

Chem 130 – First Exam

Name _____

On the following pages you will find eight questions covering various topics ranging from nomenclature to periodic properties, and electromagnetic radiation to Lewis structures. 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. For questions asking for an explanation of a periodic trend, it is insufficient to simply say "the hardness of atoms increase to the right and to the top of the periodic table." Instead, your answer must include an explanation for why this trend exists.

Partial credit is willingly given on all problems so be sure to answer all questions!

Question 1 ____/15 Question 5 ____/11

Question 2 ____/6 Question 6 ____/11

Question 3 ____/12 Question 7 ____/12

Question 4 ____/15 Question 8 ____/18

Total ____/100

Potentially useful equations and constants:

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

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

Problem 1. For each of the following, provide one example of an element satisfying the stated condition. *Do not include lanthanides and actinides in your answers, and do not use any element more than once!*

- can form a monatomic ion with a charge of -1
- has a covalent radius that is smaller than that for boron
- is in the fifth period
- has an electron configuration of $ns^2(n-1)d^{10}np^3$
- forms a +2 ion with a noble gas electron configuration
- is in the p-block
- forms monatomic ions with charges of +2 and +3
- has exactly two electrons in a d-orbital
- has one unpaired electron
- has a first ionization energy that is larger than that for fluorine
- has an electron with the quantum numbers $n = 4$ and $l = 2$
- has exactly four valence electrons
- is a semi-metal (also known as metalloid)
- cannot expand its valence shell beyond an octet
- has only three peaks in its photoelectron spectrum

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

Formula	Name	Covalent or Ionic?
Ag_2CO_3		
	cobalt (II) perchlorate	
P_4S_{10}		

Problem 3. Consider the following two photons.

Photon 1: wavelength is 250 nm

Photon 2: frequency is $5.0 \times 10^{14} \text{ s}^{-1}$

Which photon has the greater energy and what is that energy in kJ?

Will this photon have sufficient energy to eject a 4s electron from potassium, for which the ionization energy is 420 kJ/mol? Be sure to clearly justify your answer.

Problem 4. The first ionization energy for Br is less than that for Cl. Consider the following three explanations for this observation, none of which is correct. For each response, provide either a one sentence explanation for why it is incorrect or provide a counter example that proves the response to be incorrect.

(a) bromine has more protons than chlorine

(b) chlorine has fewer total electrons than bromine

(c) bromine has a smaller core charge than chlorine

In no more than two sentences explain why the first ionization energy for Br is less than that for Cl. Be sure to read the caution on the front of the exam.

Problem 5. Arrange the ions Li^+ , F^- , Na^+ , Cl^- , and Br^- in order of size, placing the smallest ion on the left and the largest ion on the right. In two or three sentences, clearly explain your reasoning. Be sure to read the caution on the front of the exam.

Problem 6. Of the elements – C, N, O, Si, P, S – which has the smallest AVEE? Clearly explain your reasoning in two to four sentences. Be sure to read the caution on the front of the exam.

Problem 7. In the Lewis structure for the compound XF_4 , where X is an unknown element, there is a single pair of non-bonding electrons on X . Identify an element that could be X (there are several possible choices). Explain how you arrived at your choice in no more than three sentences.

Problem 8. The cyanate ion and the fulminate ion both contain one atom each of carbon, nitrogen and oxygen, and both have a charge of -1. Cyanate's skeletal structure has carbon as a central atom and fulminate has nitrogen as its central atom. Draw the most valid Lewis structure for each ion (do any scratch work below the line and place your two final structures in the space below).

Cyanate

Fulminate

Annotate your structures by providing the formal charges for each atom.

Metal salts of one of these ions are commonly used as a friction-sensitive explosive in percussion caps. In one or two sentences, indicate which ion is likely to be the explosive and offer an explanation for your choice.

Place all scratch work for this problem here.