Chapter 5

MEASUREMENT

5.1

We make different kinds of measurement at our home, shop, playground etc. in our daily life. Measurement is the fundamental basis for scientific studies and practical technology. We generally estimate quantities as per our needs. But these can never be accurate measurements. For accurate and precise measurements, we use some special instruments. For example to measure the length of an object we need a scale or a tape, to measure the mass we need the physical balance, for measurement of volume a measuring cylinder etc. All these are direct methods of measurements. Sometimes measurements can not be as conveniently possible. Can you measure the thickness of a page of your book or of a coin with a meter scale? No, we cannot. Now let us try to understand the process of these measurement by indirect methods with the help of the following activities.

Activity - 1

Materials required :- Ten similiar one rupee coins, a scale.

Place the scale on a horizontal surface. Make a stack of ten one rupee coins by placing them on each other. Hold this stack of coins with one hand and place one end at some cm mark of the scale. If you keep one end of the stack at 1 cm, then note the reading of the other end of the stack on the scale (fig. 5.1). Subtracting from this reading the earlier reading (i.e. 1) gives us the thickness of the ten coins. Divide this thickness by 10, the number of coins and you will get the thickness of one coin. Repeat this activity with five and fifteen one rupee coins.

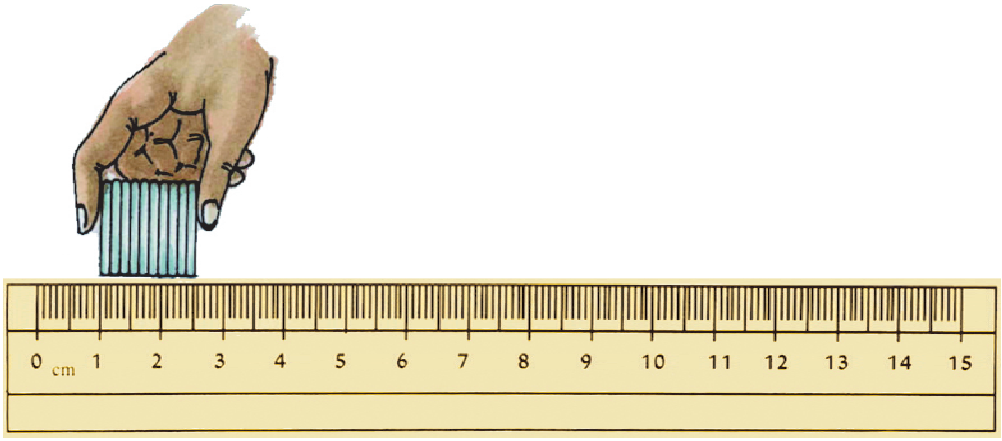


Fig.. 5.1- To find the thickness of a coin

Table - 5.1

S. No.	Number of coins	Reading of the stack of coins		Thickness of the coins	Thickness of one coin (cm)	Average Thickness of one coin (cm)
		First end (cm)	Second end (cm)			
1.						
2.						
3.						

Out of the three measurements, which is more accurate? Larger the number of coins taken the better would be the measurement.

Activity - 2

Materials required :- A piece of wire, cylindrical pencil and a scale.

Take a piece of wire. Wind it twenty times around a cylindrical pencil (fig. 5.2). Remember that the turns of the wire should be such that they are close to each other and there is no space between them. Wire wrapped in such a manner is called a coil.

Measure the length of this coil with a scale. Write the readings in table 5.2. Divide the length of the coil of the wire by the number of turns and find the thickness of the wire.

$$\text{Thickness of the wire} = \frac{\text{Total length of the coil (in cm)}}{\text{Number of turns of the wire}}$$

In the same manner, making a coil of 30 or 40 turns, find the thickness of the wire and fill in table 5.2.

