UNIT 1

PHYSICS AND MEASUREMENT

Unit outcomes: After completing this unit you should be able to:

- ✓ understand concepts related to basic measurements;
- ✓ develop skills of measuring area, volume and density;
- ✓ develop skill in producing and evaluation of a design project applying the laws of physics in its construction
- ✓ appreciate the interrelatedness of all things;
- ✓ use a wide range of possibilities for developing knowledge of the major concepts with in physics.

Introduction

One of the most important skills you need to learn in physics is measurement. In grade 7 you learnt how to measure length, time and mass. Different measuring instruments for length, time and mass has also been studied. Traditional units and standard units of measurements were differentiated. Also, you learnt that basic physical quantities are measurable. But plenty of physical quantities are expressed in terms of these basic quantities and they are called derived quantities. In this unit you will study how to measure and calculate areas of different surfaces, volumes of different bodies and the densities of substances.

1.1. Measuring Area

In this section you will learn how to measure areas of different surfaces.

Activity 1.1

Measure the length and width of the following materials

	Material	Length (m)	Width (m)	$\ell \times w$	Unit of $\ell \times w$
1	Gr-8 Physics .text				
2	Your class room				

Do you have any idea about the product $\ell \times w$ from your mathematics subject? What does it describe?

All forms of surfaces, whether they are regular or irregular shaped have lines that bound them.

Area of a surface is the space bounded by a certain line. The SI unit of area is square meter. i.e. m^2.
Other units are cm^2, mm^2, and km^2.

Table 1.1 Relationships between SI and non SI units of area

$1m^2$	$10,000cm^2$
$1m^2$	$1,000,000\ mm^2$
$1m^2$	$100\ dm^2$

Activity 1.2

1. Change $1m^2$ into cm^2, mm^2 and km^2.
2. Change $1cm^2$, $1mm^2$ and $1km^2$ into m^2

Calculating area

Activity 1.3

Find hard paper and cut it into pieces of 1cm × 1cm. Totally produce up to 100 pieces of square centimeter.

Paste these pieces of square centimeters in a regular way without leaving any space between them, on your textbook.

- How many pieces have you used to cover the whole surface of the textbook?
- Compare this number of pieces with product $\ell \times w$ of your textbook.

The method used for measuring surface area is derived directly from the method for measuring distances. Areas are measured by choosing some convenient square units. Determining how many of these units are contained in the surface we know the area. This is done by measuring the **length** and **width** of the surface and then finding the product of these measurements.

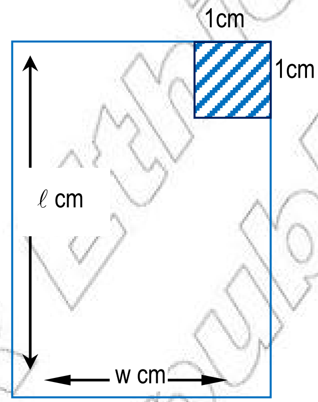


Fig 1.1 1cm × 1cm square

Areas of some common surfaces have simple mathematical relations with the enclosing curves. You have already learnt in mathematics how to find the area of a rectangle, square, triangle and circle. The followings are revisions of finding areas of different surfaces.

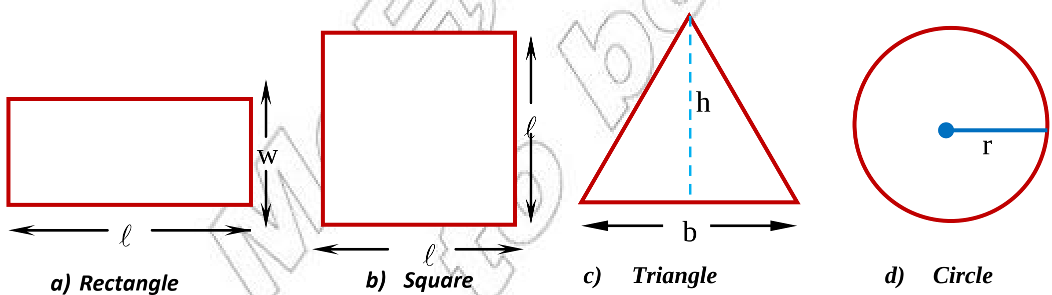


Fig 1.2. Area of different shapes

1. Area of a rectangular surface is given by the product of its **length** and **width.**

$$\text{Area} = \text{Length} \times \text{Width}$$

$$A = \ell \times w$$

2. Area of a square surface is given by the product of two sides.

$$\text{Area} = \text{Length} \times \text{Length}$$

$$A = \ell^2$$

3. Area of a triangular surface is given by the product of half of its base and height.

$$\textbf{Area} = \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times b \times h = \frac{1}{2}\,bh$$

