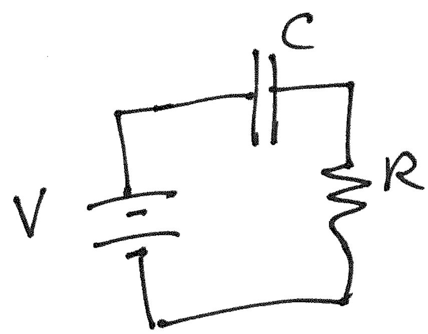
Ch.10 Prob.53

$R = 500\,\Omega$

$C = 1.50\,\mu F$ (initially uncharged)

$V = 6.16\,V$

Model for The charging capacitor



$Q(t) = Q_0(1 - e^{-t/\tau})$

where $\tau = RC$

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a) Find The initial Current

$$I(t) = \frac{dQ(t)}{dt} = Q_0\left(0 - e^{-t/\tau}\left(-\frac{1}{\tau}\right)\right) = \frac{Q_0}{\tau} e^{-t/\tau}$$

$$\boxed{I(t) = I_0 e^{-t/\tau}}$$

Since The capacitor is initially uncharged, the power supply drops all The voltage of The power supply drops over The resistor. Therefore

$$I_0 = \frac{V}{R} = \frac{6.16V}{500\,\Omega} = 0.0123A = \boxed{12.3mA}$$

b) what is The time constant?

$$\tau = RC = (500\,\Omega)(1.50 \times 10^{-6} F) = 7.5 \times 10^{-4} s = \boxed{0.75\,ms}$$

c) What is The current after 1 time constant?

$$I(t) = I_0 e^{-t/\tau} = (12.3mA)\,e^{-\tau/\tau} = (12.3mA)\,e^{-1}$$

$$\boxed{I(\tau) = 4.52\,mA}$$

d) what is The voltage on The capacitor after 1 time constant

$V = V_c + V_R \rightarrow V_c = V - V_R = V - IR$

at 1 time constant $V_c = 6.16V - (4.52 \times 10^{-3}A)(500\,\Omega) = \boxed{3.9\,V}$