Norfolk Public Schools
Science Learning in Place Plan: Chemistry Lessons

Week 7: April 27 – May 1, 2020 (Unit 9)

Monday	Tuesday	Wednesday	Thursday	Friday
Unit 2.9: Compounds and Bonding **Unit 3.9: Kinetic Theory** **Unit 6.9: Solutions** **U9: Mastery Knowledge**	**Unit 3.9: Kinetic Theory** **U9: Mastery Knowledge**		**Unit 1.9: Elements and the Periodic Table** **Unit 2.9: Compounds and Bonding** **Unit 3.9: Kinetic Theory** **Unit 4.9: The Mole and Stoichiometry** **Unit 5.9: Chemical Reactions** **Unit 6.9: Solutions** **Unit 7.9: Experimental** **U9: Mastery Knowledge**	
Unit 9 Packet page 11 Review	**Unit 9 Packet pages 12 – 13** Phase Diagram Entropy		**Unit 9 Packet pages 14 – 15** Unit 9 Quiz	

Week 8: May 4 – 8, 2020 (Unit 10)

Monday	Tuesday	Wednesday	Thursday	Friday
Unit 2.10: Compounds and Bonding	**Unit 2.10: Compounds and Bonding**	**Unit 4.10: The Mole and Stoichiometry**		
Unit 10 Packet page 1 IF 35 – Half Life of Radioactive Isotopes	**Unit 10 Packet page 2** Half Life Practice Worksheet	**Unit 10 Packet pages 3 – 4** Limiting Reactants and Percent Yield		

Week 9: May 11 – 15, 2020 (Unit 10)

| Monday	Tuesday	Wednesday	Thursday	Friday
Unit 6.10: Solutions				
Unit 10 Packet page 5 Precipitation Reactions	**Unit 10 Packet page 6** Equilibrium: Practice with K_{eq}		**Unit 10 Packet page 7** IF 81 – Le Chatelier's Principle	**Unit 10 Packet page 8** IF 82 – Le Chatelier's Principle Continued

Chemistry Unit 9

Topic	Essential Knowledge	Study and Practice
Elements and the Periodic Table **1.9**	Many of the groups on the PTOE have a name. Elements in Group 1 are called the **alkali metals**. Group 2 elements are called **alkaline earth metals**. Groups 3-12 are the **transition metals**. Group 17 elements are the **halogens**, and the unreactive **noble gases** are in group 18. Each of the groups not mentioned are named for the first element in its group. For ex. Group 16 is called the oxygen group. Groups 1, 2, 13-18 are also referred to as the representative elements.	**What kinds of compounds can be formed from the following combinations of groups? Give an example of each.** Alkali metal & a halogen, alkaline earth metal & a nitrogen group element, Halogen & oxygen group element. Read pgs 167-173. **Answer questions 14, 15 & 17 on pg 173**
Compounds and Bonding **2.9**	**Organic compounds** are based on chains of carbon atoms covalently bonded to each other. Hydrocarbons, composed of only hydrogen and carbon are the simplest organic compounds. Carbon-carbon single bonds are called alkanes, double bonds are called alkenes, and triple bonds are called alkynes. The chemical and physical properties of organic compounds are determined by **functional groups** (groups containing combinations of carbon, hydrogen, oxygen and nitrogen) attached to the carbon chain. The **–OH functional group** is characteristic of all **organic alcohols** such as methanol (CH_3OH) and ethanol (C_2H_5OH). The **–COOH functional group** is characteristic of all **organic** (carboxylic) **acids**. Examples include methanoic acid (HCOOH) and ethanoic acid (CH_3COOH).	Read pgs. 762-773, 798-799, 804-805, & 815-816. What are the first ten prefixes for organic compounds? Draw the structural formulas for two alcohols and two carboxylic acids. **Name four other functional groups** found in your text and draw their structures. **Answer question #53** on **pg 831**
Kinetic Theory **3.9**	A diagram that relates the physical state of a substance to <u>temperature</u> and <u>pressure</u> is called a **phase diagram**. The temperature and pressure at which all three states of a substance exist in equilibrium is called the **triple point.** **Solids** exist at **high** pressures and **low** temperatures**.** **Gases** exist at **low** pressures and **high** temperatures. **Heating Curves** represent the energy of phase changes. To calculate the energy change during phase changes you will need to use Heats of fusion or vaporization. (See the back of unit 7 for details)	Read pgs 436-439. Study Fig. 13.18. **Do Practice problems** 25, 28, &30 on pg. 439. Complete the **WS: Phase Diagram** **Read pg 569-573. Answer questions** 22-25 on pg 571 & 573. **What is plasma?** Read pgs 440-441 to find out.
The Mole and Stoichiometry **4.9**	An **empirical formula** shows the smallest whole number ratio of elements in a compound. **Ionic solids** are composed of oppositely charged ions arranged in a regular, repeating, crystal lattice structure; the empirical formula always gives the ratio of positive to negative ions. **Covalent compounds** are often in the form of individual molecules; the empirical formula gives the ratio of atoms in one molecule. Example: The molecular formula for glucose is $C_6H_{12}O_6$; the empirical formula is CH_2O.	Read about empirical formulas& molecular formulas and how they are determined experimentally on pgs 330-333. **Do Practice 39-42** on pg 331 &333 *Show work* *Do practice questions 78, 79, 88, & 89* on pgs 339-340. & *#7* on pg 343
Chemical Reactions **5.9**	**Neutralization** reactions result from the reaction of an acid with a base to form a salt (ionic compound) and water. These reactions are usually double replacement reactions. **HCl + NaOH → NaCl + HOH** **Neutralization occurs when the moles of hydrogen ions (H⁺) equals the moles of hydroxide (OH ⁻) ions in a solution**. The pH of a neutral solution is 7.	Read about neutralization reactions on pages 672-673. **Explain** how all neutralization rxns are the same **and** how antacids, like Tums, work in your stomach. **Write** the balanced chemical rxn between **sulfuric acid** and **aluminum hydroxide.**
Solutions **6.9**	Both **strong acids and strong bases** dissociate completely in water, and therefore **are strong electrolytes**. In a solution of a strong acid like hydrochloric acid, almost all of the HCl molecules dissociate according to the following equation: $HCl_{(aq)}$ → $H^+_{(aq)}$ + $Cl^-_{(aq)}$ **Weak acids and weak bases are weak electrolytes**. In a solution of a weak acid like acetic acid, only a few of the $HC_2H_3O_2$ molecules dissociate: $HC_2H_3O_2{}_{(aq)}$ ↔ $H^+_{(aq)}$ + $C_2H_3O_2^-{}_{(aq)}$	*Read* pgs 661-669. Use your own words to describe the differences between a strong and a weak acid. Write the dissociation reaction for the following acids: HF, HNO_2, HCN, H_2SO_4, HNO_3. Use Fig. 19.6 on pg 664 to help.
Experimental **7.9**	**Neutralization occurs when [H₃O⁺] = [OH⁻]** The following equation describes this relationship in terms of molarity **(M)** and volume **(V)**. $$M_{acid}V_{acid} = M_{base}V_{base}$$ **Titration** uses a <u>buret</u> to dispense precise amounts of solution of known concentration to determine the concentration of another solution. To safely dilute an acid, add acid to water. **Never add water to a concentrated acid.**	*Read* about **titrations** on pp. 673-674. *How can you tell when a titration is complete* and *what is this called?* *Solve* practice problems **37-38** pg 675. (show work). **Answer section review questions 71&73** on pg 684.

