By- Shailendra Shukla Sir

Chapter 2 Is matter around us Pure ?

For a common person, pure means "having no adulteration". Thus, in general sense, pure milk means, milk having no adulteration. Pure ghee means, ghee having no adulteration. But, for a scientist, all these substances are in fact, a mixture of two or more substances, and therefore, they are not pure. For example, milk is a mixture of water, fat, proteins, minerals etc.

In scientific language, a substance is said to be pure, if it consists of a single type of constituent particles, which have same chemical properties. For example, sodium chloride, magnesium oxide, sugar etc.

The chemical composition and properties of pure substances is uniform throughout. They cannot be separated into their chemical constituents by physical methods. For example, sodium chloride cannot be separated into its chemical constituents by physical methods.

In fact, most of the matter around us are not pure, but are a mixture of two or more pure components. For example, air, sea water, soil etc. all are mixtures.

What is a Mixture ?

When two or more pure substances mix together they constitute a mixture. Thus, a mixture contains more than one pure substances. For example, soft drinks, milk, air, soil, solution of sodium chloride in water etc. are mixture.

The pure components of a mixture can be separated by some suitable physical methods like handpicking, sieving, filtration, evaporation, crystallization etc. For example, dissolved sodium chloride can be separated from water by evaporation.

Types of mixture

Depending upon the nature of the constituents, the mixtures may be of following two types-

(1) Homogeneous mixtures- Such mixtures which have uniform composition and therefore, uniform properties throughout are called homogeneous mixtures or solutions. For example, sodium chloride dissolved in water, copper sulphate dissolved in water, sugar dissolved in water etc.

Homogeneous mixtures can have variable compositions. For example, let 5g of copper sulphate is dissolved in 50 ml of water. Here, a blue coloured homogeneous

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mixture (solution) gets obtained. Let, 5g additional copper sulphate is added to this solution. It will also get homogeneously distributed and a new solution having more intense colour and different composition than original gets obtained.

(2) Heterogeneous mixtures- Such mixtures which do not have uniform composition and therefore, do not have uniform properties throughout are called heterogeneous mixtures. For example, a mixture of sodium chloride and iron fillings, salt and sulphur, water and oil etc.

Heterogeneous mixtures contain physically distinct components and have non-uniform compositions.

Solution

"The homogeneous mixture of two or more substances whose composition is variable under certain limits is called solution".

In solution, the component that dissolves the other component in it (which is present in larger quantity) is called solvent while, that which is dissolved in solvent (which is present in smaller quantity) is called solute. Thus, in solution the solute particles remain homogeneously distributed amongst solvent particles.

Examples of Solution

(1) Solution of Sugar in water- Here, solute (sugar) is solid while, solvent (water) is liquid.

(2) **Tincture of iodine-** It is a solution of iodine in alcohol where, solute (iodine) is solid while, solvent (alcohol) is liquid.

(3) **Air-** It is a homogeneous mixture of a number of gases, where two main constituents are nitrogen (78%) and oxygen (21%). The other gases are present in very small quantities. It is the example of gas in gas solution.

(4) Aerated Drinks- Aerated drinks such as soda water, papsi, coca-cola etc. are the examples of gas in liquid solutions. Here, carbon dioxide (gas) is solute and water (liquid) is solvent.

(5) Alloys- These are the homogeneous mixture of two or more metals or metals and non-metals. Here, both solute and solvent are solids. Thus, it is the example of solid in solid solution.

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The components of alloys cannot be separated by physical methods, but still they are considered to be mixture because they show the properties of their constituents and can have variable composition. For, example, brass is a mixture of about 70% copper and 30% zinc.

Properties of Solutions

(1)A solution is the homogeneous mixture of two or more substances, whose composition is variable under certain limits.
(2)The particles of a solution is smaller than 1 nm (10^{-9} m) in diameter. Hence, they cannot be seen by naked eye.
(3)Due to very small particle size, they do not scatter the beam of light passing through them. Hence, the path of light is not visible in a solution.
(4)The solute particles cannot be separated by the process of filtration from the solution.
(5)When a solution kept undisturbed, the solute particles do not settle down. Thus, the solutions are stable in nature.

Concentration of Solution

The amount of solute present in given amount of solvent or solution is called conc. of solute in solution or conc. of solution.

Mode of Expression of Conc. of Solutions

(1)Mass Percentage- "The amount of solute in gram present in hundred gram of solution is called Mass percentage of solute in solution."
Mathematically,

$$\textbf{Mass \%age} = \frac{\textbf{Mass of solute (g)}}{\textbf{Mass of solution(g)}} \times 100$$

Numerical- A solution contains 50g of common salt in 500 g of water. Calculate the concentration of solution in terms of mass percentage of solute.
Solution- Given that,
Mass of solute (common salt) = 50g
Mass of solvent (water) = 500g
Mass %age of solute in solution = ?

