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Class X Science

Chemical Reactions And Equations

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Change : A change is the process in which the final state of a substance differ from its initial or original point

Classification Of Change

- PHYSICAL CHANGE
- CHEMICAL CHANGE

Physical Change

Shape / Size /Physical Change e.g melting of chocolate , or ice

Chemical Change

Compostion Change along with a change of shape /size/state e.g rusting of iron, or wood

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Q. Which of the following is a "Chemical Change"?
(A) Melting of ice into water.
(B) Dissolving sugar in water.
(C) Digestion of food in our stomach.
(D) Cutting a piece of paper into small bits.

CHEMICAL REACTIONS

A **chemical reaction** is a process in which one or more substances (called **reactants**) undergo a transformation to form one or more new substances (called **products**) with entirely different chemical properties.

CHEMICAL EQUATIONS

A symbolic representation of a chemical reaction using symbols and formulas.

For eg: Hydrogen (H_2) + Oxygen (O_2) $\rightarrow$ Water (H_2O)

Characteristics of Chemical Reactions

1. Evolution of a Gas

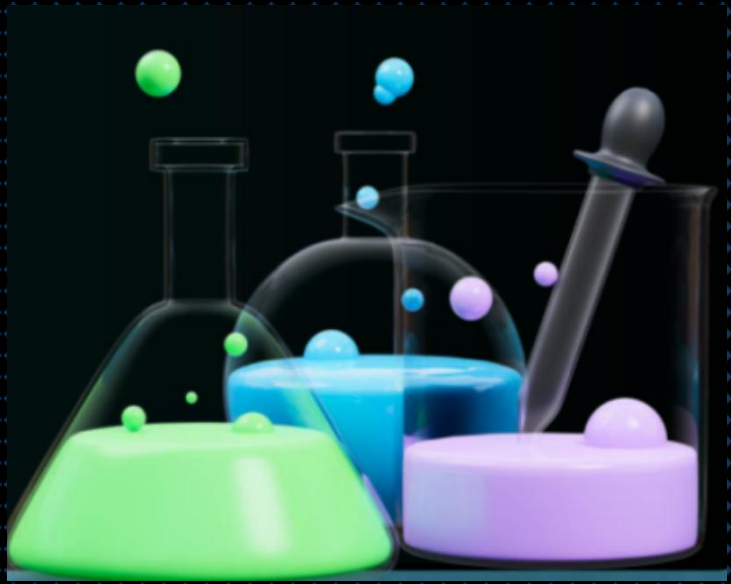
2. Formation of a Precipitate

3. Change in Color

4. Change in Temperature :-

   Exothermic (Heat is released)
   Endothermic (Heat is absorbed)

5. Change in State



REPRESENTING CHEMICAL REACTION

When heated in oxygen, magnesium burns with a bright white flame, forming white magnesium oxide powder.

Reactants: Substances that undergo a chemical change.

Products: Substances formed as a result of the chemical change.

WORD REACTION

Magnesium + Oxygen → Magnesium Oxide

$Mg + O_2 \rightarrow MgO$

Shorter way of representing a chemical reaction

NAME AND SYMBOLS OF SOME IONS

Vale-ncy	Name of ion	Symbol	Non-metallic element	Symbol	Polyatomic ions	Symbol
1.	Sodium	Na^+	Hydrogen	H^+	Ammonium	NH_4^+
	Potassium	K^+	Hydride	H^-	Hydroxide	OH^-
	Silver	Ag^+	Chloride	Cl^-	Nitrate	NO_3^-
	Copper (I)*	Cu^+	Bromide	Br^-	Hydrogen	
			Iodide	I^-	carbonate	HCO_3^-
2.	Magnesium	Mg^{2+}	Oxide	O^{2-}	Carbonate	CO_3^{2-}
	Calcium	Ca^{2+}	Sulphide	S^{2-}	Sulphite	SO_3^{2-}
	Zinc	Zn^{2+}			Sulphate	SO_4^{2-}
	Iron (II)*	Fe^{2+}				
	Copper (II)*	Cu^{2+}				
3.	Aluminium	Al^{3+}	Nitride	N^{3-}	Phosphate	PO_4^{3-}
	Iron (III)*	Fe^{3+}				

Lead (II) Pb^{2+} , Barium Ba^{2+}

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BALANCING CHEMICAL REACTION

A balanced chemical equation is one where the number of atoms of each element is equal on both the reactant and product sides.

