ST. XAVIER'S SCHOOL, PURULIA

CLASS : VI, SUB: CHEMISTRY, PHASE-II

# Chapter :-2

## The Nature of Matter (States of Matter)

Please read the attachment carefully. Write down all the question answers in the copy. All the activities given in the book along with the diagrams are important.

# INTRODUCTION

Matter is anything that has mass and occupies space. Matter can exist in three states namely solid, liquid and gas. All the objects present around you such as, chair, table, pencil, pen, even your books are matter. This implies that, detailed knowledge of matter is very essential if anybody wants to understand the world around him.

In our daily life, we come across a wide variety of things. All these things are materials. Some of these things are living and some are non-living. Living things include plants and animals whereas non-living include table, chair, pencil, pen etc.

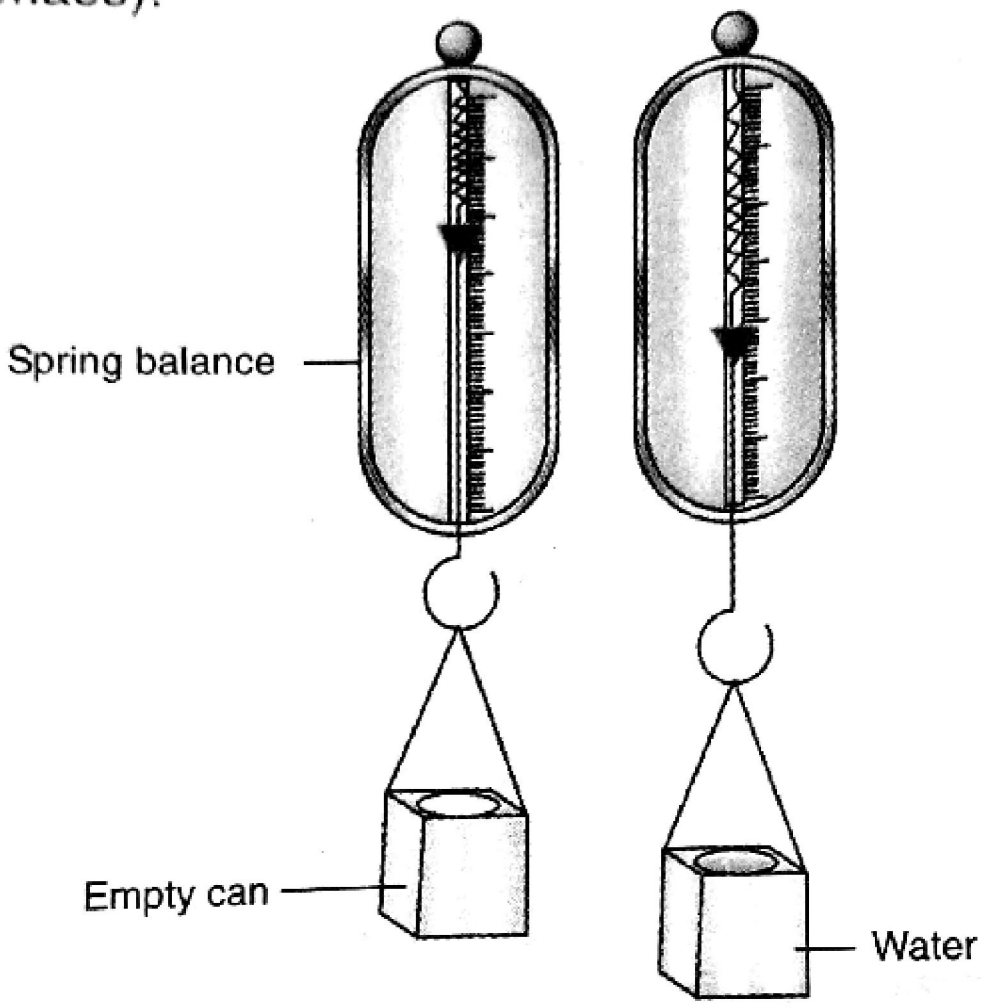
In general, all objects around us are made up of different kinds of materials. Therefore, we can say that, *'all substances are composed of matter.'*

## 1 Activity

**To show that matter can be seen.**

**Method** : Take an empty can and suspend it from aspring balance. The spring balance shows that the can has weight (mass). Now, pour water in the can. What do you notice ?

