

The Mole

①

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:

$$\boxed{1 \text{ Mole}} = \boxed{6.022 \times 10^{23} \text{ atoms or molecules}} = \boxed{\text{molar mass}} = \boxed{22.4 \text{ L of gas}}$$

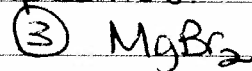
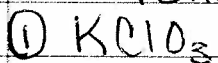
molar mass is equal to the atomic mass of an element expressed as grams per mole (g/mol) and comes from the periodic table.

For example:

$$1 \text{ mole of sodium} = 23.00 \text{ g/mol}$$

$$1 \text{ mole of water (H}_2\text{O)} = 18.02 \text{ g/mol}$$

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



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:

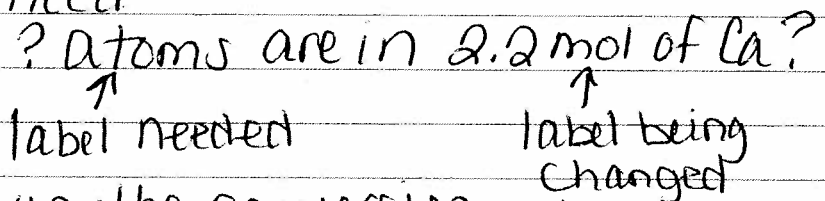
EX. ? atoms are in 2.2 mol of Ca?

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

1 mole = 6.022 x 10²³ atoms ← 2 equalities

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

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



③ Set up the conversion problem.

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

for the example → 2.2 mol Ca x $\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol Ca}} = 1.3 \times 10^{23} \text{ atoms Ca}$

* Remember to finish with sig. figs!

Practice:

① How many grams are in 3.4 x 10²⁵ 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?

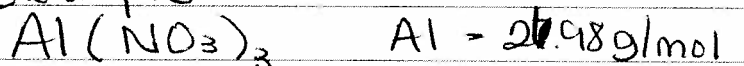
④ What mass would 3.8 moles of Sodium chloride contain?

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:



$$3 \times \text{N} = 42.03 \text{ g/mol}$$

$$9 \times \text{O} = 144.00 \text{ g/mol}$$

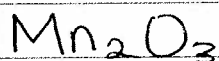
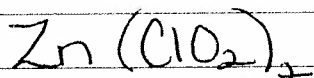
$$\text{molecular mass} = 213.01 \text{ g/mol}$$

$$\% \text{Al} = (26.98 \text{ g/mol} / 213.01 \text{ g/mol}) \times 100 = 12.67\% \text{ Al}$$

$$\% \text{N} = (42.03 \text{ g/mol} / 213.01 \text{ g/mol}) \times 100 = 19.73\% \text{ N}$$

$$\% \text{O} = (144.00 \text{ g/mol} / 213.01 \text{ g/mol}) \times 100 = 67.60\% \text{ O}$$

% Composition
Practice
BaO



Determining Empirical Formulas

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

Steps:

- ① Divide each % by the element's molar mass (ratio) ^(creates)
- 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 <u>all ratios</u> 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

$$\begin{matrix} & \downarrow & \downarrow \\ 3 & 1.3 & 2 \\ 3(3) & 1.3(3) & 2(3) \\ \hline 9 & 4 & 6 \end{matrix}$$
 your subscripts ☺

Example:

$$\frac{88.8\% \text{ Cu}}{63.55} \quad \frac{11.2\% \text{ O}}{16.00} \quad \left. \vphantom{\frac{88.8\% \text{ Cu}}{63.55}} \right\} \text{ Step \#1}$$

$$\frac{1.4}{0.7} \quad \frac{0.7}{0.7} \quad \left. \vphantom{\frac{1.4}{0.7}} \right\} \text{ Step \#2}$$

