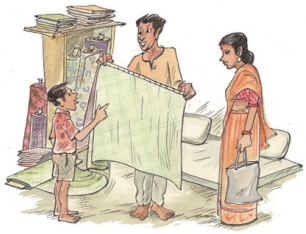
13 *Learning How to Measure*



We use metre as a unit of length and subsequently, centimetres and millimetres as smaller units of length.

Rasheed went to a cloth shop with his mother to buy clothes. The cloth merchant used a metal rod to measure the length of cloth. Rasheed asked his mother what that metal rod was and why did the merchant use it? Mother told him that the metal rod was a metre scale that was used to measure lengths. Later, both of them went to a flower market and purchased a string of jasmine flowers. While cutting the jasmine flower string, the woman selling the flowers measured its length with her hand.

Fig. 1

Rasheed was confused and started thinking :

- Why was a metre scale used to measure the length of cloth?
- Why did the woman use her hand to measure the length of the jasmine flowers' string?
- Which method is correct?
- How can we decide the correct method of measurement?

You might have observed many situations of measurement of length as in the above examples, where sometimes we use instruments and sometimes hands, foot, palms etc.

Write some more examples where we use instruments to measure the lengths and some examples where we don't use any instruments, but use foot, hand-span, palms etc. to measure the length.

Discuss which method is correct with your friends and why you think that a particular method is correct.

Fig. 2

Now find the length of your classroom using your foot-span. Enter your observations in terms of number of foot-spans in table 2 :

Table 2

S. No.	Name of the student	Number of foot-spans
1.		
2.		
3.		
4.		

- Is the number of foot-spans same when different students measure the length of class room?
- Who got more number of foot-spans? Why?
- Who got least number of foot-spans? Why?

We do not get the same measurements in two cases mentioned above because the hand-spans / foot-spans are not same for each one of us.

We often use these type of conventional methods to measure certain lengths. For example, cubits for the length of a string of flowers and length and breadth of a playground using strides. Similarly, we use this system of measurement while playing 'sirra gona', (gilli danda), where the length of the stick is used as the unit to measure the desired distance.

Foot-span Hand-span Cubit

Fig. 4

The story of the scale

Many hundred years ago, people used to measure distances with their hand-spans, strides or foot-spans. One day a very tall man went to a shop to buy some cloth. He asked for three-and-a-half arms length of cloth. The shopkeeper measured three arm lengths of cloth and then added approximately another half-arm length.

The man felt that the shopkeeper had cheated him. So he measured the cloth with his arms and found that the cloth was not even three arm lengths. He told the shopkeeper that the length of the cloth was less than three-and-a-half arms when he measured with his own arm. The shop keeper replied that his own arm was the standard for measuring. They both argued about whose arm was to be taken as standard measure. In those days, people arguing over measuring the length of fields, ropes, and hundreds of other things must have been a familiar fight. How should one measure a half or a quarter arm length?

Finally, some sensible people got together and decided to have a scale of a fixed length. In order to measure subunits, they marked this scale with several smaller but equal divisions. They then decided that everyone would measure lengths with this scale. They used wood and metal to make scales of the same length.

At one place, people decided to use the distance between the nose and the tip of the middle finger of their king as a measure (Fig. 5). They called this distance **one yard**. They used wood and metal to make scales of this length and called this distance one **yard**. This yard was divided into three equal parts and each part was called a foot. They then divided each foot into twelve equal parts called inches. They even divided each inch into smaller segments!

Fig. 5

Other countries in the world also made their own scales. Because each country had its own scale which differed from others, it led to a lot of problems in trade and commerce. There was always a chance of quarrels breaking out.

Finally in France, it was decided that a certain length of rod made of a special material (Platinum-Iridium) would be called a metre. The metre was divided into 100 equal parts and these parts were called centimetre. Each centimeter was further divided into ten equal parts called millimetre. Now we are using this as a standard measurement for length throughout the world. This original scale is preserved in a museum in France.

The story explains the need of standard instruments to measure lengths. The meter scale is internationally accepted instrument for measuring lengths.

One metre is a standard unit of length.

