

9th – Matter In Our Surroundings I



Introduction:

There are large numbers of things around us which we see and feel. For example, book, glass, pens etc. The space occupied by the book is called its volume. If we pick up the book, it has some mass. Examples of matter include wood, cloth, paper etc. Matter offers resistance by the fact that we cannot displace an object from one place to another without applying force.

Thus matter can be defined as “anything that occupies space, has mass and offers resistance is called matter.”

Substance: is a kind of matter that cannot be separated into other kinds of matter by any physical process. For example, sugar dissolved in water can be separated from water by evaporating the water. Here, sugar is a substance which cannot be broken into its components by any physical process. Similarly, sodium chloride, lime (calcium oxide) are all substances.

Physical nature of Matter

1. Matter is made up of particles

Ancient philosophers held the view that matter is continuous, like a block of wood. But it is not true. Actually, matter is made up of discrete particles.

For example: sugar gets dissolved in water but there is no change in the level of water. This is explained by assuming that matter is not continuous, rather is made up of particles. Sugar contains a large number of separate particles. These particles when dissolved in water occupy the vacant spaces between the particles of water. That is why the water level does not rise. Had sugar been continuous, like a block of wood, the water level in the beaker would have risen.

2. The particles of matter are too small to be imagined

Add some crystals of blue vitriol (copper sulphate) and dissolve them in 100ml of water. The solution will go blue. Keep on adding 100ml of fresh water, repeat this 5 to 8 times. The last solution is till blue though the intensity of the colour has gradually decreased. This indicates that a few crystals of copper sulphate are able to colour an enormously large volume of water. This also shows that a small crystal of copper sulphate contains millions of small particles.

3. The particles of some matter are in constant motion

Put an incense stick (agarbatti) in a corner of the room, you won't get its smell from a distance. Now light the incense stick using a matchstick, you can get the smell even at a certain distance. This can be explained as particles of perfume present in the incense stick freely mixed up with particles of air and have spread across the room. If the particles were not moving, the smell of incense stick would never have reached you.

Diffusion: The particles of matter have a tendency to diffuse, i.e. to intermix on their own with each other. They do so by getting into the spaces between the particles. The intermixing of particles of two different types on their own is called diffusion.

The particles of matter are in state of continuous motion. This suggests that they possess some energy, called the 'kinetic energy'. As the temperature rises, the kinetic energy of the particles increases and hence particles move faster.

4. The particles of matter attract each other

The particles of matter are held together by force acting between them. This force is called 'intermolecular force of attraction'. The strength of intermolecular





force of attraction differs from matter to matter. For example, take a chalk, an iron nail and a brick. You will observe that the chalk stick gets broken to pieces easily, piece of brick breaks but not so easily, but most difficult is to break the iron nail. We can conclude that, particles of iron are held together by the strongest force followed by the piece of brick, whereas the particles of chalk have the weakest force of attraction.

5. The particles of matter have spaces between them

During the dissolution of sugar in water the particles of sugar occupy the empty spaces between the particles of water. The empty space is called 'intermolecular space or intermolecular volume.'

Classification of matter:

- Early Indian and Greek philosophers thought that everything in this world is made up of five elements: air, water, earth, sky, fire. Hence they classified matter as five basic elements 'Panch Tatva'.
- Modern day scientists classify matter on the basis of physical and chemical properties.

1. Physical Classification: On the basis of physical properties, matter has been classified as Solids, Liquid and Gases.

2. Chemical Classification: On the basis of chemical properties, matter has been classified as elements, compounds and mixtures.

The Solid State

In solids, the intermolecular force of attraction being large, the particles of matter come very close and these are very strongly held together. The intermolecular space becomes small. The molecules, therefore, are not free to move from one place to another within the solid.

General Properties of Solids

1. Shape and Volume: A solid has a definite shape and volume. A solid retains its shape and hence the volume of solid is fixed. For example, book, salt and sugar crystals, table etc. As the particles of matter are continuously moving, they possess kinetic energy. Since the movement of particles in a solid is restricted, these particles can only vibrate about their mean position of rest. Hence the kinetic energy of the particles in a solid is much less. Hence, they have a definite shape and volume.

2. Density: density of solid is high. It is defined as mass per unit volume of a substance. $\text{Density} = \frac{\text{mass}}{\text{volume}}$. Due to strong intermolecular force, the particles of a solid are very closely packed together into a small space or volume. That is why the density of a solid is high.

3. Melting point and boiling point: the melting and boiling points of a solid are usually high. A solid remains solid because its melting and boiling points are higher than the room temperature.

4. Compressibility: Solids are incompressible, that is, the volume of a solid cannot be increased or decreased by reducing or increasing pressure upon it. However, a loaf, a piece of bread or a sponge is an exception. It has air spaces within, which makes it easily compressible.

