CHEMICAL REACTIONS AND EQUATIONS

100% Paper Yahi se banega

Topics Covered

- Balancing a Chemical Reaction
- Types of Reactions
  - → Combination
  - → Decomposition
  - → Displacement
  - → Double Displacement
- Heat in Reaction
- Oxidation Reduction – Corrosion & Rancidity
- Physical & Chemical Change

Chemical Reaction

- A process in which new Chemical(s) are formed
- Hydrogen gas react with oxygen gas to produce water under some condition

Chemical Equation

- Simple representation of a chemical reaction with symbols and formula

$$\underset{\text{Hydrogen}}{H_2\,(g)} + \underset{\text{Oxygen}}{O_2\,(g)} \rightarrow \underset{\text{Water}}{H_2O(l)}$$

Reactants → Products

(aq)	(ppt ↓)	(s)	(l)	(g ↑)
soluble in water	insoluble in water	solid	liquid	gas

How to write Chemical Formula

Name of ions	Symbol & Valency
Sodium	Na^+
Potassium	K^+
Silver	Ag^+
Copper (I)	Cu^+
Magnesium	Mg^{2+}
Calcium	Ca^{2+}
Zinc	Zn^{2+}
Iron (II) (Ferrous)	Fe^{2+}
Copper (II)	Cu^{2+}
Lead (II)	Pb^{2+}
Barium	Ba^{2+}
Aluminium	Al^{3+}
Iron (III) (Ferric)	Fe^{3+}

Non-metallic	Symbol	Polyatomic ions	Symbol
Hydrogen	H^+	Ammonium	NH_4^+
Hydride	H^-	Hydroxide	OH^-
Chloride	Cl^-	Nitrate	NO_3^-
Bromide	Br^-	Hydrogen carbonate	HCO_3^-
Iodide	I^-	Carbonate	CO_3^{2-}
Oxide	O^{2-}	Sulphite	SO_3^{2-}
Sulphide	S^{2-}	Sulphate	SO_4^{2-}
Nitride	N^{3-}	Phosphate	PO_4^{3-}

- **Sodium Chloride**

$Na^{+1}\ Cl^{-1} \rightarrow NaCl$

- **Aluminium Chloride**

$Al^{3+}\ Cl^{-1} \rightarrow AlCl_3$

- **Ferrous Sulphate**

$Fe^{2+}\ SO_4^{2-} \rightarrow FeSO_4$

- **Lead Nitrate**

$Pb^{2+}\ NO_3^{1-} \rightarrow Pb(NO_3)_2$

Balanced Chemical Equation

- **Number of atoms of each element in a chemical equation should be the same on LHS & RHS**

$$A_2\,(g) + B_2\,(g) \rightarrow 2AB\,(g)$$

4g 6g 10g

Why Balance ?

- **Total mass of reactants should be equal to total mass of products**
- Law Of Conservation of mass - mass can neither be created , nor be destroyed under ordinary conditions.

Practice :

1. $3\,Fe + 4\,H_2O \rightarrow Fe_3O_4 + 4\,H_2$

1 - Metals - K, Na , Ag , Cu, Mg, Zn, Ca , Fe, Al, Mn, Pb, Ba
2 - Non - Metals - Cl, Br, S, N, C, P,
3 - O
4 - H

Repeat Until All Atoms Balance

2. $Al_2O_3 + 6\,HCl \rightarrow 2\,AlCl_3 + 3\,H_2O$

Practice :

3. $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$

4. $3BaCl_2 + Al_2(SO_4)_3 \rightarrow 3BaSO_4 + 2AlCl_3$

60 70 120 120

5. $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

CBSE (2025)

Consider the following chemical equation :

CBSE (2025)

$$p\ Al + q\ H_2O \rightarrow r\ Al_2O_3 + s\ H_2$$

To balance this chemical equation, the values of 'p', 'q', 'r' and 's' must be repectively:

$$2\ Al + 3\ H_2O \rightarrow 1\ Al_2O_3 + 3\ H_2$$

In order to balance the below chemical equation the value of x, y and z respectively are

CBSE (2023)

$$MnO_2 + x\ HCl \longrightarrow MnCl_2 + y\ H_2O + z\ Cl_2$$

$$MnO_2 + 4\ HCl \longrightarrow MnCl_2 + 2\ H_2O + 1\ Cl_2$$

Why do we balance a chemical equation ? Name and state the law that suggests the balancing of a chemical equation? Balance the following chemical equation:

$$Zn + H_3PO_4 \rightarrow Zn_3(PO_4)_2 + H_2$$

CBSE (2025)

Ans - So that total mass of reactants should be equal to total mass of products

Law Of Conservation of mass - mass can neither be created , nor be destroyed under ordinary conditions.

H.W.

