METALS & NON-METALS

INTRODUCTION

All the materials around us are made up of chemical elements, which are found in the earth's crust. Earth is the source of coal, petroleum, graphite, diamond and many other minerals of metals and non-metals. We get various useful things like gasoline, kerosene, wax, coal gas and minerals and rocks in the natural resources, which are made up of many non-metals. These elements occur as minerals and rocks in the earth's crust. Some of these elements like oxygen, nitrogen and carbon dioxide occur in atmospheric air.

There are more than 115 element known at present 80% of these elements are metals and rest are non – metals. On the basis of their characteristic properties, all of these elements are divided into two main groups: metals and non-metals.

POSITION OF METALS AND NON-METALS IN THE PERIODIC TABLE

The elements which are placed on the left hand side (except hydrogen) and in the center of the periodic table are called metals. Such as sodium, potassium, magnesium, calcium, iron, copper zinc etc.

The elements which are place on the right hand side of the periodic table are called non-metals such as oxygen, nitrogen, chlorine, fluoric etc. These metals and non-metals are separated from each other in the periodic table by a zig-zag line. The elements placed in the zig-zag line show some properties of metals and some properties of non-metals are called metalloids. Such as Boron (B), Silicon (Si), Germanium(Ge), Arsenic (As), Antimony(Sb), Tellurium(Te) and Polonium(Po).

The position of metals, non-metals and metalloids are shown in a simple form in figure..

Metals present at the extreme left are known as light metals, while those are present in the center of the periodic table are called heavy metals or transition metals.

The element at the extreme left of the periodic table is most metallic and those on the right are least metallic or non-metallic.

POSITON OF METALS, NON-METALS AND METALLOIDS IN THE PERIODIC TABLE

Thus, metallic character decreases on going from left to right side in the periodic table. For example, sodium is more metallic than aluminium because sodium is on the left hand side of aluminium.

However on going down in a group the metallic character increases. For example, carbon is non-metal while lead is metal because metallic character increases down in a group.

Metals:

The elements which can be polished, drawn into wires (ductile), hammered into sheets (malleable) and good conductor of head and electricity are called metals. Such as gold, silver and aluminium. Al is the most abundant metal in the earth's crust.

ELECTRONIC VIEW OF METAL

An element is called metal, which forms positive ions (or cations) by losing electron.

Example: Sodium is a metal which form's sodium ion (Na^+) by losing one electron.

Similarly, magnesium metal forms Mg^{2+} by losing of two electrons, Al metal forms Al^{3+} by lose of three electrons.

Thus, metals are also known as electropositive elements.

The atoms of metals have 1 to 3 electrons in their outermost shell. For example, all the alkali metals have one electron in their outermost shell. (Lithium-2, 1, sodium 2, 8, 1, potassium-2, 8, 8, 1,….. etc).

Sodium$_{(11)}$ magnesium$_{(12)}$ and aluminium$_{13}$ (2, 8, 3) are metals having 1,2 and 3 electrons respectively in their outermost shell, which lose these electron easily. The number of electrons lost by an atom of a metal is called its valency.
Thus metals have 1 to 3 electrons in their valence shell of their atoms.
Exceptions: Hydrogen and Helium. Hydrogen is a non-metal having 1 electron in its outermost shell of its atoms. Helium having 2 electrons in its outermost shell of its atom.

PHYSICAL PROPERTIES OF METALS: The important physical properties of metals are given below:

PHYSICAL STATE OF METALS

Most of the metals are solid under normal condition of temperature and pressure (Except mercury which exist in liquid state at room temperature) For example iron, copper, Aluminium, Zinc, Sodium are solid at room temperature.

HARDNESS OF METALS

Most of the metals are hard, but all metals are not equally hard. The hardness of metals varies from metal to metal.
For example: Iron, Copper, Aluminium, Sodium and Potassium.

MALLEABILTY OF METALS

The properties in which metals can be between with a hammer into very thin sheets without breaking is called malleability. Gold and silver are the best malleable metals. Aluminium and copper are also highly malleable metals. All of these metals can beaten with a hammer to from very sheets, are called foil.

Activity-1.1

Aim: To show that the metals are malleable.

Procedure: Taken an iron nail, a piece of zinc, copper, coal, aluminium, place all of above one by on a block of iron and strikes it 4 and 5 times with a hammer.

Observation:

1. Iron nail, aluminium, copper & zinc metals change their shape into thin sheets.
2. Coal is broken into small pieces. i.e. it is not a metal, because it does not show the property of malleability.

Conclusion :

1. Zinc, Fe, Al, Cu, are malleable i.e. they are metals.
2. Coal is non-metal.

LUSTRE OF METALS

Most of the metals, in their pure state, have a shining surface. This property is called metallic luster. Example, gold is shining yellow and copper is brown, iron, aluminum and zinc are lustrous grey.

Activity-1.2: To show that metals have shine or brightness. Take a small piece of iron, copper, aluminium and magnesium. Now clean their surface by rubbing them with a sand paper.

Observation: Iron is shining grey in colour, magnesium and aluminium appear white, and gold in yellow in colour and copper is reddish in colour.

Result: Thus metals have shine or brightness.

DUCTILITY OF METALS

Ductility is also important property of metals. The ability of metals to be drawn (stretched) into thin wire generally, wires are made up of iron, copper and aluminium. Gold and silver are the most ductile metals.

For example 100 mg of silver can be drawn into a thin wire of about 200 metres long. Similarly we can draw a wire of about 2 kilometer from only 1 gm of gold. Copper and aluminium are also very ductile, and therefore, they can be drawn into thin wires which are used in electrical wiring.

We are familiar with silver foil used for decorating sweets and aluminium foil are used for wrapping food.

THERMAL CONDUCTIVITY OF METALS

The process in which a metal allows the flow of heat through it is called its thermal conductivity. Most of metals are good conductors of hard, such as silver, gold, iron, copper and aluminium. Silver and copper are the best conductor of heat.

Activity-1.3:

Aim: To show the metals are good conductor of heat.

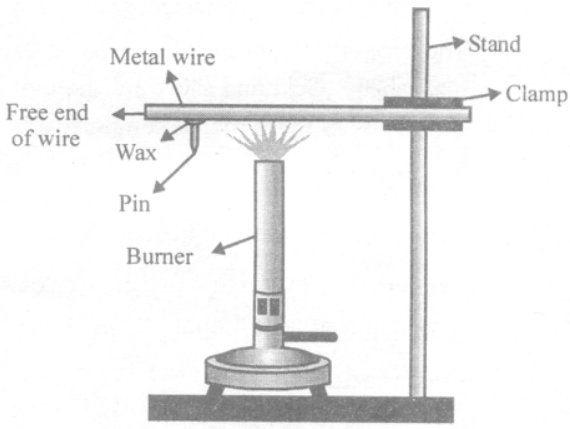
Procedure: Take a one metal rod and place its one end in hot water.

Observation: The other end also gets heated soon.

Result: This shows that metals are good conductors of heat.

Activity-1.4:

Procedure: Take a small wire and clamp it on a stand as shown in figure as below. Then fixed a pin to the free end of wire with the help of wax. Now heat the copper wire with as candle or burner near its clamped end.



Observation: After some time the other end will also become hot and wax will melt and nail will fall down.

Result: This shows that metals are good conductors of heat. This experiment also shows that metal wire does not melt. i.e. metals have high melting points. Repeat this activity with aluminium & iron metal. Now an important point is arises that "How do metals conduct heat" Metals conduct heat when a portion of an object made of metal of metal is heated, its atoms gain energy. The energetic atoms vibrate vigorously and transfer energy to the other adjacent atoms. In this way the object and anything in its contact also become hot.

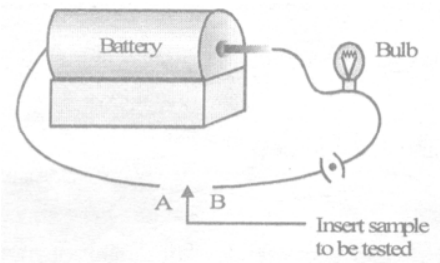
ELECTRICAL CONDUCTIVITY OF METALS

The property in which metal facilitates the flow of electric current through it is called electrical conductivity. All metals are good conductors of electricity because they contain free or mobile electrons. These free electrons
conduct electric current. Silver is the best conductor of electricity. since silver is expensive, therefore, copper and aluminium are mercury offer greater resistance to the flow of current. Therefore, they have low electrical conductivities.

Activity-1.5:

Aim: To show that metal is a good conductor of electricity.

Procedure: Take a dry cell, a bulb fitted in a holder, connecting wires (copper wire), crocodile clips and a switch. Set up all apparatus an electric circuit as shown in figure.



Observation: Take bulb glows at once when switch is on.

Result: This shows that copper metal conducts electric current, i.e. it is a good conductor of electricity.

SONROUS

The property of metals in which metals produce sound when they strike a hard object or other surface are called sonorous. Some metals like copper, silver, gold, aluminium give musical sound when they are struck by themselves or any other object.

USES OF SOME METALS

Many metals and their compounds are useful in our daily life. These are as follows: Aluminium is used to prepare utensils and house hold equipment's like vacuum cleaner. Aluminium is extensively used in making bodies of rail, cars, automobiles, trucks and aircraft. Aluminium wires are widely used in electrical work. Aluminium foil is used to wrap chocolate cigarette and medicines and to seal milk bottles.

Major use of copper is in making electrical wires. Copper is also used in making utensils, steam pipes, coin and in electroplating.

Steel is an alloy of iron which is used for making parts of machines, as building material and in the construction of fridges. As a matter of fact steel is said to be the back bone of industry.

Gold and silver called noble metals (or coinage metals) are used in jewellery

Mercury is used in thermometers barometers and to prepare amalgams.

Platinum is used to make crucible and electrodes.

Zinc is used to galvanize iron, to prepare roofing material, container of dry cells and to make brass when mixed with copper.

Metal like sodium, titanium and zirconium find their application in atomic energy and space science projects.

Titanium (Ti) and its alloys are used in aerospace, marine equipments, aircraft frames, chemical industries and chemical reactors. The wide application of titanium is attributed to its resistance to corrosion, high melting points and high strength.

The metals such as titanium, chromium, manganese and zirconium are called strategic metals because these metals play an important role in the country's economy and defence. These metals and their alloys are used in high grade steels, jet engines, space science projects and atomic energy.

NON-METALS AND THEIR GENERAL PROPERTIES

Non-metals are present on the right hand side of the periodic table (exception : Hydrogen). Among the total known elements, there are only 22 non-metals, out of which 11 are gases like oxygen, nitrogen, hydrogen one is a liquid (Bromine) and the rest 10 are solids such as sulphur, phosphorus and the allotropes of carbon (Diamond and graphite).

ELECTRTONIC VIEW OF NON-METALS

An element is called non-metal which form ions by gaining electrons. For example, oxygen is a non-metal which form O^2 ions by gaining two electrons. Similarly, nitrogen from N^{3-} ions by gaining electrons.

Thus, non-metals also known as electronegative elements.

The atoms of non-metals have usually 4 to 8 electrons in their outer most shell. For example, carbon (At No.6), Nitrogen (At. No.7), Oxygen (At.NOo.8), Fluorine (At. No.9) and Neon (At. No.10), have respectively 4, 5, 6, 7 and 8 electrons in their outermost shell. However, there are two exceptions namely hydrogen and helium which have one and two electrons in their valence shell or outer most shell, but they are non-metals.

PHYSICAL PROPERTIES OF NON-METALS

The important physical properties of non-metals are given below:

1. Non-metals may be solids, (such as sulphur, phosphorus and diamond), liquid(Bromine), or gases (such as oxygen, nitrogen, hydrogen, neon, argon, etc.) at room temperature.

2. Non-metals are usually brittle and cannot be used to make sheets and wires.

3. Non-metals are non-lustrous and cannot be polished. (Exception: Graphite and iodine are lustrous non-metals).

4. Non-metals are generally bad conductor of heat and electricity.
Exception: Graphite which is a good conductor of electricity. Non-metals do not conduct the electric current due to absent of mobile electrons.

5. Non-metals can be easily broken due to its low tensile strength.

6. Non-metals are generally light and have low densities.

7. Unlike metals, non-metals do not produce any sound when struck with an object.

8. Non-metals are soft (Exception: Diamond)

9. Non-metals have low meting and boiling points. (Exception: Graphite has very high melting point (3730^oC) On the basis of the above discussion of the physical of metals and non-metals, we have conclude that element cannot be grouped according to the physical alone, as the are many exceptions.

For example,

(i) All metals except mercury are solids at room temperature. We know that metals have very high melting points but gallium (Ga) and Caesium (Cs) have low melting points. These two will melt if we keep them on our palm.

(ii) Iodine is a non-metals but it is lustrous.

(iii) Alkali metals such as Lithium, Sodium and potassium are soft, so, that they can be easily cut with a knife. i.e. they have densities and low melting points.

(iv) Carbon is a non-metals that can exist in different forms. Each from is called an allotrope Diamond, an allotrope of carbon is the hardest natural substance. Which has very high melting and boiling point. Graphite is another allotrope of carbon which is good conductor of electricity.

The elements can be more clearly classified as metals and non-metals on the basis of their chemical properties.

2. Explain the meaning of malleable and ductile.

Ans. Malleable means that metals can be beaten into thin sheets with a hammer (without breaking). For example, if the take a piece of Al metal and best it with a hammer four or five times, we will find that the piece of Al metal turns into a thin Aluminium sheet, without breaking. Ductile means can be drawn (or stretched) into thin wire. For example, gold is the most ductile metal. Just 1 gm. of Au drawn into very thin wire about 2 Kilometer long.

Activity-1.6:

Aim: To show that metals and non-metals react differently with oxygen:

Production: Take a small piece of magnesium ribbon and hold it with a pair of tongs and burn it over the flame of burner.

Observation: Magnesium ribbon burns with brilliant light and gets into white solid residue called ash. Collect this ash in a beaker and add some water. Now, dissolve it by stirring.

Result: Test this solution with both blue and red litmus paper. The red litmus paper becomes blue but blue litmus paper remains unaffected. This shows that the solution is basic or alkaline.

