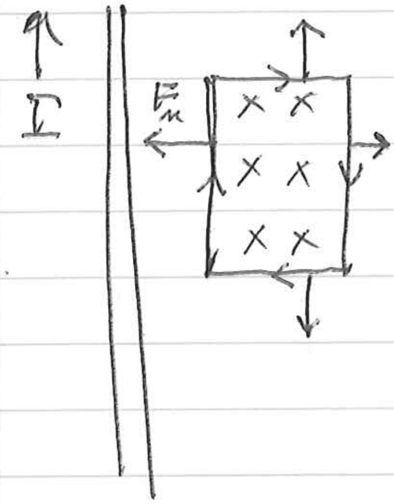
Homework 8 Solutions

(Q 29.9) $\frac{dI}{dt} < 0$



Current flows to maintain inward $\underset{\sim}{B}$.
$\Rightarrow$ clockwise current
The largest force is on the upward current closest to the wire

$\underset{\sim}{F} = I \underset{\sim}{L} \times \underset{\sim}{B} \Rightarrow$ toward the wire

Forces from currents to left and right cancel

(29.2)

$B = 6 \times 10^{-6}\,T$

a) Magnetic flux before rotating

initial flux $\Phi_i = BA = 6 \times 10^{-5}\,T \; 12 \times 10^{-4}\,m^2$

$= 7.2 \times 10^{-8}\,T m^2$

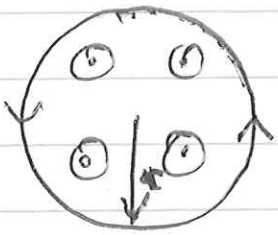
final flux $\Phi_f = 0$

b) what is the average emf?

$\mathcal{E}_{av} = N \frac{1}{\Delta t} \int dt \frac{d\Phi}{dt} = N \frac{\Delta \Phi}{\Delta t} = \frac{7.2 \times 10^{-8}}{0.04}\,V$ 200

$= 3.6 \times 10^{-4}\,V$

29.14



$R = 0.16\,\Omega$

$\frac{dB}{dt} = -0.68\,\frac{T}{s}$, $r = 0.048\,m$

a) Current flows to maintain outward flux
$\Rightarrow$ current counterclockwise

b)

$$\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{dB}{dt}A$$

$$\mathcal{E} = .68\frac{T}{s}\,\pi\,(0.048)^2\,m^2$$

$$= 6.8(\pi)(.48)^2 \times 10^{-3}\ V$$

$$= 4.9 \times 10^{-3}\ V$$

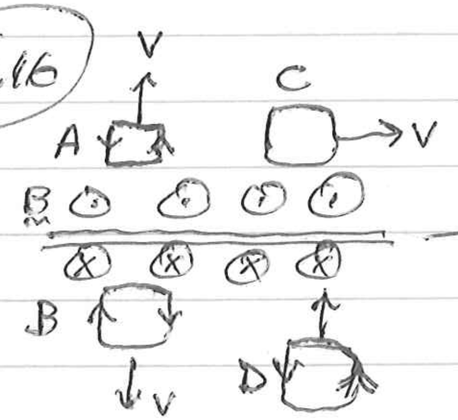
$$I = \frac{\mathcal{E}}{R} = \frac{4.9 \times 10^{-3}}{0.16}\ A = 3.08 \times 10^{-2}\ A$$

Power dissipation $= \mathcal{E}I$

$$= 4.9 \times 10^{-3}\ V\ 3.08 \times 10^{-2}\ A$$

$$= 1.5 \times 10^{-4}\ \text{watts}$$

29.16



a) A counterclockwise
B clockwise
C zero
D counterclockwise

For A: current flows to prevent outward flux from decreasing

For B: current flows to prevent inward flux from decreasing.

For C: no flux change so no current

For D: current flows to prevent inward flux from increasing.

b) Find forces on loops. Force is dominated by current flowing along the wire direction and closest to the wire. Forces from currents ~~A: Attraction~~ ⊥ to wire cancel.

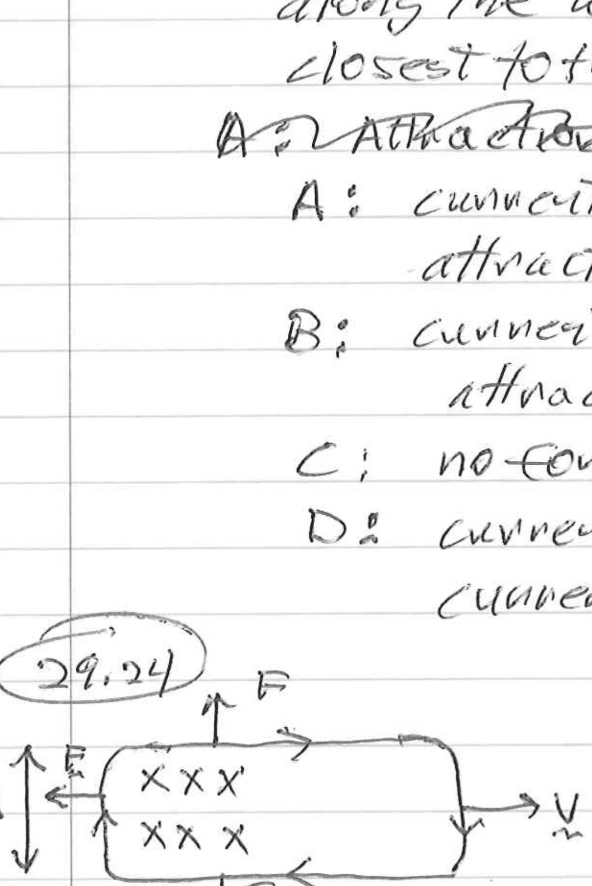
A: current is parallel to wire so attracts

