Modern Physics
Problem Set 6

JC-29) **de Broglie Waves**
A photon and a particle have the same wavelength.

a) (10 points) How do their linear momenta compare?
b) (10 points) How does the photon's energy compare to the particle's total energy?
c) (10 points) How does the photon's energy compare to the particle's kinetic energy?

JC-30) **Atomic Nucleus**
In order to study the atomic nucleus, we would like to observe the diffraction of particles whose de Broglie wavelength is about the size as the nuclear diameter, ~14 fm for a heavy nucleus such as lead. What kinetic energy should we use if the diffracted particles are

a) (10 points) electrons
b) (10 points) neutrons
c) (10 points) alpha particles (mass = 4 u)

JC-31) **Davisson-Germer Experiment Revisited**
(10 points) In the Davisson-Germer experiment using Ni crystal, a second-order intensity maximum is observed at an angle of 55 degrees. For what accelerating voltage does this occur?

JC-32) **de Broglie Wavelength of Nitrogen Molecules**
(10 points) According to statistical mechanics, the average kinetic energy of a particle in a system that is at temperature T is $3kT/2$ where k is the Boltzman constant. What is the average de Broglie wavelength of nitrogen molecules at room temperature?

JC-33) **Free Particle**
(10 points) A free particle is represented by the following plane wave function

$$\Psi(x,t) = Ae^{i(Bx-Ct)}$$

where B = 1.58 x 10^{12} and C = 7.91 x 10^{16} and SI units are understood. What are the momentum, kinetic energy and mass of the particle?

JC-34) **Schroedinger Equation**

a) (10 points) Does the wave function $\Psi(x,t) = A\ sin(kx - \omega t)$ satisfy the Schroedinger equation? Justify your answer.
b) (10 points) Does the wave function $\Psi(x,t) = A\ cos(kx - \omega t) + iA\ sin(kx - \omega t)$ satisfy the Schroedinger equation? Justify your answer.

Talk 1) **Topics**
(10 points) List 3 potential topics for your end of the semester presentation.