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) A household circuit is set up so that a 120 Volt source powers appliances that are connected in parallel. Three appliances on this circuit are turned on: a 950 Watt toaster oven, a 1200 Watt microwave, and a 1600 Watt oven.

a) If the main wire connected to the 120 Volt source has a 35 Amp circuit breaker, will the circuit be broken? Justify your answer mathematically.

b) Let's say there is no circuit breaker, so the wires can theoretically handle as much current as you wish. If you add another device in parallel to the circuit, like a 750 Watt blender, what will happen to the current going through the microwave? Will it increase, decrease or remain the same? Justify your answer mathematically or logically.

$P_1 = I_1 \Delta V_1 = 950 \qquad I_1 = \frac{950}{120} = 7.92A$

$P_2 = I_2 \Delta V_2 = 1200 \qquad I_2 = \frac{1200}{120} = 10 A$

$P_3 = I_3 \Delta V_3 = 1600 \qquad I_3 = \frac{1600}{120} = 13.3A$

$I_{TOT} = 31.25 A$

$I_{TOT} = 31.25 < 35.0 A$, so circuit doesn't break.

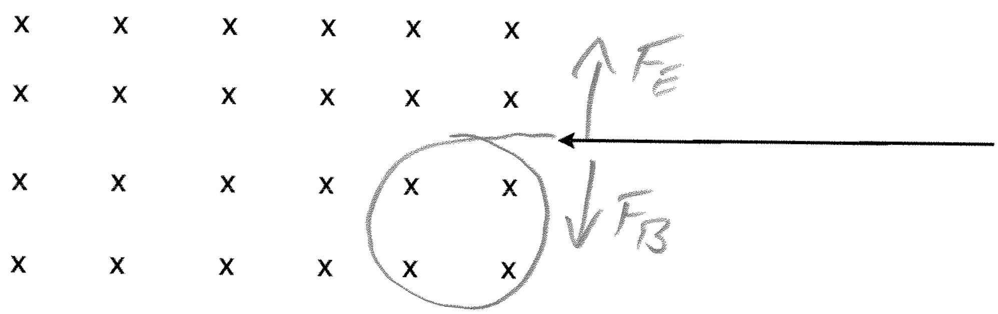
b) Adding another device in parallel will not change existing branches. ΔV still 120 Volts, so I should remain the same.

2. (35 pts) A proton is accelerated from rest to a speed of 7500 meters/sec by an electric potential difference. The proton enters a region with a uniform magnetic field of 0.45 Tesla pointing into the page as shown below.

a) What is the electric potential (voltage) through which the proton passed? Be sure to get the sign right!

b) What must be the magnitude and direction of the uniform electric field in the region of the uniform magnetic field in order for the proton to travel in a straight line?

c) If the electric field is turned off, (i) sketch the path of the proton through the magnetic field and (ii) determine the radius of the circle that the proton will move in.



a) $W_E = -\Delta U_E = -q\Delta V = \frac{1}{2}mv^2 - 0$

$$\Delta V = \frac{\frac{1}{2}(1.67\times10^{-27})(7500)^2}{1.60\times10^{-19}} = \boxed{-0.29 \text{ Volts}}$$

+ moves from high → low V, so ΔV negative

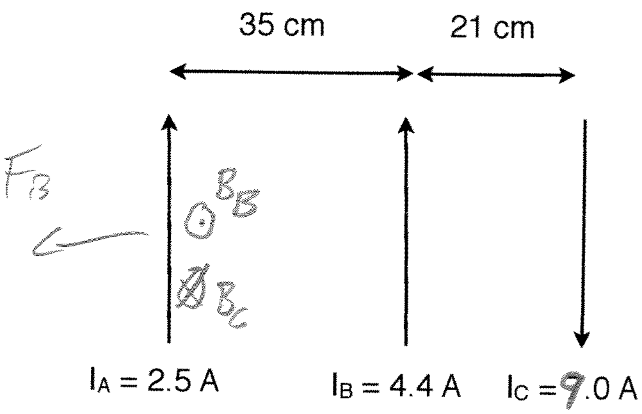
b) F_B points ↓, so F_E must point ↑

Need $qvB = qE$, so $E = vB =$ (3400 V/m, ↑)

c) Circular path: $\frac{mv^2}{r} = qvB$

$$r = \frac{mv}{qB} = \frac{(1.67\times10^{-27})(7500)}{(1.60\times10^{-19})(0.45)} = (.00017 \text{ m})$$

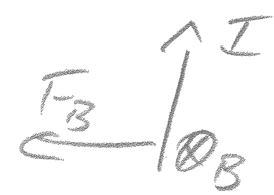
3. (35 pts) Three parallel wires are shown below. Determine the magnitude and direction of the magnetic force per unit length on wire A due to the other two wires.



$$|\vec{B}_B| = \frac{\mu_0 I_B}{2\pi(.35)} = 2.5\times10^{-6}\,T,\ \odot$$

$$|B_C| = \frac{\mu_0 I_C}{2\pi(.56)} = 3.2\times10^{-6},\ \otimes$$

$$B_{TOT} = 0.7\times10^{-6},\ \otimes$$



$$\frac{\vec{F}_B}{\ell} = \vec{I}_A \times \vec{B}_{TOT}$$

RHR #2

$$= (2.5)(.7\times10^{-6}) = 1.8\times10^{-6}\ \frac{N}{m},\ \leftarrow$$