The spring balance records more weight (mass).



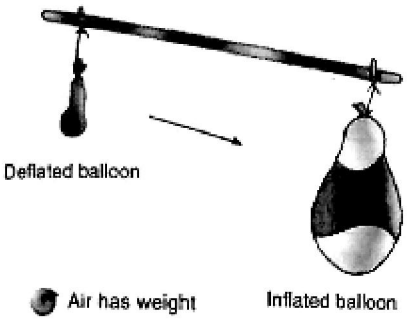

Solids and liquids have weight

**Result** : From this activity, we conclude that both solids and liquids have weight (mass) and can be perceived by senses because we can see them.

## Activity

**To show that matter occupies space.**

**Method :** Take a balloon and blow air into it. The air fills the balloon and as a result the size of balloon increases.

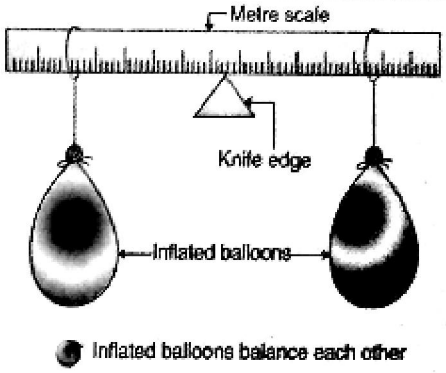



**Result :** Air occupies space. This indicates that, 'air is a matter'.

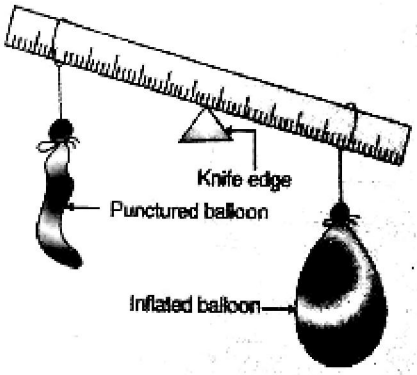
## 3 Activity

**To show that matter has got mass.**

**Method :** Take two similar balloons and inflate them equally. Suspend two balloons equally on the two corners of a metre scale which is placed on a knife edge. The scale remains in a balanced state. Now, puncture the balloon on the left, you will observe that metre scale tilts towards the right.




Inflated balloons balance each other




It shows that matter (gases) has got mass

**Result :** This activity proves that air has weight and hence it **bent towards the heavier side** where the blown balloon was hanged.

## To compare the Important Properties of solids, liquids and gases

| Property | Solids | Liquids | Gases |
|---|---|---|---|
| 1. Nature of Molecules | In solids, the molecules are closely packed. | In liquids, the molecules are loosely packed. | In gases, the molecules are very loosely packed. |
| 2. Shape | Solids keep the same shape and do not flow. | Liquids flow easily and take the shape of a container. | Gases flow easily and take the shape of a container. |
| 3. Volume | Solids have a definite volume. | Liquids have a definite volume. | Gases do not have a definite volume. |
| 4. Compressibility | Solids cannot be compressed. | Liquids can be compressed slightly. | Gases can be compressed to a much smaller volume. |
| 5. Density | Solids have high density. | Liquids have medium density. | Gases have low density. |

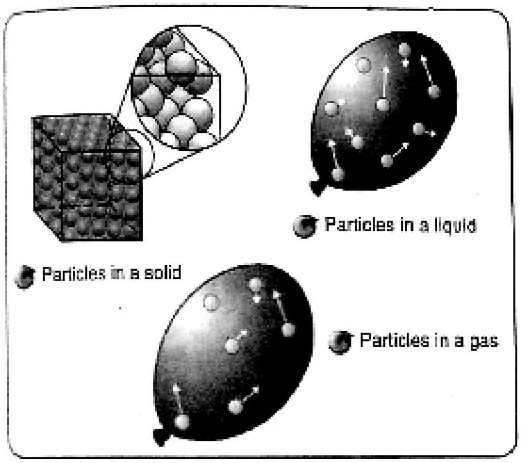
## THE KINETIC THEORY OF MATTER

The idea that all substances contain incredibly small moving particles is called the *kinetic theory of matter*.

