MATTER IN OUR SURROUNDINGS

INTRODUCTION

There are a large number of things around us which we see and feel. For example, we can see a book in front of us. A book occupies some space. The space occupied by the book is called it **volume.** If we pick up the book, we can also feel its weight. So, we conclude that the book has some **mass.** We cannot see the air around us, yet if we fill a balloon with air and then weight it carefully, we will find that not only does air occupy space (bounded by the balloon), but is also has mass.

Things like a book and air are examples of matter. Other examples of matter are wood, cloth, paper, ice, steel, water, oil etc. Further, that matter offers resistance is borne out by the fact that we cannot displace an object from one place to another without applying some force. We have to apply force to pick up a stone from the ground. Thus, matter can be defined as follows -

Anything that occupies space, has mass and offer resistance is called matter.

SUBSTANCE : A substance is a kind of matter that cannot be **separated** into other kinds of matter by any physical process. For example, sugar dissolved in water can be separated from water by simply evaporating the water. Here sugar is a substance which cannot be broken into its components by any physical process.

PHYSICAL NATURE OF MATTER

(a) Matter is Made up of Particles :

(i) Everything around us is made up of many **tiny** pieces or particles.

(ii) Particles which make up the matter are constantly **moving.**

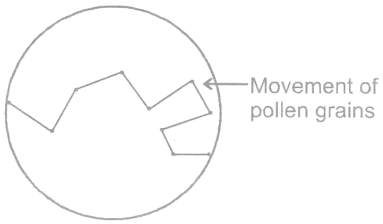
(iii) Particles which make up mater are atoms or molecules.

(i) Evidences for the presence of particles is matter : Most of the evidences for the existence of particles in matter and their motion come from the experiments of **diffusion and Brownian motion.**

(A) Dissolving a solid in a liquid : Potassium permanganate is a purple coloured solid substance and water is a liquid. We will take 2 - 3 crystals of potassium permanganate and dissolve them in 100 ml of water. Now we will take out 10 ml of this solution and put into another 90 ml of clear water. We will keep diluting the solution like this 5 to 8 times.

(B) Conclusion : This experiments shows that just a few crystals of potassium permanganate can colour a large volume of water. It means a crystal of $KMnO_4$ is made up of millions of tiny particles. They keep dividing themselves into smaller and smaller particles. Particles of $KMnO_4$ and particles of water spread into each other, it means they are moving. This movement of different particles among each other, so that they become mixed uniformly, is called diffusion.

(ii) Movement of pollen grains in water : The best evidence for the existence and movement of particles in liquids was given by **Robert Brown** in 1827. Robert Brown suspended extremely small pollen grains in water. On looking through the microscope, it was found that the pollen grains were moving rapidly throughout water in a very irregular way (**or zig - zag way).**



(A) Brownian motion : Zig - zag motion (in a very irregular way) of particles is known as Brownian motion. Brownian motion can also be observed in gases. Sometimes, when a beam of light enters a room, we can see tiny dust particles suspended in air which are moving rapidly in a very random way. This is an example of Brownian motion in gases. The tiny dust particles move here and there because they are constantly hit by the fast moving particles of air.

- Matter is made up of tiny particles.
- Particles of matter are constantly moving.

Brownian motion increases on increasing the temperature.

(b) Characteristics of Particles of Matter :

The important characteristics of particles of matter are the following :

(i) The particles of matter are very, very small : It can be explained by performing the following experiment. We will dissolve 2 or 3 drops of indigo dye in 100 ml of water. We will get a deep blue coloured solution. Now we will keep diluting the solution and we will observe that intensity of blue colour of indigo dye solution goes on decreasing.

(ii) The particles of matter have spaces between them :

(A) Experiment : We take about 100 ml of a water in a beaker and mark the level of water. We will also take 50 g of sugar. Now we will dissolve the sugar by stirring and we get 3 sugar solution.

(B) Conclusion : The level of sugar solution in the beaker is at the same mark where water level was initially in the beaker.

