Chemistry I
2nd Semester Exam Study Guide

Study the following topics and be able to apply these concepts to answer related questions to best prepare for the Chemistry exam. You should be able to:

1. Identify a given substance as an element or a compound.

Ex. Ag __E___, CO_2 ____C___, $C_6H_{12}O_6$ ___C____, O_2 ___E___, S ___E___

Elements are only one type of atom while compounds are composed of 2 or more types of atoms.

2. Identify a compound as Ionic, Metallic, Covalent Network, or Covalent Molecular.

Ex. H_2O __CM____, $CaCl_2$__I___, SO_3 __CM____ $AgNO_3$, ___I___, Fe __M____, C(graphite) __CN____

Ionic = the first element is a metal, Metallic = pure metal which will be an element on the periodic table to the left of the zig-zag line, CM = the first element is a nonmetal, CN = one of 4 substances (memorize) which are C (diamonds), C(graphite), SiO_2 which is sand (silicon dioxide), and SiC (silicon carbide)

3. Describe the properties of Ionic, Metallic, Covalent Network and Covalent Molecular substances. Refer to chart at http://images.pcmac.org/SiSFiles/Schools/AL/HooverCity/SpainParkHigh/Uploads/Forms/Types%20of%20Substances.pdf

4. Calculate the molar mass of a given compound. Ex. $AgNO_3$ _170, g/mol_____ $Al_2(SO_4)_3$ _342 g/mol_____

$AgNO_3$ = 1(108g/mol) + 1(14.0 g/mol) + 3(16.0 g/mol) = 170, g/mol

$Al_2(SO_4)_3$ = 2(27.0 g/mol) + 3(32.1 g/mol) + 12(16.0 g/mol) = 342.3 g/mol

5. Determine the number of atoms in a compound given its formula. Ex. $Al(C_2H_3O_2)_3$ __22____

6. Identify a formula as an empirical or molecular formula.

Ex. KNO_3 __E____ , H_2O_2 __M____ , K_2SO_4 __E____ , $C_6H_{12}O_6$ __M_____

Empirical formula is the simplest ratio and cannot be reduced. Molecular formulas describe covalent molecular substances and are not in the simplest ratio. The can be reduced. H_2O_2 can be reduced to HO and $C_6H_{12}O_6$ can be reduced to CH_2O.

7. Calculate the % composition of a compound from its formula.

Ex. A) What is the % oxygen in $KClO_3$? % mass = $\frac{mass\ of\ element}{molar\ mass\ of\ compound}$ x 100,

% mass = $\frac{48.0\ grams\ Oxygen}{122.6\ g}$ x 100 = 39.2 % oxygen

B) If a student experimentally determines the % oxygen in a sample of $KClO_3$ to be 37.1%, what is his % error?

% error = $\frac{Exp't\ value - Correct\ Value}{Correct\ Valu}$ x 100 % error = $\frac{37.1 - 39.2}{39.2}$ x 100 = 5.36%

8. Name compounds and write formulas for ionic compounds, covalent molecular compounds (including the 7 diatomic elements), and acids. (See practice worksheets for sample problems)

9. Write balanced equations from word equations. (See practice worksheets for more sample problems)

Silver nitrate + Calcium chloride → Silver chloride + Calcium nitrate

$2AgNO_3$ + $CaCl_2$ → $2AgCl$ + $Ca(NO_3)_2$

Remember to balance the charges first with subscripts when writing the formulas of the substances and balance atoms last with coefficients..

10. Identify the type of reaction (composition, decomposition, single replacement, double replacement, combustion of hydrocarbons) for given chemical reactions. (See practice worksheets for more sample problems)

11. Complete and balance chemical reactions given the reactants. (See practice worksheets for more sample problems)

a. Also, know the symbols used in chemical reactions (s, l, g, aq) s = solid, l = liquid, g = gas, aq = aqueous (dissolved in water).

b. Know how to indicate heat or electricity needed or the placement of catalyst

$\xrightarrow{heat}$ or $\xrightarrow{\Delta}$ $\xrightarrow{electricity}$ $\xrightarrow{catalyst}$

c. Definition of a catalyst – any substance that speeds ups a chemical reaction without changing itself. It is neither a reactant nor a product. Ex. $2KClO_3 \xrightarrow{MnO2} 2KCl + 3O_2$ MnO_2 is the catalyst in this reaction

