LEARNING OBJECTIVES

The children will be able to :

- define length, mass and time;
- express length, mass, time, temperature and area in proper units with proper symbols;
- measure length of objects using a ruler and a measuring tape;
- measure mass of an object using a beam balance and an electronic balance;
- measure time using a clock, a watch and a stop-watch;
- relate temperature of an object with its hotness or coldness;
- measure temperature of a person using a clinical thermometer;
- measure temperature of an object using a laboratory thermometer;
- measure area of an irregular object using a graph paper;
- convert a physical quantity from one unit into other related units

MEASUREMENT – ITS IMPORTANCE

We all make measurements in our daily life. *For example*, when we give a certain piece of cloth to the tailor for stitching a trouser, he takes the measurement for length of our trouser with his measuring tape. The peon in the school has to ring the bell after each period. For this, he measures time interval with a clock. When we buy fruits and vegetables, the vegetable seller measures their mass by his balance. When we are suffering from fever, the doctor measures our body temperature with a thermometer.

Our senses of touch or sight are not reliable for measurement. The senses are subjective, therefore we must make use of tools or instruments to get an exact measurement.

Measurement is basically a process of comparison : For measurement, we need a universally accepted unit and then we find how many times that unit is contained in the given quantity. *For example*, if we say that the length of a room is 5 metre, we mean that the unit of length is metre and the length of room is 5 times of the unit metre. If we say that the mass of sugar is 2 kilogram, we mean that the unit of mass is kilogram and the mass of sugar is 2 times the unit kilogram. Thus, a measurement needs *two* things :

1. The unit u, and
2. The number n which tells us how many times that unit is contained in that quantity.

Thus, a measurement is expressed as :

$$\text{Measurement} = n \times u = n\,u$$

CHOICE OF UNIT

The unit must have the following properties :

(i) It should be of convenient size, and

(ii) It must be universally accepted, *i.e.* its value must remain same at all places and at all times. It should not change with the change of place or time.

Thus, to measure a quantity, we choose a known fixed quantity of that kind as the unit and then find how many times that fixed quantity (or unit) is contained in the given quantity, *i.e.*

> **Measurement is a comparison of an unknown quantity with a known fixed quantity of the same kind.**

The value obtained on measuring a quantity is called its magnitude. The magnitude of a quantity is expressed as numbers in its unit. *For example*, to measure

the length between two points, we take a ruler of length one metre as unit and if the length on measuring, is 15 times of the unit metre, then we write length = 15 metre.

Do You Know ?

In the past, different units were used to measure the length, mass and time in different countries. There were the following three systems of units:

1. Centimetre-gram-second (C.G.S.) system
2. Foot-pound-second (F.P.S.) system, and
3. Metre-kilogram-second (M.K.S.) system or metric system.

The units of length, mass and time in these systems are listed below:

System	Unit and symbol of length	Unit and symbol of mass	Unit and symbol of time
1. C.G.S.	centimetre (cm)	gram (g)	second (s)
2. F.P.S.	foot (ft)	pound (lb)	second (s)
3. M.KS.	metre (m)	kilogram (kg)	second (s)

BASIC PHYSICAL QUANTITIES

A quantity that can be measured is called a physical quantity. In our daily life, we measure the following four basic physical quantities :

1. Length
2. Mass
3. Time
4. Temperature

In 1960, the scientists all over the world accepted a set of units for measuring the basic physical quantities length, mass, time and temperature. This set of units is called the standard international units which in short form is written as S.I. units. The S.I. units of basic quantities and their symbols are given in the following table.

S.I. units of basic quantities and their symbols

Quantity	S.I. unit	Symbol for S.I. unit
1. Length	metre	m
2. Mass	kilogram	kg
3. Time	second	s
4. Temperature	kelvin	K

Sometimes, the size of S.I. unit to express a physical quantity is not of a convenient size, it is either too small or too big. Then we use submultiple or multiple of the S.I. unit to express that physical quantity using prefixes such as milli, centi or kilo with that unit. The table below shows the meaning of prefixes milli, centi and kilo :

Meaning of the prefixes

Prefix and symbol	Meaning
1. milli (m)	$\frac{1}{1000} = 10^{-3}$
2. centi (c)	$\frac{1}{100} = 10^{-2}$
3. kilo (k)	$1000 = 10^{3}$

For example, if diameter of a pin is 0·0001 metre, it can be written as 0·1 millimetre (or 0·1 mm). Similarly, if distance between two cities is 2000 metre, it can be written as 2 kilometre (or 2 km).

Convention while writing the S.I. Units

1. Symbols used for units (other than the names of the scientists) are always written in small letters. *For example* :

Symbol of Kilogram — kg and not Kg
Symbol of metre — m and not M
Symbol of second — s and not S

2. Some units are named after the scientists. In words such units are written in lower letters. *For example*, the unit of current is named after the scientist Ampere. In words the unit of current is written as ampere and not as Ampere.
3. Symbol for a unit named after a scientist is always written with a capital letter. *For example* :

Symbol of Fahrenheit — F and not f
Symbol of Ampere — A and not a
Symbol of Newton — N and not n
Symbol of Kelvin — K and not k

4. The unit and its symbol are never written in plural.
5. In words the unit is written in small letters. *For example*, metre, not Metre; kelvin, not Kelvin etc.
6. A space is left between the symbols of two units when they are used as product. *For example*, the symbol of unit newton × second is N s.
7. Negative powers are used for the compound units formed by dividing one unit by the other. *For example*, the unit of speed is metre/second (m/s). It can also be expressed as m s^{-1}.

