6 States of Matter

We'll cover the following key points:

- Particle Arrangement in Matter
- Change of States of Matter
- Solution and Solubility
- Miscible and Immiscible Liquids

Hi, I'm EeeBee

Do you Remember:

Fundamental concept in previous class.

In class 3rd we learnt

- States of Matter
- Uses of Matter

Still curious? Talk to me by scanning the QR code.

Learning Outcomes

By the end of this chapter, students will be able to:

- Understand the concept of the three states of matter in our surroundings: solid, liquid, and gas, and their unique characteristics.
- Identify and differentiate between solids, liquids, and gases based on key features such as shape, volume, and particle arrangement.
- Explore examples of solids (e.g., rocks, books), liquids (e.g., water, milk), and gases (e.g., air, steam).
- Learn how matter can change from one state to another through processes like melting, freezing, evaporation, and condensation.

Guidelines for Teachers

The teacher can start the chapter by introducing the concept of the three states of matter, encouraging students to observe everyday objects to identify solids, liquids, and gases. Discussions can focus on the key differences between the states, such as their shape, volume, and particle behavior. The teacher can also emphasize the changes in states of matter, like ice melting into water or water evaporating into steam, helping students understand the processes involved in these transformations and their importance in daily life.

Warm Up

Write one word for the following:

1. Any substance that has mass and occupies space: _____
2. The process by which a liquid changes to its solid form: _____
3. The process by which a gas changes into liquid: _____
4. The process by which a liquid changes into gaseous form: _____
5. The process by which a solid changes to a liquid: _____

Fun Fact

Matter exists in three common states—solid, liquid, and gas—but did you know there's also plasma and Bose-Einstein condensates? Water is unique because it can exist naturally in all three states: ice, liquid water, and vapor. Glass is technically a supercooled liquid, as it flows incredibly slowly over time. Scientists are also exploring exotic states like time crystals, where particles repeat in time rather than space!

Introduction

Matter is all around us. It is defined as anything that has mass and occupies space. We know that matter exists in three states : solid, liquid and gas. Everything surrounding us is made up of matter. The air that we breathe and the books that we read is matter. A rock, a table and a book are solids. Water, petrol and milk are liquids. Oxygen, Carbon dioxide and nitrogen are examples of gases.

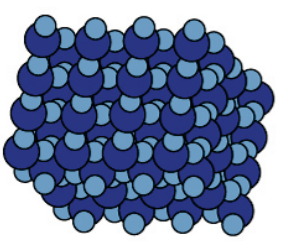
Take a Task

Watch Remedial

Particle Arrangement in Matter

Matter is made of very tiny particles which arrange themselves in different patterns resulting in three different states of matter. The smallest particles of matter are known as molecules and atoms. The three states of matter namely solids , liquids and gases can be distinguished from each other on the basis of the arrangement of their molecules and the space between these molecules (inter molecular space).

Solids

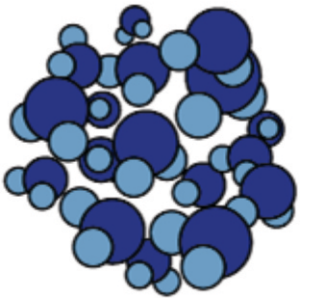


In solids, the particles are tightly packed. There is very little or no inter molecular space. As a result the particles of solids cannot move around. Thus they have a definite shape.

Properties of solids:

- The particles in solids are tightly packed.
- Solids have a definite shape.
- Solids have a definite volume.
- Due to strong attraction between molecules, solids do not flow.

Liquids

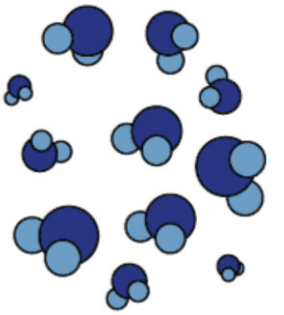


The molecules in liquids are less tightly packed than solids. There is some inter-molecular space between them. That is why, the particles in liquid can move around. Thus, liquids do not have a fixed shape. They take the shape of the container into which they are poured. Liquids, like solids have a definite volume.

