CHAPTER 2: MEASUREMENT 2

SI Units of physical quantities

The International System of Units or simply SI units is the modern form of the metric system and is generally based on a multiple or sub multiple of the number ten.

PHYSICAL QUANTITY	SI UNITS	SYMBOL FOR UNITS
mass	kilogram	kg
length	metre	m
volume	cubic metres	m^3
area	square metres	m^2
time	second	s
temperature	kelvin	K

Measuring mass

Experiment: To measure the mass of a stone using an electronic balance.

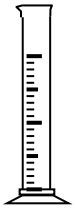
The mass of an object is a measure of the amount of matter in it and it is measured in kilograms (kg) using an electronic balance. A spring balance which is calibrated in kilograms can sometimes be used to measure mass.

1 metric ton or tonne= 1000 kg
1 kg = 1000 g
1 g = 1000 mg

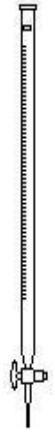
Measuring volume

Experiment: To measure the volume of some water using a measuring cylinder.

The volume of an object is the space it occupies in three dimensions. The volume of a liquid is measured directly by placing it in a measuring cylinder. If the liquid is mercury, we must place one eye on the same level as the top of the meniscus before taking the reading. For all other liquids, we must place one eye on the same level as the bottom of the meniscus before taking the reading.



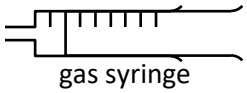
measuring cylinder



burette

volumetric pipette

For accurate measurements, scientists also use burettes and pipettes to measure the volumes of liquids.



To measure the volume of a gas, we use an apparatus called a gas syringe.

Some useful conversions of volume are:

$1\ m^3 = 1{,}000{,}000\ cm^3$ or ml

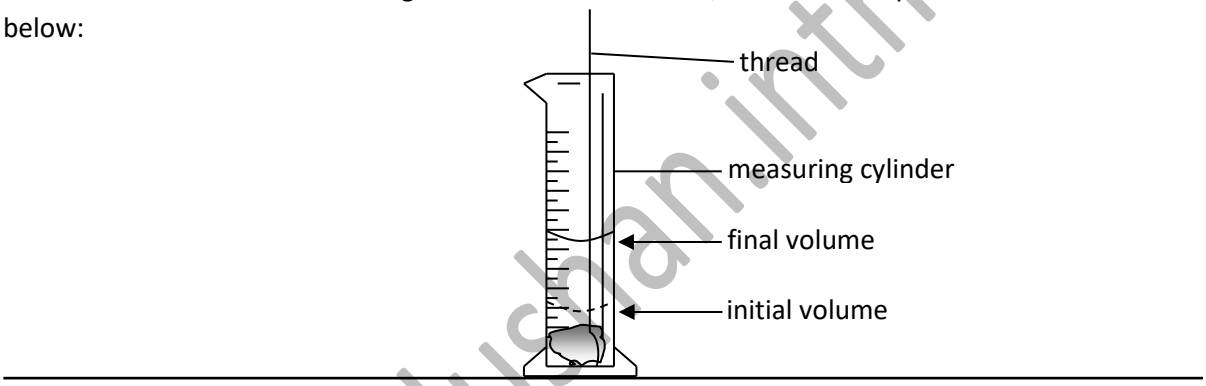
$1\ cm^3 = 1000\ mm^3$

1 litre or l = 100 cl = 1000 ml or cm^3

Volume of irregular solids

Experiment: To determine the volume of a stone using the displacement method.

To measure the volume of an irregular solid such as a stone, we use the displacement method described below:



A measuring cylinder is filled with a known volume of water. Using a thread, the stone whose volume is to be determined is carefully immersed into the measuring cylinder. The final volume is then noted. The volume of the irregular object is given by the formula:

volume of irregular object = (final volume—initial volume)

Before reading the volume, we must place the eye on the same level as the lowest part of the meniscus.

Accuracy in measurements

Whichever branch of science we study, we have to make accurate measurements to ensure standard and universally accepted values. A measurement is said to be accurate when it is as close as possible to the true value.

Different instruments are used to measure different physical quantities to obtain accurate results.

During the measurement of simple quantities, we:

1. ask different persons to repeat the measurement (sometimes with a different set of the same instrument) to ensure that the values are the same or, at least, very close to each other,
2. repeat the measurement at least four times and then calculate the average value,

3. express the physical quantity as a number, a unit and sometimes a direction, for example, '10 m to the North.'

Relative densities of solids, liquids and gases

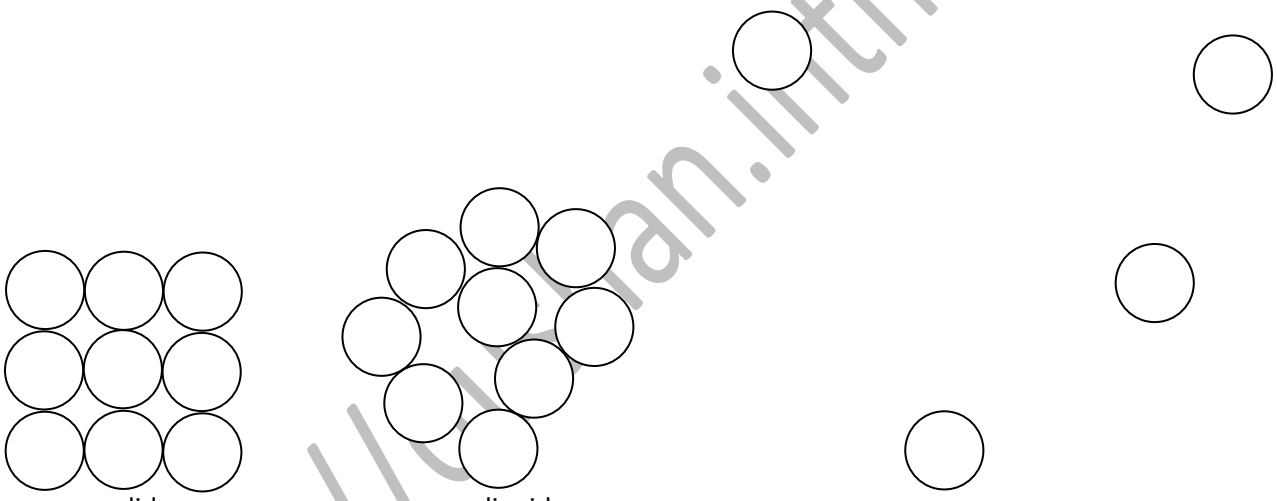
Density is defined as the mass per unit volume of a substance.

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

where density is measured in kg/m^3 or g/cm^3,
mass is measured in kg or g,
volume is measured in m^3 or cm^3.

The more mass there is, in a given volume, the greater the density of that substance will be.

The diagrams below represent the packing of the particles in a solid, in a liquid and in a gas.



Since the particles in a solid are very closely packed together in a regular manner, a solid has the highest density of the three states of matter. This is because there are more particles and therefore more mass per unit volume in a solid.

The particles in a liquid are closely packed together in a random manner, and therefore the density of a liquid is still high but lower compared to that of a solid.

In a gas the particles are so loosely packed (far apart in a random manner) that a gas has the lowest density of the three states of matter. This is because there are fewer particles and therefore less mass per unit volume in a gas.