It shows that particles sugar go into the spaces between various molecule of water due to which there is no change in the volume. Thus, from this experiment it can be concluded that, the molecules in water are not tightly packed, they have spaces between them.

(iii) The particles of matter are constantly moving : This property can be explained by diffusion.

(A) Diffusion : "*Intermixing of particles of two different types of matter on their own is called diffusion."* It is the phenomenon in which the movement of molecules or particles occur from their higher concentration towards their lower concentration.

e.g. : When a perfume bottle is opened in one corner of a room, its fragrance spreads in the whole room quickly. This happens because the particles of perfume move rapidly in all directions and mix with the moving particles of air in the room.

The particles of matter possess kinetic energy and so are constantly moving. As temperature rises, particles move faster.

(iv) Particles of matter attract each other : There are some forces of attraction between the particles of matter which bind them together.

(A) Cohesive Force : *The force of attraction between the particles of different substances is called adhesive force.*

e.g. : If we take a piece o chalk, a cube of ice and an iron nail and beat them with a hammer, chalk will easily break into smaller pieces, but more force will be required to break a cube of ice and iron nail will not break.

Reason : The reason for this is that force of attraction is quite weak in between the chalk particles, but force of attraction in between the particles of ice cube is a bit stronger, while force of attraction in between the particles of iron is very-very strong.

RIGID AND FLUID

(i) Rigid : Rigid means 'unbending' or inflexible. A solid is a rigid form of matter so that it maintains its shape when subjected to outside force.

(ii) Fluids : Fluids are the substances which have tendency to flow. A liquid is a fluid form of mater which occupies the space of the container. Liquids have a well defined surface.

A gas is a fluid form of matter which fills the whole container in which it is kept.

Liquid and gases are known as fluids.

CLASSIFICATION OF MATTER

On the basis of physical states, all matter can be classified into three groups :-

(a) Solids (b) Liquids (c) Gases

(a) Solids :

A solid is that state of matter which has definite shape, mass and volume.

e.g. : Ice, wood, coal, iron etc.

(i) Properties :

- Solids have a definite mass and definite volume.
- Solids have a definite shape.
- Solids have negligible compressibility.
- Solids have high densities.
- The intermolecular forces in solids are very strong.
- The dimensions of solid do not increase in large proportion on heating or cooling.
- Solids diffuse into one another very slowly.

(b) Liquids :

A liquid is a state of matter which has definite mass and volume but no definite shape.

e.g. : Water, alcohol, milk, mercury etc.

(i) Properties :

- Liquid have a definite mass and volume.
- Liquid do not have a definite shape.
- Liquids are slightly more compressible than that of solids.
- Density of liquids is lesser than that of solids.
- The force of attraction between the molecules of liquids is less than that of solids.
- Liquids expands far more than solids on heating.
- The particles of two different liquids can diffuse is one another easily.

(c) Gases :

A gas is a state of matter, which has definite mass, but no definite shape and no definite volume.

e.g. : O_2, N_2, H_2 etc.

(i) Properties :

- A gas contained in a vessel has a definite mass.
- Gases do not have definite shape and volume.
- Gases are highly compressible because intermolecular spaces between them are very - very large as compared to solids and liquids.
- Density of gases is extremely small as compared to solids and liquids.

- Intermolecular forces are negligible.
- Gases expands to large extent when heated.
- The gases diffuse in one another rapidly to form homogeneous mixture.

Comparison of the characteristics of three states of matter.

S.No.	Property	Solid state	Liquid state	Gaseous state
1	Interparticle spaces	Very small spaces	Comparatively large spaces	Very large spaces
2	Interparticles forces	Very strong	Weak	Very weak
3	Nature	Very hard and rigid	Fluid	Highly fluid
4	Compressibility	Negligible	Very small	Highy compressible.
5	Shape and volume	Definite shape and volume	Indenfinite shape, but definite volume	Indefinite shape as well as volume
6	Density	High	Les than the density in solid state	Very low density
7	Kinetic energy	Low	Comparatively high	Very high
8	Diffusion	Negligible	Slow	Very fast

(d) Gases are Highly Compressible therefore :

(i) LPG (Liquefied Petroleum Gas) is used in our home for cooking.

