UNIT

1

Matter

Learning Outcomes

Children will be able to:

- *describe the main postulates of the kinetic theory of matter;*
- *explain the reason of change of one state of the matter to another and vice-versa on the basis of inter particle space and inter particle attraction and collision;*
- *define and explain the law of conservation of mass using an example.*

Chapter Outlines

- Introduction
- Definition of Matter
- Kinetic Theory of Matter
- States of Matter and their Properties
  - Solid State
  - Liquid State
  - Gaseous State
- Interconversion of Matter into Different States
  - Change of State of Matter by Changing the Temperature
  - Terms Involved in the Interconversion of Matter
- Interconversion of Matter on the Basis of Kinetic Theory
  - Melting
  - Vaporisation
  - Condensation/Liquefaction
  - Freezing/Solidifaction
  - Sublimation
  - Change of State of Matter by Changing the Pressure
  - Law of Conservation of Mass
  - Limitations of Law of Conservation of Mass

INTRODUCTION

The variety of things present around us, for example, paper, book, furniture, water, tree etc., are different from one another in size, shape, colour and other features but they all have mass and occupy space. In fact, all the substances around us constitute matter.

DEFINITION OF MATTER

Matter may be defined as anything that occupies space, has mass and can be perceived by our physical senses. For example—living and non-living.

Do You Know?

Heat, sound, light are not regarded as matter because they have neither mass nor occupy space.

KINETIC THEORY OF MATTER

The main postulates of kinetic theory of matter are given below:

- All matter (solid, liquid and gas) is made up of tiny particles called atoms or molecules.
- The particles of matter are in continuous motion, and hence have kinetic energy.
- The kinetic energy of the particles increases when heated (*i.e.*, when heat energy is supplied) and decreases when cooled (*i.e.*, when heat energy is taken out).
- There is force of attraction between the particles of matter. This force between the same kind of particles is called cohesive force and between different kinds of particles is called adhesive force.
- The force of attraction between the particles decreases with increase in the distance between the particles and *vice-versa*.
- Molecular motion is greatest in gases, less in liquids and the least in solids.

The kinetic molecular theory is very useful in explaining or describing the forces between molecules and the energy that they possess as well as the effects of thermal energy, temperature and pressure on matter.

STATES OF MATTER AND THEIR PROPERTIES

Matter around us exists in three different states as solid, liquid and gas. Each state is different from each other and is characterised by unique properties. Let us discuss the properties of states of matter.

SOLID STATE

Characteristics of Solids

- Solids have definite mass, volume and shape (Fig. 1).
- They are hard, rigid and incompressible.
- They have high densities.
- Solids do not have the tendency to flow.
- They do not show the property of diffusion.

Fig. 1. Solid objects

Explanation of a Solid on the Basis of Kinetic Theory

In solids, the particles (molecules) are closely packed (Fig. 2). The particles of a solid have least kinetic energy. There is a strong inter-particle force of attraction and least or negligible inter-particle space. So that,

Do You Know?

Although sponge is a solid, it can still be bent and compressed. This is because a sponge has small holes inside it. Air is trapped inside these holes. Air is expelled when we press or squeeze these holes. Hence, bending and squeezing is possible in the case of a sponge.

the particles are not free to move. They only vibrate about their mean positions. This gives a definite shape and volume to solid. Again, they become hard, rigid and incompressible.

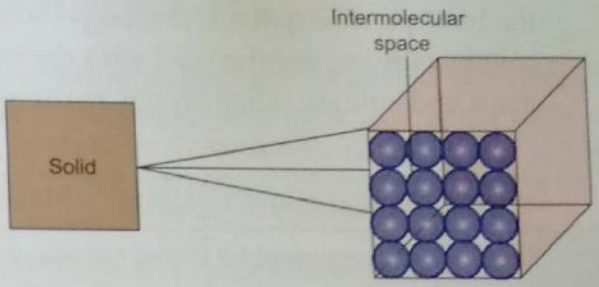


Fig. 2. Explanation of a solid on the basis of kinetic theory

LIQUID STATE

Characteristics of Liquids

- Liquids have definite mass and volume but have no definite shape.
- Liquids take the shape of the container in which they are kept.
- Liquids are non-rigid and slightly compressible.
- They have lower densities as compared to solids.
- They have the tendency to flow. They flow from higher level to the lower level.
- Liquids show the property of diffusion.

Explanation of a Liquid on the Basis of Kinetic Theory

In liquids, the particles (molecules) are loosely packed (Fig. 3). The particles of a liquid possess higher kinetic energy than solids. There is weak inter-particle force of attraction in liquids. The inter-particle space in a liquid is more than solids. Therefore, the particles are free to move within the liquid. They do not leave the liquid. Hence, liquids have a definite volume but do not have a definite shape. They flow and are slightly compressible.

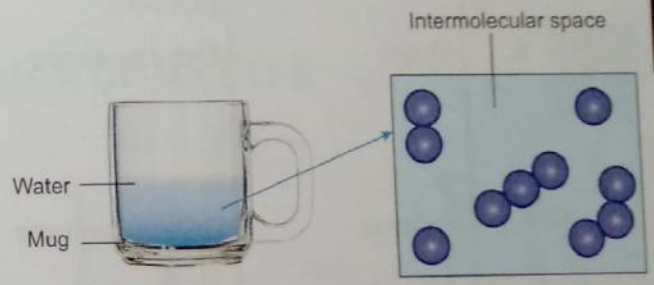


Fig. 3. Explanation of a liquid on the basis of kinetic theory

GASEOUS STATE

Characteristics of Gases

- Gases have definite mass but they neither have definite shape nor definite volume.
- They are non-rigid and highly compressible.
- They have low densities.
- They flow in all directions.
- Gases show the property of diffusion.

Explanation of a Gas on the Basis of Kinetic Theory

In gases, the particles (molecules) are far apart and move freely in a random manner (Fig. 4). The particles have very high kinetic energy. The inter-particle force of attraction is very weak and

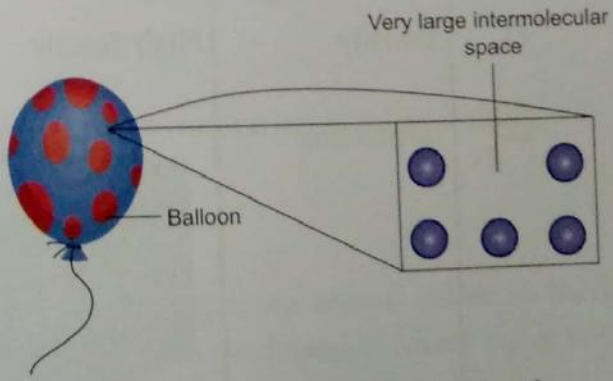
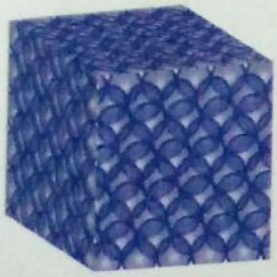
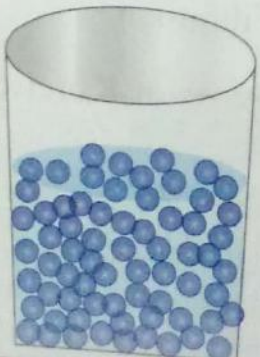
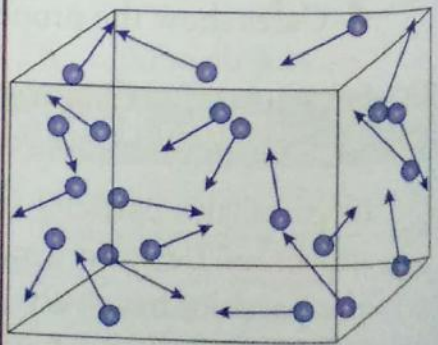


