

**PHYSICS**

- ☀ Measurements
- ☀ Force and Motion
- ☀ Heat
- ☀ Electricity
- ☀ Magnetism

**CHEMISTRY**

- ☀ Matter Around us
- ☀ Changes Around us
- ☀ Air
- ☀ Water
- ☀ Chemistry in Everyday Life

**BIOLOGY**

- ☀ The World of Plants
- ☀ The World of Animals
- ☀ Health and Hygiene
- ☀ The Cell
- ☀ Human Organ Systems
- ☀ Our Environment
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**COMPUTER SCIENCE**

- ☀ Computer - An Introduction
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# SCIENCE

## PHYSICS

### MEASUREMENTS

#### Introduction

- The comparison of unknown quantities with some known quantities is known as measurement. Measurement of a quantity has two parts : a number and its unit.

#### International System of Units - SI

| SI Units                     | Symbol |
|------------------------------|--------|
| Kelvin (temperature)         | K      |
| metre (distance)             | m      |
| ampere (electric current)    | A      |
| second (time)                | s      |
| mole (amount of substance)   | mol    |
| kilogram (mass)              | Kg     |
| candela (intensity of light) | cd     |

#### SI Base Units

|         |          |       |        |
|---------|----------|-------|--------|
| ampere  | kelvin   | mole  | second |
| candela | kilogram | metre |        |

#### Length

- The distance between one end and the other desired end is called as length. It may be the distance between the edges of a book or a table or the corners of a football ground.
- The standard unit of length is 'Metre'. It is represented by letter 'm'. Very small lengths can be measured in mm and cm.

#### Unit of length

- 1 km (kilometre) = 1000 m (metre)
- 1 m (metre) = 100 cm (centimetre)
- 1 cm (centimetre) = 10 mm (millimetre)

#### Measuring Tools

| Tools          | Purpose                                                  |
|----------------|----------------------------------------------------------|
| Measuring tape | It is used to measure the length of the distance.        |
| Stop clock     | It is used to measure the accurate time of the activity. |
| Measuring Jar  | It is used to measure the volume of the liquid.          |
| A metre scale  | It is used to measure the length of the object.          |
| Balance        | It is used to measure the mass of the object.            |

#### SI Units

- The sake of uniformity, scientists all over the world have adopted a common set of units to express measurements. This system is called as the International System of Units or SI Units.
  - SI Unit for length is Metre
  - SI Unit for mass is Kilogram
  - SI Unit for time is Second
  - Area of Surface =  $m^2$
  - Volume of Solid =  $m^3$

| Prefix | Abbreviation | Submultiple / Multiple     | For Metre                       |
|--------|--------------|----------------------------|---------------------------------|
| Deci   | d            | Submultiple : 1/10         | 10 decimetre = 1 metre          |
| Centi  | c            | Submultiple : 1/100        | 100 centimetre = 1 metre        |
| Milli  | m            | Submultiple : 1/1000       | 1000 millimetre = 1 metre       |
| Nano   | n            | Submultiple : 1/1000000000 | 1000000000 nano metre = 1 metre |
| Kilo   | k            | Multiple : 1000            | 1000 metres = 1 Kilometre       |

#### Volume

##### Volume of Solids

- Length is a fundamental quantity. That means, it cannot be expressed in any other quantities. Using length, we can find out other measurements like Area and Volume. Area is obtained by using two lengths. So, **Area = Length × Breadth**.
- Volume is also a derived quantity and it can be measured from measuring lengths.

- Unit of volume is  $cm \times cm \times cm = \text{cubic cm}$  or  $cm^3$ .

##### Volume of Liquid

- Measuring the volume of a liquid is quite easy. Liquids take the shape of the container in which they are kept. A liquid whose volume is to be found can simply be poured into a graduated container. Graduated cylinders, beakers, pipettes and burettes

are available for measuring exact volumes. The volume of liquid is usually measured in litres.

The quantity of blood in a human body is 5.5 litres

### Volume of gas

- ◆ Gases expand to fill the container into which they are placed.
- ◆ When we compress, a gas we can make the same gas to occupy lesser space. (as in LPG gas cylinder). Therefore it is not easy to talk about the volume of gas in the same way as a volume of a stone or a liquid. It is essential to take into account the pressure at which the gases are kept.
- ◆ SI unit for Volume of solid is Cubic metre. Liquids and gases are usually measured in litres. But also can be measured in  $\text{m}^3$  or cubic metre.
 

|                  |   |                                                 |
|------------------|---|-------------------------------------------------|
| $1 \text{ m}^3$  | = | 1 kilometre (kl or kL)                          |
| $1 \text{ cm}^3$ | = | 1 millilitre (ml or mL)                         |
| $1 \text{ mm}^3$ | = | 1 microlitre ( $\mu\text{l}$ or $\mu\text{L}$ ) |

### Mass

#### Mass and Weight

- ◆ Mass is the measure of the amount of matter in an object. Weight is the gravitational pull experienced by the mass.
- ◆ The SI unit of mass is kilogram. It is represented by the 'Kg'.
- ◆ Bigger weights are measured in tonne or Metric Tonne.
 

|                |   |            |
|----------------|---|------------|
| 1000 milligram | = | 1 gram     |
| 1000 gram      | = | 1 kilogram |
| 1000 kilogram  | = | 1 tonne    |

#### Beam Balance

- ◆ Beam balances are used to measure mass. A beam balance works by comparing the mass of an object to that of known mass (called a standard mass)

- An Odometer is a device used for indicating distance travelled by an automobile.
- The metric system or standard set of units was created by the French in 1790.
- A ruler or scale, used now a days to measure length was invented by a William Bedwell in 16th century.
- A standard metre rod made of an alloy of platinum and iridium is placed at the Bureau of weights and measures in Paris. National Physical Laboratory in Delhi has a copy of this metre rod.
- One kilogram is equal to the mass of a certain bar of platinum-iridium alloy that has been kept since 1889 at the International Bureau of Weights and Measures in Sevres, France.

### Electronic Balance

- ◆ An electronic balance is a device used to find accurate measurements of weight. It is used very commonly in laboratories for weighing chemicals to ensure a precise measurement of those chemicals for use in various experiments.
- ◆ Electronic balances may also be used to weigh food, other grocery items, as well as jewellery.

### Time

- ◆ Day changes into night and night into day. Seasons also change.
- ◆ Clocks are used to measure time.

### Sand Clock

In earlier days people used sand clock and sundial to measure the passage of time during the day. The shadow cast by a stick can be used to estimate time. One can also use a vessel with a small hole for computing time. These are rough methods for counting passage of time. We can use electronic clock, stopwatch and other instruments to count even smaller durations of time.

On the moon where the gravitational force is less than that is on the earth, the weight will reduce but the mass will remain same. The moon's gravitational pull is one sixth of the earth's pull. Thus objects weigh six times lighter on the Moon than on the Earth.

## NUMERICAL PROBLEMS

### Complete the following :

1. A) 7875 cm = ..... m ..... cm  
 B) 1195 m = ..... km ..... m  
 C) 15 cm 10 mm = ..... mm  
 D) 45 km 33 m = ..... m

Ans :

- |           |           |
|-----------|-----------|
| A) 78, 75 | B) 1, 195 |
| C) 160    | D) 45033  |

2. The distance between two places is 43.65 km. Convert it into metre and cm.

Ans :

#### a) Convert km into metre

$$\begin{aligned}
 1 \text{ km} &= 1000 \text{ m} \\
 \therefore 43.65 \text{ km} &= 43.65 \times 1000 = 43650 \\
 &= 43650 = 43650 \text{ m.}
 \end{aligned}$$

### b) Convert km into cm.

$$\begin{aligned}
 1 \text{ km} &= 1000 \text{ m} \\
 1 \text{ m} &= 100 \text{ cm} \\
 1 \text{ km} &= 1000 \times 100 \text{ cm} \\
 1 \text{ km} &= 100000 \text{ cm} \\
 43.65 \text{ km} &= 43.65 \times 100000 \\
 &= 4365000 \\
 &= 4365000 \text{ cm.}
 \end{aligned}$$

3. The distance between your school and your house is 2250m. Express this distance in kilometre.

Ans :

Express in kilo metre

Distance between school and house is 2250 m.

$$\begin{aligned}
 1000 \text{ m} &= 1 \text{ km} \\
 2250 \text{ m} &= 2250 \div 1000 = 2.25 \text{ km.}
 \end{aligned}$$

4. While measuring the length of a sharpened pencil, reading of the scale at one end is 2.0 cm and at the other end is 12.1 cm. What is the length of the pencil ?

