Is Matter around us Pure?

Matter

Anything which has mass and occupies space is called matter. It may be solid, liquid or gas.

Matter is of 2 types -

1. Pure Matter

2. Impure substances

Pure Matter

Pure substances may be defined as material which contains only one kind of atoms or molecules.

Pure substances are of 2 kinds : -

1. Elements -

Pure substances which are made up of only one kind of atoms are known as elements. All atoms in an element are identical. Atoms of different elements are different.

2. Compounds -

Pure substances which are made up of only one kind of molecules are known as compounds. Atoms constituting are from two or more different elements. The different elements are combined in fixed proportion in a compound.

Impure Matter

Impure matters are also called mixture. A mixture is a material which contains two or more different kinds of particles (atoms or molecules) which do not react chemically but are physically mixed together in any proportion.

Mixtures are of 2 types:

(a) Homogeneous mixtures -

A mixture is said to be homogeneous if all the components of the mixture are uniformly mixed and there are no boundaries of separation between them. For example- Salt in water etc.

(b) Heterogeneous mixtures -

A mixture is sad to be heterogeneous if all the components of the mixture are not thoroughly mixed and there are visible boundaries of separation between them. For example- Sand in water etc.

Before we proceed further we should know the difference between the properties of compounds and mixtures.

Properties of Compounds -

1. A compound is a homogeneous substance.
2. A compound has a definite composition.
3. A compound has definite melting point or boiling point.
4. Energy is absorbed or evolved in the form of heat or light during the formation of a compound.
5. The properties of compound are entirely different from those of its constituents.

   For example – If we mix Iron and Sulphur in a watch glass, we get a mixture. This is then heated till a black mass is formed. This leads to formation of compound called Iron Sulphide.

$$\underset{\text{(element)}}{Fe} + \underset{\text{(element)}}{S} \xrightarrow[\text{Heat}]{\Delta} \underset{\text{(Compound)}}{Fes}$$

   On bringing magnet near to it, no Iron is attracted towards it. Also, Sulphur does not dissolve on adding carbon disulphide, thus, not showing the properties of its constituents.

6. The constituents of a compound cannot be separated by simple physical means.

Properties of Mixtures -

1. A mixture may be homogenous or heterogeneous.
2. The composition of a mixture is variable.
3. A mixture does not have a definite melting point or boiling point.
4. Energy is neither absorbed nor evolved during the formation of a mixture.
5. The properties of mixture are the properties of its constituents.

For example- If we mix Iron and Sulphur in a watch glass, we obtain a mixture. Now, if we bring a magnet near it, it attracts the iron-filings which is the property of its constituent (Iron) whereas if we dissolve it in carbon disulphide, then Sulphur gets dissolved leaving the iron-filings unchanged, thus showing the property of its constituent (Sulphur).

6. The constituents of mixture can be separated by simple physical methods.

Physical and Chemical Changes

Physical Change -

Those changes in which only physical properties of the substances change but no new substances are formed are called physical changes.

For example – Melting of ice to form water, breaking of glass, preparing a solution etc.

Chemical Change -

Those changes in which new substances are formed are called chemical changes and chemical properties of a substance gets changed in a chemical change. For example - Rusting of iron, burning a piece of paper etc.

NOTE: There are many features which distinguish a physical and a chemical change. They are as follows: -

Physical Change	Chemical Change
1. A physical change brings about change in physical properties such as physical state, shape, size etc.	1. A chemical change brings about change in chemical properties.
2. There is no change in chemical composition of a substance during physical change.	2. There is always a change in chemical composition of a substance during chemical change.
3. No new substance is formed.	3. A new substance is always formed.
4. It is temporary and hence reversible.	4. It is permanent and hence irreversible.

Tyndall Effect

If a light is passed through a medium and its path can be seen, then the substance is said to show Tyndall effect.

Example: - When a beam of sunlight enters a dark room through some hole in the window, path of light becomes visible due to scattering of light by the colloidal dust particles present in the air of cinema hall. This shows Tyndall effect.

Solutions, Suspensions and Colloids

Solution -

A solution is defined as a homogeneous mixture of two or more chemically non-reacting substances whose composition can be varied within limits.

A solution as 2 components: -

1. Solute : The component which is dissolved or which is present in small amount is called solute. It is also called dispersive medium.

