MATTER IN OUR SURRROUNDINGS

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.

Matter may be defined as anything that occupies space, possesses mass and presence of which can be felt by any one or more of our five senses (i.e. sight, smell, taste, touch and hearing).

§§ PHYSICAL NATURE OF MATTER :

¶¶ Particle Nature of Matter – Matter is made up of particles :

To show the particle nature of matter, we perform the following experiment :

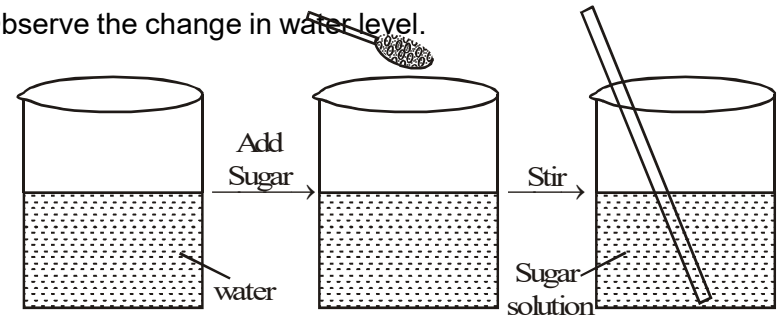
Experiment :

(a) Take about 50 ml water in 100 ml beaker.

(b) Mark the level of water.

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

(d) Observe the change in water level.



Dissolution of sugar in water. In solution particles of sugar are present in the spaces between particles of water

Figure 1

Observation and explanation: The sugar dissolves in water and there is no noticeable change in the level of water. This is because, there are some spaces in between the particles of water, which are occupied by sugar particles (when sugar dissolves in water) and thus the level of water does not rise.

When salt dissolves in water, the particles of salt get into the spaces between the particles of water and the level of solution does not rise

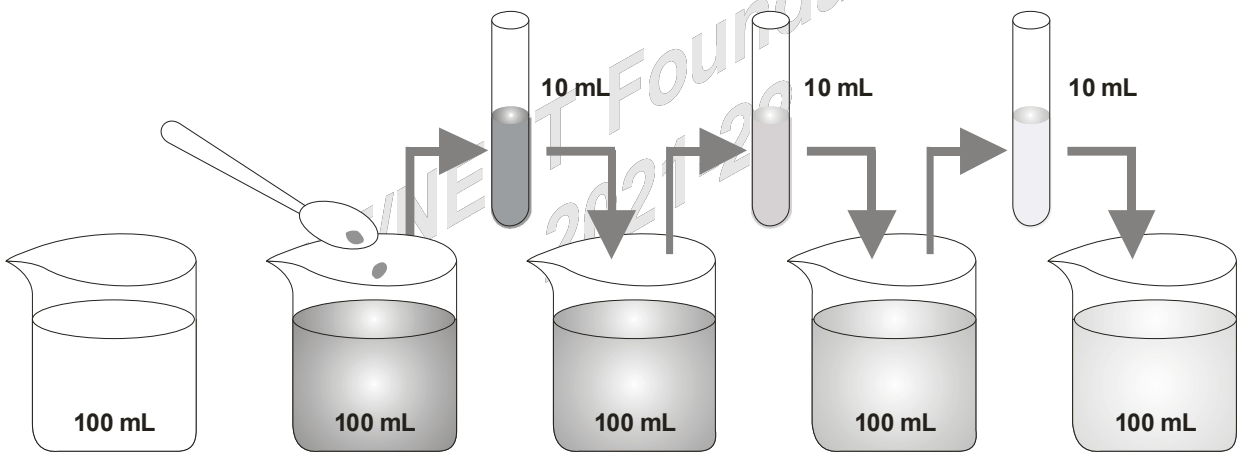
Conclusion : From above experiment, we led to conclude that, there are some spaces between the particles of matter, or in other words matter is made up of particles.

¶¶ How small are these particles of matter?

To know how small are the particles of matter from which it is made up of, let us perform the experiment :

Experiment : Take about one crystal of potassium permanganate ($KMnO_4$) and dissolve it in 100ml of water. The colour of solution will be dark pink. Take out approximate 10ml of this solution (dark pink) and put it into 90 ml of clear water. Now take 10ml of this solution and put it into another 90ml of clear water. Keep diluting the solution like this 5 – 8 times.

Observation and Explanation : The pink colour will not disappear altogether, though it becomes lighter and lighter with each dilution. This is because, there must be millions of tiny particles present in one crystal of $KMnO_4$ which keep on dividing into smaller and smaller number with each dilution, thereby making colour lighter and lighter.



Estimating how small are the particles of matter. With every dilution, though the colour becomes light, it is still visible.

Figure 2

Conclusion : From above experiment we conclude that "matter is made up of extremely small particles which can not be seen even with a powerful microscope.

or

The particles of matter are very small….. they are small beyond our imagination !!!!!.

The size of a particle of matter is of the order of nanometer, 1nm = 10^{-9}m.

§§ CHARACTERISTICS OF PARTICLES OF MATTER :

¶¶ Particles of matter have spaces between them

When potassium permanganate ($KMnO_4$), dettol, sugar or salt are dissolved in water, then their particles get evenly distributed between the spaces present among the particles of water as discussed in above experiments. Similarly when we make tea, coffee or lemonade (nimbu pani), the particles of one type of matter get into the spaces between the particles of other type of matter.

This shows that there are spaces between particles of matter.

¶¶ Particles of matter are continuously moving

The continuous motion of particles of matter can be explained more clearly by performing the following experiments :

Experiment 1 : Put one unlit incense stick (Agarbati) in one room & one lit incense stick (Agarbati) in another room.

Observation and Explanation : We will get smell while sitting at a distance from the lit stick, but to smell the unlit stick, we will have to go near it. This is because, when stick is lit, the temperature rises and hence the kinetic energy of the incense particles also increases. As a result, the particles of incense move rapidly and thus intermix with the particles of air rapidly so, we get smell of incense even when we are sitting at a distance.

On the other hand, when incense stick is not lit, temperature is low, and hence kinetic energy of incense particles is less. As a result particles of incense stick do not intermix with air rapidly, so that we have to go near the incense stick to get its smell (when it is not lit).

Conclusion: From above discussion we led to conclude that, particles of matter are never at rest, but are moving continuously. And their average speed increases with increase in temperature due to increase in kinetic energy of moving particles. As a result, rate of intermixing or rate of diffusion increases.

Gas particles always keep on moving in a zig-zag manner. This movement is called Brownian movement.

Experiment 2: Drop a crystal of copper sulphate ($CuSO_4$) or potassium permanganate ($KMnO_4$) into a glass of hot water and another containing cold water. Allow the crystals to settle at the bottom without stirring the solution.

Observation: The crystals of $CuSO_4$ or $KMnO_4$ dissolves more quickly in hot water than in cold water.

Explanation: The particles of $CuSO_4$ or $KMnO_4$ crystals do not move and thus remain fixed in their respective positions due to strong forces of attraction. On the other hand, the particles of cold water are continuously moving and thus possess some kinetic energy. Because of their K.E., the particles of cold water overcome the forces of attraction between particles of $CuSO_4$ or $KMnO_4$ crystals. As a result, the particles of $CuSO_4$ or $KMnO_4$ crystals move in between the spaces of particles of cold water and the crystals of $CuSO_4$ or $KMnO_4$ dissolves in cold water.

As the temperature rises the K.E. of both. i.e. particles of $CuSO_4$ or $KMnO_4$ crystals and water increases. Due to greater K.E., the forces of attraction between particles of $CuSO_4$ or $KMnO_4$ crystals decrease. Further due to greater K.E., the particles of water (hot water) move faster and more easily overcome the weaker forces of attraction between particles of $CuSO_4$ or $KMnO_4$ crystals than cold water.

As a result, the rate of intermixing (or rate of diffusion) increases and $CuSO_4$ or $KMnO_4$ crystals dissolves more quickly in hot water.

Conclusion : From above discussion, we led to conclude that particles of matter are continuously moving and their average speed increases with increase in temperature due to increase in K.E. of moving particles. As a result, rate of diffusion becomes faster and hence solid dissolves more quickly in hot water than in cold water.

Questions based on Experiment-2

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

Ans. 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.

Question : What happens as the time passes with respect to $KmnO_4$, and why ?

Ans. The dense violet colour starts diffusing slowly into cold water in form of coloured streaks. Gradually, the solution changes to pink colour, 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.

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

Ans. The rate of diffusion increases with the temperature. It is because the boiling hot water molecules have more kinetic energy and there are larger intermolecular spaces. Thus, the particles of solid potassium permanganate rapidly diffuse and hence, rate of diffusion increases.

Intermixing of particles of different types of matter on their own is called diffusion.

Experiment - 3 :To study diffusion of gases in water.

Materials required : 200 cc beakers half filled with tap water, wire gauze, tripod stand, spirit lamp or bunsen burner.

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.

Questions based on Experiment-3

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

Ans. Tiny bubbles of gas cling to the sides of beaker.

Question : Give an explanation to your above observation.

Ans. The tiny bubbles are of air (especially carbon dioxide and oxygen) which got dissolved in water naturally. These gases are expelled out when water is warmed.

The gases like oxygen and carbon dioxide diffuse and hence dissolve in water. The dissolved oxygen in water is essential for the respiration of water animals. The dissolved carbon dioxide helps the water plant to synthesise their food by the process of photosynthesis.

Experiment 4 : Take two beakers filled with water and put a drop of blue or red ink slowly along the sides of the first beaker and honey in the same way in the second beaker. Keep them undisturbed for some time.

Observation : The particles of ink quickly get distributed in water. As a result, colour of ink spreads throughout the water. On the other hand, particles of honey take a long time to. get distributed throughout the water.

