We are surrounded by a number of objects. eg : iron, wood, water, air etc. We do not see air but we feel its presence. All these things occupy space and have mass. In the **World of Science, matter is anything that has mass and occupies space.** There are different kinds of matter. Here, we learn about matter based on its physical properties.

ACTIVITY 5.1

Look at your surroundings, observe and write the objects around you.

In your house	1.. 2.. 3..
In the play ground	1.. 2.. 3..
In your class room	1.. 2.. 3..

5.1. PHYSICAL NATURE OF MATTER

Let us perform an activity to learn about the nature of matter.

MORE TO KNOW

The size of the atoms and molecules of matter is very small, almost beyond our imagination. It is measured in nanometres (1nm = 10^{-9}m).

ACTIVITY 5.2

Let us take a small piece of chalk and powder it. We can see that the chalk powder consists of small particles. These particles are responsible for the formation of matter (chalk). **Matter is made up of tiny particles** known as atoms and molecules. Molecules are made up of atoms. Molecules and atoms are the building blocks of matter.

Fig.5.1-Chalk piece

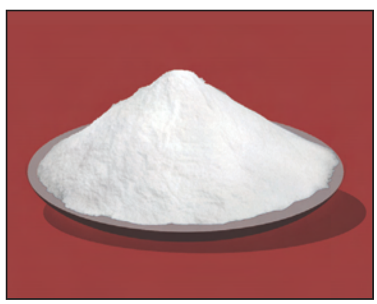


Fig.5.2-Chalk powder

5.2. CHARACTERISTICS OF PARTICLES OF MATTER

ACTIVITY 5.3

- Take some water in a beaker.
- Mark the level of water. Add some sugar to the water and stir well.
- Do you observe any change in the water level?
- What does the solution taste like?
- What happened to the sugar?
- Where did it disappear?

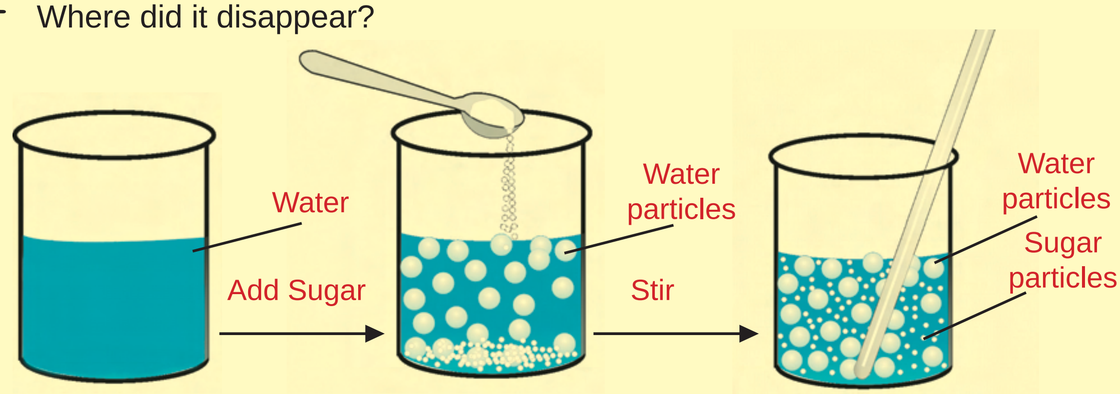


Fig.5.3-Particles of water and sugar are magnified million times.

From the above activity you can notice that there is no change in the water level but the taste is sweet. It indicates that the sugar is completely dissolved in water. When you dissolve sugar in water, the molecules of sugar occupy the space between molecules of water and get uniformly distributed in water. It is understood **that there exists a space between the molecules in matter.**

ACTIVITY 5.4

- Take a beaker with water
- Add a drop of blue ink slowly and carefully into the beaker.
- Leave it undisturbed in your classroom
- Record your observation

Fig.5.4-Diffusion of ink in water

From the above activity you can understand that **the molecules of matter continuously move and mix with each other.**

SCIENCE

ACTIVITY 5.5

- Open a water tap.
- Try to break the stream of water with your fingers.
- Are you able to break the stream of water?
- What could be the reason behind the stream of water remaining together?