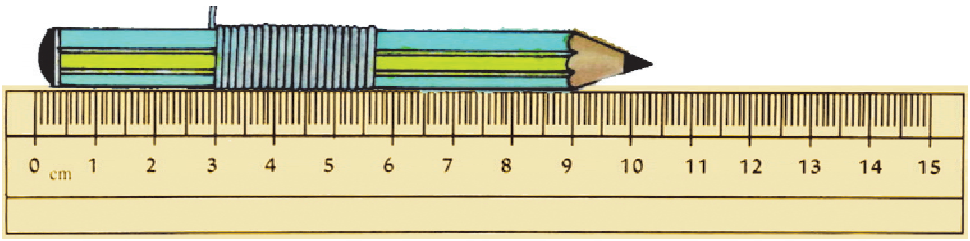


Fig. 5.2- To find the thickness of the wire

Table - 5.2

S. No.	Number of turns of the wire	Length of the coil of wire (cm)	Thickness of wire (cm)	Average Thickness of wire (cm)
1.				
2.				
3.				

Can we measure the diameter of a ball with the help of a scale? This task is difficult because the ball is spherical. For this we will take the help of two wooden blocks.

Activity - 3

Materials required :- A spherical object, two cuboidal wooden blocks, scale.

Place the scale on the table. Adjust the spherical object(ball) between two wooden blocks in such a way that it touches the surfaces of both the blocks. The edges of both the blocks touching the spherical object should be joined to the scale. Note the readings of these positions of wooden blocks on the scale and write those readings in table 5.3. The distance between both the blocks is the diameter of the spherical object. Remember that surfaces touching the spherical object should be parallel to each other and perpendicular to the scale.

Diameter of the spherical object = Reading of the second surface (cm) – Reading of the first surface (cm)

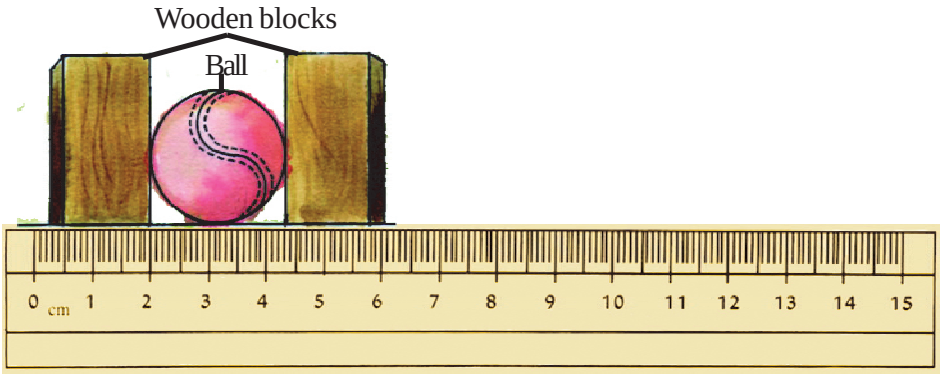


Fig. 5.3 To find the diameter of a spherical object

Table - 5.3

S. No.	Readings of blocks touching the ball		Diameter of the ball (cm)	Average diameter of the ball (cm)
	First surface (cm)	Second surface (cm)		
1.				
2.				
3.				

Child specialists use this technique to measure the height of infants.

Answer these

1. How will you measure the thickness of a page of your book?
2. The thickness of 100 sheets of paper is 10mm. Find the thickness of one sheet.
3. Torch cell is placed between two rectangular blocks. The readings of the two blocks touching the spherical surface of the cell on the scale are 2cm and 5.2cm. Find the diameter of the cell.

5.2 Area

In Fig. 5.4 given below, maps of some fields are given. Among others, the fields of Kiran, Salma and Shyamu have been depicted.

Just by observing the map, can you say, which field, out of the fields of Kiran, Salma and Shyamu is bigger? How can we decide whose field is bigger and whose is smaller?

The size of the square or rectangle made on any field or paper, depends on the extent of the surface it covers. Larger the square or rectangle made on a field or on paper, more is the surface it will cover. The measure of the surface covered by an object is called its area.

SI unit of area is square metre, and is written as m^2. This is the area of a square with a side of one metre. It is more convenient to represent the area of small objects like tiles, books, photo frames or postcards in square centimetre (cm^2). One square centimetre is the area of a square of side one centimetre. A very large surface like the area of a field is represented in Acres or Hectares.

