

Chapter 4

Materials: Metals and Non-metals

Physical Properties of Metals

- Everything around us is categorized into metals and non-metals.
- The substance which conducts heat and electricity and is lustrous is metal while the substance which is a non-lustrous and bad conductor of electricity and heat is non-metal.

♦ Physical properties of Metals:

1. Most of the metals exist in a solid-state at room temperature. For example, iron, nickel, copper, aluminium, zinc exist are solid metals.

*Exception: Mercury is the only metal that is liquid at room temperature. Elements like caesium and gallium become liquid at or just above room temperature.

2. All metals are hard.

*Exception: Metals like sodium and potassium are soft and can be cut easily with a knife. Magnesium, calcium and lead are also soft metals.

3. Metals (such as gold, iron, silver) are lustrous which means that they have a shiny appearance and reflect light from their surface.

4. Metals like silver and aluminium are malleable which means that they can be beaten into thin sheets.

⇒ The property of metals by which they can be beaten into thin sheets is called malleability.

5. Metals (such as aluminium and copper) are ductile which means that they can be drawn into wires.

The property of materials to easily shape or draw them into wires is called ductility.

6. Metals are said to be sonorous which means they produce ringing sounds when they are struck. Materials other than metals are not sonorous except mercury which exist in a liquid state.

7. Metals are very good conductors of heat and electricity for example copper and aluminium.

- Materials that allow the flow of electricity through them are said to possess electrical conductivity. Electrical wires are made up of copper or aluminium metals because they possess electrical conductivity.
- Materials that allow the flow of heat through them are said to possess thermal conductivity.
- Cooking utensils, metal bases in irons are used in good conduction of heat, heaters etc. are all made up of metals which are good conductors of heat.

*Exception: Lead and mercury are poor conductors of heat.

Physical Properties of Non-metals

1. Non-metals are found in all three states of matter.

- Solid-state: Carbon, sulphur, phosphorus and iodine etc.
- Liquid state: Bromine
- Gaseous state: Nitrogen, oxygen, fluorine and chlorine.

2. They are generally soft.

* Exception: Diamond is a non-metal which is not soft rather it is the hardest substance known.

3. They are non-lustrous and have a dull appearance.

* Exception: Graphite and Iodine have metallic lusture.

4. Non-metals are neither ductile nor malleable. They are brittle by nature that is they form powdery mass if beaten by a hammer.

⇒ Carbon fibers are ductile and can be drawn into wires.

5. Non-metals are not sonorous. They do not produce any sound when they are hit.

6. Non-metals are generally poor conductors of electricity.

* Exception: Graphite is a non-metal which is a good conductor of electricity.

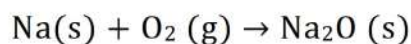
Question: Why aluminum is used to make foils to wrap food items?

Answer: Aluminum is a soft metal that can be easily beaten into thin sheets. It has a smooth shiny surface that reflects the heat coming from food. Hence, it keeps the food warm for a longer time.

Chemical Properties of Metals and Non-metals

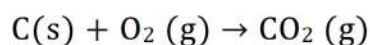
1. Reaction with oxygen (from the air)

⇒ Metals react with oxygen to form metallic oxides which are basic in nature. When metal oxides react with water, they form bases that turn red litmus blue. For example, sodium metal reacts with oxygen gas to form sodium oxide.



* Metals like sodium and potassium react vigorously with oxygen and catch fire if kept in open. Hence, they are kept in kerosene oil to prevent burning.

⇒ Non-metals react with oxygen to form non-metallic oxides which are acidic in nature. For example, carbon is a nonmetal that reacts with oxygen gas to form carbon dioxide gas which is an acidic oxide.



2. Reaction with water

⇒ Most metals react with water to liberate their hydroxide and hydrogen.

- Reaction with cold water: Highly reactive metals such as sodium and potassium react with cold water to form metal hydroxide and liberate hydrogen gas.
- Reaction with hot water: Less reactive metals such as zinc and magnesium react with hot water to form metal hydroxide and hydrogen gas.

- Reaction with steam: Metals such as iron and aluminium are very less reactive towards water and thus reacts very slowly with steam to form metal hydroxide and liberate hydrogen gas.

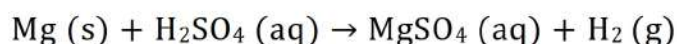
⇒ Non-metals do not react with water though they may be very reactive in air. Such non-metals are stored in water. For example, phosphorus is a very reactive non-metal. It catches fire when exposed to air. To prevent the contact of phosphorus with atmospheric oxygen, it is stored in water.

3. Reaction with acids

⇒ Most metals react with dilute mineral acids to form salt and liberate hydrogen gas.

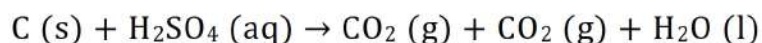
Eg: Metal + Acid → Salt + hydrogen gas

For example, magnesium is a metal that reacts with sulphuric acid to form magnesium sulphate and hydrogen gas.



⇒ There are some metals that do not react with dilute mineral acids such as gold, silver, copper, mercury and platinum.

⇒ Non-metals do not react with dilute mineral acids. However, some of them react with concentrated mineral acids to form different compounds. For example, carbon reacts sulphuric acid to form carbon dioxide, Sulphur dioxide and water.



4. Reactions with bases

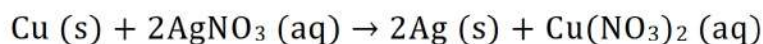
⇒ Most metals do not react with bases. Some metals such as aluminium, zinc and lead react with strong bases such as sodium hydroxide to form metallic compounds and liberate hydrogen gas. 'Pop' sounds in the reaction indicate the presence of hydrogen gas.

⇒ Non-metal does not react with a base.

5. Displacement Reactions

⇒ In a chemical reaction when an element reacts with a compound and takes the place of another element in that compound, the reaction is called a displacement reaction.

⇒ In this type of reaction, a more reactive metal displaces the less reactive metal from its compound in the solution.



⇒ The arrangement of metals in the decreasing order of their reactivity is called reactivity series of metals or activity series of metals.

Uses of Metals and Non-metals

◆ Uses of Metals:

The physical properties of different metals make them useful for different purposes.

1. Aluminium is malleable, ductile, and conducts heat which makes it a useful material for making foils, electrical wires and kitchen utensils like saucepans.
2. Gold, silver, and platinum are shiny, which makes them an attractive material for making jewellery and ornaments.
3. Mercury is used in thermometers.
4. Copper is ductile, malleable and a good conductor is used in electrical wires, in making alloys and used with gold to impart strength.

◆ Uses of Non-metals:

1. Non-metals are essential for our life which all living beings inhale during breathing involving oxygen, carbon, etc.
2. Non-metals are used in fertilizers to enhance the growth of plants.
3. Non-metals are used in water purification processes. Example: Chlorine in the form of bleaching powder, is used for purifying water.
4. Non-metals are used in crackers. Example: Phosphorus
5. Iodine is a non-metal which is used in making antiseptics. It also prevents thyroid problems and is also used as a disinfectant.