Properties of liquids:

- The particles in liquids are less tightly packed than solids. Therefore, they can flow.
- Liquids do not have a definite shape. They take the shape of the container into which they are poured.
- Liquids have a definite volume.
- Liquid flow from high level to low level.

Gases



The molecules in gases are very loosely packed and have large inter-molecular spaces between them. Therefore, they can freely move around. Thus, gases neither have a definite volume nor do they have a definite shape. They very quickly occupy the space where they are placed.

Properties of gases:

- Particles of gases are very loosely packed. Therefore they fill the entire space where they are placed.
- Gases neither have a fixed volume, nor do they have a fixed shape.
- Gases can flow in all directions.

Activity — Creative Learning

To demonstrate solid, liquid and gas

Aim: To demonstrate solid, liquid and gas. Compare and contrast.

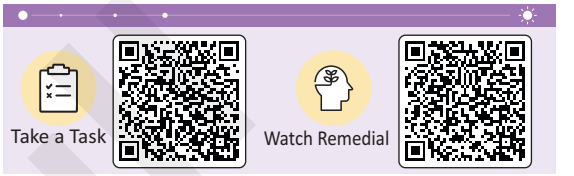
Solid : Fill a paper cup with water. Mark the level of water. Place it in the freezer overnight. Tear paper off the ice. Let the children note the change in state as the water changes into ice.

Liquid : As the ice melts above, explain to students that it is still water in a different form. It went from liquid in a cup to a hard shape, taking the shape of the cup. After all the ice melts, pour the water into the cup. Explain to the students the difference in the water volume due to evaporation.

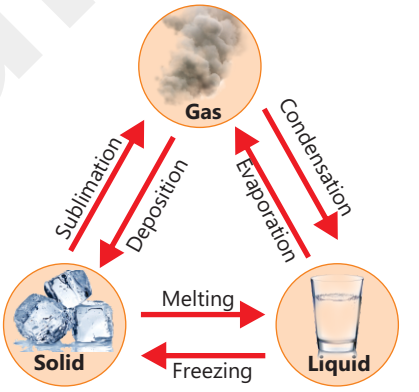
Gas : To blow a balloon without using your mouth.

Place ¾ cup of white vinegar into an empty plastic bottle. Put 2 tablespoons of baking soda into a balloon. Stretch the balloon over the mouth of the bottle keeping the balloon to the side of the bottle. Put the balloon up straight over the bottle, allowing the baking soda to enter into the vinegar. Step back and watch as the balloon inflates with carbon dioxide.

Change of States of Matter



We have learnt that all matter exists in three states: solid, liquid and gas. Matter can change its state from one to other if heated or cooled. For example ice (solid) can change its state to water (liquid) when heated. Water (liquid) can change its state to vapour (gas) on heating further. Vapour (gas) can change its state to water on cooling. Water (liquid) can change its state to ice (solid) on cooling further. Let us understand the processes involved in these changes.



Let us understand these terms in detail.

Melting: When a solid turns into a liquid, it is called melting. The temperature at which this happens is called the melting point. With rise in temperature, the energy of the molecules increases. As a result, they start moving faster thus moving apart. The melting point of ice is 0°C .

Evaporation: Evaporatin is the process by which a liquid changes into a gas. The temperature at which a liquid changes into gas is called its boiling point. On heating, the water becomes gaseous through evaporation. Drying of clothes and also of the sweat on our skin are examples of evaporation.

Condensation: Condensation is the process by which a gaseous substance changes into its liquid state by giving out heat. Having a cold drink on a hot day, the can sweats. Water vapour in the air hits the colder surface of the can and turns into liquid water.

Fun facts about Melting and Boiling

- When rocks get really hot they turn into a liquid called magma or lava.
- Gas can be turned into a liquid through pressure. By squeezing all the gas molecules tightly together a gas can become liquid.
- We use natural gas in our homes in its gaseous state, but when it is shipped in ocean tankers it shipped in a liquid state to save space.
- Mercury has the interesting properties of being both a metal and a liquid in its standard state.

Freezing or Solidification: The process by which a liquid changes into its solid form is called solidification. Water on freezing changes into ice. The temperature at which a liquid changes into a solid is called its freezing point. The freezing point of water is 0 °C or 32 °F.