$$3\,Zn + 2\,H_3PO_4 \rightarrow Zn_3(PO_4)_2 + 3\,H_2$$

Characteristics of a Chemical Reaction

F E C T S

Formation of precipitate

ex- insoluble ***$BaSO_4$***

Evolution of a Gas

Colour change

Temperature change

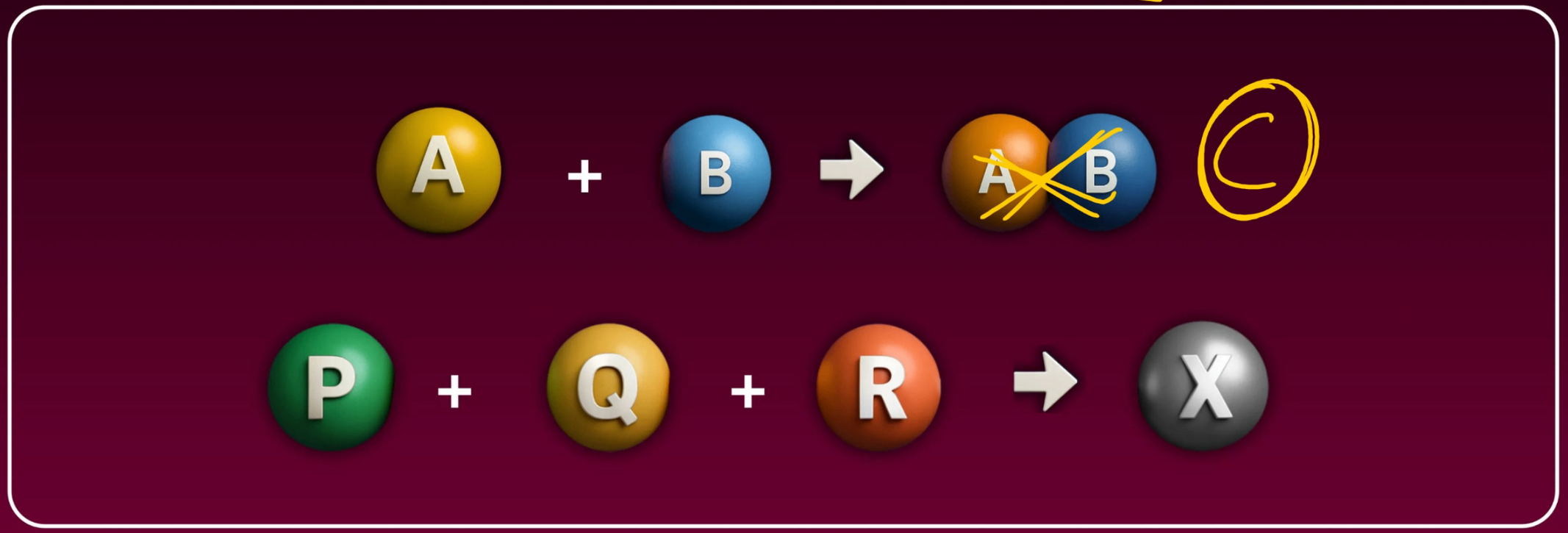
State change

TYPES OF CHEMICAL REACTION

Combination Reaction

$X + Y + Z \rightarrow S$

- Two or more reactant combine to form a single product



Burning of Magnesium Ribbon

$$2Mg\ (s) + O_2\ (g) \longrightarrow 2MgO\ (s) + Heat$$

from air

White Powder

Exothermic

DON'T FORGET

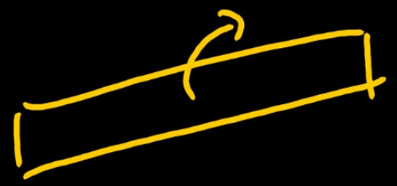
Important Points :

- Mg burns with Dazzling white flame (very bright light)
- A white MgO powder in watch glass
- Heat energy releases so temperature increases
- Combination & Exothermic Reaction

Activity 1.1

Why do we rub magnesium with sandpaper ?

Ans. To remove any layer of magnesium oxide already present on magnesium ribbon.



Why to keep magnesium ribbon away from your eyes ?

Ans. Because the reaction is exothermic & it emits dazzling white light so bright that you cannot see for a short time after looking at it.

Select from the following a statement which is not true about burning of magnesium ribbon in air:

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A It burns with a dazzling white flame

B A white powder is formed on burning

C It is an endothermic reaction

D It is an example of a combination reaction

Quicklime in Water

Quick lime → CaO
Slaked lime → $Ca(OH)_2$

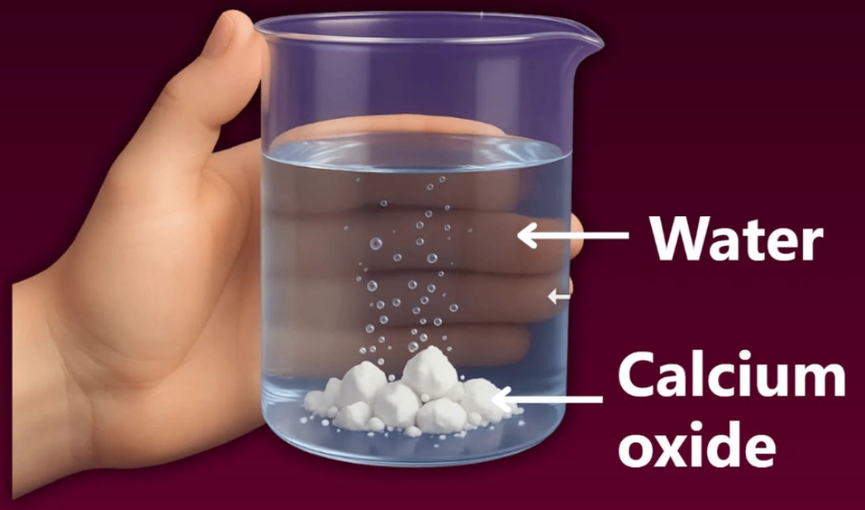
$$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2\,(aq) + Heat$$

Quick lime — Slaked lime

Important Points :

- Rise in temperature (exothermic)
- Quick lime reacts vigorously with water
- Water added slowly because reaction is exothermic
- Combination & Exothermic Reaction
- Quicklime used in making cement

Activity 1.4



The balanced chemical equation showing reaction between quicklime and water is

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A $2\ CaO + H_2O \rightarrow 2\ CaOH + H_2 + Heat$

B $CaO + H_2O \rightarrow Ca(OH)_2 + H_2 + Heat$

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

D $2\ CaO + 3\ H_2O \rightarrow 2\ Ca(OH)_3 + O_2 + Heat$

White Wash Wall

- $Ca(OH)_2$ solution is used for white washing walls.
- It reacts slowly with CO_2 (g) from air.
- $CaCO_3$ (s) is formed in 2-3 days on wall.
- This layer of $CaCO_3$ (s) gives shiny wall.

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

Calcium hydroxide (Slaked lime) + **Carbon dioxide** (From air) → **Calcium Carbonate** + **Water**

Other Examples of Combination Reaction

1) Burning of Coal

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

2) Formation of water from H2 (g) and O2 (g)

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

Select from the following a process in which a combination reaction is involved CBSE (2023)

A. Black and White photography

B. Burning of coal

C. Burning of methane

D. Digestion of food

Decomposition Reaction

$A \rightarrow B + C$

Reverse of combination ; one reactant breaks into 2 or more products

$CaCO_3$ (s) —Heat→ CaO (s) + CO_2 (g)

Limestone — Quick Lime

- Quick lime is used in making cement.

Identify the product 'X' obtained in the following chemical reaction

$$CaCO_3 \xrightarrow{\Delta} \text{'X'} + CO_2$$

$CaO + CO_2$

CBSE (2024)

A Quick lime

B Gypsum

C Limestone

D Plaster of Paris

$X \longrightarrow Y + Z$

DECOMPOSITION

Heat

(Thermal Decomposition)

Electricity

(Electrolytic Decomposition)

Light

(Photochemical Decomposition)

Thermal Decomposition - Thermolysis

Heat

$$2FeSO_4(s) \xrightarrow[\Delta]{\text{Heat}} Fe_2O_3\,(s) + SO_2\,(g) + SO_3\,(g)$$

Ferrous sulphate
Green

Ferric oxide
Reddish brown

Heat absorbed

Ferrous sulphate crystals are green in colour. On heating it loses water and changes to white colour. On further heating ferric oxide is formed which is reddish brown in colour

- *Smell of burning sulphur (matchstick) Smell of SO_2 (g) (Suffocating odour) ; pungent smell*
- *SO_2 & SO_3 are air pollutant & acidic in nature*

Thermal Decomposition & Endothermic Reaction

Hydrated Ferrous sulphate Crystals

$$FeSO_4 \cdot 7H_2O \xrightarrow{\text{Heat}} FeSO_4 + 7H_2O \quad (1)$$

Green → White

Anhydrous

$$2FeSO_4(s) \xrightarrow[\Delta]{\text{Heat}} Fe_2O_3(s) + SO_2(g) + SO_3(g) \quad (2)$$

Ferrous sulphate — White

Ferric oxide — *Reddish brown*

What is observed when hydrated ferrous sulphate crystals are heated in a dry boiling tube ? Give balanced chemical equation(s) of the reaction(s) that occur(s).

