Problem 27.11

a.) The current density (current per unit area) is:

$$J = \frac{I}{A} = \frac{8x10^{-6}\,A}{\pi\left(10^{-3}\,m\right)^2}$$

$$= 2.55\ A/m^2$$

b.) From Problem 27.3, we can write the electron density *n* as:

$$I = nqAv_d$$

$$\Rightarrow \quad J = \frac{I}{A} = nev_d$$

$$\Rightarrow \quad n = \frac{J}{ev_d}$$

$$\Rightarrow \quad = \frac{\left(2.55\ A/m^2\right)}{\left(1.6x10^{-19}C\right)\left(3x10^8\ m/s\right)}$$

$$\Rightarrow \quad = 5.3x10^{10}\ m^{-3}$$

c.) How long will Avogadro's number of electrons exit the accelerator?

$$I = \frac{\Delta q}{\Delta t}$$

$$\Rightarrow \quad \Delta t = \frac{\Delta q}{I}$$

$$= \frac{\left(N_{Avogadro} e\right)}{I}$$

$$= \frac{\left(6.02 \text{x} 10^{23}\right)\left(1.6 \text{x} 10^{-19} \text{C}\right)}{\left(8 \text{x} 10^{-6} \text{A}\right)}$$

$$= 1.2 \text{x} 10^{10} \text{ seconds}$$