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S1 New Curriculum chemistry

Theme: Mechanics and properties of matter

Chapter 2 – Measurements in Physics

Measurements

Measurement involves assigning numerical values to physical properties like length, mass, time, and temperature. Measurements of different quantities are expressed in different units. The **International System of Units (SI)** is the globally accepted standard for measuring physical quantities. It is a modern form of the metric system and is used in science, industry, and everyday commerce worldwide.

Importance of measurements in our daily life

Measurements play a crucial role in everyday life, helping us make accurate decisions and perform tasks efficiently. They are essential in the following ways.

- **Health & Medicine:** Doctors measure body temperature, blood pressure, and medication doses to ensure proper treatment.
- **Cooking & Baking:** Precise measurements of ingredients help achieve the right taste and texture in food.
- **Tailoring:** Precise measurements are vital for **trendy** outfits.



example of a trendy outfits

- **Time Management:** Clocks and schedules help us plan our day effectively.
- **Construction & Engineering:** Builders and engineers rely on measurements for designing safe and functional structures.
- **Sports & Fitness:** Athletes track speed, distance, and weight to improve performance.

- **Shopping & Finance:** Measuring weight, volume, and currency ensures fair transactions.
- **Environmental Monitoring:** Scientists measure air quality, temperature, and pollution levels to protect ecosystems.

Physical quantities

Physical quantities are divided into two groups

(a) Fundamental quantities

These are physical quantities which cannot be expressed in form of other quantities using any mathematical equations.

The table of fundamental quantities and their Standard units (SI)

Fundamental Quantity	S.I unit	Symbol of S.I unit
Length	metres	m
Mass	kilogram	kg
Time	second	s
Temperature	Kelvin	K
Current	Ampere	A

(b) Dimensional/derived quantities

These are physical quantities which can be expressed in terms of fundamental quantities.

The table below shows examples of derived quantities and their units

Quantity	SI units	Symbol of SI unit
Area	Metre squared	m ²
Volume	Metre cubic	m ³
Density	Kilogram per metre cubed	kgm ⁻³

Measuring length

The standard unit of length is metres (m).

Other metric system units include

Millimeter (mm) = 0.001m or $\frac{1}{1000}m$ or $10^{-3}m$

Centimetres (cm) = 0.01m or $\frac{1}{100}m$ or $10^{-2}m$

Kilometer (km) = 1000m or 10^3m

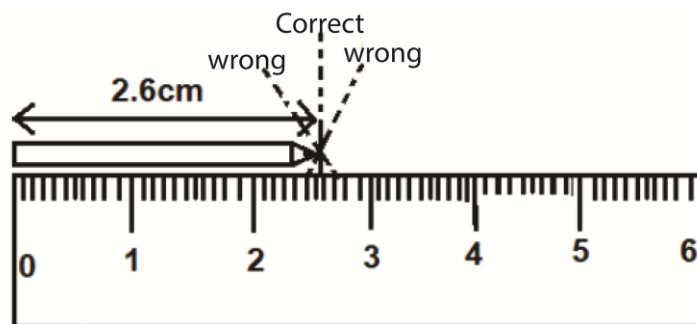
Common measuring instruments for length

(a) Meter rule



How to read a metre rule

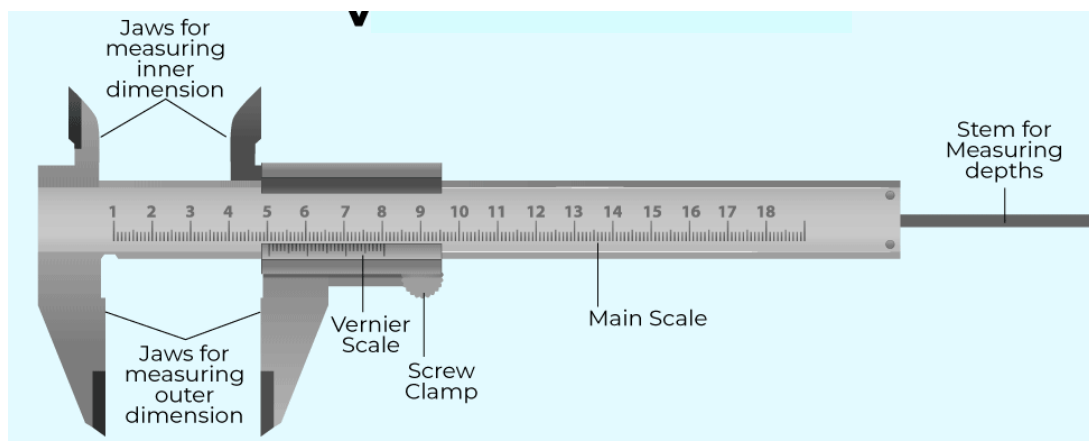
- (i) Metre rule reads distances in centimetres to 1 dip e.g., 0.0cm, 10.1 cm, 94.5cm
- (ii) A metre rule is suitable for distances from 0. 0cm to 100cm such as dimensions of books, small boxes, tables, chairs and so on.
- (iii) To accurately take a reading, the eye must be right over the mark on the scale as show below



- (iv) If required to measure distances in metres; first measure the distances in cm and then change the readings to metres by dividing by 100. For instance,

