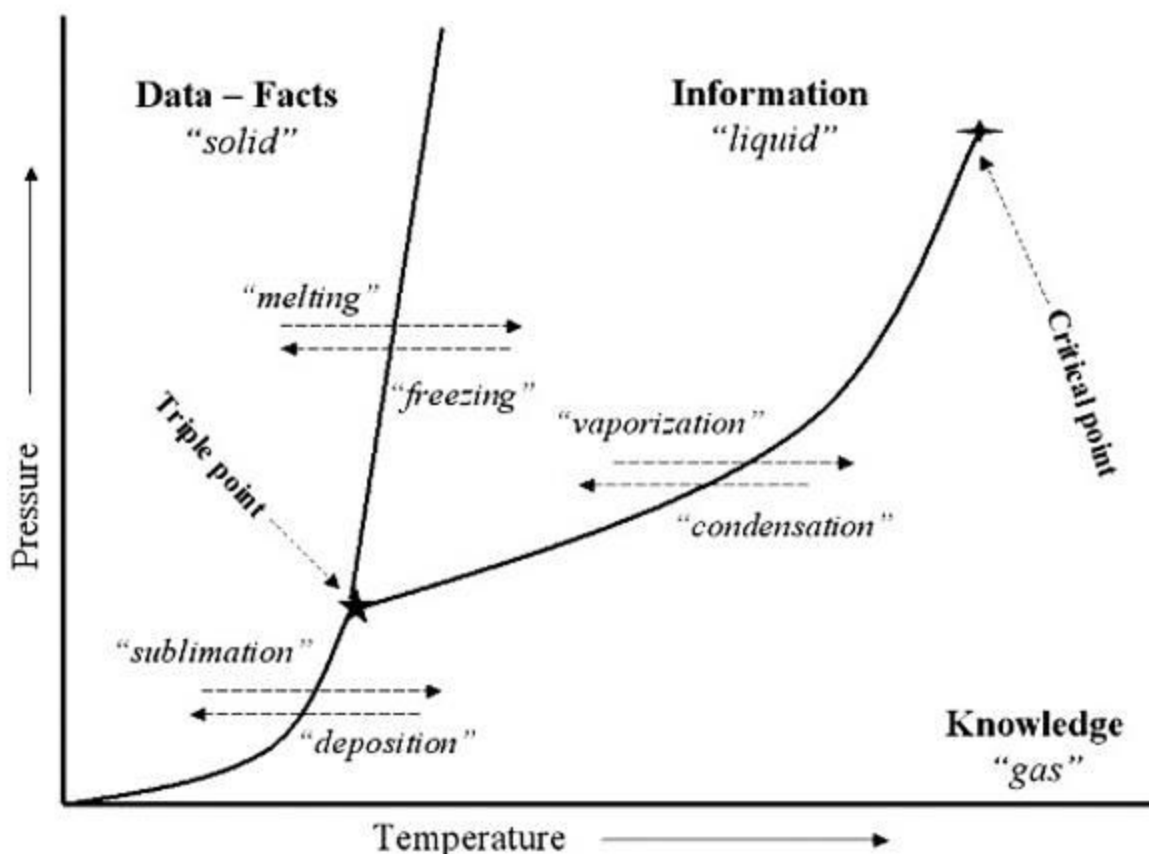


## Chemistry Final Exam Study Guide – June 2017

### Kinetic Molecular Theory, Gases, Phase Diagrams

#### Phase Diagram for H<sub>2</sub>O



1. Label the above phase diagram for H<sub>2</sub>O, include all 6 possible transitions between phases.
2. Explain how the addition or removal of energy can cause a phase change. Adding energy makes the particles move faster. Because the particles are moving faster, they can break the intermolecular forces that are holding them together in the phase they are in. Particles can move past one another, as in a liquid, and move freely, as in a gas.
3. What phase changes release energy? Exothermic---freezing and condensation and what phase changes require energy? Endothermic---melting/boiling
4. Explain why freezing is an exothermic change of state. Energy is being released as the intermolecular forces reform.
5. Describe the relationship between temperature and pressure. Direct relationship---as the temperature increases, the pressure increases. As the temperature decreases, the pressure decreases.
6. A. Describe conduction in terms of molecules bumping into each other to transfer energy. B. Explain why there is better conduction in solid and liquids than gases.
  - A. When vibrating molecules bump into the other and then makes that one also vibrate passing on the energy.