4. Area of a circular surface is given by:

$$\text{Area} = \pi \times (\text{radius})^2$$

$$A = \pi r^2$$

Table 1.2 Formula for finding areas of different surfaces

Surfaces	Formula of Area
Rectangular	$A = \ell \times w$
Square	$A = \ell \times \ell = \ell^2$
Triangle	$A = \frac{1}{2}\ell \times h$
Circle	$A = \pi r^2$

Example 1.1

What is the surface area of a table, if the length is 120 cm and its width is 80 cm?

Given	Required	Solution
$\ell = 120$ cm $w = 80$ cm	$A = ?$	$A = \ell \times w$ $= 120\text{cm} \times 80\text{cm}$ $= 9600\ \text{cm}^2$ or 0.96m^2

Example 1.2

What is the area of a square surface if its sides are 2m each?

Given	Required	Solution
$\ell = 2m$	A = ?	Area of square = ℓ^2
		$= (2m)^2$
		$= 4m^2$

Example 1.3

Find the base area of a glass. If its base is circular with a diameter of 4 cm. (take $\pi = 3.14$)

Given	Required	Solution
Diameter = 4cm	A= ?	Area of a circle = πr^2
$\therefore$ r =		$= 3.14\times (2cm)^2$
= = 2cm		$= (3.14\times 4)\ cm^2$
		$= 12.56\ cm^2$

Challenging questions

How can you calculate the surface areas of a cube, rectangular block, and cylinder?

Check point 1.1

1. What is an area? How can you measure it?
2. Write the equations for finding the areas of a rectangle, a square, a triangle and a circle.
3. Explain the relation between the diameter and the radius of a circle.
4. Express the relation between m^2 and other units such as cm^2, mm^2 and km^2.

1.2 Measuring Volume

Next, you will learn how to measure the volume of regular shaped bodies, liquids, and irregular shaped bodies.

All physical bodies around you occupy a certain amount of space. Different materials occupy different space. The space occupied by a body is called the **volume** of the body.

The volume of a body is the space occupied by the body. The SI unit of volume is cubic meter (m^3).

The volume of an object can also be expressed in cubic decimeter (dm^3), cubic centimeter (cm^3), cubic millimeter (mm^3) and so on.

One unit can be converted into another using the relations in Table 1.3.

Table 1.3 Relationships between SI and non SI units of volume

$1m^3$	$1,000,000cm^3$
$1dm^3$	$1,000cm^3$
$1cm^3$	$1, 000mm^3$

Example 1.4

How many cm^3 are there in $0.8m^3$?

Given	Solution
$V = 0.8m^3$	$1m^3 = 1000, 000cm^3$ $0.8m^3 = ?$ $\therefore$ V in $cm^3 = \frac{0.8\cancel{m^3}\times 1000,000cm^3}{1\cancel{m^3}}$ $= 800, 000\ cm^3$

Bodies are found in solid, liquid or gas forms. Moreover solid bodies are either regular or irregular in shape. Liquids do not have a definite shape. They take the shapes of their containers. Therefore different methods are used to determine the volumes of solids, liquids and gases.

Challenging questions

Explain the differences between solid, liquid and gases in terms of their volumes.

Activity 1.4

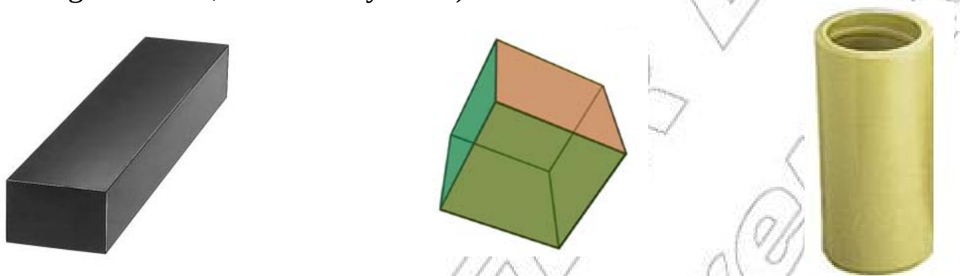
Discuss with your friends and write short notes on how to measure the volume of:

a) a match box.
b) air in your class room.
c) any liquid.
d) any irregularly shaped stone.