CBSE (2025)

List the possible sources of energy required in decomposition reactions. Illustrate any one with a suitable example.

CBSE (2025)

Ans Heat , Light & Electricity

Heat - Thermal decomposition of Ferrous Sulphate Crystals

$$2FeSO_4(s) \xrightarrow[\Delta]{\text{Heat}} Fe_2O_3\,(s) + SO_2\,(g) + SO_3\,(g)$$

Ferrous sulphate
Green

Ferric oxide
Reddish brown

$$2Pb(NO_3)_2(s) \xrightarrow[\Delta]{\text{Heat}} 2PbO(s) + 4NO_2(g) + O_2(g)$$

Lead nitrate (white) → Lead oxide (yellow residue) + Brown fumes

Important Points

- Cracking sound
- Brown fumes → $NO_2(g)$ – irritating smell
- Yellow solid residue → $PbO(s)$
- NO_2 gas is acidic in nature & turns moist blue litmus red

Thermal Decomposition & Endothermic Reaction

The products obtained when lead nitrate is heated in a boiling tube are:

$PbO + NO_2 + O_2$

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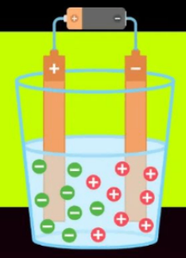
A PbO, N_2O and O_2

B NO, PbO and O_2

C $Pb(NO_2)_2$ and O_2

D NO_2, PbO and O_2

Electrolytic Decomposition / Electrolysis

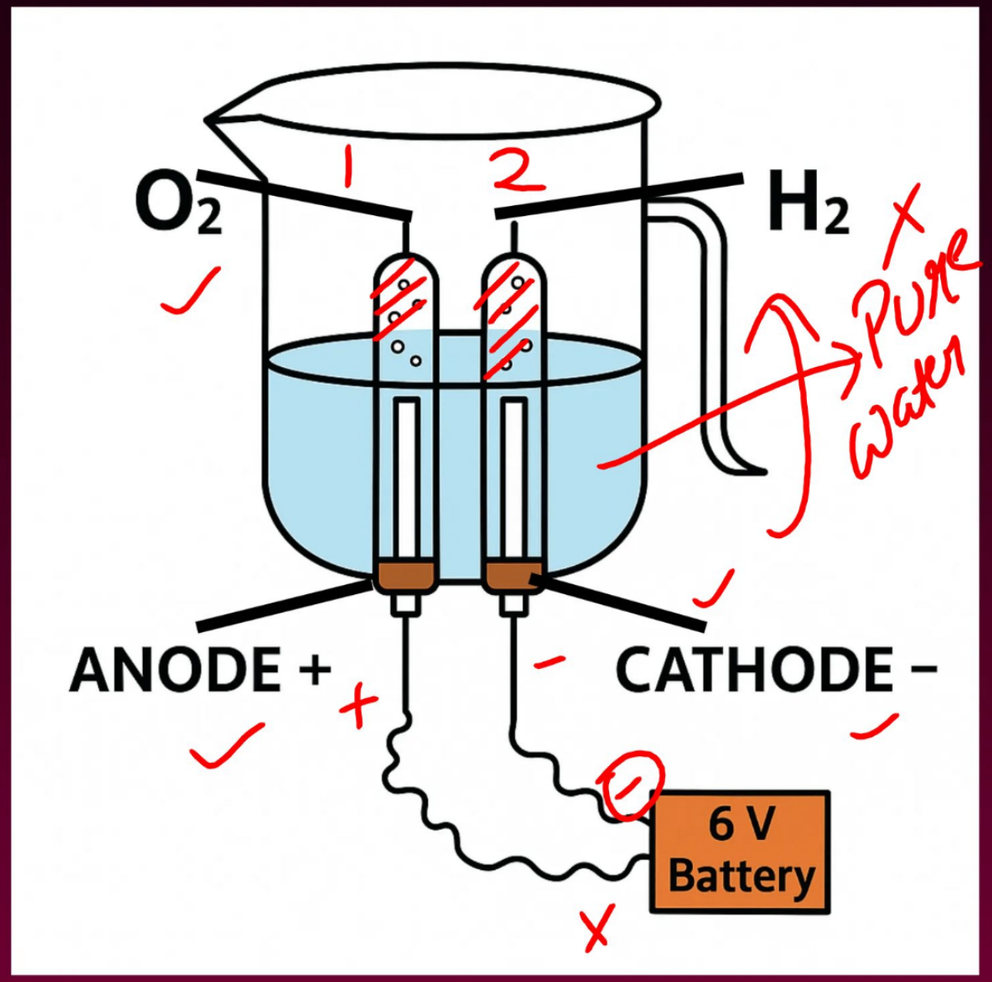


$$2H_2O\ (l) \xrightarrow{\text{Electric Current}} 2H_2\ (g) + O_2\ (g)$$

Electric Current

1 : 8 mass

2 : 1 volume



(i) H_2 gas is obtained at cathode & O_2 gas at Anode

(ii) Volume of gases $H_2 : O_2 = 2 : 1$

(ii) Mass ratio of gases $H_2 : O_2 = 1 : 8$

P A O

+ve Anode Oxygen

PAO

(iv) Burning candle is brought near

Cathode $H_2(g)$

i. Pop sound heard & candle extinguishes

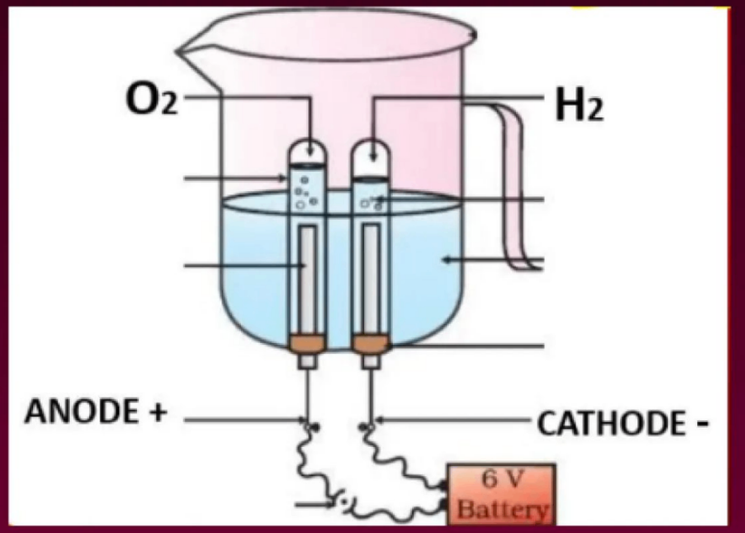
ii. Combustible but not a supporter of combustion