Ans :

Sharpened pencil starting end is 2.0 cm.

Sharpened pencil ending end is 12.1 cm.

Length of the pencil

= Ending end – Starting end

= 12.1 cm – 2.0 cm = 10.1 cm.

## OBJECTIVE TYPE QUESTIONS

1. The height of a tree can be measured by  
A) Metre scale      B) Metre rod  
C) Plastic ruler      D) Measuring tape  
Ans : (D)
2. The conversion of 7 m into cm gives  
A) 70 cm      B) 7 cm  
C) 700 cm      D) 7000 cm  
Ans : (C)
3. Quantity that can be measured is called  
A) Physical quantity      B) Unit  
C) Measurement      D) Motion  
Ans : (A)
4. Choose the correct one  
A) km > mm > cm > m  
B) km > mm > cm > km  
C) km > m > cm > mm  
D) km > cm > m > mm  
Ans : (C)
5. While measuring length using a ruler, the position of your eye should be  
A) Left side of the point  
B) Vertically above the point where the measurement is to be taken.  
C) Right side of the point  
D) Any where according to one's convenience  
Ans : (B)
6. How will you measure your height with the unit?  
A) Kilogram      B) Litre  
C) Metre      D) Second  
Ans : (C)
7. The distance between one end and other end is called \_\_\_\_\_  
A) mass      B) length  
C) time      D) None  
Ans : (B)
8. \_\_\_\_\_ is used to measure the accurate time of the activity.  
A) Clock      B) Watch  
C) Stop clock      D) Measuring  
Ans : (C)
9. Five kilometre is equal to \_\_\_\_\_  
A) 500 cm      B) 500 m  
C) 5000 m      D) 5000 cm  
Ans : (C)
10. Volume of solid is \_\_\_\_\_  
A) m<sup>2</sup>      B) m  
C) m<sup>3</sup>      D) none  
Ans : (C)
11. Twenty decimetre is equal to \_\_\_\_\_  
A) 2 km      B) 20 cm  
C) 2 metre      D) 20 metre  
Ans : (C)
12. Volume of liquid is usually measured in  
A) litres      B) grams  
C) nano      D) kilo  
Ans : (A)
13. \_\_\_\_\_ is used to measure mass.  
A) Stop clock  
B) Beam balance  
C) Electronic balance  
D) Graduated cylinder  
Ans : (B)
14. The metric system of units was created by the \_\_\_\_\_ in 1790.  
A) Italy      B) Australia  
C) Russia      D) French  
Ans : (D)
15. The moon's gravitational pull is one \_\_\_\_\_ of the earth's pull.  
A) Seventh      B) Sixth  
C) Fifth      D) Fourth  
Ans : (B)
16. Sugar : Beam balance ; Lime Juice?  
A) Measuring Jar      B) Measuring Tape  
C) Measuring Beaker      D) Measuring Chain  
Ans : (A)
17. Height of a person : cm; length of your sharpened pencil lead?  
A) m (metre)      B)  $\mu$ m (micro metre)  
C) mm (milli metre)      D) dm (deci meter)  
Ans : (C)
18. Milk : volume; vegetables?  
A) candela      B) mass  
C) mole      D) ampere  
Ans : (B)
19. Potatoes : Kilogram; Water?  
A) kilolitre      B) kilogram  
C) mass      D) litre  
Ans : (D)
20. Stop clock : accurate time; \_\_\_\_\_ : accurate weight  
A) Electronic balance      B) Beam balance  
C) Stone balance      D) None  
Ans : (A)
21. Mass : Balance; Length?  
A) Measuring tape      B) Thermo meter  
C) Hygro meter      D) Hydro meter  
Ans : (A)
22. Area : l  $\times$  b; Volume?  
A) l  $\times$  b  $\times$  d      B) l  $\times$  b  $\times$  h  
C) l<sup>2</sup>  $\times$  b<sup>2</sup>  $\times$  h<sup>2</sup>      D) None  
Ans : (B)
23. Irregular shape : Stone; Regular shape?  
A) Brick      B) Clay  
C) Boulders      D) Silt  
Ans : (A)

## **PHYSICS**

- 🍏 Measurement
- 🍏 Force and Motion
- 🍏 Heat and Temperature
- 🍏 Electricity
- 🍏 Light
- 🍏 Universe and Space

## **CHEMISTRY**

- 🍏 Matter Around Us
- 🍏 Atomic Structure
- 🍏 Changes Around Us
- 🍏 Polymer Chemistry
- 🍏 Chemistry in Daily Life

## **BIOLOGY**

- 🍏 Reproduction & Modification in Plants
- 🍏 Health and Hygiene
- 🍏 Cell Biology
- 🍏 Basis of Classification
- 🍏 Animals in Daily Life

## **COMPUTER SCIENCE**

- 🍏 Visual Communication - I
- 🍏 Digital Painting
- 🍏 Visual Communication - II

# PHYSICS

## MEASUREMENT

### Introduction

Measurement is a basic skill which forms an essential part of our day to day activities. Quantities such as mass, weight, distance, temperature, volume are called physical quantities. A value and a unit are used to express the magnitude of a physical quantity.

### Fundamental and derived quantities

Generally, physical quantities are classified into two types, namely, (i) Fundamental quantities and (ii) Derived quantities.

#### Fundamental quantities

- ♦ A set of physical quantities which cannot be expressed in terms of any other quantities are known as "Fundamental quantities". Their corresponding units are called "Fundamental units".
- ♦ An international system of units, called Si units, was adopted at the 11<sup>th</sup> General Conference on weights and measures (CGPM) in 1960. There are seven fundamental quantities in SI units (System of International units).

| Fundamental quantity       | Fundamental unit |
|----------------------------|------------------|
| Length                     | Metre (m)        |
| Mass                       | Kilogram (kg)    |
| Time                       | Second (s)       |
| Temperature                | Kelvin (K)       |
| Electric current           | Ampere (A)       |
| Amount of substance        | Mole (Mol)       |
| Luminous (light) intensity | Candela (cd)     |

### Derived quantities

The base or fundamental SI units like length, mass, time, etc. are independent of each other. The SI units for all other physical quantities such as area, density, velocity can be derived in terms of the base SI units and are called **derived units**.

#### Area

The area of a surface is the product of its length and breadth. In order to derive the unit, it is important to find out the relationship between area and the base physical quantities.

$$\therefore \text{Area} = \text{length} \times \text{breadth}$$

We know that,

$$\begin{aligned} \text{The unit of the area} &= \text{metre} \times \text{metre} \\ &= \text{metre}^2 \\ &= \text{m}^2 \end{aligned}$$

Thus, the SI unit of area is  $\text{m}^2$  and is pronounced as square metre.

One square metre is the area enclosed inside a square of side of 1 metre.

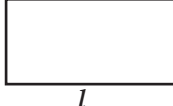
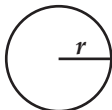
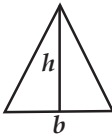
### Some of the derived quantities and their units in SI System of units

| Derived quantity                                 | Unit                                                                     |
|--------------------------------------------------|--------------------------------------------------------------------------|
| Area = length $\times$ breadth                   | $\text{m} \times \text{m} = \text{square metre (or) m}^2$                |
| Volume = length $\times$ breadth $\times$ height | $\text{m} \times \text{m} \times \text{m} = \text{cubic metre (or) m}^3$ |
| Speed = distance / time                          | $\text{m/s (or) ms}^{-1}$                                                |
| Electric charge = electric current $\times$ time | $\text{A} \times \text{s} = \text{As (or) Coulomb (C)}$                  |
| Density = mass / volume                          | $\text{Kg/m}^3$                                                          |

### Area of regularly shaped figures

The area of regularly shaped figures can be calculated using the corresponding formulae associated with shape of the figures.