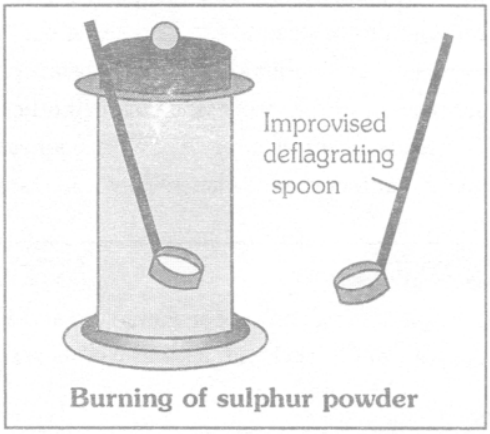
$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

$MgO(s) + H_2O(l) \longrightarrow MG(OH)_2(aq)$

$Mg(OH)_2(aq) + \text{Red litmus} \longrightarrow \text{Blue}$

Similarly,

Take a small amount of sulphur powdered in a deflagrating spoon and start burn. Then introduce the spoon into a gas jar. After burning add some water to the gas jar and shake.



Burning of sulphur powder

Observation: Test the solution with both blue and red litmus paper. The blue litmus paper becomes red and red litmus do not affected. This shows that solutions of SO_2 is acidic in nature.

$S(s) + O_2(g) \longrightarrow SO_2(g)$

$SO_2(g) + H_2O(l) \longrightarrow H_2SO_3(aq)$

$H_2SO_3(aq)$ + Blue litmus $\longrightarrow$ Red

Repeat this activity with sodium and copper metals and phosphors.

Result:

(i) Most metals form basis oxides when dissolved in water.

(ii) On the other hand, non-metals form acidic oxides. Dissolved in water.

CHEMICAL PROPERTES OF METALS

Reaction of metals with oxygen: Almost all metals combine with from metal oxides.

Metal + Oxygen $\longrightarrow$ Metal oxide

But all metals do not react with oxygen at the same rate. They show different reactivity towards oxygen. Such as sodium and potassium react so vigorously that they catch fire if kept in the open. Hence they are kept in kerosene for protection.

$4Na(s) + O_2(g) \longrightarrow 2Na_2O$

$4K(s) + O_2(g) \longrightarrow 2K_2O$

Sodium and potassium react with oxygen of air, burns with a golden yellow colour and form sodium and potassium oxides, which dissolve with water to from alkali called sodium hydroxide and potassium hydroxide. These turn red litmus blue.

$Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$

$K_2O(s) + H_2O(l) \longrightarrow 2KOH(aq)$

Zinc react with oxygen only when strongly and potassium.

$2Zn(s) + O_2(g) \longrightarrow 2ZnO$

Since, it is less reactive than sodium and potassium.

Copper does not react with oxygen even on strong heating. It reacts very slowly on prolonged heating to from cupric oxide (black oxide)

$2Cu(s) + O_2(g) \longrightarrow 2CuO(s)$

Similarly, Aluminum forms aluminum oxide.

$4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3$

The order of reactivity of these metals toward oxygen as follow.
Na > K > Mg > Zn > Fe > Cu

At ordinary temperature, the surface of metals like magnesium (Mg), Aluminum (Al), Copper(Cu), Zinc(Zn), lead etc. are covered with a thin layer of oxide. The protective oxide layer prevents the metals from further oxidation. Silver and gold does not react with oxygen due this silver and gold are called noble metals.

DO YOU KNOW?

Anodizing is a process of forming a thick oxide layer of aluminium. Aluminum develops a thin oxide layer when it exposed to air. This oxide coat of aluminum (Al) make it's resistance to further corrosion. During anodising, the resistance can be improved further by making the oxide layer thicker. In this process, a clean Al article is made the anode and dilute sulphuric acid (H_2SO_4) is used for electrolyte. The oxygen gas evolved at the anode react with Al to make a thicker protective oxide layer. This oxide layer can be dyed easily to give Al articles an attractive finishing.

NATURE OF METALLIC OXIDE

Generally, metallic oxides are basis in nature except aluminium and zinc oxides which are amphoteric in nature. That means these oxides (Al_2O_3, ZnO) react with base as well as acid. The basis of metals react with acid to give salt.

For example:

$CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$

Copper(II)oxide

Some oxide of metals dissolve in water and form alkalis.

Example for:

$Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$

Sodium hydroxide

$K_2O(s) + H_2O(l) \longrightarrow 2KOH(aq)$

Potassium hydroxide

Reaction showing amphoteric in nature of Al2O3 and ZnO.

$Al2O_3(s) + 6HCl(aq) \longrightarrow 2AlCl_3(aq) + 3H_2O(l)$

Hydrochloride acid — Aluminum chloride

$Al_2O_3(s) + 2NaOH(aq) \longrightarrow 2NaAlO_2(aq) + H_2O(l)$

Sodium hydrochloride(base) — Sodium meta aluminium

Similarly,

$ZnO(s) + 2HCl(aq) \longrightarrow 2ZnCl_2(aq) + H_2O(l)$

Hydrochloride acid — Zinc-chloride

$ZnO(s) \quad 2NaOH(aq) \longrightarrow Na_2ZnO_2(aq) + H_2o(l)$

Sodium hydroxide — Sodium Zincate

REACTION OF METALS WITH WATER

Metal react with water and produce a metal oxide and hydrogen gas. Metal oxide that are soluble in water dissolver in it to from metal hydroxide. But all do not react with water.

Metal + Water $\longrightarrow$ Metal oxide + Hydrogen gas

Metal oxide + Water $\longrightarrow$ Metal hydroxide

The following activity clears this reaction properly.

Activity: 1.7:

Procedure: Take the samples of common metals such as copper, iron, calcium, aluminum, sodium and potassium. Put small of the samples separately in beakers which half-filled with water.

Aim: To study about reactivity of metals with water & zinc.

Observation: Sodium and Potassium calcium react with cold water. Sodium and Potassium react violently with cold water, making a hissing sound. These reactions are exothermic and evolved hydrogen gas which catches fire and leads to little explosion.

Calcium react less violently and the piece of calcium starts floating in water because the bubbles of hydrogen gas formed stick to the surface of metal. Now put the metals which do not react with cold water in beaker which is half filled with hot water. Magnesium reacts rapidly with hot water. It also starts floating due to the bubbles of hydrogen sticking to surface. [The rest samples of metals which do not react with cold and hot water.

To study its reactivity with steam, to set up an experiment as shown in figure as below.

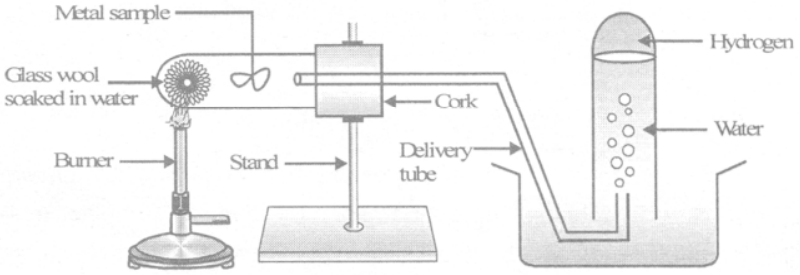


Fig : Action of Steam on a metal

A lump of wet glass wool is placed at the bottom of a boiling tube. Then placed the metals samples in the middle of the horizontally kept boiling tube one now start at the bottom of a boiling tube with a help of burner. The water present in glass wool forms steam on heating. This steam then pass over the metal. Observe that aluminium react with steam and iron does not react ordinary conditions but it reacts only when steam is passed over hot iron. Copper do not react with either at ordinary temperature or at higher temperature. The following reaction occur from the above activity.

1.(i) Na and K metals react vigorously with cold water to form NaOH and H_2 gas is liberated.

$2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$

Sodium — Cold water — Sodium hydroxide — Hydroxide gas

(ii) $2K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g)$

Potassium — Cold water — Potassium hydroxide

This reaction is so violent and exothermic that the H_2 gas evolved catches fire.

(iii) Calcium reacts with cold water to from $Ca(OH)_2$ and H_2 gas. It is less violent.

$Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$

Calcium hydroxide

(iv) Aluminum does not react either with cold or hot water. But it react only with steam to from aluminum oxide and hydrogen gas.

$2Al(s) + 3H_2O(g) \longrightarrow Al_2O_3(s) + 3H_2$

Steam — Aluminum oxide

(v) Similarly, Zinc react with steam to from zinc oxide and H_2 gas.

$Zn(s) + H_2O(g) \longrightarrow ZnO(s) + H_2$

Steam — Zinc oxide

(vi) Magnesium react with hot boiling water to form MgO and H_2 gas.

$Mg(s) + H_2O(l) \longrightarrow MgO(s) + H_2(g)$

Boiling water — Magnesium oxide

(vii) Iron metal react when steam is passed over red hot iron and form iron oxide and H_2 gas.

$3Fe(s) + 4H_2O(g) \longrightarrow Fe_3O_4(s) + H_2(g)$

Iron (Red hot) — Steam — Iron(II, III) oxide

(viii) Copper do not react with even that strong conditions Similarly, gold and silver also do not react with water. the above reactions indicates that sodium potassium are the most reactive metals while copper is less reactive.

Result: The reactivity order of these metals with water are

k > Na > Ca > Mg > Al > Zn > Fe > Cu

Reactivity with water decreases.

REACTION OF METALS WITH ACIDS

The highly reactive metals react with dilute acid to displace hydrogen from acid. The reactivity of different metals is different with same acid. This is clear by the following activity.

Activity: 1.8:

Aim: To show that different metals react differently with dilute acids.

Procedure: Take equal amount metals of small pieces of magnesium (Mg), Aluminum(Al), Zinc(Zn), Iron(Fe) and Copper(Cu), After clean by rubbing with a sand paper, these metals are place in separate test tubes. Now add about 10 ml of dilute HCl to each tube. Now suspended thermometers in each test tubes.

Observation: In the test tube which containing Mg, the hydrogen bubbles will appear very rapidly.

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl(aq) + H_2(g)$$

Magnesium Hydrochloride acid Magnesium chloride

In the test tubes containing Al and Zn reaction with acid is fast.

$$2Al(s) + 6HCl(aq) \longrightarrow 2AlCl_3(aq) + 3H_2$$

Aluminum chloride

The reaction between Fe and acid is slow.

$$Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2$$

Ferrous chloride

No reaction is observation in the tube which containing Cu and dil HCl.

$$Cu(s) + HCl(aq) \longrightarrow \text{No reaction}$$

Result: The order of reactivity of metals with dilute acid is

Na > Mg > Al > ~ Zn > Fe > Cu

Reactivity with dilute acids decreases.

Similarly.

All above metals react with dil H_2SO_4.

$$2Na(s) + 2H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + H_2$$

Sodium Sulphate

$$Mg(s) + 2H_2SO_4(aq) \longrightarrow MgSO_4(aq) + H_2$$

Magnesium sulphate

$$Fe(s) + H_2SO_4(aq) \longrightarrow FeSO_4(aq) + H_2(g)$$

Ferrous sulphate

$$Cu(s) + H_2SO_4(aq) \longrightarrow \text{No reaction}$$

IMPORTANT INFORMATION

Hydrogen gas is not evolved when metals such as Zn, Fe, Cu and Al react with nitric acid. Because HNO_3 is strong oxidising agent. It oxidizes, H_2 gas to water and is itself reduced to oxides of (NO, N_2O and NO_2) nitrogen.

$3Fe(s)$	+	$8HNO_3(aq)$	$\longrightarrow$	$3Fe(NO_3)_2(aq)$	+	$4H_2O(l)$	+	$2NO(g)$
Iron		Nitric acid (aq)		Iron(II) nitrate		Water		Nitric oxide
$3Cu(s)$	+	$8HNO_3(aq)$	$\longrightarrow$	$3Cu(NO_3)_2(aq)$	+	$4H_2O(l)$	+	$2NO(g)$
Copper		Nitric acid		Copper nitrate		Water		Nitric oxide

But copper react with hot concentrated sulphuric acid (H2SO4) to produce copper sulphate, sulphur dioxide and water.

$$Cu(s) + 2H_2SO_4 \longrightarrow CuSO_4 + 2SO_2 + 2H_2O$$

Mg react with very dilute HNO3 to evolve H2 gas.

$Mg(s)$	+	$2HNO_2(aq)$	$\longrightarrow$	$Mg(NO_3)_2(aq)$	+	$H_2O(g)$
Magnesium		Nitric acid (dil)		Magnesium nitrate		

Fe react with dil H_2SO_4 to evolve H_2 gas

$Fe(s)$	+	dil $H_2SO_4(aq)$	$\longrightarrow$	$FeSO_4(s)$	+	H_2
Iron		Sulphuric acid		Ferrous sulphate		

AQUA REGIA (ROYAL WATER)

Aqua regia is a Latin word it means “royal water”. It is a freshly prepared mixture of concentrated hydrochloride acid and concentrated nitric acid in the ratio of 3:1. It is a highly corrosive, fuming liquid and it used for dissolved gold and platinum.

REACTION METALS WITH SOLUTIONS OF OTHER METAL SALTS

When a more reactive metal is placed in a salt solution of less reactive metal, then the more reactive metal displaces the less reactive metal from its salt solution. This reaction is also known as displacement reaction. Let us it with help of following activity.

Activity: 1.9:

Aim: To compare the reactivity of the metals.

Procedure: Take a clean wire of copper and an iron nail, two tests. Now dissolve copper sulphate in water in one test tube and ferrous sulphate in another test tube. Place iron nail in the blue coloured copper sulphate solution with the help of a thread and copper wire in the greenish colour ferrous sulphate solution as shown in figure as below.

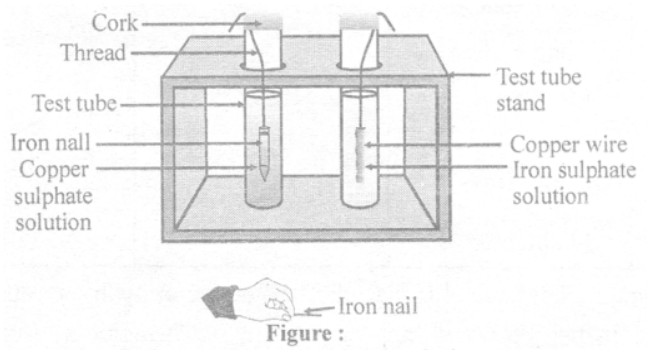


Figure :
Reaction of metals with salt solutions

Observation: Take blue colour of copper sulphate has faded and becomes greenish. The green colour of the solution is due to the formation of iron (II) sulphate and copper is displaced. A reddish-drown coating is formed on the surface of iron nail. The reaction is represented by the chemical equation.

$$Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$$

Iron — Copper sulphate solution — Ferrous sulphate

But the greenish colour of $FeSO_4$ do not change. That means no reaction take place.

Conclusion: These activities show that iron metal is more no reaction take place.

Similarly,

Reaction of copper with silver nitrate solution:

When a strip of copper metal is placed in a solution of $AgNO_3$. The solution becomes gradually blue and a shining coating of silver metal gets deposited on the copper strip. The reaction may be written as:

$$2AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2 + 2Ag$$

Silver nitrate (colourless solution) — Copper nitrate (blue colour) — Silver

However, if we place silver write in a copper sulphate solution on reaction occurs. This means copper can displace silver from its salt solution but silver cannot displace copper its solution. i.e. copper is more reactive metal than silver.