5. Flow: a solid cannot flow. The particles of a solid are so rigidly held that they are not free to slip over one another.

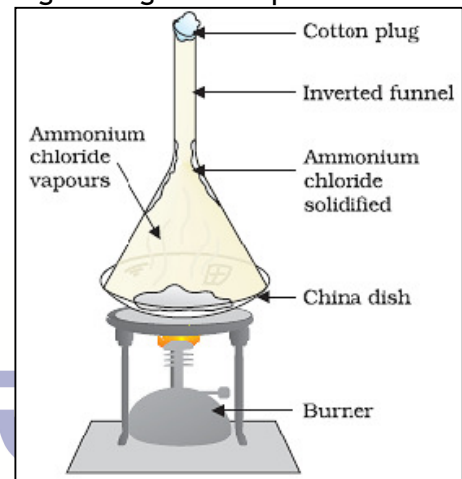




6. **Expansion or contraction:** Solids expand or contract very little on being heated or cooled. The action of heat generally increases the energy of the particles. As these particles become more energized, they vibrate about their mean position of rest more frequently. But, they do not become so energetic as to escape from their mean position. So, the extent of expansion in a solid is small. On cooling, the particles of a solid lose energy and vibrate weakly. But, as the particles do not leave their fixed positions, they do not come closer. This explains why solids contract very little on cooling.

7. **Sublimation:** The process, by which solid changes directly into its vapours without passing through the liquid state, and the vapour changes directly back into the solid in its original form, is known as 'sublimation'. On cooling, the vapours change directly back into the solids without going through the liquid state. The solid obtained as a result of sublimation is called the 'sublimate.' For example: iodine, ammonium chloride, camphor, naphthalene, dry ice etc.

- Take some ammonium chloride in a porcelain dish and cover it with an inverted conical funnel as shown.
- A test tube is inverted on the stem of the funnel. The basin is now heated on a sand bath. Ammonium chloride sublimes off as vapour and gets deposited on the cooler parts of the test tube.
- This method is usually employed to separate a sublimable solid from an un-sublimable one.



8. **Diffusion:** the process by which the particles of a substance may enter spontaneously into another substance. The movement of particles in a solid is restricted; a solid does not have the property of diffusion. If two blocks of copper and zinc are tied together and left undisturbed for a few years, it will be found that blocks have bounded together. This is because the particles of each metal have somewhat penetrated into the other.

Exercise 1

1. Find the density of a handful of sand having a mass of 208gms and it displaces a volume of 80ml of water.
2. What was the basic classification of element in ancient times?
3. A diver is able to cut through water in a swimming pool. Which property of matter does this observation show?
4. The smell of hot sizzling food reaches you several metres away, but to get the smell of cold food, you have to go close. Give reasons.
5. Rubber band changes its shape. Is it solid?

The Liquid State

In liquids, the intermolecular force of attraction being weak, the particles of matter are less strongly held together. The intermolecular space, on the other hand is large. Therefore, the particles have more freedom of movement. But the intermolecular force is not so weak as to allow the particles to leave the surface of a liquid.





General Properties of Solids

1. Shape and Volume: A liquid has no definite shape and volume. A liquid takes the shape of the vessel in which it is kept. This is because particles of a liquid can slip over one another and finally settle down to take the shape of vessel. Since the particles cannot come closer to or go farther away from one another, the volume of the liquid does not change.
2. Density: the density of liquids is lower than that of solids.
3. Compressibility: liquids can be compressed only to a small extent, that is, they are almost incompressible. However, they have a slightly higher compressibility than solids. This is because the intermolecular space in liquids is somewhat greater than that in solids.
4. Melting point and boiling point: The melting and boiling points of liquids are generally lower as compared to those of solids.
5. Fluidity: liquid has the property to flow. If water is spilled on the floor, it begins to spread out and its shape changes. But, its volume remains the same. A liquid can flow because its particles have higher kinetic energy than that of solids
6. Diffusion: Since liquids have fluidity, they have the property of intermixing. The two beakers filled with water. Add a drop of ink in one beaker and a drop of honey in other. You will observe that ink in the beaker spreads out immediately, while honey goes down leaving behind a streak along the side of the beaker. Since density of honey is greater than that of ink it diffuses into water at a slower rate than does the ink.
 - Now take two beakers, one with hot water and other with cold water. Add a crystal of blue vitriol (copper sulphate) to each. Hot water becomes blue shortly, while cold water takes much more time to become blue. This shows that the rate of diffusion of solid particles into liquid is higher at a high temperature. The rate of diffusion increases on raising the temperature.
 - As air is a mixture of gases like nitrogen, carbon dioxide and other gases. These gases dissolve in water by the process of diffusion. The oxygen and carbon dioxide dissolved in water are taken up by the aquatic animals and plants for their survival.
7. Freezing: it means transformation of a liquid into its solid state i.e. solidification of a liquid is called freezing. For example, when water is cooled to 0° C, it is converted to ice. The temperature at which freezing of a liquid occurs is called its freezing point. The presence of impurities lowers the freezing point of the liquid.
8. Evaporation: conversion of a liquid into its vapour either by exposing the liquid to air at the room temperature or by heating it below its boiling point is called 'evaporation.' For example: take common salt or sodium chloride in a porcelain dish and place it on water bath. After some time, the water from the porcelain basin has evaporated, leaving behind sodium chloride as residue.

