CONVERTING WITH MOLES
NAME:_____ __PERIOD:____ DATE:_____

A. THE MOLE

The term mole is used to describe a certain amount of matter. That amount is 6.022×10^{23} of the smallest particles that make up that form of matter. This number is called Avogadro's Number (N_A). Thus, one mole of an element contains 6.022×10^{23} atoms; one mole of a molecular compound contains 6.022×10^{23} molecules; and one mole of an ionic compound contains 6.022×10^{23} formula units. Chemistry students must be able to convert from atoms, ions, molecules, and formula units to moles, and vice versa. The following exercises will help you develop those skills.

MOLES ←→AVOGADRO'S NUMBER ←→ PARTICLES (atoms, molecules, formula units, ions)

1. How many molecules are there is 6.8 mol of carbon monoxide (CO) gas?

2. How many sodium ions are there in 0.482 mol of sodium sulfate (Na_2SO_4)?

3. How many moles are there in 6.32×10^{24} molecules of chloroform, $CHCl_3$?

4. A sample of silver metal contains 1.91×10^{21} atoms. How many moles of silver is this?

5. How many moles are there in 3.04×10^{23} molecules of hydrogen, H_2, gas?

6. How many phosphorus atoms are there in 1.75 mol of calcium phosphate, $Ca_3(PO_4)_2$?

B. **MOLAR MASS**

Atomic, molecular, and formula masses are all relative numbers. That is, they contain no units. If one said that the atomic mass of magnesium is 24 this means that its atoms are twice as heavy as those of some other element such as carbon with an atomic mass of 12. It is possible, however, to assign units to atomic, molecular, and formula masses. When the unit "grams" is used with an atomic mass, we define it as the gram atomic mass of an element. The gram atomic mass is the mass of one **mole** of an element. Similarly, the gram molecular mass is the mass of one mole of a molecular compound, and the gram formula mass is the mass of one mole of an ionic compound. The term **molar mass** is a general term that refers to the gram atomic, molecular, or formula mass of any substance. The exercises below will help you improve your ability to use these concepts.

MOLAR MASS = The sum of each element's mass as determined from the Periodic Table times its subscript in a formula.

1. What is the gram molecular mass of phosphoric acid, H_3PO_4?

2. What is the gram molecular mass of aluminum hydroxide, $Al(OH)_3$?

3. Find the molar mass of iron (III) sulfate, $Fe_2(SO_4)_3$.

4. What is the molar mass of sucrose, $C_{12}H_{22}O_{11}$?

5. Find the gram molecular mass of *p*-dichlorobenzene, $C_6H_4Cl_2$.

6. What is the molar mass of calcium bisulfate, $Ca(HSO_4)_2$?

C. CONVERTING WITH MOLES

Chemists often need to know about the quantitative relationships among the elements and compounds involved in a chemical reaction. These relationships may involve masses and/or volumes. The concept of moles is the key idea that makes it possible for chemists to deal easily and efficiently with all mass and volume relationships in chemical reactions. The following exercises illustrates methods of converting among moles, mass and volume.

MASS ⟷ **MOLAR MASS** ⟷ **MOLES**
(grams) Calculated from the Periodic Table

1. What is the mass in grams of 4.52 mol of barium chloride, $BaCl_2$?

2. In a chemical reaction, 0.397 mol of ethyl chloride (C_2H_5Cl) is produced. What is the mass in grams of this amount of ethyl chloride?

3. A chemist plans to use 435 g of ammonium nitrate in a reaction. How many moles of NH_4NO_3 is this?

4. A small bottle in the chemistry stockroom contains 43.25 g of nickel(II) carbonate. How many moles of $NiCO_3$ is this?

5. A nurse has been asked to get 0.0465 mole of quinine ($C_{20}H_{24}N_2O_2$). What mass of quinine should the nurse obtain?

6. During an electroplating process, 5.8625 g of silver is deposited on a steel bar. How many moles of Ag is this?

D. INTERMOLAR RELATIONSHIPS

When refering to a mole of any compound we can determine how many moles of each element that compound is composed of by looking at the subscripts of each. Example: in one mole of the compound H_2O, there are <u>two</u> moles of hydrogen and <u>one</u> mole of oxygen. This is called intermolar relationships.

Determine how many moles of each type of element are contained in each of the following compounds:

1. One mole of C_2H_5Cl contains: _____mol C _____mol H _____mol Cl

2. One mole of $Ca_3(PO_4)_2$ contains: _____ mol Ca _____mol P _____mol O

3. **Two** mol of $Fe_2(SO_4)_3$ (also written as $2Fe_2(SO_4)_3$) contains: ____mol Fe ____mol S ___mol O