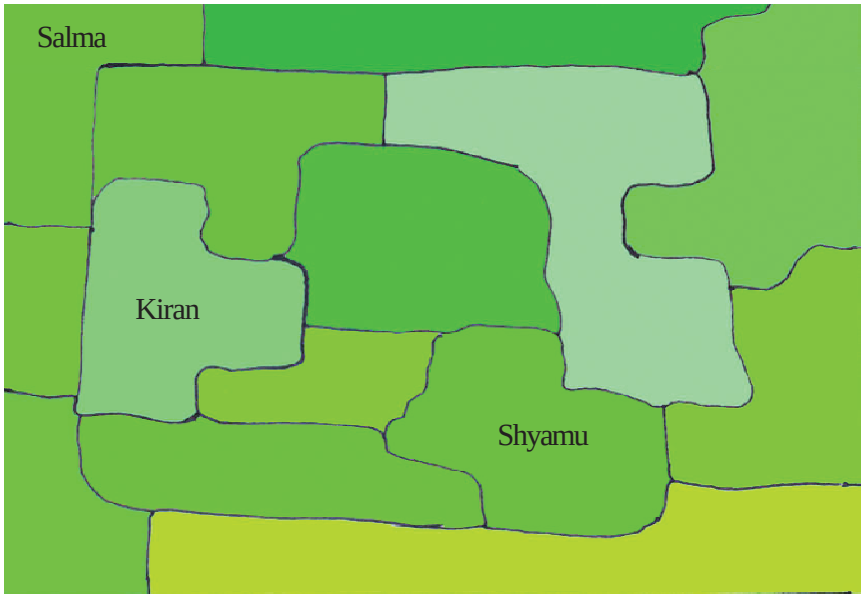


Fig. - 5.4 Fields: larger or smaller

Identify one square centimetre and one square millimetre squares in a graph paper and count the number of squares of one squares millimetre area present in a square of one square centimetre.

5.2.1 Multiples of the units of area

1 Square meter = 10000 Square centimetre

1 Aer = 100 Square metre

1 Hectare = 100 Acers

1 Hectare = 10000 Square metre

1 Decimal = 40 Square metre

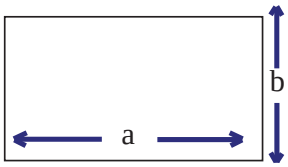
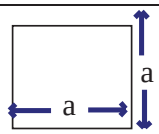
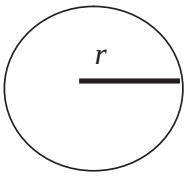
1 Acre = 100 Decimal

1 Acre = 4000 Square metre

We can find the area of the surfaces of objects with regular shapes from their length / breadth / height / radius etc. We find the area of objects with faces shaped as a rectangle by measuring the length and breadth and then using the formula for the area. The area of a circle is calculated by measuring its diameter or radius. We can even find the area of any object of fixed size with the help of a graph paper. Make the outline of the object on the graph paper and then count the number of squares present within that boundary. This will be the area of the object.

Table - 5.4

Formula to calculate the area of regular surfaces

S. No.	Figure	Name	Formula for the area
1.		Rectangle	length × breadth = a × b = ab
2.		Square	$(side)^2$ = side × side = a × a = a^2
3.		Circle	π × radius × radius = πr^2

Answer these

Calculate the area of the objects given in Table 5.5 by measuring their length and breadth.

Table - 5.5

S. No.	Object	Length / breadth / radius (cm)	Area (square cm)
1.	Cover page of the text book		
2.	Postcard		
3.	Upper surface of the table		
4.	Surface of the bottom of a bottle		

5.2.2 Finding the area of the surface of objects having irregular shapes-

Sometimes we have to find the area of a surface with an irregular shape like leaf, palm, sole of the feet etc. The area of such surfaces cannot be calculated by using the formulae given in Tables 5.4 or by other formulae of such kind. The area of such surfaces is calculated using a graph paper.

Activity - 4

Materials required :- Centimetre graph paper, a leaf, pencil and scale.

Place the object (leaf) of irregular size on the graph paper. Draw the outline with a pencil as shown in fig.-5.5. Now find the number (x) of complete squares lying inside the outline and write it in Table 5.6. Count the number (y) of squares with half or more than half part inside the outline. Leave those squares with less than half part inside the outline. The total number of squares (x + y) is the approximate value of the area of the leaf. Its unit will be square centimetre.

