Properties of Matter and Their Measurements

Physical Properties

- **Physical properties** can be measured or observed without changing the identity or composition of the substance.
  Examples: Colour, odour, melting point, boiling point, etc.

Chemical Properties

- **Chemical properties** require a chemical change to occur.
  Examples: Acidity, basicity, combustibility, etc.

Units of Measurement

Fundamental Units: Mass, length, and time are fundamental quantities, and their units are known as fundamental units.
There are seven basic units of measurement for the quantities:

1. Length
2. Mass
3. Time
4. Temperature
5. Amount of substance
6. Electric current
7. Luminous intensity

Basic Physical Quantity	*Symbol for Quantity*	*Name of SI Unit*	*Symbol for SI Unit*
Length	*l*	metre	m
Mass	*m*	kilogram	*H*
Time	*t*	second	s
Electric current	*i*	ampere	A
I hermodvnamic temperature Amount	*T*	kelvin	K
of substance	*n*	mole	mol
Luminous intensity	*K*	candela	cd

SI-System (International System of Units)

This is the most commonly used system of measurement worldwide. It defines units for all seven basic quantities.

Definitions of Basic SI Units:

1. **Metre (m)**: Length of the path travelled by light in vacuum during 1/299,792,458 of a second.

2. **Kilogram (kg)**: Unit of mass, equal to the mass of the international prototype of the kilogram.
3. **Second (s)**: Duration of 9,192,631,770 periods of radiation corresponding to the transition between two hyperfine levels of the ground state of cesium-133 atom.
4. **Kelvin (K)**: Thermodynamic temperature unit, equal to 1/273.16 of the temperature of the triple point of water.
5. **Ampere (A)**: Constant current that, if maintained in two parallel conductors 1 meter apart, produces a force of 2 x 10^-7 N per meter of length between them.
6. **Candela (cd)**: Luminous intensity, in a given direction, from a source emitting monochromatic radiation of frequency 540 x 10^12 Hz with a radiant intensity of 1/683 watt per steradian.
7. **Mole (mol)**: Amount of substance containing as many elementary entities as atoms in 0.012 kg of carbon-12.

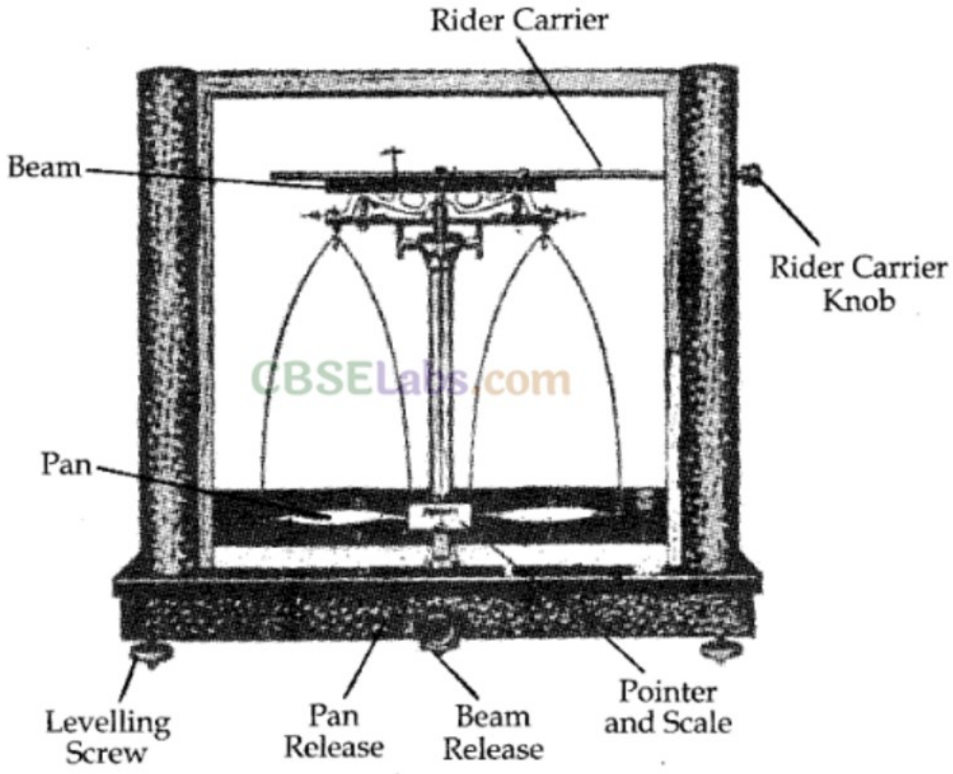


Fig. 1.1 *Analytical balance.*

Mass and Weight

- **Mass**: Amount of matter present in a substance. It is constant and can be measured using an analytical balance.
  SI Unit: Kilogram (kg).
- **Weight**: Force exerted by gravity on an object. It varies with changes in gravity.

