INTRODUCTION

In the previous chapter, we have discussed the three physical states of matter i.e., solid, liquid and gas. We have also studied their characteristics and the effect of temperature and pressure on these physical states. In the present chapter, we shall consider the chemical nature of matter. We know that the matter is made of one or moter components known as substances. In terms of science, a substance is a kind of matter which cannot be separated into any other types of matter by some physical means, Such a substance which has only one component and nothing else in it is called a pure substance. But it is quite difficult to get a pure substance as such. Substances are mostly mixed with one another and their combination is known as mixture. Please note that it is possible to mix the substances belonging to all the three states of matter. Therefore, different types of mixtures are possible. For example, in air a number of gases like nitrogen, oxygen, carbon dioxide and water vapours are present. It is therefore, a mixture. We shall discuss the types of the mixtures that are possible and also the methods used for the separation of the pure substances from the mixtures.

PURE SUBSTANCES

For an ordinary or common person, a pure substance means that it is free from adulteration i.e., free from any undesirable impurities which are added either purposely or get mixed with it of their own. For example, if you go to the shop of a general merchant and ask for some cooking oil or ghee, he will show you various varieties. On each packet or bottle, you can find the label 'pure and free from contamination'. No, doubt that oil or ghee is pure for a common man but not from scientific point of view. If we happen to go to a doctor, he will suggest morning walk so as to breath in pure air. Is that air actually pure in the eyes of a scientist ? No, it is not. Then what about a pure substance.

A few consumable items free from adulteration. But these are not pure according to science.

A pure substance means a single substance (or matter) which cannot he separated into other kinds of matter by any physical process.

Thus, ghee or oil is not a pure substance because it has a number of other substances mixed with it. Similarly, air is also not a pure substance as a number of gases like oxygen, nitrogen, carbon dioxide, water vapours etc. are present in it. Does this mean that a completely pure substance is never available. It is not like that. Single substances free from any other substance are pure substances. Metals like copper, silver, gold etc. in completely pure form are pure substances. Similarly, completely pure water is also a pure substance.

What are the types of Pure Substances ?

We have learnt that pure substances are single in nature and presence of any other substance makes them impure. Please note that the pure substances have been classified into two types. These are elements and compounds. Let us briefly study the nature and characteristics of both of them.

The earth's crust is made mainly from two elements i.e. oxygen $(46{\cdot}6\%)$ and silicon $(27{\cdot}7\%)$. The rest of the elements are present in lesser proportions.

ELEMENTS

The word element was introduced for the first time by Lavoisier. French chemist. According to him,

an element is the simplest or basic form of a pure substance which cannot be broken into anything simpler than it by physical or chemical methods.

The later studies by Dalton have shown that the simplest form of matter is atom. In the light of this, the definition of an element has been modified It may now be defined as

the pure substance which is made up of one kind of atoms only.

> **Do you know ?**
> All living tings, both plants and animals only. These are oxygen (65%) carbon (18%), hydrogen (10%), nitrogen (3%), calcium (2%) along with some other elements

The common examples of elements are hydrogen, carbon, oxygen, nitrogen, sulphur, copper, silver, gold etc. Please note that the elements are the building blocks from which the entire universe is made. Although nearly 118 elements are known, the universe is made mainly from the two. These are hydrogen (92%) and helium (7%) and the rest of the elements have a contribution of only 1% by mass. Out of the known elements, only about 92 have been found to be present in nature, the rest have been synthesised by the scientists in the laboratory. The man made elements are also known as synthetic elements. Earth is a major source of the elements. These are distributed in the different parts of the earth known as atmosphere, hydrosphere and lithosphere.

> All the known elements have been identified with the help of symbols'. No two elements have the same symbol. We shall study in detail about this in the next chapter.

TYPES OF ELEMENTS

Elements are further classified into three types on the basis of their physical state and properties. These are metals, non-metals and metalloids. We are giving a brief description of these three types of elements.

METALS

We have already mentioned that about 92 elements have been found to be present in nature i.e., these are naturally occurring. Out of these, nearly 70 elements belong to a particular class known as metals. In the metals, the atoms are very closely packed together and have special types of bonds known as metallic bonds. Because of very tight or close packing, the metals are quite hard. The important characteristics of the metal are listed.

1. Metals are solids at room temperature.

Exception : Mercury is a liquid at room temperature. Gallium and Cesium become liquid at a temperature slightly above room temperature (303 K).

2. Metals have shining surfaces. They have generally silver-grey or golden-yellow surfaces. This property is known as luster.

3. Metals are good conductors of heat and electricity.

4. Metals are generally quite hard.

Exception : Metals like sodium and potassium are soft.

5. Metals are malleable in nature. It means that they can be beaten to form very fine thin sheets. For example, fine aluminium foils are used for wrapping different types of food. Similarly, thin foils of silver are used for decorating sweets.

6. Metals are ductile in nature. It means that very fine and thin wires can be drawn from the metals. For example, all electric wires drawn from different metals are very fine.

7. Metals are sonorous which means that when they are bent or hit, they produce a tinkling sound.

8. Metals have generally high melting and boiling points.

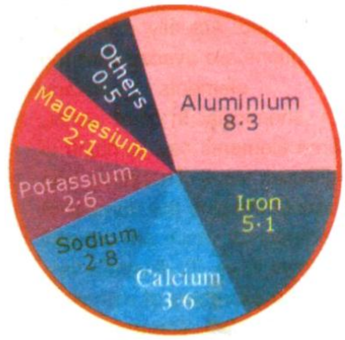
Examples : A few commonly used metals are copper, silver, gold, aluminum, iron, sodium, potassium, calcium, magnesium etc. As pointed earlier, mercury metal which is used in thermometers is a liquid at room temperature. It is silvery white In colour.

> The sound produced on bending a tin foil is known as 'tin cry'.

Among the metals, aluminium is the most abundant in earth's crust. Iron, calcium and sodium are the other metals which follow aluminium in order of decreasing abundance. Apart from earth, there are other sources from where metals can be obtained. For example, magnesium is present in chlorophyll, iron is a constituent of haemoglobin whereas zinc is found to be present in traces in the eyes of certain animals. Sea is also the source of metals like sodium, potassium, calcium and magnesium etc. These are present in the sea water as soluble salts and are mostly halides in nature.

NON METALS

Non-metals as the name suggests are opposite to metals which means that their properties are quite different from the metals. They are comparatively less in number. Only about fourteen to fifteen elements Eire non-metals. The important properties of the non-metals are listed.



Relative percentage of some metals in earth's crust.

1. Non-metals are either gases or solids at room temperature.
Exception : Bromine is a liquid at room temperature.
2. Non-metals vary in colour. Solids have generally dull surfaces.
Exception : Crystals of iodine have bright luster.
3. Non-metals are mostly poor conductors of heat and electricity.
Exception : Graphite is a good conductor of electricity.
4. Most of the non-metals are quite soft and have smaller densities than metals.
Exception : Diamond is very hard. It is probably the hardest substance known.
5. Non-metals are non-malleable and non-ductile in nature.
6. Non-metals are also not sonorous in nature.
7. As compared to metals, the non-metals have very low melting and boiling points.
Examples : Common examples of non-metals are carbon (coke, coal, charcoal), nitrogen, oxygen, chlorine, bromine, iodine, phosphorus, sulphur etc.

METALLOIDS

There are a few elements which possess the characteristics of both the metals and non-metals. These are actually border-line elements and are known as metalloids. A few common examples of metalloids are : Arsenic, Antimony, Bismuth.

• Only 92 elements occur in nature. The remaining elements are synthetic or man made.
• Most of the elements are solids and about 11 elements are gaseous in nature at room temperature.
• Elements bromine and mercury are liquids at room temperature.
• Elements cesium and gallium are liquids above 30°C. Below this temperature, they exist as solids.
• Metals and non-metals differ in most of their properties. This is on account of the difference in the structures of atoms belonging to these.

COMPOUNDS OR CHEMICAL COMPOUNDS

A compound is also a pure substance like element. But it represents a combination of two or more elements which are combined chemically. That is why, it is known as a chemical compound. A compound may be defined as:

a pure substance containing two or more elements which are combined together in a fixed proportion by mass.

For example, water is represented by the chemical formula H_2O (we shall discuss the same in the next chapter). In it, the two elements hydrogen and oxygen are present in the ratio of 2 : 16 or l : 8 by mass. Please note that water may be obtained from a number of sources such as rain, river, sea, well, lake etc. In the pure form of water from any source, the two elements are present in the same fixed ratio i.e., 1 : 8 by mass. We shall study in the next chapter that these elements are combined according to a law known as the law of constant composition. The same is the case with other compounds also.

TYPES OF COMPOUNDS

The compounds have been classified into two types. These are :
(a) Inorganic compounds : These compounds have been mostly obtained from non-living sources such as rocks and minerals. A few examples of inorganic compounds are : common salt, marble, washing soda, baking soda, carbon dioxide, ammonia, sulphuric acid etc.
(b) Organic compounds : The word 'organ' relates to different organs of living beings. Therefore, organic compounds are the compounds which are obtained from living beings i.e.. plants and animals. It has been found that all the organic compounds contain carbon as their essential constituents. Therefore, the organic compounds are quite often known as 'carbon compounds'. A few common examples of organic compounds are : methane, ethane, propane (all constituents of cooking gas), alcohol, acetic arid, sugar, proteins, oils, fats etc.

We have classified the chemical compounds baaed upon their source of origin. In addition to this, they have been classified as acids, bases and salts based upon their characteristics. For example, sulphuric acid, hydrochloric acid, nitric acid are the common acids. Sodium hydroxide, potassium hydroxide and calcium hydroxide are the well known bases. The list of salts includes sodium chloride, calcium nitrate, zinc sulphate etc. It may be noted that the salts are generally formed by the chemical combination of acid and base dissolved in water. For example.

sodium hydroxide + hydrochloric acid $\xrightarrow{(In\,water)}$ sodium chloride + water
(base) (acid) (salt)

Characteristics of Compounds

The important characteristics of the compounds are listed :

•A pure compound is composed of the same elements

As mentioned earlier, in a compound the same elements are always present in fixed ratio by mass whatever may be its mode of formation. For example, in carbon dioxide, two elements carbon and oxygen are present in the ratio of 3 : 8 by mass.

2. A pure compound is homogeneous in nature It means that if we select two or more samples of a pure compound and find the ratio of the constituent elements, it remains the same.

3. A chemical compound is formed as a result of chemical reaction between the constituent elements.

Please note that a compound cannot be formed by simply mixing the elements present. These are combined with each other as a result of some chemical reactions. For example, one method for preparing carbon dioxide is to bum coke (carbon) in air (a source of oxygen)

It is nor possible to get carbon dioxide by simply mixing coke with oxygen gas.

carbon + oxygen $\xrightarrow{(Burn)}$ carbon dioxide
(Coke) (Air)

4. Properties of the compound are altogether different from the elements from which it is formed.

Since a compound is formed as a result of chemical reaction, its properties are quite different from the elements from which it is formed. For example, hydrogen gas is combustible while oxygen is a supporter of combustion. Water is formed as result of the chemical reaction between the two gases. It is neither combustible nor a supporter of combustion. Water stops combustion and is used as fire extinguisher.

