Exam 2
Friday, March 24
100 pts

1. (24 pt) Explain each of the following true statements, **supporting your answers with diagrams and other supporting information as necessary**! Note that it is better to say why your model does not fit the rather than just making up invalid stuff in order to make it agree! (8 pt each)

    a. The element gadolinium (Gd) tends to form +3 ions while the element indium (In) tends to form both +1 and +3 ions.

    b. Silicon (Si) and germanium (Ge) atoms are about the same size, but tin (Sn) atoms are bigger than both Si and Ge.

    c. The CO bond length in the cyanate ion (OCN^- connected in that order) is 137 pm, while the average bond distance for a CO single bond is 143 pm, the average CO double bond is 123 pm and an average CO triple bond is 113 pm.

2. (24 pts) Draw the **best** inequivalent Lewis dot structures (with equivalent resonance structures if appropriate) for the following molecules and ions. Predict the geometry, draw it in 3-D, label the bond angles. (8 pts each)

Formula	Lewis dot structure(s)	Draw geometry and indicate bond angles	Molecular geometry at **each** central atom(s)	Hybridiz. at **each** central atoms	Polar or non polar
NCl_4^+					
HSO_3^-					
BrF_3					

3. (8 pt) For each of the following statements say whether they are true or false. If false, explain why they are false, if true provide brief supporting evidence! (4 pt each)

_____ The Z_{eff} of Zn is higher than the Z_{eff} of Co because Zn has more d electrons.
Explanation:

_____ The ionization energy for B is less than that for Be. Explanation:

4. (7 pt total) A hydrogen atom and a fluorine atom are brought together from a significant distance apart to form a covalent bond. Draw a diagram that represents the **energy** associated with this system of two atoms as a function of the distance between them. Briefly explain the reasons for the energy changes that you plot on the diagram. On this diagram, indicate (with an arrow) the energy involved in breaking the HF bond.

   Would breaking this bond require the input of energy or would energy be released? Explain briefly the reason for the sign of this energy difference.

5. (12 pt, 3 pt each) Answer each of the following questions:

_____ a. The symbol for the element in period 4 with the highest Z_{eff}

_____ b. The largest element in period 2

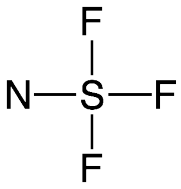
_____ c. A properly drawn dipole arrow for a O–S bond

_____ d. The electron configuration of Ni^{2+}

6. (24 pt total) The simple bonding models that you've learned in this class can even be useful to describe the most exciting, novel inorganic compounds. In 2007, a paper (*Inorg. Chem.* **2007**, *46*, 1369-1378.) showed that $[XeF]^+[AsF_6]^-$ reacted with liquid NSF_3 to form the salt $[F_3SNXeF]^+[AsF_6]^-$. Those are some bizarre compounds! Let's look at some of the individual pieces:

For the starting material NSF_3, the skeleton structure is shown below.

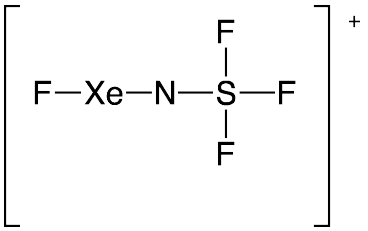
a. Fill in the missing electrons and make a valid Lewis dot structure out of it. (2 pt)
b. Assign the formal charges to the initial structure you drew, and adjust the structure if necessary to give the best inequivalent resonance structure! (5 pt)



For the novel product, there are two separate pieces which interact though ionic bonding: the AsF_6^- anion and the very interesting $[F_3SNXeF]^+$ cation.

The skeleton structure of the $[F_3SNXeF]^+$ cation is shown below (with no geometry implied). The paper states that it is the first example of a Xe bound to an "**sp hybridized N**".

c. Using the skeleton structure below, your answer to part b, and the important hybridization information above, propose a valid Lewis dot structure for this novel inorganic cation! (4pt)



d. Predict the following bond angles in the molecule based on your picture above (3 pt):

F-Xe-N

Xe-N-S

F-S-F

e. What experimental technique do you think the authors used to verify their bonding model for this cation? What information would you want to collect to verify your proposed bonding model. (3 pt)

f. The anion of the compound is a covalently bonded and much simpler anion, AsF_6^-. Do a full valence bond description of this anion (using all three steps that we did in class!). Start with a properly labeled Lewis dot structure! Clearly indicate the hybridization of the As in your answer and the orbitals used to form each of the bonds. Finally draw a picture showing those orbitals in the proper geometry. (8 pt)