MATRIX OLYMPIAD

The Most Innovative Talent Recognition Exam

CHEMISTRY

Class - IX

MATRIX

Campus : Piprali Road, Sikar, Rajasthan 332001

Phone : 01572-241911, 01572-243911

Website: www.matrixedu.in

Few words for the Readers

Dear Reader,

"*Matrix Olympiad is established to encourage school students to go a step further than their regular studies, and get a chance and exposure to competition on a wide scale. It also helps students enhance their learning of basic cognitive skills and deeper knowledge of subjects like Science, Mathematics, English, Mental Ability, Social Studies.“Matrix Olympiad helps students nurture their minds for higher targets of tomorrow and enables them to study School for JEE, NEET, CLAT, NDA, Olympiads , NSEJS, NTSE , STSE etc.*"

The above thought has been our guiding principle while designing and collating the study material for **Matrix Olympiad** . And hence, we hope that this particular material will be helpful towards your preparation for **Matrix Olympiad**.

Our team at **MATRIX** has put in their best efforts for making this particular module interesting and relevant for you. Additional efforts have been made to ensure that the content is easy to understand and error free to the extent possible. However, there might remain some inadvertent errors in answer keys and theoretical portion and we would welcome your valuable feedback regarding the same.
If there are any suggestions for corrections, please write to us at **smd@matrixacademy.co.in** and we would be highly grateful.

Finally, we would like to end this message by a famous quote by Ernest Hemingway - "*There is no friend as loyal as a book*." So, please give your study material the time and attention it deserves, and it will surely help you reach newer heights in your fight with competition examinations.

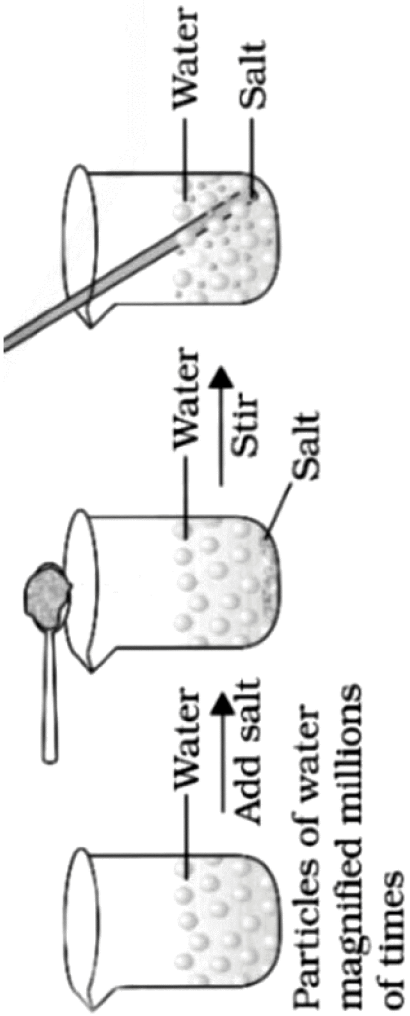
With love and best wishes !
Team MATRIX

CONTENTS

MATTER IN OUR SURROUNDINGS

1

Concepts



INTRODUCTION

There are a large number of things around us which we see and feel. For example, we can see a book in front of us. A book occupies some space. The space occupied by the book is called its volume. If we pick up the book, we can also feel its weight. So, we conclude that the book has some mass. We cannot see the air around us, yet if we fill a balloon with air and then weigh it carefully, we will find that not only does air occupy space (bounded by the balloon), but it also has mass.

Things like a book and air are examples of matter. Other examples of matter are wood, cloth, paper, ice, steel, water, oil etc.

Further, that matter offers resistance is borne out by the fact that we cannot displace an object from one place to another without applying some force. We have to apply force to pick up a stone from the ground.

Thus , matter can be defined as follows -

Anything that occupies space, has mass and offers resistance is called matter.

1. PHYSICAL NATURE OF MATTER

From a long time there were two views about the physical nature of matter.

(a) Continuous nature, Like a block of wood or sheet of glass.

(b) Particulate nature, that matter is made up of particles like sand .

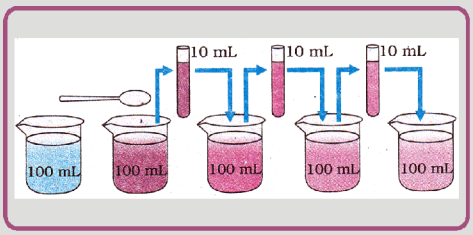
To understand whether the matter is continuous or particlulate in nature hold a sheet of glass in your hand, it appears continuous. Now throw it on the floor, it breaks into small or tiny particles. This shows that mater is not continuous but is made up of small particle. In fact, all matter in this universe is made up of small particles. These particle which make up all the matter around us are either atoms or molecules however these particles differ from one kind of matter to the other.

Thus Matter is made up of a large number of particles and size of these particles are very small.

LAB TIME
Let's Do & Learn

- **Objective : To demonstrate that the particles of a matter are very small.**
- **Preparation Materials :** Potassium permanganate crystals, water and beakers.
- **Procedure :**

1. Take a 2-3 crystals of potassium permanganate and dissolve in 100 mL of water.
2. Take 10 mL of this purple solution and mix with 90 mL of fresh water in second beaker.
3. Take 10 mL of this second solution and mix with 90 mL of fresh water in third beaker.
4. Take 10 mL of this third solution and mix with 90 mL of fresh water in fourth beaker. Dilute the solution five to six times.



- **Observation :** The water in the last beaker is still coloured and is light pink now.
- **Conclusion :** Just 2-3 crystals of potassium permanganate produce purple colour in large volume of water.

It shows that the particles of matter are very small.

2. CHARACTERISTICS OF PARTICLES OF MATTER

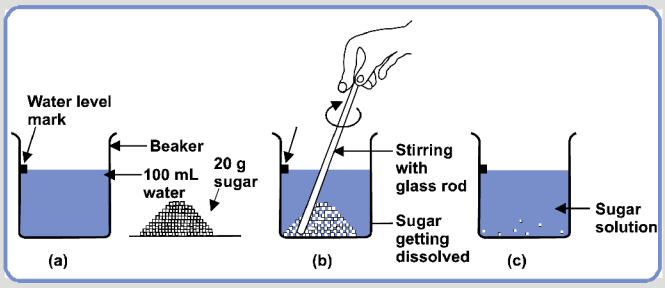
(a) The particles of matter have spaces between them

The particles of matter have some spaces between them. It can be understood by following activity.

LAB TIME
Let's Do & Learn

- **Objective : To demonstrate that the particles of a matter have spaces between them**
- **Preparation Materials Required :** Salt or sugar, Beaker and water
- **Procedure :**

1. Take a beaker and fill it half with water.
2. Mark the level of water
3. Dissolve some salt or sugar in it.



- **Observation :** Water level remains the same as earlier.
- **Conclusion :** When sugar or salt is dissolved in water, the particles of sugar or salt get into the spaces between particles of water.

(b) The particles of matter are constantly moving

The particles of matter move constantly. This property can be explained by following activity.

LAB TIME
Let's Do & Learn

- **Objective : To demonstrate that the particles of a matter are continuously moving.**

Experiment –1

- **Preparation Materials Required :** Incense stick and match Box
- **Procedure :** Light an incense stick (agarbatti) in one corner of a room.
- **Observation :** The fragrance spreads in the entire room quickly
- **Conclusion :** The vapours of incense stick get mixed with air and move rapidly in the room. Thus particles of matter are in continuous motion.

Experiment –2

- **Preparation Materials Required :** Crystals of copper sulphate , water and beakers.
- **Procedure :** Put a few crystals of copper sulphate in a beaker containing water. Do not stir.
- **Observation :** The water of the whole beaker turns blue after some time.
- **Conclusion :** The spreading of blue colour of copper sulphate is due to the movement of copper sulphate and water particles.

Focus Point

Diffusion : "Intermixing of particles of two different types of matter on their own is called diffusion."
It is the phenomenon in which the movement of molecules or particles occur from their higher concentration towards their lower concentration.

e.g. : When a perfume bottle is opened in one corner of a room, its fragrance spreads in the whole room quickly. This happens because the particles of perfume move rapidly in all directions and mix with the moving particles of air in the room.

Experiment : We take a gas jar full of bromine vapours and invert another gas jar containinig air over it, then after some time, the red-brown vapours of bromine spread out into the upper gas jar containing air.

Conclusion : In this way, the upper gas jar which contains colourless air in it, also turns red-brown. The mixing is due to the diffusion of bromine vapours (or bromine gas) into air.

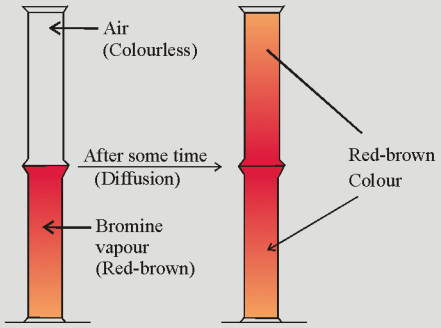


Figure : Diffusion of bromine vapour into air

(c) The particles of matter attract each other : There are some forces of attraction between the particles of matter which bind them together. It can be understood by following activity.

LAB TIME
Let's Do & Learn

- **Objective : To demonstrate the strength of attractive forces between particles of different kinds of matter**
- **Materials Required :** Iron nail, piece of chalk, ice cube and hammer.
- **Procedure :** Take an iron nail, a piece of chalk and a cube of ice. Try to break each of them by beating with a hammer.
- **Observation :** It is very easy to break the piece of chalk into smaller particles. It requires more force to break a cube of ice whereas the iron nail does not break at all.
- **Conclusion :** The force of attraction between particles of chalk is weaker than that of ice while the force of attraction between particles of iron is very strong.

Focus Point

- **Cohesive Force :** The force of attraction between the particles of same substances is called cohesive force.
- **Adhesive Force :** The force of attraction between the particles of different substances is called adhesive force

3. STATES OF MATTER

On the basis of physical states, all matter can be classified into three groups:-

(i) Solids (ii) Liquids (iii) Gases

3.1 THE SOLID STATE

A solid is that state of matter which has definite shape, mass and volume.

e.g. : Ice, wood, coal, iron etc.

Properties :

(i) Solids have a definite mass and definite volume.

(ii) Solids have a definite shape.

(iii) Solids have negligible compressibility.

(iv) Solids have high densities.

(v) The intermolecular forces in solids are very strong.

(vi) The dimensions of solid do not increase in large proportion on heating or on cooling.

(vii) Solids diffuse into one another very slowly.

3.2 THE LIQUID STATE

A liquid is a state of matter which has definite mass and volume but no definite shape.

e.g. : Water, alcohol, milk, mercury etc.

Properties :

(i) Liquids have a definite mass and volume.

(ii) Liquids do not have a definite shape.

(iii) Liquids are slightly more compressible than that of solids.

(iv) Density of liquids is lesser than that of solids.

(v) The force of attraction between the molecules of liquids is less than that of solids.

(vi) Liquids expand far more than solids on heating.

(vii) The particles of two different liquids can diffuse in one another easily to form homogeneous mixture.

3.3 THE GASEOUS STATE

A gas is a state of matter, which has definite mass, but no definite shape and no definite volume.

e.g. : O_2, N_2, H_2 etc.

Properties :

(i) A gas contained in a vessel has a definite mass.

(ii) Gases do not have definite shape and volume.

(iii) Gases are highly compressible because intermolecular spaces between them are very-very large as compared to solids and liquids.

(iv) Density of gases is extremely small as compared to solids and liquids.

(v) Intermolecular forces are negligible.

(vi) Gases expand to large extent when heated.

(vii) Gases diffuse in one another rapidly to form homogeneous mixture

Focus Point

- RIGID AND FLUID

(a) Rigid : Rigid means unbending or inflexible. A solid is a rigid form of matter so that it maintains its shape when subjected to outside force.

(b) Fluids : Fluids are the substances which have tendency to flow. A liquid is a fluid form of matter which occupies the space of the container. Liquids have a well defined surface. A gas is a fluid form of matter which fills the whole container in which it is kept.

- Liquids and gases are known as fluids.

4. FOURTH AND FIFTH STATE OF MATTER

4.1 PLASMA

It is the fourth state of matter. Scientists are reported to have discovered a new state of matter which is called plasma state. This state does not fit into any of the known three states of matter. Hence, it is often called the fourth state of matter. Plasma state consists of highly ionized gas in which the particles exist in super energetic and super excited states.

The discovery of plasma has found some practical applications. We very well know about fluorescent tubes and neon sign bulbs. The fluorescent tubes contain helium or some other gas. When electric current is passed through the gas, it produces glowing plasma, having a characteristic colour depending upon the nature of the gas.

Plasma is produced in the sun and in the stars due to high temperature. It is the presence of plasma that makes them glow.

4.2 BOSE-EINSTEIN CONDENSATE

It is the fifth state of matter.

In 1920, the noted Indian scientist Satyendra Nath Bose on the basis of his statistical calculations gave the concept of the fifth state of matter. Einstein too predicted the possibility of such a state. Later three American scientists succeeded in obtaining this state by supercooling a gas of extremely low density, The process is called Bose-Einstein condensation, and this state of matter is called Bose-Einstein Condensate (BEC).

5. COMPARISION OF THE CHARACTERISTICS OF THREE STATES OF MATTER

Property	Solid state	Liquid state	Gaseous state
Interparticle spaces	Very small spaces	Comparatively large spaces than solids	Very large spaces
Interparticle forces	Very strong	Weak	Very weak
Nature	Very hard and rigid	Fluid	Highly fluid
Compressibility	Negligible	Very small	Highly compressible.
Shape and volume	Definite shape and volume	Indefinite shape, but definite volume	Indefinite shape as well as volume
Density	High	Less than solid state	Very low density
Kinetic energy	Low	Comparatively high than solids	Very high
Diffusion	Negligible	Slow	Very fast

Focus Point

- Gases are Highly Compressible therefore :
  (1) LPG (Liquefied Petroleum Gas) is used in our home for cooking.
  (2) Oxygen cylinders supplied to hospitals contain liquid oxygen.
  (3) These days C.N.G. (Compressed Natural Gas) is used as fuel in vehicles.
- Gaseous particles move randomly at high speed and hit each other and also walls of the container, so exert pressure.

6. CAN MATTER CHANGE ITS STATE

We all know from our observation that water can exist in three states of matter-solid as ice, liquid as the familiar water and gas as water vapour .

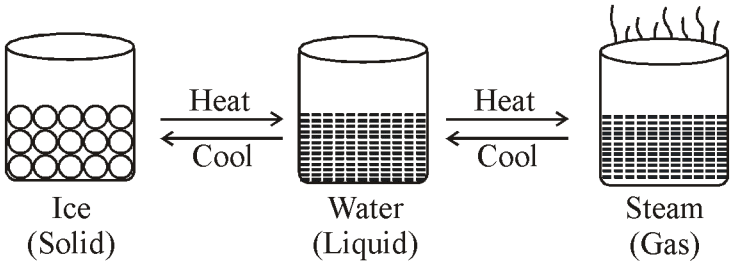
A substance may exist in three states of matter i.e. solid, liquid or gas depending upon the conditions of temperature and pressure. By changing the conditions of temperature and pressure, all three states could be obtained.

The phenomenon of change of matter from one state to another state and back to original state, by altering the conditions of temperature and pressure, is called interconversion of states of matter.

The various states of matter can be interchanged into one another by altering the conditions of -

(a) Temperature (b) Pressure

6.1 ALTERING THE TEMPERATURE OF MATTER



Solid to Liquid Change : Melting

- The process in which a solid changes into a liquid on heating is called melting or fusion.
- The temperature at which a solid changes into liquid at atmospheric pressure is called melting point of the substance
- Higher the melting point, stronger are the forces of attraction between the particles.

e.g. : Ice at 0°C changes into water at 0°C, when heat energy is supplied to it.

Liquid to solid Change : Freezing

- The process of changing a liquid into solid by cooling is called freezing.
- Freezing is also called solidfication and is reverse of melting.
- The temperature at which a liquid freezes to become a solid at atmospheric pressure is called the freezing point.

e.g. : Water at 0°C changes into Ice at 0°C, when cooling it.

Focus Point

The numerical value of melting point and boling point is same.

Melting point of ice = Freezing point of water = 0°C

Liquid to Gas Change : Boiling or Vaporisation

- The process in which a liquid substance changes into a gas on heating is called boiling or vaporisation.
- The temperature at which a liquid boils and changes into gas at atmospheric pressure is called boiling point of the liquid.
- Impurities increase the boiling point of liquids.
- Boiling point of water is taken as 373 K at 1 atm pressure.
- Higher the boiling point, stronger are the forces of attraction between the particles.

e.g. : Water at 100°C changes into water vapour at 100°C, when heat is supplied to it.

Focus Point

Differences between Gas and Vapour

- A substance is said to be a gas if its boiling point is below room temperature. For example, oxygen, nitrogen, carbon dioxide, etc. If the normal physical state of a substance is either a solid or a liquid but gets converted into the gaseous state either on its own or by absorbing energy, the gaseous state is called the vapour state. For example, vapours of water in air.
- In pressure cooker, water is subjected to heating in a closed vessel in confined space. The steam generated in fixed volume increases the pressure beyond the normal atmospheric pressure so the boiling point of water rises above 100 °C. Because the temperature of cooking medium is greater than the normal boiling point, the food gets cooked at a faster rate.