#### Area of some regularly shaped figures

| Plane figure | Diagram of figure                                                                     | Area                                                                       |
|--------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Square       |  | side $\times$ side<br>$a \times a = a^2$                                   |
| Rectangle    |  | length $\times$ breadth<br>$l \times b = lb$                               |
| Circle       |  | $\pi \times (\text{radius})^2$<br>$\pi \times r^2$<br>$\pi r^2$            |
| Triangle     |  | $(1/2) \times \text{base} \times \text{height}$<br>$1/2 \times b \times h$ |

### Area of irregularly shaped figures

- ♦ The irregularly shaped figures such as leaves, maps, flowers, bird's feather cannot be compounded by using any ordinary formula. We can find the area of these irregularly shaped figures with the help of a graph sheet.
- ♦ The method using graph sheet can also be used to find the area of regularly shaped figures also. In the case of square and rectangle, this method gives the area accurately.

**Volume**

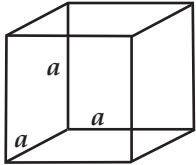
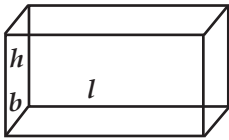
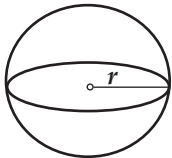
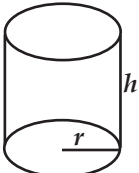
The amount of space occupied by a three dimensional object is known as its volume.

Volume = surface area  $\times$  height

The SI unit of volume is cubic metre or  $m^3$ .

**Volume of regularly shaped objects**

We can calculate the volume of the regularly shaped objects by using an appropriate formula.

| Objects  | Figure                                                                             | Volume                                                                                                            |
|----------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Cube     |   | side $\times$ side $\times$ side<br>$a \times a \times a$<br>$a^3$                                                |
| Cuboid   |   | length $\times$ breadth<br>$\times$ height<br>$l \times b \times h$<br>$lbh$                                      |
| Sphere   |   | $\frac{4}{3} \times \pi \times (\text{radius})^3$<br>$\frac{4}{3} \times \pi \times r^3$<br>$\frac{4}{3} \pi r^3$ |
| Cylinder |  | $\pi \times (\text{radius})^2 \times \text{height}$<br>$\pi \times r^2 \times h$<br>$\pi r^2 h$                   |

**Volume of liquids**

Liquids does not have a definite shape but occupies space, and hence they also have volume. When a liquid is poured into a container, it takes the shape and volume of the container. The volume of any liquid is equal to the space that it fills and it can be measured using a measuring cylinder or measuring beaker. **The maximum volume of liquid that a container can hold is known as the "capacity of the container".**

The readings are marked in the unit of "ml" i.e, millilitre in the measuring containers. **Litre is the commonly used unit to measure the volume of liquids.** Unit of volume is cubic cm if the dimensions of the object are given in cm. This cubic cm is commonly known as cc. A volume of 1000 cc is termed as one litre (l).

1 litre = 1000 cc or  $cm^3$

1000 ml = 1 litre

To measure the volume of liquids, some other units are also used. Some of them are gallon, ounce, and quart.

1 gallon = 3785 ml

1 ounce = 30 ml

1 quart = 1 litre

**Volume of irregularly shaped objects**

- As in the case of area, the volume of irregularly shaped objects cannot be determined by the existing formulae. For such cases, their volume can be determined using a measuring cylinder and water.

**Density**

- The lightness or heaviness of a body is due to its density. Density of a substance is defined as the mass of the substance contained in unit volume ( $1m^3$ ). If the mass of a substance is 'M' whose volume is 'V', then, the equation for density is given as;

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

$$D = \frac{M}{V}$$

- Unit of density** : SI unit of density is  $kg/m^3$ . The CGS unit of density is  $g/cm^3$ .

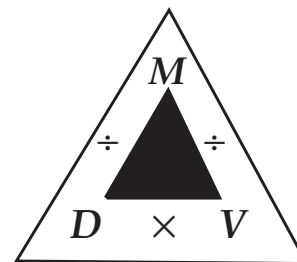
**Density of different materials**

- We know that different materials have different densities. The materials with higher density are called "**denser**" and the materials with lower density are called "**rarer**".

| Nature | Materials | Density ( $kg/m^3$ ) |
|--------|-----------|----------------------|
| Gas    | Air       | 1.2                  |
| Liquid | Kerosene  | 800                  |
|        | Water     | 1,000                |
|        | Mercury   | 13,600               |
| Solid  | Wood      | 770                  |
|        | Aluminium | 2,700                |
|        | Iron      | 7,800                |
|        | Copper    | 8,900                |
|        | Silver    | 10,500               |
|        | Gold      | 19,300               |

**Relationship between density, mass and volume**

The relationship between Mass, density and volume are represented in the following density triangle :



- Density = Mass / Volume
- Mass = Density  $\times$  Volume
- Volume = Mass / Density

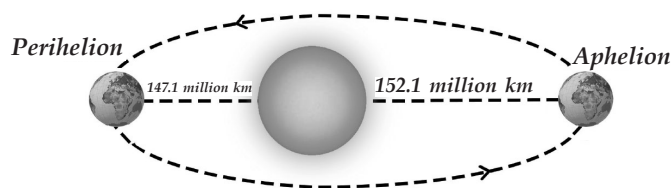
**Measuring distance of celestial bodies**

- Usually, the units of centimeter, metre and kilometre are used to express the distances in the land. However, in the context of space, astronomers use different units to measure the distance between the earth and a star or the distance between two stars. The two of such units are namely : 1. Astronomical unit, 2. Light year.

Water has more density than oil. Density of castor oil is  $961 \text{ kg/m}^3$ . If we put one drop of water in oil, water drop sinks. But, if we put one drop of oil in water, oil floats and forms a layer on water surface. However, some oils are denser than water.

**Astronomical unit**

- It is known fact that the earth revolves around the sun in an elliptical orbit.
- Hence, the distance between the sun and the earth varies every day. When the earth is in its perihelion position (Perihelion is position of the shortest distance between the earth and the sun), the distance between the earth and the sun is about 147.1 million kilometre. When the earth is in its farthest position, that is when the distance between Earth and Sun is the largest (called aphelion position) the distance is 152.1 million kilometer. The average distance between the earth and the sun is about 149.6 million kilometer. This average distance is taken as one astronomical unit.
- Neptune is 30 AU away from the Sun. It means it is thirty times farther than the Earth.
- One astronomical unit is defined as the average distance between the earth and the sun.  
 $1 \text{ AU} = 149.6 \text{ million km} = 149.6 \times 10^6 \text{ km}$   
 $= 1.496 \times 10^{11} \text{ m}.$

*Perihelion and Aphelion position of Earth***Light year**

- The nearest star to our solar system is **Proxima Centauri**. It is at a distance of 2,68,770 Au. Using the Au for measuring distances of stars would be unwieldy. Therefore, astronomers use a special unit, called 'light year'.
- We have learnt that the speed of light in vacuum is  $3 \times 10^8 \text{ m/s}$ . This means that light travels a distance of  $3 \times 10^8 \text{ m}$  in one second. In a year (non-leap), there are 365 days. Each day has 24 hours; Each hour has 60 minutes; Each minute has 60 seconds.  
 Thus, the total number of seconds in one year  
 $= 365 \times 24 \times 60 \times 60$   
 $= 3.153 \times 10^7 \text{ second}$
- If light travels a distance of  $3 \times 10^8 \text{ m}$  in one second, then the distance travelled by light in one year  
 $= 3 \times 10^8 \times 3.153 \times 10^7 = 9.46 \times 10^{15} \text{ m}$ . This distance is known as one light year.
- One light year is defined as the distance travelled by light in vacuum during the period of one year.  
 $1 \text{ Light year} = 9.46 \times 10^{15} \text{ m}.$
- In terms of light year, Proxima Centauri is at 4.22 light-years from Earth and the Solar System (and Earth). The Earth is located about 25,000 light-years away from the galactic center.

**NUMERICAL PROBLEMS**

1. What is the area of a 10 squares each of side of 1 m.

**Solution :**

$$\begin{aligned} \text{Area of a square} &= \text{side} \times \text{side} \\ &= 1 \text{ m} \times 1 \text{ m} \\ &= 1 \text{ m}^2 \text{ or } 1 \text{ square metre} \\ \text{Area of 10 squares} &= 1 \text{ square metre} \times 10 \\ &= 10 \text{ square metre} \end{aligned}$$

(Even though the area is given in square metre, the surface need not to be square in shape)

2. Find the area of the following regular shaped figures: (Take  $\pi = 22/7$ )

- A) A rectangle whose length is 12 m and breadth is 4 m.  
 B) A circle whose radius is 7 m.  
 C) A triangle whose base is 6 m and height is 8 m.

