**Chapter 03: Introduction to Quantum Physics**

**1. The Wave Property of Electrons**

**2. De Broglie’s Theory - Matter Wave**

1. In a research laboratory, electrons are accelerated to speed of 6.0 x 106 m/s. Nearby, a 1.0 x 10-9 kg speck of dust falls through the air at a speed of 0.020m/s. Calculate the de Broglie wavelength in both case
2. An electron microscope uses 40-keV electrons. Find the wavelength of this electron.

**3. The Schrödinger’s Equation**

**4. The Heisenberg’s uncertainty principle**

1. An electron is moving along x axis with the speed of 2×106 m/s (known with a precision of 0.50%). What is the minimum uncertainty with which we can simultaneously measure the position of the electron along the x axis? Given the mass of an electron 9.1×10-31 kg.
2. In an experiment, an electron is determined to be within 0.1mm of a particular point. If we try to measure the electron’s velocity, what will be the minimum uncertainty?
3. A grain of sand with the mass of 1.00 mg appears to be at rest on a smooth surface. We locate its position to within 0.01mm. What velocity limit is implied by our measurement of its position?
4. An electron is confined within a region of width 1.0 x 10-10 m.

(a) Estimate the minimum uncertainty in the x-component of the electron's momentum.

(b) If the electron has momentum with magnitude equal to the uncertainty found in part (a), what is its kinetic energy? Express the result in jou1es and in electron volts.

1. A sodium atom is in one of the states labeled ''Lowest excited levels". It remains in that state for an average time of 1.6 x 10-8 s before it makes a transition back to a ground state, emitting a photon with wavelength 589.0 nm and energy 2.105 eV. What is the uncertainty in energy of that excited state? What is the wavelength spread of the corresponding spectrum line?

**5. Particle in a square well**

1. An electron is confined to a one-dimensional, infinitely deep potential energy well of width a = 100pm.

1/ What is the least energy (in eV) the electron can have?

2/ Compute the energy level of the first excited state, of the second excited state. Draw the energy level diagram.

1. The wave function of a particle confined to an infinitely deep potential energy well is ψ(*x*) = *C* sin *Kx.* Determine the value of C, knowing that the particle must be somewhere **in all space.**
2. The wave function of a particle confined to an infinitely deep potential energy well is ψ(*x*) = sqrt(2/*a)* sin (*Kx).* The depth of the well is *a* = 100 pm. What is the probability density of finding the particle at the distance *x* = 50 pm for the value of the quantum number

1/ *n* = 1?

2/ *n* = 2 ?

**6. Tunneling Phenomena**