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CLASS X - SCIENCE

CHEMICAL REACTION AND EQUATIONS-I

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Notes X

Abhay

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TOPICS TO BE COVERED

- Change and its classification
  - Physical change & Chemical change
- Chemical reaction and Chemical equation
- Balancing a chemical equation
- Limitations of chemical equation and their removal
- Types of chemical reactions
  - Combination reaction
  - Decomposition reaction and its types

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PK HITS🔥

- Balancing (MCQs)
- Type of Reaction and Example (Specially Decomposition) → 3 March
- Color Change Activities
- Redox

CHANGE

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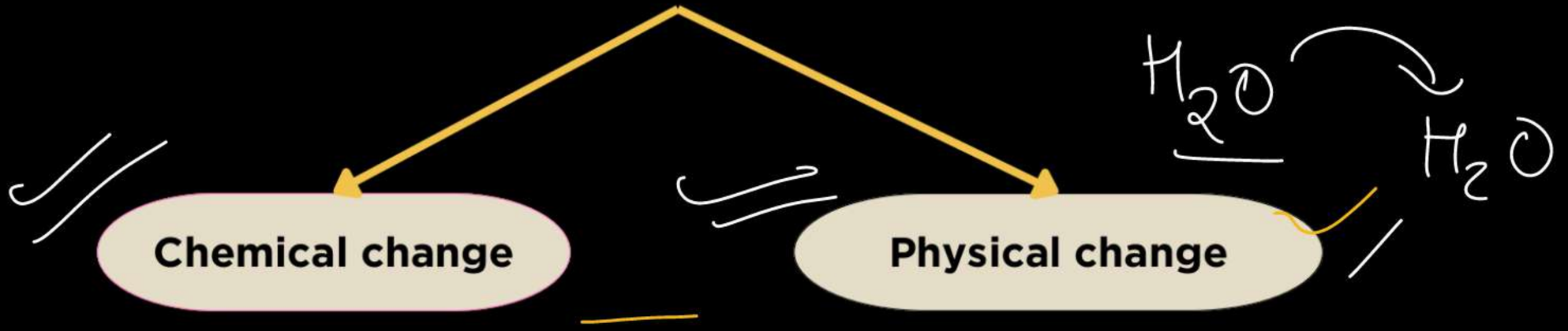
A change is a process in which the final state of a substance differs from its initial or original state.

CLASSIFICATION OF CHANGE



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Which change is this?

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PHYSICAL CHANGE

Shape/Size/Physical state change e.g. melting of chocolate, or Ice.

Breaking glass

Folding paper

Chopping Wood

Boiling water

CHEMICAL CHANGE

Composition change along with a change in shape/size/state e.g., Rusting of Iron or burning of wood.

Iron rust

Burning Wood

Baking a Cake

Metabolism

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In a Chemical reaction:

Ekdum se sb badal gya!

When a candle burns both physical and chemical changes takes place.

Physical change - changing of shape due to melting

Chemical change - combustion of fuel in presence of oxygen.

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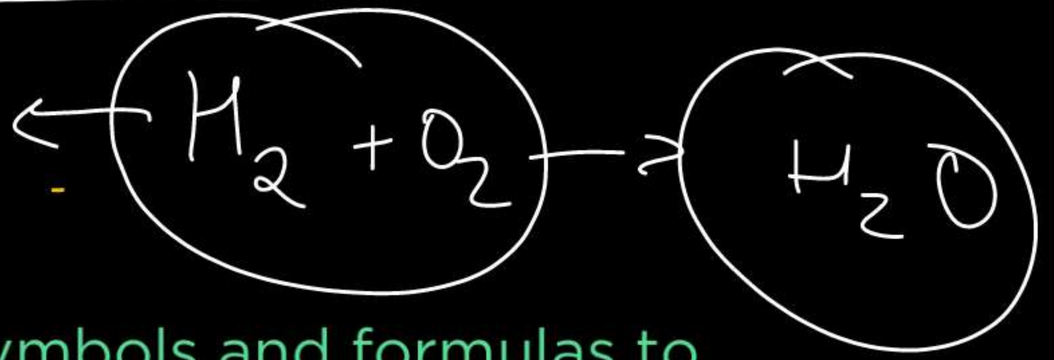
CHEMICAL REACTION

A chemical reaction is a process in which substances undergo a transformation, resulting in the formation of new substances with different chemical properties.



CHEMICAL EQUATION

It shows a chemical reaction using symbols and formulas to represent the reactants and products involved

For eg: Hydrogen (H2) + Oxygen (O2) → Water (H2O)

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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

NCERT ACTIVITY

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$Mg + O_2 \rightarrow MgO$

Activity: Burning of Magnesium Ribbon

Aim: To observe the burning of magnesium ribbon.

