CHEMICAL REACTIONS AND EQUATIONS

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.

$H_2(g)$ + $O_2(g)$ ⟶ $H_2O(l)$
Hydrogen + Oxygen ⟶ water
Reactant ⟶ product

(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} ⟶ NaCl

✲ Aluminium chloride
Al^{3+} Cl^{-1} ⟶ $AlCl_3$

✲ Ferrous Sulphate
Fe^{2+} SO_4^{2-} ⟶ $FeSO_4$

✲ lead Nitrate
Pb^{2+} NO_3^{1-} ⟶ $Pb(NO_3)_2$

Balanced chemical Equation :-

Number of atoms of each element in a chemical equation should be the same on LHS and RHS.

$A_2(g)$ + $B_2(g)$ ⟶ $2AB(g)$
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.

(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 untill All Atoms Balance.

1. $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
2. $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$
3. $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$
4. $3BaCl_2 + Al_2(SO_4)_3 \rightarrow 3BaSO_4 + 2AlCl_3$
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:

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

In order to balance the below chemical equation the value of x, y and z respectively are CBSE (2023)
$MnO_2 + x\,HCl \longrightarrow MnCl_2 + y\,H_2O + z\,Cl_2$

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

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)

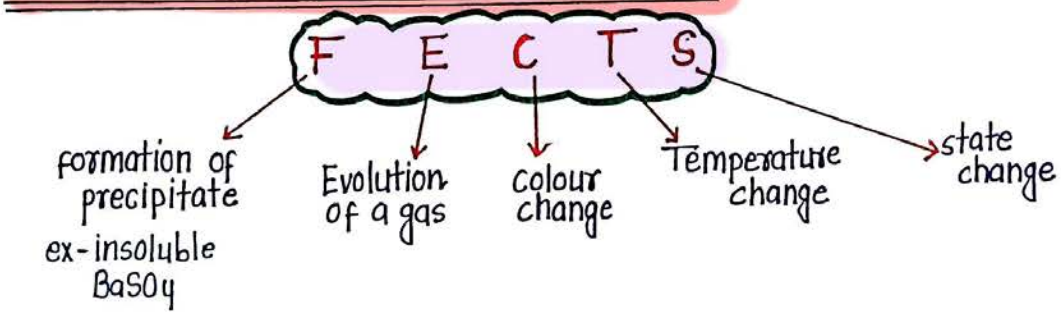
Ans - So that total mass of reactants should be equal to total mass of products

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

H.W.

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

CHARACTERISTICS OF A CHEMICAL REACTION :-



TYPES OF CHEMICAL REACTION :-

COMBINATION REACTION :- Two or more reactant combine to form a single product.

$X + Y + Z \longrightarrow S$

Burning of Magnesium Ribbon

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

from air — white powder — Exothermic

Important points:

- Mg burns with Dazzling white flame (very bright light) **Activity 1.1**
- A White MgO powder in watch glass.
- Heat energy releases so temperature increases.
- Combination and Exothermic Reaction.

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 :-

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

Quicklime — slaked lime

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

Important points

- Rise in temperature (exothermic).
- Quick lime reacts vigorously with water.
- water added slowly because reaction is exothermic.
- Combination and 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 $H_2(g)$ and $O_2(g)$.

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

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 :-

- Reverse of combination - one reactant breaks into 2 or more products.

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

Limestone → Quicklime

✡ Quicklime is used in making cement.

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

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

$CaO + CO_2$

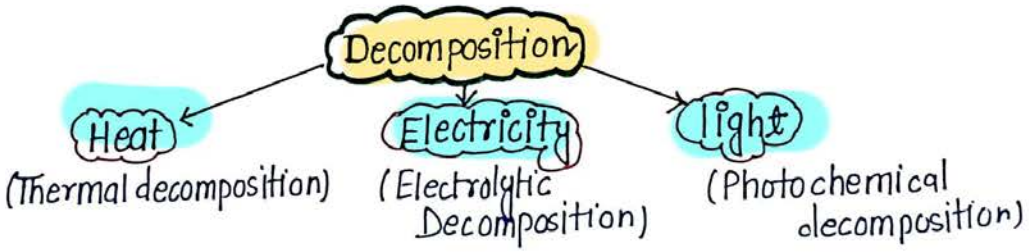
CBSE (2024)

A Quick lime

B Gypsum

C Limestone

D Plaster of Paris



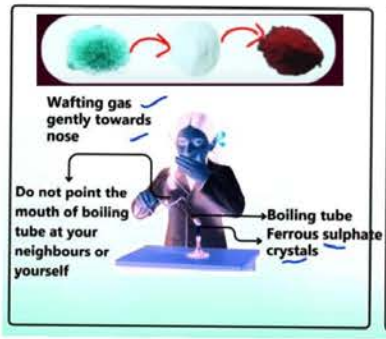
Thermal Decomposition - Thermolysis → Heat