Anode $O_2(g)$

i. Candle burns more brightly / rekindles a glowing splinter

ii. Not combustible but a supporter of combustion

(v) Pure water is a poor conductor of electricity, so a few drops of acid are added. The acid acts as an electrolyte and allows the solution to conduct electricity.



While electrolyzing water, before passing the current some drops of an acid are added. Why? Name the gases liberated at the cathode and anode. Write the relationship between the volume of gas collected at the cathode and the volume of gas collected at the cathode.

CBSE (2023)

Pure water is a poor conductor of electricity. To make it a good conductor, a few drops of dilute acid (like dilute sulphuric acid) are added before passing the electric current.

(2)

Gas liberated at cathode: Hydrogen (H_2)

Gas liberated at anode: Oxygen (O_2)

(1)

good conductor

PAO

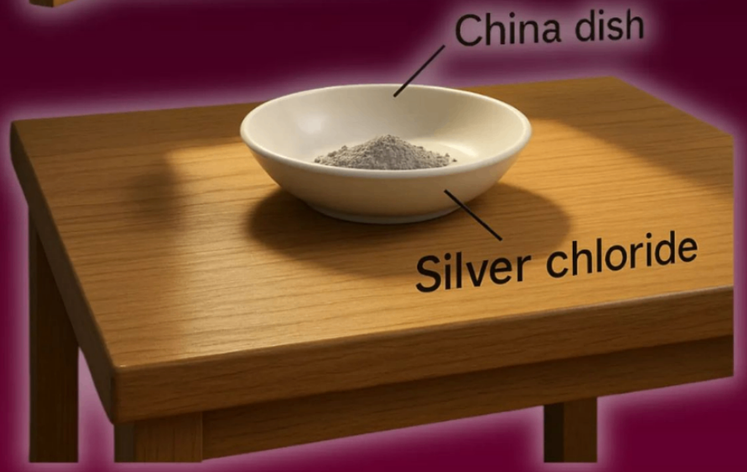
+ Anode oxygen

H_2 O_2

2 : 1

1 : 8

Photochemical Decomposition / Photolysis



$2AgCl\ (s) \xrightarrow{\text{Sunlight}} 2Ag\ (s) + Cl_2\ (g)$

(white) (Grey) (yellowish ✗ green)

$2AgBr\ (s) \xrightarrow{\text{Sunlight}} 2Ag\ (s) + Br_2\ (g)$

This is why AgCl & AgBr are kept in Black colour bottles to protect from sunlight

(Used in Black and white photography)

Silver chloride kept in a china dish turns grey in sunlight **CBSE (2023)**

A. Write the colour of silver when it was kept in the china dish

B. Name the type of chemical reaction taking place and write the chemical equation for the reaction

C. State one use of reaction. Name one more chemical which can be used for the same purpose

A. Silver chloride was white in colour when kept in the china dish.

B. The type of reaction is a photochemical decomposition reaction.

Equation:

$2AgCl\ (s) \rightarrow 2Ag\ (s) + Cl_2\ (g)$

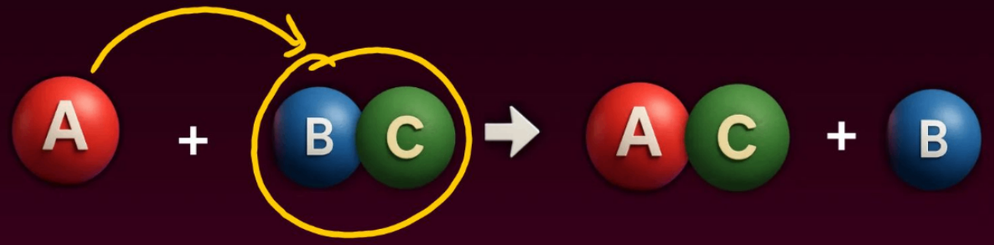
(in presence of sunlight)

C. This reaction is used in black and white photography.

Silver bromide (AgBr) can also be used for the same purpose.

Displacement Reaction

More reactive element replaces a less reactive element from its compound



A is more Reactive than B

REACTIVITY SERIES

K	Potassium	Kudi
Na	Sodium	Naal
Ca	Calcium	Car
Mg	Magneisum	Mango
Al	Aluminium	Alto
Zn	Zinc	Zisko
Fe	Iron	Fir
Pb	Lead	Lekar
H	Hydrogen	Hum
Cu	Copper	Chale
Hg	Mercury	Mathura
Ag	Silver	Saath
Au	Gold	Ghumne

