

CHEMICAL EQUATIONS

Chemical equations are symbolic representations of chemical reactions in which the reactants and the products are expressed in terms of their respective chemical formulae.

Chemical equations make use of symbols to represent factors such as the direction of the reaction and the physical states of the reacting entities.

Chemical equations were first formulated by the French chemist Jean Beguin in the year 1615.

Chemical reactions are represented on paper by ***chemical equations***.

For example, hydrogen gas (H₂) can react (burn) with oxygen gas (O₂) to form water (H₂O). The *chemical equation* for this *reaction* is written

as: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$

This is an example of a , which is a concise way of representing a chemical reaction. The initial substances are called , and the final substances are called .

Representing the Direction of the Chemical Reaction

The reactants and the products (for which the chemical formulae are written in chemical equations) can be separated by one of the following four symbols.

- In order to describe a net forward reaction, the symbol ' $\rightarrow$ ' is used.
- In order to describe a state of chemical equilibrium, the symbol ' $\rightleftharpoons$ ' is used.
- To denote stoichiometric relationships, the '=' symbol is used.
- In order to describe a reaction that occurs in both forward and backward directions, the symbol ' $\rightleftharpoons$ ' is used.

Representing the Physical States of the Reacting Entities

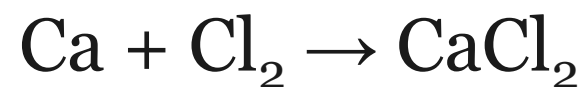
- The symbol (s) describes an entity in the solid state
- The symbol (l) denotes the liquid state of an entity
- The symbol (g) implies that the entity is in the gaseous state.
- The (aq) symbol corresponding to an entity in a chemical equation denotes an aqueous solution of that entity.

Balancing Simple Chemical Equations

When a chemist encounters a new reaction, it does not usually come with a label that shows the balanced chemical equation. Instead, the chemist must identify the reactants and products and then write them in the form of a chemical equation that may or may not be balanced as first written.

The fundamental principle behind balancing equations is the law of conservation of mass, which states that matter, meaning physical substances like atoms and molecules, cannot be created or destroyed.

This means there must be the same mass of atoms on both sides of a chemical equation, and therefore the same number of atoms.



REACTANT: 1 atom of Ca and 2 atoms of Cl

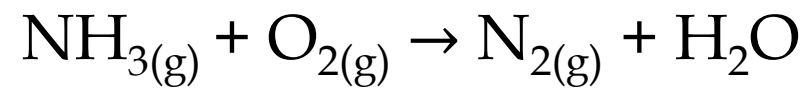
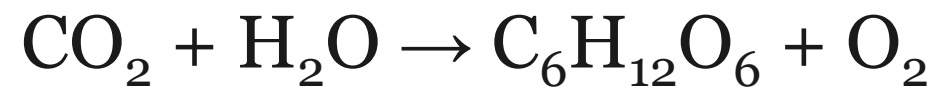
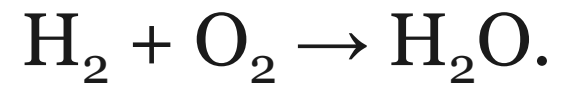
PRODUCT: 1 atom of Ca and 2 atoms of Cl

The equation is balanced because the number of atoms on the reactant side is same as those on the product side

The subscript represents the number of atoms of a given element in each molecule. For example, in 3O_2 , the coefficient is 3 and the subscript is 2.

STEPS FOR BALANCING OF EQUATION:

First, count the atoms on each side. Second, change the coefficient of one of the substances. Third, count the numbers of atoms again and, from there, repeat steps two and three until you've balanced the equation.



STOICHIOMETRY

Stoichiometry is the quantitative relation between the number of moles (and therefore mass) of various products and reactants in a chemical reaction. Chemical reactions must be balanced or, in other words, must have the same number of various atoms in the products as in the reactants.

Mass Relations from Equation

The relative numbers of reactant and product molecule are indicated by the coefficient of a balance chemical equations.