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$$\because \quad \text{Mass \%age} = \frac{\text{Mass of solute (g)}}{\text{Mass of solution(g)}} \times 100$$

$$= \frac{50\ \text{g}}{(50 + 500)\ \text{g}} \times 100$$

$$= 9\ \%$$

(2)Volume Percentage- "The volume of solute (in ml) present in 100 ml of solution is called Volume percentage of solute in solution."

Mathematically,

$$\text{Volume \%age} = \frac{\text{Volume of solute (ml)}}{\text{Volume of solution(ml)}} \times 100$$

Numerical- A solution contains 50 ml of methanol in 500 ml of its aqueous solution. Calculate the concentration of solution in terms of volume percentage of solute.

Solution- Given that,

Volume of solute (methanol) = 50 ml

Volume of solution = 500 ml

Volume %age of solute in solution = ?

$$\because \quad \text{Volume \%age} = \frac{\text{Volume of solute (ml)}}{\text{Volume of solution(ml)}} \times 100$$

$$= \frac{50\ \text{ml}}{500\ \text{ml}} \times 100$$

$$= 10\ \%$$

(3)Gram/litre Concentration (Strength of solution)- "The mass of solute in gram present in per litre of solution is called Gram/litre conc. (strength) of solution."

Mathematically,

$$\text{Gram/litre conc. (strength)} = \frac{\text{Mass of solute (g)}}{\text{Volume of solution(l)}}$$

Dilute and Concentrated Solutions

Depending upon the amount of solute present in solution, the solutions are categorized as dilute and concentrated solutions.

A solution containing small quantity of solute is called dilute solution while, that containing larger quantity of solute is called concentrated solution.

For example, 5g/liter aqueous solution of NaCl would be dilute as compared to 20g/liter aqueous solution of NaCl.

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Saturated and Unsaturated Solutions

A solution that has dissolved as much solute as it is capable of dissolving at a given temperature is said to be a saturated solution. Thus, a solutions in which no more solute can be dissolved at the same temperature is called a saturated solution.

The amount of solute dissolved in per liter of a saturated solution at a given temperature is called the solubility of the solute at that temperature.

If the amount of solute dissolved in a solution is lesser than the saturation level at a given temperature, then it is called an unsaturated solution. Thus, in these solutions, more solute can be dissolved at the same temperature.

Suspension- Such heterogeneous mixtures where solid particles do not dissolve but remain suspended throughout the bulk of the liquids are called suspension.

Particles of suspension are visible to the naked eye.

Properties of Suspension

(1) Suspension is a heterogeneous mixture.
(2) The particles of suspension are relatively bigger in size and therefore, they are visible to the naked eye.
(3) The particles of suspension scatter the beam of light passing through it and make its path visible.
(4) When a suspension is kept undisturbed, the suspended particles settle down. Thus, the suspensions are unstable in natute.
(5) After settling down of suspended particles, the suspension breaks and it does not scatter light any more.
(6) The suspended particles of a suspension can be separated by the process of filtration.

Colloidal Solutions or Colloids

Such heterogeneous mixtures in which particles of colloidal size (bigger than particles of true solutions but smaller than those of suspension) remain uniformly suspended in a dispersion medium are called colloidal solutions or colloids.

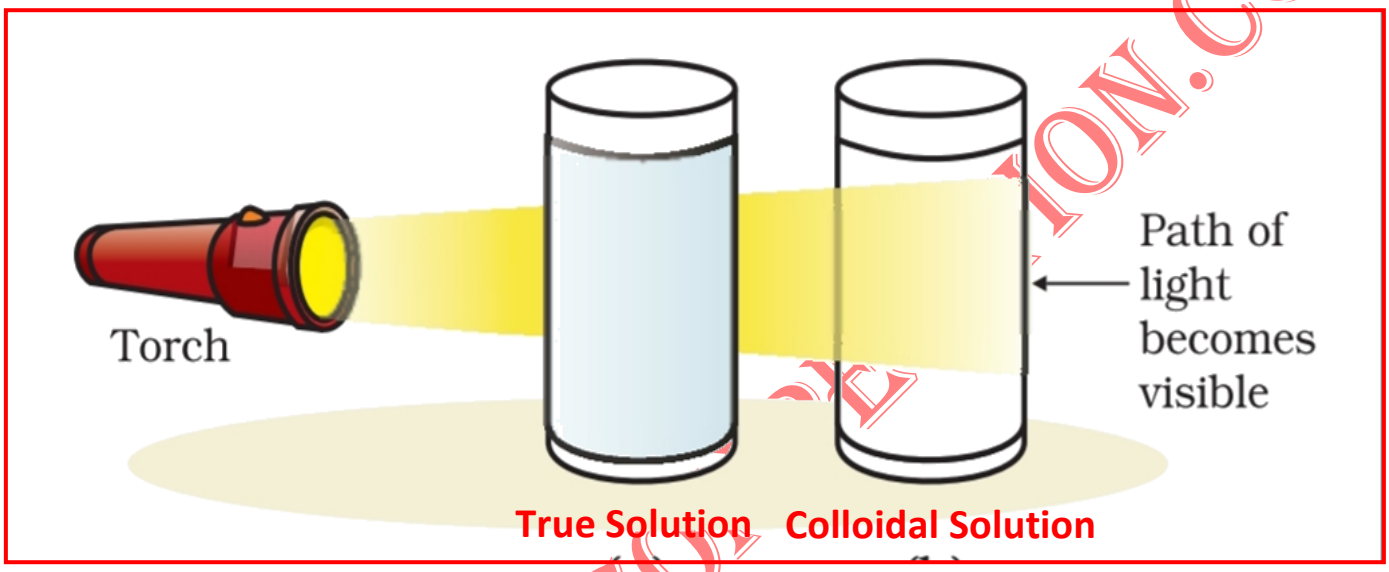
Due to relatively smaller size of particles as compared to that of suspension, colloidal solutions appear to be homogeneous, but actually they are contain two different phases and are heterogeneous in nature. Example- Milk