The reactivity series:

The arrangement of metals in order of decreasing reactivity is called reactivity series or activity series of metals. After performing displacement experiment the following series has been developed.

REACTIVITY SERIES OF METALS

	Potassium	K	**Most reactive metal**
	Sodium	Na	
	Barium	Ba	
	Calcium	Ca	
	Magnesium	Mg	
Metal more Reactive Hydrogen	Aluminium	Al	
	Zinc	Zn	
	Iron	Fe	
	Nickel	Ni	
	Tin	Sn	
	Lead	Pb	
	Hydrogen	**H**	
	Copper	Cu	
Metal less Reactive than Hydrogen	Mercury	Hg	
	Silver	Ag	
	Gold	Au	
	Platinum	Pt	**Least reactivity metal**

Reactivity Decreases

Reactivity Decreases

In the table the most reactive metal is placed at the above of hydrogen and the less reactivity metal is placed below of hydrogen. It may that hydrogen is not a metal but even than it has been placed in the reactivity series. Due to hydrogen can also lose electron and form positive ion (H^+)

QUESTIONS:

Q. Why is sodium kept immersed in kerosene oil?

Ans. Due to prevent its reaction with oxygen moisture and carbon dioxide of air.

Q. Write equation for the reactions of:

(i) Iron with steam

(ii) Calcium and potassium with water.

Ans. (i) $3Fe(s) + 4H_2O(g) \longrightarrow Fe3O_4 + H_2$

Iron — Steam — Iron (II, III) oxide

(ii) $Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$

Calcium hydroxide

$K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g)$

Potassium hydroxide

Q. Sample of four metals A, B, C and D were taken and added to the following solution one. The results obtain have been tabulated.

Metal	Iron(II) sulphate	Copper(II) sulphate	Zinc sulphate	Silver
A	No reaction	Displacement		
B	Displacement		No reaction	
C	No reaction	No reaction	No reaction	Displacement
D	No reaction	No reaction	No reaction	No reaction

Use the table above to answer the following question about metals A, B, C and D.

Q. Which is the most reactive metal?

Ans. B is the most reactive metal?

Q. What would you observation if B is added in solution of copper (II) sulphate?

Ans. The B is displace the copper metal from its blue colour of copper sulphate solution. The solution will we fade and a red-drown deposited of copper will be formed on metal B.

Q. Arrange the metal A, B, C and D in the order of decreasing reactivity.

Ans. In decreasing reactivity order.

B > A > C > D

Q. Which is gas is produced when dilute hydrochloride acid is added to a reactivity metal? Write the chemical reaction when iron reacts with dilute H_2SO_4.

Ans. H_2 gas is produced.

$Fe(s) + H_2SO_4(aq) \longrightarrow FeSO_4(aq) + H_2(g)$

Q. What would you observe when zinc is added to a solution of iron(II) sulphate? Write the chemical reaction that take place.

Ans. When zinc is added to a solution of iron (II) sulphate, then the greenish colour of iron (II). Sulphate solution fades gradually due to the formation of colourless zinc sulphate solution and iron metal is deposited on zinc.

Reaction of metals with non-metals:

Atoms of element combination to from stable molecules. The combination power of an atoms is expressed as valency. Each atoms has a tendency to attain a completely filled valance shell. The noble gases, which have a completely filled valence shell or outermost shell, so they are very stable. The electronic of noble gases and some metals and non-metals are given in the following table.

ELECTRONIC CONFIGURATION SOME ELEMENTS:

Types of element	Element	Atomic number	Number of electronic in shells			
			K	L	M	N
Noble gases	Helium (He)	2	2			
	Neon (Ne)	10	2	8		
	Argon (Ar)	18	2	8	8	
Metals	Sodium (Na)	11	2	8	1	
	Magnesium (Mg)	12	2	8	3	
	Aluminium (Al)	13	2	8	3	
	Potassium (K)	19	2	8	8	1
	Calcium (Ca)	20	2	8	8	2
Non-metals	Nitrogen (N)	7	2	5		
	Oxygen (())	8	2	6		
	Fluorine (F)	9	2	7		
	Phosphors (P)	15	2	8	5	
	Sulphur (S)	16	2	8	6	
	Chlorine (Cl)	17	2	8	7	

It is clear from the above table that except helium, all other noble gases have 8 electrons (octet) in their outermost shell. Which represent a highly stable electronic configuration. Due to this stable configuration, the noble gases have no any tendency to lose or gain electrons. So they monoatomic, sodium atom has one electron in its outermost shell. If it loses the electron from its M shell its L shell become the outermost shell, which has stable octet like noble gases. The nucleus of the atom still has 11 protons but the number of electrons has 10. therefore, if become positively charged sodium ion or cation (Na^+).

$$\underset{2,8,1}{Na} \xrightarrow{\text{lose 1. electron}} \underset{\substack{2,8 \\ \text{Sodium cation}}}{Na^+} + e^-$$

On the other hand chlorine has seven electrons in its outer most shell and it require one more electron to complete its. The nucleus of chloride atoms has 17 protons and the number of electrons become 18. This makes chloride ion, Cl^- as negatively charged

$$Cl \xrightarrow{gain\ 1.\ electron} Cl^-$$

2, 8, 7 → 2, 8, 8

Chloride ion

So, Na^+ and Cl^- ions being oppositely charged atoms which attract each other and are held by strong electrostatic forces of attraction to exist as NaCl. In other words, Na^+ and Cl^- ions are together by electrovalent or ionic bond.

The formation of one more ionic compound magnesium chloride:

The electronic configuration of magnesium (Mg) and chlorine atoms are:

Mg_{12} : 2, 8, 7

Cl_{17} : 2, 8, 7

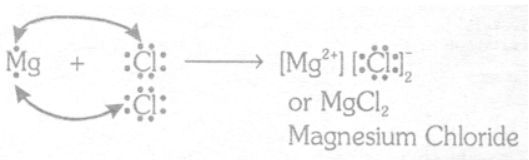
Magnesium atoms has two electrons in its valence shell. It has a tendency to lose of its electrons to stain the nearest noble gas configuration (i.e. Ne). Mg Mg^{2+}

2, 8, 7 2, 8

On the other hand, chlorine has only one electron less than the nearest noble gas (i.e. Ar) configuration. The magnesium loses its both the valence electrons to two atoms, each of which is need of one electron to form Cl^- ion.

Mg ⟶ Mg^{2+} , Cl ⟶ $2Cl^-$

2, 8, 2 2, 8, 7 2, 8, 8



The compound formed by the transfer of electrons from a metal to a non-metal are known as ionic compound or electrovalent compounds. The structure of some common ionic compounds are gives below:

Structure of some common ionic compounds:

1.	Magnesium Oxide	Mg 2, 8, 6	+	O 2, 8, 6	⟶	$Mg^{2+}[O]^{2-}$	or	MgO
2.	Magnesium Fluoride	Mg 2, 8, 6	+	2F 2, 7	⟶	$Mg^{2+2}[F]^-$	or	MgF_2
3.	Calcium Oxide	Ca 2, 8, 8, 2	+	O 2, 6	⟶	$Ca^{2+}[O]^{2-}$	or	CaO
4.	Aluminum Oxide	Al 2, 8, 2	+	O 2, 6	⟶	$2A^{3+}3[O]^{2-}$	or	Al_2O_3
5.	Magnesium Chloride	Mg 2, 8, 2	+	2Cl 2, 8, 7	⟶	$Mg2+2[Cl]^-$	or	$MgCl_2$

6. Aluminium Nitride — Al (2, 8, 3) + N (2, 5) $\longrightarrow$ $Al^{3+}N^{3-}$ or AlN

PROPERTIES OF IONIC COMPOUNDS

To learn about the properties of ionic compounds. Let us perform the following activity.

Activity : 1.10:

1. Take the samples of NaCl, KCl, $BaCl_2$ and $CaCl_2$.
   Dissolve small quantity of each solid one by one (a) in water (b) in kerosene and observe.
   Observation & conclusion:
   (a) Each salt is solution in water. (b) Each salt is insoluble in kerosene.
2. Take small quantity of each salt one by one on a metallic and heat carefully in the top flame of a Bunsen burner.

   Observation: These salts do not melt in heating in the flame of Bunsen burner.
   NaCl salt shows yellow colour flame of burner. KCl salt shows violet colour flame, $CaCl_2$ salt shows brick colour flame and $BaCl_2$ salt shows apple green colour flame of burner.

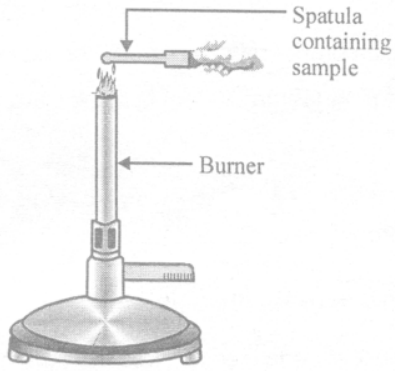
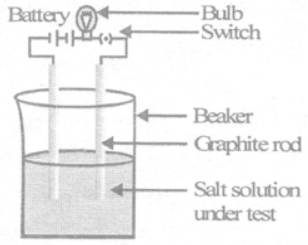


Figure
heating a salt sample on a spatula

3. **Aim :** To show that aqueous solution of ionic compounds conduct electricity.

Procedure: Dissolve a salt (NaCl) in water and make the experimental set up as shown in figure below:



Testing the conductivity of a salt solution

Observation: When the key is pressed it is observed that the bulb glows:

Result: This activity shows the current is passing through the circuit as well as through the aqueous solution.

Ionic compound	Melting Point (K)	Boiling Point (K)
NaCl	1074	1738
LiCl	878	> 1570

KBr	1007	1708
Kl	953	1600
$CaCl_2$	1055	1870
Cao	2845	3123
$MgCl_2$	987	1685

From the above observation the following general properties are present in the ionic compounds.

Physical state: Ionic compounds are solids and relatively hard because of the strong force of attraction between the positive and negative ions. This attraction of force is also known as strong electrostatic force of attraction. These compounds are generally brittle and break into pieces when pressure is applied.

Solubility: Electrovalent compounds are generally soluble in water and insoluble in solvents such as Kerosene, Petrol, etc.

Melting and boiling points: Ionic compounds have high melting and boiling points, due to the strong electrostatic force of attraction between the oppositely charged ions. Therefore, large amount of energy is needed to break these bonds.

CONDUCTION OF ELECTRICITY

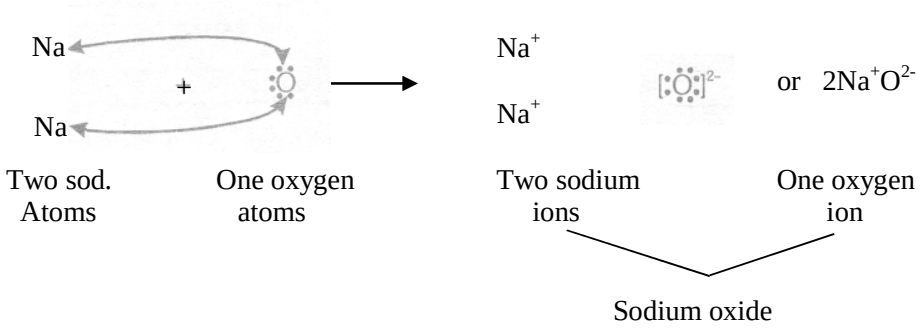
Ionic compounds in the solid state do not conduct electricity because movement of ions in the solid is not possible due to their rigid structure. But ionic compounds conduct electricity in molten state. In the molten state, the ions becomes free and therefore, conduct electricity due to mobility of ions.

QUESITONS:

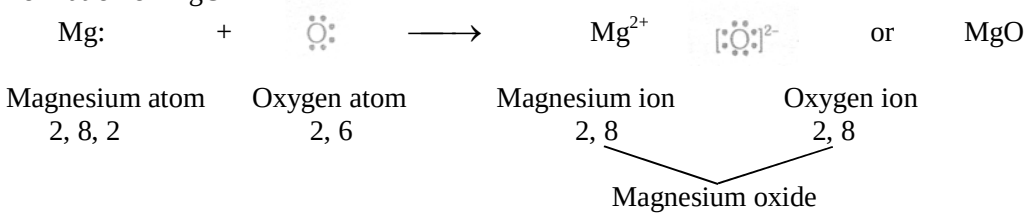
1. Write the electron-dot structure for sodium, oxygen and magnesium?

Ans. The electron dot structure of sodium is Na but to presence of 1 electron in its outermost shell of its atom. Oxygen atom has 6 electrons in its outermost shell. So, the electron structure of oxygen is O and magnesium atom has 2 electrons in its outermost shell so the electron-dot structure of Mg is Mg:

2. In the formation of Na_2O and MgO by the transfer of electron. Two sodium atoms transfer their 2 outermost electrons to oxygen atom. By losing 2 electrons, the two sodium form two sodium ions ($2Na^+$) and by gaining 2 electrons the oxygen atoms form O^{2-}



Formation of MgO



Q. What are the ions present in these compounds?

Ans. Ions of Na_2O compound are sodium ions ($2Na^+$) and oxide ions of MgO compound are Mg^{2+} and O^2

Q. Why do ionic compounds have high melting points?

Ans. The ionic compounds are made up of positive and negative ions which have the strong force of attraction between opposite charged ions. So a lot of heat energy is required to break this force of attraction or ionic bond due to this ionic compounds have high melting points.

OCCURRENCE OF METALS

The earth's crust is major source of metals. They are present in nature in the free state as well as in combined state. Aluminum is the most abundant metal in the earth's crust. The second most abundant metal is iron and third one is calcium.

NATIVE AND COMBINED STATES OF METALS

Metals occur in the crust of earth in two states: native state and combined state. A metals is said to occur native or free state when a metal is found in nature in the elementary or in combined form or metallic state. CO_2 of air or other non-metal. Copper and silver also found in the combined state as their sulphide or oxide ores.

