Class 10

SCIENCE

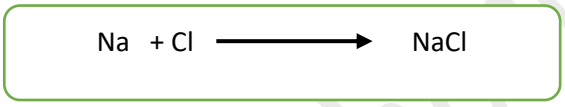
CHEMICAL EQUATION AND REACTION

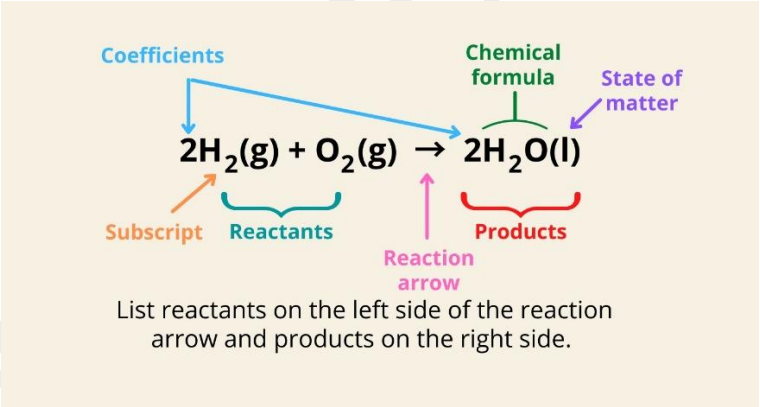
❖ What is a Chemical Reaction?

A chemical reaction is a process in which one or more substances (called reactants) are transformed into one or more new substances (called products) with different properties.

During a chemical reaction:

- Bonds between atoms in the reactants are broken.
- New bonds are formed to create the products.
- It may involve changes in energy (heat, light), color, state, or the release of a gas or precipitate.





✅ Signs That a Chemical Reaction Has Occurred:

1. **Change in Color**
   - **Example:** Iron rusts and turns reddish-brown.
   - **Indicates:** A new substance has formed.
2. **Change in Temperature**
   - **Example:** Burning fuel releases heat.
   - **Indicates:** Heat is either released (exothermic) or absorbed (endothermic).
3. **Formation of a Gas**

- **Example:** Vinegar + baking soda produces bubbles of carbon dioxide.
- **Indicates:** A gas is a new product.

4. **Formation of a Precipitate**
    - **Example:** Mixing two clear solutions forms a solid (precipitate) that settles.
    - **Indicates:** A solid product forms from liquids.
5. **Change in Smell or Odor**
    - **Example:** Spoiled food develops a bad smell.
    - **Indicates:** New chemical compounds have formed.
6. **Change in State or Formation of Light**
    - **Example:** Fireworks release bright lights.
    - **Indicates:** A chemical reaction is producing energy in the form of light.
7. **Irreversibility**
    - **Example:** Boiled egg cannot be turned back into raw egg.
    - **Indicates:** A permanent chemical change has occurred.

- **What is a Chemical Equation?**

A chemical equation is a shorthand way to show **what happens in a chemical reaction** using **chemical formulas**.

It shows:

- The **reactants** (substances you start with)
- The **products** (new substances formed)
- The **direction** of the reaction
- Sometimes **physical states** and **energy changes**

General Form of a Chemical Equation:

Reactants → Products

Example (Word Equation):
Hydrogen + Oxygen → Water

Chemical Equation:
$H_2 + O_2 \rightarrow H_2O$

🔹 Balanced Chemical Equation

In a **balanced equation**, the **number of atoms of each element** is the **same on both sides** of the arrow.

✅ Balanced form of:
$H_2 + O_2 \rightarrow H_2O$
is:
$2H_2 + O_2 \rightarrow 2H_2O$

This follows the **Law of Conservation of Mass**:

"Mass is neither created nor destroyed in a chemical reaction."

NOTE : Top Tips (CHEAT SHEET)

1. Balance metals first, then non-metals, and hydrogen & oxygen last.

2. Use coefficients only (numbers in front of formulas). Never change subscripts!

3. Start with the compound that looks most complex (has most elements).

4. For odd numbers, try doubling them to make balancing easier.

5. Check total atoms for each element at the end.

EX: Unbalanced Equation:
$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

ANS: ☑ **Step-by-step Solution:**

Step 1: Balance Carbon (C)

C_3H_8 → has **3 carbon atoms**
So, put **3** in front of CO_2:

$C_3H_8 + O_2 \rightarrow 3CO_2 + H_2O$

Step 2: Balance Hydrogen (H)

C_3H_8 → has **8 hydrogen atoms**
So, put **4** in front of H_2O (4×2 = 8 H):

