Chem 130 – First Exam

Name_____

On the following pages you will find questions covering 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 _____/15 Question 4 _____/16

Question 2 _____/10 Question 5 _____/15

Question 3 _____/14 Question 6 _____/15

Question 7 _____/15

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) forms a monatomic ion with a charge of –2

(b) is a halogen

(c) is in the third period

(d) has a valence shell electron configuration of ns^2nd^3

(e) forms a +2 ion with a noble gas electron configuration

(f) is in the *d*-block

(g) forms monoatomic ions with charges of +1 and +2

(h) has exactly two electrons in a *d*-orbital

(i) has no unpaired electrons

(j) has a valence electron with the quantum numbers $n = 3$, $l = 1$, $m_l = 0$, and $m_s = +½$

(k) is an alkali metal with a covalent radius larger than that for potassium

(l) has exactly 10 core electrons

(m) is a metalloid

(n) has a first ionization energy greater than that for fluorine

(o) is deflected by a magnetic field

Problem 2. Fill in the missing information for these three compounds, which you have seen in lab.

Formula	Name	Covalent or Ionic?
$Fe(OH)_3$		
	nitrogen dioxide	
KSCN		

Problem 3. The energy needed to remove an electron from a single He atom is 3.94×10^{-18} J. To what wavelength of light, in nanometers, does this correspond?

The Li^+ cation and the He atom have identical electron configurations of $1s^2$. To remove an electron from Li^+, will you need to use light of a longer wavelength, the same wavelength, or a shorter wavelength than that for He? Explain your reasoning in 1–3 sentences.

Problem 4. The elements Ar, Mg, and K have, in no particular order, first ionization energies, covalent radii, and average valence electron energies of

first ionization energies: 419 kJ/mol 738 kJ/mol 1521 kJ/mol

covalent radii: 0.130 nm 0.097 nm 0.196 nm

average valence electron energies: 420 kJ/mol 1845 kJ/mol 740 kJ/mol

Using the table below, match each element to its first ionization energy, to its covalent radius, and to its average valence electron energy. In the space below the table, and using no more than 4–8 sentences, define each of these properties of an atom and justify your assignments. *Please note the caution on the first page regarding written explanations.*

element	first ionization energy	covalent radius	average valence electron energy
Ar			
Mg			
K			

Problem 5. The first four ionization energies for an element are as follows:

IE_1 = 801 kJ/mol IE_2 = 2,427 kJ/mol IE_3 = 3,660 kJ/mol IE_4 = 25,026 kJ/mol

The element is in either the first or the second row of the periodic table. Identify the element and explain your reasoning. If you cannot narrow your choice to a single element, then explain which elements you can exclude (and why) and what additional information you need to identify the element. In either case, limit your response to 2–4 sentences. *Please note the caution on the first page regarding written explanations.*

Problem 6. Rank the elements in the second row of the periodic table (Li, Be, B, C, N, O, F, Ne) from the smallest first ionization energy to the largest first ionization energy. Place each element in a space below and, in 2–4 sentences, explain how you arrived at this order. *Please note the caution on the first page regarding written explanations.*

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Problem 7. We have considered two models for determining the effective nuclear charge seen by an electron: a simple model based on Bohr's model of the atom and Slater's rules, which are based on a more complete model of the atom. Using chlorine as an example, explain why these two models yield different results for Z_{eff}, illustrating your answers with appropriate calculations for Z_{eff} using each model. Limit your response to 3–6 sentences.