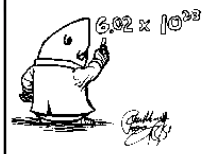
The Mole



6.02×10^{23}

STOICHIOMETRY

The study of the quantitative aspects of chemical reactions.

The Mole

- A counting unit
- Similar to a dozen, except instead of 12, it's 602 billion trillion 602,000,000,000,000,000,000,000
- 6.02×10^{23} (in scientific notation). This number is referred to as Avogadro's constant.
- This number is named in honor of Amedeo Avogadro (1776 – 1856).

But Where Did it Come From?

- It was NOT just picked! It was MEASURED.
- The constant was not measured by Avogadro but by latter scientists.
- Most measurements for Avogadro's constant were obtained through experimentation that involved the Faraday constant and the isolation of electron charges.
- Avogadro simply proposed that the volume of a gas (at a given pressure and temperature) is proportional to the number of atoms or molecules regardless of the nature of the gas.

The Mole

- **1 dozen cookies = 12 cookies**
- **1 mole of cookies = 6.02 X 10^{23} cookies**
- **1 dozen cars = 12 cars**
- **1 mole of cars = 6.02 X 10^{23} cars**
- **1 dozen Al atoms = 12 Al atoms**
- **1 mole of Al atoms = 6.02 X 10^{23} atoms**

Note that the NUMBER is always the same, but the MASS is very different!

Mole is abbreviated mol

A Mole of Particles Contains 6.02 x 10^{23} particles

1 mole C = 6.02 x 10^{23} C atoms

1 mole H_2O = 6.02 x 10^{23} H_2O molecules

1 mole NaCl = 6.02 x 10^{23} NaCl formula units

6.02 x 10^{23} Na^+ ions and

6.02 x 10^{23} Cl^- ions

Avogadro's Number as Conversion Factor

$$\frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mole}}$$

or

$$\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ particles}}$$

Note that a particle could be an atom OR a molecule!

Molar Mass

- **The Mass of 1 mole (in grams)**
- **Equal to the numerical value of the average atomic mass (get from periodic table)**

1 mole of C atoms	=	**12.0 g**
1 mole of Mg atoms	=	**24.3 g**
1 mole of Cu atoms	=	**63.5 g**

Other Names Related to Molar Mass

- **Molecular Mass/Molecular Weight:** If you have a single molecule, mass is measured in amu's instead of grams. But, the molecular mass/weight is the same numerical value as 1 mole of molecules. Only the units are different. (This is the beauty of Avogadro's Number!)
- **Formula Mass/Formula Weight:** Same goes for compounds. But again, the numerical value is the same. Only the units are different.
- **THE POINT: You may hear all of these terms** which mean the *SAME NUMBER*… just different units

Calculations with Molar Mass

molar mass

Grams ⟷ Moles

Converting Moles and Grams

Aluminum is often used for the structure of light-weight bicycle frames. How many grams of Al are in 3.00 moles of Al?

3.00 moles Al ⟶ ? g Al

Calculations

molar mass *Avogadro's number*

Grams ⟷ Moles ⟷ particles

Everything must go through Moles!!!

Atoms/Molecules and Grams

How many atoms of Cu are present in 35.4 g of Cu?

$$35.4\ \text{g Cu} \times \frac{1\ \text{mol Cu}}{63.5\ \text{g Cu}} \times \frac{6.02 \times 10^{23}\ \text{atoms Cu}}{1\ \text{mol Cu}}$$

$= 3.4 \times 10^{23}$ atoms Cu