Fig.5.5-Stream of water remains together

The above activity shows that **molecules of matter have force of attraction between them.** This force binds the molecules together. Force of attraction between the molecules (Inter molecular forces) varies from one kind of matter to another. The structure and properties of matter – whether they are hard or soft, coloured or transparent, liquid or gas- depends on the way in which the atoms and molecules are arranged.

5.3. STATES OF MATTER

Matter can exist in three physical states, i.e., solid, liquid and gas.

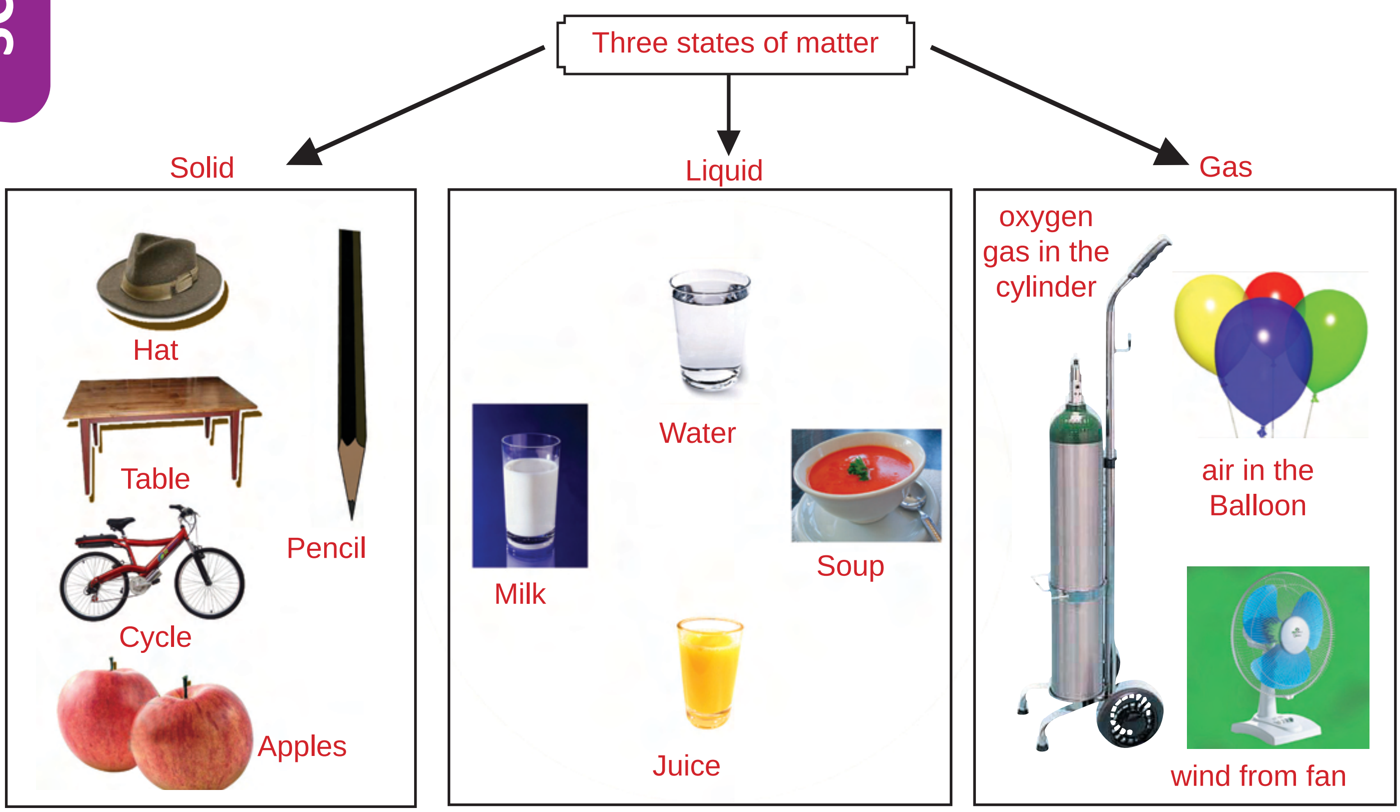


Fig.5.6-States of matter

Solid

Solids are characterized by definite shape, size and volume. In solids, the molecules are very closely arranged because the force of attraction between the molecules is very strong. They are incompressible. The following figures 5.7(a& b) are a few examples to show that matter exists in the solid state. Fig (5.8) shows how molecules are closely arranged in solids.

