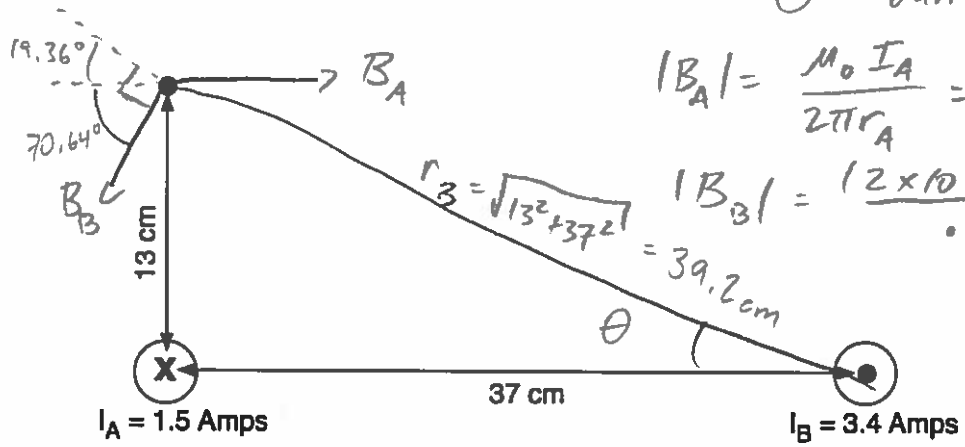
Physics 10164 - Exam 2A C

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. (35 pts) Wire A is located at the origin and carries a current of 1.5 Amps into the page. Wire B is located at coordinate x = 37 cm and carries a current of 3.4 Amps out of the page. Find the magnitude and direction of the total magnetic field due to these two wires at y = 13 cm.

$$\theta = \tan^{-1}\left(\frac{13}{37}\right) = 19.36^\circ$$



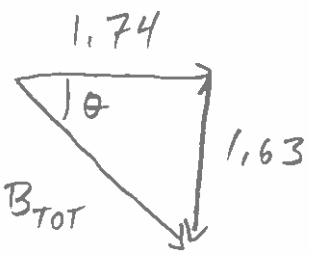
$$|B_A| = \frac{\mu_0 I_A}{2\pi r_A} = \frac{(2\times10^{-7})(1.5)}{.13} = 2.3\,\mu T$$

$$|B_B| = \frac{(2\times10^{-7})(3.4)}{.392} = 1.73\,\mu T$$

$B_{A,x} = 2.31$ $\qquad$ $B_{A,y} = 0$

$B_{B,x} = -1.73\cos 70.64^\circ = -0.57$ $\qquad$ $B_{B,y} = -1.73\sin 70.64^\circ = -1.63$

$B_{TOT,x} = 1.74$ $\qquad$ $B_{TOT,y} = -1.63$

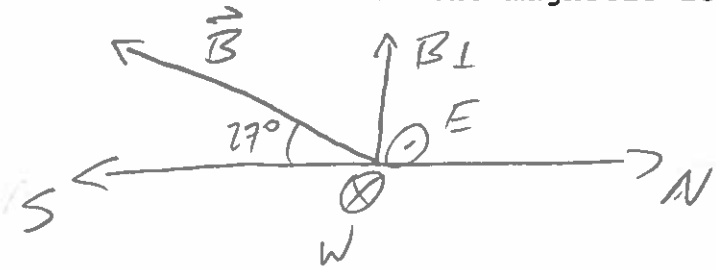


$$B_{TOT} = \sqrt{1.74^2+1.63^2} = \boxed{2.4\,\mu T}$$

$$\theta = \tan^{-1}\left(\frac{1.63}{1.73}\right) = \boxed{43^\circ \text{ below } +x}$$

2. (35 pts) A 1.2-meter long thin conducting rod oriented North-South moves East with a speed of 7500 m/s through a 4.5 μT magnetic field that points 27° vertically above due South.

a) What is the magnitude of the induced EMF in the rod?
b) Which end of the rod is positive, North or South?
c) If current flows through the rod in the direction that positive charges are forced, what is the magnitude and direction of the magnetic force on the rod?



a) $\mathcal{E}_{ind} = B_\perp l v = (4.5 \times 10^{-6} \sin 27°)(1.2)(7500)$

$= .018$ V

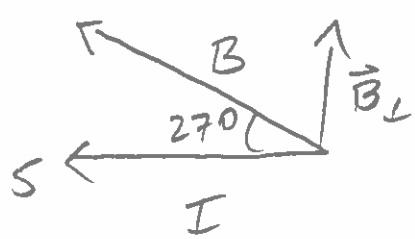
b) $\vec{F}_B = q\vec{v} \times \vec{B}$

p t f

E up

F_B must point South so + charges gather there.

c)



p t f

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

S up

Can't find I since no R given. oops.

F_B must point ⊗ = West

#3. (30 pts) A generator has an maximum voltage of 250 Volts and is connected in series to a 0.13 Ω resistor, a 78 mH inductor and a 65 μF capacitor. The generator is initially operating at the resonant frequency of this circuit.

a) What is the value of X_L at the resonant frequency?
b) What is the value of X_C at the resonant frequency?
c) What is the power dissipated by the resistor at this frequency?
d) If the frequency is reduced to a level 8.0% below the resonant frequency, what is the power dissipated by the resistor?

$$f_0 = \frac{1}{2\pi\sqrt{(.078)(65\times10^{-6})}} = 70.683\ Hz$$

a) $X_L = 2\pi(70.683)(.078) = 34.64 \approx 35\ \Omega$

b) $X_C = \frac{1}{2\pi(70.683)(65\times10^{-6})} = 34.64 \approx 35\ \Omega$

c) $\mathcal{E}_{rms} = \frac{250}{\sqrt{2}} = 176.8\ V$

$I_{rms} = 176.8/Z = 176.8/.13 = 1359.8\ A$

$P_{diss} = I_{rms}^2 R = 240{,}000$ Watts

d) $X_L = 2\pi(65.03)(.078) = 31.87\ \Omega$

$X_C = \frac{1}{2\pi(65.03)(65\times10^{-6})} = 37.65\ \Omega$

$Z = \sqrt{.13^2 + 5.78^2} = 5.78$

$I_{rms} = 176.8/5.78 = 30.57\ A$

$P_{diss} = (30.57)^2(.13) = 120$ Watts