Name: _____
Period: _____

Unit 4 Packet – Describing Substances: Mixtures and Compounds

Packet Contents Sheet (with Unit 4 Objectives)	
Worksheet 1 (Front and Back)	
Element Compound Mixture Rally Table (with Matter- Substances vs. Mixtures on back)	
Pure Substances and Mixtures Chart (with Fill-In-The-Blanks on the back)	
Worksheet 2: Avogadro's Hypothesis (2 pages)	
Dalton's Playhouse (Front and Back)	
Worksheet 3 (2 pages)	
Worksheet 4 (Front and Back)	
Unit 4 Review Guide (2 pages)	

DO NOT, under any circumstances, throw this away!
This packet MUST be saved for the final exam.

Unit 4 – Describing Substance Objectives- Learning Goal:

Students are able to use Dalton's model of the atom and Avogadro's hypothesis to demonstrate understanding of pure substances vs. mixtures and to solve quantitative problems.

Scale

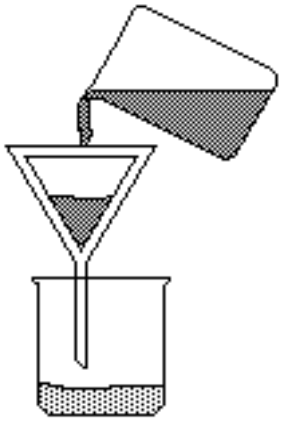
Score	Comment
Score 4	Students show mastery of score 3 without any errors plus: • Analyze and explain how Dalton's model of the atom and Avogadro's hypothesis apply to solve quantitative problems in real world situations.
Score 3	Without any major errors, students can independently: • Use Dalton's model of the atom and Avogadro's hypothesis to demonstrate understanding of pure substances vs. mixtures and to solve quantitative problems.
Score 2	With one or two major errors, students can independently: • Understand Dalton's model of the atom and Avogadro's hypothesis and recognize pure substances vs. mixtures as well as solve quantitative problems.
Score 1	With help from the teacher, students can: • Use Dalton's model of the atom and Avogadro's hypothesis to demonstrate understanding of pure substances vs. mixtures and to solve quantitative problems.
Score 0	Even with the teacher's help, students are not able to use Dalton's model of the atom and Avogadro's hypothesis to demonstrate understanding of pure substances vs. mixtures and to solve quantitative problems.

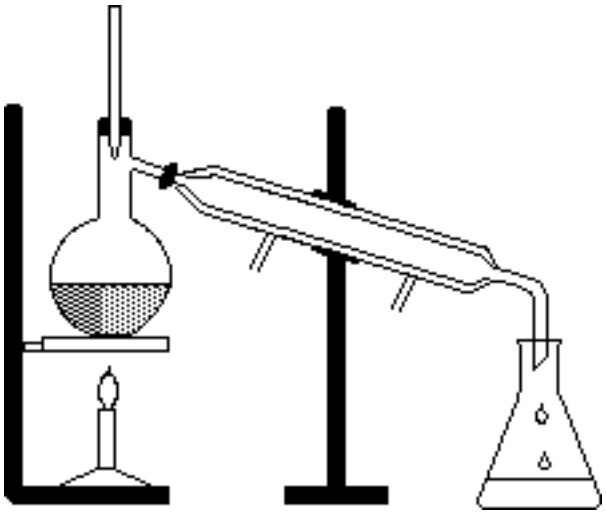
Name _____

Date _____ **Pd** ____

Chemistry – Unit 4 Worksheet 1

1. Identify the separation techniques pictured below. Which technique would be useful to separate a mixture of sand and salt? Of salt and water?





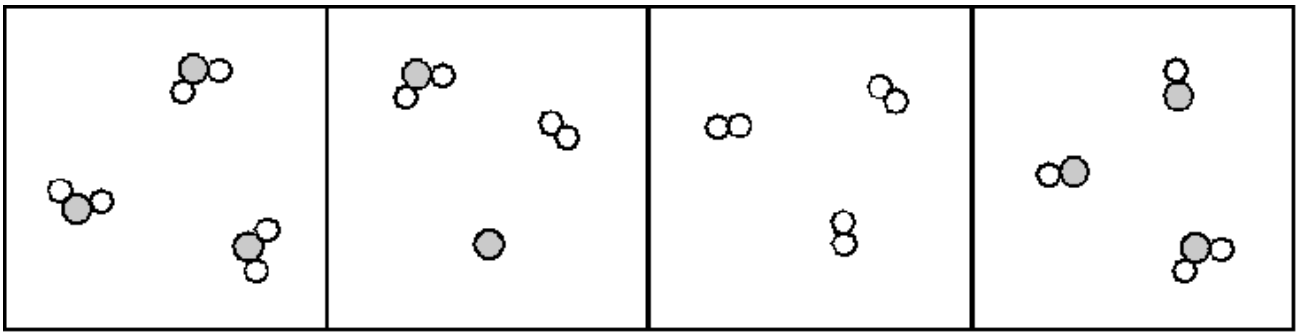
2. Explain why the technique at left would not be effective in separating a mixture of salt and sugar.

