Metals & Non-Metals
Introduction & phy properties of metals& non-metals

❖ INTRODUCTION:

Till now, scientists have discovered more than 118 elements. These are classified into metals, non-metals and metalloids. Metals are electropositive, which are hard, sonorous, malleable, ductile, with tensile strength and good conductor of heat and electricity. Non-metals have just opposite to metals in characteristics. Metalloids are the elements which show the property of both metals and non-metals. Metals occur in nature in the free as well as combined state (in minerals). Those minerals from a metal can be extracted profitably and economically are called ores, process is called metallurgy. Metals also from alloys. We will study all these different aspects of elements in this chapter.

❖ Position of Metals in the Periodic Table:

Metals occupy the left and the middle parts of the periodic table. On the right side of the periodic table are the nonmetals and the noble gases. The elements with highly metallic properties are in the extreme left of the periodic table. **Metalloids,** which have properties intermediate between those of the metals and nonmetals, constitute the dividing line between the metals and the nonmetals. Boron (B), silicon (Si), germanium (Ge), arsenic (As) and tellurium (Te) are the major metalloids.

❖ METALS:

(A) PHYSICAL PROPERTIES

(a) Important Characteristics of the Metals :

1. **Physical state :** Solids at room temperature.

   Exception : Mercury (liquid at room temperature).

2. **Shining surfaces** : Property as known as **lustre**.

3. **Conduction :** Good conductors of heat and electricity : eg. Au, Ag

   Exception : Heat (Pb), Electricity (Hg).

4. **Hardness :** Quite hard.

   Exception : Sodium & potassium are soft.

5. **Malleable** : Eg. Fine **Al foils** are used for wrapping different types of food.

   Thin foils of silver are used for decorating sweets.

6. **Ductile** : All electric wires drawn from different metals are very fine.

7. **Sonorous :** The sound produced on bending a tin foil is known as **'tin cry'**.

8. Generally, have high melting and boiling points.

9. **Density :** Metals have high density and are very heavy.

10. **Valency :** Metals have 1 to 3 electrons in the outermost shell of their atoms.

11. **Electropositive character :** Metals are elements that have a tendency to lose electors and form cations. They normally do not accept electrons.

(b) Important properties of Non-metals

1. **Physical state :** Either gases or solids at room temperature.

   Exception : Bromine (liquid at room temperature).

2. **Surface :** Non-metals vary in colour with generally **dull surfaces**.

   Exception : Diamond, Crystals of iodine have bright lustre.

3. **Conduction :** Mostly Poor conductors of heat and electricity.

   Exception : Graphite

4. **Hardness :** Quite Soft.

   Exception : Diamond

5. **Malleable :** Non-malleable and non-ductile.

6. **Not Sonorous**.

7. **Very low melting and boiling point** as compare to metals.

   Exception : Diamond, Graphite

8. **Reactivity :** They generally form acidic or neutral oxides with oxygen.

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- **Noble Metal:**

  Noble metals are metals that are resistant to corrosion or oxidation, unlike most base metals. They tend to be precious metals often due to inertness.

  Examples include gold, platinum and rhodium.

- **Precious Metals:**

  A precious metal is a rare metallic chemical element of high economic value. Chemically, the precious metals are less reactive than most elements, have high luster and high electrical conductivity. Historically, precious metals were important as currency, but are now regarded mainly as investment and industrial commodities. The best-known precious metals are gold and silver. While both have industrial uses, they are better known for their uses in art, jewelry and coinage. Other precious metals include the Platinum group metals: ruthenium, rhodium, palladium, osmium, iridium and platinum is the most widely traded.

- **Based Metal :**

  In chemistry, the term 'base metal' is used informally to refer to a metal that oxidizes or corrodes relatively easily, and reacts variably with dilute hydrochloric acid (HCl) to form hydrogen. Examples include iron, nickel, lead and zinc. Copper is considered as a base metal because it oxidizes relatively easily, although it does not react with HCl. It is commonly used in opposition to noble metal.