Law of Conservation of Mass, which states that mass can neither be created nor destroyed in a chemical reaction.

Example: Formation of Water

Unbalanced Equation:

$$H_2 + O_2 \rightarrow H_2O$$

- **Left Side (Reactants):** 2 Hydrogen, 2 Oxygen
- **Right Side (Products):** 2 Hydrogen, 1 Oxygen
  (Oxygen is not balanced)

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How to Balance an Equation

To balance an equation, we use **coefficients** (the numbers placed *in front* of a chemical formula). We **never** change the subscripts (the small numbers within a formula), as that would change the substance itself.

Example: Formation of Water

Unbalanced Equation:

$$H_2 + O_2 \rightarrow H_2O$$

- **Left Side (Reactants):** 2 Hydrogen, 2 Oxygen
- **Right Side (Products):** 2 Hydrogen, 1 Oxygen
  (Oxygen is not balanced)

Balanced Equation:

$$2H_2 + O_2 \rightarrow 2H_2O$$

- **Left Side:** 4 Hydrogen, 2 Oxygen
- **Right Side:** 4 Hydrogen, 2 Oxygen
  (Everything is now equal!)

Steps to Balance (Hit and Trial Method)

1. **Count the Atoms:** List how many atoms of each element are on the reactant and product sides.
2. **Balance the Biggest Molecule:** Start with the compound that has the maximum number of atoms.
3. **Use Coefficients:** Add numbers in front of formulas to multiply the atom counts.
4. **Check Your Work:** Re-count all atoms to make sure the LHS (Left Hand Side) equals the RHS (Right Hand Side).

Why do we balance?

If an equation is not balanced, it implies that atoms disappeared or appeared out of nowhere, which is physically impossible. Balancing makes the equation a true "map" of what happens during the reaction.

Practice Question for You:

Can you try to balance this one?

$$N_2 + H_2 \rightarrow NH_3$$

Hint: Start by looking at the Nitrogen (N) atoms!

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Q. Balance These

$$H_2 + Cl_2 \rightarrow HCl$$

$$NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$$

$$Fe + H_2O \rightarrow Fe_3O_4 + H_2$$

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Q. Balance these:

(i) $H_2 + O_2 \rightarrow H_2O$

(ii) $Al + O_2 \rightarrow Al_2O_3$

(iii) $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

(iv) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

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Q. In the following chemical equation, the values of x, y, and z respectively are:

$MnO_2 + xHCl \rightarrow MnCl_2 + yH_2O + zCl_2$

(a) 6, 2, 2

(b) 4, 1, 2

(c) 4, 2, 1

(d) 2, 2, 1

Comment

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TYPES OF CHEMICAL REACTIONS

- Combination reaction
- Decomposition reaction
- Displacement reaction
- Double-Displacement reaction

Combination Reactions

A **Combination Reaction** is a type of chemical reaction where **two or more reactants** combine to form a **single product**.

$$Reactant\ 1 + Reactant\ 2 \rightarrow Single\ Product$$

Key Examples (Class 10 Important)

1. **Burning of Coal:**

   When carbon (coal) burns in the presence of oxygen, it forms carbon dioxide gas.

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

Some More Examples

Formation of Water:

Hydrogen gas and oxygen gas combine to form liquid water.

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

Slaking of Lime (Highly Important):

When water is added to Quicklime (Calcium Oxide), it reacts vigorously to form Slaked Lime (Calcium Hydroxide) and releases a large amount of heat.

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + Heat$$

*(Note: This is also an **Exothermic Reaction** because heat is produced).*

Exothermic Reaction

An **Exothermic Reaction** is a chemical reaction in which energy is released in the form of **heat** or **light**.

Top Examples for Class 10

Burning of Natural Gas (Methane):

When methane burns in oxygen, it produces carbon dioxide, water, and a large amount of heat.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + \text{Heat}$$

Respiration (Very Important):

Respiration is considered an exothermic reaction because glucose reacts with oxygen in our cells to release energy that our body needs to function.

$$C_6H_{12}O_6(aq) + 6O_2(aq) \rightarrow 6CO_2(aq) + 6H_2O(l) + \text{Energy}$$

Endothermic Reactions

An **Endothermic Reaction** is a chemical reaction in which energy is **absorbed** from the surroundings, usually in the form of heat, light, or electricity.