Explanation : The particles of ink move rapidly due to weak forces of attraction between them. As a result, the particles of ink rapidly get into the spaces between the particles of water and hence quickly get evenly distributed in water. In contrast, the particles of honey move slowly due to strong forces of attraction between them. As a result, it takes a long time for the particles of honey to get into the spaces between the particles of water and to get evenly distributed throughout water.

Conclusion : From above discussion we led to conclude that particles are continuously moving but their average speed at any particular temperature depends upon the forces of attraction **Stronger the forces of attraction, lower is the average speed, and thus lower will be the rate of diffusion.**

¶¶ Particles of matter attract each other

The particles of matter have a force acting between them, which keeps these particles together. To illustrate this force of attraction, we perform the following experiments.

Experiment 1: Take an iron nail, a piece of chalk and a rubber band. Try to break each one of them by hammering, cutting or stretching.

Observation & Explanation : It is most difficult to break the iron nail, followed by piece of chalk & then rubber band.

This is because, the particles of iron nail are held together by the strongest forces followed by the piece of chalk, while particles of rubber band are held together by weakest forces of attraction.

Conclusion : From above experiment, we conclude that **"Particles of matter attract each other".** The strength of this force, however differs from one kind of matter to other.

Experiment 2 : Try to break the stream of tap water with your fingers.

Observation & Explanation : The stream can not be cut because particles of water attract each other strongly and hence tend to remain together.

Conclusion : Particles of matter attract each other.

Question 1: **Kitchen salt (NaCl) when added to water, gets evenly distributed in it. Which characteristic of particles of matter is exhibited by this ?**

***Solution*:** It shows that there is enough space between the particles of matter.

Question 2: **Define diffusion, is it faster in winter or summer season ?**

***Solution*:** The phenomenon of intermixing of particles of different types of matter, on their own, is called, **diffusion**. The rate of diffusion becomes faster with an increase in temperature due to increase in K.E. of moving particles. Hence diffusion is faster in summer than in winter.

Question 3: **When we light an incense stick (agarbatti) in a corner of our room, why does its fragrance spread in the whole room very quickly ?**

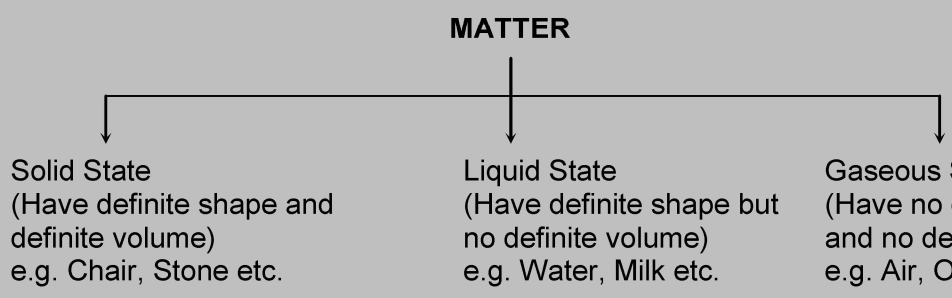
***Solution*:** When we light an incense stick, the temperature rises and hence kinetic energy of the incense particles also increases. As a result, the incense particles move rapidly and thus the rate of diffusion of incense particles with air particles becomes faster. That is why, fragrance of agarbatti (when we light it) spreads in the whole room very quickly.

Question 4: **Give reasons for the following observations. The smell of hot sizzling food reaches when you are several meters away, but to get smell from the cold food, you have to go close to it ?**

***Solution*:** The particles of matter are continuously moving, but their average speed increases with increase in temperature due to increase in K.E. of moving particles. Now since, the particles of hot vapours coming out of hot sizzling food move faster, therefore, they easily reach you even when you are several metres away. On the other hand, the particles of vapours coming out of cold food travel only slowly and hence do not reach you. Therefore, to get the smell from cold food, you have to go close to the food.

In short, due to diffusion, which becomes faster at higher temperature, vapours from hot sizzling food move faster and reach you several metres away. But you have to go close to get smell from cold food.

The matter around us exists in **three** physical states on the basis of physical properties.



(a) Water exists as ice (solid state), as liquid (liquid state) and as steam (gaseous state).

(b) Bones and teeth are solids, the blood that flows in our veins is a liquid and the air that we breathe in is a gas.

The three physical states of matter (i.e solid, liquid or gaseous) arise due to variation in the characteristics of the particles of matter.

§§ **SOLID STATE :**

Matter in solid state has a definite shape and definite volume.

Examples: Silver, copper, sand, sugar, gold, ice, wood, stone, book, needle, pencil, piece of thread, etc.

¶¶ **Properties of Solids :**

(a) Solids have a definite shape and distinct boundaries: The solids have a fixed shape and distinct boundaries due to small inter particle distances and strong forces of attraction. e.g. when a pen is put in different containers, it does not change its shape.

However, when sugar and salt, are placed in different containers, they take up the shape of the containers, yet they (sugar & salt) are solids. This is because, the shape of individual sugar or salt crystal remains fixed whether we take it in our hand, or put in a jar or in plate.

The highly ordered arrangement of constituent particles of a solid is called a lattice. This gives rise to a regular geometrical shape to the crystals.

(b) Solids possess rigidity: The solids have the tendency to maintain shape, when some outside force is applied (known as rigidity). They may break when dropped or hammered.

However some solids like rubber band, changes its shape when stretched under influence of force, but it regains its original position, when force is withdrawn. However, if excessive force is applied, rubber band breaks.

(c) Solids have a definite volume : Solids have a definite volume as they can not be compressed due to small inter particle distances.

However some solids like sponge can be easily compressed. This is because sponge has minute holes in which air is trapped so that when we press it, air is expelled and the sponge is compressed.

(d) Solids do not possess the property of diffusion :- The solids do not have the property of diffusion into other solids (i.e. the particles of two solids do not intermix). This is because the particles of solid do not move much from their positions due to small inter particle distances and strong forces of attraction.

However particles of some solids like chalk have diffused into other solids like blackboard. i.e. if we write something on blackboard with the chalk and leave it uncleaned for sometime, we will find that it becomes difficult to clean the board. This is because of diffusion of chalk particles in between the particles of blackboard and hence it becomes difficult to rub them off.

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

Ans. We can regard rubber band as a solid, because it regains its shape when the stretching force is removed from it.

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

Ans. 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.

Question.7 Sponge is a solid, yet we are able to compress it. Why ?

Ans. Sponge has very small holes throughout its structure. These holes are filled with air. When it is compressed, the air in the holes is squeezed out. Thus, we are able to cmpress it.

§§ LIQUID STATE :

The matter in liquid state have a definite volume and no definite shape.

Examples : Water, blood, benzene, alcohol, milk, petrol, cooking oil, juice, cold drink etc.

¶¶ Properties of Liquids

(a) Liquid do not have fixed shape but have a fixed volume : The liquids have a fixed volume due to strong inter particle forces of attraction in them which are strong to keep the particles together.

But these forces are not strong enough to keep the particles in fixed position, therefore, liquids do not have a fixed shape, they take up the shape of vessel in which they are placed.

(b) Liquids are not rigid but have a property to flow : Liquids can flow and change shape due to larger inter particle distances and weaker forces of attraction in them, than solids. Thus liquids are not rigid but they possess fluidity (i.e. they have property to flow).

Relative fluidity of liquids differ from one liquid to other. e.g. water flows faster than honey.

(c) Liquids possess the property of Diffusion : Due to larger inter particle distances in liquids than in solids, the particles of a liquid have more freedom of motion than solids. Thus solids, liquids and gases all can diffuse into liquids as discussed below:

(i) Diffusion of solids into liquids: When a crystal of copper sulphate or potassium permanganate (solid) is added to water (liquid), the particles of $CuSO_4$ or $KMnO_4$ quickly diffuse in between the particles of water to form a solution.

(ii) Diffusion of liquids into liquids: When water is added to alcohol or vice-versa, the two liquids quickly diffuse into each other to form a solution.

(iii) Diffusion of gases into liquids: Some gases especially O_2 and CO_2 diffuse into water i.e. dissolve in water. So that aquatic animals can breathe under water due to presence of dissolved oxygen in water.

Thus solids, liquids & gases – all can diffuse into liquids. However, the rate of diffusion of liquids is much higher than that of solids.

♠ **Rate of diffusion of different liquids :-** Different liquids have different rates of diffusion. For example a drop of blue or red ink diffuses faster than a drop of honey into water.

♠ **Rate of diffusion increase with rise in temperature :-** Rate of diffusion increases with rise in temperature, hence sugar dissolves much more quickly in hot water than in cold water.

§§ GASEOUS STATE :

The matter in gaseous state has neither definite volume nor shape.

Examples : Air, oxygen, nitrogen, hydrogen, ammonia, carbon dioxide, compressed natural gas (CNG) etc.

¶¶ Properties of Gases

(a) Gases neither have a definite shape nor a definite volume : Gases do not have a definite shape, but they acquire the shape of the vessel in which they are placed.

Similarly, gases do not have a definite volume, but attain the volume of container to which they are transferred.

(b) Gases have maximum fluidity and least rigidity : The gases have high fluidity (property to flow) and least rigidity (tendency to maintain shape) due to large inter particle space and weak inter particle forces of attraction in them.

(c) Gases are highly compressible : The gases are highly compressible due to large inter particle spaces in them. Due to high compressibility, large volume of a gas can be compressed into a small cylinder and transported easily. e.g. L.P.G. gas & O_2 supplied to hospitals in cylinders is compressed gas. Similarly these days, compressed natural gas (CNG) is used as a fuel in vehicles.

Gases are highly compressible while liquids are almost incompressible, while solids are completely incompressible.

This can be explained by the following experiment.

Experiment to illustrate comparison between solids, liquid and gases in terms of compressibility.

or

Experiment to study the compressibility of solids, liquids & gases : Take three syringes (about 100ml) and close their nozzles by rubber corks. Now remove the pistons from all syringes. Fill some water (liquid) in second syringe and chalk pieces (solid) in the third & leaving first syringe untouched. Now insert pistons back into syringes.

