HW 7

Due December 1, 2006

Note: You have two weeks to complete this assignment You will most likely not be able to do problems 5-7 until after Thanksgiving break, so don't do those until then.

Please answer all questions clearly and concisely. While you need not transcribe the question completely, it should be clear from your answer alone what you are talking about.

You are strongly encouraged to discuss the homework with your classmates, but you must complete the written homework by yourself, and of course, the material you submit must be your own.

Remember, show all of your work!

1) 6.1

2) 6.5

3)

    a. What is the de Broglie wavelength of a proton moving at 20 m/s?

    b. If a photon had this wavelength, what type (UV, Visible, Radio, etc.) would it be?

4) A particle of mass, m, trapped in a 1-d box of length, L, has energies with:

$$E_n = \frac{\hbar^2 \pi^2}{2mL^2} n^2 \tag{1}$$

    a. What is the ground state energy if the length of the box is 10^{-10} m (roughly the size of a hydrogen atom) and the particle in question is an electron? Express your answer in eV.

        You should find that the energy is of the same order (a factor of a few) the energy of a Hydrogen atom. This is not a coincidence.

    b. What is the first excited state of this system?

    c. What is the wavelength corresponding to the "Lyman-Alpha" transition of this system?

    d. What type of radiation is this?

5) You observe three (non-interacting) particles with:

$m_1 = 1$ kg, $m_2 = 2$ kg, and $m_3 = 3$ kg, and at positions:

$\vec{r}_1 = <2, 1, 0>$ m, $\vec{r}_2 = <-4, 2, 0>$ m, $\vec{r}_3 = <1, 0, 0>$ m, and with velocities:

$\vec{v}_1 = <3, 0, 0>$ m/s, $\vec{v}_2 = <-2, 2, 0>$ m/s, $\vec{v}_3 = <-1, 3, 0>$ m/s.

    a. Where is the center of mass? (I'm looking for a vector.)

    b. What is the center of mass velocity?

    c. What is the *translational* kinetic energy?

d. What is the *total* energy of the system (not including mass energy)?

e. What is the thermal energy of the "gas." ?

6) 7.4

7) 7.11