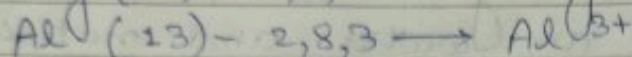
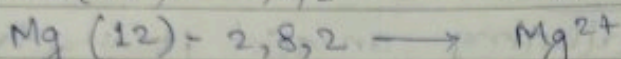
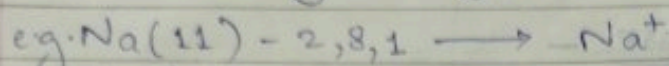


# Metals And Non-Metals

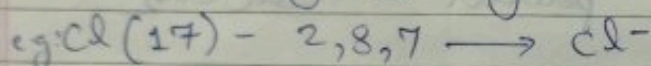
## Metals

Those elements having 1, 2, 3 electrons in their outermost orbit and forming electropositive ions (cations) by losing electrons called Metals.



## Non-metals

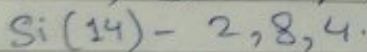
Those elements having 5, 6, 7 electrons in their outermost orbit and forming electronegative ions (anions) by gaining electrons called non-metals.



## Metaloids

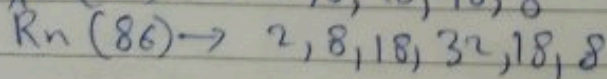
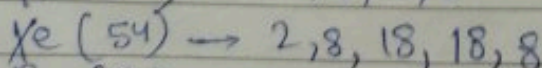
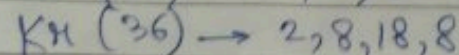
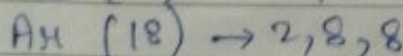
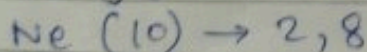
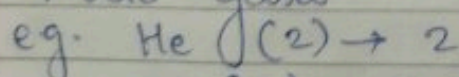
Those elements having both the properties of metals as well as non-metals and having valency 4 called Metaloids.

eg. Boron, Silicon, Germanium, Arsenic, Antimony etc.



## Noble gases (Inert gases)

Those elements are chemically stable i.e. their outermost orbit is completely filled called Noble gases.



## Metals

## Metals

### Physical Properties

- Metals are metallic in nature.
- lead (Pb)
- Most of metals are hard and brittle except some which can be cut by knife.
- Metals have high melting point. e.g. Gallium, K.
- Metals are ductile and malleable. Zn, Fe.
- Metals are malleable and ductile. Zn and Fe.
- Metals are not brittle. Zn.
- Good conductors of heat & electricity except Tungsten.



## Metals & Non-Metals (Differences)

### Metals

### Non-metals

Physical Properties

- Metals possess high metallic lustre except lead (Pb).
- Most of the metals are hard and strong except ~~Na~~ Na and K. which can be cut by knife also
- Metals possess high melting and boiling point: except Gallium, ~~Me~~ Hg, Na, K.
- Metals are usually ductile (drawn into wires) except Zn, Hg and Ga.
- Metals are usually malleable (beaten into sheet) except Zn and Hg.
- Metals are hard but not brittle except Zn.
- Good conductor of heat & electricity except Tungsten.

Non-metals having dull appearance except I and graphite (C)

Non-metals having three forms, solid, liquid as well as gases.  
 solid - ~~S~~ S, C and P.  
 liquid - Br (bromine)  
 gas - ~~H<sub>2</sub>~~ H<sub>2</sub>, O<sub>2</sub>, Cl<sub>2</sub>, N<sub>2</sub>, etc.

The melting point and boiling point of non metals are very low except C, B, Si.

Non-metals are non-ductile except C (carbon fibres used to transmit electric signals).

Non-metals are non-malleable they break into pieces when beaten with hammer.

Non-metals are generally brittle

Bad conductors of heat & electricity except Graphite.



- They form alloys (homogeneous mixture of two or more metals)
- [Chemical properties]

They do not form alloys except C and P.

- Oxides of metals are usually basic.

Example Basic oxides

$\text{Na}_2\text{O}$ ,  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{CuO}$ .

Acidic oxides

$\text{CrO}_3$ ,  $\text{Mn}_2\text{O}_7$ .

Amphoteric oxides

$\text{ZnO}$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{PbO}$

- Reaction with Hydroxide

Metals do not form hydride but if they form hydrides they are not very stable.