B. The molecules are closer together and able to rub or slide past each other rather than in gas which seldom touch.

7. Describe the various states of matter in terms of the motion and arrangement of the molecules making up the substance.

**Solid:** Molecules are tightly packed together and barely move. They have the least energy.

**Liquid:** Molecules slide past one another, easily moving. Less energy.

**Gas:** Molecules move freely and only briefly touching other molecules. Lots of energy, vibrate a lot.

8. Explain changes in volume, pressure and temperature for gases as you **increase** kinetic energy.

Volume: Kinetic Energy Increases

Pressure: Kinetic Energy Increases

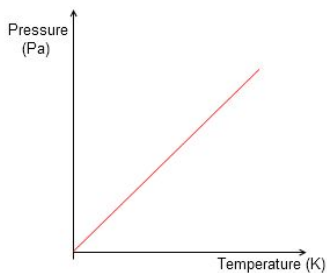
Temperature: Kinetic Energy Increases

9. Describe how melting occurs if an ice cube is dropped in a glass of pop.

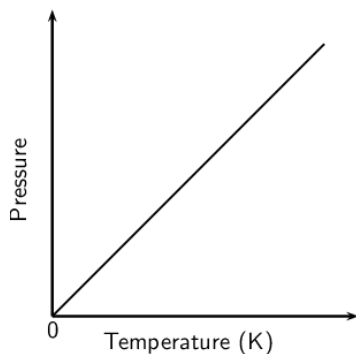
At first, the ice molecules are stuck in a specific arrangement. They are in the solid state, so they move by shaking. The warm liquid molecules surround the ice cube and move around it. The moving liquid molecules collide with and bounce off of the shaking ice molecules. The shaking ice molecules get more energy from the liquid molecules. Some of the ice molecules gain enough energy to start moving past each other. The solid water begins to change into liquid water when the ice molecules start to move around.

10. State the law and sketch a graph showing the relationship between the following properties of a gas and give an example of each;

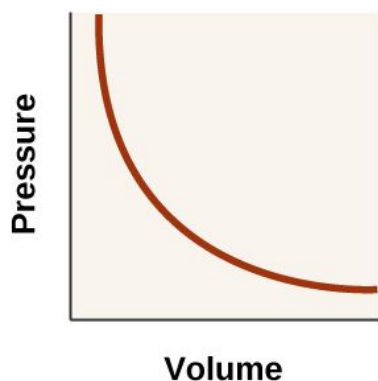
a.) temperature and pressure: [Gay-Lussac's Law](#)



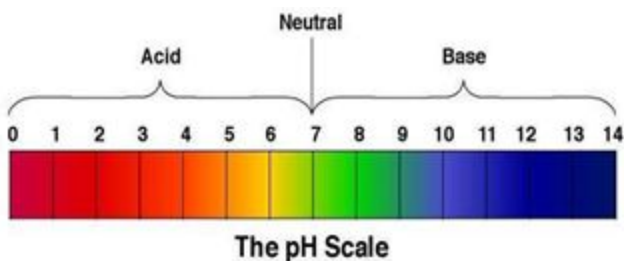
b.) temperature and volume: [Charles' Law](#)



c.) pressure and volume: [Boyle's Law](#)



## Acid, Base Chemistry



- Using the above pH scale, classify how various solutions are acidic or basic given their pH.
- Explain why lakes with limestone or calcium carbonate experience less adverse effects from acid rain than lakes with granite beds.
- Describe the outcomes of a litmus paper test that can be used to distinguish an acid from a base.
- Explain the concentration of hydronium ions and hydroxide ions as they move across the pH scale.
- Recognize formulas for common acids and bases formed from families I and II.
- Complete and balance the following equations representing neutralization reactions:
  - $\text{CsOH} + \text{H}_2\text{CO}_3 \rightarrow \text{Cs}_2\text{CO}_3 + \text{H}_2\text{O}$
  - $\text{HF} + \text{Mg}(\text{OH})_2 \rightarrow \text{MgF}_2 + \text{H}_2\text{O}$

