Chemistry 542

Fall, 2002

Problem Set 3

Due Friday, September 20

Read chapters 2 and 3 in Levine. The only parts that you will need for this problem set are 2.2, 3.4, 3.5, and 3.6, but many of the other sections should already be familiar to you from lecture. The rest we will need next week anyway.

1. Consider a cubical quantum dot with a dimension of 5 nm for each side. Suppose the dot is filled with electrons.

A. Calculate the ten lowest energy levels (ignoring the Coulomb repulsion, which is a pretty drastic assumption!), and indicate the degeneracy of each.

B. Consider a transition from the ground state to each excited state. What wavelength of light is required to induce each transition? Express your answer in nm.

2. Consider an oxygen molecule in a cube with a dimension of 1 cm on each side.

A. Calculate the number of states with energy < kT, where k is Boltzmann's constant and T = 300 K.

B. Calculate the density of states at E = kT, where T = 300 K. Express your answer as the number of states per wave number.

C. Repeat parts A and B for ^{87}Rb with T = 10^{-7} K and L = 50 micrometers.

Also do Levine 2.5, 2.6, 2.7, 2.12, and 3.31

In 2.12, Levine correctly points out that the wave functions are the same. Nevertheless, the mathematical functions are different because the coordinate system is different. Write down the wave functions for the 6 lowest stets.