DEFINITIONS

Mole Is the way the amount of substance in a gram

Molar mass is the mass of one mole in grams

Avogadro's number (N_a) represents the number of atoms in a 1-gram mole of a compound and is equal to **6.08×10^{23}** atoms/ 1 gram of a mole

Stoichiometry is measuring chemicals that come in/out of any reaction

STP (standard temperature and pressure) refers to the nominal conditions of the atmosphere at sea level, which are **0 degrees Celsius** and **1 atm**

Molarity is the amount of moles of a compound dissolved in an amount of solvent (usually water), here is equation

Molality is the total moles of a solute contained in a kilogram of a solvent, here is equation

element percentage is the percentage of a certain element in a compound, here is the equation

Stuff that depend on STP

- Boiling point
- Density
- Viscosity

NIST (national institute of standards and technology) uses a temperature of 20C and an absolute pressure of 1 atm

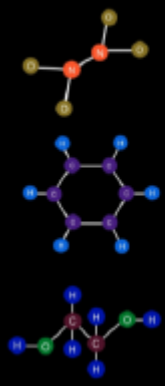
Conversion factor a number used to change one set of units to another by multiplying or dividing

Dimensional analysis is replacing quantities with their units/dimensions where mass is **M,** time is **T**, and length is **L**

Yield is the output amount of substances from a chemical reaction, where

- **Practical** is the number of substances we actually get (reality)
- **Theoretical** is the number we expect to get using a chemical equation

Empirical formula	Molecular formula
Is the simplest whole-number ratio of various atoms present in a compound	Is a chemical formula of a molecular compound that shows the kinds/numbers of atoms present in a molecule of the compound



Molecular	Empirical
N_2O_4	NO_2
C_6H_6	CH
$C_2H_6O_2$	CH_3O

Now let's get serious

WHAT IS A MOLE?

It represents the amount of chemical substance in a gram

MOLAR MASS

It is the mass of one mole worth of a substance

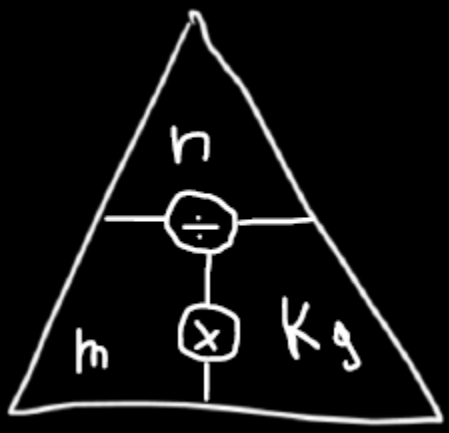
It has the same value as the molecular mass but expressed in grams per mole (**g/mol)** instead of atomic mass unit **(u)**

CALCULATIONS ON MOLE/MOLAR MASS

Element	Oxygen	Chlorine	Nitrogen	Argon
The molar mass of the atom.	O 16 g/mol	Cl 35.5 g/mol	N 14 g/mol	Ar 18 g/mol
Molecular mass of the atom.	O 16 U	Cl 35.5 U	N 14 U	Ar 18 U
Molar mass of the molecule.	O_2 2×16= 32 g/mol	Cl_2 2×35.5= 70 g/mol	N_2 2×14= 28 g/mol	Ar 1×18=18 g/mol

- The relation between the number of particles (No.), mole amount (n), Avogadro's number (N_a)

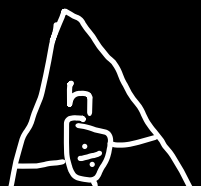
- The relation between the mole amount (n), the mass of solvent (kg), the molality (m)



- The relation between the molarity (M), volumes of solutions in liters (L), the mole amount (n)

- **The relation between the mass of the substance (Kg), the mole amount (n), and the molar mass (mass)**

- The relation between3 the mole amount (n), the concentration in % (C), the volume in liters (V)

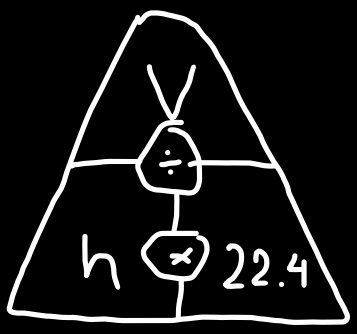


STP with gasses:

1 mol = 22.4 liters of gas

This is used in measuring densities, boiling points, viscosities, and volumes

- The relation between the mole amount (n), 22.4, volume in liters (V)



EXAMPLES

How many atoms do 6.5 moles of Cu contain? No. = n x N_a = 6.5 * 6.02x10^{23} = 3 x 10^{23} atoms

How many grams do 2.55 moles of Cu contain? total mass (kg) = n * molar mass (mass) = 2.55 * 63.3 = 162 grams

How many atoms do 30.5 grams of Si contain?

