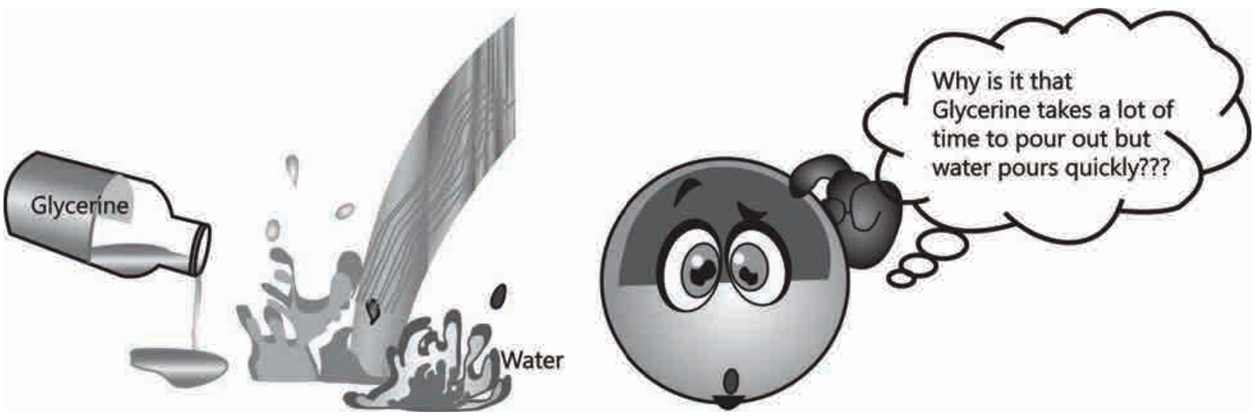
1. MATTER IN OUR SURROUNDING

The "Viscous" Story...



This Chapter has been done in an Illustration-Activity format, so that it highlights the boring facts and makes them interesting.

1. Introduction

Early Indian philosophers and ancient Greek philosophers classified matter in the form of five basic elements "Panch Tatva" – air, earth, fire, sky and water. All living and non living things are made of these five basic elements.

In our surroundings, we see a large variety of things with different shapes, size and textures. Everything in this universe is made up of material which scientists have named "Matter", for example air, food, stones, clouds, stars, plants and animals, even a small drop of water or a sand particle are matter. The perception of joy, love, hate, thought, cold, hot, pain does not constitute matter while we perceive.

Definition:

Material: In general material can be a matter from which a thing can be made The term used to describe a particular kind of matter, is called material e.g. – wood, water and marble.

2. Types of Material

Homogeneous Material	Heterogeneous Material
Which has same composition and same properties is called Homogeneous material. For e.g. – salt and water solution.	Which has different composition and different properties in material is called heterogeneous material. For e.g. – In marble, presence of grey and redgrains of other materials.

Matter: Anything which occupies space and has mass is called matter, so everything in the universe is "matter".

It can also be defined as anything that has volume and mass can be referred as Matter.

Some examples of matter are water, air, metals, plants, animals etc. The matter can be classified into different categories depending upon its physical or chemical nature.

(a) Depending on its physical state matter is categorized as a gas, a liquid and a solid For e.g. – air, water and the earth.

Changes of state are also matters of everyday experience for example, ice melts and water freezes, water changes into steam on heating and steam condenses to liquid water on cooling.

(b) Matter is classified as an element, compound or mixture depending upon its chemical nature. Elements and compounds are pure substances whereas a mixture contains two or more pure substances.

3. Physical Nature of Matter

(1) Matter is made up of particles: This can be demonstrated by a simple activity :

(a) In a 100 ml beaker take about 50 ml water.

(b) Mark the level of water.