**Solution :**

- A. Area of rectangle = length  $\times$  breadth  
 $= 12 \times 4 = 48 \text{ m}^2$   
 B. Area of circle =  $\pi \times r^2 = (22/7) \times 7 \times 7$   
 $= 154 \text{ m}^2$   
 C. Area of triangle =  $(1/2) \times \text{base} \times \text{height}$   
 $= (1/2) \times 6 \times 8 = 24 \text{ m}^2$

3. Find the volume of (Take  $\pi = 22/7$ )

- A) a cube whose side is 3 cm.  
 B) a cylinder whose radius is 3 m and height is 7 m.

**Solution :**

- A. Volume of a cube = side  $\times$  side  $\times$  side  
 $= 3 \text{ cm} \times 3 \text{ cm} \times 3 \text{ cm}$   
 $= 27 \text{ cubic cm or cm}^3$ .  
 B. Volume of a cylinder =  $\pi \times r^2 \times \text{height}$   
 $= (22/7) \times 3 \times 3 \times 7 = 198 \text{ m}^3$ .

## PHYSICS

- ◆ Measurement
- ◆ Forces and Pressure
- ◆ Light
- ◆ Heat
- ◆ Electricity
- ◆ Sound
- ◆ Magnetism
- ◆ Universe and Space Science

## CHEMISTRY

- ◆ Matter Around Us
- ◆ Changes Around Us
- ◆ Air
- ◆ Atomic Structure
- ◆ Water
- ◆ Acids & Bases
- ◆ Chemistry in Everyday Life

## BIOLOGY

- ◆ Micro-organisms
- ◆ Plant Kingdom
- ◆ Organisation of Life
- ◆ Movements in Animals
- ◆ Reaching the Age of Adolescence
- ◆ Crop Production & Management
- ◆ Conservation of Plants & Animals

## COMPUTER SCIENCE

- ◆ Introduction to the Information Age
- ◆ Libre Office Calc

# PHYSICS

## MEASUREMENT

### Introduction

- Measurement of any physical quantity involves comparison with a certain basic, internationally accepted reference standard called unit. The result of a measurement of a physical quantity is expressed by a number (or numerical measure) accompanied by a unit. Measurement is the base for all scientific studies and experimentations. It can also be described as the process of finding an unknown physical quantity by using a standard quantity.
- The units which used to denote fundamental or base quantities are called fundamental or base units. The units of all other physical quantities can be expressed as combinations of the base units. Such units obtained for the derived quantities are called **derived units**. A complete set of these units, both the base units and derived units, is known as the system of **units**.
- In order to get the measurement right, we need three basic things, they are : (i) an instrument, (ii) a standard quantity and (iii) an acceptable unit.

### System of units

People in various part of the world are using different systems of units for measurement. Some common systems of units are :

- FPS – System (Foot for length, Pound for mass and Second for time)
- CGS – System (Centimetre for length, Gram for mass and Second for time)
- MKS – System (Metre for length, Kilogram for mass and Second for time)

The 'CGS', 'MKS' and 'SI' units are metric systems of units whereas 'FPS' is a British systems of units.

### International System of Units

- In earlier days, scientists performed their experiments and recorded their results in their own system. Due to lack of communication, they couldn't organize other's experimental results. So, the scientists planned to follow a uniform system for taking the measurements.
- In 1960, in the 11<sup>th</sup> General Conference on Weights and Measures at Paris in France, the scientists recognized the need of using standard units for physical quantities. Thus "International System of Units" were created and is popularly known as SI System (abbreviated from the French name 'Système International'). The scientists chose seven physical quantities as 'Base Quantities' and defined a 'Standard Unit' to measure each one. They are known as Base Units or Fundamental Units.

### SI Base Units

| Base Quantities and Units |          |        |
|---------------------------|----------|--------|
| Quantity                  | Unit     | Symbol |
| Length                    | metre    | m      |
| Mass                      | kilogram | kg     |
| Time                      | second   | s      |
| Temperature               | kelvin   | K      |
| Electric Current          | ampere   | A      |
| Amount of Substance       | mole     | mol    |
| Luminous Intensity        | candela  | cd     |

In December 1998, the National Aeronautics and Space Administration (NASA), USA launched the Mars Climate Orbiter to collect the data of the Martian climate. Nine months later, on September 23, 1999, the Orbiter disappeared while approaching Mars at an unexpectedly low altitude. An investigation revealed that the orbital calculations were incorrect due to an error in the transfer of information between the spacecraft's team in Colorado and the mission navigation team in California. One team was using the English FPS system of units for calculation, while the other group was using the MKS system of units. This misunderstanding caused a loss of approximately 125 million dollars.

### Temperature

Temperature is a physical quantity that expresses the degree of hotness or coldness of a substance. Heat induced substance will increase its temperature. Heat removed from a substance will lower its temperature.

### Definition

- Temperature is a measure of the average kinetic energy of the particles in a system.
- The SI unit of Temperature is kelvin. 'Thermometers' are used to measure temperature directly.
- Usually, thermometers are calibrated with some standard scales. Celsius, Fahrenheit, Kelvin are the most commonly used scales to measure Temperature.
- In these thermometers, melting point of pure ice (0°C) is taken as Lower Fixed Point (LFP) and Boiling point of water (100°C) is taken as Upper Fixed Point (UFP).

| Various Scales to measure Temperature |                         |                         |                                 |
|---------------------------------------|-------------------------|-------------------------|---------------------------------|
| Types of Scale                        | Lower Fixed Point (LFP) | Upper Fixed Point (UFP) | No. of divisions in thermometer |
| Celsius                               | 0°C                     | 100°C                   | 100                             |
| Fahrenheit                            | 32°F                    | 212°F                   | 180                             |
| Kelvin                                | 273 K                   | 373 K                   | 100                             |

**Conversion of Scales of Temperatures**

The general formula for the conversion of scales of temperature is :

$$\frac{C - 0}{100} = \frac{F - 32}{180} = \frac{K - 273}{100}$$

**Application of various thermometric scales**

- Physicians use 'clinical thermometers'. It is graduated in 'Fahrenheit Scale'
- Scientists use thermometers with kelvin scale.
- Common temperature measurements are made in celsius scale. (Example: Weather reports are given in celsius scale.)

- Normal temperature of the human body is between 98.4°F and 98.6°F.
- Infra red thermometer measures the temperature of an object without any physical contact.

**Electric Current (I)**

- Flow of electric charges, in a particular direction is known as '**electric current**'.
- The magnitude of an electric current is the amount of electric charges flowing through a conductor in one second.
- If a charge (Q) flows through the circuit for time (t), then

$$I = \frac{Q}{t}$$

- SI unit of Electric Current is 'ampere' and it is denoted as A. Unit of charge is coulomb.
- One ampere is defined as one 'coulomb' of charge moving in a conductor in one second. Ammeter is a device used to measure 'electric current'.

- At very low temperature, around 30 K (–243.2° C), some conductors conduct electric current without any loss. These conductors are known as 'SUPER CONDUCTORS'.
- The super conductors are used to levitate trains from the track.
- Super conductors can be used as memory or storage element in the computers.

**Amount of substance**

- Amount of substance is a measure of the number of entities (particles) present in a substance. The entity may be an atom, molecule, ion, electron or proton etc.
- Generally, the amount of substance is directly proportional to the number of atoms or molecules.
- The SI unit of amount of substance is mole and it is denoted by symbol 'mol'.
- Mole is defined as the amount of substance, which contains  $6.023 \times 10^{23}$  entities.

The number  $6.023 \times 10^{23}$  is also known as Avagadro Number.

**Luminous Intensity****Definition**

- The measure of the power of the emitted light, by a light source in a particular direction, per unit solid angle is called as Luminous Intensity.
- The SI unit of luminous intensity is candela and is denoted as 'cd'.
- The light emitted from a common wax candle is approximately equal to one candela.
- Luminous intensity is measured by a 'photometer' (Luminous Intensity Meter) which gives the luminous intensity in terms of candela directly.

Luminous Flux or luminous power is the measure of the perceived power of light. Its SI unit is 'lumen'.