1.2.1 Measuring Volumes of Regular Shaped Solid Bodies

Solids have definite shape and volume. The shape of a solid can be regular or irregular.

Measuring volume of regular - shape solid is performed in a similar way as a surface area. The length, width and height of the body need to be measured. Then its volume is calculated using the product of the three sides (Fig 1.3 shows a rectangular block, cube and cylinder).



a) Rectangular block b) Cube c) Cylinder

Fig 1.3 Regular- shaped solids

I. Volume of a rectangular block

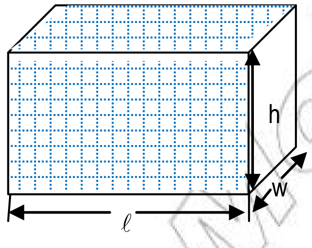


Fig 1.4 A rectangular block with sides ℓ, w and h

The volume (V) of a rectangular block having length (ℓ), width (w) and height (h) is given by:

$$V = \ell \times w \times h$$

$$V = \ell w h$$

Example 1.5

A chalk box has a length of 4cm, a width of 5cm and height of 6cm.

a) What is the volume of the chalk box?

b) How many unit chalks are needed to fill it, if each unit chalk is $2cm^3$?

Given	Solution
$\ell = 4cm$ $w = 5\ cm$ $h = 6\ cm$ Volume of unit chalk = $2cm^3$	a) volume of chalk box = ℓwh $= 4cm\times5cm\times6cm$ $= 120cm^3$ b) The volume of unit of chalk is $2cm^3$, Therefore number of chalks needed can be calculated by dividing the volume of the box by the volume of chalk i.e.

$$\text{Number of chalks needed} = \frac{\text{volume of box}}{\text{volume of unit chalk}}$$

$$= \frac{120\cancel{cm^3}}{2\cancel{cm^3}} = 60$$

$\therefore$ The box can contain 60 chalks

II. The volume of a cube

A cube is rectangular block having all its sides equal. That means

length = width = height = ℓ

Therefore $\boxed{\textbf{Volume} = \ell^3}$

1.2.2 Measuring Volume of Liquids

Liquids have no definite shape. When you pour liquids into differently shaped containers, they will have the shape of their containers. However liquids have definite volume.

Since liquids take the shape of their containers, the volume of a liquid is determined by considering their containers. The volume of a liquid can be measured by graduated measuring cylinder. (Fig 1.5).

The common unit for measuring the volume of liquid is liter (L)

.

Fig 1.5 A measuring graduated cylinder

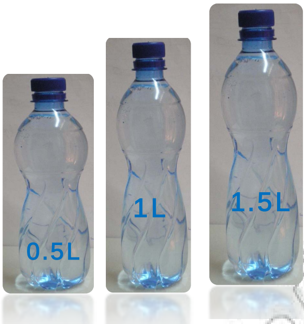


Fig 1.6 Different plastic bottles containing different volume of water.

Activity 1.5

Pour a glass of water into a measuring cylinder. If the measuring cylinder is graduated in milliliter (mL), read the volume of the water in the measuring cylinder.

Table 1.4	
1 L =	1000 mL
1 mL =	1cm^3
1m^3 =	1000 L
1L =	1dm^3

Example 1.6

1. A small swimming pool is 600 cm long, 300 cm wide and 200 cm deep. What is the volume of the water contained in the pool in cubic meters (m^3)?

Given	Required	Solution
$\ell = 600$cm w = 300cm h = 200cm	Volume in m^3 = ?	$V = \ell \times w \times h$ But first convert the unit of each dimension (size) into meter. i.e. $\ell = 600$cm = 6m; w = 300cm = 3m and h = 200cm = 2m. Therefore, V = 6m × 3m × 2m. = **36 m^3**

1.2.3 Measuring the Volume of an Irregular shaped Body

Have you noticed the over flow of tea as spoons of sugar are put into a cup filled with tea? What is the cause of the over flow?