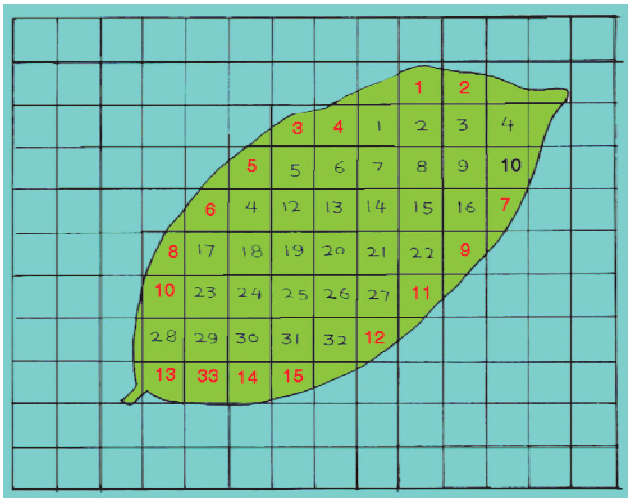


Fig. 5.5 To find the area of a leaf using the graph paper

Table - 5.6

S. No.	Number of complete squares (x)	Number of half or more than half squares (y)	Total number of squares (x + y)	Area of leaf (x + y) square cm
1.	33	15	33 + 15 = 48	48
2.	…….	……..	……..	……..

Here the area of leaf comes out to be approximately 48 square centimetre. Use the graph paper to find the area of other regular shapes like the bottom circular shape of a glass and check your answers by comparing with area found by the formula.

Answer these

1. Length and breadth of a train ticket are 5.5 cm and 3.0 cm respectively. Find its area.
2. How will you find the area of an irregular shape? Explain with the help of an example.
3. The radius of the circular bottom of the glass is 3.5 cm. Find the area of its bottom surface.
4. Give the SI unit of area.

5.3 Density

See the picture in fig. 5.6 carefully. You will find that in the first picture, trees are very close to each other while in second picture, they are far apart. This means that the first arrangement is denser because the number of trees per unit area is more in it. In the same way the distance between particles in different materials is not the same. In some like in solids, particles are close to each other while in gases they are far apart. As a result of this, the number of particles in a unit volume of different types of materials is different. Masses of particles of different materials are also different.

(a) Dense forest (b) Rarer forest

Fig. - 5.6

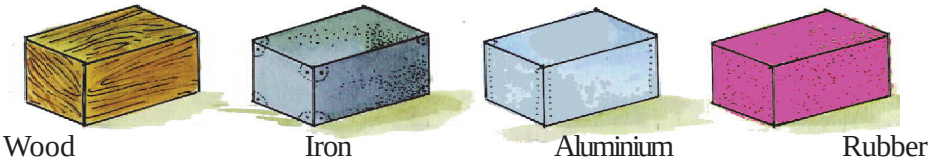
The mass of the unit volume of a material is the density of that material. Density is represented by D and its SI unit is kg per cubic metre. If V is the volume of an object and M is its mass, then

$$\text{Density D} = \frac{Mass}{Volume} = \frac{M}{V}$$

Activity - 5

Materials required :- Four cuboids of the same size and shape made of different materials.

Suppose these cuboids are made of rubber, iron, aluminium and wood respectively. Compare the masses of these cuboids by lifting them with your palm or with the help of a balance. Are their masses equal? Arrange their masses in ascending order. You will find that the cuboid of iron has the maximum mass. So the density of iron is more than that of aluminum (fig. 5.7). Therefore we can say that the quantity of matter in one cubic centimetre of iron is more than the quantity in one cubic centimetre of aluminium (fig. 5.7). This means matter in iron is denser than in aluminium.



Wood Iron Aluminium Rubber

Fig. - 5.7 Cuboids of same size and shape made up of different materials

Activity - 6

Materials required :- Three bottles with equal volumes, water, kerosene and glycerine.

Weigh the three bottles having equal volume on a balance. Fill these bottles with water, kerosene oil and glycerin respectively and weigh them. Write the weights of equal volume of the different liquids in an ascending order. Find out that inspite of equal volume, which material is the heaviest or we should say whose density is highest?

Table - 5.7

Density of some common materials

Material	Density (kg / m^3)	Material	Density (kg / m^3)
Gold	19300	Silver	10500
Copper	8900	Iron	7600
Aluminium	2740	Glycerine	1300
Water	1000	Ice	920
Kerosene oil	800	Cork	200

"Density of a material is 19300 kg / m^3; means that the mass of the matter contained in one cubic metre of that substance would be 19300 kg."

