Reminders 04-30-08:
-Exam 4 Monday May 5
-Final Exam Wednesday May 7
-Watch Your Books for the Next Two Weeks
-Robert Barchfeld 3PM Wednesday S-105

Outline:
-Particles as Waves
-Probability and Uncertanity
-Schrodinger Equation

- Does the Bohr model violate the uncertainty principle?
- If you measure the x-coordinate of a 1200kg car within 1.00μm, what is the uncertainty in its velocity? Does the uncertainty impose a practical limit on macroscopic measurements?
- Consider a 1D box of length L. Because of the uncertainty principle its kinetic energy cannot be zero. Estimate the minimum energy of an electron in a box of length $L=a_0$.

$\Delta x \Delta p \geq \hbar$

$\Delta p \geq \frac{\hbar}{\Delta x} = \frac{1.055\times10^{-34}}{1\times10^{-6}\,m}$

$\Delta p = 1.055\times10^{-28}\,kg\,m/s$

$\Delta v = \frac{\Delta p}{m} = \frac{1.055\times10^{-28}}{1200} = 8.79\times10^{-32}\,\frac{m}{s}$

$$(\underline{\Delta p})^2 = (\overline{p^2} - \overline{p}^2) = \underline{\overline{p^2}}$$

$\overline{p} = 0$ in box

$$E = \frac{p^2}{2m}$$

$$\Delta p \Delta x \geq \hbar$$

$$\Delta p \geq \frac{\hbar}{\Delta x}$$

$$E = \left(\frac{\hbar}{a_0}\right)^2 \frac{1}{2m}$$

$$(\Delta p_0)^2 = \overline{p^2} = \left(\frac{\hbar}{a_0}\right)^2$$

$$= \frac{\hbar^2}{2ma_0^2}$$

$m = 9.11 \times 10^{-31}$

$a_0 = .0529$ nm

$E = 3.8$ eV

$E = hf$

$E = \hbar\omega$

Particles as Waves?

$$\Psi = A\cos(kx - \omega t) + A\cos[(k+\Delta k)x - (\omega + \Delta\omega)t]$$

$$\Delta k \ll k \text{ and } \Delta\omega \ll \omega$$

$$\frac{\omega}{\ }$$

$$= 2A\cos 0.5(\Delta k x - \Delta\omega t)\cos(kx - \omega t)$$

$$\omega = \frac{E}{\hbar}$$

$$v_{wave} = \omega/k \qquad \omega = \left(\frac{h}{\lambda}\right)^2 \frac{1}{\hbar}\frac{1}{2m}$$

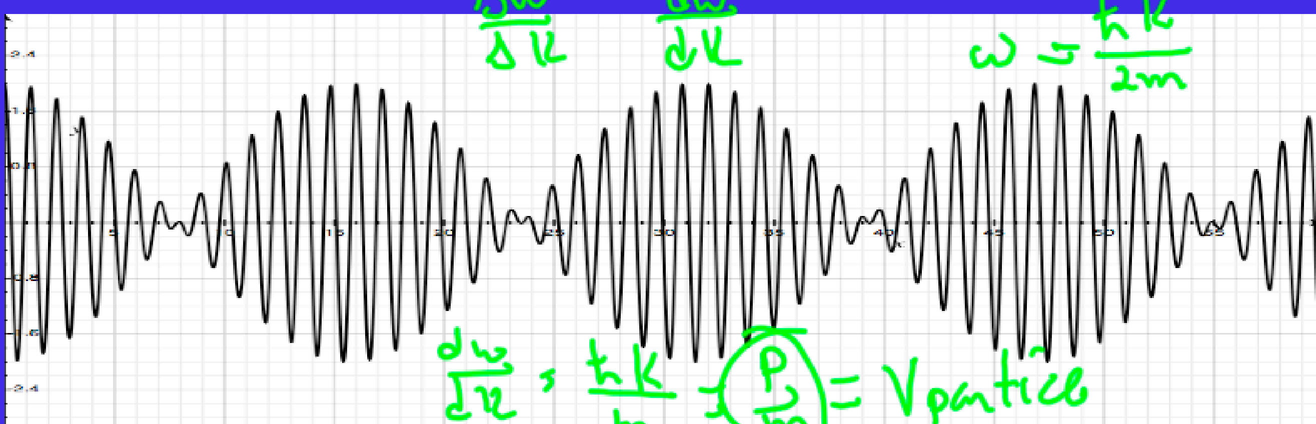
$$E = \frac{p^2}{2m} = \left(\frac{h}{\lambda}\right)^2 \frac{1}{2m}$$

v_{group} = speed of packet

$$= (\hbar k)^2 \frac{1}{\hbar}\frac{1}{2m}$$

$$v_{group} = \Delta k/\Delta\omega \rightarrow dk/d\omega = dE/dp = v_{particle}$$

$$\frac{\Delta\omega}{\Delta k} \qquad \frac{d\omega}{dk} \qquad \omega = \frac{\hbar k^2}{2m}$$



$$\frac{d\omega}{dk} = \frac{\hbar k}{m} = \frac{p}{m} = V_{particle}$$

Conditions on ψ

① Solution $\rightarrow \emptyset$ in extreme cases

② Solution finite everywhere

③ Solution continuous

④ $\frac{d\psi}{dx}$ must be continuous

- The wave function for a hydrogenic atom in its ground state is $Ce^{-Zr/a}$. This function represents the probability amplitude over a sphere of radius r. Determine the value C and the maximum value of the probability distribution $Cr^2e^{-2Zr/a}$ function.

$$\int \psi^* \psi \, dx = 1 \qquad \int_0^\infty C^2 e^{-Zr2/a} r^2 4\pi \, dr = 1$$