Review:

1. What is the pH of a 0.00001 M solution HNO_3?

2. What is the pH of a 0.001 M solution LiOH?

3. What is the pH of a 0.000043 M solution $Ca(OH)_2$?

4. Use the following reaction to answer the following:

   ___Fe(s) + ___HCl(aq) → ___$FeCl_3$(aq) + ___H_2(g)

   a. What mass of iron is needed to react completely with 2 moles of hydrochloric acid (HCl)?

   b. What mass of $FeCl_3$ will be produced if 24.0 grams of H_2 gas is formed?

   c. What volume of H_2 gas would be produced if 167.4 grams of iron react at STP?

5. Define entropy.

6. Give an example of a reaction that increases in entropy and one that decreases in entropy.

Phase Diagram
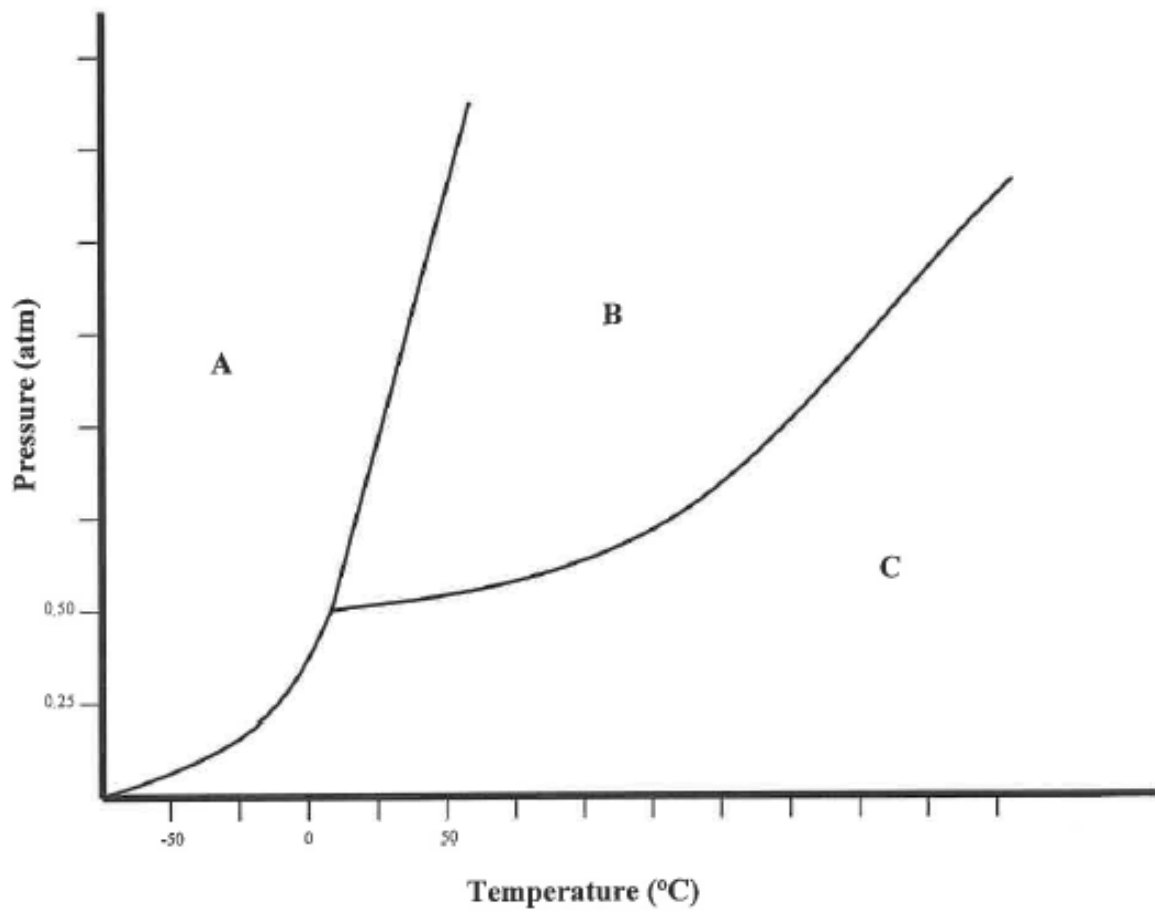
ENTROPY

Name _____

Entropy is the degree of randomness in a substance. The symbol for change in entropy is ΔS.

Solids are very ordered and have low entropy. Liquids and aqueous ions have more entropy because they move about more freely, and gases have an even larger amount of entropy. According to the Second Law of Thermodynamics, nature is always proceeding to a state of higher entropy.

Determine whether the following reactions show an increase or decrease in entropy.

1. $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$ _____

2. $H_2O(l) \rightarrow H_2O(s)$ _____

3. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ _____

4. $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$ _____

5. $KCl(s) \rightarrow KCl(l)$ _____

6. $CO_2(s) \rightarrow CO_2(g)$ _____

7. $H^+(aq) + C_2H_3O_2^-(aq) \rightarrow HC_2H_3O_3(l)$ _____

8. $C(s) + O_2(g) \rightarrow CO_2(g)$ _____

9. $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ _____

10. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ _____

11. $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ _____

12. $2Al(s) + 3I_2(s) \rightarrow 2AlI_3(s)$ _____

13. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ _____

14. $2NO(g) \rightarrow N_2(g) + O_2(g)$ _____

15. $H_2O(g) \rightarrow H_2O(l)$ _____
