MATTER IN OUR SURROUNDING

1. INTRODUCTION

Early Indian philosophers and ancient Greek philosophers classified matter in the from 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, stats, 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 no constitute matter while we perceive.

DEFINITION

Material :- The term used to describe a particular kind of matter, is called material e.g. – wood, water and marble.

Type of material :-

(a) Homogeneous material :- A material which has same composition and same properties throughout, is called homogeneous material .

(b) Heterogeneous material :- A material which has different composition and different properties in different parts is, called heterogeneous material. For e.g. – In marble, presence of grey and red grains of other materials.

Matter : - Anything which occupies space and has mass is called matter, so everything in the universe is "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) Matter is categorized as a gas, a liquid and a solid on the basis of physical state. For e.g. – Air, water, and the earth. Change 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) On the basis of chemical nature matter is classified as an element compound or mixture. Elements and compounds are pure substances whereas a mixture contains two or more pure substances.

Physical nature of matter :-

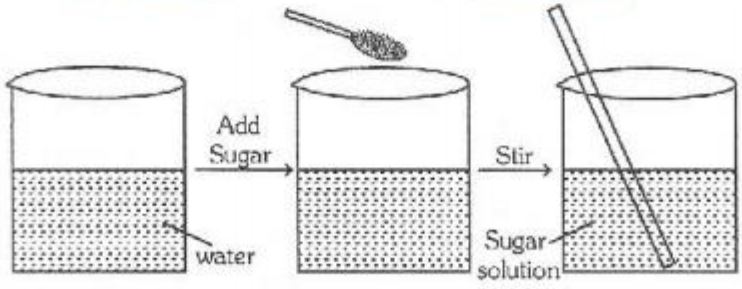
(1) Matter is made up of particles :- The particle nature of matter can be demonstrated by a simple activity

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

(b) Mark the level of water.

(c) Add some sugar to the beaker and sir 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 spaces between particles of water

Conclusion : - It is observed that crystals of sugar disappear. The level of water remains unchanged. 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.

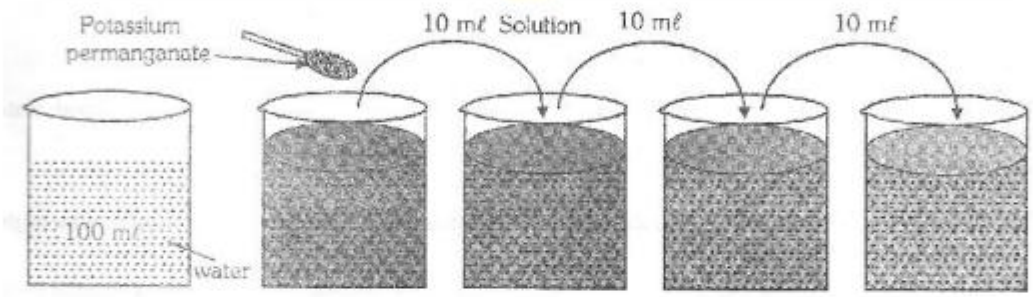
(i) Take a 250 beaker and add 100 ml water to it.

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

(iii) Take 10 ml of this solution and add to 100 ml of water taken in another beaker.

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

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



Decrease in colour of potassium permanganate solution

Conclusion :- (i) It is observed that the water 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 soleplate $CuSO_45H_2O$ crystals, (for colours)

(iii) Dettol (for smell)

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 :-

Activity – (a) If an incense stick (Agarbatti) is lighted and placed in one corner of a room, its pleasant small spreads in the whole room quickly. It demonstrates that the particles of matter possess motion. A burning incense stick produces some gases (vapour) having pleasant small. 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 kinetic Energy of particles increases with increase in temperature.

Note :- Kinetic energy :- Kinetic energy is energy of motion and is usually defined 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 $= \frac{1}{2}mv^2$

(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 purple colour of potassium permanganate starts spreading and after sometime the entire solution become purple. The rate of mixing is faster in case of hot water. This experiment demonstrates that the particle of matter possess motion and that the kinetic energy of the particles increase with increase in temperature.

Form these activities it is observed 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.

"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 between the particles of the same substance is known as cohesion. The force of attraction (or cohesion) is different in the particles of different kinetic of matter .

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

(a) Take a piece of iron wire, a piece of chalk and a rubber band.

(b) Try to break them by hammering, cutting or stretching. 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 indicates that particles in matter are held by some attractive forces, the strength of these attractive forces varies from on matter to anther.

Q. We can get smell perfume sitting several meters away, why ?

Ans. This is because perfumes contain volatile solvent which carries pleasant smelling vapours. They diffuse quite fast and can reach to people sitting several meters away.

STATES OF MATTER

Matter can be classified into 3 states on the basis of physical state-solids, liquids and gases.

Properties of solids :-

(1) Solid state :-

(a) A solid possesses a fixed volume and a definite shape, distinct boundaries and a definite mass.
(b) Solids are rigid and almost incompressible.
(c) Solids may break under force but it is difficult to change their shape.
(d) Solids generally possess high densities
(e) Solids do not exhibit diffusion.

Note:- Density : - The mass of a substance per unit of volume .

Formula – $\boxed{\text{density} = \frac{mass}{volume} = \frac{kg}{m^3}}$ **orkgm^{-3}**

InSI it is measured in kgm^{-3}.

(f) In solids intermolecular forces of attraction is more strong.

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

Volume :- All solids occupy a volume the shape occupied by a substance is called volume .
The unit of volume is m^3 (cubic meter) . The common unit of volume is litre. (L)
$1m^3 = 1000\ dm^3 = 1000\ L$
$1\ L = 1\ dm^3$
1L = 1000 ml = 1000 cm3

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 .

(ii) A rubber band undergoes a change in shape on stretching, still we call it a solid.

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

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

Some example in solids which shown diffusion –

(a) If we write something with chalk on a black-board and leave it as such for a few days, it becomes difficult to clean. This is due to diffusion of chalk particles into the surface of the black-board.