Distinction between Metals and Non-metals			
	Properties	**Metals**	**Non-metals**
1	State	Metals are solids at ordinary temperature. Exception. Mercury is a liquid	Non-metals exist in all the three states, that is solid, liquid and gas.
2	Luster	They possess luster or shine.	They possess no luster. Exception: Iodine and graphite.
3	Malleability and Ductility	Metals are generally malleable and ductile.	Non-metal are neither malleable nor ductile.
4	Hardness	Metals are generally hard. Alkali metals are exceptions.	Non-metal possesses varying hardness. Diamond is an exception. It is graphite which is a good conductor of electricity.
5	Density	They have high densities.	They generally possess low densities.
6	Conductivity	Metals are good conductors of heat and electricity.	Non-metals are poor conductors of heat and electricity. the only exception is graphite which is a good conductor of electricity
7	Melting and boiling points	They usually have high melting and boiling points.	Their melting and boiling points are usually low. The only exceptions are boron carbon and silicon.
	Chemical properties		
1	Action with mineral acids	Metal are generally react with dilute mineral acids to liberate H_2 gas.	Non-metal do not displace hydrogen or reaction with dilute minerals acids.
2	Nature of oxides	They form basis oxides. For example, Na_2O, MgO, etc. These oxides are ionic in nature.	Non-metal form acidic or natural oxides. For example, SO_2, CO_2, P_2O_5, etc. are acidic whereas CO, N_2O etc. are neutral. Theses oxides are covalent in nature.
3	Combination with hydrogen	Metal generally do not combine with hydrogen. However, Li, Na, Ca, etc. form unstable hydrides. For example, LiH, NaH, CaH_2 etc. These hydrides are ionic in character.	Non-metal combine with hydrogen to from stable hydrides. For example, HCl, H_2S, CH_4, NH_3, PH_3, etc. 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-metal form halides which are unstable and undergo hydrolysis readily. For example PCl_5, PCl_3, etc.

5	Electrochemical behaviour	Metal are electropositive in character. They form cations in solution and are deposited on the cathode when electricity is passed through their solution.	Non-metals are electronegative in character. They form anions in solution and are liberated at the anode when their salt solutions are subjected to electrolysis. Hydrogen is an exception. It usually forms positive ions and is liberated at cathode.
6	Oxidising or reducing behaviour	Metal behave as reducing agents. This is because of their tendency to lose electrons. $Na \rightarrow Na^+ e^-$	Non-metal generally behave as oxidising agents since they have the tendency to gain electrons. $1/2\ Cl_2 + e^- \rightarrow Cl^-$

COMBINED STATE

A metal is said to occur in a combined state if is found in nature in the form of its compounds.

The very reactive metal which have a tendency to react with moisture, oxygen, sulphur, halogens etc. occur is the crust of the earth in the form of their compounds. Such as: oxides, sulphides, halides, carbonates, nitrates, phosphates etc.

For example: Sodium, Potassium, Calcium, Aluminium, magnesium etc. very reactive metals. All of these are laying at the top of activity series. These are never found in the Free State. The metals in the middle of the activity series such as zinc, iron, etc. are reactivity metals are found in the earth crust mainly as oxides, sulphide or carbonates. On the basis of reactivity metals are divided into the following three categories:-

K Na Ca Mg Al	Electrolysis
Zn Fe Pb Cu	Reducing using carbon
Ag Au	Found in native state

Fig. Activity Series and related metallurgy

MINERALS AND ORES

The natural substance (elements or compounds) in which metals are their compound occur either in native state ore combined state called minerals.

For example: Aluminium occur in the earth's crust in the form of will know mineral, bauxite (Al_2O_3, $2H_2O$) and clay ($Al_2O_3 . 2SiO_2 . 2H_2O$). At some places, minerals may contain a large percentage of metal where as other may contain only a small percentage of the metal. The mineral from which metal can be conveniently and profitably extracted, is called an ore. All ores are minerals but all the minerals are not ores.

For example: Copper occur in nature in the form of several mineral like copper pyrites, copper glance (Cu_2S) and cuprite (Cu_2O). But copper can be conveniently extracted from copper pyrites ($CuFeS_2$). Therefore, ore of copper is copper pyrites. Some common ores ore listed below.

Nature of ore	Metal		Composition
Oxide ores	Aluminium	Bauxite	Al_2o_3. $2H_2O$
	Copper	Cuprite	Cu_2O
	Iron	Magnetite	Fe_2O_4
Sulphide ores	Copper	Copper pyrites	$CuFe_2O_2$
		Copper glance	Cu_2S
	Zinc	Zinc blende	ZnS
	Lead	Galena	PbS
	Mercury	Cinnabar	HgS
Carbonate ores	Calcium	Limestone	$CaCO_3$
Halide Ores	Zinc	Calcimine	$ZnCO_3$
	Sodium	Rock salt	NaCl
	Magnesium	Carnallite	KCl $MgCl_2$. $6H_2O$
	Calcium	Fluorspar	CaF_2
	Silver	Horn silver	AgCl
Sulphate ores	Calcium	Gypsum	$CaSO_4$. $2H_2O$
	Magnesium	Epson salt	$MgSO_4$. $7H_2O$
	Barium	Barites	$BaSO_4$
	Lead	Anglesite	$PbSO_4$

Since, ores of many metals are oxides due to highly reactivity of oxygen and it is very abundant on the earth crust.

METALLURGY

EXTRACTION OF METALS

The process in which a pure metal is extracted from its ores is known as extraction of metals. The various processes involved in the extraction of metals from their ores and refining for use are known as metallurgy. Various steps involved in the extraction of metals or metallurgical process:

1. Crushing and grinding of the ore.
2. Concentration of the ore or enrichment of the ore.
3. Extraction of metal from the concentrated ore.
4. Refining or purification of the impure metal.

1. **Crushing and grinding of the ore:**

Most of the ores in nature occur as big rocks. They are broken into small pieces with the help of crushers. These pieces are than reduced to fine powder with the help of a ball mill or a stamp mill. This process is known as pulverization.

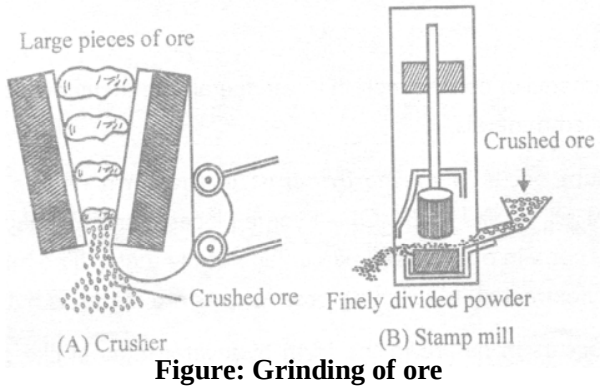


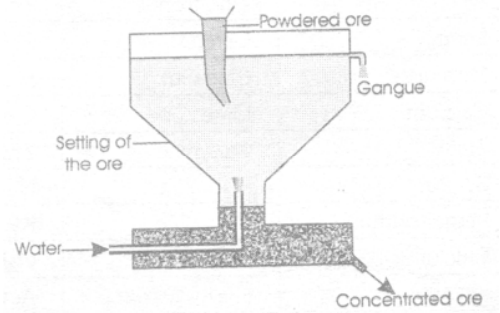
Figure: Grinding of ore

2. Enrichment of ore or concentration of ore.

The ores mined from the earth's crust contains a number of impurities, such as soil, sand etc. called gangue and matrix. The process of removal of impurities (gangue) from the ore is called enrichment of ore or concentration of ore. Enrichment of an ore is carried out by the following methods:

LEVIGATION

This method is based upon the difference in the densities of the ore particles and impurities (gangue). The powdered are is washed in a jet of water. The lighter, rocker and earthy impurities are washed away by water, while heavier ore particles ore left behind to settle down at the bottom. This process is also called hydraulic washing.



This method of concentration is usually applicable to oxides ore.

For example: Ores of iron, tin and lead are very heavy and therefore they are concentrated by this method.

FORTH FLOATION

This method is bases on the principle of difference in the wetting properties of the ore and gangue particles with water and oil. This method is commonly with water used for sulphide ores (such as copper zinc and lead). In this method, the finely powdered ore is mixed with water and a small amount of oil (pine oil or eucalyptus oil) tank. Air is blown into the mixture. The ore particle floats in the froth surface. So, this process is known a forth floatation process. The heavier impurities (gangue) settle to the bottom. The froth at the surface is transferred into another tank and some acid is added to break up the froth. The concentrated ore particles are separated by filtration and dried.

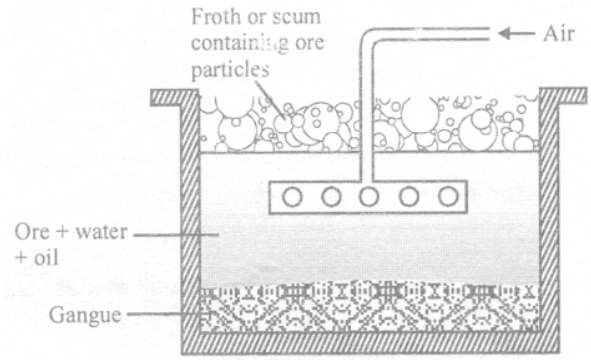
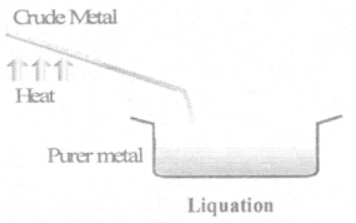


Figure : Froth floatation

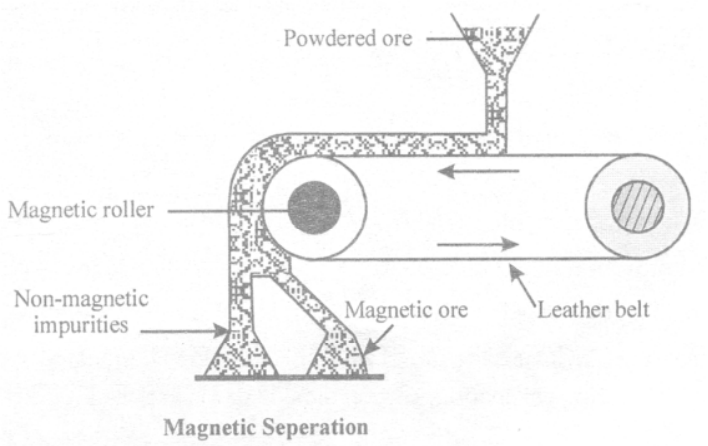
LIQUATION

This process is used to concentrated the ore whose melting point is lower than that of the impurities stibnite an ore of antimony, is concentrated by this method. The impure ore is heated. The ore melts and flows along the surface. The impurities are left behind.



MAGNETIC SEPARATION

This method depends upon the difference in the magnetic properties of the ores and gangue. The ores which are attracted by a magnet can be separated from the non-magnetic impurities with the help of magnetic separation method. It consists of a leather belt moving over two rollers.



The powdered ore is dropped over the moving belt at one end. At the other end, the magnetic impurities portion of the ore is attracted by the magnetic roller and nearer to roller while non-magnetic impurities fall further off.

For example: This method is used for concentration of iron ores (Haematite)

LEACHING OR CHEMICAL SEPARATION METHOD

It is based on the difference in some chemical property of the metal and the impurities. This method concentration is also known as leaching. In chemical method, the powdered ore is treated with a suitable solvent. The ore dissolve in it while the impurities are not soluble.

For example: Bauxite ore contains Fe_2O_3, SiO_2 etc. as impurities. Bayer's method is used to obtained pure aluminum oxide from bauxite ore. This process of chemical separation of aluminium by chemical method is known as Bayer's process. This method involved the following steps.

(i) The finely powered ore is treated with hot sodium hydroxide solution. Which react with Al_2O_3 present in bauxite ore to form sodium meta aluminium. (soluble in water).

$$\underset{\text{Aluminum oxide}}{Al_2O_3(s)} + 2NaOH(aq) \longrightarrow \underset{\text{Sodium meta aluminate}}{2NaAlO_2(aq)} + H_2O(l)$$

(From bauxite ore) (Soluble)

(ii) The filtrate (containing $NaAlO_2$ and sodium silicate (Na_2SiO_3)) is then stirred with small amount of freshly prepared $Al(OH)_3$.

The aluminum hydroxide ($Al(OH)_3$) is added to induce the precipitation of $Al(OH)_3$. It acts as seeding agent and helps in quick precipitation.

$$NaAlO_2(aq) + 2H_2O(l) \longrightarrow Al(OH)_3(s) + NaOH$$

Sodium meta aluminium — Aluminium hydroxide

(From bauxite ore) — (White ppt.)

(iii) The precipitate is separated by filtration. It is dried and heated to get pure aluminum oxide. Which is also known as alumina.

$$2Al(OH)_3 \xrightarrow{Heat} Al_2O_3(aq) + 3H_2O$$

Aluminium oxide — Aluminium oxide

Extraction of the metal from the concentrated ore or enriched ore. The metal is extracted from the concentrated ore the following steps:

(a) Conversion of the concentrated ore into its oxides.

The production of metal from the concentrated ore mainly involves reduction process. This can usually done by two process known as calcination and roasting process. The method depends upon the nature of ore. A carbonate ore is converted into oxide calcination while a sulphide ore is converted into oxide by roasting.

These two method are discussed briefly as below.

CALCIATION:

The process in which concentrated ore is heated in the absence of air is called calcination. This process is used for the following changes:

(i) To convert carbonate ores into metal oxide.

(ii) To remove water from the hydrated ores.

(iii) To remove volatile impurities from the ore.

For example: Calamine ($ZnCO_3$) is the ore of zinc which calcined i.e. heated strongly in the absence of air to convert into zinc oxide. During calcination, carbon dioxide gas is expelled.

$$ZnCO_3(s) \xrightarrow{Calcination} ZnO(s) + CO_2(g)$$

Zinc carbonate — Zinc oxide

(Calamine ore)

Similarly, in case carbonate ore of Fe, siderite ($FeCO_3$), and ore of calcium and magnesium is :

Dolomite ($CaCO_3$. $MgCO_3$)

Calcined converts into oxide

$$FeCO_3(s) \xrightarrow{Calcination} FeO(s) + CO_2(g) + 2CO_2$$

Siderite — iron (II) oxide

$$CaCO_3.MgCO_3 \xrightarrow{Calcination} CaO(s) + MgO(s) + 2CO_2(g)$$

(Dolomite) — Calcium oxide — Magnesium oxide

ROASTING

The process in which concentrated ore is heated strongly in the presence of excess air is called roasting. This process is used for converting sulphate ores to metal oxide. In this process, the following changes take place:

1. (i) The sulphide ores undergo oxidation to their oxides.

(ii) Moisture is used.

(iii) Volatile impurities are removed.

