

# For XAT , CMAT , MAT , IIFT Exam

## METALS & NON-METALS

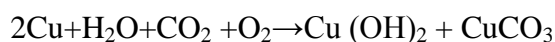
- Metals are lustrous whereas non-metals have no lustre. Metals are malleable and ductile. Non-metals do not have these properties.
- Metals are good conductors of heat and electricity but non-metals are poor Conductors.
- On burning, metals react with oxygen to produce metal oxides which are basic in nature. Non-metals react with oxygen to produce non-metallic oxides which are acidic in nature.
- Some metals react with water to produce metal hydroxides and hydrogen gas. Generally, non-metals do not react with water.
- **Metals** react with acids and produce metal salts and **hydrogen gas**. Generally, **non-metals** do not react with **acids**.
- Some metals react with bases to produce hydrogen gas.

## METALS

- Metals, in their pure state, have a shining surface. This property is Called metallic lustre.
- The property of metals by which they can be beaten into thin sheets is called malleability.
- Metals can be beaten into thin sheets. This property is called malleability. **Gold and silver are most malleability metal.**
- Ability of metals to be drawn into thin wires is called ductility. **Gold is the most ductile metal.** You will be surprised to know that a wire of about 2 km length can be drawn from one gram of gold.
- 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 heats
- Metals are good conductors of electricity. The **best conductors of electricity is silver**
- Since metals produce ringing sounds, they are said to be sonorous. The materials other than metals are not sonorous.
- When an **acid reacts with a metal, hydrogen gas** is evolved and a corresponding salt is formed  
$$\text{Acid} + \text{Metal} \rightarrow \text{Salt} + \text{Hydrogen gas}$$
- All metals except **mercury exist as solids at room temperature**
- **Gallium and cesium have very low melting points.** These two metals will melt if you keep them on your palm
- Alkali metals (**lithium, sodium, potassium**) are so soft that they can be **cut with a knife**. They have low densities and low melting points
- **Concentrated Acid:** It has relatively large amount of acid dissolved in a solvent.
- **Dilute Acid:** It has relatively smaller amount of acid dissolved in solvent.
- Almost all metals combine with oxygen to form metal oxides.  
$$\text{Metal} + \text{Oxygen} \rightarrow \text{Metal oxide}$$

- All metals do not react with oxygen at the same rate. Different metals show different reactivities towards oxygen. **Metals such as potassium and sodium react so vigorously.**
- **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**.
- **Anodising** is a process of forming a thick oxide layer of aluminium. Aluminium develops a thin oxide layer when exposed to air. This aluminium oxide coat makes it resistant to further corrosion. The resistance can be improved further by making the oxide layer thicker.
- **Silver and gold do not react with oxygen** even at **high temperatures**

When a copper vessel is exposed to moist air for long, it acquires a dull green coating. The green material is a mixture of copper hydroxide ( $\text{Cu}(\text{OH})_2$ ) and copper carbonate ( $\text{CuCO}_3$ ).



### When Metals react with Water?

- Metals react with water and produce a metal oxide and hydrogen gas. Metal oxides that are soluble in water dissolve in it to further form metal hydroxide. But all metals do not react with water.  

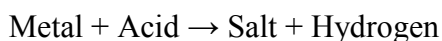
$$\text{Metal} + \text{Water} \rightarrow \text{Metal oxide} + \text{Hydrogen}$$

$$\text{Metal oxide} + \text{Water} \rightarrow \text{Metal hydroxide}$$
- Metals like **potassium and sodium** react **violently with cold water**. In case of sodium and potassium, the reaction is so violent and exothermic that the evolved hydrogen immediately **catches fire**.
- The **reaction of calcium** with water is **less violent**. The heat evolved is not sufficient for the hydrogen to catch fire. **Calcium starts floating** because the bubbles of hydrogen gas formed stick to the surface of the metal.
- **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.
- Metals like aluminium, iron and zinc do not react either with cold or hot water. But they react with steam to form the metal oxide and hydrogen.

- Metals such as lead, copper, silver and gold do not react with water at all

### When Metals react with Acids?

- Metals react with acids to give a salt and hydrogen gas.