Activity 1.6

- Pour water into a measuring cylinder. Take carefully the reading (level) of the water and call it V_1. (see Fig 1.8a)
- Tie a stone with a thread and gradually immerse the piece of stone (irregular shape) into the water in the measuring cylinder. Notice the new level of the water. Again take the reading of the cylinder and call this volume V_2.
- Calculate $V_2 - V_1$ and explain what this value mean.

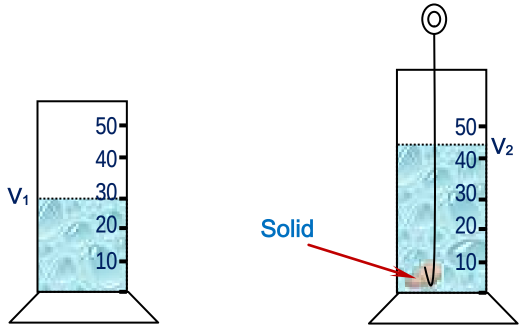
Steps to determine the volume of irregular shaped bodies

Step 1: Pour some amount of water into the measuring cylinder. Record its volume and let it be V_1

Step 2: Put an irregular- shaped body into the measuring cylinder. Record again the volume of water and irregular shaped body. Let it be V_2

Step 3: volume of the irregular shaped body (V) = $V_2 - V_1$

Fig 1.7 An irregular shaped stone



a) Volume of water only

b) Volume of water plus volume of irregular shaped stone

Fig 1.8 Measuring the volume of an irregular shaped stone.

Two bodies do not occupy the same space at the same time. For example, immerse a stone in a vessel filled with water. You can observe the over flow of water. This is because the stone and water do not occupy the same space at the same time. The water has to leave some spaces for the stone. Hence the stone displaces the water. See Fig 1.8 and 1.9. The volume of displaced water is equal to the volume of the immersed solid body.

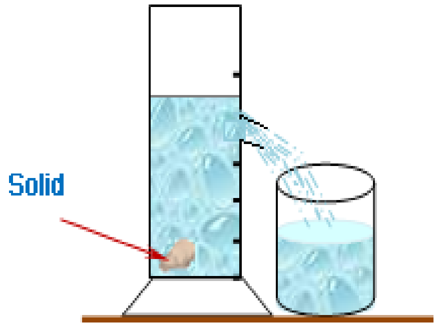


Fig 1.9 Measuring the volume of an irregular shaped body by displacement method.

Check point 1.2

1. Explain the method of calculating volume of a regular shaped body.
2. How can you measure the volume of a cylinder?
3. Explain how you can measure the volume of a liquid.
4. Describe the difference between solids, liquids and gases in relation to volume.
5. Describe the method for measuring volume of an irregular shaped body.
6. Write down the units of volume of a solid and liquid body.

1.3 Measuring the Density of a Substance

Activity 1.7

Hold blocks of wood and iron of the same volume. Consider their heaviness or lightness. Which one of them is heavier? Measure their mass and volumes.

Object	Mass	Volume	Mass/ volume
Iron block			
Wooden block			

- What do you understand by the quantity mass/volume?
- Which object does have the bigger mass/volume?
- How much mass of iron is there in a unit of volume?
- How much mass of wood is there in a unit of volume?
- What do you call the ratio of mass to volume of body?

In the above activity you determined the mass per unit volume of a wood and an iron. Comparing these quantities of mass per unit volume of iron with that of wood you find that iron has more mass in a unit volume than wood.

The secret of iron being heavier than wood of the same volume is, due to greater amount of mass per unit volume in it. This quantity is defined as the density of an iron.

Density is the amount of mass in a unit volume. Or, it is the ratio of mass to its volume. The symbol which stands for density is a Greek letter ‘ρ’ read as *roe*

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}; \quad \rho = \frac{m}{V}$$

m = mass of the body

V = volume of the body

You can also rearrange and get formula for ‘m’ and ‘V’. i.e.

$$m = \rho . V \qquad \text{and} \quad V = \frac{m}{\rho}$$

The SI unit of density is kilogram per cubic meter (kg/m^3). For example the density of water is $1000 kg/m^3$. Different substances have different densities. Table 1.5 gives the densities of different substances.