Key Examples for Class 10

Photosynthesis (Most Important):

Plants absorb sunlight (energy) to convert carbon dioxide and water into glucose and oxygen.

$$6CO_2 + 6H_2O + \text{Sunlight} \rightarrow C_6H_{12}O_6 + 6O_2$$

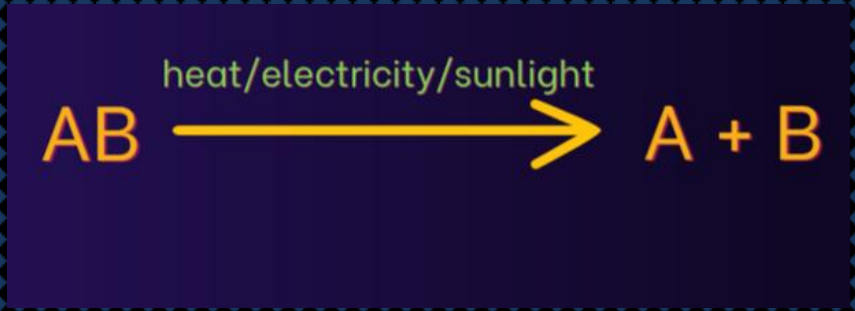
Decomposition of Calcium Carbonate:

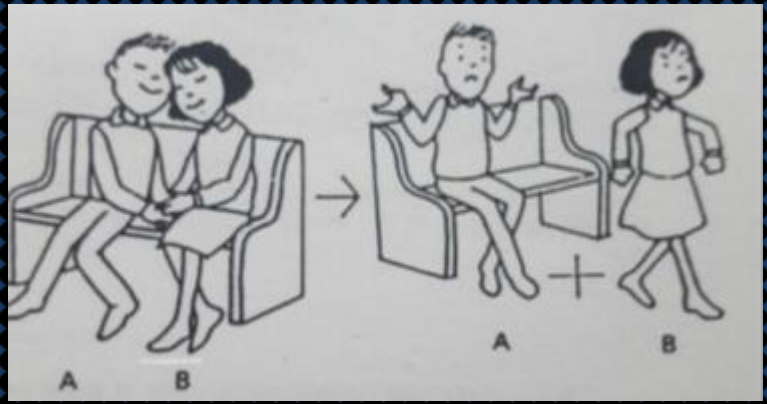
When limestone is heated, it breaks down into quicklime and carbon dioxide. It won't happen without constant heating.

$$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$$

Decomposition Reaction

A **Decomposition Reaction** is a chemical reaction in which a **single reactant** breaks down into **two or more simpler products**.





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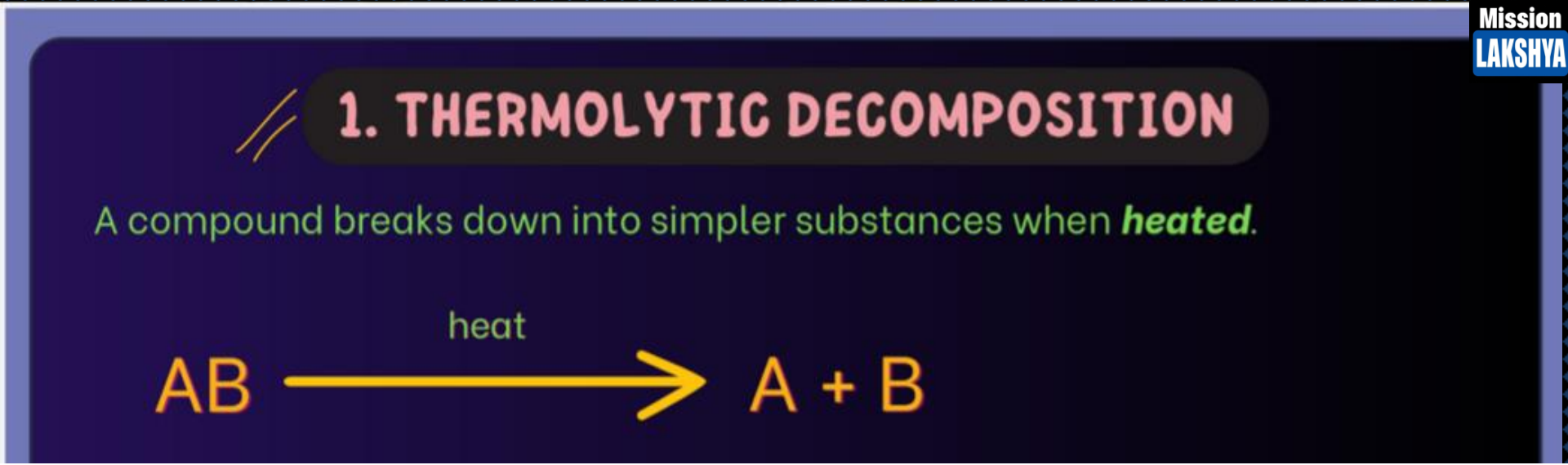
TYPES OF DECOMPOSITION REACTION