$$10.1 \text{ cm} = \frac{10.1}{100} = 0.101\text{m}$$

(b) Vernier calipers

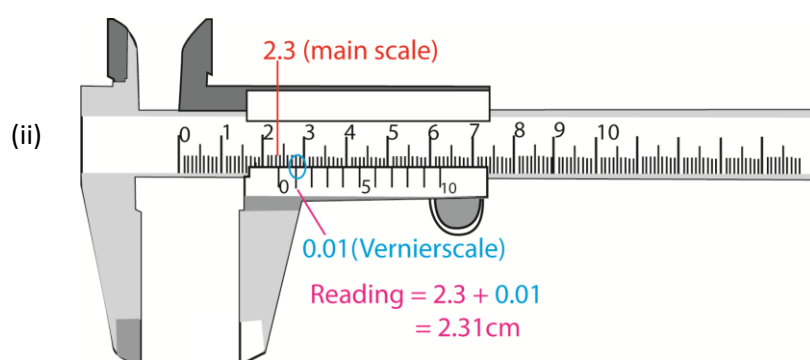
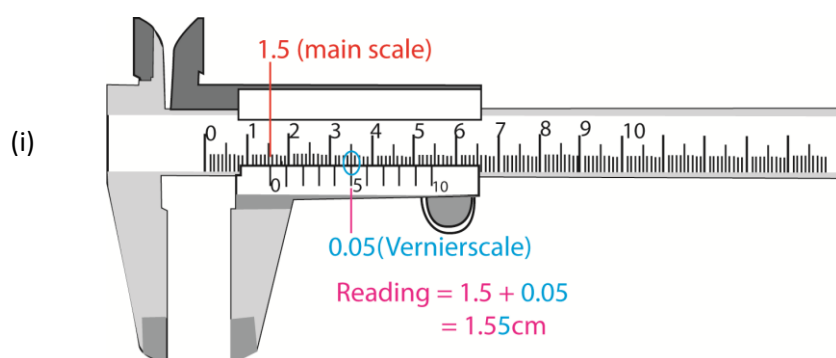


How to read a Vernier Calipers

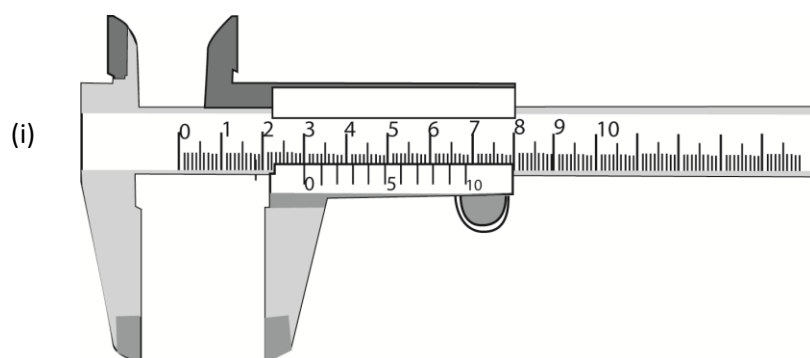
Reading a **Vernier caliper** involves understanding both the **main scale** and the **Vernier scale** to obtain precise measurements. Here's a simple step-by-step guide:

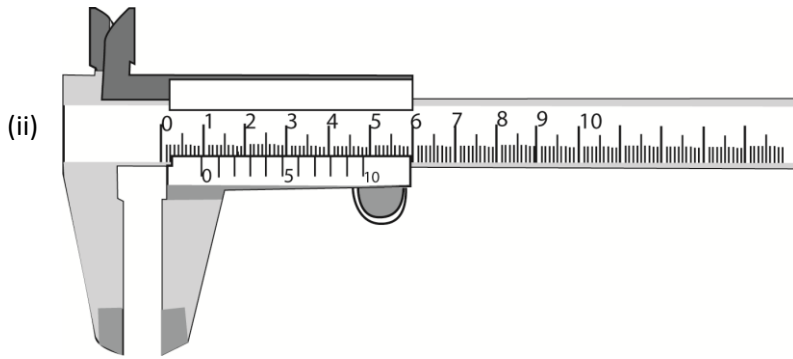
1. **Read the Main Scale** – Identify the nearest whole number or decimal value on the main scale where the zero of the Vernier scale aligns.
2. **Read the Vernier Scale** – Find the first mark on the Vernier scale that perfectly aligns with a mark on the main scale.
3. **Add the Values** – Combine the main scale reading with the Vernier scale reading to get the final measurement.
4. Vernier calipers in physics laboratory often measure from 0.00cm to 15cm or 20.00cm

Examples of Vernier caliper readings

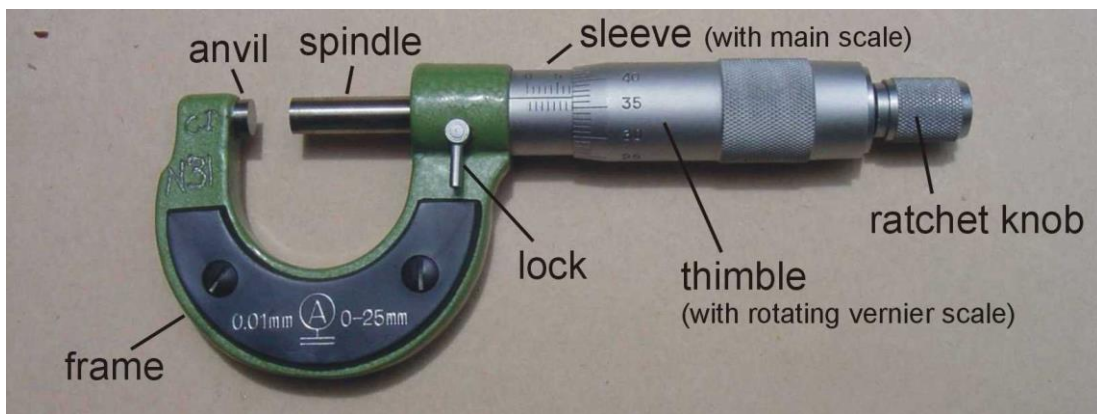


Trial 1: Find the readings on the following Vernier calipers





(c) **Micrometer screw gauge**



How to read a micrometer screw gauge

(a) Key Parts

- **Sleeve/Barrel:** Contains the **main scale** (usually in millimeters).
- **Thimble:** Contains the **rotating scale**.
- **Ratchet Stop:** Helps apply the correct force for measurement.

(b) Read the Main Scale (Sleeve)

- Using the adjust the anvil to set the micrometer screw gauge before making any readings
- Hold the object between the anvil and spindle and rotate the thimble until the object is secured and a clicking sound is heard.
- Read the visible marking on the sleeve just before the rim of thimble. Each small division on the upper side of the horizontal middle line represents **1 mm** while lower division subdivides the upper division in the middle.

