

Unit 1: Physical Quantities & Measurement

High-Detail Board Exam Notes: Definitions, Base & Derived Quantities, Measuring Instruments, Density & Significant Figures.

[Comprehensive Theory](#)

[Solved Examples](#)

[Diagrams & Formulas](#)

Definition of Physics & Primary Branches

Definition of Physics

Branch of natural science studying matter, motion, energy, space-time behavior, and fundamental interactions.



Mechanics

Laws of motion, force, and gravitational interactions.



Thermodynamics

Heat, temperature, energy transformations, and work.



Electricity & Magnetism

Static/moving electric charges and magnetic fields.

Modern & Specialised Branches

Atomic & Nuclear Physics

Structure of atoms, constituents, behavior, and atomic nuclei interactions.

Optics & Sound

Properties of light, optical instruments, wave production, and acoustics.

Astrophysics & Geophysics

Physical laws applied to celestial bodies and Earth's internal structure.

Plasma & Particle Physics

Ionized state of matter and subatomic elementary particle interactions.

Fundamental vs Derived Physical Quantities

7 Base SI Physical Quantities

Quantity	SI Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric Current	ampere	A
Temperature	kelvin	K
Amount of Substance	mole	mol
Luminous Intensity	candela	cd

Derived Quantities
Quantities expressed in terms of base quantities.

- Volume:** cubic meter (m³)
- Velocity:** meter per second (m/s)
- Force:** Newton (N = kg·m/s²)
- Density:** kg per cubic meter (kg/m³)

