IGCSE
OL
PHYSICS

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Topic 1.1 Physical Quantities and Measurements Techniques

Measurements

B) Measuring Volume

Volume is the space occupied by an object.

SI unit: Cubic Meter (m^3)

Different techniques are used to measure volume depending on the shape of the object and its state (solid, liquid or gas)

i) **Regular shapes**

Regular solid shapes have mathematical formulae to calculate their volume.

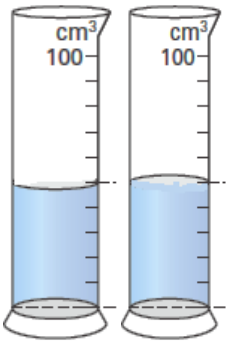
How to measure volume of regular shapes?

- Take one or more measurement of length according to the shape.
- Use a mathematical formula.

Shape	Volume formula
Cuboid	L x W x H
Cube	L^3
Sphere	$(4/3)\pi r^3$
Cylinder	$\pi r^2 h$

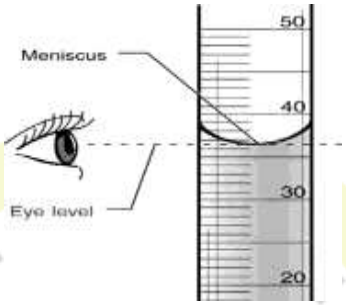
ii) **Liquids**

Volume of a liquid is measured using a graduated measuring cylinder.



Precautions:

- The measuring cylinder must be vertical, by putting it on a horizontal bench.
- The eye should be perpendicular to the scale at the liquid surface, to avoid parallax error.
- For water (and most of the liquids) take the bottom of the meniscus.
- For mercury, take the reading at the top of the meniscus.

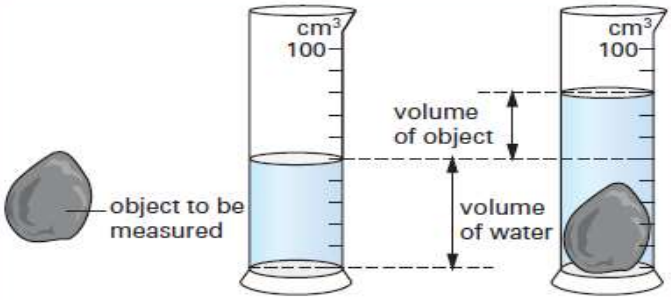


iii) **Irregular shapes**

The volumes of irregular shapes such as rocks are measured by displacement.

- Select a cylinder 3 or 4 times larger than the irregular body.
- Partially fill with water, and take the reading of volume.
- Immerse object in water, and take the reading of the new volume.
- The volume of the object is the difference between the two readings

$$Volume = Volume\ after\ immersion - volume\ of\ water$$

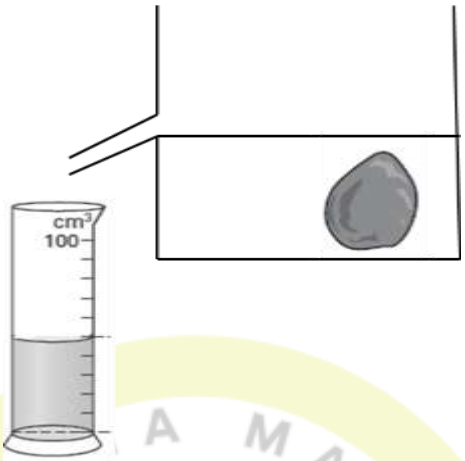


Large Irregular shapes

For larger irregular shapes use a displacement can and a measuring cylinder.

- Fill the can to the edge of displacement end, and a cylinder is just below this end.
- Immerse the object, collect the displaced water in the measuring cylinder, and measure its volume.
- The volume of the object is the volume of water in the measuring cylinder

$$Volume = Volume\ of\ water\ in\ the\ measuring\ cylinder$$



C) Measuring Time

SI unit: Seconds (s)

Tools:

Stopwatch	Ordinary Clock or Watch	Electronic Clock
		Starts and ends automatically with a certain trigger e.g. Sound, light, motion…etc.

Precautions:

Make sure that the stopwatch is reset to zero at the beginning of each measurement.

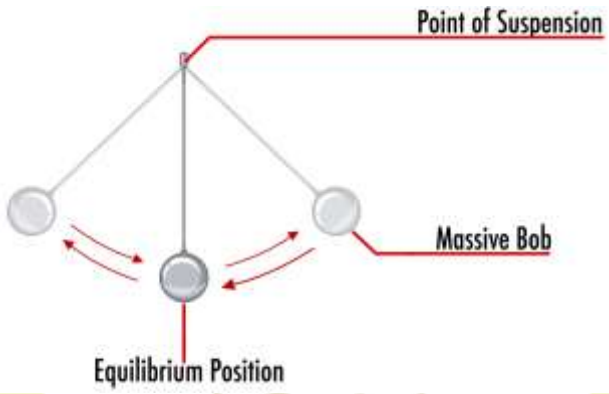
Errors

- Reaction time error. This is the time you take to press the start button of a stopwatch.
- Not using a properly stopwatch. For very small time intervals a stopwatch that gives time in milliseconds is more accurate.

Measuring the Period of a Pendulum

Pendulum it consists of a bob hanged vertically by a string.

It oscillates back and forth around its equilibrium position (in the middle)



Period is the time taken for one oscillation of the pendulum when it returns to its starting position in the same direction.

Procedures:

- Pull the bob a small distance to one side, and then release it so that it oscillates.
- Find the time for the bob to make several complete oscillations; e.g. 10 oscillations. Record the time on a stopwatch of 10 oscillations.
- The time of one oscillation (period):

$$T = \frac{time\ of\ 10\ oscillations}{10}$$

- Repeat several times from the same starting position of the bob.
- Calculate the average time of one oscillation.

Precautions:

- Make sure that the stopwatch is reset to zero at the beginning of each measurement.

Measuring the Period of a Pendulum for Different Length of String

Procedures:

- Measure the length of the string (length from the hanging point to the center of mass of the bob which is at its geometric center)
- Pull the bob a small distance to one side, and then release it so that it oscillates.
- Find the time for the bob to make several complete oscillations; e.g. 10 oscillations. Record the time on a stopwatch of 10 oscillations.
- The time of one oscillation (period):

$$T = \frac{time\ of\ 10\ oscillations}{10}$$

- Repeat several times from the same starting position of the bob.
- Calculate the average time of one oscillation.
- Change the string with a longer one
- Repeat the previous steps

Note that

To record the results of any experiment you need to formulate a table

Length/cm	Period/s			
	T_1/s	T_2/s	T_3/s	Average T/s