part encloses N loops carrying current I in one direction and N loops carrying same current in the opposite direction

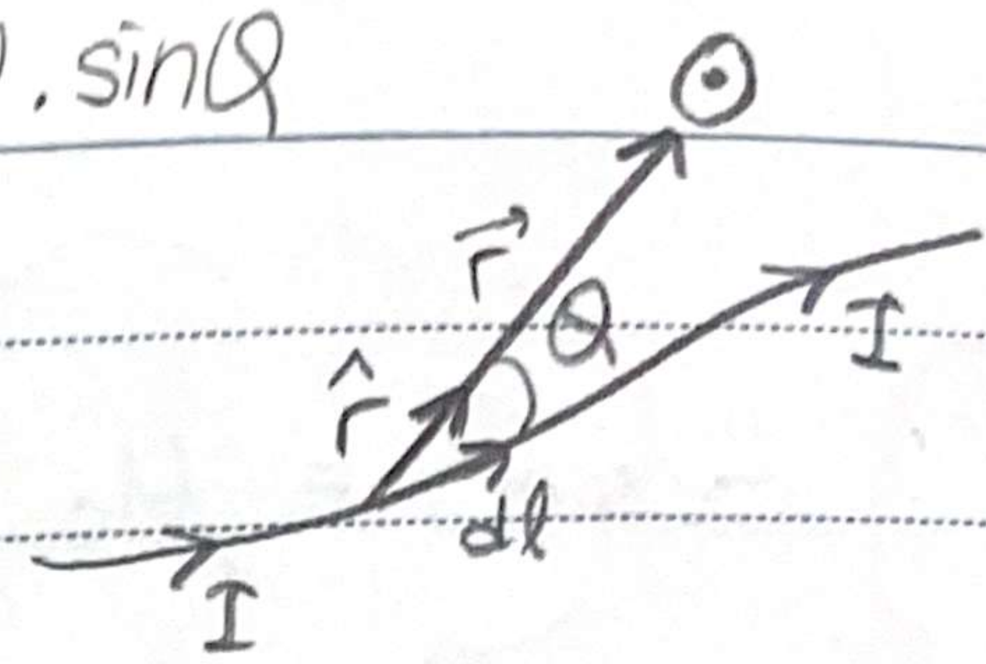


The net current enclosed by path 2 is zero

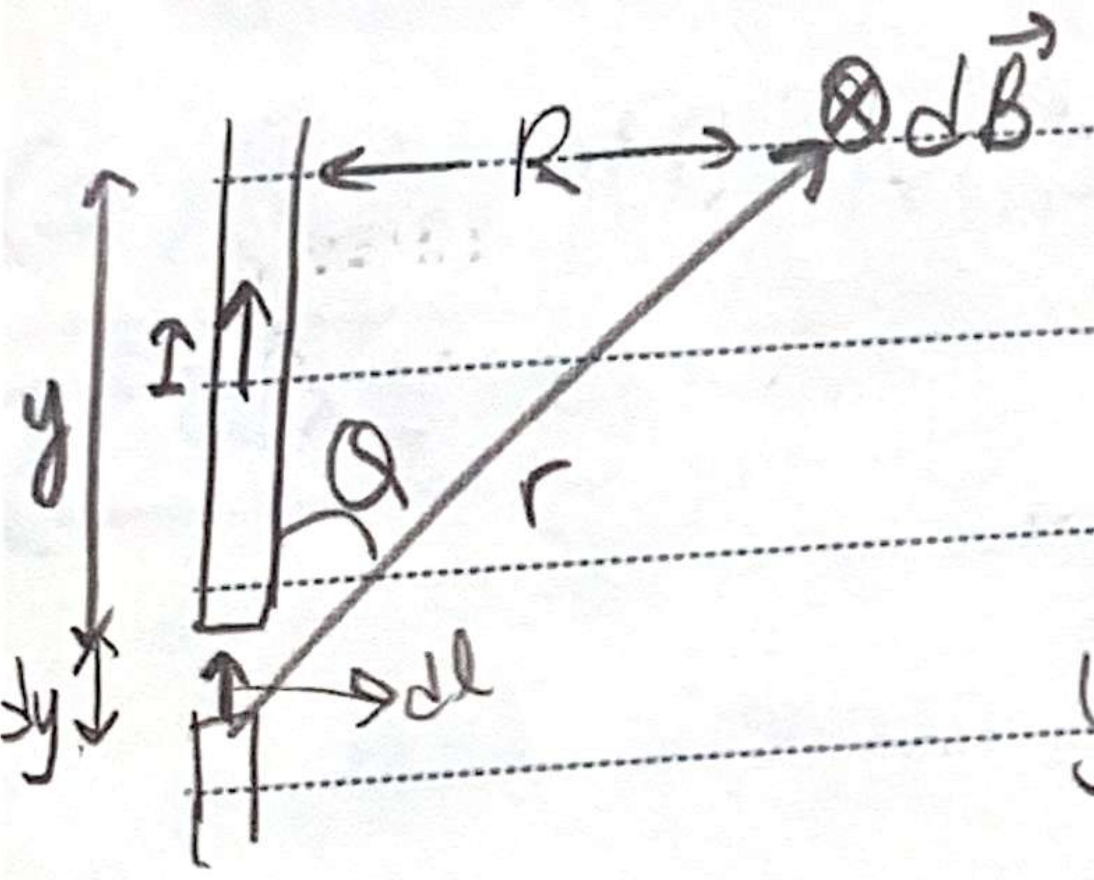
$\oint \vec{B} \vec{dl} = 0 \Rightarrow B = 0$//

