The Mole

The student will be able to:

1. List the 4 molar equalities.
2. Complete molar conversions
3. Determine molar mass
4. Determine % composition
5. Determine empirical formulas
6. Determine molecular formulas

Molar Equalities:

1 Mole = 6.022×10^{23} atoms -or- molecules = molar mass = 22.4L of a gas

molar mass is equal to the atomic mass of an element expressed as grams per mole (g/mol) and comes from the periodic table.

For example:

1 mole of sodium = 23.00 g/mol

1 mole of water (H_2O) = 18.02 g/mol

Practice: Determine the molar mass of the following molecules/compounds.

① $KClO_3$ ② Al_2S_3 ③ $MgBr_2$

Molar Conversions:

Because the 4 molar equalities can be set equal to each other they can also be used as conversion factors.

Example: ? atoms in 2.2 mol of Ca $2.2\,\text{mol Ca} \times \frac{6.022 \times 10^{23}\ \text{atoms}}{1\,\text{mol Ca}}$

Steps:

EX. ?atoms are in 2.2 mol of Ca?

(1) to start the problem choose the 2 equalities involved by looking at the labels in the problem.

$1\ mole = 6.022 \times 10^{23}\ atoms$ ← 2 equalities

The equalities can be written as a ratio $\frac{1\ mol}{6.022 \times 10^{23}\ atoms}$ or $\frac{6.022 \times 10^{23}\ atoms}{1\ mol}$

(2) the ratio you pick depends on what label is being changed and what label you need

? atoms are in 2.2 mol of Ca?

↑ label needed — ↑ label being changed

(3) Set up the conversion problem.

$$\text{amt given w/ label} \times \frac{\text{conversion unit needed}}{\text{conversion unit changing}} =$$

for the example →

$$2.2\ mol\ Ca \times \frac{6.022 \times 10^{23}\ atoms}{1\ mol\ Ca} = \boxed{1.3 \times 10^{24}\ atoms\ Ca}$$

*Remember to finish with Sig. Figs!

Practice:

(1) How many grams are in 3.4×10^{25} atoms of Sulfur?

(2) How many moles are in 4.5 L of oxygen gas?

(3) How many liters of helium gas would be 1.4×10^{20} atoms?

(4) What mass would 3.8 moles of Sodium Chloride contain?

Percent Composition

Calculating % composition determines the % of each element present in a compound based on mass.

Steps: (1) Calculate the total mass of the compound. (molecular mass)
(2) take the total mass of one of the elements & divide by the molecular mass $\times 100$
(3) Repeat for all other elements

Example:

$Al(NO_3)_3$

Al = 26.98 g/mol
3 x N = 42.03 g/mol
9 x O = 144.00 g/mol
molecular mass = 213.01 g/mol

% Al = (26.98 g/mol / 213.01 g/mol) x 100 = 12.67% Al
% N = (42.03 g/mol / 213.01 g/mol) x 100 = 19.73% N
% O = (144.00 g/mol / 213.01 g/mol) x 100 = 67.60% O

% Composition
Practice
BaO

$Zn(ClO_2)_2$

Mn_2O_3

Determining Empirical Formulas

The empirical formula is the simplest ratio of a group of elements in a compound.

Steps:

1. Divide each % by the elements molar mass (creates ratio)
2. Divide each ratio # by the smallest of the # - this should create a whole # ratio that is the subscripts for the formula.
3. (if needed) if step 2 yields a decimal: use the chart on the next page

Decimal	What to do
0.8 or higher	round # up to next whole #
0.75	multiply all ratios by 4
0.6	" " 3
0.5	" " 2
0.3	" " 3
0.25	" " 4
0.2 or less	round off to whole #

Example Ratio : Step 2 = 3 1.3 2

you can't have 0.3 of an atom, multiply all # by 3

3(3) 1.3(3) 2(3)

9 4 6

your subscripts :)

Example:

$\frac{88.8\%\ Cu}{63.55}$ $\frac{11.2\%\ O}{16.00}$ } Step #1

$\frac{1.4}{0.7}$ $\frac{0.7}{0.7}$ } Step #2

2 1 → Cu_2O

subscripts