

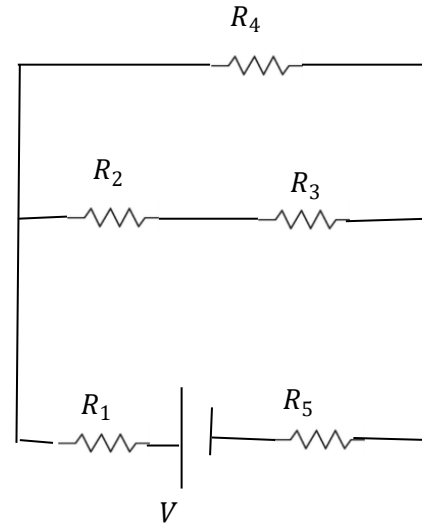
Name \_\_\_\_\_

Physics 111 Quiz #2, October 7, 2022

*Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.*

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

1. Consider the following circuit below in which some resistors are wired to a battery ( $V = 20V$ ). Let all the resistors have the same resistance  $R = 100\Omega$ . What is the effective resistance of the circuit?



Resistors  $R_2$  and  $R_3$  are in series:  $R_{23} = R_2 + R_3 = 100\Omega + 100\Omega = 200\Omega$

Resistors  $R_{23}$  and  $R_4$  are in parallel:  $\frac{1}{R_{234}} = \frac{1}{R_{23}} + \frac{1}{R_4} = \frac{1}{200\Omega} + \frac{1}{100\Omega} = \frac{3}{200\Omega} \rightarrow R_{234} = 66.7\Omega$

Resistors  $R_1$ ,  $R_{234}$ , and  $R_5$  are in series:

$$R_{eq} = R_{12345} = R_1 + R_{234} + R_5 = 100\Omega + 66.7\Omega + 100\Omega = 266.7\Omega$$

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

$$I_{total} = \frac{V}{R_{eq}} = \frac{20V}{266.7\Omega} = 0.075A = 75mA$$

3. What is the current through resistor  $R_4$ ?

$$I_4 = \frac{V_4}{R_4} = \frac{V - V_{R_1} - V_{R_5}}{R_4} = \frac{20V - 7.5V - 7.5V}{100\Omega} = 0.050A = 50mA$$

$$\text{Where } V_{R_1} = V_{R_5} = I_{total}R_1 = 0.075A \times 100\Omega = 7.5V.$$

4. What is the potential difference across resistor  $R_2$ ?

$$I_{total} = I_{R_4} + I_{R_{23}} \rightarrow I_{R_{23}} = I_{total} - I_{R_4} = 0.075A - 0.050A = 0.025A = 25mA$$

$$V_{R_2} = I_{R_{23}}R_2 = 0.025A \times 100\Omega = 2.5V$$

5. What fraction of the total energy produced by the battery (per second) is lost as heat/light across resistor  $R_5$  (per second)?

$$P_{R_4} = I_{R_5}^2 R_5 = (0.075A)^2 \times 100\Omega = 0.563W$$

$$P_b = I_{total}^2 R_{eq} = (0.075A)^2 \times 266.7\Omega = 1.5W$$

$$f = \frac{P_{R_4}}{P_b} = \frac{0.563W}{1.5W} = 0.375$$