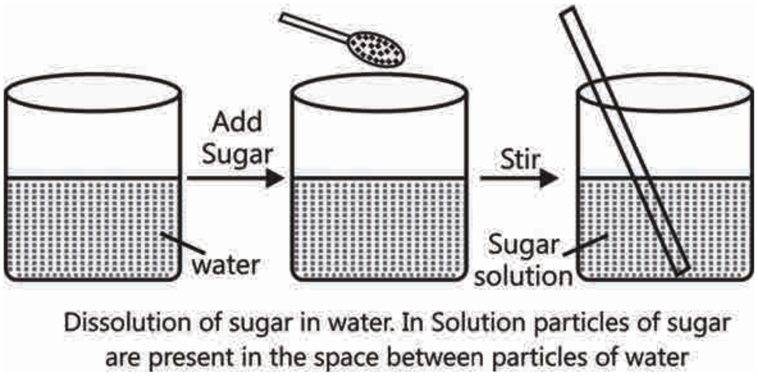


Figure 1.1: Illustration of particle nature of matter

(c) Add some sugar to the beaker and stir with the help of a glass rod.

(d) Observe the change in water level.

Conclusion: The sugar gets dissolved in water but there is no remarkable change in water level**.** These observations can be explained by assuming that matter is made up of small particles. On dissolution, the particles of sugar get distributed into the spaces between particles of water.

(2) The constituent particles of matter are extremely small in size: The following activity demonstrates that the constituent particles of matter are very small.

(i) Add 100 ml water to a 250 ml beaker.

(ii) Now add 2-3 crystals of potassium permanganate ($KMnO_4$) and stir with a glass rod in order to dissolve the crystals.

(iii) From this solution take out 10 ml and add to another beaker dilute this solution by adding 100 ml of water.

(iv) Take 10 ml of this diluted solution and put into 100 ml of water taken in another beaker.

(v) Repeat this process 10 times observe the colour of the solution in the last beaker.

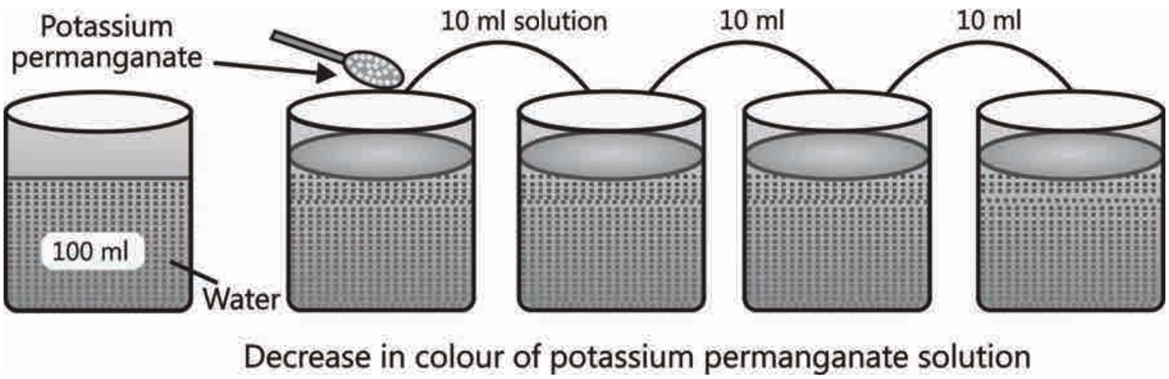


Figure 1.2: Demonstration of size of particles of matter

Conclusion:

(i) It is observed that the solution in the last beaker is still coloured but the intensity of colour becomes light. It indicates that potassium permanganate ($KMnO_4$) crystal contains millions of tiny particles, some of which are still present even in the last beaker after so much dilution.

(ii) This experiment can be done by copper sulphate $CuSO_4{\cdot}5H_2O$ crystals (for colours).

(iii) Dettol (for smell)

3.1 Characteristics of Particles of Matter

(i) Particles of matter have space between them:

Activity: When sugar is dissolved in water, the volume of the liquid remains unchanged. During dissolution, the particles of sugar get into the spaces between the particles of water. As a result, they get evenly distributed and there is no noticeable change in volume, similarly, when potassium permanganate is dissolved in water, its particle get evenly distributed throughout the bulk of water. This is indicated by uniform colour of the solution. This indicates that there are spaces between particles of matter. The particles of potassium permanganate get uniformly distributed in the spaces between water molecules.