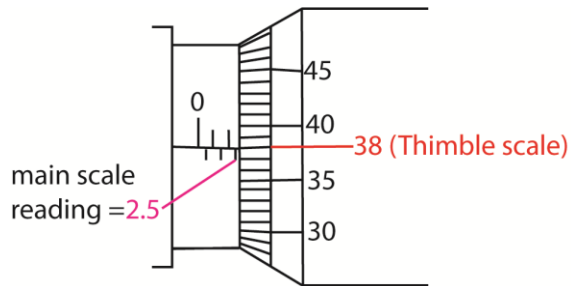
(c) Read the Thimble Scale

- Read the thimble until mark that coincides with the horizontal line of the main scale.
- Each division on the thimble represents **0.01 mm**.
- Micrometer screw gauge measures distances from 0.01mm to 25mm

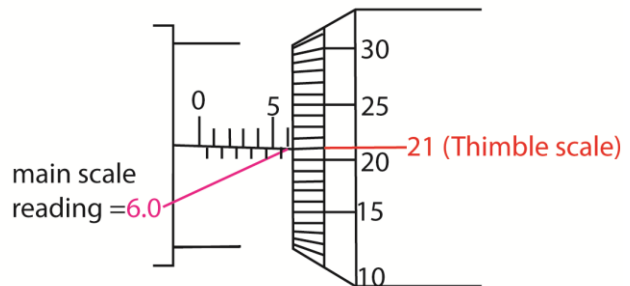
(d) Find the Total Measurement

- Add the sleeve reading to the thimble reading.
- Example: If the sleeve shows **5.0 mm** and the thimble shows **0.35 mm**, the total measurement is: **5.0 mm + 0.35 mm = 5.35 mm**

Example

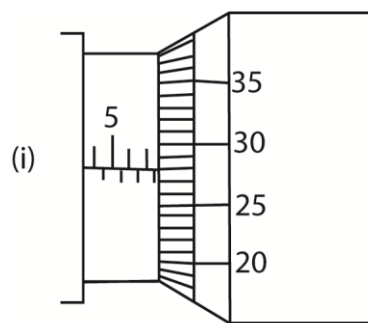


Total reading = $2.5 + 38 \times 0.01 = 2.88\text{mm}$

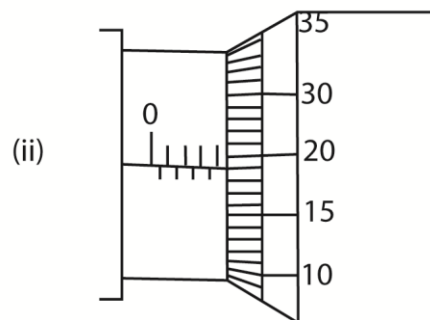


Total reading = $6.0 + 21 \times 0.01 = 6.21\text{mm}$

Trial 2: Find the readings on the following micrometer screw gauges



Total reading = _____



Total reading = _____

Trail 3:

1. Convert the following to metres

- (a) 10mm
- (b) 5cm
- (c) 4km
- (d) 2000cm

2. Convert the following as instructed

- (a) 2m to cm
- (b) 30cm to mm
- (c) 0.5km to mm
- (d) 500mm to km

(e) 20cm to m

3. Name the instrument you would use to accurately measure the following giving reasons for your answer

- (a) Thickness of pin
- (b) Length and width of classroom
- (c) Diameter of beaker
- (d) Thickness of paper
- (e) Length of table
- (f) Thickness of paper

Area

This is the amount of space an object occupies.

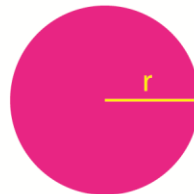
Formulae for finding area of common shapes



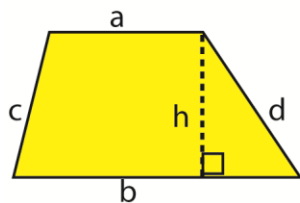
Rectangle: $L \times W$



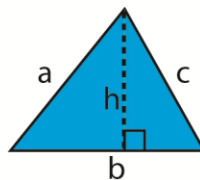
Square = a^2



Circle = πr^2

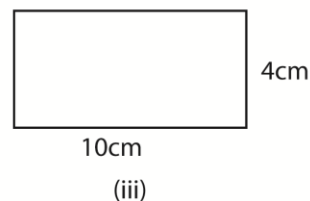
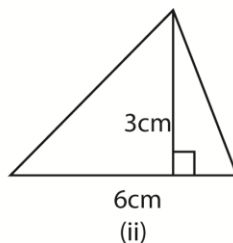
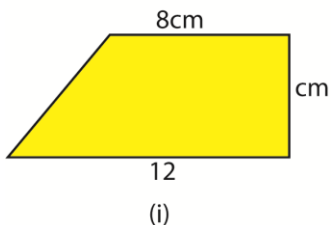


Trapezium = $\frac{1}{2}(a+c) \times h$



Triangle = $\frac{1}{2}(b \times h)$

Trial 4: Find the area of each of the following:

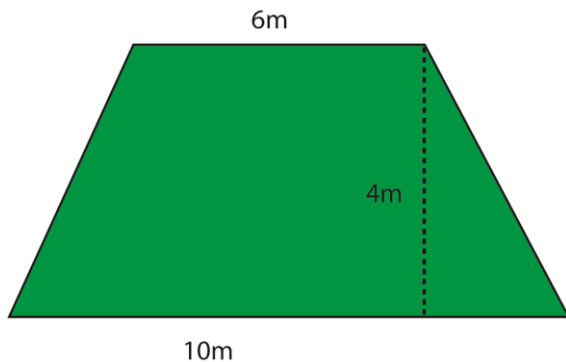


Converting units of area

To convert the units of area one may change the units of the dimensions to the preferred units and then multiply the results; or obtain the area and then convert the units directly.

