42. A mosquito of mass 0.15 mg is found to be flying at a speed of 50 cm/s within an uncertainty of 0.5 mm/s. (a) How precisely may its position be known? (b) Does this inherent uncertainty present any hindrance to the application of classical mechanics?

\[ \Delta p \Delta x \geq \frac{\hbar}{2} \]

\[ \Delta p \Delta x = \frac{\hbar}{2} \text{ best case} \]

\[ \Delta x = \frac{\hbar}{2 \Delta p} = \frac{\hbar}{2 m \Delta v} \]

\[ \Delta x = \frac{1.056 \times 10^{-34} \text{ J} \cdot \text{s}}{2(0.15 \times 10^{-6} \text{ kg})(0.5 \times 10^{-3} \text{ m/s})} = 7.0 \times 10^{-25} \text{ m} \]

This very small, smaller than a nucleus by 10 orders of magnitude, you cannot measure such a small uncertainty so effectively, you do know the location of the mosquito.

47. An electron in an atom can “jump down” from a higher energy level to a lower one, then to a lower one still. The energy the atom thus loses at each jump goes to a photon. Typically, an electron might occupy a level for a nanosecond. What uncertainty in the electron’s energy does this imply?

Now use alternative expression for Heisenberg’s uncertainty principle \( \Delta E \Delta t \geq \frac{\hbar}{2} \) because we know \( \Delta t \) and need to find \( \Delta E \)

\[ \Delta E \geq \frac{\hbar}{2 \Delta t} = \frac{1.056 \times 10^{-34} \text{ J} \cdot \text{s}}{2(1 \times 10^{-9} \text{ s})} = 5.3 \times 10^{-26} \text{ J} \]

Sig. figs: unclear because a nanosecond does not have well-defined sig. figs: I’ll take \( 2 \) sig. figs.