1.2 PRECISION INSTRUMENTS

Vernier Calipers & Least Count

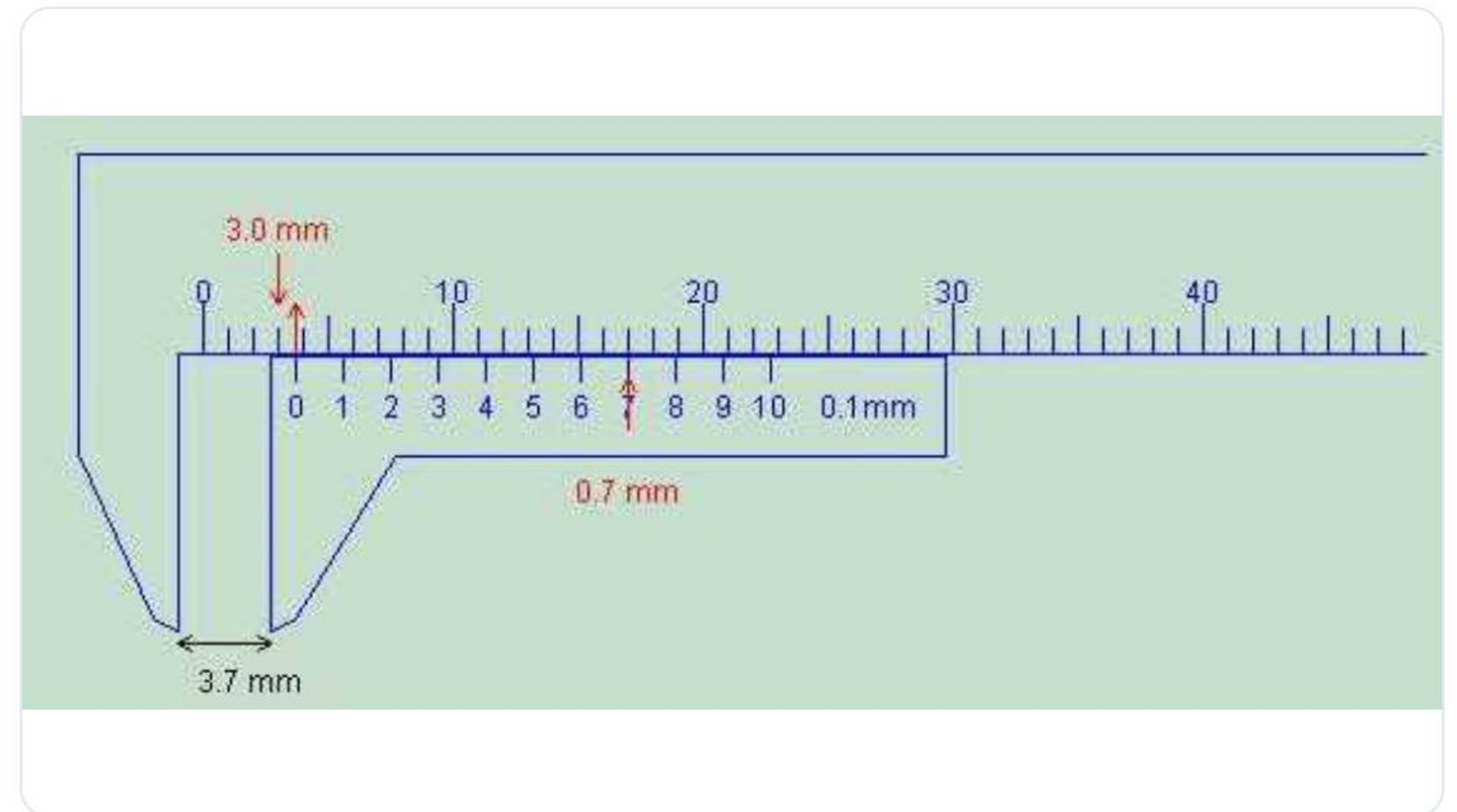
Least Count (LC) Formula

LC = 1 Smallest Main Scale Division / Total Vernier Divisions = **0.1 mm = 0.01 cm**

Main Scale: Fixed scale marked in millimeters and centimeters.

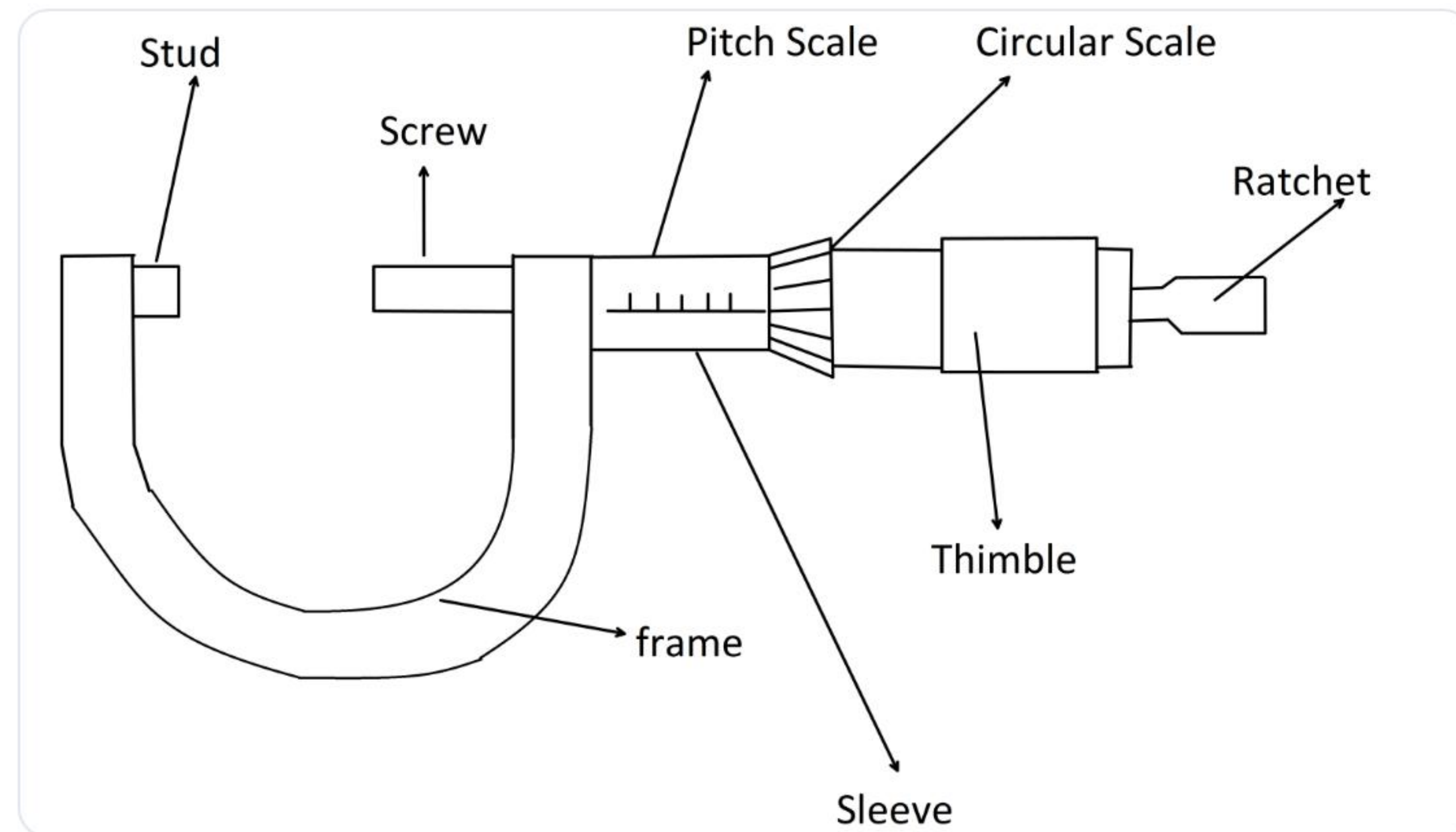
Vernier Scale: Sliding scale with 10 divisions.

