

ELEMENTS AND COMPOUNDS

- ❖ Elements are made up of same kind of atoms.

Classification of elements on the basis of physical state

1. Solid

- It occupies definite shape and definite volume
Ex: Carbon, Copper

2. Liquid

- It occupies definite volume but not definite shape
Ex: Gallium, Caesium, Mercury, Bromine

3. Gases

- It does not occupies definite shape and definite volume
Ex: Hydrogen, Oxygen

4. Plasma

- Super heated gaseous state

5. Condensate

- Bose – Einstein - Super cooled solids

Classification of elements on the basis of properties

- ❖ Among 92 elements, 70 are metals.
- ❖ Metals are generally lustre, hard, malleable and ductile.

- ❖ Metals are good conductor and sonorous.

Ex: copper, iron, gold

All the metals except Mercury exist in solid state at room temperature.

High density metals

Platinum



Gold



Silver



Mercury

Non- Metals

- ❖ Non metals are soft, brittle and have no lustre.
Ex: carbon, oxygen, chlorine

Metalloids

- ❖ Metalloids have the properties in between metals and non metals.
Ex: Arsenic, Antimony, Silicon, Boron, Germanium.

Dalton's atomic concept

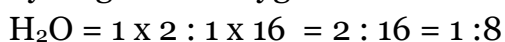
- ❖ According to John Dalton atomic concept, elements are made up of indivisible atoms. In addition to elements atoms are of same kind.

Air we breathe is not a pure substance but a mixture of gases. Milk is a mixture that contains liquid fat, protein and water.

Compounds

- ❖ Two (or) more elements combine in fixed ratio to form a compound.

Ex: water contains mass ratio of hydrogen and oxygen in 1:8



Classification of Compounds

Inorganic Compounds

- ❖ It is obtained from rocks and ores.

Ex: Baking soda, limestone

Organic Compounds

- ❖ It is obtained from plants and animals.

Ex: sucrose, protein, oil

Properties of compound

1. Components of compounds cannot be separated by physical method. It can be separated only by chemical method.
2. Formation of a compound is associated with evolution (or) absorption of heat.
3. Compound has a fixed melting and boiling point.
4. The properties of a compound are different from those of its component elements.
5. Compound is homogenous.

Uses of Compounds

Common Name	Chemical Name	Components	Uses
Water	Hydrogen monoxide H_2O	Hydrogen and Oxygen	For drinking and as solvent
Table salt	Sodium Chloride (NaCl)	Sodium and chlorine	Essential component of our daily diet, preservative for meat and fish
Sugar	Sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)	Carbon, Hydrogen and Oxygen	Preparation of sweets, and fruit juices
Baking soda	Sodium bicarbonate (NaHCO_3)	Sodium, hydrogen, carbon and oxygen	Fire extinguisher, preparation of baking powder, cakes and bread.
Washing soda	Sodium Carbonate (Na_2CO_3)	Sodium, carbon and oxygen	As a cleaning agent in soap and softening of hard water
Bleaching powder	Calcium Oxy chloride (CaOCl_2)	Calcium, oxygen and chlorine	As a bleaching agent, disinfectant and sterilisation of drinking water
Gobar gas	Methane (CH_4)	Carbon and Hydrogen	Important component of natural gas
Quick lime	Calcium oxide (CaO)	Calcium and oxygen	Manufacturing of cement and glass

Elements & Compounds

Slaked lime	Calcium hydroxide Ca(OH)_2	Calcium, oxygen and hydrogen	Whitewashing of walls.
Lime stone	Calcium Carbonate CaCO_3	Calcium, Carbon and Oxygen	Preparation of chalk pieces

Atomicity

- ❖ The number of atoms present in one molecule of an element is called the atomicity of an element.

Monoatomic _ ONE ATOM

- ❖ Silver (Ag), Potassium (K), Carbon (C) and inert gases.

Diatomic – TWO ATOMS

- ❖ Hydrogen (H_2), Bromine (Br_2), Chlorine (Cl_2), Oxygen (O_2)

Triatomic - THREE ATOMS

- ❖ Ozone (O_3)

Polyatomic - MANY ATOMS

- ❖ Phosphorus (P_4), Sulphur (S_8)

Periodic classification of elements

Dobereiner's classification of elements

- ❖ In each case, the middle element has an atomic mass almost equal to the average atomic masses of the other two elements in the triads.
- ❖ Ex: Lithium 7, Sodium 23, Potassium 39

Law of octaves

- ❖ John Newland suggested law of octaves.
- ❖ If elements are arranged in ascending order of their atomic masses then every eighth element is a kind of repetition of the first one either succeeding (or) preceding it like eighth note in octave of music.

Limitation of Newland's classification

1. This classification failed with regard to the heavier elements. i.e. those lying beyond calcium.
2. After the discovery of the noble gases, the idea of octaves did not work.

Mendeleev's periodic table

- ❖ In 1869, Mendeleev, a Russian scientist, prepared the first periodic table. He arranged the periodic table with increasing order of atomic masses.

Modern Periodic Table (H.J. Mosley)

- ❖ In 1912, Moseley, an English physicist measured the frequencies of x-rays emitted by a metal, when the metal was bombarded with high speed electrons. He plotted square roots of the frequencies against atomic numbers.
- ❖ The plot obtained was a straight line. He found that the square root of the frequency of the prominent x-rays emitted by a metal was proportional to the atomic number and not to the atomic weight of the atom of that metal.

Concepts of the Periodic table

1. From top to bottom in **groups** the atomic size of the elements increase. From left to right in

- ♦.....♦
- period**, the atomic sizes of the elements decrease.
2. From top to bottom in **groups**, the ionization energy of the elements decreases, from left to right in period, the ionization energy of the elements increases.
 3. From top to bottom in **groups**, the electron affinity increases, from left to right in **period**, the Election Affinity of the elements decreases.

elements combined together in a fixed proportion by mass.

- ❖ Two (or) more elements and compounds are fixed in any ratio to form mixtures.

Types of mixtures

- Homogenous mixture
- Heterogenous mixture

Homogenous mixture

- ❖ It is available in the same phase.
Ex. Alloys, Air

Heterogenous mixture

- ❖ Two (or) more in different phases
Ex. water mixed in oil

Law of constant composition (or)

Law of definite proportion

(Proust 1779)

- ❖ A pure chemical compound prepared by any method consists of the same

Difference between elements and compounds

S.No.	Elements	Compounds
1.	Elements are physically mixed in any ratio and no new compound is formed.	Elements are chemically combined in a fixed ratio to form a new compound.
2.	They have no sharp (or) definite melting point, boiling point, density etc.	They have definite melting point, boiling point, density etc.
3.	A mixture exhibits the properties of its constituent (or) component elements	Property of a compound is different from its constituent (or) component elements.
4.	They are either homogenous (or) heterogeneous in nature.	They are always homogenous in nature.
5.	Constituents of a mixture can be separated by physical methods like filtration, magnetic separation etc.	Constituents of a compound cannot be separated by physical methods.

Atom

- ❖ In a greek language atom means “incapability of being cut”

Sub atomic particles

Protons

- ❖ It is a positively charged particles
- ❖ It is found in the nucleus

Rusting of iron is a chemical Change that increase the weight of iron.

Electrons

- ❖ It is negatively charged particles.
- ❖ It revolves around the nucleus.

Neutrons

- ❖ It is a neutral particles.
- ❖ It is found in the nucleus.

Atomic number (A)

- ❖ The number of protons in the nucleus (or) The number of electrons revolving around the nucleus.

Mass number (Z)

- ❖ The sum of the number of protons and neutrons in two nucleus of an atom.
- ❖ Mass number (Z) = Number of protons + number of neutrons.
- ❖ No. of neutrons = mass number - atomic number ($n = Z - A$)

1. The gas that can be used to fill party balloons is Helium
2. The gas that is used to make flash light is Krypton
3. The gas widely used in advertisement signs is Neon
4. The gas present in tungsten bulb is Argon
5. The gas present in the universe is Hydrogen
6. The gas used in high intensity lamp is Xenon
7. The gas which is used in tooth pastes to keep the teeth strong is Fluorine
8. The gas which helps to keep swimming pool clean is Chlorine
9. The radioactive gas is Neptunium
10. About 21% of earth's atmosphere consists of Magnesium

Approval by IUPAC

1. IUPAC allotted the symbol of element of atomic number 112. Name of the element is Copernicium (Cn-112).

Recently approved elements by IUPAC:

- | | | |
|--------|---|-----------------|
| 1. 113 | - | Nihonium (Nh) |
| 2. 115 | - | Moscovium (Mc) |
| 3. 117 | - | Tennessine (Ts) |
| 4. 118 | - | Oganesson (Og) |

Reactivity series of metals:

Potassium (K)	These metals react with water
Sodium (Na)	
Calcium (Ca)	
Magnesium (Mg)	These metals react with dilute acids.
Aluminium (Al)	
Manganese (Mn)	
Zinc (Zn)	
Chromium (Cr)	
Iron (Fe)	
Nickel (Ni)	
Tin (Sn)	These metals do not react with dilute acids.
Lead (Pb)	
Copper (Cu)	
Silver (Ag)	
Gold (Au)	

An atom is the smallest particle of an element. A molecule is made of the same kind of atoms or different kinds of atoms

◆.....◆
Isotopes

- ❖ Invented by T.W. Richards.
- ❖ Isotopes are atoms of the same element having the same atomic number but different mass numbers Ex. ${}_3\text{Li}^7$, ${}_3\text{Li}^6$

Uses

- Fe - 59 → treatment of anemia
- I – 131 → treatment of goiter
- Co-60 → treatment of cancer
- P-32 → Eye treatment
- C-11 → Brain scan

Isobars

- ❖ Same mass numbers, different atomic numbers are called isobars. Ex. ${}_{18}\text{Ar}^{40}$, ${}_{20}\text{Ca}^{40}$

Isotones

- ❖ Elements with Different mass number, different atomic number but same number of neutrons are called isotones. ${}_6\text{C}^{13}$, ${}_7\text{N}^{14}$



ACIDS, BASES AND SALTS

Acids

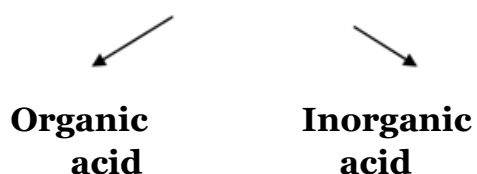
- ❖ The word acid is derived from the Latin name “acids” which means sour taste. Substances with sour taste are acids. Lemon juice, vinegar and grape juice have sour taste.
- ❖ Acid is a substance which give ions when dissolved with water. All hydrogen available substances are not considered as a acid. Acid change blue litmus to red.
- ❖ They are colorless with phenolphthalein and pink with methyl orange.

Basicity

- ❖ For acids, we use the terms basicity
- ❖ Refers to number of replaceable hydrogen atoms present in one molecule of an acid.
- ❖ Ex. Ammonia (NH_3), Methane (CH_4)

Types

I. Classification of acids based on their sources



1. Organic Acid:

- ❖ Acids present in plants and animals are organic acids. Ex. HCOOH , CH_3COOH .

2. Inorganic Acid:

- ❖ Acids from rocks and minerals are inorganic acids (or) mineral acids. Ex. Hydrochloric Acid.

II. Classification of acids based on their basicity



1. Monobasic Acid

- ❖ It is an acid which give one hydrogen ion per molecule of the acid in solution. eg. HCl , HNO_3

2. Dibasic Acid

- ❖ It is an acid which gives two hydrogen ions per molecule of the acid in solution. eg. H_2SO_4 , H_2CO_3

3. Tribasic Acid

- ❖ It is an acid which gives three hydrogen ions per molecule of the acid in solution. eg. H_3PO_4 .

III. Classification of acids based on ionization

Strong Acids

Weak Acids

Strong Acids:

- ❖ These are acids which ionise completely in water. eg. HCl

Weak Acids:

- ❖ These are acids which ionise partially in water. eg. CH_3COOH

IV. Classification of acids based on concentration

Concentrated Acid

Dilute Acid

Concentrated Acid:

- ❖ It is an acid having a relatively high percentage of acid in its aqueous solution.

Dilute Acid:

- ❖ It is an acid having a relatively low percentage of acid in aqueous solution.

Acids used in day to day life

S.No.	Acids	Sources
1.	Citric Acid	Citrus fruits like lemons and oranges
2.	Lactic Acid	Sour milk
3.	Formic Acid (IUPAC: Methanoic Acid)	Stings of ants and bees
4.	Butyric Acid	Butter
5.	Acetic Acid (IUPAC: Ethanoic Acid)	Vinegar
6.	Tartaric Acid	Tamarind, grapes

7.	Malic Acid	Apple
8.	Uric Acid	Urine
9.	Oxalic Acid	Tomato
10.	Stearic Acid	Fats
11.	Cholic Acid	Bile water
12.	Ascorbic Acid	Brinjal
13.	Amino Acid	Proteins
14.	Nucleic Acid	DNA & RNA
15.	Acetyl Salicyclic Acid	Aspirin

Some important inorganic Acids used in laboratory

Chemical Name	Other Name	Molecular Formula
Hydrochloric Acid	Muriatic Acid	HCl
Sulphuric Acid	Oil of vitriol (or) king of chemicals	H_2SO_4
Nitric Acid	Aqua fortis	HNO_3

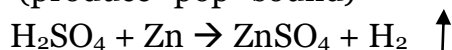
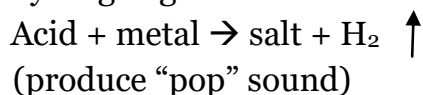
Physical properties of Acids:

- Inorganic acids are colourless. Sometimes sulphuric acid is light brown colour, concentrated Hydrochloric acid is light yellow in colour due to impurities present in it. Some organic acids are colourless solid. ex. Benzoic Acid.
- Except some organic acid, remaining all acids are soluble in water.
- Inorganic acids are highly corrosive in nature. It affects the surface of the metals and skin of the body.