Similarly when we prepare tea, coffee or lemonade (nimbu pani) we observe that particles of one type of matter get into the spaces between particles of other.

(ii) Particles of matter are continuously moving:

(a) Activity: If an incense stick (Agarbatti) is lighted and placed in one corner of a room, its pleasant smell spreads in the whole room quickly. This activity demonstrates that the particles of matter are in continuous motion. A burning incense stick produces some gases (vapour) having pleasant smell. The particles of these gases due to motion spread in the entire room and their presence can be felt by sensing the smell.

(b) Activity: To demonstrate that the kinetic energy of particles increases with increase in temperature.

(i) Take two beakers. To one beaker add 100 ml of cold water and to the other beaker add 100 ml of hot water.

(ii) Now add a crystal of potassium permanganate to both the beakers.

Conclusion: It is observed that after sometime both the solution becomes purple. The rate of mixing is faster in case of hot water. This experiment confirms that the particle of matter possess motion and that the kinetic energy of the particles increases with increase in temperature.

From these activities, we can conclude that when two different forms of matter are brought in contact, they intermix spontaneously. This intermixing is possible due to motion of the particles of matter and also due to the spaces between them. The intermixing takes place due to movement of particles of one form into the spaces between the particles of the other form of matter.

How do we define Kinetic energy? Kinetic energy is energy of motion and is usually defined as the work that will be done by the body possessing the energy when it is brought to rest. For a body of mass m having a speed v, the kinetic energy is $= \frac{1}{2}mv^2$

Diffusion:"This spontaneous intermixing of particles of two different types of matter is called diffusion".

The rate of diffusion becomes faster with increase in temperature because at higher temperature, the particles have more energy and hence move faster.

(iii) Particles of matter attract each other: There are some forces of attraction between the particles of matter which bind them together. ”The force of attraction existing between the particles of the same substance is known as cohesion”. The force of attraction (or cohesion) is different in the particles of different kinds of matter.

The following activity may be carried out to demonstrate the attractive forces between particles of matter.

Activity: Take a piece of iron wire, a piece of chalk and a rubber band. Try to break them by hammering, cutting or stretching**.**

Observation: It is observed that the piece of iron wire is most difficult to break. This indicates that particles in iron wire are held by stronger force of attraction as compared to particles in piece of chalk or rubber band.

Conclusion: Since energy is required to break crystals of matter into particles. It demonstrates that particles in matter are held together by some force of attraction, the strength of these attractive forces varies from one matter to another.

Illustration 1: We can get the smell of perfume sitting several meters away, why?

Sol: This is because constituents of perfumes are mainly volatile in nature. This volatile constituent carries pleasant smelling vapours. They diffuse quite fast and can reach to people sitting several meters away.

Illustration 2: Why can you smell the perfume of incense stick?

Sol: The particles of the perfume (matter) are not stationary, but are continuously moving. They drift through the air and hence we can smell the perfume.

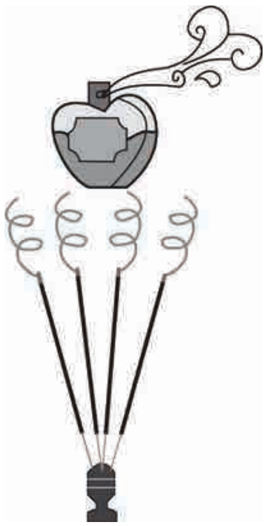


Illustration 3: Why cannot you smell of perfume at a short distance when incense stick is not lighted?

Sol: The particles of the perfume do not have sufficient energy to drift through the air. When they are lightned that time they gain energy from temperature. Thus we cannot smell it.

Illustration 4: Why is the smell of the perfume of incense stick filled the whole room in few minutes, when lighted?

Sol: When the incense stick is lighted, the heat energy makes the particles of the perfume to move rapidly. Thus, they easily drift through the air in the room and hence we can smell it everywhere in the room.

3.2 States of Matter

Their are infinite states of matter and there is no thick line between any state of matter but matter can be broadly classified into 3 states on the basis of physical state-solids, liquids and gases.