Using molar masses, we can compare the relative masses of reactants and products in a chemical equation.



4 moles of NH_3 reacts with 3 moles of O_2 to form

2moles of N_2 and 6 moles of H_2O .

Assuming 10g of NH_3 was consumed in the reaction.

$$\text{No of mole} = \frac{\text{mass}}{\text{R.M.M}} = \frac{10}{17} = 0.588\text{mol of } \text{NH}_3$$

From the mole ratio the moles of O₂ consumed as well as N and H₂O produced can be estimated.

4mole of NH₃ → 3 moles of O₂

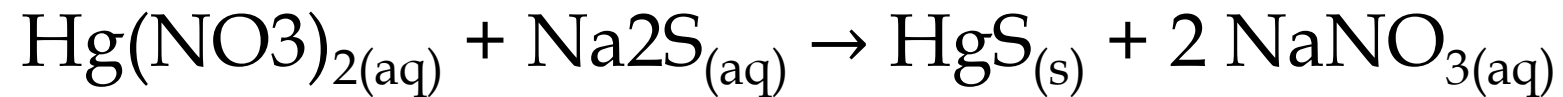
0.588 mole of NH₃ → x moles of O₂

$$4 = 3$$

$$0.580 = X$$

$$X = \frac{3 \times 0.588}{4} = 0.441 \text{ mol of O}_2$$

A solution containing 2.00g of $\text{Hg}(\text{NO}_3)_2$ was added to a solution containing Na_2S . calculate the mass of products formed according to the reaction.



1 mole of $\text{Hg}(\text{NO}_3)_2$ gives 1 mole of HgS

$$200 (14 + 16 \times 3) \rightarrow 200 + 32$$

$$324.6 \rightarrow 232$$

$$2 \rightarrow x$$

$$324.6 \times X = 232 \times 2$$

$$324.6 \times X = 464$$

$$X = \frac{464}{324.6} = 1.43 \text{ g HgS}$$

ASSIGNMENT

In a Rocket motor fueled with butane, C_4H_{10} , how many kilograms of liquid oxygen should be provided with each kilogram of butane to provide complete combustion.

Example 5: $2C_5H_{12}OH + 15O_2 \rightarrow 10CO_2 + 12H_2O$

- How many moles of O_2 are needed for the combustion of 1 mole alkanol?
- How many moles of H_2O are formed for each mole of O_2 consumed?
- How many grams of CO_2 are produced for each mole of alkanol burned
- How many grams of CO_2 are produced for each gram of alkanol burned

Mass concentration.

$$\text{Mass conc} = \frac{\text{mass (g)}}{\text{volume (dm}^3\text{)}} \quad \text{the unit is g/dm}^3$$

Example 6: what is the concentration of 4 g of NaOH dissolved in 100 ml of H₂O

$$\frac{\text{mass}}{\text{vol}} \text{ conc } \left(\frac{\text{g}}{\text{dm}^3} \right)$$

*Convert 100ml to dm³

$$\frac{100}{1000} = 0.1 \text{ dm}^3$$

$$\frac{4}{0.1} = 40 \text{ g/dm}^3$$

Molar Concentration

$$\text{Molar conc.} = \frac{\text{Mass conc.}}{\text{R.M.M}} \text{ mol/dm}^3$$

The concentration of NaOH in mole/dm³ when its concentration in g/dm³ is 40g/dm³

$$\text{Molar conc} = \frac{\text{Mass conc.}}{\text{R.M.M}} = \frac{40}{23+16+1} = \frac{40}{40} = 1 \text{ mol/dm}^3$$

You are provided with anhydrous Na_2CO_3 of 0.52g which was dissolved in 100ml of distilled water. 25ml of the stock solution of Na_2CO_3 prepared was titrated against HCL to arrive at an average titre value of 20cm³. Calculate

- a. The number of mole of Na_2CO_3 in the stock solution
- b. The number of moles of Na_2CO_3 in the 25cm³
- c. The molarity of the HCL
- d. The molarity of the Na_2CO_3