Record :

$$dB = \frac{\mu_0 . I}{4\pi} \cdot \frac{\overset{dl.\sin\theta}{dl \times \hat{r}}}{r^2}$$



28.11 For the field near a long straight wire carrying a current I, show that the Biot - Savart law gives $B = \mu_0 I / 2\pi r$



$$B = \frac{\mu_0 I}{4\pi} \int_{-\infty}^{+\infty} \frac{dy . \sin\theta}{r^2} \qquad dy = dl, \quad r = \sqrt{y^2 + R^2}$$

$$y = \frac{-R}{\tan\theta} \Longrightarrow dy = +R . \csc^2\theta . d\theta$$

$$dy = \frac{R . d\theta}{\sin^2\theta} = \frac{R . d\theta}{(R/r)^2} = \frac{r^2 d\theta}{R}$$

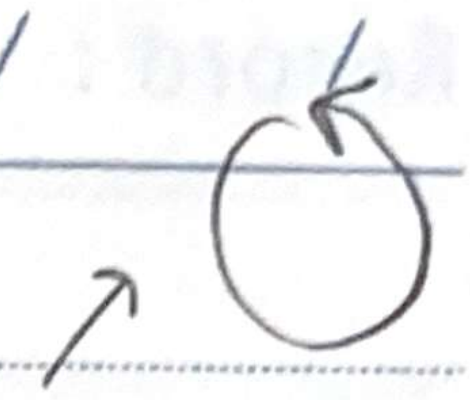
$y = -\infty$ corresponds to $\theta = 0$