"Density of a materials is 2.5 g / cm^3; it means that the mass of the matter contained in one cubic centimetre of that substance would be 2.5 g."

5.4 Accuracy of measurement

In the age of science and technology precise and accurate measurement is extremely important. In engineering and scientific works, purchase of expensive materials require correct and accurate measurement. Even scientists and pharmacists need to measure the masses of chemicals and medicines accurately. In computers and communication systems, electrical appliances, rockets, automobile industry, in the construction and maintenance once of dams for water etc, we need precise and accurate information about the size of different parameters. Even to construct the doors and windows of a building, accurate measurements are needed.

Nowadays different parts of a machine are produced at different places. If during the making of these parts precise and accurate measurement is not carried out then the parts would not fit in the machine.

Accuracy of measurement depends on the measuring instrument and we use instruments for measuring that can give us the required accuracy. For example, we can use the meter scale to measure the length of a wire but to measure its thickness accurately we use a special instrument called the screw gauge. To buy expensive things like gold, silver, platinum, diamond etc in the market, it is necessary to carry out precise and accurate measurements.

5.5 Distance-Time Graph

You might have seen that newspapers, magazines, etc. present information in various forms of graphs to make it more interesting. Let us learn to plot a distance - time graph using the data given in table 5.8 below-

Table 5.8 Motion of a Car

Time	Distance
0	0 km
1 min	1 km
2 min	2 km
3 min	3 km
4 min	4 km
5 min	5km

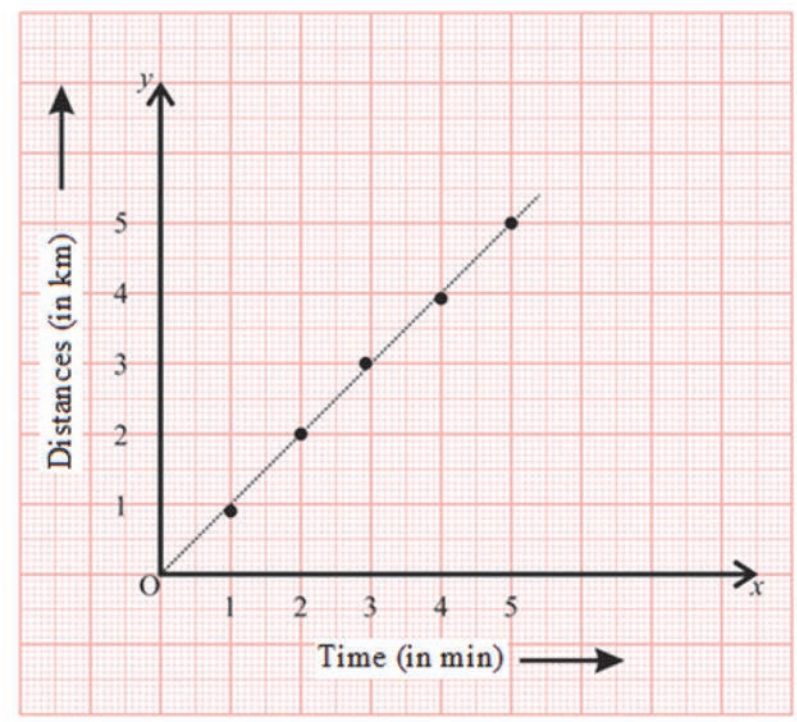


Fig 5.8 Distance- Time Graph of motion of a car.

Let us learn to plot of graph -

Take a sheet of graph paper.

- Draw two lines OX and OY perpendicular to each other, as shown is fig. 5.8.
- Take time along x-axis and distance along y-axis.
- Choose a scale to represent the distance and another to represent time on the graph. For the motion of the car scales should be as follows -

Time	1 min	= 1cm
Distance	1 km	= 1cm

- Mark values for the time and the distance on the respective axes according to the scale you have chosen. Form the motion of the car mark the time 1 min, 2 min ……. on the x-axis from the origin O.
- Similarly mark the distance 1km, 2 km …….. on the y-axis.
- Now you have to mark the points on the graph to represent each set of values for distance and time.
- According to table 5.8 mark on the graph paper the various points corresponding to different set of values.
- Join all the points on the graph as shown in figure. We obtain a straight line. This is the distance-time graph for the motion of the car.

