METALS AND NON-METALS

INTRODUCTION

Elements can be classified into various categories (such as metals, non-metals, metalloids, noble gases) on the basis of their different physical and chemical properties. Out of these the two main categories are metal and non-metals.

Metals

- Metals are defined as elements which form positive ions by losing elections.

$$Na - 1e^- \rightarrow Na^+$$

$$Ca - 2e^- \rightarrow Ca^{2+}$$

- They contain 1, 2 or 3 valence electrons.
- Metals which do not react with water, acids and alkalis and occur in free-state in nature are known as noble metals. For e.g. Gold (Au), Silver (Ag) etc.

Some examples of metals

Non-metals

- Non-metals are elements which form negative ions by gaining electrons.

$$Cl + 1e^- \rightarrow Cl^-$$

$$O + 2e^- \rightarrow O^{2-}$$

- They contain 5, 6 or 7 valence electrons.

Some examples of non-metals

Metalloids

- Metalloids are defined as elements which show the properties of both metals and non-metals.
- They contain 4 valence electrons.

Some examples of metalloids

Noble Gases

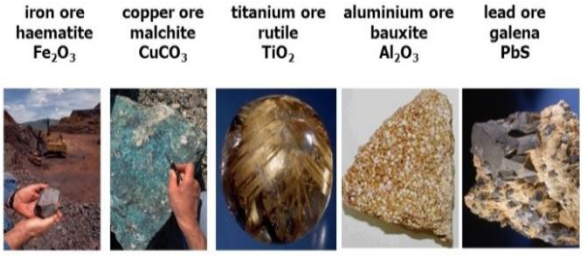
- Noble gases or inert gases are elements which do not form ions and cannot be classified as metals or non-metals.
- They contain 8 valence electrons except He which contains 2 valence electrons.
- They occur in elemental form in air.

Some examples of noble gases

Electrons — Negatively-charged particles present in the atom.
Valence electrons — Electrons present in the outermost shell of an atom.

Occurrence of Metals

- In nature, most metals occur in the combined state as minerals and ores.
- If the amount of metal is more, it is profitable to mine the rocks and extract the metal. Such rocks are called ores.
- The impurities present in the ores are called gangue (pronounced as 'gang').
- The series of process carried out to extract pure metals form their ores is called metallurgy.



Ores of metals

Occurrence of Non-metals

Non-metals occur both in free and combined state in nature.

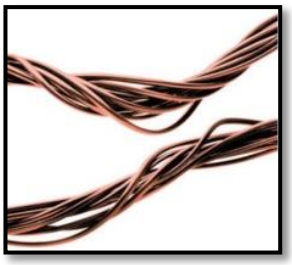
Non-metals	Occurrence
Hydrogen (most abundant element in universe)	Sun and stars, water, air, petroleum, coal etc.
Nitrogen	Air, minerals such as nitre (KNO_3) etc.
Oxygen (most abundant element in Earth's crust)	Air, water, oxides, carbonates etc.
Carbon	Graphite, diamond, coal, fossil fuels, carbonates etc.
Sulphur	Rocks as metal sulphates, sulphides etc.

Comparison of physical properties of metals and non–metals

Sr. No.	Property	Metals	Non-Metals
1	Physical State	Metals are solid at room temperature (Except mercury and gallium which are liquid metals)	Non-metals exist as solids, liquids and gases.
2	Melting and boiling points	Metals generally have high m.pt and b.pt except gallium and Cesium	Non-metals have low m.pt and b.pt except diamond and graphite
3	Density	Generally high	Generally low
4	Malleability and Ductility	Malleable and ductile	Neither malleable nor ductile; they are brittle
5	Electrical and thermal conductivity	Good conductors of heat and electricity.	Generally poor conductors of heat and electricity (except graphite)
6	Lustre	Possess shiny metallic lustre	Do not have lustre (except graphite)
7	Sonorous sound	Give sonorous sound when struck	Does not give sonorous sound
8	Hardness	Generally hard (except Na, K and Mg which are soft metals)	Solid non-metals are generally soft (except diamond).

Malleability — Property of metals by which they can be beaten into thin sheets
Ductility — Property of metals by which they can be drawn into thin wires
Lustre — Shiny appearance
Sonorous — Produce a ringing sound when struck