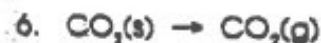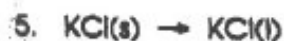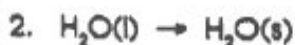
Name:

Unit 9: Chemistry
(Quiz)

Choose the best answer that either answers the question or completes the statement and <u>explain WHY</u> you chose your answer in the space provided.

a b c d ○ ○ ○ ○ 1.9	1. Which of the following is an alkali metal? a) Neon b) Flourine c) Magnesium d) Potassium
a b c d ○ ○ ○ ○ 1.9	2. Which of the following is the <u>correct</u> formula for a compound composed of an alkaline earth metal and a halogen? Explain why. a) Ba_3Cl_2 b) CsI c) $FeCl_3$ d) SrF_2
a b c d ○ ○ ○ ○ 2.10	3. Which of the following is an <u>organic</u> compound? a) $CaCl_2$ b) H_2O c) $SiCl_4$ d) CH_4
a b c d ○ ○ ○ ○ 2.10	4. A functional group is covalently bonded to the carbon chain and contains other atoms, such as nitrogen, oxygen or sulfur. Which of the following organic compounds contains the functional group for an organic acid and an alcohol, respectively? a) HCl, $NaOH$ b) CH_3OH, CH_3COOH c) CH_4, CH_3OH d) CH_3COOH, CH_3OH
a b c d ○ ○ ○ ○ 3.9	5. Use the phase diagram provided to answer the following two questions. What phase change will occur, if the temperature of the substance is increased from −25°C to 50 °C at a constant pressure of 0.75 atm. a) Boiling b) Freezing c) Melting d) Sublimation
a b c d ○ ○ ○ ○ 3.9	6. Water has a heat of vaporization for water is 40.7 kJ/mol. How much energy will be needed to boil 100 grams of water at 100 °C? a) 4070 kJ b) 226 kJ c) 7.33 kJ d) 2.46 kJ
a b c d ○ ○ ○ ○ 4.9	7. Which set represents a molecular formula with its corresponding empirical formula? a) $C_6H_8O_6$ and $CH_{1.33}O$ b) C_8H_8 and C_4H_4 c) C_4H_8 and CH_2 d) P_4O_{10} and $P_1O_{2.5}$
a b c d ○ ○ ○ ○ 4.9	8. What is the empirical formula for the compound that consists of 62.1% carbon, 10.3% hydrogen, and 27.6% oxygen: (show all calculations for credit) a) C_2H_4O b) C_3H_6O c) $C_6H_{12}O_2$ d) $C_{11}HO_5$

