

TL 5-4a (proton/bullet)

$$\oplus \rightarrow v = 500 \text{ m/s}$$

$$m_p = 1.67 \times 10^{-27} \text{ kg}$$

$$m_b = \text{about } 10 \text{ grams.}$$

$$\square \rightarrow v = 500 \text{ m/s}$$

$$\frac{\Delta v}{v} = 0.0001$$

- Use Heisenberg indeterminacy principle

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

$$\Delta x_b \geq \frac{\hbar}{2m_b \Delta v}$$

$$= \boxed{1 \times 10^{-31} \text{ meters}}$$

$$\Delta x_p \geq \frac{\hbar}{2m_p \Delta v}$$

$$= \boxed{6 \times 10^{-6} \text{ meters.}}$$