- Thermolysis

- Electrolysis

- Photolysis



The Reaction

When Calcium Carbonate ($CaCO_3$), also known as **Limestone**, is heated strongly, it decomposes into **Calcium Oxide** (CaO), also known as **Quicklime**, and **Carbon Dioxide gas** (CO_2).

$$CaCO_3(s) \xrightarrow{\Delta\ (\text{Heat})} CaO(s) + CO_2(g) \uparrow$$

Key Observations

1. **State Change:** The solid limestone stays solid (as quicklime), but a gas (CO_2) is released.
2. **Nature of Reaction:** It is an **Endothermic Reaction** because it continuously absorbs heat energy to proceed.
3. **Testing the Gas:** If you pass the evolved gas (CO_2) through **Limewater** (Calcium Hydroxide), the limewater turns **milky** due to the formation of insoluble Calcium Carbonate.

Industrial Importance

This specific reaction is very important in industries:

- **Cement Industry:** Calcium Oxide (CaO) produced from this reaction is a primary ingredient in the manufacturing of cement.
- **Glass and Steel:** It is also used in the production of glass and as a flux in steel making.

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Q. On heating $Pb(NO_3)_2$, the products formed are:

(a) $PbO+NO_2+O_2$

(b) $Pb(NO_3)_2+N_2+O_2$

(c) PbO_2+NO+O_2

(d) $PbO+N_2+O_2$

2. ELECTROLYTIC DECOMPOSITION

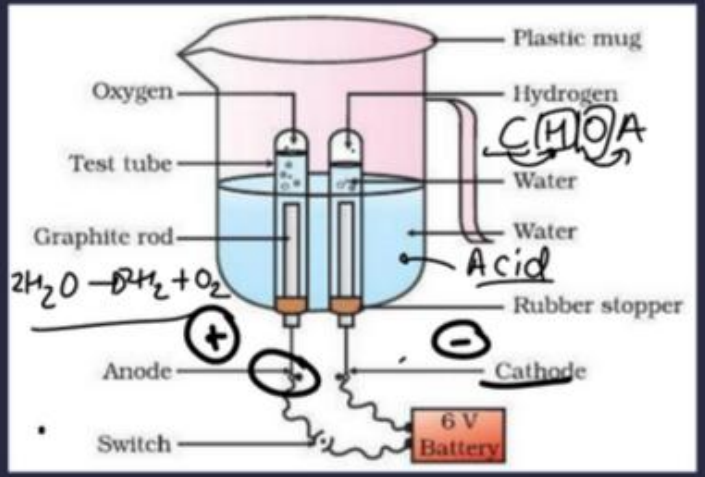
An ***electric current*** is used to decompose or break down compounds into their constituent elements or ions.

Observation: Bubbles form at both electrodes, displacing water.

- Volume of gas at cathode (negative electrode) is double the volume at anode (positive electrode).

Testing the gases:

- Gas at cathode supports burning → Hydrogen gas (H_2).
- Gas at anode rekindles a glowing splint → Oxygen gas (O_2).



Conclusion: Water decomposes into hydrogen and oxygen. The ratio of H_2 to O_2 collected = 2:1 (Volume / Mass)

Reaction: $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

Photolytic Decomposition

Photolytic Decomposition (also known as **Photolysis**) is a type of decomposition reaction that occurs when a single substance breaks down into two or more simpler substances by absorbing **light energy** (usually sunlight).

1. Most Important Examples (Class 10)

A. Decomposition of Silver Chloride ($AgCl$)

When white Silver Chloride is kept in a china dish under sunlight for some time, it turns **grey**. This is because it decomposes into Silver metal and Chlorine gas.

- **Reaction:** $2AgCl(s) \xrightarrow{\text{Sunlight}} 2Ag(s) + Cl_2(g)$
- **Observation:** The white color changes to grey.