Gas to Liquid Change : Condensation

- The process of changing a gas to a liquid on cooling is called condensation.
- Condensation is the reverse of vaporisation.
- The constant temperature at which a gas changes into liquid state by giving out heat energy at atmo spheric pressure is called condensation point.

Focus Point

The numerical value of condensation point and boiling point is same.

Condensation point of water vapour = Boiling point of water = 100°C

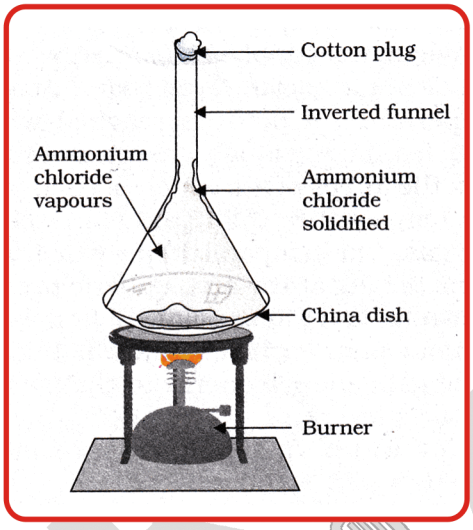
Solid to Gas or Gas to solid Change : Sublimation

- The process of change of a solid state directly to gaseous state on heating and vice-versa on cooling without passing through the liquid state is called sublimation.

$$\text{solid} \underset{\text{on cooling}}{\overset{\text{on heating}}{\rightleftharpoons}} \text{Vapour}$$

- A gaseous state directly formed from a solid on heating is known as sublime. A solid state of matter formed directly from its gaseous state on cooling is known as sublimate.

- Few examples of the substances which sublime are camphor, ammonium chloride, naphthalene, iodine, solid carbon dioxide, etc.



Focus Point

- SCALE OF MEASURING TEMPERATURE
  There are three scales of temperature
  Celsius scale (°C), Fahrenheit scale (°F) and Kelvin scale (K)
  K = 273 + °C

  $°F = \frac{9}{5}(°C) + 32$

6.2 ALTERING THE PRESSURE OF MATTER

The difference in various states of matter is due to the different intermolecular spaces between their particles. So when a gas is compressed the intermolecular space between its particles decreases and ultimately it will be converted into liquid.

Pressure and temperature determine the state of a substance. So, high pressure and low temperature can liquefy gases.

e.g. : Carbon dioxide (CO_2) is a gas under normal conditions of temperature and pressure. It can be liquefied by compressing it to a pressure 70 times more than atmospheric pressure. Solid CO_2 is known as 'Dry ice'. Solid CO_2 is extremely cold and used to 'deep freeze' food and to keep ice-cream cold.

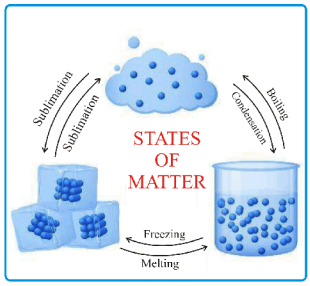


Figure : Inter Conversion of States of Matter

LAB TIME
Let's Do & Learn

- **Objective : To demonstrate that the temperature remains constant during the change of state.**
- **Preparation Materials Required :** Ice, thermometer and beaker
- **Procedure :**

(i) Take about 100 g of ice in a beaker. Hang a laboratory thermometer, in it such that its bulb is in contact with ice.

(ii) Note down the initial temperature and start heating the beaker.

(iii) Note the temperature when ice starts changing to water.

(iv) Note the temperature when the complete ice has been converted to water.

(v) Continue heating and note the temperature when water starts changing to vapours.

(vi) Note the temperature when most of the water has vaporised.

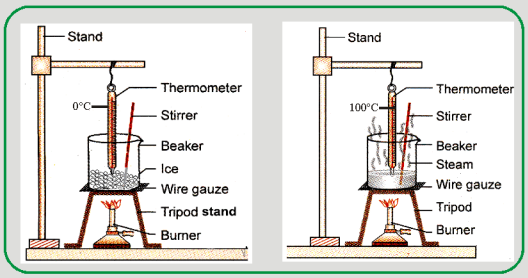


Figure : Conversion of Ice into Water and Water into Water Vapour

- **Observations :** There is no change in temperature till all the ice melts though heating continues. Temperature remains constant at 0°C.

Once the ice is converted to water, the temperature starts rising till the water begins to boil.

Once the water starts boiling, the temperature remains constant at 100°C till all the water has changed into vapours.

- **Conclusion :** During the change of state from solid to liquid or from liquid to gas, the temperature remains constant till all the solid has melted or all the liquid has vaporised. The heat energy supplied is used up in overcoming the forces of attraction and hence the thermometer does not show any rise in temperature.

7. LATENT HEAT(HIDDEN HEAT)

It is observerd that the temeprature of the system does not change after melting point is achieved till all the ice melts, though we continue to heat the beaker. This happens because the heat supplied is used up in changing the state by breaking the intermolecular forces of attraction which hold them in solid state. As a result, there is no change in temperature till all the ice melts. This energy required to change solid into liquid is called "latent heat" The word "latent" means "hidden" because this energy is hidden into the contents of the beaker.

Latent heat is of two types

(a) Latent heat of fusion (b) Latent heat of vaporization

7.1 LATENT HEAT OF FUSION

- It is defined as the amount of heat energy required to change 1 kg of a solid into liquid at atmospheric pressure without any change in temperature at its melting point.
- It is observed that latent heat of fusion of ice is 3.34×10^5 J/kg or 80 kcal/kg.
- Ice at 273 K is more effective in cooling than water at 273 K. This is due to the reason that for melting, each kilogram of ice absorbs latent heat of 3.347×10^5 joules from the substance and hence cools the substance more effectively.

7.2 LATENT HEAT OF VAPORISATION

- It is defined as the amount of heat energy required to change 1 kg of the liquid into vapour at its boiling point without any change in temperature.
- Latent heat of vaporisation of water is 22.5×10^5 J/kg or 540 kcal/kg.
- Steam contains more heat in the form of latent heat than boiling water.

8. TEMPERATURE TIME GRAPH

We can show the change of temperature with time in the form of a temperature-time graph drawn by using the readings obtained in the above experiment. Such a temperature-time graph is shown in figure.

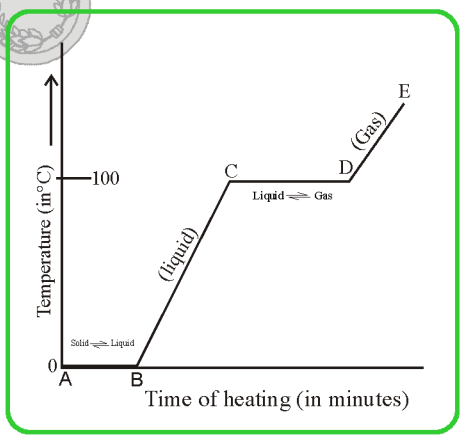


Figure : Temperature Time Graph

We can understand the above graph by taking an example of water. In this graph at point A, we have all ice. As we heat it, the ice starts melting to form water but the temperature of ice and water mixture does not rise. It remains constant at 0°C during the melting of ice. At point B, all the ice has melted to form water. Thus, we have only water at point B. Now, on heating beyond point B, the temperature of water (formed from ice) starts rising as shown by the sloping line BC in the graph. When the temperature of water reaches its boiling point i.e; 100°C, water starts converting into steam. But during the process of boiling, temperature does not rise and thus constant temperature is observed (line CD). At point D all the water has boiled to form steam. Thus, we have only steam at point D. Now on heating beyond point D, the temperature of steam rises as shown by the sloping line DE.

9. EVAPORATION

- The process of conversion of a liquid into vapours at any temperature below its boiling point is called evaporation.
- At any given temperature, the kinetic energy of some particles on the surface of a liquid is high enough to overcome the forces of attraction by other particles, hence they leave the liquid and are converted into vapours.
- During evaporation, a liquid absorbs heat energy from any other body in contact with it or from the surroundings.

9.1 FACTORS AFFECTING EVAPORATION

There are various factors which effect process of evaporation.

(i) Temperature: With the increase in temperature the rate of evaporation increases.

Rate of evaporation α T

Reason : On increasing temperature more number of particles get enough K.E. to go into the vapour state.

(ii) Surface Area : Rate of evaporation α Surface area

Since evaporation is a surface phenomena, if the surface area is increased, the rate of evaporation increases. So, while putting clothes for drying up we spread them out.

(iii) Humidity of Air : Rate of evaporation $\alpha \frac{1}{\text{Humidity}}$

Humidity is the amount of water vapour present in air. When humidity of air is low, the rate of evaporation is high and water evaporates more readily. When humidity of air is high, the rate of evaporation is low and water evaporates very slowly.

(iv) Wind Speed : Rate of evaporation α Wind speed

With the increase in wind speed, the particles of water vapour move away with the wind. So the amount of water vapour decreases in the surroundings.

(v) Nature of substance : Substances with high boiling points will evaporate slowly, while substances with low boiling points will evaporate quickly

9.2 DIFFERENCES BETWEEN EVAPORATION AND BOILING

Evaportion	Boiling
It is a surface phenomenon.	It is bulk phenomenon.
It is occurs at all temperatures below B.P.	It occurs at B.P. only.
The rate of evaportion depends upon the surface area of the liquid, humidity temperatue & wind speed.	The rate of boiling does not depend upon the surface area, wind speed, and humidity.

9.3 COOLING CAUSED BY EVAPORATION

The cooling caused by evaporation is based on the fact that when a liquid evaporates, it draws (or takes) the latent heat of vaporisation from 'anything' which it touches.

For example :

(i) We Wear Cotton Clothes in Summer :

During summer, we perspire more because of the mechanism of our body which keeps us cool. During evaporation, the particles at the surface of liquid gain energy from the surroundings or body surface. The heat energy equal to latent heat of vaporisation, is absorbed from the body, leaving the body cool. Cotton, being a good absorber of water helps in absorbing the sweat.

(ii) Pouring the acetone on our palm :

If we pour some acetone or ether or nail polish remover on our palm then we feel cool because the energy needed for evaporation is taken from our palm. Hence, our palm feels cooling.

(iii) Sprinkling of water on the open ground after a hot sunny day :

The sprinkling of water of the open ground or roof after a hot sunny day causes the cooling of the surface of roof because the water evaporates by absorbing heat from the ground and the surrounding air. In this way the ground or roof become cool and we feel comfort.

(iv)We see water droplets on the outer surface of a glass containing ice cold water :

Take some ice cold water in a glass. Soon we will see water droplets on the outer surface of the glass. The water vapour present in air on coming in contact with the cold glass of water loses energy and gets converted to liquid state which we see as water droplets.

(v) Water keeps cool in the earthen pot(matki) during summer :

When the water oozes out of the pores of an earthen pot, during hot summer, it evaporates rapidly. As the cooling is caused by evaporation, therfore, the temperature of water within the pot falls and hence it becomes cool.

(vi) Rapid cooling of hot tea :

It tea is too hot to sip, we pour it in the saucer. In doing so, we increase the surface area and the rate of evaporation increases. This in turn causes cooling and the tea attains a desired temperature for sipping.

(vii) A wet handkerchief is placed on the forehead of a person suffering from high fever :

The logic behind placing wet cloth is that as the water from the wet cloth evaporates, it takes heat from the skull and the brain within it. This, in turn, lowers the temperature of brain and protects it from any damage due to high temperature.

SOLVED EXAMPLES

SE. 1

What celsius and kelvin temperature correspond to 68°F?

Ans. To convert °F to °C

°C = (°F - 32°)× 5/9= (68 - 32) × 5/9 = 20°C

K = °C + 273 = 20 + 273 = 293 K.

SE. 2

Few iodine crystals are kept in a conical flask, it is stoppered and kept undisturbed for a long time. A few crystals are seen near the mouth and sides of the flask. Explain.

Ans. Over a period of time iodine molecules sublime and are converted into gas. Some of these gas molecules condense back on the surface of the flask and near the mouth of the flask to form iodine crystals.

SE. 3

Ordinary water boils at 100°C. Can it be made to boil at 95°C or 105°C?

Ans. Yes. The boiling point of a liquid depends upon the pressure acting on it. Water boils at 100°C at 1 atm pressure. If the pressure is reduced, it can be made to boil at lower temperature and if the pressure is increased it can be made to boil at higher temperature.

SE. 4

What happens to the heat energy supplied when the solid starts melting?

Ans. The temperature of the molten liquid remains constant till the complete solid melts. The heat energy supplied is converted into latent heat of fusion. The temperature starts rising only after the complete solid is converted to liquid.

SE. 5

The melting points of two solids X and Y are 300 K and 400 K respectively. Which has more interparticle forces?

Ans. Y has more inter particle force because higher melting point shows more energy is required to break interparticle forces.

SE. 6

How do aquatic plants survive?

Ans. The air contains gases like oxygen, nitrogen, carbon dioxide, etc. These gases dissolve in water by the process of diffusion. The oxygen and carbon dioxide are taken up by aquatic animals and plants respectively for their survival.

SE. 7

What are the factors which are responsible for bringing a change in the physical state of a substance?

Ans. Temperature and pressure are two factors which can bring about the change in physical state. But they have opposing effect. Increase in temperature separate the particles of a substance apart while increase in pressure brings them closer.

SE. 8

How can the evaporation of a liquid be made faster?

Ans. (i) By increasing the surface area

(ii) By increasing the temperature

(iii) By blowing wind

(iv) By decreasing the humidity

SE. 9

Why is solid carbon dioxide known as dry ice? Why is it stored under high pressure?

Ans. Solid carbon dioxide directly changes into carbon dioxide gas without passing through the liquid state. It is an extremely cold substance and does not wet the surface. Hence, it is called dry ice. It is stored under high pressure because on decreasing the pressure, solid carbon dioxide is directly converted to gas.

EXERCISE – I

ONLY ONE CORRECT TYPE

1. Which of following is not matter ?
(A) Joy (B) Pen
(C) Pencil (D) Air

2. Name the process by which a drop of ink spreads in a beaker of water.
(A) Diffusion (B) Vaporization
(C) Condensation (D) Sublimation

3. Which of the following has the strongest interparticle force at the room temperature?
(A) Nitrogen (B) Mercury
(C)Iron (D) Chalk

4. Fluids are
(A) liquids and gases (B) solids and gases
(C) liquids and solids (D) only solids

5. Volume of gases can be defined as
(A) definite (B) almost nil
(C) large
(D) take the volume of container

6. The physical state of matter which can be easily compressed is
(A) liquid (B) Gas
(C) solid (D) None of these

7. The change of state from solid to liquid is known as
(A) freezing (B) boiling
(C) melting (D) None of these

8. The temperature at which a solid changes into liquid at atmospheric pressure is called
(A) melting point (B) boiling point
(C) diffusion (D) evaporation

9. Convert the temperature of 373°C to the kelvin scale?
(A) 646 K (B) 546 K
(C) 300 K (D) 500 K

10. Addition of impurities to water
(A) decreases the freezing point of water
(B) increases the boiling point of water
(C) does not affect the freezing or boiling point of water
(D) both (A) and (B)

11. Which of the following indicates the relative randomness of particles in the three states of matter?
(A) Solid > liquid > gas
(B) Liquid < solid < gas
(C) Liquid > gas > solid
(D) Gas > liquid > solid

12. The process of evaporation causes
(A) heating
(B) cooling
(C) increase in temperature
(D) none of these

13. Ice floats on the surface of water because
(A) it is heavier than water
(B) the density of both water and ice is the same
(C) ice is lighter than water
(D) none of these

14. Evaporation of a liquid can take place
(A) at its boiling point
(B) below its boiling point
(C) above its boiling point
(D) at a fixed temperature

15. A liquid is kept in a China dish. The evaporation of the liquid can be accelerated
(A) by keeping the dish in the open
(B) by blowing air into the liquid
(C) by keeping the dish under a running fan
(D) all of these

16. Which one of the following statements is wrong for gases?
(A) Gases do not have a definite shape and volume
(B) Volume of the gas is equal to the volume of the container confining the gas
(C) Confined gas exerts uniform pressure on the walls of container in all directions
(D) Mass of the gas cannot be determined by weighing a container in which it is enclosed

17. The quantity of matter present in an object is called its
(A) weight (B) gram
(C) mass (D) density

18. Which of the following states has the least energetic molecules?
(A) Solid (B) Liquid
(C) Gas (D) Plasma

19. Which of the following represent the densest (high density) state of matter?
(A) Solids (B) Liquids
(C) Gases (D) Vapours

20. A gas can be best liquefied
(A) by increasing the temperature
(B) by lowering the pressure
(C) by increasing the pressure and reducing the temperature
(D) none of these

21. Which of the following statements does not go with the liquid state?
(A) Particles are loosely packed in the liquid state
(B) Fluidity is maximum in the liquid state
(C) Liquids cannot be compressed much
(D) Liquids take up the shape of any container in which they are placed

22. The value of latent heat of vaporisation of water in kcal/kg is
(A) 80 (B) 540
(C) 334 (D) 225

23. The electric bulb on long use forms a black coating on its inner surface. The process associated with this is
(A) melting of tungsten
(B) sublimation of tungsten
(C) oxidation of tungsten
(D) reduction of tungsten

24. If a few spoons of salt are dissolved in pure water then
(A) its b.pt. becomes less than 100°C
(B) its b.pt. becomes more than 100°C
(C) its freezing point becomes more than 0°C
(D) none of these

25. Latent heat of vaporisation is used to
(A) overcome the forces of attraction between molecules in solid state
(B) increase the kinetic energy of molecules in liquid state
(C) overcome the forces of attraction between molecules in liquid state
(D) increase the kinetic energy of molecules in vapour state

PARAGRAPH TYPE

PARAGRAPH # 1

The molecules of a gas are free to move about in any direction. Because of large intermolecular spaces, the gases are easily compressible. The kinetic energy of the molecules of gases is maximum and they move about randomly at a high speed. The randomly moving high speed molecules hit against the sides of containing vessel. The pressure exerted by any gas is due to the force exerted by molecules on the sides of containing vessel.