Being smaller in size, the particles of colloidal solutions cannot be seen by naked eye. However, they scatter the beam of light passing through the colloidal

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solutions and make its path visible. This phenomenon of scattering of light by colloidal solutions is called Tyndall effect.

Tyndall effect is due to scattering of light by colloidal particles. It is also observed when a beam of light enters a room through a small hole. Here, the colloidal particles of dust and smoke in air scatter the beam of light.



Types of Colloidal Solutions - **Depending upon physical state of dispersed phase and dispersion medium, colloidal solutions may be of following 8 types –**

S.No.	Physical state of Dispersed phase	Physical state of Dispersion medium	Examples
1.	Solid	Solid	Solid gels (coloured gem stone, milky glass etc.)
2.	Liquid	Solid	Gels (Jelly, Cheese, Butter)
3.	Gas	Solid	Foam (Sponge, Pumic stone etc.)
4.	Solid	Liquid	Sols, Milk of magnesia
5.	Liquid	Liquid	Emulsions (Milk, Face cream)
6.	Gas	Liquid	Foam (Froth, Shaving cream etc.)
7.	Solid	Gas	Aerosols (Automobile exhaust)
8.	Liquid	Gas	Aerosols (Fog, Mist, Cloud)

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Properties of Colloidal Solutions (Colloids)

(1) A colloid is a heterogeneous mixture.
(2) The particles of colloids are too small to be seen individually by naked eye.
(3) The particles of colloids are big enough to scatter the beam of light passing through it and make its path visible.
(4) When a colloid is kept undisturbed, the particles of dispersed phase do not settle down. Thus, the colloids are quite stable in natute.
(5) Colloidal particles can be separated by the process of filtration but they can be separated using a special technique called centrifugation

Difference Between Colloidal Solution and Suspension

Colloidal Solution	Suspension
1. Colloidal particles are relatively smaller in size	1. Suspended particles are relatively bigger in size
2. Colloidal particles are not visible by naked eye	2. Suspended particles are visible by naked eye
3. Colloidal solutions show Tyndall effect	3. Suspensions also show the phenomenon of Tyndall effect
4. Colloidal particles do not settle on standing	4. Suspended particles get settle on standing
5. These solutions are translucent	5. These are also translucent

Classification of Matter- Anything which has mass and occupies space is called matter.

Matter may be pure (such as elements and compounds) or impure (mixture).

(1) Elements- The pure matter consisting of only one types of atoms are called the elements. For example, hydrogen, oxygen, carbon, silver etc.

Being the simplest form of pure substance, the elements cannot be separated further into simpler substances.

The elements are further classified into metals (eg. Sodium, magnesium, copper, silver etc.), non-metals (eg. Hydrogen, carbon, nitrogen etc.) and metalloids (eg. Silicon, germanium, antimony etc.) having properties of both metals and nonmetals.

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(2) Compounds- When two or more elements combine in a fixed ratio they form compounds. For example, water (H_2O), sodium chloride (NaCl), glucose ($C_6H_{12}O_6$) etc. The compounds can be separated into their elements by chemical or electrochemical methods.

(3) Mixtures- When two or more substances (elements or compounds) mixed together in a any proportion, they form a mixture. For example, milk, tincture iodine, iodized salts, alloys etc. A mixture can be separated into its components by physical methods such as hand picking, sieving, filtration, evaporation, crystallization etc.

The mixtures can be homogeneous (having uniform composition and properties) or heterogeneous (not having uniform composition and properties) in nature.

Separation of Components of a Mixture

- Most of the natural substances are not chemically pure, but they are the mixture of two or more substances.
- Separation makes possible the use of different components of the mixture.
- Depending upon the nature of components a number of methods are used for separation of different components of a mixture.