a b c d
○ ○ ○ ○
 	
5.9
	9. Which of the following equations is a neutralization reaction? (to receive credit, you must identify each reaction)
	  a. $2H_2O$ (l) $\rightarrow$ $2H_2$ (g) + O_2 (g)
	  b. Na_2SO_4(aq) + $Ba(OH)_2$ (aq) $\rightarrow$ NaOH (aq) + $BaSO_4$ (s)
	  c. CH_4 (g) + O_2 (g) $\rightarrow$ CO_2(g) + H_2O (g)
	  d. H_2SO_4 (aq) + KOH (aq) $\rightarrow$ K_2SO_4 (aq) + H_2O (l)

a b c d
○ ○ ○ ○
 	
5.9
	10. Identify the products for the following reaction: $2HBr + Mg(OH)_2 \rightarrow$
	  a) $2H_2$ (g) + O_2 (g) + 2MgBr (aq)
	  b) $2H_2O$ (l) + 2MgBr (aq)
	  c) $2H_2$ (g) + O_2 (g) + $MgBr_2$ (aq)
	  d) $2H_2O$ (l) + $MgBr_2$ (aq)

a b c d
○ ○ ○ ○
 	
6.9
	11. Which of the following solutions is the best conductor of electricity?
	  a) Pure water (H_2O)
	  b) A strong base
	  c) A weak base
	  d) A weak acid

a b c d
○ ○ ○ ○
 	
6.9
	12. Which of the following equations correctly represents the dissociation of a **weak base**?
	  a) HCl(aq) $\rightarrow$ H^+(aq) + Cl^-(aq)
	  b) HCOOH(aq) $\leftrightarrow$ H^+(aq) + $HCOO^-$(aq)
	  c) KOH(aq) $\rightarrow$ K^+(aq) + OH^-(aq)
	  d) NH_3 + H_2O $\leftrightarrow$ NH_4^+(aq) + OH^-(aq)

a b c d
○ ○ ○ ○
 	
7.9
	13. What volume of a 3M HCl solution would be needed to neutralize 60.0-mL of a 2.0 M NaOH?
	  a) 90 mL
	  b) 60 mL
	  c) 40 mL
	  d) 10 mL

a b c d
○ ○ ○ ○
 	
7.9
	14. What instrument would be used to precisely titrate an unknown concentration of NaOH?
	  a) Buret
	  b) Erlenmeyer Flask
	  c) Pipette
	  d) Volumetric flask

a b c d
○ ○ ○ ○
 	
3.2 & MK
	15. In which of the following changes does entropy increase?
	  a) CO_2 (g) $\rightarrow$ CO_2 (l)
	  b) H_2O (l) $\rightarrow$ H_2O (s)
	  c) N_2 (g) + $3H_2$ (g) $\rightarrow$ $2NH_3$ (g)
	  d) NaCl (s) $\rightarrow$ Na^{+1} (aq) + Cl^{1-} (aq)

