Exam 1, Chem 311, 60 minutes, Dr. H. Guo, Sept. 12, 2008

You are allowed to bring a one page sheet containing equations and a calculator

I. Answer the following multiple choice questions (5 pts each).

1. Which of the following is considered as a wave in classical physics?
A. An electron.
B. Light.
C. A neutron.
D. An atom.
E. A molecule.

2. Which of the following equation(s) is(are) associated with classical mechanics?
A. Schrödinger's equation.
B. Maxwell's equations.
C. Newton's equation.
D. Einstein's equation.
E. De Broglie equation.

3. What was the assumption made by Planck in deriving his distribution for blackbody radiation?
A. The blackbody consists of photons.
B. The blackbody consists of electrons.
C. The oscillators in the blackbody have arbitrary energies.
D. The oscillators in the blackbody have discrete energies.
E. The oscillators in the blackbody behave according to Newton's equation.

4. Which of the following statements concerning the photoelectric effect is **false**?
A. The light consists of photons, which has a fixed energy at a given frequency.
B. No electron is emitted below the threshold frequency, no matter how intense is the radiation.
C. The threshold frequency is related to the work function of the metal.
D. Above the threshold, the number of emitted electrons is proportional to the intensity of the radiation.
E. Above the threshold, the velocity of the emitted electron is linearly proportional to the photon frequency.

5. Assuming traveling at the same speed, which of the following particles has the largest de Broglie wavelength?
A. An electron.
B. A neutron.
C. A He atom.
D. A C atom.
E. A Fe atom.

II. Solve the following simple problems

6. (10 pts) A distant star has an emission spectral peak at 612 nm, estimate its temperature.

7. (10 pts) The speed of a proton is 1.3 Mm/s. What is its de Broglie wavelength?

III. Solve the following more complicated problems

8. (15 pts) Electrons are observed to emit from a metal with a work function of 3.1 eV after stricken by a light beam with a wavelength of 320 nm. Calculate the kinetic energy of the emitted electrons and their de Broglie wavelength.

9. (20 pts) A hypothetical spacecraft of 25 kg is powered by photons emitted in the backward direction. Since there is no air drag in space, the momentum generated by the emitting photons is fully used to propel the spacecraft forward. If the power of the photon emission is 2.0 kW, what will be the speed of the spacecraft after 300 days of acceleration?

10. (20 pts) A beam of electrons was accelerated from rest through an adjustable potential field generated by two planar electrodes. Calculate the potential difference ($\Delta\phi$) needed to make the electron beam diffract by a crystal with a lattice constant of 0.2 nm.