Norfolk Public Schools
Science Learning in Place Plan: Chemistry Lessons

Week 4: April 6 – 10, 2020

Monday	Tuesday	Wednesday	Thursday	Friday
Unit 4.9: The Mole and Stoichiometry **Unit 2.9: Compounds and Bonding**		**Unit 4.9: The Mole and Stoichiometry**		**Unit 5.9: Chemical Reactions** **Unit 6.9: Solutions** **Unit 7.9: Experimental**
Unit 9 Packet pages 1 – 2 • Empirical Formulas • Compounds and Bonding		**Unit 9 Packet pages 3 – 4** • IF 55 "Determining Empirical Formulas • IF 56 "Determining Molecular Formulas		**Unit 9 Packet page 5** • Titration and Neutralization Problems

Week 5: April 13 – 17, 2020

Monday	Tuesday	Wednesday	Thursday	Friday
Spring Break				

Week 6: April 20 – 24, 2020

Monday	Tuesday	Wednesday	Thursday	Friday
Unit 3.9: Kinetic Theory	**Unit 3.9: Kinetic Theory**		**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 9 Packet page 6 • IF 14 " Phase Diagram	**Unit 9 Packet pages 7 – 8** • Heating Curve Worksheet		**Unit 9 Packet pages 9 – 10** • Unit 9 Practice	

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 temperature and pressure 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: $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$ **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: $HC_2H_3O_2{}_{(aq)} \leftrightarrow H^+_{(aq)} + C_2H_3O_2^-{}_{(aq)}$	***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 $[H_3O^+] = [OH^-]$** 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 buret 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.
Medical Health **8.9**	**Amino acids** are the building blocks of proteins. Proteins are an essential part of all living organisms especially as structural components of body tissues such as muscle, hair, collagen, etc., and as enzymes and antibodies. All amino acids are made up of chains of carbon with an amine group, a carboxylic acid and another functional group ("R"). There are three groups of amino acids: essential, nonessential, and conditional.	**Name** the amino acids in each category and **draw** the structures of at least 2 amino acids from each category. **Explain** how amino acids become proteins.

Unit 9

Name: _____

Empirical Formula

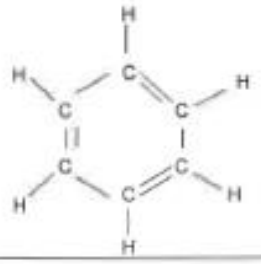
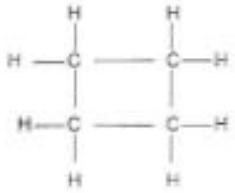
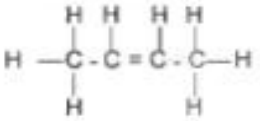
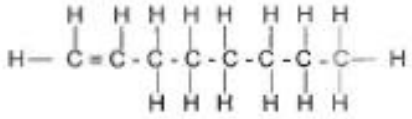
(Can a Molecule Be Identified by Its Percent Composition?)

Model: Percent Composition

The percent composition (by mass) of an element in a molecule is the mass of the element in the molecule divided by the mass of the entire molecule times 100. Or, because the number of atoms (molecules) is proportional to the number of moles of atoms (molecules),

$$\%_i = \frac{mass_i}{mass_{compound}} \times 100\%$$

Table 1: Percent Composition (by mass) of Some Common Organic Molecules

Name	Structural Formula	Molecular Formula	% Composition (by mass)	
			C	H
ethyne	HC≡CH	C_2H_2	92.31	7.69
benzene				
cyclobutane		C_4H_8		
2-butene			85.71	
1-octene				

Critical Thinking Questions:

1. Fill in the missing molecular formulas and % composition in Table 1.
2. Verify that the % composition given for ethyne in Table 1 is correct.
3. Is it possible, given the original data in Table 1, to determine the % composition by mass of H for 2-butene without using the equation given in the model above? If so, how?
4. Based on the data in Table 1, is it possible to determine the *molecular* formula of a compound solely from its percent composition? Why or why not?
5. What feature related to composition do all compounds with the same % composition have?