(ii) Oxygen cylinders supplied to hospitals contain liquid oxygen.

(iii) C.N.G. (Compressed Natural Gas) is used a fuel these days in vehicles.

Gaseous particles move randomly at high speed and hit each other and also walls of the container, so exert pressure.

EXERCISE

OBJECTIVE DPP - 1.1

1. The quantity of matter present in an object is called its -

(A) weight (B) volume (C) mass (D) Density

2. Which of the following is/are rigid(s) ?

(A) Solids (B) Liquids (C) Gases (D) Both (B) and (C)

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. What happens to the volume of the solution when small amount of sugar is dissolved in it ?

(A) Volume will increase.
(B) Volume will decrease.
(C) Volume first increases then decreases.
(D) No change in volume.

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.

SUBJECTIVE DPP - 1.2

1. What is Brownian motion ?

2. Why do gases diffuse very fast ?

3. Arrange the following substances in the increasing order of interparticle forces. Water, common salt, nitrogen.

4. Out of solid, liquid and gas, which has -
(a) maximum interparticle spaces. (b) maximum particle motion.'
(c) definite volume but no definite shape. (d) least diffusion of the particles.

5. Give four characteristics associated with the gaseous state.

6. What is common in the three states of matter ?

7. A certain substance 'A' can be compressed to very less extent, but takes up the shape of any container in which it is placed. What will be its physical state ?

8. Solids are generally very heavy while gases are light. Explain.

MATTER IN OUR SURROUNDINGS

INTERCONVERSION OF STATES OF MATTER

The phenomenon of change of mater form one state to another state and back to original state, by altering the conditions of temperature and pressure, is called interconversion of matter.

The various states of matter can be interchanged into one another by altering the conditions of -

(a) Temperature (b) Pressure.

(a) Altering the Temperature of Matter :

(i) Interconversion of solid into liquid and vice versa : The solids can be converted into liquids by heating them. Similarly liquids can be cooled to form solids.

e.g. : Ice at 0^0C changes into water at 0^0C, when heat energy is supplied to it. The water at 0^0C changes into ice at 0^0C on freezing.

(A) Melting or Fusion : The process due to which a solid changes into liquid state by **absorbing heat energy** is called melting or fusion.

(B) Freezing or Solidification : The process due to which a liquid changes into solid state by **giving out heat energy** is called freezing or solidification.

(C) Melting Point : The constant temperature at which a solid changes into liquid state by absorbing heat energy is called it melting point.

(D) Freezing Point : The constant temperature at which a liquid changes into solid state by giving out heat energy is called freezing point.

The numerical value of freezing point and melting point is same. Melting point of ice = Freezing point of water = 0^0c (273.16 k).

Explanation : On increasing the temperature of solids, the kinetic energy (K.E.) of particles increases. Due to increases in K.E., the particles start vibrating with greater speed. The energy supplied by heart **overcomes the force of attraction** between the particles. Then, the particles leave their fixed positions and start moving freely and thus solid melts.

Latent Heat of Fusion : The amount of heat energy that is required to change 1 kg of solid into liquid at atmospheric pressure and its melting point is known as the latent heat of fusion. (In Greek Latent means Hidden)

Latent heat of fusion of ice = 3.34×10^5 J/kg.

Particles of water at 0^0C (273 K) have more energy as compared to particles in ice at the same temperature.

(ii) Interconversion of liquid into gaseous state and vice versa : Liquids can be converted into gases by heating them. Similarly, gases can be converted into liquids by cooling them.

e.g. : Water at normal pressure changes into gas (steam) at 100^0C by absorbing heat. Steam at 100^0C changes into water by giving out energy.

