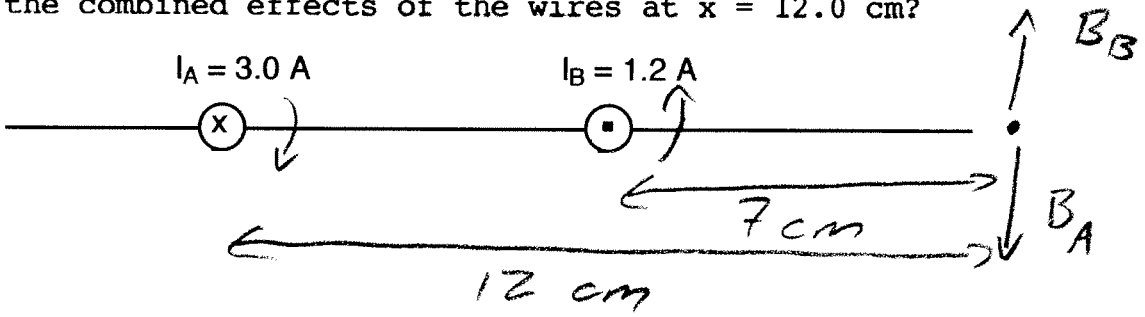
Physics 10164 - Exam 2D

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) Two wires pass through the x-axis as shown below. Wire A is at the origin, and wire B passes through the x-axis at the coordinate x = 5.0 cm.

What is the magnitude and direction of the magnetic field due to the combined effects of the wires at x = 12.0 cm?



$$\vec{B}_A = \frac{\mu_0 I_A}{2\pi r_A} = \frac{(4\pi \times 10^{-7})(3.0)}{2\pi (.12)} = 5.0 \times 10^{-6}, -y$$

$$\vec{B}_B = \frac{\mu_0 I_B}{2\pi r_B} = \frac{(4\pi \times 10^{-7})(1.2)}{2\pi (.07)} = 3.43 \times 10^{-6}, +y$$

$$B_{TOT} = 3.43 \times 10^{-6} - 5.0 \times 10^{-6}$$

$$= -1.6 \times 10^{-6}$$

or $\boxed{1.6 \times 10^{-6}, -y \text{ dir}}$

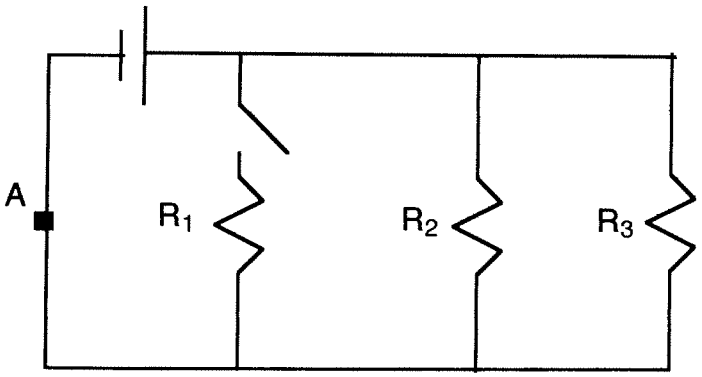
2. (40 pts) The circuit below contains a 12 Volt battery and three identical 3.0 Ohm resistors.

a) When the switch is open, how much power is dissipated by the resistor R2?

b) When the switch is open, what is the current passing through point A?

c) When the switch is closed, what happens to the power dissipated by the resistor R2 (increase, decrease or remain the same)? Justify your answer mathematically or explain your reasoning fully.

d) When the switch is closed, what happens to the current passing through point A (increase, decrease or remain the same)? Justify your answer as in c.



a) $P_2 = \frac{\Delta V_2^2}{R_2} = \frac{12^2}{3}$

$= \boxed{48\ W}$

b) $I_{TOT} = \frac{\Delta V_{TOT}}{R_{TOT}}$

$\frac{1}{R_{TOT}} = \frac{1}{3} + \frac{1}{3}$ $R_{TOT} = 1.5\ \Omega$ $I_{TOT} = \frac{12}{1.5} = \boxed{8.0\ A}$

c) ΔV_2 doesn't change, so $\boxed{P_2 = \text{same}}$

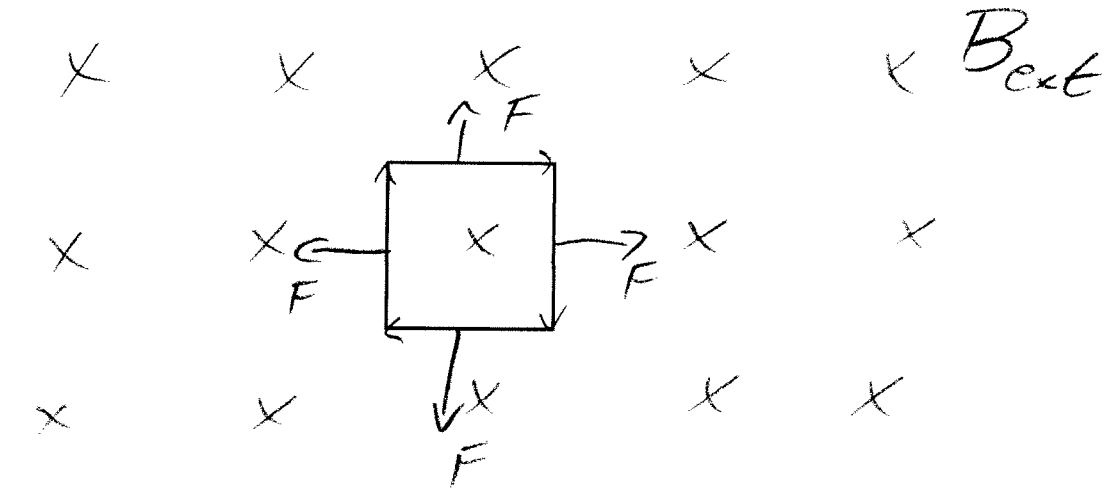
d) R_{TOT} is now $1\ \Omega$ instead of $1.5\ \Omega$,

so $\boxed{I_{TOT} \text{ increases}}$

3. (30 pts) A wire carries a 7.0 Amp current in the +x direction as shown below. A square loop, 15 cm on a side is located 25 cm below the loop as shown. The square loop carries a 3.0 Amp current in a clockwise direction.

a) What is the magnitude and direction of the net force on the current loop due to the long straight wire?

b) What is the magnitude of the torque acting on the square loop due to the long straight wire?



a) $F_{Top} = \ell I_{Top} B_{ext} \sin 90°$

$= (.15)(3.0)\dfrac{(4\pi \times 10^{-7})(7.0)}{2\pi(.25)} = 2.52\ \mu N, +y$

$F_{left} = F_{right}$ cancel out

$F_{BOT} = (.15)(3.0)\dfrac{(4\pi \times 10^{-7})(7.0)}{2\pi(.40)} = 1.58\ \mu N, -y$

$F_{TOT} = 2.52 - 1.58 = \boxed{9.4 \times 10^{-7}\ N}$

b) $\vec{B}_{loop}$ = same dir as $\vec{B}_{ext}$, so $\boxed{\vec{\tau} = 0}$