Volume

- **Volume**: Space occupied by matter. In SI units, it is expressed as cubic meter (m^3).
  Popular unit: Litre (L), though not an SI unit.
  Mathematical conversion: 1 L = 1000 mL = 1000 cm^3 = 1 dm^3.
- **Measuring Devices**: Volume of liquids can be measured using burettes, pipettes, cylinders, and measuring flasks.

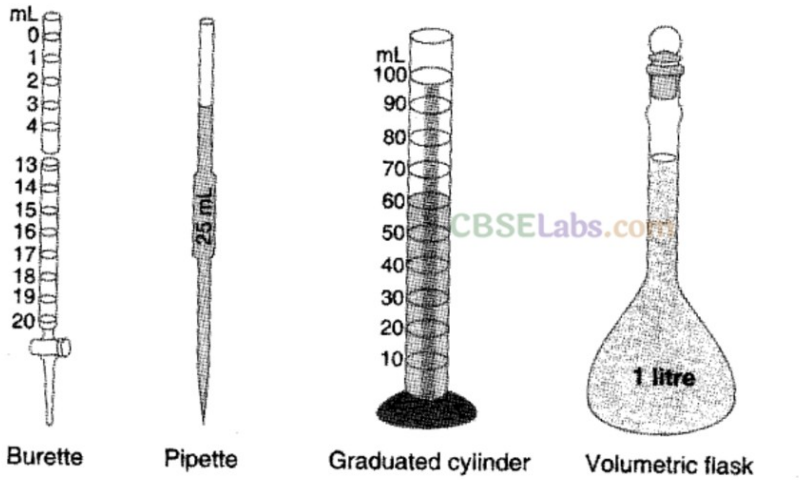
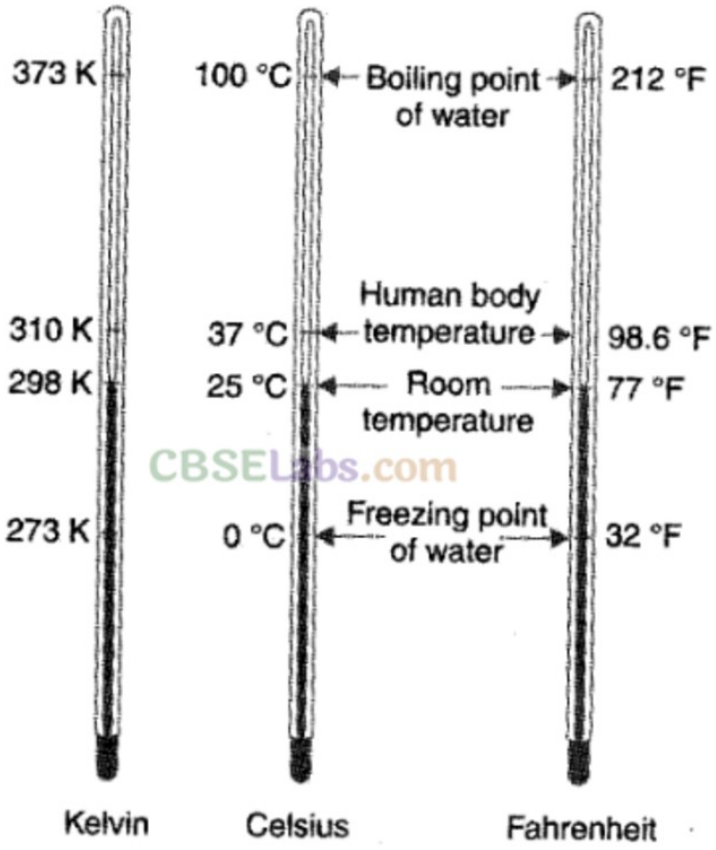


Fig. 1.2 *Some volume measuring devices.*

Temperature

Temperature can be measured using three scales:

1. **Celsius Scale (°C)**: Calibrated from 0°C (freezing point of water) to 100°C (boiling point of water).
2. **Fahrenheit Scale (°F)**: Calibrated from 32°F to 212°F.
3. **Kelvin Scale (K)**: SI scale. Temperature in Kelvin is shown with the symbol **K**.



Relationship between Kelvin Scale and Celsius Scale:

$$°F = \frac{9}{5}(°C) + 32$$

The Kelvin scale is related to Celsius scale as follows:

$$K = °C + 273.15$$

Density

- **Density**: Amount of mass per unit volume.
  SI Unit: kg/m³, but often expressed as g/cm³ in chemistry.

Density

- SI unit for density is devied from the base units for mass and volume
  - kg/m^3
  - Units are large for laboratory use
    - g/cm^3 or g/mL
- Physical property of a substance
  - Doesn't depend on amount of sample
    - As mass increases, volume increases (proportional)
    - Ratio of mass to volume is constant
  - Helps to identify a substance

Uncertainty in Measurements

All scientific measurements involve some degree of error or uncertainty, which can arise due to:

1. Skill and accuracy of the worker.
2. Limitations of measuring instruments.