Properties of solids:

3.2.1 Solid State

- **(a)** They possesses a fixed volume and a definite shape, distinct boundaries and a definite mass.
- **(b)** Rigid and almost incompressible.
- **(c)** Solids may break under force but it is difficult to change their shape.
- **(d)** Possess high densities.
- **(e)** Solids do not exhibit diffusion.
- **(f)** In solids, intermolecular forces of attraction is more strong.

Example – Table, chair, common salt, silver, ice, diamond, stone, sugar etc.

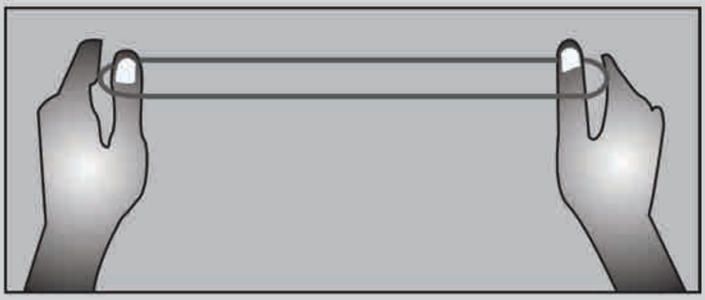
Example of solid state:

- **(i)** A wooden block should be called a solid.

Explanation – A wooden block has a fixed shape and is rigid. Hence, it should be called solid.

PLANCESS CONCEPTS

A rubber band is a solid?



A rubber band is called a solid because although it undergoes a change in shape on stretching yet it regains the same shape when the force is removed.

Figure 1.3: Elasticity of rubber

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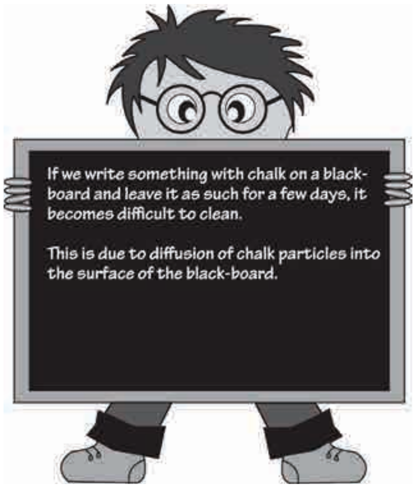

Solids generally do not exhibit diffusion: Due to smaller interparticle spaces and absence of translatory motion.

Some example in solids which show diffusion –

If two metal blocks are bound tightly together and left undisturbed for a long time, it is observed that some particles of one metal diffuse into the surface of the other metal.

Illustration 5: A rubber band is a solid, but it can change its shape. Why?

Sol: Because it regains its shape when the stretching force is removed from it.

Illustration 6: When salt or sugar are poured into different kinds of vessels, why do they take the shape of vessel?

Sol: Salt or sugar takes the shape of containing vessel, but does not change its individual shape. For example, sugar crystal are cubical and they remain cubical in any vessel.

PLANCESS CONCEPTS

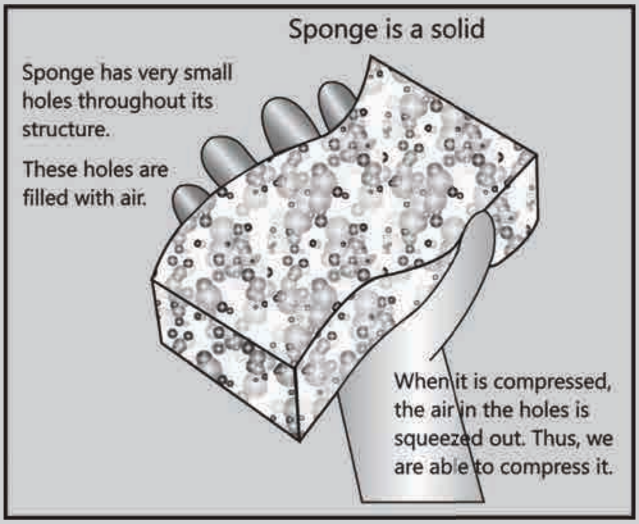

Figure 1.4: Compression of sponge

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3.2.2 Liquid State

Properties of Liquids:

(a) The matter in liquid state possesses a definite volume and mass, but no definite shape.