Procedure:

- Clean a 2 cm magnesium ribbon with sandpaper.
- Hold it with tongs and heat it in a flame.

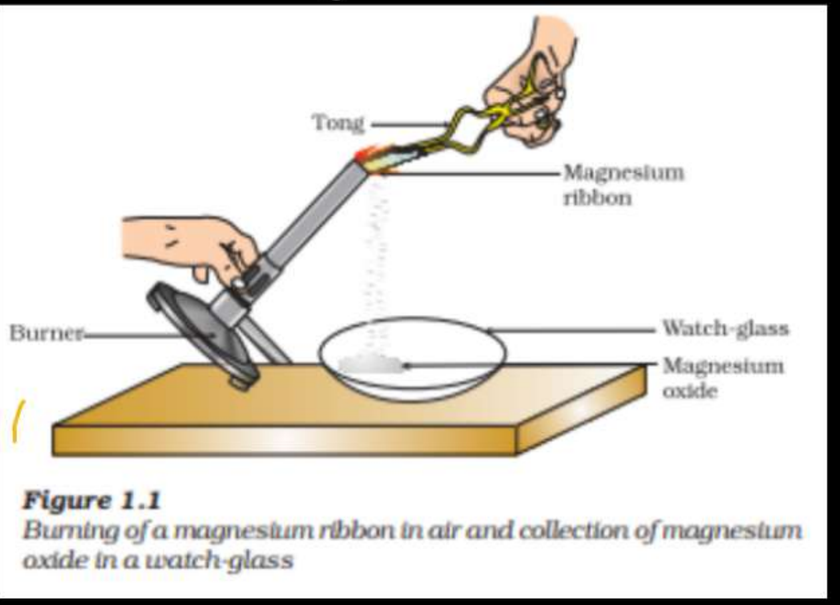

Figure 1.1
Burning of a magnesium ribbon in air and collection of magnesium oxide in a watch-glass

Observation:

- Burns with a white dazzling flame.
- Forms white ash (magnesium oxide).

Conclusion: Magnesium reacts with oxygen to form magnesium oxide (MgO).

Reaction: $2Mg + O2 \rightarrow 2MgO$

CHARACTERISTICS OF CHEMICAL REACTION

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Indicators which tell us whether the reaction took place or not

I. Change in Color

$Fe + CuSO_4$ (Blue) $\rightarrow FeSO_4$ (Blue green) $+ Cu$

II. Change in temperature

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

Exothermic Reaction

III. Change in state

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ (i.e. from gas to liquid)

CHARACTERISTICS OF CHEMICAL REACTION

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Activity

→ H_2SO_4

VI. Evolution of gas

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

V. Formation of precipitate → Insoluble Substance

$Pb(NO_3)_2(aq) + KI(aq) \rightarrow PbI_2(s) + KNO_3(aq)$

VI. Endothermic reaction (energy is absorbed)

$CaCO_3 + Heat \rightarrow CaO + CO_2$ (photosynthesis is an endothermic reaction)

CaO

VII. ~~Endo~~thermic reaction (energy is absorbed)

$CaO + H_2O \rightarrow Ca(OH)_2 + Heat$ (Digestion and respiration are exothermic reactions)

Hydrogen Test

↳ Pop Sound Test

NAME AND SYMBOLS OF SOME IONS

MgO

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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.

It must follow the *law of conservation of mass* *that is* , mass is neither created nor destroyed in a chemical reaction.

$$H_2 + O_2 \rightarrow H_2O$$

Not a balanced reaction

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LET'S LEARN HOW TO BALANCE AN EQUATION

Step 1. Writing the chemical reaction in word form.

$$\text{Iron} + \text{Steam} \xrightarrow[Fe]{} \text{Magnetite} + \text{hydrogen gas}$$

Step 2. Writing the chemical symbols in the form of a skeletal chemical equation

$$(3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2)$$

Step 3. List the number of atoms of different elements

Element	Number of atoms (Reactants)	Number of atoms (Products)
Fe	1 × 3	3
H	2 × 4 = 8	2 × 4
O	1 × 4	4

LET'S LEARN HOW TO BALANCE A EQUATION

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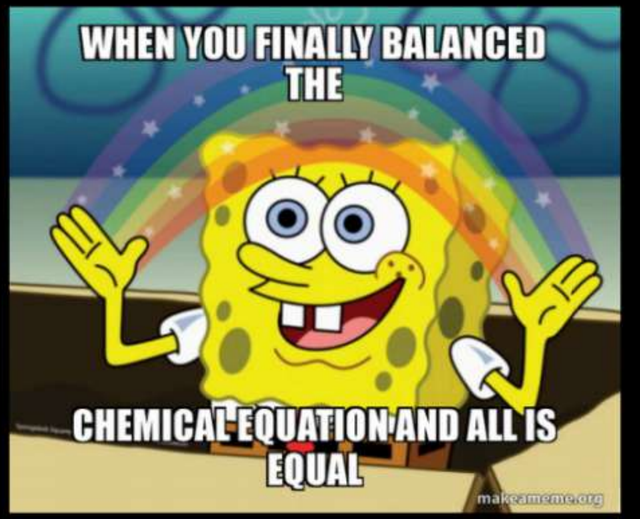
Step 4. Start balancing the compound (reactant of product) that contains the maximum number of atoms. In that compound, balance the element with the maximum number of atoms