For example: (i) Zinc blende (ZnS) is the ore of zinc which heated strongly in the presence of excess of air to convert zinc oxide and sulphur dioxide gas is expelled.

$$2ZnS(s) + 3O_2 \xrightarrow{Roasting} 2ZnO(s) + 2SO_2(g)$$

Zinc sulphide (Zinc blende ore) — Zinc oxide

2. Iron pyrite (FeS_2) is converted into ferric oxide (Fe_2O_3) by roasting.

$$4FeS_2(s) + 11O_2 \longrightarrow 2Fe_2O_3(s) + 8SO_2(g)$$

Iron pyrites — (Ferric oxide)

3. Galena (PbS) is roasted to convert it directly into mercury.

$$PbS(s) + 3O_2 \longrightarrow 2PbO(s) + 2SO_2(g)$$

Lead oxide

4. Cinnabar (HgS) is roasted to convert it directly into mercury.

$$HgS(s) + O_2 \longrightarrow Hg + SO_2(g)$$

Mercury

Extraction of metal from metal oxide or conversion of metal oxide to metal.

The metal oxide formed after calcination or roasting is converted into metal by reduction. The method used for reduction of metal oxide depends upon the nature and chemical reactivity of metal.

The different metals are extracted by different techniques. The different steps are discussed below:

Extracting the metals low in the activity series-

The metals which are low in the activity series are very sulphide (Cu_2S) are by this method. This involves the following steps.

(i) The concentrated copper sulphide is roasted in air to from copper oxide.

$$2Cu_2S(s) + 3SO_2(g) \xrightarrow{Roasted} 2Cu_2O(s) + 2SO_2(g0$$

(ii) Copper oxide is again heated with Cu_2S to reduced copper and SO_2 gas is evolved.

$$2Cu_2O(s) + CuS(g0 \xrightarrow{Heat} 6Cu(s) + SO_2(g)$$

Similarly, when cinnabar ore (HgS) is heated in air it is first converted into mercuric oxide (HgO), which is then reduced to mercury on further heating.

$$HgS(s) + 3O_2(g) \xrightarrow{Roasting} HgO(s) + SO_2(g)$$

$$HgO(s) \xrightarrow{Heat} 2Hg(l) + O_2(g)$$

Extracting metals in the middle of the activity series:

The metals in the middle of the activity series such as iron, zinc, lead etc. are moderately reactive. There are usually present as sulphides or carbonates and which are must be converted to oxides by roasting or calcination. The oxides of these metals cannot be reduced by heating alone. Therefore metal oxides are reduced to free metal by using suitable reducing agents such as carbon, carbon monoxide, aluminium, sodium or calcium. This is known as smelting.

When zinc oxide is heated with carbon, zinc metal is produced

$$ZnO(s) + C(s) \longrightarrow Zn(s) + CO(g)$$

Carbon (Reducing agent) — Zinc metal — Carbon monoxide

Similarly, Iron and lead are obtained from their oxides by heating with carbon.

$$Fe_2O_3(s) + 3C(s) \xrightarrow{Heat} 2Fe(s) + 3CO(g)$$

$$PbO(s) + C(s) \xrightarrow{Heat} Pb(s) + CO(g)$$

Reduction with CO

Iron is obtained from ferric oxide by heating with CO.

$$Fe_2O_3 + 3CO(g) \xrightarrow{Heat} 2Fe(s) + 3CO_2(g)$$

Reduction with Aluminium

Certain metal oxides are reduced by aluminium to metals. This method is known as aluminothermy or thermite process.

For example: Chromium, manganese, tritium, vanadium metal is obtained by the reduction of their oxides with Al powder. The following reaction takes place.

$$3MnO_2(g) + 4Al(s) \xrightarrow{Heat} 3Mn(s) + 2Al_2O_3(s)$$

$$Cr_2O_3(g) + 2Al(s) \xrightarrow{Heat} 2Cr(s) + Al_2O_3(g)$$

These displacement reactions are highly exothermic, so, the large amount of heat is evolved and metals are produced in the molten state. In fact the reaction of iron(III) oxide (Fe_2O_3) with aluminum. The mixture of iron oxide and aluminium powder is called thermite is used to railway tracks or cracked machine parts. This reaction is known as thermite reaction.

$$Fe_2O_3(g) + 2Al(s) \xrightarrow{Heat} 2Fe(l) + Al_2O_3(s) + Heat$$

Note: Al is metals expensive metal and so, it is not used to reduce metals are less expensive than aluminium.

Extracting metals towards the top of the activity series: Electrolytic are les expansive than aluminium. The reactive metals (which are high up in the activity series) cannot produced or reduction by electrolysis. They are obtained by electrolytic reduction of their molten oxides or chlorides. During electrolysis, the cathode supplies electrons to metal ions for their reduction to the metal. The process of metals by electrolysis process is called electro metallurgy.

For example:

(i) Aluminium oxide (Al_2O_3) is reduced to aluminium by the electrolysis of molten aluminium oxide.

$Al_2O_3 \longrightarrow 2Al^{3+} + 3O^{2-}$

The aluminium ions present in aluminium oxide go to the cathode and are reduced there to aluminium atoms.

$Al^{3+} + 3e \longrightarrow Al$

(ii) Sodium metal is obtained by the electrolysis of molten sodium chloride.

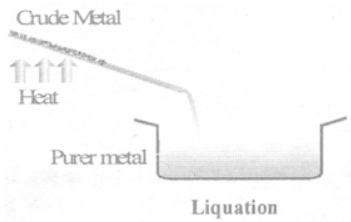
$$2NaCl \xrightarrow{Fused} 2Na^+ + 2Cl^-$$
$$2Cl^- \longrightarrow Cl_2 + 2e \text{ (at anode)}$$
$$2Na^+ + 2e \longrightarrow 2Na \text{ (at cathode)}$$
$$2NaCl \xrightarrow{Electrolysis} 2Na + Cl_2$$

PURIFICATION OR REFINING OF METALS

The metal obtained by any of the above methods is impure and is known as crude metal. The process of purifying the crude metal is called refining. The method of refining depends upon the nature of the metal and the impurities which are present in the metal. Some of the methods generally applied for refining metals are discussed below.

LIQUATION

This process is used for refining the metals having low melting points. Such as tin, lead, bismuth. etc. this is based on the principle that the metal to be refined is easily fusible (melt easily) but the impurities do not fuse easily. In this process, the impure metal is placed on the sloping hearth of the furnace and is gently heated. The hearth is maintained at a temperature slightly above the melting point of the metal. The metal melts and flows down to the bottom of sloping hearth and the impurities are left behind. The pure metal is collected to the bottom of the sloping hearth.



Distillation:

This method is used for the purification of volatile metals (which form vapours readily). Such as mercury and zinc. In this method the impure metal is heated strongly in a vessel (called retort). The pure metal distils over and its vapours are condensed separately in a receiver to get pure metal. The non- volatile impurities are left behind in the retort.

Oxidation method (Oxidative refining):

This method is used for the refining of metal in those cases in the impurities have greater tendency to get oxidised than metal itself.

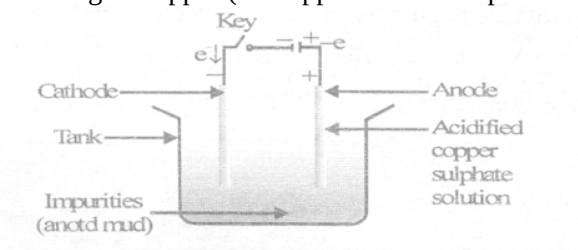
For example: Impure iron (Pig or cast iron) is refined oxidative refining method. Pig iron contains carbon, sulphur, phosphorous, silicon and manganese as impurities. When a blast of air is blown over molten pig iron these impurities are oxidised to their oxides (CO_2, SO_2, P_2O_5 etc.) and get removed. The pure iron is left behind.

Similarly, Silver is refined by this method.

Electrolytic refining:

This is the most widely method for the refining of impure metals. Many metals such as copper, zinc, tin, nickel, silver, gold etc. are refined electrolytically. It is based upon the phenomenon of electrolysis, in this process, the impure metal is made of the anode and a thin strip of pure metal is made of the cathode. A solution of the metal salt is used as an electrolyte. On passing the electric current through the electrolyte. The pure metal from the anode dissolved into electrolyte. An equivalent amount of pure metal gets deposited on the cathode. The soluble impurities go into the solution, whereas, the impurities settle down at the bottom of the anode and are known as anode mud.

For example: In the electrolytic refining of copper (The apparatus is set up as shown in figure as below) crude copper is



Electrolytic refining of copper. The electrolyte is a solution of acidified copper sulphate. The anode is impure copper, whereas the cathode is a strip of pure copper. On passing electric current, pure copper is deposited on the cathode.

Made the anode, a thin sheet of pure copper is made the cathode. The electrolyte is a solution of copper sulphate containing a small amount of dilute H_2SO_4 acid. On passing the electric current copper dissolve from the anode into the electrolyte. An equivalent amount of copper is deposited at the cathode in the from pure at metal. The following reactions occurs at the electrodes.

At anode:

$$Cu - 2e^- \xrightarrow{Oxidation} Cu^{2+}$$

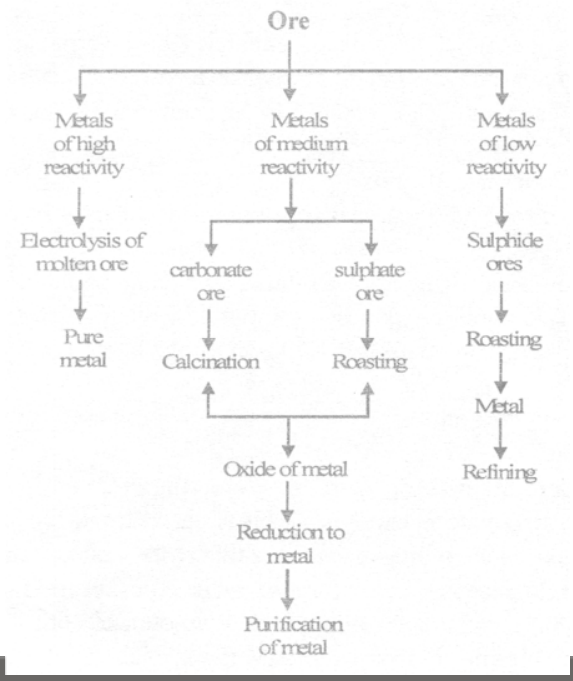
Copper (from impure anode) → Copper ion (goes into solution)

At cathode:

$$Cu^{2+} + 2e^- \xrightarrow{Oxidation} Cu$$

Pure cooper

The summary of flow sheet of different steps involved for the three types of extraction of metals is given below:



QUESTION:

1. Define the following terms:

(i) Mineral

(ii) Ore

(iii) Gangue

Ans. (i) Mineral natural substance in which metals or their compounds occur either in native state or combined state are called minerals.

(ii) The mineral from which metal can be conveniently and profitably extracted is called ore. All ores are minerals but all the minerals are not ores.

Example: (i) Copper pyrites ($CuFeS_2$) (ii) Bauxite (Al_2O_3. $2H_2O$)

(iii) The impurities which are removal from the ore before extracting of the metal is called gangue.

2. Name two metals which are found in nature in free state.

Ans. Gold and platinum.

3. What chemical process is used for obtaining a metal from its oxide?

Ans. Reduction process is used for obtaining a metal from its oxide.

CORROSION METALS

Slow destruction of metals due to chemical reactions on their surface by oxygen, carbon dioxide, moisture, sulphur dioxide, hydrogen sulphide etc. of the atmosphere, is known as corrosion of metals. In corrosion, the metal atoms give up electrons and are converted into ions, which

$M \longrightarrow M + e$

Move from one part of the metal to another more easily in the presence of moisture (because moisture provides the medium through which ions flow easily).

Almost all metals (except noble metals such as gold, platinum and palladium) get corroded.

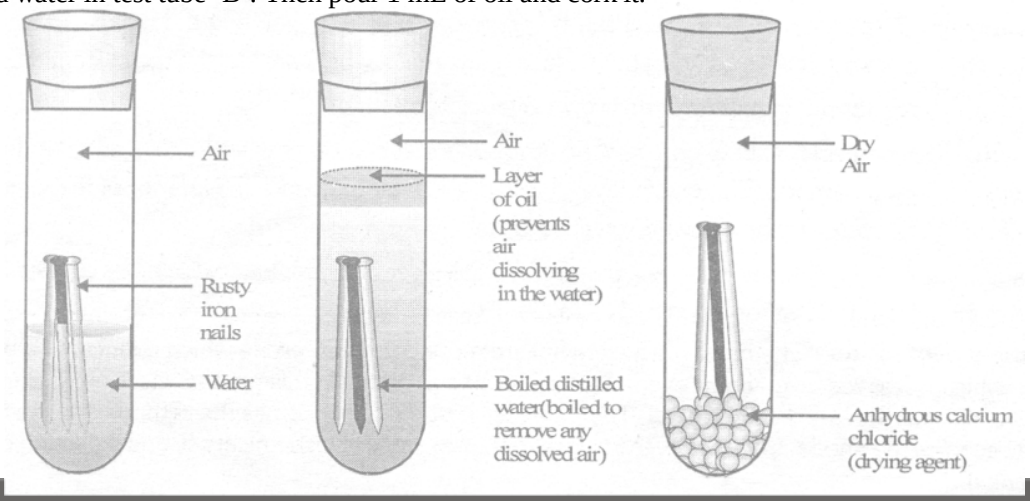
Conduction for rusting:

(i) Presence of oxygen or air

(ii) Presence of water or moisture.

Activity: 1.12: To show that rusting of ions requires both air and water.

Experiment: Take their test tubes and put one clean nail in each of their test tubes. Label these test tubes A, B and C Pour some water in test tube so that about 2/3 of the nail is immersed in water and cork the test tube. Pour some boiling distilled water in test tube 'B'. Then pour 1 mL of oil and cork it.



Put some anhydrous $CaCl_2$ in test tube 'c' and cork it. Now, have these test tubes for a few days and then observe.

Observation:

(i) The nail in test tube 'A' will rest due to nail is exposed to both air and moisture.

(ii) The nail in test tubes 'B' and 'C' are does not rust. Because test tube 'B' contain boiling distilled water and oil which prevents air dissolving in the water.

(iii) In test tube C, the anhydrous $CaCl_2$ is drying agent which absorbed any moisture air.

Conclusion: This activity clearly shows that both air and water must be necessary for rusting.

The process of rusting is continuous.

Thus, Strength of ions decreases gradually and finally the metal is damage to buildings, bridges, ships and may other articles especially which are made of ions.

Prevention of rusting : The rusting of iron can be prevented by the following methods:

(i) Iron is protected from rusting by coating it with a thin layer of another metal which is more reactive that iron. Zinc is commonly used for covering iron surfaces. The process of covering iron with zinc is called galvanization.

(ii) The iron pipes which are in contact with water such as ground water pipes are protected from rusting by connecting these with more reactive metals like Mg or Zn.