(b) Liquids are also almost incompressible but are not rigid. In fact, they can flow from a higher to a lower level. Liquids have a property of fluidity and acquire the shape of the container in which they are kept.

(c) Liquids can undergo diffusion.

(d) Liquids also have high densities but less than that of solids.

(e) In liquids, intermolecular forces of attraction is weaker than solid.

Examples: Water, alcohol, milk, diesel, petrol, kerosene oil, vegetable oil, fruit juices etc.

Solids, liquids as well as gases can diffuse into liquids. This is due to the fact that the interparticle spaces in liquids are larger and the particles in liquid state move freely.

Illustration 7: Arrange the following substances in the increasing order of forces of attraction between the particles – water, sugar and oxygen.

Sol: Oxygen, water and sugar.

Illustration 8: What is the physical state of water at:

(a) 25°C (b) 0°C (c) 100°C

Sol:

At 25°C,	Water is in liquid state.
At 0°C	Water can be in both states liquid or solid depending on the latent heat.
At 100°C	Water is in gaseous state, provided heat is supplied to it.

Illustration 9: Give two reasons to justify.

(a) Water at room temperature is a liquid.

(b) An iron almirah is solid at room temperature.

Sol: **(a)** At room temperature the attractive forces or Intermolecular forces are less and intermolecular spaces and kinetic energy is more. Thus, the molecules of water can interchange their spaces and hence water is in liquid state at room temperature.

(b) Intermolecular forces are very large and also intermolecular spaces, as well as, kinetic energy are very small. Thus, the molecules are held very, very tightly, with the result, the iron almirah has a definite shape and definite volume, and hence, is a solid.

Activity: To study diffusion of two different liquids in water.

Method: Take a dropper and fill it with red or blue-black ink. Allow one drop of the ink to trickle into the first beaker by allowing it to fall on the upper inner side of the beaker. Cover the beaker with a led and leave it undisturbed for 4 hours. Make observations after every 15 minutes and record them.

In the second beaker, add a drop of honey by the side of beaker and make observations as stated above and record them. Now try to answer the following questions.

Illustration 10: State your observation immediately after adding the blue ink drop.

Sol: The blue colour of the ink starts diffusing in water, which appears like wavy blue streaks in water.

Illustration 11: State your observation immediately after adding the honey drop.

Sol: There is no visible diffusion seen.

Illustration 12: How much time does it take for the colour of ink to spread evenly?

Sol: About two hours.

Illustration 13: How does the diffusion of honey varies with the diffusion of ink and why?

Sol: Rate of diffusion of honey is low as compared to ink. It is because the honey is a dense liquid. Its particles have strong intermolecular forces as compared to water. Thus, it diffuses slowly in water.

Example:

(i) Add few crystals of sugar to water they intermix (dissolve) with water spontaneously.

(ii) When we add few drops of ink to water, the colour of the ink gets dispersed evenly in the entire liquid.

The gases also diffuse into liquids –

Some of the examples are given below

(i) Aqueous solution of ammonia contains ammonia diffused in water.

(ii) The gases from the atmosphere diffuse and dissolve in water especially O_2, CO_2 are essential for the survival of aquatic animals and plants.

(iii) The fish and other aquatic animals can utilize the dissolved oxygen for producing energy from food.

Activity: To study diffusion of solid in, (a) water at room temperature, (b) boiling hot water.

Method: Fill one beaker with tap water at room temperature and the other beaker with boiling hot water. Drop one crystal of potassium permanganate in cold water and the other crystal in boiling hot water. Record your observations in both beakers for half an hour answer the following questions.

Illustration 14: What happens around each crystal of solid on introducing in water?

Sol: Dense and deep violet colour is formed around each crystal. However, the size of deep violet colour in hot water is larger than in the cold water.

Illustration 15: What happens as the time passes, and why?

Sol: In case of cold water:

Diffusion starts slowly into cold water in form of coloured streaks. .