We use metre as a unit of length and subsequently, centimeters and millimeters as smaller units of length.

Fig. 6

1 metre = 100 centimetres

1 centimetre = 10 millimetres

or

1 m = 100 cm

1 cm = 10 mm

In our daily life, we use different instruments like plain tape, rolled tape, centimetre scale of different sizes, made up of wood, metal or plastic.

Fig. 7

• How do you select a suitable instrument to measure length?

If you want to measure the thickness of an eraser, which of the instruments shown in Fig. 7 is more suitable and why?

Sometimes we may need to measure long distances like length and breadth of school play ground or agricultural fields or distance between our house to school, distance between one town to another town, and even longer distances such as those between one country and another country.

• Can we measure these lengths using the instruments shown in Fig. 7?

• If not, how are these distances measured?

• What instrument are used?

• Is there any other way to measure very large distances?

Discuss with your friends, parents, and teachers to know the answer.

Metre is not a convenient unit for measuring large distances. We need to define a larger unit to measure larger distances. We use kilometre as a larger unit of length. One kilometre is 1000 times longer than a metre.

1 kilometre = 1000 metres

1 Km = 1000 m

Activity-2: How do we measure?

• How do you measure the height of your classmate using a meter scale?

Ask your classmate to stand with his/her back against a wall. Make a mark on the wall exactly above his/her head.

Now measure the distance, from the floor to this mark on the wall, with a scale. Let all other students measure this length in a similar way. Record your observations in your notebook.

Study carefully the measurements reported by different students.

Do you all have the same readings of measurements? If not, what could be the reason for the differences?

In the above activity, though the measurement was done using a standard scale, results may be close to each other but not exactly equal.

The difference in reading is due to some errors in measurement. For example :

• Not marking the point exactly at the top of the head.

• Not using the metre scale in a proper manner.

To measure the lengths accurately using the standard measuring instruments like meter scale, centimeter scale and tape etc., we should take some precautions.

How to measure length accurately with a meter scale

In our day to day work, we use a wooden/plastic scale to measure lengths. It is marked or graduated in centimeters and millimetres. Suppose we are asked to measure the length of a table. We will take a metre scale. The zero mark on the scale is made to coincide with one end of the table and the reading at the point which is coinciding with the other end of the table is taken. Since a metre scale has some thickness, we may make an error if the eye is not correctly positioned. The correct position of the eye is “B” (Fig. 9) which is

vertically above the end where the reading is to be taken.

Fig. 9

Precautions while using a meter scale

We must take the following precautions while using a metre scale for measuring length :

Fig. 10

1. The scale should be placed exactly along the length to be measured.
2. Zero point on the scale should coincide with the starting point of the length to be measured.
3. Our eye must be vertically above the point of coincidence of scale where the measurement is to be taken.
4. Ensure that the ends of the scale are not worn out.
5. Measure the length of an object more than two times and then take the average of these measurements for accuracy.

Think! What can you do to know a scale is accurate or not

How can we measure a small thickness?

Can you accurately measure the thickness of the cover page of your text book or a coin using the scale? If we want to measure the thickness of a page of notebook or a coin it is not possible to directly use a scale. Let us look at the method to measure the thickness of a coin.

Activity-3: Measuring thickness of a coin

Take about 10 one rupee coins of same size and place them one upon the other as shown in Fig. 11. Measure the total thickness with a scale and then divide it by the number of coins to get the thickness of one coin.

Fig. 11

In the same way, try to measure the thickness of a page of your text book.

We generally use a scale to measure the lengths which are in a straight line like the length of a room, length of a table etc. There are certain situations where the lengths are in curved line like the perimetre of bucket, perimetre of a tava or kadai etc.

Can we measure these curved lengths with a meter scale? If not why?

Activity-4: Measuring the length of a curved path

Fix alpins at the ends of the curved line to be measured as shown in the Fig. 12. Now tie a knot with cotton thread at the first point A of the alpin A and move the cotton thread along points B, C, D, E etc.

Fig. 12

Care should be taken that the thread is neither too tight nor too loose and see that the thread coincides with the curve at each point while moving along the path. When the thread reaches the extreme end of the curved path, cut it at that point.