Element	Number of atoms (Reactants)	Number of atoms (Products)
Fe	1x3 = 3	3
H	2x4 = 8	2x4 = 8
O	1x4 = 4	4



Cu 1 1×2

O 2 1×2

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Balance the following equations:

1. $\_2\_ Cu + \_1\_ O_2 \rightarrow \_2\_ CuO$
2. $\_4\_ Al + \_3\_ O_2 \rightarrow \_2\_ Al_2O_3$
3. $\_6\_ HCl + \_1\_ Al_2O_3 \rightarrow \_2\_ AlCl_3 + \_3\_ H_2O$

Al 1×4 2×2=4

O 2×3 3×2
=6 =6

Al → 2 1×2

H → 1×6 2×3

Cl → 1×6 3×2=6

O → 3 1

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Q. After balancing the below equation, find the values of a, b, c, and d.

$$aAl_2(SO_4)_3 + bBaCl_2 \rightarrow cAlCl_3 + dBaSO_4$$

$2a = 1c$

$3a = 1d$

$b = d$

$2b = 3c$

$a = 1$

$c = 2$

$d = 3$

$b = 3$

Q. Balance the following chemical equations:

(a) $HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + H_2O$

(b) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

(c) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl$

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Q. In the chemical reaction: a SiO_2 + b HF → c SiF_4 + d H_2O

The values of a, b, c, and d are:

(a) a = 1, b = 1, c = 4, d = 2

(b) a = 1, b = 4, c = 1, d = 2

(c) a = 1, b = 2, c = 1, d = 4

(d) a = 2, b = 1, c = 2, d = 4

$a = c \Rightarrow a = 1$

$2a = d \Rightarrow c = 1$

$b = 2d \Rightarrow d = 2$

$b = 4c \Rightarrow b = 4$

LIMITATIONS OF CHEMICAL EQUATIONS

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(aq)

Doesn't tell about the physical state of reactants ✗

Can't predict whether an equation is reversible or not? ✗

Actual concentration are unknown ✗

$BaSO_4(aq)$

Is reaction complete or not? ✗

Not knowing the parameters that affect a chemical reaction such as temperature ✗

(g)

$$H_2(g) + O_2(g) \longrightarrow H_2O(\ell)$$

CATALYST

A substance that increases or decreases the reaction rate without itself being consumed in the reaction.

E.g., Formation of ammonia (Haber's Process) - Fe (+ve catalyst).
Decomposition of Hydrogen peroxide - Phosphoric acid (-ve catalyst.

TYPES OF CHEMICAL REACTIONS

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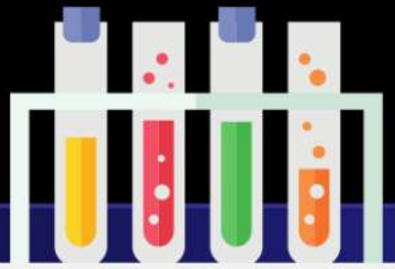
- Combination reaction
- Decomposition reaction
- Displacement reaction
- Double-Displacement reaction



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COMBINATION REACTION

A combination or synthesis reaction is a chemical reaction where two or more substances combine to form a single new substance.

$$A + B \rightarrow AB$$

$2Mg\ (s) + O2\ (g) \rightarrow 2MgO\ (s)$ [Burning of Magnesium Ribbon]

COMBINATION OF TWO COMPOUNDS

$$AB + CD \rightarrow ABCD$$

COMBINATION OF AN ELEMENT AND A COMPOUND

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$$AB + C \longrightarrow ABC$$

Ex - Oxidation of sulphur dioxide

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

COMBINATION REACTION AND ITS TYPES:

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(i) **Reaction of Calcium Oxide (Quick Lime) with Water**

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

Explanation: Quick lime reacts with water to form slaked lime (Calcium hydroxide), releasing heat (exothermic reaction).

Use in White washing: Slaked lime reacts with carbon dioxide in the air after 2-3 days, forming a shiny layer of calcium carbonate ($CaCO_3$) on walls:

$$Ca(OH)_2\ (aq) + CO_2\ (g) \rightarrow CaCO_3\ (s) + H_2O\ (l)$$

(ii) **Formation of Water** : $2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (l)$

(iii) **Burning of Coal** : $C(s) + O_2\ (g) \rightarrow CO_2\ (g)$

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$N_2 + O_2 \xrightarrow{\Delta} NO_2$

$CaO + H_2O$

Are all combination reactions exothermic?