Table 1.5 Densities of different substances

Liquid		Solids	
Substance	Density (g/cm^3)	Substance	Density (g/cm^3)
Water	1.0	Aluminum	2.2
Kerosene	0.8	Copper	8.9
Petrol	0.7	Gold	19.3
Salty Water	1.2	Iron	8.0
Mercury	13.6	Rubber	1.5
		Lead	11.3
		Ice	0.9
		Silver	10.5
		Tin	7.3

Use Table 1.5 to answer the following questions

a) Among the given substances which one is the most dense?

b) Do you know why ice floats on water? Explain it using the concept of density.

c) What is the lightest metal among the given metallic substances?

Challenging questions

1. What substances have higher densities than iron?
2. What substances are denser than water?
3. What is the substance that has the greatest density of all?
4. What is the density of water in: a) Kg/m^3 b) g/cm^3?

Measuring the density of an irregular shaped solid body

You have already learned how to measure the density of a regular shaped solid body.

To measure the density of an irregular-shaped solid body, you need to measure the mass and the volume of the irregular shaped solid body.

Challenging questions

1. How do you measure the mass of an irregular shaped solid body?
2. How do you measure the volume of an irregular shaped solid body?

You measure the mass using a beam balance. To measure the volume of an irregular shaped solid body, you use a displacement method as in Fig 1.9. The density of an irregular shaped solid body equals the mass of the irregular solid body divided by the volume of water displaced. That is the volume of the irregular shaped solid body.

Density of irregular shaped body= $\frac{\text{Mass of irregular shaped body}}{\text{final volume} - \text{initial volume}}$ $\boxed{\rho = \frac{m}{V_2 - V_1}}$

Measuring the density of liquid

You already know that a liquid doesn't have a regular shape. It takes the shape of its container. To measure the density of a liquid, you need to know its mass and volume.

Challenging question

How do you measure the mass of a liquid and volume of a liquid?

The following steps are used to measure the density of liquid

1. Measure the mass of an empty container using a beam balance and denote it as m_1.
2. Pour the liquid of a given volume into the container and measure the mass of the container and liquid together. Denote this as m_2.
3. The difference between m_2 and m_1 is the mass of the liquid (m_2- m_1).
4. Density of liquid = $\frac{\text{mass of liquid } (m_2 - m_1)}{\text{volume of liquid } (V)}$

Example 1.7

1. Figure 1.10 shows a cylinder graduated in cm^3. When an irregularly-shaped piece of metal is placed in the cylinder the water level rises as shown. If the mass of the metal is 150 g, what is the density of the solid metal?

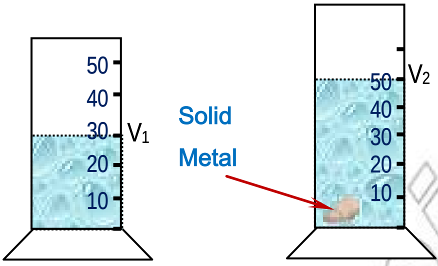


Fig 1.10 Displacement method for measuring volume

Given	Required	Solution
mass of the solid =150g	Density of the solid?	density = $\frac{\text{Mass}}{\text{Volume}} = \frac{150\text{g}}{20\text{ cm}^3}$

$V_1 = 30cm^3$ $= 7.5g/cm^3$

$V_2 = 50cm^3$

$\Rightarrow V = V_2 - V_1 = 50cm^3 - 30cm^3$

$= 20\ cm^3$ = volume of metal

Hydrometer

Activity 1.8

1. Discuss with your class mates. How you can measure the density of a liquid. How do people know whether a given milk is waterish or not?
2. What is a hydrometer?

The density of a liquid is measured by using an instrument called a **hydrometer.** A hydrometer is a glass cylinder with a weight at the bottom and a thin calibrated tube at the top.