5.7.(a)

5.7.(b)

Fig. 5.7- Examples of matter in solid state

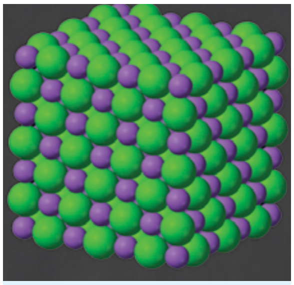


Fig.5.8
Close arrangement of molecules in solid

TO THINK...

Sponge is also a solid. Yet we are able to compress it. Why? Sponge has minute holes in which air is trapped. When we press it, the air is expelled and we are able to compress it.Solids may break under force. It is difficult to change their shape as they are highly incompressible.

Fig. 5.9. Sponge

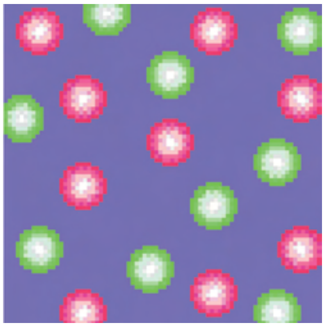


Fig.5.10
Plasma State

MORE TO KNOW

Matter exists in two more states.

Fourth State of Matter -Plasma- super heated gaseous State.

Fifth State of Matter -Bose-Einstein condensate – super cooled Solids.

Liquid

Liquids occupy definite volume but have no definite shape. It takes the shape of the container as shown in fig 5.11. Do you know why? The force of attraction between the molecules in a liquid is less when compared to solids, and these molecules are loosely packed. This allows the liquid to change its shape easily. They are negligibly compressible. A few examples for matter that exist in liquid state are water, oil, juice etc. From the fig 5.12 you can also see how the molecules are loosely arranged in liquids.


Fig. 5.11. Liquid take the shape of the container

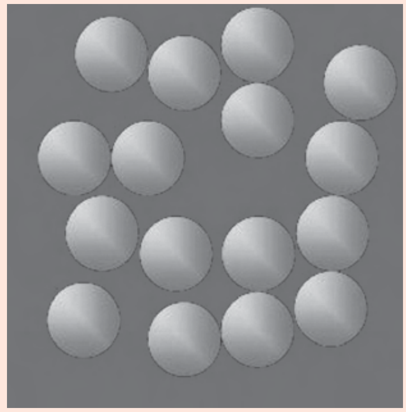


Fig 5.12. Loose arrangement of molecules in liquid

Gas

The atoms or molecules of matter that always occupies the whole of the space in which they are contained is called a **gas**, as shown in Fig 5.13 . It neither occupies a definite volume nor possesses a definite shape. The force of attraction between the molecules of a gas is negligibly small, because the molecules are very loosely packed as in Fig 5.14 . The molecules are distributed at random throughout the whole volume of the container. Gases are highly compressible when compared to solids and liquids. Gases will expand to fill the space of the container. The Liquefied Petroleum Gas (LPG) cylinder that we get in our home for cooking or the oxygen supplied to hospitals in cylinders are compressed gases. Compressed Natural Gas (CNG) is used as fuel these days in vehicles, too. In Delhi, CNG gas used as a fuel in buses.


Fig 5.13.
Gas filled balloon

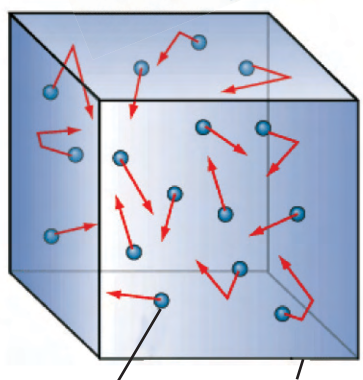


Fig5.14. Very loose arrangement of molecules in gas

ACTIVITY 5.6

Take a cork ball and press it. Do you find any change in the size or shape. No,it cannot be compressed. You know well that solids are incompressible.

