10 Motion and Measurement of Distances

Lesson at a Glance

- **Distance:** The length of the space between two points is called *distance*. In other words, how far a place/thing is from a point is known as *distance*.
- **Measurement:** To find out size, amount or degree of something by comparing it with a standard is called *measure*. The action of measuring is called *measurement*.
- In ancient times, people used length of a foot, the width of a finger, the distance of a step as units of measurement. This caused confusion and a need to develop a uniform system of measurement arose.
- For sake of uniformity, scientists from all over the world have accepted a set of standard units of measurement. The system of units now used is known as the *International System of Units* (*SI units*).

  The unit of any physical quantity (*e.g.* length, mass, temp. etc.) which is acceptable to all of the people as basic unit is called *standard unit*.

  SI units (The system International D' units) is the set of units used to maintain uniformity all over the world.
- Each measurement consists of: (*i*) numerical value (*ii*) unit of quantity
- The SI unit of length is a *metre*.

  (**Note:** *The standard metre is the length between two marks near the ends of a platinum-iridium bar (0°C) preserved in the vaults of International Bureau of Weights and Measure in Paris*).
- Besides standard unit of length, we also have standard unit of mass and time.

  The standard unit of mass is *kilogram*. The standard kilogram is the mass of a cylinder made of platinum-iridium alloy which is preserved in the vaults of International Bureau of Weights and Measure in Paris.

  A copy of the International Prototype of Kilogram is kept at National Physical Laboratory in Delhi.

The standard unit of time is a *second*. The solar day is the basis for defining the unit of time, one solar day contains 24 × 60 × 60 seconds. More accurate measurement of time has now become possible with the discovery of quartz crystal clock and atomic clock.

The system of units in which we measure length in metre (m), mass in kilogram (kg) and time in second (s) is known as M.K.S. System or Metric System.

- Besides metre, we also use multiples and submultiples of this basic unit for measuring length. For example, a centimetre (cm) is also a unit of length. It is a fraction of a metre (1/100 of a metre). In other words, centimetre is said to be a submultiple of basic unit metre. Similarly, a kilometre (km) which is 1,000 times that of a metre is a multiple of the basic unit of length.

  Multiples and submultiples of basic units of length, mass and time are given in the following table:

  Length:

  1 kilometre (km) = 1,000 metres (m)

  1 m = 100 centimetres (cm)

  1 cm = 10 millimetres (mm)
- **Measurement of Length:** We use various types of measuring devices such as a metre scale, a 15 cm scale and a measuring tape.

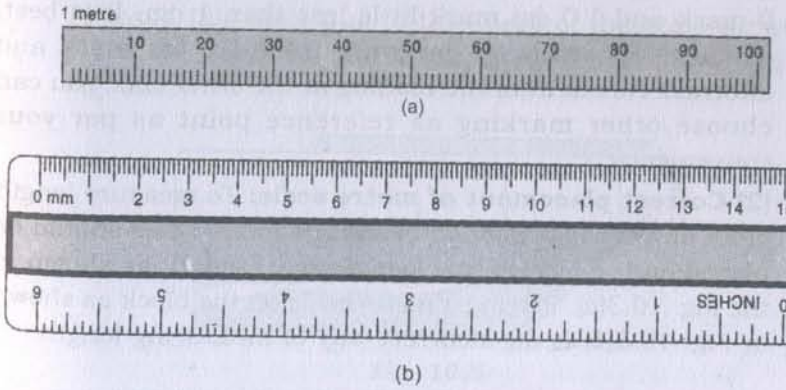
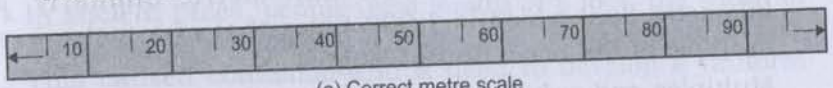


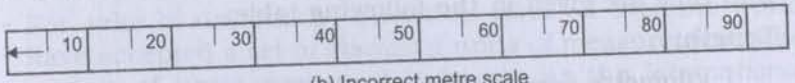
Fig. 10.1 Correct metre scale (*a*) A metre scale and (*b*) A 15 cm scale

Correct Metre Scale: A correct metre scale has the stamp of the Weights and Measure Department.

