Chemistry 2202 – Midterm Review

Review of Key Concepts:

1. The atom, isotopes and average isotopic mass

Questions for Study

1. What are the three main sub-atomic particles in an atom, and where are they located?
2. By looking at a periodic table, explain how you can determine the number of a)protons

b) neutrons and c) electrons are found in an atom.

1. What are the similarities and differences between atoms of the same element. Draw energy level diagrams for Carbon-12 and Carbon-14 to illustrate your points.
2. An ion (2+ charge) has 30 electrons and a mass number of 73. Determine the:
   1. Atomic number
   2. Number of neutrons
   3. Number of protons
   4. Isotopic Notation
3. A sample of Ni is being tested at the Voisey Bay mining site. It contains 3 main isotopes, Ni-58 (57.96 amu, 47.55%), Ni-59(58.94 amu, 21.11%) and Ni-61(60.91 amu, 31.34%). Determine the average atomic mass of the Nickel Sample.
4. A sample of Fe was determined to be composed of Fe-55 (54.97 amu) and Fe-56(55.96 amu). If the sample had an average atomic mass of 55.55 amu, determine the % composition of each isotope.
5. The mole

Questions for Study

1. Define the mole.
2. Define Avogadro’s number. Explain why this particular number is used.
3. Write the formulas to convert to and from moles and:
   1. Mass
   2. Number of Particles
   3. Volume
   4. Concentration
4. Determine the molar mass of:
   1. Calcium Carbonate
   2. Manganese(II)Nitrate
   3. Sucrose, C12H22O11
   4. Ethanol, C2H5OH
   5. Citric Acid, C6H8O7
5. A piece of pure Copper has a mass of 75.0g. Determine the number of
   1. Moles of copper
   2. Number of particles of copper
6. A sample of laughing gas, NO2 has a volume of 35.0L at STP. Determine the:
   1. Moles of gas
   2. Number of NO2 molecules
   3. Mass of NO2
   4. Number of atoms in the sample
   5. Volume of NO2 if the sample were heated to SATP.
7. Percent Composition, Percent Water of a Hydrate, Empirical and Molecular Formula Determination

Questions to Study:

1. Calculate the percent composition of each element in the following compounds:
   1. Sodium Oxide
   2. Zinc(II) Nitrite
   3. Chromium Chromate
2. What is the empirical formula for a compound which contains 0.0134 g of iron, 0.00769 g of sulfur and 0.0115 g of oxygen?
3. Find the empirical formula for a compound which contains 32.8% chromium and 67.2% chlorine.
4. Barry Um has a sample of a compound which contains only carbon, hydrogen, oxygen and nitrogen. By analysis, he finds that it contains 48.78% carbon, 2.439% hydrogen, 26.015% oxygen and 22.765nitrogen. Find its empirical formula.
5. The empirical formula for trichloroisocyanuric acid, the active ingredient in many household bleaches, is OCNCl. The molar mass of this compound is 232.41g. What is the molecular formula of trichloroisocyanuric acid.
6. Determine the molecular formula of a compound with an empirical formula of NH2 and a formula mass of 32.06 amu.
7. The molar mass of a compound is 92g. Analysis of a sample of the compound indicates that it contains 0.606g N and 1.390g O. Find its molecular formula.
8. Determine the percent composition of water in a compound that has a formula Ni(II)Cl2®3H2O
9. Stoichiometry

Questions for Study

1. Write a balanced reaction equation for the combustion of Octane, C8H18.
2. Determine the mole ratio for the reaction in the above reaction between:
   1. Octane and Oxygen
   2. Carbon Dioxide and Oxygen
   3. Water and Octane
   4. Carbon Dioxide and Water
3. If 450.0g of Octane was combusted, calculate:
   1. The volume of O2 gas required to fully react with the octane (at STP)
   2. The mass of Carbon Dioxide produced
   3. The number of molecules of water produced
4. Given the following equation: 8 Fe + S8 ---> 8 FeS
   1. What mass of iron is needed to react with 16.0 grams of sulfur?
   2. What is the theoretical yield of FeS?
   3. If the actual yield of FeS was 23.0g, calculate the percent yield.
   4. Give 2 possible reasons why the percent yield was not 100%.
5. Limiting and Excess Reactants:

Questions for Study

1. A 50.6 g sample of Mg(OH)2 is reacted with 45.0 g of HCl according to the reaction:

Mg(OH)2 + 2 HCl --> MgCl2 + 2 H2O

Determine the limiting reactant. What is the theoretical yield of MgCl2?

1. 15.00 g aluminum sulfide and 10.00 g water react until the limiting reagent is used up. Here is the balanced equation for the reaction:

Al2S3 + 6 H2O -----------> 2Al(OH)3 + 3 H2S

* 1. Which is the limiting reagent?
  2. What is the maximum mass of H2S which can be formed from these reagents?
  3. How much excess reagent remains after the reaction is complete?

1. 2 Al + 3 I2 ------> 2 AlI3

Based on the above reaction determine the limiting reactant if you start with:

* 1. 1.20 mol Al and 2.40 mol iodine.
  2. 1.20 g Al and 2.40 g iodine
  3. How many grams of Al are left over in part b?