Example -  $\text{NaH}$ ,  $\text{CaH}_2$

Oxides of non-metals are usually acidic.

Example Acidic oxides

$\text{CO}_2$ ,  $\text{SO}_2$ ,  $\text{SO}_3$ ,  $\text{NO}_2$ ,  $\text{P}_2\text{O}_5$

Neutral oxides

$\text{CO}$ ,  $\text{NO}$ ,  $\text{N}_2\text{O}$ ,  $\text{H}_2\text{O}$ .

Reaction with Hydride

Non-metals form stable hydride.

Example -  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{CH}_4$

- Metals discharged at Cathode during electrolysis

Non-metals discharge at Anode during electrolysis.

- They form cations by losing electrons

They form anions by gaining electrons.



Activity series - The arrangement of metals in the decreasing order of their reactivity in the form of a series is called Activity series.

K	Zn	Hg
Na	Fe	Ag
Ca	Pb	Pt
Mg	[H]	Au
Al	Cu	

Metallurgy - The process used for extraction of metals in their pure form from their ores called Metallurgy.

Mineral - The natural occurring compounds which contain metals in the form of rocks called Minerals.

Example - Limestone etc.

Garigue (Matrix) - The impurities which is present in Ore called Garigue or Matrix.

Ores - Those minerals from which metals are extracted commercially at a low cost with minimum effort called Ores.

Extraction Metals

Name of the ore

K

Carnallite ( $KCl \cdot MgCl_2 \cdot 6H_2O$ )

Na

Rock salt ( $NaCl$ )

Ca

Limestone, Marble ( $CaCO_3$ ,  $CaSO_4 \cdot 2H_2O$ )

Mg

Carnallite,  $MgCO_3$

Al

Bauxite ( $Al_2O_3 \cdot 2H_2O$ ) & Cryolite ( $Na_3AlF_6$ )



Zn	Zinc Blende ( $ZnS$ ) and Calamine ( $ZnCO_3$ )
Fe	Haematite ( $Fe_2O_3$ ), Magnetite ( $Fe_3O_4$ ), Iron Pyrites ( $FeS_2$ )
Pb	Galena ( $PbS$ )
Cu	Copper Pyrite ( $CuFeS_2$ )
Hg	Cinnabar ( $HgS$ )
Ag	Argentite ( $Ag_2S$ ), Horn Silver ( $AgCl$ )

Metallurgy - Under metallurgy there are four steps :-

- i) Concentration of ores
- ii) Conversion of ores into oxide ores
- iii) Reduction
- iv) Refining

Step 1 : Concentration of Ores

The process in which gangue particles are separated from ores is called concentration of ores. It involves four main methods :-

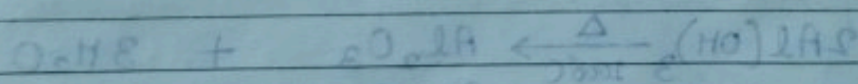
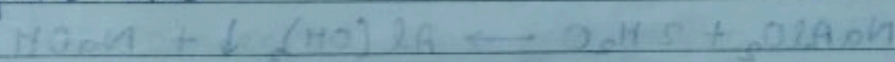
i) Hydraulic washing (gravity separation)

In this process we take a tank and water is poured into it and then powdered ore (oxide ore) mix into it. After stirring few time the heavier particles (ore particles) are settled at the bottom and the lighter particles (gangue) floats at the surface of water. The principle involve in this method that ore particles and gangue particles having different densities.



## ii) Froath Flootation Process

In this process Sulphide ores can be separated from gangue particles. In this process water is poured into a huge tank in which powdered ore mix into it. Pine oil <sup>also</sup> mix into it to make froath. Hot air pass through the hollow pipe to the solution. Since the sulphide ore is lighter in nature, it floats at the surface, and gangue particles settled at the bottom. The froath containing ore taken out and dried up to get the pure ore.



