Worksheet 1. From Newton and Maxwell, to Schrödinger

1. What is the momentum of an γ-ray with a wavelength of 1×10^{-13} m?

2. The Hamiltonian operator corresponds to which observable property of a system?

3. Rydberg's law for the wavelengths of absorption by a 1-electron atom (or ion) with atomic number Z is

$$\frac{1}{\lambda} = \left(1.0974\cdot10^{7}\ \mathrm{m}^{-1}\right)Z^{2}\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right) \qquad 1 \le n_1 < n_2 < \infty$$

Suppose you are given the Hydrogen atom in its ground state, $n_1 = 1$. **What is the lowest absorption frequency?**

4. What is the time-dependent Schrödinger equation for the complex conjugate of a wavefunction, $\Psi^{*}(x,t)$?

5. What is the quantum mechanical operator for the kinetic energy?

6. What is the complex conjugate of $\Psi(x,t) = Ae^{(a+bi)(kx-\omega t)}$?

7. Which of the following experimental results are often cited as examples of the "wave-likeness" of particles like electrons?
   (a) blackbody radiation
   (b) discrete emission lines in the hydrogen spectrum.
   (c) photoelectric effect
   (d) Compton scattering of light by a particle.
   (e) electron scattering from a crystal.

8. Which of the following experiments are often cited as examples of the "particle-likeness of radiation" like light?
   (a) blackbody radiation
   (b) discrete emission lines in the hydrogen spectrum.
   (c) photoelectric effect
   (d) Compton scattering of light by a particle.
   (e) electron scattering from a crystal.

9. The Davisson-Germer experiment demonstrated that if you shine a beam of electrons on a metal crystal, the result is
   (a) the electrons are absorbed at "critical energies" similar to the optical (light) absorption spectrum.
   (b) the electrons scatter according to the Bragg law for X-ray scattering.
   (c) the electrons go right through the metal.
   (d) the metal gets very hot and becomes a dull red color.

10. Suppose you are given a photon with energy 2 eV. What is its momentum? What is its frequency?