2. Solvent : The component which is present in larger amount is called solvent. It is also called dispersion medium.

Types of solutions -

1. Solid in Liquid : - Like sugar in water, tincture of iodine (in it iodine is dissolved in alcohol) etc.
2. Liquid in Liquid : - Like alcohol in water etc.
3. Gas in Liquid : - Like CO_2 dissolved in water in cold-drinks.
4. Solid in Solid : - Like Alloys such as Brass (copper + zinc), Bronze (copper + tin) etc.
5. Gas in Gas : - Like in air, various gases are mixed such as O_2, N_2 etc.

6. Liquid in Solid : - Like copper sulphate in dental amalgam.
7. Gas in Solid : - Gas is adsorbed over the surface of metal.
8. Solid in Gas : - Like camphor in air.
9. Liquid in Gas : - Like clouds and fog.

Properties of Solutions -

1. A solution is a homogeneous mixture.
2. Size of particles is smaller than 1 nm (10^{-9} m).
3. The particles cannot be seen by microscope.
4. It is a stable mixture, solute does not settle down over a period of time.
5. If solution is passed through filter paper, solute and solvent do not separate.
6. It does not scatter light i.e. it do not show Tyndall effect.

Suspensions -

A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of medium.

Properties of Suspension -

1. It is a heterogeneous mixture.
2. Size of the particles is greater than 100 nm.
3. Particles can be seen by naked eyes.
4. It is unstable mixture. Solute settle down at the bottom over period of time.
5. If the solution is passed through filter paper, solute and solvent gets separated.
6. It scatters light when light is passed through the solution i.e. it shows Tyndall effect.

Colloids -

Solutions in which the size of particles lies in between those of true solutions and suspensions are called colloidal solutions or simply colloids.

Types of colloids -

Dispersed Phase	Dispersion Medium	Type	Examples
1. Solid	Solid	Solid Sol	Milky glass
2. Solid	Liquid	Sol	Muddy water
3. Solid	Gas	Solid aerosol.	Smoke
4. Liquid	Solid	Gel	Jelly
5. Liquid	Liquid	Emulsion	Milk
6. Liquid	Gas	Aerosol	Fog
7. Gas	Solid	Solid foam	Pumice stone
8. Gas	Liquid	Foam	Shaving cream

Properties of Colloids -

1. It is a heterogeneous mixture

2. Size of particles is smaller than suspensions but greater than solutions (1 nm to 100 nm).

3. Particles can be seen by microscope.

4. It is a stable mixture. Particles do not settle down at the bottom over a period of time.

5. When the solution passes through the filter paper, the solute and solvent do not separate.

6. No Tyndall effect is observed.

Terms related to Solution

1. Dilute and concentrated solution -

Dilute and concentrated are comparative terms. A solution having a small amount of solute in a given solvent is dilute whereas a large amount of solute in that given solvent is concentrated when compared with one another.

2. Unsaturated and saturated solution -

- A solution that can dissolve more solute in it at a given temperature is called unsaturated solution.

- A solution which contains maximum amount of solute dissolved in a given quantity of solvent at the given temperature and which cannot dissolve any more solute at that temperature is called saturated solution.

3. Solubility -

The maximum amount of solute that can be dissolved in 100 gm of solvent is called solubility of that solute in that solvent at a particular temperature.

Alternatively, we can say that

The amount of solute needed to make saturated solution of 100 gm of solvent is called solubility of that solute in that solvent at a particular temperature.

4. Effect of Temperature on Solubility -

(a) Solubility of Solid solute in Liquid:

- As temperature increases, solubility also increases.
- Saturated solution becomes unsaturated.
- If saturated solution is cooled down, some dissolved solute separates.

(b) Solubility of Gas in Liquid:

- As temperature increases, solubility decreases.

5. Effect of Pressure on Solubility -

(a) Solid solute in Liquid:

- As temperature increases, solubility increases.
- Pressure has no effect on solubility in case of solid solute in liquid.

(b) Gas in Liquid:

- As temperature increases, solubility decreases.
- As pressure increases, solubility increases.

This is the reason that cold drinks are packaged at high pressure.

6. Concentration of Solution -

(a) Solid in Liquid:

$$\text{Concentration} = \frac{\text{Mass of Solute}}{\text{Mass of Solution}} \times 100$$

(b) Liquid in Liquid:

$$\text{Concentration} = \frac{\text{Volume of Solute}}{\text{Volume of Solution}} \times 100$$

- Concentration is the measure of amount. It is the amount of solute present in the amount of solution.