The word 'kinetic' comes from a Greek word meaning moving. The main points of the kinetic theory are:

(*i*) All matter is made-up of tiny, invisible, moving particles. These particles are actually atoms, molecules and ions.

(*ii*) Particles of different substances have different sizes.




(*iii*) Small particles move faster than larger particles at the same temperature.

(*iv*) As the temperature rises, the particles possess more energy and move around faster.

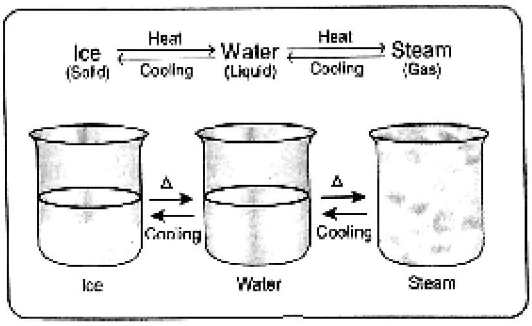
(*v*) In a solid, the particles are very close and they can only vibrate about fixed positions.

(*vi*) In a liquid, the particles are further apart. They have more energy and they can roll around each other.

(*vii*) In a gas, the particles are far apart. They move very fast and randomly in all the space they can find.

## CHANGE OF STATE

Matter can be changed from one form to another. *e.g.*, ice (solid) on heating changes to water (liquid) and on further heating changes to steam (gas).




## Worksheet

**I. Fill in the blanks with appropriate words :**

1. Air has MATTER... and occupies space.
2. In a gas, the particles are far APART.
3. A MOLECULE is the smallest particle of a substance which can exist independently.
4. Liquids have a definite VOLUME
5. Particles in ..SOLID.. are tightly packed.

**II. Give two examples of following :**

1. Naturally occurring material : WOOD, COTTON.
2. Man-made material : CHAIR TABLE
3. States of water : SOLID LIQUID GAS.

**III. Complete the table :**

| Property | Solids | Liquids | Gases |
|---|---|---|---|
| 1. Density | HIGH density | Medium density | LOW density |
| 2. Nature of molecules | Molecules are closely packed | Molecules are LOOSELY PACKED | Molecules are VERY LOOSELY PACKED. |

**IV. Write true or false :**

1. Air doesn't occupy any space. [F]
2. Solids cannot be compressed. [T]
3. Gases have low densities. [T]
4. Liquids have definite volume. [T]
5. Particles of different substances have different sizes. [T]

## MOLECULES AND ATOMS

Matter is made-up of extremely tiny particles. These particles are so small that they cannot be seen even under most powerful microscope. These tiny particles are called ***molecules. A molecule is the smallest particle of a substance which can exist independently.***

John Dalton, in 1808 discovered that a molecule itself is made-up of still smaller particles called ***atoms***. Thus, ***an atom is the smallest particle which makes matter.***

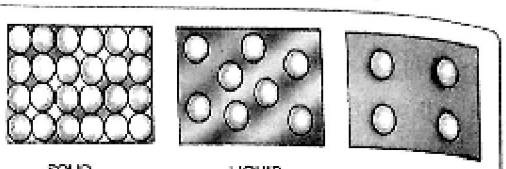
Modern researches have shown that even atom can be divided into electron, proton and neutron. Due to this reason, Dalton's theory has been proved wrong.

## ARRANGEMENT OF MOLECULES

**Solids :** In solids, the molecules are arranged compactly or closely packed. They have least intermolecular spaces. The force of attraction between the molecules is very strong and hence free movement of molecules is not there.

**Liquids :** In liquids, the molecules are loosely held. There are large intermolecular spaces. The force of attraction between the molecules is less and hence free movement of molecules is there.

**Gas :** In gases, the molecules are very loosely held. There are very large intermolecular spaces. The force of attraction between the molecules is least and hence the molecules move about freely.

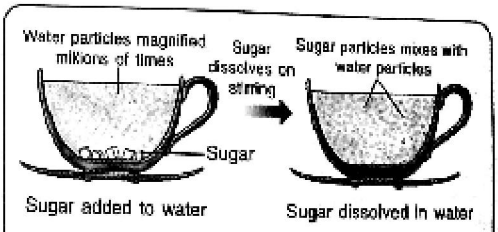



### 4 Activity

**To show the presence of intermolecular spaces in the molecules of a liquid.**

**Method :** Take a glass filled with water upto the brim. Add powdered sugar very carefully in the glass. What do you observe? Did water flow out of the glass ? Can you say why ? There are gaps in between the water molecules and sugar molecules enter these spaces.

