**Answer on Question # 68393-Physics / Quantum Mechanics**

Suppose that the momentum of a certain particle can be measured to an accuracy of one part in a thousand, Determine the minimum uncertainty in the position of a particle if the particle is (a) a 5 x 10^-3 kg mass moving with a speed of 2 m/s, (b) an electron moving with a speed of 1.8 x 10^8 m/s .

**Solution**

a) The momentum of the particle $p = mv = 5\times10^{-3}\times2 = 1\times10^{-2}\ \text{kg}\cdot\frac{\text{m}}{\text{s}}$.

So uncertainty in the momentum of a particle $\Delta p = \frac{1}{1000}p = 1\times10^{-5}\ \text{kg}\cdot\frac{\text{m}}{\text{s}}$.

From the Heisenberg's uncertainty principle

$$\Delta p\Delta x \geq \frac{\hbar}{2}$$

the minimum uncertainty in the position of a particle

$$\Delta x = \frac{\hbar}{2\Delta p} \approx \frac{1\times10^{-34}}{2\times10^{-5}} = 5\times10^{-28}\ \text{m}.$$

b) The momentum of the relativistic electron

$$p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{9.1\times10^{-31}\times1.8\times10^{8}}{\sqrt{1-\frac{(1.8\times10^{8})^2}{(3\times10^{8})^2}}} = \frac{16.38\times10^{-23}}{0.8} \approx 2\times10^{-22}\ \text{kg}\cdot\frac{\text{m}}{\text{s}}.$$

$$\Delta p = \frac{1}{1000}p = 2\times10^{-25}\ \text{kg}\cdot\frac{\text{m}}{\text{s}}.$$

Finally

$$\Delta x = \frac{\hbar}{2\Delta p} \approx \frac{1\times10^{-34}}{4\times10^{-25}} = 2.5\times10^{-10}\ \text{m} = 2.5\ \text{Å}.$$

**Answer** a) $5\times10^{-28}$ m, b) $2.5\times10^{-10}$ m.