

This chapter is one of the most important chapter. In this chapter, we will discuss properties of metals and non-metals.

METALS AND NON-METALS

Metals

Those elements which forms positive ions by losing electrons are called metals. e.g. copper, iron, aluminium, sodium etc.

Important Physical Properties of Metals

- (i) **Physical State** All the metals except mercury exist in the solid state at room temperature.
- (ii) **Lustre** All the metals have a shiny appearance. This shiny appearance is known as metallic lustre, so metals are used for making jewellery and decorations.
- (iii) **Malleability** The property of beating a metal with hammer into sheets is called malleability. Gold and silver are most malleable metals.
- (iv) **Ductility** The property that allows metals to be drawn into wires is called ductility. Gold and silver are most ductile metals. Copper and aluminium wires are used in electric fittings.
- (v) **Conductivity** Metals are good conductor of heat and electricity. They quickly transmit heat from one end to the other. Silver is the best conductor followed by gold, copper and aluminium. Lead (Pb) is the poorest conductor of heat.
- (vi) **Hardness** Metals are usually hard. It is therefore, difficult to cut them but sodium, potassium and magnesium are soft metals and thus, they are easily cut with knife.
- (vii) **Melting and Boiling Points** Metals generally have high melting and boiling points but sodium and potassium metals have low melting and boiling points.

Reactivity Series of Metals

- The arrangement of metals in order of decreasing reactivities is called reactivity or activity series. In this series, the most reactive metal is placed at the top whereas the least reactive metal is placed at the bottom.
- As we go down the series, the chemical reactivity of metals decreases.
- All metals which are placed above hydrogen in the activity series, can lose electrons more readily than hydrogen. These metals are called more reactive than hydrogen.
- On the other hand, all metals which are placed below hydrogen in the reactivity series lose electrons less readily than hydrogen and hence, they are regarded as metals less reactive than hydrogen.

Reactivity Series of Metals

K	Potassium	↑ Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
Zn	Zinc	
Fe	Iron	
Pb	Lead	
H	Hydrogen	
Cu	Copper	
Hg	Mercury	Reactivity Increases
Ag	Silver	
Au	Gold	
		Least reactive

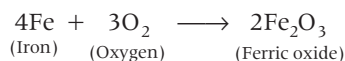
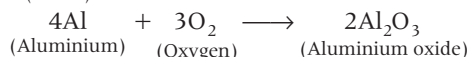
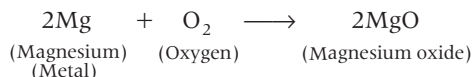
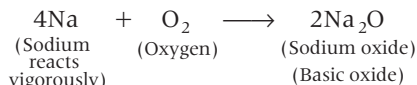
- Due to their high reactivity potassium and sodium react with moisture present in air. Hence, these are kept submerged in kerosene oil.
- Due to their low reactivity copper, silver, gold, etc., usually do not react with acid.

Important Chemical Properties of Metals

(i) Reaction with Oxygen

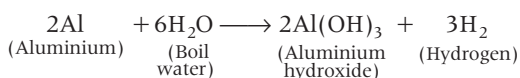
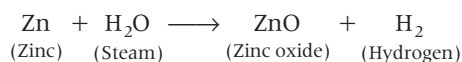
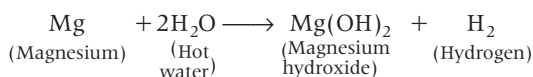
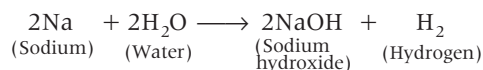
- Metals react with oxygen to form oxides these oxides are alkaline or basic in nature.

- Basic metal oxides turn red litmus into blue.



(ii) Reaction with Water

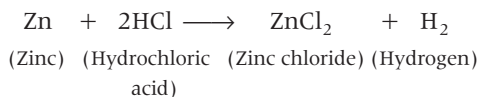
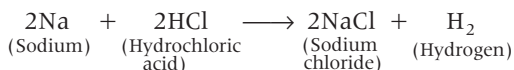
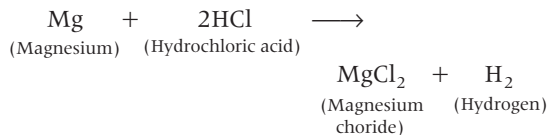
- Different metals behave differently in their reaction with water and evolve hydrogen. Sodium reacts violently with water.



Copper (Cu), silver (Ag) and gold (Au) being least reactive metals do not react with water.