(b) 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.

(2) Liquid state : Properties of Liquids :-

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

(b) Liquids are also almost incompressible but are not rigid. In fact, 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 force 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 interparticle spaces in liquids are larger and the particles in liquid state move freely.

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 – (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 form food.

(3) Gaseous state :-

Properties of Gases

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

(b) Gases are highly compressible.

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 .

(c) The gases exhibit the property of diffusing very fast into other gases.

Examples of diffusion in gases

(i) The smell (aroma) of perfumes of any thing is mix with the particles of air and reaches in seconds to very much distance.

(ii) 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) The smell of hot sizzling food reaches you several metres away. but to get the smell from cold food you have to go close.

Explanation :- The smell of hot sizzling food reaches us more quickly as compared to smell of cold food. This is because rate of diffusion is faster at higher temperature than at lower temperature. The rate of diffusion of not sizzling food is more and hence reaches you even several metres away. On the 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 exerts pressure on the walls of the container in which they are stored .

Note :- Pressure :- In the gaseous state the particle move about randomly at high speed. Due to their random movement , the particles hit each other and also the walls of the container. The pressure exerted by the gas is because of this force exerted by gas particles per unit area on the walls of the container.

The atmospheric pressure at sea level is 1 atm, and is taken as the normal atmospheric pressure.

$\boxed{P = \frac{F}{A}}$ **P = Pressure, F = Force, A = Area**

It is measured in "pascals" (Pa) in SI units and other unit is atm. These two units are related as

1 atm = 10.1 × 10^5 pa

1 bar = 1 × 10^5 pa

1 bar = 1.01 atm.

(e) Gases can flow easily in all directions.

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

Example of gaseous state :- Air, hydrogen (H_2), carbondioxide (CO_2), hydrogen sulphide (H_2S), ammonia (NH_3), oxygen (O_2), Nitrogen (N_2) etc.

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

Ans. In air the intepatricle attractive forces are negligible and hence, it is easy to separate the particles in air and we can easily move our hand through it. In a solid block of wood, the interparticle forces are very strong and hence, it is not easy to separate the particles. Therefore it is not easy to move our hand through a solid block of wood (only a karate expert can do it). Dut to this property large volume of a gas can be compressed into a small cylinder and transported easily .

STUDY OF COMPRESSIBILITY OF GASES AND LIQUIDS

Activity –

(i) Take three 100 ml syringes and close their nozzles by inserting them in a rubber cork. Remove the pistons from all the syringes.

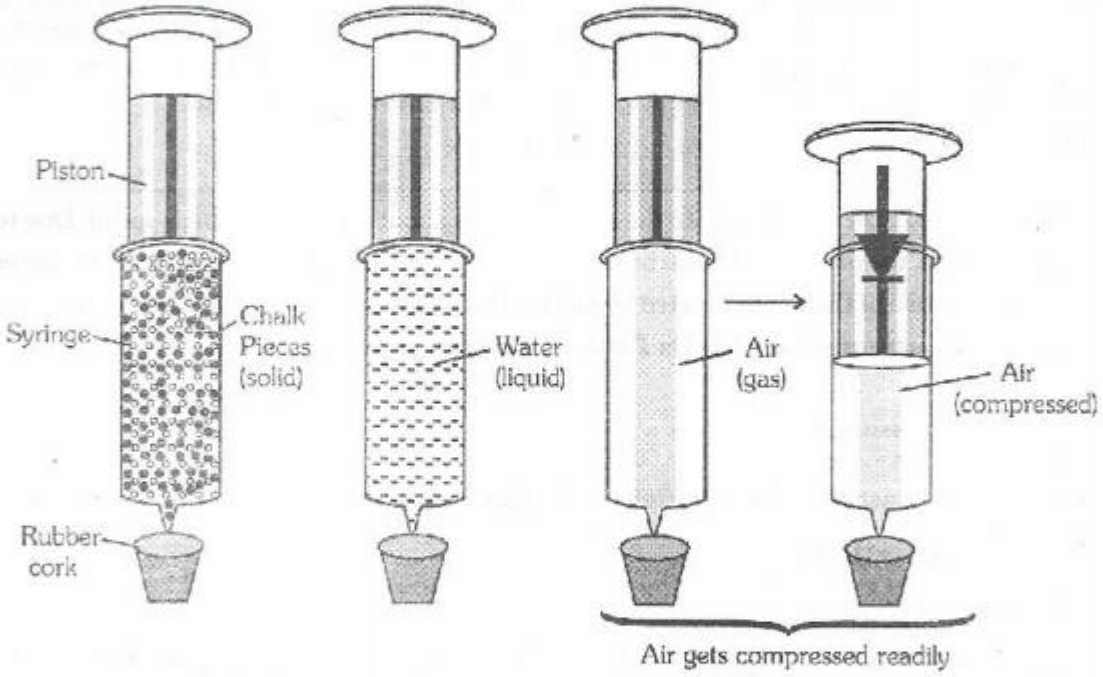
(ii) Fill chalk chalk pieces in the first, water in the second and leave third syringe as such. It already contains air

(iii) Insert the pistons back into the syringes

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

It is observed that when the syringe constraining air, is compressed by applying pressure, the piston can move downward easily and it can be compressed to a larger extent. But when the second syringe containing water is compressed, it is compressed not 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.

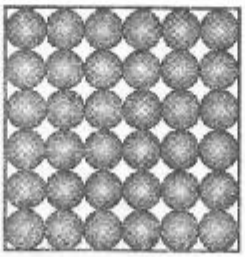
Conclusion : - This shown that gases are more compressible than liquids.



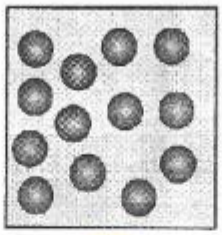
Study the compressibility of solid, liquid and gas.

