Physics 330, Spring 2009
HW#9 30 points

Problems from Tipler and Llewellyn:

1. **9.2 (5 points)** The dissociation energy of Cl_2 is 2.48 eV. Consider the formation of an NaCl molecule by the reaction

$$Na + \frac{1}{2}Cl_2 \rightarrow NaCl$$

Is this reaction endothermic (requiring energy) or exothermic (giving off energy)? How much energy per moleucle is required or given off?

2. **9.12 (5 points)** The equilibrium separation of the atoms in the HF molecule is 0.0917 nm, and its measured electric dipole moment is 6.40 $\times 10^{-30}$ C·m. What percentage of the bonding is ionic?

3. **9.17 (5 points)** The polarizability of Ne is 1.1 $\times 10^{-37}$ C^2/N. (a) At what separation would the dipole-diploe energy between a molecule of H_2O and and atoms of Ne in the atmosphere be sufficient to withstand collision with an N_2 molecule moving with the average kinetic energy for T=300 K? (b) At what separation does this energy occur for a typically bonded molecule? (c) On the basis of these results, do you expect H_2O-Ne bonds to be very likely? Explain your answer.

4. **9.23 (5 points)** Using data from Table 9-7, (a) compute the vibrational energy of the LiH molecule in its lowest vibrational state. (b) Compute the reduced mass of LiH. (c) Determine the force constant for LiH. (c) From those results, compute an estimate of the LiH bond length and compare your results with the value in the table.

5. **9.54 (5 points)** Show that the H^+-H^- system cannot be ionically bonded. (*Hint:* Show that $U(r)$ has no negative minimum.)

6. **9.55(5 points)** (a) Calculate the fractional difference $\Delta\mu/\mu$ for the reduced masses of the $H^{35}Cl$ and $H^{37}Cl$ molecules. (b) Show that the mixture of isotopes in HCl leads to a fractional difference in the frequency of a transition from one rotational state to another given by $\Delta f/f = -\Delta\mu/\mu$. (c) Compute $\Delta f/f$ and compare your results with Figure 9.29.