No, not all combination reactions are exothermic.

E.g., N2(g) + 02(g) → N02 (g)

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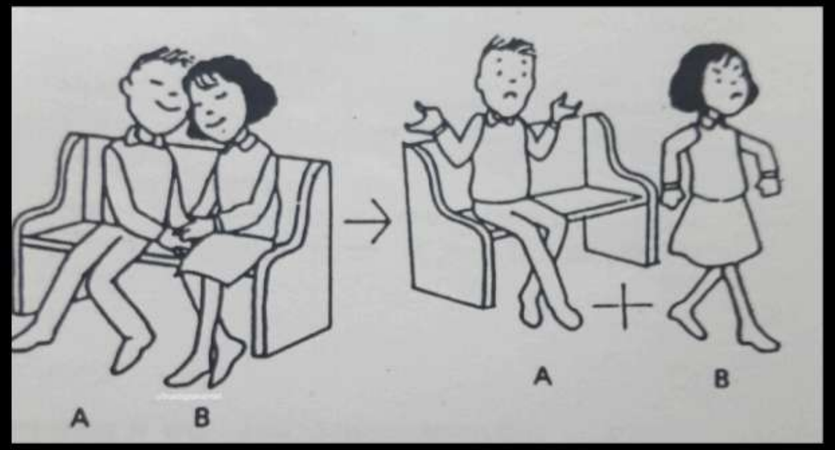
DECOMPOSITION REACTION

A chemical reaction in which a single compound breaks down into two or more elements or compounds when the energy is supplied in the form of heat, electricity or sunlight.



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TYPES OF DECOMPOSITION REACTION

Thermolysis

Electrolysis

Photolysis

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THERMOLYTIC DECOMPOSITION

A compound breaks down into simpler substances when ***heated***.

Thermolysis of lead nitrate

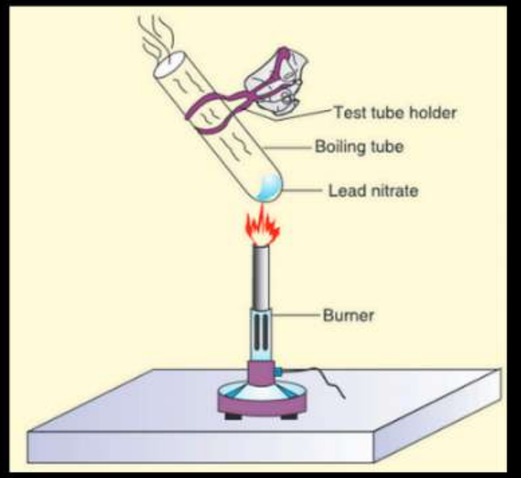
Metal nitrate + heat → Metal oxide + Nitrogen dioxide + Oxygen

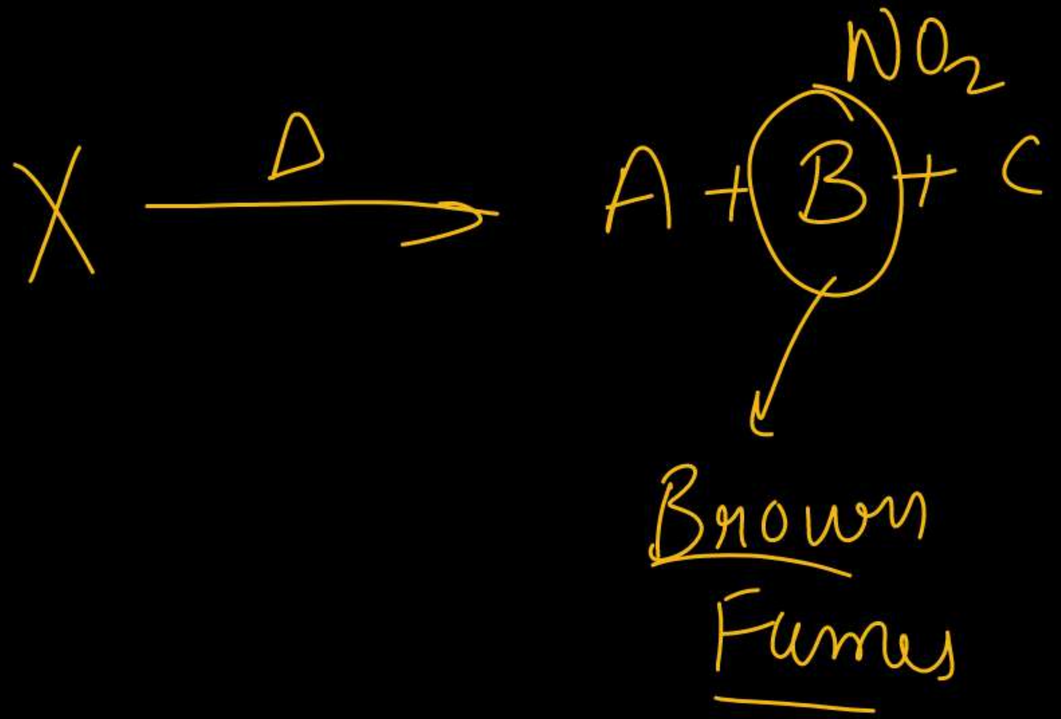
Thermal decomposition of lead nitrate:

- **On heating lead nitrate, it decomposes to yellow lead monoxide, brown nitrogen dioxide fumes, and oxygen gas:**

(write) $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$ (yellow)

- **Lead nitrate (colorless) forms yellow lead oxide, while NO_2 appears as brown fumes.**




X
Δ
A + B + C
NO2
Brown Fumes

NCERT ACTIVITY

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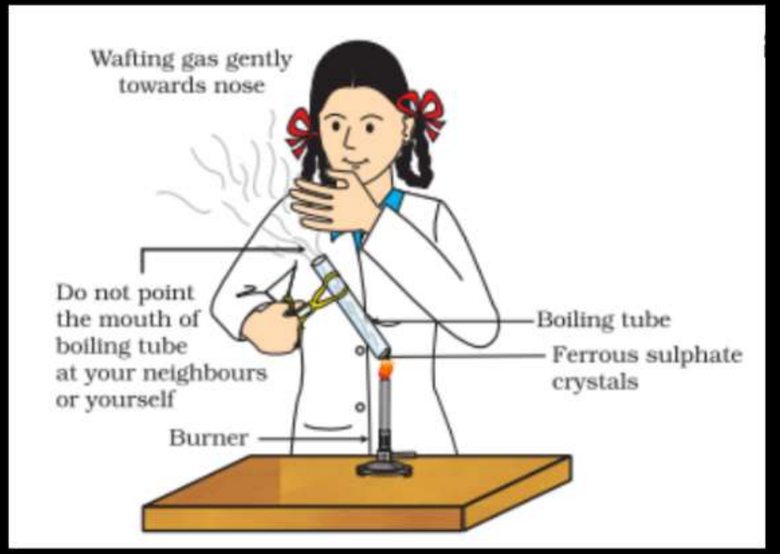
Aim: To observe the decomposition of ferrous sulphate.



Observations:

- On heating, ferrous sulphate crystals lose water and change color. (Green → White)
- $FeSO_4 \cdot 7H_2O \rightarrow FeSO_4 + 7H_2O$

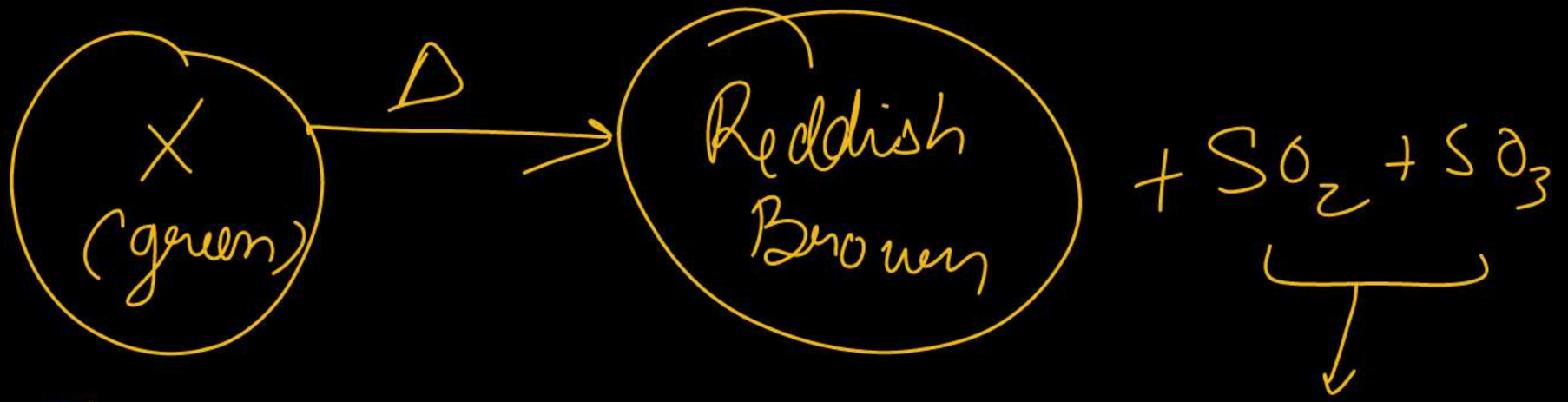
The green crystals of ferrous sulphate turn into a reddish-brown residue (ferric oxide) with the evolution of sulphur dioxide (SO_2) and sulphur trioxide (SO_3):

- $2FeSO_4\ (s) \rightarrow Fe_2O_3\ (s) + SO_2\ (g) + SO_3\ (g)$.

