Name_____ **Period**_____ **Date:**_____

I. Abstract

One of the hardest concepts for chemistry students to grasp is the mole, and the calculations that result from it. An understanding of the mole is extremely important for success in chemistry because not only is it the SI unit for quantity, but it also is the basis for most stochiometric calculations. When a chemical equation is balanced, the numerical coefficients in front of each reactant or product represent the number of moles. The determination of limiting reagents, percent yields, dilution percentages, and even molecular formulas themselves are all based on the mole concept. Chemistry students need to have a good understanding of just what a mole is and also how to perform calculations based on the mole quantity.

The study of the mole relates to many mathematical functions. Throughout a unit on the mole, students would use dimensional analysis, which is the converting of one unit to another unit through the use of conversion factors. Students learn to relate the mole to gram formula mass, number of particles, and liters of a gas.

Many students find the mole concept difficult to grasp. One reason for this is because the mole is such an extremely large number. After all, students cannot physically see 602,000,000,000,000,000,000,000 particles, at least not individually! Another reason for student confusion is that the concept of the mole is completely foreign to them. Many struggle with just exactly what a mole represents and why it is so important in chemistry.

To facilitate student understanding, we have devised some activities which will help students understand the persnickety concept of the mole.

II. Measurement Activity

There are many kinds of measurements in the world. One that we are familiar with is the dozen.

We all know that a dozen = 12

This can be a dozen of anything. A dozen eggs, a dozen donuts.

How many eggs are in 12 dozen eggs? You know how to do this, it is easy.

$$12 \text{ dozen} \times \frac{12 \text{ eggs}}{1 \text{ dozen}} = \_\_\_\_\_ \text{ eggs}$$

How many donuts are there in 6 dozen?

$$6 \text{ dozen} \times \frac{12 \text{ donuts}}{1 \text{ dozen}} = \_\_\_\_\_ \text{ donuts}$$

Another measurement is called a ream. 1 ream = 500 sheets of paper

How many sheets of paper are in 5 reams?

5 reams X $\frac{500 \text{ sheets}}{1 \text{ ream}}$ = _____ sheets

How many sheets of paper are in 6 ½ reams?

How many reams is 3,250 sheets of paper?

Another measurement is a peck. 1 peck = 16 dry pints,

How many pints are in 5 pecks?

How many pecks are in 35 dry pints?

And yet another measurement is the acre. 1 acre = 43,560 sq ft

How many sq. feet are in 3 acres?

How many acres are in 165,900 sq. ft?

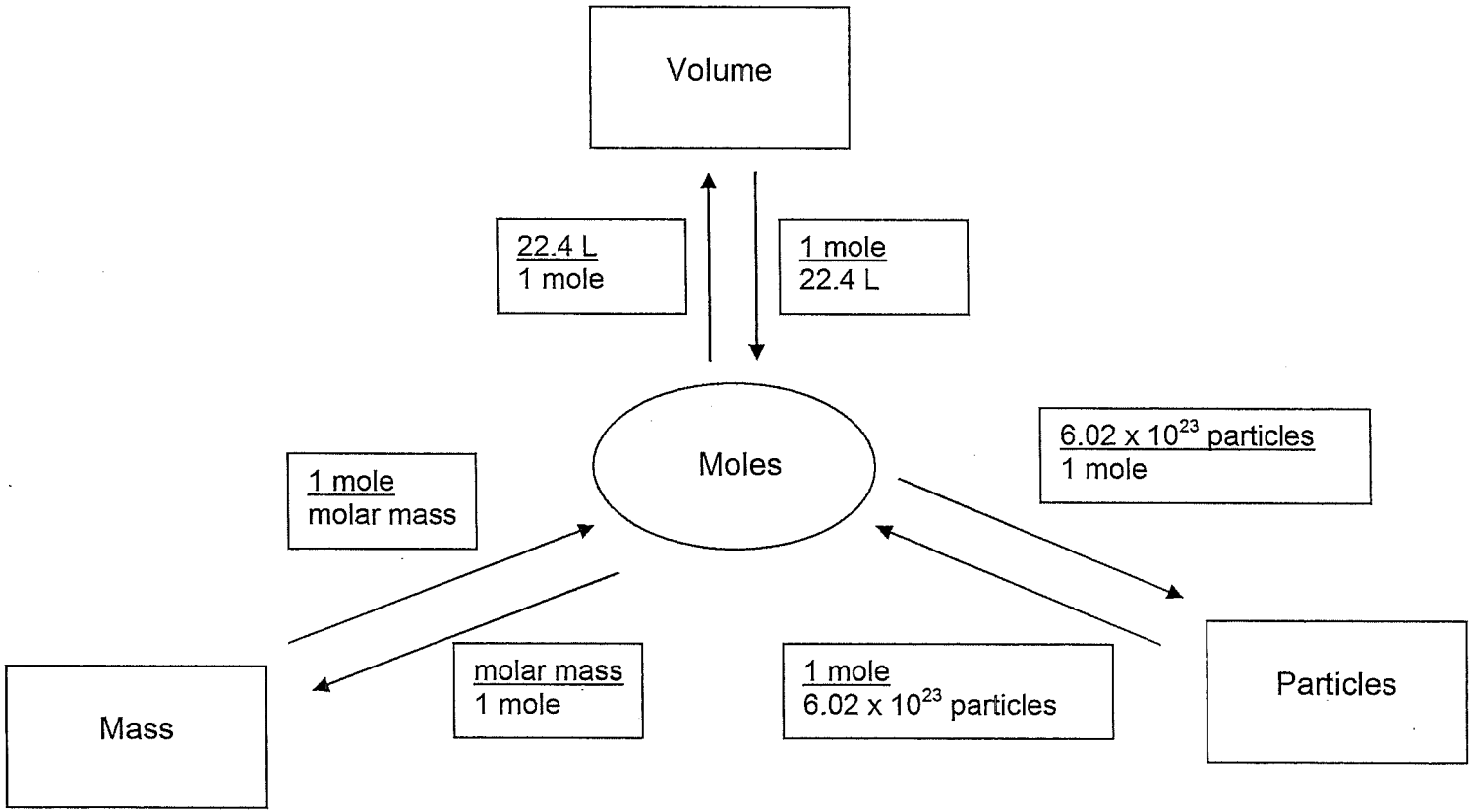
There is another measurement that has to do with Chemistry. It is called the mole.
1 mole = 6.02×10^{23} particles (these can be ions, molecules, formula units, etc)