$C_3H_8 + O_2 \rightarrow 3CO_2 + 4H_2O$

Step 3: Balance Oxygen (O)

Right side:

- CO_2: 3 × 2 = **6 O**
- H_2O: 4 × 1 = **4 O**
  Total = **6 + 4 = 10 oxygen atoms**

So, on the left, put **5** in front of O_2 (5 × 2 = 10 O):

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

EX: Unbalanced Equation:

$C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$

ANS : ☑ **Step-by-step:**

Step 1: Balance Carbon (C)
C_4H_{10} has 4 carbon atoms → Put 4 in front of CO_2:
→ $C_4H_{10} + O_2 \rightarrow 4CO_2 + H_2O$

Step 2: Balance Hydrogen (H)
C_4H_{10} has 10 H atoms → Put 5 in front of H_2O:
→ $C_4H_{10} + O_2 \rightarrow 4CO_2 + 5H_2O$

Step 3: Balance Oxygen (O)
Right side:

- CO_2: 4 × 2 = 8 O
- H_2O: 5 × 1 = 5 O
  Total = **13 O atoms**

On left, O_2 = 2 atoms per molecule.
→ Need 6.5 O_2:
$C_4H_{10} + 6.5O_2 \rightarrow 4CO_2 + 5H_2O$

Step 4: Remove the decimal (×2):
$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

☑ **Balanced Equation**

- **Physical States in Equations (optional but useful):**

Symbol	Meaning
(s)	Solid
(l)	Liquid
(g)	Gas
(aq)	Aqueous (dissolved in water)

Example:
NaCl (s) + H_2O (l) → Na^+ (aq) + Cl^- (aq)

1. Why should a magnesium ribbon be cleaned before burning in air?

Magnesium ribbon should be cleaned **by rubbing with sandpaper** before burning because:

- **A layer of magnesium oxide (MgO)** forms on its surface when it is exposed to air.

- This **oxide layer prevents proper burning** of magnesium.
- Cleaning removes the layer and allows **magnesium metal to burn more brightly and completely** in air.

2. Write the balanced chemical equation for the following reactions:

a. Hydrogen + Chlorine → Hydrogen chloride

Word Equation:
Hydrogen + Chlorine → Hydrogen chloride

Balanced Chemical Equation:
$H_2 + Cl_2 \rightarrow 2HCl$

b. Barium chloride + Aluminium sulphate → Barium sulphate + Aluminium chloride

Word Equation:
Barium chloride + Aluminium sulphate → Barium sulphate + Aluminium chloride

Balanced Chemical Equation:
$3BaCl_2 + Al_2(SO_4)_3 \rightarrow 3BaSO_4 + 2AlCl_3$

c. Sodium + Water → Sodium hydroxide + Hydrogen

Word Equation:
Sodium + Water → Sodium hydroxide + Hydrogen

Balanced Chemical Equation:
$2Na + 2H_2O \rightarrow 2NaOH + H_2$

3. Write balanced chemical equations with state symbols:

a. Barium chloride solution + Sodium sulphate solution → Barium sulphate (insoluble) + Sodium chloride solution

Balanced Chemical Equation with state symbols:
$BaCl_2\ (aq) + Na_2SO_4\ (aq) \rightarrow BaSO_4\ (s) + 2NaCl\ (aq)$

- **(aq)** = aqueous (dissolved in water)
- **(s)** = solid (precipitate)

b. Sodium hydroxide solution + Hydrochloric acid → Sodium chloride solution + Water

Balanced Chemical Equation with state symbols:
$NaOH\ (aq) + HCl\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$

- This is a **neutralization reaction** between a base and an acid.

◆ **Types of Chemical Reactions (briefly):**

1. **Combination Reaction**
   $A + B \rightarrow AB$

   a reaction in which a single product is formed from two or more reactants is known as a combination reaction.