(A) Boiling or Vaporisation : The process due to which a liquid changes into gaseous state by **absorbing heat energy** is called boiling.

(B) Condensation or Liquefaction: The process due to which a gas changes into liquid state by **giving out heat energy** is called condensation.

(C) Boiling point : The constant temperature at which a liquid rapidly changes into gaseous state by absorbing heat energy at atmospheric pressure is called boiling point.

(D) Condensation Point : The constant temperature at which a gas changes into liquid state by giving out heat energy at atmospheric pressure is called condensation point.

The numerical value of condensation point and boiling point is same. Condensation point of vapour (water) = Boiling point of water = 100^0C (373 K).

Explanation : When heat is supplied to water, particles start moving faster. At a certain temperature, a point is reached when the particles have enough energy to **break the forces of attraction between** the particles. At this temperature the liquid starts changing into gas.

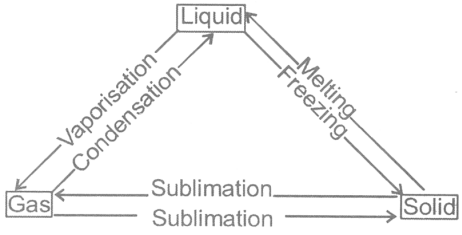
Latent heat of vaporisation : The amount of heat which is required to convert 1 kg of the liquid (at its boiling point) to vapour or gas **without any change** in temperature. Latent heat of vaporisation of water = 22.5×10^5 J/kg.

Particles in steam, that is water vapour at 373 K have more energy than water at the same temperature. Because steam have absorbed extra energy in the form of latent heat of vaporisation.

(iii) Direct interconversion of solid into gaseous state and vice versa : The changing of solid directly into vapours on heating and of vapours directly into solid on cooling is known as sublimation.

- The solid which undergoes sublimation is called **'sublime'.**
- The solid obtained by cooling the vapours of a solid is called '**sublimate'.**

e.g. : Ammonium Chloride (NH_4Cl), iodine, camphor, naphthalene (moth balls) and anthracene.



Interconversion of states of matter

EXERCISE

OBJECTIVE DPP - 2.1

1. On changing which of the following, the states of matter can be changed ?

(A) Temperature (B) Pressure (C) (A) & (B) both (D) None of these

2. Melting & freezing point of water -

(A) are same (B) have large difference between them.

(C) have close difference between them. (D) None of these

3. The boiling point of alcohol is 78^0C. What will be the temperature in Kelvin scale ?

(A) 373 K (B) 351 K (C) 375 K (D) 78 K

4. Latent heat of vaporisation of water is -

(A) 2.25×10^2 J/kg (B) 22.5×10^5 J/kg (C) 3.34×10^5 J/kg (D) 33.4×10^2 J/kg

5. S.I. unit of temperature is -

(A) Kelvin (B)Celsius (C) Both (D) None

6. In sublimation process -

(A) solid changes into liquid (B) liquid changes into gas.

(C) solid changes directly into gas. (D) None of these

7. When a liquid starts boiling, the further heat energy which is supplied -

(A) is lost to the surrounding as such.

(B) increasing the temperature of the liquid.

(C) increases the kinetic energy of the liquid.

(D) is absorbed as latent heat of vaporisation by the liquid.

8. 10^0C temperature is equal to -

(A) 163 K (B) 10 K (C) 183 K (D) 283 K

9. Which of the following will respond to sublimation ?

(A) Common salt (B) Sugar (C) Camphor (D) Potassium nitrate

10. Solids cannot be compressed because -

(A) constituent particles are very closely packed.

(B) interparticle attractive forces are weak.

(C) movement of constituent particles is restricted.

(D) constituent particles diffuse very slowly.