EXPLANATION OF SOLID, LIQUID AND GAS STATE ON THE BASIS OF MOLECULAR STRUCTURE

In case of solids :- the intermolecular spaces are very small and intermolecular forces are very large. Thus, the molecules in a solid can vibrate about their mean positions, but cannot change their positions. It is on account of this molecular arrangement, that solids have definite shape and definite volume. Further more, they are incompressible.

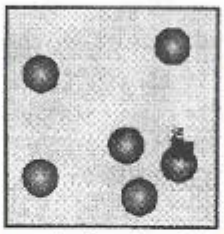


In case of liquids, the intermolecular spaces are some what large and intermolecular forces fairly small as compared to the solids. Further more, the molecules of the liquid have large kinetic energy. It is on account of the larger kinetic energy and large intermolecular spaces that the molecules can interchange their position. It is on account of this reason that liquids take the shape of containing vessel and flow from higher to lower level . However, the intermolecular forces in the liquids are sufficient to hold the molecules together and therefore, they have fixed volume. They are incompressible.



Arrangement of molecules in a liquid

In gas the intermolecular spaces are 1000 times or more than the liquids. This in turn weakens the intermolecular force to almost negligible magnitude. The molecules of a gas are free to move about in any direction. This accounts for the fact that gases have no definite shape or volume and occupy all the available apace. Due to large intermolecular space, they are easily compressible



Arrangement of molecules in a gas

Example – (i) Cooking gas used in homes is liquefied petroleum gas (LPG) which is obtained by compressing petroleum gas into steel cylinders. **(ii)** Compressed natural gas (CNG) is used as automobile fuel because the natural gas (methane) can be easily compressed **(iii)** The industrial gases such as ammonia (NH_3), chlorine (Cl_2), oxygen (O_2) etc. are compressed and transported to various places.

Q. Arrange the following substances in increasing order of forces of attraction between the particles – water, sugar , oxygen.

Ans. Oxygen < water < Sugar

Q. Give two reasons to justify -

(a) Water at room temperature is a liquid.

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

Ans. (a) (i) Intermolecular forces are less.

(ii) Intermolecular spaces and kinetic energy is more.

Thus, the molecule of water can interchange their spaces and hence water is in liquid state at room temperature (b) (i) Intermolecular forces are very large.

(ii) 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

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

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.

Comparision of characteristic properties of solids, liquids and gases :-

S.No.	Property	Solids	Liquids	Gases
1	Shape	Definite	Take the shape of the container, but do not necessarily occupy all of it	Take the shape of the container by occupying whole of the space available to them.
2	Volume	Definite	Definite	Take the volume of the container.
3	Compressibility	Almost nil	very very less	Very large
4	Fluidity of Rigidity	Rigid	Fluid	Fluid
5	Density	High	Low	Very low
6	Diffusion	Generally do no diffuse	Diffuse slowly	Diffuse rapidly
7	Free surfaces.	Any number of free surfaces.	Only one free surface	No free surface.

Chang of state of matter :- A substance may exist in three states of matter i.e., solid, liquid or gas, depending puon the conditions of temperature and pressure. By changing the conditions of temperature and pressure, all three states could be obtained (solid, liquid, gas). On heating a solid changes into a liquid which on further heating changes into gas.

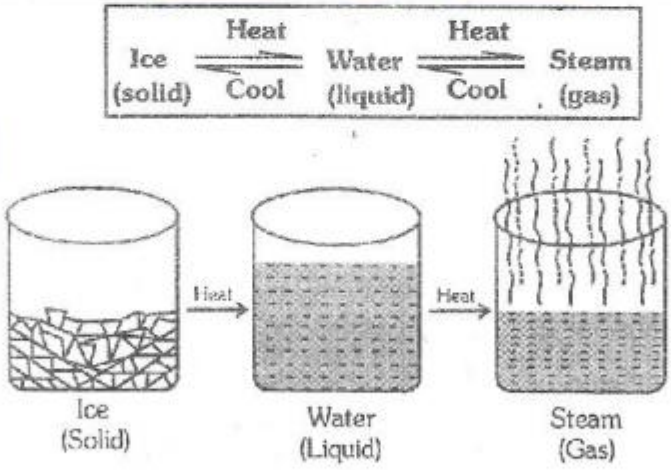
Example – Water exists in all the three states.

Solid : ice

Liquid : water.

Gas : water vapour

Ice is a solid state and may be melted to form water (liquid) which on further heating changes into steam (gas). These changes can also be reverse on cooling .



Change in three states of matter

Q. Why ice floats on water ?

Ans. Solids generally have higher density than the liquids but ice due to its specific structure has larger interparticle spaces and hence has lower density than liquid water. As a result ice floats on water.

Quantity	Unit	Symbol
Mass	Kilogram	Kg
Length	Meter	m
Temperature	Kelvin	K
Weight/force	Newton	N
Volume	Cubic meter	m^3
Density	Kilogram/Cubic meter	Kg/m^3
Pressure	Pascal	Pa

Some Important Relations
1kg = 1000g
1m = 100 cm
$1m^3 = 10^6 cm^3$ or 10^3 L (litre)
103 cm^3 = 1 L

Temperature and pressure are the two factors which decide whether a given substance would be in a solid, liquid or gaseous state.

(1) Effect of change of temperature :- The effect of temperature on three states of matter could be seen by performing the following activity

Activity :-

(i) Take a piece of about 10 – 150g of ice in a beaker.

(ii) Hang a thermometer in it so that its bulb is in contact with ice.

(iii) Start heating the beaker slowly on a low flame.

(iv) Note down the temperature when ice starts changing of water & ice has been converted to water.