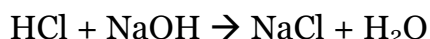
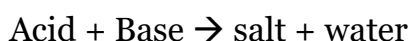
4. Acids are sour in taste
5. Acids are good conductor of electricity.

Chemical properties

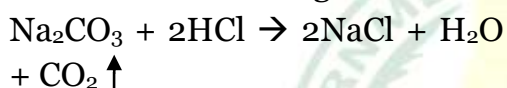
1. Acids react with metal to evolve hydrogen gas.



2. Acids react with base to form salt and water



3. Acids react with carbonate salts to produce carbon dioxide gas.



(change lime water into milky)

Strongest acid in the world

- ❖ HFSO_3 – Hydro fluoro sulphuric Acid (or) Fluoro sulphuric Acid

WHO SAYS WHAT:

Lavoisier

- ❖ Oxygen is basic substance of all acids.

Dacis

- ❖ Hydrogen is basic substance of all acids.

Arrhenius

- ❖ Hydrogen given substance is acid.
Hydroxide given substance is base.

Lowery - Bronstead

- ❖ Loss of protons is acid (H^+), gain of protons is base.

Uses of Acid

Uses of Inorganic Acid

1. In Chemical laboratories as reagents.

2. Industries for manufacturing dyes, drugs, paints, perfumes, fertilizers and explosives.
3. The extraction of glue from bones and metals from its ore.
4. Refining petroleum.

Uses of organic Acids

1. As food preservatives
2. As a source of vitamin
3. To add flavour to food stuffs and drinks.

Uses of HCl

1. HCl present in gastric juices are responsible for the digestion.
2. Used as bathroom cleaner.
3. As a pickling agent before galvanization

Uses of HNO_3

1. In the manufacture of fertilizers like ammonium nitrate.
2. In the manufacture of explosive like TNT (Trinitro toluene), TNB (Trinitro benzene), Picric acid (Trinitro phenol) etc
3. Nitro Glycerine (Dynamite)

Uses of Sulphuric Acid (H_2SO_4)

1. In lead storage battery
2. In the manufacture of HCl
3. In the manufacture of Alum
4. In the manufacture of fertilizers, drugs, detergents & explosives.

Uses of Boric Acids

1. As an antiseptic

Calcium Hydride is used as Hydrogen source in laboratories

Uses of Phosphoric Acids

1. It forms phosphatic fertilizers
2. PO_4^{3-} is involved in providing energy for chemical reactions in our body.

Uses of Ascorbic Acids

- Sources of Vitamin C

Uses of Citric Acids

- Flavouring agent & food preservative

Uses of Acetic Acids

- Flavouring agent & food preservative

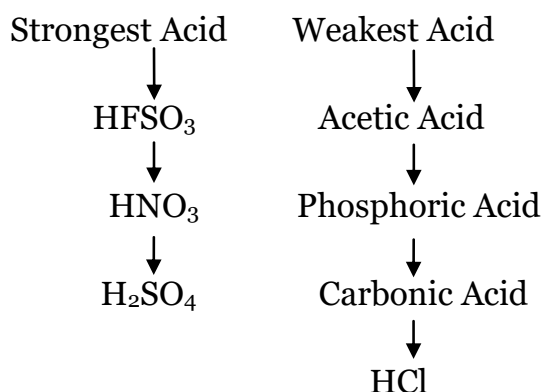
Uses of Tartaric Acids

1. Souring agent for Pickles
2. A component of baking powder (sodium bicarbonate, tartaric acid)

Bases

- ❖ Alkali derived from the arabic word “alquili” which means plant ashes.
- ❖ All alkalis are bases, but not all bases are alkali.
- ❖ Bases is a substance of metallic hydroxide (or) oxide which releases hydroxide ions when dissolved in water.
- ❖ Acid rain-Sulphuric Acid, Nitric Acid
- ❖ Dissolves glass-Hydrofluoric Acid

❖ Eye wash – Boric Acid

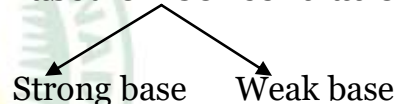


Acidity of the base

- ❖ The number of replaceable hydroxide ions per molecule of the base are known as acidity of the base.

Classification of bases

I. Based on Concentration



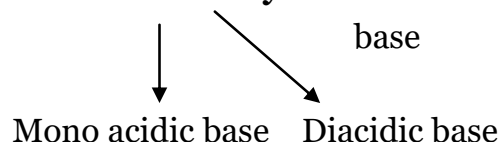
Strong base

- ❖ Completely ionized Ex. NaOH, KOH

Weak base

- ❖ Partially ionized. Ex. NH_4OH , $\text{Ca}(\text{OH})_2$

II. Based on Acidity → Tri acidic base



Mono acidic base

- ❖ It is a base which ionises in water to give one hydroxide ion per molecule.

Eg. NaOH, KOH

Titanium is called Strategic metal because it is lighter than iron.

Diacidic base

- ❖ It is a base which ionizes in water to give two hydroxide ions per molecule.

Eg. Ca(OH)_2 , Mg(OH)_2

Tri Acidic base

- ❖ It is a base which ionises in water to give three hydroxide ions per molecule.

Eg. Al(OH)_3 , Fe(OH)_3

III. Based on concentration

Concentrated alkali

Dilute alkali

Concentrated alkali

- ❖ It is an alkali having a relatively high percentage of alkali in aqueous solution.

Dilute alkali

- ❖ It is an alkali having a relatively low percentage of alkali in its aqueous solution.

Some bases used in day today life

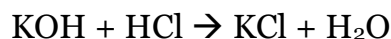
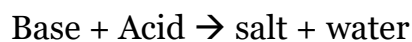
Sl. No.	Name	Other Name	Formula	Solubility in water
1.	Sodium hydroxide	Caustic soda	NaOH	soluble
2.	Potassium hydroxide	Caustic potash	KOH	soluble
3.	Calcium hydroxide	Slaked lime	Ca(OH)_2	Partially soluble
4.	Calcium oxide	Quick lime	CaO	insoluble
5.	Iron (II) hydroxide	Ferric hydroxide	Fe(OH)_3	insoluble
6.	Magnesium hydroxide	Milk of Magnesia	Mg(OH)_2	insoluble

Physical properties of bases

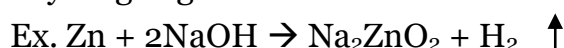
1. Bases are colourless, odourless but iron and copper hydroxides have definite colour.
2. Bases are bitter in taste.
3. Bases are corrosive in nature.
4. Bases feel soapy on touching.
5. Bases are good conductor of electricity.
6. Bases have hydroxyl ions, only non-metallic hydroxide is Ammonium hydroxide (NH_4OH).

Chemical Properties

1. Bases react with water to form salt and water, these reactions are called neutralization reaction.



2. Bases react with metal to produce hydrogen gas.



Uses of bases

1. In industries for manufacture of soap, textile, plastic

Excess of copper in human beings cause disease called WILSON

2. For manufacturing paper, pulp and medicine
3. To remove grease and stains from clothes.

Indicator

- ❖ Indicator are a group of compounds that change colour when added to solutions containing either acidic (or) basic substances.

Indicator	Colour in Acid	Colour in base
Litmus	Red	Blue
Phenolphthalin	Colourless	Pink
Turmeric	Yellow	Brick Red
Beetroot juice	Pink	Pale yellow
Red Cabbage juice	Pink / Red	Green
Methyl orange	Pink	Yellow

Salts

- ❖ Acids react with base to form salt and water. This reactions are known as neutralization reaction.
- ❖ It is an exothermic reaction.
- ❖ Acid + Base → salt + water + heat

Types of salts

1. Simple salt: **Ex.** Sodium chloride, Potassium chloride, Sodium sulphate
2. Acidic salt: **Ex.** Sodium bi sulphate, Potassium bi sulphate, Sodium bi carbonate

3. Basic salts: **Ex.** Basic magnesium chloride, Basic lead chloride
4. Double salts: **Ex.** Potash alum, Mohr salt
5. Complete salt: **Ex.** Sodium potassium carbonate, Bleaching powder
6. Complex salt: **Ex.** Potassium ferro cyanide, Sodium Zinc cyanide

General Properties of Salts

1. Salts of Sodium and potassium are colourless. **Ex.** Nacl, Kcl but Copper, Iron, Chromium salts are coloured. **Ex.** Copper sulphate – Blue colour, Potassium dichromate-Reddish orange,
2. Generally metallic salts are soluble in water but some metallic carbonates, oxides, sulphates are insoluble in water.**Ex.** Calcium Carbonate
3. Salts have high melting and boiling points
4. Aqueous solution of metallic salts conduct electricity.

Cadmium rod is used in nuclear reactor to slow down the speed of neutron.

Some salts are used in day today life

No	Common Name	Chemical Name	Formula
1	Simple salt	Sodium Chloride	NaCl
2	Washing soda	Hydrated Sodium Carbonate	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
3	Bread soda	Sodium bicarbonate	$\text{NaO} \cdot \text{CO}_3$
4	Bleaching powder	Calicum oxychloride	CaOCl_2
5	Limestone	Calcium Carbonate	CaCO_3
6	Chile salt peter	Sodium nitrate	NaNO_3
7	Hyposulfite	Sodium thio sulphate	$\text{Na}_2\text{S}_2\text{O}_3$
8	Epsom salt	Hydrated magnesium sulphate	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
9	Plaster of paris	Hydrated calcium sulphate	$\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$
10	Blue vitriol	Hydrated copper sulphate	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Uses of Salts:

1. Sodium Chloride (NaCl)

- Preserve pickles, fish, meat, vegetables

2. Sodium benzoate

- It is used to preserve food items.

3. Calcium Carbonate

- It is used to prepare chalk piece

4. Silver Nitrate

- It is used to prepare hair dyes.

❖ For acidic solution (H^+) $> 10^{-7}\text{M}$, pH

< 7

❖ For basic solution (H^+) $< 10^{-7}\text{M}$, pH

> 7

❖ When OH^- ions are taken into account the pH expression is replaced by pOH

$$\text{pOH} = -\log_{10}(\text{OH}^-)$$

pH Scale

- ❖ pH stands for the power of hydrogen ion concentration in a solution.
- ❖ Whether a solution is acidic (or) basic (or) neutral.
- ❖ pH scale was introduced by S.P.L Sorenson.
- ❖ It is mathematically expressed as $\text{pH} = -\log_{10}(\text{H}^+)$
- ❖ For neutral solution (H^+) $= 10^{-7}\text{M}$, $\text{pH} = 7$

Importance of pH in Everyday Life

1. pH in Human Body : Using pH factor, the general health condition of our body can be examined. At pH level 6.9, the body becomes prone to viral infections like cold, cough and flu. Cancer cells thrive inside the body at a pH of 5.5.
2. The pH of a normal, healthy human skin is 4.5 to 6. Proper skin pH is essential for a healthy complexion. pH of stomach fluid is approximately

Wood Furniture are coated with zinc chloride to prevent termites

- 2.0. This fluid is essential for the digestion of food.
3. Human blood pH range is 7.35 to 7.45. Any increase or decrease in this value, leads to diseases. The ideal pH for blood is 7.4.
4. pH of saliva normally ranges between 6.5 to 7.5
5. White enamel coating of our teeth is calcium phosphate, the hardest substance in our body. It does not dissolve in water. If pH of mouth falls below 5.5, the enamel gets corroded.
6. Toothpastes which are generally basic and used for cleaning the teeth can neutralize the excess acid and prevent tooth decay.
7. pH of Soil In agriculture, the pH of soil is very important. Citrus fruits require slightly alkaline soil, while rice requires acidic soil and sugarcane requires neutral soil.
8. pH of Rain Water is approximately 7 showing the high level of its purity and neutrality. If rain water is polluted by SO₂ and NO₂, acid rain occurs.