Zero Error: Positive if Vernier 0 is right of Main 0 (subtract correction).
Negative if left (add correction).



1.2 PRECISION INSTRUMENTS

Micrometer Screw Gauge



Principle & Precision

Converts small linear displacements into large rotational turns.
Measures tiny wires and sheet thickness.

Pitch of Screw: Distance moved on linear scale per revolution (1 mm or 0.5 mm).

Least Count: Pitch / Circular Scale Divisions = **0.01 mm = 0.001 cm.**

Total Measurement: Main Scale Reading + (Circular Division $\times$ LC).

1.2 MASS & TIME STANDARDS

Mass Balances, Atomic Clock & Stopwatches

Mass Standards

Kilogram standard: Platinum-Iridium alloy cylinder stored at BIPM, Sevres.

Physical Balance: Operates on principle of moments.

Electronic Balance: Digital force-balancing integrated circuits.

Time Interval & Error

Atomic Clock: Defined by 9,192,631,770 Cesium-133 vibrations.

Human Reaction Error: 0.3s–0.5s manual delay. Light gates eliminate manual error.



SI Prefixes & Scientific Notation

$$N = m \times 10^n \quad (1 \leq m < 10, n \in \mathbb{Z})$$

Multiple Prefixes

Kilo (k) = 10^3

Mega (M) = 10^6

Giga (G) = 10^9

Tera (T) = 10^{12}

Sub-Multiple Prefixes

Milli (m) = 10^{-3}

Micro (μ) = 10^{-6}

Nano (n) = 10^{-9}

Pico (p) = 10^{-12}

Standard Examples

Mass of Sun:

2.0×10^{30} kg

Mass of Electron:

9.11×10^{-31} kg

Density & Irregular Volume Measurement

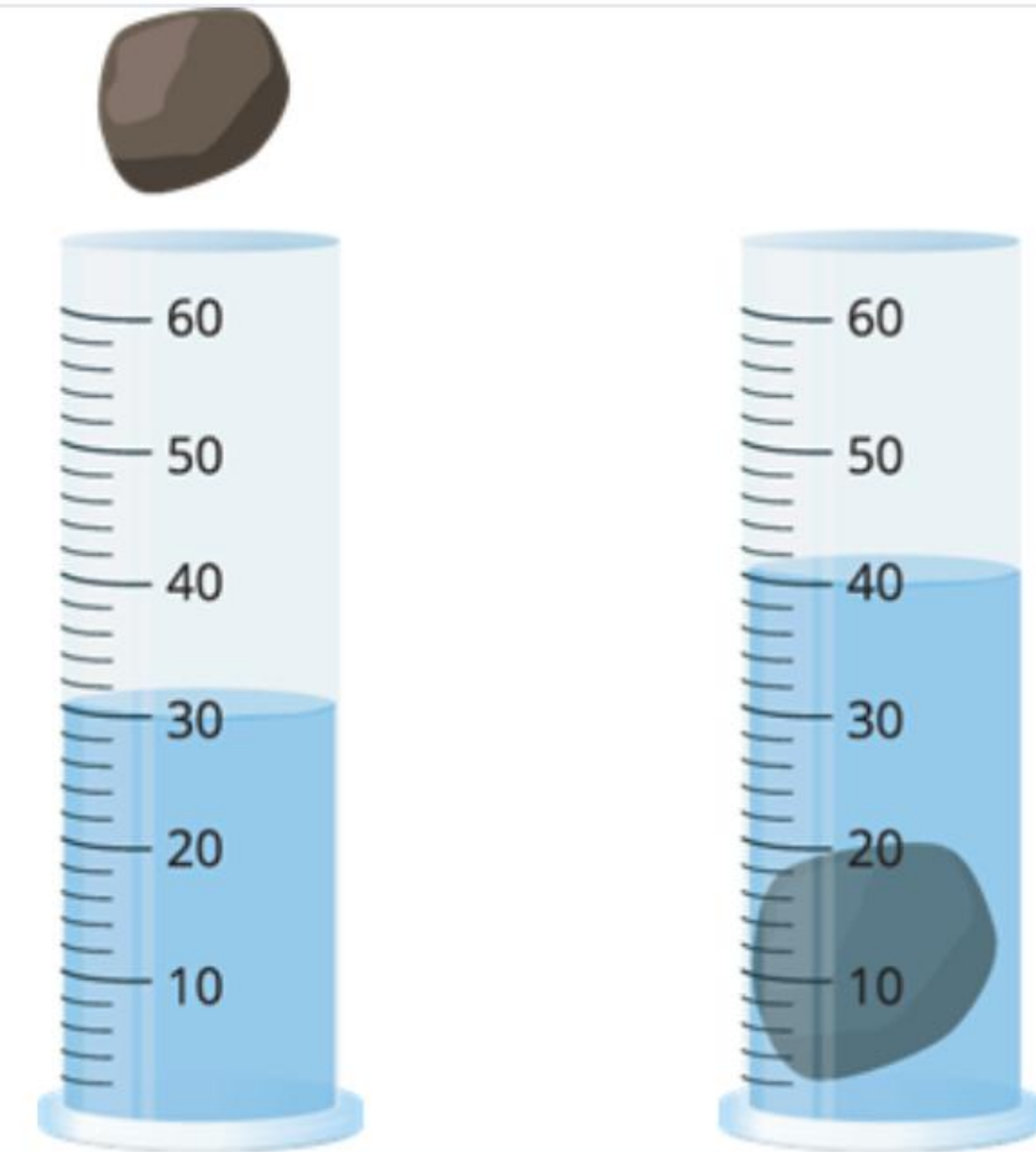
$$\rho = \frac{m}{V} \quad \text{SI Unit: kg/m}^3$$