Let us compare the compressibility of liquids and gases using an activity.

Take two hypodermic syringes and label them 1 and 2.

1. Plaster the nozzle and seal it with a cork.
2. Remove the piston (Plunger) from the syringes.
3. Fill syringe-1 with water.
4. Do not add anything in syringe 2 (still it contains air).

Insert the piston back into the syringes. You may apply some Vaseline on the piston before inserting them into the syringes for smooth movement.Now try to compress by pushing the piston in each syringe. In the case of water (liquid) in syringe1 the piston moves just a little. But in the case of air in syringe2, the piston can be pushed completely.

This shows liquids can be compressed slightly, while gases can be compressed easily.

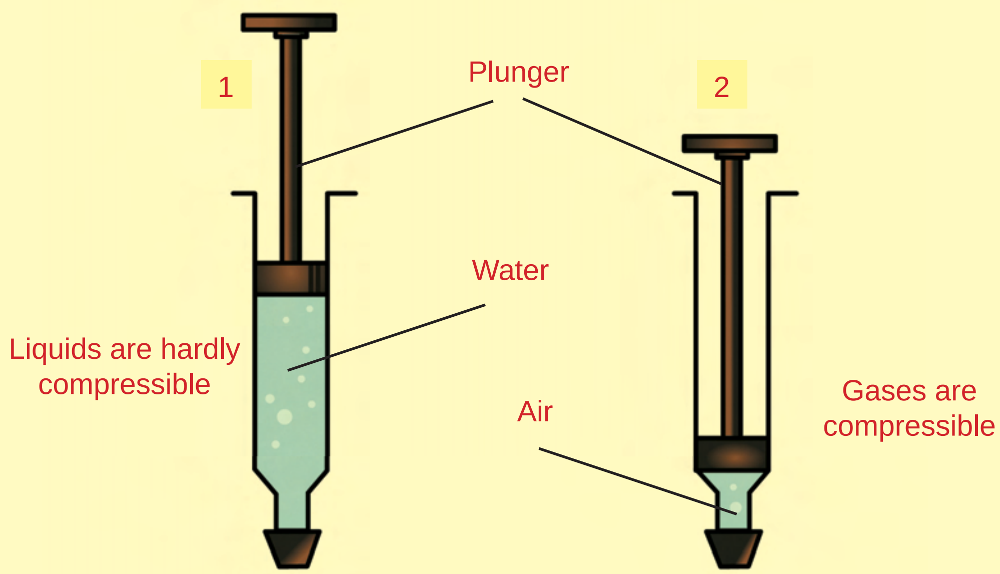


Fig. 5.15. Effect of pressure on liquid and air

MORE TO KNOW

Why does the smell of hot cooked food spread out easily?

Here the particles of the aroma of food mix with the particles of air in the kitchen and spread out from the kitchen very easily. This is due to

(i) The free particles or molecules of gas in aroma and air.

(ii) The high speed of the gaseous particles or molecules.

(iii) The large space between them.

So gases diffuse much faster than solids and liquids.

SCIENCE

Properties of Solid, Liquid and Gas :

Table5.1

S.No	SOLID	LIQUID	GAS
1	Have definite shape and volume	Have definite volume but no definite shape	Have neither definite shape nor definite volume
2	Cannot flow	Can flow from higher level to lower level	Can flow very easily and quickly
3	Intermolecular space is minimum	Intermolecular space is moderate	Intermolecular space is maximum
4	Intermolecular forces are maximum	Intermolecular forces are less	Intermolecular forces are negligible
5	They are incompressible	They are compressible to an extent	They are easily compressible

5.4 EFFECT OF TEMPERATURE ON SOLID, LIQUID AND GAS

Can you change the state of matter? i.e., from solid to liquid or from liquid to gas. Let us perform an activity to understand the effect of temperature on matter.

ACTIVITY 5.7

Take ice cubes in a container, heat the container and observe the changes.