Most reactive

Less reactive

$Zn\ (s) + CuSO_4\ (aq) \longrightarrow ZnSO_4 + Cu$ ✓

Blue — Colourless — Red / Brown

$Zn\ (s) + H_2SO_4\ (aq) \longrightarrow ZnSO_4 + H_2\uparrow$

$Fe\ (s) + CuSO_4\ (aq) \longrightarrow FeSO_4 + Cu$

$Cu(s) + PbSO_4(aq) \longrightarrow CuSO_4 + Pb$

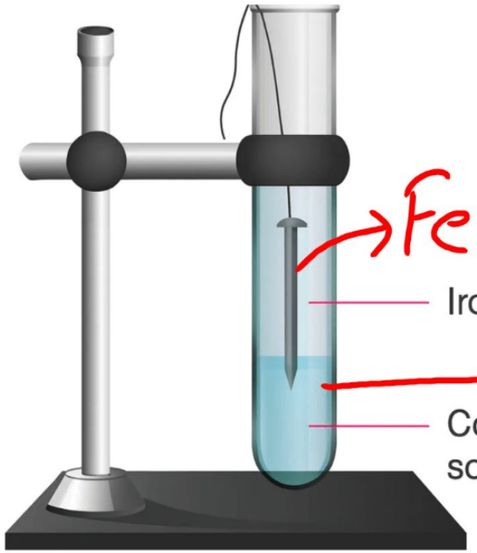
↓ Less Reactive — X

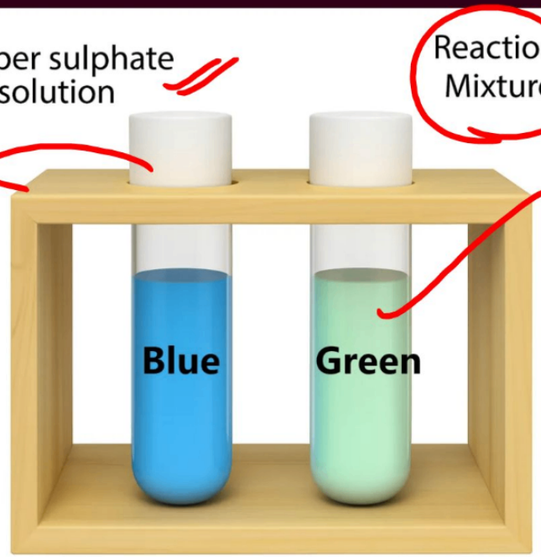
Activity 1.9

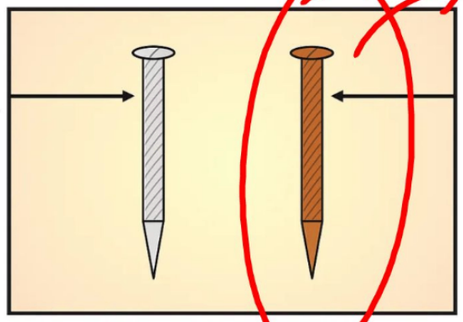
Iron Nail in Copper Sulphate Solution

$$Fe\ (s) + CuSO_4(aq) \longrightarrow FeSO_4\ (aq) + Cu\ (s)$$

Blue — Light green — Reddish Brown







Iron nail taken out from copper sulphate solution

A student has dipped some iron nails in an aqueous solution of copper sulphate. After about 25 minutes, he would observe that the colour of the solution has changed from.

CBSE (2025)

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

Blue → Green

A blue to colourless

B blue to pale green

C pale green to blue

D pale green to colourless

imp

$$Zn\ (s) + \underset{\text{dil}}{H_2SO_4\ (aq)} \longrightarrow ZnSO_4 + H_2\uparrow + \text{Heat}$$

OBSERVATIONS :

1. H_2 gas is colourless & odorless, burns with a "pop" sound & extinguishes a burning candle.
2. Temperature increases – the reaction is highly exothermic.
3. Dilute acid is used because the reaction is highly exothermic; concentrated acid would make it even more exothermic and dangerous reaction.

K
Na
Ca
Mg
Al
Zn
Fe
Pb
H
Cu
Hg
Ag
Au

Study the diagram given below and identify the gas formed in the reaction.

$$Zn + H_2SO_4(aq) \longrightarrow ZnSO_4 + H_2\uparrow$$

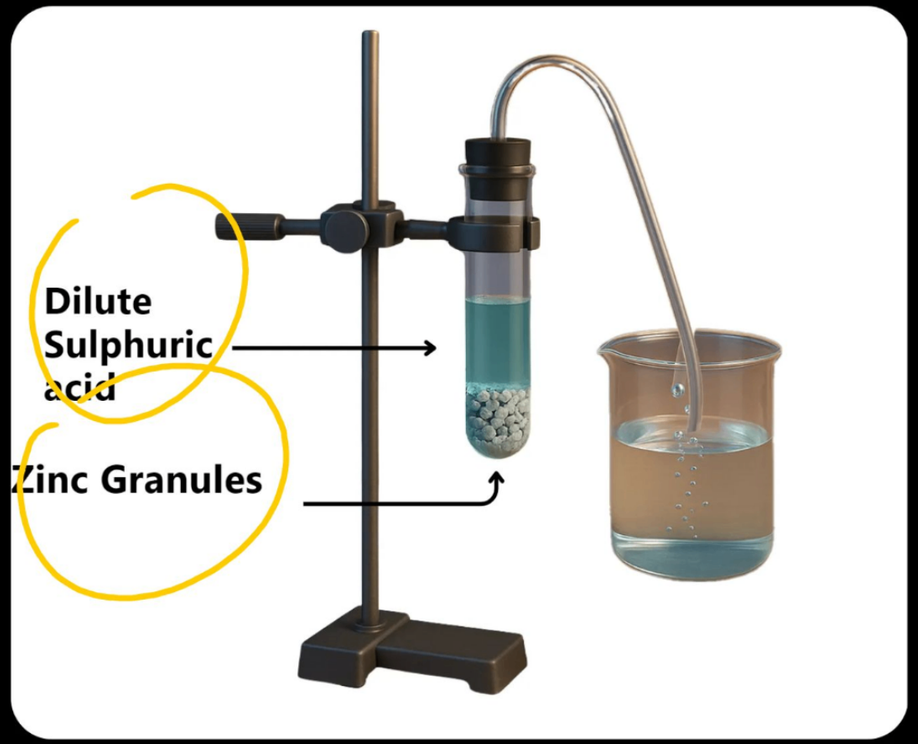
CBSE (2022)

A. Carbon dioxide, which extinguishes a burning candle

B. Oxygen, due to which a candle burns more brightly

C. Sulfur dioxide, which produces a suffocating smell

D. Hydrogen, which on burning produces a popping sound



Double Displacement Reaction

atoms X

Exchange of ions between reactants

Na_2SO_4 (aq) + $BaCl_2$ (aq) ⟶ $BaSO_4$ (s) + 2NaCl (aq)

Colourless Colourless white ppt

Which of the following reactions is different from the remaining three?

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A $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$ D.D.

B $CaO + H_2O \rightarrow Ca(OH)_2$ combination

C $KNO_3 + H_2SO_4 \rightarrow KHSO_4 + HNO_3$ D.D.

D $ZnCl_2 + H_2S \rightarrow ZnS + 2HCl$ D.D.