3. Draw particle representations for the following:

A mixture of iron and sulfur	A compound of iron and sulfur

4. Explain why a magnet can separate iron atoms from the mixture but not from the compound.

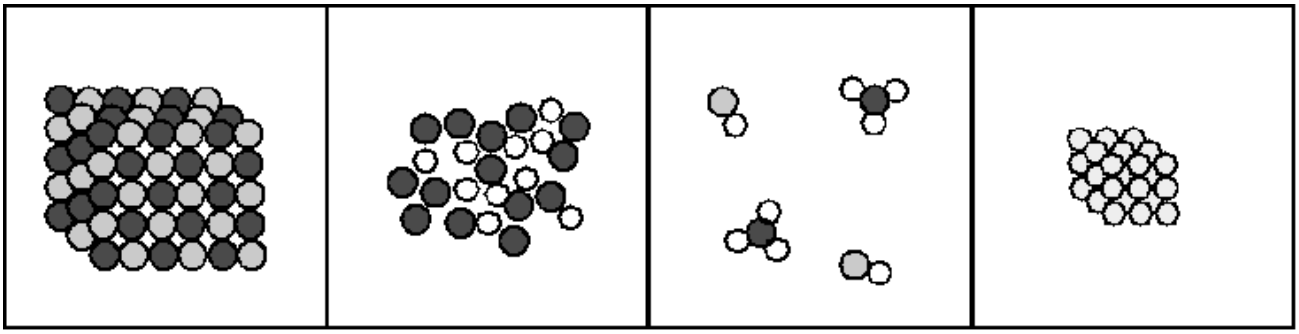
5. Consider the four containers below.



A B C D

a. Which of these are mixtures? _____ pure substances? _____
b. Which contain only compounds? _____ only elements _____

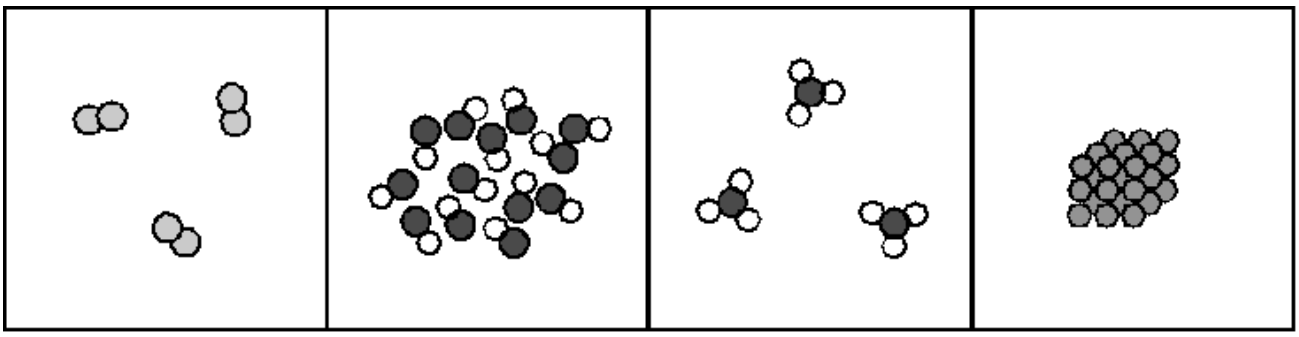
6. Consider the four containers below.



A B C D

a. Which of these are mixtures? _____ pure substances? _____
b. Which contain only compounds? _____ only elements _____

7. Consider the four containers below.



A B C D

a. Which of these are mixtures? _____ pure substances? _____
b. Which contain only compounds? _____ only elements _____

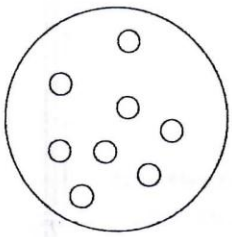
8. Which of the containers in #7 contain a gas? ____ a liquid ____ a solid _____