Remove the thread from A and then place it straight along the length of a meter scale, and measure its length.

The length of the thread is the measure of the length of the curved path.

Measurement of area

Ramu and Ravi's father brought two drawing sheets for them. After taking these sheets from their father, Ramu and Ravi started quarrelling with each other, each one claiming that his sheet was shorter than the others.

Which sheet is smaller? Which sheet is bigger? How can we decide?

Activity-5:

Fig. 13

See Fig. 13. Can you decide which is the bigger and which is the smaller sheet by observing them? If not, what method do you adopt to decide the bigger one or smaller one?

Let us do:

Take two sheets of A4 paper and cut them in the shapes of shown in Fig. 13. Now take some empty matchboxes of equal size and keep them on the sheet. Starting from one corner of the sheet, count how many matchboxes are needed to cover the entire surface of the sheet. Similarly repeat the process for the second sheet also and record the findings in your notebook.

- Which sheet needs more number of matchboxes? Which is bigger in size?

You may find that one of the sheets needs more number of matchboxes which shows that one sheet is bigger in size than the other. Thus, we need to measure the surface of an object to decide whether it is bigger or smaller.

Area is the measure of the extent of plane surface occupied by an object.

In the above activity, a matchbox is taken as a unit to measure area but it is not a standard unit. We need a standard unit to measure the area.

What is the standard unit to measure area?

Observe Fig. 14. In each figure, vertical and horizontal lines divide the surface into certain number of parts.

- Which figure has more area and why?
- Are all the parts in both figures equal?
- What is the shape of the smaller part in each diagram?
- Is the length and breadth of each smaller part equal?
- Measure the length and breadth of any one part of each diagram. What do you notice?

You may notice that the small parts in each diagram have equal lengths and breadth, one centimeter each. Area of each part is equal to one square centimetre and it is written as cm^2.

- Since Fig. 14 (a) and 14 (b) have same number of squares, of area 1 cm^2 each, both the figures have a total area of 16 cm^2 each. Thus, these figures have different shapes but equal areas.

Square centimetre (cm^2) is a standard unit to measure the area of a surface.

We use m^2 (square metre), mm^2 (square millimetre), $foot^2$ (square foot), etc., also to measure the areas according to need and requirement of the situation.

Cut a cardboard into a shape of rectangle having length 4 cm and breadth 2 cm as shown in Fig. 15. Let us measure its area.
The convenient unit to measure the area of given cardboard would be cm^2.
Take a centimetre graph paper. Each small square on this graph paper has a side equal to 1 cm. The area of each small square on this graph paper is 1 cm^2.
Place the cardboard on the centimetre graph paper (Fig. 15) and draw its outline with the help of a sharp pencil. Now remove the cardboard and mark the shape as PQRS. Count the number of squares inside the outline. The number of squares is 8.

Area of the cardboard is equal to the area covered by PQRS on the graph paper.

Area of PQRS = Total area of unit squares inside the PQRS

$= 8 \times$ area of 1 unit square

$= 8 \times 1 cm^2$

$= 8\ cm^2$

In this case, the cardboard we used has a regular shape - rectangle.

- Can you relate the measured area to some formula of finding area?

Activity-6: Measurement of irregular plane surface

Let us find out the area of a surface, say a banana peel or a leaf, which has irregular shape. Place the leaf on a graph paper as shown in Fig. 16. Mark the boundary of the piece of leaf on the graph paper with a pencil. Now remove the leaf to find the outline or

boundary of the leaf on graph paper.

Fig. 16

Count the number of complete squares (each of 1 cm^2 area) inside the boundary. Also count those squares, inside the boundary, which are half or greater than half. Add this to the number of complete squares.

This total number of squares inside the boundary gives the area of the leaf. If there are 'n' squares inside the boundary, the area of the leaf becomes n cm^2.

Neglect those squares, inside the boundary, which are less than half.

This process will gives us the value of area which is close to the actual area.

• How can you use the graph paper to get a more accurate answer?

Measurement of volume

• How do you find the volume of a solid?

