Chapter 1

MATTER AROUND US

You may have heard the phrases like 'what is the matter?' "The Matter was closed". Have you ever wondered what this 'matter' is? Meaning of this term is very different for scientists that of from a common man.

We have read about metals, non-metals; synthetic and natural materials, acids and bases etc., in previous classes. These are all examples of 'matter'.

All the things around us which exist in a variety of shapes, sizes and texture are also examples of 'matter'.

The water we drink is a matter. Similarly our food, clothes and various things that we use in our day to day life, the air we breathe, even our body etc., are examples of matter.

In a simple way anything in this world that occupies space and has mass is considered as matter.

States of matter

In previous classes, you learnt that water can exist either as a solid (ice), as a liquid or as a gas (water vapour).

We say that solids, liquids and gases are three different states of matter. Water can be found in all these states.

- Is there any substance which can be found in three states like water?

Now let us look carefully at different objects which we find around us. We can classify most of them, quite easily into one of the three states of matter.

For example, you can say that wood and coal are solids and petrol is a liquid.

Milk also is a liquid like petrol. But the properties of petrol and milk are quite different from each other.

- What are the properties that lead us to consider petrol or milk as liquids?

Let us do some activities to understand the properties of solids, liquids and gases.

Properties of solids, liquids and gases

- Do solids have definite shape and fixed volume?

If we take two solid objects, say a pen and a book, and put them in different containers, do you find any change in their

shape or volume? Imagine dropping a book on the floor. It does not flow but remains rigid with a definite shape, distinct boundaries and a fixed volume. This shows that solids have a definite shape, a fixed volume.

Activity-1

Identifying the shape and volume of liquids

For doing this activity, we need a measuring jar (cylinder) and containers of different shapes as shown in figure 1.

Fig -1 Diffrent shapes of liquid of same volume

Note: It is not compulsory to collect same containers as shown in figure 1. You can collect the containers of different shapes available to you.

You also need some liquids like water oil and milk.

Take some water in one of the container using measuring jar. Examine shape of water in the container. Pour the same water in another container and have a look at the shape, again. Repeat the process till you complete pouring of water in all containers.

- What is the shape of the water in different containers?
- Is it same in all cases?
- What shape does water take if it spill on the floor?

Take 50ml of water with the measuring jar and pour it in glass. Mark the level of water on the glass and throw it out.

Now measure 50 mL of the milk with measuring jar and pour it in the same glass. Mark the level of the milk on it.

- Are the levels of water and milk same?

Remove the milk from the glass. Now pour oil into the glass up to the level marked for water.

- Can you guess volume of oil?

This activity may seem very simple but we observe two important properties of liquids from this activity.

One, the shape of the liquid depends on the shape of the container and second though liquid takes different shapes depending on the shape of the container its volume remains same. Liquids can flow easily from one container to another. They are also called fluids.

- Can you tell, what does a fluid mean?

Look up in a dictionary of science to get its meaning.

So liquids have no fixed shape but have a fixed volume.

Activity-2

Do the gases have a definite shape and a fixed volume ?

You know about CNG (Compressed Natural Gas). Go to a petrol pump and ask them where they store CNG. Also see where CNG is stored in a CNG run vehicle. Lastly see how CNG from the pump is transferred to vehicles.

- Does CNG has a fixed volume?
- Does CNG has a definite shape?

Fig - 2 CNG cylinder in a car

From the observations in the above activity and with our daily life experiences, we can find that CNG and all other gases neither have a fixed shape nor volume.

Fig - 3 CNG gas filling station

Fig - 4 CNG tank at petrol pump

Compressibility

Activity-3

Observing the compressibility of different materials

Take a 100ml syringe.

Draw the piston to suck in air. Place your finger on the nozzle and press. Observe depth of piston moved into syringe. Is it easy or hard to press?

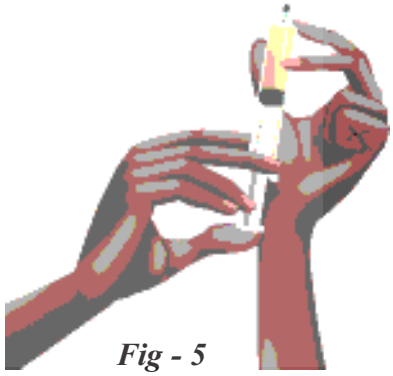

Fig - 5

- Do you find any change in volume of air in the syringe?