$y = +\infty$ " " $\theta = 180° = \pi$

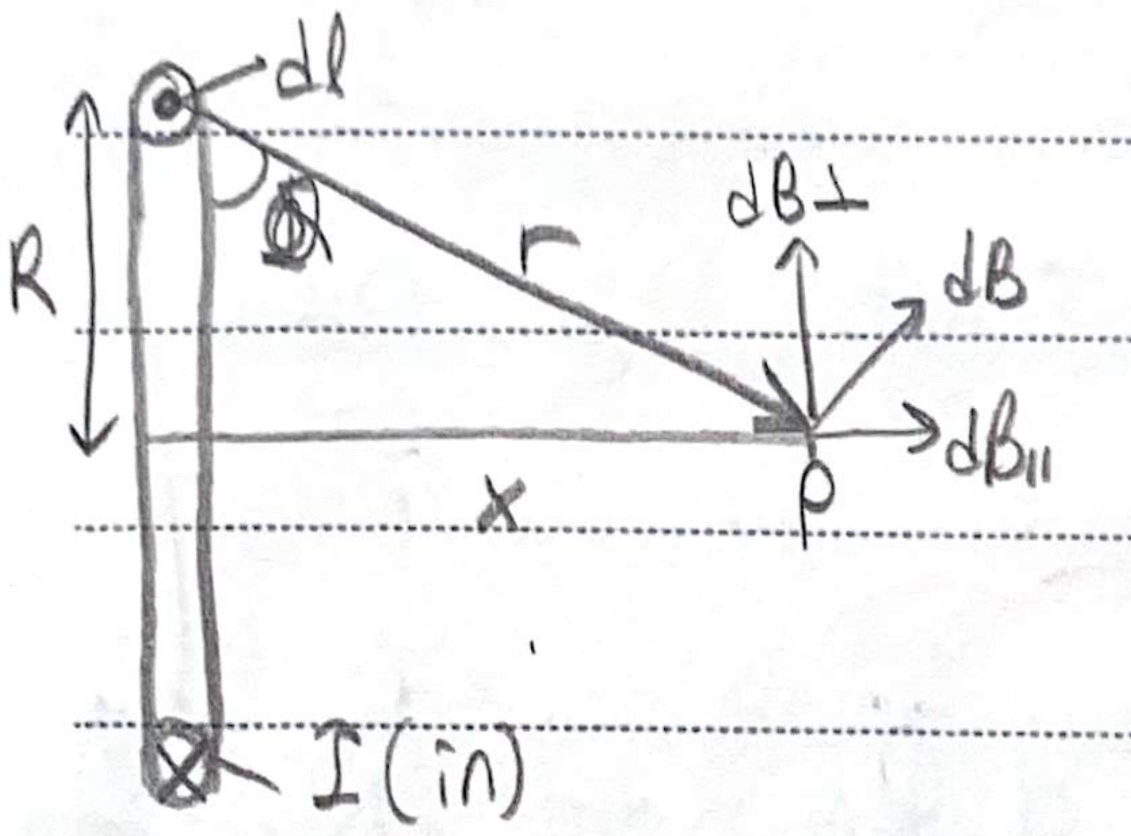
$$B = \frac{\mu_0 I}{4\pi R} \int_0^{\pi} \sin\theta \, d\theta = \frac{-\mu_0 I}{4\pi R} \cos\theta \Big|_0^{\pi} = \boxed{\frac{\mu_0 I}{2\pi R}}$$

for the field near longwire $R = r$ $B = \frac{\mu_0 I}{2\pi R}$

Express



28.12 Determine B for points on the axis of a circular loop of wire of radius R carrying a current I



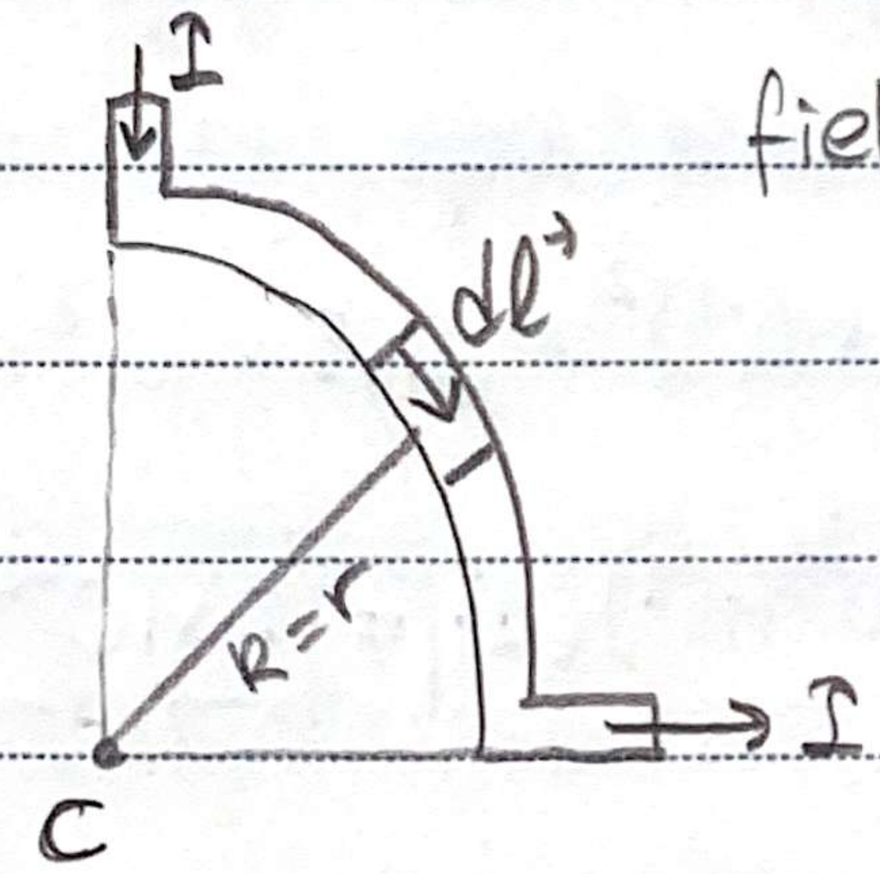
$$dB = \frac{\mu_0 \cdot I \cdot dl}{4\pi r^2} \qquad |\vec{dl} \times \hat{r}| = dl$$