The pH value of some common liquids

Liquid	pH
Lemon Juice	2.5
Wine	2.8
Apple juice	3.0
Vinegar	3.0
Urine	4.8
Coffee	5.0
Saliva	6.5
Milk	6.5
Blood	7.4
Pure water	7.0
Sea water	8.5
Toothpaste	9.0
Milk of magnesia	10.5

Problems

1. Hydrogen ion concentration of a solution is 0.001M. What is the pH value?

Solution

$$\begin{aligned}
 \text{pH} &= -\log_{10}(\text{H}^+) \\
 &= -\log_{10}(0.001) \\
 &= -\log_{10}(10^{-3}) \\
 &= -(-3) \log 10^{10} \quad \text{pH} = 3
 \end{aligned}$$

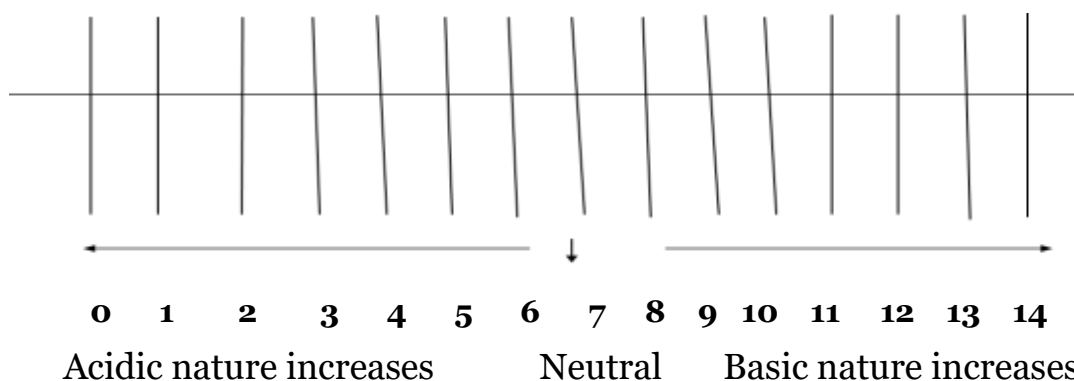
2. Hydroxide ion concentration of a solution is 0.001 m. What is the pH value?

$$pOH = -\log_{10}(10^{-3})$$

$$pOH = 3 \quad pH = 14 - pOH$$

$$= 14 - 3 \quad pH = 11$$

$$pOH = -\log_{10}(OH^-)$$



OXIDATION AND REDUCTION

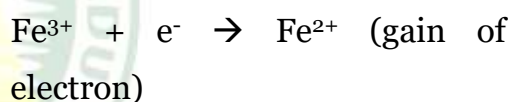
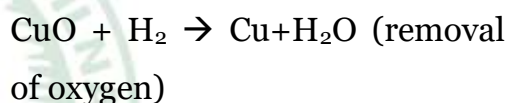
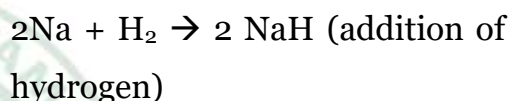
- ❖ Oxygen is the most essential element for sustaining life.
- ❖ One can live without food (or) even water for a number of days, but not without oxygen.
- ❖ In our daily life we come across phenomena like fading of the colours of the clothes, burning of combustible substances like cooking gas, wood and coal, and also rusting of iron articles. All such process fall in the category of a specific type of chemical reaction called oxidation reduction reaction (redox reaction)

Oxidation

- ❖ A chemical reaction which involves addition of oxygen (or) removal of hydrogen (or) loss of electron is called as oxidation.
 $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ (addition of oxygen)
 $\text{H}_2\text{S} + \text{Br}_2 \rightarrow 2\text{HBr} + \text{S}$ (removal of hydrogen)
 $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$ (loss of electron)

Reduction

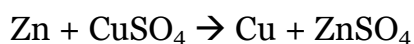
- ❖ A chemical reaction which involves addition of hydrogen (or) removal of oxygen (or) gain of electrons is called as reduction.



eg: when detergent is dissolved in water, heat is given out.

Redox reaction

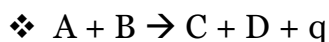
- ❖ A chemical reaction in which oxidation and reduction takes place simultaneously is called Redox reaction.



Exothermic reactions

- ❖ The chemical reactions which proceed with the evolution of heat energy are called exothermic reactions

Oxidation also has damaging effects on food and eatables. When food containing fat and oil is left as such for a long time, it becomes stale. The stale food develops bad taste and foul smell. This is very common in curd or cheese, particularly in summer. Oils and fats are slowly oxidised to certain foul-smelling compounds.

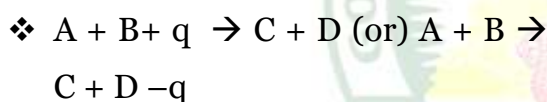


❖ q is evolution of energy. Its unit is joule and kilojoule.

❖ Ex: respiration, Acid-base, neutralisation, Combustion of petrol.

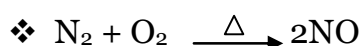
Endothermic reactions

❖ The chemical reactions which proceed with the absorption of heat energy are called endothermic reactions.



❖ q is absorption of heat.

❖ Ex: Formation of nitrogen monoxide



Rate of the chemical reaction

❖ Rate of the chemical reaction is defined as change in concentration of any one of the reactions (or) products per unit time.

+ve sign

❖ +ve sign indicates increase in concentration of B with time.

-ve sign

❖ -ve sign indicates decrease in concentration of A with time.

Valency

❖ Valency is the number of electrons transferred (or) sharing takes place between the two atoms of same (or) different elements. This number is called valency.

Valency = 1

Positively charged ions	Negatively charged ions
H ⁺ (Hydrogen ion)	Cl ⁻ chloride ion
Na ⁺ (Sodium ion)	Br ⁻ Bromide ion
K ⁺ (Potassium ion)	I ⁻ Iodide ion
Ca ⁺ (Calcium ion)	OH ⁻ Hydroxide ion
Ag ⁺ (Silver ion)	NO ₃ ⁻ Nitrate ion
NH ₄ ⁺ (Ammonium ion)	HCO ₃ ⁻ Bicarbonate ion
	CN ⁻ Cyanide ion
	NO ₂ ⁻ Nitrate ion
	NO ₂ ⁻ Nitrite ion
	MnO ₄ ⁻ Permanganate ion
	HSO ₄ ⁻ bisulphate ion

	ClO_3^- Chlorate ion
	ClO_2^- Chlorite ion

Valency = 2

Positively charged ion	Negatively charged ion
Mg^{2+} Magnesium	O^{2-} Oxide ion
Ca^{2+} Calcium ion	S^{2-} Sulphide ion
Ba^{2+} Barium ion	SO_3^{2-} Sulphide ion
Zn^{2+} Zinc ion	SO_4^{2-} Sulphate ion
	CO_3^{2-} Carbonate ion
	$\text{Cr}_2\text{O}_7^{2-}$ Dichromate ion
	MnO_4^{2-} Manganate ion
	$\text{S}_2\text{O}_3^{2-}$ Thiosulphate ion

Valency = 3

Positively charged ion	Negatively charged ion
Al^{3+} Aluminium ion	PO_4^{3-} phosphate ion
	BO_3^{3-} Borate ion

Polyvalent cations

Formula	Name	Formula	Name
Ag^+	Gold (I) (or) Agous	Ag^{3+}	Gold (III) (or) Agric
Ce^{3+}	Cerium (III) (or) Cerous	Ce^{4+}	Cerium (IV) (or) Ceric
Co^{2+}	Cobalt (II) (or) Cobaltous	Co^{3+}	Cobalt (III) (or) Cobaltic
Cr^{2+}	Chromium (II) (or) Chromous	Cr^{3+}	Chromium(III) (or) Chromic
Cu^+	Copper (I) (or) Cuprous	Cu^{2+}	Copper (II) (or) Cupric
Fe^{2+}	Iron (II) Ferrous	Fe^{3+}	Iron (III) (or) Ferric
Mn^{2+}	Manganese (ii) (or) Manganous	Mn^{3+}	Manganes (III) (or) manganic
Pb^{2+}	Lead (II) (or) Plumbous	Pb^{4+}	Lead (IV) (or) Plumbic
Sn^{2+}	Tin (II) (or) Stannous	Sn^{4+}	Tin (IV) (or) Stannic

In Tube Light there is vapour of mercury and argon.

Alkali metal valency = +1

Alkali earth metal valency = +2

Calculation Of Oxidation

Number

1. What is the oxidation number of Mn in KMnO_4 ?

Valency K is 1. Valency of oxygen is

2. KMnO_4

$$1 \times 1 + x + 4 \times (-2) = 0$$

$$1 + x - 8 = 0$$

$$x - 7 = 0$$

$$x = +7$$

$$\text{Mn} = +7$$

2. What is the oxidation number of chlorine in HClO_3 ?

Valency H = 1

Valency O = -2

HClO_3

$$1 \times 1 + x + 3 \times (-2) = 0$$

$$1 + x - 6 = 0$$

$$x - 5 = 0$$

$$x = +5$$

$$\text{Cl} = +5$$

3. What is the oxidation number chlorine in HClO_3 ?

$$1 + x - 4 = 0$$

$$x - 3 = 0$$

$$x = +3$$

Chlorine oxidation number is +3

4. What is the oxidation number of Mn in MnO_4^{2-} ?

$$x + 4 \times (-2) = -2$$

$$x = 8 - 2$$

$$x = +6$$

Mn oxidation number is +6

5. $\text{K}_3[\text{Fe}(\text{CN})_6]$ What is the oxidation of Fe?

$$k = +1, \quad \text{CN} = -1$$

$$3 \times 1 + x + -1 \times 6 = 0$$

$$3 + x - 6 = 0$$

$$x - 3 = 0$$

$$x = +3$$

Oxidation number of Fe is +3

6. What is the oxidation number chromium in $\text{K}_2\text{Cr}_2\text{O}_7$?

$$2 \times 1 + 2x + 7 \times (-2) = 0$$

$$2 + 2x - 14 = 0$$

$$2x - 12 = 0$$

$$2x = 12$$

$$x = 12/2 = +6$$

$$\text{Cr} = +6$$

7. What is the oxidation number of Uranium in UO_2^{2+} ?

$$x + 2 \times (-2) = 2+$$

$$x - 4 = +2$$

$$x = +2 + 4$$

$$x = +6$$

Oxidation number of Uranium is +6

8. What is the oxidation number of Mn in Mn_2O_3 ?

$$2x + 3 \times (-2) = 0$$

$$2x - 6 = 0$$

$$2x = +6$$

$$x = 6/2$$

$$x = +3$$

$$\text{Mn} = +3$$

9. What is the oxidation number of Mn in MnO_2 ?

$$\begin{array}{rcl} x - 4 & = & 0 \\ x & = & +4 \end{array}$$

Oxidation number of Mn is +4

10. What is the oxidation number of Fe in $\text{Fe}_2(\text{SO}_4)_3$?

$$\begin{array}{rcl} \text{Fe} & = & x \\ \text{SO}_4 & = & -2 \\ 2x + (-6) & = & 0 \\ 2x - 6 & = & 0 \\ 2x & = & 6 \\ x & = & 6/2 \\ x & = & +3 \\ \text{Fe} & = & +3 \end{array}$$

11. What is the oxidation number of Al in AlCl_3 ?

$$\begin{array}{rcl} \text{Cl} = -1, & \text{Al} = & x \\ x + (1 \times -3) & = & 0 \\ x - 3 & = & 0 \\ x & = & +3 \\ \text{Al} & = & +3 \end{array}$$

12. What is the oxidation number of S in Na_2SO_4 ?

$$\begin{array}{rcl} \text{Na} = 1, & \text{O} = & -2 \\ 2 + x + 4(-2) & = & 0 \\ 2 + x - 8 & = & 0 \\ x - 6 & = & 0 \\ x & = & +6 \end{array}$$

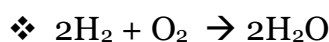
Oxidation number of Sulphur is +6

13. What is the oxidation number of Sr in SrCO_3 ?

$$\begin{array}{rcl} \text{Sr} = x & & \text{CO}_3 = -2 \\ x - 2 & = & 0 \\ x & = & +2 \end{array}$$

Oxidation number of Sr is +2

Balancing of chemical equations



❖ This is unbalanced chemical equation.

❖ According to the law of conservation of mass, two sides have the same number of atoms.

STEPS

Reactant side Product side

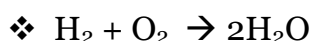
Number of hydrogen atoms

2 2

Number of oxygen atoms

2 1

❖ Hydrogen atoms are equal but oxygen atoms are not equal. So multiple by 2 on products side



❖ Now check the number of atoms

Reactant side Product side

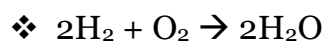
Hydrogen 2 4

Oxygen 2 2

In Flash bell Magnetism wire is kept in atmosphere of nitrogen gas.



- ❖ Both sides number of oxygen are equal. But number of Hydrogen are not equal. So left side multiple with 2 H₂.



$$\text{H} = 2 \times 2 = 4$$

$$2 = 4$$

$$\text{o} = 2$$

$$\text{H} = 2 \times$$

$$\text{o} = 2$$

- ❖ Both sides hydrogen and oxygen are equal. So equation is balanced.



CHEMISTRY OF ORES AND METALS

Minerals

- ❖ A mineral may be a single compound (or) complex mixture of various compounds of metals which are found in earth.