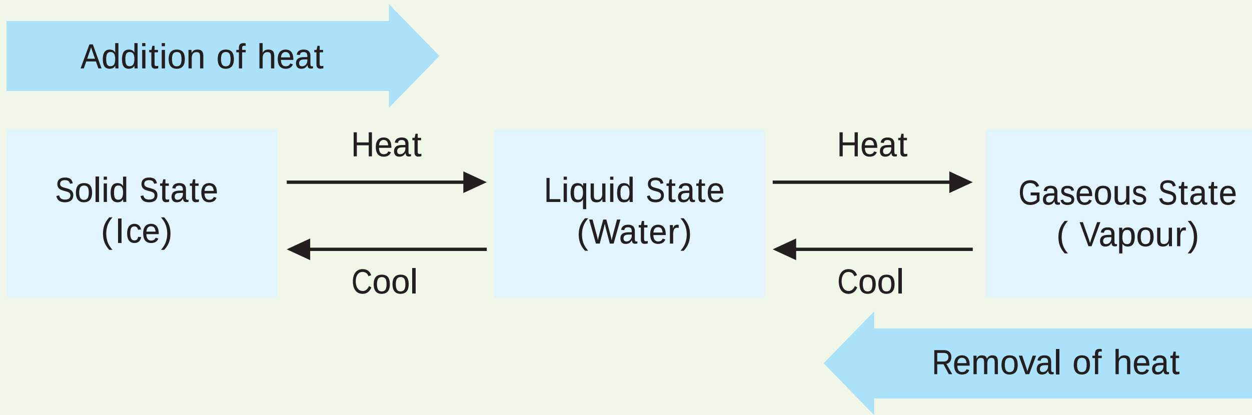

Ice (Solid)


Water (Liquid)


Vapour (Gas)

Fig. 5.16. Effect of temperature on matter.

Effect of temperature on matter



On varying the temperature, you can notice that matter will change from one state to another. For example ice (solid) in the container, on heating, becomes water (liquid) and on further heating, it changes into water vapour(gas).

Water can exist as three states of matter.

- Solid, as ice.
- Liquid, as water
- Gas, as water vapour.

What happens to the particles of matter during the change of states? How does this change of state take place? Don't we need answers to these questions?

On increasing the temperature of solids, the movement of the particles (molecules/atoms) increases. Due to the increase in movement, the particles start vibrating with greater speed. The energy supplied by heat overcomes the forces of attraction between the particles. The particles leave their fixed positions and start moving more freely. A stage is reached when the solid melts and is converted into a liquid. The temperature at which a solid melts to become a liquid is called its **melting point. The melting point of ice is 0^{o} C**

When we supply heat energy to water, the particles (molecules or atoms) start moving even faster. At a certain temperature, a point is reached when the particles have enough energy to break free from the forces of attraction between each other. At this temperature the liquid starts changing into gas. The temperature at which a liquid starts boiling is known as its **boiling point.** The boiling point of water is 100^{o} **C**

Particles from the bulk of the liquid gain enough energy to change to the vapour state. So, we infer that one state of matter can be changed into another state by varying the temperature.

THINK AND ANSWER

Does coconut oil solidify during the winter season?

ACTIVITY 5.8

Magesh is interested in classifying the different states of matter shown in the box below. Shall we help Magesh to classify the objects below, depending on its state. Put the appropriate objects in the given table (Table 5.2).


Stone


Smoke from incense sticks


Water


Petrol


Oxygen inside the Cylinder


Iron Rod

Honey


Ice Cubes


Milk


Balloon

Table 5.2

Solid	Liquid	Gas

ACTIVITY 5.9

To check whether all solids change their state at the same temperature.

- Take ice, butter and wax.
- Put the ice into the pan. Heat it until the ice changes into water. Use the thermometer to measure the temperature at which it changes the state
- Continue this process for butter and wax.
- Note down the temperature at which the solid state is converted in to liquid state in the following table.

Table 5.3

S.No.	Solids	Temperature (^0C)
1.	Ice	
2.	Butter	
3.	Wax	

EVALUATION

1. Materials which are very familiar to Raveena are given below. Help her to classify them into solids, liquids and gas.

   bricks, kerosene, milk, coconut oil, air, book, table, oxygen, carbon dioxide

2. Give reason for the following observation.

   a) We can smell the jasmine flower while we are sitting several metres away.

   b) The level of water remains the same when a pinch of salt is dissolved in it.