(iii) To decrease rusting of iron, certain antirust solution are used.

For example:

(i) When iron is exposed to moisture for a long time, its surface acquires a brown flaky substance called rust and the process is known as rusting. Rust is a mixture of Fe_2O_3 and $Fe(OH)_3$.

(ii) Copper reacts with CO_2 in the air and slowly loses its shiny brown surface and acquires a green coating of basis copper carbonate in moist air.

(iii) Silver articles becomes black after sometime when exposed to air. (Due to react with sulphate in the air to from a black coating of silver sulphide)

(iv) Lead or stainless steel lose their lustre due to corrosion.

Factors determining the rate of corrosion:

The process of corrosion is speeded up in the following circumstances.

(i) The corrosion of a more electropositive metal is speeded up when it is in contact with a less electropositive metal.

(ii) The process of corrosion is speeded up in presence of polluting materials in air (such as CO_2, SO_2, H_2S etc.)

Prevention of corrosion:

(i) **By painting:** The corrosion of a metal can be prevented simply by painting the metal surface by grease or varnish that forms a protective layer on the surface of the metal which protect the metal from moisture and air.

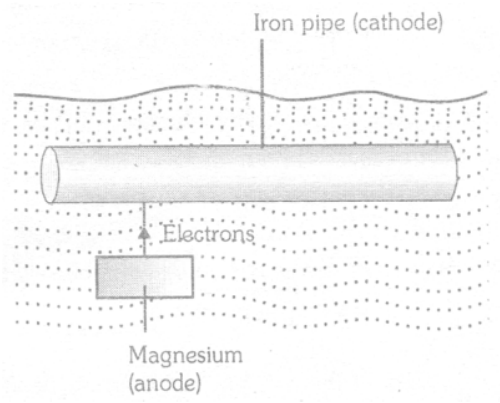
(ii) **Self prevention:** Some metals form their own layer of protection.

For example: When zinc is left exposed to the atmosphere, it combines with the oxygen of air to from a layer of zinc oxide over its surface. The oxides layer does not allow air to go into interior of the metal. Thus, Zinc is protected from corrosion by its own protective layer.

Similarly, aluminium combines with oxygen to from a dull layer of aluminium oxide on its surface which protect the aluminium from further corrosion and aluminium loses its very soon.

(ii) **Cathodic protection:** The more reactive metal are more corrosion-prone which connect to a bar of another metal (which is less reactive) that is even more prone to corrosion. In this process electron flow from the more metal becomes the anodes. In this way, the two metals from an electrochemical cell and oxidation of the metal is prevented.

For example: The pipelines (iron) under the surface of the earth are protected from corrosion by connecting them to a more reactive metal (Magnesium or Zn) which buried in the earth and connected to the pipelines by a wire.



(iv) **By alloying:** It is a very good method of improving the properties of a metal.

For example: 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 (about 0.05%) it becomes hard and strong. When iron is mixed with nickel and chromium to from stainless steel which is hard and does not rust, i.e. properties of its changes. In fact, the properties of any metal can be changed, if it is mixed with some other substances.

An alloy is a homogeneous mixture of two more metals. It can be prepared by first melting the metal and then dissolving the properties of the constituent metals (from which it made).

If have the following characteristics properties:

(i) Alloys are strong than the metals from which they are made.
(ii) They are harder than constituent metals.
(iii) They are more resistant to corrosions.
(iv) They have lower melting points than the constituent metals.
(v) They have lower electrical conductivity than pure metals.

Some of the common alloys are:

(i) **Duralumin:** It is an alloy of aluminium. It contains 95% of aluminium, 4% of copper, magnesium is 0.5% and 0.5% of manganese. It is stronger and lighter than aluminium. Duralumin is used for making bodies of air crafts, helicopters. Jets, Kitchen ware like pressure cooker. It is also used for making bodies of ships (due to it resistant to sea water corrosion). It is also known as Duralumin.

(ii) **Amalgam:** It is an alloy of mercury and one or more other metals is known as amalgam. It may be solid or liquid. A solution of sodium metal in liquid mercury metal is called sodium amalgam. Which is used for reducing agent. Amalgam of silver, tin and zinc is used by dentists for filling in teeth.

(iii) **Brass:** Brass is an alloy of copper (Cu) and Zn. It contains 80% copper and 20% zinc. It is more malleable and more strong than pure copper. Brass is used for making cooking utensils, condenser sheets, pipe, screws, bolts, wire, scientific instruments, ornaments etc.

(iv) **Bronze:** It is also the alloy of copper. It contain 90% of copper and 10% tin. It is highly resistant to corrosion and use for making utensils, statues, cooking pipes, coins, hardware etc.

(v) **Solder:** It is an alloy of lead (50%) and tin (50%). It is used for soldering (or welding) electrical wires together.

(vi) **Alloys of Gold:** The purity of gold is expressed is terms of 'carats'. Pure gold is known as 24 carats gold. It is very soft due to which it is not suitable for making jewellery. It is alloyed with either silver or copper to make it hard and it more suitable for making ornaments. In India, gold ornaments are usually made of 22 carats gold. It is an alloy of gold with silver or copper.

THE WONDER OF ANCIENT INDIAN METALLURGY

The iron pillar wrought iron which is a low near the Qutab Minar in Delhi was made around 400 BC by the iron workers of India. They had developed a process which prevented the wrought iron pillar from rusting even after thousands of years. This is likely because of formation of a thin film of magnetic oxide (Fe_3O_4) on the surface as a result of finishing treatment given to the pillar, painting it with a mixture of different salts then heating and quenching (rapid cooling). The iron pillar is 8 meters high and 6000 kg (6 tones) in weight. Which till us that ancient Indians had good knowledge of metals and their alloys carbon steel.

QUSTIONS:

1. Metallic oxides of zinc, magnesium and copper were heated with the following metals.

Metal	Zinc	Magnesium	Copper

Ans. We know that a more reactive metal can displace a less reactive metal from its oxides. In Zinc, Mg and Cu, Mg is the most reactive, Zn is less reactive, whereas Cu is the least reactive metal, we will find that the displacement reactions will takes place in the following cases: Zinc oxide, magnesium oxides, Copper oxide

2. Which metal do not corrode easily?

Ans. Gold, Silver, Copper and platinum.

3. What are alloys?

Ans. Alloys are the homogeneous mixture of two more metals or small amount of non-metals.

For example: Brass is an alloy of copper (80%) and Zn (20%).

4. What are amphoteric oxides? Give two example of amphoteric oxides.

Ans. Those metal oxides which show basic as well as acidic behaviour are known as amphoteric oxides.

For example: (i) Al_2O_3 (Aluminium oxide) & (ii) ZnO (Zinc oxide)

5. Name two metals which will displace hydrogen from dilute acids, and two metals which will not.

Ans. Na, K and Ag, Au or Cu

6. You are given a hammer, a battery, a bulb, wire and a switch.

(i) How could you use to distinguish between samples of metals and non-metals?

(ii) Assess the usefulness of these test in distinguishing between metals and non-metals.

Ans. (i) We can use a hammer to beaten the sample of metals and non-metals. After beating metal changes into thin sheet (due to malleable) and at the time of strike sound is also produced (due to sonorous). But non-metals are broken into small pieces due to brittle nature and do not produces sound.

(ii) A battery, a bulb, wires and a switch is used to set up a electrical circuit and tested the samples of metals and non-metal in this circuit. We find that metals are good conductor of electricity and non-metals are bad conductor of electricity. Usefulness of these tests are

(i) Due to these properties, metals are used to make wires to carry current but non-metals do not make wires due to brittleness.

(ii) Metals are used to make house hold utensils and factory equipment but non-metals are do not use.

PREVIOUS YEARS QUESTIONS

1. Greenish layer appears on the copper utensils if they are not cleaned for a few days. Assign reason.

(C.B.S.E. All India 1995)

Ans. Copper metal slowly reacts with water, carbon dioxide and oxygen present in air to form a layer of basic copper carbonate which is greenish in colour. This layer gets deposited on the surface of the metal.

$$2Cu + \underbrace{H_2O + CO_2 + O_2}_{\text{(Present in air)}} \longrightarrow Cu(OH)_2\ CuCO_3$$

2. An iron knife kept in blue copper sulphate solution turns the blue solution into light green. Explain.

(C.B.S.E. Delhi 1997)

Ans. Iron lies above copper in the activity series. This means that iron or iron knife will displace copper from copper sulphate solution. As a result of the reaction, ferrous sulphate will be formed and the solution will be light green in colour.

$$\underset{\text{Iron}}{Fe(s)} + \underset{\text{Copper sulphate (blue)}}{CuSO_4\ (aq)} \longrightarrow \underset{\text{Ferrous sulphate (light green)}}{FeSO_4\ (aq)} + \underset{\text{Copper}}{Cu(s)}$$

3. In nature, aluminium is found in the form of compounds while gold is found in free state. Give reason

(C.B.S.E. Foregin 2000)

Ans. This is because of the relative positions of the metals in the activity series. Aluminum is a reactive metal as it is placed above hydrogen in the activity series. Therefore, it forms compounds. Gold is placed much. Below hydrogen in the series. It is very little reactivity and occurs in the free state also called native state. Below hydrogen in the series. It is very little reactivity and occurs in the free state also called native state.

4. Why is titanium called a strategic metal? Mention two of its properties which make it so special.

(C.B.S.E. All India 2000 compt.)

Ans. Titanium is called strategic metal because it is used for making certain war equipments. The properties which make the metal so special are:

(i) It is light in weight but at the same time stronger than the other metals.

(ii) It is not affected by corrosion even if kept in the open for very long time.

5. An athlete won a bronze medal in a race competition. After some days, he found that the medal had lost its luster due to the formation of a greenish layer on it. Name the metals present in the medal. What is the reason for the appearance of a greenish layer. This layer is of basic copper carbonate.

(C.B.S.E. All India 2002 Compt.)

Ans. The bronze medal is an alloy and the constituting metals are copper and tin. The loss of luster by the medal is due to the formation of a coating of green layer. This layer is of basic copper carbonate.

6. A copper plate was dipped into a solution of $AgNO_3$. After sometime, a black layer was deposited on the copper plate. State the reason for it. Write the chemical equation for the reaction involved.

(C.B.S.E. Delhi 2002 Compt.)

Ans. Copper lies above silver in the activity series. This means that copper is more reactivity that silver. Therefore. Copper had replace silver from $AgNO_3$ solution.

$$Cu(s) + 2AgNO_3\,(aq) \longrightarrow Cu(NO_3)_2\,(aq) + \underset{\text{(Black)}}{2Ag(s)}$$

Silver got deposited on the copper plate and changed to black after sometime because silver and also some salts of silver are sensitive to light. They readily become blackish on standing or on exposure to air.

7. Name with example three common forms in which? Occur in nature. How do the metals interact with dilute acids?

(C.B.S.E. Delhi 2002)

Ans. Three common forms in which metals occur in nature are:

Sulphate form	:	Copper pyrite ($CuFeS_2$)
Oxide form	:	Bauxite ($Al_2O_3.\ 2H_2O$)
Carbonate form	:	Calamine ($ZnCO_3$)

Activity metals (which lie above hydrogen in the activity series) generally interact with dilute HCl or dilute H_2SO_4 evolve hydrogen gas. For example,

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(G)$$

The metals which lie below hydrogen in the activity series do not interact with dilute acids.

8. Write one point of difference between electrolytic reduction and with carbon. Give one example of

(C.B.S.E. All India 20002 compt.)

Ans. The electrolytic reduction takes place at the cathode by the gain of electrons in electrolysis. At the sometime, carbon reduction is carried by heating a metal oxide with coke. For example.

$$NaCl\ (molten) \xrightarrow{(Electroloysis)} Na^+ + Cl^-$$

$$Na^+ + e^- \quad Na \qquad \text{(Reduction by the gain of electrons)}$$

$$ZnO + \underset{\text{(Cooke)}}{C} \xrightarrow{Heat} Zn + CO \quad \text{(Reduction by carbon)}$$

9. Arrange the following metals in decreasing order of their reactivity:

(i) Cu, Ca, Mg, Na, Zn.

(ii) Which metal listed in (i) is most likely to occur in the native state ?

(C.B.S.E. Sample Paper 2003)

Ans. (i) Based on the activity series, the decreasing order of reactivity of metals is:

Na > Ca > Mg > Zn > Cu

(ii) Copper is most likely to occur in the native (or free) state to a very small event.

10. Define an alloy and an amalgam. State the main constituents of the following alloys: stainless steel Bronze. In which properties is each of them different from its main constituents?

(C.B.S.E. All India 2004)

Ans. An alloy is a homogenous mixture of two or more metal/non-metals. An alloy in which mercury is one of the constituents is called amalgam.

Stainless steel: An alloy of iron, chromium, nickel, and carbon. It does not get rusted whereas iron is easily rusted.

Bronze: An alloy of copper, and tin. It is less malleable than copper and is used for making coins, statues etc.

11. On the placing a piece of zinc metal in a solution of mercuric chloride, it acquires a silver surface but when it is placed in a solution of magnesium sulphate, on change is observed. State the reason for the behaviour of zinc metal. **(C.B.S.E. Delhi 2004)**

Ans. Zinc lies above mercury in the activity series and can easily replace it from mercuric chloride solution. Mercury formed in the reaction gets deposited on the surface of zinc to give it a silvery look

$Zn(s) + HgCl_2(aq) \rightarrow ZnCl_2(aq) + Hg(s)$

But zinc is placed below magnesium in the activity series. Therefore, no chemical reaction occurs between zinc and magnesium sulphate solution,

12. Which method of concentration of ore is preferred in the following cases and why?

(i) The ore has higher density particles mixed with a large bulk of low density impurities

(ii) The ore consists of copper sulphate intermixed with clay particles.

Give an example of amalgam. **(C.B.S.E. Foreign 2004)**

Ans. (i) The concentration of ore can be done by gravity separation method.

(ii) The concentration of ore is done by forth flotation process.

An amalgam of mercury with silver or gold called dental alloy is used to fill cavities in the teeth.

13. Name an ore of zinc other than zinc oxide. But which process can this ore be converted into zinc oxide?

(C.B.S.E. Delhi 2004 Compt.)

Ans. The ore of zinc other than zinc oxide (zincite) is zinc carbonate (calmine). It has the formula $ZnCO_3$. Calamine is converted into zinc oxide by calcination i.e. by heating strongly in the absence of air.

$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$

14. Give reasons for the following:

(i) Metals replace hydrogen from dilute acids whereas non-metals of not.

(ii) Carbonate and sulphate ores are usually converted into oxides.

