Chem 130 – First Exam

Name_____

On the following pages you will find questions that cover various topics ranging from nomenclature to periodic properties, and from electromagnetic radiation to the quantum model of the atom. Read each question carefully and consider how you will approach it before you put pen or pencil to paper. If you are unsure how to answer one question, then move on to another question; working on a new question may suggest an approach to the one that is more troublesome. If a question requires a written response, be sure that you answer in complete sentences and that you directly and clearly address the question. *Of particular importance for this exam: if a question asks you to explain a periodic trend, it is insufficient to write that "the <insert your property> of atoms increases to the right and to the top of the periodic table." Instead, your answer must explain why this trend exists.*

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

Question 1 _____/16	Question 5 _____/13
Question 2 _____/6	Question 6 _____/13
Question 3 _____/13	Question 7 _____/13
Question 4 _____/13	Question 8 _____/13

Total _____/100

Useful equations, constants, Slater's rules, and a periodic table are provided on a separate handout.

Please write neatly!

Problem 1. For each of the following, provide <u>one</u> example of an element that fulfills the stated condition. If no element meets the condition, then write NONE. *Do not include lanthanides and actinides in your answers, and do not use any element more than once!*

(a) is an alkaline earth

(b) has a core electron configuration of [Ar]

(c) has common ions with charges of –1 and of +1

(d) has exactly three electrons in a *p*-orbital

(e) forms a monoatomic ion with a charge of +1

(f) has exactly one unpaired electron

(g) is in the same period as chlorine

(h) has a valence electron with quantum numbers of $n = 3$, $l = 2$, $m_l = 0$, $m_s = -½$

(i) has a valence shell that consists of only *s* electrons

(j) is a halogen with a covalent radius smaller than that for chlorine

(k) forms an ion with a charge of –1 that has a noble gas electron configuration

(l) has exactly two core electrons

(m) is a metalloid (also called a semi-metal)

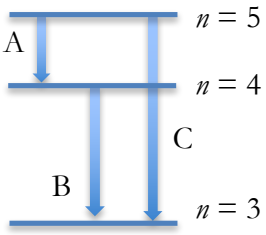
(n) is in the *p*-block

(o) has a half-filled orbital

Problem 2. Fill in the missing information for these three compounds.

Formula	Name	Covalent or Ionic?
NH_4NO_3		
	aluminum sulfate	
S_4N_3		

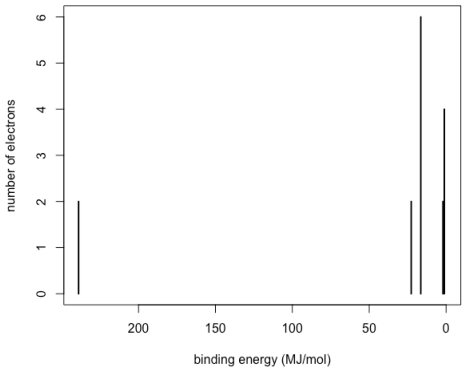
Problem 3. The figure to the right shows three possible transitions in which the sole electron in He^+ moves from a shell of higher n to a shell of lower n. Of these transitions, which will emit light with the longest wavelength? Without doing any calculations, give your answer as A, B, or C, and explain the reason for your choice in 1-2 sentences.



Given your answer above, what wavelength of light (in nm) is emitted. Note that a correct answer to this question does not depend on whether you correctly identified A, B, or C as the transition with the longest wavelength.

Problem 4. The figure to the right shows the photoelectron spectrum for element X; note that the spectrum has six peaks, with the two peaks at the far right being very close in energy.

(a) What is the electron configuration for X?



(b) Draw a circle around each peak in the photoelectron spectrum that corresponds to a core electron. In one sentence, explain your reason for choosing these peaks.

(c) The first ionization energy for element Y, which lies immediately above or immediately below X in the periodic table, is greater than the first ionization energy for X. Identify element Y by name and explain the reason for your choice, limiting your response to more than two sentences.

Problem 5. Copper forms two common cations, one with a charge of +1 and one with a charge of +2. The elements on either side of copper, nickel and zinc, form just one common cation with a charge of +2. Write the electron configurations for each element and then explain why the differences in the charges of these ions make sense, limiting your response to no more than 2–3 sentences.

Problem 6. The following three species have identical electron configurations: Ar, S^{2-}, and K^{+}. Which of these species has the largest ionization energy and which has the smallest ionization energy? Or, do all three have identical ionization energies? Explain the basis of your answer, limiting your response to 2–4 sentences.

Problem 7. Consider the set of five ions listed below and rearrange them so that they are listed from the smallest radius to the largest radius.

Na^{+} Mg^{2+} S^{2-} Cl^{-} Se^{2-}

smallest radius ⟶ ⟶ ⟶ ⟶ ⟶ ⟶ largest radius

Explain the basis of your ranking, limiting your response to 2–4 sentences.

Problem 8. The electron configuration for arsenic often is written as $[Ar]4s^2 3d^{10} 4p^3$ to indicate the order in which the element's orbitals fill. This configuration seems to suggest that the 3*d* electrons are in the valence shell; however, the 3*d* electrons generally are considered to be core electrons, leaving the 4*s* and the 4*p* electrons as valence electrons. Use Slater's rules to estimate the effective nuclear charge for one of arsenic's 3*d* electrons and for one of its 4*s* or 4*p* electrons. Next, using these values, explain why it is reasonable to consider arsenic's 3*d* electrons as core electrons. Limit your explanation to 2–3 sentences.