

## PHYSICAL QUANTITIES AND MEASUREMENT

### Physical Quantities

Physical quantities are quantities that can be measured such as length, mass, time and temperature.

A physical quantity is represented by a numerical value and a unit.

### Fundamental Quantities

These quantities cannot be derived from other quantities.

- Length (m)
- Mass (kg)
- Time (s)
- Temperature (K)
- Electric current (A)
- Amount of substance (mol)
- Luminous intensity (cd)

### Derived Quantities

Derived quantities are obtained from combinations of fundamental quantities such as area, volume, speed and density. Any quantity apart from the seven fundamental quantities is a derived quantity.

### SI Unit Conversions

Length:  $1 \text{ km} = 1000 \text{ m}$ ,  $1 \text{ m} = 100 \text{ cm}$ ,  $1 \text{ cm} = 10 \text{ mm}$

Mass:  $1 \text{ kg} = 1000 \text{ g}$ ,  $1 \text{ tonne} = 1000 \text{ kg}$

Time:  $1 \text{ min} = 60 \text{ s}$ ,  $1 \text{ hr} = 3600 \text{ s}$

Volume:  $1 \text{ litre} = 1000 \text{ cm}^3$

When converting from a larger unit to a smaller unit, we multiply by the appropriate conversion factor.

For example, to convert 10 km to metres, we multiply by 1000 because  $1 \text{ km} = 1000 \text{ m}$

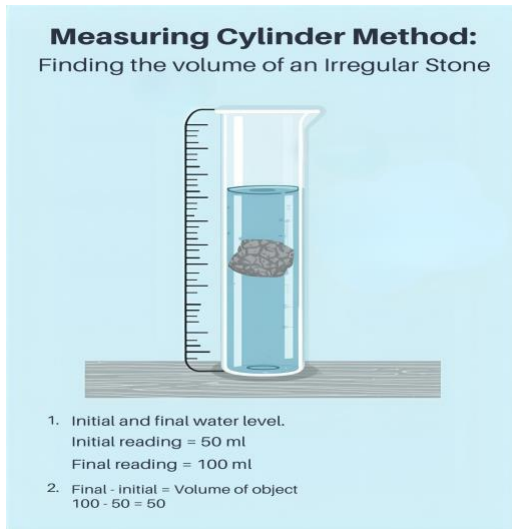
When converting from a smaller unit to a larger unit, we multiply by the appropriate conversion factor.

For example, to convert 180 seconds to minutes, we divide by 60 because  $1 \text{ min} = 60 \text{ secs}$

## **Finding the Volume of Irregular Objects**

### **Method 1: Measuring Cylinder Method**

1. Add a known volume of water to the measuring cylinder.
2. Record the initial reading.
3. Gently immerse the stone into the water.
4. Note the new reading.
5. Subtract initial volume from final volume to find volume of the stone.
6. Place the cylinder on a flat horizontal surface.
7. Read the lower meniscus.
8. Avoid parallax error by keeping the eye perpendicular to the scale.



## Method 2: Displacement Can Method

1. Fill the displacement can with water until it reaches the spout.
2. Place a measuring cylinder under the spout.
3. Gently immerse the object fully into the can.
4. Collect the displaced water.
5. Measure the volume of collected water this equals the volume of the object.
6. Avoid parallax error while reading.

## Errors and Measurements

Parallax error occurs when the eye is not perpendicular to the scale.

This error is avoided by placing the eye directly in line with the reading.

Zero error occurs when a measuring instrument does not read zero when no measurement is being taken

## Types of Zero Error

### 1. Positive Zero Error

- The zero of the circular scale is below the zero of the main scale when the instrument is closed.
- Correction: Subtract the zero error from the observed reading.

### 2. Negative Zero Error

- The zero of the circular scale is above the zero of the main scale when the instrument is closed.
- Correction: Add the zero error to the observed reading.

## Instruments for Measuring Length

- Metre rule
- Measuring tape
- Vernier calipers
- Micrometer screw gauge

## Least Count

The smallest measurement an instrument can measure accurately.

## Metre Rule

- Used to measure straight objects.

- Least count = 1 mm or 0.1 cm
- Place object parallel to the scale.

## **Flexible Measuring Tape**

- Used for curved objects.

## **Vernier Calipers**

Used to measure:

- External diameter
- Internal diameter
- Depth

## **Micrometer Screw Gauge**

Used to measure very small thicknesses, e.g.:

- Diameter of thin wire
- Thickness of paper

## **Parts**

- Anvil
- Spindle

- Main scale
- Circular scale
- Ratchet

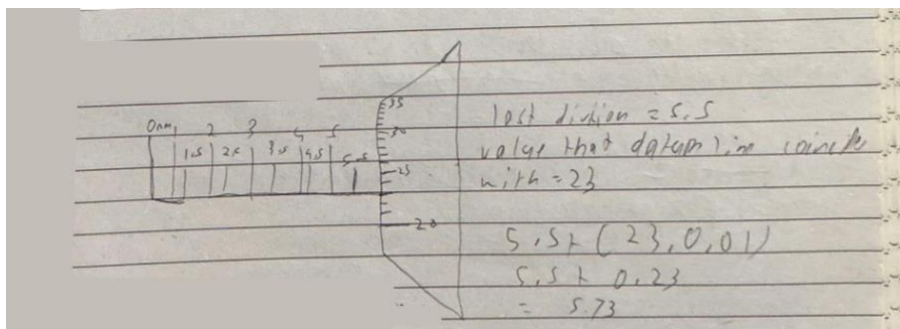
## Least Count

0.01 mm

## Formula (Micrometer Screw Gauge)

Final Reading =

Main scale reading + (Circular scale reading  $\times$  Least count)



## Oscillation

Oscillation is one complete to-and-fro motion.

Time period is the time taken for one oscillation.

Frequency is the number of oscillations per second. Unit: Hertz (Hz).

## Matter and Density

Matter is anything that occupies space and has mass.

Density = Mass / Volume

## QUESTIONS

Q. List the disadvantages of using digital/electronic micrometers over manual ones.

Answer:

- They are costly / expensive.
- The battery may run out.
- They can get damaged easily.

## Situation:

You are given a sheet of paper. You have to find the average thickness of the paper.

Describe how you will do this as accurately as possible. (6 marks)

Answer:

1. Fold the paper three times. This will give 8 layers (thicknesses).
2. Place these layers between a micrometer screw gauge.
3. Record the reading obtained on the micrometer.
4. Divide the obtained reading by 8 to get the average thickness of the paper.

Note:

- Avoid parallax error by placing the eye in such a position that the line of sight is exactly perpendicular to the scale.
- Avoid zero error by first checking that the micrometer is in a fully closed position before placing the paper in it.

Q. What do you understand by a time period of 3 seconds?

Answer:

It means that it takes 3 seconds to complete one oscillation.

Q. What do you understand by a frequency of 5 Hz?

Answer:

It means that the pendulum completes 5 oscillations in one second.

### **Measuring Volume Questions**

Q. Explain why the stone is immersed into the water gently.

Answer:

To prevent the splashing of water from spilling out of the measuring cylinder.

Q. Explain why the measuring cylinder is tapped a few times before noting down the final value.

Answer:

To remove any air bubbles dissolved or trapped in the water.

Q. Explain why the measuring cylinder is placed on a flat horizontal surface.

Answer:

- To read the correct meniscus level of the water.
- To avoid parallax error.