Heisenberg Uncertainty Principle

**Heisenberg** – The more accurately you know an object’s position, the less accurately you can know its momentum because observing tiny things like electrons changes their momentum, and resolution is on the order of the wavelength of the photon you use.

Key formula:  Small λ = large p, Large λ = small p

Observing an electron with a small wavelength:

Observing an electron with a large wavelength:

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| Momentum-position:    Δx = Range of position (m)  Δp = Range of momentum (kg m/s)  h = Planck’s Constant (6.626x10-34 Js) | Energy-time    ΔE = Range of energy (J)  Δt = Range of time (s)  h = Planck’s Constant (6.626x10-34 Js) |

Example 1: What is the uncertainty in the position of a 0.145 kg baseball with a velocity of 37.0 ± 0.3 m/s?

Example 2: An electron stays in the first excited state of hydrogen for a time of approximately Δt = 1.0 x 10-10 sDetermine the uncertainty in the energy of the electron in the first excited state.