3. Gas can be compressed into a smaller volume but a solid cannot be. Could you explain. Why?

4. Match the following:

a)	Liquid on heating	-	liquid
b)	Solid	-	easily compressible
c)	Atoms and molecules	-	becomes vapour
d)	Milk	-	cannot flow
e)	Gas	-	building blocks of matter

5. Choose the correct one from the answers given in bracket:

   a) The only substance which exists in all the three states of matter is __________ (water, stone, glass)

   b) The matter which has a negligible intermolecular space is__________ (solid, liquid, gas)

   c) 1 Nanometer is equal to __________

   (10^{-10}m, 10^{-9}m, 10^{-12}m)

6. Fill in the blanks:

   a) The force of attraction between the particles in gas is __________ (less / more) than that of a solid.

   b) __________ (Solid / Liquid) state has definite volume, but no definite shape.

7. Mohan went to a shop to buy milk. He took his bicycle to go to the shop. He saw that the air in the cycle tube was a very little. He took it to the cycle shop. The cycle mechanic used a compressor pump to inflate the cycle tube. Mohan had a doubt. “How does the compressor works?”. Help Mohan to find the answer.

8. On varying the temperature, you can notice the process that matter will change from one state to another. Name the process A, B, C and D.

$$\text{Ice} \underset{D}{\overset{A}{\rightleftharpoons}} \text{Water} \underset{C}{\overset{B}{\rightleftharpoons}} \text{Water Vapour}$$

9. Solids are incompressible. Sponge is also a solid. We are able to compress it. Could you explain. Why?

PROJECT

Collect 5 or 6 different types of used water bottles. Take a bucket of water. Fill it fully into different bottles one by one. Based on your observation, answer the following questions.

a) Does the volume remain the same?

b) Does the shape of the liquid remain same?

1 Litre 1 Litre 1 Litre 1 Litre 1 Litre

FURTHER REFERENCE

Books

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2. Introductory Chemistry - M Katyal, Oxford University press, New Delhi

Websites

http://chemistry . about.com/od/everyday chemistry.in.everyday-life htm

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http://chemistry.about.com/library/btacid.quiz.htm

Places of scientific importance for visit:

Birla Planetorium, Guindy, Chennai.

Fig. 6.1.

Arun and his father went to see a plot of land they wanted to buy. The owner of the land gave the size of the plot in square feet. Arun's father asked the owner to give the size of the plot in square metre. Arun knew that length is measured in metre. He was confused with the terms square metre and square feet. Let us help him to understand.

The measure of a surface is known as area. **Area is the extent of plane surface occupied.** The area of the plot of land is got by multiplying the length of one side by the length of the other side.

Area = length x length.

The unit of area will be

metre x metre = $(\text{metre})^2$ read as square metre and written as m^2.

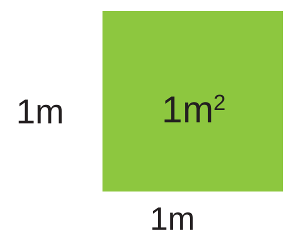
6.1. DERIVED QUANTITIES

Quantities got by the multiplication or division of fundamental physical quantities like length, mass and time are called **derived quantities**.

As area is got by using the fundamental physical quantity - length, it is known as derived quantity.

Volume and density are some other derived quantities.

One square metre is the area enclosed inside a square of side 1m



The area of a surface is $10m^2$ means that it is equivalent to 10 squares each of side of 1m

Breadth, height, depth, distance, thickness, radius, diameter are all different measures of length.

Other units of measurement

Sl.No.	Unit of length	Unit of area
1.	centimetre (cm)	square centimetre (cm^2)
2.	millimetre (mm)	square millimetre (mm^2)
3.	feet (ft)	square feet (ft^2)

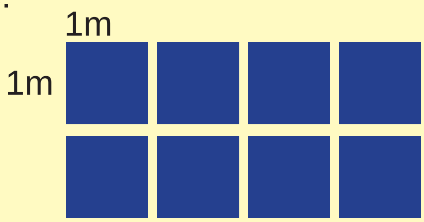
Area of agricultural fields is measured in acre and hectare