SUBJECTIVE DPP - 2.2

1. Define condensation.

2. What is latent heat of fusion ?

3. Name one property which is shown by naphthalene and not by sodium chloride.

4. Are the melting point of solid and the freezing point of liquid same or different.

5. The melting point of a substance is just below the room temperature. Predict its physical state.

6. When a solid melts, its temperature remains the same, so where does the heat energy go ?

7. Discuss the significance of the boiling point of liquid.

8. Explain the interconversion of states of matter.

MATTER IN OUR SURROUNDINGS

BY ALTERING PRESSURE

The difference in various states of matter is due to the different intermolecular spaces between their particles. So when a gas is compressed the intermolecular space between its particles decreases and ultimately it will be converted into liquid.

Pressure and temperature determine the state of a substance. So, high pressure and low temperature can liquefy gases.

e.g. : Carbon dioxide (CO_2) is a gas under normal conditions of temperature and pressure. It can be liquefied by compression it to a pressure 70 times more than atmospheric pressure.

Solid CO_2 is known as **'Dry ice'.** Solid CO_2 is extremely cold and used to 'deep freeze' food and to keep ice - cream cold.

Unit of pressure :

Atmosphere (atm) is a unit of measuring pressure exerted by a gas.

The unit of pressure is Pascal (Pa.)

1 atm = 1.01 × 10.5 Pa.

When pressure is lowered the boiling point of liquid is lowered. This helps in rapid change of liquid into gas.

EVAPORATION

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

Water changes into vapours below 100^0C. The particles of matter are always moving and are never at rest. At a given temperature in any gas, liquid or solid, there are particles with different K.E.

In case of liquids, a small fraction of particles at the surface, having higher K.E., is able to break the forces of attraction of other particles and gets converted into vapour.

The atmospheric pressure at sea level is 1 atm.

(a) Factors affecting Evaporation :

(i) Temperature : With the increase in temperature the rate of evaporation increases.

$$\text{Rate of evaporation } \alpha \text{ T}$$

Reason : On increasing temperature more number of particles get enough K.E. to go into the vapour sate.

(ii) Surface Area : Rate of evaporation α Surface area

Since evaporation is a surface phenomena, if the surface area is increased, the rate of evaporation increases. So, while putting clothes for drying up we spread them out.

(iii) Humidity of Air : Rate of evaporation $\alpha \frac{1}{\text{Humidity}}$

Humidity is the amount of water vapour present in air. When humidity of air is low, the rate of evaporation is high and water evaporates more readily. When humidity of air is high, the rate of evaporation is low and water evaporates very slowly.

(iv) Wind Speed : Rate of evaporation α Wind speed

With the increase in wind speed, the particles of water vapour move away with the wind. So the amount of water vapour decrease in the surroundings.

(v) Nature of substance : Substances with high boiling points will evaporate slowly, while substance with low boiling points will evaporate quickly.

Difference between evaporation and boiling

S.No.	Evaporation	Boiling
1	It is a surface phenomenon.	It is a bulk phenomenon.
2	It occurs at all temperatures below B.P.	It occurs at B.P. only.
3	It leaves the cooling effect.	It increases the temperature.

(b) Cooling Causes by Evaporation :

The cooling caused by evaporation is based on the fact that when a liquid evaporates, it draws (or takes) the **latent heat of vaporisation** from 'anything' which it touches.

For example :

- If we put a little of spirit (ether or petrol) on the palm of our hand then our hand feels very cold.
- Perspiration (or sweating) is our body's method of maintaining a constant temperature.

(c) We Wear Cotton Clothes in Summer :

During summer, we perspire more because of the mechanism of our body which keeps us cool. During evaporation, the particles at the surface of liquid gain energy from the surroundings or body surface. The

heat energy equal to latent heat of vaporisation is absorbed from the body leaving the body cool. Cotton, being a good absorber of water helps in absorbing the sweat.

(d) Water droplets on the outer surface of a glass containing ice cold water :

If we take some ice cold water in a tumbler then we will observe water droplets on the outer surface of tumbler.

Reason : The water vapour present in air on coming in contact with cold glass of water, loses energy. So water vapour gets converted to liquid state, which we see as water droplets.