5. Constituents of a chemical compound cannot be separated mechanically.

A compound as we know, is formed as a result of a chemical reaction. Its constituent elements can also be separated by means of chemical reaction and not mechanically. For example, hydrogen, oxygen, the constituents of water can be separated from it by passing electric current. This is known as the electrolysis of water.

Purity of compounds can be tested by determining their melting points. For example m.p. of pure sodium chloride is 1073 K. if a given sample of the salt melts at this temperature it will represent a pure sample in case the m.p. is different the sample will be impure.

6. Formation of compounds involves energy changes.

Please note that energy in the form of heat, light or electricity is either absorbed or evolved in the formation of a compound. For example, hydrogen and chlorine gases combine in the presence of sunlight to form hydrogen chloride gas.

hydrogen gas + chlorine gas $\xrightarrow{(Sunlight)}$ hydrogen chloride gas

Example 1. How will you justify that water is a compound ?

Solution. Water is considered to be a compound due to the following reasons :

(i) Water cannot be separated into its constituents hydrogen and oxygen by physical methods.

(ii) Properties of water are entirely different from its constituents hydrogen and oxygen. Hydrogen is combustible while oxygen supports combustion. Water is quite different from the two and it extinguishes fire.

(iii) Heat and light are given out when water is formed by burning hydrogen and oxygen.

(iv) The composition of water is fixed. Its constituents hydrogen and oxygen are present m the ratio of 1 : 8 by mass.

(v) Water has a fixed boiling point of 100°C (or 373 K) under atmospheric pressure of one atmosphere (or 760 mm).

TEST YOUR ABILITY

1. Is water free from suspended impurities, a pure substance ?
2. What are the major constituents of universe ?
3. Name the most abundant element in earth's crust ?
4. Name the metal which is liquid at room temperature.
5. Name one element which has the characteristics of both metals and non-metals. How do we call it ?
6. Write the main characteristics of metals and non-metals.
7. A substance can be beaten into sheets and drawn into wires. What will you call it ?
8. Number of chemical compounds is not linked with number of elements. Justify.
9. Write any three characteristics of chemical compounds.
10. Classify the following into metals and non-metals ?
(i) Helium (ii) Sodium (iii) Hydrogen (iv) Mercury (v) Graphite (vi) Lead (vii) Chlorine (viii) Phosphorus.
11. When two substances A and B are powdered together in a pestle and mortar, a large amount of heat is evolved. As a result, a new substance C is formed? What is the nature of the new substance ?

ANSWERS TO SELECTIVE PROBLEMS

1. No **2.** Hydrogen and Helium **3.** Oxygen **4.** Mercury **5.** Arsenic (Metalloid) **7.** It is both malleable and ductile. **10.** Metals : (ii), (iv), (vi) ; Non-metals : (i), (iii), (v), (vii), (viii) **11.** Compound.

IMPURE SUBSTANCES OR MIXTURES

We have so far studied in detail about pure substances. These are single in nature and may be either elements or compounds. Now, what do we get if we simply mix two or more elements or compounds. The combination is known as the mixture. For example, if we dissolve sugar in water which are both pure compounds, the sugar solution in water is known as a mixture. It has been formed by simple mixing without any chemical reaction. Moreover, sugar and water can be present in any ratio. In the light of the above discussion, a mixture may be defined as :

the combination of two or more substances (elements or compounds) which are not chemically combined with each other and may also be present in any proportion.

> Elements and compounds are pure substances. Mixtures are not pure substance in terms of science.

We have considered the example of sugar solution. There are different ways in which mixtures are formed. Moreover, it is normally not possible for substances to exist in pure form. They exist in combination with each other to form a mixture. In many cases, the pure substances have less utility or application. In the form of mixture, these are more useful. One such example is of gold. The purity of gold is expressed in carats. Completely pure gold (or 100 percent gold) is 24 carats. As such, it is not useful in making coins or ornaments because it is very soft and cannot stand wear and tear. It is generally mixed with a small amount of copper or silver and it becomes 22 carat gold. This is very commonly used in making ornaments and coins etc.

TYPES OF MIXTURES

We have read that mixtures are formed as a result of the combination between two or more pure substances i.e. elements or compounds or both. The mixtures are of two types. These are homogeneous and heterogeneous.

HOMOGENEOUS MIXTURES

A mixture is said to be homogeneous if the different constituents or substances present in if are uniformly mixed without any clear boundary of separation.

A homogeneous mixture has a uniform composition throughout. A few examples of homogeneous mixtures are as follows :

(a) When we dissolve a salt like sodium chloride or sugar in water, the solution formed is known as a homogeneous mixture. The different constituents are so uniformly mixed that it may not be possible to identify them. This means that there is no boundary of separation in them.

(b) Air is also a homogenous mixture of a number of gases like nitrogen, oxygen, carbon

> In a homogeneous mixture the constituents or components may be present in different proportions. For example if we prepare three solutions of copper sulphate in water by taking different amounts of the crystalline solid the blue solutions thus formed will not have the same intensity of the blue colour. But all the solutions represent mixture solutions.

dioxide, water vapours, inert gases etc. All the gases present in air are uniformly mixed throughout. It is not possible to identify these gases present in air.

> In a homogeneous mixture the constituents are uniformly mixed and have no boundaries (or joins) of separation. In a heterogeneous mixture the constituents are either present in different phases or in the same phase but have clear boundaries of separation. In homogeneous mixture the constituent particles cannot be identified or seen without the help of powerful microscope. In a heterogeneous mixture these can be easily seen sometimes with naked eye only.

HETEROGENEOUS MIXTURES

A mixture is said to be heterogeneous if it does not have a uniform composition and also has visible boundaries of separation between the constituents.

A few examples of heterogeneous mixtures are listed.

(a) A mixture of sand and common salt is regarded as a heterogeneous mixture. No doubt, these are present in the same phase i.e., solid phase but have clear boundaries of separation. The particles of sand and common salt can be easily seen in the mixture.

(b) Similarly, oil and water form a heterogeneous mixture. Here also both the constituents are liquids but have different boundaries of separation. Both oil and water are present in different layers.

DIFFERENCE BETWEEN COMPOUNDS AND MIXTURES

We have seen that a compound is a pure substance formed by the combination of two or more elements. A mixture is not pure in the sense that two or more elements or compounds are involved in its formation. To decide whether a particular sample is a compound or a mixture, we have to keep in mind the following points of distinction between the two.

Distinction between compounds and a mixture

Compounds	Mixture
1. In a compound, two or more elements are combined chemically.	In a mixture, two or more elements or compounds are simply mixed and not combined chemically.
2. In a compound. the elements are present in the fixed ratio by mass. This ratio cannot change.	In a mixture, the constituents are not present in fixed ratio. It can vary.
3. Compounds are always homogeneous i.e., they have the same composition throughout.	Mixtures may be either homogeneous or heterogeneous in nature.
4. In a compound. the constituents lose their identities i.e.. a compound does not show the characteristics of the constituting elements-	In a mixture, the constituents do not lose their identities i.e., a mixture shows the characteristics of all the constituents.
5. In the formation of a compound, energy in the form of heat, light or electricity is either absorbed or evolved.	No energy change is noticed in the formation of a mixture.
6. In a compound, the constituents cannot be separated by physical means.	The constituents from a mixture can be easily separated by physical means.

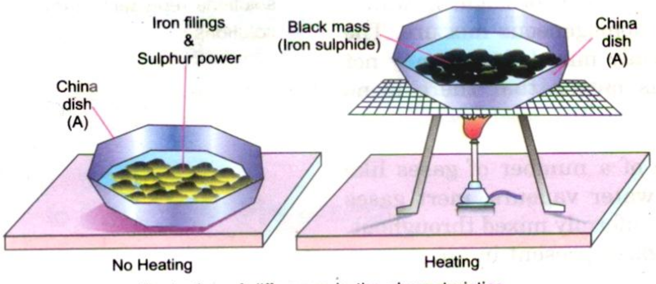


Illustration of difference in the characteristics of a mixture and a compound

ACTIVITY

Let us illustrate the main point of distinction between a mixture and a compound by the following experiment.

In two separate china dishes marked [A] and [B], take mixture of nearly 50 g of iron filings and 3 g of powdered sulphur. Keep the dish [A] as such while heat the dish [B] to red hot for sometime and then cool it.

OBSERVATIONS

1. In the china dish [A] both iron filings and sulphur powder retain their colour. In the dish [B] a black mass will be formed.
2. Bring a magnet near the mass present in both the dishes. Iron filings will readily cling to the magnet in dish [A] while this will not happen in dish [B].
3. Transfer a small amount of the mass from dish [A] into a glass tube. Add carbon disulphide (liquid) to it and shake for sometime. The yellow powder will dissolve leaving behind the iron filings in the tube. Repeat the same experiment with the mass present in dish [B] also. Nothing will happen.
4. Take a small amount of the material from dish [A] in a glass tube and add a few drops of dilute hydrochloric acid to it. A colourless and odourless gas will be evolved accompanied by brisk effervescence. This is hydrogen gas which can be confirmed by performing certain tests.
In a similar manner, add a few drops of the same acid to the material taken from the tube B. Immediately a gas with the smell similar to rotten eggs will be evolved. It is hydrogen sulphide gas.

CONCLUSION

• From the observations listed above, we conclude that in the china dish [A], both iron filings and powdered sulphur are in the form of a mixture. In the dish [B], a chemical reaction has resulted upon heating and the black mass of iron sulphide is formed. It is a compound.

> Most of the books regard mixtures as substance. These are not substances but mixture of substances which may be either elements or compounds or both. Thus it is not proper to call a mixture as a single substance.

Iron + Sulphur $\xrightarrow{\text{Heat}}$ Iron sulphide
• Iron filings present in dish [A] are attracted towards the magnet. Since iron sulphide is a compound, it is not attracted towards the magnet in dish [B].
• Carbon disulphide has dissolved sulphur present in dish [A] leaving behind iron filings.
• Dilute hydrochloric acid has reacted with iron filings in dish [A] to evolve hydrogen gas.

Iron + Hydrochloric acid $\longrightarrow$ Iron chloride + Hydrogen
At the same time, the acid has reacted with iron sulphide in dish [B] to evolve hydrogen sulphide gas. It has the smell of rotten eggs.