$dB_{\parallel} \rightarrow$ parallel $\quad dB_{\perp} \rightarrow$ perpendicular

$$B = B_{\parallel} = \int dB \cdot \cos\theta = \int dB \frac{R}{r} = \int dB \cdot \frac{R}{\sqrt{R^2+x^2}}$$

$$B = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{R}{(R^2+x^2)^{3/2}} \underbrace{\int dl}_{2\pi r} = \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}} \qquad \text{if } x=0, \rightarrow \frac{\mu_0 I}{2R}$$

28.13 The current I enters and leaves. Find the magnetic field at point C



$\vec{dl} \,/\!/\, \hat{r}$, therefore $\vec{dl} \times \hat{r} = 0$

$$dB = \frac{\mu_0 \cdot I \cdot dl}{4\pi R^2}$$

where $r=R$ is the radius of the section, $\sin 90° = 1$

$$B = \int dB = \frac{\mu_0 \cdot I}{4\pi R^2} \int dl = \frac{\mu_0 . I}{4\pi R^2}\left(\frac{1}{4} \cdot 2\pi R\right) = \boxed{\frac{\mu_0 I}{8R}}$$

Record :

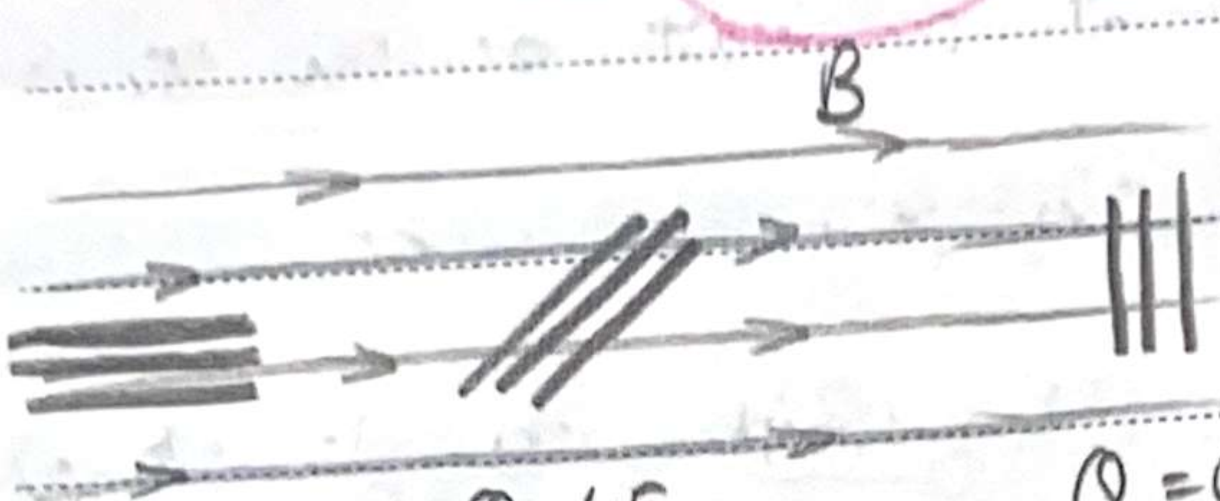
$I = \frac{\mathcal{E}}{R}$

CHAPTER 29

$$\Phi_B = \int \vec{B}\, dA$$

$1 Wb = 1\, T m^2$

$\mathcal{E} = \frac{\Delta \Phi_B}{\Delta t}$



$Q = 90$ $\Phi = 0$

$Q = 45$ $\Phi = BA\cos 45$

$Q = 0$ $\Phi_B = BA$

$$\mathcal{E} = -\frac{d\Phi_B}{dt} \text{ or } -\frac{N . d\Phi_B}{dt}$$

$$= -\frac{N . \Delta\Phi_B}{dt}$$

29.2 A square loop of wire of side $l = 5.0 cm$ is in a uniform magnetic field $B = 0.16 T$ What is the magnetic flux in the loop