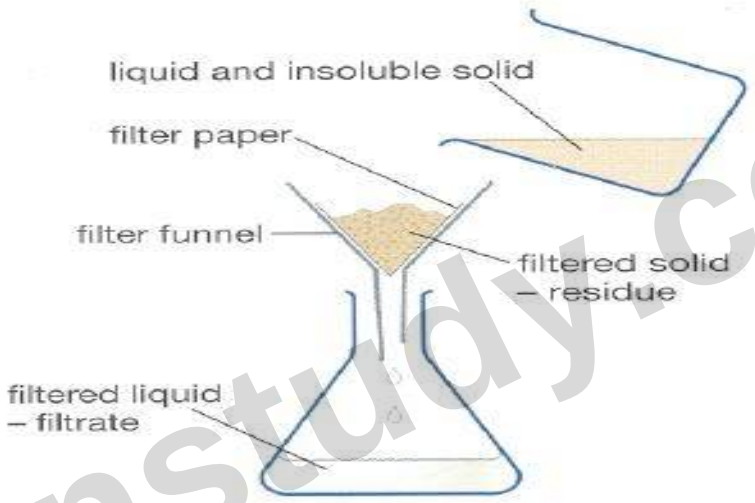
Separation of Mixtures

The method to be used for separating a mixture depends on the nature of its constituents. Here are few to separate various constituents of mixture **-**

1. Filtration:

Filtration is a process in which the solute and the solvent are separated using Filter paper. The difference in the solubility of the constituents is used to separate them in this process.

Basically, it is used to separate insoluble substances from liquid. The substance which is not soluble and remains behind on the filter paper is called residue while the one which is filtered out is called filtrate.



For example: Sand and water can be separated by the process of filtration.

2. Evaporation:

Evaporation is a process which is used to separate a substance that has dissolved in water(or any other liquid).The use of process of evaporation for separating a mixture is based on the fact that liquids vaporize easily whereas solids do not vaporize easily.

Evaporation is used for recovering dissolved solid substances from liquid mixtures(or solutions) but the liquid itself cannot be recovered by this method. The liquid vaporizes and get lost to the air. Due to evaporation, ink which is a mixture of dye and water, we can obtain its constituents separately.

3. Crystallization:

It is a process of cooling a hot, concentrated solution of a substance to obtain crystals is called crystallization. The process of crystallization is used for obtaining a pure solid substance from impure sample. This is done as follows:-

1. The impure solid substance is dissolved in the minimum amount of water to form a solution.
2. The solution is filtered to remove insoluble impurities.
3. The clear solution is heated gently on a water bath till a concentrated or a saturated solution is obtained. Then stop heating.
4. Allow the hot, concentrated solution to cool slowly.
5. Crystals of pure solid are formed. Impurities remain dissolved in the solution.
6. Separate the crystals of pure solid by filtration and dry.

Crystal of Copper Sulphate ***Solution of Copper Sulphate***

4. Chromatography:

Chromatography is a technique used for separation of those solutes that dissolve in same solvent in very small quantities, the most common being paper chromatography. This separation is based on the fact that though two or more substances are soluble in same solvent (say water) but their solubility may be different.

It can be used to separate dye from ink. The method for separation is as follows:-

- Take a thin and long strip of filter paper. Draw a pencil line on it, about three centimeters from one end.
- Put a small drop of black ink on filter paper strip at the centre of the pencil line. Let the ink dry.
- When the drop of ink has dried, the filter paper strip is lowered into a tall glass jar containing some water in its lower part (keeping the pencil line at the bottom). The strip should be held vertical. Please note that though the lower end should dip in water but pencil line should remain above the water level.
- When the water reaches the top end, the strip is removed from the jar and dried. The paper containing separate coloured spots is obtained.