1 Acre = 4047 m^2 = 100 cent

1 hectare = 2.47 acre

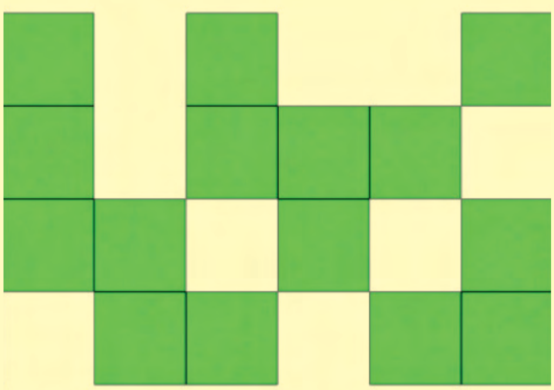
ACTIVITY 6.1

Let us find the area of the given figure.



ACTIVITY 6.2

Let us find the area of the given figure (coloured portion) in cm^2 and mm^2. The side of each small square is 1cm.



ACTIVITY 6.3

Name the unit convenient to measure the area of these surfaces we see in everyday life [mm^2, cm^2, m^2, ft^2, acre].

Sl. No.	Surface	Unit of area
1	Teacher's table top	
2	Black board	
3	Science text book	
4	Measuring scale	
5	Eraser	
6	Class room	
7	Play ground	
8	Agricultural land	

MORE TO KNOW

A metre is much longer than a foot. Do you know how many feet make a metre?

1 metre = 3.28 feet

So, 1 m^2 = 10.76 ft^2

SELF CHECK

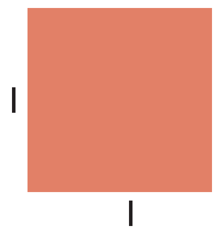
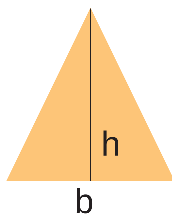
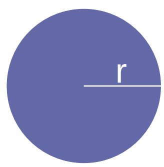
1cm^2 = ------------- mm^2

1 m^2 = --------------- cm^2

REMEMBER

Even though the area is given in square metre, the surface need not be square in shape.

The surfaces need not be a rectangle or square always. We use the following formulae to calculate the area of some regular objects. (i.e.) objects which have definite geometric shape.

S.No.	Shape	Figure	Area	Formula
1.	Square		length x length	l^2
2.	Rectangle		length x breadth	l b
3.	Triangle		½ x base x height	$\frac{1}{2}$ bh
4.	Circle		π x radius x radius	πr^2 $\pi = \frac{22}{7}$ or 3.14

ACTIVITY 6.4

- Take a graph sheet and draw a square of any size in it and find its area in square millimetre (mm^2) and in square centimetre (cm^2).
- Repeat the activity by drawing a rectangle.
- Verify your answer by using the formula.

Let us try the method of measuring the area of irregular objects (i.e) objects which do not have regular geometric shape .

We can use a graph sheet to measure their area.

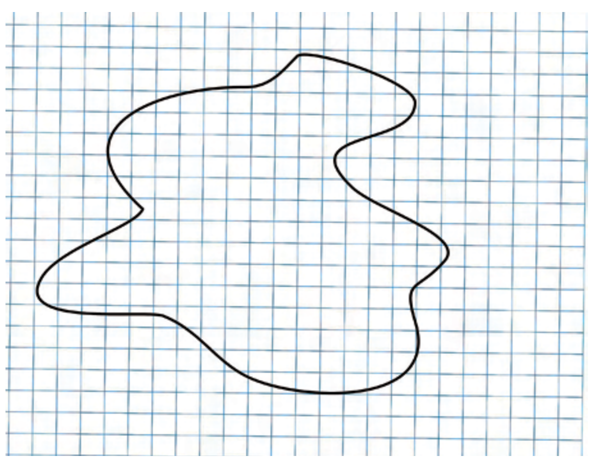


Fig. 6.2.

ACTIVITY 6.5

Let us take an object having irregular shape like a broken glass or a broken tile and measure its area.