26. A gas fills all the space in a container in which it is kept because
(A) the gases have large intermolecular spaces
(B) the molecules are not free to move
(C) the randomly moving molecules hit against the walls of container
(D) the molecules have large intermolecular forces of attraction

27. When pressure is applied on a gas, it is converted to a liquid due to
(A) increase in intermolecular forces of attraction between the particles
(B) increase in intermolecular distances between the particles
(C) decrease in intermolecular forces of attraction between the particles
(D) increase in kinetic energy of particles

28. The force per unit area exerted by the particles of the gas on the walls of container is called
(A) atmospheric pressure
(B) pressure of the gas
(C) kinetic energy of the gas
(D) density of the gas

PARAGRAPH # 2

The phenomenon of change of liquid into vapours at any temperature below its boiling point is called evaporation. The rate of evaporation increases with increase in surface area, temperature, speed of wind and decrease in humidity. Evaporatioin causes cooling due to decrease in average kinetic energy of the remaining liquid after the surface molecules leave. Lower the boiling point of the liquid, higher is its rate of evaporation.

29. Synthetic clothes are uncomfortable in summer because
(A) they absorb kinetic energy from the air molecules
(B) they do not let the sweat evaporate
(C) they are highly porous
(D) they are very thick

30. Liquids like ether and acetone are kept in cool places because
(A) ether and acetone have high boiling points
(B) the rate of evaporation increases with surface area
(C) ether and acetone are volatile liquids with low boiling points
(D) ether and acetone have lower density than water

31. The water spilled on the floor evaporates faster than the water in a glass due to
(A) increase in surface area
(B) increase in temperature
(C) increase in humidity
(D) decrease in kinetic energy

MATCH THE COLUMN TYPE

32.

Column-I	**Column-II**
(P) Liquid $\rightarrow$ solid	1. Evaporation
(Q) Solid $\rightarrow$ gas	2. Condensation
(R) Gas $\rightarrow$ liquid	3. Sublimation
(S) Liquid $\rightarrow$ gas	4. Solidification

(A) P-3, Q-2, R-1 S-4 (B)P-4, Q-3, R-2 S-1
(C) P-2, Q-3, R-1 S-4 (D)P-1, Q-2, R-3 S-4

33.

Column-I	**Column-II**
(P) Increase in surface area	1. Evaporation increases
(Q) Decrease in temperature	2. Evaporation Decreases
(R) Evaporation	3. Bulk phenomenon
(S) Boiling	4. Surface phenomenon

(A) P-l, Q-2, R-4, S-3 (B) P-l, Q-4, R-3, S-2
(C) P-2, Q-l, R-3, S-4 (D) P-4, Q-2, R-3, S-1

EXERCISE – II

VERY SHORT ANSWER TYPE

1. Is the melting point temperature of solid and the freezing point temperature of liquid same or different ?
2. What is the heat absorbed during the change of state of substance called ?
3. Name a common substance which can undergo a change in the state upon heating or cooling without any change in its composition?
4. Predict the physical state of a substance which has melting point below room temperature.
5. What is the space occupied by matter called?
6. Name the temperature at which a liquid solidifies.
7. Why do solids generally lack the property of diffusion?
8. Define gaseous state of a substance.
9. Is dry ice the same thing as ordinary ice?
10. Which property of gas can explain the characteristic that there is large space between the molecules of a gas?

SHORT ANSWER TYPE

1. Define (i) Latent heat of fusion of a solid.
   (ii) Condensation
2. What is the difference between gas and vapour?
3. What is humidity? What is its effect on evaporation?
4. Explain what happens to the molecular motion and energy of 1 kg of water at 273 K when it is changed into ice at same temperature. How is the latent heat of fusion related to the energy exchange that takes place during this change of state.
5. The water taken from sea, freezes at about -2°C and boils at about 101°C. Explain the reason.

LONG ANSWER TYPE

1. State the various factors which affect evaporation.
2. What is meant by interconvertibility of the states of matter?
3. What are the main differences between evaporation and vaporisation or boiling?
4. Calculate the temperature at which Fahrenheit and Celsius scales have the same reading.
5. Why do solids, liquids and gases have different properties?

TRUE AND FALSE

1. Evaporation decreases with increasein humidity.
2. Process of converting liquid to solid called fusion process.
3. Happiness is example of matter.
4. Alcohol have definite volume and definite shape.
5. Diffusion of gas particles maximum.

FILL IN THE BLANKS

1. The force of attraction between same type of particles called _____.
2. Process of converting gas into liquid called _____.
3. Full form of LPG _____.
4. With increase in temperature the rate of evaporation_____.
5. Iron is example of _____ state of matter.

Answer Key

EXERCISE–I														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	A	C	A	D	B	C	A	A	D	D	B	C	B	D
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
D	C	A	A	C	B	B	B	B	C	A	A	B	B	C
31	32	33												
A	B	A												

EXERCISE – II

TRUE / FALSE

1. T **2.** F **3.** F **4.** F **5.** T

FILL IN THE BLANKS

1. Cohesive force **2.** Condensation **3.** Liquefied petroleum gas

4. Increases **5.** Solid

SELF PROGRESS ASSESSMENT FRAMEWORK

(CHAPTER : MATTER IN OUR SURROUNDINGS)

CONTENT	STATUS	DATE OF COMPLETION	SELF SIGNATURE
Theory			
In-Text Examples			
Solved Examples			
NCERT Exercises			
Exercise I			
Exercise II			
Short Note-1			
Revision - 1			
Revision - 2			
Revision - 3			
Remark			

NOTES :

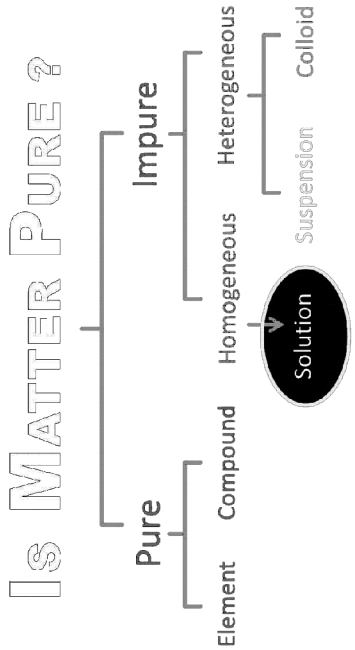
1. In the status, put "completed" only when you have thoroughly worked through this particular section.
2. Always remember to put down the date of completion correctly. It will help you in future at the time of revision.

Space for Notes :

IS MATTER AROUND US PURE

2

Concepts

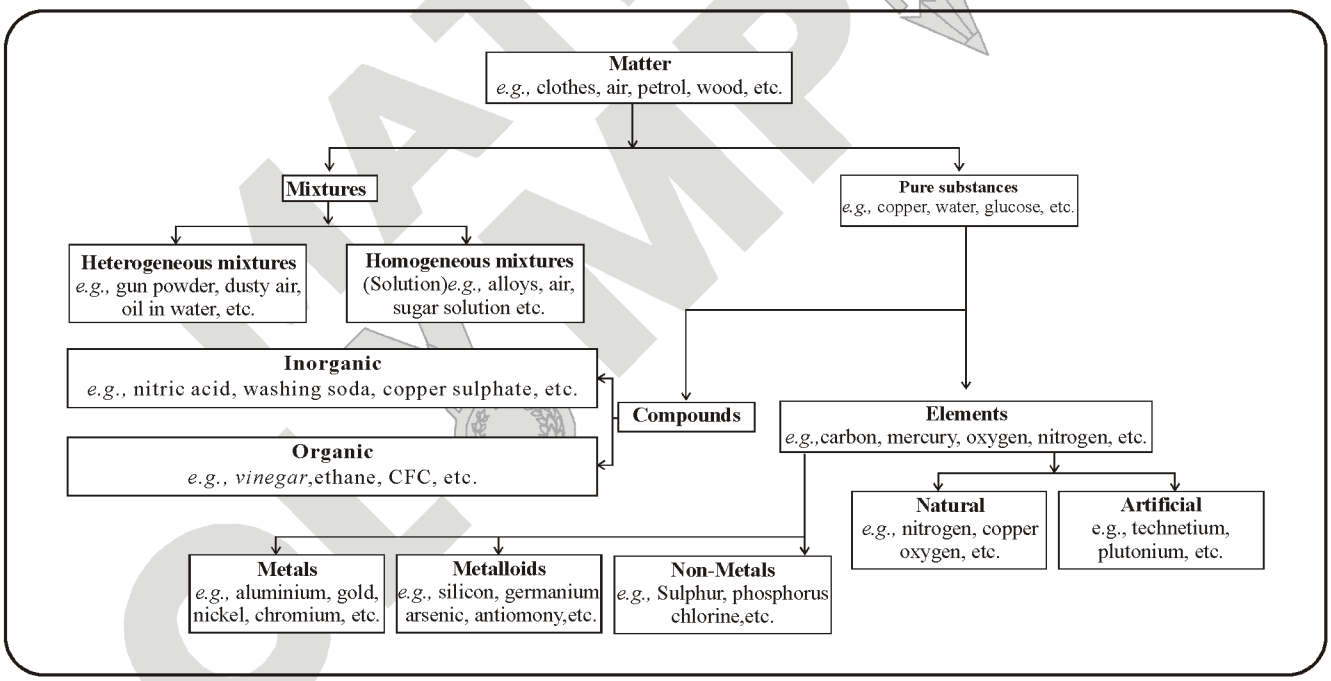


INTRODUCTION

In 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 all the matter around us is not pure. If we observe some soil and some sugar placed on two different sheets of paper with a magnifying glass, we find that soil contains clay particles, some grass particles and even some dead insects, etc. That is, soil contains particles of different kinds, thus it is called an impure substance(or mixture). Now observe sugar which contains only one kind of particles, is called a pure substance. 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 substances as such. Substances are mostly mixed with one another and their combination is known as mixture.

1. CLASSIFICATION OF MATTER



2. PURE SUBSTANCE

- A substance consists of a single type of particles.
- Substances are always homogeneous.
- All the elements and compounds are pure substances because they contain only one kind of particles.
- A pure substance cannot be separated into other kinds of matter by any physical process.
- A pure substance has a fixed composition as well as a fixed boiling point and melting point.
- Pure Substances can be divided into two types:

(i) Elements

(ii) Compounds

2.1 ELEMENTS

An element is a substance which cannot be split up into two or more simpler substances by the usual chemical methods of applying heat, light or electric energy or by any physical methods.

An element cannot be split up into two (or more) simpler substances because it is made of only one kind of atoms.

Some facts about elements

(i) The earth's crust is made mainly of two elements i.e. oxygen 46.6 % and silicon 27.7 %.

(ii) First three elements namely oxygen 65%, Carbon 18 % and Hydrogen 10 % account for more than 90 % mass of human body.

(iii) As many as 118 elements are known.

(iv) 92 elements occur in nature and the rest are artificially made. These man-made elements are called synthetic elements.

(v) Majority of the elements are solids.

(vi) Eleven elements are in gaseous state at room temperature.

(vii) Two elements are liquid at room temperature i.e. mercury and bromine.

(viii) Elements gallium and caesium become liquid at temperature slightly above room temperature (at 30°C).

Classification of elements

(a) Metals : Metals are the electropositive elements which possess tendency of losing one or more of their valence electrons attaining octet and thereby forming cations.

For example, Sodium, Magnesium, Iron etc.

(b) Non metals : Non-metals are the electronegative elements which possess tendency to form anion (negative ions) by gaining one or more electrons.

For example, Carbon, Oxygen, Chlorine etc.

(c) Metalloids : The elements which show some properties of metals and some other properties of non-metals are called metalloids. There properties are intermediate between the properties of metals and non-metals. Metalloids are also sometimes called semi-metals.

For example, Boron (B), Silicon (Si), and Germanium (Ge) etc.

Some difference between Metals and Non-metals

Physical Properties	Metals	Non-Metals
State	Metals are solids at room temperature **Exception:** Mercury (Hg) is a liquid at room temperature.	The non-metals are either solids or gases at room temperature. **Exception :** Bromine is a liquid at room temperature.
Lustre	Metals are generally lustrous, i.e, they have a shining surface and can be polished, e.g., gold silver, copper, etc.	Non-metals generally do not have any lustre, dull in appearance e.g., sulphur and phosphorus etc. **Exception :** Iodine has a lustrous appearance.
Melting and Boiling Points	Metals have generally high melting points and boiling points, e.g., the melting point of iron is 1535°C. **Exception:** Sodium, potassium and gallium have low melting points. The melting point of gallium is so low that it occurs in liquid state at temperature slightly above room temperature.	Non-metals have low melting points and boiling points. **Exception:** Carbon and silicon, which have high melting points.

Density	Metals have high densities, i.e., they are heavy, e.g., the density of mercury is 13.6 gm/cm^3 which is quite high. **Exception:** Sodium, potassium, calcium and magnesium which are light-weight metals. Sodium and potassium are so light that they can float on water.	Non-metals have low densities. i.e,, they are light substances. For example, the density of sulphur is 2gm/cm^3, which is quite low. **Exception:** The density of diamond (an allotropic form or of carbon) is high.
Ductility	Metals are ductile, i.e., they can be drawn into thin wires. Gold and silver are the best ductile metals. Other examples are copper and aluminium which can be drawn into wires and are used in electrical wiring.	Non-metals are non-ductile, i.e., they cannot be drawn into thin wires, e.g., sulphur and phosphorus when stretched do not form wires but break into pieces.
Malleability	Metals are generally malleable, i.e., they can be beaten into thin sheets with a hammer, e.g., silver foils are used for decorative purpose on sweets.	Non-metals are not malleable but brittle, i.e., when beaten with a hammer, they break into pieces.
Conduction of heat and electricity	Metals are good conductors of heat and electricity. Silver is the best conductor of heat and electricity whereas lead is the poorest conductory of heat. Metals are good conductors of electricity because they contain free electrons to conduct electricity.	Non-metals are generally bad conductors of heat and electricity, e.g., the non-metals like sulphur, phosphorus, etc., do not conduct heat and electricity. **Exception :** Graphite (an allotropic form of carbon) is a good conductor of electricity.
Hardness	Metals are hard (except sodium and potassium which are soft metals) but not brittle. Sodium and potassium are so soft that they can be cut with a knife.	Non-metals are generally soft except, diamond (an allotropic form of carbon) which is the hardest substance known.
Sonority	Metals are said to be sonorous, i.e., they make a noise when they are hit with an object.	Non-metals are not sonorous.

2.2 COMPOUNDS

A compound is a substance made up of two or more elements chemically combined in a fixed proportion by mass. A compound is formed as a result of chemical reaction, between the constituent elements. The properties of compound are different from the properties of the elements from which it is formed.

For example, Water (H_2O) is a compound made up of two elements hydrogen, and oxygen chemically combined in a fixed proportion of 1 : 8 by mass.

♦ **Characteristics of a compound :**

- In a compound constituent are present in definite proportion by mass.
- The properties of compound are different from the properties of its constituents.
- The constituents of a compound cannot be separated by simple physical process.
- Formation of a compound is generally accompanied by change in energy, in the form of heat or light.
- A compound has a fixed melting point and boiling point.
- Compound is always homogeneous in nature.

Focus Point

- Number of compounds is not limited like number of elements.

♦ **Classification of compound:**

(A) On the basis of sources :

(i) 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.

(ii) 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.

A few common examples of organic compounds are : methane, ethane, propane (all constituents of cooking gas), alcohol, acetic acid, sugar, proteins, oils, fats etc.

(B) On the basis of their properties :

(i) Acids : Compounds which give hydrogen ion in aqueous solution.

For example, hydrochloric acid, sulphuric acid, nitric acid, formic acid etc.

(ii) Bases : Compounds which give hydroxide ion in aqueous solution.

For example, Sodium hydroxide, Potassium hydroxide etc.

(iii) Salts : It is formed by the chemical reaction between acids and bases.

For example, ammonium chloride, zinc sulphate etc.

Difference between Elements and Compounds

	Element	Compound
1.	An element consists of the same kind of atoms.	A compound is composed of different kind of atoms.
2.	An element cannot be split up by physical and chemical methods.	A compound can be split up into new substances only by chemical methods.
3.	The property of an element is the property of its constituent atoms.	The property of a compound is quite different from that of its constituents atom.

Focus Point

- Purity of compounds can be tested by determining their melting or boiling points. Pure compounds have fixed melting point and boiling point.

