

Chem 130 – Second Exam

Name _____

On the following pages you will find eight questions covering various topics ranging from the geometry of inorganic compounds to different types of bonding. Read each question carefully and consider how you might approach the problem before you put pen or pencil to paper. If you aren't sure how to start a question, move to another problem; working on a new question may 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 ____/28 Question 5 ____/10

Question 2 ____/6 Question 6 ____/10

Question 3 ____/16 Question 7 ____/10

Question 4 ____/4 Question 8 ____/16

Total ____/100

Potentially useful equations and constants:

$$c = \lambda\nu \quad E = h\nu \quad KE = h\nu - BE \quad \frac{1}{\lambda} = 1.09737 \times 10^{-2} \text{ nm} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \quad V = \frac{kq_1q_2}{d}$$

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

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

$$c = 2.998 \times 10^8 \text{ m/s} \quad h = 6.626 \times 10^{-34} \text{ Js} \quad N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

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. Finally, state the name for the bonding 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
$\underline{\text{C}}\text{Cl}_2\text{F}_2$				Bond angle for an F-C-Cl bond is....
$\underline{\text{I}}\text{O}_2\text{F}_2^-$				Bond angle for a O-I-O bond is....
$\underline{\text{I}}\text{Cl}_4^-$				Bond angle for a Cl-I-Cl bond is....
$\underline{\text{Xe}}\text{OF}_4$				Bond angle for an F-Xe-F bond is...

Problem 2. An element Z forms the ion ZF_2^- with a linear 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. Partial charges, formal charges and oxidation numbers describe the arrangement of electrons or charge in a molecule or ion. Provide a one sentence definition (no formulas) for each that explains what information it provides.

partial charge:

formal charge:

oxidation number:

Consider the compound IBr. What are the formal charges, partial charges and oxidation numbers for each atom in this compound? Place your answers in the table and show your work in the space below the table.

	Br	I
formal charge		
partial charge		
oxidation number		

Which of these provides the most accurate information about the distribution of charge within the molecule? Defend your choice in one sentence.

Problem 4. Barium ferrate, BaFeO_4 , is being tested for use in batteries for hybrid cars. What is the oxidation state for iron in this compound. To receive partial credit for this problem you must explain how you arrived at your answer.

Problem 5. Consider the following molecules and ions— NO_2^- , CO_3^{2-} , BF_3 and NH_3 . The central atom for three of these compounds use the same type of hybrid orbitals; the fourth compound uses a different set of hybrid orbitals. Identify the molecule or ion that is different and indicate its hybridization. Be sure to explain your reasoning.

Problem 6. The following compounds— HCl , ICl and SCl_2 —are generally considered to be covalent. As we have seen, a pure covalent bond is rare. Rank these compounds from that with the least ionic character to that with the greatest ionic character. Place your answers in the table and show any relevant work and/or explanation in the space below the table.

least ionic	\longleftrightarrow	most ionic

Problem 7. The following compounds— MgH_2 , BaSi_2 and ZnS —have similar ionic characters, but differ in the degree of metallic and covalent character. Rank these compounds from that with the most metallic character to that with the most covalent character. Place your answers in the table and show any relevant work and/or explanation in the space below the table.

most metallic	\longleftrightarrow	most covalent

Problem 8. Molecular orbitals form when atomic orbitals or hybrid orbitals interact. Consider the three p-orbitals on an atom. When these orbitals interact with the three p-orbitals on another atom, what types of molecular orbitals form (name and symbol)? How many of each different type of orbital form? For each type of molecular orbital, draw a picture showing where the electron density is found. Place your answers in the table below (note – there are more rows than there are answers).

type of molecular orbital	number of molecular orbitals	sketch showing distribution of electrons in the molecular orbital (each • represents an atom)
		
		
		
		
		
		