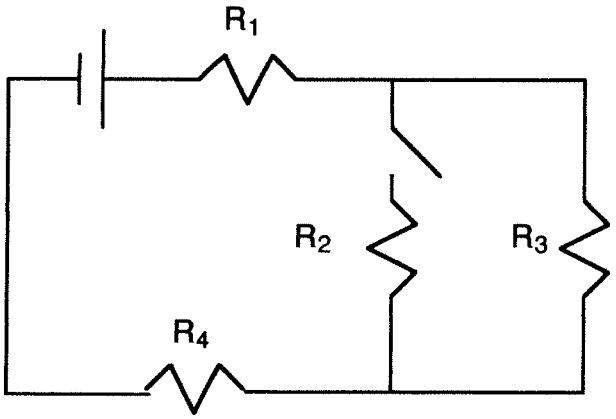
Physics 10164 - Exam 2A

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) The circuit below contains a 12 Volt battery and four identical resistors of 2.0 Ohms each.

a) When the switch is open, what is the power dissipated by the resistor R3?

b) When the switch is closed, does the power dissipated by R3 increase, decrease or remain the same? Justify your answer mathematically or with clearly stated reasoning.



a) $R_{TOT} = 6\ \Omega$

$I_{TOT} = 2.0\ A$

$P_3 = (2^2)(2) = 8\ W$

b) $R_{23} = 1\ \Omega$

$R_{TOT} = R_1 + R_{23} + R_4 = 5\ \Omega$

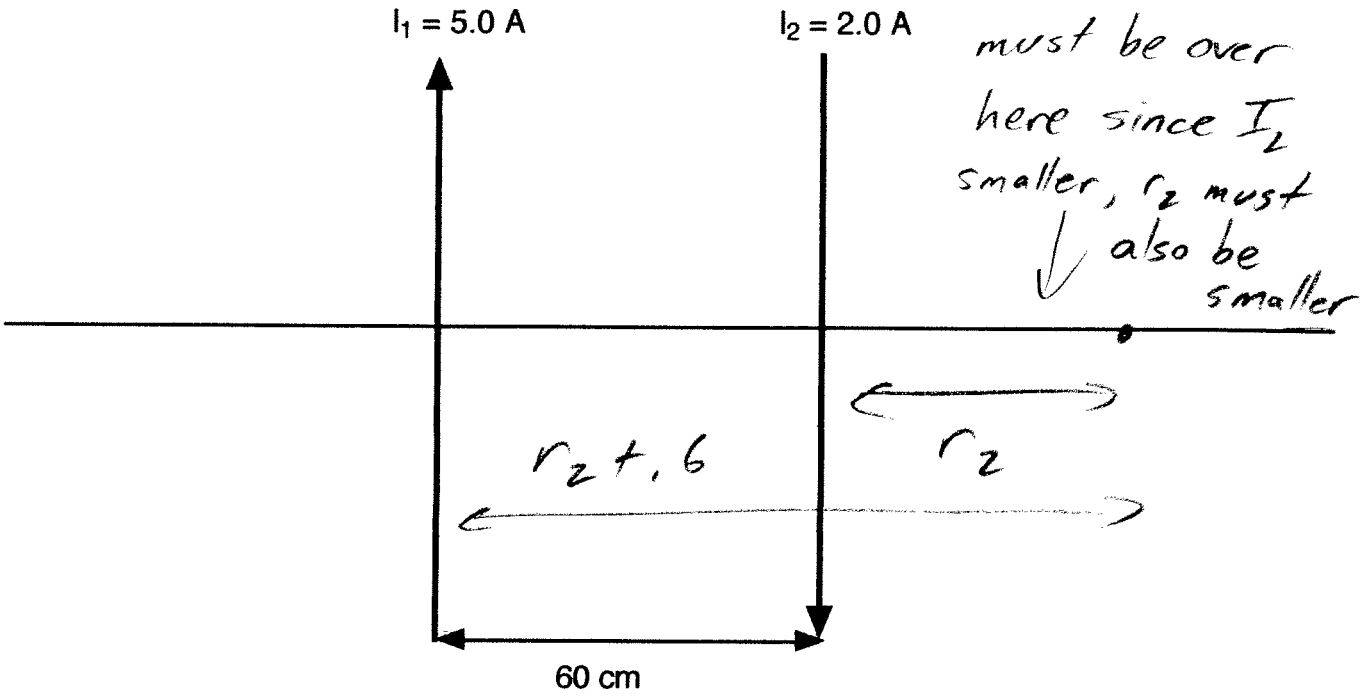
$I_{TOT} = 2.4\ A$

$\Rightarrow \Delta V_{23} = I_{TOT} R_{23} = 2.4\ V$

$P_3 = \frac{(2.4)^2}{2} = 2.9\ W$

P_3 decreases

2. (30 pts) Two parallel currents are shown below. At what point along the horizontal line does the net magnetic field due to these currents equal zero?



Need $|B_1| = |B_2|$

$$\frac{\mu_0 (5)}{2\pi (r_2 + .6)} = \frac{\mu_0 (2)}{2\pi r_2}$$

$$5 r_2 = 2 r_2 + 1.2$$

$$3 r_2 = 1.2$$

$$\boxed{r_2 = 0.40 \text{ m}}$$

3. (30 pts) A circuit contains a 12-Volt battery, a 600 Ohm resistor, an initially uncharged capacitor and a switch. At t=0, the switch is closed, and the capacitor begins to charge.

After 3.2 milliseconds, the voltage drop across the capacitor is equal to the voltage drop across the resistor. What is the capacitance of the capacitor?

If $\Delta V_R = \Delta V_C$, then each is 6 Volts.

$$6\,V = \left(\frac{\mathcal{E}}{R} e^{-t/\tau}\right) R$$

$$\Delta V_R = I \quad R$$

$$6 = 12\, e^{-.0032/\tau}$$

$$\ln 0.5 = -\frac{.0032}{\tau}$$

$$\tau = -\frac{.0032}{-0.693} = .00462$$

$$(600)C = .00462$$

$$\boxed{C = 7.7\ \mu F}$$