Example

The dimensions of a maize field are given in diagram below



Find the area of the field in

(i) cm^2

Method I

$$1\text{m} = 100\text{cm}$$

$$\therefore 6\text{m} = 600\text{cm}; 10\text{m} = 1000\text{cm} \text{ and } 4\text{m} = 400\text{m}$$

$$\begin{aligned} A &= \frac{1}{2}(a + b) \times h \\ &= \frac{1}{2}(600 + 1000) \times 400 \\ &= 320,000\text{cm}^2 \end{aligned}$$

Method II

$$\text{Area in metres} = \frac{1}{2}(6 + 10) \times 4 = 32\text{m}^2$$

$$\text{But } 1\text{m}^2 = 100\text{cm} \times 100\text{cm} = 10,000\text{cm}^2$$

$$\begin{aligned} \therefore 32\text{m}^2 &= (32 \times 10,000)\text{cm}^2 \\ &= 320,000\text{cm}^2 \end{aligned}$$

(ii) km^2

Method I

$$1\text{m} = \frac{1}{1000}\text{cm}$$

$$\therefore 6\text{m} = \frac{6}{1000} = \mathbf{0.006}\text{km}; 10\text{m} = \frac{10}{1000} = \mathbf{0.010}\text{km} \text{ and } 4\text{m} = \frac{4}{1000} = \mathbf{0.004}\text{km}$$

$$A = \frac{1}{2}(a + b) \times h$$

$$= \frac{1}{2}(\mathbf{0.006} + \mathbf{0.010}) \times \mathbf{0.004}$$

$$= \mathbf{0.000032}\text{km}^2$$

Method II

$$\text{Area in metres} = \frac{1}{2}(\mathbf{6} + \mathbf{10}) \times \mathbf{4} = 32\text{m}^2$$

$$\text{But } 1\text{m}^2 = \frac{1}{1000}\text{ km} \times \frac{1}{1000}\text{ km} = \frac{1}{1000000}\text{ km cm}^2$$

$$\therefore 32\text{m}^2 = (32 \times \frac{1}{1000000})\text{km}^2$$

$$= \mathbf{0.000032}\text{km}^2$$

Trial 4:

(a) Calculate following units as instructed

(i) 30mm^2 to cm^2

(ii) 100mm^2 to m^2

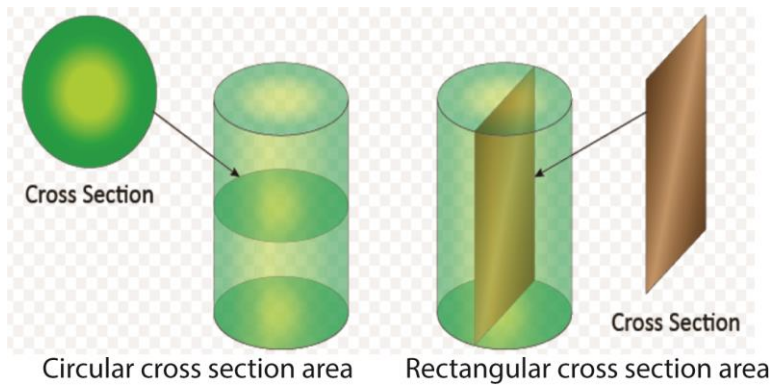
(iii) 24m^2 to cm^2

(iv) 32km^2 to m^2

(b) A house requires tiles for a hall measuring 30m by 15 m. If a tile measures 20cm by 10cm, how many tiles are requires.

Cross-sectional Area

The **cross-sectional area** of an object refers to the surface area of its slice perpendicular to its length. It's commonly used in engineering, physics, and construction.

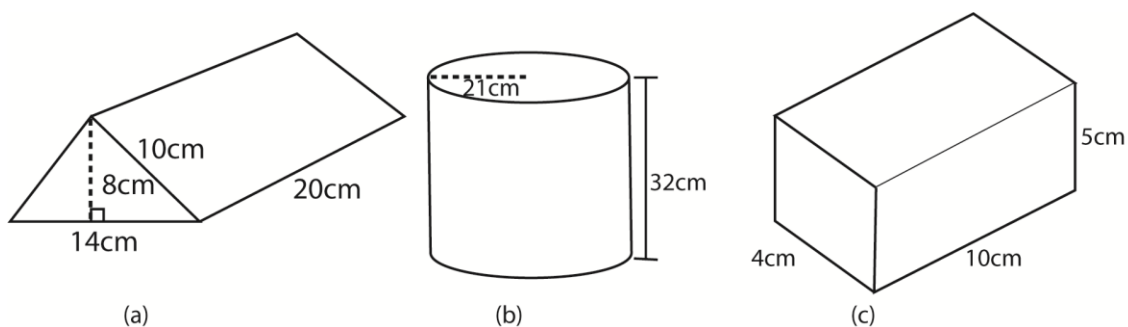


How to Calculate Cross-Sectional Area

The formula depends on the shape of the object:

- **Circle:** $A = \pi r^2$ (where r is the radius)
- **Rectangle:** $A = \text{width} \times \text{length}$
- **Square:** $A = \text{side}^2$
- **Triangle:** $A = \frac{1}{2} \times \text{base} \times \text{height}$
- **Hollow Pipe:** $A = \pi(R^2 - r^2)$ (where R is the outer radius and r is the inner radius)

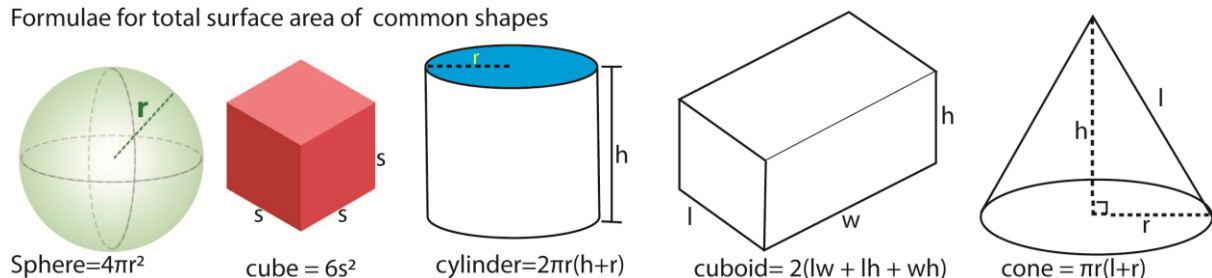
Trial 5: Find the cross sectional areas of the following objects in m^2 .