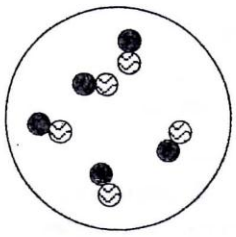
Names_____

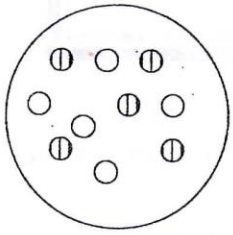
_____

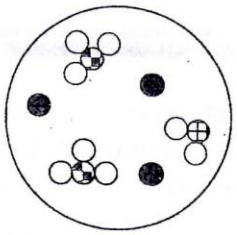
Element Compound Mixture Rally Table

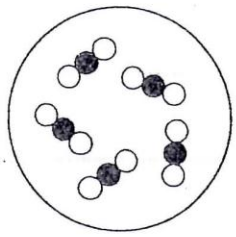
Each of the following is a microscopic view of a substance. Identify each as an element compound, or mixture.

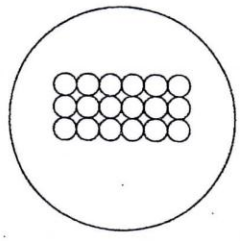


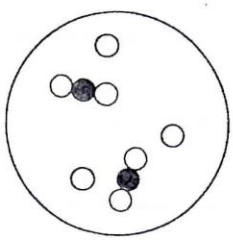


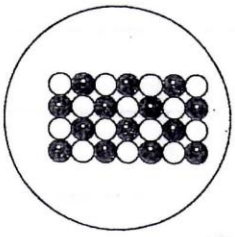


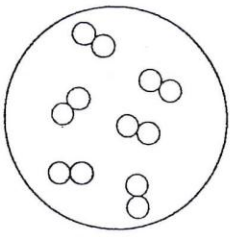


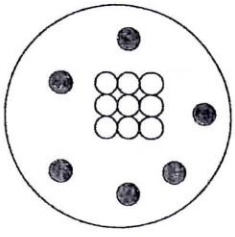








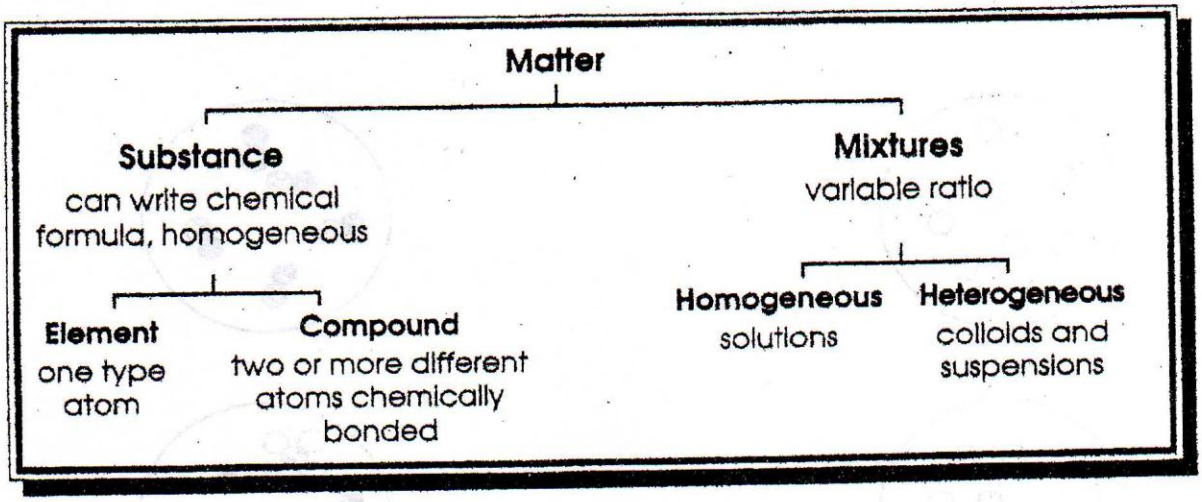




MATTER—SUBSTANCES VS. MIXTURES

Name _____

All matter can be classified as either a substance (element or compound) or a mixture (heterogeneous or homogeneous).



Classify each of the following as to whether it is a substance or a mixture. If it is a substance, write Element or Compound in the substance column. If it is a mixture, write Heterogeneous or Homogeneous in the mixture column.