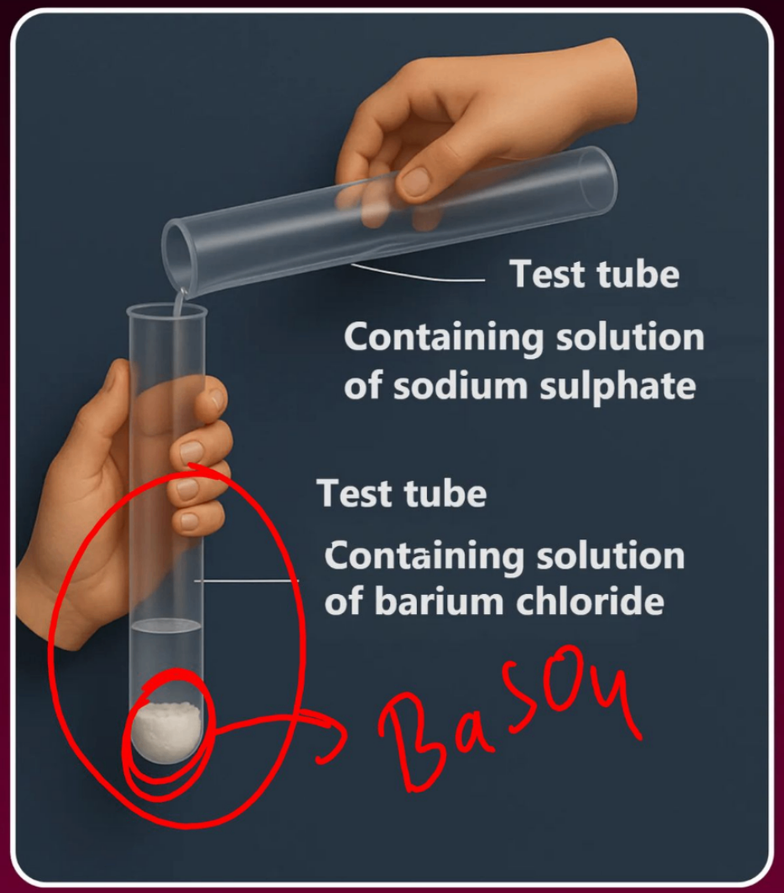
D.D. + ppt.

Sodium sulphate (aq) + Barium chloride (aq) — D.D.

Na_2SO_4 (aq) + $BaCl_2$ (aq) ⟶ $BaSO_4$ (s) + 2NaCl (aq)

Colourless Colourless

white ppt
insoluble in water



OBSERVATIONS :

(i) White insoluble substance (precipitate) of $BaSO_4$ is formed.

(ii) Double Displacement & precipitation reaction.

Precipitation Reaction – When two aqueous soluble soluble solutions react to form a semi soluble/insoluble salt, the salt is called precipitate & such reaction is called precipitation reaction

(iii) ions in solution - After Reaction Na^+, Cl^-

What is observed when an aqueous solution of sodium sulphate is added to an aqueous solution of barium chloride taken in a test tube? Write chemical equation for the reaction that occurs and name the type of reaction.

Ans

CBSE (2025)

White insoluble substance (precipitate) of $BaSO_4$ is formed.

$$Na_2SO_4\,(aq) + BaCl_2\,(aq) \longrightarrow BaSO_4\,(s) + 2NaCl\,(aq)$$

Colourless Colourless

white ppt
insoluble in water

Lead nitrate (aq) + Potassium iodide (aq)

D.D. Pb^{2+} I^{-1}

$Pb(NO_3)_2$ (aq) + 2KI (aq) ⟶ PbI_2 ↓ + $2KNO_3$ (aq)

Colourless Colourless

Yellow ppt
(Insoluble in water)

(i) Yellow insoluble substance (precipitate) of PbI_2 is formed.

(ii) Double Displacement & precipitation reaction.

(iii) Ions in solution - K^+, NO_3^-

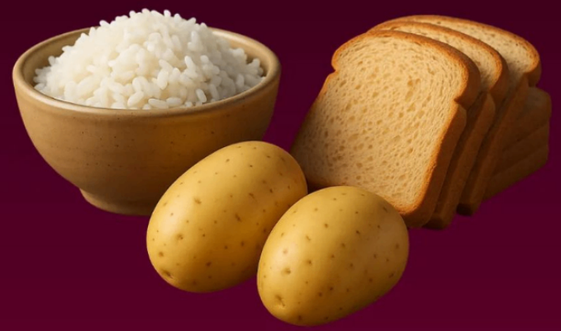
Heat in Reactions

A + B → C + Heat → Released

EXOTHERMIC

Examples :

1. Respiration → Energy



Carbohydrates → Glucose

Glucose + Oxygen → CO_2 (g) + H_2O (l) + Energy

$C_6H_{12}O_6 + O_2$

2. Burning of Natural Gas :

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

Methane

3. Decomposition of vegetable into compost

4. Burning of Mg Ribbon

$$2Mg\,(s) + O_2\,(g) \longrightarrow 2MgO\,(s) + \text{Heat}$$

5. Quick lime with water

$$CaO\,(s) + H_2O\,(l) \longrightarrow Ca(OH)_2 + \text{Heat}$$

Absorbed

ENDOTHERMIC → Decomposition

Examples :

Decomposition of :

Heat

$FeSO_4$ Crystal	$FeSO_4$	Heat →
$CaCO_3$ (s)	$CaCO_3$	Heat →
$Pb(NO_3)_2$ (s)	$Pb(NO_3)_2$	Heat →
AgCl (s)	AgCl	Heat →
AgBr (s)	AgBr	Heat →
H_2O (l)	H_2O	Heat →

H.W.

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

The above reaction is a/an

+ Heat Respiration

A Displacement reaction

B Endothermic reaction

CBSE (2022)

C Exothermic reaction

D Neutralization reaction

Select the endothermic reaction from the following:

CBSE (2023)

A Decomposition of vegetable matter into compost Exo

B Decomposition of calcium carbonate to form quicklime and carbon dioxide

C Burning of a candle Exo

D Process of respiration Exo

Oxidiation & Reduction

$A + O_2 \rightarrow Oxid$
$B + H_2 \rightarrow Redction$

Oxidation : If a chemical (A)