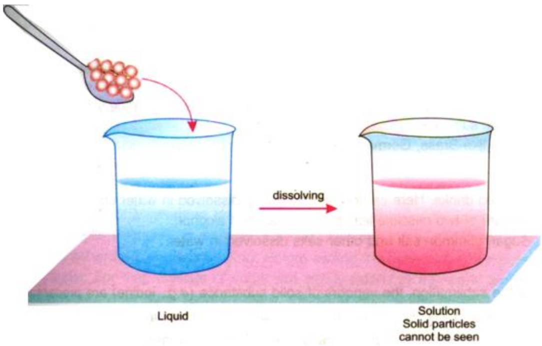
Iron sulphide + Hydrochloric acid $\longrightarrow$ Iron chloride + Hydrogen sulphide
Example 2. Classify the following as pure substances or mixtures. Separate the pure substances into elements, compounds and divide the mixtures into homogeneous and heterogeneous :
(i) Air (ii) Milk (iii) Graphite (iv) Gasoline fv) Diamond (vi) Tap water (vii) Distilled water (viii) Oxygen (ix) Brass (x) 22 Carat gold (xi) Steel (xii) Iron (xiii) Sodium chloride (xiv) Iodised table salt.
Solution. (i) Air : Mixture (Homogeneous)
(ii) Milk : Mixture (Homogeneous)
(iii) Graphite : Pure substance (Element)
(iv) Gasoline : Mixture (Homogeneous)
(v) Diamond : Pure substance (Element)
(vi) Tap water : Mixture (Homogeneous)
(vii) Distilled water : Pure substance (Compound)
(viii) Oxygen : Pure substance (Element)
(ix) Brass : Mixture (Homogeneous)
(x) 22 Carat gold : Mixture (Homogeneous)
(xi) Steel : Mixture (Homogeneous)
(xii) Iron : Pure substance (Element)
(xiii) Sodium chloride : Pure substance (Compound)
(xiv) lodized table salt : Mixture (Heterogeneous)

Example 3. How will you justify that air is a mixture and not a compound ?
Solution. The justification can be done on the basis of the following points m its support.
1. The composition of air is not always the same. At high altitudes, the percentage of oxygen decreases. Similarly, in industrial towns, we normally say that the air is more polluted. This means that the percentages of carbon monoxide, sulphur dioxide and other poisonous gases in air has increased.
2. The major constituents of air can be easily separated by physical methods such as liquefication. fractional distillation etc. We shall discuss these methods a little later in the present chapter.

3. The different gases present in air do not lose their identities. For example, air supports combustion which means that it contains oxygen. Similarly, air turns lime water milky. This establishes the presence of carbon dioxide in air.
4. No energy changes or no chemical reactions occur when the constituents of air are tried to be mixed.
All these evidences support the fact that air is a mixture and not a compound.
In terms of science, a pure substance has only one component and nothing else in It.
•Pure substances are of two types. These are elements and compounds.
•An element is a pure substance made up of one type of atoms only.
•Elements are classified as metals, non-metals and metalloids
•Aluminium is the most abundant metal present in earth's crust.
•Metals are malleable (beaten into sheets) and ductile (drawn into wires).
•Diamond is probably the hardest substance known.
•A chemical compound is a pure substance which contains two or more elements combined together in fixed proportion by mass.
•Number of elements is limited (about 118) but the number of compounds is unlimited.
•A mixture cannot be regarded as a pure substance in terms of science.
•A mixture is not a single substance but a combination of two more substances (elements or compounds).
•In a homogeneous mixture, the constituents present are uniformly mixed without any visible boundaries of separation.
•In a heterogeneous mixture the constituents are not uniformly mixed and have clear boundaries of separation,

WHAT IS A SOLUTION ?

In the discussion of homogeneous mixtures, we have stated that these are solutions. Actually, when one substance dissolves or mixes well with another substance, we regard the mixture as the solution. Whenever we think about any solution, we imagine that it must have been prepared by mixing some solid substance in a liquid. In the previous chapter, we have read that there are empty spaces present in a liquid in which particles of a solid can be very easily accommodated. The mixture of the solid dissolved in a liquid is known as the solution.



Formation of a solution by mixing solid in a liquid.

About tow third of the earth's surface is covered by sea which is a solution of different salts dissolved in water. Along with salt some gases like oxygen carbon dioxide are also dissolved in sea eater. These are quite useful for life to continue in sea or ocean particularly of the sea animals.

From the above discussion, we conclude that a homogeneous mixture of two or more substances is regarded as a solution. A solution may be defined as :
a homogeneous mixture of two or more non-reacting substances whose composition can also be varied within certain limits.
A solution is sometimes also called a true solution.

COMPONENTS OF A SOLUTION

In a solution, any number of components or constituents can be present as is the case of sea water. However, for the sake of convenience, we shall consider only binary solutions. Such solutions have only two constituents or components. These are known as solute and solvent.

In a binary solution the component present in small amount is called solute while the one in greater amount or proportion is kwon as solvent.

For example, we dissolve sugar in water to prepare the sugar solution. In this solution, sugar acts as the solute and water as the solvent.

TYPES O(SOLUTIONS

Solid, liquid and gas are the three phases in which substances are distributed. All of them can form homogeneous mixtures or solutions. This means that in a binary solution, any of these can act as the solvent or solute. Nine different types of binary solutions are possible. These have been further divided into three types depending upon the nature of the substance acting as the solvent. The three types of solutions are

• Solid solutions : In these, solid acts as the solvent,

• Liquid solutions : In these, liquid acts as the solvent.

• Gaseous solutions : In these, gas acts as the solvent.

The different solutions belonging to these types along with a few examples are listed in a tabular form.

Types of binary solutions

Solute	Solvent	Examples
Solid Solutions		
Gas	Solid	Gases present on metal surface under high pressure e.g. nitrogen (N2) and hydrogen (H2) on the surface of Ni metal.
Liquid	Solid	Salts having water of crystallisation or hydrated salts e.g., Blue vitriol or hydrated copper sulphate.
Solid	Solid	Alloys like Brass, German silver etc.
Liquid Solutions		
Gas	Liquid	Aerated drinks. Here carbon dioxide gas is dissolved in water under pressure
Liquid	Liquid	Mixture of two miscible liquids i.e., water and alcohol.
Solid	liquid	Sugar, common salt and other salts dissolved in water.
Gaseous Solutions		
Solid	Gas	In the sublimation. the vapours of solid substance (e.g.. iodine) are present in air.
liquid	Gas	Clouds and fog. Here water drops (liquid) are dissolved in air (gas)
Gas	Gas	Air represents a mixture of gases like nitrogen, oxygen. carbon dioxide, water vapours etc.

• Only a mixture of miscible liquids is a solution. In case they do not mix with each other and form separate layers (e.g.. oil and water), such a solution is known as emulsion. We shall study emulsions under colloidal solutions

• Alloys are the homogeneous mixture of two or more metals. Although the constituents are solids, alloys are regarded as the solutions.

> Hydrogen chloride gas is a students. pure substance since it is a chemical compound i.e., HCI(g). However. Hydrochloric acid prepared by passing the gas into water is a homogeneous mixture. It is therefore, a solution.

EXAMPLES OF SOLUTIONS

A few examples of the solutions are given for the benefit of the students.

• Sugar in water. In this solution, sugar is the solute while water acts as the solvent. It is an example of solid in liquid solution (liquid solution).

• Iodine in alcohol. Here, iodine (a crystalline violet solid) is the solute and alcohol (ethyl alcohol) behaves as the solvent. The solution is quite often known as tincture of iodine. It is used as an antiseptic in case of wounds. It is an example of solid in liquid solution (liquid solution).

• Aerated drinks (such as soda water), Here carbon dioxide gas is dissolved in water under pressure, It is an example of gas in liquid solution (liquid solution).

• Air. It is a homogeneous mixture of different gases. Out of these, oxygen (21%) and nitrogen (78%) are the main constituents while the other gases are present in small proportions. It is a solution of gas in gas (gaseous solution).

• Copper sulphate in water. In this blue solution, copper sulphate acts as the solute while water is the solvent. It is an example of solid in liquid solution (liquid solution).

• Brass. It is an alloy which contains nearly 70% copper and 30% zinc by ma3a. It is homogeneous in nature and is an example of solid in solid solution (solid solution).

SATURATED AND UNSATURATED SOLUTIONS

Although nine different types of solutions are known, but the most common among them are those in which liquid acts as the solvent and solid as the solute. The solutions of different salts in water and sugar solution all belong to this type. These solutions have been further classified as saturated and unsaturated.

A solution is saturated if it has the maximum amount of the solute dissolved in it at a given temperature. In case it is less than the maximum amount the solution is regarded as unsaturated solution.

ACTIVITY

The formation of a saturated solution can be illustrated by nimbu pani which we prepare quite frequently in summer. For that, a certain amount of water is taken in a container (e.g., a glass beaker). Before adding the nimbu juice, we generally mix sugar. For that, crystals of sugar are slowly added to the water along with occasional stirring by a spoon, Initially, the sugar will readily dissolve in water. But slowly and slowly, the process of dissolution will become difficult. 11 we go on adding sugar to the solution which is formed, a stage will be reached when it will not dissolve any further. It will start settling at the bottom of the container i.e., beaker in this case. At this stage. the solution is regarded as saturated solution.

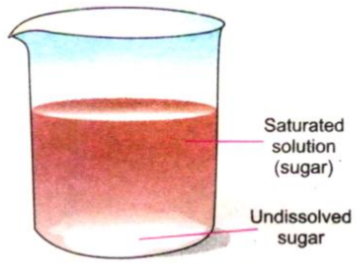


Illustration of a saturated solution.

a solution becomes saturated if the solute starts separating at the bottom of the container in which the solution is being prepared at a given temperature.

A saturated solution generally becomes unsaturated upon heating

It has been stated that a solution which has less than the maximum amount of the solute present in it at a given temperature is unsaturated. In other words, a solution which has still an urge or desire to dissolve more of the solute is an unsaturated solution. Saturated solutions generally become unsaturated upon heating. If a beaker (Fig. 2.5) containing saturated sugar solution is heated slowly, we find that sugar deposited at the bottom of it will slowly dissolve till the solution becomes dear. This shows that the solution has become unsaturated upon heating.

We have read that if a solution has les than the maximum amount of the solute dissolved it is called unsaturated solution. At the same time the solution having maximum amount of the solute is saturated. What will we call a solution if it has more than the maximum amount of the solute present ? such a solution is known as super saturate solution .

PROPERTIES OF A SOLUTION

The properties of a solution are as follows :

1. A solution is of homogeneous nature which means that it has the same composition throughout.

2. All the components or constituents in a solution are present in the same phase.

3. The size of the solute particles in a solution is very small (the diameter of the particles is generally less than 1 nm or 10^{-9} m).

4. Particles of a solution cannot be seen by naked eye or by ordinary microscope.

5. In a solution, the solute particles are so small that they can pass through the pores of even fine filter papers. This means that solute cannot be separated from the solvent by filtration.

Please note that aqueous means large excess of water. Whenever we try to dissolve a solute in water to prepare a solution we do not bother whether the water that we are adding is only in required amount or more. It is generally more than what is actually needed. That is why the word aqueous is used for such a solution. For example an aqueous solution chloride in water is represented as NaCI (aq).