(1) Evaporation

- **Separation of Coloured Component (Dye) from Blue/ Black Ink**
- Ink is a mixture of two or more dyes of different colours dissolved in water.
- The non-volatile component (dyes) of ink is separated from volatile component (solvent) by evaporation.

Activity 1

- Fill half a beaker with water.
- Put a watch glass on the mouth of the beaker.
- Put few drops of ink on the watch glass.
- Now start heating the beaker. Here, we avoid the heating of ink directly.
- Here, evaporation of volatile component (solvent) gets started from the watch glass.

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- Continue heating until entire solvent gets evaporated leaving behind the dyes (non-volatile components) on watch glass as residue.
- Observe carefully and record your observations.



- **Now Answer the following-**
- What do you think has got evaporated from the watch glass ?
- Is there a residue on the watch glass ?
- What is your interpretation ? Is ink a single substance (pure) or it is a mixture of two or more substances ?

(2) Chromatography

- **Is the Dye in Black Ink a single Colour ?**
- Ink is a mixture of two or more dyes of different colours dissolved in water.
- Different coloured components of dyes are separated by chromatography.

Activity 2

- Take a thin strip of filter paper.
- Draw a line approximately 3 cm above the lower edge of it using pencil.
- Put a small drop of ink from a sketch pen or fountain pen at the centre of line drawn and let it dry.

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- Lower this filter paper in a beaker containing water in such a way that, the drop of ink is just above the water level and leave it undisturbed.
- Watch carefully as the water rises up on the filter paper and record your observations.

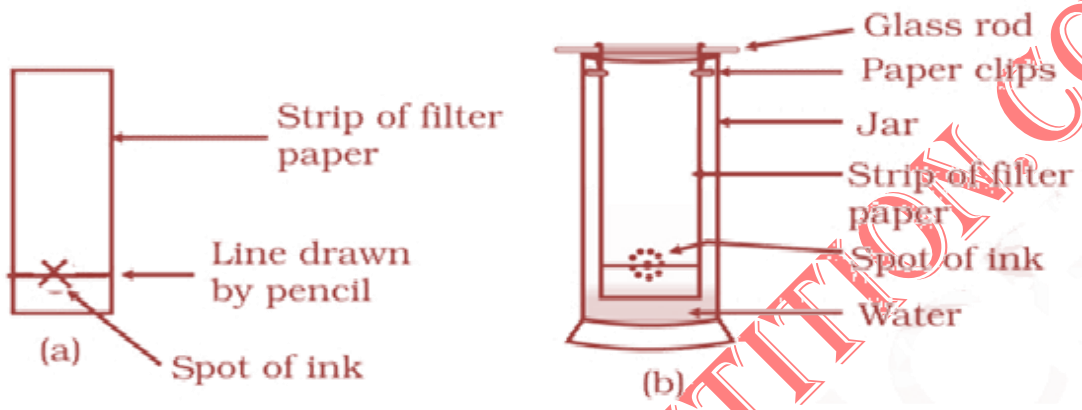


Fig.- Paper Chromatography

- As the water rises on filter paper, it takes the dye particles along with it.
- Here, more soluble coloured component rises faster.
- Thus, different components get separated forming different spots on filter paper.
- **Now Answer the following-**
- What do you observe on the filter paper as the water rises on it ?
- Do you obtain different colours on the strip of filter paper ?
- What according to you can be the reason for the rise of the coloured spot on the paper strip ?

(3) Distillation

- **Separation of two Miscible Liquids**

(i) Simple Distillation-

- This method is used for the separation of components of a mixture containing two miscible liquids that boil without decomposition and have sufficient difference in their boiling points.
- For example, acetone and water can be separated from their mixture by simple distillation.

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Activity 3

- Take a mixture of acetone and water in a distillation flask.
- Fit it with a thermometer.
- Arrange the apparatus as follows-