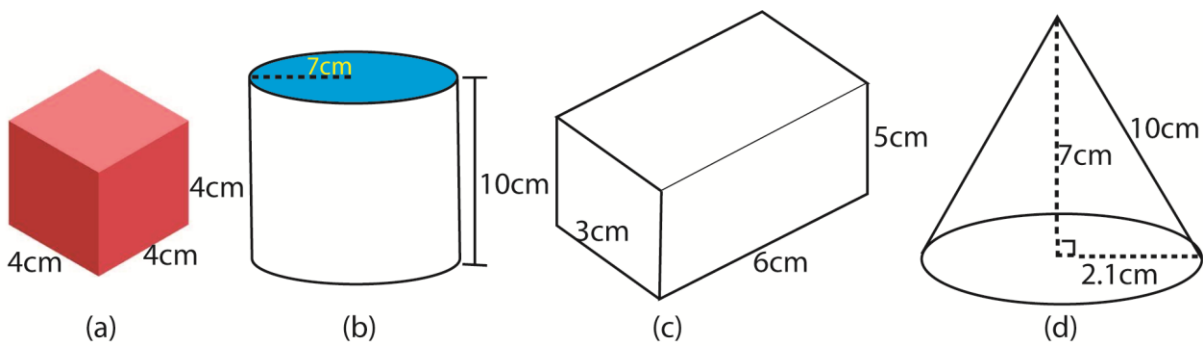
Total surface area

The **total surface area** of an object is the sum of the areas of all its faces or surfaces. The formula depends on the shape:

Formulae for total surface area of common shapes



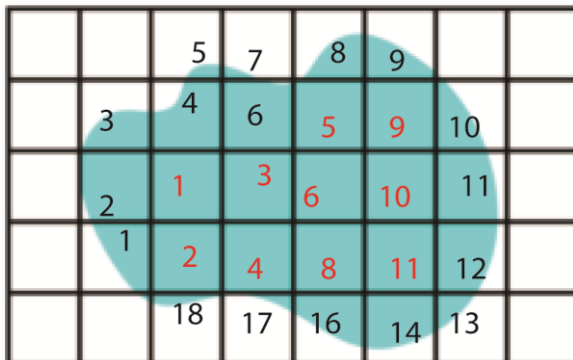
Trial 6: Find the total surface areas of the following objects in m².



How to find area of an irregular object

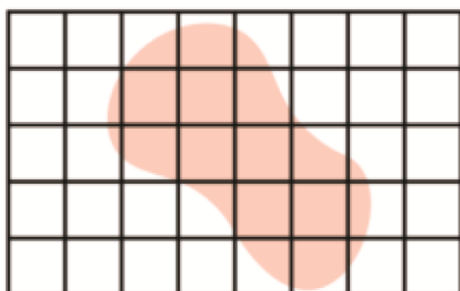
- (i) Place the object on a graph paper and trace out its boundary.
- (ii) Area of object = **area of a square** $\left[\frac{\text{Number of full squares} + \text{number of incomplete squares}}{2} \right]$

Example



The area of the shape = $11 + \frac{18}{2} = 20$ squares

Trial 7: Estimate the area for the following shapes below.



(a)

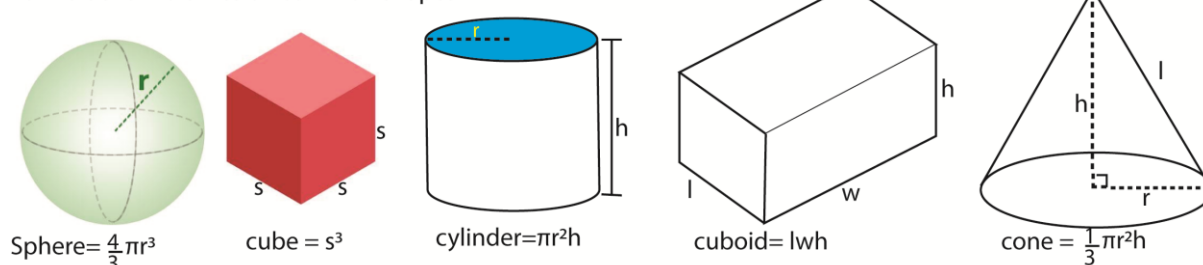


(b)

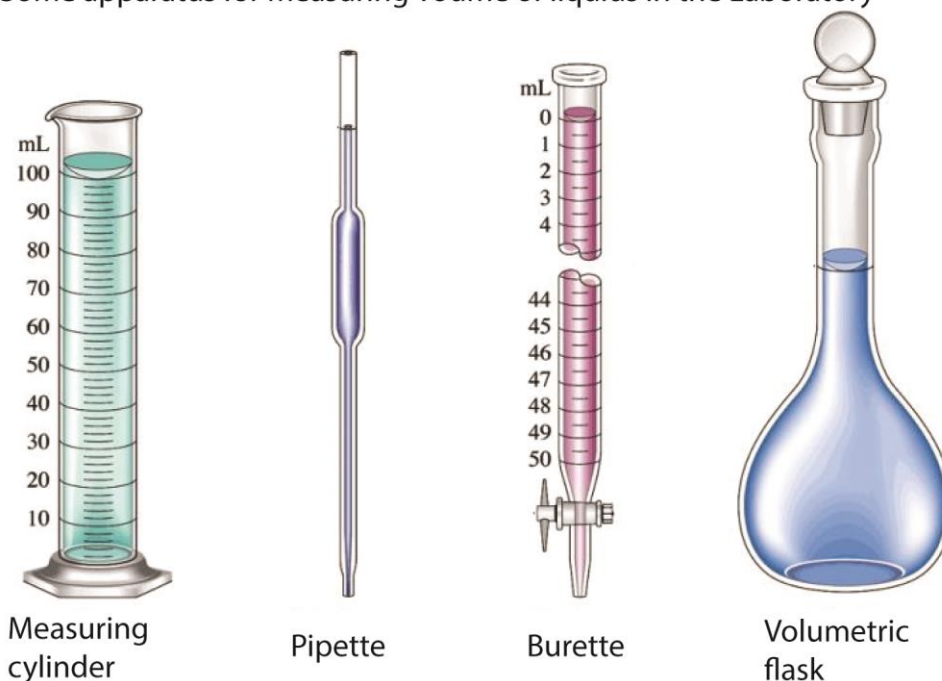
Volume

Volume is the amount of space that an object or substance occupies. It is measured in cubic units such as cubic centimeters (cm³), cubic meters (m³), or liters (L).