12. Solve Stoichiometry problems:

a. Understanding mole ratios from the balanced equations (mole-mole problems)

Ex. Given the reaction in problem #9, how many moles of silver nitrate are required to react with 3 moles of calcium chloride? $2AgNO_3 + CaCl_2 \rightarrow 2AgCl + Ca(NO_3)_2$

$$3 \text{ mol } CaCl_2 \left(\frac{2 \text{ mol } AgNO3}{1 \text{ mol } CaCl2}\right) = 6 \text{ mol } AgNO_3$$

B) How many moles of silver chloride would be produced from 1 mole of calcium chloride?

$$1 \text{ mol } CaCl_2 \left(\frac{2 \text{ mol } AgCl}{1 \text{ mol } CaCl2}\right) = 2 \text{ mol } AgCl$$

b. Mass - Mass Problems

Ex. Given the reaction in problem #9, how many grams of silver chloride could be produced from 5.0 grams of calcium chloride reacting with excess silver nitrate?

$$2AgNO_3 + \overset{5.0\text{ g}}{CaCl_2} \rightarrow \overset{x\text{ g}}{2AgCl} + Ca(NO_3)_2$$

$$5.0 \text{ g } CaCl_2 \left(\frac{1 \text{ mol}}{111 \text{ g}}\right) \left(\frac{2 \text{ mol } AgCl}{1 \text{ mol } CaCl2}\right) \left(\frac{143.5 \text{ g}}{1 \text{ mol}}\right) = 12.9 \text{ g } AgCl$$

c. Gas Vol. - Mass Problems (at STP)

Ex. How many liters of Hydrogen gas could be produced at STP when 10.0 grams of magnesium is reacted with excess hydrochloric acid? $Mg + 2HCl \rightarrow MgCl_2 + H_2$

$$10.0 \text{ g Mg} \left(\frac{1 \text{ mol}}{24.3 \text{ g}}\right) \left(\frac{1 \text{ mol } H2}{1 \text{ mol } CaCl2}\right) \left(\frac{22.4 \text{ L}}{1 \text{ mol}}\right) = 12.9 \text{ g } AgCl$$

d. % Yield Problems

Ex. What is the % yield if 2.00 grams of sodium carbonate reacted with excess calcium chloride to produce 1.75 grams of calcium carbonate? 2.00 g Na_2CO_3 is the given and 1.75 grams $CaCO_3$ is the experimental yield.

2.00 g x g

$Na_2CO_3 + CaCl_2 \rightarrow 2NaCl + CaCO_3$

$2.0\text{ g } Na_2CO_3\left(\frac{1\ mol}{106\ g}\right)\left(\frac{1\ mol\ CaCO3}{1\ mol\ Na2CO3}\right)\left(\frac{100.\ g}{1\ mol}\right) = 1.89\text{ g } CaCO_3$ (Theoretical Yield)

$\%\text{ yield} = \frac{experimental\ yield}{theoretical\ yield} \times 100$ $\%\text{ yield} = \frac{1.75\ g}{1.89\ g} \times 100 = 92.6\ \%\text{ yield}$

e. Concentration Problems

Ex. 1. What is the molarity of a solution if 3.31 grams of Pb(NO3)2 is added to enough water to make 500. mL of solution?

$$\text{Molarity} = \frac{\frac{grams\ solute}{molar\ mass\ solute}}{liters\ of\ solution} = \frac{\frac{3.31\ g}{331\ g/mol}}{0.500\ L} = 0.0200\text{ M}$$

2. What is the molality of a solution if 85.0 grams of AgNO3 dissolved into 150. grams of water?

$$\text{Molality} = \frac{\frac{grams\ solute}{molar\ mass\ solute}}{kilograms\ of\ solvent} = \frac{\frac{85.0\ g}{170\ g/mol}}{0.150\ kg} = 3.33\text{ m}$$

3. What is the mass % of a solution if 15.0 grams of NaCl is dissolved into 45.0 grams of water?

$\text{Mass \%} = \frac{mass\ of\ solute}{mass\ of\ solution} \times 100$ $\text{Mass \%} = \frac{15.0\ g}{60.0\ g} \times 100 = 25.0\ \%$

(mass of solution = mass of solute + mass of solvent)