(Brown)

Conclusion:

- Ferrous sulphate decomposes into ferric oxide and releases SO_2 and SO_3 gases.
- This is a thermal decomposition reaction.



$FeSO_4 \cdot 7H_2O$

Fe_2O_3

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Thermolysis of hydrated ferrous sulphate

$FeSO_4.7H_2O\ (s) + heat \rightarrow FeSO_4\ (s) + 7H_2O\ (g)$

White color

$2FeSO_4\ (s) + heat \rightarrow Fe_2O_3\ (s) + SO_2\ (g) + SO_3\ (g).$

(reddish brown)

Thermolysis of hydrated copper sulphate

$CuSO_4.5H_2O\ (s) + heat \rightarrow CuSO_4\ (s) + 5H_2O\ (g)$

White color

(Blue)

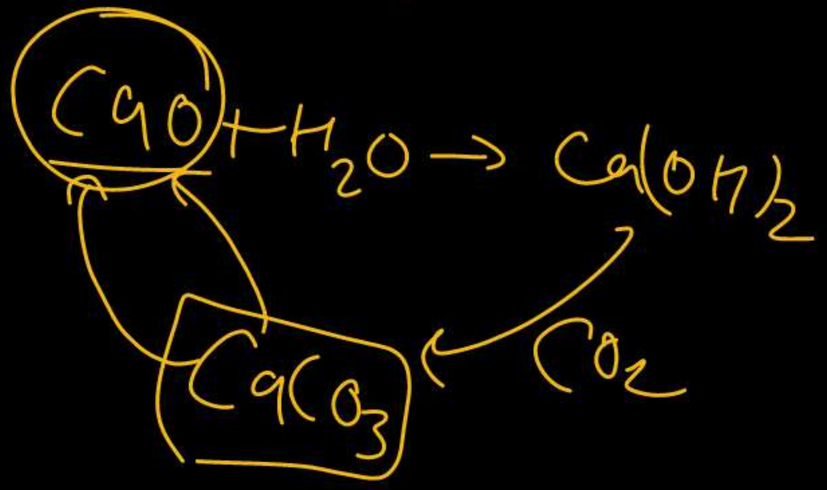
$2CuSO_4\ (s) + heat \rightarrow 4CuO\ (s) + 2SO_2\ (g) + SO_3\ (g) + O_2(g)$

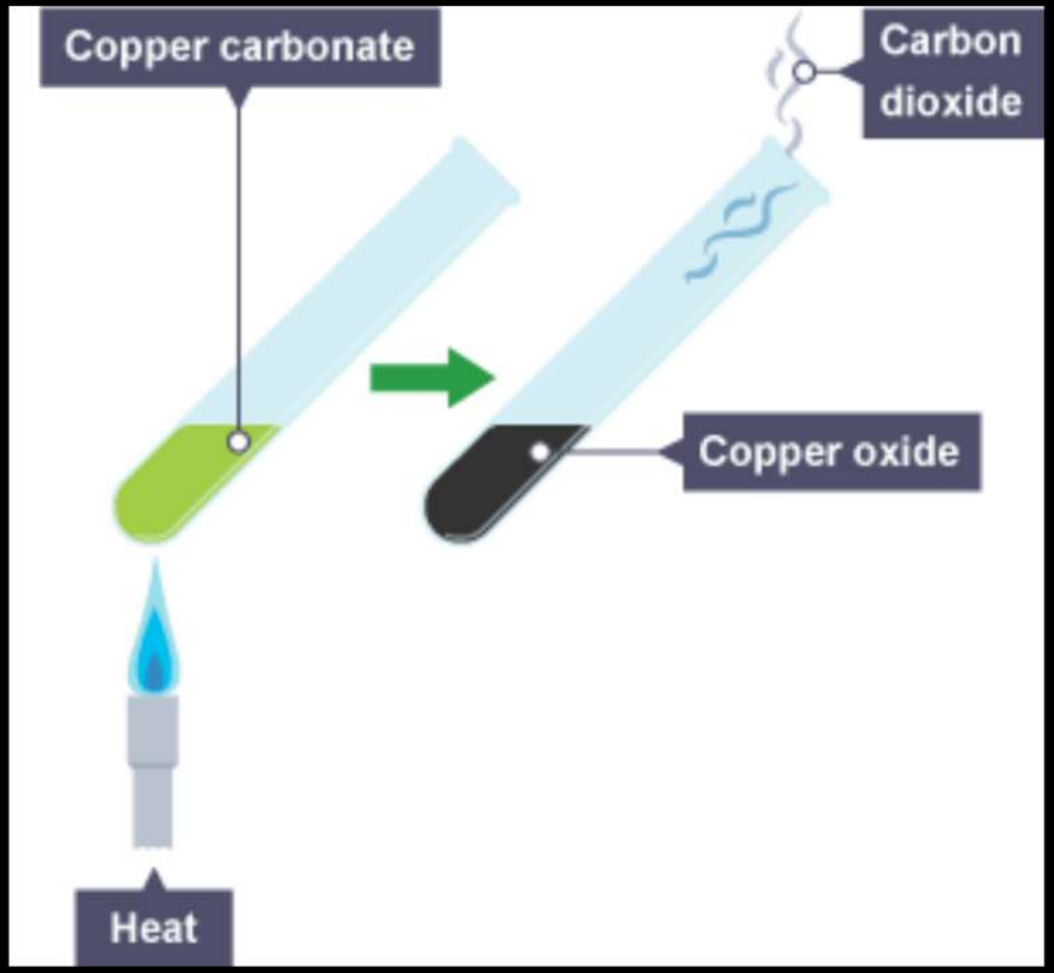
(Black)

