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.

Problem 1. For each of the following, provide **one** example of an element that fulfills the stated condition. If no element meets the condition, then write NONE. Limit your elements to those in the first five rows of the periodic table (H through Xe). *Do not use any element more than once!*

(a) is a transition metal

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

(c) forms a monoatomic ion with a charge of –2

(d) has exactly five electrons in a *d*-orbital

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

(f) has exactly two unpaired electrons

(g) is in the same period as aluminum

(h) has five peaks in its photoelectron spectroscopy spectrum

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

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

(k) forms an ion with a charge of +2 that has a noble gas electron configuration

(l) has ten core electrons

(m) is an alkali metal

(n) is in the *s*-block

(o) has a *Z* of 30

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

Formula	Name	Covalent or Ionic?
$CaCl_2$		
	iron(II) phosphate	
P_4O_{10}		

Problem 3. Consider two photons, one with a wavelength of 250 nm and one with a frequency of 5.0×10^{14} s^{-1}. Which photon has the greatest energy, in Joules, and what is that energy?

The ionization energy of a 4*s* electron in potassium, K, is 420 kJ/mol. Is the photon you identified above capable of ejecting this electron? Justify your response with a suitable calculation and a one sentence explanation.

Problem 4. The first three ionization energies for lithium, Li, are 520 kJ/mol, 7,298 kJ/mol, and 11,815 kJ/mol. The photoelectron spectroscopy, PES, spectrum for lithium, however, has just two peaks, one at 6260 kJ/mol and one at 520 kJ/mol. In 3-5 sentences, explain why there are three ionization energies but just two peaks in the PES spectrum. As part of your answer, explain why both sets of data share a common value of 520 kJ/mol.

Problem 5. The average valence electron energy, AVEE, for the first three noble gases are

He: 2,370 kJ/mol Ne: 2,730 kJ/mol Ar: 1,845 kJ/mol

In general, the AVEE becomes smaller as you go down a group. In 2-4 sentences, propose an explanation for why neon's AVEE is greater than that for helium.

Problem 6. Consider the set of elements listed below and identify the element with the smallest covalent radius and the element with the largest covalent radius. Explain the reason(s) for your selections in 2-3 sentences. Be sure to make note of the caution on the exam's first page.

N O F P S Cl

smallest covalent radius is_____ largest covalent radius is_____

Problem 7. Consider the set of ion listed below and identify the largest ion and the smallest ion. Explain the reason(s) for your selections in 2-3 sentences. Be sure to make note of the caution on the exam's first page.

Na^+ Mg^{2+} Al^{3+} S^{2-} Cl^- Se^{2-}

smallest ion is_____ largest ion is_____

Problem 8. The structure of the periodic table suggests that electrons will enter a 4*s* orbital before they will enter a 3*d* orbital. Once electrons are in both orbitals, however, it generally is easier to remove an electron from a 4*s* orbital than to remove it from a 3*d* orbital. Using manganese, Mn, as an example, apply Slater's rules to determine Z_{eff} for a 3*d* electron and for a 4*s* electron. Explain, in 1-3 sentences why your results support the observation that manganese will lose a 4*s* electron before it loses a 3*d* electron.