Ans. (i) Metals are electropositive in nature. Their atoms readily lose electrons to from positive ions. The electrons are accepted by H^+ ions of the acid to evolved hydrogen gas. For example,

$$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^- \rightarrow H_2(g)$$

Non-metals are electronegative in nature. This means that their atoms can take up electrons and cannot lose them. Therefore they do not evolved hydrogen on reacting with dilute acids.

(ii) Carbonate and sulphide ores are usually converted into oxides because it is easier to reduce metal oxide to metallic state than metal sulphide and metal carbonate. A number of method are available for this purpose.

15. Give reasons of the following: **(C.B.S.E. Delhi 2004)**

For making gold ornaments, 22-carat gold is generally preferred to 24-carat gold

Ans. 24-carat gold is quite pure and is very soft. As such, it cannot br used for making gold ornaments 22- carat gold is an alloy of gold containing a small amount of copper or silver. It is hard and more ductile as compared to pure gold. The ornaments are generally made from 22-carat gold.

16. (a) Why is ZnO called an amphoteric oxide? Name another amphoteric oxide.

(b) What are alkalies? Give one example of alkalies. **(C.B.S.E. Delhi 2005)**

Ans. (a) Zinc oxide (ZnO) is called amphoteric oxide as it behaves both as acidic oxide and basic oxide

$$\underset{\text{(Basic oxide)}}{ZnO} + \underset{\text{(Acid)}}{2HCl} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2} + H_2O$$

$$\underset{\text{(Acidic oxide)}}{ZnO} + \underset{\text{(Base)}}{2NaOH} \longrightarrow \underset{\text{Sod zincates}}{Na_2ZnO_2} + H_2O$$

Aluminium oxide (Al_2O_3) is another amphoteric oxide.

(b) Water soluble hydroxide of metals are known as alkalies. For example, NaOH.

17. (a) What would you observe when you put

(i) some zinc pieces into blue copper sulphate solution?

(ii) some copper pieces in green ferrous sulphate solution?

(b) Name a metal which combines with hydrogen gas. Name the compound formed.

(C.B.S.E. All India 2005)

Ans. (a) (i) Blue colour of copper sulphate solution will slowly disappear.

(ii) No change will be noticed. For details, consult text-part.

(b) Sodium combines with hydrogen to from sodium hydride.

$$2Na + H_2 \longrightarrow \underset{\text{Sod, hydride}}{2NaH}$$

18. (a) Are all pure liquids bad conductors of electricity?

(b) Name a liquids which is a good conductor of electricity but does not undergo electrolysis on passing electric current .

(c) If pure water is used, no electrolysis takes place. Why ?

(d) Name one practical application based on the phenomenon of electrolysis. **(C.B.S.E. All India 2007)**

Ans. (a) No, there are exceptions also. Mercury in pure state a good conductor of electricity.

(b) Mercury is a good conductor of electricity but does not undergo electrolysis.

(c) Pure water (H_2O) does not dissociate into on passing electric current.

(d) The process of electroplating on the surface of metals is based on the phenomenon of electrolysis

19. From amongst the metals sodium calcium, aluminium, copper and magnesium name the metal:

(i) which reacts with water only upon boiling?

(ii) which does not react even steam? **(C.B.S.E. Delhi 2008)**

Ans. (i) Aluminium metal reacts with water only upon boiling.

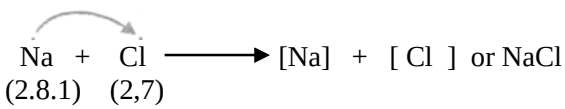
(ii) Copper does not react even with steam.

20. (i) Show the formation of NaCl from sodium and chloride atoms by the transfer of electron(s).

(ii) Why has sodium chloride a high melting point?

(iii) Name the cathode and anode in the electro refining of copper. **(C.B.S.E. Delhi 2008)**

Ans. (i) Formation of NaCl by electron transfer.



(ii) Sodium chloride is a crystalline solid. In it, a large number of Na^+ and Cl^- ions are closely packed in space. These are attracted towards one another by strong electrostatic force of attraction. Therefore, sodium chloride has a very high melting point(1074K).

(iii) In the electro fining of copper, a plate or rod of impure metal acts as the anode. At the same time, a plate or rod of pure metal acts as the cathode.

21. Hydrogen gas is evolved by reacting a pieces of magnesium ribbon with water:

(i) Describe how you could show that the gas collected is hydrogen.

(ii) Write a symbol equation for the reaction taking place between magnesium and water.

(iii) Suggest how the appearance of magnesium would change after a week.

(iv) A few drops of universal indicator solution were added to water in the beaker. What colour would you expect to see and what pH would this colour indicate? **(C.B.S.E. Delhi 2008)**

Ans. (i) If we bring a lighted splint near the gas, it will burn very brightly, accompanied by explosion along with a 'pop sound'. This shows that the gas evolved is hydrogen.

(ii) The symbol equation for the reaction is $Mg + 2H_2O$ $Mg(OH)_2$

(iii) After a weeks' time, magnesium will lose all its shine and a deposit of magnesium hydrogen will be formed on the surface of the seven.

(iv) The indicator will acquire blue colour indication that the solution is basic. The pH of the solution is expected to be more than seven.

22. (a) Why are ionic compound usually hard?

(b) How is that ionic compound in the solid state do not conduct electricity and they do so in the molten state?

(C.B.S.E. Delhi 2008)

Ans. (a) Ionic compounds are very closely packed in space. As a result, the vacant spaces or sites are quite less and the attractive forces among the ions are very strong. They are therefore, generally hard.

(b) The conductivity of ionic compound is due is movement or mobility of the ions that are present. For example, the electrical conductivity of sodium chloride ($Na^+ Cl^-$) is because of the mobility of the ions present. Since the ions can move only in the molten state and not in the solid state, these compounds are conducting only in the molten state.

23. (a) Name a solvent in which ionic compounds are generally soluble.

(b) Why are aqueous solutions of ionic compounds able to conduct electricity? **(C.B.S.E Delhi 2008)**

Ans. (a) Ionic compounds are generally soluble in water which is of polar nature.

(b) Ionic compounds conduct electricity due to the movement of ions that are released in aqueous solution

For example, sodium chloride (NaCl) is conducting due to the movement of Na^+ and Cl^- ions that the released in solution.

24. Give reasons for the following; **(C.B.S.E. All India 2008)**

(i) Zinc can displace copper from copper sulphate solution.

(ii) Silver articles become black after sometime when exposed to air.

(iii) A metal sulphide is converted to its oxide to extract the metal from sulphide ore.

Ans. (i) Zinc is place above copper in the activity series. Therefore, it can easily displace from copper sulphate solution.

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

(ii) Air contains traces of hydrogen sulphide (H_2S) gas. Silver has a tendency to combine with H_2S to from silver sulphide (Ag_2S) which is black in colour. On account of this, silver articles become black after some when kept exposed to air.

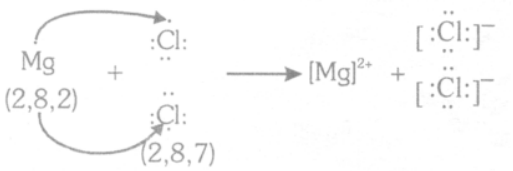
(iii) A metal suphide is normally converted into oxide by heating with excess of air or oxygen. This process is called roasting. Actually, the oxide of metal which is formed can be easily reduced to the metallic form by reduction with carbon or some electropositive element. For example.

$$2ZnS + 3O_2 \xrightarrow{heat} 2ZnO + 2SO_2$$

$$ZnO + C \xrightarrow{heat} Zn + CO$$

25. Show the formation of magnesium chloride form it elements. **(C.B.S.E. All India 2008)**

Ans.



26. What is meant by refining of metals? Describe the electrolytic refining of copper with the help of a neat diagram?

(C.B.S.E. Delhi 2009)

Ans. The process of conversion of a crude metal into pure metal is known as refining of metals. For the electrolytic refining of copper, consult text part.

27. An ore on heating in air produces sulphate dioxide. Which process would you suggest for its concentration? Describe briefly any two steps involved in the conversion of the concentrated ore into related metal.

(C.B.S.E. Delhi 2009)

Ans. Since the ore upon heating in air produces sulphur dioxide, it is a sulphate ore. In general, sulphide ores of metals are concentrated by froth Floatation process. For details, consult text part.

Conversion of concentrated ore into related metal. The steps which are actually employed for the conversion of the concentrated ore into metal depends upon the nature of the ore. However, two common steps that are used in many ores are: Calcination/ roasting and reduction. For details, consult text part.

28. A student has been collecting silver coins and copper coins. One day she observed a black coating on silver coins and a green coating on copper coins. Which chemical phenomenon is responsible for these coatings? Write the chemical names of black and green coating?

Ans. The phenomenon is known as corrosion. Air contains traces of hydrogen sulphide gas which reacts with silver metal present in the coin to from silver sulphide. Fi is black in colour.

$$2Ag + H_2S \longrightarrow \underset{\text{Silver sulphide (Black)}}{Ag_2S} + H_2$$

Similarly, copper present in the coin reacts with oxygen and traces of both carbon dioxide and water vapours present in air to form a green mass. It is chemically basic copper carbonate:

$$2Cu + \underbrace{H_2O + CO_2}_{\text{(Present in air)}} + O_2 \longrightarrow \underset{\text{Basic copper carbonate (Green)}}{Cu(OH)_2.\ CuCO_3}$$

29. Alloys are used electrically heating devise rather than pure metals. Give one reason.

Ans. Alloys are used generally the combination of two or more metals. Since metals are good conductors of electricity a combination of metals i.e., alloy is expected to be a better conductor of electricity than the pure metal.

30. State which of the following chemical reactions will take place or not, giving suitable reason for each

(i) $Zn(s) + CuSo_4(aq) \longrightarrow ZnSO_4(aq) + Cu(s)$

(ii) $Fe(s) + ZnSO_4(aq) \longrightarrow FeSO_4(aq) + Zn(s)$

(iii) $Zn(s) + FeSO_4(aq) \longrightarrow ZnSO_4(aq) + Fe(s)$

Ans. All chemical reactions are the examples of displacement reactions. Only that reaction will take place in which the metal which is displace the other metal from the salt solution is placed above it in the reactivity series of metals.

(i) Zinc can displace copper from copper sulphate solution because it is placed above copper in the reactivity series.

(ii) Iron cannot displace zinc from sulphate solution because it is placed below zinc in the reactivity series.

(iii) Zinc can displace iron from zinc sulphate solution because it is placed above iron in reactivity series.

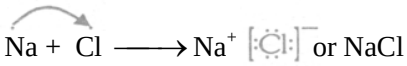
31. Metal generally occur in the solid state. Name and write symbol of a metal that exists in liquid state at room temperature.

Ans. The metal is mercury (Hg). It is a liquid at room temperature.

32. Write the electron-dot structure for sodium and chloride atoms. How do these form a chemical bond? Name the type of bond so formed. Why does a compound has high melting point?

Ans. Electron dot structure: Na (2, 8, 1)  (2, 8, 7)

Chemical bond known as ionic bond is formed by the transference of an electron from sodium atom to chloride atom.



Sodium chloride exists as a crystalline solid in which a large number of Na^+ and Cl^- ions are closely packed in space. Since attractive force among the ions are quite large, the compound has a very high melting point.

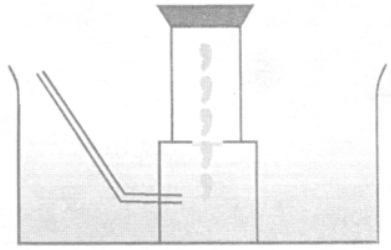
33. A metal is treated with dilute suphuric acid. The gas evolved is collected by the method shown in the figure. Answer the following.

(i) Name the gas.

(ii) Name the method of collection of the gas.

(iii) Is the soluble or insoluble in water?

(iv) Is the gas lighter or heavier than air?



Ans. (i) The gas evolved is hydrogen (H_2)

(ii) The gas has been collected by the downward of water.

(iii) The gas is insoluble in water. That is why it has been collected over water.

(iv) The gas is lighter than air.

34. A, B and C are there element which undergo chemical reactions according to following equations.

$$A_2O_3 + 2B \longrightarrow B_2O_3 + 2A$$

$$3CSO_4 + 2B \longrightarrow B_2(SO_4)_3 + 3C$$

$$3CO + 2A \longrightarrow A_2O_3 + 3C$$

Answer the following questions:

(a) Which element is the most reactivity ?

(b) Which element is the least reactivity?

Ans. (a) The most reactive element is ‘B’ as it has replaced both ‘A’ and ‘C’ from their compounds.

(b) The least which element is ‘C’ as it has been replaced by both ‘A’ and ‘B’.

35. E is an element which in one amongst copper, Zinc , aluminium and iron. It shows following properties:

(a) One of its ores is rich in E_2O_3 (b) E_2O_3 is not attacked by water. (c) It forms two chloride ECl_2 and ECl_3 Name the element and justify your answer.

Ans. The clue for the correct answer is the formation of ECl_2 and ECl_3. This shows that the element E has variable valencies of 2 and 3. Out of the element listed, only iron exists in divalent and trivalent forms.

(a) The ore rich in Fe_2O_3 is haematite .

(b) Haematite (Fe_2O_3) is not attacked by water

(c) The two chlorides are : iron (II) chloride or $Fecl_2$ and iron (III) chloride or $FeCl_3$.

36. An element reacts with oxygen to form an oxide which dissolves in hydrochloric acid. The oxide formed also turns a solution of red litmus blue. Is the element a metal or non-metal ? Explain with the help of a suitable example.

Ans. The oxide of the element is basic as it turns red litmus blue, this means that the element is a metal (M). Let the metal be sodium (Na). The chemical equations that are involved are :

$$4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$$

Sodium Sodium oxide

$$Na_2O(s) + H_2O(\ell) \longrightarrow 2NaOH(aq)$$

Basic oxide

$$Na_2O(s)2HCl(dil.) \longrightarrow 2NaCl(aq) + H2O(\ell)$$

37. An element E combines with oxygen to form an oxide E_2O which is a good conductor of electricity. Give the following informations:

(i) How many electrons will be present in the valence shell of the element E ?

(ii) Write the formula of the compound when the element E combines with chlorine .

Ans. (i) From the formula E_2O of the oxide, it is clear that the valency of the element E is one. This means that it has only one electron in the valence shell.

(ii) We know that chlorine is movement. Since the valency of the element e is a also one, the formula of the chloride of the element is ECl.

