SCIENCE

UNIT - 1

MATTER

After studying this unit you :

- explain the properties of matter.
- give examples for different states of matter - solids, liquids and gases.
- find out the arrangement of particles in solids, liquids and gases.
- recognize the effects of heat on solids, liquids and gases.
- define the terms mass, density, pressure and buoyancy.

Materials in nature have drawn interest of man from the beginning. He created new materials based on the properties. The fundamental question was what are the constituents of matter ? Answer to this question was visualised as that of particular nature by philosophers like **Kanada** and **Democratus**. This proposition was confirmed by **John Dalton** based on experiments.

Activity 1.1 : *Take a piece of chalk and crush it into powder. As you continue crushing, you will get very fine particles. Can you divide these particles further? Think it over.*

An ancient Indian philosopher maharshi **Kanada** was the first who said that **Substances are made up of very minute particles.**

Fig. 1.1
Maharshi Kanada

He was originally named Uluk. he has given us the idea of **kana** (particle). He says that matter can be divided into smaller particles and then further divided till no further division is possible. His assumption was that the remaining indivisible entity is **kana**.

John Dalton based on certain experimental evidences proposed the atomic theory of matter. According to his theory, the indivisible smallest particle of an element is called **atom**. Atom can neither be created nor be destroyed.

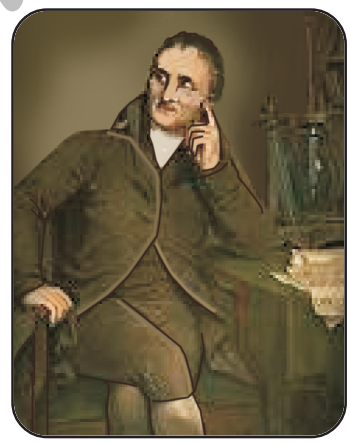


Fig. 1.2
John Dalton

This entity does not exist in a free state and can not be sensed through any human organ. Atom is an indivisible particle. The matter that exists is made up of atom that cannot be visible. What a wonder it is!

Later on these factors have undergone many changes. According to modern atomic theory, atom can be divisible. You will study more about this in higher classes.

Properties of Matter :

a. Matter occupies space :

Activity 1.2 : *Keep a stone on a table. In the same place try to keep a ball. Can you place both of them at the same place ? If not why ?*

We can't keep them because two things cannot occupy the same place at the same time.

Activity 1.3 : *Place a glass beaker completely filled with water on a plate. Immerse a stone tied to a thread slowly into the beaker. Some water in the beaker flows out and collects in the plate.*

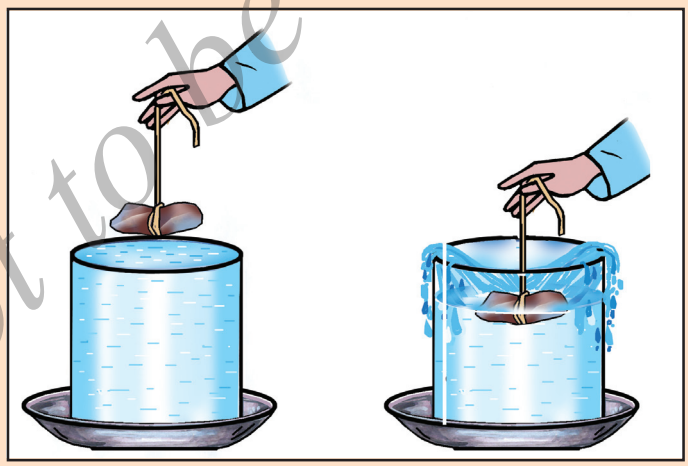


Fig. 1.3
Matter occupies space

You might have seen many things around you. Things like table, pen, books, play materials and many other things are made of matter. The word material relates to matter.

When you look around, you can observe that all matter occupies space. You may not see air but its presence can be felt. It is also matter. How can you demonstrate that air also occupies space ?