Ores

- ❖ The mineral from which a metal can be readily and economically extracted on a large scale is said to be an ore.
- ❖ **All minerals cannot be called as ores, but all ores are minerals.**

Oxide ores

- Bauxite - $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
- Cuprite - Cu_2O
- Haematite - Fe_2O_3
- Zincite - ZnO
- Cassiterite
(or) Tinstone - SnO_2
- Pyrolusite - MnO_2
- Pitch Blende - U_3O_8

Halides Ores

- Rock salt - NaCl
- Carnallite - $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
- Horn silver - AgCl
- Fluorspar - CaF_2

Sulphide ores

- Copper pyrites - CuFeS_2
- Copper glance - Cu_2S
- Zinc blende - ZnS
- Cinnabar - HgS
- Galena - PbS
- Argentite
(or) Silver glance - Ag_2S
- Iron Pyrites - FeS_2

Carbonate ores

- Calamine - ZnCO_3
- Limestone
(or) Marble - CaCO_3
- Magnesite - MgCO_3
- Siderite - FeCO_3

Sodium peroxide is used in submarine and also to purify closed air in hospital

Sulphate ores

- Epsom salt - $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
- Gypsum - $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- Barytes - BaSO_4
- Anglesite - PbSO_4

Silicate ores

- Asbestos - $\text{CaSiO}_3 \cdot 3\text{MgSiO}_3$
- Felspar - KAlSi_3O_8
- Mica - $\text{K}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot 2\text{H}_2\text{O}$

Phosphate ores

- Phosphorite - $\text{Ca}_3(\text{PO}_4)_2$

Ores of important Metals**1. Iron (Fe)**

- Hematite - Fe_2O_3
- Magnetite - Fe_3O_4
- Iron Pyrites - FeS_2
- Siderite - FeCO_3

2. Copper (Cu)

- Copper pyrites - CuFeS_2
- Cuprite (or) Ruby Copper - Cu_2O
- Copper glance - Cu_2S
- Malachite - $\text{Cu}(\text{OH})_2, \text{CuCO}_3$
- Azurite - $2\text{CuCO}_3, \text{Cu}(\text{OH})_2$

3. Aluminium (Al)

- Bauxite - $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
- Corundum - Al_2O_3
- Cryolite - Na_3AlF_6
- Mica - $\text{KAlSi}_2\text{O}_{10}(\text{OH})_2$
- Felspar - KAlSi_3O_8

4. Mercury (Hg)

- Chinnabar - HgS

5. Lead (Pb)

- Galena - PbS
- Cerrusite - PbCO_3
- Anglesite - PbSO_4

6. Tin (Sn)

- Cassiterite (tinstone) - SnO_2

7. Uranium (Ur)

- Pitch blende - U_3O_8
- Eranotite - $(\text{K}_2\text{O} \cdot 2\text{UO}_2, \text{U}_2\text{O}_5 \cdot \text{NH}_2\text{O})$

8. Sodium (Na)

- Chile saltpetre - NaNO_3
- Trona - $\text{Na}_2\text{CO}_3, 2\text{NaHCO}_3 \cdot 3\text{H}_2\text{O}$
- Borax - $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$
- Common salt - NaCl

9. Potassium (K)

- Nitre (salt peter) - KNO_3
- Carnalite - $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$

10. Magnesium (Mg)

- Magnesite - MgCO_3
- Dolomite - $\text{MgCO}_3 \cdot \text{CaCO}_3$
- Epsom salt - $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
- Kieserite - $\text{MgSO}_4 \cdot \text{H}_2\text{O}$

- Carnalite - $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$

11. Calcium (Ca)

- Dolomite - $\text{CaCO}_3 \cdot \text{MgCO}_3$
- Calcite - CaCO_3
- Gypsum - CaF_2
- Fluorspar - $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- Asbestos - $\text{CaSiO}_3 \cdot \text{MgSiO}_3$

12. Strontium (Sr)

- Strontianite - SrCO_3
- Silestine - SrSO_4

13. Silver (Ag)

- Ruby Silver- $3 \text{Ag}_2 \text{S} \cdot \text{Sb}_2\text{S}_3$
- Horn Silver- AgCl

14. Gold (Au)

- Calaverite - AuTe_2
- Silvenites - $[(\text{Ag}, \text{Au}) \text{Te}_2]$

15. Barium (Ba)

- Barytes - BaSO_4

16. Zinc (Zn)

- Zinc blende - ZnS
- Zincite - ZnO
- Calamine - ZnCO_3

17. Tin (Sn)

- Casseterite - SnO_2

18. Antimony (Sb)

- Stibenite - Sb_2S_3

19. Cadmium (Cd)

- Greenocite - CdS

20. Bismuthinite (Bi_2S_3)

- Bismuthite - Bi_2S_3

21. Cobalt (Co)

- Smelite - CoAsS_2

22. Nickel (Ni)

- Milarite - NiS

23. Magnese (Mn)

- Pyrolusite - MnO_2
- Magnite - $\text{Mn}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$

24. Uranium (U)

- Carnetite - $\text{K}(\text{UO})_2 \cdot \text{VO}_4 \cdot 3\text{H}_2\text{O}$
- Pitch blende - U_3O_8

Lead pipe is not used for drinking water because it forms poisonous lead hydroxide $\text{Pb}(\text{OH})_2$

The difficulty in the Mendeleev's periodic table is overcome by introduction of Modern periodic table. It is also known as Long form of periodic table. In this table, properties of elements are dependent on their electronic configurations-distributions. Hence, modern periodic law is defined as the properties of elements and the periodic function of their atomic numbers.

❖ Among metals, silver is the best conductor of electricity.

❖ Among nonmetals, graphite is the only conductor of electricity.

❖ Mercury is a metal with a very low melting point and it becomes liquid at room temperature.

Metals and Non Metals

❖ Tungsten has the highest melting point of any metal-over 3410°C .

❖ The lightest metal is Lithium.

❖ It weighs about half as much as water.

❖ Osmium is the heaviest metal. It is about 22 times heavier than water and nearly 3 times heavier than iron.

Alloys:

❖ Alnicos are alloys of Iron, Aluminium and Nickel, Cobalt.

❖ Alnicos are used to make magnets, up to 25 times as strong as ordinary magnets.

Methods of making Alloys

1) By fusing the metals together.

2) By compressing finely divided metals one over the other.

Amalgam: An amalgam is an alloy of mercury with metals such as sodium, gold, silver, etc.

Zinc Oxide is known as flower of Zinc. Also known as Chinese white is used as paints.

Copper Alloys

Name of the alloy	Reason for alloying	Uses
i.Brass(Cu,Zn)	Lustrous,easily cast,malleable, ductile,harder than Cu.	Electrical fittings, medals, hardware, decorative items.
ii.Bronze(Cu,Sn)	Hard, brittle and polishable.	Statues, coins, bells, gongs.

Aluminum Alloys

Name of the alloy	Reason for alloying	Uses
i.Duralumin (Al,Mg,Mn,Cu)	Light,strong,resistant to corrosion, stronger than aluminium.	Aircraft,tools, pressure cookers
ii.Magnalium(Al,Mg)	Light, hard, tough, corrosion resistant.	Aircraft, scientific instruments

Iron Alloys

Name of the alloy	Reason for alloying	Uses
i.Stainless steel (Fe,C,Ni,Cr)	Lustrous,corrosion resistant,high tensile strength.	Utensils,cutlery,automobile parts.
ii.Nickel steel (Fe,C,Ni)	Hard, corrosion resistant,elastic.	Cables,aircraft parts,propeller.

Metallurgy

- ◆ Metallurgy is as old as our civilization. Copper was the first metal to be used in making utensils and weapons. Metals play a significant role in our life.
- ◆ They constitute the mineral wealth of a country which is the measure of its prosperity. Metals like Titanium, Chromium, Manganese, Zirconium etc. find their applications in the

manufacture of defence equipments. These are called strategic metals. The metal Uranium plays a vital role in nuclear reactions releasing enormous energy called nuclear energy. Copper, Silver and Gold are called coinage metals as they are used in making coins, jewelry etc.

Terminology

- ❖ **Minerals:** A mineral may be a single compound or a complex mixture of various compounds of metals found in the earth.

Purity of gold is expressed in carats. 24 carat gold = pure gold. For making ornaments 22 carat gold is used which contains 22 parts of gold by weight and 2 parts of copper by weight. The percentage of purity is $\left(\frac{22}{24}\right) \times 100 = 91.6\%$ (916 Make gold) From one gram of gold, nearly 2km of filament can be drawn. It is an amazing fact indeed!

❖ **Ores:**

The mineral from which a metal can be readily and economically extracted on a large scale is said to be an ore.

For example, clay ($\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$) and bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$) are the two minerals of Aluminium, but Aluminium can be profitably extracted only from bauxite.

Hence bauxite is an ore of aluminium and clay is its mineral.

Mining:

- ❖ The process of extracting the ores from the earth's crust is called mining.
- ❖ **Metallurgy:** The various steps involved in the extraction of metals from their

ores as well as refining of crude metals are collectively known as metallurgy.

- ❖ **Gangue of Matrix:** The rocky impurity, associated with the ore is called gangue of matrix
- ❖ **Flux:** It is the substance added to the ore to reduce the fusion temperature and to remove impurities. e.g. Calcium oxide, Silica.
- ❖ **Slag:** It is the fusible product formed when flux reacts with gangue during the extraction of metals.
- ❖ **Flux + Gangue** → Slag
- ❖ **Smelting:** Smelting is the process of reducing the roasted metallic oxide to metal in molten condition. In this process, impurities are removed by the addition of flux as slag.

METALLURGY OF ALUMINIUM, COPPER AND IRON

Metallurgy of Aluminium

Al	13
ALUMINUM	
26.98	2.70
660	2467



Symbol : Al

Colour : Silvery white

Atomic number : 13

Electronic configuration: 2, 8, 3

Valency : 3

Atomic mass : 27

Silver Spoon is not used in egg food because it forms black silver sulphide.

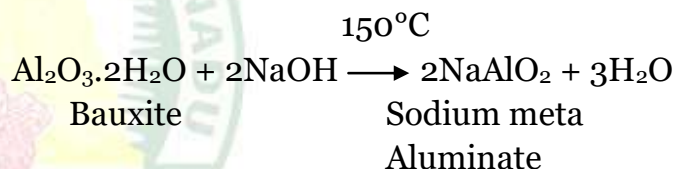
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graph TD
    ORE[ORE] -- "Gravity separation, Froth floatation, Magnetic separation, Leaching" --> CO[Concentrated ore]
    CO --> H[Metals of high reactivity]
    CO --> M[Metals of moderate reactivity]
    CO --> L[Metals of low reactivity]
    H -- "Electrolytic reduction, Refining" --> PM1[Pure Metal]
    M -- "Calcination, Roasting, Reduction, Refining" --> PM2[Pure Metal]
    L -- "Roasting, Reduction, Refining" --> PM3[Pure Metal]
  
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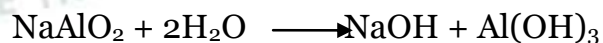
Aluminium is the metal found most abundantly in the earth's crust. Since it is a reactive metal, it occurs in the combined state. The important ores of aluminium are as follows:

Name of the ore	Formula
Bauxite	$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
Cryolite	Na_3AlF_6
Corundum	Al_2O_3

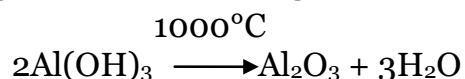
- i. Bauxite ore is finely ground and heated under pressure with concentrated caustic soda solution at 150°C to obtain sodium meta aluminate.



ii. On diluting sodium meta aluminate with water, aluminium hydroxide precipitate is obtained.



iii. The precipitate is filtered, washed, dried and ignited at 1000°C to get alumina.

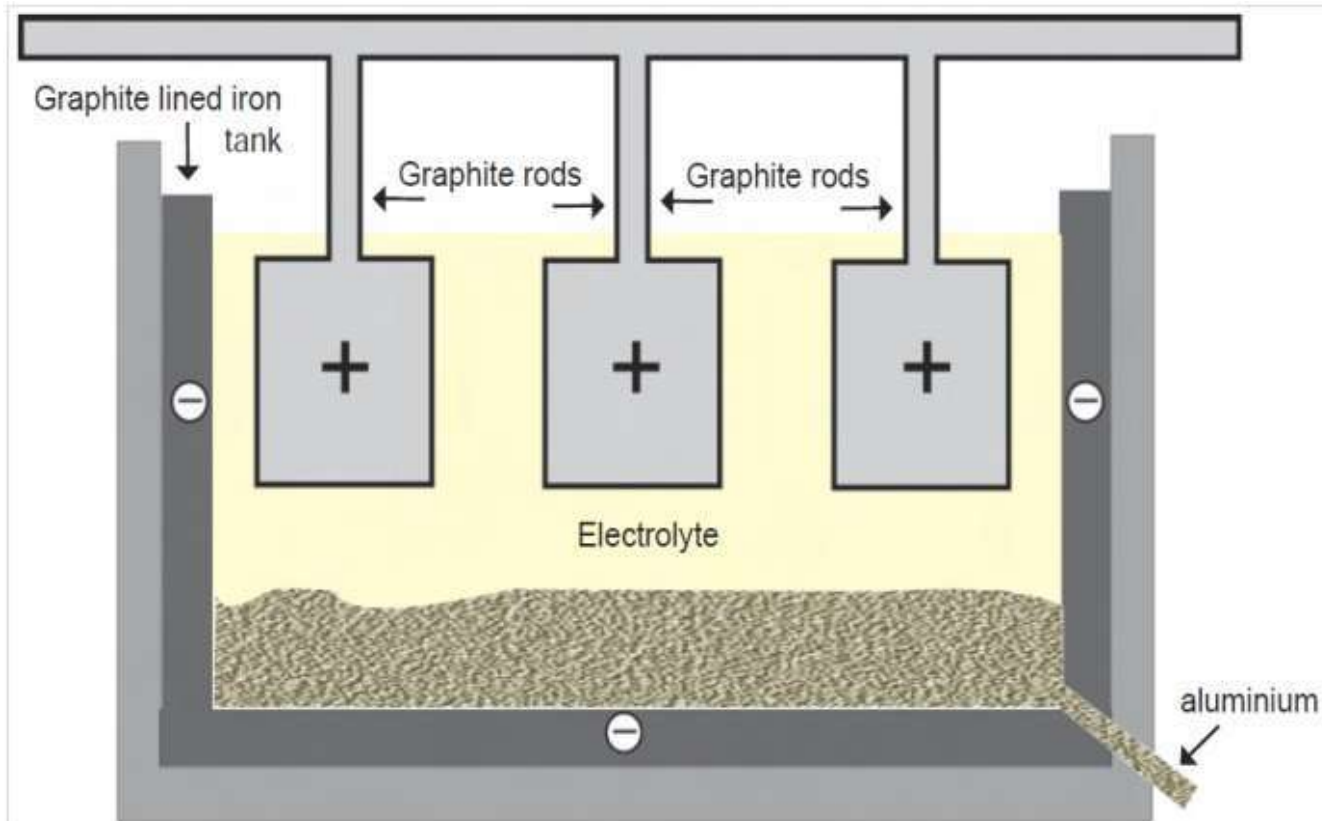


Extraction of aluminium from bauxite involves two stages:

The conversion of Bauxite into Alumina involves the following steps:

Aluminium is produced by the electrolytic reduction of fused alumina (Al_2O_3) in the electrolytic cell.