## The Mole and Stoichiometry

*(You also need to know how to balance an equation & predict products!)*

- Given the following equation:  $2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2$

How many grams of oxygen are made if 3.75 moles of  $\text{KClO}_3$  decompose?

$$3.75 \text{ mol KClO}_3 \times \frac{3 \text{ mol O}_2}{2 \text{ mol KClO}_3} \times \frac{32 \text{ g O}_2}{1 \text{ mol O}_2} = 180 \text{ g O}_2$$

- How many moles are in 2.5 grams of KCN?

Moles = Mass/ Molar Mass

$$0.04 \text{ mol} = 2.5 \text{ g}/65.12 \text{ g/mol}$$

- How many atoms of NaCl are in a 28.6 g sample?

Atoms = Moles x Avogadro's Number

$$\text{Moles} = 28.6 \text{ g} / 58.45 \text{ g/mol} = 0.4585 \text{ mol}$$

$$2.7\text{e}23 = 0.4585 \text{ mol} \times 6.022\text{e}23 \text{ atoms}$$

4. Given the following equation:  $2 \text{ K} + \text{Cl}_2 \rightarrow 2 \text{ KCl}$

How many grams of KCl is produced from 2.50 g of K?

$$2.5 \text{ g K} \times \frac{1 \text{ mol K}}{39 \text{ g K}} \times \frac{2 \text{ mol KCl}}{2 \text{ mol K}} \times \frac{74.5 \text{ g KCl}}{1 \text{ mol KCl}} = 4.8 \text{ g KCl}$$

5. Calculate the percent by weight of each element in  $\text{Na}_2\text{SO}_4$ .

$$\% \text{ composition} = \frac{\text{grams of element}}{\text{grams of compound}} \times 100$$

$$\text{Na: } 2 \times 23 = 46 \text{ g}$$

$$\text{Na: } 46 \text{ g} / 142 \text{ g} \times 100 = 32.4 \%$$

$$\text{S: } 1 \times 32 = 32 \text{ g}$$

$$\text{S: } 32 \text{ g} / 142 \text{ g} \times 100 = 22.5 \%$$

$$\text{O: } 4 \times 16 = 64 \text{ g}$$

$$\text{O: } 64 \text{ g} / 142 \text{ g} \times 100 = 45.1 \%$$

$$142 \text{ g Na}_2\text{SO}_4$$

6. Benzene, a non-polar solvent used for many applications in industry, and a major component in many organic compounds has the following percent composition:

$$\text{C} = 92.3\% \quad \text{H} = 7.8 \%$$

a. Find Benzene's **empirical formula**.

b. Find the **Molecular formula** of benzene if the entire formula mass is 78.12 g/mol

Handwritten calculations for finding the empirical and molecular formula of benzene:

6. C = 92.3% → 92.3 g  
 A. H = 7.8% → 7.8 g

$92.3 \text{ g C} \times \frac{1 \text{ mol C}}{12 \text{ g C}} = \frac{7.69}{7.69} = 1$

$7.8 \text{ g H} \times \frac{1 \text{ mol H}}{1.01 \text{ g H}} = \frac{7.72}{7.69} = 1$

Empirical Formula =  $\text{C}_1\text{H}_1$

6. B. C:  $1 \times 12 = 12$   
 H:  $1 \times 1.01 = 1.01$   
 13.01 g/mol

given  $\rightarrow \frac{78.12 \text{ g/mol}}{13.01 \text{ g/mol}} = 7$

$7 \text{ C}_1\text{H}_1 \rightarrow \text{C}_7\text{H}_7$  Molecular Formula

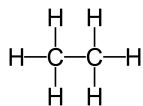
## Organic Chemistry

1. Define organic compound.

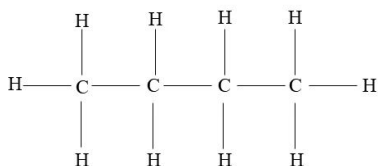
One or more atoms of carbon are covalently linked to atoms of other elements, most commonly hydrogen, oxygen, or nitrogen.