- Hydrogen gas is not evolved** when a metal reacts with **nitric acid**. It is because  $\text{HNO}_3$  is a strong oxidising agent. It oxidises the  $\text{H}_2$  produced to water and itself gets reduced to any of the nitrogen oxides ( $\text{N}_2\text{O}$ ,  $\text{NO}$ ,  $\text{NO}_2$ ). But magnesium (Mg) and manganese (Mn) react with very dilute  $\text{HNO}_3$  to evolve  $\text{H}_2$  gas.
- Aqua regia** is a freshly prepared mixture of concentrated **hydrochloric acid** and concentrated **nitric acid** in the ratio of **3:1**. Aqua regia is a highly corrosive, fuming liquid. It is one of the few reagents that is able to dissolve **gold and platinum**. It is used for cleaning and refining gold.

### The Reactivity Series

- The reactivity series is a list of metals arranged in the order of their decreasing activities

Symbol	Metal
K	Potassium
Na	Sodium
Ca	Calcium
Mg	Magnesium
Al	Aluminum
Zn	Zinc
Fe	Iron
Pb	Lead
H	Hydrogen
Cu	Copper
Hg	Mercury
Ag	Silver



Au	Gold
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## LIST OF METAL AND THEIR ORES

- Ores mined from the earth are usually contaminated with large amounts of impurities such as soil, sand, etc., called gangue. The impurities must be removed from the ore prior to the extraction of the metal. The processes used for removing the gangue from the ore are based on the differences between the physical or chemical properties of the gangue and the ore.

METALS	ORES
Sodium	Trona Borax Common salt
Aluminum	Bauxite
Potassium	Nitrate Carnalite
Magnesium	Magnesite Dolomite Epsom salt
Silver	Ruby silver Horn silver
Mercury	Cinnabar
Tin	Cassiterite
Lead	Galena
Gold	Calaverite Silvenites

Calcium	Dolomite Gypsum Fluorspar Asbestos
Iron	Haemethite Magnetite
Bismuth	Bismuthate

#### Refining of Metals

- The most widely used method for refining impure metals is electrolytic refining.
- Many metals, such as copper, zinc, tin, nickel, silver, gold, etc., are refined electrolytically.

## NON-METALS

- Examples of non-metals are carbon, sulphur, iodine, oxygen, hydrogen, etc.
- **Non-metals are either solids or gases except bromine which is a liquid at room temperature**
- Iodine is a non-metal but it is lustrous
- 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
- Non-metals produce acidic oxides when dissolve in water

## CORROSION

- When a metal is attacked by substances around it such as moisture, acids, etc., it is said to corrode and this process is called corrosion. The **black coating on silver** and the **green coating on copper** are other examples of corrosion

## PREVENTION OF CORROSION

- Rusting of iron can be prevented by painting, oiling, greasing, galvanizing , chrome plating, anodizing or making alloys
- **Galvanization** is a method of protecting steel and iron from rusting by coating them with a thin layer of **zinc**.

- The process of rusting can be represented by the following equation:

Iron (Fe) + Oxygen (O<sub>2</sub> , from the air) + water (H<sub>2</sub>O) → rust (iron oxide Fe<sub>2</sub>O<sub>3</sub> )

For rusting, the presence of both oxygen and water (or water vapour) is essential.

- Stainless steel is made by mixing iron with carbon and metals like chromium, nickel and manganese. It does not rust.

## ALLOYING

- Alloying is a very good **method of improving the properties of a metal**.
- Alloy is a homogeneous mixture of two or more metals, or a metal and a Non-metal.
- Iron is the most widely used metal. But it is never used in its pure state. This is because pure iron is very soft and stretches easily when hot. But, if it is **mixed with a small amount of carbon**, it becomes hard and strong. When iron is mixed with nickel and chromium, we get stainless steel, which is hard and does not rust.
- Pure gold, known as 24 carat gold, is very soft. It is, therefore, not suitable for making jewellery. It is alloyed with either silver or copper to make it hard. Generally, in India, 22 carat gold is used for making ornaments. It means that 22 parts of pure gold is alloyed with 2 parts of either copper or silver.

## IMPORTANT ALLOYS

Alloy	Combinations
Solder	Lead and Tin
Brass	Copper and zinc
Stainless steel	Iron, Chromium and Nickel

Bronze	Copper and Tin
Invar	Iron and Nickel
Constantan	Copper and Nickel
Gun metal	Copper ,tin and zinc
Sterling silver	Silver and copper
German silver	Copper , zinc and Nickel

- An amalgam is an alloy of mercury.
- Electrical conductivity and melting point of an alloy is less than that of pure metals.
- Some alloys have lower melting point than pure metals (Example: Solder is an alloy of lead and tin which has lower melting point than each of the metals).
- Solder is used for welding electrical wires together.
- Alloys do not get corroded or get corroded to very less extent