Know this :
A person can enter a room filled by air. Air can accommodate objects and hence we can infer that the particles are sparsely distributed.

b.Matter has weight :

Activity 1.4 :

Take a weighing balance. Place a 50 ml empty beaker on the pan of the balance and weigh it. Observe the position of the needle. Fill the beaker completely with water and observe the position of the needle.

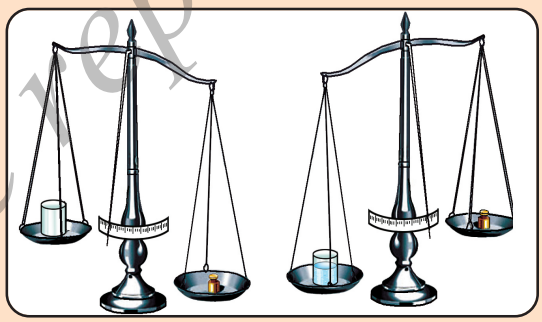


Fig. 1.4
Matter has weight

This shows that the matter has weight.

From these activities it can be observed that **matter** is anything that occupies space and has weight.

Matter is made up of minute particles :

All matter is made up of minute particles. The total number of particles present in the matter depends on the weight of the substance. The nature of these particles depend on the substances.

Know this :
Visible matter is made up of invisible particles.

States of Matter :

The arrangement of particles makes matter into three physical states i.e, solids, liquids and gases.

Activity 1.5 : *Classify the following into solids, liquids and gases. 1. ice 2. air 3. kerosene 4. fruit juice 5. smoke 6. sugar.*

Arrangement of particles in solids :

In solids, particles are held together closely in a compact manner. There is a force of attraction between the particles. Solids have definite volume and shape. They can be placed one above the other or beside. As the particles of solids are closely packed, they cannot be compressed. Hence they cannot move freely.

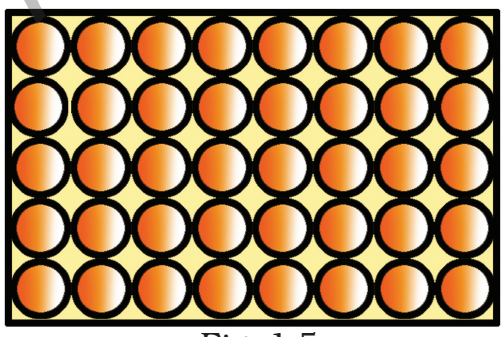


Fig. 1.5
Arrangement of particles in solids

Arrangement of particles in liquids :

In liquids, the particles are close together but they are not arranged in an order as in case of solids. The particles in a liquid can slide, that means they have freedom to move within the boundary.

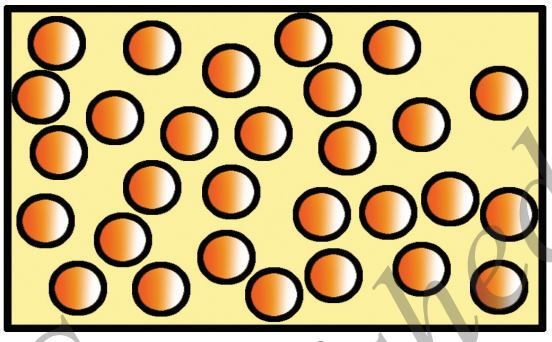


Fig. 1.6
Arrangement of particles in liquids

Put a drop of blue ink into a glass of water. Observe the movement of particles until the entire liquid becomes bluish. The liquids can flow easily. Liquids can be poured from one vessel to another. Liquids have definite volume but they do not have a definite shape. They take the shape of the container.