Based on "ChemActivity 30: Empirical Formula" from *Chemistry: A Guided Inquiry (2nd Edition)* by Moog & Farrell.

Unit 9 Name: _____

Information

The **empirical formula** of a compound describes the relative number of each type of atom in the compound. It is given in term of the smallest-possible-whole-number ratios (as subscripts). For example, Ethane, whose molecular formula is C_2H_6, has an empirical formula of CH_3. (Note that the subscript "1" is omitted.)

Critical Thinking Questions:

6. What feature related to the composition of a compound can be determined solely by the percent composition?

Exercises:

1. Determine the empirical formula of each of the molecules in Table 1.
   a. ethyne -
   b. benzene -
   c. cyclobutane -
   d. 2-butene -
   e. 1-octene -

2. The molecule 2-hexene has the molecular formula, C_6H_{12}. Refer to Table 1 and determine the percent composition of H in this molecule.

3. Determine the percent composition of each element in acetic acid, CH_3COOH.
   C –
   H –
   O –

4. A molecule containing only nitrogen and oxygen contains (by mass) 36.8% nitrogen.
   a. How many grams of N would be found in a 100 g sample of the compound? How many grams of O would be found in the same sample?
   b. How many moles of N would be found in a 100 g sample of the compound? How many moles of O would be found in the same sample?
   c. What is the ratio of the number of moles of O to the number of moles of N?
   d. What is the empirical formula of the compound?

5. A compound used as a dry-cleaning fluid was analyzed and found to contain 18.00% C, 2.27% H and 79.73% Cl. Determine the empirical formula of the fluid.

6. An unknown liquid contains 38.7% C and 51.6% O by mass. The remainder of the compound is H. What is the empirical formula of the compound?

7. A compound containing only P, O, and Zn is used as a dental cement. A sample of the cement is analyzed and gives 33.16% O and 16.04% P. Determine the empirical formula of the cement.

DETERMINING EMPIRICAL FORMULAS

Name _____

What is the empirical formula (lowest whole number ratio) of the compounds below?

1. 75% carbon, 25% hydrogen

_____

2. 52.7% potassium, 47.3% chlorine

_____

3. 22.1% aluminum, 25.4% phosphorus, 52.5% oxygen

_____

4. 13% magnesium, 87% bromine

_____

5. 32.4% sodium, 22.5% sulfur, 45.1% oxygen

_____

6. 25.3% copper, 12.9% sulfur, 25.7% oxygen, 36.1% water

_____

DETERMINING MOLECULAR FORMULAS (TRUE FORMULAS)

Name _____

Solve the problems below.

1. The empirical formula of a compound is NO_2. Its molecular mass is 92 g/mol. What is its molecular formula?

_____

2. The empirical formula of a compound is CH_2. Its molecular mass is 70 g/mol. What is its molecular formula?

_____

3. A compound is found to be 40.0% carbon, 6.7% hydrogen and 53.5% oxygen. Its molecular mass is 60. g/mol. What is its molecular formula?

_____

4. A compound is 64.9% carbon, 13.5% hydrogen and 21.6% oxygen. Its molecular mass is 74 g/mol. What is its molecular formula?

_____

5. A compound is 54.5% carbon, 9.1% hydrogen and 36.4% oxygen. Its molecular mass is 88 g/mol. What is its molecular formula?

