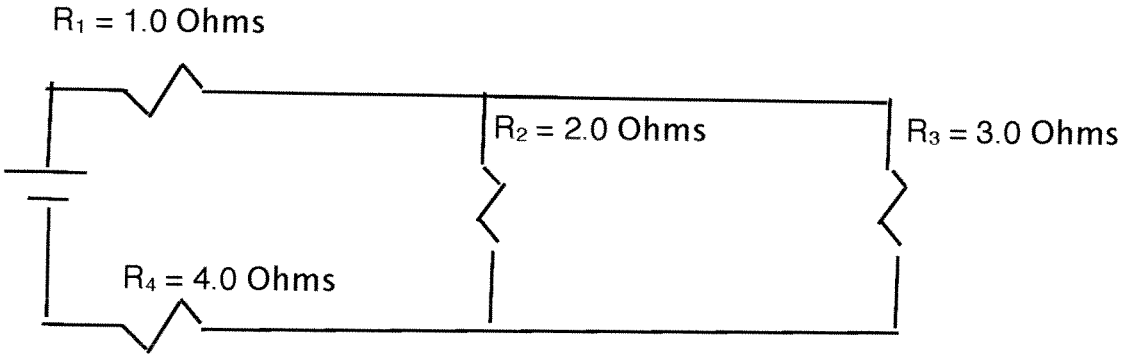
Physics 10164 - Exam 2B

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) For the circuit below, the EMF is 24 Volts.

a) Determine the power dissipated by the resistor R_1.

b) If resistor R_3 is reduced from 3.0 Ohms to 1.0 Ohm, will the power dissipated by R_1 increase, decrease or remain the same? Justify your answer mathematically or logically.



a) $\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{2} + \frac{1}{3}$ $\quad R_{23} = 1.2\,\Omega$

$R_{TOT} = R_1 + R_{23} + R_4 = 6.2\,\Omega$

$I_{TOT} = \frac{24}{6.2} = 3.87\,A$

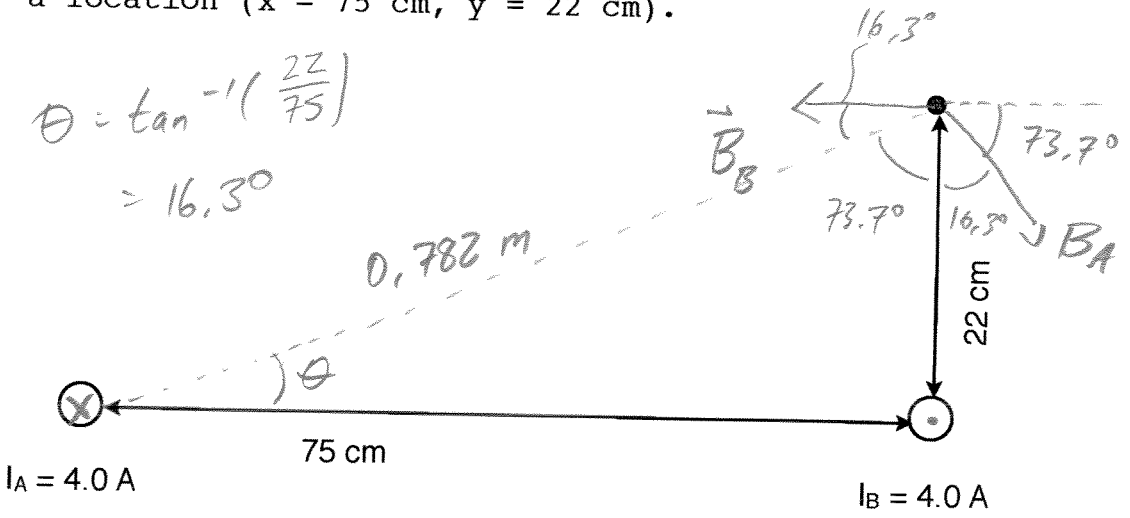
$I_1 = I_{TOT} = 3.87\,A$ $\quad P_1 = (3.87)^2(1) = 15\,W$

b) If $R_3 \downarrow$, then $R_{TOT} \downarrow$, so $I_{TOT} \uparrow$ $\quad P_1 \uparrow$

$R_{23} = 0.667\,\Omega$ $\quad I_{TOT} = 4.23\,A$

$R_{TOT} = 5.67\,\Omega$ $\quad = I_1$ $\quad P_1 = 18\,W$

2. (35 pts) Two parallel wires carry equal currents of 4.0 Amps in opposite directions, as shown below. Wire A carries current into the page, wire B carries current out of the page. Wire A crosses through the origin. Wire B crosses through the x-axis 75 cm from the origin. Find the magnitude and direction of the total magnetic field due to the two wires at a location (x = 75 cm, y = 22 cm).