Activity 1.6 : *Fill a beaker with water. Note the level of water. Pour this water into vessel of different shapes as shown in the figure. Water takes the shape of the vessel into which it is poured.*

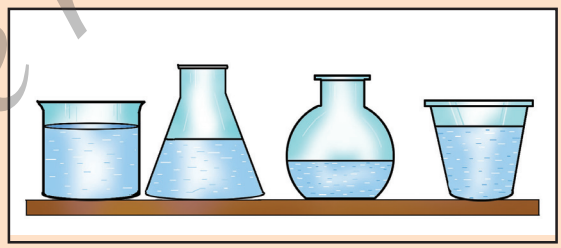


Fig. 1.7
Liquid takes the shape of the container

Pour the water again into the beaker. Observe whether the volume of water has changed.

Mention the properties of liquids you understand from this activity. Repeat the same activity using other containers used in daily life.

Arrangement of particles in gases :

You might have experienced the fragrance by an incense stick which is kept glowing in a room. How did the fragrance spread to the entire room ?

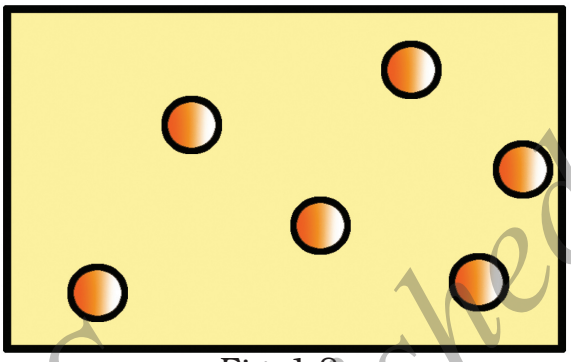
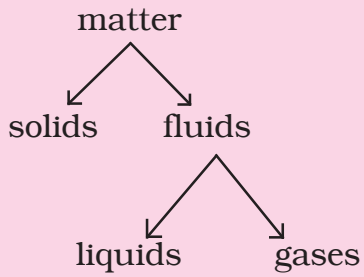


Fig. 1.8
Arrangement of particles in gases

In gases the particles are loosely arranged. The gas particles in a container move independently in all directions. Gases have no definite shape or volume. Gases take the shape and volume of the container. Gases occupy the free space of the container completely.

Know this :
Air, in sanskrit is called Gandhavahana.

Know this :
Liquids and gases are termed as fluids on the capacity to flow exhibited by these.



Think :
Gases can be easily compressed. Why ?

Activity 1.7 : *Take a syringe without needle. Pull its handle back. Air enters the syringe. Close the mouth of the syringe with your finger. Now push the handle of the syringe inside. The volume of air decreases. By this, we can understand that gases can be compressed. Now, draw some water in the syringe. Close the mouth of the syringe with your finger. Push the piston forward. The volume of water does not decrease. By this, we understand that water (liquids) cannot be easily compressed.*

Try this experiment with other liquids also.

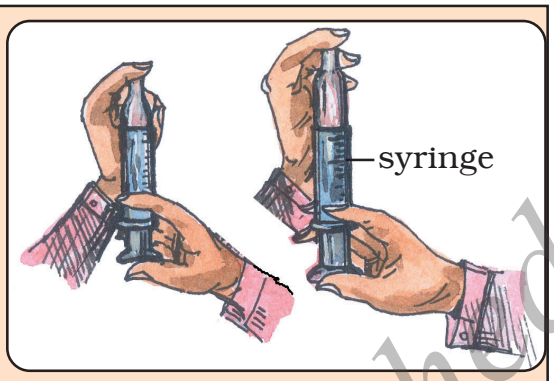


Fig. 1.9
Comparing the compression of liquid with gas.

Activity 1.8 : *Take a balloon half filled with air. Its mouth should be tied with rubber band. Immerse it in luke warm water. What happens ? You will observe that balloon expands. The volume of gas depends upon temperature. It also depends upon pressure. Large volume of gas can be filled in a small cylinder like gas cylinder in a kitchen by means of compression.*

Know this :