6. If a solution is left alone even for a very long time, the solute particles present in it do not settle down. This shows that a solution is quite stable in nature.

7. Due to the very small size, the solute particles in a solution do not scatter a beam of light i{ made to pass through it. This means that the path of the light is not visible in a solution.

8. A solution having maximum amount of the solute dissolved at a particular temperature is known as saturated solution. If it is less than the maximum amount, the solution is unsaturated in nature.

9. A saturated solution generally becomes unsaturated upon heating.

10. A solution in which water acts as the solvent is regarded as the aqueous solution while the one in which any other liquid is the solvent is known as non-aqueous solution. For example,
Solution of salt in water is aqueous solution. Solution of bromine in carbon tetrachloride is non-aqueous solution.

CONCENTRATION OF A SOLUTION

We have read that a binary solution has two components or constituents. These are solute and solvent. The relative amounts of the solute and solvent in the solution either by mass or by volume, represent the concentration of the solution. Based upon these, solutions are of different types like dilute, concentrated, saturated and unsaturated.

EXPRESSING THE CONCENTRATION OF A SOLUTION

The concentration of a solution is expressed as the amount of the solute present in a given amount of the solvent or solution. It is normally expressed as mass percent or as volume percent.

MASS PERCENT

- Both mass percent and volume percent are simply ratios an have no units.
- Concentration of solution can also be expressed as weight/ volume (W/V)

Mass percent of a solution may be defined as :
the number of parts by mass of one component (solute or solvent) per 100 parts by mass of the solution.
It A and B are the two components of a binary solution,

Mass percent of $A = \frac{W_A}{W_A + W_B} \times 100$

Mass percent of $B = \frac{W_B}{W_A + W_B} \times 100$

•VOLUME PERCENT

Volume percent of a solution may be defined as :
the number of parts by volume of one component (solute or solvent) per 100 parts by volume of the solution.

Mathematically Volume percent of $A = \frac{V_A}{V_A + V_B} \times 100$

Volume percent of $B = \frac{V_B}{V_A + V_B} \times 100$

Example 4 : A solution has been prepared by dissolving 5g of urea in 95 g of water. What is the mass percent of urea in the solution ?

Solution. Mass percent (Mass %) $= \frac{Mass\ of\ solute}{Mass\ of\ solutoin} \times 100$

Mass of urea = 5 g, Mass of water = 95 g

Mass percent of urea $= \frac{(5g)}{(5g + 95g)} \times 100 = 5\%$

•Example 5. Calculate the masses of cane sugar and water required to prepare 250 g of 25 % solution of cane sugar.

Solution. Mass percent $= \frac{Mass\ of\ solute}{Maa\ of\ solution} \times 100$

Mass percent = 25 g, Mass of solution = 2520 g

$\therefore \quad 25 = \frac{Mass\ of\ cane\ sugar}{(250\,g)} \times 100$

$\therefore$ Mass of cane sugar $= \frac{25 \times (250g)}{100} = 62{\cdot}5\,g$

Mass of water $= 250 - 62{\cdot}5 = 187{\cdot}5\,g$

Example 6. A solution cantinas 35 g of common salt in 300 g of water. Calculate the concentration of the solution.

Solution. Concentration of solution $= \dfrac{Mass\ of\ solute}{Mass\ of\ solution} \times 100$

Mass of common salt = 35 g
Mass of water = 300 g
Mass of solution = (300 + 35) = 335 g

Concentration of solution $= \dfrac{(35g)}{(335g)} \times 100 = 10{\cdot}45\,\%$.

Example 7. A solution contain 5 mL of alcohol mixed with 75 mL of water. Calculate the concentration of solution in terms of volume percent.

Solution. Concentration of solution $= \dfrac{Volume\ of\ solute}{Volume\ of\ solution} \times 100$

Volume of alcohol = 5 mL
Volume of solution = (5 + 75) = 80 mL

Concentration of solution $= \dfrac{(5\,mL)}{(80\,mL)} \times 100 = 6{\cdot}25\,\%$

STRENGTH OF A SOLUTION

In addition of mass percent and volume percent, the concentration of a solution may also be expressed in terms of strength. It may be defined as :

The amount of the solute in grams present in one litre (or dm ^{3}) of the solution

Mathematically, Strength $= \dfrac{Mass\ of\ solute\ in\ grams}{Volume\ of\ solution\ in\ liters\ (or\ dm^3)}$

Example 8. Calculate the strength of a solution containing 5 g of glucose in 200 mL of the solution.

Solution. Strength of solution $= \dfrac{Mass\ of\ solute}{Volume\ of\ solution\ in\ liters}$

Mass of glucose = 5 g

Volume of solution = 200 mL $= \dfrac{200}{1000} = 0{\cdot}2\,L$

Strength of solution $= \dfrac{5\,g}{0{\cdot}2\,L} = 25\,g\,/\,L$

SOLUBILITY OF A SOLUTE

The solubility of a solute in a solution is always expressed with respect to the saturated solution. It may be defined as :

The maximum amount of the solute which can be dissolved in 100 g $(0{\cdot}1kg)$ of the solvent to form a saturated solution at a given temperature

Example.9. 4 g of a solute are dissolved in 40 g of water to form a saturated solution at 25^oC Calculate the solubility of the solute.

Solution. Solution (in saturated solution) $= \dfrac{Mass\ of\ solute}{Mass\ of\ solvent} \times 100$

Mass of solute = 4 g
Mass of solvent = 40 g

Solubility (in saturated solution) $= \dfrac{(4\,g)}{(40\,g)} \times (100g) = 10\,g$

Example 10. (a) What mass of potassium chloride would be needed to form a saturated solution in 50 g of water at 298 K ? Given that solubility the salt is 46/100 g at this temperature.
(b) What will happen if this solution is cooled ?

Solution. (a) Mass of potassium chloride in 100 g of water in saturated solution = 46 g
Mass of potassium chloride in 50 g of water in saturated solution

$$= \frac{(46\,g)}{(100\,g)} \times (50g) = 23\,g$$

(b) When the solution is cooled, the solubility of salt in water will decrease. The means that upon cooling, it will start separating from the solution in crystalline.

EFFECT OF TEMPERATURE ON THE SOLUBILITY OF SALT IN WATER

Whenever we talk about the solubility of a salt, the temperature at which the process of dissolution is carried is always mentioned. This means that the solubilities of salts in solvents (generally water) are influenced by the change in temperature. Actually, the effect of temperature depends upon the heat energy changes which accompany the process.

• If heat energy is needed or absorbed in the process, it is of endothermic nature.

• If heat energy is evolved or released in the process, it is of exothermic nature.

> • While expressing the solubility the solution must be saturated but for expressing concentration (mass percent or volume percent) the solution need not be saturated in nature.
> • While expressing solubility mass of solvent is considered but for expressing concentration the mass or volume of the solution is taken into consideration.

Effect of temperature on endothermic dissolution process

Most of the salts like sodium chloride, potassium chloride, sodium consideration. nitrate, ammonium chloride etc. dissolve in water with the absorption of heat. It is used up to separate the ions from these salts which later on dissolve in water. In all these salts, the solubility increases with rise in temperature. This means that sodium chloride becomes more soluble in water upon heating.

Effect of temperature on exothermic dissolution process

Only a few salts like lithium carbonate, sodium carbonate monohydrate, cerium sulphate etc. dissolve in water with the evolution of heat. This means that the process is of exothermic nature. In these salts, the solubility in water decreases with rise in temperature.

A homogeneous mixture of two or more non-reacting substances is called a solution.

•In a binary solution, the component present in small amount is called solute while the one in greater amount or proportion is known as solvent.

•Liquid solutions in which liquid acts as the solvent and solid is the solute are very common.

•A solution containing maximum amount of the solute dissolved in it at a given temperature is called saturated solution.

•A saturated solution becomes unsaturated upon heating or upon dilution.

•A solution in which water acts as the solvent, is known as aqueous solution. A solution in which any other liquid acts as the solvent, is called non-aqueous solution.

•The amount of the solute present In one litre (or dm^3) of solution represents the strength of the solution.

•The maximum amount of the solute which can be dissolved in 100 g of the solvent to form a saturated solution at a given temperature, is known as solubility.

TEST YOUR ABILITY

1. What type of mixture does a solution represent ?
2. Give one example of a solution in which liquid is a solute as well as solvent.
3. Write the characteristics of a solution.
4. Give one example of a non-aqueous solution.
5. Give the main points of distinction between a compound and a mixture.
6. A combination of common salt and iron filings is a mixture and not a compound. Justify.
7. Can a single substance act as a mixture ?

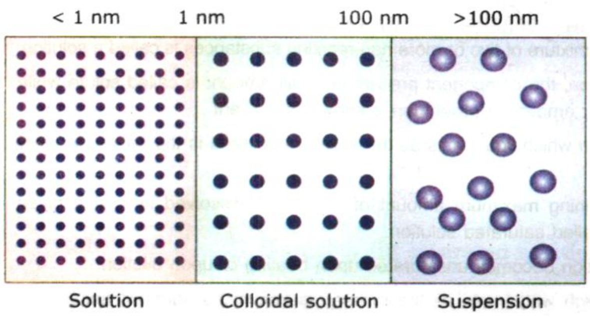
8. How is the concentration of a solution expressed ?
9. Define the terms mass percent and volume percent.
10. When does a solution become saturated ?
11. Give the composition of brass and bronze. What do we call them ?
12. 'Give one example of solution in which solid acts as the solvent and liquid as the solute.
13. A solution is prepared by dissolving 20 g of sugar in 80 g of water. What is the concentration of the solution ?
14. A solution of alcohol in water has been prepared by mixing 100 mL of alcohol in 400 mL of water Calculate the volume percentage of the solution.
15. A solution contains 16 g of urea in 120 g of the solution. Find the mass percentage of the solution.

ANSWER TO SELECTIVE PROBLEMS

1. Homogeneous mixture. **2.** A mixture of alcohol and water. **4.** A solution of iodine dissolved in carbon tetrachloride. **7.** No, it cannot. **8.** In terms of mass percent and volume percent. **10.** When the solute start settling at a given temperature. **11.** Brass (copper and zinc), Bronze (copper and tin), Alloys. **12.** Hydrated copper sulphate also known as blue vitriol. **13.** 20 percent **14.** 20percent **15.** $13 \cdot 3$ percent.