In addition, correct metre scale has arrow marks (↔) on both the ends as shown in the Fig. 10.2(*a*). An incorrect metre scale may not have arrow mark on one or both ends [Fig. 10.2(*b*)]. It may be due to the reason that shopkeeper may have cut off the ends to shorten the length of metre scale. You must ensure before buying that metre scale has a stamp of the Weights and Measure Department and arrow marks on both the ends. When you find that a shopkeeper is using incorrect metre scale then you must inform the office of Weights and Measure. To measure with incorrect metre scale is an offence.



(a) Correct metre scale

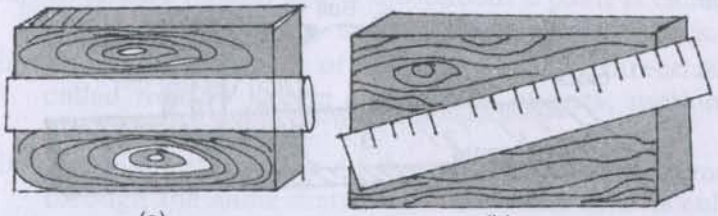


(b) Incorrect metre scale

Fig. 10.2 Correct use of metre scale

(1) 0-Mark should not be taken as reference point: Usually we should not take measurement from 0-mark of the metre scale, because the ends of the wooden scale do get damaged after long use. This makes the length between 0-mark and 1.0 cm mark little less than 1 cm. It is best, whenever possible, to measure from 1.0 cm mark and subtract 1.0 cm from the reading at the other end. You can choose other marking as reference point as per your convenience.

(2) Correct placement of metre scale: To measure length of an object say a wooden block, the metre scale should be placed on the block very close along its length as shown in the Fig. 10.3(*a*). Placing a metre scale on the block as shown in Fig. 10.3(*b*) is an incorrect way of measuring length.



(a) (b)

Fig. 10.3

(3) Correct placement of eye: The metre scale has some thickness. When it is used to measure length of a block as shown in the Fig. 10.4, we must look vertically down at the mark on the scale coinciding with the edge of the block. In case, eye is displaced to the left or right of the vertical, an error in the reading will be introduced.

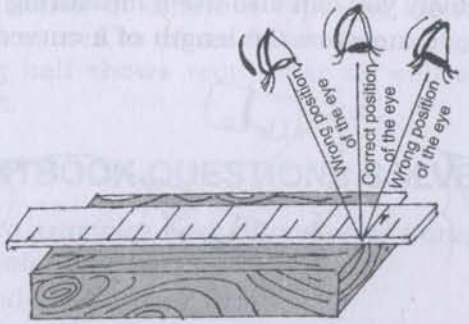


Fig. 10.4

To avoid this error due to thickness of the scale we would place the scale on the block edgewise as shown in the Fig. 10.5.

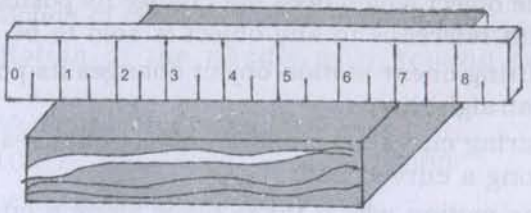


Fig. 10.5

You can measure the diameter of a cricket or pingpong ball by the arrangement shown in the Fig. 10.6. Measure the distance between the two edges of the wooden blocks. This will give the diameter of the ball.

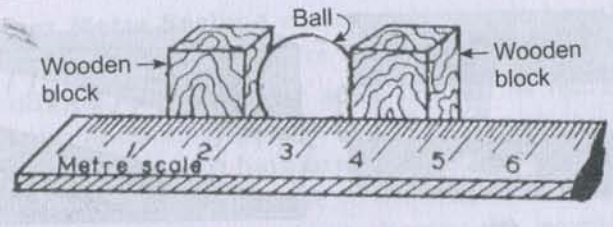


Fig. 10.6

You can measure the length of a curved object in the following way.

Place an inelastic thread along the curved surface of an object to mark its length (Fig. 10.7). Measure this length of thread with the help of a metre scale. This will give you the length of curved object.

In this activity you can also use a measuring tape instead of thread, to measure the length of a curved surface.

