Topic: Measurement of Mass, Weight, Length, and Time

1. INTRODUCTION

In physics, **measurement** refers to the process of comparing a physical quantity with a standard unit. To understand and describe physical phenomena accurately, we need to measure key quantities such as **mass, weight, length, and time**. These are **fundamental quantities**, and they form the basis of all physical measurements.

2. MEASUREMENT OF MASS

🔹 Definition of Mass

Mass is the **quantity of matter** contained in an object. It is a **scalar quantity** (i.e., it has magnitude but no direction).

- **SI Unit**: kilogram (kg)
- **Other units**: gram (g), milligram (mg), tonne (t)

1 kg = 1000 g
1 g = 1000 mg
1 tonne = 1000 kg

🔹 Instruments for Measuring Mass

1. **Triple Beam Balance**: Used in school laboratories for measuring solid objects.
2. **Electronic Balance**: Gives accurate digital readings of mass.
3. **Spring Balance** *(not ideal for mass)*: Measures weight (which is related to mass via gravity).
4. **Beam Balance**: Compares mass by balancing two sides with standard weights.

🔹 Properties of Mass

- Mass is constant everywhere (Earth, Moon, space).
- It is not affected by gravity or location.
- It is a fundamental property of matter.

3. MEASUREMENT OF WEIGHT

🔹 Definition of Weight

Weight is the **force** with which the earth attracts a body towards its center due to gravity. It is a **vector quantity** (i.e., it has both magnitude and direction—downward).

- **Formula**:

Weight(W)=Mass(m) × Acceleration due to gravity(g)

Where:

  - m = mass in kilograms (kg)
  - g = 9.8 m/s² on Earth

- **SI Unit**: Newton (N)

Example: A mass of 2 kg has a weight of 2 × 9.8 = 19.6

🔹 Instrument for Measuring Weight

- **Spring Balance**: Measures the weight (force) based on how much a spring stretches.

🔹 Properties of Weight

- Weight varies with gravity (e.g., on the Moon, weight is 1/6th of Earth's).
- Weight acts downwards.
- Weight is zero in space (zero gravity).

4. MEASUREMENT OF LENGTH

🔹 Definition of Length

Length is the **distance** between two points. It is a **scalar quantity**.

- **SI Unit**: metre (m)
- **Other units**: centimeter (cm), millimeter (mm), kilometer (km)

1 m = 100 cm = 1000 mm
1 km = 1000 m

🔹 Instruments for Measuring Length

Instrument	Usage	Accuracy
Meter Rule	Measuring objects longer than 1 cm (up to 1 m)	±0.5 mm
Vernier Caliper	Measuring small distances, external and internal diameters	±0.1 mm
Micrometer Screw Gauge	Measuring very small thicknesses (e.g., wire, foil)	±0.01 mm
Measuring Tape	Measuring long curved surfaces (e.g., body, room)	±1 cm
Ruler	Short distances (usually 15–30 cm)	±0.5 mm

🔹 Precautions When Measuring Length

- Ensure the ruler is straight and aligned.
- Avoid parallax error: the eye should be perpendicular to the scale.
- Start from the zero mark.
- Use appropriate instrument for the object's size.

5. MEASUREMENT OF TIME

🔹 Definition of Time

Time is the **interval between two events**. It helps us measure how long something lasts.

- **SI Unit**: second (s)
- **Other units**: minute (min), hour (h)

1 min = 60 seconds
1 hour = 60 minutes = 3600 seconds

🔹 Instruments for Measuring Time

Instrument	Usage	Accuracy
Stopwatch/Stop clock	Timing experiments or races	±0.1 s (manual), ±0.01 s (digital)
Pendulum clock	Uses oscillations of a pendulum	±0.5 s
Electronic Timer	Accurate timing in labs and physics practicals	±0.001 s
Wristwatch/Clock	General timekeeping	±1 s or better

🔹 Methods of Measuring Time

1. **Simple Pendulum**: Time is measured based on the regular swing (oscillation) of a pendulum.
2. **Stopwatch**: Used to measure the time taken for an event, such as a fall or a chemical reaction.

6. Differences Between Mass and Weight

Property	Mass	Weight
Definition	Quantity of matter in a body	Force acting on mass due to gravity
Symbol	mmm	WWW
SI Unit	Kilogram (kg)	Newton (N)
Type of Quantity	Scalar	Vector
Affected by Gravity?	No	Yes
Instrument Used	Beam balance, electronic balance	Spring balance