MEASUREMENT OF LENGTH

Length is the distance between two points. When we measure the width (or thickness), breadth, depth, diameter, height etc., we actually measure the length.

Units of length

The S.I. unit of length is metre. In short form it is written as m.

A metre was intially defined as the distance between two points on a rod of platinum alloy kept at 0°C in the International Bureau of Weights and Measures at Sevres near Paris.

Nowadays one metre is defined as the distance travelled by light in air in $\frac{1}{299,792,458}$ of a second (or in $\frac{1}{3\times10^8}$ of a second).

Simple multiples and sub-multiples of metre : It is not convenient to express long lengths in terms of metre. They are expressed in kilometre (in short form km).

i.e. a kilometer is a multiple of metre.

One kilometre is equal to 1000 metre

1 kilometre = 1000 metre

In short form, 1 km = 1000 m (or 10^3 m)

Thus, the distance between Delhi and Agra, instead of writing as 200,000 metre is more conveniently written as 200 kilometre.

Similarly, it is convenient to express the lengths which are shorter than a metre in centimetre. *For example*, the length of a pen is expressed in centimetre. A centimetre is a sub-multiple of metre. In short form, we write centimetre as cm.

One centimetre is one-hundredth part of a metre or 100 centimetre make 1 metre. Thus,

1 metre = 100 centimetre (or1 m = 100 cm)

or 1 centimetre = $\frac{1}{100}$ metre (or 1 cm = $\frac{1}{100}$ m)

The lengths still shorter than a centimetre are expressed in **millimetre**. *For example*, the thickness of a coin is expressed in millimetre. A millimetre is another sub-multiple of metre. In short form, millimetre is written as mm.

One millimetre is one thousandth part of a metre or 1000 millimetre make one metre. Thus,

1 metre = 1000 millimetre (or 1 m = 1000 mm)

or 1 millimetre = $\frac{1}{1000}$ metre (or 1 mm = $\frac{1}{1000}$ m)

The sub multiple and multiple units of length are summarized in the following table.

Multiples and submultiples of a metre :

Multiple

Kilometre (symbol km)

1 km = 1000 m

Submultiples

(1) *Centimetre* (symbol cm)

$1 \text{ cm} = \frac{1}{100} \text{ m or } 10^{-2} \text{ cm}$

(2) *Millimetre* (symbol mm)

$1 \text{ mm} = \frac{1}{1000} \text{ m or } 10^{-3} \text{ m}$

In F.P.S. system, the unit of length is **foot** (symbol **ft**). Its smaller unit is inch (symbol inch). They are related as :

1ft = 12 inch

The bigger unit than foot is **yard** (symbol yd) where

1 yard = 3 foot = 36 inch

or 1 yd = 3 ft = 36 inch

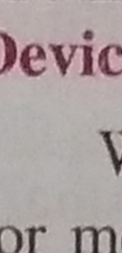
In C.G.S. system, the unit of length is **centimetre** (symbol **cm**).

Relationship between ft, inch and cm:

1 inch = 2·54 cm

1 ft = 30·48 cm

and, 1 yd = 91·44 cm or 0·91 m (nearly)



Do You Know ?

1. Apart from millimetre (mm) and centimetre (cm), sometimes we also use decimetre (symbol dm) as sub multiple of metre.

   1 decimetre = $\frac{1}{10}$ metre = 10^{-1} metre

2. Apart from kilometre, sometimes we also use decametre (dam) and hectometre (hm) as multiples of metre.

   1 decametre = 10 metre

   and 1 hectometre = 100 metre

Devices for measuring length

We use mainly the following two devices for measuring length :

1. A metre ruler and 2. A measuring tape

1. Use of a metre ruler to measure length

Description of a metre ruler : Generally, we use a wooden (or plastic) ruler to measure the length. It is 1 metre long and is divided into 100 equal parts. Each part is a centimetre. Each centimetre is further divided into 10 equal parts. Each small part is a millimetre. Thus, a metre ruler is marked in centimetre and millimetre. Smaller rulers measuring 50 cm, 30 cm and 15 cm are also available Fig. 2.1 shows a ruler of length 15 cm.

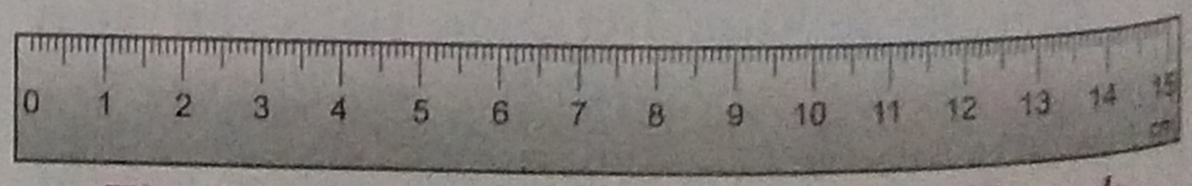


Fig. 2.1 A ruler 15 centimetre long with each division equal to 1 millimetre

Page :

Date : / /

Answer the following questions:

1 What is measurement?

2. Give an example of measurement.

3. What are the properties of unit?

4. How many systems of units are there? Name them.

5. What is a physical quantity?

6. Name four basic physical quantities.

7. Write any five conventions of writing S.I. unit.

8. What is length?

9. How will you define A metre?

10. What is the S.I unit of length?