$\theta = \tan^{-1}\left(\frac{22}{75}\right)$

$= 16.3°$

$|B_A| = \frac{\mu_0 I_A}{2\pi(.782)} = 1.02 \times 10^{-6}\ T,\ 73.7°$ below $+x$

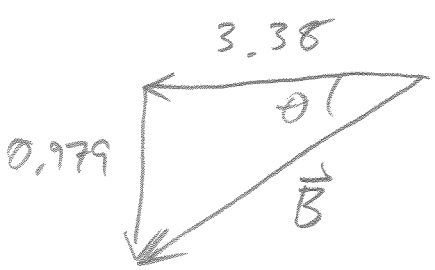
$|B_B| = \frac{\mu_0 I_B}{2\pi(.22)} = 3.64 \times 10^{-6}\ T,\ -x$

$B_{Ax} = 1.02 \cos 73.7°$ $\quad B_{Ay} = 1.02 \sin 73.7°$

$= 0.28$ $\quad = -0.979$

$B_{Bx} = -3.64$ $\quad B_{By} = 0$

$B_{TOT,x} = -3.38$ $\quad B_{TOT,y} = -0.979$



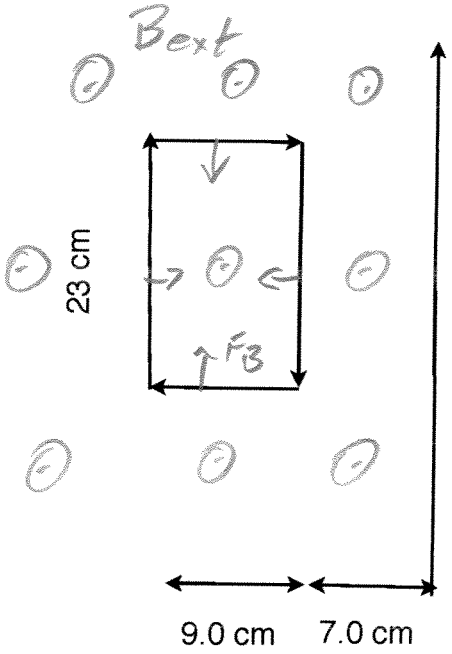
$|\vec{B}_{TOT}| = 3.5 \times 10^{-6}\ T$

$\theta = \tan^{-1}\left(\frac{.979}{3.38}\right) = 16°$ below $-x$

3. (30 pts) A long straight wire carries a current of 7.5 Amps. Next to the wire is a loop that carries a 3.0 Amp current in a clockwise path.

a) Determine the magnitude and direction of the force on the current loop due to the long straight wire.

b) Does the current loop experience any torque? If yes, calculate the mangitude of the torque. If no, explain why not.



Top + bottom, B_{ext} has same magnitude, F_B equal + opposite, cancels out.

Right side

$$B_{ext} = \frac{\mu_0 (7.5)}{2\pi (.07)} = 21.4 \times 10^{-6}\ T$$

$$|\vec{F}_B| = \ell I_{loop} \times B_{ext}$$

$$= (.23)(3.0)(21.4 \times 10^{-6}) = 1.48 \times 10^{-5}\ T \leftarrow$$

Left side: $B_{ext} = \frac{\mu_0 (7.5)}{2\pi (.16)} = 9.4 \times 10^{-6}\ T$

$$|\vec{F}_B| = (.23)(3.0)(9.4 \times 10^{-6}) = 0.65 \times 10^{-5}\ \rightarrow$$

$$F_{TOT} = +0.65 \times 10^{-5} - 1.48 \times 10^{-5} = -8.3 \times 10^{-6}$$

$8.3 \times 10^{-6}\ N, \leftarrow$