CHAPTER FIFTEEN

METALS AND NON-METALS:

Based on the differences in their physical and chemical properties, elements are either classified as metals or non-metals.

Metals:

- With the exception of mercury, all the other metals are solids. -
A metal is said to be tough if it can withstand or resist shock load, and with respect to hardness, a metal is said to be hard when it can resist wear, scratches and cuts.

Properties of metals:

These properties are:

(1) Malleability: -

This refers to the ability of the metal to be beaten into any shape.
- Metals which can be hammered, rolled or processed at room temperature without breaking are said to be malleable.

(2) Ductility:-

- A metal is said to be ductile if it can be stretched cold or at room temperature into fine wire, without breaking.

(3) Lustrous:-

- Metals are said to have lustre or are lustrous, which implies that they have polished or shiny surfaces or their surfaces can easily be polished.

(4) Heat and electricity conduction:

- Metals are good conductors of heat and electricity.

(5) High melting point-and-density:

- Metals have high melting points and high densities.

(6) High tensile strength:

- They also have high tensile strength.

Properties of non-metals:

(1) They are bad conductors of heat and electricity.
(2) Solid non-metals such as graphite are brittle, which implies that they can easily break without bending. (3) They are generally not lustrous if they are solid and have low tensile strength. (4) They are not malleable or ductile.

Metals	Uses	Properties that makes it suitable
Aluminum	Overhead electricity cable. Saucepans	Good conductor of electricity.
Sodium	As a coolant in nuclear reactors.	Conducts heat very well.
Zinc	To coat iron to make galvanized iron.	Protects the iron from rusting.
Tin	To coat steel cans.	Protects the steel from rusting.
Mercury	In thermometers.	Expands on heating, easy to see and does not wet the sides of the tubes.

Iron:

- Iron is a metal which has a low density but a high tensile strength, and can be used in making over head electricity cables.
- Because it is malleable iron can be used in making hoes, blades, knives, roofing sheets, pylons and parts of cars. - It can also be converted into steel. - Naturally, iron is not found in the pure state but rather in the ore state.

- This means that it is found in the compound form, together with oxygen and other elements.
- Together, the compound of the metal and the rock in which the compound is found make up the ore. -
Examples of iron ores are:

(1) Haematite (Fe_2O_3).
(2) Magnetite Fe_3O_4).
(3) Siderite ($FeCO_3$).
(4) Limonite (FeO.OH).
(5) Iron Pyrite (FeS_2).

Extraction of iron:

- Because iron is a very active element, it is found in the compound form and forms compounds which are very stable.
- The smelting or splitting of such a compound or ore gives us the metal or iron.
- The main process involved in the extraction of iron are:

(1) The concentration of the ore:

- In this process, the ore is broken down in order to be able to separate the iron ore from the sand particles it is mixed with. - By simply washing in a stream, the waste or the sand particles can be removed while the concentrated or good ore is had. - The ore is then roasted in the air and the main product had is Fe_2O_3.

(2) Charging of the furnace:

- The material used in the blast furnace used to make iron is called the charge. - This charge is made up of the iron ore (i.e. the iron IIII oxide, Fe_2O_3), the sand impurities (SrO_2), limestone ($CaCo_3$) and coke. - These mentioned items are introduced into the blast furnace, which is a tall structure of height 30m and 9m in diameter at its lowest part. - The filling of the blast furnace is called charging and this is done at the top. - A blast of hot air can be introduced low down in the furnace, through several pipes called tuyenes.
- A well at the bottom of the furnace serves to hold the molten iron and slag, till they are ran off.

- The mixture of ore, coke, SIO_2 and limestone are continuously fed in from the top and the blast furnace once started is kept going for months at a time, until repair works are necessary or work is lacking.

(3) Heating the furnace:

- Each blast furnace has several giant stoves, at the bottom in which gas is burnt.
- After the heating of the stove, very hot air is pumped through it and then blown into the blast furnace.
- While one stove is being blown, others are being heated for the blowing process.

(4) The making of the iron:

- As already stated, the starting material is the iron ore.
- Coke and limestone are added to it, and the combination is cooked in a blast furnace using a great blast of hot air blown into it. - The hot air enters the furnace near the bottom through the tuyenes and this causes the coke to burn.
- The coke has two main purposes as it burns in the blast furnace with the air blows. (1) The gas produced as a result of its burning changes the iron oxide into pure iron.
(2) The terrific heat produced causes the iron as well as all the impurities to melt.
- The melted iron free from impurities trickles down to the lower part of the furnace, while the slag containing the impurities floats on top of the pool of iron. - These impurities float on top because they are lighter and are removed by being drained from the furnace. - At longer intervals, the iron which contains some carbon is removed. - The limestone assists in the removal of the impurities from the iron ore. - Many of the impurities do not melt at a temperature as low as the melting point of iron, and the limestone when added or mixed with the heated ore acts as a flux, and combines with the impurities causing them to melt at a lower temperature than usual.
- The oxygen within the air combines with carbon to form carbon monoxide.

- As hot carbon monoxide flows through the iron ore, it combines with the oxygen found within the air to form carbon dioxide, and by so doing, the iron is set free.

(5) Lighting the furnace:

- The blast furnace is filled with coke and ore, and the bottom of the furnace is filled with wood which is used to start the burning of the coke.
- Once the furnace has been started, it keeps operating day and night continuously, and may even run for more than two years.

Types of steel:

(1) Mild steel:

- It contains 99.5% iron and 0.5% carbon.
- Its special property is that even though it is hard, it can easily be worked and it is used in the making of cars.

(2) Hard steel:

- It contains 99% iron and 1% carbon.
- Its special property is that is it hard and it is used in the making of blades for cutting tools.

(3) Durirons:

- It contains 84% iron, 1% carbon and 15% silicon.
- Its special property is that it is not affected by acid, and it is used in the making of tanks and pipes in chemical factories.

Extraction of aluminum:

- Because iron is less reactive than aluminum, it is produced by the smelting of its ore in the presence of carbon.
-The carbon is in the form of coke or charcoal and in the case of iron, the smelting takes place in the blast furnace. -
Since aluminum is a very reactive element, it is also found in the compound form.
- Because this compound is very stable, a large amount of electric current is needed to split the ore or the compound, in order to get the metal. -
The extraction of aluminum from its ore called bauxite, is by the process of electrolysis.
- Because the bauxite contains an impurity (Fe_2O_3), it has a dark brown colour.
- And because of the presence of these impurities, the process of the extraction of aluminum is in two parts.