❖ **Ferrous Metal :** The term "ferrous" is derived from the Latin word meaning "containing iron". This can include pure iron, such as wrought iron, or an alloy such as steel. Ferrous metals are often magnetic, but not exclusively.

Alloy : An alloy is a mixture of two or more elements in solid solution in which the major component is a metal. Most pure metals are either too soft, brittle or chemically reactive for practical use. Combining different ratios of metals as alloys modify the properties of pure metals to produce desirable characteristics.

The aim of making alloys is generally to make them less brittle, harder, resistant to corrosion, or have a more desirable color and luster. Examples of alloys are steel (iron and carbon), brass (copper and zinc), bronze (copper and tin), and duralumin (aluminum and copper).

Alloys specially designed for highly demanding applications, such as jet engines, may contains more than ten elements. Stainless steel (Fe + C + Cr + Ni) are used where resistance to corrosion is important Al and Mg alloys are used for strength and light applications. Nickel-based super alloys are used in high temperature applications such as turbocharger, pressure vessel and heat exchangers. Generally electrical conductivity of an alloy is less than that of pure metal.

(i) There are several metals that are low density, soft and have low melting points, these (the alkali and alkaline earth metals) are extremely reactive, and are rarely encountered in their elemental, metallic form. Some metals like sodium are so soft that they can be even cut with knife. Three metals are magnetic. These are iron, cobalt and nickel. Steel is a mixture of elements but mostly iron, so it is also magnetic. The other metals are not magnetic. Mercury is the only metal which is found in liquid state at room temperature.

(ii) Gold is probably one of the hardest metals. From one gram of the metal, a wire of nearly two kilometer's can be drawn. However the metals differ in their ductility capacity.

(iii) Metals such as titanium, chromium, manganese, zirconium, etc. are classified as strategic metals play important role in the country's economy and defence. These metals and their alloys are used in

(a) atomic energy,

(b) space science projects

(c) jet engines

(d) high grade steels

(e) defence equipment's

(iv) Iridium is the heaviest metal while lithium is the lighest metal.

Some more properties of Metals:

(i) Ionization energy of an element is the amount of energy required to remove the outermost electron from an isolated atom of the element in gaseous state.

$$A(g) + \text{Ionization energy } A^{+}(g) + e^{-}$$

Ionization energy of an element is the measure of tendency of an element to lose electrons.

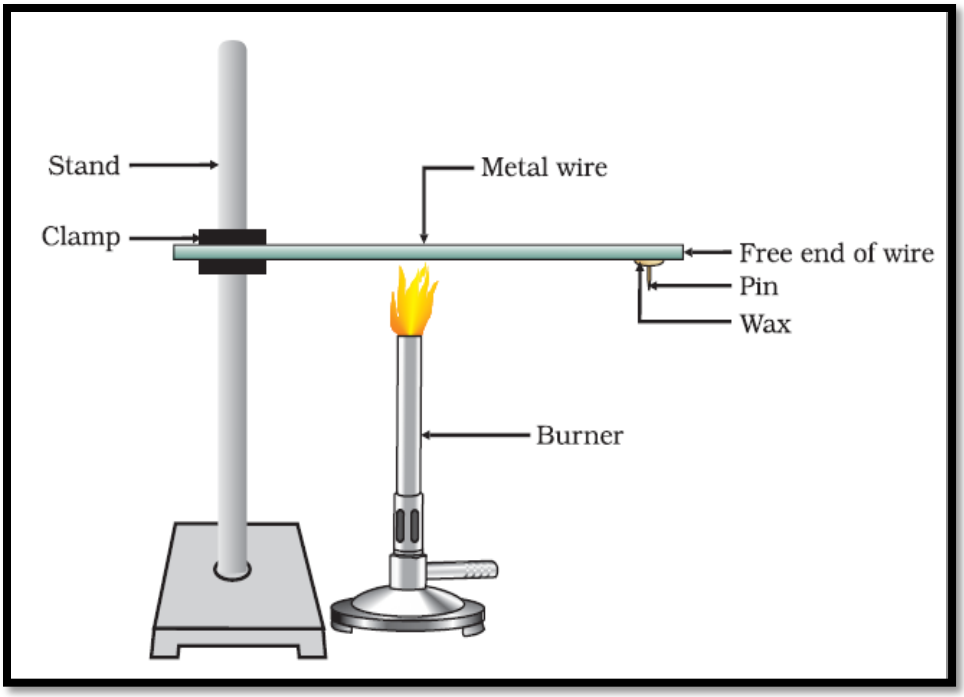
(ii) Thermal and Electrical Conductivity