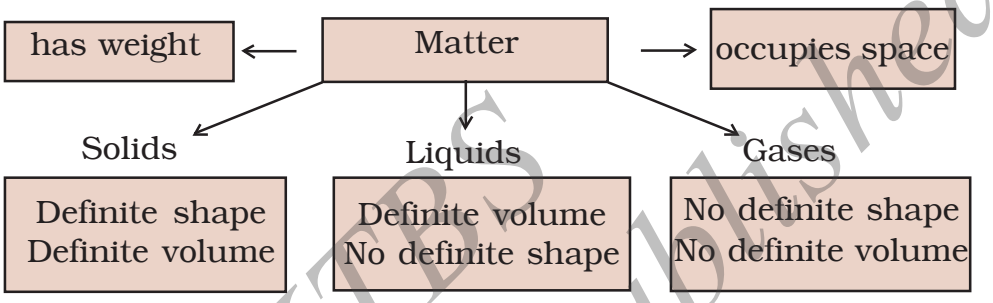
Plasma is fourth state of matter. At extremely high temperatures, certain substances will be in the state of plasma. In this state, the particles of matter will be ionized. These particles can move independently. Plasma particles will be in continuous motion.

Example : Matter in stars, matter in flouroscent lamps and gas welding.

Know this :
Volume is the amount of space occupied by matter (except in gases - in case of gases volume depends upon compression).
SI Unit of volume is m^3.

Word help :
SI - System International.

Graphical representation of properties of matter



Think :
You might have heard some angry people saying, "I will destroy this piece of paper by burning it." Can they really destroy it ? Can matter be destroyed? or can it be created?

When paper is burnt, ash remains. The weight of ash is less compared to that of paper. Have we destroyed the paper? Let us see. Actually burning consumes air along with paper. The products obtained are many invisible gaseous constituents along with solid ash.

If we take into account the weight of paper and air consumed and compare with gaseous products and ash, we are surprised to note that the weight remains the same. This leads to the Law of conservation of matter.

It was noticed by scientists long ago that the quantity of matter remained the same in all changes that they had observed. Scientist **Lavosier**, put this

observation in the form of a law called **The law of conservation of matter.** It states that, the quantity of matter in this universe never varies (that is, the quantity of matter remains the same) regardless of what change it undergoes.

Effect of heat on solids, liquids and gases :

1.Expansion :

What will happen to the volume of solids, liquids and gases on heating ? Let us conduct some activities to know about this.

Activity 1.9 : *Take a thin metal disc of the size of a one-rupee coin. Place it on a wooden board. Now hammer two nails on the board in such a way that the metal disc will just brush tightly against the two nails as it can slide between them (As shown in the figure).*

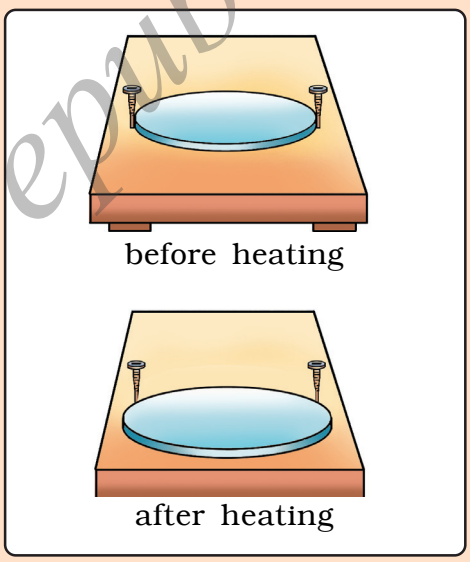


Fig. 1.10
Expansion of solid on heating

Now holding the disc with tongs, heat it and try to pass it between the two nails. It is stuck, can you think why ? The disc expands on heating. As a result the disc could not just pass between the nails. On cooling the disk again passes through the nails.

The other examples are, hot iron ring placed on wooden wheel of a cart and sagging of electric lines during sunny days.