2. Draw the structural formulas for the following simple hydrocarbons:

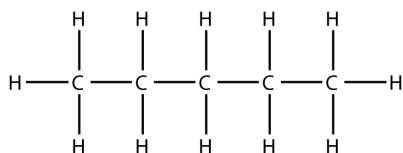
a. Ethane:  $\text{C}_2\text{H}_6$



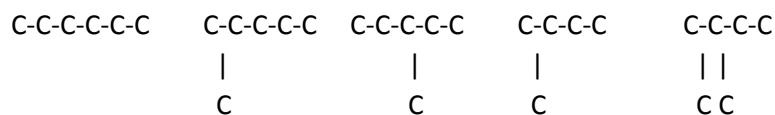
b. Butane:  $\text{C}_4\text{H}_{10}$



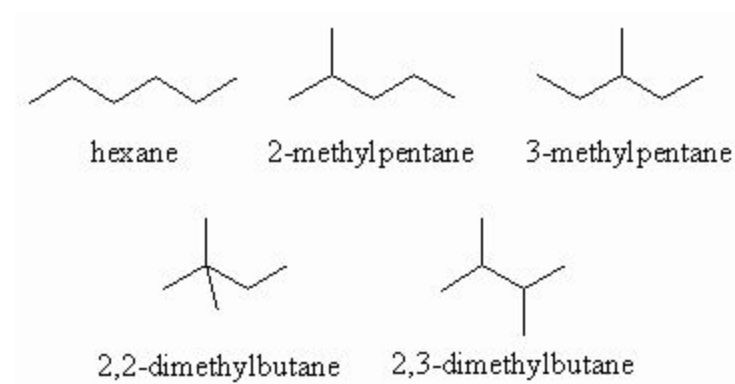
c. Pentane:  $\text{C}_5\text{H}_{12}$



3. Draw all of the structural isomers possible for the alkane with the molecular formula  $\text{C}_6\text{H}_{14}$ . Show only the carbon chains.



hexane	2-methyl	3-methyl	2,2-dimethyl	2,3-dimethyl
	pentane	pentane	butane	butane



4. Recognize that proteins, starches, and other large biological molecules are polymers.

**Polymer:** a substance that has a molecular structure made mostly or entirely of a large number of similar units bonded together. Example: Plastics

### **Stoichiometry Scenarios Practice**

1. Chromium is a transition element that is an important component of chrome plating. Chrome plating is used on metals and in steel alloys to control corrosion. What is the mass in grams of 4.56 moles of chromium needed to coat the rims of an automobile?

$$(4.56 \text{ mol Cr}) \times (51.9961 \text{ g Cr} / 1 \text{ mol Cr}) = 237 \text{ g Cr}$$

2. **Ethanol** ( $\text{C}_2\text{H}_5\text{OH}$ ), a domestically produced fuel source, is often blended with gasoline. A sample of ethanol has a mass of 49.3 g. How many moles does the sample contain?

$$(49.3 \text{ g C}_2\text{H}_5\text{OH}) \times (1 \text{ mol} / 46 \text{ g C}_2\text{H}_5\text{OH}) = 1.1 \text{ mol C}_2\text{H}_5\text{OH}$$

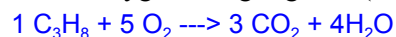
3. The characteristic odor of garlic is due to *allyl sulfide* ( $(\text{C}_3\text{H}_5)_2\text{S}$ ). A recipe for hummus calls for garlic that contains no more than **6.89 mol** of allyl sulfide. How many **grams** of allyl sulfide would you recommend?

$$(6.89 \text{ mol } (\text{C}_3\text{H}_5)_2\text{S}) \times (114.2086 \text{ g } (\text{C}_3\text{H}_5)_2\text{S} / 1 \text{ mol } (\text{C}_3\text{H}_5)_2\text{S}) = 787 \text{ g } (\text{C}_3\text{H}_5)_2\text{S}$$

4. A gold necklace has a mass of 23.0 g. How many particles of gold atoms does the necklace contain?

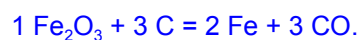
$$(23.0 \text{ g Au}) \times (1 \text{ mol Au} / 197 \text{ g Au}) \times (6.022 \times 10^{23} / 1 \text{ mol Au}) = 7.03 \times 10^{22} \text{ particles Au}$$

5. One disadvantage of burning propane ( $\text{C}_3\text{H}_8$ ) is that carbon dioxide is one of the products. The released carbon dioxide increases the amount of  $\text{CO}_2$  in the atmosphere and increases the effects of global warming. How many **moles of  $\text{CO}_2$**  would you say is produced when **86.3 moles of propane** is burned in excess oxygen in a gas grill? (Hint: Write a balanced equation first!)



