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**Chapter 3 Assignment:**

Atoms, Electrons, and Periodic

Trends

/70

## Problem 1 [ /10]

For the five sets of four quantum numbers below, explain what is wrong with each set for an electron in a one-electron atom. Make sure to refer back to the limits of each quantum number.

(a) *n* = 1, *l* = 1, *ml* = +1, *ms* = +

(b) *n* = 2, *l* = 0, *ml* = +1, *ms* = –

(c) *n* = 3, *l* = -1, *ml* = 0, *ms* = +

(d) *n* = 4, *l* = 2, *ml* = +3, *ms* = 0

(e) *n* = 5, *l* = +3, *ml* = –2, *ms* = - 1

## Problem 2 [ /5]

Fill in the missing values or names of the following sets of quantum numbers.

(a) *n* = 2, *l* = ?, *ml* = +1; name: 2*p*

(b) *n* = ?, *l* = 0, *ml* = ?; name: 4*s*

(c) *n* = 3, *l* = 1, *ml* = +1; name: ?

(d) *n* = 3, *l* = ?, *ml* = 0; name: 3*d*

## Problem 3 [ /5]

Identify the element that matches each of the following descriptions.

(a) The ground state electron configuration of the ion of this element carrying a 4+ charge is [Ar] 4s2 3*d*3.

(b) The electron configuration of this element in its first excited state is [Ar] 4*s*1 4*p*1.3*d*10

(c) The ground state electron configuration of this element is [Xe] 6*s*2.4*f*1 5*d*1

(d) The ion of this element carrying a charge of 3– has the ground state electron configuration [Xe].

(e) The ground state electron configuration of the ion of this element that has a charge of 5+ is [Kr] 5s24*d*6.

## Problem 4 [ /15]

Use the aufbau principle to write the ground state electron configuration of the following ions.

(a) Ir4+ (b) Co3+

(c) In3+ (d) Bi3–

(e) Hg+

## Problem 5 [ /14]

(a) Explain Pauli Exclusion Principle and Hund’s Rule. (4)

(b) Use orbital diagrams to represent the ground state electron configuration of the ions in problem 4. (10)

## Problem 6 [ /6]

The element tungsten has the symbol W, after the name of the ore, wolframite, from which it can be recovered.

(a) Use the aufbau principle to write the ground state electron configuration of an atom of this element. (3)

(b) How many of the electrons in this atom have a principal quantum number of 4? (1)

(c) How many electrons are in the valence shell of this atom? (1)

(d) When this atom is excited, between what atomic orbitals will an electron move for the smallest possible

increase in energy? (1)

## Problem 7 [ /4]

The radius of the S2– ion is 1.84 × 10–10 m. Predict how the radius of P3– and Se2–  will compare to this value. What factors are taken into consideration when making this prediction?

## Problem 8 [ /4]

The radii of the K+ ion and the F– ion are about the same even though K+ has one more energy level than F–. What factor(s) must account for this similarity in size?

## Problem 9 [ /4]

Within group 9 of the periodic table, IE1 for Co is greater than IE1 for Rh. However, in group 10, IE1 for Ni is smaller than IE1 for Pd. Compare the ground state electron configurations of these elements to account for the difference. The groud state electron configurations of Rh and Pd are given as follows:

Rh: 1*s*2 2*s*2 2*p*6 3*s*2 3*p*6 4*s*2 3*d*10 4*p*6 5*s*1 4*d*8

Pd: 1*s*2 2*s*2 2*p*6 3*s*2 3*p*6 4*s*2 3*d*10 4*p*6 4*d*10

Make sure to compare Co to Rh and Ni to Pd.

## Problem 10 [ /3]

Some elements have both high ionization energy and high electron affinity while some have both low ionization energy and low electron affinity. And there are also some that have high ionization energy but low electron affinity. What are the factors that account for these two properties that help explain this diversity in trends?

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**Chapter 4 Assignment:**

Structure and Properties of

Substances

/70

## Problem 1 [ /10]

Volatility is a property of a liquid that indicates how readily it evaporates. Ionic solids generally have low volatility and covalent compounds that evaporate easily are said to be highly volatile. For each pair of compounds listed below, calculate the difference in electronegativity to determine the ionic character of each and from this information, indicate which will be more volatile.

(a) CaF2 and BeF2

(b) CCl4 and AlI3

(c) SiH4 and PCl3

(d) Cl2O and CS2

(e) SeF6 and ICl3

## Problem 2 [ /6]

Examine the data in the chart below and answer the questions that follow.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Melting Point (ºC)** | Electrical Conductivity | | |
| **solid state** | **liquid state** | **aqueous solution** |
| A | 710 | non-conductor | good | good |
| B | 960 | good | good | insoluble |
| C | 1455 | good | good | insoluble |
| D | 650 | non-conductor | good | good |
| E | –25 | non-conductor | non-conductor | insoluble |
| F | 162 | non-conductor | non-conductor | good |

(a) Which of these substances are likely composed of ions?

(b) Which of these substances are likely metals?

(c) Which of these substances are likely covalent compounds?

## Problem 3 [ /10]

Osmium tetroxide, OsO4, is a highly toxic compound that has been used in trace amounts in stains for microscope slides. Assuming that there are eight valence electrons in the osmium atom,

i) draw a Lewis structure for this molecule (Make sure to show your work: NGe-, Ve-, #bonds, Le-)

ii) use VSEPR theory to predict its general and specific shape

iii) indicate the overall polarity of the molecule

iv) indicate if the Os — O bonds are coordinate covalent.

## Problem 4 [ /8]

(a) Compare the shapes of the two fluorides of bismuth, BiF3 and BiF5. (draw them!!) (2)

(b) Indicate the polarity of the Bi — F bond and the polarity of the two molecules. (3)

(c) Which of these two fluorides will be expected to have the higher boiling point? Give a reason for your answer. (3)

## Problem 5 [ /10]

Phosphoryl chloride, POCl3, is a highly toxic reagent used in the synthesis of some phosphorus containing molecules. Its use is highly regulated with strict waste disposal procedures.

i) draw a Lewis structure for this molecule (Make sure to show your work: NGe-, Ve-, #bonds, Le-)

ii) use VSEPR theory to predict its general and specific shape

iii) indicate the overall polarity of the molecule.

iv) indicate any co-ordinate covalent bonds.

## Problem 6 [ /4]

Compare the intermolecular forces that exist in Br2(l) and ICl(l). Based upon these forces of attraction, explain which of the two compounds will have the higher melting point?

## Problem 7 [ /4]

Compare the properties of an engine oil used in your lawnmower with that used in a snow blower. Relate these properties to the intermolecular forces in each type of oil.

## Problem 8 [ /10]

For a molecule of SeF4Cl2,

i) draw a Lewis structure for this molecule (Make sure to show your work: NGe-, Ve-, #bonds, Le-)

ii) use VSEPR theory to predict its general and specific shape

iii) indicate the overall polarity of the molecule.

iv) indicate any co-ordinate covalent bonds.

## Problem 9 [ /8]

You are given a white crystalline solid and are asked to classify the substance based upon the type of bonding present. You find that the crystal shatters when struck with a hammer and a sample of the substance melts at 115ºC. The sample is insoluble in water but dissolves in acetone, an organic solvent.

(a) What types of intermolecular and intramolecular forces are present in the sample? Explain fully how you made your decision.

(b) Classify the solid.