Solution and Solubility

A solution is a mixture of molecules that are evenly distributed. A simple solution consists of a solute and a solvent. In a solution, the substance that dissolves is called the solute and the substance in which a solute dissolves is called the solvent.

Take a Task

Watch Remedial

Did you know ?

Dry Ice

It is actually solid Carbon Dioxide at a temperature of -79 degrees centigrade.

Dry Ice is particularly useful for freezing, and keeping things frozen because of its very cold temperature: -109.3°F or -78.5°C. Dry Ice is widely used because it is simple to freeze and easy to handle using insulated gloves. Dry Ice changes directly from a solid to a gas -sublimation- in normal atmospheric conditions without going through a wet liquid stage. Therefore it gets the name "dry ice."

The process by which a solid changes into gas directly is called sublimation.

Check 'N' Mate — Critical Thinking

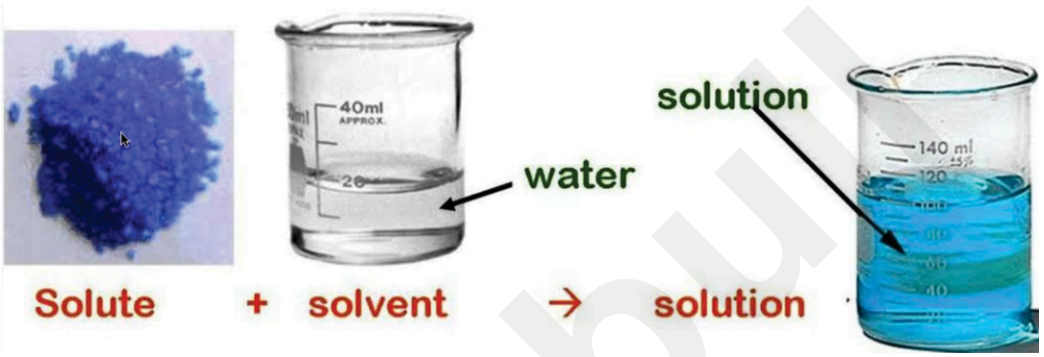
Write 'T' for true and 'F' for false statements.

1. Oxygen, carbon dioxide and nitrogen are examples of liquids. ☐

2. The molecules in liquids are less tightly packed than solids.
3. The molecules in gases are very closely packed to each other.
4. Water can change its state to vapour on heating.
5. The freezing point of water is 0°C or 32°F.

For example: When salt dissolves in water it forms salt-water solution. Here, salt is the solute, water is the solvent and salty water is the solution.

Most substances dissolve in water and hence it is called the universal solvent.



Soluble and insoluble Substances : Substances that dissolve completely in a solvent to make a solution are called soluble substances. For example, sugar is dissolved in water to make a sugar solution. Substances that do not dissolve in a solvent are called insoluble substances. For example chalk powder does not dissolve in water.

Types of Solution: Based on the type and state of solute and solvent present in a solution, there may be different types of solution.

- **Solid in Liquid:** In this type of solution, a solid (solute) dissolves in a liquid (solvent) to make a solution. Example : Salt –water solution.
- **Liquid in liquid:** In this type of solution, a liquid (solute) dissolves in a liquid (solvent) to make a solution. Example : Orange juice and water.
- **Gas in liquid:** In this type of solution, a gas (solute) dissolves in a liquid (solvent) to make a solution. Example : Carbonated (fizzy) drinks. Here carbon dioxide dissolves in water. Oxygen dissolved in water is used by all aquatic animals for breathing.
- **Gas in gas:** In this type of solution a gas (solute) dissolves in another gas (solvent) to make a solution. Example : A room freshener sprayed in a room. Air is the perfect example of a mixture of a number of gases.

Activity

Creative Learning

Aim: Activity to demonstrate the solubility of substances

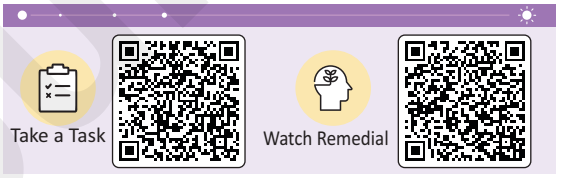
Materials required: 10 tumblers, water, stirrer, strainer and substances like salt, chalk powder, wheat bran, milk and sand.