One lumen is defined as the luminous flux of the light produced by the light source that emits one candela of luminous intensity over a solid angle of one steradian.

**Plane angle**

- It is the angle between the intersection of two straight lines or intersection of two planes.
- The SI unit of Plane Angle is 'radian' and is denoted as 'rad'.
- Radian is the angle subtended at the centre of a circle by an arc whose length is equal to the radius of the circle.

$$\pi \text{ radian} = 180^\circ$$

$$1 \text{ radian} = \frac{180^\circ}{\pi}$$

**Solid Angle**

- It is the angle formed by three or more planes intersecting at a common point.
- It can also be defined as 'angle formed at the vertex of the cone'
- The SI unit of solid angle is 'steradian' and is denoted as 'sr'.

**Definition**

- Steradian is the solid angle at the centre of a sphere subtended by a portion whose surface area is equal to the square of its radius of the sphere.

Until 1995, plane angle and solid angle were classified under supplementary quantities. However, they were shifted to derived quantities after 1995.

**Difference between Plane Angle and Solid Angle**

| Plane Angle                                           | Solid Angle                                                              |
|-------------------------------------------------------|--------------------------------------------------------------------------|
| Angle between the intersection of two lines or planes | Angle between the intersection of three or more planes at a common point |
| It is two dimensional                                 | It is three dimensional                                                  |
| Unit is radian                                        | Unit is steradian                                                        |

**Clocks**

Clocks are used to measure time intervals. So, many clocks were used from the ancient time. Scientists modified the clock's mechanism to obtain accuracy.

**Types of clocks based on display**

1. Analog clocks
2. Digital clocks

**1. Analog clocks**

- ◆ It looks like a classic clock. It has three hands to show the time.
- ◆ **Hours Hand** : It is short and thick. It shows 'hour'.
- ◆ **Minutes Hand** : It is long and thin. It shows 'minute'.
- ◆ **Seconds Hand** : It is long and very thin. It shows 'second'. It makes one rotation in one minute and 60 rotations in one hour.
- ◆ Analog clocks can be driven either mechanically or electronically.

**2. Digital clocks**

- ◆ A digital clock displays the time directly. It shows the time in numerals or other symbols. It may have a 12 hours or 24 hours display.
- ◆ Recent clocks are showing Date, Day, Month, Year, Temperature etc.
- ◆ Digital clocks are often called as Electronic Clocks.

**Types of clocks based on working mechanism****1. Quartz clock**

- ◆ These clocks are activated by 'electronic oscillations', which are controlled by a 'quartz crystal'.
- ◆ The frequency of a vibrating crystal is very precise. So, the quartz clock is more accurate than the mechanical clock.
- ◆ These clocks have an accuracy of one second in every  $10^9$  seconds.

The principle of a quartz clock is the Piezo - electric property of a crystal. Piezo-electric property means that when a pressure is applied along a particular axis of a crystal, an electric potential difference is developed in a perpendicular axis.

In the reverse piezo-electric effect, a crystal becomes mechanically stressed when a voltage is applied across its opposite faces.

**Greenwich Mean Time (GMT)** is the mean solar time at the Royal Observatory, located at Greenwich in London. It is measured at the longitude of zero degree.

The Earth is divided into 24 zones, each of a width of 15 degree longitude. These regions are called as 'Time Zones'. Time difference between two adjacent time zones is 1 hour.

**Indian Standard Time (IST)** : The location of Mirzapur in Uttar Pradesh is taken as the reference longitude of the Indian Standard Time. It is located at 82.5 degree longitude.

IST = GMT + 5:30 hours

**2. Atomic clock**

- ◆ These clocks are making use of periodic vibrations occurring within the atom.
- ◆ These clocks have an accuracy of one second in every  $10^{13}$  seconds.
- ◆ Atomic clocks are used in Global Positioning System (GPS), Global Navigation Satellite System (GLONASS) and International time distribution services.

The first atomic clock was developed in 1949 at the US National Bureau of Standards. But, it was less accurate than the quartz clock.

The first accurate atomic clock (based on Caesium - 133) was built by Louis Essen and Jack Penny in 1955, at the National Physics Laboratory in the United Kingdom.

**Accuracy in Measurements**

- ◆ Measurement is the base of all experiments in science and technology. The value of every measurement contains some uncertainty. These uncertainties are called as 'Errors'.
- ◆ The difference between the real value and the observed value is called an error.

**Accuracy**

Accuracy is the closeness of a measured value to the actual value or true value.

**Precision**

Precision is the closeness of two or more measurements to each other.

**Approximation**

- ◆ Approximation is the process of finding a number, which is acceptably close to the exact value of the measurement of a physical quantity.
- ◆ It is an estimation of a number obtained by rounding off a number to its nearest place value.
- ◆ When the data are inadequate, physicists are in need of an approximation to find the solution for problems. Approximations are usually based on certain assumptions having a scientific background and they can be modified whenever accuracy is needed.

**Rounding off**

- ◆ Calculators are widely used in day to day life to do the calculations. The result given by a calculator has too many digits. Hence, the result containing more digits should be rounded off. The technique of rounding off is used in many areas of physics.

**Rules for rounding off**

- ◆ Decide which is the last digit to keep.
- ◆ Leave it the same, if the next digit is less than 5.
- ◆ Increase it by one, if the next digit is 5 or greater than 5.



# GENERAL SCIENCE

## PHYSICS

- ☆ *Measurement*
- ☆ *Motion*
- ☆ *Fluids*
- ☆ *Electric charge and Electric current*
- ☆ *Magnetism and Electromagnetism*
- ☆ *Light*
- ☆ *Heat*
- ☆ *Sound*
- ☆ *Universe*

## CHEMISTRY

- ☆ *Matter Around Us*
- ☆ *Atomic Structure*
- ☆ *Periodic classification of elements*
- ☆ *Chemical bonding*
- ☆ *Acids, Bases and Salts*
- ☆ *Carbon and its Compounds*
- ☆ *Applied Chemistry*

## BIOLOGY

- ☆ *Animal Kingdom*
- ☆ *Organization of Tissues*
- ☆ *Plant Physiology*
- ☆ *Organ Systems in Animals*
- ☆ *Nutrition and Health*
- ☆ *World of Microbes*
- ☆ *Economic Biology*
- ☆ *Environmental Science*

## COMPUTER SCIENCE

- ☆ *Computer - An Introduction*
- ☆ *Parts of Computer*
- ☆ *Hardware and Software*

# PHYSICS

## MEASUREMENT

### Introduction

- Measurement is the act of determining an object's size, length, weight, capacity or other features. It is the basis of all important scientific study. Measurement can also be stated as the determination of the size or magnitude of a quantity and it is considered as a cornerstone of trade, science, technology and quantitative research in various disciplines.

### Physical Quantities

- Physical quantity can be classified into two types: **fundamental quantities** and **derived quantities**.
- Quantities which cannot be expressed in terms of any other physical quantities are called fundamental quantities. Example: Length, mass, time, temperature, etc. Quantities which are calculated from two or more measurements are called derived quantities. Example : area, volume and density etc. Physical quantities have a numerical value (a number) and a unit of measurement.

### Units

- A unit is the standard quantity with which unknown quantities are compared. It is defined as a specific magnitude of a physical quantity that has been adopted by law or convention. For example, feet is the unit for measuring length. That means, 10 feet is equal to 10 times the definite predetermined length, called feet.
- In earlier time, different unit systems were used by people in different countries. They are :

### Unit systems of early period :

| System | Length     | Mass     | Time   |
|--------|------------|----------|--------|
| CGS    | centimetre | gram     | second |
| FPS    | foot       | pound    | second |
| MKS    | metre      | kilogram | second |

- But, at the end of the Second World War there was a necessity to use worldwide system of measurement. Hence, SI (International System of Units) system of units was developed and recommended by General Conference on Weights and Measures in 1960 for international usage.

### SI System of Units

- SI system of units is the modernised and improved form of the previous system of units. It is accepted in almost all the countries of the world. It is based on a certain set of fundamental units from which derived units are obtained by multiplication or division. There are seven fundamental units in the SI system of units.

- The units used to measure the fundamental quantities are called fundamental units and the units which are used to measure derived quantities are called derived units.

