Name_____

Physics 111 Quiz #3, September 29, 2025

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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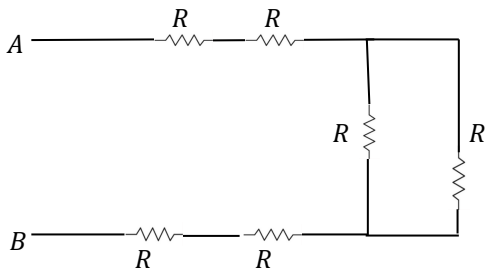
1. Suppose that you have the network of resistors shown below, where this network of resistors forms part of a larger circuit which is not shown. What is the equivalent resistance of the network of resistors if each resistor has a value of $R = 90k\Omega$?



The right-most resistors are in parallel and the equivalent resistance of this combination is:

$$\frac{1}{R'} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R} \rightarrow R' = \frac{R}{2}$$

This resistor is in series with the remaining four resistors. The equivalent resistance of the circuit is therefore:

$$R_{eq} = R + R + R + R + \frac{R}{2} = 4.5R = 4.5 \times 90000\Omega = 4.1 \times 10^5\Omega$$

2. Suppose at points A and B in the circuit above that we connect a $100V$ battery and a capacitor with capacitance C. If we need to ultimately store $500mJ$ worth of energy in the capacitor when the capacitor is fully charged, what is the value of the capacitance that should be used?

$$U = \frac{1}{2}CV^2 \rightarrow C = \frac{2U}{V^2} = \frac{2 \times 500 \times 10^{-3}J}{(100V)^2} = 1 \times 10^{-4}F$$

3. What is the time constant for the circuit in part 2?

   $\tau = R_{eq}C = 4.1 \times 10^5\Omega \times 1 \times 10^{-4}F = 41s$

4. Suppose that the battery is disconnected and the fully charged capacitor is connected to the network of resistors in part 1. What initial current flows in the circuit?

   $V = IR_{eq} \rightarrow I = \frac{V}{R_{eq}} = \frac{100V}{4.1 \times 10^5\Omega} = 2.4 \times 10^{-4}A$

5. How long does it take the discharging capacitor to lose 60% of its initial stored charge?

   $Q(t) = 0.4Q_{max} = Q_{max}e^{-\frac{t}{RC}} \rightarrow t = -RC\ln(0.4) = -41s \times \ln(0.4) = 37.6s$