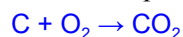
$$(86.3 \text{ mol C}_3\text{H}_8) \times (3 \text{ mol CO}_2 / 1 \text{ mol C}_3\text{H}_8) = 258.9 \text{ mol C}_3\text{H}_8$$

6. Molten iron and carbon monoxide are produced in a blast furnace by the reaction of iron(III) oxide and coke (carbon). If 17.86 grams of pure  $\text{Fe}_2\text{O}_3$  are used, how many grams of iron can be produced? (Hint: Write a balanced equation first!)



$$(17.86 \text{ g Fe}_2\text{O}_3) \times (1 \text{ mol Fe}_2\text{O}_3 / 159.69 \text{ g Fe}_2\text{O}_3) \times (2 \text{ mol Fe} / 1 \text{ mol Fe}_2\text{O}_3) \times (55.8 \text{ g Fe} / 1 \text{ mol Fe}) = 12.5 \text{ g Fe}$$

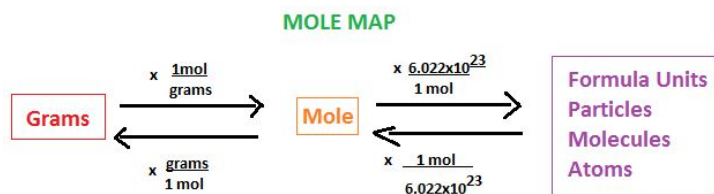
7. How many grams of carbon dioxide are formed by burning 190.0 grams of carbon? (Hint: Write a balanced equation first!)



$$(190.0 \text{ g C}) \times (1 \text{ mol C} / 12.01078 \text{ g C}) \times (1 \text{ mol CO}_2 / 1 \text{ mol C}) \times (44.00964 \text{ g CO}_2 / 1 \text{ mol CO}_2) = 696.2 \text{ g CO}_2$$

8. What is Avogadro's number? How is it related to a mole? How can you convert between moles and particles?

**Avogadro's number:** number of units in one mole of any substance, equal to  $6.022140857 \times 10^{23}$ .  
One mole of any substance contains  $6.022 \cdot 10^{23}$  atoms, ions, or molecules of that substance.



## Reaction Types

1. Write a basic equation for these reaction types: synthesis, decomposition, single replacement, double replacement, combustion, neutralization. (What will the products be?)

**Synthesis:**  $A + B \rightarrow AB$



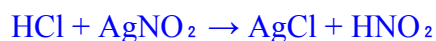
**Decomposition:**  $AB \rightarrow A + B$



**Single Replacement:**  $A + BC \rightarrow B + AC$



**Double Replacement:**  $AB + CD \rightarrow CB + AD$



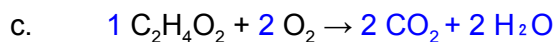
**Combustion:**  $\text{C}_x\text{H}_y + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$



**Neutralization:**  $\text{HA} + \text{BOH} \rightarrow \text{BA} + \text{H}_2\text{O}$



2. Predict the products of these reactions:



## Gas Law Problems (What is happening to the particles?)

What relationship do the variables (**P, V, T**) have?  $P \propto V \downarrow$  or  $P \propto V \uparrow$      $V \propto T$  or  $V \propto T \downarrow$      $T \propto P$  or  $T \propto P \downarrow$

1. A balloon is at a pressure of 750 torr and a volume of 100 mL. What will the new volume of the balloon be if the pressure is reduced to 300 torr?

2. A balloon that has a volume of 30 L at 20 degrees Celsius is heated to 100 degrees Celsius. What is the new volume of the balloon at this temperature?