Procedure: Take 5 tumblers and pour water into each. Now add the substances provided into each tumbler separately. Stir each tumbler with the stirrer. Notice the change in each tumbler. Now strain the contents of all the 5 tumblers into 5 new tumblers with the help of a strainer.

Observation: Notice that chalk powder , wheat bran and sand are left behind in the strainer whereas salt and milk easily pass through the strainer.

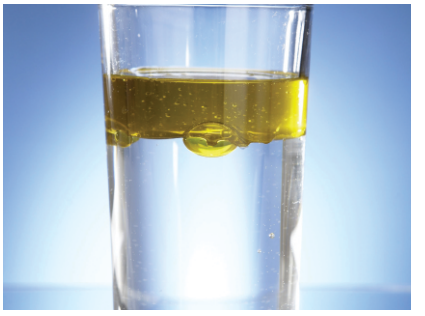
Inference: Substances like salt and milk dissolve completely in water and are called soluble substances and substances like chalk powder, wheat bran and sand are left behind in the strainer and do not dissolve in water and are hence called insoluble substances.

Miscible and Immiscible Liquids



When two liquids, on mixing, mix completely so that one cannot be separated from the other, they are called miscible liquids. For example milk and water. When two liquids cannot be mixed with each other, they are called immiscible liquids. For example oil and water. When two such liquids are mixed, the lighter liquid (oil) floats over the surface of the heavier liquid (water).

Miscible liquids



Immiscible liquids

Separation of Substances (in Liquids)

Both substances *i.e.,* insoluble and soluble can be separated from their solvents by using different methods.

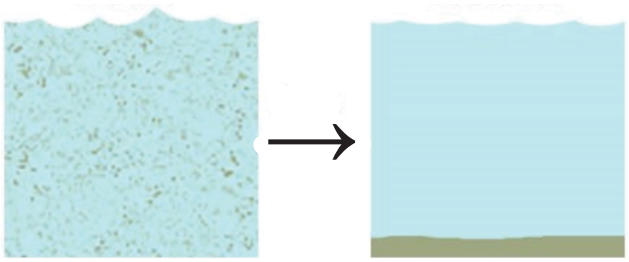
Separation of Insoluble Substances:

Substances that are insoluble in water can be separated through various processes such as sedimentation, decantation and filtration.

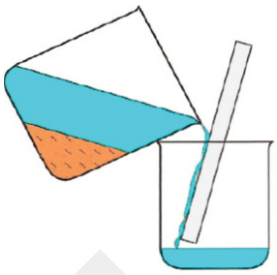
Sedimentation and decantation: These two processes are normally used in combination to separate insoluble solid substances from a mixture of solids and liquids.

Sedimentation: The process by which insoluble solid particles settle down at the bottom of a solid liquid mixture is called sedimentation. For example, when muddy water containing soil and sand is left undisturbed, soil and sand being insoluble, settle at the bottom. This process is called sedimentation and the solid substances settling down at the bottom are called sediments.

Decantation: This process takes place after sedimentation. The pouring of the upper layer which contains water is called decantation.

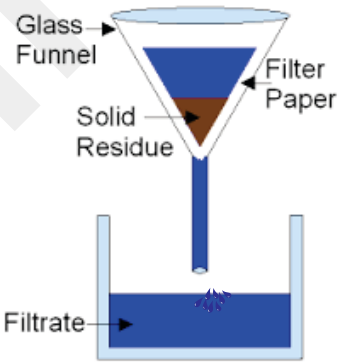


Sedimentation



Decantation

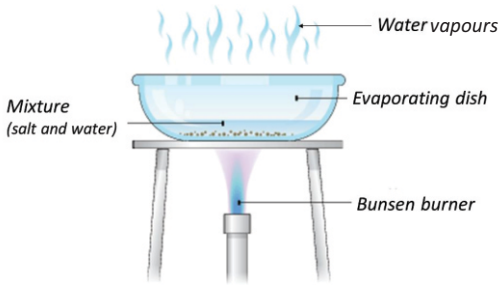
Filtration: This method is used to separate fine insoluble solid particles from a mixture of solid and liquid. In this process, the mixture is allowed to passes through a filtering device. Solid particles are left as residue in the filtering device. The clear liquid pass through the filtering device and is called the filtrate.