Mrs. John is constructing a house. She needs sand and enquired about prices. The supplier informed her that two tractor loads of sand costs Rs. 4000/- and one lorry load of sand costs about Rs. 4000/-.

• Which deal is cheaper for Mrs. John? A lorry or a tractor?

• How can you decide which load has more quantity of sand?

To decide the quantity contained either in a lorry or tractor, we need to know the volume of the body of lorry as well as that of the body of tractor.

Volume is a measure of the extent of space occupied by a body.

Measurement of volume of liquids

• How can you measure the volume of kerosene?

• How do you decide the volume of milk?

We use some measuring cylinders to measure the volumes of liquids such as kerosene, milk, oils, water, etc. The volume of liquids is expressed in liters (l) or millilitres (ml)

Measuring cylinder

It is cylindrical in shape, with graduations marked on its body. Measuring cylinders are available in different sizes. They are used in laboratories to measure a certain volume of a liquid and to measure milk, oils, etc by shop keepers. We can fill it with the liquid to be measured and then read the marking at the lowest point of the concave surface of liquid. We must bring our eyes in line with this level of liquid and then read it.

Apart from measuring the volumes of liquids, we also measure the volumes of solids, for example, loose solids like sand, clay, and ready mix of cement.

• What is the standard unit of measuring the volume of solids?

• Are you able to measure the volume of loose solids?

• How can you decide a standard unit of volume of a solid?

Look at Fig. 18. There are certain number of identical cubes of length, breadth and height 1 cm each, and a cardboard box of length 3 cm, breadth 2 cm, and height 2 cm.

Fig. 18

Place three cubes in a line so as to cover the entire length. Along the side of this line, place another line of three cubes so as to completely cover the base of the box (Fig. 19). How many cubes have you used so far?

How many cubes do you need to cover the entire empty space in the box?

Fig. 19

Place more cubes over this set of blocks; so that the total space is occupied by the blocks. Calculate the number of cubes occupying the rectangular box.

• How many cubes occupy the rectangular box?

• Can you guess volume of rectangluar box.

Since each cube has measurement of 1 cm length, 1 cm breadth, and 1 cm height, the volume of one cube is equal to 1cm x 1cm x 1cm = $1cm^3$ which is known as 1 cubic centimetre and written as 1 cm^3.

Cubic centimetre is a standard unit for measurement of volume of solids.

Therefore the volume of the rectangular cardboard box is equal to the total number of cubes occupying it.

Therefore volume of rectangular cardboard box = 12 × 1 cm^3 = 12 cm^3.

However, if we multiply length, breadth and height, it would be

$$3 \text{ cm} \times 2 \text{ cm} \times 2 \text{ cm} = 12 \text{ cm}^3$$

Therefore, we can say volume of a box = length × breadth × height

Do you know?

You must have noticed that the volumes of liquids are written in ml while those of solids are written in cm^3. Do you know the relation between these two units. The two units are related as follows :

$$1 \text{ ml} = 1 \text{ cm}^3$$

Measurement of volume of irregular solids using a measuring cylinder

Take a measuring cylinder and fill almost half of it with water. Record the volume of water (Fig. 20). Let us assume it is “a” cm^3 (or “a” ml).

Now tie a small irregular solid (stone) with a fine cotton thread. Put the solid gently into the water in the cylinder so that it is completely immersed in water.

What changes do you notice in the water level of the cylinder?

You may notice that the level of water in the measuring cylinder rises as the stone displaces water equal to its own volume. Record the new volume of water. Let us assume that it is “b” ml.

Now the volume of stone will be the difference between the second volume and the first volume i.e volume of the stone = (b - a) cm^3.

Keywords

Measure, standard unit area, volume, regular surface, irregular surface, rectangular body, measuring cylinder, graph paper

What we have learnt

• We use some conventional ways like hand-span, foot - span, cubit, etc. for rough measurements in our daily life.

• We need standard instruments to measure lengths accurately.

• Meter scale is a standard instrument to measure length.

• Meter is the standard unit for measuring length. Larger distances can be measured in kilometers.

• Area is a measure of the extent of the plane surface occupied by an object.