Let's do some calculating with the mole.

How many particles are in 3 moles? This is easy, just like before.

3 moles X $\frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mole}}$ = _____ particles

How many particles are in 7.5 moles?


Volume
22.4 L
1 mole
1 mole
22.4 L
Moles
1 mole
molar mass
6.02 x 10^23 particles
1 mole
Mass
molar mass
1 mole
1 mole
6.02 x 10^23 particles
Particles

THE MOLE AND AVOGADRO'S NUMBER

Name _____

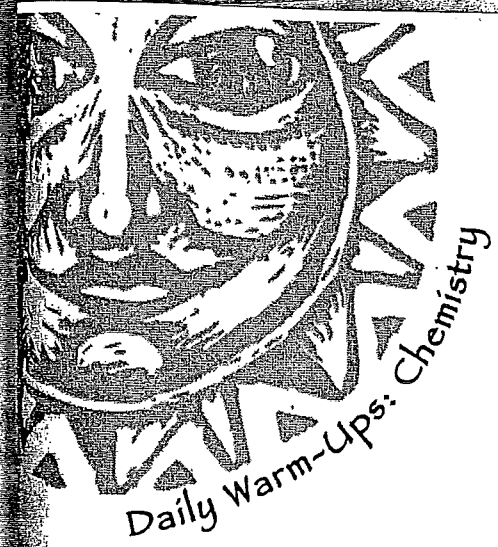
One mole of a substance contains Avogadro's Number (6.02×10^{23}) of molecules.

How many molecules are in the quantities below?

1. 2.0 moles
2. 1.5 moles
3. 0.75 mole
4. 15 moles
5. 0.35 mole

How many moles are in the number of molecules below?

1. 6.02×10^{23}
2. 1.204×10^{24}
3. 1.5×10^{20}
4. 3.4×10^{26}
5. 7.5×10^{19}



The Mighty Mole

In chemistry the *mole* is a way of keeping track of a large group of particles and also a way of determining the amount of matter in a substance. The mole can be thought of in much the same way as the dozen. A dozen eggs is 12 eggs, a dozen cars is 12 cars, and a dozen of any kind of object is 12 of that object. A mole is a number equal to 6.02×10^{23} particles. So a mole of pickles would have 6.02×10^{23} pickles in it. To give you some idea of how big a mole is, one scientist estimated that a mole of peas would cover the entire surface of the earth, oceans and all, to a depth of 6 inches. As you can see, the mole is not a unit we would use in counting everyday objects; however, it is well suited for counting atoms and molecules because there may be trillions and trillions of them in a very small sample.