Gradually, the solution becomes pink, which is darker near the base of the beaker.

In case of hot water:

The dense violet colour rapidly diffuses to form pink colour, which is more homogeneous as compared to the cold water.

Illustration 16: Does the rate of diffusion change with temperature? If so, why?

Sol:

1. The rate of diffusion increases with the temperature.
2. It is because the at higher temperature, the molecules possess more kinetic energy and there are larger intermolecular spaces.
3. Thus, the particles of solid potassium permanganate rapidly diffuse and hence, rate of diffusion increases.
4. As temperature increases ,kinetic energy increases ,initermolecular forces decreases and rate of diffusion increases.

Activity: To study diffusion of gases in water.

Method: Place the wire gauze over tripod stand and then the beaker containing water. Heat the beaker by a spirit lamp or a Bunsen burner on low flame. Do not allow the water to boil. Make your observations as the water is being heated and answer the following questions.

Illustration 17: What do you observe on the sides of glass beaker?

Sol: Tiny bubbles of gas appears on the sides of beaker.

Illustration 18: Give an explanation to your above observation.

Sol:

1. The tiny bubbles are due to dissolved gases present in the water(Carbon dioxide and oxygen)
2. These gases are expelled out when water is warmed.
3. The gases like oxygen and carbon dioxide diffuse and hence dissolve in water.
4. The dissolved oxygen in water is essential for the respiration of water animals.
5. The dissolved carbon dioxide helps the water plant to synthesise their food by the process of photosynthesis.

3.2.3 Gaseous State, Properties of Gases:

(a) The matter in gaseous state has neither definite volume nor definite shape but it has definite mass. It acquires the shape and volume of the container.

(b) Gases are highly compressible.

Activity: To show the gases are far more compressible as compared to liquids.

Method: Take a syringe. Fill half of the syringe with water. Close the nozzle of the syringe with the help of a rubber cork. Push the plunger inward with maximum force and record your observation. Now stop applying the force and again record your observations.

Take another syringe and fill half of the syringe with air by drawing its plunger outward. Close the nozzle of syringe with the help of rubber cork.Push the plunger inward with maximum force and record your observations. Now stop applying the force and again record your observation.

ANSWER TO THE "VISCOUS" STORY

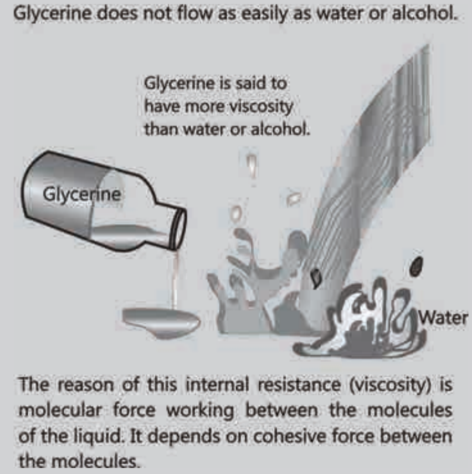

Figure 1.5: Viscosity of liquid

Now let us answer the following questions (19-21) based on the above activity:

Illustration 19: What do you observe when force is applied and then removed on the plunger of the syringe containing water? Give a reason for your answer.

Sol: **Observation:**

1) The plunger does not move inward on the application of force.
2) When the force is removed, the plunger does not move backward.

Reason: Liquids have small intermolecular spaces Thus, they cannot be compressed.

Illustration 20: What do you observe when force is applied and then removed on the plunger of the syringe containing air? Give a reason for your answer.

Sol: **Observation:**

1) The plunger moves downward on the application of force to a considerable length.
2) When the force is removed, the plunger moves backward and takes its original position.

Reason:

(i) The gases have large intermolecular spaces. Thus, they easily get compressed on the application of force.

(ii) The compressed gases are under high pressure. When the force is removed, this high pressure forces the plunger back to its original position.