Separation of Soluble Substances

Soluble substances may be separated from their solutions by processes such as evaporation and condensation and also through distillation.

Evaporation and Condensation: This process involves boiling the solution containing soluble impurities. For example salt or sugar can be separated from their solution by a combination of evaporation and condensation. The solution is heated until the water evaporates and the remaining residue is salt or sugar. In this process, however, water is lost through evaporation which can be obtained back through condensation.

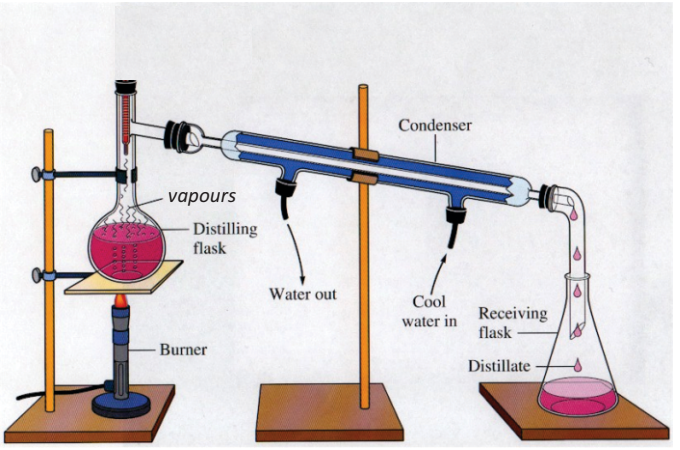


Evaporation

Distillation: Distillation is a process of removing soluble impurities from its mixture with water. The process of distillation involves the following steps:

- The mixture of water and the solute is heated in a round bottomed flask to boiling temperature.
- The neck of the round bottomed flask is connected to a condenser which cools the water vapours that has escaped from the round bottomed flask.
- The vapour on cooling changes into water droplets and is collected in a flask attached to the condenser.

Pure water thus collected by the process of distillation is called distilled water. It is the purest form of water as it is free from all kinds of impurities. However, it is not suitable for drinking as it doesn't even have the dissolved minerals that should be present in drinking water. This water can be used in car and inverter batteries, for medical purpose, in laboratories etc.



Distillation

Check 'N' Mate

Critical Thinking

Fill in the blanks with correct words.

1. A solution is a mixture of _____ (molecules/particles) that are evenly distributed.
2. Salt-water solution is a _____ (solid in liquid/gas in gas) solution.
3. _____ (Filtration/Decantation) method is used to separate fine insoluble solid particles.
4. Salt or sugar can be separated from their solution by _____ (evaporation and condensation/distillation).

In a Nutshell

- Matter exists in three states- solid, liquid and gas.
- The three states of matter have different inter-molecular spaces.
- Solids have definite shape and volume.
- Liquids have no definite shape but have a definite volume.
- Gases have neither a definite shape, nor a definite volume.
- Matter can be changed from one form to another.
- The process by which solid changes into liquid on heating is called melting.
- The process by which a liquid changes into a gas is called evaporation.
- The process by which a gas changes into liquid is called condensation.
- The process by which a liquid changes into solid is called freezing.

- A solution is a mixture of molecules that are evenly distributed.
- Liquids can be miscible (orange juice and water) or immiscible (oil and water).
- Substances insoluble in water may be separated by sedimentation, decantation and filtration.
- Substance soluble in water are separated by evaporation and condensation and distillation.

Key Words

Improving Vocabulary

Contraction	:	Decrease in the size of substance on cooling.
Evaporation	:	The change from liquid to gas.
Miscible	:	When two liquids mix completely so that one cannot be separated from the other.
Immiscible	:	When two liquids cannot be mixed with each other.
Sedimentation	:	The process by which insoluble solid particles settle down at the bottom of a solid liquid mixture.
Decantation	:	The process by which the clear liquid at the top is poured after sedimentation.
Filtration	:	This method is used to separate fine insoluble solid particles from a mixture of solid and liquid.
Distillation	:	A process of removing soluble impurities from its mixture with water.