Now fill water in the syringe and do the press the piston as said above.

- Is it easier to press the syringe with water or air.

Now take a piece of wood and press it with your thumb.

- What do you observe when you press the wood?
- Is their any change in its volume?

From the above observations, you find that gases are highly compressible as compared to liquids and solids.

In our houses liquefied petroleum gas (LPG) is used for cooking. Nowadays CNG is used in many auotmobiles. In all these purposes, large volume of gas is compressed into cylinders of smaller volume to make it portable.

Think and discuss

- Let us stretch a rubber band. Is there a change in its shape?
- Is it solid or liquid? Why?

(What does happen if the stretching is stopped ? What does happen if the stretching is too much?)

Take some finely powdered salt (not crystals) and keep it in two different jars.

- Which shape does the powdered salt take?
- Can you say salt as a liquid based on change in its shape?

Justify your observations.

Take a sponge. Observe its shape.

- Can you compress it? Is it a soild? Why?
- Why do'nt you able compress a wooden block?

Diffusion

Activity-4

Observing the diffusion of gases

Ask your friend to hold an unlit incense stick and stand in one corner of the room. Then you go and stand in the other corner.

- Can you smell anything?

Now ask your friend to light the incense stick.

- Can you smell anything now?

When you light the incense stick, the scent in the vapour form and smoke mix with air and move across the room to reach our nose.

The movement of air, vapours of scent and smoke is known as **diffusion**. In this case, smoke, vapour of scent and air are highly mobile and are in the form of gases.

If you spray a perfume or deodorant in one corner of the room, it spreads soon to all directions.

- Does the smell from burning incense stick and deodarant spray reach someone on the other end at the same time?

Activity-5

Observing the diffusion of liquids

Take two 250 ml beakers and fill them with water. Use a dropper and put a drop of blue or red ink or $KMnO_4$ solution slowly along the sides of first beaker.

Fig - 6 Diffusion of potassium permanganate in water

- What do you observe after adding the ink drop or $KMnO_4$ drop?

You can observe that liquids also diffuse into each other like gases.

- How much time does it take the colour of ink to spread evenly throughout water?
- What do you conclude from this activity?

Activity-6

Observing the diffusion of particles of solids into liquids

Take a beaker full of water and add a small potassium permanganate crystal to it and observe the changes.

Repeat the experiment with a crystal of copper sulphate.

- Do you observe diffusion?
- Is it faster or slower than that observed in other two activities?

From activities 4, 5, and 6 it is clear that solids and liquids diffuse into liquids and gases diffuse in to gases.

Certain gases from atmosphere particularly oxygen and carbon dioxide, diffuse and dissolve in water. and support the survival of aquatic animals and plants,

Diffusion therefore is a very important process for living things.

Oxygen diffuses from lungs into blood. Carbon dioxide diffuses from blood into lungs.

Solids, liquids and gases diffuse into liquids and rate of diffusion of gases is higher than that of liquids or solids.

Diffusion of two gases

Lab Activity

Aim: To observe the speed of diffusion of two gasses.

Material required: Glass tube with scale, Ammonium Solution, Hydrochloric acid, pieces of cotton and rubber cork.

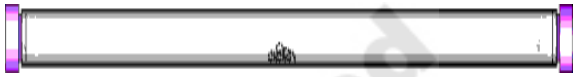

Fig - 7

Note: Teacher should take care of handling hydrochloric acid and prevent the children from touching the acid.

Procedure: Take a 1 m long narrow glass tube.

Take two pieces of cotton wool; soak one in hydrochloric acid solution and another in ammonia solution.

Put them separately at the two ends of the tube. Block the ends of the tube and observe.

The hydrochloric acid gives off hydrogen chloride gas and ammonia solution gives off ammonia gas.

Both gases react together to form a white substance called ammonium chloride.

- Observe where the ammonium chloride is formed in the tube.

Explain.

- How the two gases traveled along the tube?
- Which gas traveled faster?

Do this

So far you have studied some properties that can be used to distinguish between solids, liquids and gases. Fill the table given below based on your knowledge.