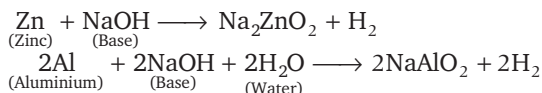
(iii) Reaction with Acids

- Metals which are more reactive than hydrogen, evolve hydrogen on reaction with acids. Copper, silver and gold do not react with dilute hydrochloric acid but copper reacts with sulphuric acid and nitric acid.
- Although with nitric acid, metals (except magnesium and manganese) do not evolve hydrogen.

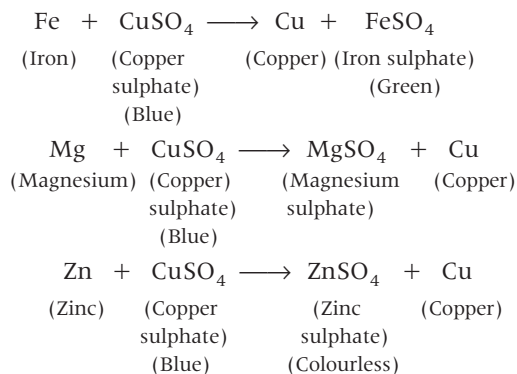


(iv) Reaction with Bases

All metals do not react with bases to produce hydrogen gas. Some metals react with bases to form salts and hydrogen gas.

**(v) Displacement Reactions**

A more reactive metal can displace less reactive metals from their salt solutions. Less reactive metals cannot displace more reactive metals.

**Uses of Metals**

- Metals are used in making machinery, automobiles, aeroplanes, trans satellites, industrial gadgets, water biolers etc.

Non-Metals

- Those elements which form negative ions by gaining electrons are called **non-metals**. e.g. carbon, iodine, sulphur, oxygen, hydrogen etc. The non-metals are either solids or gases except bromine which is a liquid.

Physical Properties of Non-metals

- Malleability and ductility** Non-metals are neither malleable nor ductile. However, diamond an allotropic form of carbon, is of ductile nature, since it is quite hard.
- Brittleness** Non-metals are brittle in nature. For instance, sulphur is a brittle solid. If it is hammered, it breaks into pieces.

- Physical state** Most of the non-metals are soft (if solid). Only diamond, an allotropic form of carbon is the hardest known substance.

- Lustre** Non-metals do not have lustre, i.e. shining surface. However, diamond, graphite (a form of carbon) and iodine have lustre, even though they are non-metals.

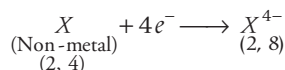
- Electrical and thermal conductivity** Non-metals are generally poor conductors of heat and electricity. Graphite, another allotrope of carbon, is a good conductor of electricity.

- Melting and boiling points** Generally, non-metals have low melting and boiling points. But non-metals that are solids have comparatively higher boiling points, e.g. B, Si, C etc.

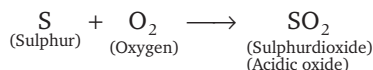
Note The gases like nitrogen, oxygen, carbon dioxide etc., which constitute air are all poor conductors of electricity.

Chemical Properties of Non-metals

- The chemical properties of non-metals is due to their electronegative nature, i.e. tendency to gain electrons in their valence shells to achieve the configuration of nearest noble gas elements.

**(i) Reaction With Oxygen**

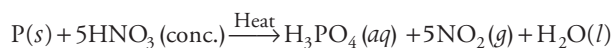
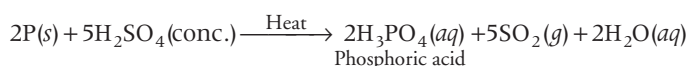
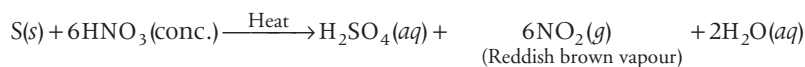
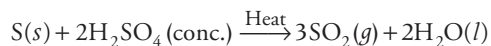
Non-metals react with oxygen to form non-metal oxide which are acidic in nature. The acidic non-metal oxides turn blue litmus to red.

**(ii). Reaction with Water**

- Non-metals do not react with water or steam to evolve hydrogen gas.
- This is because non-metals cannot give electrons to hydrogen in water and therefore, hydrogen gas cannot be released.

(iii) Reaction with Acids

- Non-metals do not react with dilute acids to release hydrogen gas. The reason is that a non-metal is an electron acceptor, it cannot supply electrons to the H^+ ions of acids to reduce them to hydrogen gas.
- Thus, it cannot displace hydrogen gas from acids. But on heating with concentrated acids, these form oxides or salts.



(iv) Reaction With Bases

Some non-metals react with bases but no hydrogen gas is produced. The reaction of most metals with bases are complex.