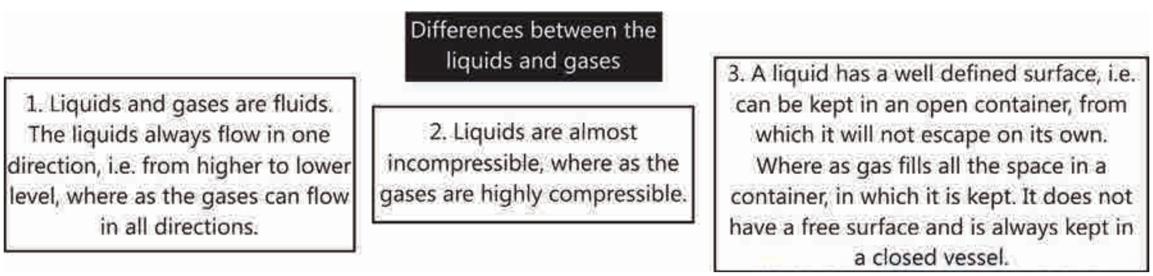

Illustration 21: Give reasons

(a) A gas fills completely the vessel, in which it is kept.

Sol:

1. The gas molecules have large intermolecular spaces and high kinetic energy, but intermolecular force of attraction is very small.
2. Thus, the gas molecule spread in the entire space of the vessel on account of high kinetic energy and practically zero or low intermolecular forces, hence fill entire space of the vessel.

(b) A gas exerts pressure on the walls of the container.

Sol:

1. Gas molecules have very large kinetic energy.
2. Due to high kinetic energy they collide with each other and with the walls of the vessel.
3. When these molecules strike against the walls of vessel, they exert certain average force per unit area.
4. As Pressure = Force/unit area
5. Therefore, the gases exert pressure on the sides of the containing vessel.

(c) A wooden table should be called a solid.

Sol: As we know the definition and characteristics of solid, Solids are rigid, incompressible and have definite shape and volume. Since the table has all the above mentioned properties, therefore, it is solid.

PLANCESS CONCEPTS

We can easily move our hand in air, but to do the same through a solid block of wood, we need a karate expert.

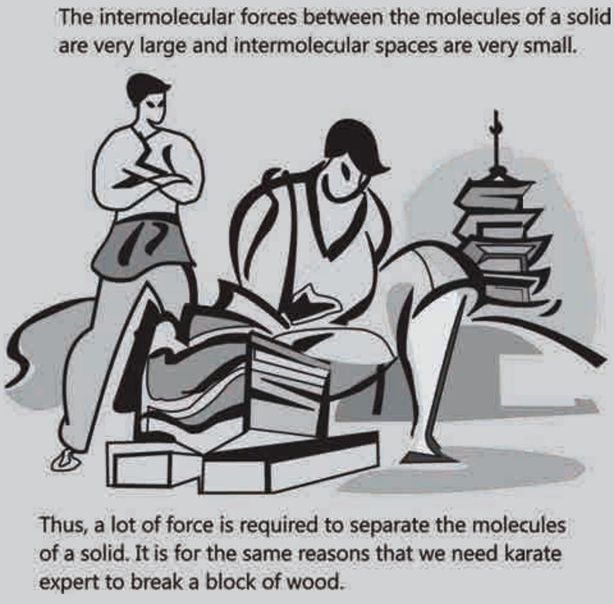

Figure 1.6: Intermolecular force of attraction in solid molecule

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Illustration 22: The mass per unit volume of a substance is called density, (Density = Mass / Volume). Arrange the following in the order of increasing density:

Air, exhaust from chimneys, honey, water, chalk, cotton and iron.

Sol: Exhaust from chimneys, air, cotton, water, honey and iron.

e.g.

(i) CNG (compressed Natural gas) is used as fuel in internal combustion engines.

(ii) Oxygen in compressed form is supplied to hospitals for serious patients in cylinders.

(iii) LPG (Liquefied petroleum gas) which is used in home for cooking.

Examples of diffusion in gases

(i) Aroma of Perfumes -The smell (aroma) of perfumes of anything is mixed with the particles of air and reaches in seconds to very much distance.

(ii) Smell of ammonia-It is commonly observed that if a bottle of ammonia is opened in one corner of the laboratory, its smell can be felt in the other corner of the laboratory after some time.