Property	Solid	Liquid	Gas
Shape	fixed		
Volume		fixed	
Compressibilty			
Diffusion			

Can matter change its state?

We started our discussion by recalling that water exists in all the three states.

You must have seen many other materials that can exist in different states.

For example, coconut oil is usually liquid. But if it is too cold it becomes solid.

Camphor is a solid but if we leave it in the open air for some time it directly changes to gas.

You may have seen moth (naphthalene) balls being placed in clothes. The smell remains even when they disappear. This is because the solid balls have changed from solid state to gaseous state.

Solids, liquids and gases are states of matter but you need to think about, why are the properties of matter different in different states?

- When does water change into ice and then into vapour?
- Why do gases diffuse faster than solids or liquids?

Scientists have tried to explain these facts by examining the physical nature of matter.

What is matter made up of ?

All matter is made of very tiny particles. This looks as simple statement but it is very difficult to explain and understand about matter.

For this we need more details about these particles and their arrangement inside various forms of matter.

Activity - 8

How small are the particles of a matter?

Take a beaker with water. Mark the level of water. Add 1 or 2 crystals of potassium permanganate and dissolve them in water.

- What does happen to the colour of water?

Now take out approximately 10ml of this solution and add it to 90ml of clear water in another beaker.

- What does happen to the colour of water?

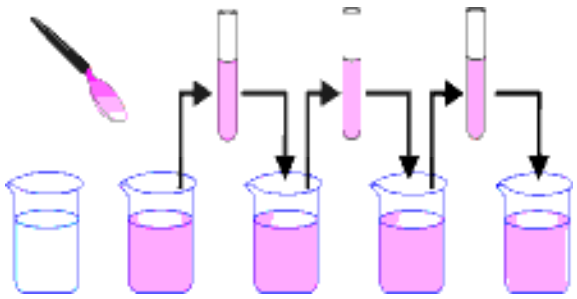

Fig - 8

Again take out 10ml of this solution and add to another 90ml of clear water. Carryout this process 4, 5 times as shown in figure 8 and observe changes in colour of the solution.

- Is the water still coloured?
- How is it possible for two small crystals of potassium permanganate to colour a large volume of water?
- What do understand from this activity?

Repeat the activity by taking a few crystals of copper sulphate instead of potassium permanganate.

Several interesting conclusions can be drawn from the above activity.

We can conclude that there must be several tiny particles in just one crystal of potassium permanganate, which are uniformly distributed in water to change its colour.

Similarly a few crystals of copper sulphate too has several tiny particles which are distributed in large quantity of water to give colour.

So both solid and liquids (including water) are made up of tiny particles.

- How do the particles of the solid distribute in the liquid?

Let us find

Activity - 9

There exists space between particles

Take a beaker and fill it with some water and mark the water level.

Add some salt and stir it thoroughly with a glass rod. Observe if there is any change in water level. Add some more salt and stir it again.

Observe the change in level of water.

Fig - 9

- Does the level of water change?
- What did happen to the salt?
- Can you see it in the water?

From the activities 8 & 9 we can conclude that both solid and liquid particles have some space between them and the solid particles enter in to the space between the liquid particles on dissolving solid in liquid.

Recall the incense stick activity. Do you agree that gas is also made up of particles and they have large space between them.

Particles of matter attract each other

Activity - 10

Observing the force of attraction between the particles of the matter

Open a water tap and allow the water to reach the ground. Now try to break the stream of water with your finger.

- Can you break the stream permanently or momentarily?
- Are you able to break the stream of water any where from the tap to ground?

- What is the reason behind the stream of water remaining together?
- Now try to break a piece of iron nail with your hands.
- Are you able to do it? or Does it rejoin?
- What about a piece of chalk?

From the above observations we can say that particles of the matter have forces acting between them that keeps the particles together.

It is also clear that this force is not equally strong in all the forms of matter.

How diffusion takes place?

We have already carried out several activities to explain diffusion of particles of solids, liquids and gases. Diffusion can be possible only when the particles of matter move continuously.

In the incense stick activity, the particles responsible for scent move and enter the space between the air particles. The scent particles quickly spread across the room.

Particles of solids, liquids and gases can diffuse into liquids and gases. Rate of diffusion of gases is higher than the liquids, while the rate of diffusion of liquids is higher than solids. There are two reasons for higher rate of diffusion of gases. One is due to the higher speed of gas particles and another due to greater space between them.