magnetic field $B = 0.16T$ What is the magnetic flux in the loop

a) When B is perpendicular to the face of the loop

area $\rightarrow A = l^2 = (5 \times 10^{-2})^2 = 2.5 \times 10^{-3} m^2$

$\Phi_B = \vec{B}\, \vec{A}$

$\Phi_B = B.A.\cos 0 = (0.16\, T)(2.5 \times 10^{-3} m^2)(1) = \boxed{4 \times 10^{-4}\, Wb}$

b) When B is at an angle of 30° to the area A of the loop?

$\Phi_B = B.A.\cos 30° = (0.16\, T)(2.5 \times 10^{-3})(\cos 30) = \boxed{3.5 \times 10^{-4}\, Wb}$

c) Magnitude of the average current in the loop if it has a resistance of $0.012\, \Omega$ and it is rotated from position (b) to (a) in 0.14 s?

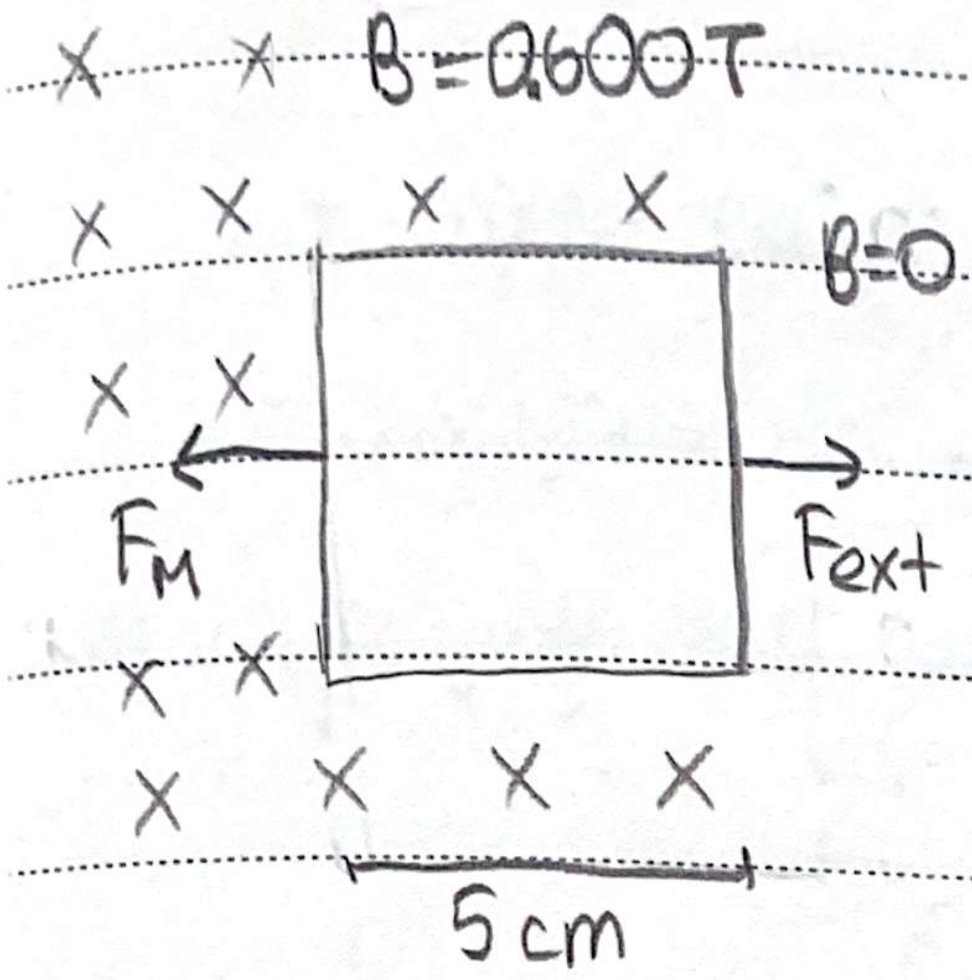
$\mathcal{E} = \frac{\Delta \Phi_B}{\Delta t} = \frac{(4 \times 10^{-4} Wb) - (3.5 \times 10^{-4})}{0.14\, s} = 3.6 \times 10^{-4} V$