Page 7



Electrolytic reduction of alumina

Cathode: Iron tank lined with graphite.

Anode: A bunch of graphite rods suspended in molten electrolyte.

Electrolyte: Pure alumina + molten cryolite + fluorspar (fluorspar lowers the fusion temperature of electrolyte)

Temperature : 900-950°C

Voltage used : 5-6V

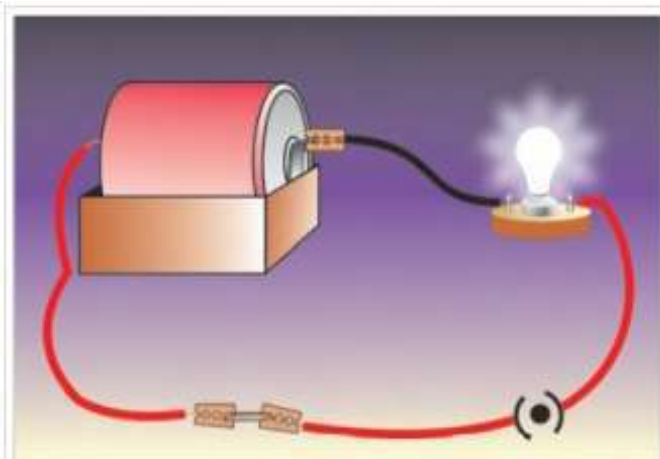
The overall equation for aluminium extraction is $2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2\uparrow$

Aluminium is deposited at the cathode and oxygen gas is liberated at the anode. Oxygen combines with graphite to form CO_2 .

Properties of Aluminium

Physical properties:

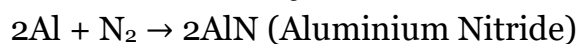
- It is a silvery white metal.
- It has low density and it is light.
- It is malleable and ductile.
- It is a good conductor of heat and electricity.



Electric conductivity of metal

- vi. It can be polished to produce a shiny attractive appearance.

1. Reaction with air: It is not affected by dry air. On heating at 800°C , aluminium burns very brightly forming its oxide and nitride.


$$\underset{\text{Steam}}{2\text{Al}} + \underset{\text{Aluminium}}{3\text{H}_2\text{O}} \longrightarrow \underset{\text{Aluminium}}{\text{Al}_2\text{O}_3} + \underset{\text{Oxide}}{3\text{H}_2\uparrow}$$
$$2\text{Al} + 2\text{NaOH} + 2\text{H}_2\text{O} \longrightarrow 2\text{NaAlO}_2 + 3\text{H}_2 \uparrow$$

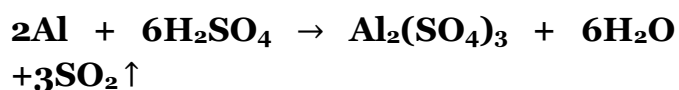
Sodium meta
aluminate

$$2\text{Al} + 6\text{HCl} \longrightarrow 2\text{AlCl}_3 + 3\text{H}_2 \uparrow$$

Aluminium
Chloride

$$\mathbf{2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2 \uparrow}$$

Dilute



hot & conc. Aluminium
Sulphuric acid Sulphate

Dilute or concentrated nitric acid does not attack aluminium, but it renders aluminium passive due to the formation of an oxide film on its surface.

$$\text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow 2\text{Fe} + \text{Al}_2\text{O}_3 + \text{Heat}$$

USES	FORM	REASON
Household utensils	Aluminium metal	It is light, cheap, corrosion resistant, and a good conductor of heat.
Electrical cable industry	Aluminium wires	Aluminium wires
Aeroplanes and other Industrial parts	Duralumin Al,Cu,Mg,Mn Magnalium Al,Mg	Its alloys are light, have high tensile strength and corrosion resistant.
Thermite welding	Al powder and Fe_2O_3	Its powder is a strong reducing agent and reduces Fe_2O_3 to iron.



Aircraft - An alloy of aluminium

Metallurgy of Copper



Symbol : Cu

Atomic mass : 63.55

Atomic number : 29

Electronic configuration : 2, 8, 18, 1

Valency : 1 and 2

Occurrence: It was named as cuprum by the Romans because they got it from the Island of Cyprus. Copper is found in the **native state** as well as in the combined state.

Ores of copper	Formula
Copper pyrites	CuFeS_2
Cuprite or ruby copper	Cu_2O
Copper glance	Cu_2S

The chief ore of copper is copper pyrite. It yields nearly 76% of the world production of copper.

Extraction from Copper Pyrites:

Extraction of copper from copper pyrites involves the following steps:

1. Crushing and concentration: The ore is crushed and then concentrated by froth-floatation process.

2. Roasting: The concentrated ore is roasted in excess of air. During the process of roasting,

i. moisture and volatile impurities are removed.

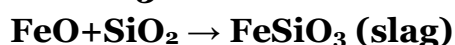
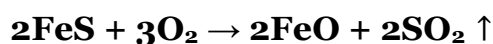
ii. **sulphur**, phosphorus, arsenic and antimony are removed as oxides. Copper pyrite is partly converted into sulphides of copper and iron.



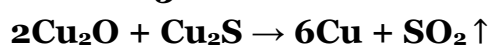
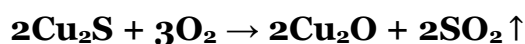
3. Smelting: The roasted ore is mixed with powdered coke and sand and is heated in a blast furnace to obtain matte and slag.

(**Matte** = $\text{Cu}_2\text{S} + \text{FeS}$) The slag is removed as waste.

4. Bessemerisation: The molten matte is transferred to Bessemer converter in order to obtain **blister copper**. Ferrous sulphide from matte is oxidised to ferrous oxide, which is removed as slag using silica.



Iron silicate



Blister copper

5. Refining: Blister copper contains 98% of pure copper and 2% of impurities and is purified by electrolytic refining.

Electrolytic Refining

This method is used to get metal of a high degree of purity. For electrolytic refining of copper, we use:

Cathode: A thin plate of pure copper metal.

Anode: A block of impure copper metal.

Electrolyte: Copper sulphate solution acidified with sulphuric acid.

When electric current is passed through the electrolytic solution, pure copper gets deposited at the cathode and the impurities settle at the bottom of the anode in the form of sludge called **anode mud**.

Properties

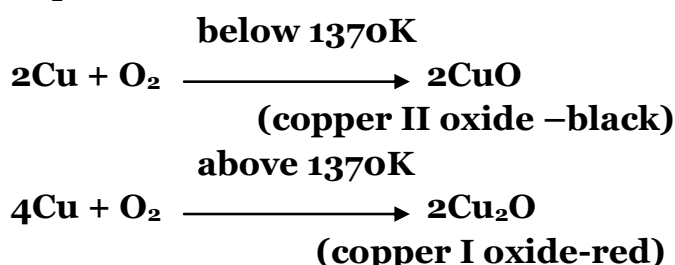
Physical properties: Copper is a reddish brown metal, with high lustre, high density and high melting point (1356°C).

Chemical properties:

i. **Action of Air and Moisture:** Copper gets covered with a green layer of basic copper carbonate in the presence of CO₂ and moisture.



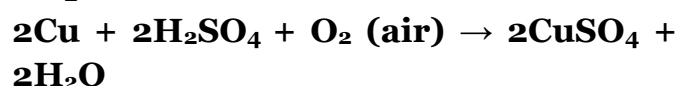
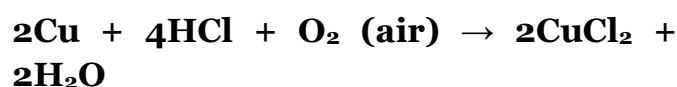
ii. **Action of Heat:** On heating at different temperatures in the presence of oxygen, copper forms two types of oxides CuO, Cu₂O.



iii. Action of Acids:

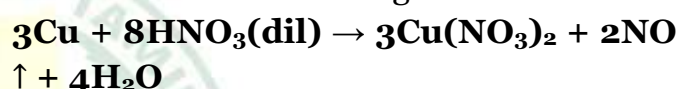
a) With dil.HCl and dil.H₂SO₄:

Dilute acids such as HCl and H₂SO₄ have no action on these metals in the absence of air. Copper dissolves in these acids in the presence of air.



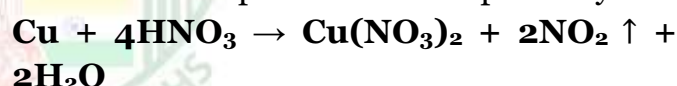
b) With dil.HNO₃:

Copper reacts with dil.HNO₃ with the liberation of Nitric Oxide gas.



c) With con.HNO₃ and con.H₂SO₄:

Copper reacts with con. HNO₃ and con. H₂SO₄ with the liberation of nitrogen dioxide and sulphur dioxide respectively.

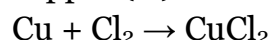


(conc.)



(conc.)

iv. **Action of Chlorine:** Chlorine reacts with copper, resulting in the formation of copper (II) chloride.



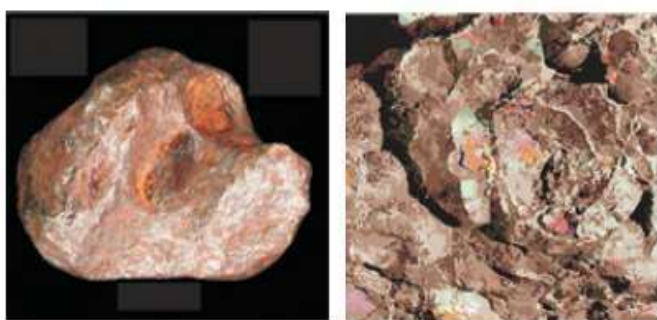
v. **Action of Alkalis:** Copper is not attacked by alkalis.

Uses of Copper:

- It is extensively used in manufacturing electric cables and other electric appliances.

- It is used for making utensils, containers, calorimeters and coins.
- It is used in electroplating.
- It is alloyed with gold and silver for making coins and jewels.

Metallurgy of Iron



Symbol: Fe

Colour: Greyish white

Atomic mass: 55.9

Atomic number: 26

Electronic configuration : 2, 8, 14, 2

Valency: 2 & 3

Occurrence:

Iron is the second most abundant metal available next to aluminium. It occurs in nature as oxides, sulphides and carbonates.

The ores of iron are given in the following table:

Ores of iron	Formula
Haematite	Fe ₂ O ₃
Magnetite	Fe ₃ O ₄
Iron pyrite	FeS ₂

Extraction of Iron from Haematite Ore (Fe₂O₃)

1. Concentration by Gravity Separation

The powdered ore is washed with a stream of water. As a result, the lighter sand particles and other impurities are washed

away and the heavier ore particles settle down.

2. Roasting and Calcination

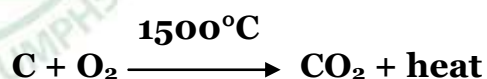
The concentrated ore is strongly heated in a limited supply of air in a reverberatory furnace. As a result, moisture is driven out and sulphur, arsenic and phosphorus impurities are oxidised off.

3. Smelting (in a Blast Furnace)

The **charge** consisting of roasted ore, coke and limestone in the ratio **8 : 4 : 1** is smelted in a blast furnace by introducing it through the **cup and cone** arrangement at the top. There are three important regions in the furnace.

i. The Lower Region (Combustion Zone)-the temperature is at 1500°C.

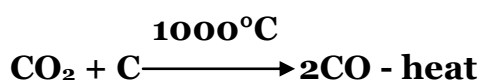
In this region, coke burns with oxygen to form CO₂ when the charge comes in contact with a hot blast of air.



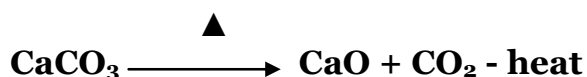
It is an exothermic reaction since heat is liberated.

ii. The Middle Region (Fusion Zone)-

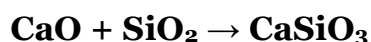
The temperature prevails at 1000°C. In this region, CO₂ is reduced to CO.



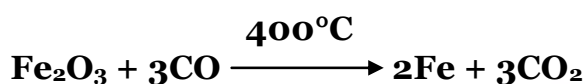
Limestone decomposes to calcium oxide and CO₂.



These two reactions are endothermic due to the absorption of heat. Calcium oxide combines with silica to form calcium silicate slag.



iii. The Upper Region (Reduction Zone)-The temperature prevails at 4000C. In this region carbon monoxide reduces ferric oxide to form a fairly pure spongy iron.