Type of Matter	Substance	Mixture
1. chlorine		
2. water		
3. soil		
4. sugar water		
5. oxygen		
6. carbon dioxide		
7. rocky road ice cream		
8. alcohol		
9. pure air		
10. iron		

Pure Substances and Mixtures

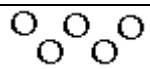
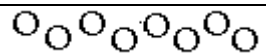
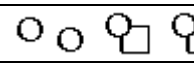
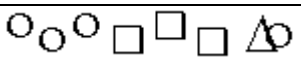
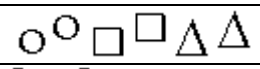
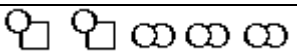
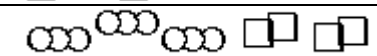
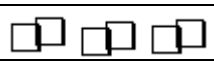
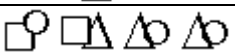
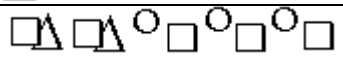
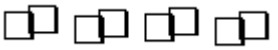
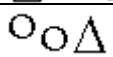
Elements and Compounds

Atoms and Molecules

A = 

B =

C = 

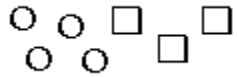
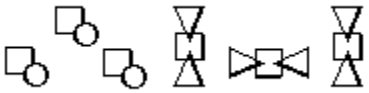
Item #	Drawing	Pure substance?	Mixture?	Total # of atoms	Total # of molecules	# of different types of compounds	# of different types of pure substances in mixture	Formula
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								

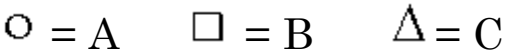
Name _____

Date _____ **Pd** ____

Elements, Compounds, Mixtures, Pure Substances, Atoms, and Molecules

Fill in the missing information:

DRAWINGS	FORMULAS	DESCRIPTION
		A mixture of two elements
	$AB + C$	
		One element and one compound
		
		Three molecules of an element
	$B_2 + BC$	
		One compound
		A mixture of compounds



Name _____

Date _____ Pd ____

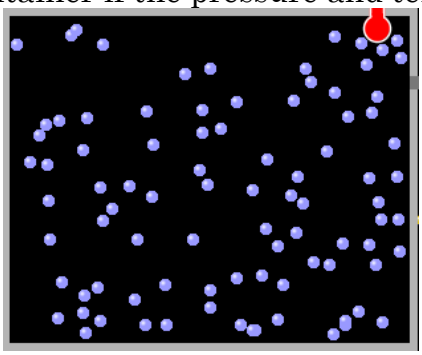
Chemistry – Unit 4 Worksheet 2

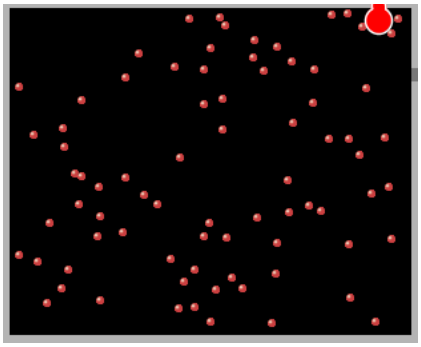
Avogadro's Hypothesis

In Unit 2, you learned that the pressure of a gas is proportional to the Kelvin temperature ($P \propto T$), when the volume and number of particles is held constant. Now consider equal volumes of two gases at the same temperature (in the figures below, the sphere in the upper corner of the box is a thermometer bulb).

Part 1

1. What is reasonable to conclude about the number of gas particles in each container if the pressure and temperature is the same in both containers?

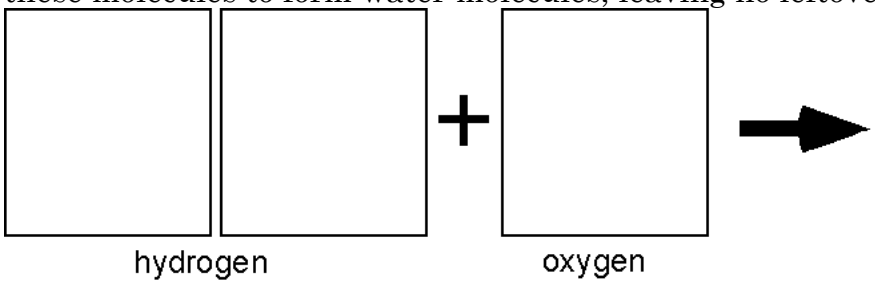




Avogadro reached this same conclusion building on the work of Gay-Lussac, who first noted that gases (at the same T and P) reacted in simple integer volume ratios. His hypothesis made it possible to deduce the formulas of compounds formed when these gases react.