(A) Study of Thermal Conductivity of Metals

(a) Take an aluminum or copper rod and clamp it on a stand as shown in figure.

(b) Put some wax on one end of the rod.

(c) Start heating the rod, from a place away from the wax, with the help of a burner.



What do you observe?

It is observed that the wax starts melting.

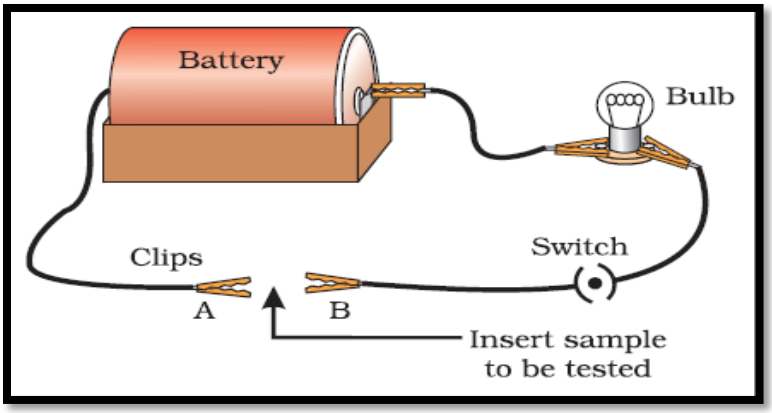
The rod does not melt even after heating for a long time.

This activity demonstrates that the metals are good conductors of heat and have high melting points.

(B) Study of Electrical Conductivity of Metals

(a) Take wires of copper, aluminum, iron etc.

(b) Set up the electric circuit as shown in figure.



(c) Place the different wires between points A and B one by one and observe whether the bulb glows or not after completing the circuit.

It is observed that bulb glows in case of different metals indicating that metals are good conductor of electricity.

Property	Metals	Non – Metals
1. Action with mineral acids	Metals generally react with dilute mineral acids to liberate H_2 gas	Non-metals do not displace hydrogen on reaction with dilute minerals acids
2. Nature of oxides	They form basic oxides. These oxides are ionic in nature. Some oxides like Al_2O_3 are amphoteric also.	Non-metals form acidic or neutral oxides. These oxides are covalent in nature.
3. Combination with hydrogen	Only a few metals combine with hydrogen to form hydrides. These hydrides are ionic in character.	Non-metals combine with hydrogen to form stable hydrides. These hydrides are covalent.
4. Combination with halogens	They combine with halogens to form well defined and stable crystalline solids. For example, NaCl, KBr, etc.	Non-metals form halides which are unstable and undergo hydrolysis readily. For example, PCl_5, PCl_3, etc.
5. Electrochemical behavior	Metals are electropositive in character. They form cations in solutions and are deposited on the cathode when electricity passed through their solutions.	Non-metals are electronegative in character. They form anions in solutions and are liberated at the anode when electricity is passed through their solutions. Hydrogen is an exception. It usually forms positive ions and is liberated at cathode.
6. Oxidising or reducing behaviour	Metals behave as reducing agents. This is because of their tendency to lose electrons.	Non-metals generally behave as oxidizing agents since they have the tendency to gain electrons.