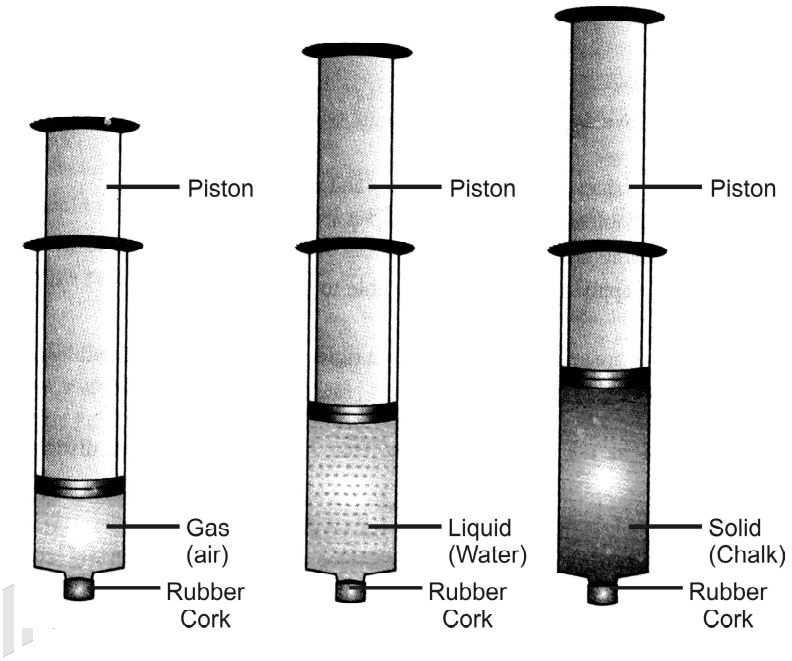


Figure 3

Observation and explanation: The piston of first syringe (left untouched) which contained air (gas) was easily pushed in. The piston of the second syringe which contained water (liquid) was pushed in only a little, while the piston of the third syringe which contained chalk pieces could not be pushed in at all. Thus, air is easily compressible, water is almost incompressible, while chalk pieces are completely incompressible.

Conclusion: The spaces between particles of gases are maximum, intermediate in liquids and minimum in solids. Thus, gases are highly compressible, liquids are almost incompressible, while solids are completely incompressible.

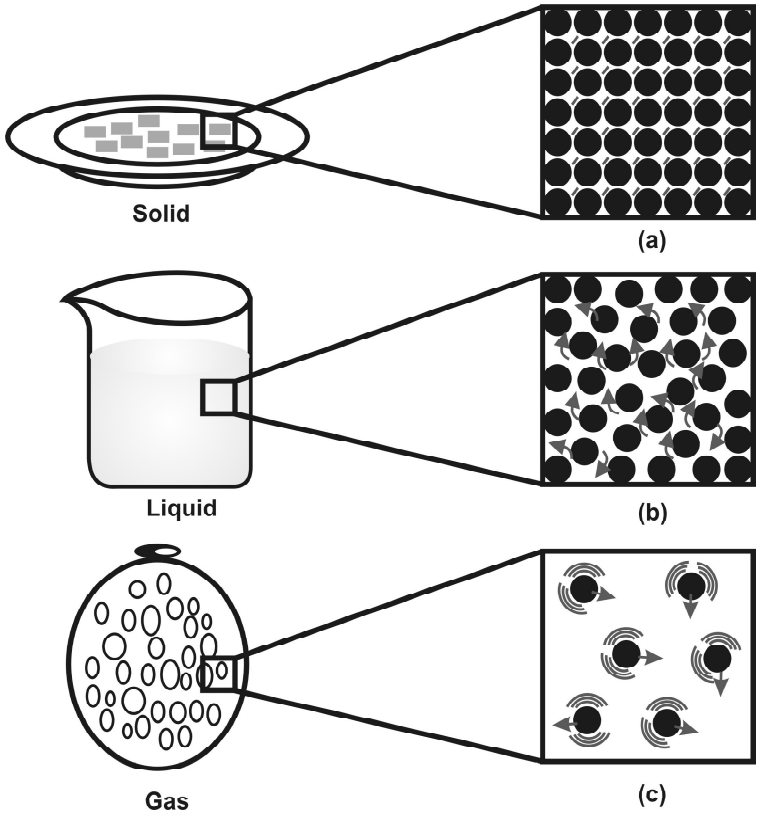
(d) Gases have low density : Gases have low density as compared to solids and liquids due to large inter molecular spaces in them. i.e. mass per unit volume of a gas is small and hence gases have low density.

(e) The Kinetic energy of particles in the gaseous state is quite high :- Due to large inter particle distances and weak forces of attraction, the particles of a gas can move freely & thus have large rotational, translational and vibrational motion and due to large translational motion, their kinetic energy is quite high which can be further increased by increasing the temperature of gas.

(f) Gases exert pressure : Due to larger inter particle distances and weaker inter particle forces of attractions, particles of a gas are moving continuously in different directions with different velocities. Due to this random motion, the particles of gas collide with each other and also with the walls of the containing vessel. Due to these collisions, the particles of the gas exert a force on the walls of the container. This force per unit area exerted by the particles of the gas on the walls of containing vessel is called the **pressure of the gas**.

Random motion means motion in different directions with different velocities. The random motion of particles of a gas is due to larger inter particle distances and weaker inter particle forces of attraction between them, unlike liquids & solids.

The motion and inter particle distances in solids, liquids & gases are as shown in fig.



a, b and c show the magnified schematic pictures of the three states of matter. The motion of the particles can be seen and compared in the three states of matter.

Figure 4

(g) Gases diffuse very rapidly : Due to random motion, the particles of one gas readily move into spaces between the particles of the other gas. (called diffusion)

Thus, gases diffuse very rapidly, rate of diffusion increases with increase in temperature.

The most familiar example of diffusion of gases is found in our homes, e.g. we come to know what is cooked in the kitchen without even entering there, by the smell due to rapid diffusion. (i.e.

rapid intermixing of particles of aroma with particles of air). Since rate of diffusion becomes faster at high temperature the smell of hot cooked food travels faster than that of the cold food.

The rate of diffusion of a gas is inversely proportional to the square root of its density, this is called Graham's law of diffusion

Differences in the characteristics of states of matter (solids, liquids & gases) :

S.No.	Property	Solid	Liquid	Gas
1.	Packing	The particles are most closely packed.	The particles are less closely packed than solids.	Particles are at sufficient distances from each other.
2.	Shape	Solids have definite shape.	Liquids do not have definite shape. They assume the shape of container.	Gases do not have a definite shape. They assume the shape of container.
3.	Volume	Solids have definite volume.	Liquids have definite volume.	Gases do not have definite volume. They assume the volume of container.
4.	Density	Solids have high density.	Liquids have less density than solids but more than gases.	Gases have the least density.
5.	Diffusion	Solids have no tendency to diffuse.	Liquids have a tendency to diffuse slowly.	Gases diffuse rapidly.
6.	Rigidity	Rigid.	Fluid.	Fluid.
7.	Compressibility	Negligible.	Very low.	High.
8.	Inter-molecular forces of attraction	Maximum.	Less than solids.	Negligible.
9.	Kinetic energy of molecules	Least.	More than solids.	Very high.

Fourth and fifth states of matter

Fourth state of matter (Plasma):

The fourth state of matter is plasma.

Plasma is an ionized gas, a gas into which sufficient energy is provided to free

electrons from atoms or molecules and to allow both species, ions and electrons, to coexist.

Plasma occurs naturally and makes up the stuff of our sun, the core of stars and occurs in quasars, x-ray beam emitting pulsars, and supernovas.

On earth, plasma is naturally occurring in flames, lightning and the auroras.

Most space plasmas have a very low density, for example the Solar Wind which averages only 10 particles per cubic-cm. Inter-particle collisions are unlikely - hence these plasmas are termed collision less.

Fifth state of matter (Bose - Einstein condensate):

The collapse of the atoms into a single quantum state is known as Bose condensation or Bose-Einstein condensate is 5th state of matter.

The Bose-Einstein condensate occurs at ultra-low temperature, close to the point that the atoms are not moving at all.

A Bose-Einstein condensate is a gaseous superfluid phase formed by atoms cooled to temperatures very near to absolute zero.(0 K or -273^{0}C)

The first condensate was produced by Eric Cornell and Carl Wieman in 1995 at the University of Colorado at Boulder, using a gas of rubidium atoms cooled to 170 nanokelvins (nK). —Under such conditions, a large fraction of the atoms collapse into the lowest quantum state, producing a superfluid.

This phenomenon was predicted in the 1920s by Satyendra Nath Bose and Albert Einstein, based on Bose's work on the statistical mechanics of photons, which was then formalized and generalized by Einstein.

Ex :liquid Helium

SOLVED ILLUSTRATONS

Question 9: Give reasons :

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

Ans. The molecules of a gas have large intermolecular spaces and kinetic energy, but extermely small intermolecular forces. Thus, the molecules of the gas spread in the entire space of the containing vessel on account of high kinetic energy and practically to intermolecular forces, hence fill entire space of the vessel.

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

Ans. The molecules of a gas have very large kinetic energy. When these molecules strike against the walls of containing vessel, they exert certain average force per unit area. As the force per unit area is known as pressure, therefore, the gases exert pressure on the sides of the containing vessel.

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

Ans. Solids are rigid, incompressible and have definite shape and volume. Since the table has all the above mentioned properties, therefore, it it solid.

(d) We can easily move our hand in air, but to do the same through a solid block of wood, we

need a karate expert.

The intermolecular forces between the molecules of a gas are almost negligible and intermolecular spaces are very large. Thus, we can easily move our hand in air, without any appreciable force.