B: current parallel to wire so attracts

C: no force

D: current anti-parallel to wire current so repells

(29.24)



Clockwise current to maintain flux into page

$a = 1.5\,cm$

$R = 0.6\,\Omega$

$B = 2.4T$

$$\mathcal{E} = B\frac{dA}{dt} = BaV$$

$$= 2.4T\ 0.015m\ 3.0\frac{m}{s}$$

$$= 1.08 \times 10^{-1}\ V$$

$$I = \frac{\mathcal{E}}{R} = \frac{.108\ V}{.6\ \Omega} = 0.18\ A$$

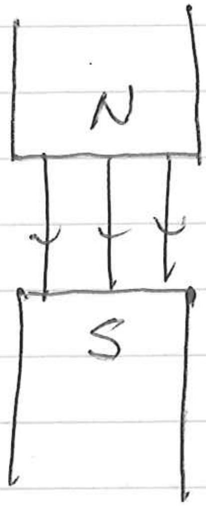
Force from upward current on the left

$$F = ILB = 0.18A\ 0.015m\ 2.4T$$

$$= 6.5 \times 10^{-3}\ N$$

Forces from horizontal currents cancel.

29.34



view from S pole

current counter. clockwise to maintain outward flux through the loop.

$$\mathcal{E} = -\frac{d\Phi}{dt}$$

$$= -A\frac{dB}{dt}$$

$$= -\pi r^2 \frac{dB}{dt}$$

$$= \pi (2.25)^2\, 10^{-4} m^2\, \frac{0.25\,T}{s}$$

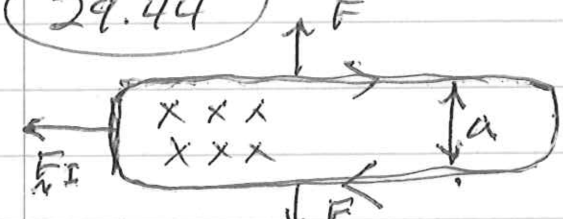
$$= 4 \times 10^{-4}\, V$$

$$\oint \underset{\sim}{E} \cdot d\underset{\sim}{l} = \mathcal{E} = E\, 2\pi r$$

$$E = \frac{\mathcal{E}}{2\pi r} = \frac{4 \times 10^{-4}\, V}{2\pi\, 2.25 \times 10^{-2}\, m}$$

$$= 2.8 \times 10^{-3}\, \frac{V}{m}$$

29.44



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

$F_{ext} = 0.18\, N$

$m = 2.4 \times 10^{-2}\, kg$

$R = 5 \times 10^{-3}\, \Omega$

a) For $V = 3 \times 10^{-2}\, m/s$, what is acceleration?

Find emf. Current clockwise.

$$\mathcal{E} = -B\frac{dA}{dt} = +BaV$$

$$= 2.9\,T\; 4 \times 10^{-2}\, m\; 3 \times 10^{-2}\, \frac{m}{s} = 3.5 \times 10^{-3}\, V$$

$$I = \frac{\mathcal{E}}{R} = \frac{3.5\times10^{-3}\,V}{5\times10^{-3}\,\Omega} = 0.7A$$

$$F_I = ILB = 0.7A\ 4\times10^{-2}m\ 2.9T$$

$$= 8.1\times10^{-2}N$$

$$F_{tot} = F_{ext} - F_I = (0.18 - 0.081)N$$
$$= 0.1\,N$$

$$a = F_{TOT}/m = \frac{0.1N}{2.4\times10^{-2}kg}$$

$$= 4.2\,\frac{m}{s^2}$$

b) What is the terminal speed?

⇒ want $F_I = F_{ext}$

For $V_0 = 3\times10^{-2}m/s$, $F_I = 0.081\,N$

$$F_{ext} = 0.18N = \frac{0.081N\ V_t}{3\times10^{-2}m/s}$$

$$V_t = \frac{0.18N}{0.081N}\ 3\times10^{-2}\frac{m}{s}$$

$$= 6.7\times10^{-2}\frac{m}{s}$$

⇒ no acceleration at terminal speed.

c) No emf and current when loop is out of B

$$a = \frac{0.18N}{2.4\times10^{-2}kg} = 7.5\,\frac{m}{s^2}$$