Problem 27.5

Assume $I(t) = I_o e^{-t/\tau}$

a.) How much charge passes between $t = 0$ and τ?

$$I(t) = \frac{dq(t)}{dt}$$

$$\Rightarrow \quad Q = \int dq = \int I\, dt$$

$$\Rightarrow \quad Q = \int_{t=0}^{\tau} \left(I_o e^{-t/\tau} \right) dt$$

$$\Rightarrow \quad Q = -I_o \tau e^{-t/\tau} \Big|_{t=0}^{\tau}$$

$$\Rightarrow \quad Q = -I_o \tau \left(e^{-\tau/\tau} - e^{-0/\tau} \right)$$

$$\Rightarrow \quad Q = I_o \tau \left(1 - \frac{1}{e} \right)$$

$$\Rightarrow \quad Q = .632 I_o \tau$$

Problem 27.5

Assume $I(t) = I_o e^{-t/\tau}$

b.) How much charge passes between t = 0 and 10τ ?

$$I(t) = \frac{dq(t)}{dt}$$

$$\Rightarrow \quad Q = \int dq = \int I \, dt$$

$$\Rightarrow \quad Q = \int_{t=0}^{10\tau} \left(I_o e^{-t/\tau} \right) dt$$

$$\Rightarrow \quad Q = -I_o \tau e^{-t/\tau} \Big|_{t=0}^{10\tau}$$

$$\Rightarrow \quad Q = -I_o \tau \left(e^{-10\tau/\tau} - e^{-0/\tau} \right)$$

$$\Rightarrow \quad Q = I_o \tau \left(1 - \frac{1}{e^{10}} \right)$$

$$\Rightarrow \quad Q = .99995 I_o \tau$$

Problem 27.5

Assume $I(t) = I_o e^{-t/\tau}$

c.) How much charge passes between t = 0 and 10τ?

$$I(t) = \frac{dq(t)}{dt}$$

$$\Rightarrow \quad Q = \int dq = \int I\,dt$$

$$\Rightarrow \quad Q = \int_{t=0}^{\infty} \left(I_o e^{-t/\tau}\right) dt$$

$$\Rightarrow \quad Q = -I_o \tau e^{-t/\tau} \Big|_{t=0}^{\infty}$$

$$\Rightarrow \quad Q = -I_o \tau \left(e^{-\infty/\tau} - e^{-0/\tau}\right)$$

$$\Rightarrow \quad Q = I_o \tau \left(1 - \frac{1}{e^{\infty}}\right)$$

$$\Rightarrow \quad Q = I_o \tau$$