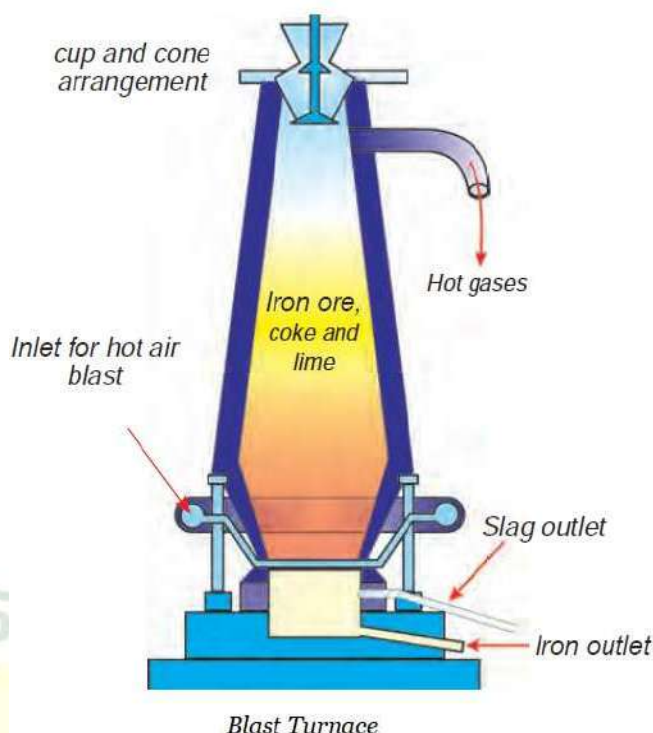
The molten iron is collected at the bottom of the furnace after removing the slag.

The iron thus formed is called pig iron. It is remelted and cast into different moulds. This iron is called cast iron.

MORE TO KNOW

CALCINATION: It is a process in which ore is heated in the absence of air. As a result of calcination, the carbonate ore is converted into its oxide.

ROASTING: It is a process in which ore is heated in the presence of excess of air. As a result of roasting, the sulphide ore is converted into its oxide.



MORE TO KNOW

Depending on the carbon content, iron is classified into 3 types:

Pig iron with carbon content of 2- 4.5%

Wrought iron with carbon content of <0.25%

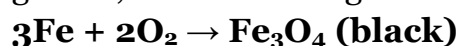
Steel with carbon content of 0.25-2%.

Physical Properties

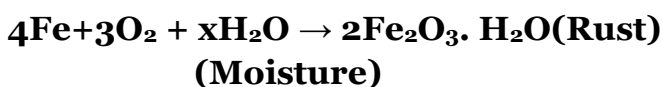
- It is a heavy metal of density 7.9 g/cc.
- It is a lustrous metal, greyish white in colour.
- It has high tensility, malleability and ductility.
- It is a good conductor of heat and electricity.
- It can be magnetised.

Chemical properties

1. Reaction with air or oxygen: Only on heating in air, iron forms magnetic oxide.



2. Reaction with moist air: When iron is exposed to moist air, it forms a layer of brown hydrated ferric oxide on its surface. This compound is known as rust and the phenomenon of formation of rust is known as rusting.



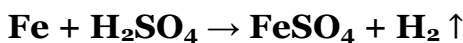
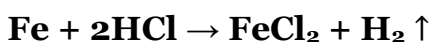
3. Reaction with steam: When steam is passed over red hot iron, magnetic oxide is formed.



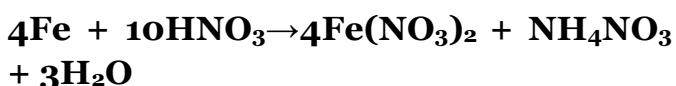
4. Reaction with chlorine: Iron combines with chlorine to form ferric chloride.



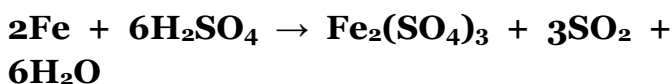
5. Reaction with acids: With dilute HCl and dilute H₂SO₄ it liberates H₂ gas.



With dilute HNO₃ in cold condition it gives ferrous nitrate.



With conc. H₂SO₄ it forms ferric sulphate.



When iron is dipped in conc. HNO₃ it becomes chemically **inert or passive** due to the formation of a layer of iron oxide (Fe₃O₄) on its surface.

Uses of Iron

i. Pig iron is used in making pipes, stoves, radiators, railings, manhole covers and drain pipes.

ii. Steel is used in the construction of buildings, machinery, transmission cables and T.V. towers and in making alloys.

iii. Wrought iron is used in making springs, anchors and electromagnets.

ALLOYS

An alloy is a homogeneous mixture of a metal with other metals or with non-metals that are fused together.

Alloys are solid solutions. Alloys can be considered as solid solutions in which the metal with high concentration is the **solvent** and the metal with low concentration is the **solute**. For example, brass is an alloy of zinc(solute) in copper(solvent).

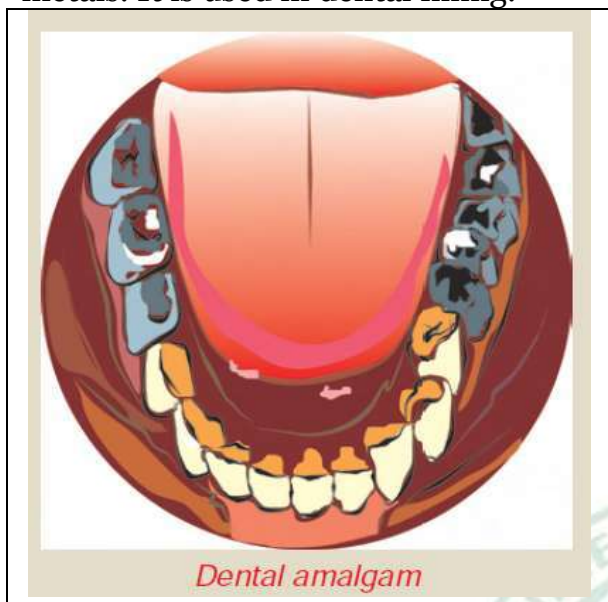
Methods of making Alloys

1. By fusing the metals together.
2. By compressing finely divided metals one over the other.

Amalgam: An amalgam is an alloy of mercury with metals such as sodium, gold, silver, etc.

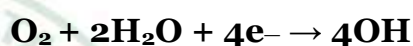
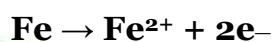
DENTAL AMALGAMS

It is an alloy of mercury with silver and tin metals. It is used in dental filling.



Corrosion is defined as the slow and steady destruction of a metal by the environment. It results in the deterioration of the metal to form metal compounds by means of chemical reactions with the environment.

When the surface of iron is exposed to moisture and other gases present in the atmosphere, chemical reaction takes place.



Copper Alloys

Name of the alloy	Reason for alloying	Uses
i. Brass (Cu, Zn)	Lustrous, easily cast, malleable, ductile, harder than Cu.	Electrical fittings, medals, hardware, decorative items.
ii. Bronze (Cu, Sn)	Hard, brittle and polishable.	Statues, coins, bells, gongs.

Aluminium Alloys

Name of the alloy	Reason for alloying	Uses
i. Duralumin (Al, Mg, Mn, Cu)	Light, strong, resistant to corrosion, stronger than aluminium.	Aircraft, tools, pressure cookers
ii. Magnalium (Al, Mg)	Light, hard, tough, corrosion resistant.	Aircraft, scientific instruments

Iron Alloys

Name of the alloy	Reason for alloying	Uses
i. Stainless steel (Fe, C, Ni, Cr)	Lustrous, corrosion resistant, high tensile strength.	Utensils, cutlery, automobile parts.
ii. Nickel steel (Fe, C, Ni)	Hard, corrosion resistant, elastic.	Cables, aircraft parts, propeller.

- ◆.....◆
- The Fe^{2+} ions are oxidised to Fe^{3+} ions. The Fe^{3+} ions combine with OH^- ions to form $\text{Fe}(\text{OH})_3$. This becomes rust ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) which is hydrated ferric oxide.

❖ Electroplating: It is a method of coating one metal with another by passing electric current. Example: silver plating, nickel plating. This method not only protects but also enhances the metallic appearance.

Methods of preventing corrosion:

- ❖ Corrosion of metals is prevented by not allowing them to come in contact with moisture CO_2 and O_2 . This is achieved by the following methods:
- ❖ By coating with paints: Paint coated metal surfaces keep out air and moisture.
- ❖ By coating with oil and grease: Application of oil and grease on the surface of iron tools prevent them from being acted upon by moisture and air.
- ❖ By alloying with other metals: Alloyed metals are more resistant to corrosion. Example: stainless steel.
- ❖ By the process of galvanization: This is a process of coating zinc on iron sheets by using electric current. In this, zinc forms a protective layer of zinc carbonate on the surface of iron. This prevents corrosion.

❖ Sacrificial protection: Magnesium is more reactive than iron. When it is coated on the articles made of steel it sacrifices itself to protect steel.

Silver is the best conductor while lead is the poorest conductor, While lead is the poorest condition of electricity.

CARBON AND ITS COMPOUNDS

Carbon is a non-metal

symbol	: C
Atomic Number	: 6
Atomic Mass	: 12
Valency	: 4

$1s^2 2s^2 2p^2$ ie $k=2, l=4$, k shell has 2 electrons, l shell has 4 electrons. Since it has four electrons in its outermost shell, its valency is four.

Allotropy

❖ The electronic configuration of carbon is $k=3, l=4$. It has four electrons in the valence shell and belongs to group IV A (group 14) of the periodic table. Other element in the 14th group is Silicon, Germanium, Tin, Lead.

❖ Allotropy is defined as the property by which an element can exist in more than one form that is physically different but chemically similar.

Allotropes of carbon

❖ Without carbon, no living thing could survive. Human beings are made of carbon compounds.

❖ Carbon compounds hold the key to plant and animal life on earth. Hence, carbon chemistry is called living chemistry.

❖ Carbon exists in three allotropic forms.

1. Crystalline form. Ex. Diamond, Graphite
2. Amorphous form. Ex. Coke, Charcoal
3. Fullerene.

❖ **Catenation-special property of carbon**

Diamond

Electronic configuration of carbon

❖ The atomic number of carbon is 6. The electronic configuration is

❖ Diamond is a allotropy of carbon. Polished Diamond is more shine.

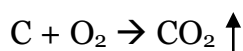
❖ In India diamonds are found in Panna mines in Madhya Pradesh,

Wajrakarur in Andhra Pradesh and Golkunda mines in Karnataka.

- ❖ In diamond each carbon atom is bonded to four other carbon atoms forming a rigid three dimensional structure, accounting for its hardness and rigidity .
- ❖ It is a Hexagonal cubic structure
- ❖ Kohinoor diamond is 105 Carat
- ❖ Kohinoor diamond is 21.68 g.

Characteristics of a diamond

1. It is a hardest naturally occurring substance
2. Colourless, transparent substance
3. It has a density of 3.5g/cm^3 .
4. It does not conduct electricity
5. It sublimates when heated to about 3500°C
6. Action of air
 - When heated to 800°C , it burns to give carbon dioxide.



Diamond uses

1. It is used in Jewellery.
2. Diamonds are used for cutting glass and even for drilling hard rocks.
3. It is used for making protective window in space crafts.

4. It is used in delicate eye surgeries as surgical tools.
5. High technology thermometers,
 $1 \text{ carat} = 200 \text{ mg}$

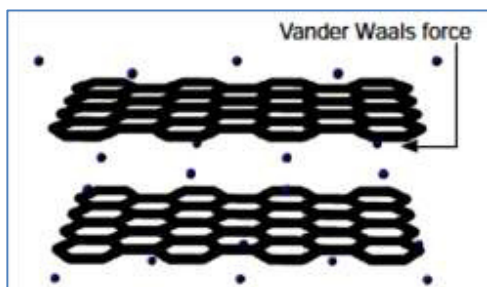
Graphite

- ❖ Graphite is an allotropy of carbon.
- ❖ Graphite exporting countries are China, India, Brazil, North Korea and Canada.
- ❖ In Graphite each carbon atom is bonded to three other Carbon atoms in the same plane giving hexagonal layers held together by weak vander waals forces accounting for softness.
- ❖ Graphite burns in air at 700°C to form CO_2 .
 1. Graphite is a good conductor of electricity
 2. Graphite is used to make pencils.

Graphite properties

- ❖ Graphite are generally greenish –black and opaque, melting point 3700°C , density 2.3 g / cm^3
- ❖ Graphite is soft and greasy to touch.

CARBON AND ITS COMPOUNDS



Uses of graphite

1. Graphite is used as a lubricant in machines.
2. Graphite is used as an electrode in dry cells.
3. It is used to make pencil lead.
4. It is used to make ink and paint.
5. Graphite is used as moderator in nuclear reactors.
6. It is used to make artificial diamonds.

Fullerene (C₆₀)

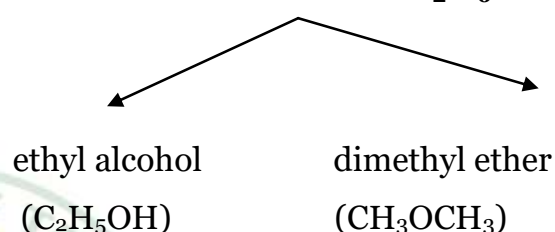
1. Fullerenes form another type of carbon allotropes.
2. It is identified to contain 60 carbon atoms in the shape of football.
3. It looks like the geodesic dome designed by the US architect Buckminster Fuller it is named as Buckminster Fullerene.
4. Discovered by Richard Smalley, Robert Curl and Harry Kroto.

Isomerism

- ❖ Isomerism, the phenomenon by which two (or) more compounds to have same molecular formula but different structural formula with difference in properties.

Examples

❖ molecular formula C₂H₆O



Hydrocarbons

- ❖ Organic compounds containing only carbon and hydrogen are called Hydrocarbons.

1. Saturated hydrocarbons

- Alkanes – General formula (C_nH_{2n+2})

2. Unsaturated hydrocarbons

- Alkenes (C_nH_{2n})
- Alkynes (C_nH_{2n-2})

Functional groups

- ❖ Functional group may be defined as an atom (or) group of atoms (or) reactive part which is responsible for the characteristic properties of the compounds.

