Chem 130 – Second Exam

Name________________________________

On the following pages you will find questions covering varies topics ranging from the geometry of inorganic compounds to different types of bonding. Read each question carefully and think about how to approach the problem before you put pen or pencil to paper. If you aren't sure how to start a question, move on to another problem; often working on a new question will suggest an approach to that more troublesome problem. For problems requiring a written response, be sure that your answer is written in complete sentences and that it directly and clearly answers the question. Partial credit is willingly given on all problems so be sure to answer all questions!

Question 1 _____/24

Question 2 _____/8

Question 3 _____/8

Question 4 _____/10

Question 5 _____/8

Question 6 _____/8

Question 7 _____/8

Question 8 _____/8

Question 9 _____/18

Total _____

Potentially useful equations and constants:

$$c = \lambda\nu \qquad E = h\nu \qquad KE = h\nu - BE \qquad \frac{1}{\lambda} = 1.09737\times10^{-2}\ \text{nm}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \qquad V = \frac{kq_1q_2}{d}$$

$$FC_a = V_a - N_a - \frac{B_a}{2} \qquad \delta_a = V_a - N_a - B_a\left(\frac{EN_a}{EN_a + EN_b}\right)$$

$$OX_a = V_a - N_a - B_a \times (0 \text{ if least EN}; 1 \text{ if most EN})$$

$$c = 2.998\times10^{8}\ \text{m/s} \qquad h = 6.626\times10^{-34}\ \text{Js} \qquad N_A = 6.022\times10^{23}\ \text{mol}^{-1}$$

Problem 1. For each of the following molecules or ions, draw any one valid Lewis structure of your choosing (it need not be the "best" structure). Annotate your structure by indicating the formal charge on each atom. Then, state the name for the geometry around the underlined central atom, predict whether the molecule or ion is polar or non-polar, and give the idealized bond angle for the stated bonds.

Molecule or Ion	Lewis Structure	Bonding Geometry	Polar or Non-Polar?	Ideal Bond Angle
$\underline{S}O_3^{2-}$				Bond angle for an O-S-O bond is….
$\underline{Xe}F_3^+$				Bond angle for a F-Xe-F bond is….
$\underline{I}Cl_4^+$				Bond angle for a Cl-I-Cl bond is….
$\underline{S}O_2$				Bond angle for an O-S-O bond is…

Problem 2. An element Z forms a molecular compound with the stoichiometry ZBr_3 that is known to have trigonal pyramidal geometry. Give an example of an element that could be Z. Be sure to clearly explain your reasoning in one or two sentences.

Problem 3. A bond dissociation energy is the energy needed to break a bond. Consider the following three compounds or ions containing an N–O bond: NO^+, HNO, and NO_3^-. Rank these three compounds from the weakest N–O bond to the strongest N–O bond. Be sure to clearly explain your reasoning with appropriate Lewis structures and two or three sentences.

Problem 4. Match the following compounds or ions in the list on the left to the type of bond described in the list on the right; each of the bond descriptions will be used only once. Use arrows to show the matched pairs, but be sure that your answers are clear. Use the space to the left or at the bottom for any scratch work you wish me to see.

Compound or Ion	Bond description
I_2	includes a σ bond from the overlap of an s-orbital and a p-orbital
HI	includes a σ bond using a sp^3 hybrid orbital
I_3^-	includes a σ bond from the overlap of two p-orbitals
ICl_4^-	includes a σ bond using a d^2sp^3 hybrid orbital
IO_3^-	includes a σ bond using a dsp^3 hybrid orbital

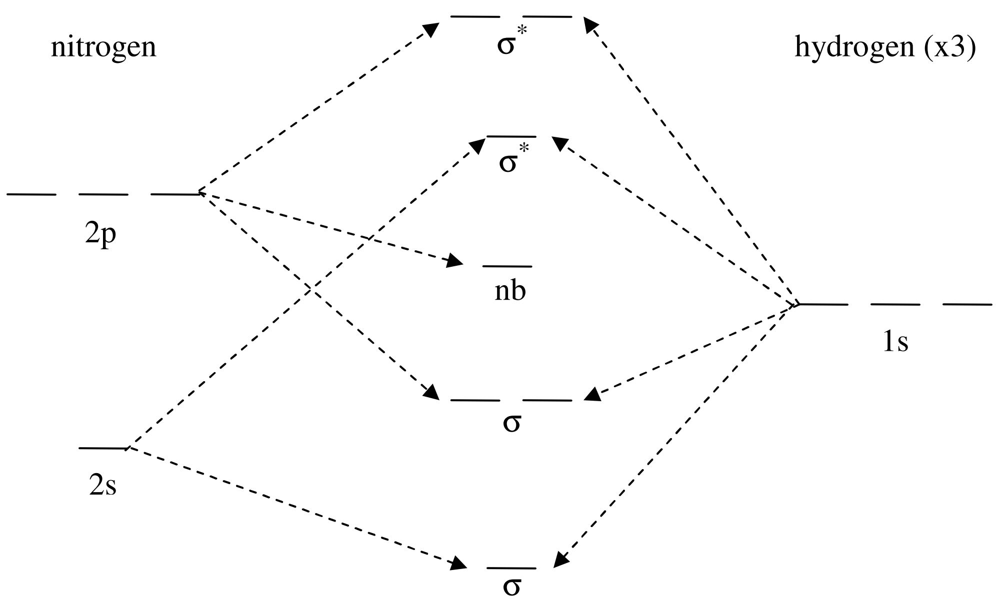
Problem 5. Based on the positions of gallium (Ga) and oxygen (O) in the periodic table, which of the following formulas is the most likely form of gallium oxide: GaO, GaO_2, GaO_3, Ga_2O, or Ga_2O_3? Briefly defend your choice in one or two sentences.

Problem 6. Briefly, in two or three sentences, explain the difference between metallic, covalent, and ionic bonding in terms of the localization of electrons.

Problem 7. Consider the following ionic compounds – MgF_2, SrF_2, and BeF_2. Which of these compounds has the highest melting point? Briefly justify your choice in two or three sentences.

Problem 8. Consider the compounds $BaSi_2$, MgH_2, and SO_2. One of these compounds is considered ionic, one is covalent, and one is metallic. Using an argument based on electronegativities, classify these three compounds. Briefly explain your reasoning in two or three sentences.

Problem 9. Shown below is a molecular orbital (MO) diagram for ammonia, NH_3. Although NH_3 is a polyatomic molecule, we can still use an MO diagram to characterize the bonding. Note that the right side of the MO diagram has three 1s orbitals, one for each of ammonia's three H atoms and that the molecular orbital identified as "nb" is non-bonding. Complete the MO diagram by placing the appropriate number of valence electrons in the atomic orbitals and the molecular orbitals.



<u>Based on your molecular orbital diagram</u>, what is the total bond order for NH_3? Be sure to explain your reasoning.

In a short paragraph, compare the description of the bonding of ammonia given in this molecular orbital diagram to the description given by a simple Lewis structure. As part of your answer, discuss ways in which the two models provide similar conclusions about the bonding in ammonia and ways in which the two models provide different conclusions about the bonding in ammonia.