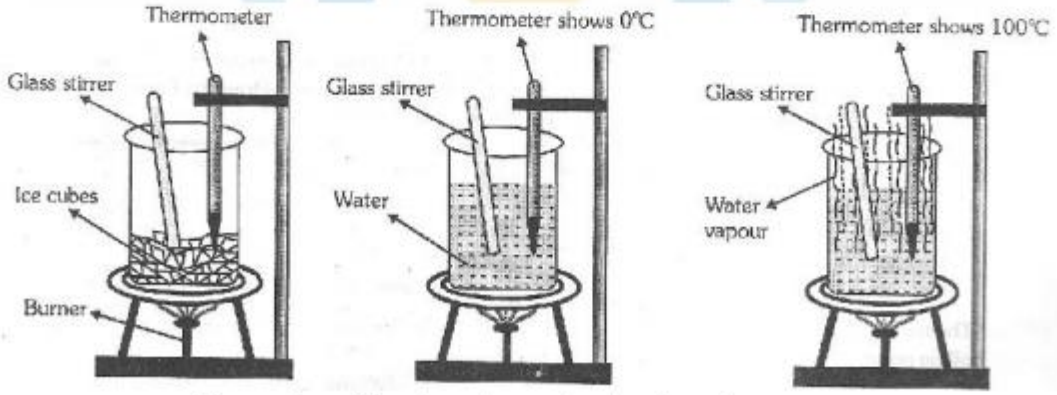
(v) Record all observations for the conversion of solid ice into liquid water.

(vi) Now, place a glass rod in the beaker and slowly heat the beaker with constant stirring with help of a glass rod.

(vii) Note the temperature when water starts changing into water vapours.

(viii) Record all observations for the conversion of water in the liquid state to vapour state.

It is observed that as temperature increases, the ice starts changing into water. This change is called **"Melting"** The temperature remains same till all the ice changes into water. The thermometer shown 0^0C until all the ice has melted. On further heating, the temperature stats rising. At 373 K (or 100^0C), water starts boiling. As the water continue boiling the temperature remains almost constant.



Conversion of ice to water and water to water vapour

Explanation about interconversion of different three state of matter :-

(i) **Solid to liquid change (melting) : -** Ice is a solid. In solid, the particles are tightly packed together. When we heat a solid, its particles become more energetic and kinetic energy of the particles increase. Dut to the increase in kinetic energy, the particles start vibrating more strongly with grater speed. The energy supplied by heat overcomes the intermolecular forces of attraction between the particles. As a result, the particles leave their mean position and break away from each other. After this solid melts and a liquid is formed.

"The temperature at which a solid melts to become a liquid at the atmospheric pressure is called its melting point". The process of melting is also called "Fusion". The melting point of ice is 0^0C. It may also be written as 273.16 K or 273 K.

NOTE :- The temperature is represented in celsius scale as ^{0}C. Now a days it is expressed on kelvin scale (K).

Conversion of temperature on celsius scale to kelvin scale:

For example :- $0^0C = 0 + 273 = 273$ K

$100_0C = 100 + 273 = 373$

Conversion of temperature on kelvin scale to scelsius scale :

For example :- 373 K = 373 – 273 = 100^0C

Q.	**Convert the following temperatures to the celsius scale.**	
	(a) 300 K	**(b) 573 K**
Ans.	**(a) 300 – 273 = 27^0C**	**(b) 573 – 273 300^0C**
Q.	**Convert the following temperature to the kelvin scale.**	
	(a) 25^0C	**(b) 373^0C**
Ans.	**(a) 25 + 273 = 298 K**	**(b) 373 + 273 = 646 K**

It is observed that the temperature of the system does not change after melting point is achieved till the ice melts, though we continue to heat the beaker. This is happen because the heat supplied is used up in changing the state by breaking the intermolecular forces of attraction which hold them in solid state. As a result, there is no change in temperature till all the ice melts. This energy required to change solid into liquid is called **"latent heat"**. The word "latent" means **"hidden"** because this energy is hidden into the contents of the beaker.

Latent heat is of two types :- (a) Latent heat of fusion (b) Latent heat of vaporization.

(a) Latent heat of fusion : - Latent heat of fusionis defined as the amount of heat energy required to change 1 kg of a solid into a liquid at atmospheric pressure without any change in temperature at its melting point". The latent heat of fusion of ice is 3.34×10^5 J/Kg

Q. Ice is at 273 K more effective in cooling, than water at the same temperature, why ?

Ans. One kilogram of ice at 273 K, needs 3, 36000 J of heat energy in order to from water at 273 K. As the ice can extract out large amount of heat energy on melting to form water at the same temperature, therefore, it is more effective in cooling.

(ii) **Liquid to gas change (Boiling or vaporizations) :-** In a liquid most of the particles are close together. When we supply heat energy to the liquid, the particles of water start vibrating even faster. Some of the particles become so energetic that they can overcome the attractive forces of the particles around them. Therefore, they become free to move and escape from the liquid. Thus the liquid evaporates i.e., starts changing into gas.

"The temperature at which a liquid changes into a gas or vapour at the atmospheric pressure is called its boiling point".

"Boiling" is a bulk phenomenon.

Example – For water, the boiling point is 100^0C or 373 K. The particles in steam i.e., water vapour at 373 K have more energy than water at the same temperature.

Reason :- This is because the particle in steam have absorbed extra energy in the form of latent heat of vaporization.

(b) Latent heat of vaporization :- The latent heat of vaporization of a liquid is the quantity of heat in joule required to convert 1 kilogram of the liquid (at its boiling point) to vapour or gas, without any change in temperature. The latent heat of vaporization of water is 22.5×10^5 joules per kilogram (or $22.5 \times 10_5$ J/kg)

Q. What produces more severe burns, boiling water or stem ?

Ans. Steam will produce more severe burns than boiling water. It is because, 1 g of steam at 373 K (100^0C) contains 2260 J of energy more in the form of latent heat of vaporization as compared to water at 373 K (100^0). Thus steam produces more severe burns.

The boiling point of a liquid also indicates the strength of intermolecular force of attraction between particles. Volatile liquids such as alcohol, petrol and acetone have very weak intermolecular forces. Therefore, they boil at low temperature. On the other hand, water has stronger intermolecular forces of attraction and therefore, it boils at higher temperature. When steam is cooled, it condenses to water & when water is cooled, it changes to ice.