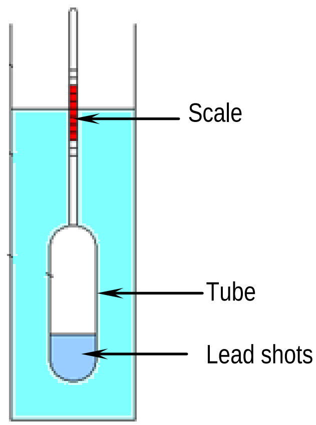


Fig 1.11 A Hydrometer

To measure the density of a liquid you let the hydrometer float in the liquid and note the depth to which it sinks. For example, the density of milk can be measured using a hydrometer.

The denser the milk the lesser the depth to which the hydrometer sinks. The smaller the density of the milk the more the depth to which the hydrometer sinks. (The milk is waterish when the density is small, and is fatty when the density is bigger).

Significance of knowing the density of materials:

1. Airplanes, moving parts of engines, bodies of buses etc. must be strong but not heavy. They are made of substances with low densities. For example aluminum has a density of 2.7 g/cm^3 which is lighter than steel (ρ_s = 7.7g/cm^3).
2. Density is important to identify pure substance from mixtures. For example the density of gold is 19.3 g/cm^3. Gold mixed with other metals has a lower density.
3. Civil engineers also use the idea of density to determine the durability of their building.

From your daily life mention some activities in which you apply the idea of density.

Check point 1.3

1. **What is density?**
2. **Describe the relationship between mass, volume and density of a body.**
3. **How can you measure the density of**
   - **a) a regular shaped solid body?**
   - **b) an Irregular shaped solid body?**
   - **c) Liquid?**
4. **Explain how a hydrometer works.**

1.4 Dimensional Expression of a Physical Quantity

The dimensions of a physical quantity refer to the fundamental unit or units contained in it.

Any quantity which can be measured in a mass unit is said to have the dimension of a mass. This is expressed by the symbol [M]. Similarly, any quantity which can be measured in length unit is said to have the dimension of length [L].

Every physical quantity can be expressed interms of the basic or fundamental quantities. For the system of units, the quantities M, L, T are used to represent mass, length, time respectively. The power to which the fundamental units are raised to obtain any physical quantity are called the dimensions of that quantity. For example, the dimensions of area = length × length; are $[L^2]$.

The dimensions of a physical quantity show how the quantity is related, through its defining equation, to the basic quantities.

For example, if we write the physical quantity speed as $[v] = [LT^{-1}]$ we indicate that speed is measured by dividing a length by a time.

Some quantities are described by a number which is independent of the units such quantities are said to be **dimensionless.**

For example, a relative density of a substance is dimensionless. It does not have a unit. Mechanical advantages and velocity ratio are dimensionless quantities in machines. Can you name other physical quantities that are dimensionless?

Table 1.6 Dimensional Expression of some physical quantities

Fundamental units			Derived units		
Phy.Quan	Unit	Dimension	Phy. Quan	Unit	Dimension
Mass	kilogram	[M]	Area	m^2	$[L^2]$
Length	meter	[L]	Volume	m^3	$[L^3]$
Time	second	[T]	Density	$\frac{kg}{m^3}$	$[ML^{-3}]$
			Speed.	m/s	$[LT^{-1}]$
			Force	$kg.m/s^2$	$[MLT^{-2}]$

The derived units are based on the fundamental units. In many cases, they involve more than one fundamental units.

In such a case the dimensions of such units are expressed in general as $K(M)^x (L)^y (T)^z$. Where K is a number. x, y and z indicate how many times the particular unit is involved.

For example, a force of 10 N can be rewritten as: 10 MLT^{-2}
Here K = 10, x = 1, y = 1 and z = -2

The values of x, y and z can be found from the definition of the physical quantities involved. The power to which the fundamental units are raised to obtain the derived units are called the dimensions of the derived units.

Table 1.7 The dimensions of some important physical quantities

Physical quantity	Dimension
Velocity	$[LT^{-1}]$
Momentum	$[MLT^{-1}]$
Acceleration	$[LT^{-2}]$
Energy	$[ML^2 T^{-2}]$
Frequency	$[T^{-1}]$
Power	$[ML^2 T^{-3}]$
Charge	[AT]

Example 1.8

1. **Area:** The area of a square whose sides are 1m each is 1m × 1m = $1m^2$. Thus the unit of area is the square of unit of length. Since the dimension of length is (L), the dimensions of area is (L) × (L) = L^2. Thus, area has two dimensions in length.
2. **Volume:** The volume of a unit cube = 1m × 1m × 1m = $1m^3$ i.e. the unit of volume is the cube of unit of length. So the dimensions of volume is [L] [L] [L] = $[L]^3$. Thus volume has 3 dimensions in length.