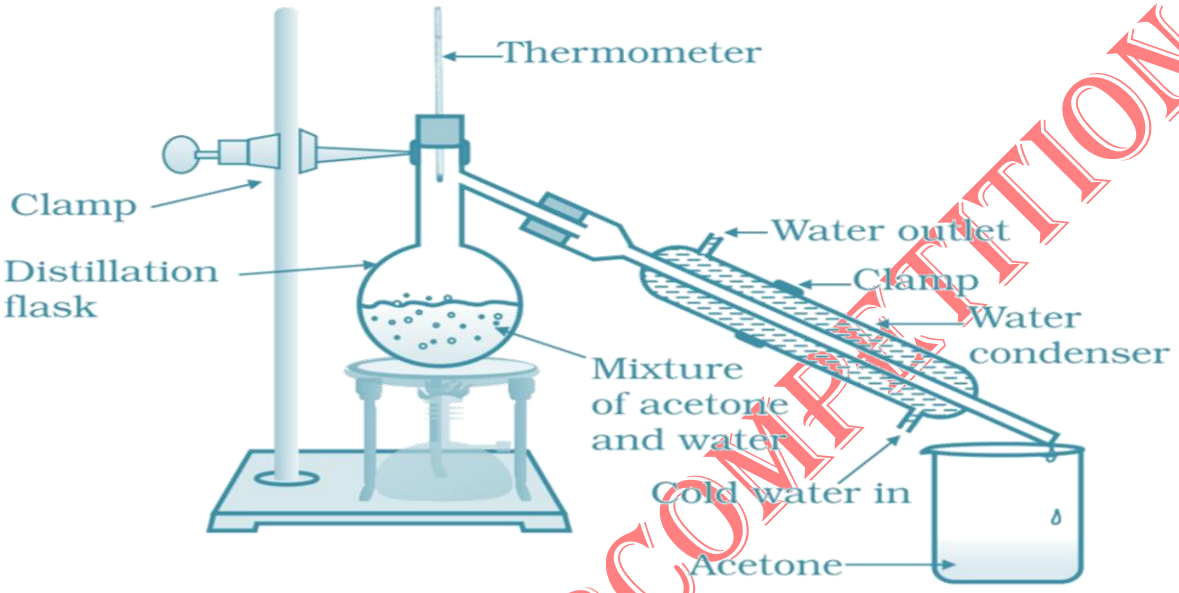


Fig.- Simple Distillation

- Heat the mixture slowly keeping a close watch at the thermometer.
- The acetone vaporises, condenses in the condenser and can be collected from the condenser outlet.
- Water is left behind in the distillation flask.
- **Now Answer the following-**
- What do you observe as you start heating the mixture.
- At what temperature does the thermometer reading become constant for some time ?
- What is the boiling point of acetone ?
- Why do the two components separate ?

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(2) Fractional Distillation

- This method is used for the separation of components of a mixture containing two or more miscible liquids that boil without decomposition but have difference in their boiling points lesser than 25^0C.
- For example, different gases of air and different components of petroleum are separated by the process of fractional distillation.
- The apparatus used in fractional distillation is similar to that in simple distillation, except that a fractionating column is fitted in between distillation flask and condenser.
- A simple fractionating column is a tube packed with glass beads. The beads provides surface for vapours to cool and condense repeatedly.

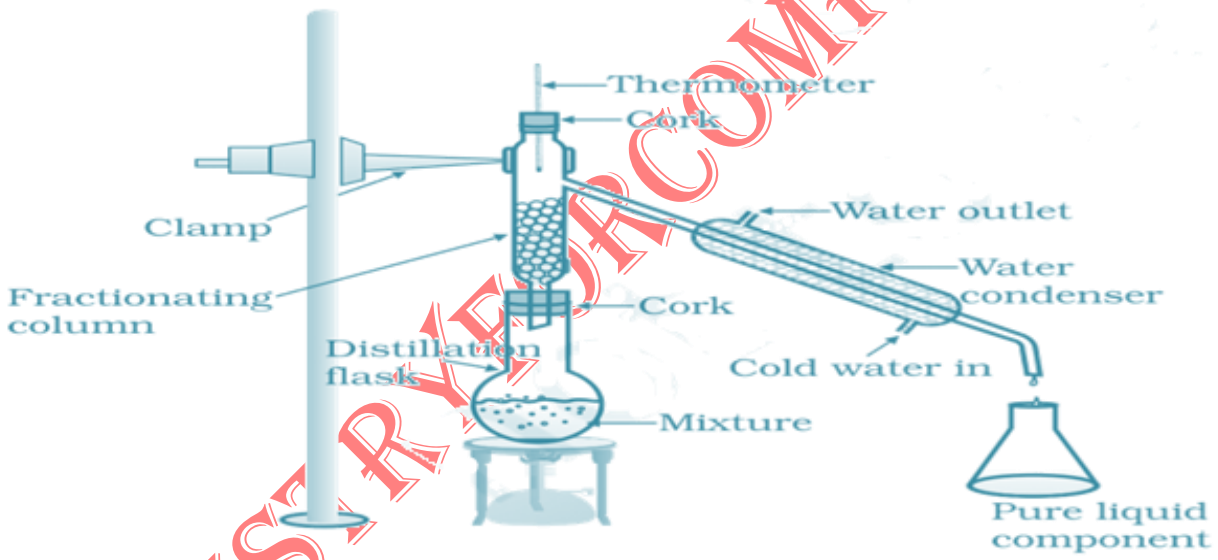


Fig.- Fractional Distillation

Separation of Different Gases from Air

- Air is the homogeneous mixture of a number of gases such as nitrogen (78.1%), oxygen (20.9%), argon (0.9 %), carbon dioxide (0.03%) etc.
- Different gases of air are separated by fractional distillation.