Stem —(*Cool below 100^0C*, *Condensation*)→ **Condenses to water** —(*Cool below 0^0C*, *Solidification*)→ **Frozen or solidifies to Ice**

Solid state ⇌ (Heat / Cool) **Liquid state** ⇌ (Heat / Cool) **Gaseous state**

NOTE :- Condensing is opposite to evaporating and freezing is opposite to melting.

Q. What is the physical state of water at -
(a) 25^0C (b) 0^0C (c) 100^0C

Ans. (a) 25^0C – Water is in liquid state.
(b) 0^0C – Water is in solid state.
(c) 100^0C – Water is in gaseous state.

Sublimation

The process due to which a solid directly changes into gaseous state on heating, without changing first into liquid state and the gaseous state, directly change into solid state on cooling, is known as "Sublimation"

Example :- Ammonium chloride, camphor, iodine, naphthalene, solid carbon dioxide or (dry Ice), anthreacene.

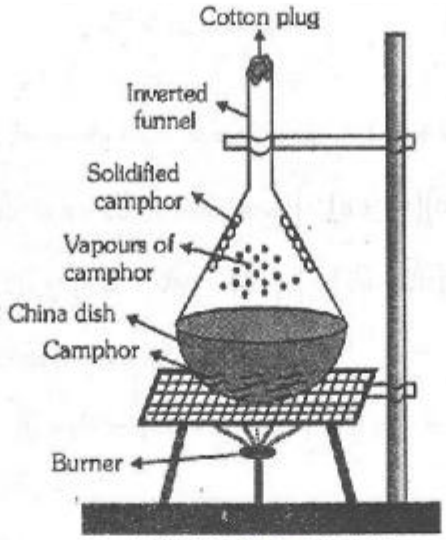
Sublime :- A gaseous form, directly formed from a solid on heating , is known as sublime.

Sublimate :- A solid state of matter formed directly from its gaseous state on cooling, is called sublimate.

To understand sublimation process we can do an activity :-

1. Take some camphor or ammonium chloride.
2. Power it and put in a china dish.
3. lace an inverted funnel over the china dish.
4. Heat the china dish slowly.

We observe that solid camphor on heating gets converted into vapour which gets condensed on the funnel. Solid state is directly converted in to gaseous state. This experiment shows sublimation process.



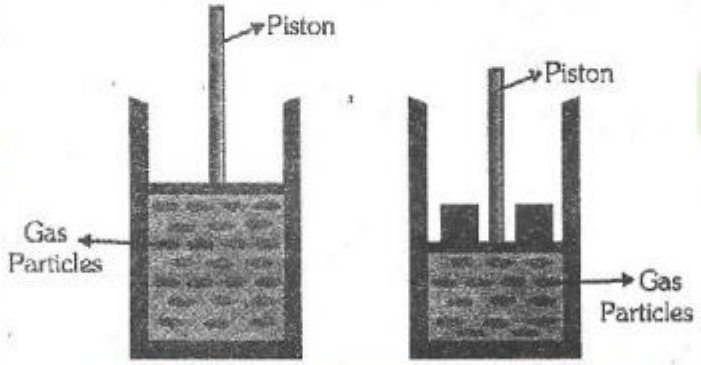
Sublimation process

Q.	**Naphthalene balls disappear with time without leaving any solid why ?**
Ans.	**Naphthalene is volatile solid and has a tendency to sublime, therefore, it changes into vapours completely which disappear into the air and no solid is left**

(2) Effect of change of pressure :- Gases are compressible because on applying pressure, the space between the gaseous particles decreases. Therefore gases can be compressed readily.

By applying pressure and reducing temperature, the gases can be converted into liquids i.e. gases will be liquefied.

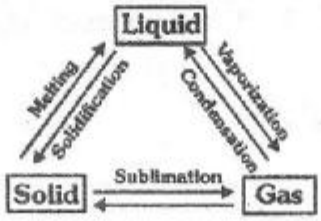
"This process of conversion of a gas into a liquid by increasing pressure or decreasing temperature is called liquefaction.



By applying pressure particles of matter can be brought close together

Thus, we can conclude that temperature and pressure determine the state of a substance ; solid, liquid or gaseous.
NOTE :- Solid carbondioxide is also called dry ice, Solid CO_2 gets converted into gaseous state directly on

Interchange between different states



Three conditions of temperature and pressure which decide the state of matter :-

- If the melting point of a substance is above the room temperature at the atmospheric pressure, it is called **solid**.
- If the boiling point of a substance is above room temperature under atmospheric pressure, it is classified as **liquid**.
- If the boiling point of the substance is below the room temperature at the atmospheric pressure, it is called **gas**.

EVAPORATION

"The process of a liquid changing into vapour (or gas) even below its boiling point is called evaporation ".

Evaporation of a liquid can take place even at room temperature, though it is faster at higher temperatures. It is **surface phenomenon** because it occurs at surface of a liquid only.

Whatever be the temperature at which evaporation takes place, the latent heat of vaporizations must be supplied whenever a liquid changes into vapour (or gas).

Explanation about Evaporation :- Some particles in a liquid always have more kinetic energy than the others. So even when a liquid is well below its boiling point, some of its particles have enough energy to break the force of attraction between the particles and escape from the surface of the liquid in the form of vapour (or gas). Thus, the fast moving particles (or molecule) of a liquid are constantly escaping from the liquid to from vapour (or gas)

Examples :- (i) Water in ponds changes from liquid to vapour without reaching the boiling point.
(ii) Water when left uncovered slowly changes into vapour.
(iii) When we put wet clothes for drying, the water from the clothes goes to the atmosphere.

Differences between evaporation and boiling.

	Evaporation	Boiling
1	Evaporation process takes place spontaneously at all temperatures.	Boiling takes place only at definite temperature (boiling point) at which the vapour pressure of the liquid is equal to atmospheric pressure.
2	Evaporation takes place only at the surface of the liquid	Boiling takes place even below the surface of the liquid in the form of bubbles.

