Chem 130, Eppley
Spring 2017

Exam 3

Friday, April 28

1. (24 pt) For each of the following statements, justify using the information you've learned from this class. **Illustrate your answers with chemical equations and/or diagrams- a picture is frequently worth a thousand words!** (8 pt each)

   a. Intrinsic semiconductors like Si are better conductors than insulators, but both p- and n-doped semiconductors will conduct better than an intrinsic semiconductor.

   b. When you dissolve $CrCl_3$ in aqueous solution you get an acidic solution, but when you dissolve and NaHS and NaClO in aqueous solution you get a basic solutions.

   c. Elemental Si, H_2O, and Na_2SO_4 all contain covalent bonds, yet all are held together differently in the solid state, and their melting and boiling points are quite different from one another (be sure to propose the relative rankings in your answer!).

2. (10 pt) The sea of electrons model and band theory are two ways to consider the bonding in metals. For **both** Na and Mg metal, draw pictures that represents this type of bonding for each of the two models. For each model, explain why both metals conduct.

Sea of Electron Model		Band Theory	
Na	Mg	Na	Mg

3. (24 pt) For each of the following statements, fill in the blank with an appropriate answer: (3 pts each)

_____ a. A compound that will have both ionic and covalent bonds holding it together in the solid state

_____ b. The form of Al^{3+} in an aqueous solution at a pH of 7

_____ c. An example of a weak base that will be deprotonate HSO_3^-

_____ d. An example of a **ionic** compound where impurities lead to interesting colors (be as specific as you can!)

_____ e. Type of semiconductor device used in both LEDs and solar cells

_____ f. The K_a value range for a strong acid

_____ g. The type of alloy where a smaller element fits into the holes left by another element.

4. (17 pt total) The aurora borealis light effects come from the emission of light from the excited state of the N_2 and N_2^+. Valence bond theory doesn't actually do a very good job of explaining the bonding in N_2^+ or the colors that are emitted from excitation, so we use MO Theory to explain these things.

   a. **Draw and clearly label** the ground state MO diagram for N_2^+ in the box below, assuming that s-p mixing occurs (you can, but you do not need to include the AOs that you are starting with). (5 pt)

   b. What is the LUMO for N_2^+? (2 pt)

   c. Draw a picture of the LUMO. (2 pt)

   d. Write the electron configuration for N_2^+ based on your diagram (3 pt)

   e. Would you expect the bond length to be longer or shorter in N_2^+ than in N_2? Explain! (5 pt)

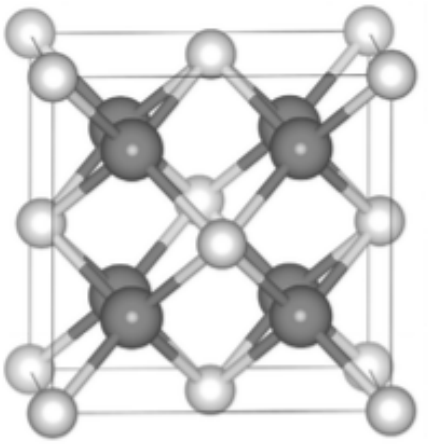
5. (11 pt) As spring approaches, you may start seeing mosquitos flying around and you might get bitten by one! There is an old folk remedy for mosquito bites that involves applying baking soda to the bite. Is there any truth to the tale? Mosquitos release formic acid (HCOOH) when they bite someone.
   a. (3 pt) Write an equation for reaction between the HCO_3^- in baking soda and formic acid.

   b. (4 pt) Label the acid, base, conjugate acid and conjugate base and predict whether the reaction will favor products or not.

   c. Draw a predominance diagram to predict what will happen to formic acid alone when it becomes distributed through your bloodstream (pH=7.4). What form will be most important at that pH? (4 pt)

6. (14 pt) In February of 2017, a group of chemists, geologists, physicists scientists from China, Russia, Germany, Italy, and the US isolated the first example of a compound of He at very high pressures (about 1 x 10^6 atmospheres!). The structure of that compound is shown below and contains Na (gray) and He (white) atoms. Although the bonding in this compound is not really like the other solids we've talked about, you can easily analyze its structure using the tools from class.

    a. Calculate the formula of this new compound based on the structure below. Show your work carefully, including how you counted each atom. (4 pt)



    b. What is the packing arrangement of the He atoms? (2 pt)

    c. What type of holes do the Na atoms occupy? (2 pt)

    d. What is the coordination number of the He atoms? (2pt)

    e. The packing of the He atoms alone can be described in a different way than you already described it. What is another name for the packing arrangement? (2 pt)

    f. The Na and He together form a structure very similar to one of the other structures you looked at in lab. Which structure was that? (2 pt)