Chemical reactions

Mr. Khan

What is a chemical reaction?

- **A Process by chemical bonds break and/or new Chemical Bonds form.**

Signs of a chemical reaction taking place

- **Change in color**
- **Formation of a precipitate or gas (bubbles).**
- **Change in odor/smell**
- **Change in temperature**
- **Something is burning**
- **Light is being produced**

Important Vocabularies

$3N_2O_5$

3=coefficient

2 and 5 are subscript

Reactant: A substance that takes part in and undergoes changes during chemical reaction.

Product: A substance that is present at the end of the chemical reaction (result of the chemical reaction).

Coefficient: Comes before the symbol of a substance. Tell you how many moles of the substance is there.

Subscript: Comes after the symbol of the element on the bottom right.

Precipitate: A new solid that forms as a result of a chemical reaction.

Writing chemical reaction

1. **Reactants goes on the left side of the equation.**
2. **Products goes on the right side of the equation.**
3. **There should be → between the reactant and the product side.**

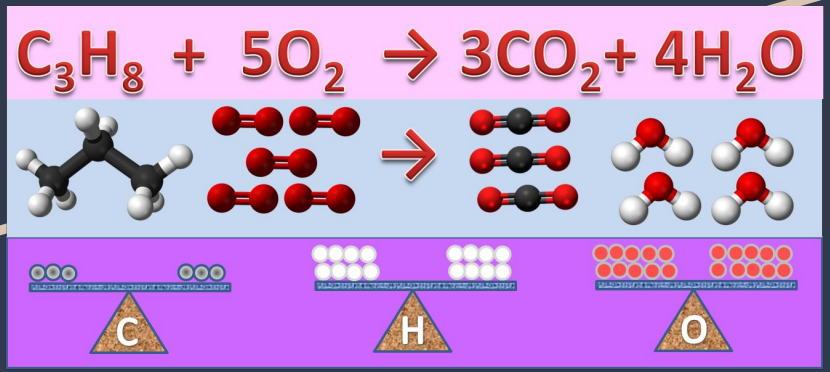
Writing chemical reaction

4. You need to make sure that both the reactant and product side have the same number of atoms for each element through balancing the chemical reaction.

Law of Conservation of mass

In a chemical reaction, mass is neither created or destroyed. Already existing atoms rearrange themselves to make new substances.

Law of Conservation of mass



https://phet.colorado.edu/en/simulations/balancing-chemical-equations

Review of the Phet simulation

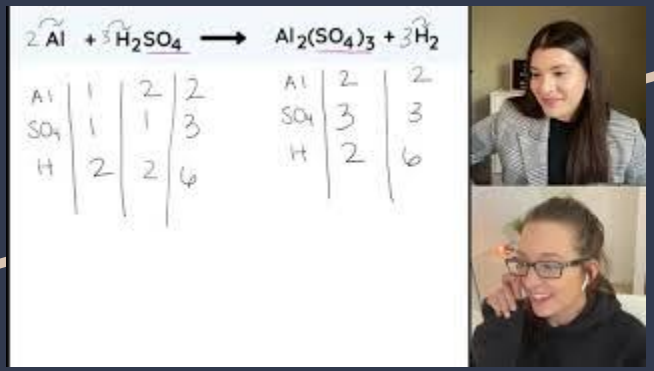
Excess reactant / leftover: **a reactant present in an amount in excess of that required to combine with all of the limiting reactant.**

Limiting reactant: **the reactant that gets consumed first in a chemical reaction and therefore limits how much product can be formed.**

Rules for Balancing chemical equations:

****Make sure you balance one type of atom/polyatomic ions at a time*****

- **Step 1:** Balance atoms of elements that are combined and only appear once on each side of the equation.
- **Step 2:** balance polyatomic ions that appear on both sides of the equation as a single unit.
- **Step 3:** Balance O, H, or any other atoms that appears multiple times on either reactant or product side.


2 Al + 3 H2SO4 → Al2(SO4)3 + 3 H2
Al 1 2 2
SO4 1 1 3
H 2 2 6
Al 2 2
SO4 3 3
H 2 6

Types of Chemical reactions: Synthesis/ composition

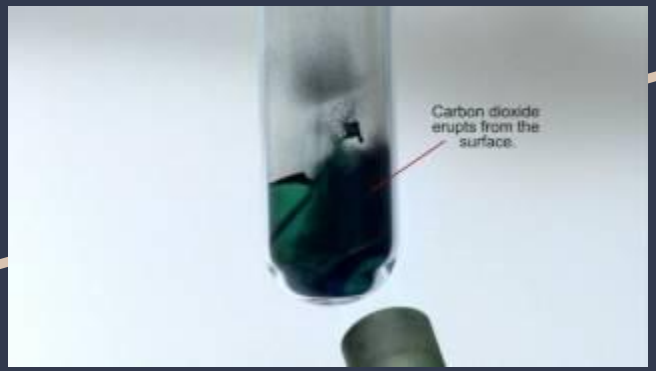
$$\_\_Al_{(s)} + \_\_\_Br_{2(l)} \rightarrow \_\_\_\_AlBr_{3(s)}$$

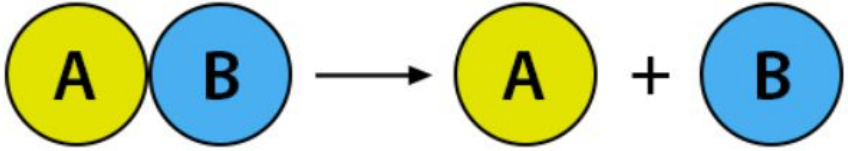
- **The term Synthesis is more often used instead of composition.**
- **Two or more simpler substances combine to make a single product.**
- **Formation of new intramolecular forces.**