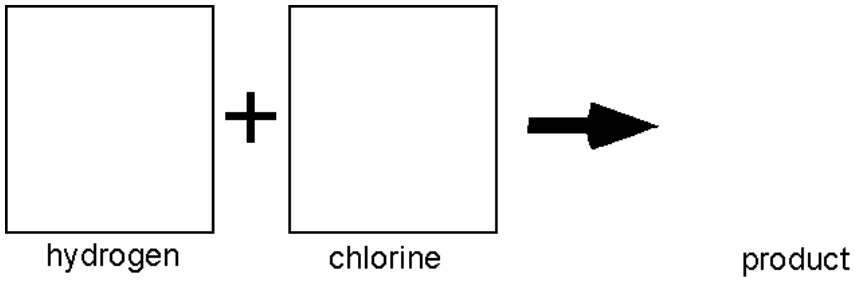
You have seen evidence that two volumes of hydrogen gas react with one volume of oxygen gas (at the same T and P) to produce water. The conclusion that two *molecules* of hydrogen combine with one *molecule* of oxygen to form water works only if we assume that each volume of gas contains the same number of particles.

2. Represent molecules of hydrogen and oxygen in the containers below. React these molecules to form water molecules, leaving no leftover gas.

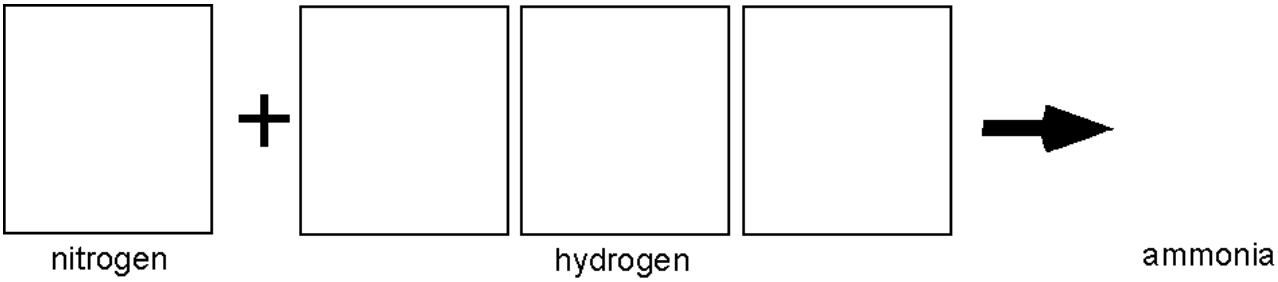


What do the H, O, and 2 in the chemical formula tell us about the composition of water?

3. In like manner, represent particle diagrams that account for the fact that one volume of hydrogen combines with one volume of chlorine to form hydrogen chloride. What do you suppose is the formula of hydrogen chloride?



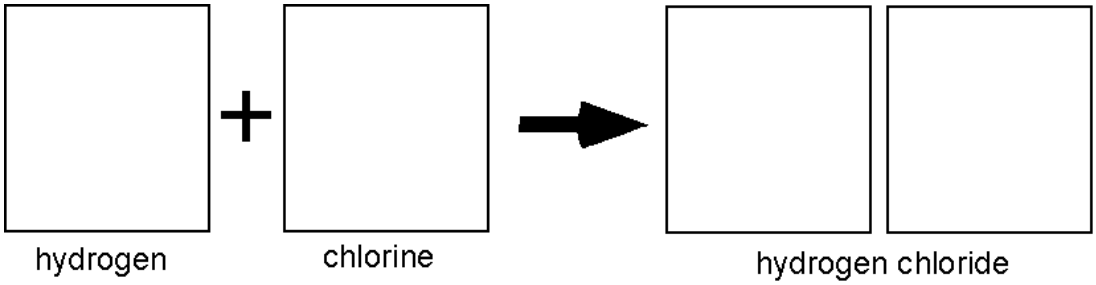
4. Represent the reaction in which one volume of nitrogen gas reacts with three volumes of hydrogen gas to form ammonia. What is the formula for ammonia?



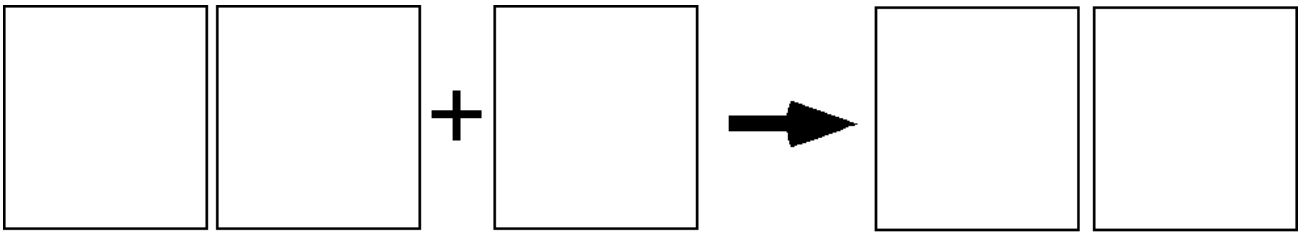
Part 2

Chemists occasionally found that one volume of gas A reacted with one volume of gas B to produce *two volumes* of gaseous product. Early chemists like Gay-Lussac, were unable to account for this behavior of gases. Avogadro's key contribution was that he reasoned that the molecules of some gaseous elements *must contain two atoms*.