Fig. 4. Explanation of a gas on the basis of kinetic theory

the inter-particle space is very large. So that, the particles move freely in all directions. The particles collide with one another and with the walls of the container. That's why they do not have a definite shape and volume. They occupy entire space.

Table 1: Comparative Study of Three States of Matter and their Properties

S. No.	Parameters	Solid	Liquid	Gas
1.	Arrangement of molecules	Very closely packed	Loosely packed	Molecules are far apart
2.	Intermolecular force of attraction	Very strong	Weak	Weakest
3.	Intermolecular space	Minimum (almost negligible)	More than solids	Maximum (very large)
4.	Position of molecules	The position of molecules is fixed. They only vibrate about their fixed position.	The position of molecules is not fixed. They move freely.	The molecules move freely in all directions.
5.	Shape	Definite shape	No definite shape. It takes the shape of the container in which it is kept.	No definite shape
6.	Volume	Definite volume	Definite volume	No definite volume. It occupies the entire available space (volume).
7.	Rigidity	Highly rigid	Non-rigid	Non-rigid
8.	Fluidity (tendency to flow)	It does not flow.	It flows from the higher level to the lower level.	It flows in all directions.
9.	Compressibility	Incompressible	Slightly compressible	Highly compressible
10.	Kinetic energy	Least	Higher than liquids	Highest
11.	Density	High density	Moderate to high density	Low density
12.	Illustration			

INTERCONVERSION OF MATTER INTO DIFFERENT STATES

Matter can change from one form to other form, *i.e.*, from solids to liquids to gases and *vice-versa*. The phenomenon of the change of matter from one state to another and back to original state is known as interconversion of the states of matter.

Matter can be changed from one state to another by changing temperature or pressure.

CHANGE OF STATE OF MATTER BY CHANGING THE TEMPERATURE

When we heat a solid substance, it changes into liquid and then into gas. On the other hand, when we cool a gas, it changes into liquid and then into solid. For example—ice changes into water and then into steam on heating (Fig. 5). The reverse process takes place on cooling.

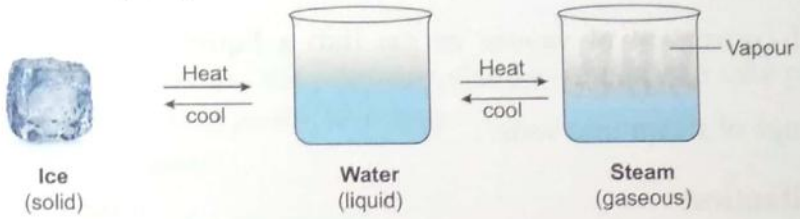


Fig. 5. Change in state of water

TERMS INVOLVED IN THE INTERCONVERSION OF MATTER

Melting or Fusion

The process of conversion of a solid into a liquid on heating is called melting or fusion (Fig. 6).

Example: Ice to water.

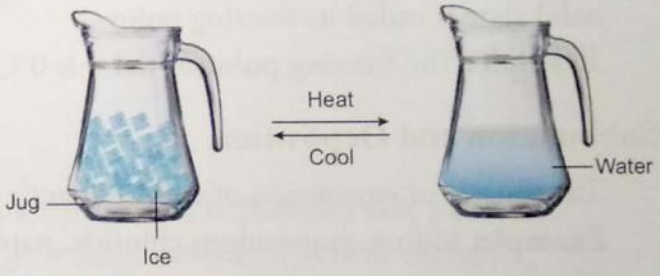


Fig. 6. Interconversion of solid into liquid and *vice-versa*

Melting Point

The constant temperature at which a solid changes into its liquid state is called its melting point. Different substances have different melting points in their pure state.

Example: Melting point of pure water is 0°C.

Boiling or Vaporisation

The process of conversion of a liquid into gaseous or vapour state on heating is called boiling.

Example: Change of water into steam is an example of boiling.

Boiling Point

The constant or fixed temperature at which a liquid changes into gaseous state is called its boiling point. At this temperature, the pressure of the vapour formed from the liquid becomes equal to the atmospheric pressure. Different liquids have different boiling points.

Example: The boiling point of pure water is 100°C.

Evaporation

The process during which a liquid changes into its vapour below its boiling point is called evaporation. Boiling is an extreme form of evaporation.

Note: A substance that remains in the gaseous state under normal conditions of room temperature and atmospheric pressure is called a gas.
Example: Oxygen, hydrogen, etc.
A substance that is solid or liquid under normal conditions of room temperature and pressure but changes into gaseous state on heating is called vapour.
Example: Water vapour, iodine vapour.

Condensation or Liquefaction

The process of conversion of vapour or gas into a liquid on cooling is called condensation or liquefaction.

Example: Change of steam into water.

Freezing or Solidfaction

The process of conversion of a liquid into its solid state on cooling is called freezing.

Example: Change of water into ice.

Freezing Point

The constant temperature at which a liquid changes into its solid state is called its freezing point.

Example: The freezing point of water is 0°C.

Do You Know?

The numerical value of melting point and freezing point a substance is same. For example, the melting point and freezing point in water is 0°C.

Sublimation and Deposition

The process of conversion of a solid directly into gaseous state on heating is called sublimation.

Example: Iodine, ammonium chloride, naphthalene etc., undergo sublimation on heating.

The process during which a gas directly changes into solid state on cooling is called deposition (Fig. 7).