## iii) Magnetic Separation

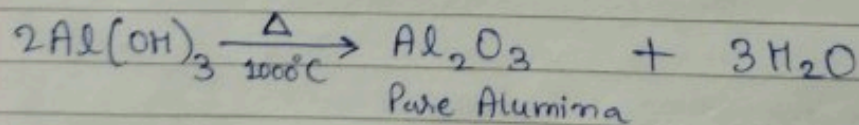
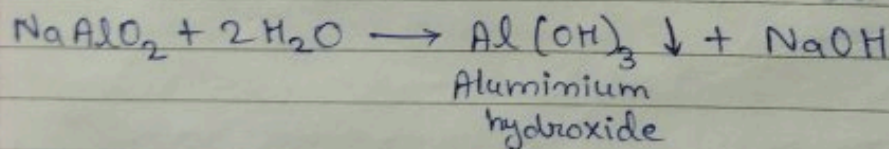
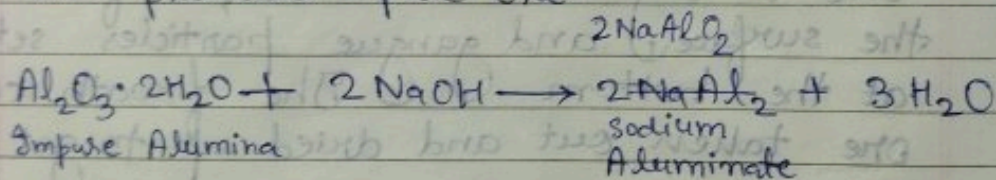
In this process iron ore can be separated from gangue. This process involve two rollers connected with a belt. The powdered ore dropped on the belt at the ore



end which moves with belt and reach to the roller contain magnet. The magnet attract the ores and the impurities separated from it.

#### iv) Chemical Separation (Bayer's Method)

In this method high active ores can be separated from its gangue particles. Few chemicals which on reaction with impure ore provides pure ore.



#### Step 2: Conversion of Ores into oxide ores

Ores can be converted into oxide ore because the extraction of metal from oxide ore is cheaper and easier. It involves two methods:-

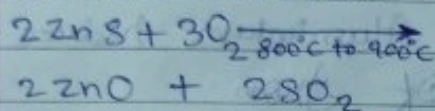
##### i) Calcination



## ii) Roasting

### Roasting

- The ore is heated in excess of air.
- Sulphide ores are generally used in this method.

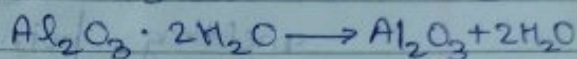
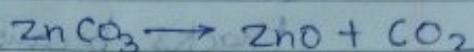


- Volatile impurities are removed as oxides ( $\text{SO}_2$ ,  $\text{P}_2\text{O}_5$ ) and ore becomes porous and more reactive.

### Calcination

The ore is heated in absence of air.

Carbonate and hydrated ores are used in this method.

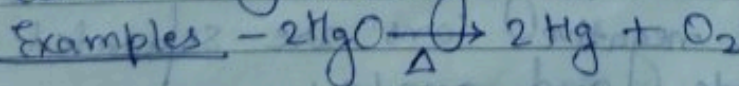


Moisture and organic impurities are removed.

## Step 3: Reduction

After converting ore into oxide ore, the oxygen present in it has to be removed to get pure metal. This process is called Reduction. It involves four steps:-

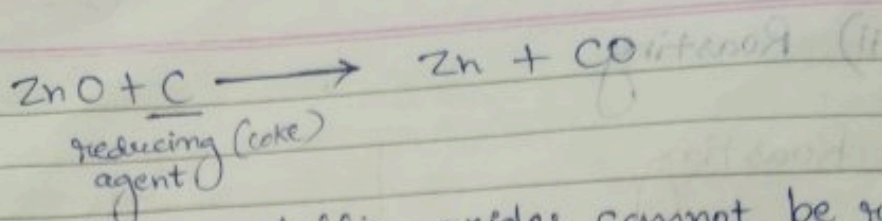
- i) Those metals which <sup>are</sup> present <sup>in</sup> lower position in activity series can be obtained by direct heating.