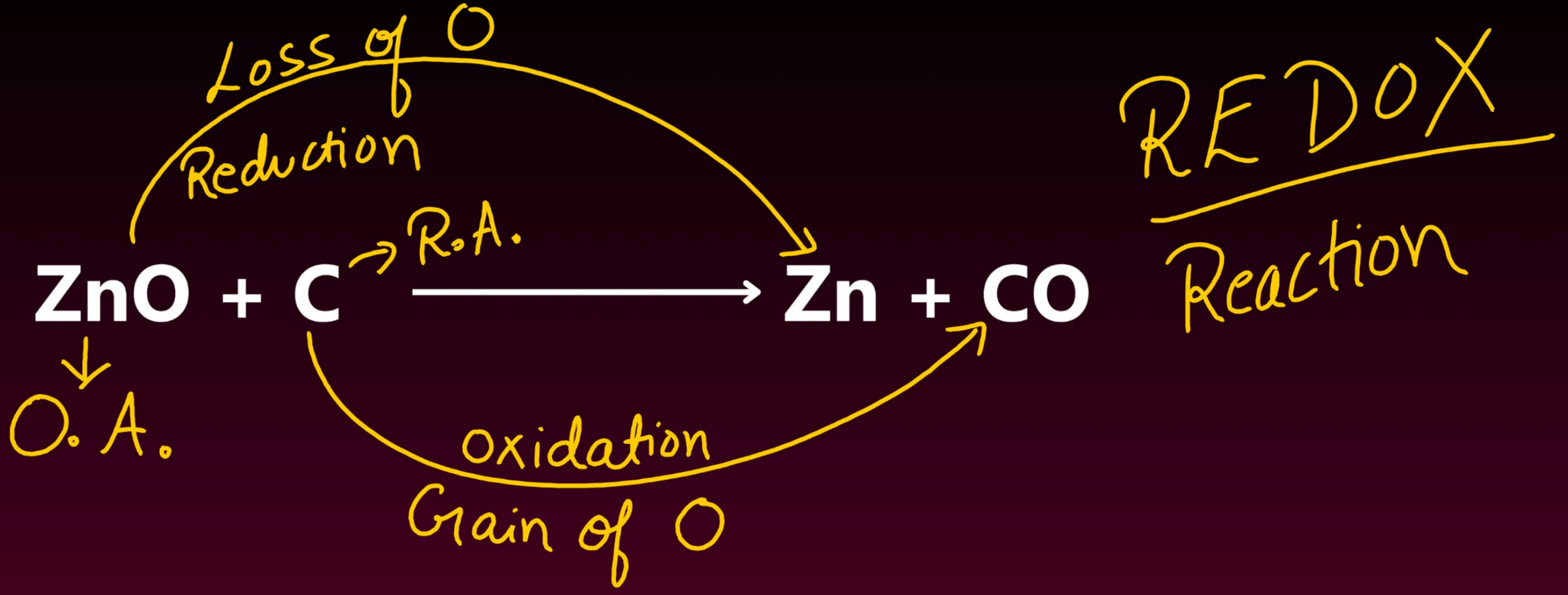
- Gains Oxygen
- Loses Hydrogen

It is called oxidation of A.
A is said to be oxidised.

Reduction : If a chemical (B)

- Gains Hydrogen
- Loses Oxygen

It is called reduction of B.
B is said to be reduced.

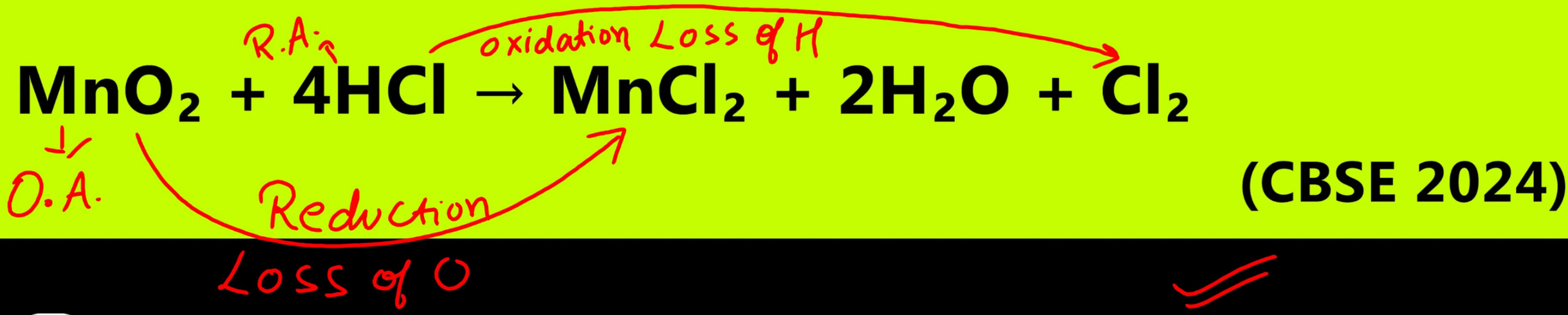


REDOX REACTIONS

A Reaction in which Oxidation & Reduction Occurs

Jiska Hoga Oxidation Wo banega Reducing Agent → R.A.

Jiska Hoga Reduction Wo banega Oxidising Agent → O.A.



(CBSE 2024)

A MnO_2 is oxidised and HCl is reduced.

B HCl is oxidised.

C MnO_2 is reduced.

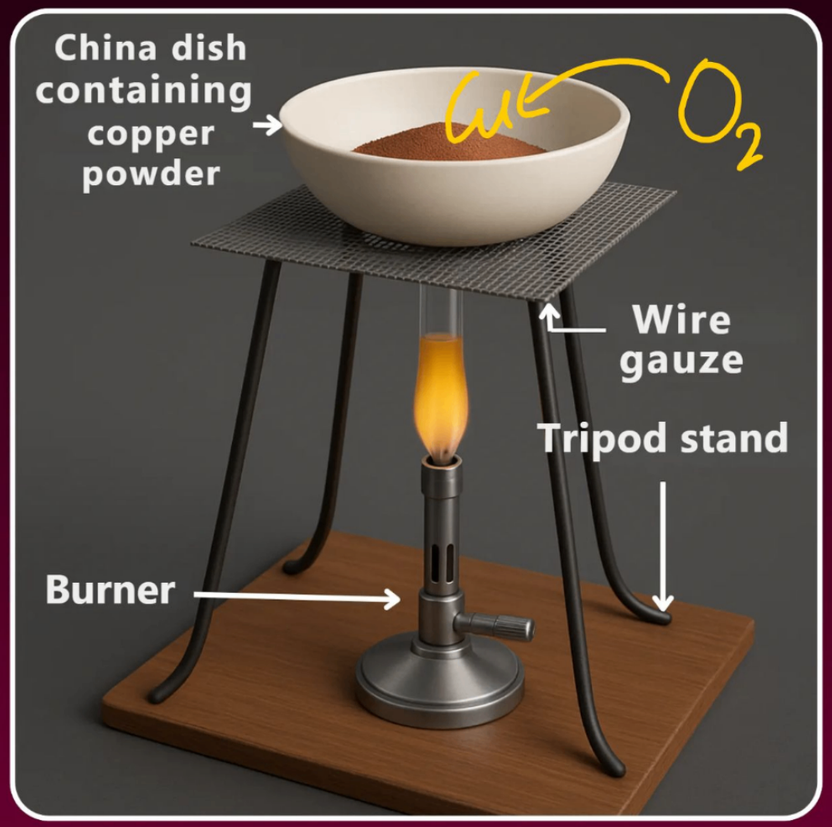
D MnO_2 is reduced and HCl is oxidised

Oxidation of Copper

Gain of O ⇒ Oxidation

$$\underset{\text{Reddish / Brownish}}{Cu\ (s) + O_2\ (g)} \xrightarrow{\text{Heat}} \underset{\text{Black colour}}{CuO\ (s)}$$

