

Chapter 34 Problem 36 †

Given

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

$$v = 5.0 \times 10^7 \text{ m/s}$$

$$\Delta v = \pm 10\%$$

$$h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$$

Solution

Find the minimum uncertainty of the position.

The uncertainty of the velocity is from -10% to +10% or

$$\Delta v = 0.20(5.0 \times 10^7 \text{ m/s}) = 1.0 \times 10^7 \text{ m/s}$$

From Heisenberg's uncertainty principle

$$\Delta x \Delta p \geq \hbar$$

Rewriting momentum as velocity times mass and solving for uncertainty in position we get

$$m \Delta x \Delta v \geq \frac{h}{2\pi}$$

$$\Delta x \geq \frac{h}{2\pi m \Delta v}$$

Substituting in the provided values gives

$$\Delta x \geq \frac{6.63 \times 10^{-34} \text{ J} \cdot \text{s}}{2\pi(9.11 \times 10^{-31} \text{ kg})(1.0 \times 10^7 \text{ m/s})}$$

$$\Delta x \geq 1.16 \times 10^{-11} \text{ m}$$

†Problem from Essential University Physics, Wolfson