**Result :** Intermolecular spaces are present in the liquid which then gets filled with solid sugar molecules.




Explaining what happens when sugar dissolves in water

### 5 Activity

**To show that gas molecules can diffuse easily.**

**Method :** Apply perfume on your body. What do you observe? The fragrance of perfume spreads

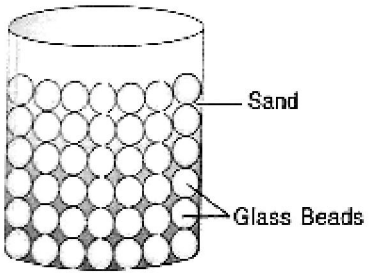
all over the room. What does this show? This indicates that molecules of perfume spread all over the room. As a result of this, we are able to smell it.

**Result** : Gas molecules diffuse easily and thus, can move freely in all directions.

Perfume bottle

## Skill Fill

Take a glass jar and fill it with small glass beads such that all the beads are closely packed and no more bead can be accomodated. Now, add a bowl full of sand to it. You will observe that sand easily goes inside and fill in the spaces between the beads.



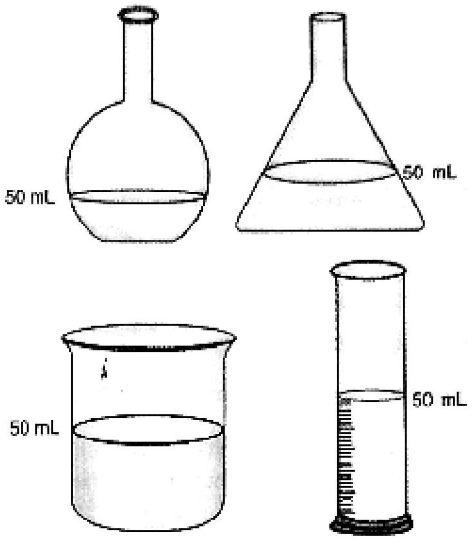

**Conclusion** : This experiment clearly shows that smaller particles FILL UP spaces between the bigger particles.

## 6 Activity

**To show that liquids have a definite volume but do not have a definite shape.**

**Method** : Take different types of glass apparatus available in your chemistry laboratory and pour 50 mL of coloured solution in all of them and observe.

**Observation** : You will find different shapes of liquid in different beakers although volume of liquid was same in all.




Liquids do not have a fixed shape

**Result :** Liquids have definite volume but do not have definite shape.

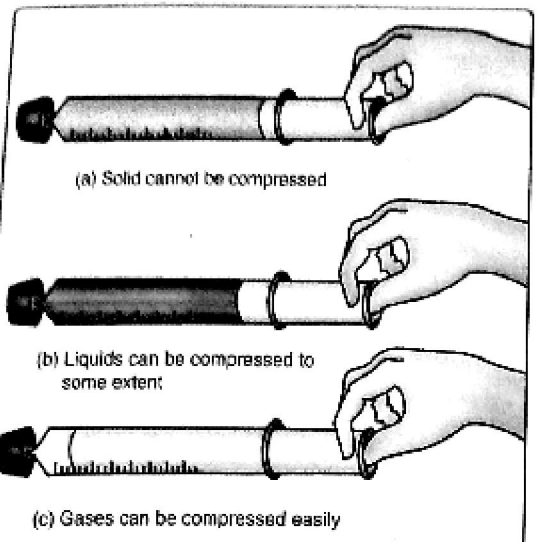
## 7 Activity

**To show compressibility in different states of matter.**

**Method :** Take three disposable syringes, without needle. Seal their nozzles with tape and fix them into the cork as shown in the figure. Remove their pistons and fill sand in the first syringe and coloured water in the second syringe. Remove cork and tape of third syringe. Pull its piston back to ensure the presence of air inside the syringe. Seal the nozzle again. Note down the initial reading of piston in all the three syringes. Now, try to compress all the three syringes.

