

METALS [METALS AND NON-METALS]

Elements are divided mainly into two groups on the basis of physical and chemical properties – Metal and Non-metal.

METALS

PHYSICAL PROPERTIES

- (i) Metals in their pure state, have a shining surface. This property is called metallic lustre. Metals are generally hard. The hardness varies from metal to metal.
- (ii) Metals can be beaten into thin sheets. This property is called malleability.
- (iii) Ductility the ability of metals to be drawn into thin wires. Gold is the most ductile metal.
- (iv) Metals are good conductors of heat and have high melting points. The best conductors of heat are silver and copper. Lead and mercury are comparatively poor conductors of heat.
- (v) Metals have high melting points.
- (vi) The metals that produce a sound on striking a hard surface are said to be sonorous.

But there are many exceptions, like: –

- (i) All metals except mercury exist as solids at room temperature. Metals have high melting points but gallium and caesium have very low melting points. These two metals will melt if you keep them on your palm.
- (ii) Iodine is a non-metal but it is lustrous.
- (iii) Carbon is a non-metal that can exist in different forms. Each form is called an allotrope. Diamond, an allotrope of carbon, is the hardest natural substance known and has a very high melting and boiling point. Graphite, another allotrope of carbon, is a conductor of electricity.
- (iv) Alkali metals (lithium, sodium, potassium) are so soft that they can be cut with a knife. They have low densities and low melting points.

CHEMICAL PROPERTIES OF METALS

(i) Reaction with oxygen:

All metals do not react with oxygen at the same rate. Different metals show different reactivities towards oxygen.

- (i) Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.
- (ii) At ordinary temperature, the surfaces of metals such as magnesium, aluminium, zinc, lead, etc., are covered with a thin layer of oxide. The protective oxide layer prevents the metal from further oxidation.
- (iii) Iron does not burn on heating but iron filings burn vigorously when sprinkled in the flame of the burner.
- (iv) Copper does not burn, but the hot metal is coated with a black coloured layer of copper(II) oxide.
- (v) Silver and gold do not react with oxygen even at high temperatures.

But burning in oxygen does not help us to decide about the reactivity of zinc, iron, copper or lead. Let us see some more reactions to arrive at a conclusion about the order **of reactivity of these metals**.

Almost all metals combine with oxygen to form metal oxides.

Metal + Oxygen → Metal oxide

- a) Alkali metals react vigorously with oxygen. Lithium, potassium, sodium, are alkali metals.

Sodium metal forms sodium oxide when reacts with oxygen.



Potassium metal forms potassium oxide when reacts with oxygen.



- b) Reaction of magnesium - Magnesium burns with dazzling light in air and produces lot of heat giving magnesium oxide



- c) Reaction of aluminium: Aluminium metal does not react with oxygen at room temperature but it gives aluminium oxide when burnt in air.



- d) Reaction of zinc: Zinc does not react with oxygen at room temperature. But it gives zinc oxide when heated strongly in air.



- e) Reaction of Iron: Iron does not react with oxygen at room temperature. But when iron is heated strongly in air, it gives iron oxide.



Iron filings give sparkle in flame when burnt.

- f) Reaction of copper metal with oxygen: Copper does not react with oxygen at room temperature but when burnt in air, it gives copper oxide, a black oxide.



- (ii) **Reaction of metals with water:**Metals form respective metal hydroxide and hydrogen gas when react with water.

Metal + Water ⇌ Metal hydroxide + Hydrogen

- a) Alkali Metals

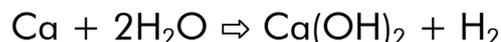
Reaction of sodium: Sodium metal forms sodium hydroxide and liberates hydrogen gas along with lot of heat when reacts with water.



Reaction of potassium: Potassium metal forms potassium hydroxide and liberates hydrogen gas along with lot of heat when reacts with water.

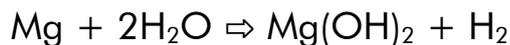


- b) Reaction of calcium: Calcium forms calcium hydroxide along with hydrogen gas and heat when reacts with water. Calcium starts floating because the bubbles of hydrogen gas formed stick to the surface of the metal.



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- c) Reaction of magnesium: Magnesium does not react with cold water. It reacts with hot water to form magnesium hydroxide and hydrogen. It also starts floating due to the bubbles of hydrogen gas sticking to its surface.