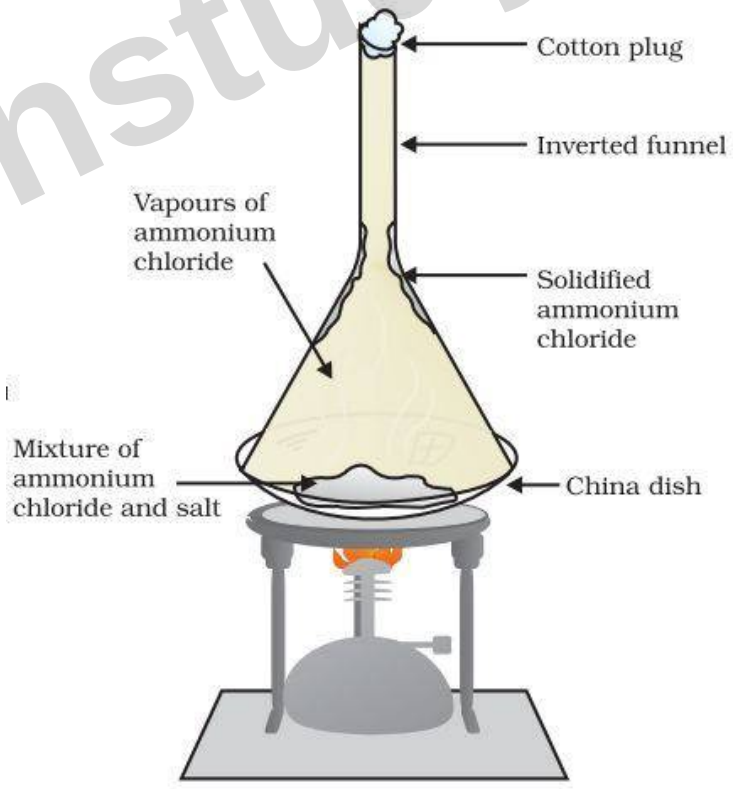
5. Sublimation:

The changing of a solid directly into vapours on heating and of vapours into solid on cooling is called sublimation. The solid which undergoes sublimation is said to sublime. The process of sublimation is used to separate those substances from mixture which sublime on heating. The solid substance obtained by cooling the vapours is known as sublimate. The substances like ammonium chloride, camphor undergo sublimation.

The process of sublimation is used to separate that component of solid-solid mixture which sublimes on heating (the other component of the mixture being non-volatile).

Here is an example to show how sublimation helps in separating common salt and ammonium chloride-

- Take a mixture of common salt and ammonium chloride in a china dish placed on a tripod stand.
- Cover the china dish with an inverted glass funnel and put a cotton plug on the open end of the funnel to prevent vapours going to the atmosphere.
- Heat the mixture using burner. On heating, ammonium chloride changes into white vapours which rise up and get converted into solid ammonium chloride on coming in contact with cold inner walls of the funnel.
- Here, pure ammonium collects on thinner walls of the funnel in the form of the sublimate and can be removed. Since common salt is not prone to sublimation so it remains behind in the china dish.

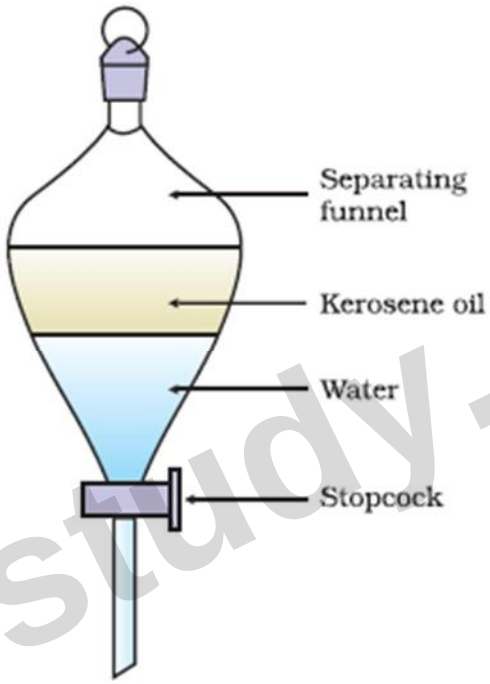


6. Separation of Two Immiscible Liquids:

This process is used to separate 2 liquids which don't mix into one another. These two immiscible liquids are separated through separating funnel.

A separating funnel is a type of funnel which has a stopcock in its stem to allow the flow of liquid from it , or to stop the flow of liquid from it. The separation of two immiscible liquids depends on the difference in their densities. Example - Kerosene Oil and water.

Figure below shows separation of Kerosene oil and water.