5. Consider the reaction between hydrogen and chlorine. *Two* volumes of hydrogen chloride are formed. Sketch particle diagrams consistent with Avogadro's Hypothesis to represent this reaction. Explain why hydrogen and chlorine molecules that have only one atom each cannot account for the observed behavior.

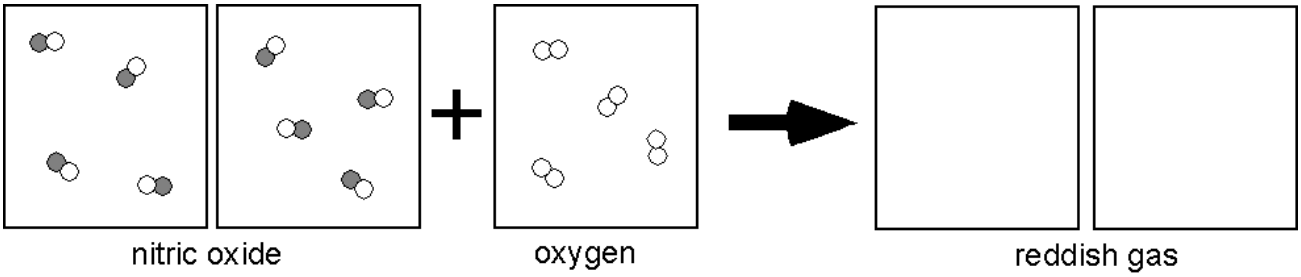


6. When two volumes of hydrogen gas react with one volume of oxygen gas, two volumes of gaseous water are formed. Modify the diagram you made for #2 to represent molecules of hydrogen, oxygen and water in this reaction.



Explain why molecules of oxygen must have an even number of atoms.

7. Two volumes of nitric oxide react with one volume of oxygen gas to form two volumes of a reddish-brown gas. Deduce the formula of this gas and sketch particle representations of its molecules.



Name _____

Date _____ **Pd** ____

Chemistry – Unit 4 Notes
Dalton's Playhouse

In the late 18th century, Joseph Priestly, Antoine Lavoisier and others performed some critical experiments that helped Dalton develop his theories on the atomic model of matter. The simulation at the website: **http://web.visionlearning.com/dalton_playhouse/ad_loader.html** will allow you to replicate some of the key experiments these scientists performed. Answer the questions on the website and keep track of your responses on this notes sheet.

Part 1 – Priestley

Calx	100g	200g	216.59g
Mass of product			
Volume of product			

1. What happened to the mass of the material in the flask as it was heated?

2. What did you note about the masses of the gas produced and the mercury metal left in the flask?

3. State the relationship between the volume of gas produced and the mass of the calx that was heated.

Part 2 – Lavoisier

You will need to record the initial and final values for oxygen and phlogiston in each of the trials order to complete the table below.

	Initial	Burn 1/3		Burn 2/3		Burn all	
		After	Used	After	Used	After	Used
Mass oxygen used							
Mass phlogiston used							
Mass of product							
Volume oxygen used							
Volume phlogiston used							
Volume of product							

1. With relation to the volumes of the gases, in what specific proportion did phlogiston react with oxygen?

2. How did the mass of the gas in all three vessels before burning compare to the total mass after burning?

Part 3 – Diamond and Charcoal

0.20g diamond	Mass of oxygen	Volume of oxygen	Mass of product	Volume of product
initial				
final				
0.40g diamond	Mass of oxygen	Volume of oxygen	Mass of product	Volume of product
initial				
final				
0.20g charcoal	Mass of oxygen	Volume of oxygen	Mass of product	Volume of product
initial				
final				
0.40g charcoal	Mass of oxygen	Volume of oxygen	Mass of product	Volume of product
initial				
final				

1. How did the mass of gas formed compare if you used the same amount of diamond and charcoal?

Concepts

1. Which of the core concepts below most logically follows from the experiments you conducted in Track 1- Priestley?
   a. Red calx turns into mercury when it is heated.
   b. Some substances are composed of discrete amounts of two or more other substances.
   c. All substances can be broken down into simpler materials by heating them.