The intermolecular forces between the molecules of a solid are very large and intermolecular spaces are very small. Thus, a lot of force is required to separate the molecules of a solid. It is for the same reasons that we need karate expert to break a block of wood.

Question 10: 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.

Ans. Exhaust from chimneys, air, cotton, water, honey and iron.

Question 11: **What is the general name of :**

(a) rigid form of matter ?

(b) fluid forms of matter ?

***Solution*:** (a) Solid
(b) Liquid and Gas

Question 12: **Which diffuses faster : a liquid or a gas ?**

***Solution*:** Gas

Question 13: **We can get the smell of perfume sitting several metres away, comment.**

***Solution*:** Since gases diffuse rapidly, the particles of vapours of perfume (gas) diffuse or intermix with the particles of air (gas) rapidly and thus reach us sitting at some distance. Consequently we can get the smell of perfume sitting several metres away.

Question 14: **Arrange the following substances in increasing order of forces of attraction between particles – water, sugar, oxygen.**

***Solution*:** Water is a liquid, sugar is a solid & oxygen is a gas. The increasing order of forces of attraction between particles is : gas < liquid < solid.

Hence, increasing order of forces of attraction of particles is : oxygen < water < sugar.

Question 15: **Give two reasons to justify :**

(a) Water at room temperature is a liquid

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

***Solution*:** (a) Water at room temperature is a liquid because :

(i) It has a fixed volume but does not have a definite shape.

(ii) It can flow easily from one vessel to another, so it has fluidity.

(b) An iron almirah is a solid at room temperature because :

(i) It has a fixed volume and definite shape.

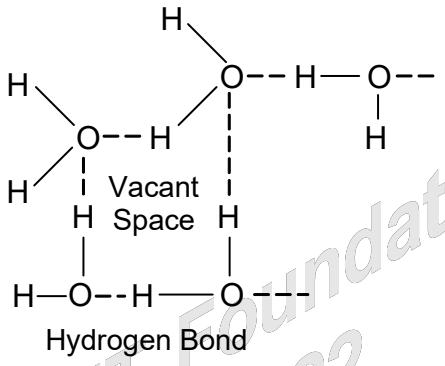
(ii) It can not be compressed and it has distinct boundaries.

Question 16: The diver is able to cut through water in a swimming pool.

Ans. Explanation :– The diver is able to cut through water in the swimming pool because matter is not continuous, but it is made up of particles which have vacant spaces between them moreover, the attractive forces between molecules of water are not very strong. The diver can easily cut through water by applying force to displace water and occupy its place.

Question 17: **Liquids generally have lower density as compared to solids. But you must have observed that ice floats on water. Find out why?**

***Solution*:** The water in form of ice (solid) forms hydrogen bonds, due to which, some empty spaces are created between the molecules of water in ice. As a result, volume increases for the same mass of water in ice. In other words mass per unit volume or density of ice is less than that of water and hence ice floats on water.



TEACHING TASK

I. Single Correct Choice Type:

1. What is the physical state of CNG

A) Solid B) liquid C) Gas D) None of these

2 The gas in a container:

A) Spread out along the bottom of the container.

B) Spread out all through the container.

C) Will not spread out at all.

D) Spread out only at the top of the container

3. Identify the liquid state of water:

A) Dew B) Cloud C) Mist D) Fog

4. The physical state of water in the polar ice caps and glaciers is:

A) Liquid B) Gas C) Solid D) None of these

5. In Plasma state:

A) Ions and electrons co-exist B) Atoms and molecules co-exist

C) Atoms and ions co-exist D) Molecules and protons co-exist

6. Bose Einstein Condensate was first produced by:

A) Eric Cornell B) Carl Wieman C) Lise Meitner D) Both 1 and 2

7. Gasses are highly compressible because

A) inter molecular space are very large B) inter molecular space are very low

C) inter molecular forces are very high D) None

8. Kinetic energy of molecules in solids is

A) large B) small C) least D) high

9. Liquids expands more than solids on ..... and contract more on ..... respectively.

A) heating & cooling B) evapouration & heating

C) cooling & evaporation D) None

10. Property exploited in the usage of perfumes is

A)Compressibility of gas B)Diffusion of gas

C)Expansibility of gas D)Both C and B

II. Multi Correct Choice Type:

1. Which of the following requires container?

A) Water B)Milk C) Oil D) Wood

2. Solids have

A) definite shape B)definite volume C) highdensity D) no free surface

3. Which of the following is a non matter

A)Heat B)Light C)Vaccum D)Book

1. Which of the following is correct statement?

A) Matter is made up of tiny particles called molecules

B) Molecules of matter are in constant vibration.

C) Matter can exist in two states.

D) Matter may change from one state to another state when there is change in temperature and pressure.

2. Choose the correct statement(s)

A) Solids do not diffuse.

B) The density of liquids relatively less than solids.

C) Gases exert pressure in all directions. D) None of the above.

3. Which of the following is true about gases?

A) Gases have no definite volume. B) Gases have no free surface.

C) Gases have no definite shape D) Gases are highly compressible.

4.. Choose the incorrect statement(s).

A) Solid has no definite shape.

B) Solids do not need a container to hold them.

C) Solids have no definite volume. D) Solids do not expand on heating.

III. Matrix Matching Type:

1). a) Flowing 1) Solid

b) Diffusion 2) Liquids

c) High density 3) Gases

d) One free surface 4) Plasma

2) **Column-I** **Column-II**

a) Atom 1.Takes the shape of the container

b)solid 2.smallest particle of the matter

c)Liquid 3.Highly compressible

d)Gas 4.any no of free surfaces

e) molecules 5.rigid

TEACHING TASK KEY:

I) 1.C 2.B 3.A 4.C 5.A 6.D 7.A 8.B 9.A 10.B

II) 1.A,B,C 2.A,B,C 3.A,B,C 4.A,B,D 5.A,B,C 6.A,B,C,D 7.A,C,D

III) 1. a - 2, b - 3, c - 1, d - 2 2. a-2, b-5, c-1, d-3,e-4

LEARNERS TASK

BEGINNERS (LEVEL-I)

Single Correct Answer Type :

1. Which of the following has the strongest interparticle force at the room temperature?

(A) Nitrogen (B) Mercury (C) Iron (D) Chalk

2. What is volume of gases?

(A) Definite (B) Almost Nil

(C) Large (D) Take the volume of container

3. Which of the following statements is/are correct ?

(A) Intermolecular forces of attraction is solids are maximum.

(B) Intermolecular forces of attraction is gases are minimum.

(C) Intermolecular spaces in solids are minimum.

(D) All of the above

4. Based on the statements given here choose the correct answer.

(1) Same sugar can be added to a full glass of water without causing overflow.

(2) A liquid is contianuous even-though space is present between the molecules.

(A) (1) and (2) are true (B) (1) and (2) are False

(C) Only (1) is true (D) Only (2) is true

5. Which of the following is not correct for gases ?
(A) Gases have definite mass. (B) Gases have definite shape.
(C) Gases have definite volume (D) Both (B) and (C)

6. Which of the following is not an example of matter ?
(A) Air (B) Feeling of cold (C) Dust (D) None of these

7. Which of the following statements is correct ?
(A) Interparticle spaces are maximum in the gaseous state of a substance.
(B) Particles which constitute the matter follow a zig-zag path.
(C) Solid state is the most compact state of substance.
(D) All are correct

8. Which out of the following does not make sense.
(A) Solids have fixed shape and fixed volume.
(B) Liquids can be compressed easily, but not gases.
(C) The particles of solids have negligible kinetic energy.
(D) Property of diffusion is maximum in the gaseous state.

9. Which of the following is/are application(s) of high compressibility of gases ?
(A) L.P.G. is used as fuel in homes for cooking food.
(B) Oxygen cylinders are supplied to hospitals.
(C) C.N.G. is used as fuel in vehicles.
(D) All of these

10. Which of the following statements does not go with the liquid state ?
(A) Particles are loosely packed in the liquid state.
(B) Fluidity is the maximum in the liquid state.
(C) Liquids can be compressed.
(D) Liquids take up the shape of any container in which these are placed.

11. Bose Einstein Condensate was first produced by:
A) Eric Cornell B) Carl Wieman C) Lise Meitner D) Both 1 and 2

12. The phenomenon of intermixing of particles of different types of matter, on their own, is called
(A) Diffusion (B) Collision (C) Both 1 & 2 (D) None

13. Kinetic energy of molecules in solids is
A) large B) small C) least D) high

14. If a perfume bottle is opened in one corner of a room, the smell can be felt after sometime in the opposite corner. This shows that
(A) particles of matter are constantly moving
(B) the perfume is strong
(C) the room has fan which circulates the perfume

(D) None of these

15. The matter that has stronger inter particle forces between an iron piece and a chalk piece is
(A) iron (B) chalk piece
(C) both (D) neither

16. The volume of matter in 1 kg of cotton is _____ that present in 1 kg of sugar
(A) smaller than (B) greater than
(C) equal to (D) can not say

17. The type of motion that is present in solids is
(A) random (B) linear (in a straight line)
(C) vibratory (D) circular

18. The type of motion that is present in liquid is
(A) random (B) linear (in a straight line)
(C) vibratory (D) circular

19. The type of motion that is present in gases is
(A) random (B) linear (in a straight line)
C) vibratory (D) circular

20. The physical state of matter whose volume can change significantly by changing temperature only is
(A) solid (B) gas
(C) liquid (D) all three

21. The physical state of matter whose volume can change significantly by changing pressure only is
(A) solid (B) gas
(C) liquid (D) all three

22. "All matter is made up of very small particles which cannot be further broken down. These particles are called atoms". This statement is one of the assumptions of
(A) Rutherford's nuclear theory (B) Bohr's theory
(C) Dalton's atomic theory (D) Kinetic theory of gases

23. When an incense stick is lit in one corner of the room, the aroma is felt equally in all parts of the room. This is due to
(A) Evaporation (B) Combustion
(C) Sublimation (D) Diffusion

ACHIEVERS (LEVEL-II)

1. Write comparitive properties of solids, liquids and gases.

2. How many type of matter can be classified? Explain both of these.

3. Write an example which shows the effect of change of temperature on solid.

4. Define about **:–** (a) Plasma (b)Bose Einstein condensate.

5. What are the characteristics of particles of matter?

6. Why do we see water droplets on the outer surface of a glass containing ice cold water?

7. Give one simple activity/experiment to show

(i) Particles of matter are very small

(ii) Ammonium chloride sublimes.