Gold Sheet

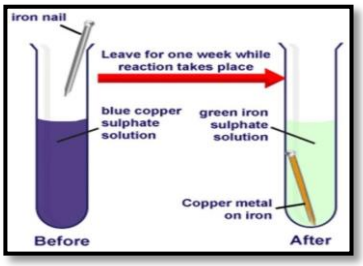


Copper Wire

Bell

Comparison of Chemical Properties of Metals and Non-metals

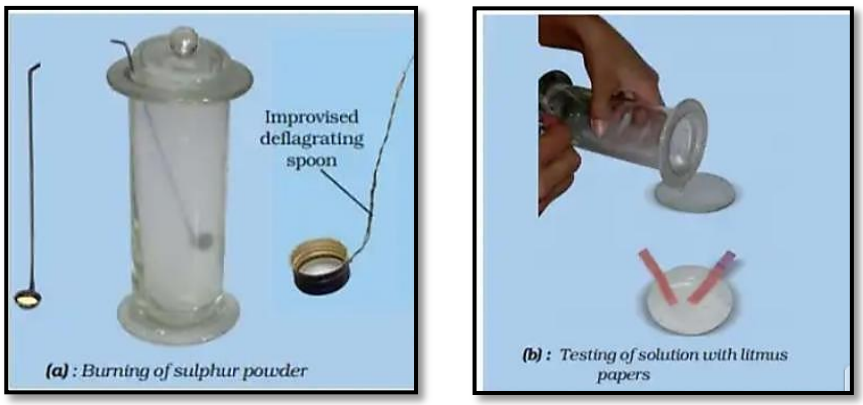
1	Reaction with Oxygen	Metal + Oxygen→ Metal oxide $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$ $2Cu(s) + O_2(g) \rightarrow 2CuO$ Metals form basic oxides	Non-metal + Oxygen → Non-metal oxide $C + O_2 \rightarrow CO_2$ $S + O_2 \rightarrow SO_2$ Non-metals form acidic oxides
2	Reaction with water	Metal + Water →Metal oxides or metal hydroxide and H_2 gas is released. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH + H_2(g)\uparrow$ $Mg + H_2O \rightarrow MgO + H_2\uparrow$	Non-metals do not react with water.
3	Reaction with dilute acids	Metal + Acid → Metal salt + Hydrogen $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$ $2Na(s) + H_2SO_4 \rightarrow Na_2SO_4(aq) + H_2(g)$	Non-metals do not react with acids.
4	Reaction with salt solutions (Displacement reaction)	When metals react with salt solution, more reactive metal will displace a less reactive metal from its salt solution. $CuSO_4(aq) + Fe(s) \rightarrow FeSO_4(aq) + Cu(s)$	When non-metals react with salt solution, more reactive non-metal displace a less reactive non-metal from its salt solution. $2NaBr(aq) + Cl_2(g) \rightarrow 2NaCl(aq) + Br_2(aq)$



Testing of nature of oxide of metals and non-metals

Metals form basic oxides and non-metals form acidic oxides. This can be easily tested by dissolving the oxide in water and then observing the colour change of the litmus paper dipped in this solution.

- If blue litmus paper turns red then it is an acidic oxide.
- If red litmus paper turns blue then it is a basic oxide.



Testing the nature of non-metallic oxide using litmus paper

Uses of some metals, non-metals and metalloids

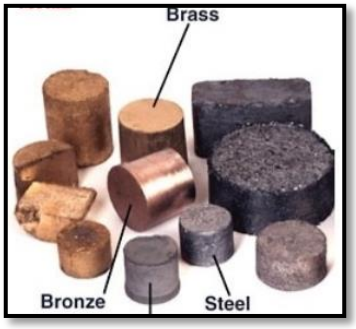
Metals	Uses
Iron	Pipes, sinks, storage tanks, railings, nails, bolts, chairs, agricultural tools, construction of buildings, ships etc.
Copper	Electric wires, cables, heating utensils, car radiators, alloys etc.
Aluminium	Cooking utensils, foil, paint, bodies of aircrafts and cars etc.
Zinc	Dry cells, coating of iron sheets, alloys preparation etc.
Mercury	Thermometers, barometers etc.

Non-Metals	Uses
Suphur	Manufacture of sulphuric acid, vulcanization of rubber, skin ointments, insecticides, fungicides etc.
Phosphorus	Matchboxes, fireworks, phosphate fertilizers etc.
Carbon	As graphite in making lead of pencils, electrodes in dry cell, as diamond in jewellery, as coal as fuel etc.
Hydrogen	Extraction of metals, oxy-hydrogen flame, manufacture of ammonia gas etc.

Metalloids	Uses
Silicon	In electronic and computer industries to make transistors, microchips etc., to manufacture silicons to make waterproof clothes, greases etc.

Alloys

- An alloy is a homogenous mixture of two or more metals, or one or more metals and a non-metal (usually carbon).
- Alloys can be used to –
    a) increase hardness of metals
    b) make metals more resistant to attack by chemical and atmospheric corrosion
    c) change the properties of metals in other ways



Alloys

Alloys, their composition, properties and uses

Alloy	Constituents Present	Properties	Uses
brass	copper, zinc	hard, corrosion-resistant	utensils, electrical goods, cartridge containers, parts of watches and musical instruments
bronze	copper, tin	hard, corrosion-resistant	statues, bearings
solder	lead, tin	low melting point	joining metals
steel	iron, carbon	very strong	bodies of ships and other vehicles, bridges, railway lines, construction of buildings
stainless	iron, chromium,	very strong,	utensils, cutlery, surgical
steel	nickel	does not rust	instruments
Duralumin (or duralium)	aluminium, copper, magnesium, manganese	light and strong	bodies of aeroplanes and vehicles
Magnalium	aluminium, magnesium	light and strong	balances and other light instruments, bodies of aeroplanes and vehicles
German Silver	Copper, zinc, nickel	high electrical resistance	utensils, electric heaters, resistors

CONCEPT MAP