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- Here, first air is compressed by increasing pressure and then it is cooled by decreasing temperature to get liquid air.
- Now liquid air is warmed slowly in fractional distillation column, where different gases get separated at different heights depending upon their boiling points.

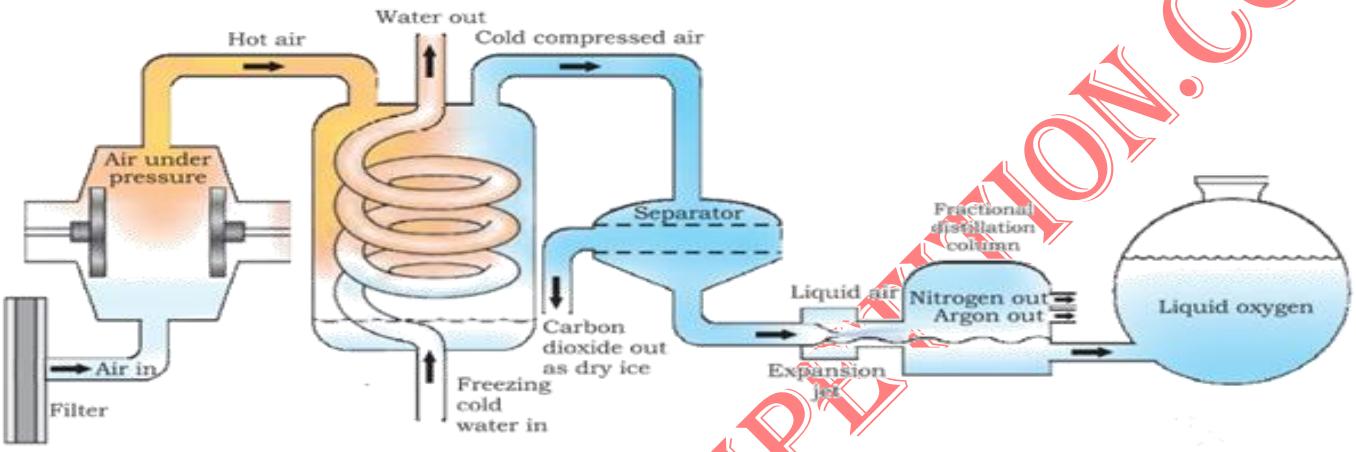
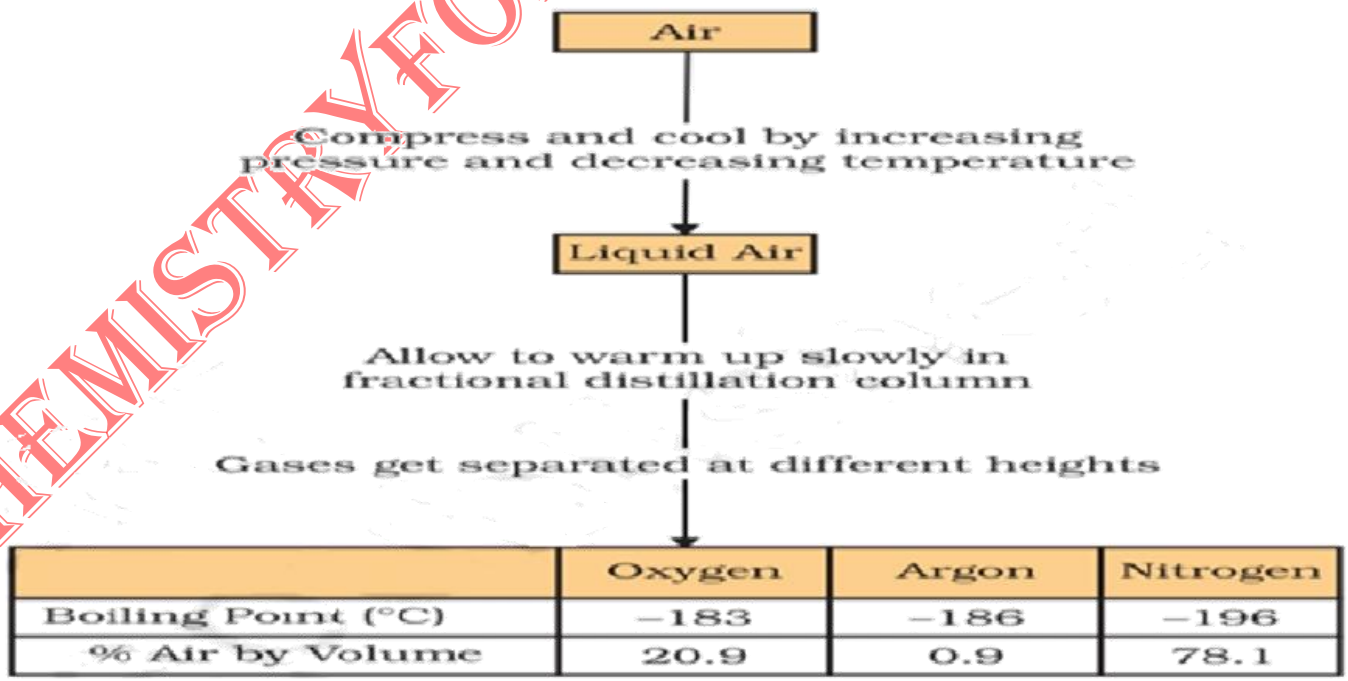