### Fundamental physical quantities and their units

| Fundamental Quantities | Unit     | Symbol |
|------------------------|----------|--------|
| Length                 | metre    | m      |
| Mass                   | kilogram | kg     |
| Time                   | second   | s      |
| Temperature            | kelvin   | K      |
| Electric current       | ampere   | A      |
| Luminous intensity     | candela  | cd     |
| Amount of substance    | mole     | mol    |

### Derived quantities and their units

| Physical quantity | Expression                 | Unit                    |
|-------------------|----------------------------|-------------------------|
| Area              | length $\times$ breadth    | m <sup>2</sup>          |
| Volume            | area $\times$ height       | m <sup>3</sup>          |
| Density           | mass / volume              | kgm <sup>-3</sup>       |
| Velocity          | displacement/time          | ms <sup>-1</sup>        |
| Momentum          | mass $\times$ velocity     | kgms <sup>-1</sup>      |
| Acceleration      | velocity / time            | ms <sup>-2</sup>        |
| Force             | mass $\times$ acceleration | kgms <sup>-2</sup> or N |
| Pressure          | force / area               | Nm <sup>-2</sup> or Pa  |
| Energy (work)     | force $\times$ distance    | Nm or J                 |
| Surface tension   | force / length             | Nm <sup>-1</sup>        |

### Fundamental Units

#### Length

- Length is defined as the distance between two points. The SI unit of length is metre. One metre is the distance travelled by light through vacuum in 1/29,97,92,458 second.
- In order to measure very large distance (distance of astronomical objects) the following units are used : **Light year, Astronomical unit, Parsec.**

- Light travels  $3 \times 10^8$  m in one second or 3 lakhs kilometre in one second. The total number of seconds in one year is equal to  $365 \times 24 \times 60 \times 60 = 3.153 \times 10^7$  second. 1 light year =  $(3.153 \times 10^7) \times (3 \times 10^8) = 9.46 \times 10^{15}$  m.
- The nearest star alpha centauri is about 1.34 parsec from the sun. Most of the stars visible to the unaided eye in the night sky are within 500 parsec distance from the sun.

**Light year**

- It is the distance travelled by light in one year in vacuum and it is equal to  $9.46 \times 10^{15}$  m.

**Astronomical unit (AU)**

- It is the mean distance of the centre of the Sun from the centre of the earth.

$$1 \text{ AU} = 1.496 \times 10^{11} \text{ m}$$

**Parsec**

- Parsec is the unit of distance used to measure astronomical objects outside the solar system.

$$1 \text{ parsec} = 3.26 \text{ light year.}$$

- To measure small distances such as distance between two atoms in a molecule, the size of the nucleus and the wavelength, submultiples of ten is used.

| Larger Units           | In metre                 |
|------------------------|--------------------------|
| Kilometre (km)         | $10^3$ m                 |
| Astronomical unit (AU) | $1.496 \times 10^{11}$ m |
| Light year (ly)        | $9.46 \times 10^{15}$ m  |
| Parsec (pc)            | $3.08 \times 10^{16}$ m  |

| Smaller Units                      | In metre     |
|------------------------------------|--------------|
| Fermi (f)*                         | $10^{-15}$ m |
| Angstrom ( $\text{\AA}$ )*         | $10^{-10}$ m |
| Nanometre (nm)                     | $10^{-9}$ m  |
| Micron (micrometre $\mu\text{m}$ ) | $10^{-6}$ m  |
| Millimetre (mm)                    | $10^{-3}$ m  |
| Centimetre (cm)                    | $10^{-2}$ m  |

**Mass**

- Mass is the quantity of matter contained in a body. The SI unit of mass is kilogram (kg). The kilogram is the mass of a particular international prototype cylinder made of platinum-iridium alloy, kept at the International Bureau of Weights and Measures at Sevres, France.
- The units gram (g) and milligram (mg) are the submultiples of ten (1/10) of the unit kg. Similarly, quintal and metric tonne are multiples of ten ( $\times 10$ ) of the unit kg.

**Atomic mass unit :**

- Mass of a proton, neutron and electron can be determined using atomic mass unit.

$$1 \text{ amu} = 1/12^{\text{th}} \text{ of the mass of } \text{C}^{12} \text{ atom.}$$

- $1 \text{ g} = 0.001 \text{ kg}$
- $1 \text{ mg} = 0.000001 \text{ kg}$
- $1 \text{ quintal} = 100 \text{ kg}$
- $1 \text{ Metric tonne} = 1000 \text{ kg} = 10 \text{ quintal}$
- $1 \text{ Solar mass} = 2 \times 10^{30} \text{ kg.}$

**Time**

Time is a measure of duration of events and the intervals between them. The SI unit of time is second. One second is the time required for the light to propagate 29,97,92,458 metres through vacuum. It is also defined as  $1/86,400^{\text{th}}$  part of a mean solar day. Larger unit for measuring time is millennium.

$$1 \text{ millenium} = 3.16 \times 10^9 \text{ s}$$

- Mass of 1 ml of water = 1 g
- Mass of 1 l of water = 1 kg

**Temperature**

- Temperature is the measure of hotness or coldness of a body. SI unit of temperature is denoted by Kelvin (K).
- One Kelvin is the fraction ( $1/273.16$ ) of the thermodynamic temperature of the triple point of water. i.e., the temperature at which saturated water vapour, pure water and melting ice are in equilibrium.
- Zero Kelvin (0 K) is commonly known as absolute zero. Celsius ( $^{\circ}\text{C}$ ) and Fahrenheit (F) are the other units used for measuring temperature.

**Temperature conversion table**

| Units                             | Fahrenheit                  | Celsius               | Kelvin                      |
|-----------------------------------|-----------------------------|-----------------------|-----------------------------|
| Fahrenheit ( $^{\circ}\text{F}$ ) | F                           | $(F - 32) \times 5/9$ | $(F - 32) \times 5/9 + 273$ |
| Celsius ( $^{\circ}\text{C}$ )    | $(C \times 9/5) + 32$       | C                     | $C + 273$                   |
| Kelvin (K)                        | $(K - 273) \times 9/5 + 32$ | $K - 273$             | K                           |

**Unit Prefixes**

- Unit prefixes are the symbols placed before the symbol of a unit to specify the order of magnitude of a quantity. They are useful to express very large or very small quantities. k (kilo) is the unit prefix in the unit, kilometer. A unit prefix stands for a specific positive or negative power of 10.
- The physical quantities vary in different proportion like from  $10^{-15}$  m being the nucleus diameter to  $10^{26}$  m being the distance between two stars and  $9.11 \times 10^{-31}$  kg being the electron mass to  $2.2 \times 10^{41}$  kg being the mass of the milky way galaxy.

| Power of 10 | Prefix | Symbol |
|-------------|--------|--------|
| $10^{15}$   | peta   | P      |
| $10^{12}$   | tera   | T      |
| $10^9$      | giga   | G      |
| $10^6$      | mega   | M      |
| $10^3$      | kilo   | K      |
| $10^2$      | hecto  | h      |
| $10^1$      | deca   | da     |

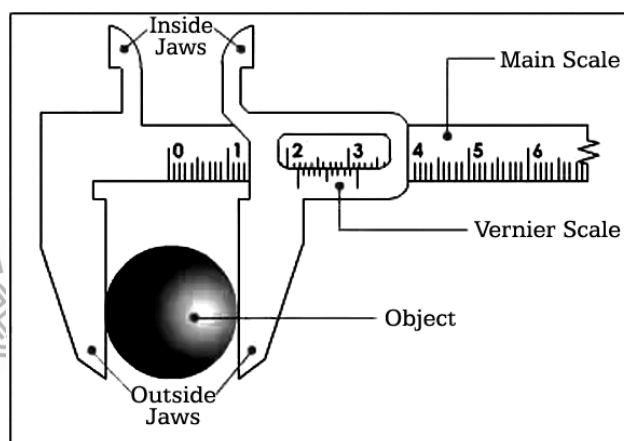
| Power of 10 | Prefix | Symbol |
|-------------|--------|--------|
| $10^{-1}$   | deci   | d      |
| $10^{-2}$   | centi  | c      |
| $10^{-3}$   | milli  | m      |
| $10^{-6}$   | micro  | $\mu$  |
| $10^{-9}$   | nano   | n      |
| $10^{-12}$  | pico   | p      |
| $10^{-15}$  | femto  | f      |