Follow the steps given below:

1) Place the object on a graph sheet and draw the outline (like shown in figure 12.2).
2) Count the number of small squares enclosed within the outline. If more than half a square is inside the boundary, count it as one otherwise neglect it.
3) Each small square of the graph sheet has a side of 1mm or area $1mm^2$.
4) Area of the irregular object = Number of squares counted X 1 mm^2

The area of the irregular object $\Big\}$ = ------mm^2.

= ------ cm^2.

EXPERIMENT

1) Repeat the procedure to find the area of a leaf.
2) Draw squares of the area of one square metre and one square foot. Compare the two areas.

TO THINK

How would you find the surface area of

(a) a banana and

(b) your palm?

Volume

Kumar's family lives in a small house. They have no cupboard to keep their clothes. Kumar asked his father to buy a cupboard. His father refused to buy it as the cupboard would occupy considerable space in the house.

The space occupied by a body is called its volume.

ACTIVITY 6.6

Shall we observe the following figures of the objects and get an idea about their size and volume?

Bicycle

Nail

Pen

Motorcycle

Chair

Bench

Bus

Write the names of the objects in the increasing order of size. From your observation answer the following questions.

1) Which object is the smallest and which is the biggest in size?

2) Which object occupies the minimum space and which the maximum space?

3) What do you infer from the above?

[Objects of smaller size occupy less volume and objects of larger size occupy more volume]

Shall we calculate the volume of regular objects ?

Volume of some regular objects is obtained by multiplying the base area by their height.

Volume = base area x height

Can you tell the unit with which volume is measured?

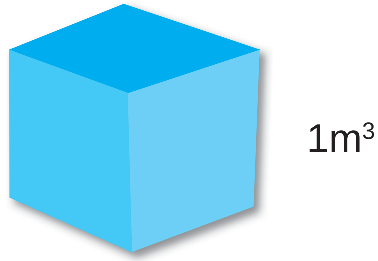
It is, $m^2 \times m = m^3$ which is known as cubic metre.

The volume may also be expressed with different units depending upon the unit of measurement.

Unit of length	Unit of volume
milli metre (mm)	cubic millimetre (mm^3)
centimetre (cm)	cubic centimetre (cm^3)

The volume of an object is $10m^3$ means that it is equivalent to 10 cubes each of side 1m.

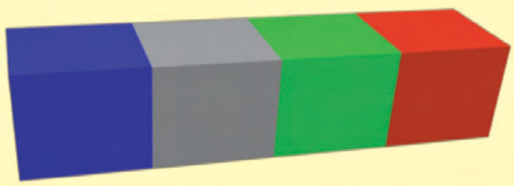
One cubic metre is the volume of a cube of side 1m.

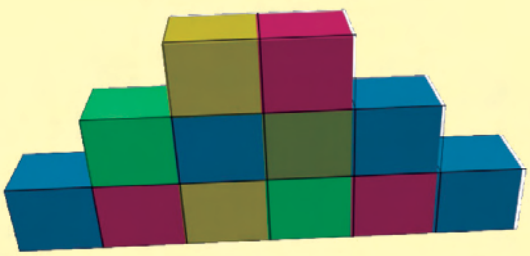


ACTIVITY 6.7

Let us calculate the volume of the objects shown below:

The side of each small cube is 1 cm in length.

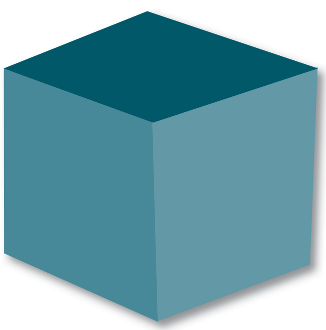


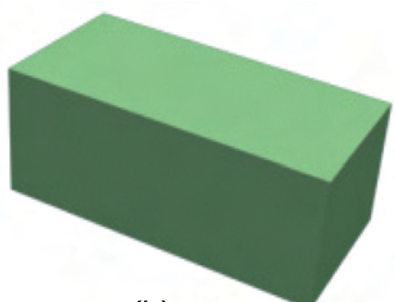


ACTIVITY 6.8

1. How many small cubes make the big cube shown in the picture ?
2. If the side of each small cube is 1 cm in length, find the total volume of the big cube.

Using the concepts discussed so far, try to write the names of the given shapes and the formula for calculating their volume.


(a)


(b)


(c)