KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF PHYSICS

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Physics 212 – Quiz #4a
Chapter 1

Name: Key Id#:

Consider a proton moving with a speed of 10^7 m/s along the x-axis. If the uncertainty in its position is 2 pm, calculate the minimum uncertainty in

(a) momentum

$$\Delta p_x \cdot \Delta x \geq \frac{\hbar}{2}$$

or $(\Delta p_x)_{min} \cdot \Delta x = \frac{\hbar}{2} \Rightarrow (\Delta p_x)_{min} = \frac{\hbar}{2\Delta x} = \frac{h}{4\pi \Delta x}$

$$(\Delta p_x)_{min} = \frac{6.63\times10^{-34}}{8\times\pi\times10^{-12}} = \boxed{2.65\times10^{-23}\ \text{Kg}\cdot\frac{\text{m}}{\text{s}}}$$

(b) speed

$$v = \frac{p}{m} \Rightarrow (\Delta v)_{min} = \frac{(\Delta p_x)_{min}}{m}$$

$$(\Delta v)_{min} = \frac{2.65\times10^{-23}}{1.673\times10^{-27}} = \boxed{1.58\times10^{4}\ \text{m/s}}$$

(c) and kinetic energy

$$K = \frac{1}{2} m v^2 \qquad dK = \frac{2}{2} m v\, dv$$

$$\Delta K = m v \Delta v$$

$$(\Delta K)_{min} = m v (\Delta v)_{min} = (1.673\times10^{-27})(10^{7})(1.58\times10^{4})$$

$$\boxed{(\Delta K)_{min} = 2.65\times10^{-16}\ \text{J}}$$