### Rules and Conventions for writing SI Units and their Symbols

- ◆ The units named after scientists are not written with a capital initial letter. Eg : newton, henry, ampere and watt.
- ◆ The symbols of the units named after scientists should be written by the initial capital letter. Eg : N for newton, H for henry, A for ampere and W for watt.
- ◆ Small letters are used as symbols for units not derived from a proper noun. Eg : m for metre, kg for kilogram.
- ◆ No full stop or other punctuation marks should be used within or at the end of symbols. Eg : 50 m and not as 50 m.
- ◆ The symbols of the units are not expressed in plural form. Eg : 10 kg not as kgs.
- ◆ When temperature is expressed in kelvin, the degree sign is omitted. Eg : 283 K not as 283° K (If expressed in Celsius scale, degree sign should be included e.g. 100° C not as 100 C, 108° F not as 108 F).
- ◆ Use of solidus / is recommended only for indicating a division of one letter unit symbol by another unit symbol. Not more than one solidus is used. Eg :  $\text{ms}^{-1}$  not as m/s.  $\text{J/K/mol}$  should be  $\text{JK}^{-1} \text{mol}^{-1}$ .
- ◆ The number and units should be separated by a space. Eg :  $15 \text{ kgms}^{-1}$  not as  $15\text{kgms}^{-1}$ .
- ◆ Accepted symbols alone should only be used. Eg : Ampere should not be written as amp and second should not be written as sec.
- ◆ The numerical values of physical quantities should be written in scientific form. Eg : The density of mercury should be written as  $1.36 \times 10^4 \text{ kg m}^{-3}$  not as  $13600 \text{ kg m}^{-3}$ .

### Vernier Caliper

- ◆ The smallest length which can be measured by metre scale is called least count. In metre scale the measurements are calibrated in cm and mm. Usually the least count of a scale is 1mm. However, in order to measure the objects with more accuracy, Vernier Caliper and Screw Gauge are used.
- ◆ Accuracy of Vernier Caliper is 0.1mm.



Vernier Caliper

### Working of Vernier Caliper

- ◆ The first step in using the Vernier caliper is to find out its least count, range and zero error.

### Least count

Least count of the instrument (L.C)

$$= \frac{\text{Value of one smallest main scale division}}{\text{Total number of vernier scale division}}$$

The main scale division will be in centimeter, further divided into millimetre. The value of the smallest main scale division is 1 mm. The Vernier scale division is obtained by counting number of division in it. In the Vernier scale there will be 10 divisions.

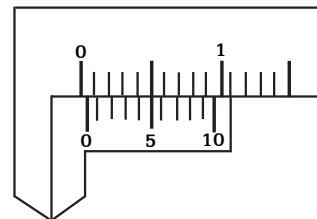
$$\text{L.C} = \frac{1\text{mm}}{10} = 0.1\text{mm} = 0.01\text{cm}$$

Pierre Vernier (1580 – 1637) was a French government official and he was interested on Cartography and Surveying. This led to the invention of a precise instrument called Vernier Caliper.

### Zero error :

- ◆ Zero error may be Positive or Negative. If the zero marking of the main scale coincides with that of the zero marking of the vernier scale, then it is said as zero error. If it not, then the instrument is having zero error.
- ◆ If the zero of a vernier is shifted to the Right of main scale, it is called Positive error. On the other hand, if the zero of the vernier is shifted to the left of the zero of Main scale, then it is negative error.

### Positive zero error :



Positive Zero error

## PHYSICS

- ☆ *Laws of Motion*
- ☆ *Optics*
- ☆ *Thermal Physics*
- ☆ *Electricity*
- ☆ *Acoustics*
- ☆ *Nuclear Physics*

## CHEMISTRY

- ☆ *Atoms and Molecules*
- ☆ *Periodic Classification of Elements*
- ☆ *Solutions*
- ☆ *Types of Chemical Reactions*
- ☆ *Carbon and its Compounds*

## BIOLOGY

- ☆ *Plant Anatomy and Plant Physiology*
- ☆ *Structural Organisation of Animals*
- ☆ *Transportation in Plants and Circulation in Animals*
- ☆ *Nervous System*
- ☆ *Plant and Animal Hormones*
- ☆ *Reproduction in Plants and Animals*
- ☆ *Heredity*
- ☆ *Origin and Evolution of Life*
- ☆ *Breeding and Biotechnology*
- ☆ *Health and Diseases*
- ☆ *Environmental Management*

## COMPUTER SCIENCE

- ☆ *Visual Communication*

# PHYSICS

## LAWS OF MOTION

### Introduction

- ♦ The laws of motion are fundamental and enable us to understand everyday phenomena. Generally, a body needs a 'push' or 'pull' to move, or bring to rest or change its velocity. Hence, this 'push' or 'pull' is called as '**force**'. Motion can be uniform or non-uniform. Sir Isaac Newton defined motion in a more scientific manner using his three laws. These laws help us to understand the motion of a body and also to predict the future course of its motion, if we know the forces acting on it.
- ♦ Mechanics is the branch of physics that deals with the effect of force on bodies. It is divided into two branches, namely, statics and dynamics.

### Force and Motion

**Statics** : It deals with the bodies, which are at rest under the action of forces. **Dynamics**: It is the study of moving bodies under the action of forces. Dynamics is further divided as follows.

**Kinematics** : It deals with the motion of bodies without considering the cause of motion.

**Kinetics** : It deals with the motion of bodies considering the cause of motion.

### Inertia

The inherent property of a body to resist any change in its state of rest or the state of uniform motion, unless it is influenced upon by an external unbalanced force, is known as '**inertia**'.

### Types of Inertia

**Inertia of rest** : The resistance of a body to change its state of rest is called inertia of rest.

**Inertia of motion** : The resistance of a body to change its state of motion is called inertia of motion.

**Inertia of direction** : The resistance of a body to change its direction of motion is called inertia of direction.

### Examples of Inertia

- ♦ An athlete runs some distance before jumping. Because, this will help him jump longer and higher. (Inertia of motion)
- ♦ When we make a sharp turn while driving a car, you tend to lean sideways, (Inertia of direction).
- ♦ When we vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down, (Inertia of rest).

### Linear Momentum

- ♦ The impact of a force is more if the velocity and the mass of the body is more. To quantify the impact of a force exactly, a new physical quantity known as linear momentum is defined. The linear momentum measures the impact of a force on a body.

- ♦ The product of mass and velocity of a moving body gives the magnitude of linear momentum. It acts in the direction of the velocity of the object. Linear momentum is a vector quantity.

Linear Momentum = mass  $\times$  velocity

$$p = mv$$

- ♦ It helps to measure the magnitude of a force. Unit of momentum in SI system is  $\text{kg ms}^{-1}$  and in C.G.S system its unit is  $\text{g cm s}^{-1}$ .

### Newton's Laws of Motion

#### Newton's First Law

This law states that every body continues to be in its state of rest or the state of uniform motion along a straight line unless it is acted upon by some external force. It gives the definition of force as well as inertia.

#### Force

Force is an external effort in the form of push or pull, which :

- ♦ produces or tries to produce the motion of a static body.
- ♦ stops or tries to stop a moving body.
- ♦ changes or tries to change the direction of motion of a moving body.

Force has both magnitude and direction. So, it is a vector quantity.

#### Types of forces

Based on the direction in which the forces act, they can be classified into two types as: (a) Like parallel forces and (b) Unlike parallel forces.

**Like parallel forces** : Two or more forces of equal or unequal magnitude acting along the same direction, parallel to each other are called like parallel forces.

**Unlike parallel forces** : If two or more equal forces or unequal forces act along opposite directions parallel to each other, then they are called unlike parallel forces.

#### Resultant Force

- ♦ When several forces act simultaneously on the same body, then the combined effect of the multiple forces can be represented by a single force, which is termed as '**resultant force**'. It is equal to the vector sum (adding the magnitude of the forces with their direction) of all the forces.

- ♦ If the resultant force of all the forces acting on a body is equal to zero, then the body will be in equilibrium. Such forces are called balanced forces. If the resultant force is not equal to zero, then it causes the motion of the body due to unbalanced forces

- ♦ Examples : Drawing water from a well, force applied with a crow bar, forces on a weight balance, etc.

- ◆ A system can be brought to equilibrium by applying another force, which is equal to the resultant force in magnitude, but opposite in direction. Such force is called as 'Equilibrant'.