- As it is a straight line it indicates that the car is moving with a constant speed. However if the speed of the object keeps changing, the graph can be of any shape.

5.6 Measurement of speed of an object in motion

You all know that, speed of a moving object = $\frac{\text{Distance travelled}}{\text{Time taken}}$

Let us measure speed with the help of values given in the table 5.9 -

Table - 5.9

Distance travelled and time taken by a moving ball.

Distance travelled by a moving ball (m)	Time taken (s)	Speed = Distance/ Time taken (m/s)
5	2	
10	4	
15	8	

You have learnt how to calculate speed. There is a meter fitted on the top of a scooter, motorcycles dashboards of cars, buses, etc. which is called speedometer. It records the speed directly in km/h.

5.7 Time period of a simple pendulum-

In previous classes you have learnt about the time-period of a simple pendulum. The time taken to complete one oscillation by a pendulum is called its time-period. In this way by calculating the time taken for 20 complete oscillations, we can measure the time period of one oscillation.

You have already learnt to calculate the speed of a moving object, now, let us find out, how winds moving at high speed cause cyclone.

5.8 High speed winds and Air Pressure.

Table - 5.10

Materials required- Empty bottle (Wide mouthed) paper, etc.

Crumple a small piece of paper into a ball of size smaller than the mouth of an empty bottle. Hold the empty bottle on its side and place the paper ball just inside its mouth. Now try to blow on the ball to force it into the bottle. Try the activity with bottle of different mouth sizes. What did you observe? Why is it difficult to force the paper ball into the bottle?

When we blow into the mouth of the bottle, the air near the mouth has higher speed, this decreases the pressure there. The air pressure inside the bottle is higher than near the mouth. The air inside the bottle pushes the ball out (fig. 5.9).

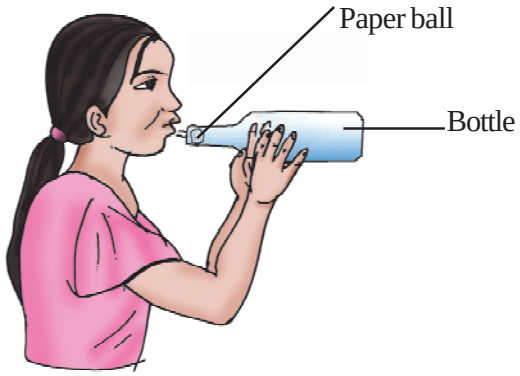


Fig 5.9 Blowing into the bottle

We see that the increased wind speed is indeed accompanied by a reduced air pressure. Air moves from the region where the air pressure is high to the region where the pressure is low. The greater the difference in pressure, the faster the air moves. The formation of a low pressure system with very high-speed winds revolving around it leads to cyclone.

Answer these

1. What does the statement "Iron is heavier than wood," mean?
2. What is meant by density? Give its SI units.
3. The mass of a material contained in 10 cm^3 is 10000 kg. Calculate its density.
4. Why is it essential that different parts of a machine fitting in to each other have the same measure?
5. The distance between two stations is 240 km. A train covers this distance in 4 hours. Find the speed of the train.

We have learnt

- Indirect methods are used to measure small lengths and widths.
- The measure of the extent of the surface of any object is called its area. SI unit of area is square metre.
- It is more convenient to represent the area of small objects in square centimetre or in square millimetre.
- The area of big surfaces like fields and grounds is represented in units like Acres or Hectares.

- The area of the surfaces of objects having regular shapes is found by measuring their length / breadth / radius etc and then by making use of suitable formulae.
- Area of an irregular shape is calculated by using a graph paper.
- The mass of a unit volume of the material is called its density.
- SI unit of density is kg / m^3.