3. **Density:** $[M]^1\,[L]^{-3}$

Since density is $\frac{\text{mass}}{\text{volume}}$

The dimension of density is $\frac{[M]}{[L^3]}$

$[M]^{+1}[L]^{-3}$

The uses of dimensions

Each term in a correct physical equation must have the same dimensions. Use of this fact is called the method of dimensions.

In a correct physical equation we can equate both number and unit for each term that appears. If we could not equate the unit, then a change of the system of units might result in the numbers changing by different factors, which would invalidate an equation whose numbers were previously equal.

i) Conversion of units

When several system of units are in common use, the method of dimension gives a quick way of converting units for complex derived quantities from one system to another.

ii) To check equations

Since physical equations are dimensionally homogeneous, terms which are incorrect can quickly be detected.

iii) Dimensional analysis

This enables us to predict how physical quantities may be related.

Check point 1.4

1. **What do you understand by "dimensional expression"?**
2. **Express the dimensions of area, volume, density, speed, acceleration, force, work, and power.**

1.5 Scientific Notation

Activity 1.9

Measure the height, width and length of your classroom in cm and calculate the volume of the class room in:

i) m^3 ii) mm^3 iii) km^3

Have you noticed any problem in expressing the volume of the room in the above units?

- Explain the advantage and disadvantage of writing the volume in the above units?
- Do you know any other option of writing this volume?

Obviously when you are doing Activity 1.9 you may have come across many problems. The problems are:

- The numbers are long and tiresome to write.
- The numbers may take up a lot of space.
- Errors may easily be made in reading the number of zeros. etc.

Suppose the distance from the sun to the earth is about 150 million km. This is fully written as:

s = 150,000,000 km where 's' stands for distance.

This distance is written in terms of other units, as

in meter, s = 150,000,000,000 m

in centimeter, s = 15,000,000,000,000 cm,

in millimeter, s = 150,000,000,000,000 mm

Do you notice the space you are taking to write such big numbers? And can you read the numbers in centimeters and millimeters?

Similarly to write very small numbers, you need to put as many zeros as possible before a numeral.

Using such numbers repeatedly in operations will finish the pages of your notebook very soon. Therefore, a simple method of writing small and large numbers is needed. The **scientific notation** is such a method.

The scientific notation is a way of writing very large and very small numbers using a power of 10. Remember your mathematics knowledge of writing numbers in power of 10.

Scientific notation is representation of a quantitiy in the form of $a \times 10^n$. Where 'a' is a number lying between 1 and 10 and 'n' is an integer number

In the scientific notation, only one non-zero number (digit) remains to the left (in front) of the decimal point. To compensate for the places the decimal point is shifted. To do this, you use power often. The numbers in the above examples can be written using the scientific notions.

$s = 1.5 \times 10^8 km$

$s = 1.5 \times 10^{11} m$

$s = 1.5 \times 10^{13} cm$

$s = 1.5 \times 10^{14} mm$

Challenging questions

Convert the following numbers into scientific notation

a) 300,000,000 cm

b) 0.000,000,000,000,128 cm

Prefixes

You have learnt that there is only one unit for basic or derived quantities. Scientists have felt that the powers of ten in the scientific notion are not suitable for writing. Therefore, they have given symbols for some of the powers of ten.

Prefixes involve power of ten which are multiples and sub multiplies. The symbols for the powers of ten are called prefixes. The word ''prefix'' means something put in front of another. As its name indicates, prefixes are put in front of units.

Table 1.8 shows the prefixes for some common multiples and submultiples.

For example in the quantity 5 km, m is the symbol of meter. The letter 'k' is a prefix. 'k' stands for 10^3. Thus, 5km = 5×10^3 m.