Practice: Balance the following equation

1. ____N_2 + ____H_2 → ____NH_3
2. ____Na + ____Cl_2 → ____NaCl
3. ____H_2 + ____O_2 → ____H_2O
4. ____H_2 + ____O_2 → ____H_2O_2
5. ____P + ____O_2 → ____P_2O_5
6. ____S_8 + ____O_2 → ____SO_3

Types of Chemical reactions: Decomposition





Reactant Product

- $\_\_\_CuCO_{3(s)} \rightarrow \_\_\_CuO_{(s)} + \_\_\_CO_{2(g)}$
- **Reactant breaks apart into simpler substances.**
- **Breaking of intramolecular forces.**

Practice: Balance the following equation

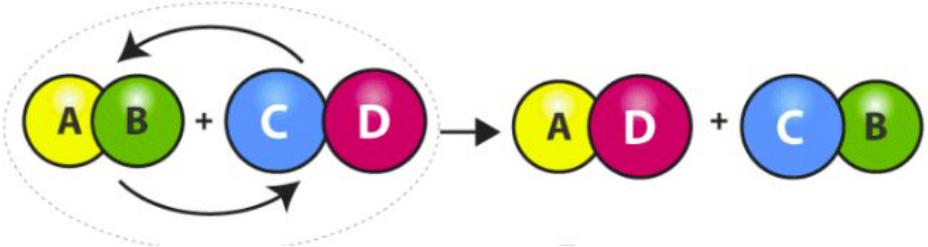
1. ___$KClO_3$ → ___KCl + ___O_2
2. ___$ZnCO_3$ → ___ZnO + ___CO_2
3. ___Na_2CO_3 →___Na_2O +___CO_2
4. ___H_2O_2 → ___H_2O + ___O_2
5. ___Al_2O_3 → ___Al + ___O_2

Types of Chemical reactions: Single ionic replacement

$$\_\_CuCl_{2(aq)} + Al \rightarrow \_\_\_AlCl_{3(aq)} + \_\_\downarrow Cu_{(s)}$$

- One ion replaces the other Ion.
- In this reaction, Aluminum ion replaces the copper ion to produce Aluminum chloride (dissolved in water) and copper (solid precipitate)
- ↓ means precipitate.

Types of Chemical reactions: Double ionic replacement



- **Two ions from different compounds swap places.**
- **Li^+ is more attracted to NO_3^- than Cl^-.**
- **Also, Ag^+ is more attracted to Cl^- than to NO_3^-.**
- **As a result, they swap places to form a bond with the components that they feel more attracted to.**

Practice: Balance the following equation and determine the type of chemical reaction

1. ___$NaCl$ + ___F_2 → ___NaF + ___Cl_2
2. ___$NaBr$ + ___CaF_2 → ___NaF + ___$CaBr_2$
3. ___K + ___$MgBr_2$→ ___KBr + ___Mg

More balancing chemical equation

1. $\_\_Pb(OH)_2 + \_\_HCl \rightarrow \_\_H_2O + \_\_PbCl_2$
2. $\_\_AlBr_3 + \_\_K_2SO_4 \rightarrow \_\_KBr + \_\_Al_2(SO_4)_3$
3. $\_\_FeCl_3 + \_\_NaOH \rightarrow \_\_Fe(OH)_3 + \_\_NaCl$
4. $\_\_HCl + \_\_CaCO_3 \rightarrow \_\_CaCl_2 + \_\_H_2O + \_\_CO_2$
5. $\_\_HNO_3 + \_\_NaHCO_3 \rightarrow \_\_NaNO_3 + \_\_H_2O + \_\_CO_2$
6. $\_\_H_2SO_4 + \_\_NaNO_2 \rightarrow \_\_HNO_2 + \_\_Na_2SO_4$

Hydrocarbon

Hydrocarbon

- A compound mainly made of carbon and hydrogen.
- Naturally occurring.
- Main component of Natural and oil.

How to balance Combustion reaction

Step 1: Balance the metal/carbon first.

Step 2: Balance the Hydrogen (if present).

Step 3: Balance the oxygen.

These are the general rules for balancing combustion reactions.

Combustion Reaction

1. $\_\_CH_4 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$
2. $\_\_C_2H_4 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$
3. $\_\_C_2H_2 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$
4. $\_\_C_6H_6 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$
5. $\_\_C_3H_8 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$

Combustion Reaction

6. $\_\_C_8H_{18} + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$

7. $\_\_C_2H_6 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$

8. $\_\_C_4H_{10} + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$

9. $\_\_C_5H_{12} + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$

10. $\_\_C_6H_{14} + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$

Oxidation number

Definition: Total number of electrons that an atom loses or gains to form a chemical bond with another atom.

Example: **Cr = +6** Chromium lost 6 electron to form a bond with another atom.

Br = -1; Bromine gained an electron to form a bond with another atom.

Determining oxidation number:

Rules:

1. **Oxidation number of any uncombined element is 0.**
   - **Example: oxidation number of Ar =0, N=0.**
2. **The oxidation number of a monatomic ion equals the charge of the ion.**
   - **Example: Cu^{2+} =+2, Br^{-}=-1, etc.**

Determining oxidation number:

3. The more electronegative element in a binary compound is assigned the number equal to the charge it would have if it were an ion.

- **Example: In SCl_2; S is more electronegative than Cl. Therefore, oxidation number of S is -2 because S^{-2} is the more common ion for Sulfur.**

Determining oxidation number:

4.