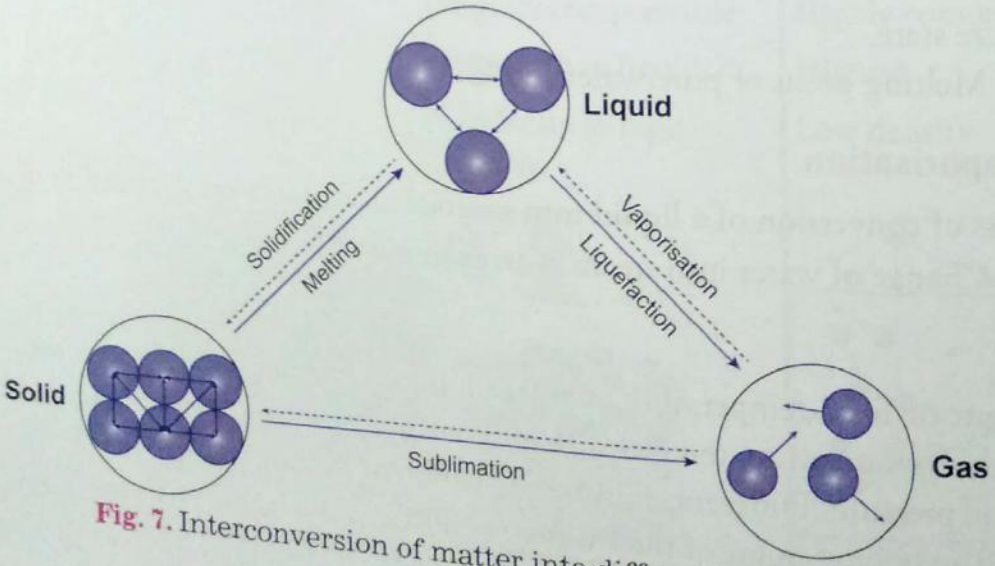


Fig. 7. Interconversion of matter into different states

INTERCONVERSION OF MATTER ON THE BASIS OF KINETIC THEORY (FIG. 8)

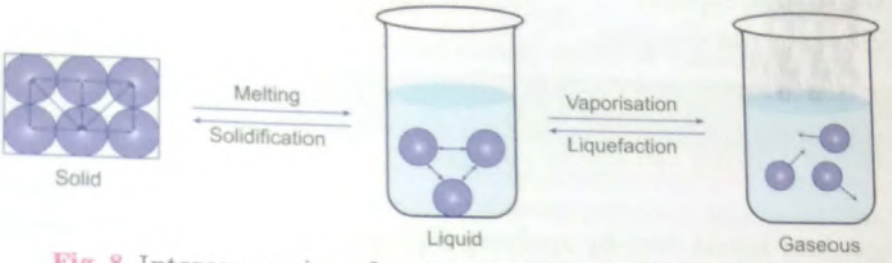


Fig. 8. Interconversion of matter on the basis of kinetic theory

MELTING

On heating solids, temperature rises and the following changes in particles take place:

- Particles gain energy and store it as potential energy.
- Inter-particle attraction decreases.
- Inter-particle space increases.
- Particles become free at melting point.

VAPORISATION

On heating liquids, temperature rises and the following changes in particles take place:

- Particles gain energy and store it as potential energy.
- Inter-particle attraction decreases to a large extent.
- Inter-particle space increases to a large extent.
- Particles become free at boiling point.

CONDENSATION/LIQUEFACTION

On cooling gases, the temperature falls and the following changes in particles take place:

- Particles lose energy as the stored potential energy in them is released as heat energy.
- Inter-particle attraction increases.
- Inter-particle space decreases to a greater extent.
- The movement of particles decreases at liquefaction point.

FREEZING/SOLIDIFACTION

On cooling liquids, the temperature falls and the following changes in particles take place:

- Particles lose energy as the stored potential energy in them is released in the form of heat energy.
- Inter-particle attraction increases.
- Inter-particle space decreases.
- The particles do not move from their positions at the freezing point.

SUBLIMATION

On heating a sublimable solid, the following changes in the particles take place as they have weak intermolecular force of attraction:

- Particles gain kinetic energy and start vibrating vigorously.
- Inter-particle attraction is overcome so that, the molecules become free and escape from the surface of the solid as vapour.
- Inter-particle space also decreases.

CHANGE OF STATE OF MATTER BY CHANGING THE PRESSURE

The physical state of a matter can also be changed by changing the pressure.

For example:

- A gas changes into liquid state by applying high pressure and lowering its temperature. We get liquid gases like liquid oxygen, liquid hydrogen by this method (see Fig. 9).
- The cooking gas (LPG) in the gas cylinders is present in the liquid state under high pressure. On opening the valve of regulator, the pressure decreases and LPG comes out in the form of a gas.

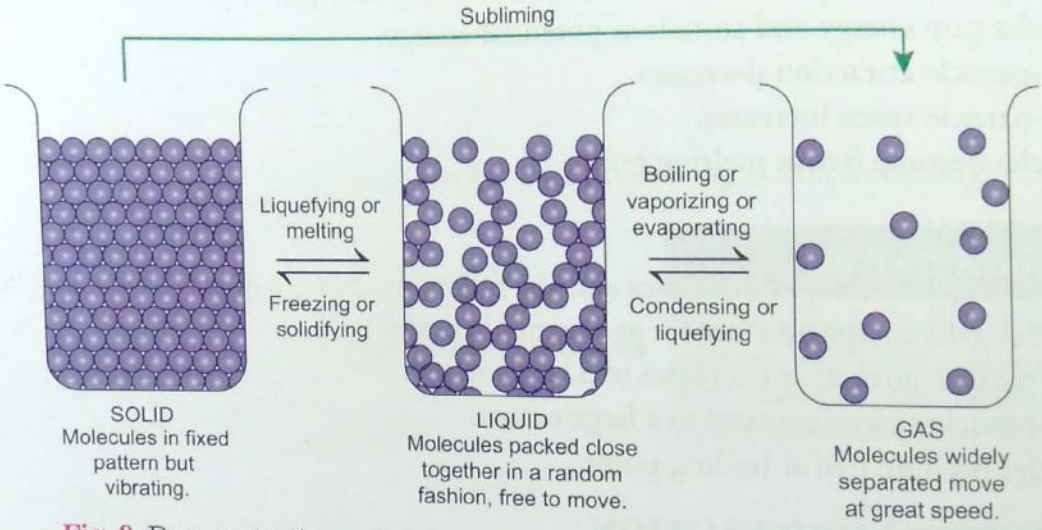


Fig. 9. Demonstration of interconversion of matter into different states

LAW OF CONSERVATION OF MASS

In 1789, a French Chemist Antoine Lavoisier gave the law of conservation of mass (Fig. 10).

According to this law,

"Mass can neither be created nor destroyed during a physical or chemical change."

In a chemical reaction, the total mass of the reactants is equal to the total mass of the products.

$$\underbrace{A + B}_{\text{Reactants}} \longrightarrow \underbrace{C + D}_{\text{Products}}$$

Total mass of reactants = Total mass of products

During a physical change also, the mass remains conserved. For example, the mass of ice is equal to the mass of water obtained after melting of ice.

