

Revision Notes on Materials: Metals and Non-Metals

Metals and Non-metals differ in terms of their physical and chemical properties.

Physical Properties of Metals and Non-metals

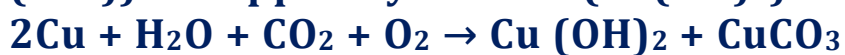
Physical Properties	Metals	Non-Metals
Conductivity	Metals (such as iron or copper) are good conductors of heat and electricity.	Non-metals (such as coal or sulphur) are poor conductors of heat and electricity. Graphite is an exception as it is a good conductor of electricity.
Ductility	Metals (such as aluminium and copper) are ductile, which means that they can be drawn into wires.	Non-metals are brittle (break down when struck) and hence, they cannot be drawn into wires.
Hardness	All metals are hard though there are some exceptions. Sodium and potassium are soft and can be cut with a knife.	Most non-metals are soft. Diamonds are exceptions as they are the hardest material found on Earth. However, they are also very brittle and break when struck with a hammer.
Lustre	Metals (such as gold, silver and copper) are lustrous, which means that they reflect light from their surface	Non-metals (such as coal)

	and can be polished.	are generally dull and do not reflect light. Hence, they lack metallic lustre.
Malleability	Metals (such as silver and aluminium) are malleable, which means that they can be beaten into thin sheets.	Since non-metals break easily, they cannot be pounded into sheets.
Physical State	Most metals remain solid at room temperature, except mercury and gallium which remain liquid at room temperature.	Most non-metals exist in two of the three states of matter at room temperature: Gases (such as oxygen), and Solids (such as carbon).
Sonorous	Metals produce ringing sounds when they are struck and hence, they are sonorous, except Mercury which is liquid in nature.	Non-metals are non-sonorous and do not produce the typical metallic sound when they are struck.
Examples	Iron, copper, aluminium, calcium, magnesium, etc.	Sulphur, carbon, oxygen, phosphorus, etc.

➤ **Note:** Copper Vessels also acquire a dull green coating (made up of copper hydroxide and copper carbonate) when they are exposed to moist air. It is called **Verdigris**.

Chemical Equation for Green Coating on Copper

Copper (Cu) + Moist Air (Water (H₂O) + Oxygen (O₂) + Carbon Dioxide (CO₂)) → Copper Hydroxide (Cu(OH)₂) + Copper Carbonate (CuCO₃)



Copper carbonate and copper hydroxide are basic in nature.

Note: This green coating can be copper chloride if the copper reacts with sea air, or copper acetate if the copper reacts with acetic acid.

Chemical Properties of Metals and Non-metals

Reaction of Metals with Oxygen

When metals react with oxygen, they form metal oxide.

Metal + O₂ → Metal Oxide

For Example:

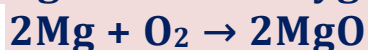
1. Copper + Oxygen → Copper Oxide (black)



2. Aluminium + Oxygen → Aluminium Oxide



3. Magnesium + Oxygen → Magnesium Oxide



The reactivity of metals with oxygen differs. **For Example:**

- Sodium and Potassium react so vigorously with air that they catch fire when they are kept in open. Hence, they are immersed in kerosene to store them.
- The surfaces of Magnesium, Aluminium, Zinc and Lead are covered with a thin layer of oxide to make sure that they do not get oxidised anymore.
- While iron does not burn when heated, iron filings burn vigorously.
- Copper surface is coated with a thin layer of black copper oxide to prevent the process of further oxidation from taking place.
- Gold and silver do not react with Oxygen.

Amphoteric Oxides: Some metal oxides react both with acids and bases to produce salts and water. Such metal oxides are called amphoteric oxides. For example:

Aluminium Oxide + Hydrochloric Acid → Aluminium Chloride + Water



Aluminium Oxide + Sodium Hydroxide → Sodium Aluminate + Water



Reaction of Metals with Water

Metal + (cold) Water → Metal hydroxide + Hydrogen

Metal + Steam → Metal oxide + Hydrogen

For Example:

Sodium + Water → Sodium Hydroxide + Hydrogen + Heat



Calcium + Water → Calcium Hydroxide + Hydrogen



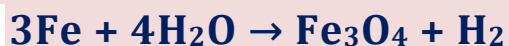
Magnesium + Water → Magnesium Hydroxide + Hydrogen



Aluminium + Water → Aluminium Oxide + Hydrogen



Iron + Water → Iron Oxide + Hydrogen



The reactivity of metals with water differs. **For Example:**

- Sodium, Potassium and Calcium react with cold water.
- Magnesium reacts slowly with hot water to form slightly soluble magnesium hydroxide.
- Aluminium, Zinc and Iron react with steam.
- Lead, Copper, Silver and Gold do not react with water.

Note: Calcium and magnesium float on water as bubbles of hydrogen stick to their surface.

Reaction of Metals with Solutions of Other Metal Salts

Metal A + Salt Solution of Metal B → Salt Solution of Metal A + Metal B

More reactive metals replaces less reactive metals.

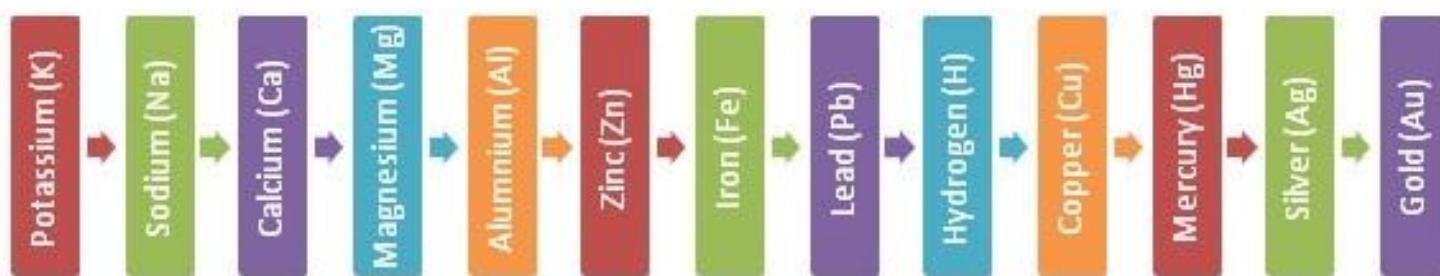
Less reactive metals cannot replace more reactive metals.

For Example:

Iron + Copper Sulphate → Iron Sulphate + Copper



The reactivity series is given below:



❖ **Next Topic: Reaction of Different Metals and Non-metals with Acids**