Displacement Reaction

A **Displacement Reaction** is a chemical reaction in which a **more reactive element** displaces (removes) a **less reactive element** from its compound or salt solution.

Think of it like a stronger player replacing a weaker player in a team.

1. General Form

$$A + BC \rightarrow AC + B$$

(Where A is more reactive than B)

Reactivity Series

Potassium	Please
Sodium	Stop
Calcium	Calling
Magnesium	Me
Aluminium	A
Zinc	Zebra
Iron	I
Lead	Like
Hydrogen	Him
Copper	Calling
Silver	Smart
Gold	Goat

Trick to learn This Table

Double Displacement Reaction

A **Double Displacement Reaction** is a type of chemical reaction where two compounds react by an **exchange of ions** to form two new compounds.

$$AB + CD \rightarrow AD + CB$$

2. Most Important Example (Class 10)

Reaction between Sodium Sulphate and Barium Chloride:

When you mix a solution of Sodium Sulphate (Na_2SO_4) with Barium Chloride ($BaCl_2$), a white insoluble substance is formed instantaneously.

- **Equation:**

$$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) \downarrow + 2NaCl(aq)$$

- **Observation:** A **white precipitate** of Barium Sulphate (Ba_4) is formed.
- **Explanation:** The Ba^{2+} ions react with SO_4^{2-} ions to form the white solid.

Practice Question

Practice Question

Scenario: A student mixes a solution of **Sodium Sulphate (Na_2SO_4)** with a solution of **Barium Chloride ($BaCl_2$)** in a test tube.

Questions:

1. **Observation:** What will the student observe immediately after mixing the two solutions?
2. **Product Name:** Identify the white substance formed during the reaction.
3. **Chemical Equation:** Write the balanced chemical equation for this reaction, including physical states.
4. **Reaction Type:** Why is this reaction also called a **Precipitation Reaction**?

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Q. Write the balanced chemical equation when barium chloride reacts with sodium sulphate.

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SOCHO!

Q.Consider the following chemical equations I and II:

- $Mg+2HCl \rightarrow MgCl_2+H_2$
- $NaOH+HCl \rightarrow NaCl+H_2O$

The correct statement about these equations is:

(A) 'I' is a displacement reaction and 'II' is a decomposition reaction.

(B) 'I' is a displacement reaction and 'II' is a double displacement reaction.

(C) Both 'I' and 'II' are displacement reactions.

(D) Both 'I' and 'II' are double displacement reactions.

Oxidation

Oxidation can be defined in two main ways: based on oxygen/hydrogen exchange (classical view) or based on electron transfer (modern view).

1. Classical Definition

Oxidation is a process which involves:

- **The addition of Oxygen** to a substance.
- **The removal of Hydrogen** from a substance.

Example: Addition of Oxygen

When Copper powder is heated in a china dish, it reacts with oxygen in the air to form a black coating of Copper(II) Oxide.

$$2Cu + O_2 \xrightarrow{\text{Heat}} 2CuO$$

In this reaction, Copper (Cu) is **oxidized** to Copper Oxide (CuO) because oxygen is added to it.

Reduction

Reduction is the exact opposite of oxidation. Like oxidation, it can be defined in two ways: through the gain/loss of oxygen and hydrogen, or through the movement of electrons.

1. Classical Definition

Reduction is a process that involves:

- **The addition of Hydrogen** to a substance.
- **The removal of Oxygen** from a substance.

Example: Removal of Oxygen

When hydrogen gas is passed over heated black Copper Oxide, the black coating turns reddish-brown as it changes back into copper.

$$CuO + H_2 \xrightarrow{\text{Heat}} Cu + H_2O$$

In this reaction, Copper Oxide (CuO) is **reduced** to Copper (Cu) because oxygen is removed from it.

Redox

A **Redox Reaction** is a chemical reaction in which **Reduction** and **Oxidation** take place simultaneously. The name "Redox" itself is a combination of **Red**uction and **Ox**idation.