Fig. 10. Antoine Lavoisier

LIMITATIONS OF LAW OF CONSERVATION OF MASS

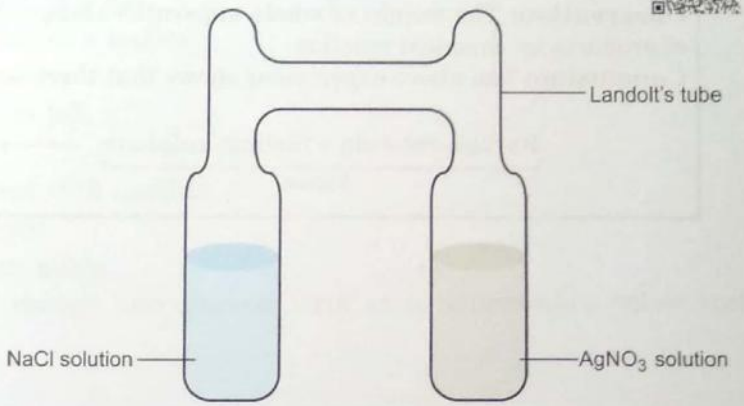
This law does not hold good for those reactions in which the conversion of an appreciable amount of mass into huge amount of energy is involved.

For example: nuclear reactions. Thus, mass and energy are to be considered together.

ACTIVITY 1

TO VERIFY THE LAW OF CONSERVATION OF MASS (LANDOLT'S EXPERIMENT)

- Prepare separate saturated solutions of sodium chloride and silver nitrate solution.
- Take the solution of sodium chloride in one limb and silver nitrate solution in other limb of Landolt's tube (Fig. 11).
- Seal both the limbs with corks.
- Note down the weight of Landolt's tube with its contents carefully.
- Mix the two solutions by shaking the tubes. A white precipitate of silver chloride is obtained.
- Weigh the Landolt's tube again after the experiment.



$NaCl + AgNO_3 \longrightarrow AgCl\downarrow + NaNO_3$

Fig. 11. Landolt's experiment

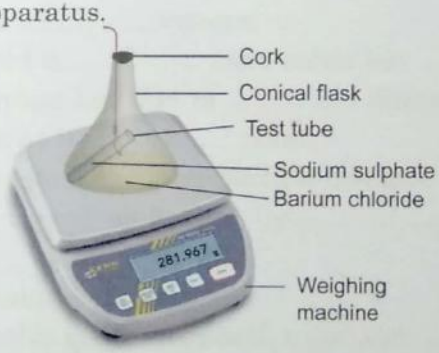
Observation: The mass of the tube and its content do not change after mixing, *i.e.*, the total mass remains constant.

Conclusion: During the chemical reaction, total mass is constant, *i.e.*, matter is neither created nor destroyed. However, it has changed from one form to another due to rearrangement of atoms. It proves the law of conservation of mass.

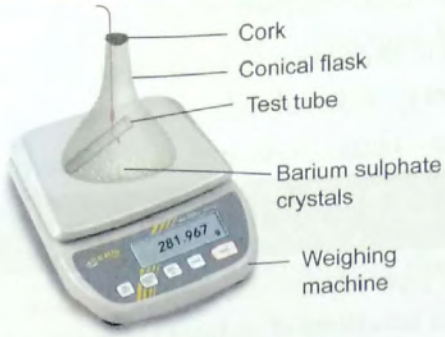
ACTIVITY 2

TO VERIFY THE LAW OF CONSERVATION OF MASS

- Take some barium chloride solution in a conical flask and place small amount of sodium sulphate solution in a test tube suspend this test tube inside the conical flask as shown in the figure. Now weigh the whole apparatus.



- Just loose the thread of the test tube and allow to mix sodium sulphate solution into barium chloride solution. Both react together to form white barium sulphate precipitate. Weigh the apparatus again along with the contents.



Observation: The weight of whole apparatus along with all reactants remains same after the formation of products by chemical reaction.

Conclusion: The above experiment shows that there is no change in total mass after chemical reaction.

$$\underbrace{\text{Barium chloride} + \text{Sodium sulphate}}_{X \text{ gram}} \longrightarrow \underbrace{\text{Barium sulphate} + \text{Sodium chloride}}_{X \text{ gram}}$$

[10]

WORKSHEET

TYPE I: OBJECTIVE TYPE QUESTIONS

A. Write True (T) or False (F) against each of the following statements.

1. Gases have any number of free surface.
2. Intermolecular force in case of solids is maximum.
3. During sublimation, the substance must be heated.
4. An increase in pressure can cause liquefaction of a gas.
5. Mass remains constant during interconversion of a matter.
6. Molecules of a gas have least kinetic energy.
7. During freezing, the temperature continues to fall.
8. Liquids have only one free surface.
9. Solids do not diffuse when they are in contact with another.
10. The mass can neither be created nor destroyed.
11. The density of liquids is relatively more than solids.
12. In case of boiling, the liquids can slowly change into gaseous form at a temperature below their boiling point.
13. All the gases are vapours.

B. Fill in the blank spaces by choosing the correct word from the given list.

molecules	less	definite	gas
atoms	more	increases	solid
closely	indefinite	boiling	kinetic
sublimation	gain	vibrate	lose
energy			

1. Matter is composed of tiny particles called ....., which are joined to form ..... .
2. The particles of matter possess ..... energy due to their continuous motion.
3. The particles are very ..... packed in solids.
4. The particles of solids can just ..... about their mean positions.
5. Liquids have ..... shape but ..... volume.
6. The intermolecular space in a liquid is ..... than solids but ..... than gases.
7. Particles of a ..... do not diffuse but that of ..... diffuse rapidly.
8. A liquid changes into vapour state at its ..... point.
9. The inter-particle attraction decreases if the inter-particle distance ..... .
10. Ammonium chloride changes into vapour on heating by ..... process.
11. During liquefaction, the particles ..... energy.
12. The particles ..... energy during vaporisation.
13. The law of conservation of mass holds good when both mass and ..... are considered together.

C. Tick (✓) the most appropriate answer.

1. When a substance in gaseous state is cooled the kinetic energy decreases and the intermolecular force of attraction:

(a) decreases
(b) increases
(c) does not change
(d) both increases and decreases

2. The interconversion of matter can be brought about by changing:
(a) temperature (b) pressure (c) temperature only (d) both (a) and (b)

3. With the supply of heat energy to matter, the kinetic energy of its particles:
(a) decreases (b) increases (c) remains same (d) cannot be said

4. The process due to which a liquid changes into solid state is called:
(a) melting (b) freezing (c) boiling (d) evaporating

5. Which of the following state of matter is highly compressible?
(a) Solid (b) Liquid (c) Gas (d) None of these

6. The room fresheners are based on the property of:
(a) melting (b) diffusion (c) fusion (d) sublimation

7. Which of the following state of matter has no free surface?
(a) Solid (b) Liquid (c) Gas (d) None of these

8. In which of the following state of matter diffusion of particles is not possible?
(a) Solid (b) Liquid (c) Gas (d) All of these

9. The process due to which a solid directly changes into gaseous state on heating is known as:
(a) vaporisation (b) melting (c) sublimation (d) condensation

10. The intermolecular force acting between molecules of different kinds is called:
(a) attractive force (b) cohesive force (c) adhesive force (d) molecular force

