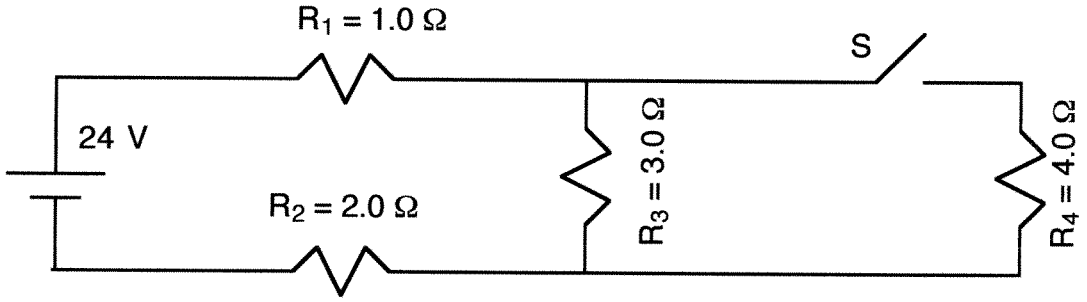
Physics 10164 - Exam 2A

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. (40 pts) Answer the following questions about the circuit shown below.

a) Switch S is initially open. When switch S is closed, what happens to the power dissipated by the resistor R_1? Does it increase, decrease or remain the same? Justify your answer.

b) With S closed, what is the power dissipated by R_3?



a) S closed means overall R drops,

so overall I increases.

$I_1 = I_{TOT}$, so $P_1 = I_1^2 R_1$ increases

b) $\frac{1}{R_{34}} = \frac{1}{3} + \frac{1}{4} \Rightarrow R_{34} = 1.714\,\Omega$

$R_{TOT} = 1.0 + 1.714 + 2.0 = 4.714\,\Omega$

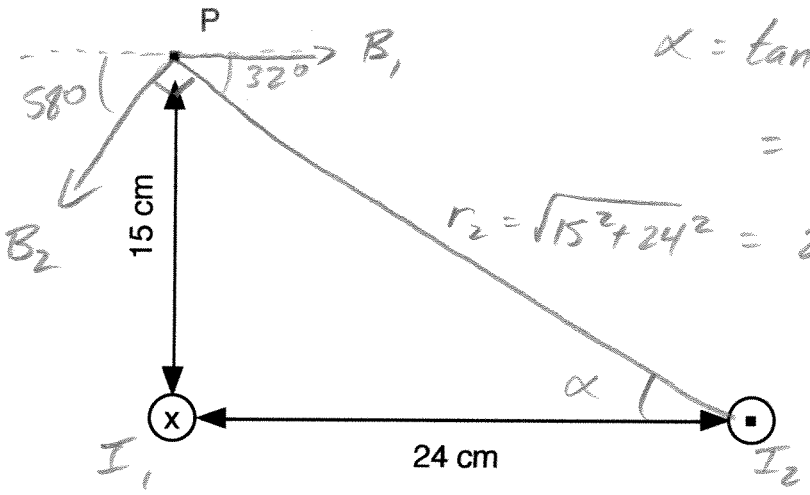
$I_{TOT} = \frac{\mathcal{E}}{R_{TOT}} = \frac{24}{4.714} = 5.09$

$\Rightarrow I_{34} = 5.09\ A$

$\Rightarrow \Delta V_{34} = I_{34} R_{34} = 8.73$ Volts

$\Delta V_3 = 8.73$ Volts $\quad P_3 = \frac{\Delta V_3^2}{R_3} = 25\ W$

2. (30 pts) Wire 1 carries a current of 5.0 Amps into the page, and wire 2 carries a current of 8.0 Amps out of the page. What is the <u>magnitude and direction</u> of the total magnetic field at point P due to these wires?



$\alpha = \tan^{-1}\left(\frac{15}{24}\right) = 32°$

$r_2 = \sqrt{15^2 + 24^2} = 28.3 \text{ cm}$

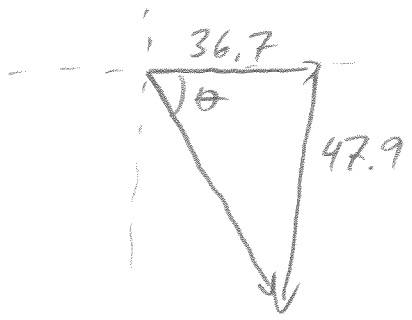
$|\vec{B}_1| = \frac{\mu_0 I_1}{2\pi r_1} = \frac{(4\pi \times 10^{-7})(5)}{2\pi(.15)} = 6.67\,\mu T, +x$

$|\vec{B}_2| = \frac{\mu_0 I_2}{2\pi r_2} = \frac{(4\pi \times 10^{-7})(8)}{2\pi(.283)} = 5.65\,\mu T, 58° \text{ below } -x$

$B_{1x} = 6.67 \qquad B_{1y} = 0$

$B_{2x} = -5.65\cos 58° = -3.00 \qquad B_{2y} = -5.65\sin 58° = -4.79$

$B_{TOTx} = 3.67 \qquad B_{TOTy} = -4.79$



$\theta = \tan^{-1}\left(\frac{47.9}{36.7}\right) = 53° \text{ below } +x$

$\vec{B} = \sqrt{36.7^2 + 47.9^2} = 6.0\,\mu T$

3. (30 pts) A proton is initially at rest and then accelerated through a 240 Volt potential difference. The proton then travels East at a constant speed into a region of uniform magnetic field of 3.4 Tesla directed into the page. (+x dir)

a) Determine the magnitude and direction of the magnetic force that will act on the proton due to the uniform field.

b) What is the magnitude and direction of the uniform electric field needed in this region in order to allow the proton to continue to travel East at a constant velocity?

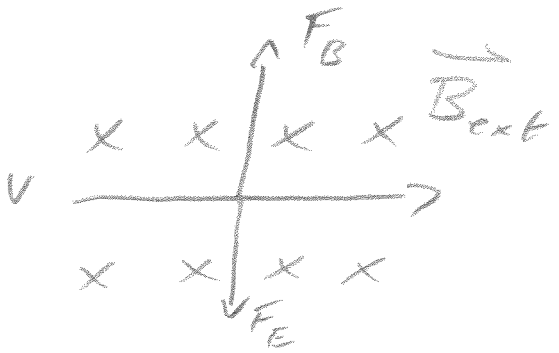
a) $W_E = W_{TOT} = \Delta K$

$$-q\Delta V = \tfrac{1}{2}mv^2 - 0$$

$$-(1.6\times10^{-19})(-240) = \tfrac{1}{2}(1.67\times10^{-27})v^2$$

$$v^2 = 4.6\times10^{10}$$

$$v = 2.14\times10^5 \text{ m/s}$$



F_B points +y (RHR)

$$F_B = qvB\sin\theta$$

$$= (1.6\times10^{-19})(2.14\times10^5)(3.4)$$

$$= \boxed{1.2\times10^{-13}\text{ N, +y}}$$

b) $\vec{E}$ must point -y to offset $\vec{F}_B$ or North

$$F_B = F_E$$

$$qvB = qE$$

$$E = vB = \boxed{7.3\times10^5 \tfrac{V}{m}\text{, -y}}$$ or South