Table 1.8. Prefixes of units			
Prefix	symbol	Factor by which the base unit is multiplied	
tera	T	10^{12}	multiplies
giga	G	10^{9}	
mega	M	10^{6}	
kilo	k	10^{3}	
hector	h	10^{2}	
deca	da	10^{1}	
deci	d	10^{-1}	sub multiplies
centi	c	10^{-2}	
milli	m	10^{-3}	
micro	µ	10^{-6}	
nano	n	10^{-9}	
pico	p	10^{-12}	

Check point 1.5

1. **What do we mean by a 'scientific notation'?**
   Write 1,000,000 w
   1,000 m
   0.001 cm using scientific notation
2. **Explain the use of scientific notation**
3. **Give some practical examples where prefixes are used**
4. **What are the prefixes used to write**
   a) 1,000,000 (1 million)
   b) 1,000,000,000 (1 billion)
   c) $\frac{1}{1,000,000}$
   d) $\frac{1}{1,000}$

SUMMARY

In this unit you learnt that:

- area of a surface is the region bounded by a certain curve. The methods used for measuring surface area are derived directly from the methods for measuring distances. Area of some regular shaped bodies:-
  1. Area of a rectangular surface = Length × width
  2. Area of a square = ℓ^2
  3. Area of a triangular surface = ½ (bh)
  4. Area of a circular surface = πr^2.
- the SI unit of area is square meter (m^2).
- volume of a body is the space occupied by the body. The SI unit of volume is cubic meter (m^3).
- volume of rectangular block = ℓwh.
- volume of cube = ℓ^3.
- volume of a liquid can be measured using a measuring cylinder. Volume of irregular shaped bodies can be measured by using displacement of a liquid.
- density is the amount of mass per unit volume. The formula of density is $\rho = m/V$.
- the density of regular shaped bodies can be obtained by measuring the mass and volume of the bodies.
- hydrometer is an instrument used to measure the density of liquids.
- the dimensions of a physical quantity shows, how the quantity is related to the basic quantities. Scientific notation is a convenient way of representing values of measurements in order to perform mathematical operations. Prefixes are powers of 10, written before units.

Review Questions and Problems

I. Write 'true' if the statement is true and 'false' if the statement is false.

1. One square meter (m^2) is equal to ten thousand square centimeters (10,000 cm^2).
2. Measuring cylinder is used to measure the volume of a liquid.
3. The volume of irregular-shaped bodies is determined by using beam balance.
4. Hydrometer is a devise used to measure the volume of a liquid.

II. Answer the following questions.

1. Define the following terms and phrases.
   a. Area
   b. Volume
   c. density
   d. dimensional expression
   e. scientific notation
2. Describe how you can determine:
   i) Surface area of a. a rectangle b. a triangle
   ii) Volume of an irregular shape solid body
   iii) Density of a liquid.
3. What is the use of a hydrometer?
4. Explain the advantage of using scientific notation.
5. What are the prefixes used to write multiples of numbers?

III. Work out problems.

1. A box is 30 cm wide, 40 cm long and 25 cm high Calculate:
   a. the area of its base.
   b. the volume of the box.
2. When 10 similar coins are dropped into a graduated cylinder the level of the water in the cylinder raised from 75mL to 100mL. What is the average volume of each coin?
3. What is the area of a rectangular plate whose sides measure 27.3cm by 17.5cm?

4. Compute the following operations in scientific notation. (Use your mathematical knowledge)
   a. $2.7 \times 10^{2}N \div 3.6 \times 10^{-4}m^{2}$
   b. $3.9 \times 10^{-2}m - 2.3 \times 10^{-3}m$
5. Write the followings in i) the scientific notation,
   ii) prefixes
   a. 15,000,000,000 kg
   b. 0.00000189 m
   c. 0.000,000,000,000,000,000,0030 second
   d. 6000,000,000,000,000,000,000,000 km
6. Carry out the following computation
   $(8.60 \times 10^{5}) \times (6.17 \times 10^{-2}) \div (1.79 \times 10^{-4})$. Write your answer in scientific notation with one digit to the left of the decimal. (use your mathematical knowledge)
7. Compute the dimensions of gravitational constant G; where
   $F = \frac{Gm_1m_2}{r^2}$.
8. Check the dimensional consistencies in the following equations
   a. $s = v_o t + \frac{1}{2}at^2$
   b. $v^2 = v^2_o + 2\ as$, where s is the distance moved in time t, v_o and v are the initiate and final velocities and 'a' is the acceleration.