Generally Transition metal and their compound are coloured.

Sl.No.	Molecular formula	Common Name	IUPAC Name
1.	CH ₃ OH	Methyl alcohol	Methanol
2.	CH ₃ CH ₂ OH	Ethyl alcohol	Ethanol
3.	CH ₃ CH ₂ CH ₂ OH	n-Propyl alcohol	1-propanol
4.	$\begin{array}{c} \text{CH}_3 \text{ CH CH}_3 \\ \\ \text{OH} \end{array}$	Isopropyl alcohol	2-propanol
5.	CH ₃ CH ₂ CH ₂ CH ₂ OH	n-Butyl alcohol	1-Butanol
6.	$\begin{array}{c} \text{CH}_3 \text{ CH CH}_2\text{OH} \\ \\ \text{CH}_3 \end{array}$	Isobutyl alcohol	2-methyl-1-Propanol

Sl.No.	Molecular formula	Common Name	IUPAC Name
1.	HCOOH	Formic Acid	Methanoic Acid
2.	CH ₃ COOH	Acetic Acid	Ethanoic Acid
3.	CH ₃ CH ₂ COOH	Propionic Acid	Propanoic Acid
4.	CH ₃ CH ₂ CH ₂ COOH	n-Butyric Acid	Butanoic Acid

Sl.No.	Molecular formula	Common Name	IUPAC Name
1.	HCHO	Formaldehyde	Methanal
2.	CH ₃ CHO	Acetaldehyde	Ethanal
3.	CH ₃ CH ₂ CHO	Propionaldehyde	Propanal
4.	CH ₃ CH ₂ CH ₂ CHO	Butyraldehyde	Butanal

1. Alcohol – OH is the functional group

2. Carboxylic Acid

❖ Functional group of the carboxylic acid is – COOH

3. Aldehydes

❖ Functional group of the aldehyde is – CHO

4. Ketones

❖ The functional group of Ketone is – Co

Lithium is the lightest and the most reluctant metal.

♦.....♦

CARBON AND ITS COMPOUNDS

SI.No.	Molecular formula	Common Name	IUPAC Name
1.	$\text{CH}_3 \text{COCH}_3$	Dimethyl ketone (Acetone)	Propanone
2.	$\text{CH}_3 \text{COCH}_2 \text{CH}_3$	Ethyl Methyl ketone	Butanone
3.	$\text{CH}_3 \text{CH}_2 \text{COCH}_2 \text{CH}_3$	Diethyl ketone	3-pentanone

Methylated spirit

- ❖ 95% Ethanol
- ❖ 5% Methanol

Rectified spirit

- ❖ 95.5% Ethanol
- ❖ 4.5% water

Amorphous Carbon

1. Coal
2. Charcoal
3. Lamp-black
4. Carbon black
5. Gas carbon
6. Petroleum charcoal

Ethanol is used

1. as an anti-freeze in automobile radiators.
2. as a preservative for biological specimen.

3. as an antiseptic to sterilize wounds, in hospitals.

4. as a solvent for drugs, oils, fats, perfumes, dyes, etc. In the preparation of methylated spirit (mixture of 95% of ethanol and 5% of methanol), rectified spirit (mixture of 95.5% of ethanol and 4.5% of water), power alcohol (mixture of petrol and ethanol) and denatured spirit (ethanol mixed with pyridine). in cough and digestive syrups.

Evil effects of consuming alcohol

1. If ethanol is consumed, it tends to slow down the metabolism of our body and depresses the central nervous system.
2. It causes mental depression and emotional disorder.

Gold and Silver are the most malleable metals.

3. It affects our health by causing ulcer, high blood pressure, cancer, brain and liver damage.
4. Nearly 40% accidents occur due to drunken driving.
5. Unlike ethanol, intake of methanol in very small quantities can cause death.
6. Methanol is oxidized to methanal (formaldehyde) in the liver and methanol reacts rapidly with the components of cells
7. Methanal causes the protoplasm to get coagulated, in the same way an egg coagulates while cooking. Methanol also affects the optic nerve, causing blindness.

Coal

Sl. No.	Type	Carbon	Grade
1.	Peat	27%	Very Low grade
2.	Lignite	28.30%	Low grade
3.	Bituminous	80%	High grade
4.	Anthracite	90%	Most superior variety

Isotopes of Carbon

Stable radioactive

C^{12} (98.93%)
 C^{13} (1.07)

C^{14} (half life
period 5730 years)

Uses of Carbon and its compounds

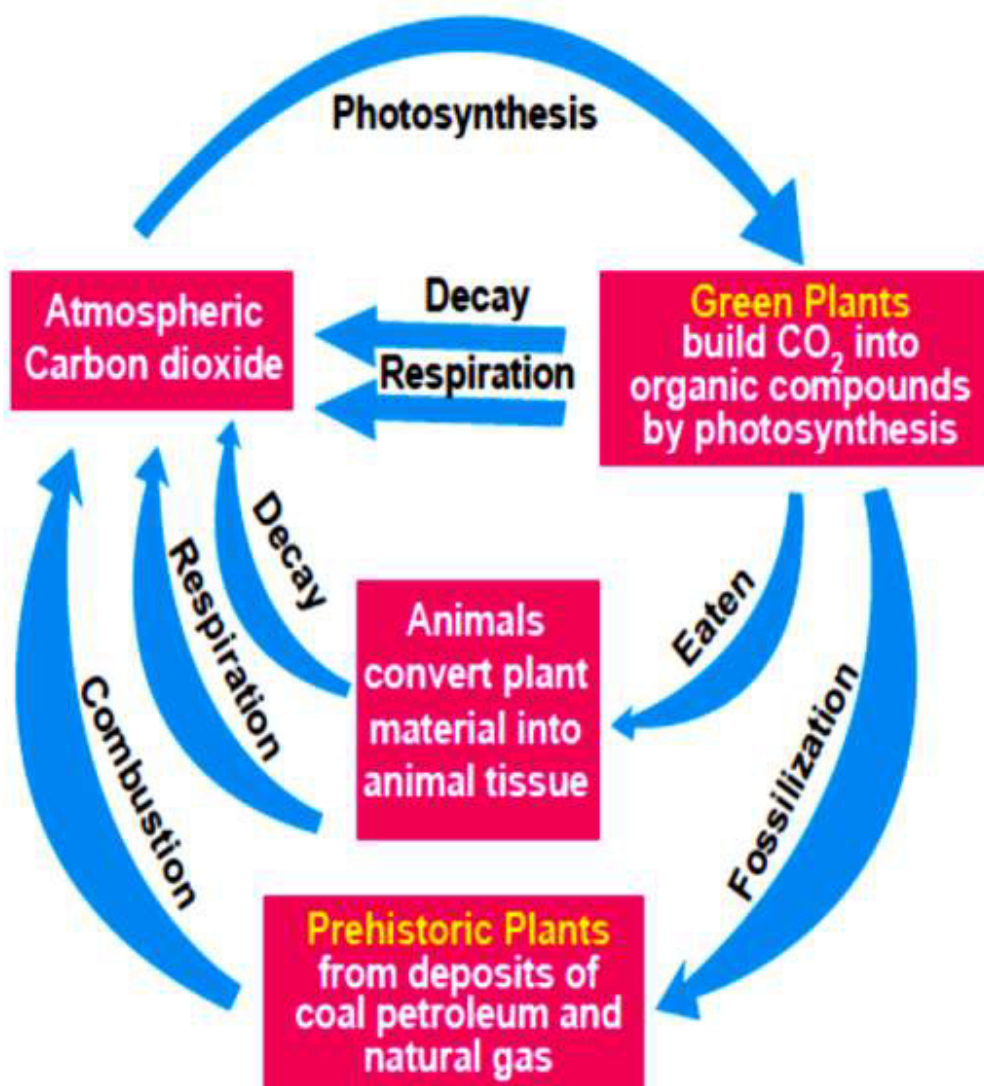
Ethanoic acid

1. For making vinegar which is used as a preservative in food and fruit juices.
2. As a laboratory reagent.
3. For coagulating rubber from latex.
4. In the preparation of dyes, perfumes and medicines.

1. Carbon and its compounds play important role in world economy.
2. Halogenated carbon compounds are used in coolant, fire extinguishers and solvent.
3. CS_2 , viscose rayon (Artificial silk) and can be used for preparation

World famous Eiffel Tower has steel and cement base

CARBON CYCLE



Potassium Carbonate K_2CO_3 is known as Pear acid.

NITROGEN AND ITS COMPOUNDS

❖ 15th group elements include Nitrogen, Phosphorus, Arsenic, Antimony and Bismuth.

❖ All the above elements have the general electronic configuration is $ns^2 np^3$.

- Symbol : N
- Atomic Number : 7
- Mass Number : 14
- Valency : 2, 5

❖ Rutherford in 1772 discovered Nitrogen.

❖ Air contains $\frac{3}{4}$ part of elementary Nitrogen.

❖ Nitrogen is a essential for plant and animal proteins.

❖ Nitrogen as a compound state in the salt peter, chile salt petere and ammonium salts.

Fixation of nitrogen

❖ The nitrogen present in the atmosphere is free (or) elementary nitrogen. The conversation of free atmospheric nitrogen to a nitrogen compound is called fixation of nitrogen.

Methods employed for fixation (or) brining atmospheric nitrogen into combination

❖ A mixture of nitrogen and hydrogen in the ratio 1 : 3 under pressure (200-900 ppm) is passed over a catalyst, finely divided into iron and molybdenum as promotor, heated to about 770K.

Nitrogen fixation in nature

❖ Due to electrical disturbances atomospheric nitrogen and oxygen combine to give Nitric oxide.

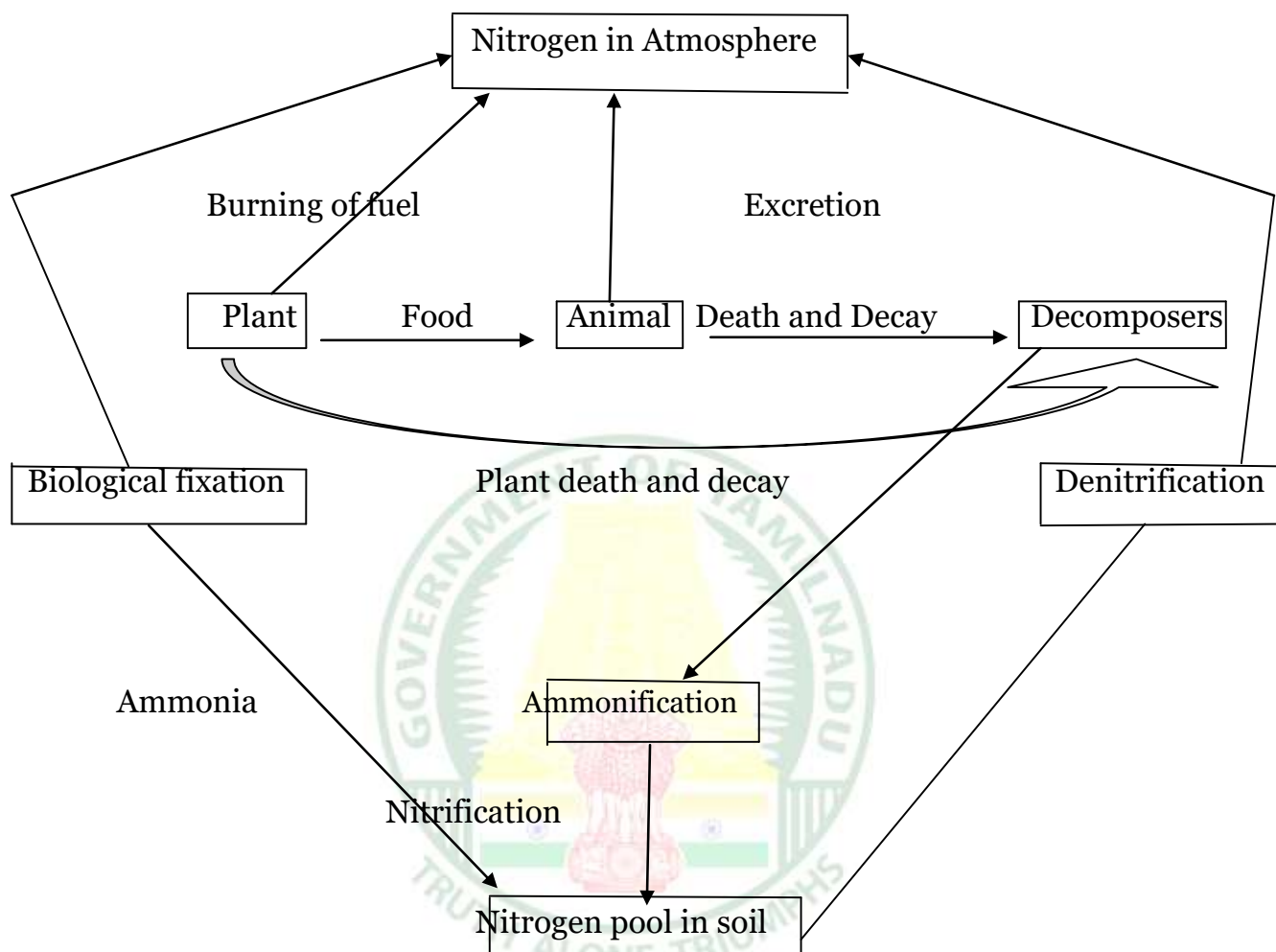
❖ Nitric oxide is further oxidised to give nitrogen dioxide.

