SCIENCE

Physics

- *Measurement*
- *Forces, Motion and Pressure*
- *Heat*
- *Electricity*
- *Light*
- *Universe and Space Science*
- *Sound*
- *Magnetism*

Chemistry

- *Air*
- *Water*
- *Acids and Bases*
- *Matter*
- *Atomic Structure*
- *Changes Around Us*
- *Polymer Chemistry*
- *Chemistry in Everyday Life*

Biology

- *Organisation of Life* ✦ *Basis of Classification*
- *Reproduction and Modification in Plants*
- *Health and Hygiene*
- *Cell Biology* ✦ *Plant Kingdom*
- *Animals in Daily Life* ✦ *Micro-Organisms*
- *Movements*
- *Reaching the Age of Adolescence*
- *Crop Production and Management*
- *Conservation of Plants and Animals*

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 11th 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 'Systeme 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 :

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

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

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

- 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 6.023×10^{23} entities.

The number 6.023×10^{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.

π radian = 180°

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

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

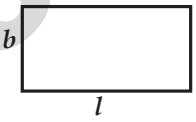
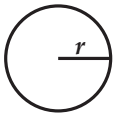
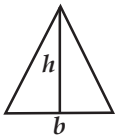
- These clocks are making use of periodic vibrations occurring within the atom.
- These clocks have an accuracy of one second in every 10^{13} seconds.
- Atomic clocks are used in Global Positioning System (GPS), Global Navigation Satellite System (GLONASS) and International time distribution services.

- 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 Lauis Essan and Jack Penny in 1955, at the National Physics Laboratory in the United Kingdom.

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 × side a × a = a^2
Rectangle		length × breadth l × b = lb
Circle		π × (radius)^2 $\pi \times r^2$ πr^2
Triangle		(1/2) × base × height 1/2 × b × 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 × 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.