Explanation for the process of evaporation: As the particles of liquid are constantly moving, they collide with each other. They also collide with particles of air when left exposed. In doing so, some of the particles at the surface of the liquid acquire extra energy and overcome the intermolecular forces of attraction that pull them back and keep them with the bulk of the liquid. These highly energetic particles leave the surface and go into vapour.

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Factors affecting evaporation:

- Nature of liquid: lower the boiling point of a liquid, higher is its rate of evaporation. For example, boiling point of water is 100°C and that of ether is 34°C. Hence, ether evaporates much faster than water.
- Temperature of liquid: higher the temperature of a liquid, higher is its rate of evaporation. This is because the speed of particles is increased at a higher temperature
- Surface area of the liquid: larger the surface area, higher is its rate of evaporation. A large surface area provides more energy for particles to go out for evaporation. That is why unfolded clothes dry faster than a folded one.
- Wind velocity: in an airy place the rate of evaporation of liquid is faster. The wind carries away the particles of vapour more rapidly.
- Humidity: the amount of water vapour present in air is called humidity. In humid air very little evaporation takes place, while in dry air rapid evaporation occurs. So, wet clothes take longer time to dry in humid air, but they dry faster in dry air.

Evaporation causes cooling: when the surface particles take up energy and escape into air as gas. This results in fall of temperature of liquid. The liquid is thus cooled.

- Fill an earthen pitcher with water and note the temperature. Now cover it with lid and keep for 3 to 4 hours and now note the temperature. The temperature has fallen i.e. water in the pitcher has become colder. The fine pores in the pitcher allow water particles to come on the outer surface from where the particles escape into air. The heat for evaporation comes from bulk of water in the pitcher. This makes the water colder.
- Place a few drops of spirit on your palm. You will feel cold. This is because heat required for evaporation is drawn from your palm.
- During summers we perspire profusely. The sweat draws heat from our body and evaporates away. This makes us feel cool. Cotton, being a good absorber of water, absorbs sweat and exposes it to air. This is why we prefer to wear cotton clothes in summer.

9. Boiling and boiling point: When a liquid is heated, their vapour gradually increases. When the vapour pressure equals atmospheric pressure, the liquid begins to boil. The temperature at which boiling occurs is called the 'boiling point of the liquid.' The boiling of the liquid occurs throughout the mass of the liquid with bubbles coming out from its interior.

Effect of pressure on boiling point: higher the pressure, higher is the boiling point and vice versa. As we go up in the air, the pressure of the atmosphere decreases and the boiling point of a liquid also decreases. Hence, we need more time and heat to cook at high altitudes.

Effect of impurity on boiling point: the term 'impurity' means any foreign substance added to a pure liquid. The presence of non-volatile substance as an impurity in the liquid raises the boiling point of the liquid.

Difference between evaporation and boiling

S no.	Evaporation	Boiling
1.	It is a spontaneous process occurring at all temperatures	It occurs at a particular temperature, called the boiling point

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2.	It occurs only at the surface of the liquid.	It occurs throughout the mass of the liquid with the formation of bubbles.
3.	It causes cooling effect.	It does not produce cooling effect.

Worksheet

1. How are aquatic plants and animals able to survive underwater?
2. Liquids generally have lower density as compared to solids. But you must have observed that ice floats on water. Give reasons.
3. Define density. Arrange the following matters in increasing order of their densities: air, wood, a plastic chair, honey, water, cotton, alcohol and iron.
4. Name the state of matter containing super energetic and super excited particles.
5. How does the water kept in earthen pot become cool during summers?
6. What makes the sun and the stars glow?
7. What type of clothes should we wear in summers?
8. Why boiling called a bulk phenomenon?
9. What happens to the melting point of ice when pressure is increased?
10. Why perspiration keeps our body cool?
11. Comment on the following:
 1. Evaporation causes cooling
 2. Rate of evaporation of an aqueous solution decreases with increases in humidity.
 3. Sponge through compressible is a solid. Give reasons
12. Draw a well labeled diagram to show sublimation of ammonium chloride.