Factors Affecting Evaporation

There are five factors which affects the rate of evaporations:

(i) **Nature of liquid :-** Different liquids have different rates of evaporation. A liquid having weaker interparticle attractive forces evaporates at faster rate because less energy is required to overcome the attractive forces.
Example – Acetone evaporates faster than water.

(ii) **Surface area of the liquid :-** The evaporation depends upon the surface area. If the surface area is increased, the rate of evaporation increases because the high energy particles from liquid can go into gas phase only through surface.

Example :- (a) The rate of evaporation increases when we put kerosene or petrol in an open china dish than in a test tube.
(b) Clothes dry faster when they are well spread because the surface area for evaporation increases.

(iii) **Temperature:-** Rate of evaporation increases with increase in temperature. This is because with the increase in temperature more number of particles get enough kinetic energy to go into the vapour state (or gaseous state)
Example – Clothes dry faster in summers than in winters.

(iv) Humidity in the air:- The air around us contains water vapour or moisture. The amount of water present in the air is referred to as humidity. The air cannor hold more than a definite amount of water vapour at a given temperature. If the humidity is more, the rate of vaporization decreases. The rate of evaporation is more if the air is dry.

Example :- Clothes do not dry easily during rainy season because the rate of evaporation is less due to high moisture content (humidity) in the air.

(v) Wind speed:- The rate of evaporation also increases with increase in speed of the wind. This is because with increase in speed of wind, the particles of water vapour move away with wind resulting decrease in the amount of vapour in the atmosphere.

Example:- (i) Clothes dry faster on a windy day.

(ii) In a desert cooler an exhaust fan sucks the moist air from the cooler chamber which results in greater are of evaporation of water an hence greater cooling.

Evaporation causes cooling:- During evaporation, cooling is always caused. This is because evaporation is a phenomenon in which only the high energy particles leave the liquid surface. As a result, the particles having low energy are left behind. Therefore, the average molecular energy of the remaining particles left in the liquid state is lowered. As a result, there is decrease in temperature on the part of the liquid that is left. Thus evaporation causes cooling.

Example:- (i) When we pour some acetone on our palm, we feel cold. This is because the particles gain energy from our palm or surroundings and leave the palm feeling cool.

(ii) We sprinkle water on the root or open ground after a sunny hot day. This cools the roof or open ground. This is because the large latent heat of vaporization of water. helps to cool the hot surface.

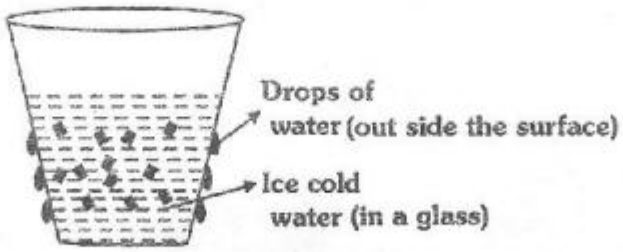
Some other examples of evaporation:-

(i) We should wear cotton clothes in hot summer days to keep cool and comfortable.

This can be explained as follow. We get a lot of sweat on our body in hot summer days. Cotton is a good absorber of water, so it absorbs the sweat from our body and exposes it to the air for evaporation. The evaporation of this sweat cools our body. The synthetic clothes (made of polyester etc) do not absorb much of sweat, so they fail to keep our body cool in summer.

(ii) We see water droplets on the outer surface of a glass containing ice-cold water

Take some ice-cold water in a glass. Soon we will see water droplets on the outer surface of the glass. The water vapour present in air, on coming in contact with the cold glass of water loses energy and gets converted to liquid state, which we see as water droplets.



Droplets formed on the surface of the glass containing ice cold water

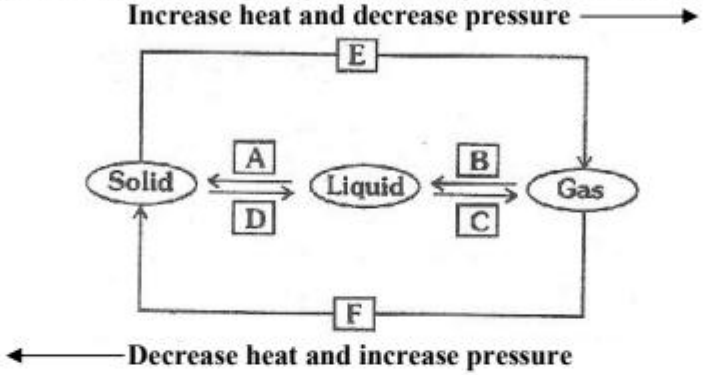
(iii) Water keeps cool in the earthen pot (matki) during summer:- When the water oozes out of the pores of an earthen pot, during hot summer, it evaporates rapidly. As the cooling is caused by evaporation, therefore, the temperature of water within the pot falls and hence it become cool.

(iv) Rapid cooling of hot tea:- If tea is too hot to sip, we pour it in the saucer. In doing so, we increase the surface are and the rate of evaporation. This, in turn, causes cooling and the tea attains a desired temperature for sipping.

(v) A wet handkerchief is placed on the fore head of a person suffering from high fever. The logic behind placing wet cloth is that as the water from the wet cloth evaporates, it takes heat from the skull and the brain within it. This, in turn, lowers the temperature of brain and protects it from any damage due to high temperature.

(iv) We often sprinkle water on the road in summer. The water evaporates rapidly from the hot surface of the road, there by taking heat away from it. Thus, the road become cool.

Q. Name A, B, C, D, E and F in the following diagram showing change in its state.



Ans A : Fusion
B : Vaporization
C : Condensation
D : Solidification
E &F : Sublimation

PLASMA

(i) Plasma is a mixture of free electrons and ions.

(ii) Plasma is considered the fourth state of matter.

(iii) Plasma occurs naturally in the stars (including the sun). Inside the stars, the temperature is so high that the atoms break up. Some of the electrons break away from the atoms converting the rest of atoms into electrically charged particles called ions. This mixture of free electrons and ions is a star is called plasma.