Reverse



OBSERVATIONS :

(i) Reddish/Brownish copper metal changes to black colour CuO(s)

(ii) If $H_2(g)$ is passed over CuO, black colour changes to brown.

$$\underset{\text{Black colour}}{CuO(s) + H_2(g)} \xrightarrow{\text{Heat}} \underset{\text{Reddish / Brownish}}{Cu(s) + H_2O}$$

Loss of O ⇒ Reduction

A copper wire on burning in flame, gets coated with a black substance. Write the chemical equation of the reaction that takes place. How can this chemical change be reversed ?

CBSE (2025)

Ans

$$Cu\,(s) + O_2\,(g) \xrightarrow{\text{Heat}} CuO\,(s)$$

oxidation

Reddish / Brown

Black colour

This can be reversed by passing $H_2(g)$ over CuO + Heat

$$CuO(s) + H_2(g) \xrightarrow{\text{Heat}} Cu(s) + H_2O$$

Reduction

Black colour

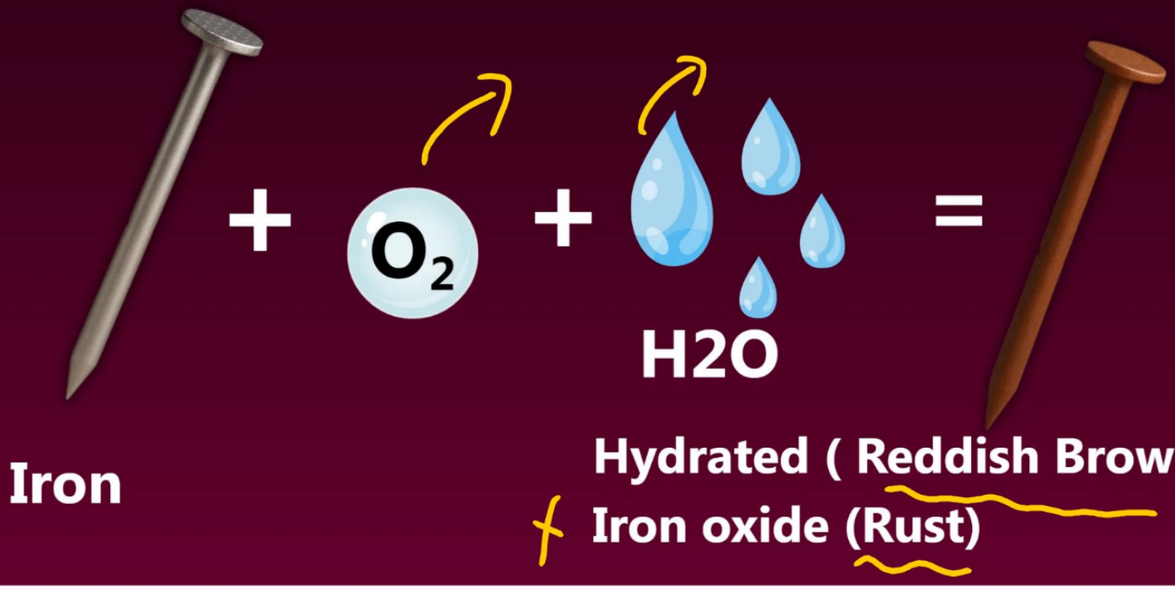
Reddish Brown

Corrosion

When a metal is attacked by substances around it such as moisture (water vapour + oxygen), acid etc., it is said to corrode and this process is called corrosion.

Example -

1) Rusting of Iron



2) Tarnishing of copper - Red to Greeen Colour

Copper $\xrightarrow[H_2O \quad CO_2]{O_2}$ Copper Hydroxide + Copper carbonate (green)

3) Tarnishing of silver - Grey to Black Colour

Silver $\xrightarrow[O_2]{H_2S}$ Silver sulphide (Black)

Note : Corrosion is an example of Oxidation

Rancidity

Rancid

The taste or smell of food material containing fat / oil changes when it is left exposed to air for a long time.

Oxidation of Fat / Oil present in food material causes Rancidity

Prevention :

Antioxidents

Air tight container

N_2

Bag of chips
(Flushed with Nitrogen gas)

Chemical Change

→ New chemical formed

- A chemical reaction happened.
- Shape, size, color, etc. may also change.
- New chemicals are formed.

→ Sugar → alcohal

(O2)

Burning of Paper

Fermentation of grapes

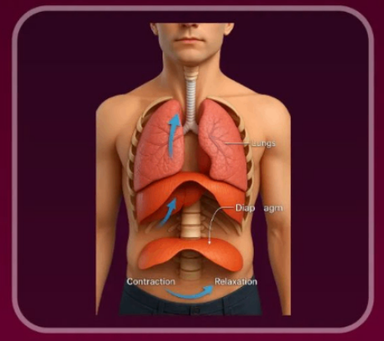
Souring of milk

Curd from milk left in a room during summer

Rusting of Iron

Food Digestion

Food Cooking



Respiration

Chemical Battery Usage

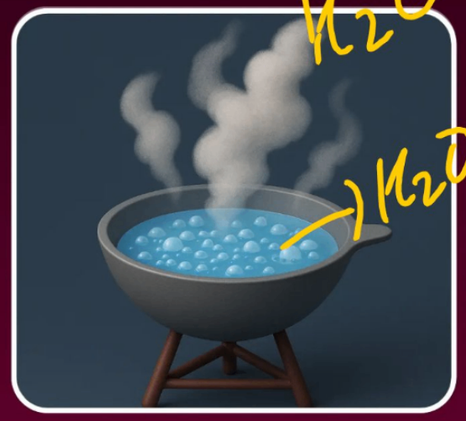
Baking a cake

Physical Change

B. of C ↓ Chemical change

- No chemical reaction happened.
- Shape, size, color, etc. may change.
- No New chemicals are formed.

H_2O → H_2O



Boiling water from the evaporating dish

H_2O → H_2O

Melting of ice to give water

H_2O → Solid → liquid

Melting of wax

P.C

Crushing a paper cup

Crystallization