   EX:

$$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$$
(Quick lime) (Slaked lime)

(i) Burning of coal

$$C(s) + O_2(g) \longrightarrow CO_2(g)$$

(ii) Formation of water form $H_2(g)$ and $O_2(g)$

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$$

2. **Decomposition Reaction**
   AB → A + B

***A decomposition reaction** is a type of chemical reaction in which a single compound breaks down into two or more simpler substances (elements or smaller compounds). It usually requires an input of energy in the form of heat, light, or electricity.*

Thermal decomposition of calcium carbonate ($CaCO_3$):

$$CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$$

***Photolysis** is a decomposition reaction in which a substance is broken down by the energy from light (usually sunlight).*

Decomposition of silver chloride (AgCl):

$$2AgCl \xrightarrow{\text{sunlight}} 2Ag + Cl_2$$

***Electrolysis** is the process of using **electric current** to decompose a compound (usually in liquid or molten form) into its elements. It is a type of **electrolytic decomposition reaction**.*

Electrolysis of water (H_2O):

$$2H_2O(l) \xrightarrow{\text{electricity}} 2H_2(g) + O_2(g)$$

Explanation:

When electric current is passed through water containing a small amount of acid or salt (to make it a better conductor), it decomposes into **hydrogen gas** and **oxygen gas**.

- **Hydrogen** is collected at the **cathode** (negative electrode).
- **Oxygen** is collected at the **anode** (positive electrode).

3. **Displacement Reaction**
   A + BC → AC + B

A displacement reaction is a chemical reaction in which a more reactive element displaces a less reactive element from its compound.

Reaction between zinc and copper sulfate:

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

4. **Double Displacement Reaction**
   AB + CD → AD + CB

   A double displacement reaction (also called double replacement or metathesis reaction) is a chemical reaction where two compounds exchange ions to form two new compounds. Often, one of the products is a precipitate, gas, or water.

   Reaction between sodium sulfate and barium chloride:

   $$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 \downarrow + 2NaCl$$

   Explanation:

   - Sodium sulfate and barium chloride are both soluble salts.
   - When mixed, **barium sulfate ($BaSO_4$)** forms as a white precipitate (insoluble), and sodium chloride remains in solution.

5. **Combustion Reaction**
   Fuel + O_2 → CO_2 + H_2O + Heat

   A combustion reaction is a chemical reaction in which a substance reacts rapidly with oxygen to produce heat and light, usually in the form of a flame. It typically involves the burning of a fuel (like hydrocarbons).

   Combustion of methane (CH_4):

   $$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Heat} + \text{Light}$$

   Explanation:

   - Methane (a hydrocarbon) burns in oxygen.
   - It produces **carbon dioxide**, **water**, and releases **energy** in the form of **heat and light**.

   Types of Combustion:

1. **Complete Combustion:**
   - **Sufficient oxygen is present.**
   - **Products: CO_2 + H_2O**
   - **Example: CH_4 + O_2 → CO_2 + H_2O**

2. **Incomplete Combustion:**
    - Limited oxygen.
    - Produces **carbon monoxide (CO)** or **soot (C)** instead of CO_2.
    - Example:

$$2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$$

Corrosion

Definition:
Corrosion is the **gradual destruction** of metals due to **chemical reactions** with substances in the environment, such as **air, water, acids**, or **salts**.

Rusting of iron

$$4Fe + 3O_2 + 6H_2O \rightarrow 4Fe(OH)_3$$

Over time, this forms **hydrated iron(III) oxide ($Fe_2O_3 \cdot xH_2O$)**, which is commonly known as **rust**.

➢ Other Examples of Corrosion:

- **Copper** turns green due to formation of **basic copper carbonate**.
- **Silver** turns black due to **silver sulfide (Ag_2S)** formation.
- **Aluminum** forms a protective layer of **aluminum oxide**.

➢ Prevention of Corrosion:

- **Painting or coating** the metal
- **Galvanization** (coating with zinc)
- **Oiling/Greasing**
- **Alloying** (e.g., stainless steel)
- **Electroplating**

➢ Rancidity

Definition:
Rancidity is the process by which **oils and fats** in food **get oxidized**, leading to a **bad smell, taste**, and sometimes a change in color. It is caused mainly by the **oxidation of fats and oils** when exposed to **air (oxygen), light**, or **moisture**.

Types of Rancidity:

1. **Oxidative Rancidity:**

- Caused by reaction of fats/oils with **oxygen**.
- Common in oily foods (e.g., chips, butter).

2. Hydrolytic Rancidity:

- Caused by reaction with **water** (often with enzymes or bacteria).
- Often occurs in dairy products.

Examples:

- Spoiled **butter** smells bad due to rancidity.
- **Fried snacks** like chips taste stale over time if not stored properly.

Prevention of Rancidity:

1. **Storing food in airtight containers** (reduces contact with oxygen).
2. **Refrigeration** (slows down oxidation).
3. **Adding antioxidants** (like BHA, BHT, vitamin E) to food.
4. **Vacuum packing** or **flushing with nitrogen gas** (to remove oxygen).
5. **Keeping away from light and heat.**