Physics 10164 - Exam 2

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. (20 pts) A circuit consists of a 120 Volt battery, a switch that is initially open, a 12,000 Ohm resistor and a 20 μF capacitor, initially uncharged. At t=0, the switch is closed.

a) At what time is the voltage drop across the capacitor equal to 100 Volts?

b) At this time, what is the voltage drop across the resistor?

$$\Delta V_c = \mathcal{E}(1 - e^{-t/\tau})$$ similar to Q since $\Delta V_c = \frac{Q}{C}$

a) $\tau = RC = (12000)(20 \times 10^{-6}) = 0.24\,s$

$$100 = 120(1 - e^{-t/\tau})$$

$$0.833 = 1 - e^{-t/\tau}$$

$$\ln 0.167 = -\frac{t}{\tau} \qquad t = -(.24)\ln 0.167$$

$$= \boxed{0.43\,s}$$

b) Loop rule $\Delta V_c + \Delta V_R = \mathcal{E}$

$$100 + \Delta V_R = 120$$

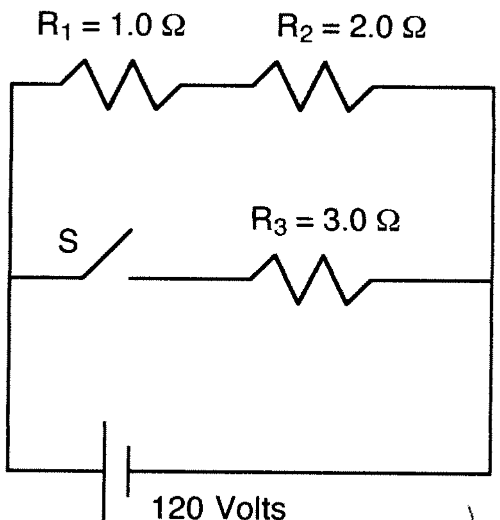
$$\boxed{\Delta V_R = 20\,V}$$

2. (30 pts) For the circuit shown below, the switch S is initially closed.

a) What is the voltage drop across the resistor R_1?

b) What is the power dissipated by resistor R_1?

c) When the switch is opened, does the power dissipated by resistor R_1 increase, decrease or remain the same. Justify your answer.



With S closed,

$\Delta V_{12} = 120$ Volts

$R_{12} = 3.0\ \Omega$

$I_{12} = 40\ A$

a) $\Delta V_1 = (40A)(1.0\Omega) = \boxed{40 \text{ Volts}}$

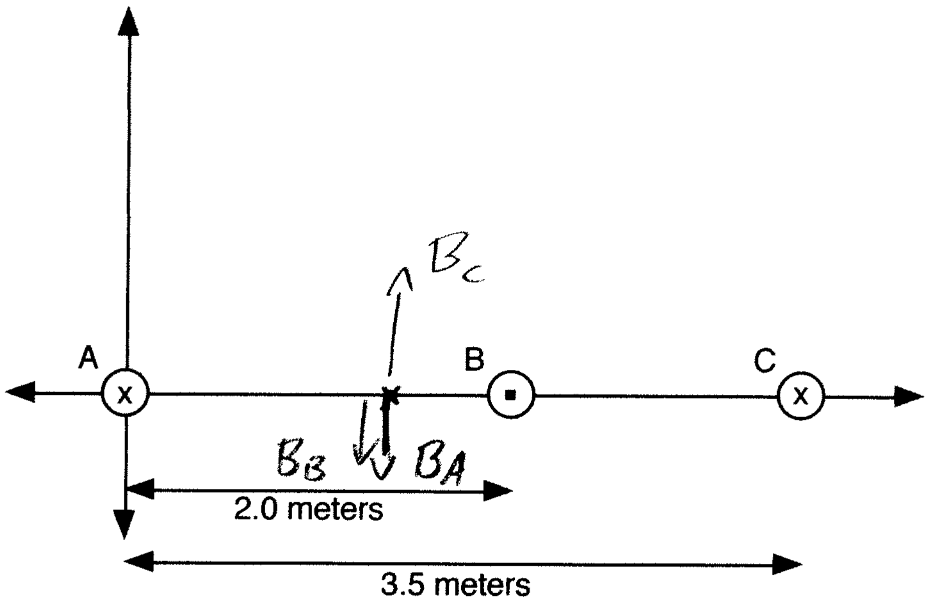
b) $P_1 = I_1^2 R_1 = (40)^2(1) = \boxed{1600 \text{ Watts}}$

