

Ch. 12 Prob 55

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$q_e = 1.6 \times 10^{-19} \text{ C}$$

$$r = 2.0 \text{ cm}$$

$$v = 2.0 \times 10^5 \text{ m/s}$$

$$n = 25 \frac{\text{turns}}{\text{cm}}$$

Find the current in the solenoid

From the circular motion of the electron, we can find the strength of the magnetic field

$$r = \frac{mv}{qB} \rightarrow B = \frac{mv}{q \cdot r} = \frac{(9.11 \times 10^{-31} \text{ kg})(2.0 \times 10^5 \text{ m/s})}{(1.6 \times 10^{-19} \text{ C})(2.0 \times 10^{-2} \text{ m})}$$

$$B = 5.69 \times 10^{-5} \text{ T}$$

Now for a solenoid

$$B = \mu_0 n I$$

$$n = 25 \frac{\text{turns}}{\text{cm}} \left(\frac{100 \text{ cm}}{1 \text{ m}} \right) = 2500 \frac{\text{turns}}{\text{m}}$$

So the current is

$$I = \frac{B}{\mu_0 n} = \frac{5.69 \times 10^{-5} \text{ T}}{(4\pi \times 10^{-7}) \frac{\text{T} \cdot \text{m}}{\text{A}} (2500 \frac{\text{turns}}{\text{m}})}$$

$$I = 0.018 \text{ A}$$

$$\boxed{18 \text{ mA}}$$

