Name_____

Physics 111 Quiz #3, September 30, 2024

Please show all work, thoughts and/or reasoning to receive partial credit. The quiz is worth 10 points total, and all parts may not be of equal weight.

I affirm that I have carried out my academic endeavors with full academic honesty.

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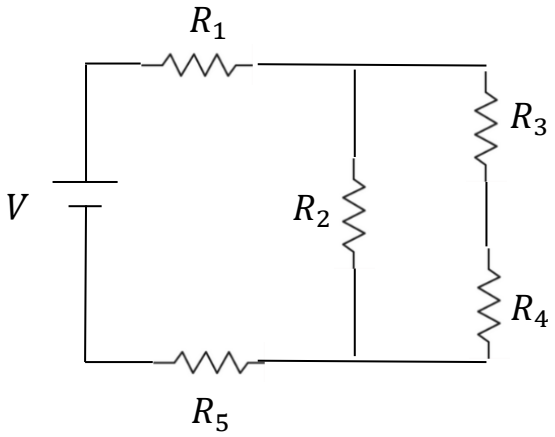
1. A resistor is constructed out of nickel ($\rho = 7 \times 10^{-8}\Omega m$) with a length of $L = 3m$. If the resistance needs to be $R = 100\Omega$, what is the diameter (in μm) of the wire needed?

$$R = \frac{\rho L}{A} = \frac{\rho L}{\pi r^2} \rightarrow r = \sqrt{\frac{\rho L}{\pi R}} = \sqrt{\frac{7 \times 10^{-8}\Omega m \times 3m}{\pi \times 100\Omega}} = 2.59 \times 10^{-5} m$$

$$D = 2r = 2 \times 2.59 \times 10^{-5} m = 5.18 \times 10^{-5} m = 51.8 \times 10^{-6} m = 51.8 \mu m$$

Suppose that you have the circuit below in which some resistors (each with resistance $R = 100\Omega$) are wired to a $50V$ battery.



2. What is the equivalent resistance of the circuit?

R_3 and R_4 are in series: $R_{34} = R_3 + R_4 = 100\Omega + 100\Omega = 200\Omega$

R_2 and R_{34} are in parallel: $\frac{1}{R_{234}} = \frac{1}{R_2} + \frac{1}{R_{34}}$

$$\frac{1}{R_{234}} = \frac{1}{100\Omega} + \frac{1}{200\Omega} = \frac{3}{200\Omega} \rightarrow R_{234} = \frac{200\Omega}{3} = 66.7\Omega$$

R_1, R_{234} and R_5 are in series: $R_{eq} = R_1 + R_{234} + R_5 = 100\Omega + 66.7\Omega + 100\Omega = 266.7\Omega$

3. What is the total current produced by the battery?

$$I_{total} = \frac{V}{R_{eq}} = \frac{50V}{266.7\Omega} = 0.188A = 188mA$$

4. What is the power dissipated across resistor R_5?

$P_{R_5} = I_{total}^2 R_5 = (0.188A)^2 \times 100\Omega = 3.5W$

Or, $V_{R_5} = I_{total} R_5 = 0.188A \times 100\Omega = 18.8V$ so that

$P_{R_5} = I_{total} V_{R_5} = 0.188A \times 18.8V = 3.5W$

Or, $P_{R_5} = \frac{V_{R_5}^2}{R_5} = \frac{(18.8V)^2}{100\Omega} = 3.5W$

5. What is the current that flows through resistor R_3?

$V_{R_2} = V_{R_{34}} = V_{R_{234}}$ since these resistors are in parallel. The voltage across resistor $R_{234}$is given by using conservation of energy.

$V = V_{R_1} + V_{R_{234}} + V_{R_5} \rightarrow V_{R_{234}} = V - V_{R_1} - V_{R_5} = V - I_{total}(R_1 + R_5)$

$V_{R_{234}} = V - I_{total}(R_1 + R_5) = 50V - 0.188A(100\Omega + 100\Omega) = 12.4V$

The current in resistor R_3 (and R_4) is given by Ohm's law: $I_{34} = I_3 = \frac{V_{R_{34}}}{R_{34}} = \frac{12.4V}{200\Omega} = 0.062A = 62mA$