_____

Name:_____

Titration and Neutralization Problems

Predict the products and write a balanced equation for the following neutralization reactions:

1. $HCl + NaOH \rightarrow$
2. $HNO_3 + KOH \rightarrow$
3. $LiOH + H_2SO_4 \rightarrow$
4. $Ca(OH)_2 + HF \rightarrow$
5. $Al(OH)_3 + H_2SO_4 \rightarrow$
6. $H_3PO_4 + Mg(OH)_2 \rightarrow$

Answer and show the appropriate calculations for the following titration problems:
(hint: $M_{acid}xV_{acid} = M_{Base}xV_{Base}$)

1. What is the molarity of a solution of HCl if 250 mL of a 0.50 M solution of NaOH will completely neutralize 100.mL of this acid?

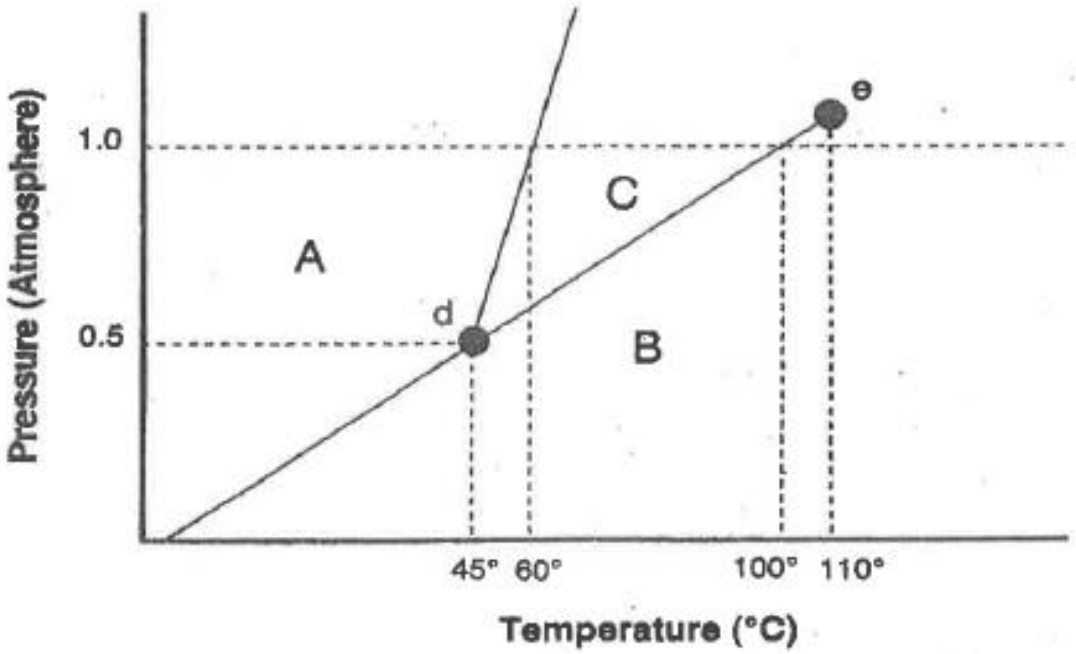
2. If 45 mL of a 2.0 M acetic acid ($HC_2H_3O_2$) solution completely neutralizes 135 mL an unknown concentration of ammonia (NH_3), what is the concentration of the ammonia?

3. What volume of 3.0 M HBr solution will completely neutralize 750 mL of a 1.5 M LiOH solution?

4. How many liters of a 2.0 M H_2SO_4 solution is needed to completely react with 500 mL of a 0.50 M $Al(OH)_3$ solution?**

PHASE DIAGRAM

Name _____



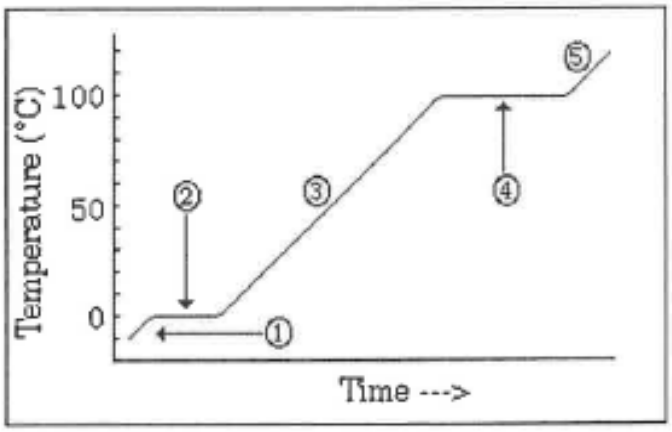
Answer the following questions using the chart above.