3. MIXTURE (IMPURE SUBSTANCE)

A mixture is a substance which consists of two or more elements or compounds not chemically combined together. All the solutions are mixtures. The various substances present in a mixture are known as "constituents of the mixture" or "components of the mixture".

For example, Lemonade (nimbu pani) is a mixture of water, lemon juice, sugar and salt.

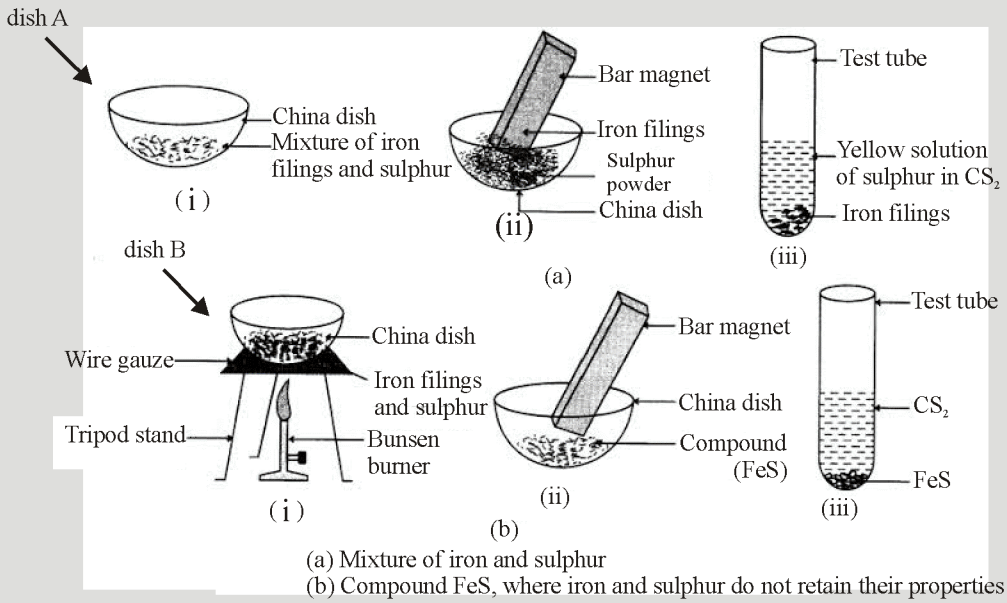
A mixture consists of two or more different type of particles having different chemical nature. Mixture may be homogeneous or heterogeneous. A mixture does not have a fixed composition or a fixed melting point and boiling point.

♦ **Properties of mixture:**

- A mixture can be separated into its constituents by physical or chemical processes.
- A mixture shows the properties of all the constituents present in it.
- Formation of mixture may or may not be accompanied with energy change.
- The composition of a mixture is variable, the constituents can be present in any proportion by mass.
- A mixture does not have a definite melting point, boiling point.
- A mixture may be homogeneous or heterogeneous.

LAB TIME
Let's Do & Learn

- **Objective : To distinguish between mixtures and compounds.**
- **Materials required :** Two separate China dishes marked (A) and (B), mixture of nearly 50 g of iron filings and 3 g of powdered sulphur.
- **Procedure :** Keep the dish (A) as such while heating the dish (B) to red hot for sometime and then cool it.



(a) Mixture of iron and sulphur
(b) Compound FeS, where iron and sulphur do not retain their properties

- **Observations :**

(i) In the China dish (A) both iron filings and sulphur powder retain their colour. In the dish (B) ablack mass will be formed.

(ii) 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).

(iii) 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.

- **Conclusion :**

(i) 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.

(ii) Iron filings present in dish (A) are attracted towards the magnet. Since iron sulphide is a com pound, it is not attracted towards the magnet.

Difference between compounds and mixtures

S.N.	Characteristics	Compounds	Mixtures
1.	Nature	In a compound, two or more elements Combine chemically.	In a mixture, two or more elements or compounds are mixed, such that they do not combine chemically.
2.	Structure	Compounds have a definite structure.	Mixtures do not have a definite structure.
3.	Composition	In case of a compound the constituents are present in a fixed ratio by weight.	In case of mixtures, their constituents can be present in any ratio, i.e., they have variable composition.
4.	Properties	The properties of a compound are entirely different from the properties of its constituents.	The constituents of a mixture retain their individual physical and chemical properties.
5.	Separation of constituents	The constituents of a compound cannot be separated by physical means.	The constituents of a mixture can be separated by physical means.
6.	Energy changes	During the formation of a compound energy is either absorbed or released, i.e., a compound is the result of a chemical change.	During the formation of a mixture energy changes may or may not take place.

Focus Point

- For a common man, pure actually mean having no adulteration. But for a scientist pure means that is contains only one type of matter or particles, all of which are same in their chemical nature.

3.1 TYPES OF MIXTURES

- **Based on the composition, mixture are of two types**

(1) Homogeneous mixtures: Those mixtures in which the substances are uniformly mixed together and are indistinguishable from one another, are called homogeneous mixtures.

All the homogeneous mixtures are called solutions.

For example,

A mixture of sugar in water (called sugar solution) is a homogeneous mixture because all the parts of sugar solution have the same sugar-water composition and appear to be equally sweet. There is no visible boundary of separation between sugar and water particles in a sugar solution.

(2) Heterogeneous mixtures: Those mixtures in which the components are not mixed uniformly and there is a boundary of separation between them, called heterogeneous mixtures.

For example, The mixture of sugar and sand is a heterogeneous mixture because different parts of this mixture will have different sugar-sand composition. Some parts of this mixture will have more of sugar particles whereas other parts will have more of sand particles. There is a visible boundary of separation between sugar and sand particles.

A mixture containing two (or more) immiscible liquids is also a heterogeneous mixture.

Let's discuss more about homogeneous and heterogeneous mixture by an activity.

LAB TIME
Let's Do & Learn

- **Objective : To illustrate the concept of homogeneous and heterogeneous mixtures.**
- **Materials required:**

Beakers, water, spatula, copper sulphate powder, potassium permanganate or common salt.

- **Procedure :**

(i) Let us divide the class into groups A, B, C and D.

(ii) Group A takes a beaker containing 50 mL of water and one spatula full of copper sulphate powder. Group B takes 50 mL of water and two spatula full of copper sulphate powder in a beaker.

(iii) Group C and D can take different amounts of copper sulphate and potassium permanganate or common salt(sodium chloride) and mix the given components to form a mixture.

(iv) Report the observations on the uniformity in colour and texture.

- **Observation and discussion :**

(i) Both groups A and B have obtained homogeneous mixtures since the composition of these mixtures or solutions is uniform throughout.

(ii) Although both the groups have obtained copper sulphate solutions but the intensity of colour of the two solutions is different. The intensity of blue colour in the solution obtained by group B which contains two spatula full of copper sulphate is much higher than the solution obtained by group A which contains one spatula full of copper sulphate.

(iii) Both groups C and D have obtained heterogeneous mixtures since they not only have physically distinct boundaries but also their composition is not uniform.

- **Conclusion:**

(i) Soluble substances such as copper sulphate, common salt or sugar when dissolved in water form homogeneous mixtures, whose composition depend upon the amount of the substance dissolved.

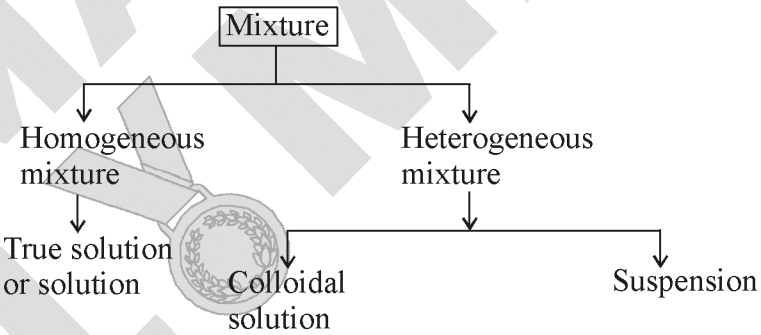
(ii) When two or more solids which do not react chemically are mixed, they always form heterogeneous mixtures.

Difference between homogeneous and heterogeneous mixture

Homogeneous mixture	Heterogeneous mixture
It has a uniform composition throughout the mass.	It does not have a uniform composition throughout the mass.
No visible boundaries of separation between the various constituents.	Visible boundaries of separation between the various constituents.
e.g. : salt in water, alcohol in water etc.	e.g. : sand and sugar, oil in water etc.

Focus Point

- Alloys are mixtures of two or more metals or a metal and a non-metal and cannot be separated into their components by physical methods. But still, an alloy is considered as a mixture because it shows the properties of its constituents and can have variable composition. For example brass is a mixture of approximately 30% zinc and 70% copper.



Flow chart for type of mixture

4. TRUE SOLUTION OR SOLUTION

You come across various soda water etc. are all examples of solutions. Usually we think of a solution as a liquid or a gas dissolved in it. But we can also have solid solutions (alloys) and gaseous solutions (air).

A solution is a homogeneous mixture of two or more substances.

♦ **Components of a solution:**

The substances which homogeneously mix up together to form a solution are called the components of the solution. When two substances form a solution, one substance is said to dissolve into the other.

The substance which gets dissolved is commonly known as **solute** and the medium in which it gets dissolved is termed as **solvent** or the component of a solution present in excess is referred to as the **solvent** while the other component present in the smaller amount is called the **solute**.

For example,

(a) A solution of sugar in water is a solid in liquid solution. In this solution sugar is the solute and water is the solvent.

(b) A solution of iodine in alcohol known as 'tincture of iodine' has iodine (solid) as the solute and alcohol (liquid) as the solvent.

(c) Aerated drinks like soda water etc., are gas in liquid solutions. These contain carbon dioxide (gas) as solute and water (liquid) as the solvent.

(d) Air is a homogeneous mixture of a number of gases. Its two main constituents are. Oxygen (21%) and nitrogen (78%). The other gases are present in very small quantities.

♦ **Properties of Solution:**

(i) The solute particles in a solution cannot be seen by naked eyes or even with microscope. This is because the solute particles present in a solution are very small, smaller, than 1 nm [1 nm = 10^{-9} metre = 10^{-7} cm].

(ii) A solution is a homogeneous transparent mixture, i.e., the solution has the same composition and the same properties throughout its bulk.

(iii) The particles of a solution being very small do not scatter light beam passing through the solution. When a beam of light is passed through a solution, light beam is not visible during its passage through a solution.

(iv) A solution is stable, i.e., the solute particles do not settle down due to gravity on keeping the solution undisturbed even for a long time.

(v) The solute particles present in a solution cannot be separated from the solvent by filtration.

Focus Point

- Most of the substances are soluble in water, that's why water is some time called a universal solvent.
- A solution in which water acts as the solvent is called an aqueous solution while the one in which any other liquid act as solvent is called a non-aqueous solution.

4.1 TYPE OF SOLUTION

♦ **On the basis of physical states of solute and solvent:**

Any state of matter (solid, liquid or gas) can act both as a solvent and as a solute during the formation of a solution. Therefore, depending upon the physical states of solute and solvent, true solutions are classified as -

Name of solution		Solute	Solvent	Examples
Solid solution				
1.	Solid in solid	Solid	Solid	Alloys like steel, brass, bronze, German silver, solder(lead,tin) etc.
2.	Liquid in solid	Liquid	Solid	Hydrated crystal such as blue vitriol (hydrated copper sulphate), dental amalgam (mercury liquid and silver solid).
3.	Gas in solid	Gas	Solid	Gases adsorbed over the surface of the metals (such as nickel, palladium, platinum etc.) under pressure.
Liquid solution				
4.	Solid in liquid	Solid	Liquid	Sugar, common salt or other salts dissolved in water, tincture of iodine.
5.	Liquid in liquid	Liquid	Liquid	Mixture of two miscible liquids such as acetone and water, alcohol and water, vinegar (acetic acid and water), etc.
6.	Gas in liquid	Gas	Liquid	Aerated drinks (carbon dioxide dissolved in water under pressure).
Gaseous solution				
7.	Solid in gas	Solid	Gas	Camphor in air or iodine in air.
8.	Liquid in gas	Liquid	Gas	Clouds and fog (water drops (liquid) dispersed in air).
9.	Gas in gas	Gas	Gas	Air (mixture of gases like nitrogen, oxygen, carbon dioxide, inert gases etc.)

♦ **On the basis of amount of solute:**

Different amount of a given substance may be dissolved in a given quantity of the solvent. Thus solutions of different concentration of a given substance in a given solvent may be prepared. A particular solution may have less amount of the dissolved solute while the other solution may have more amount of dissolved solute in the solution. So depending upon the quantity of solute present in a given mass of the solvent, solutions are classified into three types:

(a) Unsaturated solution: A solution in which more quantity of the solute can be dissolved without changing the temperature is called **unsaturated solution.**

An unsaturated solution contains lesser amount of the dissolved solute, and more solute can be dissolved in it without changing the temperature. An unsaturated solution does not contain the maximum quantity of the solute which can be dissolved in it at a given temperature.

(b) Saturated solution: A solution in which no more solute can be dissolved at a particular temperature is called **saturated solution.**

(c) Super saturated solution: A solution that contains more solute than would be necessary to saturate it at a given temperature.

♦ **On the basis of nature of solvent:**

(a) Aqueous Solutions: The solutions obtained by dissolving various substances in water are called aqueous solutions.

The common examples are:

(i) Common salt dissolved in water. (ii) Sugar dissolved in water.

(iii) Acetic acid dissolved in water etc.

(b) Non-Aqueous Solutions: The solutions obtained by dissolving the substances in liquids other than water are called non-aqueous solutions. The common non-aqueous solvents are alcohol, carbon disulphide, carbon tetra-chloride, acetone, benzene etc.

Examples of non-aqueous solutions are:

(i) Iodine dissolved in carbon tetrachloride. (ii) Sulphur dissolved in carbon disulphide.

(iii) Sugar dissolved in alcohol etc.

Focus Point

- A super saturated solution is meta stable. This means that the solute will go to the bottom of the container and a super saturated solution becomes saturated again by heating up the solutions
- Amalgam is an alloy of a metal with mercury.

5. SOLUBILITY

The maximum amount of the solute (in grams) which can be dissolved in 100 grams of the solvent to form the saturated solution is called solubility of the solute in that solvent at that temperature.

Solubility of any solute can be determined as :

$$\text{Solubility} = \frac{\text{Maximum amount of solute dissolved(gm)}}{\text{Amount of solvent(gm)}} \times 100$$

To understand more about solubility, let's discuss an activity.

LAB TIME
Let's Do & Learn

- **Objective:To demonstrate that different substances have different solubilities in the same solvent.**
- **Materials required**

Beakers, water, sugar, glass rod, barium chloride, common salt.

- **Procedure :**

(i) Take approximately 50 mL of water each in two separate beakers.

(ii) Add common salt in one beaker and sugar or barium chloride in the second beaker with continuous stirring.

(iii) When no more solute can be dissolved, heat the contents of the beaker.

(iv) Start adding the solute again.

- **Discussion and observation :**

(i) The amounts of common salt, sugar and barium chloride that can be dissolved in water (50 mL) at room temperature are different.

(ii) When a saturated solution at a certain temperature is cooled, the solubility decreases and the amount of the solute which exceeds the solubility at the lower temperature crystallizes out of the solution.

- **Conclusion :**

Different substances have different solubilities in a given solvent at the same temperature and in general the solubility decreases as the solution is cooled and the extra amount of the solute crystallizes out.

Focus Point

- While expressing the solubility the solution must be saturated but for expressing concentration, the solution need not be saturated in nature.
- While expressing the solubility mass of solvent is considered but for expressing concentration the mass or volume of solution is considered.

Example 1

A maximum of 24g of potassium nitrate can be dissolved in 75g of water at 20°C. Calculate the solubility of potassium nitrate in water at this temperature.

Solution :

75g of water dissolves = 24g of potassium nitrate

100 g of water dissolves = $\frac{24 \times 100}{75} = 32$ g of potassium nitrate.

Focus Point

- Solubility of sodium chloride (common salt) in water at 20°C is 36 g / 100 g. This shows that at the maximum 36 grams of sodium chloride can be dissolved in 100 gram of water at 20°C.
- Solubility of potassium nitrate in water at 20°C is 32 g / 100 g. A maximum of 32 grams of potassium nitrate can be dissolved in 100 grams of water at 20°C.

5.1 EFFECT OF TEMPERATURE AND PRESSURE ON SOLUBILITY

♦ Effect of Temperature on the solubility of a solid in a liquid

Generally solubility of solid solute increase on increase in temperature.

For example,

Solubility of sugar, glucose, sodium chloride, potassium nitrate etc. in water increases with the increase in temperature. When such solutes are dissolved in water, the solution gets cooled. It is because heat energy is absorbed during the formation of such solutions. Heat is taken away from the solution. Therefore, solution gets cooled.

♦ **Effect of Pressure on the Solubility of Solid in a Liquid**

Since solids are not compressible so the solubility of a solid (solute) in a liquid does not change with the change in pressure.

♦ **Effect of Temperature on the Solubility of a Gas in a Liquid**

The solubility of a gas in a liquid decreases with the increase in temperature. It is because when a solution of the gas in a liquid is heated, some of the gas escapes out. When water is heated, the dissolved gases (O_2, CO_2 etc.) escape out and their solubility decreases.