Time to Apply

Applying and Creating

Water can be observed as liquid, solid(ice) or gas. It moves around the environment in a process known as the water cycle. Agree? Draw a labelled diagram to illustrate this.

Time to Discuss

Pondering and Communicating

An egg, when put in a bowl of water sinks but the egg floats when put in a salty water bowl. why?

EXERCISE

That turn curiosity into confidence—let's begin!

Gap Analyzer™
Take a Test

A. Objective Type Questions.

1. The conversion of ice into water is an example of:
   a. Evaporation ☐ b. Condensation ☐
   c. Melting ☐ d. Freezing ☐
2. Gases consists of particles that _____ .
   a. have a regular arrangement ☐
   b. are very far apart ☐
   c. are strongly attracted to each other ☐
   d. have an irregular arrangement ☐
3. The difference between boiling and evaporation is that:
   a. There is no difference between boiling and evaporation. ☐
   b. Boiling changes the liquid into gas while evaporation makes the liquid disappear. ☐
   c. Boiling occurs at one temperature only whereas evaporation occurs at different temperatures. ☐
   d. Evaporation occurs at one temperature only whereas boiling occurs at different temperatures. ☐
4. The molecules in a liquid are:
   a. Closer together than in a solid and further apart than in a gas ☐
   b. Spaced the same as in solids and gases ☐
   c. Closer than in gases but further apart than in solids ☐
   d. None of the above ☐
5. When the temperature of a gas decreases, it:
   a. Expands ☐ b. Rises ☐
   c. Condenses ☐ d. Becomes less dense ☐
6. Water drops that collect on the surface of a glass of cold drink comes from:
   a. The cold drink ☐ b. The air ☐
   c. The glass ☐ d. None of these ☐
7. The attraction between the molecules of which of these is the highest ?
   a. Liquid ☐ b. Gas ☐
   c. Solid ☐ d. All are the same ☐

B. Fill in the blanks :

1. The temperature at which a liquid changes into gas is known as its _____ .
2. The molecules of liquid has some _____ between them.
3. Substances that are insoluble in water can be separated by processes such as _____, _____, _____ .
4. In fizzy drinks _____ is dissolved in water to give the characteristic fizz.
5. Oil and water are examples of _____ liquids.
6. A simple solution always consists of a _____ and a _____ .
7. Carbon dioxide in solid form is also known as _____ .

C. Very Short Answer Questions.

Name them.

1. A metal that is liquid in nature _____ .
2. The clear liquid passing through a filtering device _____ .
3. Milk and water are example of this type of liquids _____ .
4. An example of gas dissolved in water is _____ .
5. Purest form of water but is not suitable for drinking _____ .
6. The substance that is dissolved in a solution _____ .
7. Smallest particle of matter _____ .

D. Short Answer Questions.

1. What is matter? What is it made up of? Name the different states of matter.
2. What is known as universal solvent? Why is it called so?
3. Define sublimation.
4. Explain the concept of solute, solvent and solution.
5. Name the processes that are used to separate substances that are insoluble in water.

D. Long Answer Questions.

1. With the help of a neat diagram explain the molecular structures of solids, liquids and gases giving 3 properties of each.
2. What is a solution? Explain the different types of solutions with examples.
3. With the help of a diagram describe the process of distillation. Mention a few uses of distilled water.
4. Describe a process to separate insoluble solid particles from a mixture of solid and liquid.

Time to Recall

Remembering and Analysing

Recall and complete the concept map given below.

Changes of State of Matter

M_____ E_____ C_____ F_____

Time to Observe

Observing, Critical Thinking, Analysing

Classify the objects given in the box as solid, liquid or gas. Also, give reason for each classification.

ice cubes steam from a kettle rock lava from volcano
spoon wind ice-cream brick shampoo oxygen honey oil

Objects	State	Reason for classification

Time to Create

Creating and Collaborating

Display the three states of matter while you prepare cold jello dessert using water and jello crystals. Write a detailed note on how the three states of matter get displayed in the process.