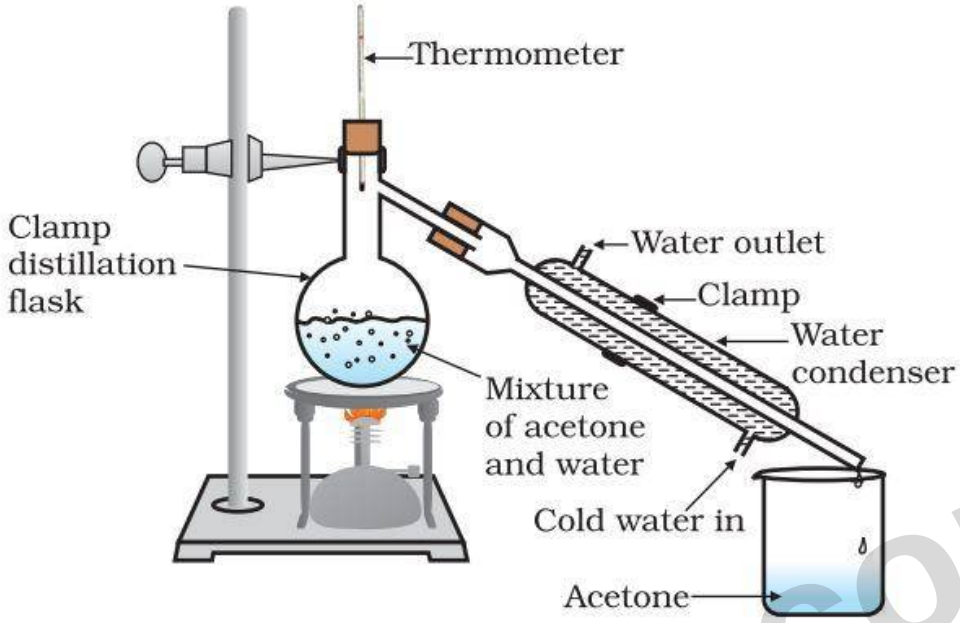
Kerosene Oil having low density settles to the top of water and water is easily obtained by opening the stopcock of the funnel.

NOTE: - The principle is that immiscible liquids separate out in layers depending on their densities.

7. Separation of Miscible Liquids / Distillation:

This process is used to separate 2 liquids which are miscible i.e. they mix into each other in all proportions and form a single layer when put in a container. In this method , we start heating a liquid to form vapour , then cooling the vapour to get back liquid. The liquid obtained by condensing the the vapour is called distillate. This process is used for those liquids which have sufficient difference in their boiling points.

Figure below shows the process of distillation.



This process is valid only when the difference in boiling point is more than 25 K.

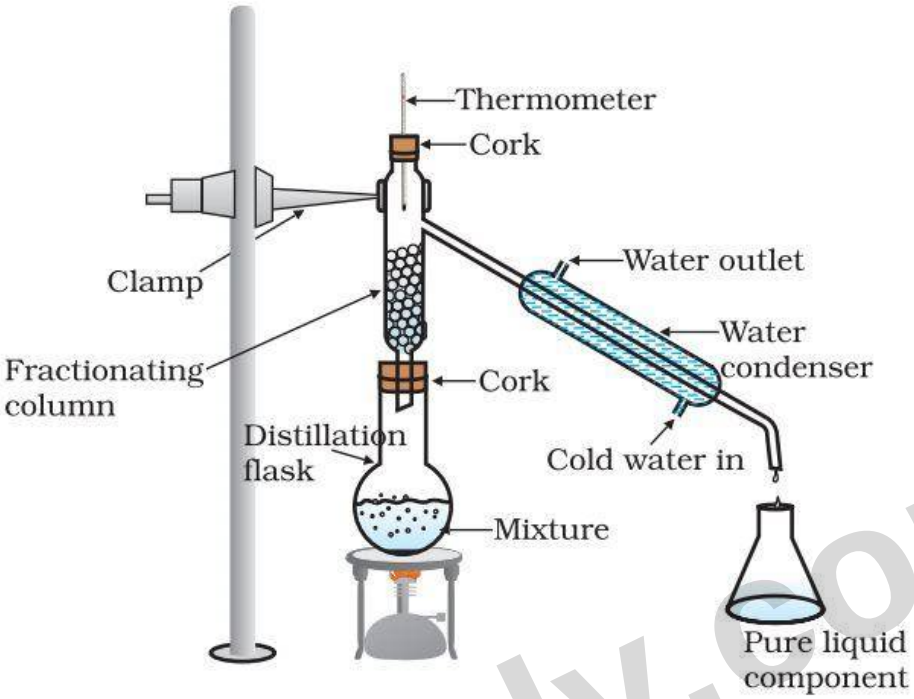
8. Fractional Distillation:

Fractional distillation is a process of separating two or more miscible liquids by distillation, the distillate being collected in fractions boiling at different temperatures.