♦ **Effect of Pressure on the Solubility of a Gas in a Liquid**

The solubility of a gas in a liquid increases with the increase in pressure, and decreases with the decrease in pressure.

6. CONCENTRATION OF SOLUTION

When one tea spoon sugar is added in a beaker (containing water) while two tea spoon sugar is added in another beaker then we observe that sugar solution present in second beaker is more sweet because in this beaker more amount of sugar is present.

We can say that concentration of solution in beaker two is more than the concentration of solution in beaker one. The concentration of a solution may be defined as the amount of solute present in a given amount (mass or volume) of solution and can be expressed in various ways given below :

6.1 MASS BY MASS PERCENTAGE OF SOLUTION (W/W%)

Mass by mass percentage is defined as the mass of the solute in grams present in 100 g of the solution.

$$w/w\% = \frac{\text{mass of solute(gm)}}{\text{mass of solution (gm)}} \times 100$$

$$w/w\% = \frac{\text{mass of solute}}{(\text{mass of solute} + \text{mass of solvent})} \times 100$$

Example 2

A solution is prepared by dissolving 12g of sodium chloride in 150g of solution. Calculate the mass percentage of solution.

Solution :

$$w/w\% = \frac{\text{mass of solute(gm)}}{\text{mass of solution (gm)}} \times 100$$

$$= \frac{12}{150} \times 100 = 8\%$$

Example 3

A solution contains 40 grams of common salt in 320 grams of water. Calculate the concentration in terms of mass by mass percentage of the solutions.

Solution :

Mass of solute (salt) = 40g

Mass of solvent (water) = 320 gm

Mass of solution = 40 + 320 = 360 g

$$w/w\% = \frac{\text{mass of solute(gm)}}{\text{mass of solution (gm)}} \times 100$$

$$= \frac{40 \times 100}{360} = 11.1\%$$

6.2 MASS BY VOLUME PERCENTAGE OF SOLUTION (W/V%)

It is defined as the mass of solute in gram present in 100 mL of solution.

$$\text{Mass by volume percentage (w/v\%)} = \frac{\text{mass of solute(gm)}}{\text{volume of solution(mL)}} \times 100$$

Example 4

Calculate the w/v % of a solution containing 5g of glucose in 200 mL of the solution.

Solution :

Mass of solute (glucose) = 5g

volume of solution = 200 mL

$$\text{Mass by volume percentage (w/v\%)} = \frac{\text{mass of solute(gm)}}{\text{volume of solution(mL)}} \times 100$$

$$= \frac{5}{200} \times 100 = 2.5\ \%\ w/v$$

6.3 VOLUME BY VOLUME PERCENTAGE OF SOLUTION (V/V%)

It is defined as the volume of solute in mL present in 100 mL of solution

$$\text{Volume by volume percentage (v/v\%)} = \frac{\text{volume of solute(mL)}}{\text{volume of solution (mL)}} \times 100$$

Example 5

10 mL of ethanol is mixed with 90 mL of water. What is the volume percentage of ethanol in the solution ?

Solution :

Volume of ethanol (solute) = 10 mL

Volume of water (solvent) = 90 mL

Total volume of solution = 10 + 90 = 100 mL

$$\text{Volume by volume percentage (v/v\%)} = \frac{\text{volume of solute(mL)}}{\text{volume of solution (mL)}} \times 100$$

$$= \frac{10}{100} \times 100 = 10\% \text{ v/v}$$

Focus Point

- Parts per Million (ppm) and parts per Billion (ppb) unit are used for expressing concentration of trace amounts of substance present in the total amount of solution.

$$\text{ppm} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$$

$$\text{ppb} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^9$$

7. SUSPENSION

A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium and tend to settle down with time. Those substances which are insoluble in a liquid form suspension.

For example :

If we dissolve powdered chalk or sand in water, they do not dissolve in water, but settle down after sometime. These are the examples of suspensions. Muddy water is a suspension of soil in water. Milk of magnesia is a suspension of magnesium hydroxide in water.

♦ **Properties of Suspension:** Important properties of suspension are given below

(i) Size of the particles: Size of the particles of suspension is quite large (greater than 100 nm).

(ii) Heterogeneous character: Suspension is a heterogeneous mixture which is not transparent.

(iii) Visibility: The particles of suspension can be seen by the naked eyes.

(iv) Scattering of light: The particles of a suspension scatter a beam of light passing through it and make its path visible.

(v) Stability: When the suspension is left undisturbed, the solute particles settle down showing that a suspension is unstable.

(vi) Filtration: The suspension can be separated by filtration, a residue is left on the filter paper.

8. COLLOIDAL SOLUTION

A colloidal solution is a heterogeneous mixture in which the size of the solute particles is intermediate between those in true solutions and those in suspensions.

For Example,

Smoke, shoe polish, shaving cream, face cream, milk, cheese, butter, jelly, blood, starch solution, solutions of synthetic detergents etc. are the important examples of colloidal solutions. The physical state of the colloidal solutions may be solid, liquid or gas.

♦ **Components of colloidal solution :** A colloidal solution contains dispersion medium and dispersed phase.

- **Dispersion Medium:** The medium in which colloidal particles are dispersed is called dispersion medium. Dispersion medium is always present in larger amount.
- **Dispersed phase:** The solute-like component or the colloidal particles which are dispersed in a solvent are called dispersed phase. Dispersed phase is always present in smaller amount.

For Example,

- In smoke, air is present in larger amount whereas colloidal particles of carbon are present in smaller amount. Therefore, air is the dispersion medium whereas carbon particles are dispersed phase.
- Milk is a colloidal solution in which liquid fat is dispersed in water. Water is present in larger amount whereas liquid fat is present in smaller amount. Water is the dispersion medium and liquid fat is the dispersed phase.

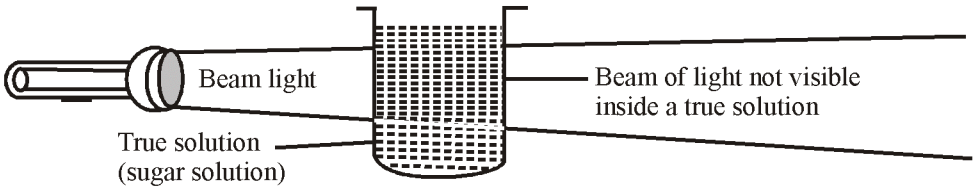
8.1 PROPERTIES OF COLLOIDAL SOLUTION

(i) Heterogeneous character: The particles of colloids are uniformly spread throughout the solution, the mixture appears to be homogeneous. It is due to the relatively smaller size of colloidal particles. But actually, a colloidal solution is a heterogeneous mixture.

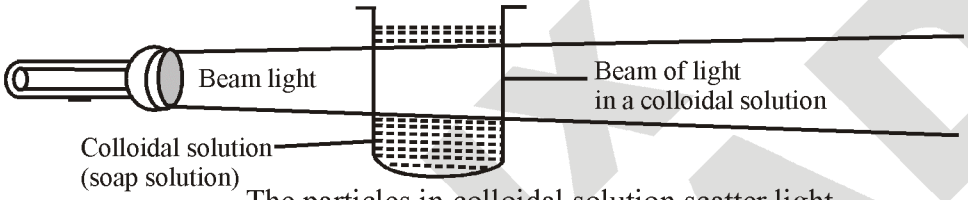
(ii) Size of the colloidal particles: The size of the dispersed phase ranges from 1 nm to 100 nm in a colloidal solution.

(iii) Visibility: Because of the small size of colloidal particles, we cannot see them by naked eyes. It is difficult to see the colloidal particles even with a microscope.

(iv) Tyndall effect: Scattering of light by colloidal solutions is called **Tyndall effect.** When a beam of light is passed in a solution of sodium chloride or sugar, the path of light is not visible inside the true solution. But if a beam of light is passed in a colloidal solution of milk or starch, the path of light becomes visible inside the colloidal solution. It is called Tyndall effect. Tyndall effect is due to the scattering of light.



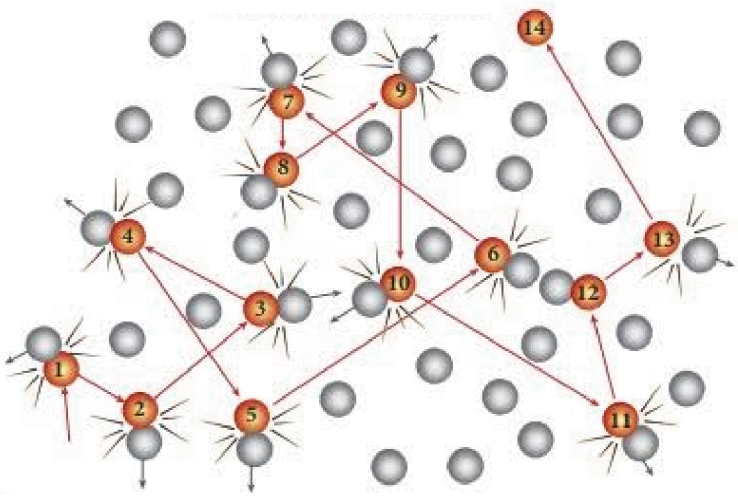
The particles in true solution do not scatter light.
True solution does not show Tyndall effect.



The particles in colloidal solution scatter light
Colloidal solution shows Tyndall effect

Colloidal particles scatter the beam of light passing through it. Colloidal particles cannot reflect the light due to their small size. But the size of colloidal particles is fairly large to scatter the light and make the path visible. Tyndall effect can be observed when a beam of light enters a room through a small hole. This happens due to the scattering of light by the particles of dust and smoke present in air. Tyndall effect can also be observed when sunlight passes through the canopy of a dense forest.

(v) Brownian movement : Particles of colloidal solution follow zig zag path. It is normally not possible to see the colloidal particle because of their very small size. However, their path can be seen under a microscope. Brownian movement may be defined as continuous zig-zag movement of colloidal particles in a colloid. This Brownian movement arises due to hitting of the colloidal particles by the particles of the dispersion medium from different directions with different forces.



Particles in Brownian motion

(vi) Filtration: If the colloidal solution is left undisturbed for sometime, it does not settle down. This shows that colloidal solutions are quite stable. But if colloidal solution is left for a long time, the solute particles may settle down. It is important to know that though colloidal solutions cannot be separated by filtration but colloidal particles (dispersed phase) can be separated from the colloidal solution by special methods such as heating, cooling, centrifugation etc.

Focus Point

- Colloidal particles follow a zig-zag path. Such type of movement was noticed for the first time by Robert Brown, an English scientist, hence is called Brownian movement after his name.

8.2 CLASSIFICATION OF COLLOIDS

Colloids are classified on the basis of the physical state of the dispersion medium and dispersed phase. Dispersion medium and dispersed phase may be solid, liquid or gas.

Both dispersion medium and dispersed phase cannot be gas because all non-reacting gases mix together and form homogeneous solution whereas colloidal solutions are heterogeneous mixtures. There are 8 types of colloidal systems.

Type	Dispersed Phase	Dispersion Medium	Examples
Aerosol	Liquid	Gas	Fog, clouds, mist
Aerosol	Solid	Gas	Smoke, automobile exhaust, dust storm, volcanic dust
Foam	Gas	Liquid	Froth, air bubble, soap lather, lemonade
Emulsion	Liquid	Liquid	Milk, face cream, nail polish, shampoo, oil in water, water in oil.
Sol	Solid	Liquid	Milk of magnesia, muddy water, aqueous solution of starch, proteins albumin etc.
Solid foam	Gas	Solid	Foam, rubber, sponge, pumice stone
Gel	Liquid	Solid	Jelly, cheese, butter
Solid Sol	Solid	Solid	Coloured gemstone, milky glass, rock salts, marble.

Focus Point

- Depending upon the dispersion medium, the sols are given special names as follow:

Dispersion medium	Name of the sol
Water	Aquasol or Hydrosol
Alcohol	Alcosol
Benzene	Benzosol
Gases	Aerosol

9. SEPARATION TECHNIQUES

Generally following physical properties are considered in the separation of the constituents of a mixture.

- Densities of the constituents of the mixture.
- Melting points and boiling points of the constituents of the mixture.
- Property of volatility of one or more constituents of the mixture.
- Solubility of the constituents of the mixture in different solvents.
- Ability of the constituents of the mixture to sublime.
- Ability of the constituents of the mixture to diffuse.

MIXTURES

↓

Separation Technique

(A) Separation of Solid-solid Mixture
i. Magnetic separation
ii. Solvent extraction
iii. By Sublimation
iv. By crystallisation

(B) Separation of Solid-liquid Mixture
i. Filtration
ii. Centrifugation
iii. Sedimentation & Decantation
iv. Evaporation
v. Chromatography

(C) Separation of Liquid-liquid Mixture
i. Separating funnel
ii. Distillation
iii. Fractional distillation

(D) Separation of Gas-gas Mixture
i. Diffusion

Focus Point

- Heterogeneous mixture can be separated into their respective components by simple physical methods such as handpicking, sieving, filtration etc, in every day life. However, for separating homogeneous mixtures special techniques are employed depending upon the difference in one or more properties.

9.1 SEPARATION OF SOLID-SOLID MIXTURES

(i) Magnetic separation method:

Principle: This method is based on the fact that one of the components of a solid-solid mixture is magnetic while the other is non-magnetic in nature.

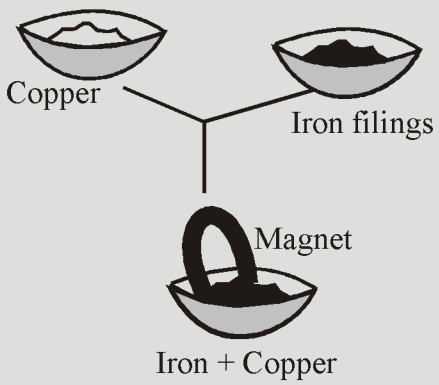
Let's discuss an activity to understand this method.

LAB TIME
Let's Do & Learn

- **Objective: To Separate the mixture of iron filings and copper turnings.**
- **Material required :** Iron filings, copper turnings, horse-shoe magnet, china dish.
- **Procedure :**

(i) A solid-solid mixture of iron filings and copper turnings can be separated by this technique because iron is magnetic in nature, whereas copper is non-magnetic in nature.

(ii) The given mixture is spreaded in a dish. Now run one end of a strong bar magnet or horse shoe magnet through it.



- **Obervation :**

On lifting the magnet, some iron filings get attracted towards magnet. Remove them by hand and collect them in a dish. On repeating the process several times, all the iron filings are picked up and collected in the dish. Copper turnings are left behind in the dish.

- **Conclusion :**

Non- magnetic component can be separated from magnetic component by using magnet.

(ii) By Sublimation : We have learnt in previous chapter that ammonium chloride changes directly from solid to gaseous state on heating. So, to separate such mixtures that contain a sublimable volatile component from a non-sublimable impurity (salt in this case), the sublimation process is used.

The changing of solid directly into vapours on heating and of vapours directly into solid on cooling is known as **sublimation.**

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

Let's discuss an activity to understand sublimation method.

LAB TIME
Let's Do & Learn

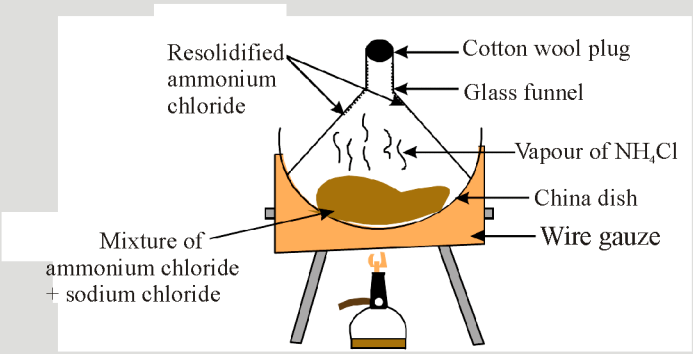
- **Objective: To separate a mixture of ammonium chloride and common salt.**
- **Materials required:** Ammonium chloride, common salt, China dish, cotton and inverted funnel.
- **Procedure :**

(i) Place the mixture of common salt and ammonium chloride in a china dish and heat it over a low Bunsen flame.

(ii) Place a clean glass funnel in an inverted position in the china dish and close the mouth of its stem with cotton wool.

(iii) The ammonium chloride in the mixture sublimes to form dense white fumes. These fumes condense on the cooler sides of the funnel in the form of fine white powder.

(iv) When the mixture gives off no more white fumes, lift the funnel, scrap the fine white powder from its sides on a piece of paper. This is pure ammonium chloride. The residue left behind in the funnel is sodium chloride.



Separation by sublimation

- **Observations :**

The vapours of pure ammonium chloride undergo sublimation and are deposited near the neck of the funnel while common salt, the non-sublimable substance remains in the China dish as residue.

- **Conclusion :**

A sublimable volatile component can be separated from a non-volatile component of the mixture.

Some more examples of mixtures which can be separated by sublimation method.

Solid-Solid Mixutre	Sublimable Solid
Common salt and ammonium chloride	Ammonium chloride
Sand and iodine	Iodine
Common salt and iodine	Iodine
Sodium sulphate and benzoic acid	Benzoic acid
Iron filings and naphthalene	Naphthalene

(iii) By Using a Suitable Solvent :

In some cases, one constituent of a mixture is soluble in a particular liquid solvent whereas the other constituent is insoluble in it. This difference in the solubilities of the constituents of a mixture can be used to separate them.

