Problem 2-1 (as assigned by Dr. Peeples)

Given a potential field, calculate the energy and velocity of an electron.

Moving an electron through a potential of 1 volt causes 1 electron-volt (eV) of energy gain. The electron gains 1 eV=$1.6\text{X}10^{-19}$ J.

$$E = \frac{1}{2}mv^2$$

$$v = \sqrt{2E/m} = \left[\frac{2*1.6*10^{-19}}{9.1*10^{-31}}\right]^{\frac{1}{2}} = 5.93*10^5\, m/s$$

Problem 2-5

What is a particle's momentum uncertainty if we know its position to within 1Å?

$$\Delta p_x = \frac{\hbar}{2*\Delta x} = \frac{6.63*10^{-34}}{4\pi*10^{-10}} = 5.3*10^{-25}\, kg*m/s$$

What is the particle's uncertainty in time if we know energy within 1eV?

$$\Delta t = \frac{\hbar}{2*\Delta E} = 3.3*10^{-16}\, s$$

Problem 2-6

What are the wavelengths for electrons of 100 eV and 12,000 eV energies. What does this imply about electron microscopy?

$$v = \sqrt{2E/m}$$

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2Em}} = \frac{6.63*10^{-34}}{[2*9.11*10^{-31}]^{1/2}} E^{-1/2}$$

For 100 eV, $\lambda = 1.23*10^{-10}\, m = 1.23Å$

For 12,000 eV, $\lambda = 1.12*10^{-11}\, m = 0.112Å$

These wavelengths are much shorter than those of visible light (~5000 Å) and thereby impart much higher resolution to the electron microscope.

Problem 2-11

Calculate the first three energy levels for a 10 *Å* quantum well with infinite walls.

From Eq. 2.33

$$E_n = \frac{n^2\pi^2\hbar^2}{2mL^2} = \frac{(6.63*10^{-34})^2}{8*9.11*10^{-31}*[10^{-9}]^2}n^2$$

$$E_1 = 0.603*10^{-19}J = 0.377eV$$
$$E_2 = 0.377*4 = 1.508eV$$
$$E_3 = 0.377*9 = 3.393eV$$