**Observation :** You will find that :

(*i*) The piston remains unmoved in the first syringe containing coloured sand (solid).



(a) Solid cannot be compressed

(b) Liquids can be compressed to some extent

(c) Gases can be compressed easily

(*ii*) The piston moves a little in case of second syringe containing coloured water (liquid).

(*iii*) The piston moves completely forward in case of a third syringe containing air (gas).

**Result :** This activity shows that :

(*i*) Solids are incompressible.

(*ii*) Liquids can be compressed to some extent.

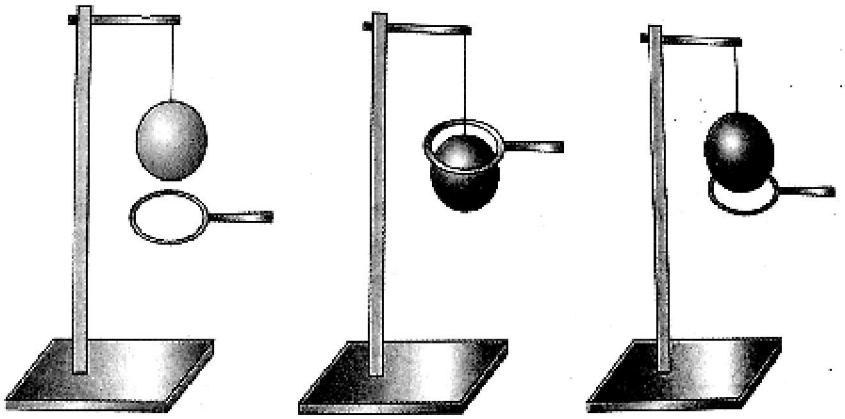
(*iii*) Gases can be compressed easily.

## CHANGE OF STATE

Heat results in weakening of the intermolecular forces of attraction thus, causing change of states.

Solids have molecules packed tightly. When solids are heated, the heat energy is used to weaken the existing forces and hence separates the molecules, thereby forming a liquid state. When the liquid molecules are heated further, more heat further separates the molecules, thereby forming gascous state. Heat even results in the expansion of solids. Most of the solids expand on heating as their molecular force of attraction decreases and atoms move away from each other.

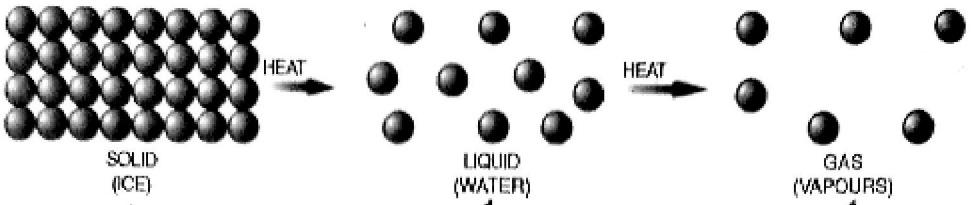
## Skill Fill



Before Heating | Before Heating | After Heating

Take a metallic ball and suspend it from the stand. Pass it through a metallic frame (ring). The ball passes easily. Now, heat the ball strongly, the ball does not pass through the metallic frame after heating. This clearly shows that solid expands on heating.

**Conclusion :** The metallic ball increases in size when it is heated so it does not pass through the same metallic frame (Ring).




Heat weakens the existing force and separate the molecules

More heat further separates the molecules

As a result of the above fact, intermolecular spaces increase and solid changes to liquid

As a result of the above fact, intermolecular spaces increase infinitely and the liquid state changes into vapour state

Change of states

## Worksheet

**I. Fill in the blanks with appropriate words :**

1. An MOLECULE is the smallest particle of a substance which can exist independently.
2. In GASES, the force of attraction between the molecules is least.
3. GASEOUS molecules diffuse easily and thus, can move freely in all directions.
4. Liquids have definite VOLUME but do not have definite SHAPE.
5. Solids cannot be COMPRESSED

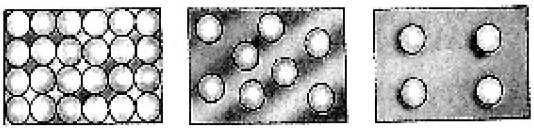
**II. Match the following :**

| | | |
|---|---|---|
| 1. Gas molecules (c) | (a) | least intermolecular spaces |
| 2. Liquids (e) | (b) | exist independently |
| 3. Solids (a) | (c) | diffuse easily |
| 4. Molecules (b) | (d) | smallest particle |
| 5. Atom (d) | (e) | definite volume |

