Scientists decided to classify metals as substances exhibiting certain similar properties.

METALS

Metals are Electropositive in nature..i.e they tend to give away Electrons.

Metals always have a tendency to lose these Electrons. If a substance loses electrons then it loses some negatively charged particles and hence the no of positively charges particles will be more and the substance will be Electropositive in nature.

Some Elements will lose more electrons , while others will lose less electrons.

E.g. when Sodium loses and Electron it will become Na+

NON -METALS

Non Metals are substances which are Electronegative in nature. So they have a tendency to gain electrons.

Eg. Carbon, Sulphur, Iodine , Oxygen, Hydrogen.

Most of the Non metals are either solids or gases

However there are some exceptions and some of them are liquids e.g. bromine.

Inside the atom of a non metal, they want to get additional electron and hence the substance becomes electronegative in nature.

Uses of Non Metals

---→Non metals are also important. E.g Oxygen and CO_2 are needed by both humans and plants.

---→Even the combustion of fuel in rockets needs Oxygen which is a non metal.

---→The gases like Nitrogen are good for development of plants.

---→Coal, a fuel is made up of carbon which is a non metal.

---→Neon lights are made up of Neon Gas.

---→Gas balloons also contain Hydrogen and helium

---→Swimming pools contain Chlorine for keeping away infections.

---→ A lot of antiseptics also use non metals like iodine in them.

COMPARISONS OF METALS AND NON METALS

	PROPERTY	METALS	NON-METALS
1.	**Physical State**	Always Solids (**Exception – Hg(Mercury)** which is liquid at room temperature.	Exist as solid, liquid, gas Solids – Carbon (C) , Sulphur (S), Phosphorus (P), Iodine (I) Liquids – Bromium (Br) Gases – Oxygen (O), Hydrogen(H), Nitrogen(N), Helium(He), Chlorine(Cl), Argon(Ar)
2.	**Hardness**	Generally hard . Eg. Fe, Cu, Al **(Exception Sodium(Na), Potassium(K) and Lithium are soft)**	Generally soft **(Exception – Diamond (C),** is the hardest natural substance known)
3.	**Lustre (Shine)**	Lustrous. i.e they are shiny Example → Gold, Silver, Platinum, Exception→ Sodium, Potassium	Non-Lustrous Exception→ Diamond, Iodine as they both have lustre
4.	**Malleability** (Property of a material to be beaten into thin sheets)	Malleable Example→Aluminium foil, Au, Ag, Copper etc. Gold and Silver are the most malleable and are used to make jewellery of diff shapes.	Non-Malleable Example→ Carbon, Sulphur
5.	**Ductility** (Property of a material to be drawn into thin wires)	Ductile Example→ Copper and aluminium is used in electrical wires. Gold is very ductile and malleable.	Non – Ductile Example → Coal
6.	**Conductivity** (Flow of heat and electricity)	Good thermal and electrical conductors Example→ Copper, Aluminium, Steel	Poor Conductors **Exception → Graphite (c) which is a good conductor of Electricity** Example→ Wood, Plastic They don't conduct electricity.
7.	**Sonorous** (Property of producing sound when struck hard)	Sonorous	Non-sonorous
8.	**Melting and Boiling point**	**High Melting and Boiling point. So they don't boil or melt easily.** e.g. Tungsten is the metal with the highest melting point . That is why Tungsten is used in the filament of bulbs. This is because when an electric current passes through	Low **Except Diamond which has a very high melting and boiling point.**

		the tungsten wire, the wire does not melt with a rise in temperature. Sodium and Potassium have low melting points. Even if you get Na near fire, it tends to catch fire. Hence Na is stored in kerosene. **Except Cesium and Gallium** which have exceptionally low melting point. They melt in the palm.	
9.	**Density**	High They are very heavy. An iron box will be heavier than a plastic box. So the atoms or molecules are more densely packed in a same area in a metal as compared to a non metal. Iridium & Osmium have highest densities. Lithium has the lowest density.	Low
10.	Examples	Hg, Na, K, Au, Ag, Al, Mg, Fe, Zn, Cu	C, I, S, P, Br, O, H, N, He, Cl, Ar

CHEMICAL PROPERTIES OF METALS

Reaction with Oxygen

Almost all Metals react with Oxygen to form Metal Oxides.

For Example:

- $2Mg + O_2 \rightarrow 2MgO$
- $2Ca + O_2 \rightarrow 2CaO$(Calcium Oxide)
- $4K + O_2 \rightarrow 2K_2O$(Potassium Oxide)
- $Al + O_2 \rightarrow Al_2O_3$(Aluminium Oxide)
- $2Mg + O_2 \rightarrow 2MgO$
- $Fe + O_2 \rightarrow Fe_2O_3$ (Ferric Oxide)

These Metal oxides is that they are Basic in Nature.

Basic in nature means that when we add water to this metal oxide, it produces a Base.

So,

Basic Oxide + Water → Base (Metal hydroxide)

- $MgO + H_2O \rightarrow Mg(OH)_2$
- $Na_2O + H_2O \rightarrow NaOH$
- $K_2O + H_2O \rightarrow KOH$

A Litmus paper helps us to identify if a chemical is an acid or a base.

- Metals and metal oxides react with water to form hydroxides or oxides depending upon whether the metal is a very reactive or a moderately reactive metal.