Thermolysis of Calcium Carbonate

$CaCO_3(s) + heat \rightarrow CaO(s) + CO_2(g)$

Quicklime





ELECTROLYTIC DECOMPOSITION

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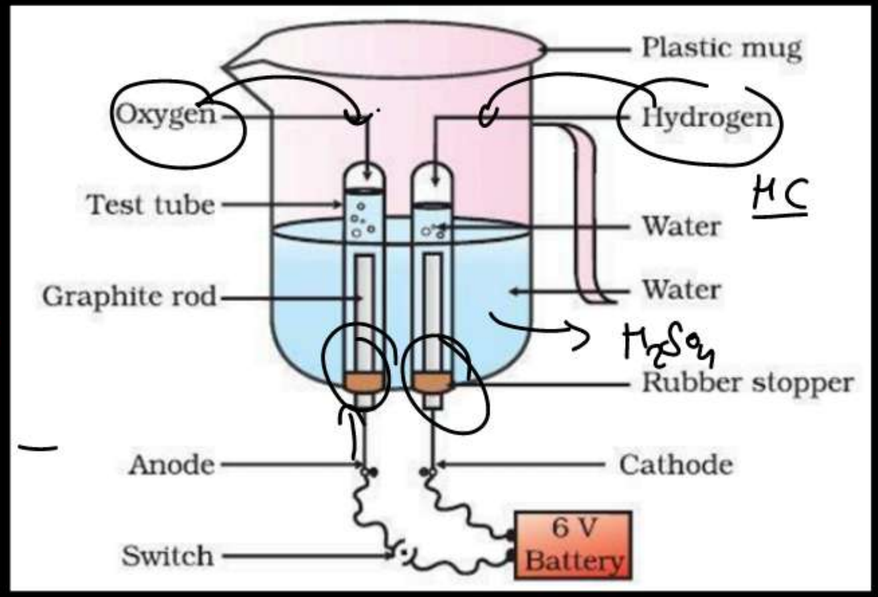
An ***electric current*** is used to decompose or break down compounds into their constituent elements or ions.

Electrolysis of lead nitrate

When an electric current is passed through water, it breaks down into hydrogen gas (H2) at the cathode and oxygen gas (O2) at the anode.

$H_2 : O_2$ 2:1

2H2O (l) + electricity → 2H2 (g) + O2 (g)



ELECTROLYTIC DECOMPOSITION

Electrolysis of sodium chloride

When an aqueous solution of sodium chloride (table salt) is subjected to electrolysis, it decomposes into chlorine gas (Cl2) at the anode and hydrogen gas (H2) at the cathode.

Anode

Cathode

2NaCl (l) + electricity → 2Na (s) + Cl2 (g) + H_2↑

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PHOTOLYTIC DECOMPOSITION

These are initiated by exposure to light.

Photolysis of Silver chloride

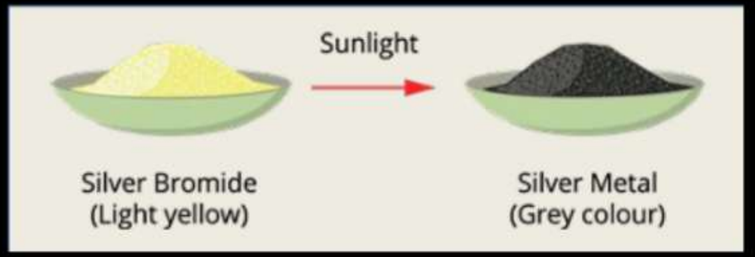
$$2AgCl\ (s) + \text{sunlight} \rightarrow 2Ag\ (s) + Cl_2\ (g)$$

White — Grey

Photolysis of Silver bromide

$$2AgBr\ (s) + \text{sunlight} \rightarrow 2Ag\ (s) + Br_2\ (g)$$

light yellow — Grey



These reaction of silver halides is used in Black and White photography.