13. Explain the relationship between pressure, temperature, and volume of gases.

Ex. If a gas occupies 5.0 liters when the temperature is 25.0 ºC and the pressure is 750 mm Hg, what volume will it occupy at STP? (You must know what STP is)

(STP = 1 atm or 760 mm Hg and 0° C or 273 K)

$\frac{P1V1}{T1} = \frac{P2V2}{T2}$ $\frac{(750\ mm\ Hg)(5.0\ L)}{298\ K} = \frac{(760\ mm\ Hg)(V2)}{273\ K}$

$$V_2 = \frac{(750\ mm\ Hg)(5.0\ L)(273\ K)}{(298\ K)(760\ mm\ Hg)} = 4.52\text{ L}$$

14. Solve problems using the ideal gas law.

Ex. 1. What volume will 5.0 grams of O_2 occupy at 15.0 ºC and 745 mm Hg ? P = 745/ 760 = 0.980 atm

PV = nRT PV = (g/mm)RT $(0{,}980\text{ atm})(V_2) = (5.0\text{ g}/ 32.0\text{ g/mol})(0.0821)(288\text{K})$

$V_2 = 3.77$ L

2. How many moles of gas are present in a 2.0 liter container at 30.0 ºC and 800 mm Hg?

P = 800/760 = 1.05 atm PV = nRT $n = \frac{(1.05\ atm)(2.0\ L)}{(0{,}0821)(303K)} = 0.0844$ mol

15. Explain the differences between solutions, colloids, and suspensions

Solutions = smallest solute particles (ions or molecules), solute particles will not settle out due to gravity, solute particles can pass thru both a semi-permeable membrane and filter paper. Do not give the Tyndall effect.

Colloids = medium sized solute particles, solute particles do Not settle out due tp gravity, solute particles cannot pass thru a semi-permeable membrane but they can pass thru filter paper. Colloids do give the Tyndall effect (causes light to scatter – in other words, you can see the beam of light).

Suspensions – largest solute particles, solute particle will settle out due to gravity, solute particles cannot pass thru either a semi-permeable membrane or a piece of filter paper, Suspensions do give the Tyndall effect.

16. Identify a solute as an electrolyte or a nonelectrolyte. (electrolytes are acids, bases, or salts, nonelectrolytes are composed of covalent molecular substances
What type of particles are in solutions of electrolytes? Ions
What type of particles are in solutions of nonelectrolytes? Neutral molecules

17. Explain the differences between saturated, unsaturated, and supersaturated solutions.

Saturated = contains the maximum amount of solute particles in solution. If more solute is added, it will not dissolve and simply sink to the bottom.
Unsaturated = contains less than the maximum amount of solute in solution. If more solute is added, it will dissolve.
Supersaturated – contains more than the maximum amount of solute. This is a rare situation. If a single grain of solute is added.to the solution, much more solute will precipitate out of the solution.

18. Explain how temperature affects the solubility of

A) solids or liquids in a liquid – as temperature is increased, the solubility generally increases meaning more solute will dissolve at higher temperatures.
B) gases in a liquid - as temperature is increased, the solubility generally decreases meaning fewer gas molecules will dissolve at higher temperatures

You must also be able to interpret a solubility graph SIMILAR TO PAGE 414 IN YOUR TEXTBOOK..

19. Explain how pressure affects the solubility of A) solids or liquids in a liquid and B) gases in a liquid.

A) Pressure has no effect on the solubility of solids and liquids in liquids.

B) As the pressure on the gas above the liquid is increased, the solubility of the gas in the liquid increases. The higher the pressure, the more gas that dissolves.

20. List and explain the 3 ways to increase the rate of dissolving a solute in a solvent.

1. Heat the solution
2. Stir the solution
3. Crush the solute to increase the surface are.

All of these increase the contact between solute and solvent which helps them to dissolve faster.

21. Define colligative properties – colligative properties are properties of solutions that depend upon how much of the solute is dissolved, not what the solute is.
Describe how the osmotic pressure, the freezing temperature, and boiling point change as the concentration of the solution changes. – As the concentration of the solution increases, the freezing point of the solution decreases, the boiling point increases, the vapor pressure decreases, and the osmotic pressure increases.
Also, relate freezing point depression to the making of ice cream – rock salt was added so the ice-water mixture around the ice cream so the temperature got colder and froze the ice cream.