Questions for practice

1. Choose the correct answer

1. The length and breadth of a room are respectively 6m and 5m. The area of its floor would be-

(a) 30 square centimetre (b) 30 square metre

(c) 15 square metre (d) 22 square metre

2. Average of lengths 5m, 5.2m, 5.4m, 5.6m and 5.8m would be

(a) 5.2 metre (b) 5.0 metre

(c) 5.4 metre (d) 5.5 metre

3. Area of a card having an irregular shape is measured -

(a) by an inch tape (b) by a metre scale

(c) by a graph paper (c) by a measuring cylinder

4. Hectare is the unit of -

(a) area (b) length

(c) density (d) perimeter

5. Formula for the density of material is -

(a) mass x volume (b) mass / volume

(c) volume / mass (d) mass + volume

2. Fill in the blanks -

1. SI unit of density is _____.
2. Space occupied by the surface of an object is called its_____.
3. The _____ of a unit _____ of any material is called its density.
4. The SI unit of area is _____.

3. Find the true and the false statements. Correct the false statements.

1. The total distance in going around any shape is called its area.
2. Density of iron is greater than that of water.
3. The area of an irregular shape is found by using a graph paper.
4. The area of a field is measured in square centimetre.

4. Answer the following questions-

1. You have been given a long wire, a metre scale and a bangle. How will you find the diameter (thickness) of the bangle?
2. A stack has been made by keeping 25 identical coins one over the other. The lower and upper ends of the pack lie at 5.0 cm and 13.6 cm respectively on the scale. Find the thickness of one coin.
3. One side of a square object is 4.3cm. Find its area.
4. Arrange copper, aluminium, wood and iron in order of increasing density.
5. Write water, kerosene oil and glycerine in decreasing order of density.
6. What do we mean by saying that the density of an object is 920 kg / m^3?
7. Density of glass is 2500 kg / m^3. If the mass of a piece of glass is 0.025 kg, find its volume.
8. In the given liquid which solid substance will float or imerge.

Ice	-	Kerosene oil
Aluminium	-	Glycerine
Cork	-	Water

9. Draw distance- time graph using given values.

Time(s)	10	20	30	40	50	60	70	80	90
Distance (m/s)	20	40	60	80	100	120	140	160	180

10. If a simple pendulum takes 32 seconds to complete 20 oscillations, find its time period.

Do these also

1. Take a piece of thread or a wire of length 16cm and with its help make

(1) a square with a side 4 cm.

(2) a rectangle having length 5 cm and breath 4 cm.

(3) a rectangle having length 7 cm and breath 9 cm.

Using a graph paper find the area of the surfaces occupied by each of the shapes made. Find the area also by using the formula.

2. Take a test tube and pour 5 mL each of water, glycerine and coconut oil in it. Take care not to shake the test tube. Which liquid is at the bottom? Why?

3. To find the area of the curved surface of a cylindrical pencil, take a rectangular piece of paper with width equal to the length of the pencil. Now place the pencil at one end of the paper parallel to its width and wrap the paper over the pencil a number of times. Count the number of wraps and also find out the area of the rectangular paper. Divide that area by the number of wraps. This is the area of one wrap or the area of the curved surface of the cylindrical pencil.

4. Anemometer

Materials required:- 4 small paper cups, 2 strips of cardboard, gum, stapler, a sketch pen, a sharpened pencil with eraser at one end.

Method: -Take a scale; draw crosses on the cardboard strips. This will give you the centers of the strips. Fix the strips at the centre, putting one over the other so that they make a plus (+) sign. Now fix the four cups at the ends of the two strips. Colour the outer surface of one cup with a marker or a sketch pen. All the four cups should face in the same direction.

Push a pin through the centre of the strips and attach the strips and the cups to the eraser of the pencil (fig.5.10). Check that the strips rotate freely when you blow on the cups. Your anemometer is ready. Counting the number of rotations per minute will give you an estimate of the speed of the wind. To observe the changes in the wind speed, use it at different places and different times of the day. Check whether the speed is same or different?

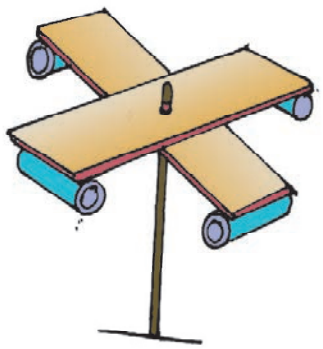


Fig 5.10 Anemometer

5. In class 6th you have learnt about the oscillatory motion of a simple pendulum, to measure time. Now, try to record the time period of a pendulum using strings of different length. State whether using different lengths of string affect the time period of oscillation. Discuss it in the class with your friends.