If a Metal is very reactive then,

Metal (Active) + H_2O → Metal Hydroxide (Base) + H_2 + Heat

$Al + H_2O \rightarrow Al(OH)_3 + H_2 + Heat$

$Na + H_2O \rightarrow NaOH + H_2 + Heat$

$K + H_2O \rightarrow KOH + H_2 + Heat$

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

$Mg + H_2O \rightarrow Mg(OH)_2 + H_2 + Heat$

Na > K > Ca > Mg

Na, K → Highly reactive, violent reaction, releases heat and catches fire. Hence, Na, K are stored in kerosene.

Metal (Moderate) + H_2O → Metal oxide (Base) + H_2

$Zn + H_2O$ (Steam) $\rightarrow ZnO + H_2$

A good example of metals reacting with oxygen and water is that of CORROSION

Corrosion

- Corrosion is the continuous wearing of metals when they react with Oxygen in the presence of water.
- Occurs in presence of O_2 and H_2O (Moist air). It's an Atmospheric reaction.
- It can occur even if Iron is exposed to air and a few drops of water are present on its surface.
- It's a slow change. It leads to the metal losing its luster and even a change in its colour.
- A few examples of Corrosion are Rusting & Patina

(a) Rusting :

When Fe reacts with O_2 in the air or in H_2O it forms a compound called Iron oxide / Ferric oxide

$4Fe + 3O_2 + H_2O \rightarrow 2Fe_2O_3.H_2O$ (hydrated ferric oxide) (RUST – Reddish brown coating)

(b) Patina

On metal, patina is a coating of various chemical compounds such as oxides, carbonates, sulfides, or sulfates formed on the surface during exposure to atmospheric elements (oxygen, rain, acid rain, carbon dioxide, sulfur-bearing compounds).

$2 Cu + \{O_2 + H_2O + CO_2\} \rightarrow CuCO_3 + Cu(OH)_2$

(c) Chromium Oxide forms on the outer layer of stainless steel (see from Youtube)

(d) Tarnish gets deposited on silver teapots, trays and jewellery.

NOTE: However at times, this layer is beneficial too. Formation of Aluminium Oxide on the surface of Aluminium metal acts as a transparent protective layer which prevents further damage to the metal surface.

Reaction with Acids

Metal + Acids → Salt + H_2

Metals react with Acids to form a Salt and release Hydrogen Gas. This reaction is also called a Displacement Reaction.

In a Displacement reaction – a more reactive metal, displaces less reactive metal, form its salt solution.

Reactivity Series – Arrangement of metal sin decreasing order of reactivity.

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

- Metals high in Reactivity series are →highly reactive, and displace others, below them.
- Metals low in Reactivity series → do not react.

Displacement Reactions →Types

1. More reactive element replaces less reactive element from salt solution. $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
2. Metal replaces hydrogen from water. $Mg + H_2O$ (boiling) $\rightarrow MgO + H_2$
3. Replacement of hydrogen from acid by metal. $Zn + Hcl \rightarrow ZnCl_2 + H_2$ | $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

H_2 gas – highly combustible

A burning matchstick brought near H_2 gas. It burns with a pop sound, and a blue flame.

Salt – In chemistry, a **salt** is an ionic compound that can be formed by the neutralization reaction of an acid and a base. Salts are composed of related numbers of cations (positively charged ions) and anions (negative ions) so that the product is electrically neutral (without a net charge).

REACTIONS OF NON-METALS

Reaction with O_2

Non-Metal + O_2 → Non Metallic Oxide (Acidic Oxide)

This Non Metallic Oxide is Acidic in nature.

Result:-

$S + O_2 \rightarrow SO_2$ (Sulphur Dioxide)

$SO_2 + H_2O \rightarrow H_2SO_3$ (Sulphurous Acid)

Turns Blue litmus → Red which means the substance formed is acidic in nature

Q. Write reactions of C, and N_2 with Air (O_2).

Ans. $C + O_2 \rightarrow CO_2$ $N_2 + O_2 \rightarrow NO_2$

USES OF METALS

	PROPERTY	USE	EXAMPLE
1.	Hard, Shiny	Jewellery	Au, Ag, Pt
2.	Good Thermal Conductors	Cooking Vessels	Al, Fe, Cu, Stainless Steel, Steel
3.	Good electrical Conductors, Malleable, Ductile	Electrical Cables & Wires	Cu, Mg, Al, W (Tungston)
4.	Strong	Construction of bridges, houses, railway tracks	Fe
5.	Sonorous	Making bells	Fe, Cu, Ag
6.	Galvanization	Rust – free Iron	Zn, Cr (Chromium)
7.	Electroplating	Rust – free equipments and instruments	Cr, Ni (Nickel)
8.	Alloy, formation – alloying	Corrosion – free, strong, durable	Steel, Stainless Steel
9.	Malleable	Packaging material	Al, Cu, Ag, Au
10.	Thermal Expansion	Thermometer	Hg (Mercury)

USES OF NON-METALS

1. Photosynthesis – CO_2 and H_2O are made of non-metals and needed for life.
2. Respiration – O_2 is necessary. O is a non-metal.
3. Nutrients – N and P are essential for plant growth. Found in manure and fertilizers.
4. Carbon Dioxide – Greenhouse gas, causes global warming.
5. Bakelite – Poor thermal and electrical conductor. Used in covering wires and handles of cooking vessels.
6. Diamond – Jewellery, cutting and drilling.
7. Graphite – Excellent thermal and electrical conductor.
8. Neon – Electrical advertising signboards.
9. Metallurgy – Extraction of metals, from ores.
10. Fe, C, N & I found in body.