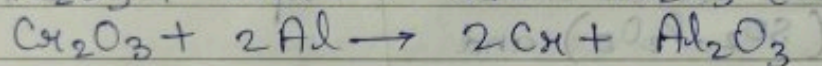
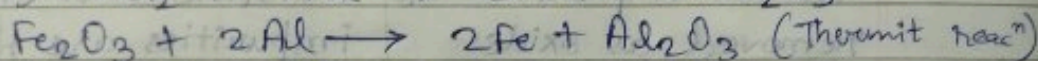
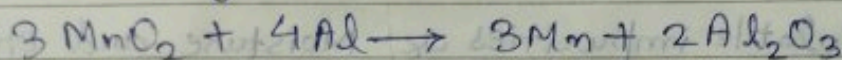
- ii) Those metals which are at the middle of the activity series,

Examples - ( $\text{Fe}$ ,  $\text{Zn}$ ,  $\text{Ni}$ ,  $\text{Sn}$ ) cannot be reduced by direct heating. So they require a reducing agent.

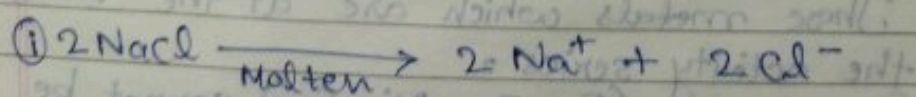




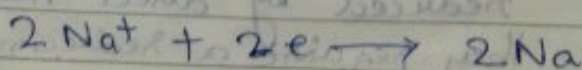
- iii) Some metallic oxides cannot be reduced by using carbon as a reducing agent. Examples - (Mn, Fe, Cr) These can be reduced by using Aluminium as a reducing agent. This process is also known as Alumino Thermite Process. It is used to join the broken railway tracks because Aluminium reduce the melting point of Iron.



- iv) The reactive metals which are at the top of the activity series cannot be reduced by any other method because they have great affinity towards oxygen. So, these can be reduced by electrolytic refining reduction. In this process we take an electrolytic tank containing two metallic plates, one positively charge called anode and one negatively charge called cathode. The salt solution of the metal which can be reduced of the metal taken as Electrolytes. The electric current passed through the solution and positive and negative ions are separated into cathode and anode.

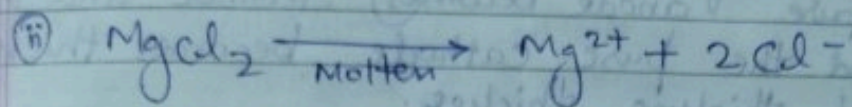
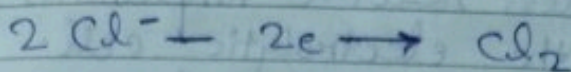


at Cathode

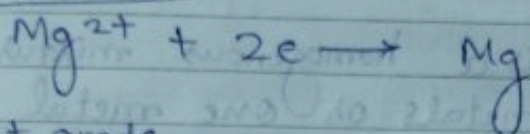




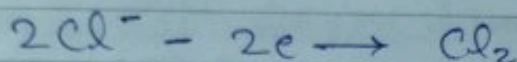
at anode



at cathode



at anode



### Step 4: Refining Of Ore

The metal obtained from ore is not ~~100%~~ 100% pure. It contains various impurities. So it must be refined before use.

#### i) Liquation

In this process we separate the metals having low melting points from the metals having high melting points.

Examples - Pb, Sn

#### ii) Electrolytic Refining

This is the method widely used for all metals such as Al, Cu, Sn, Pb, Au.

In this method the impure metal is made anode while pure metallic rod acts as cathode. A salt solution of metal acts as electrolyte. On passing the electric current the pure metal gets deposited on the cathode. The more reactive impurities present in the metal remain in the solution.



and the less reactive impurities falls to the bottom of the electrolytic cell. The impure anode becomes thinner and thinner and the pure cathode becomes thicker and thicker.

Alloy - It is a homogenous mixture of two or more metals or one metal or non-metal.

Purposes of making alloys :-

- To modify the appearance and the colour.
- To improve the chemical properties.
- To lower the melting point.
- To increase the hardness and tensile strength.
- To increase resistance to electricity.