For example, sugar is soluble in water whereas sand is insoluble in it, so a mixture of sugar and sand can be separated by using water as solvent.

This will become more clear from the following activity.

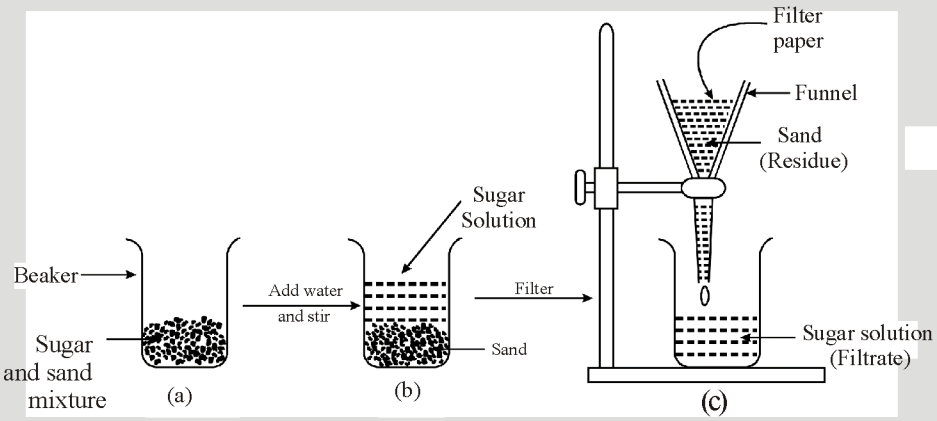
LAB TIME
Let's Do & Learn

- **Objective: To Separate a Mixture of Sugar and Sand.**
- **Materials required:** Sugar, sand, water, beakers, filter papers, funnel etc.
- **Procedure :**

(i) The mixture of sugar and sand is taken in a beaker and water is added to it.

(ii) The mixture is stirred to dissolve the sugar.

(iii) The sugar solution containing sand is filtered by pouring over a filter paper kept in a funnel.



- **Observation and discussion :**

Sand remains as a residue on the filter paper and sugar solution is obtained as a filtrate in the beaker kept below the funnel. The sugar solution is evaporated carefully to get the crystals of sugar.

- **Conclusion :**

In this way, a mixture of sugar and sand has been separated by using water as the solvent.

(iv) Crystallisation

The crystallisation method is used to purify solids. For example, the salt we get from sea water can have impurities in it. To remove these impurities, the process of crystallisation is used.

The process by which a pure soluble substance is separated in the form of crystals from its hot and saturated solution on cooling is called crystallisation.

Crystallisation is better than simple evaporation as a method to get pure solids from liquid as :

(i) some solids may decompose or get charred when heated to dryness.

(ii) on evaporation some dissolved impurities also get deposited with the solid while in crystallisation, crystals of pure solid are crystallised leaving the impurities in the solution.

LAB TIME
Let's Do & Learn

- **Objective : To obtain pure copper sulphate from impure sample using crystallisation.**
- **Materials required :**

China dish, water, impure sample of copper sulphate, filter paper.

- **Procedure :**

(i) Take some (approximately 5g) impure sample of copper sulphate in a china dish.

(ii) Dissolve it in minimum amount of water.

(iii) Filter the impurities out.

(iv) Evaporate water from the copper sulphate solution so as to get a saturated solution.

(v) Cover the solution with a filter paper and leave it undisturbed at room temperature to cool slowly for a day.

(vi) You will obtain the crystals of copper sulphate in the chine dish. This process is called **crystallisation**.

- **Discussion and observation :**

When a hot saturated solution of copper sulphate is allowed to cool, crystals of copper sulphate separate out. All these crystal have a definite geometrical shape and hence look alike. We can separate these crystals from the liquid (called mother liquor) by the process of filtration.

- **Conclusion :**

When a hot saturated solution of a substance is allowed to cool, crystals of the substance having definite geometrical shapes separate out.

♦ **Applications of Crystallisation:**

(i) Purification of salt that we get from sea water.

(ii) Separation of crystals of alum (phitkari) from impure samples.

9.2 SEPARATION OF MIXTURE OF SOLID AND LIQUID

(i) By Evaporation : This method is used for separating a solid dissolved in a liquid. The solution is heated on a water bath or sand bath. This evaporates leaving the solid behind.

Let's understand this process by following activity.

LAB TIME
Let's Do & Learn

- **Objective : To separate the coloured components (dye) from blue or black ink by evaporation.**
- **Materials required:**

Beakers, watch glass, ink, burner, wire gauze, tripod stand, water.

- **Procedure :**

(i) Fill half a beaker with water.

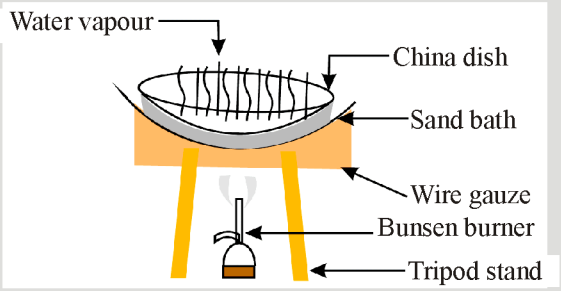
(ii) Put a watch glass on the mouth of the beaker.

(iii) Put few drops of ink on the watch glass.

(iv) Now start heating the beaker. You will see that evaporation is taking place from the watch glass.

(v) Continue heating as the evaporation goes on and stop heating when you do not see any further change on the watch glass.

(vi) Observe carefully and record your observations.



- **Observation and discussion :**

Ink (blue or black) is a mixture of dyes in water. When the ink is heated, the volatile component of the mixture i.e.water gets evaporated while the non volatile components of the mixture i.e. dyes remain as the residue.

- **Conclusion :**

The method of evaporation can be used to separate the volatile component (solvent) of the mixture from its non-volatile solute.

Some more examples of mixture are given below in table which can be separated by using evaporation.

Solid-liquid Mixture	Non-volatile Solid	Liquid
Common salt and water	Common salt	Water
Sodium nitrate and water	Sodium nitrate	Water
Copper sulphate and water	Copper sulphate	Water

(ii) By Centrifugation : Sometimes the solid particles in a liquid are very small and pass through a filter paper. For such particles the filtration technique cannot be used for separation. Such mixtures are separated by centrifugation.

The method of separating finely suspended or colloidal particles in a liquid, by whirling the liquid at a very high speed is called **centrifugation.**

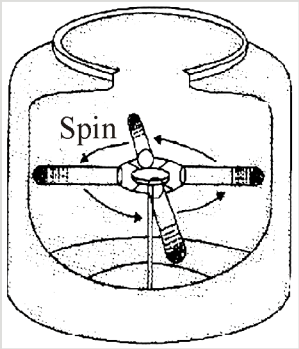
♦ **Principle :** It is based on the principle that when a very fine suspension or a colloidal solution is whirled rapidly, then the heavier particles are forced towards the bottom of liquid and the lighter stay at the top.

Let's understand this process by following activity.

LAB TIME
Let's Do & Learn

- **Objective : To separate cream from milk by centrifugation or by churning.**
- **Materials required :**

Milk, test tube, centrifuge machine or churner.



- **Procedure :**

(i) Take some full-cream milk in a test tube.
(ii) Centrifuge it by using a centrifuging machine for two minutes.
If a centrifuging machine is not available in the school, you can do this activity at home by using a milk churner, used in the kitchen.

- **Discussion and Observation :**

When the milk is churned, the lighter fat particles collide with each other to form cream. The cream thus separated starts floating on the surface of milk and is continuously collected from the outlet provided near the top of the centrifuging machine.

- **Conclusion:**

Liquid mixtures which contain solute particles which can easily pass through a filter paper(i.e. colloids) can be separated by using a centrifuging machine

♦ **Applications of centrifugation :**

(1) It is employed in milk dairies to separate cream from the milk.

(2) It is employed in diagnostic laboratories in testing urine samples.

(3) It is employed in blood banks to separate different constituents of blood.

(4) It is used in drying machines to squeeze out water from the wet clothes.

(iii) By Chromatography :

The process of separation of different dissolved constituents of a mixture by adsorbing them over an appropriate adsorbent material is called **chromatography**.

The adsorbent medium is generally magnesium oxide, alumina or filter paper. The solvent generally used for dissolving a mixture of two or more constituents is water or alcohol.

The different constituents of a mixture get adsorbed differently on the same adsorbent material, because they have different rates of movement.

The rate of movement of each adsorbed material depends upon :

(1) The relative solubility of the constituents of mixture in a given solvent.

(2)The relative affinity of the constituents of mixture for the adsorbent medium.

If a filter paper is used as an adsorbent material for the separation of various constituents of a mixture, then this method of separation of mixture is called paper chromatography.

Paper chromatography is very useful in separating various constituents of coloured solutes present in a mixture of lime, ink, dyes etc.

Focus Point

- Kroma means colour in Greek language and technique of chromatography was first applied for the separation of colours, so this name was given.

Let's discuss an activity to understand chromatography method.

LAB TIME
Let's Do & Learn

- **Objective : To separate the different coloured components of ink using chromatography.**
- **Materials required :**

Filter paper, pencil, ink, jar / glass beaker / test tube, water.

- **Procedure :**

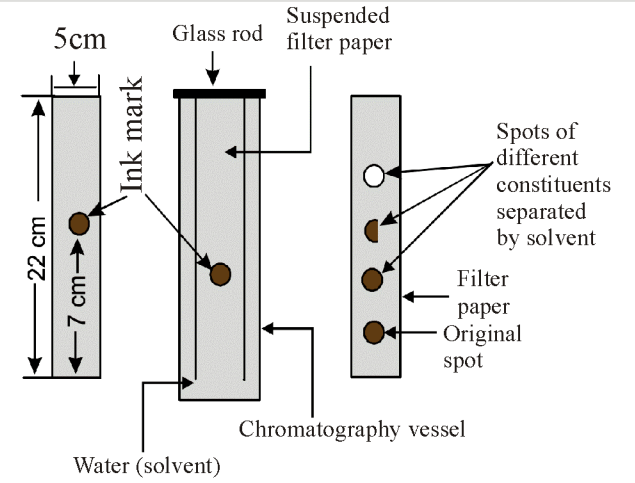
(i) Take a thin strip of filter paper.

(ii) Draw a line on it using a pencil, approximately 7 cm above the lower edge.

(iii) Put a small drop of ink (water soluble, that is, from a sketch pen or fountain pen) at the centre of the line. Let it dry.

(iv) Lower the filter paper into a jar / glass beaker / test tube containing water so that the drop of ink on the paper is just above the water level, as shown in figure below and leave it undisturbed.

(v) Watch carefully, as the water rises up on the filter paper. Record your observations.



- **Discussion and observation :**

(i) As water rises on the filter paper, it takes along with it different components of the ink.

(ii) Since a dye usually consists of two or more coloured substance, therefore, different colours are obtained on the filter paper strip. The dye which is more soluble in water dissolves first rises faster and produces a coloured spot on the paper at a higher position. The less soluble dyes dissolve a little later, rise slower and form coloured spots at lower heights. In this way, all the dyes present in black ink get separated.

- **Conclusion :**

Separation of different coloured components present in ink occurs on a chromatographic paper due to their different solubilities in water.

♦ **Applications of chromatography :**

(1) It is used to separate colours from dye.

(2) It is used in the separation of amino acids.

(3) It is used in the separation of sugar from urine.

(4) It is used in the separation of drugs from the samples of blood.

Focus Point

- Kromo is Greek word means colour. There are many types of chromatography like gas chromatography, liquid chromatography, etc, but the simplest form is the paper chromatography.
- **Adsorption** : The process by which molecules of a substances, such as a gas or a liquid, collect on the surface of another substance such as a solid. The molecules are attracted to the surface but do not enter the solid's minutes spaces as in absorption.
- Paper chromatography is very useful in separating various constituents of coloured solutes present in a mixture like, ink dyes, etc.

9.3 SEPARATION OF MIXTURE OF TWO LIQUIDS

(i) By Distillation : Distillation 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 (more than 25°C).

Distillation is the process of heating a liquid to form vapour and then cooling the vapour to get back liquid.

Distillation can be represented as :

$$\text{Liquid} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} \text{Vapour (or gas)}$$

Let's understand this method by following activity.

LAB TIME
Let's Do & Learn

• **Objective : To separate a mixture of two miscible liquids using distillation.**

• **Materials required :**

Distillation flask, thermometer, stand, burner, water condenser, conical flask, mixture of water & acetone.

• **Procedure :**

(i) Let us try to separate acetone and water from their solution.

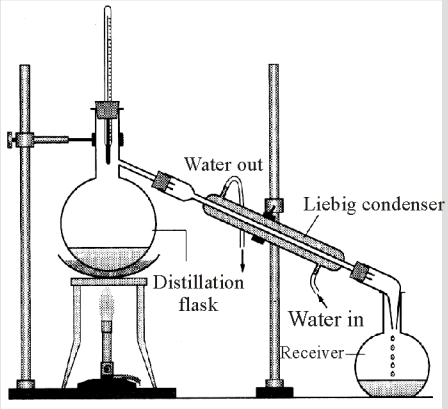
(ii) Take the mixture in a distillation flask. Fit it with a thermometer.

(iii) Arrange the apparatus.

(iv) Heat the mixture slowly keeping a close watch at the thermometer.

(v) The acetone vaporises, condenses in the condenser and can be collected from the condenser outlet.

(vi) Water is left behind in the distillation flask.



• **Discussion and observation :**

(i) When the mixture is heated, the vapours of the low boiling liquid, i.e., acetone are first formed. These travel upwards. On passing through the condenser, they get condensed to form liquid acetone which is collected in the beaker.

(ii) The boiling point of acetone is 329 K(56°C), therefore, the thermometer reading becomes constant at 329 K when acetone is distilling.

• **Conclusion :**

Separation of the components of a mixture containing two miscible liquids which boil without decomposition and have difference in their boiling points (more than 25°C) can be carried out by simple distillation.

Focus Point

- Those liquids which mix together in all proportions and form a single layer, are called miscible liquids.
- The liquid obtained by condensing the vapour in the process of distillation is called Distillate.

♦ **Fractional distillation :** In case of two liquids which have very close boiling points, both the liquids tend to distil over in different proportions.

To separate a mixture of two or more miscible liquids for which the difference in boiling points is less than 25 K, fractional distillation process is used.

The apparatus is similar to that for simple distillation, except that a fractionating column is fitted in between the distillation flask and the condenser.

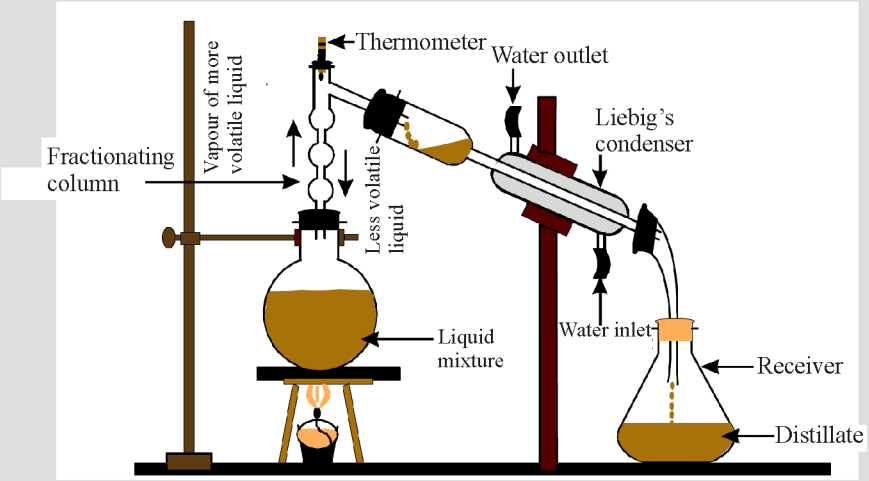
Let's understand fractional distillation method by following activity.

LAB TIME
Let's Do & Learn

- **Objective : To separate a mixture of alcohol and water.**
- **Materials required:** Mixture of ethyl alcohol and water, distillation flask, fractionating column.
- **Procedure :**

(i) Take a mixture of ethyl alcohol (boiling point 351 K) and water (boiling point 373 K) in a distillation flask provided with a fractionating column.

(ii) Start heating the liquid mixture till the mixture starts boiling.



• **Observations :**

(i) More volatile liquid is condensed first and collected in the flask.

(ii) Less volatile liquid with high boiling point is collected next in another flask.

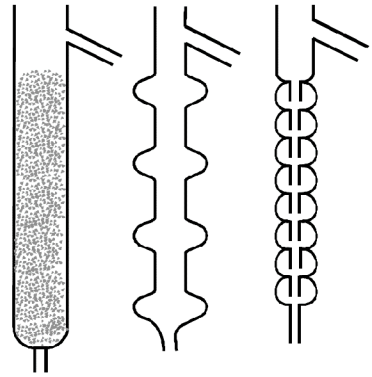
• **Conclusion :**

On heating, vapours of alcohol (low boiling point) escape from the flask and get condensed more readily. At the same time the vapours of water (high boiling point) fall back in the flask after getting condensed through fractionating column. When whole of the alcohol has distilled, the temperature starts rising on further heating. When the vapour pressure of water becomes equal to atmospheric pressure, it starts boiling. The vapours are condensed and collected.