(iv) The sun and other stars glow because of the presence of plasma in them.

(v) Plasma can also be made on the earth by passing "electricity through gases at very low pressure taken in a glass tube (called discharge tube).

(vi) Plasma makes a fluorescent tube (or neon sign bulb) to glow.

BOSE-EINSTEIN CONDENSATE (BEC)

In 1920, and Indian scientist **"Satyendra Nath Bose"** did some calculation for the fifth state of matter. On the basis of these calculations, Albert Einstein predicted the existence of a new state of matter called Bose-Einstein condensate (BEC). The fifth state of matter called Bose-Einstein condensate was finally achieved by three scientists, **Cornell, Ketterle and Wieman** of USA by cooling a gas of extremely low density (about one hundred thousandth the density of normal air) to super low temperatures.

EXERCISE

(A) OBJECTIVE TYPE QUESTIONS:-

1. Which of the following has the strongest interparticle force a 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. The change of state from solid to liquid known as-
   (A) Fusion (B) Boiling (C) Melting (D) None of these
4. Dry ice is -
   (A) Water in solid state (B) Water in gaseous state
   (C) CO_2 in liquid state (D) CO_2 in solid state
5. The boiling point of water on kelvin scale is -
   (A) 573 K (B) 273 K (C) 373 K (D) 100 K
6. The process of change of a liquid into vapour at any temperature is called –
   (A Diffusion (B) Evaporation (C) Cooling (D) Heating
7. Which factor affecting Evaporation -
   (A) Temperature (B) Surface area (C) Both (A) & (B) (D) None of these
8. On increasing the temperature of the liquid the rate of evaporation is -
   (A) Increase (B) Decreases (C) No Change (D) None of these
9. Fluids are -
   (A) Liquids and gases (B) Solids and gases (C) Liquids and solids (D) Only solids
10. Which substance undergo sublimation process -
    (A) Naphthalene (B) CO_2 (C) Ice (D) N_2
11. Condensation Process is -
    (A) Change of state from gas to liquid (B) Change of state from liquid to gas
    (C) Change of state from gas to solid (D) Change of state from solid to liquid
12. The temperature at which liquid starts boiling at atmospheric pressure known as-
    (A) Melting point (B) Boiling point (C) Latent heat (D) Condensation
13. The melting point of ice is -
    (A) 0^0C (B) 4^0C (C) 5^0C (D) None of these
14. The physical state of matter which can be easily compressed -
    (A) Liquid (B) Gas (C) Solid (D) None of these

15. Name the process by which a drop of ink spreads in a beaker of water -

(A) Diffusion (B) Vaporization (C) Condensation (D) Sublimation

16. The temperature at which a solid changes into liquid at atmospheric pressure is called-

(A) Melting point (B) Boiling point (C) Diffusion (D) Evaporation

17. Convert the temperature of 373^0C to the kelvin scale?

(A) 646 K (B) 546 K (C) 300 K (D) 500 K

18. Convert the temperature of 270K to the celsius scale -

(A) -3^0C (B) -4^0C (C) 2^0C (D) 5^0C

19. Plasma is the …… state of matter -

(A) First (B) Second (C) Third (D) Fourth

20. The process for the change of a solid directly into its vapour is called - \

(A) Evaporation (B) Ebullition (C) Condensation (D) Sublimation

(B) FILL IN THE BLANKS :-

1. Density is measured in ……..
2. The change of a liquid into vapour is called ……
3. The matter in our surrounding exists in three states …….. and ……
4. Matter is made up of very small ……
5. The change of a solid directly into gas is called ……..
6. Smell of cooked food reaches us in seconds due to the process known as ……..
7. Intermolecular space in solids is …… than that of liquids.
8. …… have definite volume but not definite shape.
9. Rapid evaporation depends on the ……..are exposed to atmosphere.
10. Intermolecular forces of attraction are …… in solids,…….. in liquids and ……. In gases.
11. Boiling point of water is …….. K and melting point of ice is …… K.
12. 1 atm is equal to ……
13. Change of vapour state to liquid state is called ……..
14. The best evidence that the particles of matter are constantly moving comes from the studies of …….. and ……..and ……
15. Plasma is a mixture of ……..and ……

(C) WRITE T FOR TRUE AND F FOR FALSE STATEMENT :-

1. Air, water, chair, table and smell are examples of matter.
2. Gases have highest rate of diffustoin among all the three states of matter.
3. Evaporation causes heating.
4. Camphor changes to gaseous state without changing into liquid.

5. Water has boiling point equal to 100^0C.
6. Evaporation is a bulk phenomenon.
7. Intermolecular foreces are maximum in solids and minimum in gases.
8. Condensing is opposite to evaporation and freezing is opposite to melting.
9. The large in humidity is out of the factor which increases the rate of evaporation.

(D) VERY SHORT ANSWER QUESTIONS:-

1. Name the physical state of matter which can be easily compressed ?

Ans. Gaseous.

2. Will increase or decrease of pressure help to liquefy a gas?

Ans. Increase of pressure.

3. Which of the following are matter? Chair, Air, Love, Smell, Hate, Almonds, Thought, cold-drink, smell of perfume?

Ans. Chair, air, almonds, cold, drink, and smell of perfume are matter.

4. A substance has a definite volume but no definite shape state whether this substance is a solid a liquid or a gas.

Ans. Liquid.

5. Define :- (a) Boiling point (b) Melting point

Ans. (a) Boiling point: - Boiling point is the temperature at which a liquid changes into gas or vapour.

(b) Melting point:- Melting point is the temperature at which a solid melts to become a liquid.

6. Define:- (a) Latent heat of fusion (b) Latent heat of vaporization.

Ans. (a) Latent heat of fusion :- The amount of heat energy that is required to change 1 kg of a solid into liquid at atmospheric pressure without any change of temperature is called latent heat of fusion.

(b) Latent heat of vaporization:- The amount of heat energy that is required to change 1 kg of a liquid into vapour at atmospheric pressure without any change of temperature is called latent heat of vaporization.