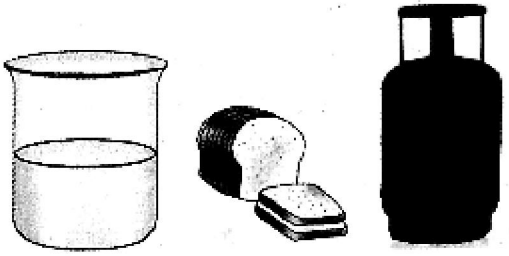
**III. Write true or false :**

1. Heat weakens the existing force and separate the molecules. T
2. Liquids can be compressed to some extent. T
3. Gas molecules cannot diffuse. F
4. Molecules are tightly packed in liquids. F
5. Atom is divisible. F

**IV. Which state is represented by following and match it with the examples ?**



SOLID LIQUID GAS



LIQUID SOLID GAS

1. Material is a substance which is used to make an object.
2. Matter is anything which occupies space, has weight and can be perceived by senses.
3. Man-made materials are those which are synthesized by humans.
4. The three states can be interchanged by changing the temperature.
5. The idea that all substances contain incredibly small moving particles is called the kinetic theory of matter.
6. Molecules are compactly arranged in solids, loosely packed in liquids and are far apart in gases.
7. Intermolecular forces of attraction are maximum in solids, less in liquids and least in gases.
8. Solids have definite shape and volume but cannot be compressed.
9. Liquids have no definite shape but have a definite volume and can flow. They can be compressed negligibly.
10. Gases have neither definite shape nor definite volume and can flow freely. They can be easily compressed.


**Q.1. Why are solids denser than liquids and gases ?**

**Ans.** In solids, the particles are very close. There are strong forces of attraction between the molecules. As a result, solids are denser than liquids and gases.

**Q.2. Why solids cannot flow ?**

**Ans.** Solids have molecules close to each other due to which strong intermolecular forces are present between them thus, these particles cannot move from their mean position. As a result, solids cannot flow.

**Q.3. Why liquids can be compressed ?**

**Ans.** In liquids, the particles are further apart. Forces between particles are not as strong as in solids. Due to this reason, the molecules can be brought slightly closer, hence liquids can be slightly compressed.

**Q.4. Why gases have very low densities ?**

**Ans.** In a gas, the particles are very far apart. Forces between particles are almost zero and hence, they have very low densities.

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**Ans.** In a gas, the particles are very far apart. Forces between particles are almost zero and hence, they have very low densities.

**Q.5. How do gases fill whole of the container ?**

**Ans.** Gas particles move very fast in all the spaces they can find. Due to this reason, they have the tendency to occupy the vacant spaces and thus they fill whole of the container.

**Q.6. How does heat energy bring change of state ?**

**Ans.** Heat given to the substance changes into kinetic energy and the molecules start vibrating with the help of this energy. More is the energy supplied, more is the movement of molecules away from each other and as a result of this, change of state is observed.

**Q.7. Why liquids like honey, mustard oil and lubricating oil are sticky and viscous in nature ?**

**Ans.** In these liquids, there is more friction between the different layers of molecules. This friction opposes the flow of these liquids and hence they are called viscous liquids.


## A. TICK (✓) THE MOST APPROPRIATE ANSWER :

1. Molecules are tightly packed in :
   (a) Solids (b) Liquids (c) Gases (d) None of these.
2. Which of the following is an example of man-made material :
   (a) Wood (b) Fruits (c) Nylon (d) Herb.
3. Intermolecular spaces are maximum in :
   (a) Solids (b) Liquids (c) Gases (d) Non-metals.
4. The change of state from solid to liquid is known as :
   (a) Fusion (b) Vaporisation (c) Solidification (d) Sublimation.
5. Maximum kinetic energy is possessed by :
   (a) Solids (b) Liquids (c) Gases (d) Gel.
6. The agent which results in weakening the intermolecular forces of attraction is :
   (a) Heat (b) Air (c) Water (d) None of these.
7. The smallest particle which makes up the matter is :
   (a) Atom (b) Molecule (c) Element (d) Compound.
8. Which one of these is capable of sublimating :
   (a) Camphor (b) Milk (c) Sodium (d) Calcium.