Focus Point

• The process of fractional distillation is useful only, if the difference in the boiling points of the two miscible liquids is less than 25°C.

♦ **Fractionating column :** The design of a fractionating column is such that the vapours of one liquid (with a higher boiling point) are preferentially condensed as compared to the vapours of the other liquid (with lower boiling point).



Different types of fractionating columns

Some miscible liquid-liquid mixtures are given below which can be separated by using distillation method.

Miscible liquid - liquid mixture	Component which distils over
Ethyl alcohol (b.p. 78°C) + Water (b.p. 100°C)	Ethyl alcohol
Methyl alcohol (b.p. 64.5°C) + Ethyl alcohol (b.p. 78°C)	Methyl alcohol
Acetone (b.p. 56. 5°C) + Water (b.p. 100°C)	Acetone
Acetone (b.p. 56.5° C) + Ethyl alcohol (b.p. 78°C)	Acetone
Methyl alcohol (b.p. 64.5 °C) + Acetone (b.p. 56. 5°C)	Acetone

Focus Point

- Petroleum products are also separated by fractional distillation.

(ii) By Separating Funnel :

A mixture of two immiscible liquids can be separated by using a separating funnel. Two liquids which do not mix with each other are called immiscible liquids. These liquids form heterogeneous mixture. On standing they separate out into two separate layers depending upon their densities.

♦ **Principle :** The separation of two immiscible liquids is based on the difference in their densities. The apparatus used for separation is separating funnel. It is a long glass tube provided with a tap at its bottom. The table below shows different immiscible liquids which can be separated by separating funnel.

Immiscible Liquid - liquid Mixture	Heavier Liquid	Lighter Liquid
Benzene and water	Water	Benzene
Kerosene oil and water	Water	Kerosene oil
Turpentine oil and water	Water	Turpentine oil
Chloroform and water	Chloroform	Water
Mustard oil and water	Water	Mustard oil

Let's understand this process by following activity.

LAB TIME
Let's Do & Learn

- **Objective : To illustrate separation of two immiscible liquids using a separating funnel.**
- **Materials required:**

Beakers, separating funnel, kerosene oil, water.

- **Procedure :**

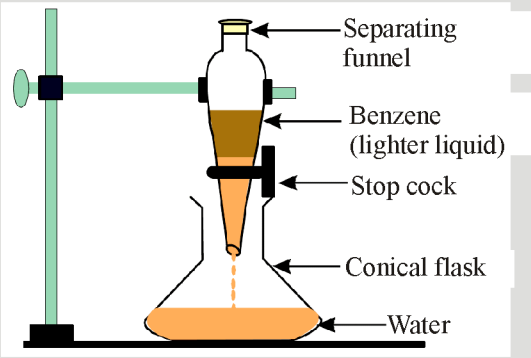
(i) Let us try to separate kerosene oil from water using a separating funnel.

(ii) Pour the mixture of kerosene oil and water in a separating funnel.

(iii) Let it stand undisturbed for sometime so that separate layers of oil and water are formed.

(iv) Open the stopcock of the separating funnel and pour out the lower layer of water carefully.

(v) Close the stopcock of the separating funnel as the oil reaches the stopcock.



- **Discussion and Observation :**

Kerosene oil and water being insoluble form two separate layers. Kerosene oil being lighter than water forms the upper layer while water forms the lower layer. On opening the stopcock of separating funnel, the lower layer of water comes out first and is collected in a beaker. When the water layer has completely run off, then the stopcock is closed.

The kerosene is left behind in the separating funnel. It can be removed in a separate beaker by opening the stopcock again.

- **Conclusion :**

Immiscible liquid separate out in different layers depending upon their densities and hence can be separated using a separating funnel.

♦ **Applications of separating funnel method :**

(1) This method is used for separating any two immiscible liquids.

(2) This method is used in separation of slag (a waste material) from the molten metals during their extraction. For example, during the extraction of iron from its ore, the molten iron and slag collect at the base of blast furnace. The slag being less dense floats up the surface of molten iron. They are drained out from two different outlets.

10. SEPARATION OF GASES FROM AIR

In order to separate the major components of air, it is first purified, then liquefied and finally fractionally distilled. The steps involved in the process are as follows -

♦ **Purification of Air :**

(i) Air generally contains carbon dioxide gas, hydrogen sulphide gas and sulphur dioxide gas as impurities. In addition to it there are dust particles also .

(ii) First of all air is washed by passing it through water, where the dust particles are removed.

(iii) The washed air is passed through dilute caustic soda solution, where the gases like carbon dioxide, sulphur dioxide and hydrogen sulphide are removed.

(iv) The purified air, however, contains moisture. The moist air is passed through pipes, maintained at a temperature below –20° C, where water vapour present in it freezes and hence, air becomes dry.

(v) The air leaving the cooling pipes is free from all impurities.

♦ **Liquefaction of Air** :

(i) The cool air, free from all impurities is compressed to a pressure 200 times more than the atmospheric pressure. The compression raises the temperature of the air.

(ii) The hot compressed air is then passed through cooling tank in which cold water enters from one end and warm water leaves from the other end.

(iii) The compressed and cooled air is passed through a spiral pipe, placed in a vacuum flask. The end of spiral pipe is provided with a fine jet.

(iv) When compressed air suddenly escapes from the jet, its pressure suddenly falls. Thus, its molecules move wide apart. When the molecules move wide apart, they need energy. This energy is taken by the molecules from themselves and hence, their temperature drops.

(v) The air so cooled, is now at a pressure equal to that of atmosphere. This cooled air rises up and in the process further cools the incoming compressed air in spiral tube. The air is then sucked again by the compression pump and the cycle is repeated. With every cycle, the temperature of air drops, till it liquefies.

♦ **Fractional Distillation of Air :**

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

Air

↓

Compress and cool by increasing pressure and decreasing temperature

↓

Liquid Air

↓

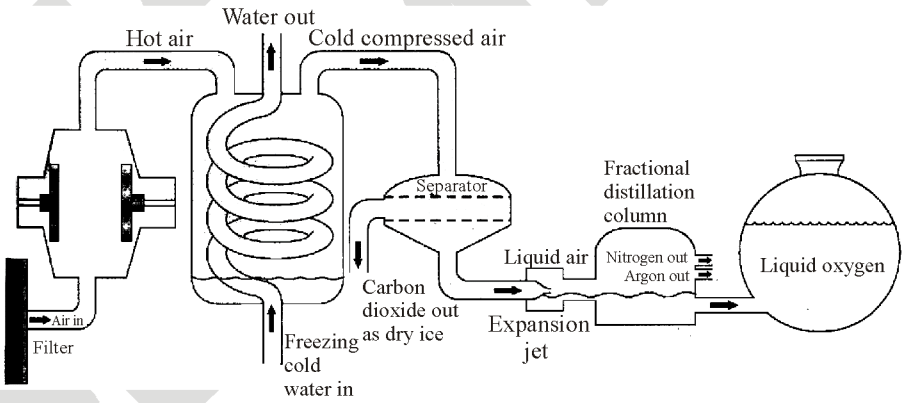
Allow to warm up slowly in fractional distillation column

↓

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

(i) The liquid air mainly consists of nitrogen and oxygen, and is at a temperature of – 200° C.

(ii) The boiling point of liquid nitrogen is – 195° C and that of liquid oxygen is – 183° C.



(iii) The liquid is gradually warmed to – 195° C, when nitrogen starts boiling off from the liquid air. The nitrogen gas so formed, is compressed and filled in steel cylinders.

(iv) The liquefied oxygen left behind, is also changed to gas and then filled in compressed state in steel cylinders.

11. CITYWATER SUPPLY

River water is normally used to supply drinking water to big cities. This water is unfit for drinking purpose as it contains a large amount of suspended impurities and harmful micro-organisms, such as bacteria and germs. The river water is purified in the following stages -

(i) Sedimentation :

The water is allowed to stand in big tanks where heavier suspended impurities settle down. To increase the rate of sedimentation, alum is added to it (loading). The impurities settle down at the bottom.

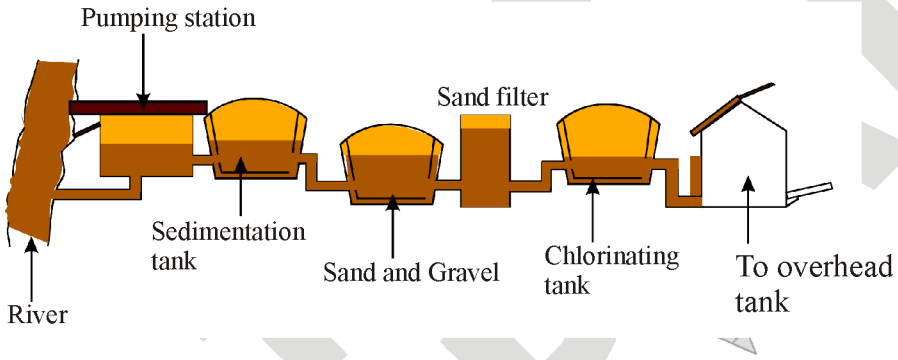
(ii) Filtration :

The semi-clear water is allowed to pass through beds of sand, charcoal and gravel to remove suspended impurities. After that water is passed through sand filter.

(iii) Removal of Harmful Micro-Organism or Sterilization :

The harmful bacteria in filtered water can cause very serious diseases such as typhoid, cholera, jaundice, dysentery, etc.

Thus, to the filtered water bleaching powder or chlorine gas is added. This kills the micro-organisms and hence the water becomes fit for drinking. This water is directly pumped into overhead tanks for supply to a city.



12. PHYSICAL AND CHEMICAL CHANGES

Some kind of change always takes place in the matter when it is subjected to energy changes. Almost all the changes (except nuclear changes) taking place in the matter can be classified under two headings, these are as follows -

12.1 PHYSICAL CHANGES

Definition : A change which alters some specific physical property of the matter, like its state, texture, magnetic or electrical conditions or its colour, without causing any change in the composition of its molecules, is called physical change, provided it gets reversed, if the cause producing the change is removed.

Following points need special consideration :

(i) No new or different product is formed : The composition of molecules of the substance remains unaltered. For example,

Ice melts to form water. In this example only the appearance (state) of matter has changed from solid to liquid. However, the composition of the molecules of ice or water remains same, i.e., for every 1 g of hydrogen there is 8 g of oxygen required . Thus, only a physical change has occurred.

(ii) The change is temporary and reversible : It means the change can be reversed by altering the causes which produce the change. For example,

The water formed from ice can be changed back to ice by placing it in a freezing mixture (a mixture of ice and common salt).

Focus Point

- On altering the experimental conditions, the change which gets reversed, is a physical change.

(iii) There is no net gain or loss of energy : The amount of energy required to bring about a physical change is generally equal to the amount of energy required to reverse the change. Thus, there is no net energy change involved. For example,

If 1 g of water at 100° C on changing into steam at 100°C needs 2260 J of heat energy, then 1 g of steam at 100° C on changing into water at 100° C, gives out 2260 J of heat energy. Thus, the net energy change is zero.

(iv) There is no change in the weight of substance : During a physical change it is only the energy which is added or removed. No matter is added during a physical change. Similarly, no matter is removed during a physical change. Therefore, mass of the substance remains same.

Some examples involving physical changes

Physical Change	Observation	Change in Physical Property
1. Switching on an electric bulb.	The bulb glows and gives out heat and light energy.	The physical appearance of the bulb changes.
2. Rubbing a permanent magnet on a steel rod.	The steel rod gets magnetised. If it is brought near iron nails, they get attracted.	The steel rod acquires the the property of attracting pieces of iron.
3. Action of heat of iodine	The brownish grey crystals of iodine change to form violet vapours. On cooling the vapours condense on cooler parts of the test tube to form crystals.	Change in state and colour.
4. Dissolving common salt in water.	The white crystalline salt disappear in water. However the water tastes exactly like common salt and it can be recovered by evaporation	Change in state.

♦ **Some Common Examples of Physical Changes :**

- Formation of dew.
- Crystallisation of sugar from its solution.
- Breaking of a glass pane.
- A rock rolling down a hill.
- Melting of wax.
- Evaporation of water.
- Ringing of an electric bell.
- Freezing of ice cream.
- Bending of a glass tube by heating.
- Sublimation of camphor.

12.2 CHEMICAL CHANGES

Definition : A change which alters the specific properties of a material by bringing about a change in its molecular composition, followed by a change in state, is called a chemical change.

Following points need special consideration :

(i) A chemical change results in the formation of one or more new products : The products formed have different properties than the original substance. Thus, the composition of the molecules of products is different from the original substance.

For example,

When sugar is gently heated in a test tube, it melts. It gradually changes to brown colour, giving a large amount of steamy fumes. In the end a black mass is left which consists of carbon. Thus, new substances, viz. carbon and water (steam), are formed. In this change, the arrangement between the molecules of carbon, hydrogen and oxygen breaks. The hydrogen and oxygen atoms separate from carbon atoms and join together to form water. The carbon atoms are set free and are left as black residue.

$$\text{Sugar} \xrightarrow{\text{Heat}} \text{Carbon} + \text{Steam}$$

(ii) The weight of the substance undergoing chemical change usually changes :

For example,

During the heating of sugar, the weight of the black residue is far less than the actual weight of the sugar. However, this is an apparent change in weight. If we take the weight of steam into account and add to it the weight of carbon, then total weight will be equal to the weight of sugar crystals. Thus, strictly speaking, total weight of substances taking part in a chemical change remains constant.

(iii) The chemical change is permanent and irreversible : It means the change will not reverse by altering the experimental conditions.

For example,

The sugar, which has decomposed on heating to form carbon and steam will not change to sugar on cooling.

(iv) During chemical change energy is either absorbed or given out : The various atoms in a chemical compound are joined by attractive forces commonly called bonds. The making or breaking of the bonds always requires exchange of energy. Thus, some amount of heat is either absorbed or given out during a chemical change.

Some examples involving chemical changes:

Chemical Change	Observation	Equation
1. Burning of magnesium in air.	When a magnesium heated in flame of Bunsen burner, it catches fire and burns with dazzling white flame to form white ash.	Magnesium + Oxygen →Magnesium oxide
2. Rusting of iron	When iron (silver grey) is left exposed to moist air for a few days, reddish brown powdery mass (rust) is found on its surface.	Iron + Oxygen + Water → Rust
3. Burning of LPG	LPG (Liquefied Petroleum Gas) is burnt, with pale blue flame and liberates colourless gas carbon dioxide along with steam.	Butane (LPG) + Oxygen →Carbon dioxide+Water

♦ **Some common examples of chemical changes**

- Burning of wood or charcoal
- Burning of candle
- Digestion of food
- Curdling of milk
- Formation of biogas (Gobar gas)
- Burning of petrol or diesel
- Smoking of cigarette
- Drying of paint
- Rusting of iron
- Ripening of fruit
- Clotting of blood
- Fading of the colour of a dyed cloth
- Baking of cake
- Photosynthesis
- Formation of wine
- Butter turning rancid
- Electrolysis of water into hydrogen and oxygen
- Formation of water from hydrogen and oxygen

Focus Point

- A chemical change is also called a chemical reaction.

Difference between physical and chemical changes

Physical Change	Chemical Change
1. The change take place only in state, texture, colour, electrical or magnetic properties or solubility, etc. However, molecular properties (composition) do not change.	1. The change takes place in state, texture, colour, electrical or magnetic properties along with the change in its molecular properties (i.e. its molecular arrangement changes.)
2. The specific properties of the substance remain unaltered after the physical change.	2. The specific properties of the substance change completely after the chemical change.
3. No new substances are produced.	3. Always new substances are produced.
4. There is no change of weight, if a substance is undergoing a physical change.	4. There is always a change in apparent weight of substance, when it undergoes a chemical changes.
5. Energy change may or may not occur during a physical change.	5. There is always a net absorption or release of energy during a chemical change.
6. It is temporary change and is usually reversed by removing the cause of the change.	6. It is permanent change and cannot be reversed by removing the cause of the change.

SOLVED EXAMPLES

SE. 1

How will you separate a mixture of common salt, sulphur powder and sand?

Ans. First shake the mixture with carbon disulphide, sulphur powder dissolves leaving behind common salt and sand. The mixture is filtered. Evaporation of carbon disulphide from the filtrate gives sulphur powder. The residue left on the filter paper consists of common salt and sand. Shake this mixture well with water when common salt dissolves leaving behind sand. The mixture is filtered. Evaporation of water from the filtrate gives common salt.

SE. 2

Comment upon the following :

(i) Smoke and fog are aerosols.

(ii) An emulsifying agent stabilizes a colloidal sol of a solid in a liquid.

(iii) Amalgamated zinc is a compound.

Ans. (i) A colloidal solution in which gas is the dispersion medium is called the aerosol. Since smoke is a colloidal sol of solid carbon particles in air and fog is a colloidal sol of moisture (water droplets) in air, therefore, both are aerosols.

(ii) Colloidal sols of solid in liquid or liquid in solid are quite stable. Therefore, they do not need any emulsifying agent. However, liquid in liquid type colloidal sols called emulsions are usually unstable. Therefore, to stabilize them usually emulsifying agents are added. For example, milk in which liquid fat is dispersed in water is stabilized by the protein lactalbumin present in it.