8. What is matter? Write three states of water in which it exists.

9. Write an activity which shows the compressibility of gases & liquids.

EXPLORERS (LEVEL-III)

I) Multiple Correct Answer Type :

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

1. Which of the following statements are incorrect
(A) Solids have a definite shape but not distinct boundaries
(B) Liquids don't have have a definite shape but occupies definite volume
(C) Liquids and gases doesnt occupy definite volume
(D) Gases occupiesvolume of the container

2. Which of the following statements are correct
(A) 1nm = 10^{-9}m (B) 1nm = 10^{-7}cm
(C) 1nm = 10^{-11}m (D) 1nm = 10^{-11}cm

3. Which of the following statements are correct
(A) Relative fluidity of liquids differ from one liquid to other
(B) Liquids are not rigid but have a property to flow
(C) Liquids donot possess the property of Diffusion
(D) Rate of diffusion decrease with rise in temperature

4. Separation of a mixture into its constituents depend on
(A) physical properties (B) chemical properties
(C) physical state (D) nuclear change

II) Assertion – Reason Type questions :

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

5. **Statement-I** : The phenomenon of intermixing of particles of different types of matter, on their own, is called, **diffusion**
Statement-II : Rate of diffusion increases with rise in temperature.

6. **Statement-I** : Gases are highly compressible while liquids are almost incompressible
Statement-II : Compressibility factor depends on intermolecular spaces.

III) Linked Comprehension Type :

- *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

Random motion means motion in different directions with different velocities. The random motion of particles of a gas is due to larger inter particle distances and weaker inter particle forces of attraction between them

7. The increasing order of rate of diffusion is for the following examples

A) oxygen < water < sugar. B) sugar < oxygen < water

C) water < oxygen < sugar. D) sugar < water < oxygen

8. Relation between intermolecular spaces and random motion of molecules

A) Directly propotional to each other B) Inversely propotional to each other

C) Not related to each other D) Cannot be predicted

IV) Matrix Match Type :

- *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*
  *If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

9)

Column-I	Column-II
a) Bose-Einstin condensate	1) No free surfaces
b) Gases	2) Any no. of free surfaces
c) Solids	3) Can flow
d) Liquids	4) Fifth state of matter
	5) Only one free surface

ΦΦ LEARNERS TASK KEY:

☐ **BEGINNERS :** 1)C 2)D 3)D 4)A 5)D 6)B 7)D 8)B 9)D 10)B
11)D 12)A 13)B 14)A 15)A 16)B 17)C 18)A 19)A 20)B
21)B 22)C 23)D

☐ **EXPLORERES :** 1)A, C 2)A,B 3)A, B 4)B, C 5)B 6)A 7)D
8)D 9)(a →4),(b→ 1), (c →2), (d → 3)

§§ Latent heat:

The amount of heat required to change the state of matter from one state to another without rise in temperature is known as latent heat of that substance.

Latent heat is of two types:

(i) Latent heat of fusion: The amount of heat required to change the state of matter from solid state to liquid state without rise in temperature is known as latent heat of fusion.

(ii) Latent heat of vaporisation: The amount of heat required to change the state of matter from liquid state to gaseous state without rise in temperature is known as latent heat of vaporisation.

Some substances may exist in all the three states of matter in different conditions, for example, water can exist in three states of matter:

(i) in solid state as ice.

(ii) in liquid state as water.

(iii) in gaseous state as water vapours or steam.

This inter conversion of matter can be achieved by the following two ways :

(a) by changing the temperature.

(b) by changing the pressure.

Now question arises, that :

How does the matter convert from one state to another by changing temperature & Pressure ?

or

What is the effect of change of temperature and pressure on three states of matter ?

Common Unit of Temperature and SI Unit of Temperature : Common unit of measuring temperature is degree Celsius (°C). The SI unit of measuring temperature is Kelvin which is denoted by the symbol K. The Kelvin scale and Celsius scale of temperature are interconvertible and the relation can be written as :

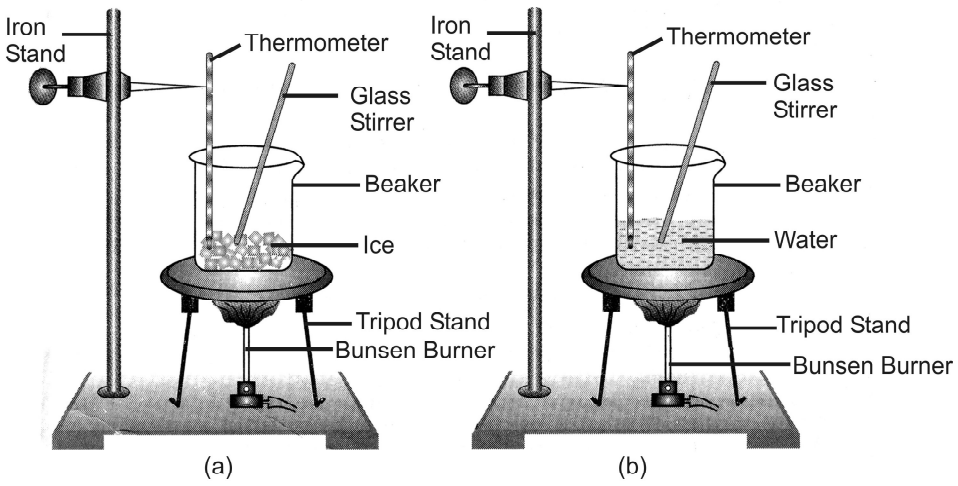
***Temperature in Kelvin (K) scale = Temperature in Celsius (°C) scale* + 273.**

§§ EFFECT OF CHANGE OF TEMPERATURE

Effect of temperature on the change of state of matter can be explained by the following experiment :

¶¶ Increasing the temperature by heating

Experiment: Take about 150g of ice in a beaker and suspend a laboratory thermometer so that its bulb is in contact with the ice (figure 5). Now start heating the beaker.



(a) Conversion of ice to water, (b) Conversion of water to water vapour.

Figure 5

Observation: On heating, it will be observed that first the ice (solid) melts to form water (liquid). If the heating is carried out further, the liquid (water) will change to gaseous state (vapour).

Discussion :-

(i) Change of state from solid to liquid (fusion): When heat is supplied to a solid (ice), the kinetic energy of solid particles increases due to increase in temperature. As a result, solid particles start vibrating with high speed. On further increasing temperature, the heat energy overcomes the forces of attraction between solid particles. At this temperature, the particles leave their fixed positions, start flowing and thus solid melts to form a liquid.

The temperature at which a solid melts to become a liquid at atmospheric pressure is called its '**melting point'**. This process of change of solid state into liquid state is also called **'Fusion'**.

Solid $\xrightarrow{\text{Heat}}$ Liquid

The melting point of ice is O^0C or 273 K (O^0C = 273 + 0 = 273K). This temperature (i.e. O^0C) remains constant till all the ice has melted even though we continue to supply the heat. This is because, the heat energy supplied is absorbed by the particles of ice to overcome the forces of attraction between them to change them from solid to liquid state without showing any rise in temperature. Therefore, it is considered that this heat gets hidden within the particles and is thus called latent heat (latent means hidden).

(ii) Change of state from liquid to gas (vaporisation) : When heat is further supplied to the liquid, kinetic energy of liquid particles increase further, as a result of this, inter-particle distance increase (app. 100 times). Hence, the magnitude of forces of attraction holding the liquid particles becomes so less that, the liquid particles break apart from the liquid state and change to gaseous or vapour state.

The pressure of air in atmosphere is called **atmospheric pressure.**

Liquid $\xrightarrow{\text{Heat}}$ Gas

Each pure liquid has a fixed boiling point. The boiling point of pure water is 100^0C or 373 K (100^0C = 273 + 100 = 373K) This temperature (i.e. 100^0C) again becomes constant till all the liquid has vaporized. This is again because that heat energy supplied is absorbed by the liquid water particles to overcome the forces of attraction between them to change from liquid water to steam, without showing any rise in temperature. In other words, heat gets hidden within the particles and is therefore, called latent heat.

¶¶ On decreasing temperature by cooling

(i) Change of state from liquid to solid (solidification): When water is cooled (by lowering its temperature) it gets changed into solid 'ice'. The process of changing a liquid into a solid by cooling is called "freezing". When the temperature is lowered particles of the matter lose energy due to which they move slowly. If we continue to lower the temperature then the particles of substance stops moving and vibrates around their fixed position. At this point the liquid freezes and gets converted into solid.

Liquid $\xrightarrow{\text{Cool}}$ Solid

Freezing is the reverse of melting. So the freezing point of a liquid is the same as the melting point of its solid form.

The amount of heat energy that is required to change 1kg of solid into liquid at atmospheric pressure at its boiling point is called, **latent heat of vaporization.**

(ii) Change of state from gas to liquid (condensation): When the temperature of gaseous state of matter is lowered, it is converted into liquid state. So, the process of changing a gas (or vapour) to a liquid by cooling, is called **condensation.**

For example, when temperature of water vapour is lowered it gets converted into liquid water.

Explanation: when the temperature is lowered then the particle of gaseous state lose energy and their movement slow down, because of this they move closer together until they start being attracted to each other and form a liquid.

$$\text{Gas} \xrightarrow{\text{Cool}} \text{Liquid}$$

Condensation is the reverse of vaporization.