Chemistry Unit 10

Topic	Essential Knowledge	Study and Practice
Elements and the Periodic Table 1.10	**Atomic radius increases going from top to bottom down a group because,** the valence electrons are added at higher principal energy levels and are farther away from the nucleus. This means that both ionization energy and electronegativity decrease going down a group. **Atomic radius decreases going from left to right across a period** because valence electrons are added at the same principal energy level and protons are added to the nucleus, increasing the pull of the nucleus on the electrons. This means that both ionization energy and electronegativity increase going across a period.	Review Ch.6.3 **Answer** chapter review questions 38-48 on 186
Compounds and Bonding 2.10	The **half-life** of a radioactive isotope is the time it takes for one half of a sample of that isotope to decay. Carbon-14 is a radioactive isotope with a half-life of 5730 years. This means that in 5730 years, one half of the ^{14}C in a particular sample would be converted to another element (i.e. undergo a nuclear reaction)	**Read** pg 882. Answer questions 9&10 on pg 884 & #47 on pg 900. If you have 100 grams a substance with a half-life of 2 years, how many grams would be remaining after 10 years? Show work.
Energy 3.10	A **reaction rate** describes how rapidly a chemical change takes place. Reaction rates are determined experimentally by measuring a change in some physical property such as volume, temperature, concentration, color, mass or pH over time. The collision theory is a model that proposes molecules must collide with enough energy and in the proper orientation in order to react. Any factor that increases the energy or orientation will increase the rate of a reaction. For example, **there is a direct relationship between temperature and reaction rate** because the higher the temperature a substance has the more energy its particles have when they collide. There are 5 factors which could affect reaction rate; **Nature of reactants, temperature, concentration, surface area, and catalysts. ***	Read Chemical **What affects the rate of a reaction** on pgs 594-601. Using the Collision Theory, explain why and how these 5 factors affect the rate of a rxn. *(refer to the back of unit 8 unit sheet)
The Mole and Stoichiometry 4.10	When two reactants form product, the reactant that controls or limits the actual amount of product is called the **limiting reactant**. In other words, the limiting reactant is the one that is completely used up in a reaction. The other reactant is in excess. The amount of product that should be produced is called the **expected yield**. The amount of product that is really (experimentally) obtained during a chemical reaction is called the **actual yield**. Percent yield = $\frac{actual}{expected}$ x 100 %	Read pgs 400-408. Show work for practice problems 28-31, & 38 on pgs 403, 406, & 408.
Chemical Reactions 5.10	Some **double replacement** reactions involve the production of a precipitate (solid product). The solubility rules are used to determine if a solid product will be made. Essentially all **nitrates** are soluble and all **alkali** metal cations are soluble. See rules for other soluble or insoluble ions. These reactions can be written as complete ionic or **net ionic** equations. The net ionic equations do <u>not</u> show the **spectator ions**.	Read pgs 369-73 and **study** Table 11.3 on pg 372. **Do** problems **25-28, 31 & 32** on pgs 371 & 373
Solutions 6.10	**Reversible reactions reach equilibrium.** At equilibrium, the forward and reverse reactions occur at the same rate. When a reversible reaction reaches equilibrium either products or reactants are favored (in greater concentration). An equilibrium constant (K) can be calculated. If K is > 1, then products are favored. If K is < 1, then reactants are favored. **K=[products]/[reactants]** **When a system at equilibrium is disturbed by applying stress, the equilibrium position shifts to relieve the stress.** Stresses that can change equilibrium include changes in concentration, temperature or pressure. **	**Read** about *Chemical Equilibrium* on pgs 609-620 **Answer questions 17&18 on pg** 615 and #'s89 &90 on pg 639.
Experimental 7.10	There is a multitude of scientists who are credited with many of the discoveries in chemistry. Several are important in the development of the model of the modern day atom and Periodic Table of Elements. Dalton, JJ Thomson, Millikan, Rutherford, Bohr, Planck, De Broglie, Einstein, Schrodinger, Curie, Heisenberg, Mosley, and Mendeleev.	*Write a sentence about what or how each of the chemists (mentioned to the left) contributed to or were given credit for discovering.*

HALF-LIFE OF
RADIOACTIVE ISOTOPES

Name _____

1. How much of a 100.0 g sample of ^{198}Au is left after 8.10 days if its half-life is 2.70 days?

_____

2. A 50.0 g sample of ^{16}N decays to 12.5 g in 14.4 seconds. What is its half-life?

_____

3. The half-life of ^{42}K is 12.4 hours. How much of a $75\bar{0}$ g sample is left after 62.0 hours?

_____

4. What is the half-life of ^{99}Tc if a $50\bar{0}$ g sample decays to 62.5 g in 639,000 years?

_____

5. The half-life of ^{232}Th is 1.4×10^{10} years. If there are 25.0 g of the sample left after 2.8×10^{10} years, how many grams were in the original sample?

_____

6. There are 5.0 g of ^{131}I left after 40.35 days. How many grams were in the original sample if its half-life is 8.07 days?

_____

Half-life Practice Worksheet

1. Sodium-24 has a half-life of 15 hours. How much sodium-24 will remain in an 18.0 g sample after 60 hours?

2. After 42 days a 2.0 g sample of phosphorus-32 contains only 0.25 g of the isotope. What is the half-life of phosphorus-32?

3. Polonium-214 has a relatively short half-life of 164 seconds. How many seconds would it take for 8.0 g of this isotope to decay to 0.25 g?

