CHAPTER 2: MEASUREMENT 1

Physical quantities

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.

A physical quantity is one that can be expressed in numbers either by measuring or by calculating it. Thus, the physical quantity 'mass' can be expressed by stating a number in its appropriate units, for example, '12 g'. Honesty, on the other hand, is not a physical quantity because it cannot be expressed in numbers.

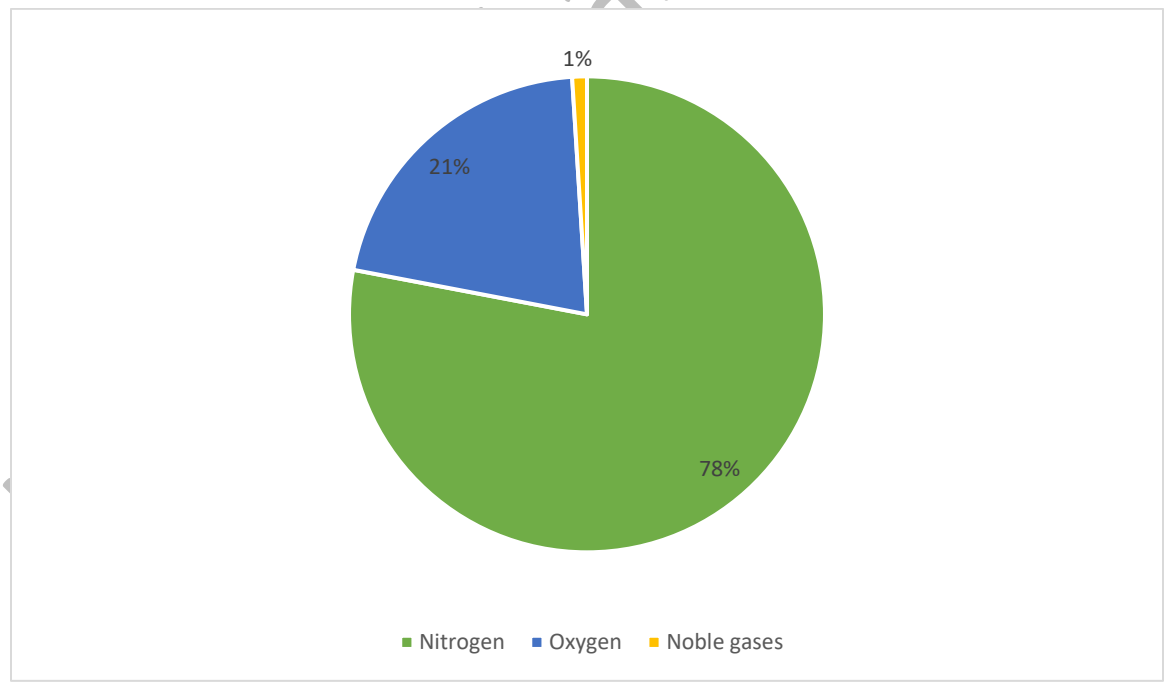
Different instruments are used to measure different physical quantities to obtain accurate results.

Representing data using tables and charts

To make data easier to learn or understand, scientists often represent them using tables or charts.

A table consists of a list of facts or numbers arranged in a special order, usually in rows and columns. The most important table used by chemists is called the Periodic Table of the Elements.

A chart is a graphical representation of data, in which the data is represented by symbols, such as bars in a bar chart or slices in a pie chart. For example, a pie chart can be used to represent the percentage composition of the three main gases present in air.



Measuring mass

Experiment: To measure the mass of some salt 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.

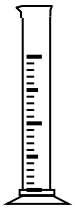
1 metric ton or tonne= 1000 kg
1 kg = 1000 g
1 g = 1000 mg

Measuring volume

Experiment: To measure the volume of a liquid chemical using a measuring cylinder.

The volume of an object is the space it occupies in three dimensions. We can calculate the volume of regular objects using appropriate formulae.

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.

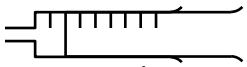


measuring cylinder

burette

volumetric pipette

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



gas syringe

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

Measuring time

Experiment: Measuring the time it takes for hydrochloric acid to corrode a magnesium ribbon.

Time is a measure of the duration of an event and it is measured in seconds (s). Longer intervals of time are measured using a clock, a watch or a stop clock. Shorter intervals of time are measured using an analogue or digital stopwatch.

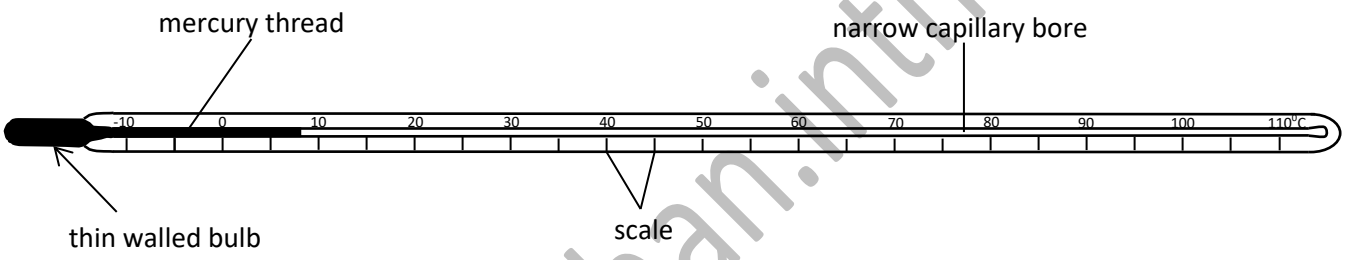
1 h = 60 minutes
1 minute = 60 s

Measuring temperature

Experiment: To measure the temperature of a liquid chemical using a laboratory thermometer.

Temperature is the degree of hotness and it is measured in kelvins (K) using a thermometer.

We can measure temperature with a mercury-in-glass thermometer or a digital thermometer. The laboratory thermometer shown below can measure temperature ranging from -10 ^{0}C to 110 ^{0}C. The smallest division on its scale represents 1 ^{0}C.



If we know the temperature in degrees celsius (^{0}C), we can calculate the temperature in kelvins simply by adding the number 273 to it.

The importance of data loggers

Experiment: To monitor the pH of aquarium water for a week.

A data logger is an electronic device, with a built-in instrument or sensor that records data over time or in relation to location. They are based on a digital processor or computer. They are generally small, battery-powered, portable, and equipped with sensors, a microprocessor and internal memory for data storage. Some data loggers interface with a personal computer and utilize software to activate the data logger and to view and analyse the collected data. Other models have a local interface device (keypad or LCD) and can be used as a stand-alone device.

One of the primary benefits of using data loggers is the ability to automatically collect data on a 24-hour basis. Upon activation, data loggers are typically deployed and left unattended to measure and record information for the duration of the monitoring period. This allows for a comprehensive, accurate picture of the environmental conditions being monitored, such as soil moisture level recording, gas pressure recording, water temperature or pH. Data loggers are also used for science education enabling 'measurement', 'scientific investigation' and an appreciation of 'change'.