HETEROGENEOUS MIXTURES-SUSPENSIONS AND COLLOIDAL SOLUTION

We have studied that homogeneous mixtures are regarded as solution, or true solutions. The heterogeneous mixtures in which the components or constituents are present in which the components are of two types. These are known as suspensions and colloidal solutions. Thus, we conclude that are solutions (or true solution), colloidal solutions and suspensions. They differ mainly in the size of difference in their properties. In a true solution, the size of the particles is less than 1 nm $(1nm = 10^{-9} m = 10^{-7} cm)$. In a colloidal solution, it is between 1 to 100 nm while in a suspension, the size of the particles is more than 1000 nm as shown in the figure 2.6. Please note that it is mainly the small particle size which makes a true solution homogeneous. The other two are of heterogeneous nature due to comparatively bigger size of particles. We have discussed in details the different aspects of solutions or homogenous mixture. Let us study the other two i.e., suspensions and colloidal solutions.



Representation of solution, colloidal solution and suspension.

WHAT ARE SUSPENSIONS ?

In order to study the nature of suspensions, let us illustrate by simple experiment which your normally perform in the laboratory. When bubbles of carbon dioxide gas are passed through lime water taken in a galls tube, the latter becomes milky white. It is a milk like turbid mixture. Actually, lime water contains in the calcium hydroxide which combines with carbon dioxide to form calcium carbonate and water calcium hydroxide + carbon dioxide $\rightarrow$ calcium carbonate + water (Lime water)
The milky solution is because of the particles of calcium carbonate which have size more than 100 nm. The milky solution is therefore, known as suspension. When the solution is allowed to remain undisturbed for sometime, the particles slowly settle at the bottom of the tube and are no longer in motion. This is known as precipitate and in this case, it is white in colour. In the light of the above discussion,
a suspension may be defined as a heterogeneous mixture in which the solid particles are spread throughout the liquid without dissolving in it. They settle as precipitate if the suspension is left undisturbed for sometime.

PROPERTIES OF SUSPENSION

1. A suspension is of heterogeneous nature, There are two phases. The solid particles represent one phase while the liquid in which these are suspended or distributed forms the other phase.
2. The particle size in a suspension is more than 100 nm (or $10^{-7} m$).
3. The particles in a suspension can be seen with naked eyes and also under a microscope.

4. The solid particles present in the suspension can be easily separated by ordinary filter papers. No special filter papers are needed for the purpose.

5. The particles in a suspension are unstable. They settle down alter sometime when the suspension is kept undisturbed. This is known as precipitate.

> Place not that suspension and precipitate are basically same. In a suspension the solid particles are in a state of motion. When they settle a precipitate results.

Examples : Chalk-water mixture used for coating walls, muddy water, milk of magnesia and other medicines in the form of suspensions, some paints etc. are the examples of suspensions. It may be noted that the suspensions are formed by only those substances which do not dissolve in water.

WHAT ARE COLLOIDAL SOLUTIONS ?

Colloidal solutions are also heterogeneous in nature like suspensions, but they have smaller size of the particles which are distributed. It ranges between 1 nm to 100 nm i.e., in between the particle size of true solution and suspension. Since the particle sizes are close to what we notice in solutions, most of the colloidal solutions appear to be homogeneous like true solutions but actually these are not.

We come across a large variety of the colloidal solutions in daily life. Smoke coming out of the chimneys of factories, tooth paste, ink, blood, soap solutions, jellies, starch solution in water are a few common examples.

ACTIVITY

To illustrate the formation of a colloidal solution, dissolve a small piece of washing soap in water taken in a beaker. With the help of a pipe which is normally used for sipping cold drink, blow some air into the solution. What will you observe? Soap bubbles will be formed in the beaker. They represent a colloidal solution.

TYPES OF COLLOIDAL SOLUTION

We have stated earlier that the colloidal solutions are the heterogeneous mixtures. This means that the constituents are not present in a single phase. Actually there are two phases in a colloidal solution. These are known as dispersed phase and dispersion medium.

The component present in smaller proportion is the dispersed phase while the one present in greater proportion is the dispersion medium.

Please note that the dispersed phase in a colloidal solution is comparable with solute in a true solution. Similarly, the dispersion medium can be compared with the solvent. However, they differ in the sense that in a true solution, solute and solvent are present in a single phase but in colloidal solution, they represent separate phases. In other words. a true solution is homogeneous while colloidal solution is of heterogeneous nature. All this happens because of the difference in the particle size.

> A mixture of non reacting gases can never be heterogeneous. It is always homogeneous in nature. This means that gases cannot form colloidal solutions.

Just as in case of true solutions, the substances belonging to all the three states of matter can act as dispersed phase or dispersion medium depending upon their relative amounts or proportions. Thus, nine different types of colloidal solutions are also possible. But there are actually eight and not nine as we notice in true solutions. When two different gases are mixed, they always form a homogeneous and not heterogeneous mixture.

The different types of colloidal solutions along with a few example are listed in the form of a table.

Eight different types of colloidal solutions

S. No.	Dispersed phase	Dispersion medium	Name of colloidal solution	Examples
1.	Gas	Liquid	Foam	Soap, leather, whipped cream, soda water
2.	Gas	Solid	Solid foam	Pumice stone, rubber, bread
3.	Liquid	Gas	Aerosol	Mist, fog, cloud, insecticide spray
4.	Liquid	Liquid	Emulsion	Milk, cod liver oil, tonics in liquid form

5.	Liquid	Solid	Gel	Jelly, butter, cheese, boot polish, curd
6.	Solid	Gas	Aerosol	Smoke, dust storm, volcanic dust and haze
7.	Solid	Liquid	Sols	Paints, starch dispersed in water, gold sol
8.	Solid	Solid	Solid sols	Alloys, coloured glasses, gem stones, ruby glass.

Although eight different types of colloidal solutions are possible, but the most common among them have liquid acting as the dispersion medium while solid or gas as the dispersed phase. Colloidal solutions are also known as colloidal sols.

PROPERTIES OF COLLOIDAL SOLUTIONS OR COLLOIDS

The important properties of colloidal solutions are briefly discussed.

1. colloidal solution appear to be homogeneous but are actually heterogeneous in nature.

This happens because of particle size (1 nm to 100 nm) which is quite close to particles in true solution. We cannot see the particles in a colloidal solution as we do in case of suspension. But these can be seen under a microscope.

2. Colloidal solutions are a two phase system

We have discussed above that the colloidal solutions represent a two phase system. These are dispersed phase and dispersion medium. That is why, the colloidal solutions are of heterogeneous nature.

3. Colloidal particles pass through ordinary filter papers

In most of the cases, the colloidal solutions pass through ordinary filter papers like true solutions. This is because of the fine size of the dispersed phase or colloidal particles. Special filter papers known as ultra filter papers have to be used to separate these particles from the dispersion medium

4. Colloidal particles carry charge

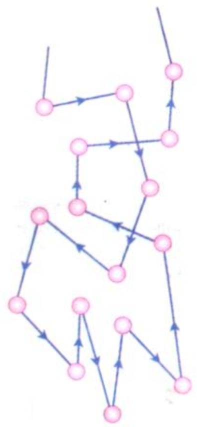
We have learnt that the dispersed phase particles in a colloidal solution remain dispersed or suspended. They do not come close to one another as in case of suspension. This happens due to the presence of some charge (positive or negative) on these particles. Please remember that all the particles belonging to a particular colloidal solution carry the same charge. That is why, these similarly charged particles repel each other and remain dispersed or suspended.

- Hemoglobin starch gelatin metal like copper silver gold metal sulphides have negative charge on their particles.
- The hydroxides of metals like iron aluminium calcium etc. have positive charge on their particles.

Different theories have been given to explain the origin of charge on the colloidal particles. It is not possible to discuss them in the present book.

5. Particles m a colloidal solution follow zig-zag path

It is normally not possible to see the colloidal particles because of their very small size. However, their path can be seen under a microscope. These particles follow a zig-zag path. You can observe this motion while watching a film in a theater. The beam of light which falls on the screen from behind has dust particles present in it. They follow zig-zag path. Such type of movement of the colloidal particles was noticed for the by Robert Brown, an English scientist in 1828. This is known as Brownian Movement.



Zig-zag motion of colloidal particles (Brownian Movement)

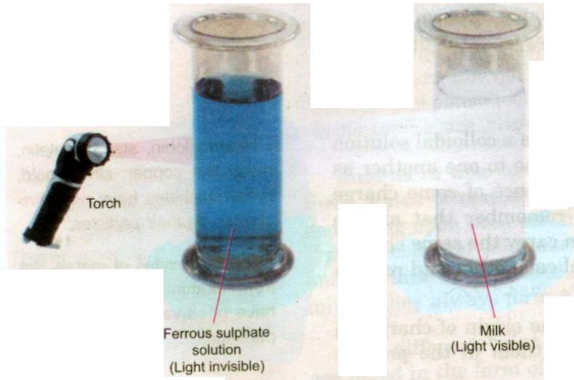
6. Colloidal solution scatters the beam of light passing through it

When a beam of light from a certain source is focussed or passed through a colloidal solution kept in the dark, its path becomes visible

While passing through the solution. Along with this, the colloidal particles can also be seen following a zig-zag path. But it does not happen when the same beam is passed through a true solution (e.g., sodium chloride solution). Actually, the particles present in a colloidal solution have size

Tyndall effect shown by colloidal solution big enough to scatter or disperse the light rays present in the beam as they fall on them. As a result, these rays as well as the colloidal particles become visible. This scattering of light by colloidal particles is known as Tyndall effect. This effect is not noticed in a true solution because the particles present in it are too small to scatter the light.

Tyndall effect is quite helpful in distinguishing a colloidal solution form a true solution.



Demonstration of Tyndall effect

ACTIVITY

In two separate jars or containers. take ferrous sulphate solution (light green in colour) and milk solution dilutes with water.
Focus a torch on these jars kept jn a dark place. Torch light will not be visible in ferrous sulphate solution. However, the same can be seen in milk solution.
Actually, ferrous sulphate solution is a true solution and does not show any Tyndall effect, On the other hand, the effect will be noticed in milk which is an emulsion or colloidal solution in nature.

7. Colloidals solutions in which only liquids participate are known as emulsions

Protein casein helps in stabilising milk which is an oil in water emulsion.

In the table giving the different types of colloidal solutions, it has been mentioned that the solutions in which liquid acts as the dispersed phase and other in which liquid as the dispression medium, are known as emulsions. However, these are not miscible with each other. If they mix up or become miscible, we get a true solution and not an emulsion- In as emulsion, one of the constituents is generally oily while other is water soluble. Thus, the emulsions are oil-water in nature. We know that normally oil and water form separate layers and are not expected to mix up. But certain substances known as emulsifiers help in forming a stable emulsions of oil and water. These emulsifiers are generally proteins in nature. A few common examples of emulsions are : milk, cod-liver oil, both cold and vanishing creams, moisturising creams, paints etc.

APPLICATIONS OF COLLOIDAL SOLUTIONS

The field of colloids is so vast that it may not be possible to describe the same at this level. Similarly, the colloidal solutions have wide rang of applications. Only a few out of these are being discussed to generate some interest about this field.