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

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

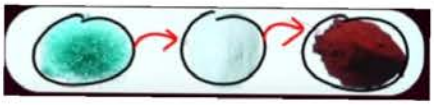
- *Smell of burning sulphur (matchstick) Smell of SO_2 (g) (Suffocating odour) ; pungent smell*
- *SO_2 & SO_3 are air pollutant & acidic in nature*

Thermal Decomposition & Endothermic Reaction

$$FeSO_4.7H_2O \xrightarrow{Heat} FeSO_4 + 7H_2O \longrightarrow (1)$$

Hydrated ferrous sulphate Crystals — Green → White

Anhydrous



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

Ferrous sulphate — White

Ferric oxide — Reddish Brown

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

Ans Heat , Light & Electricity

CBSE (2025)

Heat - Thermal decomposition of Ferrous Sulphate Crystals

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

Ferrous sulphate (Green) — 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)

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

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 and turns moist blue litmus red.

✱ Thermal Decomposition and Endothermic Reaction.

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

$PbO + NO_2 + O_2$

CBSE (2024)

A PbO, N_2O and O_2

B NO, PbO and O_2

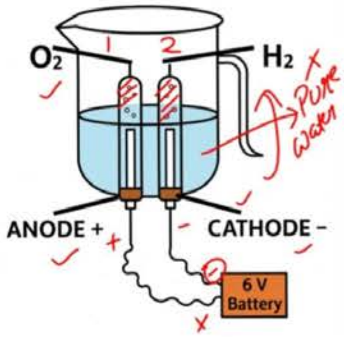
C $Pb(NO_2)_2$ and O_2

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; mass 1 : 8; volume 2 : 1)

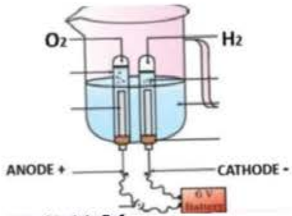


(i) H_2 gas is obtained at cathode and O_2 gas at Anode.
(ii) Volume of gases $H_2 : O_2 = 2:1$
(iii) Mass ratio of gases $H_2 : O_2 = 1:8$

P A O → Oxygen
+ve Anode

(iv) Burning candle is brought near

Cathode – $H_2(g)$
(1) Pop sound heard and candle extinguishes.
(2) Combustible but not a supporter of combustion.



Anode – $O_2(g)$
(1) Candle burns more brightly/rekindles a glowing splinter.
(2) Not combustible but a supporter of a 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 anode 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. → good conductor

Gas liberated at cathode: Hydrogen (H_2) (2)
Gas liberated at anode: Oxygen (O_2) (1)

P A O
+ Anode Oxygen

$H_2 : O_2$
2 : 1
1 : 8

Photochemical Decomposition / Photolysis :-

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

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

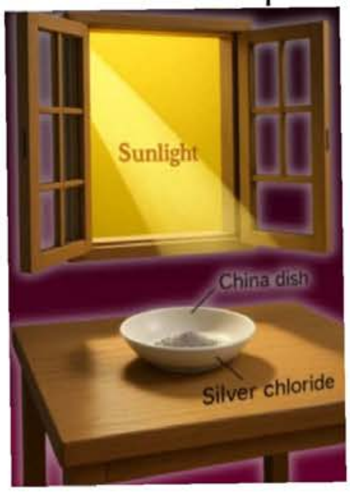
This is why AgCl and AgBr are kept in Black colour bottles to protect from sunlight.
(Used in Black and White photography)

Silver chloride kept in a china dish turns grey in sunlight CBSE (2023)
A. Write the colour of silver chloride 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)

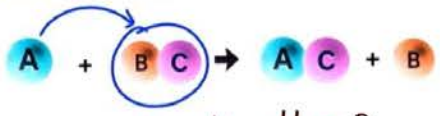
C. This reaction is used in black and white photography.
Silver bromide (AgBr) can also be used for the same purpose.



Define the term decomposition reaction. Write one chemical equation each for decomposition reaction where energy is supplied in the form of heat, light or electricity.

Displacement Reaction :-

More reactive element replace 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

$Zn(s) + Cu(SO_4)\,aq \longrightarrow ZnSO_4 + Cu$

Blue — colourless — Red/Brown

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

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

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

↓ Less Reactive.

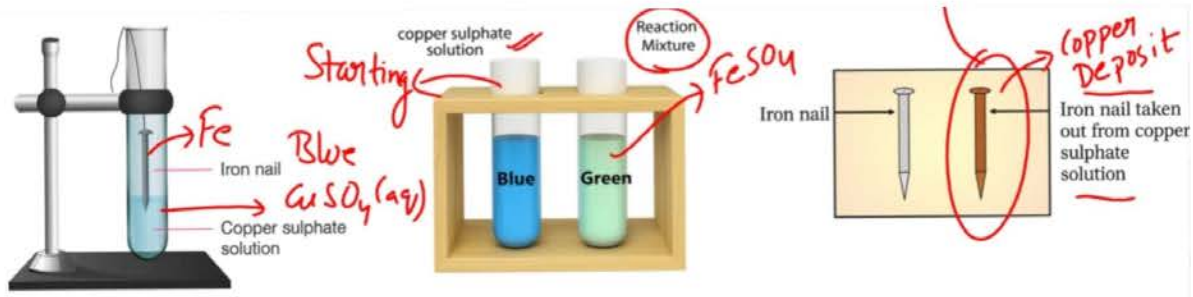
K More Reactive
Na
Ca
Mg
Al
Zn
Fe
Pb
H
Cu
Hg
Ag
Au

Activity 1.9

Iron Nail in Copper Sulphate solution. — Pale Green

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

Blue — light Green — Reddish Brown



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

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

dil

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

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.