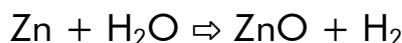
When steam is passed over magnesium metal, magnesium oxide and hydrogen gas are formed.



- d) Reaction of aluminium: Aluminium does not react with cold water is too slow to come into notice. But when steam is passed over aluminium metal; aluminium oxide and hydrogen gas are produced.



- e) Reaction of zinc: Zinc metal produces zinc oxide and hydrogen gas when steam is passed over it. Zinc does not react with cold water.

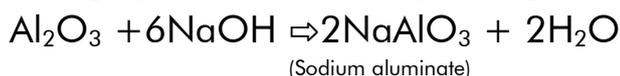
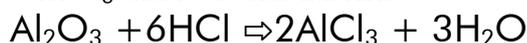


- f) Reaction of Iron: Reaction of iron with cold water is very slow. Iron forms rust (iron oxide) when reacts with moisture present in atmosphere. Iron oxide and hydrogen gas are formed by passing of steam over iron metal.



- g) Other metals usually do not react with water or react very slowly. Metals such as lead, copper, silver and gold do not react with water at all.

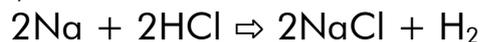
- (iii) **Reaction of Metals Oxides:** Some metal oxides, such as aluminium oxide, zinc oxide, etc., show both acidic as well as basic behaviour. Such metal oxides which react with both acids as well as bases to produce salts and water are known as **amphoteric oxides**. Aluminium oxide reacts in the following manner with acids and bases –



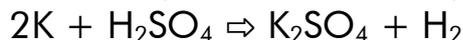
- (iv) **Reaction of metals with Acids:** Metals react with acids to give a salt and hydrogen gas.

Metal + Dilute acid → Salt + Hydrogen

- a) Reaction of sodium metal: Sodium metal gives sodium chloride and hydrogen gas when react with dilute hydrochloric acid.



- b) Reaction of potassium: Potassium sulphate and hydrogen gas are formed when potassium reacts with dilute sulphuric acid.



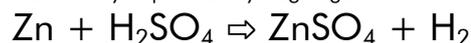
- c) Reaction of magnesium: Magnesium chloride and hydrogen gas are formed when magnesium reacts with dilute hydrochloric acid.



- d) Reaction of aluminium: Aluminium chloride and hydrogen gas are formed.



- e) Reaction of zinc: Zinc sulphate and hydrogen gas are formed when zinc reacts with dilute sulphuric acid. This method is used in laboratory to produce hydrogen gas.



- f) Copper, gold and silver are known as noble metals. These do not react with water or dilute acids.

- g) Hydrogen gas is not evolved when a metal reacts with nitric acid. It is because HNO_3 is a strong oxidising agent. It oxidises the H_2 produced to water and itself gets reduced to any of the nitrogen oxides (N_2O , NO , NO_2). But magnesium (Mg) and manganese (Mn) react with very dilute HNO_3 to evolve H_2 gas.

- (v) **Reaction of Metal Oxide with Water:** Metal oxides are basic in nature. Aqueous solution of metal oxides turns red litmus blue.

Metal oxide + Water → Metal hydroxide

Most of the metal oxides are insoluble in water. Alkali metal oxides are soluble in water. Alkali metal oxides give strong base when dissolved in water.

- a) Reaction of sodium oxide: Sodium oxide gives sodium hydroxide when reacts with water.



- b) Reaction of magnesium oxide: Magnesium oxide gives magnesium hydroxide with water.



- c) Reaction of potassium oxide: Potassium oxide gives potassium hydroxide when reacts with water.



(vi) Reaction of Metals with Solutions of other Metal Salts?

Reactive metals can displace less reactive metals from their compounds in solution or molten form. It is simple and easy if metal A displaces metal B from its solution, it is more reactive than B.



The Reactivity Series

The **reactivity series is a list of metals** arranged in the order of their decreasing activities. After performing displacement experiments the following series, known as the **reactivity or activity series** has been developed. Reactivity of some metals are given in descending order $\text{K} > \text{Na} > \text{Ca} > \text{Mg} > \text{Al} > \text{Zn} > \text{Fe} > \text{Pb} > \text{Cu}$