$I = \frac{\mathcal{E}}{R} = \frac{3.6 \times 10^{-4}}{0.012\, \Omega} = \boxed{0.030 A = 30 mA}$

Record :

/ /

29.5 A 100 loop square coil of wire, with side $\ell = 5$ cm and total resistance $100\,\Omega$, is positioned perpendicular to a uniform 0.600 T mag. field. It is quickly pulled from the field at constant speed to a region where B drops abruptly to zero. At $t=0$, the right edge of the coil is at the edge of the field. It takes 0.100 s for the whole coil to reach the field free region. Find



a) the rate of change in flux through the coil

$A = \ell^2 = 2.5 \times 10^{-3}\,m^2$

$\Phi_B = B \cdot A = (0.6\,T)(2.5\times10^{-3}\,m^2) = 1.5\times10^{-3}$ Wb

after 0.1 s, the flux is zero $\quad \dfrac{\Delta \Phi_B}{\Delta t} = \dfrac{0-(1.5\times10^{-3})}{0.1} = \boxed{-1.5\times10^{-2}\,Wb/s}$

b) the emf and current induced

the emf induced $\rightarrow \mathcal{E} = -N \cdot \dfrac{\Delta \Phi_B}{\Delta t} = -100 \cdot (-1.5\times10^{-2}) \Rightarrow \boxed{\mathcal{E} = 1.5\,V}$

$I = \mathcal{E}/R = \dfrac{1.5\,V}{100\,\Omega} = \boxed{1.5\times10^{-2}\,A}$

c) How much energy is dissipated in the coil?

$E = P \cdot t = (I^2 R) \cdot t = (1.5\times10^{-2}A)^2(100\,\Omega)(0.1\,s) \Rightarrow \boxed{E = 2.25\times10^{-3}\,J}$

d) What was the average force required (F_{ext})?

$E = W \Rightarrow W = F \cdot d \Rightarrow F = \dfrac{W}{d} = \dfrac{2.25\times10^{-3}\,J}{5\times10^{-2}\,m} \Rightarrow \boxed{F = 45\times10^{-3}\,N}$

$$\mathcal{E} = \frac{d\Phi_B}{dt} = \frac{B\,dA}{dt} = \frac{B\ell v\,dt}{dt} \Big\} \quad \mathcal{E} = B\ell v$$

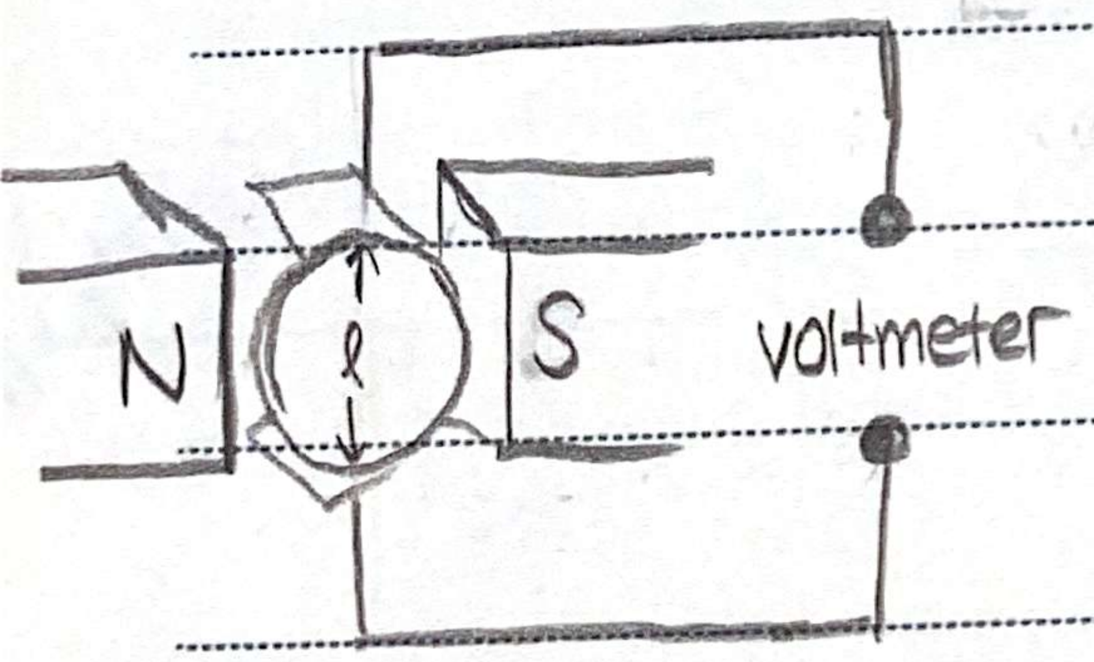
$dA = \ell . dx \Rightarrow dx = v . dt$