Similarly the greater diffusion rate in liquids compared to solids is because particles in liquids move freely and have greater space between them when compared to particles of solids.

Observe following diagram which shows the difference in arrangement of particles in solids, liquids and gases.

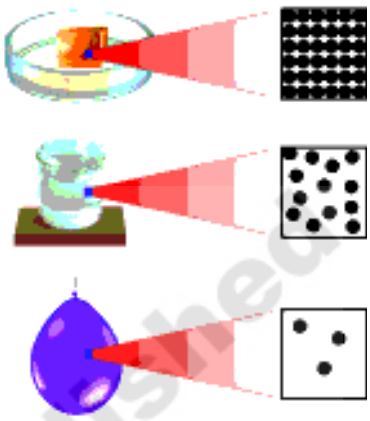

Fig - 10

In a gas the particles are not as close together as in a liquid. If a coloured gas is mixed with a colourless gas, the colour spreads evenly in it. This happens faster in gas than in a liquid, because of large gaps between the partcicles of gas make and fewer particles obstruct in the way of spreading.

You can see the diffusion of bromine when it diffuses through air. Bromine is a brownish coloured gas. Hence its diffusion in colourless air can be seen clearly. If we alow Bromine to diffuse in vaccume, it diffuses faster into vaccume, because there are no particles to obstruct in its way.

Now you understand about matter and states of matter, you also understand that matter is made up of particles. You also understand that it is the characteristics of the particles that decides the properties of matter and states of matter. You may be curious to know:

- What chages do occur inside the matter during a change of state?
- How does this change of state take place?
- What does happen to the particles of matter during a change of state?

Let's try to understand the factors effecting the change of state.

Effect of temperature

Do you guess what happen if water is heated during the diffusion of liquids as in activity 5. You can try it yourself. You find that diffusion becomes faster.

- How does this experience help you to discuss about the effect of temperature on change of states in matter?

Let us find,

Activity-11

Effect of temperature on change of state

Take about 100g of ice in a beaker. Keep the bulb of a laboratory thermometer in contact with the ice. Set up the beaker as shown in the figure 11.

Note the temperature. Heat the beaker slowly. Record the change in temperature after every 30 seconds.

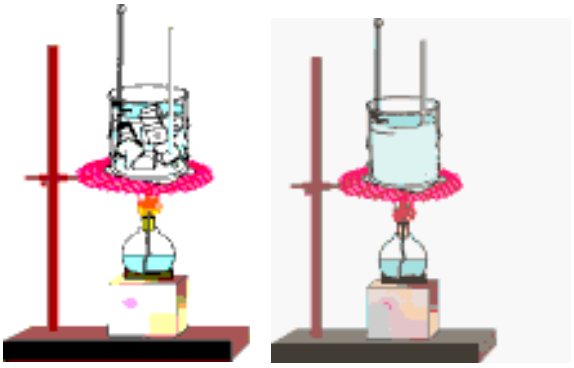

Fig - 11

Let the ice melt completely.

Now place a glass rod in beaker and continue heating till water starts boiling. After sometime all the water will be vaporized.

- Does the temperature change continuously?
- Does the temperature remain constant for a while at any time during the period of heating?
- At what temperature does this happen?
- Did you notice the changes in temperature, at various stages like just start melting, during melting and at completion of melting?

Do you know?

Strange behaviour of water

A liquid usually expands when it is heated but water behaves differently. Between 0°C to 4°C, its volume shrinks. Same amount of water in solid ice occupies more volume than liquid water. Thus density of ice is less than the density of same amount of water. Hence ice floats on water rather than sinking. This is very important for survival of marine life which lives in ponds in the colder areas. In extremely cold weather the water at the top become colder and colder, until it freezes. While the ice floats on the top, the animals Continue to live in the water below, which does not freeze and remains at 4^0C. The ice on the top of the pond insulates water below it and it stops the water from losing the heat to air.

The melting point of ice is 0^OCelcius.

The temperature of the mixture of solid ice and liquid water does not change for sometime when it reaches melting point. The temperature starts changing only when ice completely melts.

On heating the water in the beaker, the particles gain energy. Due to additional heat energy, the particles move more freely by overcoming the force of attraction between the particles.