❖ Nitrogen dioxide reacts with rain water in the presence of oxygen to produce nitric acid.

❖ Nitric acid reacts with bases of the soil to give nitrates.

In addition to this, certain bacteria living in the nodules on roots of leguminuous plants. Eg. pea, beans etc. Convert nitrogen into nitrogenous compounds which can be directly assimilated by the plant.

NITROGEN CYCLE



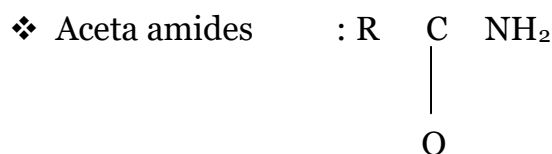
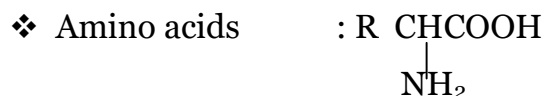
Organism involved in nitrogen cycle

1.	Nitrogen fixation	Rhizobium, Azetobacter and Nostoc
2.	Ammonification	Ammonifying bacteria and fungi
3.	Nitrification	Nitrosomonas and Nitrobacter
4.	Denitrification	Pseudomonas

Nitrogen compounds

- ❖ Nitriles C : N
- ❖ Nitro compounds : NO₂
- ❖ Amines : NH₂
- ❖ Diazonium salts : N₂Cl

♦.....NITROGEN AND ITS COMPOUNDS.....♦



❖ It is a highly corrosive strong mineral acid.

Preparation

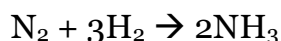
❖ Chile salt peter's method – by NaNO_3

Nitrogen compounds

1. Ammonia (NH_3)

❖ Ammonia is a basically colourless and a strong smelled gas like onion.

Preparation



Uses

1. Liquefied ammonia is used in freezing ice in the refrigerators
2. Ammonia is used in the production of ammonium salts and urea.
3. In the production of nitric acid (HNO_3)
4. In the production of sodium carbonate
5. In the production of hydrogen

Test for ammonia

- ❖ Ammonia turns moistured litmus blue
- ❖ It gives white fumes with HCl gas owing to the formation of solid NH_4Cl

2. Nitric Acid (HNO_3)

❖ Nitric acid is also known as aqua fortis and spirit of nitre.

Uses

1. It is used to prepare “aqua regia” to dissolve the noble elements.
2. In the manufacture of explosives like dynamite, TNT, TNP, TNB

3. Nitrous Acid HNO_2

- ❖ Nitrous acid is a weak and monobasis acid.
- ❖ It has been prepared only in the form of cold, dilute solutions.

Uses

1. It is used as agricultural fertilizers where it promotes vigorous growth in plants.
2. It helps in the purification of silver, gold and platinum.

4. Nitric oxide NO (or) Nitrogen Oxide

❖ It is also known as nitrogen monoxide.

Preparation

❖ It is produced naturally during the electrical discharge of lighting in thunder storms



Uses

1. Nitric oxide (NO) is an important signalling molecule that acts in many tissues to regulate a diverse range of physiological and cellular processes.
2. It plays an important role in Neuro Transmission, immune defence, the regulation of cell death and cell motility.

5. Nitrous oxide (N₂O)

❖ “Laughing gas”

Source



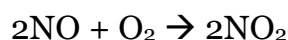
Uses

1. It is used in surgery for its anaesthetic and analgesic effects.
2. It is used as an oxidizer in rocketry and in motor racing to increase the power output of engines.

6. Nitrogen Dioxide (NO₂)

- ❖ Nitrogen dioxide is a reddish brown toxic gas.
- ❖ It is a prominent air pollutant.

Preparation



Uses

1. Nitrogen dioxide, has been used as a catalyst in certain oxidation reactions

2. It is used as a rocket fuel.

Isotopes of nitrogen

Stable	Radioactive
--------	-------------

${}^7\text{N}^{14}$

${}^7\text{N}^{13}$

${}^7\text{N}^{15}$

${}^7\text{N}^{16}$

1. Half life period is N¹³ is 10 minutes
2. N¹⁶ used in nuclear reactor instead of heavy water
3. Plants obtained food from N¹⁵
4. North-South polar region occurs sky light such as aurora borealis, Aurora australis due to N¹⁴.

Uses of nitrogen compounds

1. Liquid ammonia is used as a solvent
2. Ammonia is used as a refrigerant in ice plants.
3. Artificial silk, urea, fertilizers washing soda are prepared by ammonia.
4. Nitrous acid is used in the manufacture of azo-dyes.
5. Nitrous oxide is used as a anaesthetic.
6. Nitric acid is used in the manufacture of fertilizers explosives liked TNT, GTN etc.

NITROGEN AND ITS COMPOUNDS

7. Nitric acid is used in the purification of gold and silver.
8. Nitric acid is used in pickling of stainless steel.
9. Liquid nitrogen is used as a refrigerant.

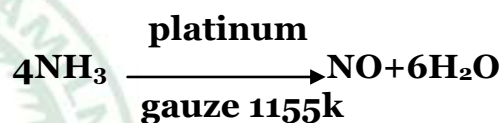
Nitric Acid

- ❖ Nitric acid is an important oxyacid of nitrogen. It was called as “aqua fortis” by alchemists. It means strong water. It was first prepared by Glauber (1650)

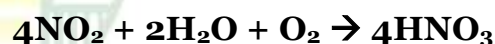
Preparation of nitric acid (ostwald's process)

- ❖ Toluene react with nitrating mixture (con HNO_3 , con H_2SO_4) react to form TNT
- ❖ GTN (Nitro glycerine (or) glycerol trinitrate)
- ❖ Glycerol reacts with con HNO_3 , con H_2SO_4 to get GTN.

- ❖ Large quantities of ammonia manufactured by Haber's process are converted into nitric acid by ostwald's process.



(Nitrogen Dioxide)



TNT (Tri nitro toluene)

FERTILIZERS, PESTICIDES AND INSECTICIDES

Plant nutrients

- ❖ Plants like human beings and animals require food for their growth and development.
- ❖ The food of plants is composed of certain chemical elements known as plant nutrients (or) plant food elements.
- ❖ Plants get nutrients from air, water and soil.

1. Air → Carbon, Oxygen
 2. Water → Hydrogen
 3. Soil → Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Iron, Manganese, Boron, Zinc, Copper, Molybdenum and Chlorine.
- ❖ Nearly 16 elements are essential for plant growth and reproduction.

Classification of nutrients

Macro Nutrients

- ❖ Elements which are needed in large quantities for growth of the plants are called Macro Nutrients.
- ❖ They are Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorous, Sulphur, Potassium, Calcium, Magnesium and Iron.

Micro Nutrients

- ❖ Elements which are needed by the plants in very small quantities are called micro nutrients.
- ❖ They are Manganese, Copper, Molybdenum, Zinc, Boron and Chlorine.

Zeolite is used to remove hardness of water.

Deficiency diseases for plants

Sl. No.	Nutrient	Adverse effects
1.	Nitrogen	The plant becomes yellowish (or) light green and remains stunted. The leaves and young fruits tend to drop prematurely and growth gives poor yield.
2.	Phosphorus	Root and shoot growth is restricted and plants become thin and spindly leaves may shed prematurely and there may be considerable delay in flowering and fruiting.
3.	Potassium	Deficiency of potassium may cause chlorosis (ie) yellowing of leaves and scorch in the case of fruit trees.
4.	Calcium	The normal growth of the plant is arrested. Roots may become short, stubby and brown.
5.	Magnesium	Chlorosis the yellowing of the older leaves. This is called chlorosis.
6.	Sulphur	Young leaves may turn yellow and roots, stems may become abnormally long and may also develop woodiness.
7.	Iron	In deficiency of iron, chlorosis of young leaves takes place but the veins remain green. In severe deficiency, leaves become almost pale white because of loss of chlorophyll.
8.	Manganese	A deficiency of manganese leads to chlorosis in the interveinal tissue of net-veined leaves and plants.
9.	Zinc	Shortening of internodes. Interveinal chlorosis of the foliage, particularly in lower leaves, with the size reduction in young leaves.
10.	Copper	Copper deficiency is evident as chlorosis, withering and often distortion of the terminal leaves.
11.	Molybdenum	The deficiency of molybdenum reduces the activity of the symbiotic and non-symbiotic nitrogen fixing organism.
12.	Boron	Plant growth is retarded and the leaves turn yellow (or) red. Boron deficiency is generally associated with sterility and malformation of reproductive organs.

Fertilizers

of essential elements required for plant growth.

- ❖ Fertilizers are those substances which must be added to the soil in order to remove the deficiency

Natural fertilizers

Manure

- ❖ Manure is an organic substance and is prepared by the decomposition of plant and animal wastes.

Farm yard manure

- ❖ This is the decomposed mixture of excreta (dung) and urine of farm animals like cow, horse, goat and sheep along with left over manures and contain nitrogen, phosphorus and potassium.
1. Nitrogen- 0.5%
 2. Potassium oxide – 0.5%
 3. Phosphorus penta oxide – 0.2%

Compost

- ❖ Compost prepared by using earth worms to speed up the process of decomposition of plant and animal wastes is called vermi compost.

Green manures

- ❖ Leguminous plants like sun-hemp (or) cluster bean are grown and then mulched by ploughing them back into the soil. This helps in enriching the soil with nitrogen and phosphorus

Artificial Fertilizers

- ❖ Artificial Fertilizers are chemicals commercially produced in factories and used as plant nutrients.

Properties of good fertilizers

- ❖ The element present in the compound must be easily available to the plant.
- ❖ The substance must be soluble in water.
- ❖ It should be stable, so that it may be made available to the plant for a long time.
- ❖ It should not be very costly.
- ❖ It should maintain the PH of the soil in the vicinity of 7 to 8.
- ❖ It should not be a poison for plant

TYPES OF ARTIFICIAL FERTILIZERS

Nitrogen fertilizers

- ❖ Soil takes up the nitrogen in the form of ammonium (or) nitrate ions and forms amino acids with carbon compounds in the complex chemical system in the plant.
- ❖ These amino acids are then converted into proteins and enzymes. Proteins thus formed

make part of the protoplasm, while enzymes act as catalysts for various reactions taking place in the plants.

- ❖ Nitrogen is also a special constituent of the chlorophyll, without which photosynthesis is not possible.

Ammonium Sulphate

- ❖ It contains 24-25% of nitrogen.

Calcium Ammonium Nitrate (CAN)

- ❖ It contains 20% of nitrogen

Urea

1. It contains 46.6% of nitrogen.
2. Product cost is low
3. It maintain pH Value.

Importance of nitrogen

1. Production of DNA, RNA
2. Production of amino acids
3. Formation of protoplasam

Production of nitrogen fertilizers in Tamil Nadu

- ❖ Ammonium sulphate, Urea, Ammonium Chloride, Calcium ammonium nitrate

Importance of phosphorus

1. Production of ATP energy molecule.
2. Support of DNA, RNA production

Phosphorous fertilizers

1. It stimulate to crop growth
2. It help growth seed, flower and root growth
3. It helps to increase the number of N_2 fixing bacteria in roots.

Calcium super phosphate

- ❖ It contains 16-20% P_2O_5

Older Phosphorus fertilizers

- ❖ Dicalcium phosphate
- ❖ Triple superphosphate

Potassium fertilizers

- ❖ It helps to plant growth
- ❖ It helps to resistance from insects, disease resistance protection from drought
- ❖ Ex. Potassium nitrate, Potassium chloride, Potassium sulphate.

Bio fertilizers

- ❖ Fertilizers which are derived from living organism are called bio fertilizers.
- ❖ The main source of bio-fertilizers are bacteria, cyanobacteria and fungi. Bio fertilizers are renewable and non- polluting sources of plant nutrients. They also improve the soil condition. Rhizobium and Cyanobacteria

such as Anabena and Nostoc are common bio fertilizers.

Pests

- ❖ Pests are organisms of plants (or) animal origin which damage cultivated crops (or) plant products in storage.

Insecticides

- ❖ The chemical substances which are used to kill the insects are called insecticides.
- ❖ Ex. DDT (Dichloro diphenyl trichloro ethane)
- ❖ Malathion, Endosulphone, Gammexane (or) Lindane (or) BHC (Benzene hexa chloride)

Fungicides

- ❖ The chemicals used to kill fungi are called fungicides.
- ❖ Ex. Bordeaux mixture ($\text{CuSO}_4 + \text{Ca(OH)}_2$), Copper oxy chloride

Rodenticides

- ❖ The chemicals used to kill rodents like rats, mice and squirrel are called rodenticides.
- ❖ Ex. Zinc phosphate, Arsenic, Thallium sulphate, white phosphorous

Weedicides

- ❖ The chemicals substances which are used to kill the weeds are called weedicides.
- ❖ Ex. 2,4 -D (2,4 dichlorophenoxy acetic acid)

Insect pests

I. Chewing Insects

- ❖ They cut and chew the root, stem and leaves of the plants. eg. grasshoppers, caterpillars etc.

II. Sucking Insects

- ❖ They suck the cell sap from different parts of the plants. eg. leaf hoppers, aphids etc.

III. Borer insects

- ❖ They bore and enter different parts and feed on the plant tissues. eg. Sugarcane borer.

Methods of insect pest control

- ❖ Root cutting insects are controlled by mixing insecticides in soil. eg. chlorophyriphos
- ❖ Stem and leaf cutting and boring insects are controlled by dusting (or) spraying contact insecticides. eg. Malathion, Lindane and Thiodan
- ❖ The sap sucking insects can be controlled by spraying insecticides. eg. Dimethoate and Metasystox.