29.6 An airplane travels 1000 km/h in a region where the Earths magnetic field is about 5×10^{-5} T and is nearly vertical. What is the potential difference induced between the wing tips that are 70 m apart?

$v = 1000$ km/h $= 280$ m/s $\quad \vec{v} \perp \vec{B}$

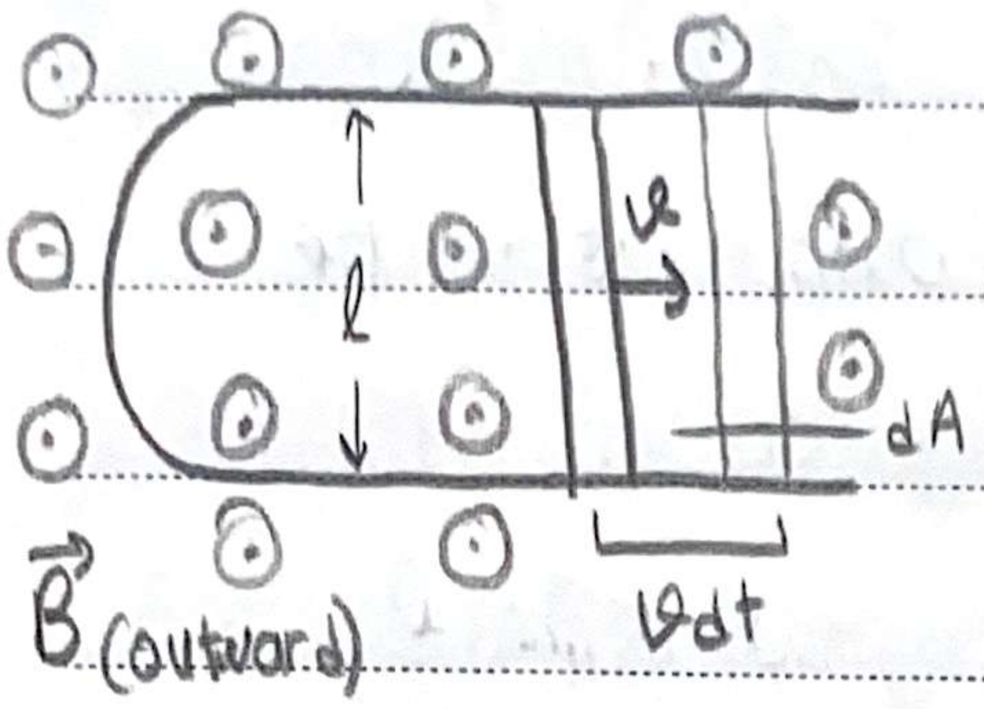
$\mathcal{E} = B\ell v = (5 \times 10^{-5}\,T)(70\,m)(280\,m/s) \approx \boxed{\mathcal{E} = 1V}$ //

29.7 The rate of blood flow in our body's vessels can be measured using the apparatus shown, since blood contains charged ions. Suppose that the blood vessel is 2.00 mm in diameter, the magnetic field is 0.080 T, and the emf is 0.10 mV. What is the flow velocity?