c) S opens, ΔV_{12} unchanged

I_{12} unchanged

so $P_1 = I_1^2 R_1$ $\boxed{\text{unchanged}}$

3. (20 pts) Three wires pass through the x-axis as shown on the diagram below. Wire A at (0,0) has a current of 3.0 Amps directed into the page. Wire B at (2.0,0) has a current of 1.4 Amps directed out of the page, and wire C (at 3.5,0)has a current of 2.4 Amps directed into the page. What is the magnitude and direction of the total magnetic field due to these wires at the point x = 1.5 meters?



$$B_A = \frac{\mu_0 I_A}{2\pi r_A} = \frac{(2\times10^{-7})(3.0)}{1.5} = 4\times10^{-7},\ -y$$

$$B_B = \frac{\mu_0 I_B}{2\pi r_B} = \frac{(2\times10^{-7})(1.4)}{0.5} = 5.6\times10^{-7},\ -y$$

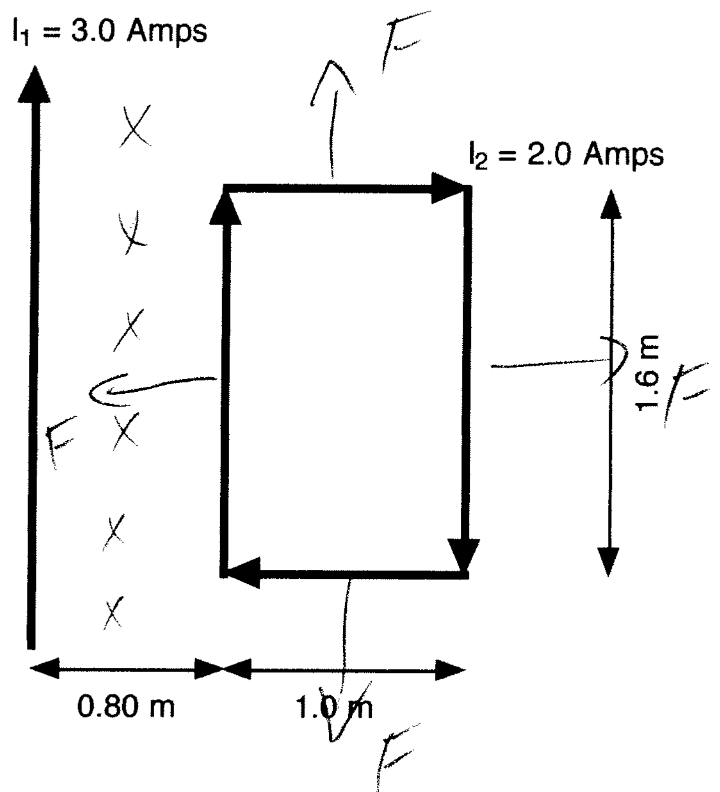
$$B_C = \frac{\mu_0 I_C}{2\pi r_C} = \frac{(2\times10^{-7})(2.4)}{2.0} = 2.4\times10^{-7},\ +y$$

$$B_{TOT} = -4 - 5.6 + 2.4 = \boxed{7.2\times10^{-7},\ -y}$$

4. (30 pts) A long straight wire carries a current of 3.0 Amps as shown below. Next to the wire is a rectangular loop which carries a current of 2.0 Amps in a clockwise direction.

a) Indicate on the diagram below the direction of magnetic force on each of the four sides of the loop.

b) Find the magnitude and direction of the net magnetic force on the loop.



b) $F_{TOP} = F_{BOT}$

cancels out

$$F_{left} = \frac{\mu_0 I_A I_B (1.6)}{2\pi(0.80)} = (2\times10^{-7})(3)(2)(2)$$

$$= 24 \times 10^{-7} N, -x$$

$$F_{rt} = \frac{\mu_0 I_A I_B (1.6)}{2\pi(1.8)} = 10.7 \times 10^{-7} N, +x$$

$$\boxed{F_{TOT} = 13 \times 10^{-7} N, -x \text{ dir}}$$