At a certain temperature the solid melts and changes into liquid. The temperature at which a solid melts to become a liquid is called 'melting point'. The process of changing liquid to solid is known as **'fusion'.**

The melting point of a substance depends on the strength of the force of attraction among the particles.

The higher the force of attraction among the particles the higher will be the melting point.

In above activity, the heat energy absorbed by ice without showing any rise in temperature is used up in changing the state by overcoming the forces of attraction among the particles.

Particles in liquid water at 0^0C have more energy as compared to particles in ice at the same temperature. Because the particles in water absorb heat energy during the process of coversion from ice to liquid water.

The amount of heat energy that is required to overcome the force of attraction among the particles is given by the latent heat of the substance.

Latent heat of fusion is defined as the amount of heat energy required to change 1 kg of a solid, completely into liquid at atmospheric pressure at its melting point.

- What does happen if the heating of water continued?

On supplying heat energy to water particles they start moving faster. At a certain temperature, the particles have enough energy to become free from the forces of attraction among the particles and the liquid starts changing into gas. The temperature at which a liquid starts boiling at the atmospheric pressure is known as its **boiling point**. Boiling point of water is 100^OC.

Particles in water vapour at 100^OC have more energy than the particles in liquid water at the same temperature. This is because particles in water vapour have absorbed additional energy in the form of latent heat of vaporization.

So we can infer that one state of matter can be changed into another state by obsorbing or radiating heat energy.

Now, we have learnt that substances around us change state from solid to liquid and from liquid to gas on supply of heat.

But there are some substances that change directly from solid state to gaseous state and vice versa without passing through the liquid state. We have read about sublimation which is one such change.

Do you know?

We can use another unit called Kelvin to measure temperature. The melting point of ice is 0^OCelcius. 0^0C i.e. 273K. and Boiling point of water is 100^0C (or) 273+100=373K

Effects of change of pressure

We already know that various kinds of states are due to the differences in the distances between the constituent particles.

- What will happen when we apply pressure and compress a gas enclosed in a cylinder?
- Will the particles come closer?
- Do you think that increasing or decreasing the pressure can change the state of matter?
- Can we liquify gases by applying pressure or reducing temperature?

Recall that solid carbon dioxide (from the chapter "Combustion, fuel and flame" of last year) is stored under high pressures.

Solid carbon dioxide converts directly in to gaseous state when the pressure is decreased to 1 atmosphere. Due to this reason solid carbon dioxide is also known as dry ice.

Thus we can say that pressure and temperature determine the state of a substance - whether it will be solid, liquid or gas.

Let us use our understanding of particle nature of matter to explain some day to day observations.

Evaporation

- Do we always need to supply heat or change the pressure for changing the state of matter?
- Can the change of state from liquid to vapour take place without the liquid reaching its boiling point?

You have exerienced drying of wet clothes in air. In this process water directly changes into vapour form without reaching its boiling point.

- Can you give few more examples for this type of change?
- What could be the reasons for this type of changes in states?

The particles of matter irrespective of the state at the given temperatures possess different energies.

For example, in liquids the particles at the surface posses higher energy than particles in the bulk of water. The particles on the surface are able to break away from the force of attraction of other particles and change into vapour state.

This phenomena of change of a liquid into vapours at any temperature below its boiling point is called evaporation.

Activity-12

Effect of surface area, Humidity and wind speed on evaporation

Take 5ml of water in a test tube and in a china dish separately and keep them under the fan. Take 5ml of water in another china dish and keep it in the cupboard.

Record room temperatures and time taken for evaporation of water in all three cases. If possible, repeat the activity on a rainy day and record your observations.

- In which case evoparation is fast?
- What do you infer about the effect of surface area and wind speed on evaporation?

You must have noticed that the rate of evaporation in china dish is faster.

Since evaporation is a surface phenomena, during evoparation process the particles escape from the surface of liquid. The increase in the surface area provides more scope for particles to escape from the surface. Hence, increases the rate of evaporation.

Humidity is another factor that effects evaporation. The amount of water present in air is called humidity.

The air around us cannot hold more than a definite amount of water vapour at a given temperature.

If the amount of water vapour is high in air the rate of evaporation will decrease. So clothes dry slowly during rainy season but fast on a sunny and windy day.