2. Which of the core concepts below most logically follows from the experiments you conducted in Track 2- Lavoisier?
   a. The total mass of the products is greater than the mass of the reactants.
   b. The total mass of the products is less than the mass of the reactants.
   c. The total mass of the products is exactly equal to the mass of the reactants.

3. Which of the core concepts below most logically follows from the experiments you conducted in Track 3- Diamond?
   a. Elements combine in specific, defined ratios in chemical reactions.
   b. Carbon reacts differently depending whether it is in the diamond or charcoal form.
   c. Carbon can form carbon dioxide when neither air nor oxygen is present.

Name _____

Date _____ **Pd** ____

Chemistry – Unit 4 Worksheet 3

Use the following information about the masses of elements in each pair of compounds to help you suggest formulas that account for these ratios.

1. Compounds of carbon and oxygen

Compound A: 57.1 g O / 42.9 g C

Compound B: 72.7 g O and 27.3 C

a. Determine the value of the ratio $\frac{\text{mass O}}{\text{mass C}}$ in each compound. A ____ B _____

b. How does the mass ratio for compound B compare to that in compound A?

c. Express these ratios as improper fractions.

d. For each hypothesis, sketch particle diagrams for the compounds of A and B that account for these mass ratios. Write the formula for the compound in each diagram.

Hypothesis 1	**Hypothesis 2**
Atoms of C and O have the same mass	Atoms of O are heavier than C atoms by the ratio in compound A.
A	A
B	B

2. Compounds of copper and oxygen

Compound A: 79.9 g Cu / 20.1 g O

Compound B: 88.8 g Cu / 11.2 g O

a. Determine the value of the ratio $\frac{\text{mass Cu}}{\text{mass O}}$ in each compound. A ____ B _____

b. How does the mass ratio for compound B compare to that in compound A?

c. Express these ratios as improper fractions.

d. For each hypothesis, sketch particle diagrams for the compounds of A and B that account for these mass ratios. Write the formula for the compound in each diagram.

Hypothesis 1	Hypothesis 2
Atoms of Cu and O have the same mass	Cu atoms are heavier than O atoms by the ratio in compound A.
A	A
B	B

Which hypothesis seems more reasonable to you? Justify your answer.

Use the hypothesis you have chosen to suggest formulas for the following pairs of compounds.

3. Compounds of copper and chlorine

Compound A: 35.9 g of Cl / 64.1 g of Cu

Compound B: 52.8 g of Cl / 47.2 g Cu

a. Determine the value of the ratio $\frac{\text{mass Cl}}{\text{mass Cu}}$ in each compound. A ____ B ____

b. How does the mass ratio for compound B compare to that in compound A?

c. What are the simplest formulas for compounds A and B? Explain your reasoning.

4. Compounds of iron and chlorine (be careful!)

Compound A: 56.0 g of Cl / 44.0 g of Fe

Compound B: 65.6 g of Cl / 34.4 g of Fe

a. Determine the value of the ratio $\frac{\text{mass Cl}}{\text{mass Fe}}$ in each compound. A ____ B ____

b. The ratios you determined in step (a) give the mass of Cl that combines with 1 g of Fe in each compound. To determine how the mass of Cl in compound B compares to the mass of Cl in compound A for the same amount of Fe, divide these ratios and express the answer as an improper fraction. What does this fraction tell you about the *number* of Cl atoms in each of the two compounds?

c. What would be the formulas of the two compounds, assuming that each compound contains one atom of Fe?

Name _____

Date _____ **Pd** ____

Chemistry – Unit 4 Worksheet 4

Answer the following questions. Be sure to show all mathematical work and reasoning and use complete sentences in explanations.

1. Table sugar is a compound known as sucrose. Sucrose is composed of the elements carbon, hydrogen, and oxygen. Analysis of a 20.0 g of sucrose from a bag of sugar finds that the sugar is composed of 8.44 g of carbon, 1.30 g of hydrogen, and 10.26 g of oxygen.
    a. Express, as fractions, the ratio of the mass of each element to the total mass of the sample.

    b. Using these ratios, calculate the percent composition by mass of each element in the compound.

2. A similar chemical analysis is performed on a 500.0 g sample of the sugar isolated from a sample of pure sugar cane. Analysis shows this sample contains 211.0 g of carbon, 32.5 g of hydrogen, and 256.5 g of oxygen.
    a. Determine the percent composition by mass of each element in the sugar cane sample.

    b. Could the sugar in this sample be sucrose? Justify your conclusion.

3. A similar chemical analysis is performed on a 200.0g sample of the sugar found in corn syrup. This sample contains 80.0g of carbon, 13.3 g of hydrogen and 106.7 g of oxygen.
    a. Determine the percent composition by mass of each element in the sugar cane sample.

    b. Could the sugar in corn syrup be sucrose? Justify your conclusion.