#### Action of forces

| Action of forces                                                                                   | Diagram                                                                           | Resultant force ( $F_{\text{net}}$ )                                                                                                                      |
|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Parallel forces are acting in the same direction                                                   |  | $F_{\text{net}} = F_1 + F_2$                                                                                                                              |
| Parallel unequal forces are acting in opposite directions                                          |  | $F_{\text{net}} = F_1 - F_2$ (if $F_1 > F_2$ )<br>$F_{\text{net}} = F_2 - F_1$ (if $F_2 > F_1$ )<br>$F_{\text{net}}$ is directed along the greater force. |
| Parallel equal forces are acting in opposite directions in the same line of action ( $F_1 = F_2$ ) |  | $F_{\text{net}} = F_1 - F_2$ ( $F_1 = F_2$ )<br>$F_{\text{net}} = 0$                                                                                      |

#### Rotating Effect of Force

- ◆ We can observe that the position of the handle in a door is at the edge of door. This is because, the door can be easily opened or closed when we apply the force at a point far away from the fixed edge. This turning effect of the applied force is more when the distance between the fixed edge and the point of application of force is more.
- ◆ The axis of the fixed edge about which the door is rotated is called as the 'axis of rotation'. If we fix one end of a rod to the floor/wall, and apply a force and the other end tangentially, the rod will be turned about the fixed point is called as "point of rotation".

#### Moment of the force

- ◆ The rotating or turning effect of a force about a fixed point or fixed axis is called moment of the force about that point or torque ( $\tau$ ). It is measured by the product of the force ( $F$ ) and the perpendicular distance ( $d$ ) between the fixed point or the fixed axis and the line of action of the force.  
 $\tau = F \times d$ .
- ◆ Torque is a vector quantity. It is acting along the direction, perpendicular to the plane containing the line of action of force and the distance. Its SI unit is N m.
- ◆ **Couple** : Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple. The line of action of the two forces does not coincide. It does not produce any translatory motion since the resultant is zero. But, a couple results in causes the rotation of the body. Rotating effect of a couple is known as moment of a couple.
- ◆ **Examples** : Turning a tap, winding or unwinding a screw, spinning of a top, etc.
- ◆ Moment of a couple is measured by the product of any one of the forces and the perpendicular distance between the line of action of two forces. The turning effect of a couple is measured by the magnitude of its moment.

Moment of a couple = Force  $\times$  perpendicular distance between the line of action of forces  
 $M = F \times S$

- ◆ The unit of moment of a couple is newton metre (Nm) in SI system and dyne cm in CGS system.
- ◆ By convention, the direction of moment of a force or couple is taken as positive if the body is rotated in the anti-clockwise direction and negative if it is rotate in the clockwise direction.

#### Application of Torque

- ◆ **Gears** : A gear is a circular wheel with teeth around its rim. It helps to change the speed of rotation of a wheel by changing the torque and helps to transmit power.
- ◆ **Seasaw** : Most of us have played on the seasaw. Since there is a difference in the weight of the persons sitting on it, the heavier person lifts the lighter person. When the heavier person comes closer to the pivot point (fulcrum) the distance of the line of action of the force decreases. It causes less amount of torque to act on it. This enables the lighter person to lift the heavier person.
- ◆ **Steering Wheel** : A small steering wheel enables you to manoeuvre a car easily by transferring a torque to the wheels with less effort.

#### Principle of Moments

When a number of like or unlike parallel forces act on a rigid body and the body is in equilibrium, then the algebraic sum of the moments in the clockwise direction is equal to the algebraic sum of the moments in the anticlockwise direction. In other words, at equilibrium, the algebraic sum of the moments of all the individual forces about any point is equal to zero.

The principle of moments can be written as :

$$\left\{ \begin{array}{l} \text{Moment in clockwise} \\ \text{direction} \end{array} \right\} = \left\{ \begin{array}{l} \text{Moment in anticlockwise} \\ \text{direction} \end{array} \right\}$$

$$(F_1 \times d_1) = (F_2 \times d_2)$$

$$\Rightarrow F_1 \times d_1 = F_2 \times d_2$$

### Newton's Second Law of Motion

- According to the second law of motion, "the force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force". It is also called as "**Law of Force**".

∴ Newton's second law of motion can be expressed as  $F = ma$

$$\text{(i.e) Force (F) = Mass (mass) } \times \text{ acceleration (a)}$$

- Units of force** : SI unit of force is newton (N) and in C.G.S system its unit is dyne.
- Definition of 1 newton (N)** : The amount of force required for a body of mass 1kg produces an acceleration of  $1\text{ms}^{-2}$ ,  $1\text{N} = 1\text{kg ms}^{-2}$
- Definition of 1 dyne** : The amount of force required for a body of mass 1 gram produces an acceleration of  $1\text{ cm s}^{-2}$ ,  $1\text{ dyne} = 1\text{ g cm s}^{-2}$  ; also  $1\text{ N} = 10^5\text{ dyne}$ .
- Unit force** : The amount of force required to produce an acceleration of  $1\text{ ms}^{-2}$  in a body of mass 1kg is called 'unit force'.
- Gravitational unit of force** : In the SI system of units, gravitational unit of force is kilogram force, represented by kg f. In the CGS system its unit is gram force, represented by g f.  
 $1\text{ kg f} = 1\text{ kg} \times 9.8\text{ ms}^{-2} = 9.8\text{ N}$  ;  
 $1\text{ g f} = 1\text{ g} \times 980\text{ cm s}^{-2} = 980\text{ dyne}$

### Impulse

- A large force acting for a very short interval of time is called as 'Impulsive force'. When a force F acts on a body for a period of time t, then the product of force and time is known as 'impulse' represented by 'J'

$$\text{Impulse, } J = F \times t \longrightarrow (1)$$

By Newton's second law

$$F = \Delta p/t \quad (\Delta \text{ refers to change})$$

$$\Delta p = F \times t \longrightarrow (2)$$

From (1) and (2)

$$J = \Delta p$$

- Impulse is also equal to the magnitude of change in momentum. Its unit is  $\text{kg m s}^{-1}$  or N s.
- Change in momentum can be achieved in two ways. They are :
  - a large force acting for a short period of time and
  - a smaller force acting for a longer period of time.

### Examples :

- Automobiles are fitted with springs and shock absorbers to reduce jerks while moving on uneven roads.
- In cricket, a fielder pulls back his hands while catching the ball. He experiences a smaller force for

a longer interval of time to catch the ball, resulting in a lesser impulse on his hands.

### Newton's Third Law of Motion

- Newton's third law states that 'for every action, there is an equal and opposite reaction. They always act on two different bodies'.
- If a body A applies a force  $F_A$  on a body B, then the body B reacts with force  $F_B$  on the body A, which is equal to  $F_A$  in magnitude, but opposite in direction.  $F_B = -F_A$

### Examples :

- When birds fly they push the air downwards with their wings (Action) and the air pushes the bird upwards (Reaction).
- When a person swims he pushes the water using the hands backwards (Action), and the water pushes the swimmer in the forward direction (Reaction).
- When we fire a bullet, the gun recoils backward and the bullet is moving forward (Action) and the gun equalises this forward action by moving backward (Reaction).

### Principle of Conservation of Linear Momentum

- There is no change in the linear momentum of a system of bodies as long as no net external force acts on them.
- Principle of conservation of linear momentum can be expressed as, "in the absence of an external force, the algebraic sum of the momentum after collision is numerically equal to the algebraic sum of the momentum before collision".

$$\text{i.e, } m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$$

### Rocket Propulsion

- Propulsion of rockets is based on the law of conservation of linear momentum as well as Newton's III law of motion. Rockets are filled with a fuel (either liquid or solid) in the propellant tank. When the rocket is fired, this fuel is burnt and a hot gas is ejected with a high speed from the nozzle of the rocket, producing a huge momentum. To balance this momentum, an equal and opposite reaction force is produced in the combustion chamber, which makes the rocket project forward.
- While in motion, the mass of the rocket gradually decreases, until the fuel is completely burnt out. Since, there is no net external force acting on it, the linear momentum of the system is conserved. The mass of the rocket decreases with altitude, which results in the gradual increase in velocity of the rocket. At one stage, it reaches a velocity, which is sufficient to just escape from the gravitational pull of the Earth. This velocity is called escape velocity.