1. What section represents the solid phase? _____
2. What section represents the liquid phase? _____
3. What section represents the gas phase? _____
4. What letter represents the triple point? _____
5. What letter represents the critical point? _____
6. What is this substance's normal melting point? _____
7. What is this substance's normal boiling point? _____
8. Above what temperature is it impossible to liquify this substance no matter what the pressure? _____
9. At what temperature and pressure do all three phases coexist? _____
10. Is the density of the solid greater than or less than the density of the liquid? _____
11. Would an increase in pressure cause this substance to freeze or melt? _____

Name: _____

Heating Curve Worksheet

The diagram below is a plot of temperature vs. time. It represents the heating of what is initially ice at -10°C at a near constant rate of heat transfer.



Common terms and definitions:

Specific heat capacity is the energy needed to raise 1 gram of a substance by 1°C.
($Cp_{H_2O_{(s)}}$ = 4.18 J/g·°C, $Cp_{H_2O_{(l)}}$ = 2.10 J/g·°C, & $Cp_{H_2O_{(g)}}$ = 2.00 J/g·°C)

Heat of fusion is the amount of energy needed to melt a given amount of solid into liquid.(ΔH_{fus} = 6.0 kJ/mol)

Heat of vaporization is the amount of energy needed to melt a given amount of liquid into gas. (ΔH_{vap} = 40.7 kJ/mol)

1. Based on your knowledge of phase changes, complete the chart below as it relates to the Heating Curve for water:

Segment	Phase(s) Present	What is happening to energy being absorbed? (potential or kinetic)	Phase Change (Yes or No)	Equation for Energy	Constants needed for calculation
1					
2					
3					
4					
5					

2. What is the melting point of this substance?_____
3. At what temperature would this sample finish boiling?_____
4. When this substance is melting, the temperature of the ice-water mixture remains constant because:
   a. Heat is not being absorbed
   b. The ice is colder that the water
   c. Heat energy is being converted to potential energy
   d. Heat energy is being converted to kinetic energy

5. When a given quantity of water is heated at a constant rate, the phase change from liquid to gas takes longer than the phase change from solid to liquid because:
   a. The heat of vaporization is greater than the heat of fusion
   b. The heat of fusion is greater than the heat of vaporization
   c. The average kinetic energy of the molecules is greater in steam than in water
   d. Ice absorbs energy more rapidly than water does

Name: _____

Calculations: Use the equations and constants in chart on the other side to solve the problems.

1. Calculate the amount of energy needed to convert 20.0 grams of ice at -25.0 °C to steam at 115.0 °C.

2. Calculate the amount of energy needed to convert 10.0 grams of ice at -5.0 °C to water at 25.0 °C

3. Calculate the amount of energy released when 2.00 grams of steam at 110.0 °C condenses on a mirror at 20.0 °C

4. Calculate the energy required to take 450.0 g of water from 27.5°C to 102.0°C.

Unit 9 Practice

Name the following compounds:

1. Mg_3P_2
2. CO_2
3. HBr
4. $(NH_4)_2S$
5. $Ca_3(PO_4)_2$
6. $CoCl_3$
7. CH_4
8. H_2SO_3
9. Cu_2CO_3
10. P_4O_{10}
11. H_3PO_4
12. SF_6

Write the formula for the following ionic compounds:

1. Aluminum hydroxide
2. Sodium oxide
3. Calcium phosphide
4. Magnesium nitrate
5. Copper (II) chloride
6. Ammonium sulfate
7. Potassium fluoride
8. Chromium (III) nitride