Fig.- Separation of Components of Air

- The flow diagram of different steps involved in separation of gases from air is as follow-



	Oxygen	Argon	Nitrogen
Boiling Point (°C)	−183	−186	−196
% Air by Volume	20.9	0.9	78.1

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- **Now Answer the following-**
- Arrange the gases present in air in increasing order of their boiling points.
- Which gas forms the liquid first as air is cooled ?

(4) Centrifugation

- **How can we separate cream from milk ?**
- Sometimes the solid particles present in a liquid are very small and pass through the pores of filter paper. Filtration technique cannot be used for separation of these particles.
- The components of such mixtures are separated using the process of centrifugation.
- The principle of centrifugation is based on the fact that, when a liquid spun rapidly, the denser particles are forced to the bottom while, the lighter particles stay at the top.

Applications

- Now-a-days, we get full-cream, toned and double-toned varieties of milk packed in poly packs or tetra packs in the market. These varieties of milk contain different amounts of fat and are obtained by the process of centrifugation. Centrifugation is used in-
- Diagnostic laboratories for blood and urine tests.
- Dairies and home to separate butter from cream.
- Washing machines to squeeze out water from wet clothes.

Activity 4

- Take some full-cream milk in a test tube.
- Centrifuge it by using a centrifuging machine for two minutes. If a centrifuging machine is not available, do it acat home using a milk churner, used in the kitchen.
- If you have a milk dairy nearby, visit it and ask (i) how they separate cream from milk and (ii) how they make cheese (paneer) from milk.

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Now answer

- What do you observe on churning the milk ?
- Explain how the separation of cream from milk takes place.

(5) Separation using Separating Funnel

- **How can we separate a mixture of two immiscible liquids ?**
- The components of a mixture containing two or more immiscible liquids are separated using a separating funnel.
- The principle is that, on keeping undisturbed, the components of a mixture of immiscible liquids separate out in different layers depending on their densities.

Activity 5

- Let us try to separate kerosene oil from water using a separating funnel.
- Pour the mixture of kerosene oil and water in a separating funnel.
- Let it stand undisturbed for sometime so that separate layers of oil and water are formed.
- Open the stopcock of the separating funnel and pour out the lower layer of water carefully.
- Close the stopcock of the separating funnel as the oil reaches the stop-cock.

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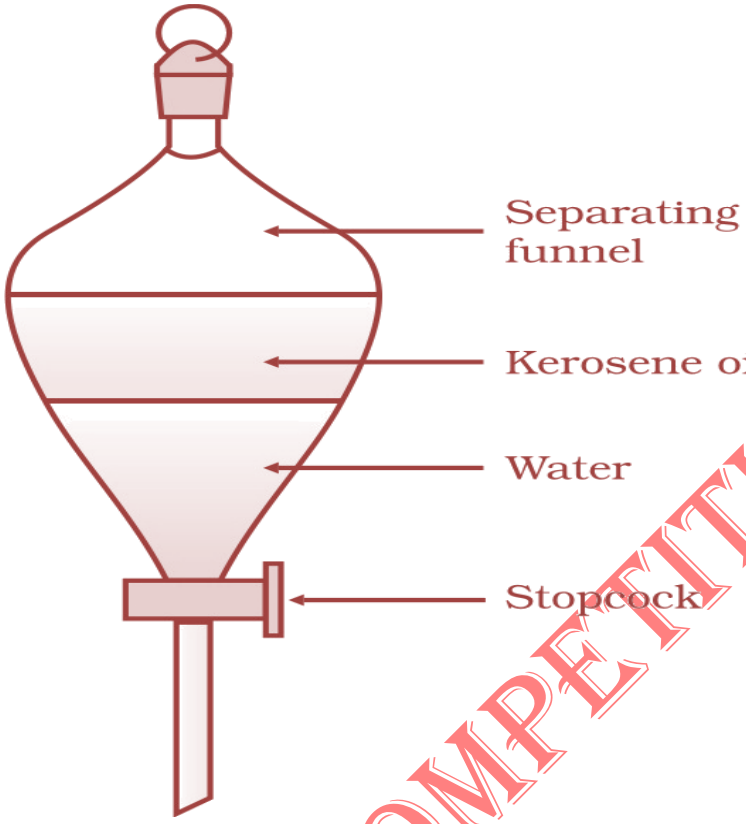


Fig.-Separation of immiscible liquids

Applications

- To separate mixture of oil and water.
- In the extraction of iron from its ore, the lighter slag is removed from the top by this method to leave the molten iron at the bottom in the furnace.
- The principle is that immiscible liquids separate out in layers depending on their densities.

