HW Set #1 Due 9/2/10 (at the beginning of class)

Work the following problems from chapters 1 and 3
Chapter 1
24
Chapter 3
4, 6

Other problems.

1. In nuclear fusion atomic nuclei are combined. Examine the following reaction of two isotopes of hydrogen to make an isotope of helium. Deutrium (^{2}H) + Tritium (^{3}H) can "react" to form Helium-4 and a neutron.

$$^2_1H + ^3_1H \rightarrow ^1_0n + ^4_2He$$

Find the masses of each of these to at least 10 significant figures (Table 19.1).
Find the change in mass that accompanies this reaction and convert that mass change to an energy change using Einstein's theory of relativity ($E = mc^2$).
How much energy is released per mole of Helium?

Compare this to covalent bond formation. The formation of molecular hydrogen H_2 from two atoms of hydrogen is 436 kJ mol^{-1}. What does this tell you about the "mass loss" in this reaction?

2. Metallic gold has a density of 19.3 g cm^{-3}. Using the atomic mass of gold, determine the "volume" of one gold atom. Use this to determine an atomic "radius". Compare this to a "known" value you find in a reference.

3. Follow-up on problem 3.6. Imagine you initially have a gold nucleus and an electron separated by and infinite distance. You then move the electron so it is now at a separation of 1Å . What is the change in potential energy of the electron? What is the reduction in total energy? What is the change in kinetic energy of the electron? What is the change in the velocity of the electron (you can assume it has essentially zero velocity to begin with)? Do you see any potential problems with this?

4. Let's look at the oddity that is "shared" electrons by examining the coulomb potential for an electron between two nuclei. For simplicity let's work in atomic units where the charge on the electron is -1, the charge on a proton is +1, and $4\pi\epsilon_0 = 1$, and the bohr radius a_0 is = 1. Imagine two protons separated by $2a_0$ with an electron between them. First calculate the total potential energy of the electron exactly between the two nuclei (this will have three parts, the nuclear repulsion and the attraction of the electron to each nucleus). Then calculate the potentially energy when the electron is close to one nucleus or the other (say $0.5a_0$ from one of them). Which is lower? Where is the energy the electrostatic potential energy the highest?