## B. FILL IN THE BLANKS :

1. The three states of matter are SOLID, LIQUID and GAS.
2. When a gas is cooled its molecules LOSES energy.
3. Molecules are compactly arranged in SOLIDS.
4. The position of molecules in a solid is FIRM.
5. GASEOUS molecules move freely in all directions.
6. Air has WEIGHT and occupies SPACE.
7. Intermolecular forces of attraction are least in GASES.

## C. WRITE TRUE OR FALSE FOR EACH STATEMENT. REWRITE THE FALSE STATEMENTS CORRECTLY :

1. Gas molecules move freely in all directions. [T]
2. Weight can be measured with the help of a spring balance. [T]
3. Nylon and steel are natural materials. [F]
4. Solids keep the same shape and has definite volume. [T]
5. Molecule is the smallest particle of a substance which can exist independently. [T]
6. Barnard discovered that a molecule is made-up of smaller particles called atoms. [F]

## D. FIND THE ODD ONE OUT GIVING REASON :

1. Nitrogen, oxygen, chlorine, water.
2. Solids, liquids, gas, protons.
3. Electron, proton, neutron, atom.
4. Ice, water, steam, naphthalene.
5. Condensation, evaporation, sublimation, solidification.

## MATCH THE COLUMNS :

| Column A | Column B |
|---|---|
| 1. Solids (f) | (a) Have least intermolecular force. |
| 2. Atom (d) | (b) Smallest particles that exist independently. |
| 3. Nylon (e) | (c) Change of state from liquid to gas. |
| 4. Molecules (b) | (d) Tiny particle of an element. |
| 5. Vapour (c) | (e) Man-made material. |
| 6. Gas (a) | (f) Have maximum density. |

Q.D.FIND THE ODD ONE OUT GIVING REASONS:-

1.water:-it is a compound.rest are elements/gases

2.protons:-one of the parts that comprise of the three states of matter.rest are the three states of matter.or others are three states of matter where proton isn't.

3.atom:-electron ,proton,neutron are parts of an atom .

4.napthalene:-it is a different compound.rest are the three states of water.

5.sublimation:-it is the process of conversion of a solid state directly into gaseous state without enterin g the liquid state

Q.F.GIVE REASONS FOR THE FOLLOWING:-

Q. 1.gases have low densities:-page no :13 of this attachment.conceptual questions.question no:-4.

Q:-2.heat energy brings change of state:- page no :13 of this attachment.conceptual questions.question no:-6

Q:-3.solids donot flow:- page no :13 of this attachment.conceptual questions.question no:-2

Q:-4.liquids cannot be compressed:- page no :13 of this attachment.conceptual questions.question no:-3

Q.G.ANSWER THE FOLLOWING QUESTIONS:-

1.matter is anything which occupies space,has weight and can be perceived by one of our senses.the three states of matter are solid,liquid and gases

2.in solids the molecules are arranged compactly or closely pac ked.they have least intermolecular spaces.the force of attraction between the molecules is very strong and hence the free movement of molecules is not there.

3. page no :6 of this attachment

4.yes, atoms are divisable.reaserches have shown that an atom can be divided into protons,neutrons,and electrons.

5.page no:-8,activity :-4 of this attachment.diagram needs to be drawn

6.page no:-8 of this attachment,under the heading of "arrangement of molecules".the answer is the full paragraph of solids,liquids,and gases along with the diagram given below of solids liquids and gases.

7.page no:8 &9 of this attachment.activity 5.full experiment.diagram needs to be drawn

8.page no:-7 of this attachment under the heading of kinetic theory of matter.full paragraph is the answer till point no vii.

Question no :-c:-write true and false for each statement:-

1.true

2.true

3.false.nylon and rayon are artificial/manmade materials.

4.true

5.true

6.false.dalton discovered that a molecule is made up of smaller particles called atoms

WORKSHEET

I.FILL IN THE BLANKS:-

1.Air has matter/mass and occupies space.

OBJECTIVE QUESTIONS:-

B.FILL IN THE BLANKS:-

4.the position of molecules in a solid is fixed/firm