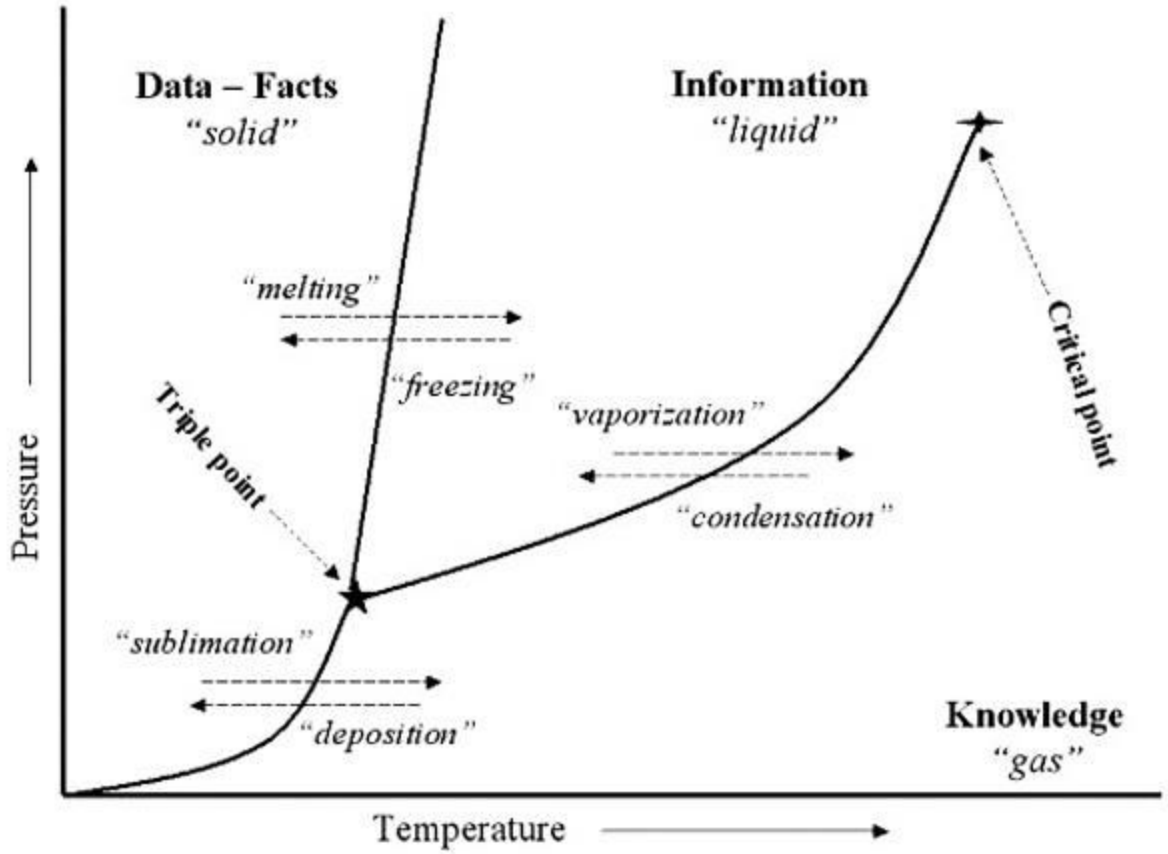
Chemistry Final Exam Study Guide – June 2017

Kinetic Molecular Theory, Gases, Phase Diagrams

Phase Diagram for H_2O



1. Label the above phase diagram for H_2O, 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.

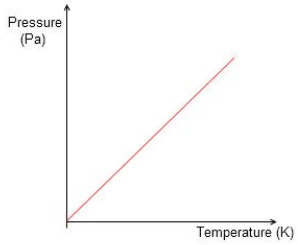
Volume: Kinetic Energy Increases
Pressure: Kinetic Energy Increases
Temperature: Kinetic Energy Increases

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

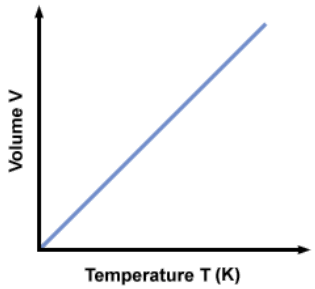
At first, the ice molecules are stuck in a specific arrangement. They are in the solid state, so they move by shaking. The warm liquid molecules surround the ice cube and move around it. The moving liquid molecules collide with and bounce off of the shaking ice molecules. The shaking ice molecules get 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;

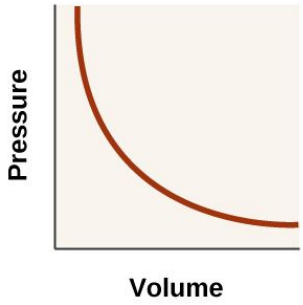
a.) temperature and pressure: Gay-Lussac's Law (As temperature increases, the pressure increases)