(6) Sublimation

- **How can we separate a mixture of salt and camphor ?**
- On heating camphor changes directly from solid to gaseous state. This phenomenon is called sublimation.
- The sublimable volatile components are separated from a mixture containing non-sublimable impurities using the process of sublimation.

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- Some examples of solids which sublime are ammonium chloride, naphthalene, anthracene etc.

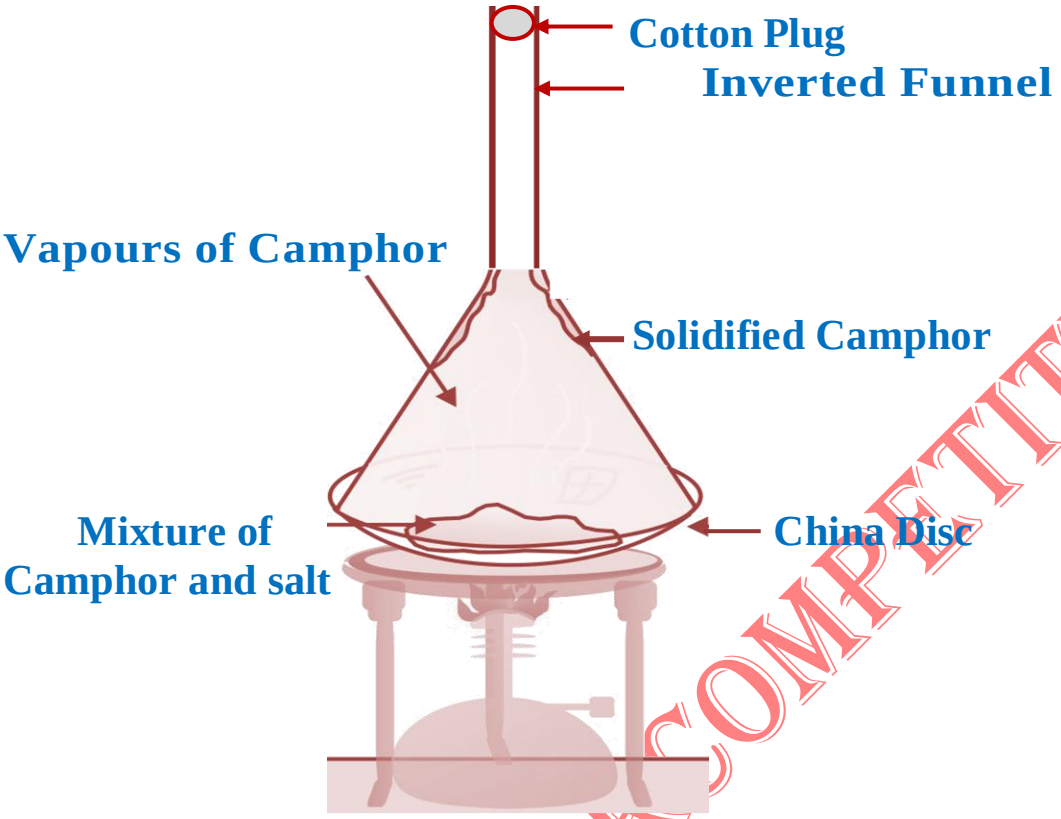


Fig.-Separation of camphor and salt by sublimation

- For separation, the mixture of camphor (sublimable) and salt (non-sublimable) is taken in a China dish and it is covered with an inverted funnel provided with cotton plug to arrest the camphor vapours. On heating camphor changes directly from solid to vapour and solidifies at the wall of funnel. Salt being non-sublimable remains left in China dish.

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Separation methods of different types of Mixtures

Type of Mixture	Separation method
1. Solids soluble in a liquid such as common salt dissolved in water	Crystallization
2. Solids insoluble in a liquid such as cream in milk	Centrifugation
3. Two miscible liquids such as alcohol and water or acetone and water	Distillation
4. Two immiscible liquids such as water and oil	Separating funnel
5. Ammonium chloride and sand	Sublimation
6. Different dyes of ink	Chromatography
7. Different gases of air	Fractional distillation
8.Different components of petrolium	Fractional distillation

Difference between Physical and Chemical Changes

Physical Change	Chemical Change
1.In this change chemical properties of substance remains unchanged	1.Here, chemical properties of substance gets changed
2. Here, new substance is not formed	2. Here, new substance get formed
3. It is reversible in nature	3. It is irreversible in nature
4. Here, heat is not evolved or absorved	4. It involves absorption or emission of heat

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