Formulae for volumes of common shapes



Some apparatus for measuring volume of liquids in the Laboratory



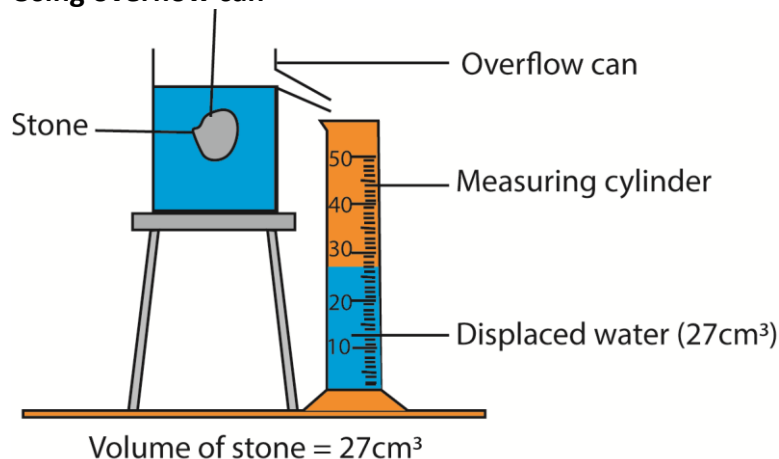
Measuring volume of irregular objects

(a) Water Displacement Method (For Solid Objects)

- (i) Fill a **graduated cylinder** or container with water and record the initial volume.
- (ii) Submerge the **irregular object** completely in the water.
- (iii) Record the **new water level**.
- (iv) **Volume = Final Volume - Initial Volume.**



(b) Using overflow can



Step-by-Step Method

- (i) **Fill the Overflow Can:** Fill the can with water **until it just reaches the spout**. Let any excess water **drain out** to ensure an accurate measurement.
- (ii) **Submerge the Irregular Object:** Gently place the object into the water, ensuring it is **fully submerged**. The displaced water will flow out of the spout.
- (iii) **Collect the Overflow Water:** Place a **measuring cylinder** or another container under the spout to collect the displaced water. Be precise—avoid splashes or evaporation.
- (iv) **Measure the Volume** Read the **graduated scale** on the measuring cylinder.
- (v) The volume of the collected water is **equal to the volume of the object**.

Trial 8:

(a) Convert the following units as instructed

- (i) 200cm^3 to m^3
- (ii) 20 liters to cm^3
- (iii) 4m^3 to mm^3
- (iv) 6litres to m^3

(b) Bbosa has $40,000\text{cm}^3$ of milk and sells a litre at UGX 500. How much will he earn from this milk.

(c) After dropping a stone into a measuring cylinder containing 50cm^3 of water, the volume raised to 80cm^3 -mark. Find the volume of the stone.

(d) Explain how the volumes of an Irish potato can be measured.

Time

Time **is a fundamental concept** that helps us measure the duration between events. Scientifically, time is the ongoing progression of existence, SI unit of time is seconds (s) but it can be measured in minutes, hours, days and years.

Relationships among seconds, minutes, hours and days

1day = 24hours

1hour = 60 minutes

1minute = 60 seconds

Measuring time

Measuring time **involves using different tools and units depending on the level of precision needed.**

Instrument for measuring time



Stop clock



Stop watch

Trial 9:

(a) Convert the following

- (i) 2.5 hour to seconds
- (ii) 48 hours to days
- (iii) 1 day to minutes and then seconds
- (iv) 72 minutes to hours

(b) How many seconds are

- (i) 4 milliseconds
- (ii) 30 microseconds

Mass

Mass is the quantity of matter contained in the body. SI unit of mass is kilogram. Other units are grams, and tonnes.

Apparatus for measuring mass in school laboratories



Beam balance



Digital balance

Trial 10: Convert the following to kg

- (i) 10mg
- (ii) 100g
- (iii) 2 tonnes

Scientific significant figures

Significant figures are the digits in a number that contribute to its precision. They are important in scientific measurements and calculations to ensure accuracy without unnecessary rounding or exaggeration.

Rules for Determining Significant Figures

1. **Nonzero digits** are always significant (e.g., **123** has **3 significant figures**).
2. **Leading zeros** (zeros before the first nonzero digit) are **not significant** (e.g., **0.0032** has **2 significant figures**).
3. **Zeros between nonzero digits** are significant (e.g., **103** has **3 significant figures**).
4. **Trailing zeros in a decimal number** are significant (e.g., **2.400** has **4 significant figures**).
5. **Trailing zeros in a whole number without a decimal point** may or may not be significant, depending on notation (e.g., **1500** has **2 significant figures**, but **1500.** has **4**).

Why Significant Figures Matter

- They help indicate **measurement precision**.
- They prevent **overestimating accuracy** in scientific calculations.
- They ensure consistency in rounding when performing mathematical operations.

Rounding off numbers

Rounding off numbers helps simplify values while maintaining reasonable accuracy. The rounding method depends on the place value you're focusing on. Here's how it works:

General Rounding Rules

1. **Identify the place value** to round to (e.g., nearest **ten, hundred, decimal place**).
2. **Check the next digit:**
 - If it's **5 or more**, **increase** the rounding digit by **1**.
 - If it's **4 or less**, **keep** the rounding digit the same.
3. **Replace remaining digits** with zeros (for whole numbers) or remove them (for decimals).

Examples

- Rounding 376 to the nearest ten → 380 (since 6 is **5 or more**, increase the 7 to 8).
- Rounding 2.347 to the nearest hundredth → 2.35 (since 7 is **5 or more**, increase the 4 to 5).

Multiplication of numbers

- (i) When multiplying or dividing numbers with differing significant figures, the resultant takes the lower number of significant figures used in obtaining the result
- (ii) For addition or subtraction of numbers, the result takes the lower number of decimal places.

Example

(a) Find the difference between 1.456 and 0.9

$$1.456 - 0.9 = 0.556$$

$$= 0.6$$

(b) Divide 3.42 by 1.645

$$3.42 \div 1.645 = 2.079$$

$$= 2.08$$

Trial 11:

(a) Write the following numbers to 3 s.f.