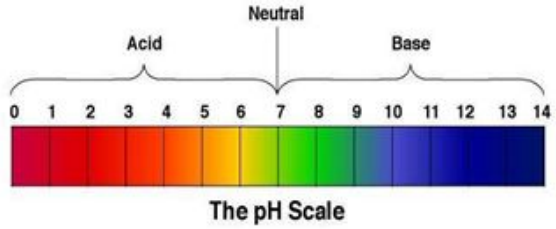
b.) temperature and volume: Charles' Law (As temperature increases, the volume increases)



c.) pressure and volume: Boyle's Law (As the pressure increases, the volume decreases)



Acid, Base Chemistry



1. Using the above pH scale, classify how various solutions are acidic or basic given their pH. Less than 7 = acidic, Greater than 7 = basic, 7 = neutral
2. Explain why lakes with limestone or calcium carbonate experience less adverse effects from acid rain than lakes with granite beds. The calcium carbonate and limestone react with the acid and neutralize the acid in acid rain.
3. Describe the outcomes of a litmus paper test that can be used to distinguish an acid from a base. Red litmus turns blue in the presence of a base, blue litmus turns red in the presence of an acid.
4. Explain the concentration of hydronium ions and hydroxide ions as they move across the pH scale. Acids---high concentration of H+ Bases---High concentration of OH-
5. Recognize formulas for common acids and bases formed from families I and II.
6. Complete and balance the following equations representing neutralization reactions:

a) **2**CsOH + H_2CO_3 → Cs_2CO_3 + 2 H_2O

b) 2HF + $Mg(OH)_2$ → MgF_2 + 2H_2O

The Mole and Stoichiometry

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

1. Given the following equation: 2 $KClO_3$ --> 2 KCl + 3 O_2

How many grams of oxygen are made if 3.75 moles of $KClO_3$ decompose?

3.75 mol $KClO_3$ x $\frac{3 \text{ mol } O_2}{2 \text{ mol } KClO_3}$ x $\frac{32 \text{ g } O_2}{1 \text{ mol } O_2}$ = 180 g O_2

2. How many moles are in 2.5 grams of KCN?

Moles = Mass/ Molar Mass

0.04 mol = 2.5 g/65.12 g/mol

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

Atoms = Moles x Avogadro's Number

Moles = 28.6 g / 58.45 g/mol = 0.4585 mol

2.7e23 = 0.4585 mol x 6.022e23 atoms

4. Given the following equation: 2 K + Cl_2 ---> 2 KCl

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

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

5. Calculate the percent by weight of each element in Na_2SO_4.

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

Na: 2 x 23 = 46 g

S: 1 x 32 = 32 g

O: 4 x 16 = 64 g

142 g Na_2SO_4

Na: 46 g/142 g x 100 = **32.4 %**

S: 32 g/142 g x 100 = **22.5 %**

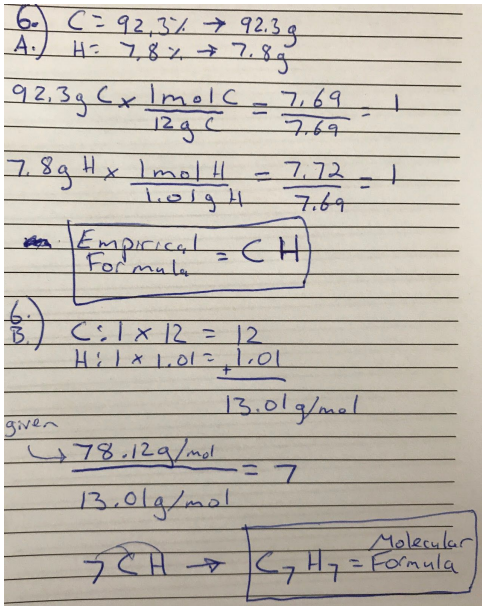
O: 64 g/142 g x 100 = **45.1 %**

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:

C = 92.3% 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



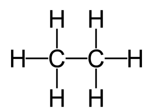
Organic Chemistry

1. Define organic compound.

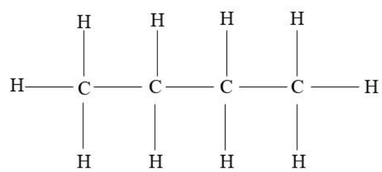
One or more atoms of carbon are covalently linked to atoms of other elements, most commonly hydrogen, oxygen, or nitrogen.