1. Bleeding from a cut can be immediately stopped by applying alum or ferric chloride

Blood consists of haemoglobins which are negatively charged colloidal particles. On applying alum or ferric chloride, these particles take up positively charged ions (cations) from these substances. They get their charge removed and get precipitated (or coagulated). As a result, the bleeding stops because blood becomes very thick.

2. Medicines in colloidal form can be easily absorbed by the body.

Most of the medicines, particularly antibiotics and B-complex etc are in the form of colloidal dispersions or emulsions. These are readily absorbed in the intestines.

3. Soaps clean dirty clothes due to the formation of colloidal solutions.

Clothes initially become oily because of persepiration coming out of the pores of the body. When dust particles and organic matter suspended in air come in their contact, they become dirty. Now ordinary water cannot remove oil drops from clothes. Soap helps in forming an emulsion between water and oil drops carrying dust. As a result, these are removed from the clothes and they get washed.

4. Delta is formed when river water comes in contact with sea water for a long period

River water is mostly muddy. These mud particles are charged colloidal particles. When river comes in contact with sea, the dissolved salts present m sea water provide ions with charge opposite to the charge on mud particles. These particles get uncharged and combine with each other to form bigger particles. They settle as solid mass. Over the years, deltas appear at these places.

5. Sky appears to be blue in colour

When we look at the sky, it appears to be blue in colour. It is for your knowledge that there is no blue colour as such in the sky. Actually, fine particles of dust et£. are always present in the atmosphere, When sun light falls on these particles, they scatter light with a blue colour or tinge. That is why sky is blue.

DISTINCTION IN SUSPENSION. COLLOIDAL SOLUTION AND SOLUTION

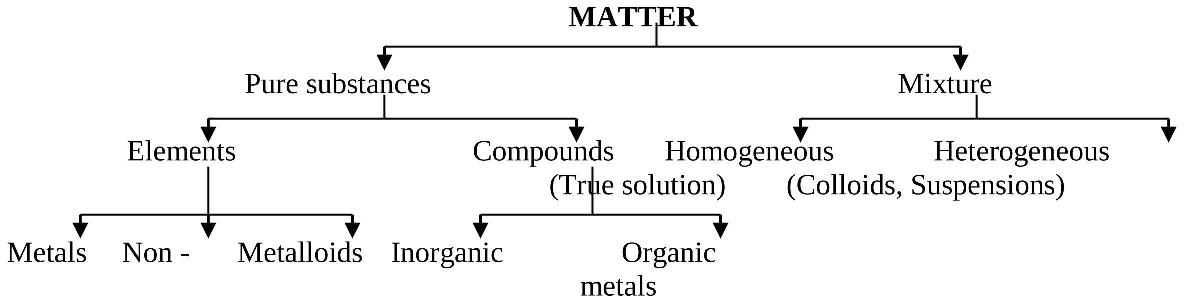
In the discussion made so far, we have learnt that these solutions differ mainly in the size of the particles which are responsible for their different properties. Based upon the information that we have gathered, these solutions are distinguished in the form of a table.

Table : Distinguishing characteristics of suspension, colloidal solution and solution

	Property	Suspension	Colloidal solution	Solution
1.	Particle size	> 100 nm	1 to 100 nm	< 1 nm
2.	Separation by Ordinary filtration	Possible	Not possible	Not possible
3.	Settling of particles	Settle of their own	Settle only on centrifugation	Do not settle
4.	Appearance	Opaque	Generally transparent	Transparent
5.	Tyndall effect	Shows	Shows	Does not show
6.	Diffusion of particles	Do not diffuse	Diffuse slowly	Diffuse rapidly
7.	Brownian movement	May show	Shows	May or may not show
8.	Nature	Heterogeneous	Heterogeneous	Homogeneous

Flow Sheet Representation of the Chemical Classification of Matter

A flow sheet representation of the chemical classification of matter on the basis of the discussion, is given for the benefit of the students.



STORE IN YOUR MEMORY

• Solutions (or true solutions) are homogeneous in nature white both the colloidal solution and suspensions are heterogeneous.
• All the three differ in the particle size.
• In a suspension the particles settle as precipitate when it is allowed to remain undisturbed for sometime.
• Colloidal solutions are of heterogeneous nature. They consist of two phases known as dispersed phase and dispersion medium.
• Eight different types of colloidal solutions are possible. A mixture of gases always forms homogeneous solution.
• Particles in a colloidal solution follow Zig-zag path and their movement is known as Brownian Movement.
• Colloidal solutions scatter the light as it is made to pass through them, This phenomenon is called Tyndall effect.
• Dispersed phase particles in a colloidal solution carry either positive or negative charge.
• Colloidal solutions of two immiscible liquids are known as emulsions.

TEST YOUR ABILITY

1. How many phases are present in a colloidal solution ?
2. What is the particle size in a colloidal solution ?
3. What will happen if a suspension is allowed to remain undisturbed for sometime ?

4. Give an example of a colloidal solution in which solid acts as the dispersion medium and liquid as the dispersed phase.
5. What is Tyndall effect ? Why do true solutions fail to show Tyndall effect ?
6. Name the emulsifier which stabilises milk emulsion.
7. Point out whether the following statements are True or False :
(i) Particles in a colloidal solution can be seen with naked eyes.
(ii) The stability of colloidal solution is because of the charge on the colloidal particles.
(iii) Particles in colloidal solution follow zig-zag path.
(iv) Colloidal solutions can be filtered by ordinary filter papers.
(v) Colloidal solutions are of homogeneous nature.
(vi) Particles in a colloidal solution settle after sometime.
(vii) Butter is an example of gel.
8. Give three points of difference between a solution and colloidal solution. How will distinguish between them by performing a test ?
9. In what type of solutions, Brownian movement is observed ?
10. What do you understand by a colloidal solution ? Give four examples of colloidal solutions.
11. Compare the characteristics of solution, colloidal solution and suspension.
12. The particle size of a substance 'A' present in water is 200 nm. What will be the nature of the solution expected ?

ANSWERS TO SELECTIVE PROBLEMS

1. Two **2.** 1 nm to 100 nm **3.** The particles will settle in the form of precipitale
4. Cheese (gel) **6.** Casein (protein) **7.** (i) False (ii) True (iii) True (iv) False (v) False (vi) False (vii) True **9.** Colloidal solutions **12.** Suspension.

SEPARATING THE COMPONENTS OF A MIXTURE

We have learnt that mixtures whether homogeneous or heterogeneous result from the mixing of pure substances i.e. elements and compounds. No chemical reactions occur in the formation of mixtures. Sometimes, we are also required to separate these substances present in a given mixture. Moreover, in many cases, the naturally occurring substances are impure. They are associated with certain impurities. These have to be removed and some suitable methods or techniques are needed for the same. In general, the separation of constituents from a mixture depends upon.

- The type of mixture (homogeneous or heterogeneous)
- The nature of the substances present in the mixture.

It may be noted that in a heterogeneous mixture, the constituents are present have clear boundaries of separation, Therefore, their separation is quite easy by some physical methods. Problems do arise in homogeneous mixtures. These are in the form of solutions and special methods have to be adopted for the separation of constituents present. Physical properties such as melting point, boiling point, relative solubilities in a particular solvent and a few more such properties are quite useful in separating the constituents from a mixture or in purifying an impure sample.

SEPARATION OF CONSTITUENTS FROM A HETEROGENEOUS MIXTURE

Filtration through a funnel

Heterogeneous mixtures are comparatively easy to separate because the different constituents are can be easily seen. The separation as stated above is based upon the physical properties of these constituents. Let us briefly discuss a few commonly used methods.

SEDIMENTATION FOLLOWED BY FILTRATION

This method is particularly useful when the constituents are to be separated from a suspension. Let us illustrate by considering a suspension of calcium carbonate formed by bubbling carbon dioxide gas through lime water taken in flask or beaker. It is chemically calcium hydroxide dissolved in water.

calcium hydroxide + carbon dioxide $\rightarrow$ calcium carbonate + water
(Milky solution)

The suspension is milky in colour. White residue of calcium carbonate can be separated from the suspension with the help the process of sedimentation followed by filtration. The suspension is allowed to remain undisturbed for sometime in a beaker or any other container. Its particles settle down under the influence of gravity. The settling of the particles is called sedimentation. As a result, a white residue of calcium carbonate is formed. This can be separated from the solution by filtration as shown in Fig. 2.10. As a result, the white residue will be collected on the filter paper. The liquid (filtrate) will pass through the filter paper and will be collected in a beaker or flask placed below the funnel as shown in the figure. The advantage of this method is that both the components present in different phases (one solid and other liquid) can be separated by this method. It is very commonly used in the laboratory for the separation of crystals of copper sulphate, nitre (potassium nitrate) or potash alum prepared by some suitable methods.

How to Fit a Filter Paper in the Glass Funnel ?
Take a circular filter paper (white in colour) and fold it into semi-circular halves. Now, refold and open it in such a way that a cone with three layers on one side and one side is obtained as shown the

Folding of Filter Paper and fitting in a funnel

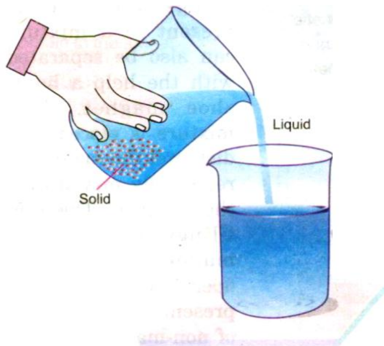
Wet the inner walls on the other of the funnel with the solution to be filtered and insert the cone in it. Support the funnel on a funnel stand and place a flask (or test tube) below it. Pour the liquid or solution to be filtered on three folds of the filter paper cone with the help of a glass rod.

Examples : The separation of a few mixtures by the process of filtration is given below :

(i) A mixture of sand and water can be separated by this method The particles of sand are collected on the filter paper and pure water passes into the beaker.

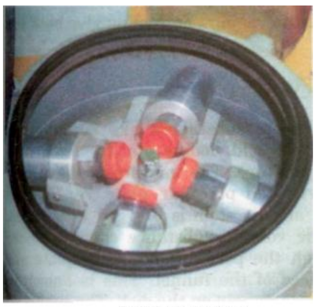
(ii) The white precipitate of silver chloride formed by mix solutions of silver nitrate and sodium chloride can be separated by filtration.

(iii) A mixture of iron particles and sulphur can also be separated by this process. The mixture is dissolved in carbon disulphide solvent. Sulphur passes into the solution while iron particles remain as such. The mixture solution is then filtered. The solid iron particles remain on the filter paper. From the solution which is collected in the beaker, sulphur can be recovered by evaporating it.



Decantation

In some cases simple method of decantation can be used to separate the residue from the liquid. The suspension present in the flask or beaker is kept undisturbed for sometime (may be overnight) The residue will settle at the bottom. The liquid collected above can be removed by decantation leaving behind the residue.