Balance and classify the following types of chemical reactions:

1. $Cl_2 + KI \rightarrow KCl + I_2$
2. $Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$
3. $KClO_3 \rightarrow O_2 + KCl$
4. $Na + P \rightarrow Na_3P$
5. $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$
6. $Na_2SO_4 + BaCl_2 \rightarrow NaCl + BaSO_4$
7. $CaCO_3 \rightarrow Ca + CO_2$
8. $HNO_3 + Mg(OH)_2 \rightarrow H_2O + Mg(NO_3)_2$
9. $Na + BaF_2 \rightarrow NaF + Ba$
10. $Fe + O_2 \rightarrow Fe_2O_3$

Draw the structural formula for the following molecules and identify any functional groups.

1. CH_2O
2. C_2H_2
3. CH_3COOH
4. C_3H_6O
5. CH_3OCH_3
6. CH_3OH
7. C_2H_4
8. CH_4

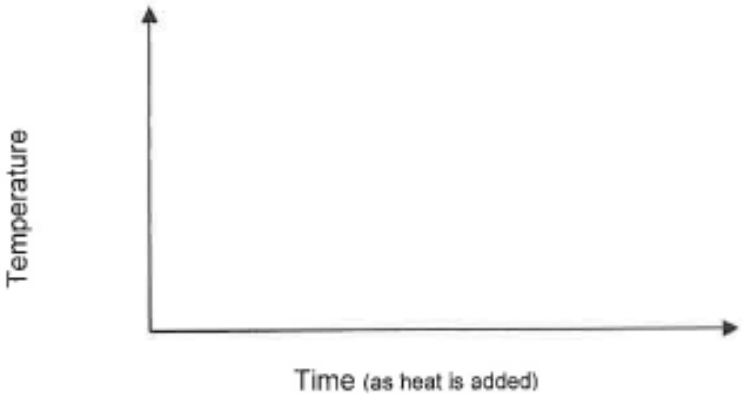
Phase Diagram: Use the phase diagram provided to answer the following questions:

1. What phase of matter is labeled A?
2. What phase of matter is labeled B?
3. What phase of matter is labeled C?
4. What is the normal melting point? Boiling point?
5. What phase change will occur if the pressure is decreased from 0.75 atm to 0.25 atm at 0 °C?
6. What phase change will occur if the temperature is increased from 100 °C to 200 °C at 0.75 atm?

Unit 9 Review Continued

Heating Curve: Use the information provided about ethanol to draw a properly labeled heating curve and to calculate the total amount of energy needed to convert 100.0 grams of solid ethanol at -120.0 °C to 100.0 grams of ethanol at 100.0 °C.

M_{pt} = -114.1 °C
B_{pt} = 78.3 °C
$C_{p(solid)}$ = 0.97 J/g•°C
$C_{p(liquid)}$ = 2.46 J/g•°C
$C_{p(gas)}$ = 1.71 J/g•°C
ΔH_{fus} = 4.93 kJ/mol
ΔH_{vap} = 38.6 kJ/mol



Show all calculations:

Empirical Formulas:

1. What is the empirical formula of a compound found to have 54.1 % calcium, 43.2 % oxygen, 2.70 % hydrogen.

2. What is the molecular formula of a compound found to have 40.0 % carbon, 53.3 % oxygen, 6.7 % hydrogen and a molar mass of the compound is 150 g/mol.

Titration Problems:

1. How many liters of a 2.0 M HNO_3 solution is needed to completely react with 500 mL of a 0.50M LiOH solution?

2. What is the concentration 75.0 mL of HCl solution if 27.8 mL of a 0.50 M KOH solution is used to neutralize the acid completely?

3. How many liters of a 1.5 M H_2SO_4 solution is needed to completely react with 500 mL of a 0.50 M $Al(OH)_3$ solution?