Alloy's name	Composition	Properties	Used for making
--------------	-------------	------------	-----------------

• <u>Duralumine</u> (Al)	(95%) Al, (4%) Cu, (0.5%) Mg, (0.5%) Mn	i) light but as strong as steel ii) Hard and resistant to corrosion iii) Highly ductile	i) Boats of air craft and buses. ii) Pressure cooker and light tools.
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• <u>Magnalium</u> (Al)	(90 to 95%) Al, (10 to 5%) Mg	i) Resist to corrosion ii) Light but strong	i) Scientific instruments ii) Beam balance iii) Household appliances
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• <u>Alnico</u> (Al)	Al, Ni, Co, Fe	i) light ii) Shiny iii) resist to corrosion	i) Used for making magnets.
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Alloy's name

• Stainless (Fe)

• Invar (Fe)

• Nickel steel (Fe)

• Brass (Cu + Zn)

• Bronze (Cu + Zn)

• German silver (Cu + Zn)





Alloy's name      Composition      Properties      Used for making

- Stainless steel (73%) Fe, (18%) Cr, (8%) Ni, (1%) C  
(Fe)  
i) Resist to corrosion  
ii) Lustrous  
iii) Resist to acids and alkalis  
i) Making cutlery, surgical instruments and utensils.
- Invar (63%) Fe, (36%) Ni, (1%) C  
(Fe)  
i) Negligible to expansion  
i) Pendulum clock and various scientific instruments.
- Nickel steel (98%) Fe, (2%) Ni  
(Fe)  
i) Hard and elastic  
ii) Resistant to corrosion  
i) Used for making electric wire, cables, automobile parts.
- Brass (60 to 70%) Cu, (40 to 30%) Zn  
(Cu+Zn)  
i) Malleable and Ductile  
ii) Resist to corrosion  
iii) Can be easily cast  
i) Decorative hardware, screws and handles, electrical goods, parts of watches, musical instruments.
- Bronze (80%) Cu, (18%) Sn, (2%) Zn  
(Cu+Zn)  
i) Resist to corrosion  
ii) Can be polished  
iii) Hard & easily cast  
i) Making medals, statues, coins, bearings.
- German silver (50%) Cu, (30%) Zn, (20%) Ni  
(Cu+Zn)  
i) White and light  
ii) Malleable and Ductile  
iii) High electrical resistance  
i) Electric heaters, resistors, rheostat and decorative items.



Alloy's name    Composition    Properties    Used for making

- Gun metal (88%) Cu, (8%) Sn, (1%) Zn, (1%) Pb
  - i) Hard and brittle
  - ii) Easy to cut
  - i) Making gears, bearings, barrels of cannons
- Solder or Fuse metal Pb, Sn
  - i) Low melting point
  - ii) High tensile strength
  - i) Welding purpose
  - ii) Making fuse wires.

Q. Give an example of the following.

- i) A metal liquid at room temperature.  
→ Mercury (Hg)
- ii) Can be easily cut with a knife.  
→ Sodium (Na) & Potassium (K)
- iii) Best conductor of heat.  
→ Silver (Ag)
- iv) Poor conductor of heat.  
→ Lead (Pb)

Q. Why is Sodium kept immersed in kerosene oil?

- Sodium is highly reactive metal. It can react very fast with oxygen from air. To protect it from reaction, it is stored in kerosene oil.

Q. Why do ionic compounds have high melting points?

→ In ionic compounds, the ions are held together by strong electrostatic forces of attraction. A large amount of energy is required to overcome these forces, hence ionic compounds have high melting points.

Q. Give an example of a metal that is liquid at room temperature.

- i) Platinum

→ Platinum is a noble metal and does not react with air and water.

- ii) Aluminium

→ Aluminium is a reactive metal and reacts with air to form a thin layer of aluminium oxide, which prevents further reaction.

- iii) What is the use of aluminium?

→ It is used for making aircraft, foil, and other products.



Q. Why do ionic compounds have high melting points?

→ In ionic compounds, strong electrostatic forces of attraction are present between the oppositely charged ions. When these compounds are heated, a lot of heat is consumed to break the force of attraction during melting. Therefore, ionic compounds have high melting and boiling points.

Q. Give reasons :-

i) Platinum, Gold and Silver are used to make jewellery.

→ Platinum, Gold and Silver are least reactive metal which are also called Nobel metals. They are not corroded by air and water. So, they are used to make jewellery.

ii) Aluminium is highly reactive metal yet it is ~~not~~ used to make utensils for cooking.

→ A thin layer of Aluminium Oxide ( $Al_2O_3$ ) forms on the surface of Aluminium, prevents it from corrosion. Thus, Aluminium vessels do not react with any ingredient of food and are suitable for cooking.

iii) What is Aqua regia?

→ It is the mixture of HCl and <sup>form conc.</sup>  $HNO_3$  in the ratio