4. How many days does it take for 16 g of palladium-103 to decay to 1.0 g? The half-life of palladium-103 is 17 days.

5. Thallium-208 has a half-life of 3.053 min. How long will it take for 120.0 g to decay to 7.50 g?

6. If the half-life of iodine-131 is 8.10 days, how long will it take a 50.00 g sample to decay to 6.25 g?

7. The half-life of hafnium-156 is 0.025 s. How long will it take a 560 g sample to decay to one-fourth its original mass?

Limiting Reactant and Percent Yield

A **limiting reactant** is the reactant in a chemical reaction that limits how much product can be made. In other words, it is the reactant that produces the lesser amount of product (theoretical yield).

The **percent yield** is the amount of product actually made in the laboratory experiment as compared to a theoretical or projected amount. There is a formula for calculating percent yield.

Problems: In most cases you will need to write a balanced equation for the reaction. Show all work and box & label each answer.

1. Identify the **limiting reactant** when 2.20 grams of magnesium react with 4.50 L of oxygen gas to produce magnesium oxide. What is the **theoretical yield** of magnesium oxide in grams?

2. When 32.0 grams of oxygen gas (O_2) reacts with 23.0 grams of ethanol (C_2H_5OH) during combustion, what is the **limiting reactant**? What is the **theoretical yield** in grams of CO_2?

3. What is the **limiting reactant** when 154 grams of Ag reacts with 189 grams of HNO_3? What is the **theoretical yield** in grams of silver nitrate ($AgNO_3$)?
   $3Ag_{(s)} + 4HNO_{3\ (aq)} \rightarrow 3AgNO_{3\ (aq)} + NO_{(g)} + 2H_2O_{(l)}$

4. Hydrogen gas (H_2) is produced when methane (CH_4) reacts with water. The other product is CO_2. Using 80.0 grams of water, how many **liters** of H_2 can be produced at STP? What is the **limiting reactant**?

5. Methyl alcohol (CH_3OH) can be made by reacting carbon monoxide with hydrogen gas. Starting with 2.50 grams of H_2 and 30.0 L of CO, what **mass** of methyl alcohol could be produced at STP? Which is the **limiting reactant**?

6. A student used 1.34 grams of silver to produce silver(I) nitrate. The actual yield was 2.01 g. Calculate the **percent yield**.
   $3Ag_{(s)} + 4HNO_{3\ (aq)} \rightarrow 3AgNO_{3\ (aq)} + NO_{(g)} + 2H_2O_{(l)}$

7. To prepare paint pigment chrome yellow, $PbCrO_4$, a student started with 5.552 grams of $Pb(NO_3)_2$. The actual yield of $PbCrO_4$ was 5.096 grams. Calculate the theoretical yield and the **percent yield**.
   $Pb(NO_3)_{2\ (aq)} + Na_2CrO_{4\ (aq)} \rightarrow PbCrO_{4\ (s)} + 2NaNO_{3\ (aq)}$

8. Diborane (B_2H_6) is widely used in the synthesis of organic compounds. Diborane is made by the reaction: $NaBH_4 + I_2 \rightarrow B_2H_6 + 2NaI + H_2$. If 6.30 grams of $NaBH_4$ are reacted with excess I_2, how many **grams** of diborane could theoretically be isolated? If 1.90 grams of diborane are actually produced, what is the **percent yield**?

9. Ammonia gas can be produced by reacting CaO with NH_4Cl. Water and calcium chloride are produced in addition to ammonia (NH_3). If 23.0 grams of CaO and 50.0 grams of NH_4Cl are mixed, what is the **maximum possible volume** of NH_3 that can be produced at STP? If 16.1 L of NH_3 are actually produced, what is the **percent yield** of NH_3?

10. Determine the **actual yield** in grams of MgO when 20.0 grams of magneisium are burned in air. The percent yield of the reaction is 97.9 % complete. (see reaction from #1).

11. Determine the **actual yield** in grams of Fe_2O_3 when 10.0 grams of iron (II) sulfide is burned in air. The percent yield of the reaction is 88.1 %.
$$4FeS_{(s)} + 7O_{2\,(g)} \rightarrow 2Fe_2O_{3\,(s)} + 4SO_{2\,(g)}$$

12. Determine the **actual yield** in grams of CCl_4 when 175.0 grams of Cl_2 reacts with methane (CH_4). The percent yield of the reaction is 75.4 %.
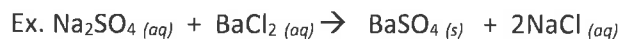$$CH_{4\,(g)} + 4Cl_{2\,(g)} \rightarrow CCl_{4\,(g)} + 4HCl_{(g)}$$

Bonus:
For any 2 LR problems, find the mass of excess reactant left over.
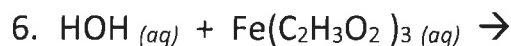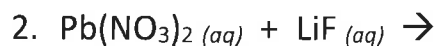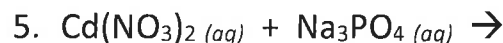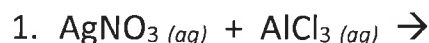
Precipitation Reactions

A **precipitation reaction** is a type of double replacement reaction in which one of the products is an insoluble solid. Precipitation reactions can be written in one of three ways: as complete, complete ionic, or net ionic reactions. The net ionic reaction will not show **the spectator ions** (ions who do not participate in the reaction itself). In order to determine the products of a precipitation reaction on must become familiar with the solubility rules.

