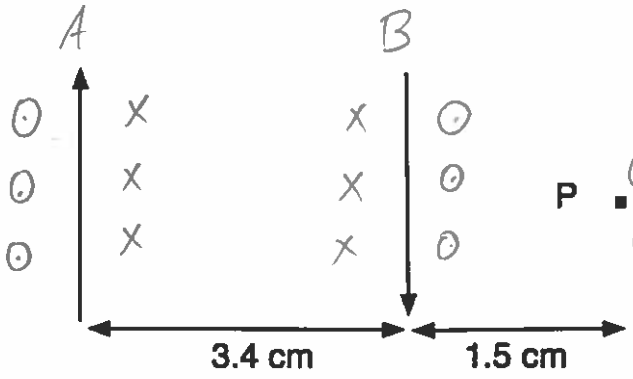
Physics 10164 - Exam 2A

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. (30 pts) Wire A has a current of 8.5 A pointing toward the top of the page (+y). Wire B has a current of 2.4 A pointing toward the bottom of the page (-y).

a) (15 pts) Find the magnitude and direction of the magnetic field at point P.

b) (15 pts) An electron is passing through point P with a velocity of 2.4×10^5 m/s in a direction 35° below +x. Find the magnitude (5 pts) and direction (10 pts) of the electron's acceleration.



$B_A = \mu_0(8.5)/2\pi(.049)$

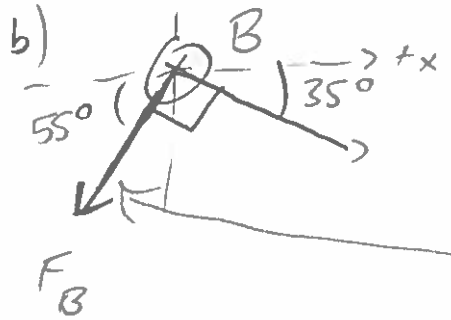
$B_B = \mu_0(2.4)/2\pi(.015)$

$B_{TOT} = +B_B - B_A = +32\,\mu T - 34.7\,\mu T$

$= -2.7\,\mu T$

$= \boxed{2.7\,\mu T, \otimes}$

b)



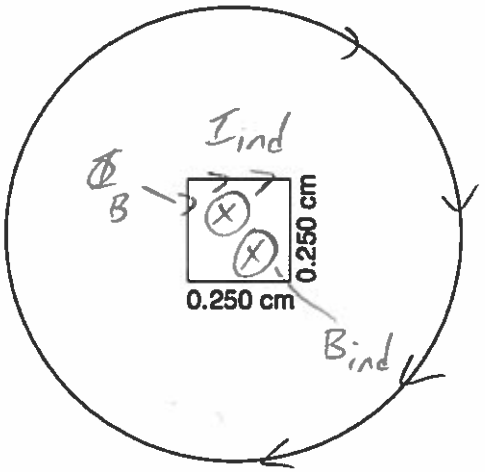
(using left hand rule)

$a = \frac{F_B}{m} = \frac{qvB\sin 90}{m}$

$= \boxed{1.1 \times 10^{11}\ m/s^2 \text{ at } 55° \text{ below } -x}$

2. (35 pts) A solenoid contains 235 turns/cm and a clockwise current of 0.450 Amps as seen from one end. There is a small square loop with 133 turns positioned along the axis of the solenoid.

The plane of the square loop is perpendicular to the axis of the solenoid, and it has a resistance of 0.158 Ohms. The current in the solenoid drops to zero in a time interval of 0.320 seconds. During this interval, what is the magnitude and direction of induced current in the square loop?



$$B_{Sol} = \frac{\mu_0 N I}{\ell}$$

$$= \frac{(4\pi \times 10^{-7})(235)(.450)}{.01}$$

$$= 1.33 \times 10^{-2}\ T$$

$$|\mathcal{E}_{ind}| = N\frac{\Delta \Phi_B}{\Delta t} = \frac{N \Delta B A \sin\theta}{\Delta t}$$

$$= \frac{(133)(1.33 \times 10^{-2})(.00250)^2(1)}{0.320} = 0.345 \times 10^{-4}$$

$$I_{ind} = \mathcal{E}_{ind}/R = \frac{.345 \times 10^{-4}}{.158} = \boxed{2.18 \times 10^{-4}\ A}$$

$\Phi_B = \otimes$, decreasing

$\Rightarrow B_{ind} = \otimes \Rightarrow \boxed{I_{ind} = \text{clockwise}}$

#3. (35 pts) An AC circuit contains a 120-Volt rms voltage source, a 12 Ohm resistor, and a 38 mH inductor.

a) When operated at a frequency of 60.0 Hz, what is the average power dissipated by the resistor?
b) At 120 Hz, what is the power dissipated by the resistor?
c) At 120 Hz, what is the maximum value of the current?
d) At 120 Hz, what is the maximum value of the voltage drop across the inductor?
e) When the current has its maximum value found in part c, what is (i) the voltage drop across the inductor and (ii) the voltage drop across the source? Justify each answer.

a) $X_L = 2\pi(60)(.038) = 14.3\ \Omega$

$Z = \sqrt{R^2 + X_L^2} = 18.7\ \Omega$

$I_{rms} = \frac{120}{Z} = 6.42\ A$

$P_{avg} = I_{rms}^2 R = \boxed{490\ \text{Watts}}$

b) $X_L = 2\pi(120)(.038) = 28.65\ \Omega$

$Z = \sqrt{R^2 + X_L^2} = 31.06\ \Omega \Rightarrow I_{rms} = \frac{\mathcal{E}_{rms}}{Z} = 3.86\ A$

$P_{avg} = (3.86)^2(12) = \boxed{180\ \text{Watts}}$

c) $I_{max} = I_{rms}/.707 = \boxed{5.5\ A}$

d) $\Delta V_{L,MAX} = I_{max} X_L = \boxed{160\ \text{Volts}}$

e) $\boxed{\Delta V_L = 0}$ since I 90° out of phase with ΔV_L

$\Delta V_R = I_{max} R = 66\ V$

so $\boxed{\Delta V_{\mathcal{E}} = 66\ V}$ according to loop rule