(i) 304678

(ii) 0.62547

(iii) 4.267×10^{-3}

(iv) 9.4593

(v) 5.4754×10^5

(b) Perform the following arithmetic

(i) 2.005×3.07

(ii) 1.068×0.42

(iii) $1.25 + 14.235$

(iv) $1.067 \div 0.25$

(v)
$$\frac{3.68 + 4.978}{0.0973 - 3.26 \times 20.3}$$

(c) Round of the following to 2 significant figures

(i) 9.4678

(ii) 0.63247

(iii) 4.467×10^{-3}

(iv) 5.4744×10^6

Scientific notation (exponential or standard form)

Standard form is a way of writing very large or very small numbers concisely using powers of ten. It is commonly used in mathematics and science.

How to Write a Number in Standard Form

The format is: $a \times 10^n$

Where:

- a is a number between **1 and 9**
- n is the **power of 10** (positive for large numbers, negative for small numbers)

Examples

1. **Large number:**
 - 5,600,0005,600,000 $\rightarrow 5.6 \times 10^6$
 - The decimal point moves **6 places** to the left.
2. **Small number:**
 - 0.000420.00042 $\rightarrow 4.2 \times 10^{-4}$
 - The decimal point moves **4 places** to the right.

Trial 11: Write the following number in scientific notation

- (i) 0.00009
- (ii) 4500000
- (iii) 0.049
- (iv) 527200 to 2 s.f.

The scientific method

The **scientific method** is a systematic process used to investigate questions, solve problems, and develop theories in science. It ensures that conclusions are based on **observable, repeatable, and testable** evidence.

Steps of the Scientific Method

1. **Observation** – Identify a phenomenon or problem.
2. **Question** – Formulate a question based on your observations.
3. **Hypothesis** – Create an educated guess or prediction.
4. **Experimentation** – Design and conduct a controlled experiment.
5. **Data Collection** – Gather and analyze results.
6. **Conclusion** – Determine if your hypothesis was correct or needs revision.
7. **Communication** – Share findings for peer review and further study.

Why Scientific method important

- Helps minimize **bias**.
- Ensures **repeatable and reliable** results.
- Advances knowledge in fields like physics, biology, and chemistry.

Density

It mass per unit volume

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Importance of measuring density

Measuring **density** is crucial across various fields, as it helps determine material properties, identify substances, and optimize industrial processes. Here's why density measurement matters:

1. Identification of Materials

- Different substances have unique densities, allowing scientists to distinguish between materials (e.g., water vs. oil).
- Helps in **quality control** and verifying the purity of substances.

2. Engineering & Construction

- Ensures materials like **metals, wood, and plastics** meet design specifications.
- Used in structural stability analysis for buildings, aircraft, and bridges.

3. Manufacturing & Industry

- Density helps in **mixing chemicals** accurately in pharmaceuticals, cosmetics, and food production.
- Affects packaging decisions—for example, lighter materials reduce shipping costs.

4. Environmental & Scientific Applications

- Used to monitor **water pollution** and measure oil spills.
- Helps analyze geological samples in mining and earth science.

5. Everyday Applications

- Determines whether an object will **float or sink** in a liquid.
- Important in cooking, especially in understanding ingredient proportions.

Example

(a) 500cm^3 of a liquid has a mass 600g. Find the density of the liquid in kgm^{-3} .

$$1\text{cm}^3 = 1\text{cm} \times 1\text{cm} \times 1\text{cm} = 10^{-2}\text{m} \times 10^{-2}\text{m} \times 10^{-2}\text{m} = 10^{-6}\text{m}^3$$

$$\therefore 500\text{cm}^3 = 500 \times 10^{-6} = 5 \times 10^{-4}\text{m}^3$$

$$1\text{g} = 10^{-3}\text{ kg}$$

$$\therefore 600\text{g} = 600 \times 10^{-3} = 0.6\text{kg}$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{0.6}{5 \times 10^{-4}} = 1200\text{kgm}^{-3}$$

(b) Find the density of a cube of side 40cm and mass of 600g.

$$40\text{cm} = \frac{40}{100} = 0.4\text{m}$$

$$\text{Volume of the cube} = l^3 = 0.4 \times 0.4 \times 0.4 = 0.064$$

$$600\text{g} = \frac{600}{1000} = 0.6\text{kg}$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{0.6}{0.064} = 9.375\text{kgm}^{-3}$$

Density of air

Air has a mass and volume and therefore its density can be calculated.

Experiment to show that air occupies space

Experiment: Air Takes Up Space

Materials Needed:

- A clear glass or cup
- A tissue paper
- A bowl of water

Steps:

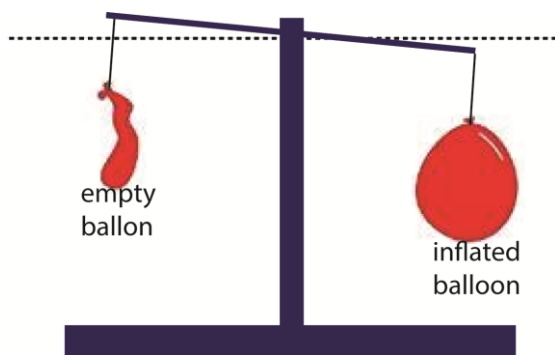
1. **Prepare the Glass**
 - Take a dry **tissue paper** and crumple it.
 - Place it **inside the bottom** of the glass.
 - Make sure the tissue doesn't fall out.
2. **Invert the Glass**
 - Turn the glass **upside down**.
 - Keep it **straight and steady**.
3. **Submerge the Glass in Water**
 - Lower the inverted glass **into the bowl of water**.
 - Make sure it is **fully submerged**, but **do not tilt** it.
4. **Observe What Happens**
 - Remove the glass from the water and check the tissue.

- The tissue remains **completely dry!**

Explanation:

- Air inside the **glass** takes up space.
- When the glass is **submerged**, water **cannot enter** because the air inside the glass is pushing back.
- This proves that **air occupies space**, preventing the water from reaching the tissue.

Experiment to show that air has weight



Materials Needed:

- **Two identical balloons**
- **A ruler or a wooden stick**
- **String**
- **A pin or needle**

Steps:

1. **Make a Balance**
 - Tie the **stick** in the middle using the **string** to hang it like a balance.
 - Attach **one balloon** to each end of the ruler.
 - Make sure both balloons are **empty** (not inflated) and balanced.
2. **Inflate One Balloon**
 - Blow air into one balloon and tie it securely.
 - Leave the other balloon as it is.
3. **Observe the Balance**
 - Attach both balloons to the ruler again.
 - The **side with the inflated balloon** will move **downward**, showing that it is heavier.