Water Displacement Method

Volume of irregular solid = Final Water Volume (V_2) - Initial Water Volume (V_1).

Specific Gravity (Relative Density)

Ratio of density of substance to density of pure water at 4°C.
(Dimensionless/Unitless).



Rules for Significant Figures

RULE 1

Non-Zero Digits

All non-zero digits are always significant.

Example: 2.25 has 3 sig figs.

RULE 2

Leading Zeros

Zeros before first non-zero digit are NOT significant.

Example: 0.00034 has 2 sig figs.

RULE 3

Trapped Zeros

Zeros between non-zero digits are ALWAYS significant.

Example: 2045 has 4 sig figs.

RULE 4

Trailing Zeros

Significant ONLY if an explicit decimal point is present.

Example: 200 (1 sig fig) vs 200. (3 sig figs).

KARACHI EDU Exam Numerical Practice

PROBLEM 1

Iron Wrecking Ball Mass

Given: $r = 18 \text{ cm} = 0.18 \text{ m}$, $\rho = 7.8 \text{ g/cm}^3 = 7800 \text{ kg/m}^3$

Formula: $V = \frac{4}{3} \pi r^3 = 0.024 \text{ m}^3$

Mass: $m = \rho \times V = 7800 \times 0.024$

Answer: $m = 187.2 \text{ kg}$

PROBLEM 2

Cylinder Cross-Section Area

Given: $d = 5 \text{ cm}$, $r = 2.5 \text{ cm} = 0.025 \text{ m}$

Formula: $A = \pi r^2 = 3.14 \times (0.025)^2$

Calculated: $A = 0.00196 \text{ m}^2$

Significant Figs: 1.9 cm^2 (2 Sig Figs)

PROBLEM 3

Unit Conversions

- $1 \text{ Liter} = 1000 \text{ cm}^3 = 10^{-3} \text{ m}^3$
- $1 \text{ cm} = 10 \text{ mm} = 10^{-2} \text{ m}$
- $1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$
- $1 \text{ Year} \approx 3.15 \times 10^7 \text{ seconds}$



KARACHI EDU EXAM TARGET

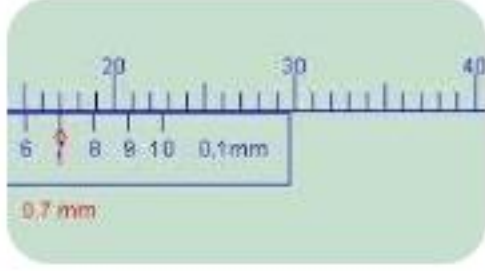
Chapter 1 Revision & Board Mastery Complete

Always double check instrument zero error signs before recording readings! Practice numerical conversions daily for maximum marks in Sindh Board Exams.

✓ SI Units Memorized

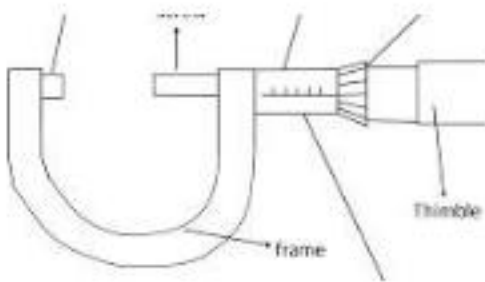
✓ Least Counts Mastered

Image Sources



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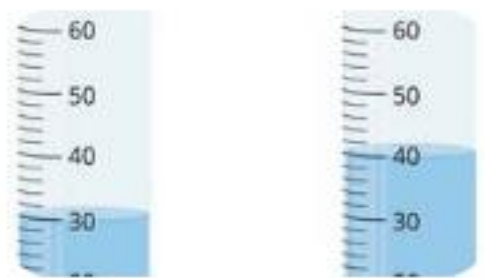
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