Because of increase in wind speed, water vapour particles move away with the wind, decreasing the amount of water vapour in the surroundings.

Experience with evaporation

- Why do you feel cooler after sweating?

When you get sweat, on working or physical excercise the sweat evaporates from surface of your body by absorbing the heat from your body. The particles of liquid absorb energy required for evaporation from your body and escape to the surroundings. This make you to feel cool.

- Can you give some more examples from daily life where we can feel the effect of evaporation?
- Why do we store water in matkas (earthern pots)?

Discuss these topics with your friends.

Think and discuss

- Why do we wear cotton clothes in summer?
- Why do we see water droplets on outer surface of a glass containing ice - cold water?
- Why do pigs toil in the mud in hot days?

Key words

Matter, states of matter, solid, liquid, gas, particles, diffusion, forces of attraction, evaporation, compressed natural gas, melting point, fusion, boiling point, sublimation, evaporation, latent heat of fusion.

What we have learnt

- Matter is made up of particles
- The particles of matter are very small-they are small beyond our imagination
- Particles of matter have space between them

- Particles of matter move continuously in liquids and gases.
- Matter exists in three states i.e., solid, liquid and gas
- The force of attraction between the particles are maximum in solids, intermediate in liquids and minimum in gases.
- The particles are arranged orderly in the case of solids while particles move randomly. in gasses.
- Diffusion is possible only when particles of matter move continously.
- Rate of diffusion of gases is higher than that of liquids (or) solids.
- The states of matter are not permanent. The state of matter can be changed by changing temperature or pressure.
- Evoparation is a surface phenomenon because particles from the surface gain enough energy to overcome the forces of attraction present in the liquid and change into the vapour state.
- Boiling is a bulk phenomenon because particles of the entire liquid change into vapour state.
- Changes in temperature, surface area and wind speed effect rates of evaporation.
- Humidity is the amount of water vapour present in air.

Improve your learning

1. Describe an activity which provides the evidence for (A,S_1)
   a) the motion of particles
   b) attraction between particles
   c) inter-particle space
2. Name the characteristics of matter that are demonstrated by diffusion.(A,S_1)
3. "When sugar is dissolved in water there is no increase in volume". Is it true or false? Comment on the statement keeping in mind the amount of sugar, amount of water etc.(A,S_1)
4. Is there any change in mass when a substance changes its state? Explain with example.(A,S_1)
5. Do all substances change from solid to liquid and liquid to gas on heating? Explain.(A,S_1)
6. Define the following terms: (A,S_1)
   a) melting point b) boiling point c) evaporation
7. Correct the following statements. (A,S_1)
   a) Water boils at 100°C under atmospheric pressure.

b) a liquid evaporates above its boiling point

c) solids have the largest inter-particle space.

d) gases have the strongest inter-particle forces.

8. Why do we prefer to sip hot tea with a saucer rather than a cup?(A,S_1)

9. When water solidifies to ice then heat is (A,S_1)

a) Liberated

b) Absorbed

c) No change

d) Depending on the condition of heat absorbed or liberated.

10. Convert the following temperatures to the Celsius scale.(A,S_1)

(a) 283k (b) 570k

11. Convert the following temperatures to the Kelvin scale.(A,S_1)

(a) 27^0c (b) 367^0c

12. How can we smell perfume sitting several metres away from the source?(A,S_2)

13. Steam produces more severe burns than boiling water. Think why?(A,S_2)

14. Fill in the blanks.(A,S_1)

a) Temperature does not change while a solid substance is ……..... or a liquid substance is…….

b) A vapour on cooling changes into ….....….and on further cooling changes into….....

c) Matter changes from one state to another either raising the ….....……. or lowering the…..……

d) A change in which a solid on heating directly changes into vapour state is called …….....….

e) The inter particle spaces are.....….in gaseous and.….....….in solids.

15. Match the following.(A,S_1)

a)	conversion of liquid into gas	( )	(i) gas
b)	Non- compressible	( )	(ii) solid
c)	maximum expansion	( )	(iii) particle
d)	constituents of matter	( )	(iv) evaporation

16. How do you appreciate sweating mechanism of human body to control the temperature of the body?(A,S_6)

17. Make a model to explain the structure of particles in solids, liquids and gases.(A,S_5)