Centrifugal machine

Use of centrifugal machines in the formation as well as separation of the precipitates (residues)
These days, centrifugal machines are being used in the separation of the precipitates. They also help in their formation as well. For example, the milky solution of calcium carbonate formed in the above experiment is transferred into a test tube which is placed in the centrifugal machine. The machine can be rotated either by hand i.e. manually or electrically. By doing so, the small solid particles suspended in the solution get more opportunity to mutually collide. As a result,

they combine and grow in size to form the precipitate. Centrifugation also helps in the settling of' the particles as residue. After sometime, the tube is taken out from the machine and the liquid collected above can be suitably removed or decanted leaving behind the residue. This technique has become very common and you will get an opportunity to use it in the higher classes.

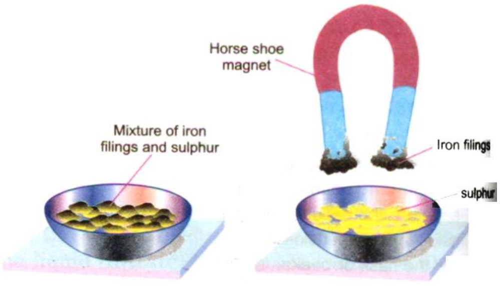
• Centrifugal machines are commonly used in diagnostic centers where tests are performed.
• Washing machines used for washing dirty clothes are centrifugal machines in nature.
• Separation of Cream from Milk

We all know that number of soluble last are present in milk. They can be separated from the milk as a residue known as cream. This can be done with the help of centrifugal machine also called contrifugating machine. The given sample of milk is placed in the machine which is rotated at a very high speed by passing electric current. The particles of different fats present collide with one another at a fast speed. As a result, they combine to form bigger particles in the form of precipitate or residue known as cream. It keeps on escaping from the outlet that is provided leaving behind the fat free milk. Single tone and double tone milk which we often find at shops, have been formed in this way.

MAGNETIC SEPARATION

The separation by a magnet, also called magnetic separation, can used to separate two constituents from a mixture if one them is magna and the other is non- magnetic in nature. For example, iron filings and sulphur present in a mixture can also be separated with the help a horse shoe magnet. This mixture is placed in a dish and the magnet is repeatedly moved over the mixture. The iron filings Stick to the magnet in each operation and can be removed. After sometime, the entire iron filings present in the mixture will be removed leaving behind sulphur which of non-magnetic nature.

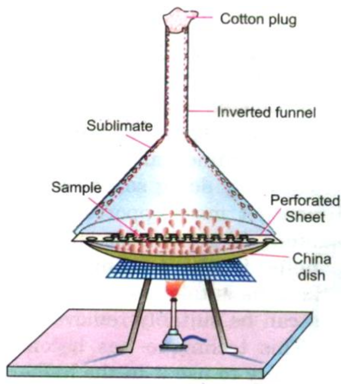
> Magnetic separation can be used to separate the components form a mixture if one of them is of magnetic nature while the other is non magnetic



Separation of a mixture of iron filings and sulphur

SEPARATION OF SUBSTANCE UNDERGOING SUBLIMATION FORM A MIXTURE

The process of sublimation is used to separate those solids from their mixtures which directly pass to the vapour state upon heating without passing through the liquid state and the vapoure on cooling give back the solids again



Process of Sublimation

$$\text{Solid} \underset{\text{Cool}}{\overset{\text{Heat}}{\rightleftharpoons}} \text{Vapours}$$

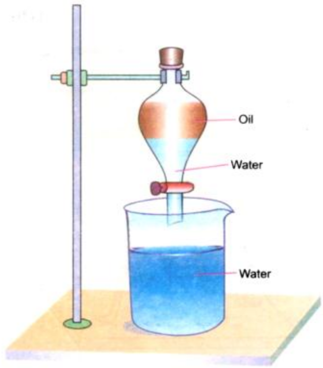
The process can be used to separate substances like naphthalene camphor, ammonium chloride, benzoic acid, iodine etc. from the volatile volatile components present in the mixture. The mixture is taken in a china dish and is covered by a perforated porcelain plate. An inverted glass funnel is placed over the dish and its stem is plugged with cotton. The dish is heated gently when the volatile substance changes to the vapours. These vapours pass through the perforations of the plate and get collected on the inner cold surface of the funnel. This is known as sublimate. The nonvolatile constituents remain on the dish. The sublimate can be removed from the funnel.

Examples. The following mixtures are separated into constituents by sublimation process.

• A mixture of ammonium chloride (undergoes sublimation and sodium chloride (does not undergo sublimation) can be separated.
• A mixture of camphor which is a solid with pleasant smell (undergoes sublimation) and salt can be separated.

SEPARATION OF TWO IMMISCIBLE LIQUIDS

Oil and water normally do not mix. When these are placed together, they form separate layers. These are therefore, known as Immiscible liquids. The mixture is regarded as heterogeneous and the separation can done by the use of separating funnel.



Separation of kerosene oil and water by separating funnel

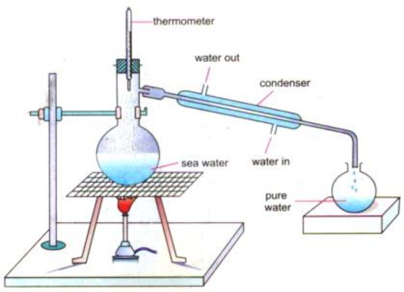
ACTIVITY

Let us separate a liquid mixture of kerosene oil and water. It is placed in the separating glass funnel which is kept undisturbed on a stand for some time. As kerosene oil is lighter than water, it will form the upper layer while water will form the lower layer in the fennel. The boundary of separation can be easily seen Now a beaker is placed below the funnel and the tap is opened to remove water or aqueous layer. When it gets transferred completely in the beaker, the tap is immediately closed. Kerosene oil will remain in the funnel and can be later on taken out by opening the tap once again.
This method is applicable for all types of immiscible liquid mixtures provided they differ in their densities.

Examples:
A liquid mixture of mustard oil and water can be separated. Mustard oil being lighter will form the upper layer while water being heavier will form the lower layer.
•A liquid mixture of carbon tetrachloride (forms lower layer) and water (forms upper layer) can also be separated.
•In some heterogeneous mixtures consisting of two crystalline solid constituents, the crystals differ in their shapes. For example, in a mixture of potash alum and nitre (potassium nitrate), the crystals of potash alum are octahedral in shape while those of nitre are needle like in shape. In such cases, the separation can be done by simple hand picking A forces can also be used for picking up the crystals.
•The process of sieving can be used in some cases. For this, seives with specific pore size can be used. Wheat grains can be separated from husk. Similarly, tea leaves are separated from tea through small sieves commonly used in houses.

Example 11: You are given an impure sample of sugar containing impurity of some chalk. How will you purify it ?
Solution. The impure sample of sugar containing some chalk impurity represents a heterogeneous mixture. In order to purify the sample or to recover sugar from it, dissolve about 5g of the sample in minimum volume of water in a beaker. Stir occasionally with a glass rod. Filter the solution formed through funnel as discussed earlier. The chalk impurity will be left on the filter paper. The filtrate will be a sugar solution in water. Transfer the solution in a china dish. Concentrate by heating so that the volume of the solution becomes nearly half. The solution will be saturated. Place the china dish over a beaker full of water and allow to remain undisturbed for sometime. Pure crystals of sugar will appear in the dish. They can be separated by using filtration technique as discussed earlier.

SEPARATION OF CONSTITUENTS FROM HOMOGENEOUS MIXTURE

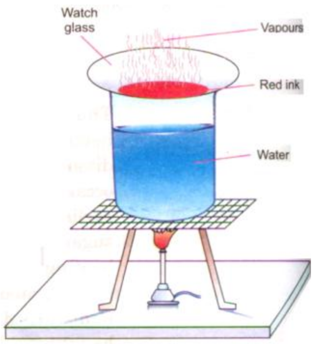


Purification of sea water by distillation

In a homogeneous mixture, the constituents are present in a single phase. It is either a mixture of some miscible liquids or a liquid in which some dissolved salts are present as impurities (e.g. sea water). Let us briefly discuss a few methods to affect the separation of the constituents from the mixtures.
• Separation of non-volatile soluble impurities from a liquid (Purification of sea water)
Sea water as we all know contains some dissolved salts (e.g., sodium chloride, potassium iodide etc.) as impurities. But these are non-volatile in nature. This means that even upon strong heating, these salts do not change into vapours. The purification of sea water can be done with the help of a technique called distillation or simple distillation. The impure solution is taken in a glass flask known as distillation flask. It is provided with a thermometer to record temperature and an outlet for the vapours. The flask is heated.

Water will change into vapours once it starts boiling. These vapours escaping from the flask are passed through a condenser. Water is kept circulating around it. Vapours will get condensed into liquid form which is completely pure. It can be collected in the receiver as shown in the figure. The impurities being non-volatile in nature will be left behind in the flask. Other liquids containing soluble non-volatile impurities can also be purified in the same way.

A salt like sodium chloride can be separated from sea water by simple evaporation. For this, sea water is heated in a china dish. The water will slowly evaporate and a white residue of salt (sodium chloride) will be left behind in the dish.



Slow evaporation of liquid from a watch glass.

ACTIVITY

This method can also be used to isolate a solid substance from the solution in which it is present. Let us apply it to isolate red dye from a few drops of red ink. The technique called evaporation is carried by placing the drops of ink on a watch glass, It is placed over a beaker full of water as shown in the Fig. 2.18. The beaker is heated and the water placed inside will be also heated up. 11 will cause the evaporation of the liquid from the watch glass. After some time, a red residue will be left on it in the dry state. It is the red dye.

The direct heating of the ink drops in this case is avoided because it may be just possible that the red dye present in the ink may decompose during direct heating.

The direct heating of the ink drops in this case is avoided because it may be just possible that the red dye present in the ink may decompose during direct heating.

• **Separation of constituents from a Miscible Liquid Mixture.**

The separation is based upon the difference in the boiling points of the constituents present.

• **Constituents differing in boiling point by more than 25^oC (Separation of acetone and water).**

The boiling point temperature of acetone is 56^oC (319 K) while that of water is 100^oC (373 K). the separation can be done in the distillation flask.

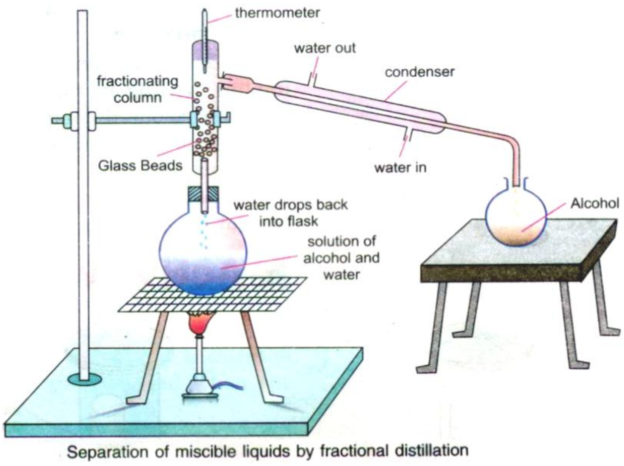
Take the liquid mixture in the distillation flask and heat from below. Since the boiling point temperature of acetone (56°C) is less than that of water, it will change into vapours which will rise upwards. They will get condensed on passing through the condenser and collect in the receiver. At this temperature, water will not boil and will remain in the flask. Thus. the process of distillation helps in separating acetone and water.