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

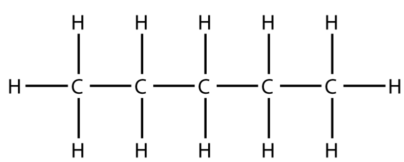
a. Ethane: C_2H_6



b. Butane: C_4H_{10}



c. Pentane: C_5H_{12}



3. Draw all of the structural isomers possible for the alkane with the molecular formula C_6H_{14}. Show only the carbon chains.

```
C-C-C-C-C-C     C-C-C-C-C    C-C-C-C-C     C-C-C-C       C-C-C-C
                |                 |        |             | |
                C                 C        C             C C

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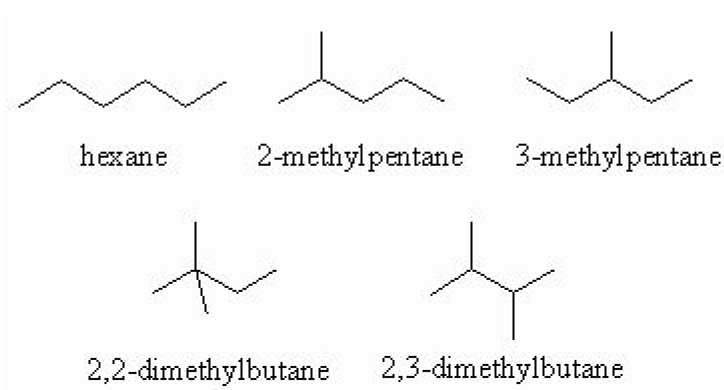


4. Recognize that proteins, starches, and other large biological molecules are polymers.

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 mol Cr) x (51.9961 g Cr / 1 mol Cr) = 237 g Cr

2. Ethanol (C_2H_5OH), 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 g C_2H_5OH) x (1 mol / 46 g C_2H_5OH) = 1.1 mol C_2H_5OH

3. The characteristic odor of garlic is due to *allyl sulfide* **$(C_3H_5)_2S$**. 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 mol $(C_3H_5)_2S$) x (114.2086 g $(C_3H_5)2_S$ / 1 mol $(C_3H_5)2_S$) = 787 g $(C_3H_5)_2S$

4. A gold necklace has a mass of 23.0 g. How many particles of gold atoms does the necklace contain?
(23.0 g Au) x (1 mol Au / 197 g Au) x ($6.022x10^{23}$/ 1 mol Au) = $7.03x10^{22}$ particles Au

5. One disadvantage of burning propane (C_3H_8) is that carbon dioxide is one of the products. The released carbon dioxide increases the amount of CO_2 in the atmosphere and increases the effects of global warming. How many **moles of 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!)
1 C_3H_8 + 5 O_2 ---> 3 CO_2 + 4H_2O
(86.3 mol C_3H_8) x (3 mol CO_2 / 1 mol C_3H_8) = 258.9 mol C_3H_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 Fe_2O_3 are used, how many grams of iron can be produced? (Hint: Write a balanced equation first!)
1 Fe_2O_3 + 3 C = 2 Fe + 3 CO.

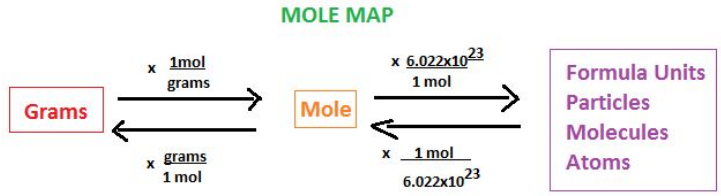
(17.86 g Fe_2O_3) x (1 mol Fe_2O_3 / 159.69 g Fe_2O_3) x (2 mol Fe / 1 mol Fe_2O_3) x (55.8 g Fe / 1 mol Fe) = 12.5g Fe

7. How many grams of carbon dioxide are formed by burning 190.0 grams of carbon? (Hint: Write a balanced equation first!)
C + O_2 → CO_2

(190.0 g C) x (1 mol C / 12.01078 g C) x (1 mol CO_2 / 1 mol C) x (44.00964 g CO_2/ 1 mol CO_2) = 696.2 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 · 1023 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 →AB

$2\ Na + Cl_2 \rightarrow 2\ NaCl$

Decomposition: AB → A + B

$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$

Single Replacement: A + BC → B + AC

$Mg + 2\ HCl \rightarrow H_2 + MgCl_2$

Double Replacement: AB + CD → CB + AD

$HCl + AgNO_2 \rightarrow AgCl + HNO_2$

Combustion: C□H□ + O_2 → CO_2 + H_2O

$C_6H_{12} + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$

Neutralization:HA + BOH →BA + H_2O

$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

2. Predict the products of these reactions:

a. $3\ Na + 1\ FeBr_3 \rightarrow 3\ NaBr + 1\ Fe$

b. $2\ NaOH + 1\ H_2SO_4 \rightarrow 1\ Na_2SO_4 + 2\ H_2O$

c. $1\ C_2H_4O_2 + 2\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$

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

What relationship do the variables **(P, V ,T)** have? P^V ↓ or P ↓ V^ (Inverse relationship)
V^T^orV ↓ T ↓ (Direct relationship) T^P^orT ↓ P ↓ (Direct relationship)

(Not for Mr. Sader's Class) 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?

P1= 750 torr V1 = 100ml P2= 300 torr V2 = ? P1V1=P2V2 (750)(100) = (300)(x) V2 = 250 mL

(Not for Mr. Sader's Class)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?

V1 = 30 L T1 = 20 +273 = 293 K V2= x T2 = 100 + 273= 373 K V1/T1 = V2/T2 30/293 = x/373

V2 =38.2 L