PLASMA

This state consist of super energetic and super excited particles. These particles are in the form of ionised gases.

For e.g : neon sign bulb and fluorescent tube

Neon sign bulb - Neon gas

Fluorescent tube - Helium gas

When electrical energy flows through gas, it gets ionised and hence plasma is created. Plasma glows with a special colour depending on nature of gas. Sun and the stars glow because of the pressure of plasma.

BOSE - EINSTIEN CONSENSATE (B.E.C.)

The B.E.C. is formed by cooling a gas of extremely low density, about one-hundred - thousandth the density of normal air, to super low temperature.

EXERCISE

OBJECTIVE DPP - 3.1

1. Dry ice means -

(A) solid ammonia (B) solid carbon dioxide

(C) solid sulphur dioxide (D) normal ice

2. On a hot humid day rate of evaporation -

(A) is more (B) is less

(C) initially more, later on less (D) remains same.

3. During evaporation, particles of a liquid change into vapours only -

(A) form the surface. (B) from the bulk.

(C) from both surface and bulk. (D) neither from surface nor from bulk.

4. Rate of evaporation depends upon -

(A) temperature (B) surface area (C) humidity (D) All of these

5. Pressure of air at sea level is -

(A) one atmosphere (B) 76 cm of Hg (C) 760 mm of Hg (D) All of these

6. One atmosphere is equal to -

(A) 1.01×10^5 Pa (B) 3.46×10^4 Pa (C) 1 Pa (D) 10 Pa

7. During evaporation of liquid -

(A) the temperature of the liquid falls.

(B) the temperature of the liquid rises.

(C) the temperature of the liquid remains unchanged.

(D) all statements are wrong.

8. As temperature increases rate of evaporation -

(A) increases (B) decreases.

(C) first increases, then decreases. (D) remains same.

9. A gas can be best liquefied -

(A) by increasing the temperature.

(B) by lowering the pressure.

(C) by increasing the pressure and reducing the temperature.

(D) None of these is correct.

10. In which phenomenon water changes into water vapour below its boiling point ?

(A) Evaporation (B) Condensation

(C) Boiling (D) No such phenomena exists

SUBEJCTIVE DPP - 3.2

1. What is relation between pressure in atmospheres and pressure in pascals ?

2. Distinguish between boiling and evaporation.

3. Explain how gases can be liquefied ?

4. Clothes dry fast on a windy day. Why ?

5. Explain the factors affecting the rate of evaporation.

6. Why do we sweat more on a humid day ?

7. What is the purpose of sipping coffee from a saucer instead of sipping from a glass or cup ?

8. Why do we normally prefer cotton clothes during summer ?

ANSWER KEY

(OBJECTIVE DPP - 1.1)

Qus.	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	D	D	D	B	D	B	D	B

(SUBJECTIVE DPP - 1.2)

Sol.6 All of them occupy space and have mass.

Sol.7 The physical state of the substance 'A' is a liquid.

Sol.8 In the solids, the particles are very closely packed. As a result, the number of particles per unit volume is quite large. Therefore, the solids are normally quite heavy. In the gases, the particles are loosely packed. The number of particles per unit volume is comparatively small, Therefore, gases are light.

(OBJECTIVE DPP - 2.1)

Qus.	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	B	B	A	C	D	D	C	A

(SUBJECTIVE DPP - 2.2)

Sol.3 naphthalene undergoes sublimation upon heating and directly changes into vapours. Sodium chloride (common salt) does not undergo sublimation. It melts on strong heating.

Sol.4 Same

Sol.5 Liquid

Sol.7 The boiling point of the liquids help is comparing the magnitude or strength of the interparticle or intermolecular forces present in them. Greater these forces, more will be the boiling point of the liquid.

(OBJECTIVE DPP - 3.1)

Qus.	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	A	D	D	A	A	A	C	A

(SUBJECTIVE DPP - 3.2)

Sol. 1 atm = 1.01×10^5 Pa