(iii) Amalgamated zinc is obtained by vigorously shaking zinc granules with a solution of mercuric chloride. As a result, the surface of zinc granules is coated with mercury. In other words, amalgamated zinc is not a compound but is a heterogeneous mixture of zinc and mercury.

SE. 3

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
(v) Diamond	(vi) Tap water
(vii) Distilled water	(viii) Oxygen
(ix) Brass	(x) 22Carat gold
(xi) Steel	(xii) Iron
(xiii) Sodium chloride	(xiv) Gun powder

Ans. (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) Gun powder : Mixture (Heterogeneous)

SE. 4

How will you separate the components of gun powder?

Ans. Gun powder is a mixture of nitre (potassium nitrate), sulphur and powdered charcoal. The mixture is thoroughly shaken with water when nitre goes into solution leaving behind sulphur and charcoal undissolved. The solution is filtered out. The filtrate contains aqueous solution of nitre.

On slow evaporation, the filtrate gives crystals of nitre.

Undissolved residue containing sulphur and charcoal is treated with carbon disulphide solution. Sulphur dissolves in the solution but charcoal does not. On filtration, charcoal is obtained as a residue. The filtrate, which contains sulphur, on evaporation gives sulphur as the residue.

SE. 5

How will you separate the components of a mixture of common salt and sand?

Ans. The mixture is treated with water. Common salt dissolves in water, but sand remains undissolved. The solution is filtered. The filtrate is an aqueous solution of common salt. The solution on evaporation gives common salt as the residue.

SE. 6

Calculate the concentration of a solution in volume percent made when 56g of water is mixed with 0.17 L of ethanol.

Ans. Volume of water = $\frac{\text{mass}}{\text{density}}$

$= \frac{56g}{1.0gcm^{-3}} = 56cm^3 = 56mL$

volume of ethanol = 0.17 L = 0.17 × 1000 mL =170 mL

volume of solution = (56+170) mL = 226 mL

concentration percent by volume

$= \frac{56}{226} \times 100 = 24.78\%$

SE. 7

How will you separate iron filings, ammonium chloride and sand from their mixture?

Ans. The mixture containing iron filings, ammonium chloride and sand is separated as follows:

(i) Iron filings are attracted by a magnet so they are removed by the method of magnetic separation. When a magnet is moved in this mixture, iron filings cling to the magnet and get separated. We are then left with ammonium chloride and sand.

(ii) Ammonium chloride sublimes on heating whereas sand does not sublime. So, ammonium chloride is separated from sand by the process of sublimation. When the mixture containing ammonium chloride and sand is heated, then ammonium chloride forms vapours easily. These vapours on cooling give pure ammonium chloride.

SE. 8

You are given a mixture of sand, water and mustard oil. How will you separate the components of this mixture?

Ans. This mixture contains three components : sand, water and mustard oil. Now, sand is a solid which is insoluble in water as well as mustard oil. Water and mustard oil are immiscible liquids. (i) The mixture of sand, water and mustard oil is filtered. Sand is left on the filter paper as residue. Water and mustard oil collects as filtrate. (ii) The filtrate containing water and mustard oil is put in a separating funnel. Water forms the lower layer and mustard oil forms the upper layer in separating funnel. The lower layer of water is run out first by opening the stop-cock of the separating funnel.

Mustard oil remains behind in the separating funnel and can be removed separately.

SE. 9

If 110 g of salt is present in 550 g of solution, calculate the concentration of solution.

Ans. Here, mass of solute (salt) = 110 g

And, mass of solution = 550 g

Now, we know that :

Concentration of solution (w/w%)

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$= \frac{110}{550} \times 100 = \frac{100}{5} = 20 \text{ percent (or 20\%)}$$

Thus, the concentration of this salt solution is 20 per cent (w/w) (or it is a 20% salt solution).

SE. 10

A solution contains 50 mL of alcohol mixed with 150 mL of water. Calculate the concentration of this solution.

Ans. Volume of solute (alcohol) = 50 mL

Volume of solvent (water) = 150 mL

So, Volume of solution

= Volume of solute + Volume of solvent

= 50 + 150 = 200 mL

Concentration of solution (v/v%)

$$= \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

$$= \frac{50}{200} \times 100 = 25\%(\text{v/ v})$$

SE. 11

Can physical and chemical changes occur together? Illustrate your answer.

Ans. In some cases, physical and chemical changes occur together. One such example is burning of candle. The solid wax present in the candle first changes into liquid state and then into the vapour state. Both these changes are physical changes. The wax vapours then combine with oxygen of the air to form a mixture of carbon dioxide and water. This involves a chemical change. The unburnt wax vapours again change first to the liquid state and finally to the solid state. This interconversion of states is a physical change. Thus, burning of candle involves both physical and chemical changes.

SE. 12

How can a saturated solution be made unsaturated?

Ans. A saturated solution can be made unsaturated in the following two ways :

(i) By increasing the temperature of the solution. When a saturated solution is heated, solubility of the solute increases and hence the solution becomes unsaturated.

(ii) By adding more of the solvent or by diluting.

SE. 13

Mercuric oxide is a red powder (HgO). When heated in a dry test tube, it gives out liquid mercury and colourless oxygen gas as :

Mercuric oxide $\rightarrow$ Mercury + Oxygen

What conclusion will you draw regarding these three substances : mercuric oxide, mercury and oxygen?

Ans. **Mercuric oxide :** It is a compound because it splits up into simpler substances mercury and oxygen.

Mercury : It is an element because it cannot be further decomposed into simpler substances.

Oxygen : It is also an element because it cannot be further decomposed into simpler substances.

EXERCISE – I

ONLY ONE CORRECT TYPE

1. The components of the substance can be separated by a chemical means only then it is a/an
(A) element (B) compound
(C) mixture (C) none of these

2. The zig-zag movement of dispersed phase particles in a colloidal system is known as
(A) Brownian motion
(B) translational motion
(C) circular motion
(D) linear motion

3. Iodized common salt is
(A) homogeneous mixture
(B) heterogeneous mixture
(C) pure substance
(D) oxidized substance

4. Pigments of natural colours can be separated by
(A) chromatography (B) centrifugation
(C) filtration (D) sublimation

5. The fine particles of an insoluble substance uniformly dispersed throughout a gas or liquid. This mixture is called
(A) suspension (B) precipitate
(C) colloidal solution (D) impurity

6. Which of the following upon shaking with water will not form a true solution?
(A) Alum (B) Common salt
(C) Albumin (D) Sucrose

7. Which of the following will show Tyndall effect?
(A) Starch solution
(B) Sodium chloride solution
(C) Copper sulphate solution
(D) Sugar solution

8. An emulsion is a colloidal solution formed by mixing
(A) two miscible liquids
(B) any two liquids
(C) any two gases
(D) two immiscible liquids

9. The size of colloidal particles is in the range of
(A) 1-100 nm (B) 100-1000 nm
(C) 10^{-5}m-10^{-7}m (D) 10^{-7}-10^{-9}cm

10. Brass contains
(A) gold and copper (B) copper and zinc
(C) zinc and silver (D) copper and silver

11. Which of the following is a homogeneous mixture?
(A) Solution of sugar in water
(B) Chalk powder in water
(C) Kerosene oil in water
(D) None of these

12. Solutions with low concentrations of solutes are
(A) concentrated solutions
(B) dilute solutions
(C) solvents
(D) none of these

13. Which of the following statement is correct?
(A) A pure substance must contain only one type of atom.
(B) A mixture containing two compounds must be heterogeneous.
(C) A heterogeneous mixture must contain at least three components.
(D) A homogeneous mixture must be uniform.

14. Which of the following is not an example of a physical change?
(A) Dissolving sugar in water
(B) Casting iron in moulds
(C) Settling of cement
(D) Magnetisation of iron

15. Separation of petroleum into its components is done by
(A) chromatography
(B) sublimation
(C) distillation
(D) fractional distillation

16. Identify the false statement.
(A) Colloids are homogeneous
(B) Colloids show Tyndall effect
(C) Colloids show Brownian movement
(D) The size of colloidal particles ranges between 1 -100 nm

17. Smoke is an example of
(A) gas dispersed in liquid
(B) gas dispersed in solid
(C) solid dispersed in gas
(D) solid dispersed in solid

18. Which one of the following is correctly matched?
(A) Emulsion - mud (B) Foam - mist
(C) Aerosol - smoke (D) Solid sol - cake

19. Which gas present in air has the highest boiling point?
(A) Oxygen (B) Nitrogen
(C) Argon (D) Hydrogen

20. Which of the following involves both physical and chemical change?
(A) Burning of a candle
(B) Rusting of iron
(C) Cooking of food
(D) Boiling of water

21. We can separate a pure solid from its solution by
(A) crystallization (B) simple distillation
(C) sedimentation (D) both (A) and (B)

22. Soda water is a solution of carbon dioxide in water. What is this solution composed of?
(A) Liquid solute in a gaseous solvent
(B) Gaseous solute in a liquid solvent
(C) Liquid solute in a liquid solvent
(D) Gas in suspended form in liquid

23. Which of the following pairs does not contain both elements?
(A) Carbon, silicon (B) Helium, nitrogen
(C) Bronze, zinc (D) Copper, silver

24. Principle of chromatography is
(A) rate of absorption (B) rate of adsorption
(C) rate of diffusion (D) none of these

25. A 15% alcohol solution means
(A) 15 mL alcohol and 85 mL water
(B) 15 mL alcohol and 100 mL water
(C) 15 mL water and 85 mL alcohol
(D) 15 mL alcohol and 50 mL water

PARAGRAPH TYPE

PARAGRAPH # 1

Pure substances can be elements or compounds. An element is a form of matter which cannot be broken down by chemical reactions into simpler substances. A compound is a substance composed of two or more different types of elements, chemically combined in a fixed proportion. Properties of a compound are different from its constituent elements, whereas a mixture shows the properties of its constituting elements or compounds.

26. Which of the following is not a pure substance?
(A) Tin (B) Coal
(C) Ice (D) Lime stone

27. The substance formed by mixing, crushing and heating iron filings and sulphur powder is
(A) an element (B) a compound
(C) a mixture (D) a solution

28. Lustre, ductility, malleability, conductivity are properties of

(A) metals (B) non-metals

(C) metalloids (D) compounds

PARAGRAPH # 2

The substances which homogeneously mix up together to form a solution are called the components of the solution. When two substances form a solution, one substance is said to dissolve into the other.

The substance which gets dissolved is commonly known as solute and the medium in which it gets dissolved is

termed as solvent or the component of a solution present in excess is referred to as the solvent while the other

component present in the smaller amount is called the solute.

A colloidal solution is a heterogeneous mixture in which the size of the solute particles is intermediate between

those in true solutions and those in suspensions.

29. Blood is example of–

(A) True solution (B) Suspension

(C) Colloidal solution (D) None of these

30. The size of colloidal particle

(A) <1 nm (B) 10A° – 1000 A°

(C) 10^{-9} cm –10^{-7} cm (D) >10 nm

31. Air is example of

(A) Heterogenous mixtue

(B) Colloidal

(C) Suspension

(D) Homogeneous mixture

MATCH THE COLUMN TYPE

In this section, each question has two matching lists Choices for the correct combination of elements **List-I** and **List-II** are given as options (A), (B), (C) and (D) out of which one is correct.

32.

Column-I	**Column-II**
(P) Fog	1. Solid in gas
(Q) Smoke	2. Solid in solid
(R) Steel	3. Solid in liquid
(S) Toothpaste	4. Liquid in gas

(A) P-4, Q- 1, R-2, S-3

(B) P-2, Q- 3, R-1, S-4

(C) P-1, Q- 2, R-3, S-4

(D) P-3, Q- 2, R-1, S-4

33.

Column-I	**Column-II**
(P) Miscible liquids	1. Distillation
(Q) Immiscible liquids	2. Crystallisation
(R) Impure copper sulphate	3. Sublimation
(S) Salt and ammonium chloride	4. Separating funnel

(A) P-4, Q- 1, R-2, S-3

(B) P-1, Q- 4, R-2, S-3

(C) P-1, Q- 2, R-3, S-4

(D) P-3, Q- 2, R-1, S-4

EXERCISE – II

VERY SHORT ANSWER TYPE

1. In terms of physical properties why is it possible to separate the components of a mixture by physical means?
2. Is ice water homogeneous or heterogeneous substance? Is it pure or impure substance?
3. Explain why filter paper cannot be used to separate colloids?
4. What is meant by the terms composition and structure when referring to matter?
5. Classify the following elements as metal, non-metal or metalloid : aluminium, fluorine, gallium, phosphorus, tellurium, thorium, barium, strontium, calcium, krypton.
6. What type of mixture can be separated by technique of crystallisation?
7. Name the methods used for
   (i) getting pure sugar from impure sample,
   (ii) separating mixtures of components in blue ink.
8. Give an example of a non-aqueous solution.
9. 100 mL of alcohol is dissolved in 400 mL of water. Calculate the volume percentage of the solute.
10. Particle size of a substance in water is 200 nm. What is the nature of the solution?

SHORT ANSWER TYPE

1. Which type of solution is aerated water?
2. What type of a change is rusting of iron?
3. By using the words solvent, solute, dissolve, solution, soluble, insoluble, filtrate and residue, explain how will you separate common salt from wheat husk.
4. A mixture of ethyl alcohol and water is homogeneous while that of oil and water is heterogeneous. Why?
5. Identify the statements which belong to a mixture and a compound.
   (a) The properties of the constituents are entirely different from the properties of the product formed by their chemical reaction.
   (b) The constituents retain their individual chemical properties in the product formed by mixing them.

LONG ANSWER TYPE

1. When 100 g of a saturated solution is evaporated at 50°C, 50 g of solid is left over. Find the solubility of the substance at 50°C.
2. Why is the product formed on heating 1 g of sulphur powder and 2 g of copper turnings called a compound while the product formed by mixing 1 g of sulphur powder and 2 g of copper turnings is called a mixture?
3. List few applications of colloids.
4. Difference between solution, colloidal solution and suspension.
5. Identify the following as either a physical or a chemical property,
   (i) Soap is slippery,
   (ii) Gold does not rust,
   (iii) Water freezes at 0°C.
   (iv) Cooking gas burns in air to give a flame,
   (v) Ice melts when kept outside the fridge.

TRUE AND FALSE TYPE

1. Air is a heterogeneous mixture.
2. Silver is a compound.
3. Compounds are homogeneous in nature.
4. Non-miscible liquids can be separated by distillation.
5. Rusting of iron is a chemical change.

FILL IN THE BLANKS

1. Liquid in liquid colloidal solution called_____.
2. Size of solution particle _____.
3. A mixture of two immiscible liquids can seperated by _____.
4. Clotting of blood is example of _____.
5. The scattering of light by colloidal particle called_____.

NUMERICAL TYPE QUESTIONS

1. If 2ml acetone is present in 45ml of its aqueous solution, what will be concentration of this solution?
   (A) 4.4% (B) 0.44%
   (C) 44% (D) 44.1%
2. If 110g of copper sulphate is present in 550g of solution, what will be concentration of solution ?
   (A) 20% (B) 30%
   (C) 40% (D) 80%
3. 12 gram of potassium sulphate is dissolved in 75g of water at 60°C. What is it's solubility in water at that temperature ?
   (A) 8g (B) 16g
   (C) 4g (D) 32g
4. A solution contain 30g sugar in 370g water. What will be concentration of this solution ?
   (A) 7.75% (B) 7.0%
   (C) 7.5% (D) 0.07%
5. How much water should be added to 15g salt to obtain 15% salt solution ?
   (A) 75g (B) 85g
   (C) 100g (D) 95g

Answer Key

EXERCISE–I														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	A	B	A	C	C	A	D	A	B	A	B	D	C	D
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A	C	C	A	A	D	B	C	B	A	B	B	A	C	C
31	32	33												
D	A	B												

EXERCISE – II

TRUE AND FALSE

1. F **2.** F **3.** T **4.** F **5.** T

FILL IN THE BLANKS

1. Emulsion **2.** <1 nm **3.** Seperating funnel

4. Chemical change **5.** Tyndall effect

NUMERICAL TYPE

1. A **2.** A **3.** B **4.** B **5.** B

SELF PROGRESS ASSESSMENT FRAMEWORK

(CHAPTER : IS MATTER AROUND US PURE)

CONTENT	STATUS	DATE OF COMPLETION	SELF SIGNATURE
Theory			
In-Text Examples			
Solved Examples			
NCERT Exercises			
Exercise I			
Exercise II			
Short Note-1			
Revision - 1			
Revision - 2			
Revision - 3			
Remark			

NOTES :

1. In the status, put "completed" only when you have thoroughly worked through this particular section.
2. Always remember to put down the date of completion correctly. It will help you in future at the time of revision.

Space for Notes :

MATRIX

JEE Division | NEET Division

Piprali Road, Sikar, Rajasthan 332001 | 01572-241911, 01572-243911

MATRIX HIGH SCHOOL

Pre-foundation & Schooling Division

Piprali Road, Sikar, (Raj.) 332001 | Bikaner Bypass Road, Near Gokulpura Village, Sikar (Raj.) 332021 | 01572-242911

Scan QR to Register

Visit us www.mof.matrixedu.in

@matrixsikar @matrix_sikar @MatrixSikar /c/matrixacademy