

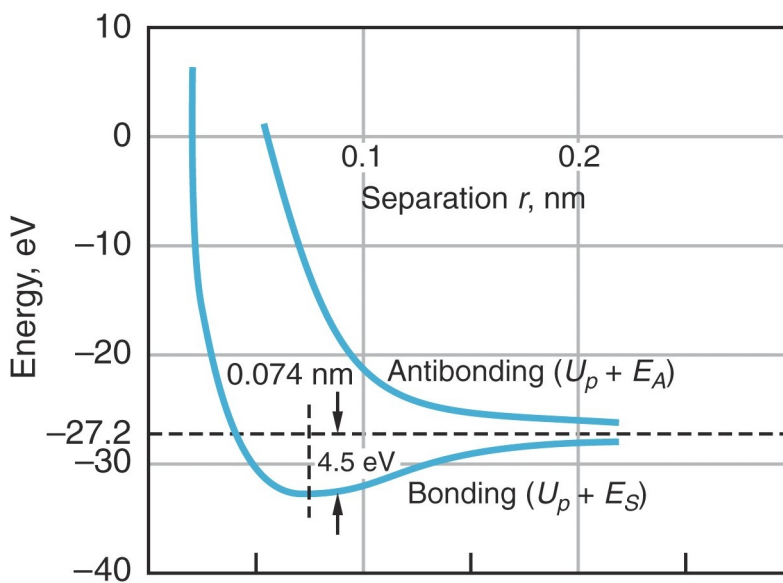
## Physics 308: Assignment 5

Due in class Thursday, February 28, 2008

- Hydrogen can bond covalently with many atoms, including sulfur, tellurium, phosphorus, and antimony. What would you expect to be the chemical formulae of the resulting molecules? (Hint: First draw the electronic configurations.)
- What kind of bonding mechanism would you expect for (a) the  $\text{CaCl}_2$  molecule, (b) the  $\text{O}_2$  molecule, and (c) the  $\text{CH}_4$  molecule?
- The potential energy between two atoms in a molecule can often be well described by the Lenard-Jones potential, which is written

$$U(r) = U_0 \left[ \left( \frac{a}{r} \right)^{12} - 2 \left( \frac{a}{r} \right)^6 \right],$$

where  $U_0$  and  $a$  are constants. (a) Find the interatomic separation  $r_0$  for which the potential energy is a minimum. (b) Find the corresponding value of  $U_{\min}$ . (c) Use the figure below to obtain numerical values for  $r_0$  and  $U_0$  for the  $\text{H}_2$  molecule. Express your answer in nanometers and electron volts. (d) Make a plot of the potential energy  $U(r)$  versus the internuclear separation  $r$  for the  $\text{H}_2$  molecule. Plot each term separately, together with the total  $U(r)$ .



- Suppose that hard spheres of radius  $R$  are arranged in a simple cubic structure. (a) If the hard spheres touch so as to take up minimum volume, what is the size of the unit cell? (b) What fraction of the volume of the unit cell is occupied by the hard spheres?