• Generally we measure area in square metres or square centimetres etc.

• Volume is a measure of the extent of space occupied by a body.

• Volume of solids is measured in cubic metres, cubic centimetres, etc.

• Volume of liquids is measured in litres or millilitres.

$$1cm^3 = 1ml$$

Improve your learning

1. What is the smallest distance that you can measure with a centimetre scale?

2. Are we able to measure the thickness of a metal wire using a scale? Explain.

3. A school hall measures 20 m in length and 15 m in breadth. Find its area.

4. Ramu's father had a rectangular plot of length 60 ft. and breadth 50 ft. He built a house occupying length 40 ft. of the plot and breadth 40 ft. and in the remaining area he planned a garden.

Can you help Ramu to find out the area of his garden?

5. Match the following :

A B

a) A litre i) 10000 m^2
b) A metre ii) 1000 ml
c) A Kilometre iii) 100 cm
d) A Centimetre iv) 1000 m
e) 1 hectare v) 10 mm

6. Millilitre is a unit for measuring _____

7. For measuring long distances we can use _____ as a unit.

8. What method will you adopt to measure the volume of a banana? Explain?

9. Identify incorrect statements among the following and rewrite them with necessary corrections :

a) One square metre is equal to 100 square centimetres.

b) The appropriate unit for reporting the volume of a cylindrical rod is cm^2.

c) The appropriate instrument to measure the thickness of a 25 paisa coin is a tailor's tape.

d) A measuring cylinder can directly measure the volume of solids.

11. How will you measure the area of your palm using graph paper? Explain.

12. Measure the volume of "Kalakanda" (sugar crystal) and piece of "Patika" (alum). Record your measurements in table 4.

Ask your friends to measure volumes of the same pieces of Kalakanda and Patika and record the values.

Table 4

S. No.	Name of the student	Volume of Kalakanda	Volume of Patika
1			
2			
3			
4			

- Are all the values of volumes of Kalakanda equal?
- Are all the values of volumes of Patika equal?
- If not, state the possible reasons.

13. A carpenter who makes wooden furniture, needs accuracy in measurments. Do you ever notice how he measures? How whould you appreciate him.

14. Make a visit to panchayat office collect information how VRO measure areas of agricultural lands in your village. Prepare a questionaire for this.

15. Collect any invitation card with envelope. Find out the difference between the measurments of card and cover. Write down the process that you follow.

16. The distance between numbers in a clock is accurately same. List out the things that you observe in your surroundings with accurate distance between them.

17. Try to imagine the area of CD, sim card, mobile phone then find out the area of the above by using graph paper. Compare the values of your guess with graph paper

measurment. Which thing is closely related to your guess?

* * * * *

The Danyang-Kunshan Grand Bridge is the world's longest bridge. It is a 164.8 kilometres (102.4 mi) long.

Activity-1: Measuring Lengths

Measure the length of one side of a table using your hand-span (Fig. 3). Ask your classmates to do the same. Record the length of the table in terms of number of hand-spans in table 1 :

Table 1

S. No.	Name of the student	Number of hand-spans
1.		
2.		
3.		
4.		
5.		

Do all of you get the same number of hand-spans for the length of the table?

- Who got more number of hand-spans?
- Why is there a difference in number of hand spans though you measured the same table?

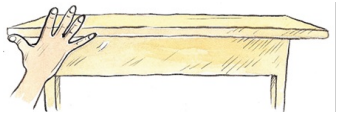
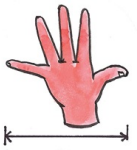
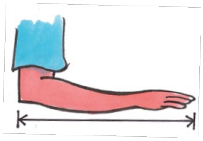


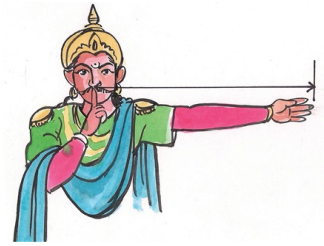
Fig. 3

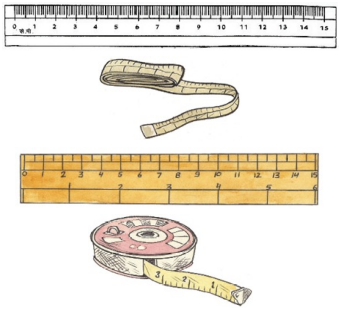
In 1590 Zaccharias Janssen and his son Hans invented micro scope.





