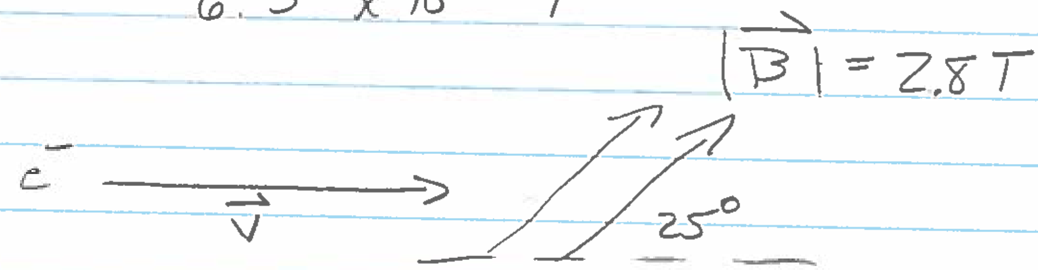
Solutions Exam 2 S15 PHY 2005

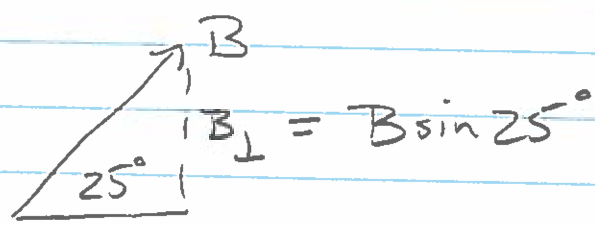
1. Magnetic field inside long solenoid:

$$B = \mu_0 n I \qquad n = \text{turns}/m$$

$$= \left(4\pi \times 10^{-7}\,\frac{N}{A^2}\right)\frac{250}{0.2\,m}(4\,A)$$

$$= 6.3 \times 10^{-3}\,T$$

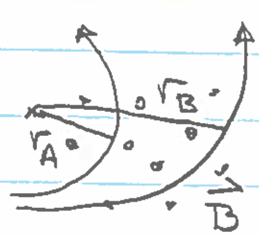
2. 



RH rule gives v B out of paper, but e^- has negative charge, so force is into paper

magnitude $evB = (1.6 \times 10^{-19}\,C)(4.0 \times 10^{5}\,\frac{m}{s})(2.8\,T)$

$$= 7.6 \times 10^{-14}\,N \text{ into paper}$$

3. 

Equate centripetal and magnetic forces

$$q\cancel{v}B = \frac{m_A v^{\cancel{2}}}{r_A}$$

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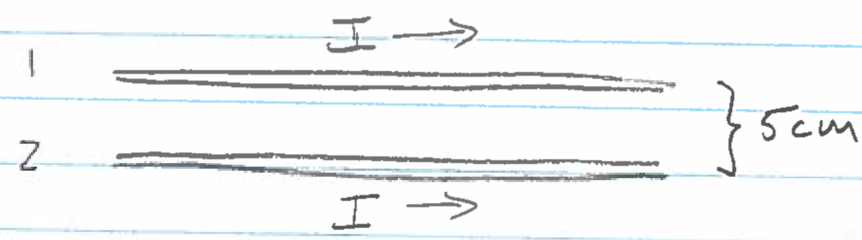
$$v_A = v_B = v$$

$$\frac{m_B}{m_A} = \frac{\cancel{qB}\, r_B}{\cancel{qB}\, r_A} = \frac{r_B}{r_A}$$

$$m_B = m_A\left(\frac{r_B}{r_A}\right) = (10\,u)\left(\frac{12.84\text{ cm}}{5.35\text{ cm}}\right)$$

$$= 24\,u$$

4.

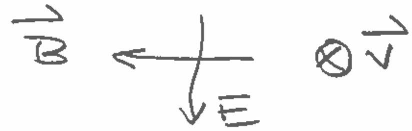


B on 1 due to 2 $= \dfrac{\mu_0 I}{2\pi r}$

Force on 2 due to B is

$$IlB = Il\left(\frac{\mu_0 I}{2\pi r}\right) \propto I^2$$

$\Rightarrow$ Increase I by 2 $\Rightarrow$ F increases by 4!



5. Electric force points <u>up</u> (e^- is negative)

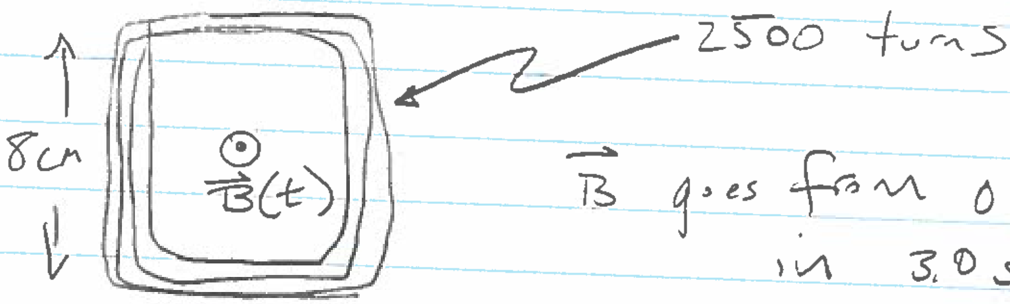
Magnetic force (rh rule) points <u>down</u>
(v B force is up, but e^- neg.)