(v) Displacement Reaction

Non-metals also show displacement reaction like metals. e.g.

$$\underset{\text{Chlorine}}{Cl_2} + \underset{\text{Sodium bromide}}{2NaBr} \longrightarrow \underset{\text{Sodium chloride}}{2NaCl} + \underset{\text{Bromine}}{Br_2}$$

Differences between Metals and Non-metals

Properties	Metals	Non-metals
Physical	Metals are solid at room temperature except mercury.	Non-metals may be solid, e.g., C, liquid, e.g., Br ₂ or gases e.g., O ₂ , Cl ₂ at room temperature.
	They are lustrous.	They are non-lustrous (except iodine).
	They are malleable and ductile.	They are non-malleable and non-ductile.
	They are sonorous (produce ringing sound).	They are non-sonorous.
	They are good conductor of heat and electricity.	They are bad conductor of heat and electricity (except graphite).
	They have high tensile strength.	They have low tensile strength.
	They are usually hard.	They are usually soft.
	They are very strong.	They are not very strong.
	They have high melting and boiling points.	They have low melting and boiling points.
Chemical	They form basic oxides which on dissolving in water, forms base. $4Na + O_2 \longrightarrow 2Na_2O$ $Na_2O + H_2O \longrightarrow 2NaOH$ base	They form acidic and neutral oxides like CO ₂ , SO ₂ , (acidic) and CO, N ₂ O, NO (neutral), etc.
	They displace hydrogen from acids.	They do not displace hydrogen from acids.
	They react with water to evolve hydrogen gas.	They do not react with water to evolve hydrogen gas.

Uses of Non-Metals

Some important uses of non-metals are given below:

- (i) Oxygen is used by plants and animals for breathing. It is also used for burning of fuels in homes, factories and transport vehicles.
- (ii) Nitrogen is used in making fertilisers to enhance the growth of plants. It is also used in food packaging to keep the food fresh.
- (iii) Chlorine is used in the water purification process.
- (iv) Iodine is used in the purple coloured solution (tincture iodine) which is applied on wounds as an antiseptic.
- (v) Sulphur and phosphorus are used in firework such as crackers, etc.
- (vi) Carbon is used as a fuel such as charcoal, coke and coal.

Corrosion

The wasting away of a metal layer-by-layer due to the formation of metal compounds on the surface is called corrosion. Corrosion in case of iron is called rusting. Iron is widely used metal. It corrodes faster when exposed to moist air. The presence of air (oxygen) and water is essential for rusting.

Prevention from Corrosion

Corrosion of metals can be prevented by following processes

- (i) **Painting** The most common method of preventing corrosion is to coat the metals surface with paint.
- (ii) **Greasing** A coat of oil or grease also protects metals from corrosion by air and moisture.
- (iii) **Galvanisation** Another common method of protecting iron from

rusting is to coat its surface with a thin layer of a non-corrosive metals like zinc. This process is called galvanisation.

- (iv) **Electroplating** Iron and steel are protected from corrosion by coating them with a layer of tin or chromium metals which are resistant to corrosion. This is done by electroplating. A thin layer of tin, deposited on the inner surface of iron containers, makes them safe for storing food.
- (v) **Alloying** Some metals when alloyed with other metals become more resistant to corrosion. e.g. iron when alloyed with chromium and nickel forms stainless steel. It is resistant to corrosion and does not rust at all.

Alloy	Percentage composition	Uses
Bronze	Cu = 89%, Sn = 11%	For making statues, coins, utensils etc.
Brass	Cu = 70%, Zn = 30%	For making utensils, parts of machinery, condenser tubes, wires, etc.
Duralumin	Al = 90%, Cu = 4%	Making parts of aeroplanes and automobiles, pressure cookers etc.
Magnalium	Al = 95%, Mg = 5%	Balance beams, some light instruments.
Gun metal	Cu = 90%, Sn = 10%	For making gun barrels.
Bell metal	Cu = 80%, Sn = 20%	For making bells and gongs.
German silver	Cu = 60%, Zn = 20%, Ni = 20%	For making silverware, resistance wires.
Dental alloy	Ag = 34%, Hg = 53%, Sn = 12.5%, Cu = 2%, Zn = 0.5%	For filling cavities of teeth.
Solder	Pb = 50%, Sn = 50%	For soldering two metal or wires metal pieces.
Stainless steel	Fe = 73%, Cr = 18%	Utensils, cycle and automobile parts, shaving