Activity 1.10 : *Can you think of some more examples in day to day life where the volume of substance change due to heat.*

Activity 1.11 : *Fill a test tube with coloured water. Close the mouth of the test tube with a single holed rubber cork. Insert a capillary tube through the hole. Ensure that the water in the test tube rises into the capillary tube so that its level can be seen above the cork. Mark the level of the water in the capillary tube.*

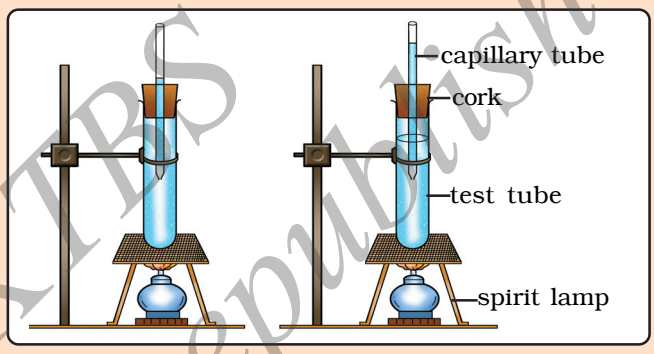


Fig 1.11
Expansion of liquid on heating

Heat the test tube. Observe the level of water in the capillary tube. Level of water rises slowly in the tube. Can you think why ? It means that on heating water expands. Now stop heating. Slowly the water goes back to its original level. Why do you think this happens ?

Activity 1.12 : *Take an empty bottle. Is the bottle really empty ? No, it is filled with air. Fix a balloon to its neck. Place the bottle in a vessel containing hot water.*

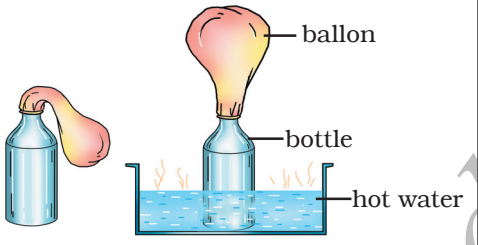


Fig. 1. 12
Expansion of gas on heating

You find that balloon gets inflated. Why is the balloon inflated ? The reason is that the air in the bottle expands when its temperature rises. Take the bottle out of hot water and allow it to cool. When the air in the bottle is cooled, the balloon is deflated showing that air contracts on cooling.

From these activities, we can infer that solids, liquids and gases expand when heated.

Know this :

Heating leads to expansion and cooling leads to contraction.

Think :

Why do we fill a little less air in a bicycle tube in summer ?

2.Change of Physical state :

You might have seen some substances being heated. What will happen when they are heated ? On heating, solids melt into liquid at a certain temperature and on further heating liquid vaporizes.

This change of a solid substance into liquid substance and then into gases on heating is called **change of state of that substance.**

What changes take place, when the heat in a substance is taken away ? For example, when we place water in refrigerator, it becomes ice.

$$\text{Solid} \underset{-\text{heat}}{\overset{+\text{heat}}{\rightleftharpoons}} \text{Liquid} \underset{-\text{heat}}{\overset{+\text{heat}}{\rightleftharpoons}} \text{Gas}$$

+heat=heat is given
-heat=heat is taken away

It means that for a substance to undergo a change of state, heat must either be given or taken away from it.

Sublimation :

We know that, on heating the solids are converted first into liquid and then into vapour. Similarly, on cooling, the vapours are converted first into liquid and then into solid. But some solids on heating directly change to their vapour state and vice versa without passing through the liquid state.

The change of state from solid to vapour or from vapour to solid without passing through the liquid state is called **sublimation.**

Some solids like camphor, Iodine, Ammonium chloride on heating directly pass on to vapour state without becoming liquid. Such substances are called **sublimates.** When the vapours of a sublimate are cooled they directly get solidified without becoming liquid.

$$\text{Solid} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{Vapour}$$

Experiment :

Take the mixture of naphthalene balls and sodium chloride in an evaporating dish. Cover it with a glass funnel as shown in the figure. Take some cotton and close the other end of the funnel. Heat the dish slowly. When heated, naphthalene balls convert into vapours and the vapours will get collected on the inner side of the funnel. Stop heating. The colourless crystals of naphthalene balls are obtained. Observe the changes that took place in sodium chloride.