Therefore they can cancel to give zero net force <u>if</u>

$$\not{e} v B = \not{e} E \Rightarrow B = \frac{E}{v}$$

$$= \frac{2000 \text{ V/m}}{7000 \text{ m/s}} = 0.29 \text{ T}$$

6.



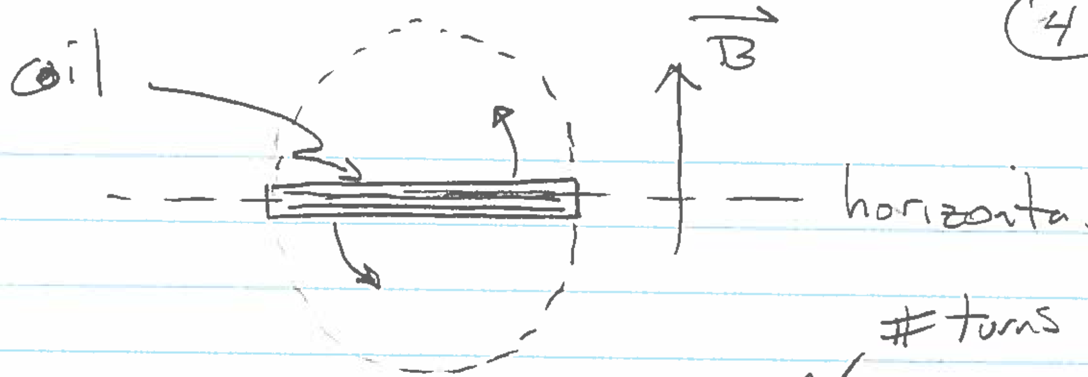
$\vec{B}$ goes from 0 to 1.5 in 3.0 s

Faraday: $V_{ind} = -\frac{\delta \Phi}{\delta t} = \frac{N A \delta B}{\delta t}$ (N = # turns)

$$\frac{(2500)(0.08\text{m})^2(1.5\text{T} - 0\text{T})}{3.0\text{s}}$$

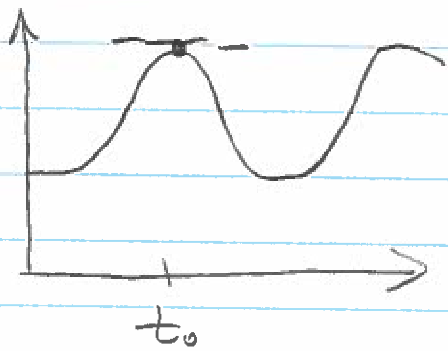
$$= 8.0 \text{ V}$$

7.



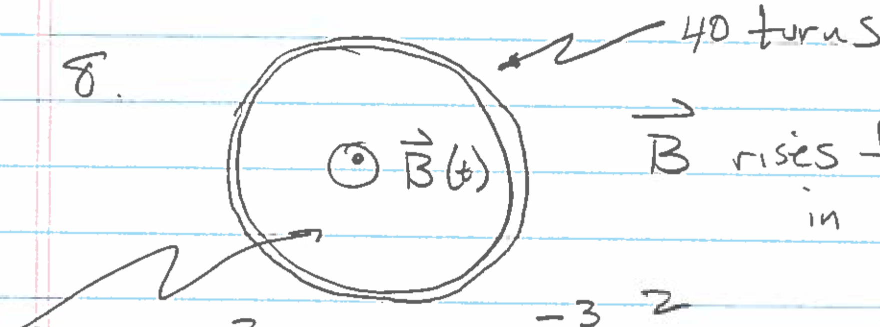
Faraday $V_{ind} = -\frac{\delta \Phi}{\delta t} = -NB\frac{\delta A_\perp}{\delta t}$ (# turns)

Perpendicular area $A_\perp(t)$



when $A_\perp$ is max (loop horizontal), rate of change of flux is zero!

8.



$\vec{B}$ rises from 1.0 T to 5.0 T in 4.0 s

$A = 25\ cm^2 = 2.5\times10^{-3}\ m^2$

$V_{ind} = -\frac{\delta \Phi}{\delta t} = -NA\frac{\delta B}{\delta t} = 40\,(2.5\times10^{-3}\ m^2)\left(\frac{4.0\,T}{4.0\,s}\right)$ (# turns)

$= 0.1\ V$

Ohm's law $I = V_{ind}/R = \frac{0.1\ V}{0.4\ \Omega} = 0.25\ A$

$= 250\ mA$

other problems beyond scope of course