General Solubility rules
usually soluble

Soluble Compounds	Exceptions
• Salts of Na^+ K^+ NH_4^+	
• Salts of Cl^- Br^- I^-	• Ag^+ Hg_2^{+2} Pb^{+2}
• Salt of F^-	• Mg^{+2} Ca^{+2} Sr^{+2} Ba^{+2} Pb^{+2}
• Salts of NO_3^- ClO_3^- ClO_4^- and $C_2H_3O_2^-$	
• Salts of SO_4^{-2}	• Sr^{+2} Ba^{+2} Pb^{+2}

Ex. $Na_2SO_{4\ (aq)}$ + $BaCl_{2\ (aq)}$ → $BaSO_{4\ (s)}$ + $2NaCl_{(aq)}$

Complete ionic: $2\ Na^+_{(aq)}$ + $SO_4^{2-}_{\ (aq)}$ + $Ba^{2+}_{(aq)}$ + $2\ Cl^-_{(aq)}$ → $BaSO_{4\ (s)}$ + $2\ Na^+_{\ (aq)}$ + $2\ Cl^-_{\ (aq)}$

Net ionic: $SO_4^{2-}_{\ (aq)}$ + $Ba^{2+}_{(aq)}$ → $BaSO_{4\ (s)}$
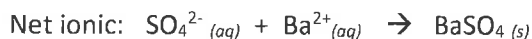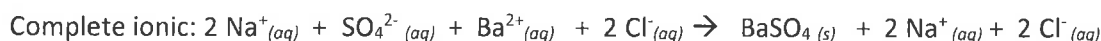
Problems: Write the balanced complete reaction, complete ionic reaction and the net ionic reactions for each. Be sure to include state symbols.
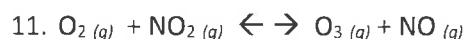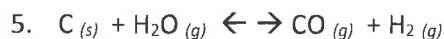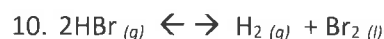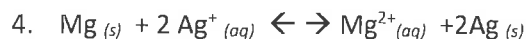
1. $AgNO_{3\ (aq)}$ + $AlCl_{3\ (aq)}$ →

5. $Cd(NO_3)_{2\ (aq)}$ + $Na_3PO_{4\ (aq)}$ →

2. $Pb(NO_3)_{2\ (aq)}$ + $LiF_{(aq)}$ →

6. $HOH_{(aq)}$ + $Fe(C_2H_3O_2)_{3\ (aq)}$ →

3. $NH_4OH_{(aq)}$ + $Al(NO_3)_{3\ (aq)}$ →

7. $NaNO_{3\ (aq)}$ + $KF_{(aq)}$ →
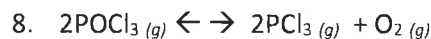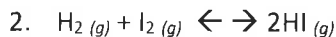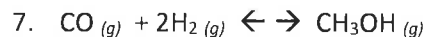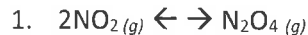
4. $K_2CO_{3\ (aq)}$ + $MgI_{2\ (aq)}$ →
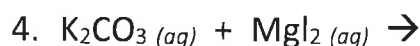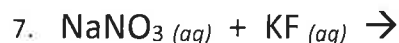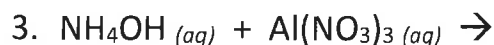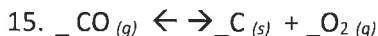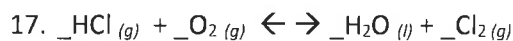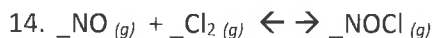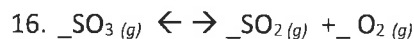
Equilibrium: Practice with K_{eq}

Equilibrium is reached when the rate of the forward reaction is equal to the rate of the reverse reaction. Keq, the equilibrium constant, is an expression of the ratio of the product concentration to the reactant concentration at equilibrium. Only gases and aqueous solution will affect a reaction's equilibrium constant.

$$K_{eq} = \frac{[products]}{[reactants]}$$

Write the equilibrium expressions (for K_{eq}) for the following reactions.