11. According to law of conservation of mass, in a chemical reaction, the mass of the reactants is:
(a) equal to the mass of products (b) half of the mass of products
(c) double the mass of products (d) four times the mass of products

D. Match the Statements in Column A with those in Column B.

S. No.	Column A		Column B
1.	The process due to which a solid changes into liquid state by absorbing of heat energy.	(a)	Diffusion
2.	Intermixing of different substances due to random motions of their molecules.	(b)	Gas
3.	The intermolecular force acting between same kind of molecules.	(c)	Melting
4.	The molecules of a state of matter having very large kinetic energy.	(d)	Adhesive
5.	The intermolecular force acting between different kinds of molecules.	(e)	Cohesive

TYPE II: SUBJECTIVE TYPE QUESTIONS

1. Define matter. State three characteristics of matter.
2. What are the postulates of kinetic theory of matter?
3. Explain the different states of matter on the basis of kinetic theory.
4. Differentiate between boiling point and freezing point.
5. What do you mean by interconversion of states of matter? What are the two factors responsible for the interconversion of matter?
6. Differentiate between gas and vapour.

7. On the basis of kinetic theory, explain the conversion of:
   (a) a solid into liquid
   (b) a liquid into vapour
   (c) a vapour into liquid
   (d) a liquid into solid.
8. Define the terms:
   (a) Sublimation
   (b) Freezing point
   (c) Melting point
   (d) Boiling point
9. State law of conservation of mass. Write an activity to prove this law.
10. Give reasons for the following:
   (i) Solids are rigid and have fixed shape.
   (ii) Solids are not compressible but gases are highly compressible.
   (iii) Particles of matter have kinetic energy.
   (iv) Naphthalene sublimes on heating.
   (v) Kinetic energy of molecules of gases is very large but that of solids is the least.
11. State which of the three states of matter have:
   (i) a definite volume and a shape.
   (ii) a definite shape
   (iii) no definite volume
   (iv) no free surfaces
   (v) diffuse very easily
   (vi) least inter-particle distance
   (vii) least inter-particle attraction.
   (viii) maximum inter-particle attraction.
   (ix) no definite volume and shape.
   (x) large inter-particle distance.
12. Diagram based question:
   Observe the given pictures and answer the following:

(A) (B) (C)

   (a) In which of the substance/s
      (i) intermolecular force of attraction is the strongest
      (ii) kinetic energy is maximum
      (iii) the property of diffusion is observed
      (iv) fluidity is not observed.
   (b) What changes in kinetic energy and inter-particle space take place when the substance shown in Fig. (B) is cooled? What is this process called?
   (c) Define the term when the substance shown in Fig. (B) is heated.

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UNIT

2

Physical and Chemical Changes

Learning Outcomes

Children will be able to:

- *illustrate different changes occurring in nature with examples learned in previous classes;*
- *perform some activities to show some well-known changes;*
- *differentiate between physical and chemical changes and classify the changes.*

Chapter Outlines

- Introduction
- Natural and Man Made Changes
- Periodic and Non-periodic Changes
- Slow and Fast Changes
- Reversible and Irreversible Changes
- Physical and Chemical Changes
  - Physical Changes
  - Chemical Changes
  - Simultaneous Physical and Chemical Changes

INTRODUCTION

In our daily life, we come across many changes in our surroundings. These changes may involve one or more substances (see Fig. 1).

Making a sugar solution, formation of curd from milk, rusting of iron, ripening of fruits, melting of glaciers, change of seasons, growth of seedling into a plant are few examples of changes.

Change in weather

Burning of wood

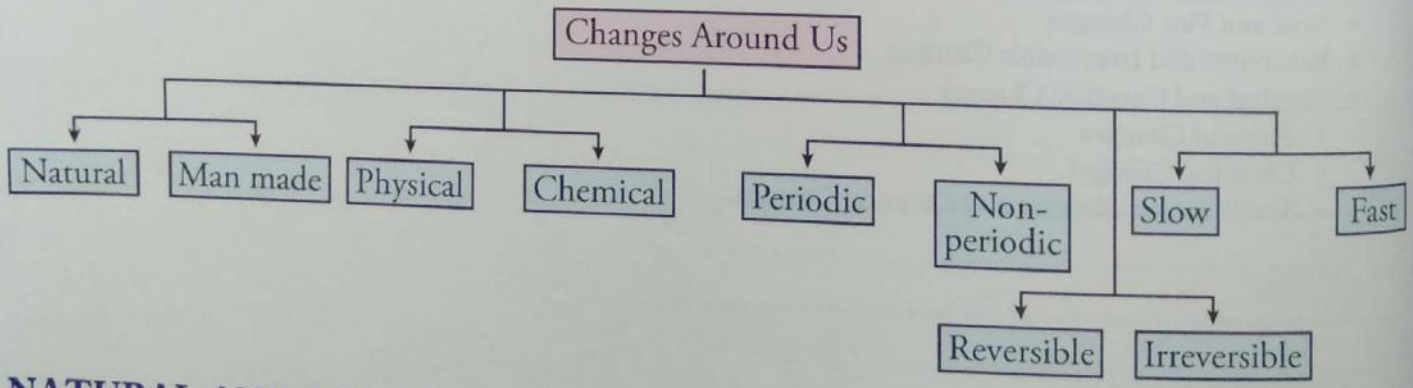
Ripening of fruits

Formation of curd from milk

Rusting of iron

Fig. 1. Changes around us

In this chapter, we will discuss the different types of changes that take place around us. Various changes around us can be divided into following types:



1. NATURAL AND MAN MADE CHANGES

- Changes that occur naturally by their own and are not under the control of human beings are called natural changes.

  For example: Formation of coal from decaying matter, volcanic eruption, growth of a seed into plant, change in weather etc.

- Changes that takes place due to human effort and can be controlled by human beings are called man made changed.
  For example: Dissolving salt and sugar in water, cooking of food, burning of oil etc.

2. PERIODIC AND NON-PERIODIC CHANGES

- The changes which take place after a certain interval of time are called periodic changes.
  For example: Change of season, heart beat, occurrence of day and night, season cycle, movement of a pendulum.
- The changes which do not occur after a certain period of time are called non-periodic changes.
  For example: Rusting of iron, volcano eruption, change of weather.

3. SLOW AND FAST CHANGES

- The changes which take long time to occur are called slow changes.
  For example: Formation of curd from milk, rusting of iron, formation of water, growth of tree etc.
- The changes which take place in a short span of time are called fast changes.
  For example: Burning of fuels, eruption of volcanoes etc.