When the boiling point difference between 2 miscible liquids is less than 25 K, then fractional distillation is used. In this process, except distillation apparatus, a fractionating column is fitted in between distillation flask and the condenser.

A simple fractionating column has glass beads. These beads provide surface for vapour to cool and condense rapidly.

Figure above shows the process of Fractional distillation.



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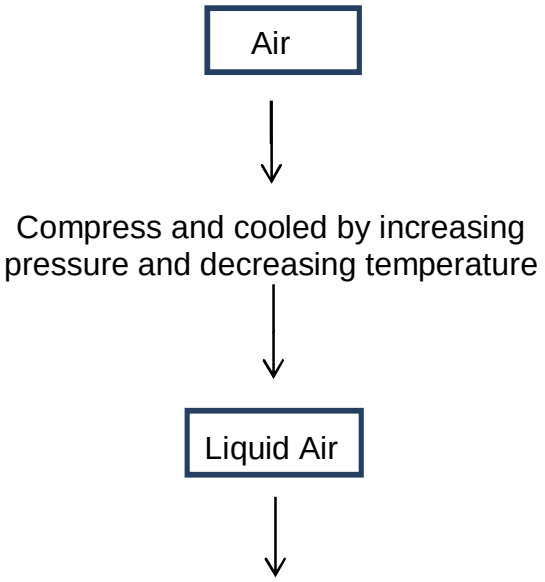
9. Separation of Gases from Air

Air is a ***homogeneous*** mixture of gases and can be separated into its constituents by fractional distillation. The flow diagram shows the steps of process:



Allow to arm up slowly in
fractional distillation column

Gases get separated at different heights

10. Centrifugation:

If we have a mixture of fine suspended particles in liquid, we can separate it through filtration but that is time consuming .So, we use the process of centrifugation to rapidly separate the mixture. Centrifugation is done by a machine called centrifuge.

Centrifugation is a method for separating the suspended particles of a substance from a liquid in which the mixture is rotated (or spun) at high speed in a centrifuge.

As the mixture rotates rapidly, a force acts on heavier suspended particles in it and brings them down to the bottom. The clear liquid being lighter remains on the top. This process is used to separate cream from milk.

11. Cleaning Water for Drinking

To have clean water we need to pass the water obtained from lake through a long process. It is as follows -

1. **SEDIMENTATION TANK -** Heavy impure particles settle down when water is left for some time.
2. **LOADING TANK -** Alum is mixed with water. Even small suspended particles settle down.
3. **FILTRATION TANK -** It has 3 layers of fine sand, coarse sand & tiny stones. When water passes through them, it is further cleaned.
4. **CHLORINATION TANK -** Chlorine is mixed with water in the tank. It kills gems. Now water is sent to home.

Classification of Matter

We have studied that matter are of two types – Pure and Impure. Elements are pure matters.
Around 100 **elements** exist in nature. Out of those, around 92 are natural and rests are man- made elements. Among them 2 elements are liquid in state - Bromine and Mercury whereas 11 of them exhibit gaseous state like hydrogen , oxygen, nitrogen etc. Thus, most of them are solid in nature.
Cesium and Gallium are solid at room temperature but tends to change into liquid when temperature increases**.**

Properties of metals and non-metals -

Metals	Non-metals
1. Metals are luster.	Non-metals do not have luster.
2. They are generally grey or gold n colour.	They posses multiple colours.
3. They conduct heat & electricity.	They do not conduct heat & electricity.
4. They are malleable i.e. they can be beaten into thin sheets.	They are non malleable i.e. they cannot be beaten into thin sheets.
5. They are ductile i.e. they can be drawn into thin wires.	They are non ductile i.e. they cannot be drawn into thin wires.
6. They are sonorous i.e. they produce sound when hit.	They are non sonorous i.e. they do not produce sound when hit.

Metalloids -

They are those elements which have properties of both metal and non-metal. For example - Germanium, Silicon etc.