- n = total mass (kg) / molar mass (mass) = 30.5 / 28.1 = 1.08 moles
- No. = n * 6.02 x 10^{23} = 1.08 * 6.02 x 10^{23} = 6.5 x 10^{23} atoms

Find the mass and number of atoms of iron in 10g of Fe2O3 (with steps)?

- n (Fe2O3) = total mass (kg) / molar mass (mass) = 10 / 159.7 = .06 moles
- No. (Fe2O3) = n * 6.02x10^{23} = 3.76 x 10^{22} atoms
- Iron_percentage = number*mass of iron atoms / sum of all number*mass of atoms = $\frac{2\times55.845}{(2\times55.845)+(3\times16)}$ = .699
- No. (Fe) = No. (Fe2O3) * .699 = 2.62 x 10^{22} atoms
- Mass (Fe) = mass (Fe2O3) * .699 = 6.99 g

Here is the balanced equation $4Al + 3O_2 \rightarrow 2Al_2O_3$

- **How many grams of oxygen are required to react with 3 mole Al:**

4 mole (Al) : 3 mole (O_2)

3 mole (Al) : x mole (O_2)

- how many grams of Al_2O_3 will be formed when 12.5 of O_2 react with Al

4 mole (Al) : 3 mole (O_2) → (O_2 → 16 x 2)

x mole (Al) : 2 mole (Al_2O_3) → 2 mole (Al_2O_3) x 102 (Al_2O_3) = 72 g

From the balanced equation, we see that 3 moles of O_2 react

2 moles of Al_2O_3. This is the

- Caffeine has the following composition: 49.48% of carbon, 5.19% of hydrogen, 16.48% of oxygen and 28.85% of nitrogen. The molecular weight is 194.19 g/mol. Find out the molecular and empirical formula.
    - Step 1 : getting the weight for each element
        - Weight (C) = 194.19 * .4948 = 96 g
        - Weight (H) = 194.19 * .0519 = 10 g
        - Weight (O) = 194.19 * .1648 = 32 g
        - Weight (N) = 194.19 * .2885 = 56 g
    - Step 2 : getting the ratios
        - C = 96 / 12 = 8
        - H = 10 / 1 = 10
        - O = 32 / 16 = 2
        - N = 56 / 14 = 4
    - Step 3 : putting them all together
        - $C_8H_{10}N_4O_2$
    - Step 4 : simplifying
        - $C_4H_5N_2O$

STIOCHIOMETRY

It is measuring chemicals that go in/out reactions

When writing a reaction we have to balance the equation, so number of elements there is equal to here

CHEMICAL EQUATION

It's a symbolic representation of a chemical reaction, it consists of 3 main parts

Reactants -> Products

EXAMPLE -> $2H_{2(l)} + 2O \rightarrow 2H_2O$

NOTE 1 -> The number highlighted in **red** is called a **coefficient**, it tells us the mole count of the matter, or if we went to small scale, a multiplier for the amount of atoms

Basically in our context

2 moles of H_2 and 2 moles of oxygen will result in 2 moles of water molecules

NOTE 2 -> When you have a compound like **H_2O** or **$CaCO_3$**, don't place the coefficient in front of each part of the equation like **$2H_22O$** or **$2Ca2CO_3$**
but just add one coefficient in front, so it will be **$2H_2O$** and **$2CaCO_3$**

NOTE 3 -> when you have a chemical equation like this $2Nacl_{(aq)} \rightarrow 2Na_{(s)} + Cl_{2\,(g)}$
those symbols refer to the state of the substance in the reaction, here is a list of them

BALANCING CHEMICAL EQUATIONS

To balance a chemical equation, the number of atoms on one side, must equal the number of atoms on the other side, you can do that by **changing the coefficient**, DO NOT change the subscript

So for example

$Fe + O_2 \rightarrow Fe_2O_3$

As you can see, there is a problem here

Reactant side => 1 iron, 2 oxygen | **Product side =>** 2 iron, 3 oxygen

We can fix it by adding coefficients/multipliers to each part of the equation

Here it is step by step

1. **Try to balance the number of iron atoms ->** we set the reactant **Fe** to have a coefficient of **2** so it becomes **$2Fe + O_2 \rightarrow Fe_2O_3$**
2. **Try to balance the number of oxygen atoms ->** you have 3 oxygen on the product side, and 2 oxygen on the reactant side, to make them equal, you must make them both into the same number, let's say 6, so we make the coefficient of the reactant oxygen into **3**, and the coefficient of the product oxygen into **2**, so it becomes **$2Fe + 3O_2 \rightarrow 2Fe_2O_3$**
3. **Try to balance the number of iron atoms again** -> because the product **Fe** shares the same coefficient as its O, then we now have 4 iron on the product side, and 2 iron on the reactant side, so we can just turn the coefficient on the reactant side to **4** instead of **2**, and we have this balanced equation **$4Fe + 3O_2 \rightarrow 2Fe_2O_3$**

This is basically how balancing works, you just play around with the coefficients until the left side equals the right side