NCERT ACTIVITY

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Observation:

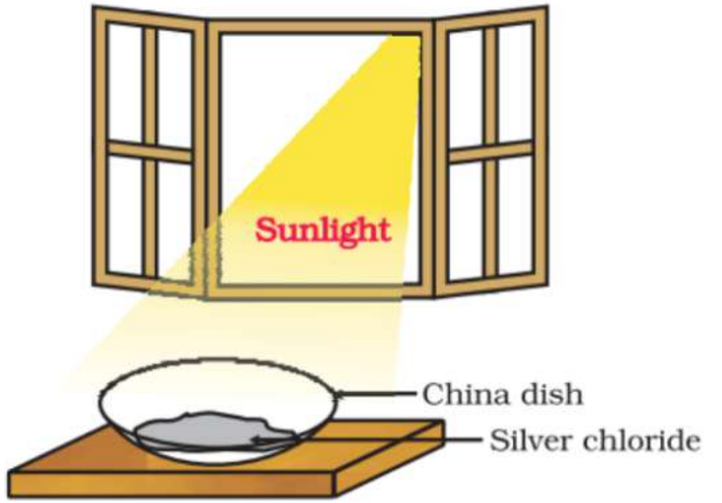
1. Silver chloride (AgCl) is white in color.
2. When 2 g of silver chloride is placed in sunlight, its color changes from white to grey.

Reaction:

- $2AgCl(s) + Sunlight \rightarrow 2Ag(s) + Cl_2(g)$
- White → Grey (due to silver metal formation).
- Chlorine gas (yellowish-green) is released.

Conclusion:

- Silver chloride decomposes into silver and chlorine gas in the presence of sunlight.
- This reaction is a photolysis reaction, as sunlight initiates the decomposition.



Activity 1.8

- Take about 2 g silver chloride in a china dish.
- What is its colour?
- Place this china dish in sunlight for some time (Fig. 1.7).
- Observe the colour of the silver chloride after some time.

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Are all decomposition reactions endothermic?

Yes all decomposition reactions are endothermic. Decomposition reactions involve breaking of bonds which require energy.

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1. When 2 mL of sodium hydroxide solution is added to a few pieces of granulated zinc in a test tube and warmed, the reaction that occurs can be written as a balanced chemical equation. Which of the following is correct?

(a) $NaOH + Zn \rightarrow NaZnO_2 + H_2O$
(b) $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$
(c) $2NaOH + Zn \rightarrow NaZnO_2 + H_2$
(d) $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2O$

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2. Which of the following is a combination reaction?

(a) $CaO + H_2O \rightarrow Ca(OH)_2$

(b) $2H_2O_2 \rightarrow 2H_2O + O_2$

(c) $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

(d) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

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3. Which of the following is a decomposition reaction?

(a) $NaOH + HCl \rightarrow NaCl + H_2O$

(b) $NH_4CHNO \rightarrow H_2NCONH_2$

(c) $2KClO_3 \rightarrow 2KCl + 3O_2$

(d) $H_2 + I_2 \rightarrow 2HI$

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4. Which of the following is not correct?

Kl Pta lgega

(a) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

(b) $2Ag + Cu(NO_3)_2 \rightarrow 2AgNO_3 + Cu$

(c) $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

(d) $Mg + 2HCl \rightarrow MgCl_2 + H_2$

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5. In an electrolytic cell where electrolysis is carried, anode has:

(a) Positive change
(b) Negative charge
(c) Connected to negative terminal of the battery
(d) None of these is correct.

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6. Assertion: "All decomposition reactions are endothermic."
Reason: Energy is required to break chemical bonds in the reactant.

Options:

A. Both Assertion and Reason are true, and Reason is the correct explanation.
B. Both Assertion and Reason are true, but Reason is not the correct explanation.
C. Assertion is true, but Reason is false.
D. Both Assertion and Reason are false.

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7. What is a balanced chemical equation? Why is it important to balance a chemical equation, and which law is followed while doing so?

A balanced chemical equation is one in which the number of atoms of each element is the same on both sides (reactant and product side) of the equation.
Balancing a chemical equation is important because it ensures that the law of conservation of mass is followed. This law states that mass can neither be created nor destroyed in a chemical reaction. Therefore, the total mass of the reactants must be equal to the total mass of the products, ensuring that the number of atoms of each element remains unchanged during the reaction.