

Quiz 20.1C

A 125 μF capacitor and an unknown resistor are connected in series with a 78.0 Volt power source. At $t = 0.00$ s, a switch is closed to complete the circuit, and the capacitor begins to charge. A student determines that the voltage drop across the capacitor after 1.33 seconds is 38.0 Volts.

- a) What is the charge on the capacitor at this time?
- b) What is the time constant of this circuit?
- c) What is the resistance of the resistor in this circuit?
- d) At $t = 1.33$ seconds, what is the current in the circuit?

a) $Q = C\Delta V = (125 \times 10^{-6})(38) = \boxed{4.75 \times 10^{-3} \text{ C}}$

b) $Q_{\text{max}} = CE$
so $Q = Q_{\text{max}}(1 - e^{-t/\tau})$
 $\Delta V = E(1 - e^{-t/\tau})$
 $38 = 78(1 - e^{-t/\tau})$
 $0.487 = 1 - e^{-t/\tau}$
 $0.5128 = e^{-t/\tau}$
 $-0.6678 = -\frac{t}{\tau}$
 $\tau = \frac{t}{.6678}$
 $= \boxed{1.995}$

c) $\tau = RC$
 $1.99 = R(125 \times 10^{-6})$
 $\Rightarrow \boxed{R = 15900 \Omega}$

d) $\Delta V_C + \Delta V_R = E$
 $38 + \Delta V_R = 78$
 $\Delta V_R = 40 = IR$
 $40 = I(15900)$
 $\Rightarrow \boxed{I = 2.51 \times 10^{-3} \text{ A}}$