22. List and explain the 4 factors that affect the rate of a reaction.
1. Heat the solution – molecules move faster and collide more. They also have more energy when they collide which helps them to react faster.
2, Increase the concentration of the reactants – this allows more molecules to collide at any given time making the reaction occur faster.
3. Add a catalyst
4. Increase surface area – using a powder rather than big chunks allows more molecules to come in contact with each other making the reaction go faster.

23. Define what an acid is and what a base is.
Arrhenius Acid – an acid is a covalent compound that produces the H_3O^+ concentration, The positive ion is always hydrogen.

Arrhenius Base – a base is a substance that increases the OH^- ion when dissolved in water,

Bronsted-Lowry Acid – a proton (H+) donor. The acid still must contain a hydrogen.

Bronsted=Lowry Base – a proton (H+) acceptor.

24. List and explain the properties of acids and bases. See note for properties
What are the products when an acid is neutralized by a base or vice-versa? Salt + water

25. Define the pH scale. A scale from 0-14 where 0 = strong acid, 7 = neutral, and 14 = strong base

26. Calculate pH, pOH, $[H_3O^+]$ and $[OH^-]$. Problems similar to acid/base worksheet done in class.
Ex. 1. What is the pH, pOH, $[H_3O^+]$, and $[OH^-]$ in a 0.750 M HCl solution?
0.750 M = [HCl] = $[H_3O^+]$ [OH-] = $\frac{1 \times 10^{-14}}{0.750}$ = 1.33×10^{-14}
pH = -log $[H_3O^+]$ = -log(0.750) = 0.125 pOH = 14 – 0.125 = 13.875

2. What are the $[H_3O^+]$, and $[OH^-]$ in a solution with a pH = 12.5 ?
$[H_3O^+] = 10^{-pH}$ $[H_3O^+] = 10^{-12.5} = 3.16 \times 10^{-13}$ M

$[OH^-] = 10^{-pOH}$ [OH-] = $10^{-1.5}$ = 0.0316 M

3. A student titrated 50.0 ml sample of ammonium hydroxide (NH_4OH) with 35.0 ml of a 0.30 M HCl solution. What is the molarity of the ammonium hydroxide?

$M_AV_A = M_BV_B$ $= M_B(50.0\ mL)$ $M_B = \frac{(0.30\ M)(35.0\ mL)}{50.0\ mL} = 0.21$ M

27. Solve gas law problems using Boyle's Law, Charles' Law, Gay-Lussac's Law, Ideal Gas Law – similar to worksheet problems.

Ex. 1. Convert ºC to Kelvin: 100ºC = __373 K 25ºC = 298_ K 450 K = 177 ºC

2. If the pressure on 5.0 liters of gas is tripled, what will happen to its volume it temperature remains constant?

It would be reduced by a third. 5.0/3 = 1.67 Liters.

3. If the volume of a gas is 10.0 liters when the temperature is 25.0 ºC, what would be the new volume if the temperature was raised to 50.0 ºC and the pressure remains the same?

$\frac{V1}{T1} = \frac{V2}{T2}$ $\frac{10.0\ L}{298\ K} = \frac{V2}{323\ K}$ $V_2 = \frac{(10.0\ L)(323K)}{298\ K} = 10.8$ L

4. What will happen to the pressure of a gas in a rigid container if the kelvin temperature is doubled?

The pressure will double. (Gay-Lussac's Law)

28. What are the 3 types of intermolecular forces (IMF's) between molecules? Which is strongest? Which is weakest?

1. London Dispersion Forces – Weakest
2. Dipole-Dipole Forces
3. Hydrogen Bonds – Strongest

29. What are the 3 elements that can form hydrogen bonds when hydrogen is attached to them?

(F,O, N) 1. Fluorine 2. Oxygen 3. Nitrogen

30. CH_4 has weak IMF's while NH_3 has much stronger IMF's. Which would you expect to have a higher boiling point? Why?

The stronger the IMF's, the higher the boiling point because it takes more energy to break the stronger bonds. CH_4 is nonpolar so only has weak London Forces while NH_3 has the stronger hydrogen bonds.

31. Explain how soap works to clean.

Water is polar and most dirt is oily and nonpolar. The rule is "like dissolves like" so oily dirt does not dissolve in water. Soap is a long chain hydrocarbon that is nonpolar but has a polar head. The nonpolar end attaches to the oil while the polar end attaches to the water, This links the 2 together.