

## Chem 130 – First Exam

Name \_\_\_\_\_

On the following pages you will find questions covering various topics ranging from nomenclature to periodic properties, and electromagnetic radiation to Lewis structures. 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 \_\_\_\_/15

Question 2 \_\_\_\_/6

Question 3 \_\_\_\_/12

Question 4 \_\_\_\_/18

Question 5 \_\_\_\_/24

Question 6 \_\_\_\_/12

Question 7 \_\_\_\_/13

Total \_\_\_\_\_

Potentially useful equations and constants:

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

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

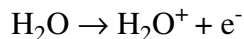
**Problem 1.** For each of the following, provide one example of an element satisfying the stated condition. *Do not use any element more than once!*

- can form monatomic ions with charges of -1 and +1
- is an alkaline metal
- is in the fourth period
- has a valence shell electron configuration of  $ns^2np^4$
- forms a +2 ion with a noble gas electron configuration
- is in the f-block
- forms monatomic ions with charges of +2 and +3
- has exactly four electrons in a d-orbital
- has two unpaired electrons
- has a core charge of +8
- has an electron with the quantum numbers  $n = 3$  and  $l = 1$
- has exactly three valence electrons
- is a semi-metal (also known as metalloid)
- cannot expand its valence shell beyond an octet
- has only two peaks in its photoelectron spectrum

**Problem 2.** Fill in the missing spaces in the following table:

Formula	Name	Covalent or Ionic?
FeSO <sub>4</sub>		
	cobalt(II) phosphate	
N <sub>2</sub> O <sub>5</sub>		

**Problem 3.** Life on earth would not be possible if the energy of radiation reaching the earth from the sun was sufficient to ionize water



The ionization energy for this reaction is 1200 kJ/mol. What wavelength ( $\lambda$ ) of light provides this energy?

**Problem 4.** The second ionization energies,  $\text{IE}_2$ , are listed here for the elements hydrogen to neon:

element	H	He	Li	Be	B	C	N	O	F	Ne
$\text{IE}_2$ (kJ/mol)	-	5248	7300	1757	2430	2350	2860	3390	3370	3950

Several questions based on this data are provided below. In each case, answer the question using a maximum of two sentences.

Explain why no value is given for hydrogen's second ionization energy.

Explain why the second ionization energy for beryllium is significantly less than that for lithium.

Explain why the second ionization energies for oxygen and fluorine are so similar.

**Problem 5.** The following data is available for the mysterious element X.

Peaks in the PES spectrum	Covalent Radius	First Ionization Energy	AVEE	Core Charge
5	0.110 nm	1012 kJ/mol	1.39 MJ/mol	+5

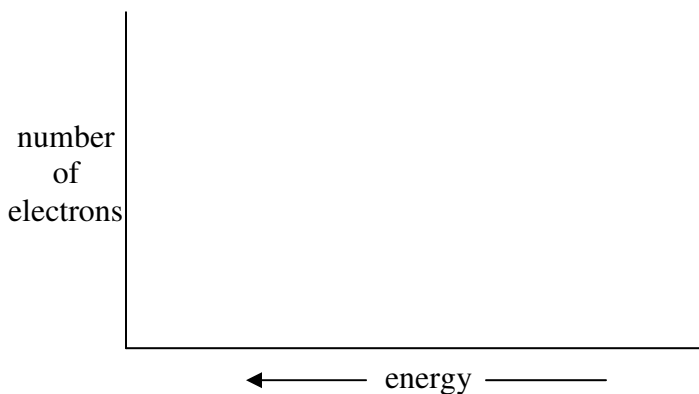
Identify the mysterious element X. In no more than three sentences explain your reasoning.

Give the electron configuration for the mysterious element X (using the noble gas designation for the core electrons) and underline the orbital containing the electron responsible for the first ionization energy.

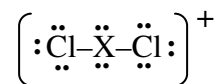
Will the AVEE for the element with one more proton than the mysterious element X be greater than, less than, or the same as that for X. In no more than two sentences, justify your answer.

Will the element whose core charge is +5 and whose first ionization energy is 1402 kJ/mol have a covalent radius that is larger than, smaller than, or the same size as that for mysterious element X. Explain your reasoning using no more than two sentences.

Using the axes provided here, draw the PES spectrum for the mysterious element X. Be sure to indicate the relative height of each peak. Label each peak with the appropriate orbital designation (e.g. 2p, 3d, etc.).

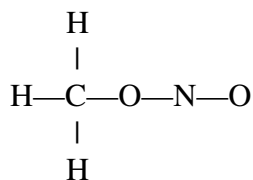


Problem 6. Shown below is the Lewis structure for the compound  $\text{XCl}_2^+$ .



Based on this Lewis structure, identify an element that could be X (there are several possibilities). Explain how you arrived at your choice for X in no more than three sentences.

Problem 7. Shown below is the basic bonding framework methyl nitrite,  $\text{CH}_3\text{NO}_2$ .



Note that the bonding framework shows single bonds, but makes no claims about the presence or absence of double or triple bonds. Complete the Lewis structure for methyl nitrite with the goal of minimizing formal charges. **Use the back of this page to do any scratch work and place *only* your final answer here.**

Methyl nitrite has two different bond lengths for the N-O bonds. One is 122 pm and the other is 137 pm. In your final Lewis structure, circle the bond that has the bond length of 122 pm.