

Physics 212 – Quiz #4
Chapter 4

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Name: Key Id#: _____

1. To "observe" small objects, one measures the diffraction of particles whose de Broglie wavelength is approximately equal to the object's size. Find the kinetic energy (in eV) required for electrons to resolve a large organic molecule of size 10 nm?

$$\lambda = \frac{h}{p}$$
$$K = \frac{1}{2} m_e v^2 = \frac{p^2}{2m_e} \Rightarrow p = \sqrt{2m_e K}$$
$$\Rightarrow \lambda = \frac{h}{\sqrt{2m_e K}} \Rightarrow K = \frac{h^2}{2m \lambda^2}$$
$$K = 2.41 \times 10^{-12} \text{ J} = \boxed{0.015 \text{ eV}}$$

2. A proton has a kinetic energy of 1.0 MeV. If its momentum is measured with an uncertainty of 5.0%, what is the minimum uncertainty in its position?

$$\Delta x \cdot \Delta p = \frac{\hbar}{2}$$
$$K = \frac{p^2}{2m} \Rightarrow p = \sqrt{2mK} = 2.3 \times 10^{-20} \text{ kg} \cdot \frac{\text{m}}{\text{s}}$$
$$\frac{\Delta p}{p} = 0.05 \Rightarrow \Delta p = 1.1 \times 10^{-21} \text{ kg} \cdot \frac{\text{m}}{\text{s}}$$
$$\Delta x = \frac{\hbar}{2 \Delta p} = \frac{1.05 \times 10^{-34}}{2 \times 1.1 \times 10^{-21}} = \boxed{4.5 \times 10^{-14} \text{ m}}$$