Ch. 9 Prob. 88

$$q(t) = q_0 e^{-t/\tau} = 10.0\,C\; e^{-t/5s}$$

so $q_0 = 10.0\,C$, $\tau = 5.0\,s$

a) Initial current through the wire.

$$I = \frac{dq}{dt} = \frac{d}{dt}\left(q_0 e^{-t/\tau}\right)$$

$$I = q_0\left(\frac{-1}{\tau}\right)e^{-t/\tau} = -\frac{q_0}{\tau}e^{-t/\tau} = -I_0 e^{-t/\tau}$$

at $t = 0\,s$ $\quad I(0) = -\frac{(10.0\,C)}{(5.0\,s)}e^{-0} = \boxed{-2.0\,A}$

b) Find the current at $t = \frac{\tau}{2} = \frac{5.0\,s}{2} = 2.5\,s$

$$I(2.5) = -\frac{(10.0\,C)}{(5.0\,s)}e^{-\tau/2/\tau} = -2.00\,e^{-1/2}$$

$$= \boxed{-1.21\,A}$$

c) Find the time when $I = \frac{I_0}{2}$

Now $I = -I_0 e^{-t/\tau}$ $\quad \frac{I}{I_0} = e^{-t/\tau}$

Ignore the negative sign. This just indicates the direction of current flow. We just want the magnitude.

so $\frac{I}{I_0} = e^{-t/\tau} \rightarrow \ln\left(I/I_0\right) = -t/\tau$

$$t = -\tau \ln\left(I/I_0\right)$$

$$t = -(5.0\,s)\ln\left(\frac{I_0/2}{I_0}\right) = -(5.0\,s)\ln\left(\tfrac{1}{2}\right) = \boxed{3.47\,s}$$