8 • Mathematics of Chemical Formulas
Stoichiometry Terms
(1 of 8)

stoichiometry	study of the quantitative relationships in chemical formulas and equations.
atomic mass	weighted average mass of an atom, found on the periodic table
formula mass	sum of the atomic masses of the atoms in a formula
molecular mass	sum of the atomic masses of the atoms in a molecular formula
gram atomic mass	atomic mass written in grams
gram formula mass	formula mass written in grams
gram molecular mass	molecular mass written in grams

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Calculating Formula Mass
(2 of 8)

Formula or molecular mass is found by simply summing the atomic masses (on the periodic table) of each atom in a formula.

H_2SO_4
1.01 + 1.01 + 32.06 + 16.0 + 16.0 + 16.0 + 16.0 = 98.08 u
2(1.01) + 32.06 + 4(16.0) = **98.06 u** or **98.06 g/mole**

Generally, round off your answers to the **hundredths** or **tenths** place. Don't round off too much (98.06 g/mol or 98.1 g/mol is OK, but don't round off to 98 g/mol)

Units
Use **u** or **amu** if you are referring to **one atom or molecule**

8 • Mathematics of Chemical Formulas
Mole Facts
(3 of 8)

A **mole** (abbreviated **mol**) is a certain number of things. It is sometimes called the **chemist's dozen**.
A dozen is 12 things, a mole is 6.02×10^{23} things.

Avogadro's Number
1 mole of any substance contains 6.02×10^{23} molecules

Molar Volume (measured at P = 760 mmHg and T = 0 °C)
1 mole of any gas has a volume of 22.4 Liters

Molar Mass (see gram formula mass)
1 mole of any substance is its gram formula mass

$$\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ molecules}} \qquad \frac{1 \text{ mole}}{22.4 \text{ L}} \qquad \frac{1 \text{ mole}}{\text{molar mass}}$$

8 • Mathematics of Chemical Formulas
Line Equations
(4 of 8)

A **Line Equation** is the preferred way to show conversions between **quantities** (amount, mass, volume, and number) by canceling **units** (moles, grams, liters, and molecules)

The line equation consists of the **Given Value**, the **Desired Unit,** and the **line equation** itself.

Example: What is the mass of 135 Liters of CH_4 (at STP)?
Given: 135 L CH_4
Desired: ? g CH_4

$$135 \text{ L } CH_4 \times \frac{1 \text{ mol } CH_4}{22.4 \text{ L } CH_4} \times \frac{16.0 \text{ g } CH_4}{1 \text{ mol } CH_4} = 96.43 \text{ g } CH_4$$

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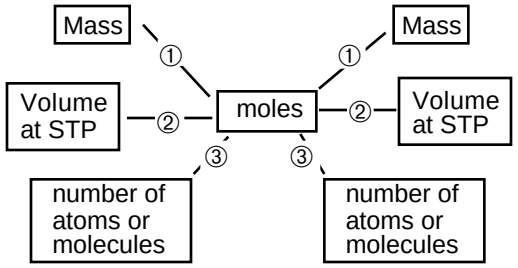
Mole Relationships
(5 of 8)

The "**Mole Map**" shows the structure of mole problems



1) $\frac{1 \text{ mol}}{\text{molar mass}}$ 2) $\frac{1 \text{ mol}}{22.4 \text{ L}}$ 3) $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}}$

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Percentage Composition (by mass)
(6 of 8)

Percentage Composition quantifies what portion (by mass) of a substance is made up of each element.

Set up a **fraction**: $\frac{\text{mass of element}}{\text{mass of molecule}}$

Change to **percentage**: $100 \times \frac{\text{mass of element}}{\text{mass of molecule}}$

Generally, round off your answers to the tenth's place.

The percentage compositions of each element should add up to 100% (or very close, like 99.9% or 100.1%)

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Formula from % Composition
(7 of 8)

Given the **Percentage Composition** of a formula, you can calculate the **empirical formula** of the substance.

Step 1	assume you have **100 g** of substance so the **percentages** become **grams**
Step 2	change **grams** of each element to **moles** of **atoms** of that element
Step 3	set up a formula with the moles example: $C_{2.4}\ H_{4.8}$
Step 4	simplify the formula by dividing moles by the smallest value $C_{\frac{2.4}{2.4}}\ H_{\frac{4.8}{2.4}} = CH_2$
Step 5	If ratio becomes… 1:1.33 or 1:1.66 multiply by 3

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Other Mole Problems and Conversions
(8 of 8)

The **gas density** is often converted to **molar mass**:

Example:
The gas density of a gas is 3.165 g/Liter (at STP). What is the molar mass of the gas?

Knowing that 22.4 L is 1 mole, you can set up the ratio:

$$\frac{3.165 \text{ g}}{1 \text{ Liter}} = \frac{\text{molar mass}}{22.4 \text{ L}}$$

Other **metric conversions** you should know:

$$\frac{1000 \text{ mL}}{1 \text{ Liter}} \qquad \frac{1 \text{ kg}}{1000 \text{ grams}}$$