Conclusion: From the above discussion, we led to conclude that one state of matter can be changed into another or vice-versa by changing the temperature.

$$\text{Solid State} \underset{\text{Cool}}{\overset{\text{Heat}}{\rightleftharpoons}} \text{Liquid State} \underset{\text{Cool}}{\overset{\text{Heat}}{\rightleftharpoons}} \text{Gaseous State}$$

Remember: Melting point of ice is same as the freezing point of water. It is O^0C or 273K under one atmospheric pressure. In other words, at O^0C both ice and water exist together. But particles in water have more energy as compared to particles in ice at same temperature i.e. at 0^0C. This is because during the change of state from ice to water, heat energy equal to latent heat of fusion has been absorbed.

The particles of steam have higher energy than the particles of liquid water at same temperature i.e. at 100^0C. This is again because, during change of state from liquid water to steam or vapours, heat energy equal to latent heat of vaporization has been absorbed.

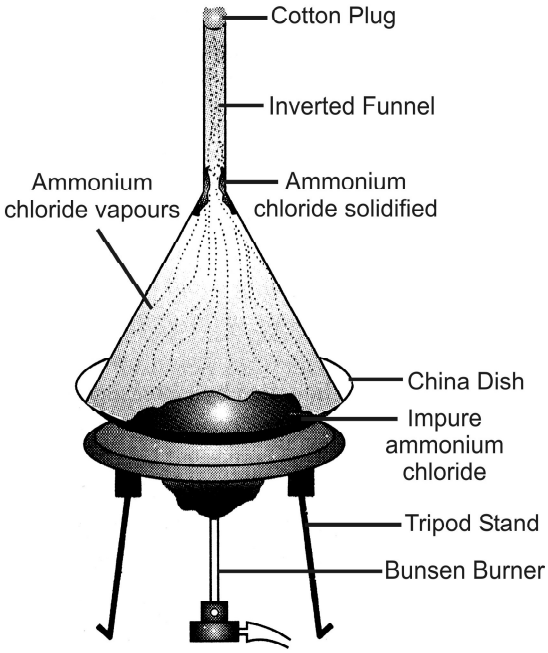
§§ SUBLIMATION

Sublimation is the process of conversion of a solid directly into a gas or vice-versa without changing into liquid state.

$$\text{Solid} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} \text{Vapour (or gas)}$$

Experiment to demonstrate sublimation : Take some ammonium chloride (NH_4Cl) in a china dish, and cover it with an inverted funnel as shown in figure plug the stem of funnel with cotton. Now heat slowly.

Observation and Discussion : Ammonium chloride, will convert into vapours which will deposit on the inner side of the funnel as sublimate. The vapours in turn, condense on the cooler portions of the funnel to give pure NH_4Cl.



Sublimation of ammonium chloride

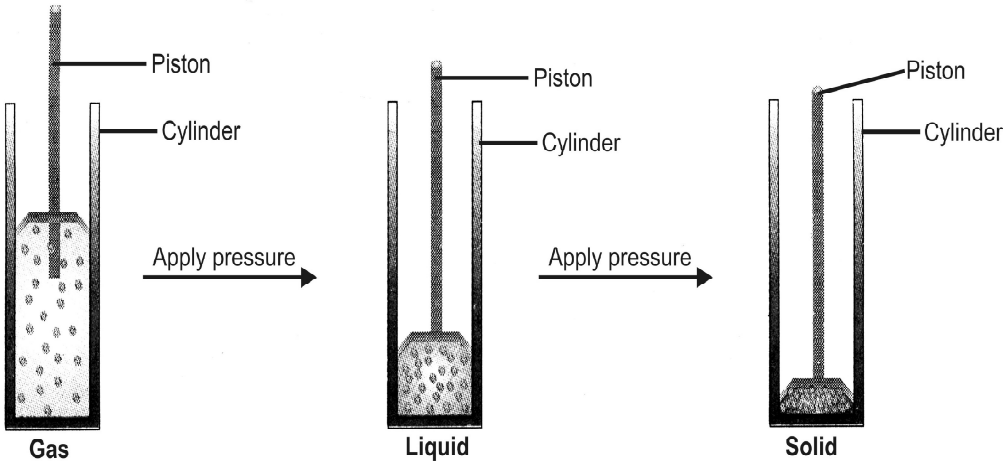
Figure 6

Conclusion: A change of state directly from solid to gas without changing into liquid (or vice-versa) is called **sublimation.**

§§ **EFFECT OF CHANGE OF PRESSURE**

The effect of pressure on the states of matter can be discussed by the following experiment:

Experiment : Take a gas in a cylinder and apply pressure by pushing the piston down as shown in figure 7.



(a) (b) (c)

By applying pressure, particles of a gas come close together

Figure 7

Observation: A gas can be first liquefied and then converted into solid.

Liquification of gas : A gas can be liquefied by applying pressure or by lowering the temperature. For every gas, there is a minimum temperature above which gas cannot be liquefied by applying pressure. This temperature is called "critical temperature". The minimum pressure which is required to liquefy a gas at critical temperature is called "critical pressure".

Discussion: When the particles of fluid are present under low pressure, they are in the gaseous state as shown in the figure (a). When some high pressure is applied on the gas, the forces of attraction between gas particles become so high that they bind the gas particles together to form the liquid state [figure (b)]. Ultimately under very high pressure, the forces of attraction become so strong that the liquid may change into the solid state [figure (c)].

For example, CO_2 gas can be liquefied easily either by applying pressure or by reducing the temperature. However, CO_2 is cooled (by reducing temperature) under high pressure, it can be directly converted into solid CO_2 called **'dry ice'.**

Solid CO_2 is called dry ice, because unlike ordinary ice, dry ice does not wet the surface on which it melts. It is used as a refrigerant. This is because, if pressure on dry ice is reduced to one atmosphere, it directly gets converted into gaseous state without passing through the liquid state. It is because of the reason, that dry ice is stored under high pressure.

Conclusion: From above discussion, It is clear that a gas can be liquefied by increasing pressure and decreasing temperature and vice, versa hence, it follows that both pressure and temperature determine the state of a substance, whether, it will be a solid, liquid or gas. The entire change has been represented as below:

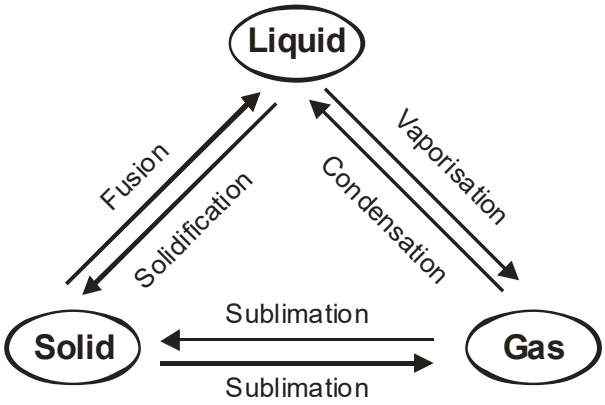


Figure 8

Question 17: **Convert the following temperature to Celsius scale :**

(a) 300 K

(b) 573 K

***Solution*:** We know that $^0C = K - 273$

(a) $300\ K = 300 - 273 = 27^0C$

(b) $573\ K = 573 - 273 = 300^0C$

Question 18: **What is the physical state of water at :**

(a) 25^0C

(b) 0^0C

(c) 100^0C ?

***Solution*:** (a) At 25^0C, physical state of water is a liquid.

(b) At 0^0C, physical state of water can be either a solid (ice) or a liquid.

(c) At 100^0C, boiling point of water, water exists both as a liquid as well as a gas.

Question 19: **For any substance, why does the temperature remain constant during the change of state?**

***Solution*:** The temperature remains constant during the change of state of a substance at its melting point or boiling point because, heat energy supplied to the substance is used up in overcoming the forces of attraction between the molecules. As a result, the temperature does not rise till the entire substance undergoes change of state.

Question 20: **Suggest a method to liquify the atmospheric gases.**

***Solution*:** Atmospheric gases can be liquified either by increasing the pressure or decreasing the temperature (i.e. by cooling). This is because, by doing so, the forces of attraction between gas particles become so high that they bind these particles together to form the liquid state.

Question 21: **The Naphthalene balls disappear with time without leaving any solid. Give reason.**

***Solution*:** Naphthalene undergoes sublimation slowly at room temperature. As a result, solid naphthalene gets converted into vapours which become a part of air around us. Therefore, naphthalene balls disappear without leaving any solid.

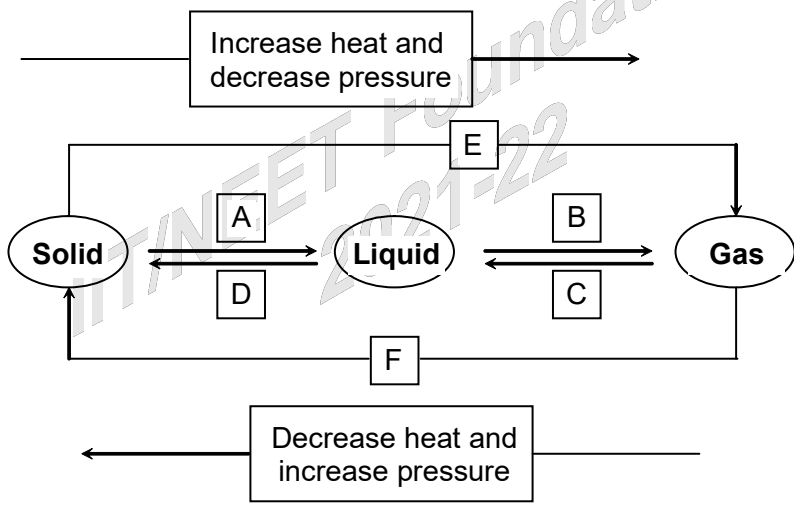
Question 22: **Why is ice at 273K more effective in cooling than water at the same temperature?**

***Solution*:** At 273K, ice can absorbs more amount of heat than water due to its latent heat of fusion. In other words, the ice at 273K has less heat energy than water at same temperature and hence ice is more effective in cooling than water at the same temperature.