$$v = \frac{\mathcal{E}}{B.\ell} = \frac{1.10^{-4}\,V}{(0.08\,T)(2 \times 10^{-3})} = \boxed{0.63\,m/s}$$ //

29.8 To make the rod move to the right at speed v, you need to apply an external force on the rod to the right.



a) Explain and determine the magnitude of the required force.

$$\vec{F} = I . \vec{l} \times \vec{B}$$

→ the magnetic of external force to the right needs to balance the magnetic force.

$$F = I . l . B \text{ to the left}$$

$$I = \frac{\mathcal{E}}{R} = \frac{Blv}{R} \qquad F = \left(\frac{Blv}{R}\right) . lB = \boxed{\frac{B^2 l^2}{R} . v}$$

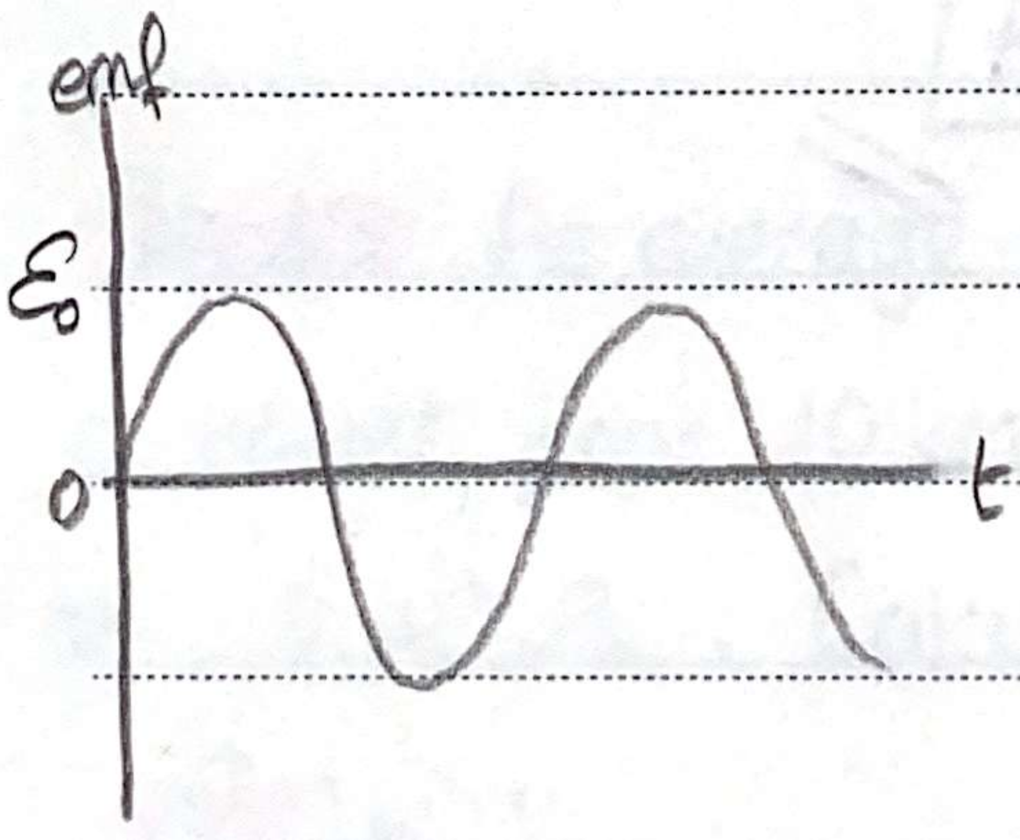
b) What external power is needed to move the rod?

$$P_{ext} = F . v = \frac{B^2 l^2 v^2}{R} \qquad P_R = I^2 . R$$

$$I = \frac{\mathcal{E}}{R} = \frac{Blv}{R} \qquad \boxed{P_R = \frac{B^2 l^2 v^2}{R}}$$

so the power input equals the power dissipatred in the resistance

electric generators



$$\mathcal{E} = -BA \frac{d}{dt} (\cos \omega t)$$

$$\mathcal{E} = BA\omega \sin \omega t$$

For N loops,

↳ $\mathcal{E} = N . BA\omega \sin \omega t$

$\mathcal{E}_0 = N . BA\omega$

$\mathcal{E} = \mathcal{E}_0 . \sin \omega t$