• Constituents differing in boiling point by less than 25°C. (Separation of ethyl alcohol and water)

The boiling point temperature of ethyl alcohol is 78°C (351 K) while that of water is 100°C (373 K). The process of simple distillation cannot be used because the vapours of both the liquids will rise simultaneously upon heating the flask. Here the process known as fractional distillation is used. It means that the two liquids are collected in separate fractions.

ACTIVITY

The process is carried in a distillation flask which we have described earlier. It is provided with a fractionating column having some glass beads in it. The purpose behind having such a column fractionating is to obstruct the upward movement of the vapours of the two liquids. The vapours of high boiling liquid (water in this case) will get condensed releasing energy (latent heat of fusion) that will be taken up by the vapours of low boiling liquid (alcohol in this case). This means that by using fractionating column, both evaporation and condensation will occur simultaneously- Vapours of alcohol will escape from the flask and will collect in the receiver after condensation as described in case of simple distillation. At the sometime. the vapours of water (high boiling liquid) will fall back in the flask after getting condensed. In this manner, fractional distillation helps in separating two miscible liquids.



Separation of miscible liquids by fractional distillation

Acetone (b.p = 56° C) and ethyl alcohol (b.p = 78° 0 can also be separated from the miscible liquid mixture.
Air is a homogeneous mixture of a number of gases like nitrogen, oxygen, inert gases and carbon dioxide etc. These can be separated from air by fractional distillation. In fact, air is first liquefied by increasing the pressure and decreasing the temperature. The liquefied air is then subjected to fractional distillation when the gas with lesser boiling point gets distilled first. For example, the boiling points of the main gases nitrogen (78·1% by volume) and oxygen (20·9% by volume) are – 196°C and – 182°C respectively. When the liquefied air is distilled fractionally, nitrogen will be distilled first and oxygen afterwards.
The separation of nitrogen and oxygen form air is shown by a flow sheer diagram.

Air

Pressure increased
Temperature decreased

Liquefied air

Fractional distillation

Low boiling | **High boiling**

Nitrogen | **Oxygen**

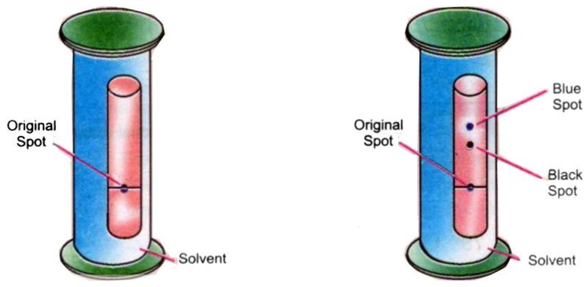
Separation of nitrogen and oxygen from liquefied air

• Use of chromatography in the separation of constituents from a mixture

In Greek, the word 'Kroma' means colour and the word chromatograply implies 'writing in colour'. Actually, this technique was initially used to separate coloured components from pigments and dyes. But now it has wide range of applications. Chromatography is of a number of types such as adsorption, thin layer, paper and gas chromatography etc. However. the paper chromatography is very simple and is commonly used in the laboratory.

ACTIVITY

With the help of this technique we can Identify the blue as well black components in a drop the ink which is water soluble. In order to perform the experiment, take a strip of very fine filter paper (25 x 5 cm). Draw a fine line on the paper from one end approximately at a distance of 3 cm. With the help of a fine capillary tube, put a small drop of blue/black ink mixture in the centre of the line by a pencil as shown in the Fig. 2.21. Allow the strip to dry for sometime.



Separation of blue and black components from blue/black ink by paper chromatography.

Now suspend the strip in a jar containing a small amount of water so that the end of strip which has been marked dips in water to a length of about 0·5 to 1 cm. Allow the strip to stand undisturbed in the jar for about 20 to 30 minutes. Due to capillary action. Water will rise upwards. Blue/black ink is actually a mixture of blue and black dyes. Both the components present in the mixture will rise upwards. The more soluble will move faster. In this way, the blue and black colours will get separated as shown in the figure.
Paper chromatography helps in separating and identifying the components present in homogeneous mixtures which may be available even in very small amount. It also helps in checking the purity of a given sample. It may not be possible to discuss more details at this level of the students.

Example 12 : How will you separate the constituents present in the following mixtures.

(i) Common salt and water (ii) lodine and sand
(iii) Kerosene and water (iv) Sugar and sulphur.

Solution.
(i) Common salt and water. Since common salt (sodium chloride) is soluble in water, it can be separated by crystallisation. The process of distillation can also be used because sodium chloride is non-volatile and water is volatile in nature.
(ii) lodine and sand. Sublimation process can be used. lodine will sublime on heating while sand will remain unaffected.

(iii) Kerosene and water. The liquids are not miscible with each other. Separation can be done by using a separating funnel.
(iv) Sugar and sulphur. The mixture is dissolved in carbon disulphide in a beaker by stirring with a glass rod. Sulphur dissolves while sugar remains as such. On filtering, sugar separates as the residue. The filtrate upon concentration and cooling gives crystals of sulphur.

PHYSICAL AND CHEMICAL CHANGES

In the study of the formation of compounds and mixtures, we have learnt that a compound is formed as a result of some chemical reaction or chemical change. However, no such change occurs when a mixture is formed by mixing elements or compounds. In other words, the mixing of the constituents in a mixture involves a physical change. Let us study in brief these two types of changes that are taking place.

PHYSICAL CHANGE

A physical change as the name suggests, brings about a change in the physical state of matter under suitable conditions. We have learnt in chapter one that the three states of matter are linked with the interparticle spaces and also interparticle forces. The physical changes occur when there is some change either in these spaces or forces. For example, the change of state of ice to water and then to water vapours is because of these changes which occur upon heating. These get reversed when the vapours are cooled.
It may be noted that during the physical changes, the chemical identities of the substances do not change. Rather they retain these. For example, in all the three states, water does not change the colour of either blue litmus or red litmus. This means that it remains neutral towards litmus. Even in the formation of mixture, the different substances simply mix without involving any energy changes. That is why they can be separated from the mixture by suitable means. A few important characteristics associated with physical changes are listed.
1. A physical change involves a change in the physical state of a substance by changing either the interparticle spaces or interparticle forces.
2. There is no change in the composition of the substances during the physical change.
3. The substances undergoing physical change do not change their main characteristics.
4. No new substance is formed during a physical change.
5. The change is temporary and can be reversed by reversing the conditions which bring about the change.
6. No energy change occurs during a physical change.

CHEMICAL CHANGE

A chemical change as the name suggests. brings a change in the chemical composition of the matter. Actually, the substances which are participating in a chemical change have to combine with each other. During this, there is an exchange of their constituents and new substances are formed. This means that chemical changes occur on account of the chemical reactions. For example,
silver nitrate + sodium chloride $\xrightarrow{\text{(in water)}}$ silver chloride + sodium nitrate
As new substances are formed during chemical reactions, these cannot be easily reversed of their own. Energy changes are always noticed in these reactions.
Thus, we can conclude that the characteristics associated with chemical changes are the reverse of what we have mentioned in physical changes. However, a few important out of these are listed.
1. As a result of chemical change, the physical state of the substance may or may not change.
2. There is always a change in the chemical composition of the substances undergoing chemical changes.
3. There is also change in characteristics of the substances involved in these changes.
4. New substances are always formed during chemical changes.
5. The chemical change is of permanent nature and cannot be easily reversed.
6. Energy changes always occur in the chemical reactions responsible for these changes.

Distinction between physical change and chemical change

Physical Change	Chemical Change
1. It is of temporary nature.	It is of permanent nature.
2. It can be easily reversed.	It cannot be reversed.
3. Only the physical properties of substances	Both physical and chemical properties change.

change.	
4. No new substance is formed in a physical change.	New substances are always formed in a chemical change.
5. Identities of the substances do not change.	Identities of the substances change.
6. Energy changes normally do not occur.	Energy changes always take place.

Example 13 : Classify the following as physical and chemical changes.

(i) Coriversion of milk into curd (ii) Burning of magnesium ribbon in air
(iii) Rusting of iron nails (iv) Dissolving salt in water
(v) Burning of coal (vi) Electrolysis of sodium chloride solutoin by passing current
(vii) Crystallisation of copper sulphte.

Solution : (i) Chemical change (ii) Chemical change (iii) Chemical change (iv) Physical change (v) Chemical change (vi) Chemical change (vii) Physical change.

Example 14 : Can physical and chemical changes also occur together ? Illustrate your answer.

Solution : In some cases, the physical and the chemical changes can occur together. One such example is the burning of candle. The wax present in the candle changes to liquid state. This means that the change is of physical nature. At the sometime, the constituents carbon and hydrogen present in wax react with the oxygen of air to form new substances. This means that a chemical reaction or change is also taking place. Moreover, in this case when the molten wax solidifies after sometime, its composition does not remain the same.

TEST YOUR ABILITY

1. Can we separate a mixture of alcohol and water by separating funnel ?
2. A mixture contains sand and naphthalene. Both are solids. Suggest a method for their separation.
3. What type of liquid mixture will kerosene and water form ? How will you separate it?
4. How does chromatography help in identifying the components present in blue/black ink ?
5. Suggest methods to separate the constituents from the following mixtures :
(i) Common salt and naphthalene (ii) Petrol and crude oil
(iii) Ammonium chloride and sugar (iv) Acetone and methyl alcohol
(v) Constituents from a dye available in very small amount.
6. Which of the following are chemical changes ?
(i) Growth of a plant (ii) Burning of candle
(iii) Drying of wet clothes in sun light (iv) Digestion of food
(v) Freezing of water (vi) Cooking of vegetables.
7. How will you bring about the following separation ?
(i) Butter from curd (ii) Oil from water
(iii) Iron pins from sand (iv) Fine mud particles floating in water
(v) Alcohol from water (vi) Tea leaves from tea.
8. What do you understand by physical and chemical changes ? How will you distinguish them ?

ANSWERS TO SELECTIVE PROBLEM

1. No. because the mixture is miscible. **2.** By sublimation **3.** Immiscible. by separating funnel

5. (i) By sublimation (ii), By fractional distillation (iii) By sublimation (iv) By fractional distillation (v) By paper chromatography. **6.** (i), (ii), (iv), (vi) **7.** (i) By centrifugation (ii) By separating funnel (iii) By a magnet (iv) By centrifugation (v) By fractional distillation (vi) By filtration.

The End