The Danyang-Kunshan Grand Bridge is the world's longest bridge. It is a 164.8 kilometres (102.4 mi) long.

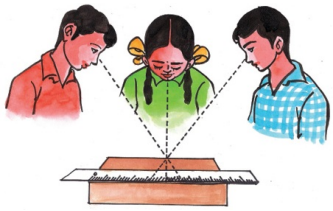




The simple protractor in your compass box looks like a semicircular disk marked with degrees, from 0º to 180º.

Fig. 8

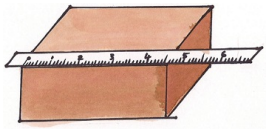
The foot is divided into 12 inches.



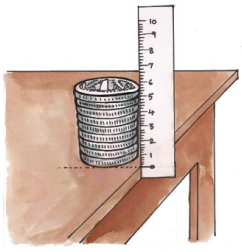
A

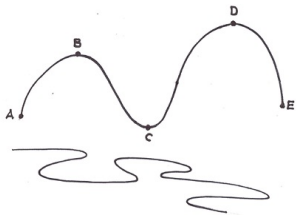
B

C

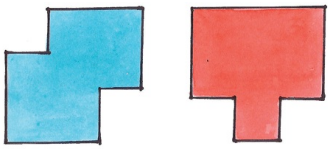


The initial metric unit of mass, the “gram,” was defined as the mass of one cubic centimeter (a cube that is 0.01 metre on each side) of water at its temperature of maximum density.





The Arthashastra offers a wealth of evidence for the wide varieties of standardized weights and measures of the time.



Sheet A

Sheet B

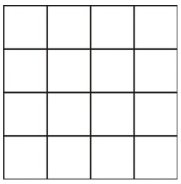
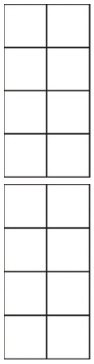


Fig. 14

(a)



(b)

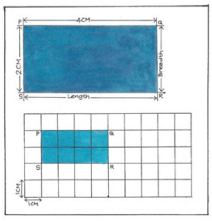
Table 3 : Units of measurement

S.No.	Units of Length	Symbol	Units of Area	Symbol
1	Meter	m	Square metre	m^2
2	Centimetre	cm	Square Centimetre	cm^2
3	Millimetre	mm	Square millimetre	mm^2
4	Feet	ft	Square feet	ft^2

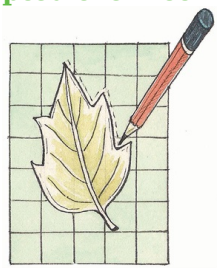
Activity-6: Measuring the area of a regular surface

The Mughal measurement system measured land in terms of “gaz” and “bigha”.

Fig. 15



The Republic of India adopted the metric system on April 1, 1957.



The distance travelled by Aeroplane or Ship per hour is measured by knots or nautical miles. 1 Knot is equal to 1.852 Km/h.

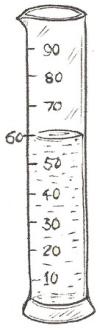
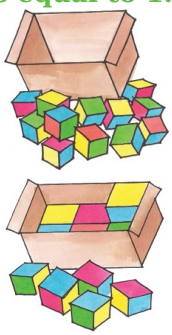


Fig. 17

1 mile is equal to 1.61 kms.



Astronomers use a method called parallax to measure the distance to some stars.

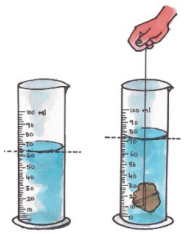


Fig. 20

Nanometre - A metric unit which equals to a 1/1,000,000,000 of a meter.
Computer memory is measured by Bites, Kilobyte (KB), Megabyte (MB), Gigabyte (GB) and Terabyte (TB).