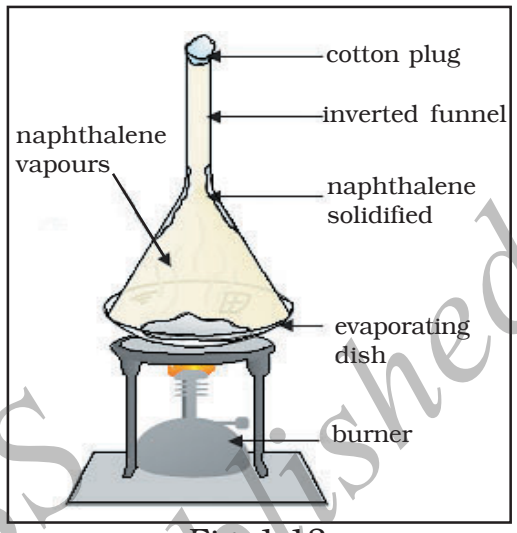


Fig. 1.13
Sublimation

Mass :

Mass is the quantity of matter in a given object or a substance. The mass is measured by using a physical balance or common balance. The SI unit of mass is kilogram (kg).

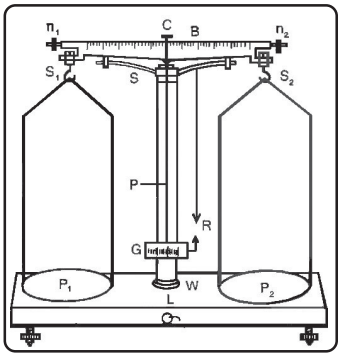


Fig. 1.14
Physical balance

Know this :

1000 mg = 1 g
1000 g = 1 kg
100 kg = 1 quintal
1000 kg = 1 ton

Activity 1.13 : *Find out other types of balances used to measure mass in old and modern times.*

Density :

Consider three different beakers of 25 m*l*. Let the first beaker be empty. (Is it really empty ?) Fill the second beaker with water and the third beaker with iron filings.

Weigh each beaker on the balance. Do all the three beakers show same mass ? If not why ? Each of the beaker shows different mass, because of the total number of particles contained in them. The particles are more densely packed in iron than that of water and air. This is because, density of iron is more than that of water, density of water is more than that of air. With these examples, can you define density ? **Density** is the amount of mass contained in a unit volume. The SI unit of density is kilogram per cubic metre (kg/m^3).

The density depends on two factors -

1. mass of each particle.
2. compactness of arrangement of these particles.

Pressure :

Have you heard of people talking about pressure at a place, pressure cooker etc. what is this pressure? Let us understand it through an activity.

Activity 1.14 : *Take a tumbler containing water. Place a blade horizontally. It floats. Place the same blade perpendicular to the surface of water. See what happens. (Be careful when you handle the blade).*

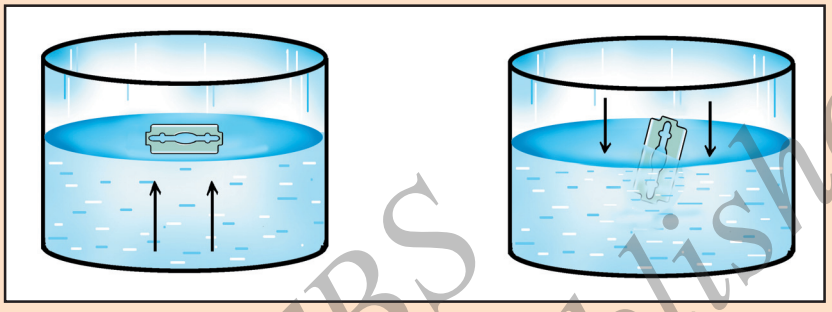


Fig. 1.15

Even thoug the mass of the blade is same it floats in the former case, but sinks in the later case.

When the blade is placed horizontally, its mass is distributed over a wider area. Therefore mass per unit area is less and hence it floats.