(iii) Smell of Hot Food- The smell of hot sizzling food reaches you several metres away, but to get the smell from cold food you have to go close.

The rate of diffusion is faster at higher temperature than at lower temperature. As the temperature increases rate diffusion process increases. Thus the rate of diffusion of hot sizzling food is more and hence reaches you even several metres away. On the other hand, rate of diffusion of cold food is less and therefore, you have to go quite close to it in order to get its smell.

(d) Gases exert pressure on the walls of the container in which they are stored.

(e) Gases can flow easily in all directions.

(f) Gases have very low densities as compared to solids and liquids

Example of gaseous state :– (i) Air, (ii) Hydrogen (H_2), (iii) Carbon dioxide (CO_2), (iv) Hydrogen sulphide (H_2S), (v) Ammonia (NH_3), (vi) Oxygen (O_2), (vii) Nitrogen (N_2) etc.

3.3 Study of Compressibility of Gases and Liquids

Activity

(i) Take three 100 ml syringes and close their nozzles with the help of rubber cork. Remove the pistons from all the syringes.

(ii) Fill the first syringe with chalk pieces, second with water and leave third syringe as such since it already contains air.

(iii) Now insert the pistons back into the syringes.

(iv) Compress all the syringes by pushing the pistons.

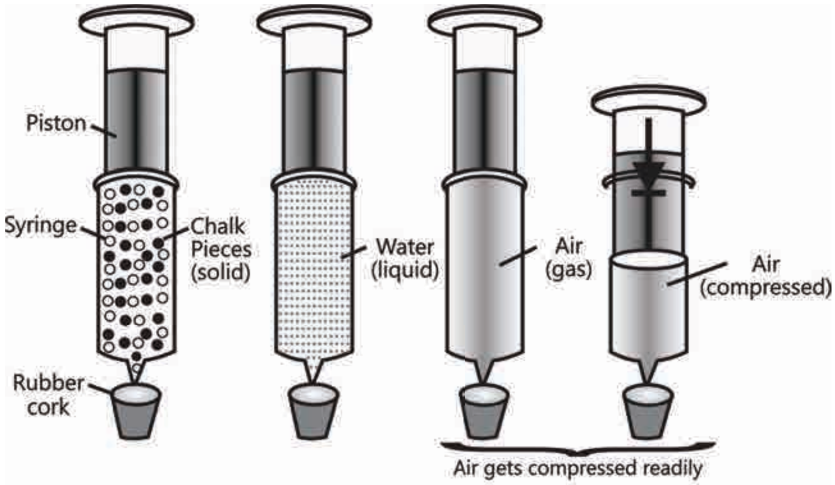

Figure 1.7: Experiment to study the compressibility of solid, liquid and gas

Observation- It is observed that

Extent of compression is in the order

First syringe<Second Syringe<Third Syringe.

When the third syringe is compressed by applying pressure, the piston can move downward easily and it can be compressed to a larger extent. The second syringe (containing water-Liquid) is not compressed easily and it can be compressed to much lesser extent than that of air. The first syringe (containing chalk pieces -solid) is compressed with most difficulty.

3.3.1 Explanation of Solid, Liquid and Gas State on the Basis of Molecular Structure

Table 1.1: Molecular structure of solid, liquid and gas

Solids	Liquids	Gas
(i) The intermolecular spaces are very small and intermolecular forces are very large.	(i) The intermolecular spaces are some what large and intermolecular forces fairly small as compared to the solids.	(i) The intermolecular spaces are 1000 times or more than the liquids. Intermolecular forces are very low.
(ii) The molecules in a solid can vibrate about their mean positions, but cannot change their positions.	(ii) The molecules of the liquid have large kinetic energy.	(ii) This in turn weakens the intermolecular forces to almost negligible magnitude.
(iii) It is on account of this molecular arrangement, that solids have definite shape and definite volume.	(iii) It is on account of the larger kinetic energy and large intermolecular spaces that the molecules can interchange their position.	(iii) The molecules of a gas are free to move about in any direction.