38. Match the entries in Column-I with those given in Column-II.

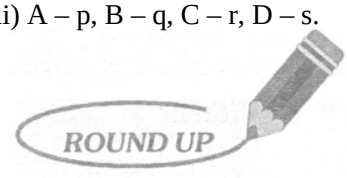
(i)

Column-I		**Column-II**	
(A)	Galena	(p)	SnO_2
(B)	Haematite	(q)	$CaCO_3MgCO_3$
(C)	Cassiterite	(r)	Fe_2O_3
(D)	Dolomite	(s)	PbS

(ii)

Column-I		**Column-II**	
(A)	**Froth floatation process**	**(p)**	**Zinc sulphide**
(B)	**Magnetic separation**	**(q)**	**Ferric oxide**
(C)	**Thermite process**	**(r)**	**Chromium oxide**
(D)	**Leaching**	**(s)**	**Aluminium oxide**

Ans. **(i)** A – s, B – r, C – p, D – p (ii) A – p, B – q, C – r, D – s.



- Element can be classified as metals and non-metals.
- Metals are generally hard, have high melting and boiling points, are malleable, ductile and have high tensile strength, have luster, are good conductors of heat and electricity and are sonorous.
- Non-metals are not hard, have no luster, have low melting and boiling points, are not malleable, ductile or tensile and are poor conductors of heat and electricity.
- Metals generally have 1 to 3 electrons in their valence shell. They lose (donate) these electrons to form positively charged ions. The formation of ion from a metal due to loss of electron is basically an oxidation process, and hence, metal are reducing agents.
- Metals combine with oxygen to form their oxides which are basic in nature. However, the oxides of zinc and aluminium are acidic as well as basic in nature. They are called amphoteric oxides.
- Different metals have different reactivities with water and dilute acids .
- A list of metals arranged in the order of their decreasing chemical reactivity is known as activity series of metals.
- Metals above hydrogen are called reactive metals. They displace hydrogen from the dilute acids.
- Metal occur in nature as free elements or in the form of their compounds.
- The various processes involved in the extraction or in the form of their ores is called metallurgy.
- Alloys are homogeneous mixture of two or more metals (or non-metals) in fused state.

EXERCISE # 1 FOR SCHOOL / BOARD EXAM.

(A) OBJECTIVE TYPE QUESTIONS :

1. The non-metal which is a liquid at room temperature –
(A) Oxygen (B) Fluorine (C) Sulphur (D) Bromine

2. Non-metal generally form –
(A) Anions (B) Cations (C) Ions (D) None of these

3. Which is the least conductor of heat –
(A) Gold (B) Platinum (C) Silver (D) Lead

4. Which of the following metal can we cut with the knife –
(A) Gold (B) Potassium (C) Iron (D) All of these

5. Metal have ……..no, of electrons in their outer most shell –
(A) 1 to 8 (B) 7 to 9 (C) 1 to 3 (D) 10 to 12

6. Which oxide is neutral ?
(A) NO_2 (B) MgO (C) H_2O (D) None of these

7. Which hydride commercially known as hydrolith –
(A) MgH_2 (B) CaH_2 (C) NaH (D) KH

8. Which of the following elements is metalloid –
(A) Si (B) Sb (C) A and B (D) Zn

9. Which metal does not react with oxygen –
(A) Cu (B) Au (C) A and B (D) Fe

10. Which non-metal have shining surface –
(A) Graphite (B) Phosphorus (C) Sulphur (D) None of these

11. Which non-metal have semi-conductor property –
(A) Boron (B) Carbon (C) Silicon (D) Magnesium

12. Which metal has high melting point –
(A) Sn (B) W (C) Sb (D) pb

13. $Al_2.O_3\ 2SiO_2.\ 2H_2O$ is the chemical formula of –
(A) Bauxite (B) Haemetite (C) China Clay (D) Monazite

14. An alloy is –
(A) A element (B) A mixture (C) an isomer (D) A metalloid

15. Which chemical is known as king of chemicals –
(A) H_2CO_3 (B) HCl (C) CH_3COOH (D) H_2SO_4

16. Which non-metal is the best conductor of electricity –
(A) Phosphorus (B) Fluorine (C) Graphite (D) Bromine

17. Which compound is used in photography –

(A) $AgNO_3$ (B) AgO (C) AgBr (D) AgCl

18. $NaHCO_3$ is chemical formula of –

(A) Sodium bicarbonate (B) Sodium carbonate (C) Sodium hydroxide (D) Sodium Chloride

19. Carnallite is the mineral of –

(A) Na (B) Ca (C) Mg (D) All of these

20. The sodium metal can be stored in –

(A) Benzene (B) Alcohol (C) Kerosine (D) Toluene

21. The magnesium is used in –

(A) Flash bulb (B) Grignard reagent (C) Electron alloy (D) All of these

22. In the reaction $M + O_2 \rightarrow MO_2$ (super oxide) the metal is –

(A) Li (B) Na (C) K (D) Ba

23. The most malleable metal is –

(A) Sodium (B) Cilium (C) Gold (D) Lead

24. Cinnabar is an ore of –

(A) Mercury (B) Copper (C) Calcium (D) Lead

25. The constituent of haemoglobin is –

(A) Iron (B) Sodium (C) Copper (D) Magnesium

26. Pure gold is equal to –

(A) 24 carat (B) 10 carat (C) 22 carat (D) 23 carat

27. Which of the following metals is less reactive than hydrogen –

(A) Cu (B) Ba (C) Mg (D) Pb

28. Which of the following metal react vigorously with oxygen –

(A) Zinc (B) Magnesium (C) Sodium (D) Copper

29. Which metal is used for making foils used in packing of food materials –

(A) Copper (B) Platinum (C) Aluminium (D) Sodium

30. The most abundant metal in the earth crust is –

(A) Al (B) Fe (C) O (D) Cu

31. The second most abundant metal present in the crust of the earth is –

(A) Ca (B) Al (C) Cu (D) Fe

EXERCISE # 1 ANSWER KEY

Objective type questions

1. D	**2.** A	**3.** D	**4.** B	**5.** C	**6.** C	**7.** B	**8.** C
9. B	**10.** A	**11.** C	**12.** B	**13.** C	**14.** B	**15.** D	**16.** C
17. C	**18.** A	**19.** C	**20.** C	**21.** D	**22.** C	**23.** C	**24.** A
25. A	**26.** A	**27.** A	**28.** C	**29.** C	**30.** A	**31.** D	

EXERCISE # 1 FOR SCHOOL / BOARD EXAM.

1. Which of the following reactions cannot occur –
(A) $2AgNO_3(aq.) + Fe(s) \rightarrow Fe(NO_3)_2(aq.) + 2Ag(s)$
(B) $CuSO_4(aq.) + Zn(s) \rightarrow ZnSO_4(aq.) + Cuq\ (s)$
(C) $CuSO_4(aq.) + 2Ag(s) \rightarrow Cu(s) + Ag_2SO_4(aq)$
(D) $2AgNO_3(aq.) + Zn \rightarrow ZnSO_4(aq) + 2Ag(s)$

2. Which of the following is the sulphide ore of copper –
(A) Azurite (B) Copper glance (C) Cuprite (D) Malachite

3. Because of the high electropositively, the atom of metals can easily form –
(A) Positive ions (B) Negatively ions (C) Neutral ions (D) Covalent bonds

4. Metals above hydrogen in activity series –
(A) React with acids to liberate hydrogen ions (B) React with acids to liberate hydrogen gas
(C) React with water at ordinary temperature (D) One of these

5. Volatile metals are purifies by –
(A) Oxidation (B) Distillation (C) Liquation (D) Electrolytic refining

6. Which of the following gas is lighter –
(A) H_2 (B) SO_2 (C) O_2 (D) NO_2

7. Amalgam is homogeneous mixture of –
(A) Metal and metal (B) Metal and mercury (C) Metal and non-metal (D) All of these

8. Duralumin is an alloy of –
(A) Cu (B) Zn (C) Al (D) None of these

9. Which of the following is a ferrous alloy –
(A) Solder (B) Brass (C) Magnesium (D) Steel

10. Which of the following statements is correct –
(A) All minerals are ores (B) All ores are minerals (C) Some ores are minerals (D) None is correct

11. Which metal is used in thermite process –
(A) C (B) Co (C) Al (D) A & B

12. The steps involved in metallurgical process –
(A) Crushing & grinding of the ore
(B) Concentration of the ore or enrichment of the ore
(C) Extraction of metal from the concentrated ore
(D) All of these

13. Which metal is higher in the activity series –
(A) K (B) Ca (C) Fe (D) Pt

14. Food cans are coated with tin and not zinc because –
(A) Zinc is costlier than tin (B) Zinc has a higher melting point than tin
(C) Zinc is more reactive than tin (D) Zinc is less reactive than tin

15. When element M of lA group reacts with water, it gives –
(A) MOH + O_2 (B) MOH + H_2O (C) MOH + H_2 (D) MH + H_2

EXERCISE # 2 ANSWER KEY

1. C	**2.** B	**3.** A	**4.** B	**5.** B	**6.** A	**7.** B	**8.** C
9. D	**10.** A	**11.** C	**12.** D	**13.** A	**14.**C	**15.** C	

EXERCISE # 3 FOR SCHOOL / BOARD EXAM.

(B) FILL IN THE BLANKS :

1. The minerals from which metals can be extracted economically are called ……..
2. The processes involved in the production of a metal from the ore are collectively known as……..
3. The rocky material found with ores is known as ……
4. Cinnabar is an ore of ……..
5. …….is the most abundant metal in the earth's crust.
6. The reactive metals occur in nature in the ……...state.
7. Electromagnets are used to concentrate ……..ores.
8. ……. is the best conductor of electricity.
9. Sodium amalgam is a mixture of sodium and ……..
10. Out of Al, Zn and Ag, only ……cannot displace hydrogen from dil. HCl.

(C) TURE OR FALSE :

1. Mercury is a liquid non-metal.
2. Magnelium is an ore of magnesium.
3. In electrorefining of copper, impure copper is made anode.
4. Sodium is less reactive than copper.
5. Iron can liberate H_2 form dil. H_2SO_4 but copper liberate H_2 from dil. H_2SO_4.

6. Silver metal acts as non-conductor of electric current.
7. Van Arkel method is used for refining copper metal.
8. Oxygen is the most abundant metal in the earth's crust.
9. The reactive metal do not occur in nature in the free state.
10. Float floatation process is used to concentrate magnetic ores.

(D) MATCH THE COLUMNS :

1. Which one of the methods given in column-I is applied for the extraction of the meta given in column-II.

Column-I	**Column-II**
(A) Electrolytic reduction	(i) Aluminium
(B) Reduction with carbon	(ii) Zinc
(C) Reduction with aluminium	(iii) Sodium
	(iv) Iron
	(v) Manganese
	(vi) Chromium

2. Match the entries of column-I with appropriate entries of column-II.

Column-I (Metal to be extracted)	**Column-II (Method used of reduction of oxide)**
(A) Iron or zinc	(i) Reduction with aluminium
(B) Manganese or chromium	(ii) Reduction with carbon
(C) Mercury	(iii) Electrolytic reduction
(D) Aluminium	(iv) Reduction of heating alone

EXERCISE # 3 ANSWER KEY

- ***Fill in the blanks***

1. Ore	**2.** Metallurgy	**3.** Gangue	**4.** Mercury
5. Aluminium	**6.** Combined	**7.** Magnetic	**8.** Silver

- ***True or False***

1. T	**2.** T	**3.** T	**4.** F	**5.** T
6. F	**7.** F	**8.** F	**9.** T	**10.** F

- ***Match the following***

1. A-(i)&(ii)	B-(ii)&(iv)	C-(v)&(vi)	
2. A-(ii)	B-(i)	C-(iv)	D-(iii)

EXERCISE # 4 FOR SCHOOL / BOARD EXAM.

(E) VERY SHORT TYPE QUESTIONS :

1. What would happen to copper vessel if it is left for a few days in humid atmosphere without being cleaned ?

2. Which chemical element is alloyed with copper to make bronze ?

3. Why do shopkeepers apply oil on tools make of iron while storing them ?

or Why do we apply oil on iron tools kept in storage ?

4. Name the metal used for making the body of aircraft .

5. Which one of the following is (a) the most reactive (b) the least reactive ?

Au, Na, Cu, Ca

6. Name one non-metal and one metal which are liquid at room temperature

7. Name an ore of zinc other than zinc oxide. By what process can this ore be converted to zinc oxide ?

8. Select the metalloids / from amongst the following elements.

(i) Bismuth (ii) Copper (iii) Zinc (iv) Iron

9. Name a metal the offers high resistance to the passage of electricity than copper.

10. A green layer is gradually formed on a copper plate left exposed to air for a week in bath room. What could this green substance be ?

11. Name two metals both of which are very ductile as well as very malleable.

12. What types of reaction is involved in rusting ?

13. From amongst the metals sodium, calcium, aluminium, copper and magnesium, name the metal

(i) Which reacts with water only on boiling and

(ii) another which does not react even with steam .

(F) SHORT TYPE QUESTION :

1. An elements reacts with oxygen to form an oxide which dissolves in dilute hydrochloric acid. The oxide also turns a solution of red litmus blue. Is the element a metal or a non-metal ? Explain with the help of a suitable example.

2. What is activity series of metals ? Rearrange the following metal in an increasing order of reactivity :

Aluminium, Zinc, Mercury.

3. Choose the metal (from the list given below) which can displace zinc from zinc sulphate solution, Lead, Copper, Magnesium, Silver. Write the equation of the chemical reaction involved.

4. Sate two ways to prevent the rusting of iron.

5. What chemical process is used for obtaining a metal from its oxide ?

6. Explain why metal replace hydrogen from acids, whereas nonmetals do not.

7. Sodium hydroxide should not be stored in aluminium containers. Why ?

8. Explain why sodium is not found in the native state.

9. Name three nonmetallic oxide which are acidic.

10. What do you mean by corrosion of metals ?

(G) LONG TYPE QUESTIONS :

1. Describe two method for the concentration of ores.

2. **Explain the following terms.**

(a) Metallurgy (b) Flux (c) Calcination (d) Roasting

3. Explain the method used for the extraction of aluminium from its ore. Illustrate your answer with the help of a neat, labeled diagram .

4. How does aluminium react with the following substances ?

(a) Water (b) Sulphuric acid (c) Carbon monoxide (d) Ferric oxide

5. Name the chief ore of iron. What are the three raw material used in the production of iron from its ore ? With the help of a labeled diagram of a blast furnace, describe the extraction of iron from its ore. Write the chemical equation of the reactions involved in the furnace.

6. What is allotropy ? Name any four allotropic modifications of sulphur. Describe the action of heat on shulphur.

7. Draw a labeled diagram of Frisch process for mining sulphur. State the function of the following in the Frasch process .

(a) Superheated water (b) Air at high pressure