Explanation:

- Air inside the balloon has **mass**, and when added to the balloon, it increases its **weight**.
- This proves that **air has weight**, even though we don't always feel it.

How to determine the density of a liquid

Materials Needed:

- Weighing scale
- Graduated cylinder
- liquid

Steps to Measure Density

- Weigh an empty **graduated cylinder or container** = a g
- Pour the liquid ($V\text{cm}^3$) into the container and weigh it again = b g
- Mass of the liquid = $(b - a)\text{g}$
- Density of the liquid = $\frac{(b-a)}{V} \text{gcm}^3$

Density of the mixtures

Suppose a mixture of two components, say P and Q of masses M_p and M_q with volumes V_p and V_q ; the density of the mixture is obtained from the formula

$$\text{Density of the mixture} = \frac{M_p + M_q}{V_p + V_q}$$

Trial 12:

- (a) A liquid has a relative density of 45gcm^{-3} . Find its density in kgm^{-3}
- (b) Two substances x and y are mixed in such a way that a mass of 250g of x with volume 150cm^3 is mixed with a mass of 50g with volume 250cm^3 . Calculate the density of the mixture.
- (c) A mixture of density 0.25gcm^{-3} is made by mixing P of mass 240g and Q of mass xg. If the volume of P is 250cm^3 and the volume of Q is 750cm^3 . Find the mass of Q.
- (d) A glass box with a 10cm^3 base contains water to a height of 10cm^3 . The volume rose to 12cm^3 when a stone of mass 650g was dropped carefully into the box.
 - (i) Find the volume of the stone
 - (ii) Find the density of the stone in kgm^{-3}

Floating and sinking

A substance **floats** when its density is lower than that of the liquid and **sinks** when its density is higher than that of the liquid.

Relative density

The density of pure water is $1\text{gcm}^{-3} = 1000\text{kgm}^{-3}$

Relative density is the ratio of density substance to density of pure water

Mathematically

$$\text{Relative density} = \frac{\text{density of substance}}{\text{density of pure water}} \\ = \frac{\text{kg m}^{-3}}{\text{kg m}^{-3}}$$

∴ Relative density has no units.

Differences between relative density and density

Relative density	Density
Is the ratio of density of substance to density of pure water	Is the mass per unit of volume
Has no unit	S.I unit is kg m^{-3}

Example

Calculate the relative density of a block having dimension 4m x 3m x 2m given its mass in 48000g

$$V = L \times W \times H \\ = 4\text{m} \times 3\text{m} \times 2\text{m} \\ = 24\text{m}^3$$

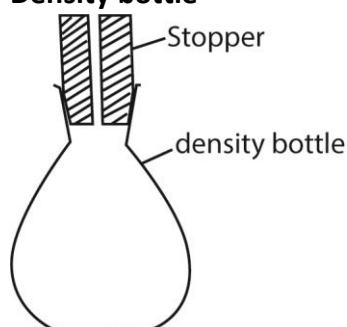
$$\text{Mass} = 48000\text{g} = \frac{48000\text{kg}}{1000} = 48\text{kg}$$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \\ = \frac{48\text{kg}}{24\text{m}^3} = 2\text{kg m}^{-3}$$

$$\text{Density of pure water} = 1000\text{kg m}^{-3}$$

$$\text{Relative density} = \frac{\text{density of block}}{\text{density of pure water}} \\ = \frac{2\text{kg m}^{-3}}{1000\text{kg m}^{-3}} = 0.002$$

Density bottle



The density bottle always contains exactly the same volume when the liquid when the bottle is full and the stopper is inserted, the excess liquid rises up through the hole levels is at the top of the hole.

Experiment to measure the relative density of a liquid by the use of density bottle

Procedure

- (i) Using a balance, obtain mass empty density bottle = M_d g
- (ii) Determine the mass of the bottle full of liquid $Q = M_q$
- (iii) Determine the mass of the bottle full of water = M_w

Calculations

$$\text{Mass of the liquid } Q = M_q - M_d$$

$$\text{Mass of water} = M_w - M_d$$

$$\text{Relative density} = \frac{M_q - M_d}{M_w - M_d}$$

Example

A density bottle weighs 20g when empty, 50g when full of liquid and 30g when full of water. Find the

- (a) Relative density liquid
 - (b) Density of liquid in
 - (i) kgm^{-3}
 - (ii) gcm^{-3}
- $$M_e = 20\text{g}$$
- $$M_L = 50\text{g}$$
- $$M_w = 30\text{g}$$

$$\begin{aligned} \text{(a) Relative density} &= \frac{M_L - M_e}{M_w - M_e} \\ &= \frac{50\text{g} - 20\text{g}}{30\text{g} - 20\text{g}} \\ &= \frac{30\text{g}}{10} \\ &= \mathbf{3} \end{aligned}$$

- (b) Density of water = 1000kgm^{-3}
 - (i) In kgm^{-3}
$$\mathbf{3} = \frac{\text{Density of liquid}}{1000\text{kgm}^{-3}}$$
Density of liquid = $3 \times 1000\text{kgm}^{-3}$
$$= \mathbf{3000\text{kgm}^{-3}}$$
 - (ii) In gcm^{-3}
$$\mathbf{3} = \frac{\text{Density of liquid}}{1\text{g cm}^{-3}}$$
Density of liquid = $3 \times 1\text{gcm}^{-3}$
$$= \mathbf{3\text{gcm}^{-3}}$$

Trial 13:

1. Given the data below
 - Mass of empty density bottle = 19g
 - Mass of bottle full of water = 69g
 - Mass of bottle full of liquid = 59g
 - (i) Find the mass of liquid in density bottle
 - (ii) Find the relative density of the liquid
 - (iii) Find the density of liquid in kgm^{-3}

2. The density bottle has a mass of 70g when empty, 90g when full of water and 94g when full of liquid. Find
- (i) Relative density of the liquid
 - (ii) The density of the liquid

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Thanks

Dr. Bbosa Science