4. REVERSIBLE AND IRREVERSIBLE CHANGES

- The change that can be reversed into its original form easily is called a reversible change.
  For example:

1. When water is cooled, it changes into ice but on heating ice changes into water again. Therefore, it is a reversible change.

$$\text{Water (Liquid)} \underset{\text{Melting}}{\overset{\text{Freezing}}{\rightleftharpoons}} \text{Ice (Solid)}$$

2. Water on boiling changes into steam. Steam can be reversed back into water by cooling. It is also a physical change.

$$\text{Water (Liquid)} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} \text{Steam (Gas)}$$

3. Stretching of a spring is a reversible change because it comes back to its original length after removing the weight (Fig. 2a-b).

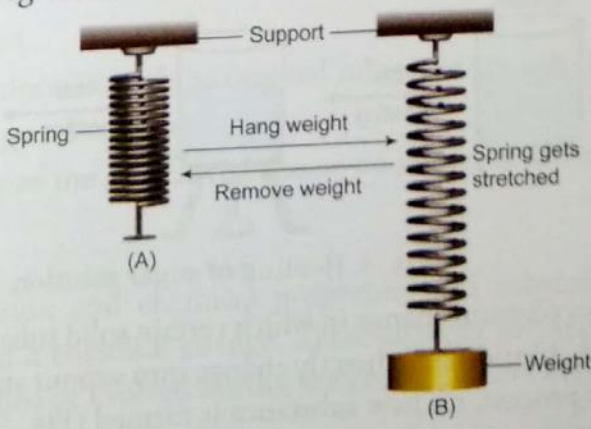


Fig. 2(A)-(B). Stretching of a spring is a reversible change

5. PHYSICAL AND CHEMICAL CHANGES

A matter can undergo either physical or chemical change. It depends on the fact that whether a new substance will be formed or not.

PHYSICAL CHANGES

These are temporary and reversible changes in which no new substance is formed. These changes involve change of states.

There are few examples for physical changes as shown below:

1. The melting of ice into water and then into vapour by heating is a physical change. The condensation of water vapour into water and then into ice by cooling is also a physical change (See Fig. 3). It means that the change in physical state of a matter is an example of physical change.

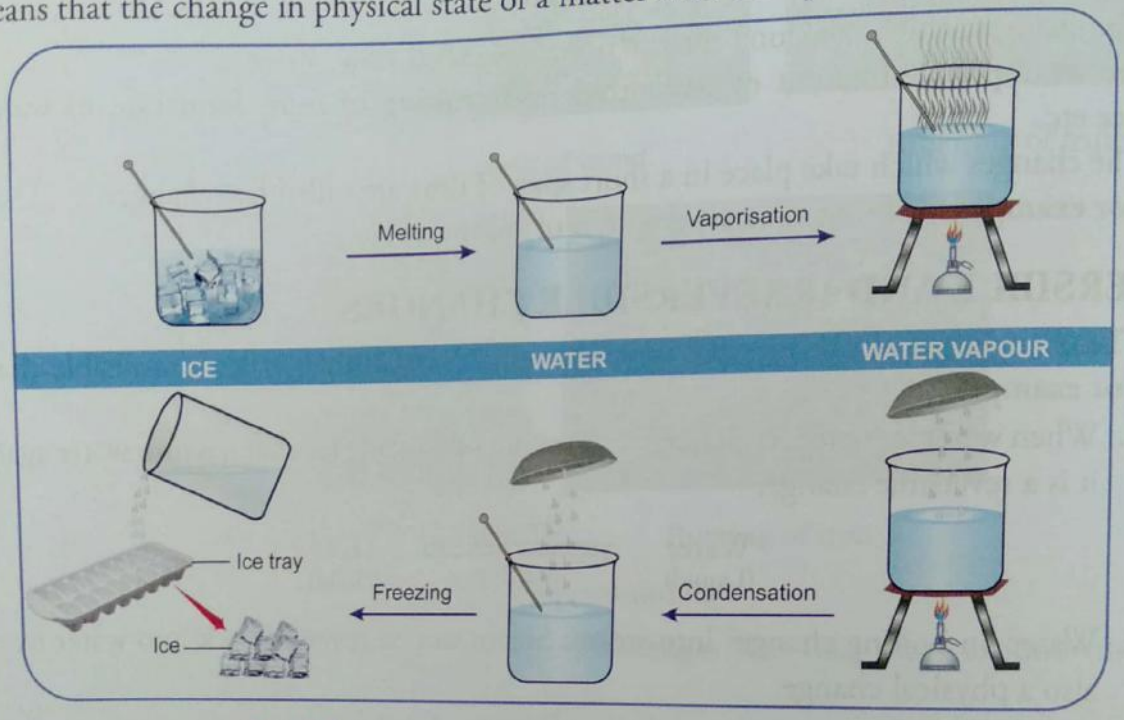


Fig. 3. Interconversion of ice and water vapour

2. Sugar dissolved in water is a physical change because on heating the solution water gets evaporated and sugar is regained (Fig. 4).

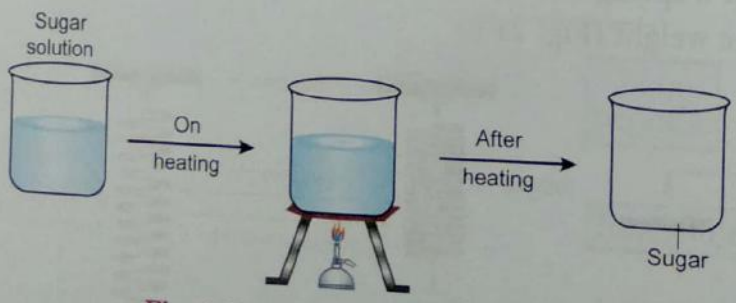


Fig. 4. Heating of sugar solution

3. Sublimation is also a physical change in which certain solid substances like camphor, naphthalene, iodine, ammonium chloride etc., directly change into vapour state on heating and can be regained on cooling. In this process, no new substance is formed (Fig. 5).

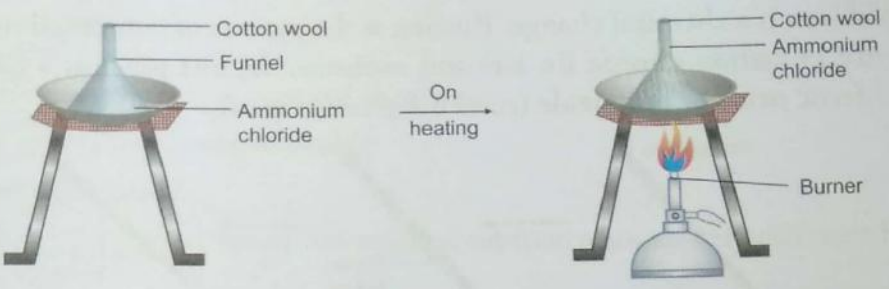


Fig. 5. Sublimation

4. An iron wire turns red hot and glows on heating but the wire comes back in the original form on cooling (Fig. 6).

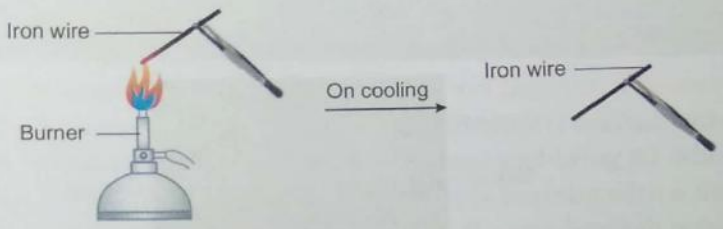


Fig. 6. Heating of iron wire

5. The wooden wheels of a bullock cart is fitted with the iron rim to increase their durability (Fig. 7). The diameter of rim is slightly smaller than that of the wheel. When iron rim is heated, it expands. It is then placed over the wooden wheels and then cooled by pouring cold water on it. The iron rim contracts and gets fitted on the wooden wheel tightly. Expansion and contraction of iron rim on heating and cooling is a temporary, reversible and a physical change.