Question 23: **What produces more severe burns, boiling water or steam ?**

***Solution*:** The steam has more heat energy stored in it than in boiling water at the same temperature (i.e at 373K) due to latent heat of vaporization. Hence, steam will produce more severe burns than boiling water.

Question 24: **Name A, B, C, D, E and F in the following diagram showing change in its state :**



***Solution*:** A – Fusion
B – Vaporisation
C – Condensation
D – Solidification
E – Sublimation
F – Sublimation

§§ EVAPORATION :

The phenomenon of change of a liquid into vapours at any temperature below its boiling point is called 'evaporation'. Evaporation is a surface phenomenon i.e. only the particles present on the surface are involved.

§§ FACTORS AFFECTING EVAPORATION

¶¶ Surface Area

Greater is the surface area more is the rate of evaporation. This is because only the particles on the surface of the liquid get converted into vapours.

For example, we often spread the wet clothes in air to dry them. By doing so, the surface area available for evaporation of water increases and hence the clothes get dried up soon.

¶¶ Increase in temperature

The rate of evaporation increases with increase in temperature due to increase in K.E. of liquid particles. This is because, due to increase in K.E., the liquid particles can more easily overcome the forces of attraction of neighbouring particles on the surface of liquid and hence can more easily get converted into vapours.

For example, evaporation of a liquid occurs at a faster rate in summer than in winter.

¶¶ Decrease in Humidity

By humidity we mean, the amount of water vapour present in air. The air around us can hold only a certain definite amount of water vapours at a particular temperature. Now in case, humidity of air is already high i.e. the amount of water vapours in the air is already high, then air can hold only a little more amount of vapours to reach that optimum level (as air can hold only a certain definite amount of water vapours). Therefore the rate of evaporation decreases.

For example, we sweat a lot in hot and humid weather than in dry weather because, air already has high amount of water vapours in humid and hot weather. Therefore, the sweat liquid that comes out of our skin does not evaporate and remains sticking to our body.

¶¶ Increase in the speed of wind

The rate of evaporation increases with increase in wind speed. This is because, due to increase in wind energy, the liquid particles move away with the wind and thus decreasing water vapours in the surroundings.

For example, wet clothes dry faster on a windy day due to increase in wind speed and thereby increasing the rate of evaporation. Similarly we usually sit under the fan during summer days (when we sweat a lot) because fan increases the wind speed around us, thereby increasing the rate of evaporation and making us feel more comfortable (since evaporation causes cooling).

¶¶ Nature of Liquid

The rate of evaporation also depends upon the nature of the liquid. In other words, lesser is the boiling point, more is the tendency of the liquid to evaporate or to change into vapours. It can be explained more clearly by the following example :

Alcohol with a boiling point 351K or 78^0C evaporates much more quickly than water with a boiling point 373K (or 100^0C). This is because the inter particle force of attraction are weaker in alcohol than in water, so that the particles of alcohol can leave the liquid surface to form vapours more easily than the particles of water and thus rate of evaporation of alcohol is faster than that of water.

Hence the liquid with less boiling point will evaporate more quickly than the liquid with more boiling point.

The effect of factors like surface area, temperature, humidity and wind speed on the rate of evaporation of liquids can be explained more clearly by performing the following experiment :

Experiment:

Step I : Take 5ml of water in a test tube and keep it under a fan.

Step II : Take 5ml of water in an open china dish and keep it under a fan.

Step III : Take 5 ml of water in an open china dish and keep it inside a cupboard.

Step IV : Repeat all above three steps of experiment on a rainy day or humid weather and record the time and days taken for evaporation process in all cases.

Observation :

(i) The water taken in a test tube will evaporate slowly than the water taken in two open china dishes.

(ii) The water taken in open china dish placed under fan will evaporate more quickly then water taken in open china dish placed inside a cup-board.

(iii) The first three processes will take longer time for evaporation process on a rainy day or humid weather

Discussion: The surface area of water exposed to atmosphere is minimum in case of test tube, so, it takes a long time (2/3 days) for 5ml of water to evaporate. Although surface area of 5ml of water taken in two open china dishes is the same, yet water in the china dish placed under the fan evaporates more quickly than the water in china dish placed inside a cupboard. This is because wind speed increase due to fan and thereby increases rate of evaporation.

On the other hand, three processes will take longer time for evaporation process on a rainy day or humid whether.

This is due to the reason that

(i) on a rainy day, temperature is reduced and thus rate of evaporation is decreased

(ii) in a humid weather, the amount of water vapours in air are already high and thus rate evaporation is decreased.

Conclusion: From above discussion we led to conclude that, the rate of evaporation of liquid increases with

(i) increase in surface area exposed to the atmosphere.

(ii) increase in temperature.

(iii) increase in wind speed.

(iv) decrease in humidity (i.e. amount of water vapours present in air)

§§ HOW DOES EVAPORATION CAUSES COOLING ?

During evaporation, only the liquid particles having high K.E. leave the surface of the liquid and get converted into vapours. As a result, the average K.E. of the remaining particles of the liquid decreases and hence temperature falls, thus evaporation causes cooling.

It can be explained more clearly by the following example

Place some water in an open vessel. The water keeps on evaporating. For evaporation to occur heat energy is taken from water. The particles of water in turn, absorb energy from the surroundings to regain the energy lost during evaporation. This absorption of energy from the surroundings makes the surroundings cool. Hence evaporation causes cooling.

§§ SOME EXAMPLES OF COOLING CAUSED BY EVAPORATION FROM DAILY LIFE :

(i) Pouring of Acetone on palm : We feel cool when we pour some acetone on our palm. This is because, the energy needed for evaporation is taken from the palm which, in turn, feels cooling.

(ii) Sprinkling water on roof or open ground in summer: We often sprinkle water on the roof of the house or open ground on a hot sunny day. The reason being that the large heat of vaporization of water helps to cool the hot surface.

(iii) Wearing cotton clothes in summer: During summer, we sweat or perspire a lot. The cotton, being a good absorber of water, absorbs the sweat and exposes it to the atmosphere for easy evaporation. Consequently our body feels cool (because evaporation causes cooling). Thus, we wear cotton clothes in summer.

(iv) Water droplets are seen on the outer surface of a glass tumbler containing ice cold water: This is due to the reason that, water vapours present in air, on coming in contact with the cold surface of the glass, lose energy and get condensed or get converted into the liquid state which are see as water droplets.

§§ DIFFERENCE BETWEEN BOILING AND EVAPORATION

	Boiling		Evaporation
1.	Boiling takes place at a particular temperature when the liquid is heated	1.	Evaporation occurs on its own at all temperatures.
2.	Boiling is a bulk phenomenon i.e. it takes place from the whole liquid.	2.	Evaporation is a surface phenomenon i.e. it takes place only from the surface of the liquid.
3.	No cooling is caused during boiling.	3.	Cooling is always caused by evaporation.

Question 25: **Why does a desert cooler cool better on a hot dry day ?**

***Solution*:** A hot dry day means temperature of the atmosphere is high and humidity of air is low. Since both these factors increase the rate of evaporation, an enormous cooling is produced and thus desert cooler cool better on a hot dry day.

Question 26: **How does the water kept in an earthen pot (matka) become cool during summer?**

***Solution*:** During summer, water kept in an earthen pot (matka) continues to evaporate through the fine pores on it. Since evaporation causes cooling, water kept in **matka** becomes cool during summer.

Question 27: **Why are we able to sip hot tea or milk faster from a saucer rather than a cup ?**

***Solution*:** The surface area of the liquid hot tea or milk is more in a saucer than in a cup. Therefore, evaporation or cooling will take place more rapidly in a saucer than in a cup. Consequently we are able to sip hot tea or milk faster from a saucer rather than a cup.

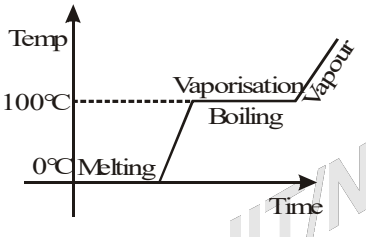
Question 28: **What type of clothes should we wear in summer?**

***Solution*:** In summer, we sweat or perspire more. The cotton clothes, being good absorber of water, absorbs the sweat and exposes it to the atmosphere for easy evaporation. Since evaporation causes cooling, therefore, we should wear cotton clothes in summer.

TEACHING TASK

Single answer type questions :

1. In an experiment of conversion of ice into water and water into vapour, observations were recorded and a graph plotted for temperature against time as shown below. From the graph it can be concluded that :-



(A) Ice takes time to heat up to 0°C

(B) During melting and boiling temperature does not rise

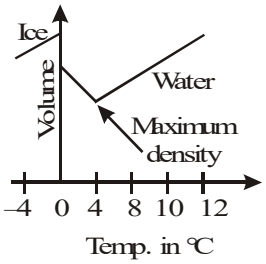
(C) Process of boiling takes longer time than the process of melting

(D) All the above

2. The SI unit of temperature is :-

(A) °C (B) °F (C) K (D) All of the above

3. Study the graph given below and select the correct statement



(A) When water is cooled to 4°C it contracts

(B) At 0°C water freezes

(C) The volume of ice is more than that of water

(D) All of these

4. The solid state of CO_2 is called :-

(A) Tear gas (B) Cooking gas (C) Dry ice (D) Laughing gas

5. Corresponding temperature in the Kelvin scale for 104°C F is :-

(A) 313 K (B) 203 (C) 308 K (D) 377 K

6. When the vapour pressure of a liquid is equal to its atmospheric pressure, then it :-

(A) Freezes (B) Evaporates

(C) Boils (D) Does not undergo any change

7. When ice is converted into water :-

(A) Heat is absorbed (B) Heat is released

(C) Temperature increases (D) Temperature decreases

8. When water particles condenses on air on dust, it forms :-

(A) mist (B) fog (C) frost (D) Vapour

9. Which is more effective in cooling ?

(A) Water at 0°C (B) Water at 100°C (C) Ice at 0°C (D) All of these

10. The temperature at which Celsius and Fahrenheit scales show the same reading is :-

(A) 40° K (B) 100° F (C) – 40° C (D) – 100°C

11. Latent heat of fusion for ice is :-

(A) 80 gm cal^{-1} (B) 80 cal / gm (C) 19 J cal^{-1} (D) None of these

II. Reason & Assertion type

(A) (A) and (R) are true and (R) explains (A)

(B) (A) and (R) are true but (R) does not explain (A)

(C) Only (A) is true (D) Only (R) is true

12. Based on the statements given here choose the correct answer.

Assertion(A): Boiling point of a liquid increases with increase in temperature.