1. Identifying Redox (Oxygen/Hydrogen Method)

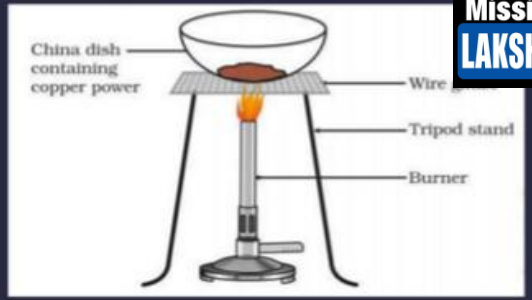
Let's look at the classic example used in Class 10: The reaction between Copper Oxide and Hydrogen gas.

$$CuO + H_2 \xrightarrow{\Delta} Cu + H_2O$$

- **Oxidation:** Hydrogen (H_2) gains oxygen to become H_2O. Therefore, H_2 **is oxidized**.
- **Reduction:** Copper Oxide (CuO) loses oxygen to become Cu. Therefore, CuO **is reduced**.

Reaction of Copper Powder with Oxygen

- **Aim: To observe the oxidation of copper when heated.**
- **Observation: Copper powder (reddish-brown) turns black on heating. Black layer of CuO (copper oxide) forms.**
- **Conclusion: Copper undergoes oxidation, forming CuO. This is an exothermic reaction (heat is released).**
- **Reaction: $2Cu + O_2 \rightarrow 2CuO$**



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Practice Question

Identify the following in the reaction given below:

$$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$$

1. Which substance is **oxidized**?
2. Which substance is **reduced**?
3. Which one is the **oxidizing agent**?
4. Which one is the **reducing agent**?

Corrosion

Corrosion is a natural process where metals are gradually destroyed by the action of air, moisture, or chemicals (like acids) on their surface.

Chemically, it is an **oxidation reaction** where the metal loses electrons to oxygen in the environment.

1. Common Examples of Corrosion

- **Rusting of Iron:** When iron is exposed to moist air for a long time, it acquires a coating of a brown flaky substance called **rust**.
  - **Formula for Rust:** $Fe_2O_3 \cdot xH_2O$ (Hydrated Ferric Oxide)
  - **Condition:** Both **Oxygen** and **Water** are essential for rusting.
- **Tarnishing of Silver:**
  Silver articles become **black** after some time when exposed to air. This is because silver reacts with Sulphur in the air to form a coating of Silver Sulphide.
  - **Equation:** $2Ag + H_2S \rightarrow Ag_2S\ (\text{Black}) + H_2$

PREVENTING CORROSION

Painting

Greasing or oiling

Alloying

Metals after corrosion prevention be like:

Rancidity

Rancidity is the process of complete or incomplete oxidation of fats and oils when they are exposed to air, light, or moisture.

How to identify Rancidity?

Unpleasant Smell: The food starts smelling "off" or sour.

Bad Taste: The taste becomes stale or bitter.

Color Change: In some cases, the physical appearance or color of the food might change.

2. Prevention of Rancidity

Since rancidity is caused by oxidation, we can prevent it by stopping oxygen from reaching the food:

- **Adding Antioxidants:** These are substances that prevent oxidation. They are often added to foods containing fats and oils (e.g., BHA and BHT).
- **Vacuum Packing:** Removing all air from the packaging before sealing it.
- **Nitrogen Flushing:** This is why your chips packets are always "full of air." Manufacturers flush the bags with **Nitrogen gas**. Nitrogen is an inert gas that prevents the chips from coming into contact with oxygen, keeping them fresh and crunchy.
- **Refrigeration:** Storing food at low temperatures slows down the rate of oxidation.
- **Airtight Containers:** Using sealed containers reduces the amount of fresh oxygen available to react with the food.
- **Storing away from Light:** Keeping food in dark places or opaque containers slows down the photolytic oxidation of fats.

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Q. What is corrosion? Write one example. Mention two methods to prevent corrosion.

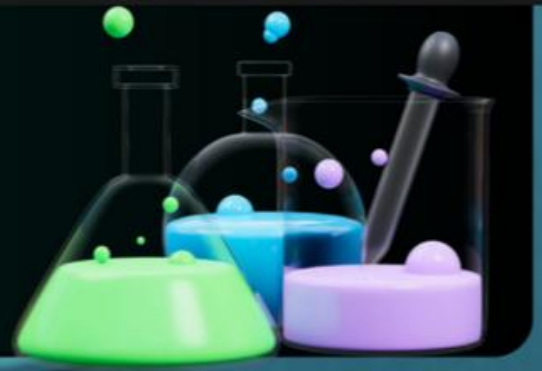
Q. Assertion (A): Iron articles rust in the presence of air and moisture.
Reason (R): Rust is hydrated ferric oxide.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.



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Thank You Bachooo.....

"In the chemistry of life, be the reactant that starts amazing transformations!"