Fig. 7. Wheel of a bullock cart

Conclusions

In each of the cases, the change is a physical change because:

- The change is temporary and reversible.
- No new substance is formed.
- The properties and the composition of the original substance are not changed.
- No net gain or loss of energy takes place.
- There is no change in mass of the substance because no matter is added or removed.

CHEMICAL CHANGES

A change in which composition and chemical properties of a substance are changed and new substances are formed is called a chemical change. These changes involve energy changes. It means that the energy is either absorbed or evolved during the change. There are few examples for chemical change as shown ahead:

1. Rusting of iron is a chemical change. Rusting is the process of combination of iron with oxygen in presence of carbon dioxide (in air) and moisture. In this process, a new compound called hydrated ferric oxide or iron oxide (rust) is formed (Fig. 8).

Fig. 8. Rust formation

2. Formation of curd from milk is also an example of chemical change (Fig. 9). Addition of curd to milk changes it permanently into curd which is a new substance. It is also an irreversible change because milk cannot be further gained from curd.

Fig. 9. Formation of curd

3. Addition of dilute sulphuric acid to magnesium gives magnesium sulphate and hydrogen gas. It is a permanent and irreversible change in which new substances (magnesium sulphate and hydrogen gas) are formed (Fig. 10). They can not be converted back into their original substances (magnesium and dilute acid). Therefore, it is a chemical change.

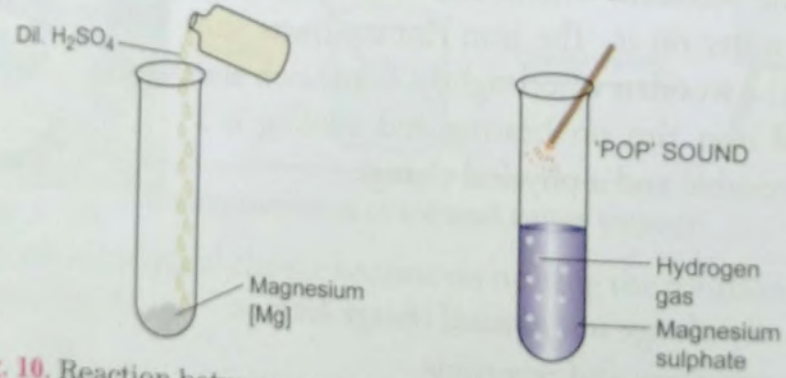


Fig. 10. Reaction between magnesium and dilute sulphuric acid

4. Copper carbonate on heating gives new substances copper oxide and carbon dioxide which is a permanent and reversible change (Fig. 11).

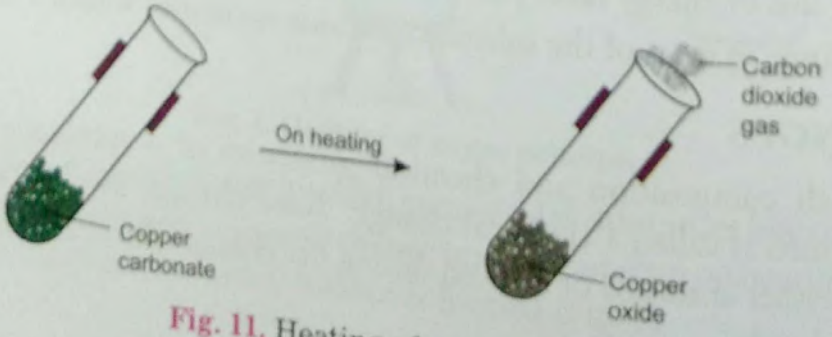


Fig. 11. Heating of copper carbonate

Conclusions

In each of the above cases, there is a chemical change as:

- The change is permanent and irreversible.
- A new substance is formed.
- The properties and composition of the original substance are entirely different from that of new substance.
- The exchange of energy takes place.
- There is a change in the mass of the substance because matter is added or removed.

Activity

To observe the formation of a new substance on heating a magnesium ribbon.

- Take a small piece of magnesium ribbon and clean it by rubbing its surface with a sand paper.
- Hold the magnesium ribbon at one end with a pair of tongs and bring its other end over the flame of a burner [Fig. 12(a)]. The magnesium ribbon starts burning with a dazzling white light. Hold the burning magnesium ribbon over a watch glass so that the powdery ash being formed by the burning of magnesium collects in the watch glass [Fig. 12(b)]. Actually when magnesium ribbon burns in air then the magnesium metal combines with oxygen (of air) to form a new substance called magnesium oxide. This change can be written in the form of reaction as follows:

$$\underset{\text{Magnesium}}{2Mg} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Magnesium oxide}}{2MgO} \text{ (White powdery ash)}$$

- This proves that burning of magnesium ribbon is a chemical change because new substance magnesium oxide is formed during change.

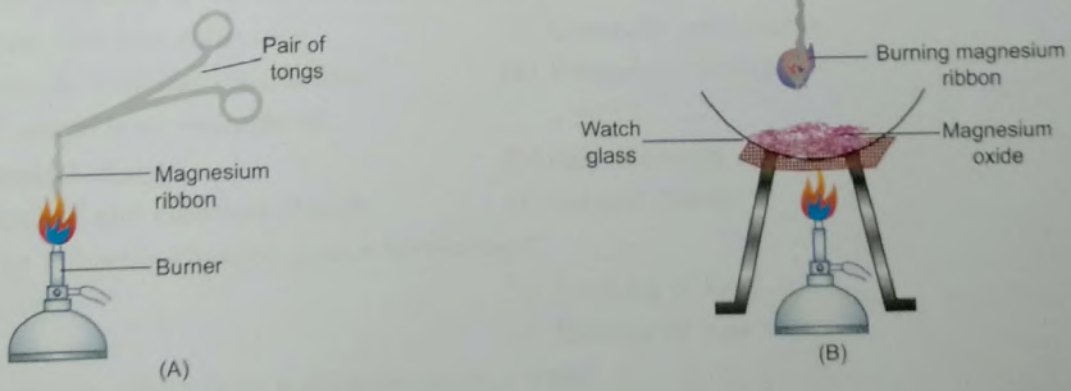


Fig. 12(A)-(B). (A) Magnesium ribbon being heated over a burner, (B) Magnesium ribbon burns in air to form magnesium oxide

Table 1: Distinction between Physical and Chemical Changes

S. No.	Physical Changes	Chemical Changes
1.	No new substances are formed.	New substances are formed.
2.	It is a temporary change.	It is a permanent change.
3.	It is generally reversible.	It is generally irreversible.
4.	Only the physical properties like state, odour, colour, shape etc., of the substance change.	Both physical and chemical properties of the substance change.
5.	There is no change in mass.	Masses of the substances change. However total mass remains unchanged.
6.	There is no absorption or evolution of heat (energy).	It is accompanied by evolution or absorption of heat and sometimes emission of light.