Fig. 10.7

- **Motion:**
  - (*i*) The object which changes its position with time with reference to any object is said to be in *motion.*
  - (*ii*) The object which does not change its position with time with reference to any object is said to be at *rest.*
  - (*iii*) During linear motion object changes its position along a straight line.
  - (*iv*) During curvilinear motion object changes its position along a curved path.
  - (*v*) The motion which takes place along a curved path is called *circular motion.*
  - (*vi*) If an object repeats its motion after a fixed interval of time it is called *periodic motion.* For example, movement of pendulum, heartbeat.

  - (*vii*) To and fro motion of an object about a point is called *oscillatory motion* e.g. swing, pendulum of a clock.
  - (*viii*) The zig-zag motion of an object in any direction is called *random motion* e.g. motion of ants, motion of dust particles in air.
  - (*ix*) The motion in which all the particles of a body move through the same distance in the same time is called *translatory motion.* It is of two kinds: (*a*) Rectilinear and (*b*) Curvilinear.
    - (*a*) When a body moves along a straight line, the motion described by the body is called *rectilinear motion*, e.g. car moving on a straight line.
    - (*b*) The motion in which a body moves along a curved line, is called *curvilinear motion.*
  - (*x*) The motion of a ball on the ground shows a combination of different types of motion. The ball rotates as well as moves forward on the ground. Thus, rolling ball shows rectilinear as well as rotational motion.

TEXTBOOK QUESTIONS SOLVED

Q.1. *Give two examples each of modes of transport used on land, water and air.*

Ans. (*i*) Land—Bus, truck, train.
(*ii*) Water—Ship, boat.
(*iii*) Air—Aeroplane, Helicopter.

Q.2. *Fill in the blanks:*
(*i*) *One metre is* _____ *cm.*
(*ii*) *Five kilometre is* _____ *m.*
(*iii*) *Motion of a child on a swing is* _____.
(*iv*) *Motion of the needle of a sewing machine is* _____.
(*v*) *Motion of wheel of a bicycle is* _____.

Ans. (*i*) 100 (*ii*) 5000
(*iii*) periodic (oscillatory) motion
(*iv*) periodic oscillatory (*v*) circular.

Q.3. *Why can a pace or a footstep not be used as a standard unit of length?*

Ans. Because a pace or a footstep of each and every person is not equal.

Q.4. *Arrange the following lengths in their increasing magnitude :*

1 metre, 1 centimetre, 1 kilometre, 1 millimetre.

Ans. Ascending order of length:

1 millimetre < 1 centimetre < 1 metre < 1 kilometre

Q.5. *The height of a person is 1.65 m. Express it in cm and mm.*

Ans. (*a*) 1.65 m, as one metre = 100 cm

= 1.65 × 100 cm = 165 cm

(*b*) 1.65 × 100 × 10 mm = 1650 mm.

Q.6. *The distance between Radha's home and her school is 3250 m. Express this distance in km.*

Ans. As one km = 1000 m

So, $3250 \text{ m} = \frac{3250}{1000} \text{ km} = 3.250 \text{ km}$

Thus, distance between Radha's home and her school is 3.250 km.

Q.7. *While measuring the length of a knitting needle, the reading of the scale at one end is 3.0 cm and at the other end is 33.1 cm. What is the length of the needle?*

Ans. Length of the needle = 33.1 cm – 3.0 cm = 30.1 cm.

Q.8. *Write the similarities and differences between the motion of a bicycle and a ceiling fan that has been switched on.*

Ans. (*i*) **Similarity:** Both the wheel of a bicycle and a ceiling fan exhibit motion on a fixed axis.

(*ii*) **Dissimilarity:** Bicycle moves forward thus executes rectilinear motion but fan does not show such motion.

Q.9. *Why could you not use an elastic measuring tape to measure distance? What would be some of the problems you would meet in telling someone about a distance you measured with an elastic tape?*

Ans. An elastic measuring tape gives incorrect length of the distance between two points.

Reasons:

(*i*) The length of the elastic tape varies and depends upon the force by which it is stretched.

(*ii*) Measurement would vary between 2 or 3 readings even when measured by the same person and by the same elastic tape.

(*iii*) Measurement would also vary if different persons measure the same distance.

Q.10. *Give two examples of periodic motion.*

Ans. (*i*) Oscillations of a pendulum.

(*ii*) Motion of swing/motion of earth round the sun.