4. A 1.0 g sample of hydrogen reacts completely with 19.0 g of fluorine to form a compound of hydrogen and fluorine.
    a. What is the percent by mass of each element in the compound?

    b. What mass of hydrogen would be present in a 50 g sample of this compound?

    c. Justify your answer to b.

5. Explain how the previous examples help to illustrate the Law of Definite Proportions.

6. Two compounds of hydrogen and oxygen are tested. Compound I contains 15.0 g of hydrogen and 120.0 g of oxygen. Compound II contains 2.0 g of hydrogen and 32.0 g of oxygen.
    a. Determine the ratio of the mass of oxygen to the mass of hydrogen in each of the compounds.

    b. Why are the compounds not the same?

    c. What is significant about these mass ratios?

    d. If compound II is water, what could be the formula of compound I?

7. Nitrogen and oxygen combine to form a variety of compounds. The following data were collected for three different compounds of nitrogen and oxygen:

Analysis Data of Nitrogen & Oxygen Compounds	
Compound	Mass of Nitrogen that combines with 1.00 g of Oxygen
A	1.750 g
B	0.8750 g
C	0.4375 g

a. Additional evidence shows that the formula of compound B is NO. Sketch particle diagrams of molecules of all three compounds.

b. Justify your representations above mathematically.

8. Explain how the examples in questions 6 and 7 help to illustrate the Law of Multiple Proportions.

Name _____

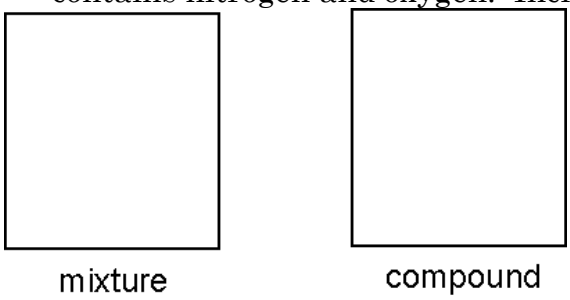
Date _____ **Pd** ____

Chemistry – Unit 4 Review

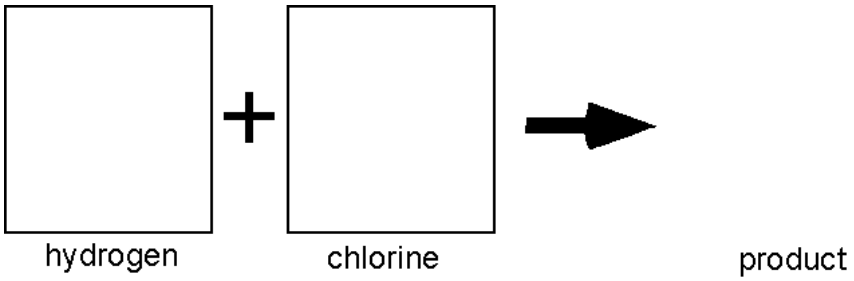
1. Give an example of mixture that needs to be separated by a filter.

2. Give an example of a mixture that needs to be separated by distillation.

3. Draw a picture of a mixture of nitrogen and oxygen and a compound that contains nitrogen and oxygen. Include a key.



4. Draw the following and make **two volumes** of product.



5. Explain the problem above using Avogadro's Hypothesis.

6. What are the 7 diatomic molecules?

7. What do you think monatomic means?

8. Who was Democritus and why do we study him in chemistry?

9. Who was John Dalton?

10. Summarize the postulates in Dalton's Atomic Theory of Matter.

11. What does the Law of Definite Proportions state?

12. What does the Law of Multiple Proportions state?

13. What is the formula for percent composition by mass?

14. For the following compounds determine each element's percent composition by mass:

    a. A compound that contains 12.0 g of Carbon and 16.0 g of O.

    b. A compound that contains 24.0 g of Carbon and 64.0 g of O.

    c. Are these the same compound, why or why not?

    d. What would be the mass of Carbon if you had 176.0g of compound **b**?

15. Hydrogen and oxygen form several compounds. Two of these have the following mass composition.

Compound A: 4.0 g of H and 32.0 g of O

Compound B: 2.0 g of H and 32.0 g of O

a. Determine the value of the ratio $\frac{\text{mass H}}{\text{mass O}}$ in each compound.

A ____ B _____

b. How does the mass ratio for compound A compare to that in compound B?

c. Sketch particle diagrams for the compounds of A and B that account for these mass ratios. Write the formula for the compound below each diagram. Compound A is water.