When the blade is kept perpendicular to the water layer, it sinks since the mass is distributed over a smaller area. Therefore the consequence depends upon mass per unit area. This is called pressure. ***Pressure*** *is the force exerted on a unit area.*

Think :

Which is heavier, one kg cotton or one kg iron ? The quick answer without thinking is iron. Why do we think so ? In our mind, the concept of density will be operating. In reality, we think about the heavier density object iron. But their masses are same.

Buoyancy :

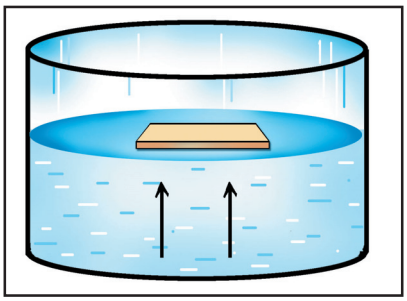


Fig. 1.16

Think :
Generally wood floats on water. Why ?

Activity 1.15 : *Take some water in a beaker and put a few drops of oil on water. Oil drops do not sink but float on water. Why ?*

When an object is immersed in water, it exerts a downward force on water and the water in turn exerts an upward force or upthrust on the objects. The upthrust is equal to the mass of the liquid displaced. It is this upthrust that keeps a body afloat. This upthrust is called the force of buoyancy. The phenomenon is termed as **buoyancy**.

Due to buoyancy, a well practised swimmer can float on the surface of water without swimming.

Metals and Non-Metals :

We make use of many materials in our daily life. Make a list of materials used in the kitchen and in the play field. You might have listed utensils, tennis ball, bat etc. What is the difference among them ?

Apart from classifying matter into solids, liquids and gases, there are other methods of classifying matter. They are elements, compounds and mixtures. Elements are classified into **metals** and **non-metals**. You will study about metals and non-metals in higher classes.

Remember :

- Maharshi Kanada was the first philosopher who has perceived the idea of Kana (particle).
- The atomic theory of matter was first proposed by John Dalton as a concept.
- Matter is any thing which occupies space and has weight.
- Matter is classified into solids, liquids and gases.
- The arrangement of particles in solids, liquids and gases are different.
- Solids have a definite shape and definite volume.
- Liquids have definite volume but not definite shape.
- Gases do not have definite shape and definite volume.
- Matter cannot be destroyed. It exists in one or the other form.
- Solids, liquids and gases will expand on heating.
- Mass is the quantity of matter in a given object or a substance.

- The SI unit of mass is kg.
- Density is the amount of mass contained in a unit volume.
- The SI unit of density is kg/m^3.
- Pressure is the force exerted on an unit area.
- Matter can also be classified into elements, compounds and mixtures.
- Elements are classified into metals and non-metals.

Tips :

- Don't believe that people can destroy matter.
- Don't try to float on water. Inspite of buoyancy you may get drowned in water.

Exercises :

I. Choose the most appropriate answer and put a tick (✓) mark against it :

1. Atomic theory was proposed by
   a. Kanada b. John Dalton
   c. Lavosier d. Berzilius
2. The particles are held tightly in
   a. liquids b. plasma
   c. solids d. gases
3. Liquids have a
   a. definite volume but not definite shape b. definite shape and definite volume
   c. definite volume d. definite shape

4. The quantity of matter in a given object or a substance is called

a. buoyancy b. density

c. pressure d. mass

II. Fill in the blanks with suitable words :

1. The law of conservation of matter is given by the scientist _____
2. SI unit of mass is _____
3. The SI unit of density is _____
4. The elements are classified into _____ and _____

III. Answer the following questions :

1. What is matter ?
2. State the properties of matter.
3. How can you prove that matter occupies space?
4. Name the three forms of matter.
5. How are the particles arranged in solids and liquids ?
6. Gases have no definite shape and volume. Why ?
7. What is sublimation ?
8. State the law of conservation of matter.
9. Define density and pressure.
10. Explain buoyancy ?