SIMULTANEOUS PHYSICAL AND CHEMICAL CHANGES

Burning of a candle is an example of simultaneous physical and chemical change. The melting of wax changes it into liquid. It changes back into solid wax on cooling. Thus, melting of candle wax is a physical change (Fig. 13).

Some of the liquid wax changes into wax vapour and burns in air to produce carbon dioxide and water vapour. It also produces heat and light. Thus burning of wax is a chemical change.

Fig. 13. A burning candle

WORKSHEET

TYPE I: OBJECTIVE TYPE QUESTIONS

A. Write True (T) or False (F) against each of the following statements.

1. Breathing by human beings is an example of chemical change.
2. Sublimation of ammonium chloride and camphor are physical and reversible changes.
3. Chemical changes involve only a change in the physical properties.
4. Rusting of iron is a fast physical change.
5. Magnetization of a soft iron bar is an example of chemical change.
6. Curdling of milk and growth of a plant are irreversible changes.

B. Fill in the blanks by choosing the correct word from the given list.

physical	irreversible	chemical	heat
reversible			

1. Chemical change involves evolution or absorption of ..... .
2. Rusting of iron is ..... in nature.
3. Interconversion of states of a matter is a ..... change.
4. Matter is added or removed during a ..... change.
5. Dissolution of sugar in water is considered as ..... and ..... change.
6. When the total mass of a substance is altered, the change is known as ..... change.
7. Expansion and contraction of a metal on heating and cooling is an example of ..... change.

C. Tick (✓) the most appropriate answer.

1. Which of the following is not correct about a chemical change?
   (a) Formation of a new substance
   (b) Generally irreversible
   (c) No change in chemical composition
   (d) Permanent change
2. Burning of candle is an example of:
   (a) only physical change
   (b) only chemical change
   (c) both physical and chemical change
   (d) natural change
3. Which of the following changes cannot be reversed?
   (a) Melting of ice
   (b) Cooking of food
   (c) Boiling of water
   (d) Heating of iron wire
4. A physical change differs from a chemical change when:
   (i) no new substance is formed
   (ii) physical properties change
   (iii) chemical properties change
   (iv) energy is released
   (a) (i) and (ii)
   (b) (ii) and (iii)
   (c) (iii) and (iv)
   (d) (i) and (iv)
5. The equation that represents a chemical change is:
   (a) ice $\longrightarrow$ water
   (b) water $\longrightarrow$ steam
   (c) carbon + oxygen $\longrightarrow$ carbon dioxide
   (d) water + common salt $\longrightarrow$ solution of common salt

D. Match the Statements in Column A with those in Column B.

S. No.	Column A		Column B
1.	Decomposition of fruit juice.	(a)	Physical change
2.	Rottening of fruits.	(b)	Chemical change
3.	Boiling of milk.		
4.	Formation of curd from milk.		
5.	Coal to coal ash.		
6.	Seed to plants.		
7.	Copper to copper sulphate solution.		
8.	Sugar to sugar solution.		
9.	Magnesium to magnesium oxide.		
10.	Passing of current through electric bulb.		

E. Classify the following changes into physical or chemical change.

1. Burning of sulphur.
2. Melting of wax.
3. Evaporation of water.
4. Dissolution of sugar in water.
5. Heating of copper carbonate.
6. Addition of dilute acid to magnesium.
7. Souring of milk.
8. Phosphorus burns in air.
9. Iron forms rust in moist air.
10. Conversion of water to ice.
11. Magnetization of iron.

F. Classify the following processes into physical and chemical change:

Digestion, drying plant, respiration, sublimation, fermentation, condensation, ripening of fruit, growth of a plant, vaporisation of water, burning, freezing, melting of butter.

TYPE II: SUBJECTIVE TYPE QUESTIONS

1. Give reason for the following:
   (a) Magnetization of iron is a physical change but rusting of iron is a chemical change.
   (b) Heating of platinum wire is a reversible change but heating of magnesium ribbon is an irreversible change.
   (c) Change of reasons is a periodic change but change of weather is a non-periodic change.
   (d) Burning of coal is a chemical change.
   (e) Dissolution of quick lime in water is a chemical change but dissolution of common salt in water is a physical change.
   (f) Addition of dilute sulphuric acid to zinc metal is a chemical change.
2. Sodium sulphate is added to water and is made to dissolve into it by stirring. A salt solution is obtained which is then boiled leaving behind a residue:
   (a) Is this a physical or chemical change?

(b) Name the residue left after boiling the salt solution.

(c) Is the change reversible or irreversible in nature?

(d) Are the composition and properties of the salt changed?

3. Give differences between the following with suitable examples:

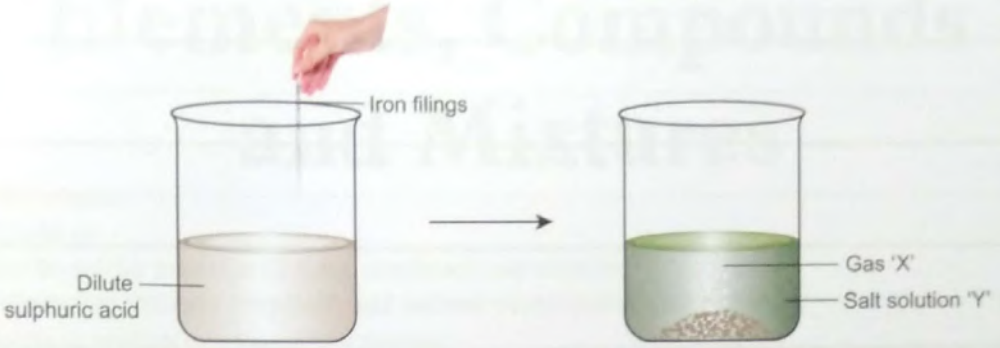
(a) Physical and chemical change

(b) Reversible and irreversible change

(c) Periodic and non-periodic change

4. Diagram based questions:

The diagram represents the addition of iron to dilute sulphuric acid.



Answer the following questions:

(a) Which type of change does take place in the above reaction?

(b) Which new substance 'Y' is formed?

(c) Which gas 'X' is evolved in the above reaction?

(d) What type of energy change does take place?