1. $2NO_{2\,(g)} \leftrightarrow N_2O_{4\,(g)}$

2. $H_{2\,(g)} + I_{2\,(g)} \leftrightarrow 2HI_{(g)}$

3. $CaSO_{4\,(s)} \leftrightarrow Ca^{2+}_{(aq)} + SO_4^{\,2-}_{(aq)}$

4. $Mg_{(s)} + 2\,Ag^+_{(aq)} \leftrightarrow Mg^{2+}_{(aq)} + 2Ag_{(s)}$

5. $C_{(s)} + H_2O_{(g)} \leftrightarrow CO_{(g)} + H_{2\,(g)}$

6. $CO_{2\,(g)} + H_2O_{(l)} \leftrightarrow H^+_{(aq)} + HCO_3^-_{(aq)}$

7. $CO_{(g)} + 2H_{2\,(g)} \leftrightarrow CH_3OH_{(g)}$

8. $2POCl_{3\,(g)} \leftrightarrow 2PCl_{3\,(g)} + O_{2\,(g)}$

9. $Sn_{(s)} + 2CO_{2\,(g)} \leftrightarrow SnO_{2\,(g)} + 2CO_{(g)}$

10. $2HBr_{(g)} \leftrightarrow H_{2\,(g)} + Br_{2\,(l)}$

11. $O_{2\,(g)} + NO_{2\,(g)} \leftrightarrow O_{3\,(g)} + NO_{(g)}$

12. $Fe_{(s)} + H_2O_{(g)} \leftrightarrow FeO_{(s)} + H_{2\,(g)}$
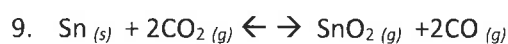
Balance the following equations. Write the equilibrium expressions (for K_{eq}) for each reaction.

13. $\_O_{3\,(g)} \leftrightarrow \_O_{2\,(g)}$

14. $\_NO_{(g)} + \_Cl_{2\,(g)} \leftrightarrow \_NOCl_{(g)}$

15. $\_CO_{(g)} \leftrightarrow \_C_{(s)} + \_O_{2\,(g)}$

16. $\_SO_{3\,(g)} \leftrightarrow \_SO_{2\,(g)} + \_O_{2\,(g)}$

17. $\_HCl_{(g)} + \_O_{2\,(g)} \leftrightarrow \_H_2O_{(l)} + \_Cl_{2\,(g)}$

18. $\_Sb_2S_{3\,(s)} + \_H_{2\,(g)} \leftrightarrow \_Sb_{(s)} + \_H_2S_{(g)}$
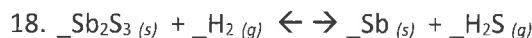
For questions (13-18): Indicate which direction equilibrium would shift for each reaction if pressure were increased.

13.   14.   15.   16.   17.   18.

LE CHATELIER'S PRINCIPLE

Name _____

Le Chatelier's Principle states that when a system at equilibrium is subjected to a stress, the system will shift its equilibrium point in order to relieve the stress.

Complete the following chart by writing left, right or none for equilibrium shift, and decreases, increases or remains the same for the concentrations of reactants and products, and for the value of K.

$$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g) + 22.0 \text{ kcal}$$

Stress	Equilibrium Shift	$[N_2]$	$[H_2]$	$[NH_3]$	K
1. Add N_2	right	——	decreases	increases	remains the same
2. Add H_2			——		
3. Add NH_3				——	
4. Remove N_2		——			
5. Remove H_2			——		
6. Remove NH_3				——	
7. Increase Temperature					
8. Decrease Temperature					
9. Increase Pressure					
10. Decrease Pressure					

LE CHATELIER'S PRINCIPLE CONTINUED

Name _____

$$12.6 \text{ kcal} + H_2(g) + I_2(g) \leftrightarrow 2HI(g)$$
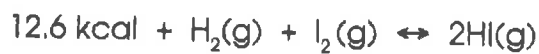
Stress	Equilibrium Shift	[H₂]	[I₂]	[HI]	K
1. Add H₂	right	———	decreases	increases	remains the same
2. Add I₂			———		
3. Add HI				———	
4. Remove H₂		———			
5. Remove I₂			———		
6. Remove HI				———	
7. Increase Temperature					
8. Decrease Temperature					
9. Increase Pressure					
10. Decrease Pressure					

$$NaOH(s) \leftrightarrow Na^+(aq) + OH^-(aq) + 10.6 \text{ kcal}$$
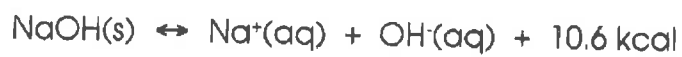
(Remember that pure solids and liquids do not affect equilibrium values.)

Stress	Equilibrium Shift	Amount NaOH(s)	[Na⁺]	[OH⁻]	K
1. Add NaOH(s)		———			
2. Add NaCl (Adds Na⁺)			———		
3. Add KOH (Adds OH⁻)				———	
4. Add H⁺ (Removes OH⁻)				———	
5. Increase Temperature					
6. Decrease Temperature					
7. Increase Pressure					
8. Decrease Pressure					