1. Solutions:

Questions for Study:

1. Define the following:
   1. Solution
   2. Solvent
   3. Solute
   4. Miscible
   5. Immiscible
2. A chemist is preparing a saturated solution of sodium chloride but has added too much water to the solution, so the solution is unsaturated. What are 2 possible ways he can saturate his solution?
3. Draw a before and after picture of a crystal after it has been placed in a solution that is:
   1. Saturated
   2. Unsaturated
   3. Supersaturated
4. Explain the following:
   1. Bubbles of air form in a glass of water after it warms up during the night.
   2. A can of soda is fizzy when it is opened.
5. Classify each of the following as dissociation, ionization or molecular salvation:
   1. HCl (aq)🡪 H+(aq) + Cl-(aq)
   2. CH3OH(S) 🡪 CH3OH(aq)
   3. H2SO4(aq) 🡪 2H+(aq) + SO42-
   4. LiNO3(S) 🡪 Li+(aq) + NO3-(aq)
   5. C6H12O6(S) 🡪 C6H12O6(aq)
   6. MgI2(aq) 🡪 Mg2+(aq) + 2I-(aq)
6. Explain the difference between ionization and dissociation.
7. Write the formulas for each of the following and state whether each compound is either soluble or insoluble in water. For the soluble compounds write the dissociation reaction
   1. Calcium Phosphate
   2. Ammonium Sulfide
   3. Sodium Dichromate
   4. Silver Chloride
8. Write the total ionic and net ionic equations for mixing of the following solutions:
   1. Barium Hydroxide and Lead(II) Acetate
   2. Iron Nitrate and Potassium Carbonate
   3. Sodium Chloride and Magnesium Sulfide
9. Write dissociation equations and determine the concentrations for each ion for the following solutions:
   1. 0.25mol/L solution of Calcium Cyanide
   2. 0.0010M solution of Potassium Silicate
   3. 3.4M solution of Iron(III) Sulfate
10. Solution Stoichiometry:

Questions for study:

1. Calculate the molar concentration of the following solutions:
   1. 389.45g of Lead(IV) Nitrate in 45.0L of water
   2. 0.00400 g of Potassium Chloride in 4.5ml of water
2. Calculate the number of moles in the following:
   1. 75.0ml of a 0.300mol/L sucrose solution
   2. 4.5 x 103 L of a 2.0 x 10-5 mol/L Lithium Cyanide Solution
3. A 0.25M solution of Citric acid is diluted to make 100ml of a 0.025M solution. Determine the volume of the original solution.
4. Calculate the concentration of 250.0ml of a 5.1M that has been diluted by adding 125.0ml of water.
5. For the following reaction:

3K2CO3(aq) + 2Fe(III)Cl3(aq) 🡪 Fe(III)2(CO3)3(S) + 6KCl(aq)

* 1. Write a total ionic and net ionic reaction
  2. If 500ml of a 0.750mol/L Potassium Carbonate solution was reacted with 300ml of an Iron(III) Chloride solution, determine the concentration of the Iron(III) Chloride solution required to react fully with the Potassium Carbonate Solution.
  3. Determine the concentration of K+ ions in the resulting solution (hint: write a dissociation equation for K2CO3)

Numerical Answers to Selected problems:

Here are some useful sites as well for helping you check your work!

<http://firstyear.chem.usyd.edu.au/calculators/empirical_formula.shtml>

<http://www.graphpad.com/quickcalcs/molarityform.cfm>

[www.cdli.ca/courses/chem2202](http://www.cdli.ca/courses/chem2202)

<http://www.chemhaven.org/che101/tools/percentcomp/percentcomp.cgi>

iv. Atomic #32, 41 neutrons, 32 protons

v. 59.09 amu

vi. Fe-55 = 41% Fe-56 = 59%

x. CaCO3 = 100.09 g/mol Mn(II)(NO3)2 = 178.96 g/mol Sucrose = 342.30 g/mol

Ethanol = 46.07 g/mol Citric Acid = 192.12 g/mol

xi. a. 1.18 mol b. 7.10 x 1023

xii. a. 1.56 mol b. 9.41 x 1023 c. 71.9 g d. 2.82 x 1024 e. 38.8 L

xiii. a. Na = 74.19% O = 25.81% b. Zn = 41.55% N = 17.80% O = 40.65%

1. Cr = 61.90% O = 38.10%

xiv. FeSO3

xv. CrCl3

xvi. C5H3O2N2 <http://firstyear.chem.usyd.edu.au/calculators/empirical_formula.shtml>

xvii. O3C3N3Cl3

xviii. N2H4

xix. N2O4

xx. 27.43%

xxiii. a. 1190L b. 1390g c. 2.13 x 1025

xxiv. a. 27.9 g b. 43.9 g c. 52.39%

xxv. a. HCl b. 58.55g

xxvi. a. H2O b. 9.46g c. 1.11g

xxvii. a. Al b. Al c. 1.03g

xxix. Evaporate water, add NaCl or possibly reduce the temperature.

xxx. a. Crystal will remain the same b. Crystal will dissolve c. crystal will grow

xxxi. a. Gases are less soluble at higher temperatures b. Gas are less soluble in low pressure

xxxii. a. Ionization b. Molecular Solvation c. Ionization d. Dissociation e. Molecular Solvation

f. Dissociation

xxxiii. Dissociation occurs when ionic compounds dissolve. The ions separate when placed in water, although the ions had their charge the entire time. Ionization occurs when a covalent (molecular) compound dissolves, and seperates into 2 or more ions. The compound did not consist of ions until placed in water.

xxxvi. a. [Ca2+] = 0.25M [CN-] = 0.50 M

b. [K+]= 0.0020M [SiO32-] = 0.0010M

c. [Fe3+] = 6.8M [SO42-]= 10.3 M

xxxvii. a. 0.0190M b. 0.011M

xxxvii. a. 0.0225 mol b. 0.090 mol

xxxix. 10ml or 0.010L

xl. 3.4 M

xli. b. 0.833 M c. 0.938M