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

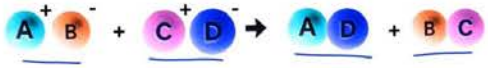
B. Oxygen, due to which a candle burns more brightly

C. Sulfur dioxide, which produces a suffocating smell

D. Hydrogen, which on burning produces a popping sound

Double Displacement Reaction :- Exchange of ions between reactants.

atoms ✗



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

colourless colourless white ppt

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

CBSE (2024)

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.

sodium sulphate (aq) + Barium chloride (aq)

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

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)

$Pb(NO_3)_2(aq) + 2KI(aq) \longrightarrow PbI_2\downarrow + 2KNO_3(aq)$

colourless colourless yellow ppt (insoluble in water)

D·D· $Pb^{2+}I^{-1}$

(i) yellow insoluble substance (precipitate) of PbI_2 is formed.
(ii) Double Displacement and precipitation reaction.
(iii) Ions in solution.

Heat in Reactions

A + B → C + Heat (Released) EXOTHERMIC

Examples- (1) Respiration

carbohydrate → Glucose

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

$C_6H_{12}O_6$ O_2

(2) Burning of Natural Gas

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g) + Heat$ (methane)

(3) Decomposition of Mg Ribbon

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

(4) Decomposition of vegetable into compost

(5) Quick lime with water

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

A —Heat (Absorbed)→ B + C ENDOTHERMIC (Decomposition)

Examples :
Decomposition of : (Heat) (H.W.)

$FeSO_4$ 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→

$C_6H_{12}O_6(aq) + 6O_2(aq) \rightarrow 6CO_2(aq) + 6H_2O(l)$ + Heat (Respiration)
The above reaction is a/an

A Displacement reaction B Endothermic reaction CBSE (2022)
C Exothermic reaction D Neutralization reaction

Select the endothermic reaction from the following:

A Decomposition of vegetable matter into compost (EXO) CBSE (2023)
B Decomposition of calcium carbonate to form quicklime and carbon dioxide
C Burning of a candle (EXO)
D Process of respiration (EXO)

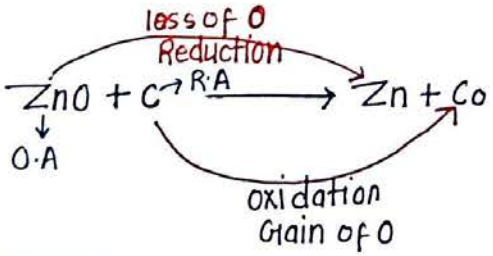
Oxidation And Reduction

Oxidation - if a chemical (A)
- Gains Oxygen
- losses 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 Reaction

Redox Reaction :- A reaction in which oxidation and Reduction occurs.

Jiska Hoga Oxidation Wo banega Reducing agent ↗ R.A
Jiska Hoga Reduction Wo banega Oxidising agent. ↘ O.A

$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$ (CBSE 2024)

R.A, oxidation Loss of H, O.A, Reduction, Loss of O

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

$2Cu(s) + O_2(g) \xrightarrow{Heat} 2CuO(s)$

Reddish/Brownish → Black colour

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

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

Reddish / Brown → Black colour

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

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

Black colour → Reddish Brown

observation :-

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

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

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

Black colour → Reddish/Brownish

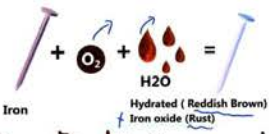
loss of O ⇒ Reduction

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 Green colour

$$\text{copper} \xrightarrow[H_2O\ ,\ CO_2]{O_2} \text{copper Hydroxide} + \text{copper carbonate (green)}$$

3) Tarnishing of silver - Grey to black colour

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

Note :- corrosion is an example of oxidation.

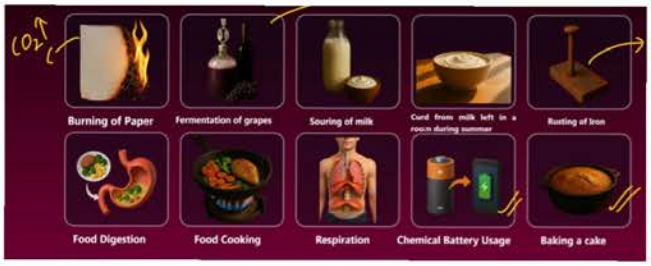
Rancidity :-

- 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 :-

Chemical change

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



Physical change

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

B.of C → Chemical change