Physics 2145 Homework #8: RC Circuits

1. A 6.0 μF capacitor is initially uncharged. It is connected in series with a switch, a 10 kΩ resistor, and an emf of 40 volts. When the switch is closed, the capacitor begins to charge.

   a) Calculate the time constant of the circuit.
   b) Calculate the current through the resistor immediately after the switch is closed, at t=30ms, and a very long time after the switch is closed.
   c) Calculate the charge on the capacitor immediately after the switch is closed, at t=30ms, and a very long time after the switch is closed.
   d) Calculate the voltage across the capacitor immediately after the switch is closed, at t=30ms, and a very long time after the switch is closed.
   e) Calculate the time after which the current has decreased to one fifth its maximum value.
   f) Sketch, qualitatively, current, charge, and voltage as functions of time.

2. A capacitor of capacitance C= 2 μF has been charged so that the potential difference between its plates is 100 V. The capacitor is then connected to a 20k Ω resistor, the circuit is closed by closing a switch, and the capacitor begins to discharge.

   a) Calculate the time constant of the circuit.
   b) Calculate the current through the resistor immediately after the switch is closed, at t=10ms, and a very long time after the switch is closed.
   c) Calculate the charge on the capacitor immediately after the switch is closed, at t=10ms, and a very long time after the switch is closed.
   d) Calculate the voltage across the capacitor immediately after the switch is closed, at t=10ms, and a very long time after the switch is closed.
   e) Calculate the time after which the charge has decreased to one fourth its maximum value.
   f) Sketch, qualitatively, current, charge, and voltage as functions of time.

3. A 50μF capacitor has been charged to a certain potential difference and is then discharged through a resistor. It takes 2ms for the potential difference across the capacitor to decrease to ⅓ of its initial value.

   a) Based on this information, would you expect the time constant of the circuit to be smaller or larger than 2ms? Much smaller/larger, or relatively close?
   b) Find the resistance of the resistor.
   c) Calculate the time constant of the circuit.