PRACTICE EXERCISE

1. Choose the incorrect information about metals
 (a) metals are lustrous
 (b) metals are brittle
 (c) metals are sonorous
 (d) metals are ductile
2. Which of the following metals is not solid at room temperature?
 (a) Iron
 (b) Sodium
 (c) Mercury
 (d) Zinc
3. Which of the following has highest tensile strength?
 (a) Diamond
 (b) Copper
 (c) Graphite
 (d) Sulphur
4. Most malleable metal is
 (a) magnesium
 (b) gold
 (c) iron
 (d) copper
5. Metals are usually hard. But exception to this fact is
 (a) zinc
 (b) copper
 (c) iron
 (d) sodium
6. The metal with exceptionally low melting point is
 (a) potassium
 (b) copper
 (c) calcium
 (d) aluminium
7. The most reactive element among the following is
 (a) Na
 (b) K
 (c) Ca
 (d) Mg
8. Which of the following metals is suggested to be stored submerged in kerosene?
 (a) Al
 (b) Mg
 (c) Ca
 (d) Na
9. Which metal is suitable to store acid in its vessel?
 (a) Aluminium
 (b) Iron
 (c) Copper
 (d) Zinc
10. Potassium metal should be stored in
 (a) kerosene oil
 (b) alcohol
 (c) water
 (d) hydrochloric acid
11. Magnesium reacts with oxygen to give
 (a) MgO_2
 (b) MgO
 (c) Mg_2O
 (d) $\text{Mg}(\text{OH})_2$
12. Which of the following reacts vigorously with water?
 (a) Sodium
 (b) Aluminium
 (c) Copper
 (d) Iron
13. Which of the following metals does not react with water at all?
 (a) Aluminium
 (b) Silver
 (c) Gold
 (d) Both (b) and (c)
14. What would be the product of following reaction?

$$\underset{\text{(Gold)}}{\text{Au}} + \underset{\text{(Hydrochloric acid)}}{\text{dil. HCl}} \longrightarrow$$
 (a) $\text{AuCl}_2 + \text{H}_2$
 (b) $\text{AuCl} + \text{H}_2$
 (c) $\text{AuCl}_3 + \text{H}_2$
 (d) No reaction takes place
15. In a reaction, copper can displace
 (a) iron
 (b) magnesium
 (c) silver
 (d) All of these
16. Which of the following burns with an explosion in contact with water and air ?
 (a) Na
 (b) Ca
 (c) Mg
 (d) Zn
17. Complete the following equation

$$\text{Zn} + \text{CuSO}_4 \longrightarrow \dots + \text{Cu}$$
 (a) ZnO
 (b) ZnSO_4
 (c) CuO
 (d) ZnS
18. A non-metal having lustre is
 (a) iodine
 (b) bromine
 (c) sulphur
 (d) carbon
19. The good conductor of electricity is
 (a) graphite
 (b) diamond
 (c) phosphorus
 (d) carborundum

20. Which of the following elements is a metalloid ?
(a) Lead (b) Tin
(c) Antimony (d) Barium
21. Which of the following is the hardest substance ?
(a) Chromium (b) Rubidium
(c) Diamond (d) Iron
22. Which of the following can not be beaten into thin sheets?
(a) Zinc (b) Phosphorus
(c) Copper (d) Iron
23. Non metals reacts with oxygen to form
(a) Basic oxides (b) Acidic oxides
(c) Neutral oxides (d) Salt and water
24. Which of the following oxides in aqueous solution does not turn red litmus blue?
(a) CO_2 (b) Na_2O
(c) MgO (d) Fe_2O_3
25. The metal which is used to make thermometers is
(a) Zinc (b) Aluminium
(c) Iron (d) Mercury
26. Chlorine is used in
(a) food packaging.
(b) water purification process.
(c) galvanising iron.
(d) fireworks
27. Iron rusts faster when
(a) exposed to dry air
(b) exposed to moist air
(c) painted
(d) galvanised
28. Which of the following metals is used in galvanisation of iron?
(a) Aluminium
(b) Copper
(c) Magnesium
(d) Zinc
29. Which of the following is not suggested to prevent metals from corrosion?
(a) Dipping metal in salt solution
(b) Painting
(c) Greasing
(d) Electroplating
30. Coating iron and steel article with chromium metal is done through
(a) greasing (b) galvanisation
(c) electroplating (d) All of these
31. Stainless steel is corrosion resistant because of
(a) alloying (b) painting
(c) greasing (d) electroplating
32. Which of the following elements is highly resistant to corrosion ?
(a) Iron (b) Titanium
(c) Nickel (d) Silver
33. The metal present in brass and bronze is
(a) Zn (b) Mg (c) Cu (d) Al
34. Pick the odd one out
(a) titanium (b) bronze
(c) solder (d) gun metal
35. Which of the following does not contain copper?
(a) German silver (b) Bronze
(c) Brass (d) Duralumin

[illegible]