7. What is sublimation?

Ans. Sublimation is the change of gaseous state directly to solid state on cooling, without going through liquid state and vice versa.

8. Give reasons-

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

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

Ans. (a) In gases, the particles are very loosely packed and the attractive forces between the particles are negligibly small. As a result, the particles of gases, move randomly in all direction and therefore, fill the vessels completely.

(b) The molecules of a gas are free to move randomly in all direction. During their motion, they collide with one another and also with the walls of the container. The constant bombardment of the molecules on the walls of the container exerts a steady force. The force acting per unit area on the walls of the container is called pressure. Thus, gases exert pressure.

9. What are the characteristics of the particles of matter?

Ans. The Characteristics of the particles of matter?

(i) All matter consist of very small particles.

(ii) The particles of matter have vacant spaces between them.

(iii) The particles of matter are continuously moving and possess kinetic energy.

(iv) The particles of matter attract each other with a force called intermolecular force of attraction. The intermolecular forces of attraction are maximum in solids and least in gases, Liquids have intermolecular force in between solids and gases.

(v) Particles of matter mix with each other on their own and get into the spaces between particles of each other.

10. What is plasma?

Ans. Plasma is fourth state of matter which consists of super energetic and super excited particles in the form of ionized gases.

11. What are full forms of CNG and LPG? And write their uses?

Ans. CNG is compressed natural gas which is being used in vehicles as a fuel. LPG is liquefied petroleum gas which is used for cooking and also for vehicles as a fuel.

12. Change the following celsius temperature to kelvin scale- **(KVS 2005)**

(i) -273^0C (ii) -100^0C (iii) -40^0C (iv) $+30^0C$

Ans. In kelvin scale -

(i) $-273^0C + 273 = 0$ K

(ii) $-100 + 273 = 173$ K

(iii) $-40 + 273 = 233$ K

(iv) $+30^0C + 273 = 303$ K

13. Convert (a) 300 K (b) 573 K into celsius scale- **(NCERT)**

Ans. (a) 300 K in celsius scale = $300 - 273 = 27^0C$.

(b) 573 K in celsius scale = $573 - 273 = 300^0C$.

14. Why does our plam feel cold, when we put some acetone petrol as perfume on it ?

Ans. The particles of acetone, petrol, perfume gain energy from our plam and evaporate causing the plam to feel cold.

15. Have you ever thought how do aquatic plants and animal survive ? from where do they get oxygen ?

Ans. The aquatic plants and animals survive because the gases from the atmosphere diffuse and dissolve in water. These gases mainly contain carbondioxide and oxygen are therefore, taken by the plants and animals respectively for their survival .

16. The mass per unit volume of a substance is called density (density = mass /volume). Arrange the following in order of increasing density – air , exhaust from chimneys, honey, water, chalk, cotton and iron.

Ans. The order of increasing density is : - air < exhaust from chimney < cotton < water < honey < iron.

(E) LONG TYPE QUESTIONS :-

1. Write comparative properties of solids, liquids and gases. **[Refer Page No. – 8]**

2. How many type of matter can be classified ? Explain both of these. **[Refer Page No. - 3, 4, 5]**

3. Write an example which shows the effect of change of temperature on solid . **[Refer Page No. - 9]**

4. What is evaporation ? Explain about the factors affection Evaporation ? **[Refer Page No. – 13, 14]**

5. What is sublimation process ? Give an example to define it. **[Refer Page No. – 11, 12]**

6. What is the difference between evaporation and boiling ? **[Refer Page No. - 13]**

7. Give some example of evaporation. **[Refer Page No.14, 15]**

8. Define about :- (a) Plasma (b) Bose Einstein condensate. **[Refer Page No. - 15]**

9. Explain molecular structure of solid, liquid and gaseous state ? **[Refer Page No. – 6, 7]**

10. What is diffusion ? Give some example of it.

[Definition of diffusion on Pg. No. – 3, Ex. Of diffusion on Pg. No. 5]

11. What are the characteristics of particles of matter ? **[Refer Page No. - 2, 3]**

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

[Refer Page No. - 14]

13. Give one simple activity /experiment to show

(ii) Particles of matter are very small **[Refer Page No. - 2]**

(ii) Ammonium chloride sublimes. **[Refer Page No. – 11, 12]**

14. What is matter ? write three states of water in which it exists.

[Definition of matter on Pg. No. – 1, States of water on Pg. No. 8]

15. Convert the following :

(i) 375 K to celsius scale. **[Hint :- 357 – 273 convert into ^{0}C]**

(ii) 27^0C to kelvin scale . **[Hint :- 27 + 273 convert into K]**

(iii) 1.01×10^5 Pa to atmosphere. **[Hint :- 1 atm = 1.01×10^5 Pa]**

16. Write an activity which shows the compressibility of gases & liquids. **[Refer Page No. - 6]**

17. Define about :-

(i) Pressure & its unit **[Refer Page No. - 5]**

(ii) Density **[Refer Page No. - 3]**

(iii)Volume **[Refer Page No. - 4]**

(iv) Kinetic energy **[Refer Page No. - 2]**

MATTER IN OUR SURROUNDING **ANSWER KEY** **EXERCISE**

- **Objective type question**

1. C **2.** D **3.** C **4.** D **5.** C **6.** B **7.** C **8.** A **9.** A **10.** A
11. A **12**. B **13.** A **14.** B **15.** A **16.** A **17.** A **18.** A **19.** D **20.** D

- **Fill in the blanks**

1. Kilogram per cubic meter
2. Vaporization
3. Solid, liquid and gas
4. Particles
5. Sublimation
6. Diffusion
7. Less
8. Liquids
9. Surface
10. Maximum, intermediate, minimum
11. 373, 273
12. 1.01×10^6Pa
13. Condensation
14. Diffusion, brownian, motion
15. Free electrons and ions.

- **True (T). False (F)**

1.F 2.F 3.F 4.T 5.T 6.F 7.T 8.T 9.T 10.F