Answer the following.

a. How many moles of atoms are in 4.04×10^{24} atoms?

b. How many atoms are in 3.20 moles of atoms?

c. How many moles of carbon atoms are in 1.75×10^{25} carbon atoms?

Grams/Moles Calculations

Given the following, find the number of moles:

1) 30 grams of H_3PO_4

2) 25 grams of HF

3) 110 grams of $NaHCO_3$

4) 1.1 grams of $FeCl_3$

5) 987 grams of $Ra(OH)_2$

6) 564 grams of copper

7) 12.3 grams of CO_2

8) 89 grams of $Pb(CH_3COO)_4$

Given the following, find the number of grams:

9) 4 moles of $Cu(CN)_2$

10) 5.6 moles of C_6H_6

11) 21.3 moles of $BaCO_3$

12) 1.2 moles of $(NH_4)_3PO_3$

13) 9.3×10^{-3} moles of SmO

14) 6.6 moles of ZnO

15) 5.4 moles of K_2SO_4

16) 88.4 moles of NI_3

12

MOLES AND MASS

Name _____

Determine the number of moles in each of the quantities below.

1. 25 g of NaCl _____
2. 125 g of H_2SO_4 _____
3. 100. g of $KMnO_4$ _____
4. 74 g of KCl _____
5. 35 g of $CuSO_4 \bullet 5H_2O$ _____

Determine the number of grams in each of the quantities below.

1. 2.5 moles of NaCl _____
2. 0.50 moles of H_2SO_4 _____
3. 1.70 moles of $KMnO_4$ _____
4. 0.25 moles of KCl _____
5. 3.2 moles of $CuSO_4 \bullet 5H_2O$ _____

THE MOLE AND VOLUME

Name _____

For gases at STP (273 K and 1 atm pressure), one mole occupies a volume of 22.4 L. What volume will the following quantities of gases occupy at STP?

1. 1.00 mole of H_2
2. 3.20 moles of O_2
3. 0.750 mole of N_2
4. 1.75 moles of CO_2
5. 0.50 mole of NH_3
6. 5.0 g of H_2
7. 100. g of O_2
8. 28.0 g of N_2
9. 60. g of CO_2
10. 10. g of NH_3

PERCENTAGE COMPOSITION

Name _____

Determine the percentage composition of each of the compounds below.

1. $KMnO_4$

   K = _____

   Mn = _____

   O = _____

---

2. HCl

   H = _____

   Cl = _____

---

3. $Mg(NO_3)_2$

   Mg = _____

   N = _____

   O = _____

---

4. $(NH_4)_3PO_4$

   N = _____

   H = _____

   P = _____

   O = _____

---

5. $Al_2(SO_4)_3$

   Al = _____

   S = _____

   O = _____

Solve the following problems.

6. How many grams of oxygen can be produced from the decomposition of 100. g of $KClO_3$? _____

7. How much iron can be recovered from 25.0 g of Fe_2O_3? _____

8. How much silver can be produced from 125 g of Ag_2S? _____

Moles, Molecules, and Grams Worksheet

1) How many molecules are there in 24 grams of FeF_3?

2) How many molecules are there in 450 grams of Na_2SO_4?

3) How many grams are there in 2.3×10^{24} atoms of silver?

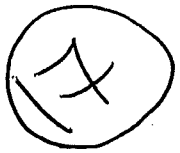
4) How many grams are there in 7.4×10^{23} molecules of $AgNO_3$?

5) How many grams are there in 7.5×10^{23} molecules of H_2SO_4?

6) How many molecules are there in 122 grams of $Cu(NO_3)_2$?

7) How many grams are there in 9.4×10^{25} molecules of H_2?

8) How many molecules are there in 230 grams of $CoCl_2$?



9) How many molecules are there in 2.3 grams of NH_4SO_2?

10) How many grams are there in 3.3×10^{23} molecules of N_2I_6?

11) How many molecules are there in 200 grams of CCl_4?

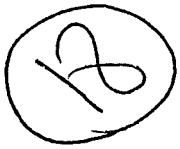
12) How many grams are there in 1×10^{24} molecules of BCl_3?

13) How many grams are there in 4.5×10^{22} molecules of $Ba(NO_2)_2$?

14) How many molecules are there in 9.34 grams of LiCl?

15) How many grams do 4.3×10^{21} molecules of UF_6 weigh?

16) How many molecules are there in 230 grams of NH_4OH?



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?

_____

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

_____