Reason(R): The volume of liquids increases on boiling and the vaporisation curve shows the variation of the boilingpoint of a liquid with pressure and expands the equilibrium state between liquid and vapour phase.

13. Assertion(A): In polar regions aquatic life is safe in water under frozen ice.

Reason(R): Water has a high latent heat of fusion and the upper portion of ice does not allow the heat of the water to escape to the surroundings.

14. Assertion(A): If we increase the temperature of a gas inside a container, its pressure also increases.

Reason(R): Upon heating, the rate of collisions of the gas molecules increase and increases the impact of force on the walls of the container.

III. Matrix Matching Type

15.

Column-I	Column-II
(i) Solid	(a) Super energetic particles
(ii) Liquid	(b) No shape nor fixed volume at a given pressure
(iii) Gas	(c) Has definite shape
(iv) Plasma	(d) Define shape with less molecular forces than that in solids

16.

Column-I	Column-II
(i) Evaporation	(a) Liquid to gas at a fixed temperature
(ii) Vaporisation	(b) Solid to gas
(iii) Sublimation	(c) Gas to solid
(iv) Hoar frost	(d) Liquid into gas at any temperature

TEACHING TASK KEY

1)D 2)C 3)D 4)C 5)A 6)C 7)A 8)A 9)C 10)C

11)B 12)A 13)A 14)A 15) (i) – c, (ii) – d, (iii) – b, (iv) – a

16) (i) – a, (ii) – b, (iii) – c, (iv) – d

STUDENT TASK

BEGINNERS (LEVEL-I)

I.Single Correct Choice Type:

1. The smallest particle of an element is:

   A) An atom B) A molecule C) Substance D) Compound

2. which of the following is a rigid substance

   A) Wood B) Water C) Air D) Honey

3. The inter particle forces are moderate in

   A)sand B) water C) nitrogen D) oxygen

4. The kinetic energy of the particles of matter will be in the following order

   A)solid >liquid> gas B)solid <liquid< gas

   C) gas >liquid> solid D)solid >gas>liquid

5. The boiling point of liquid is ..... with addition of impurities to it

   A)increases B)decreases

   C) remains same D)can' be predicted

6. Evaporation takes place

   A)below the boiling point of the liquid

   B) above the boiling point of the liquid

   C)at the boiling point of the liquid

   D) above or below the boiling point of the liquid

7. Drying of wet clothes is an example for

   A) Vapourisation B) Boiling C) Freezing D) Evaporation

8. High diffusion property

   A) Nitrogen gas B) Water C) Soluble solids D) All are same.

9. In solids molecules are

   A) Having high intermolecular attraction B) Having less intermolecular distance

   C) Are fixed in their positions D) All the above

10. Having highest kinetic energy to the molecules among the following

    A) Water vapour B) Water C) Ice D) Sand

11. Gases occupies available space because

    A) Intermolecular spaces are high B) Intermolecular attraction is negligible

    C) Less density D) Highly compressible.

ACHIEVERS (LEVEL-II)

1. State two uses of interconversion of matter ?
2. Diffrentiate between the following
   A)evaporation and boiling
   B)gas and vapour
3. Namw the phenomenone that causes the following
   A)Formation of clouds
   B)Dry ice dissapears if kept on a table
   C)Ghee on heating changes into liquid
4. Give one simple activity/experiment to show
   (i) Particles of matter are very small
   (ii) Ammonium chloride sublimes.
5. Convert the following:
   (i) 375 K to celsius scale. (ii) 27°C to kelvin scale. (iii) 1.01×10^5 Pa to atmosphere.

EXPLORERS (LEVEL-III)

I.MCQs with more than one answer is correct :

1. Properties of solids
   A) rigid B) Less density C) Diffusion D) High melting point
2. Sublimating solids
   A) Solid carbondioxide B) Liquid oxygen
   C) Naphthalene D) Ammonium chloride.
3. Inter conversion of states of matter depends on
   A) Temperature B) Pressure C) density D) volume.
4. Properties of matter
   A) Volume B) Sense C) Mass D) Energy.
5. Which of the following material requires a container
   A)water B)Milk C)Oil D) Wood
6. Matter occupies _____ and has _____.
   A) Space B) Heat C) Mass D) Pressure
7. The whole universe is composed of :
   A) Matter B) Energy C) Atoms D) Molecules

8. Melting point of ice is

A)0^0c B)253K C)100^0c D)273K

9. Sublimation is a process of inter conversion of

A) solid to gas B)gas to solid

C)liquid to gas D)gas to liquid

10. Which of the followoing process occur on cooling

A) melting B) Liquification

C) Solidification D) condensation

II. Matrix Match Type:

1.

Column-I		**Column-II**
a)	Liquifaction	1) Solid state to direct gaseous state
b)	Melting point	2) Liquid changes into solid
c)	Freezing point	3) Solid changes into liquid
d)	Sublimation	4) Gaseous states to liquid state
		5) Liquid to gaseous state

A) a - 4, b - 1, c - 2, d - 3 B) a - 4, b - 3, c - 2, d - 1

C) a - 2, b - 3, c - 1, d - 4 D) a -3, b -2, c - 4, d - 1

2.

Column-I	**Column-II**
a) The molecules are made up of smaller particles	1) Molecules
b) Matter is made up of	2) Liquefaction point
c) The constant temperature at which gas changes into liquid	3) Atoms

A) a - 3, b - 1, c - 2, B) a - 1, b - 3, c - 2,

C) a - 2, b - 3, c - 1, D) a -3, b -2, c - 1,

III. Comprehension Type:

Interconversion of matter involves change of state of matter from one state to another state and back to its original state due to change in temperature and pressure.

1. The constant temperature at which a gas changes into a liquid state is called:

A) Boiling point B) Freezing point

C) Liquefaction point D) Melting poinht

2. The change in state from liquid to gaseous is known as:

A) Evaporation B) Vapourisation C) Both 1 and 2 D) Condensation

3. Solids vapourise without melting into liquid this process is involved in:

A) Sublimation B) Evaporation C) Condensation D) Liquifaction

RESEARCHERS (**Level - IV)**

1. A drop of ink can diffuse faster as compared to a drop of honey because

A) The attractive forces among the particles in blue ink are less compared to honey

B) The attractive forces among the particles in blue ink is more as compared to honey

C) There are no atlractive forces among the particles in blue ink

D) There are no attractive forces among the particles of honey

2. You know boiling point of water is 100^0C. You are applying more pressure on water when you are heating. Change observed in the boiling point of water is

A) Less than 100^0C B) equal to 100^0C

C) no boiling point D) Greater than 100^0C

3. Inter convertion involved in usage of "odonil" in wash room is

A) Sublimation B)Deposition C)Melting D)Freezing

4. Interconversion of matter involves change of matter from one state to another and back to its original state. It is affected by changes in conditions such as

A) Only temperature. B) Only pressure.

C) Both temperature and pressure. D) Neither pressure nor temperature

5. Water $\underset{B}{\overset{A}{\rightleftharpoons}}$ Water vapour

A) A : solidification, B : vaporisation

B) A : vaporisation, B : condensation

C) A : melting, B : solidification

D) A : condensation, B : melting

6. The fundamental property of matter by virtue of which body resists to change its original position is called

A) Elasticity B) Buoyancy C) Continuity D) Inertia

7. Solid $\underset{B}{\overset{A}{\rightleftharpoons}}$ Liquid .Select the right option

A) A : vaporisation, B : condensation

B) A : condensation, B : vaporisation

C) A : sublimation, B : liquefaction

D) A : melting, B : solidification

8. The glow of stars is due to the presence of ..... in it

A)metane B) plasma C) nitrogen D) oxygen

9. Which of the following is gaseous form of the solid

A)Slaked lime B) Graphite C)solid CO_2 D)quick lime

10. $\underset{(Solid)}{Ice} \overset{A}{\underset{B}{\rightleftharpoons}} \underset{liquid}{Water} \overset{A}{\underset{B}{\rightleftharpoons}} \underset{gas}{Water\ vapour}$ Identify A, B

	(A)	*(B)*
A)	Heating	Heating
B)	Cooling	Heating
C)	Heating	Cooling
D)	Cooling	Cooling

STUDENT TASK KEY

BEGINNERS (Level-I) : 1.A 2.A 3.B 4 .C 5.B 6.A 7.D 8.A 9.D 10.A 11.B

EXPLORERS (Level-III) : 1.A,D 2.A,C,D 3.A,B 4.A,B,C 5.B,C 6.A,C 7.A,B 8.A,D 9.A,B 10.B,C,D

Matrix Matching: 1) B 2) A

Comprehension type : 1) C 2) C 3) A

(RESEARCHERS)Level -IV 1. A 2.B 3.A 4.C 5.A 6.A 7.D 8. B 9.C 10.C