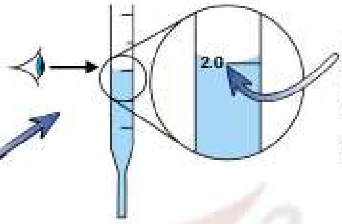
Taking Measurements

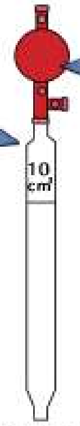
As part of your assessment, you'll sit a paper that will test your practical (experimental) skills. There are a few things you need to know about practical work. These pages are about using apparatus to take measurements.

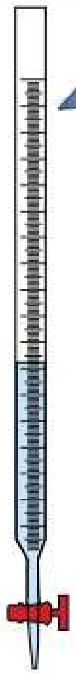
Three Ways to Measure Liquids

There are a few methods you might use to measure the volume of a liquid. Whichever method you use, always read the volume from the bottom of the meniscus (the curved upper surface of the liquid) when it's at eye level.



Pipettes are long, narrow tubes that are used to suck up an accurate volume of liquid and transfer it to another container. A pipette filler attached to the end of the pipette is used so that you can safely control the amount of liquid you're drawing up. Pipettes are often calibrated to allow for the fact that the last drop of liquid stays in the pipette when the liquid is ejected. This reduces transfer errors.

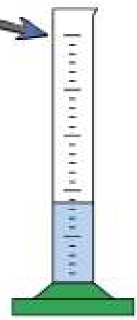




Burettes measure from top to bottom (so when they're filled to the top of the scale, the scale reads zero). They have a tap at the bottom which you can use to release the liquid into another container (you can even release it drop by drop). To use a burette, take an initial reading, and once you've released as much liquid as you want, take a final reading. The difference between the readings tells you how much liquid you used.

Burettes are used a lot for titrations. There's loads more about titrations on page 81.

Measuring cylinders are the most common way to measure out a liquid. They come in all different sizes. Make sure you choose one that's the right size for the measurement you want to make. It's no good using a huge 1000 cm³ cylinder to measure out 2 cm³ of a liquid — the graduations will be too big, and you'll end up with massive errors. It'd be much better to use one that measures up to 10 cm³.



If you only want a couple of drops of liquid, and don't need it to be accurately measured, you can use a dropping pipette to transfer it. For example, this is how you'd add a couple of drops of indicator into a mixture.

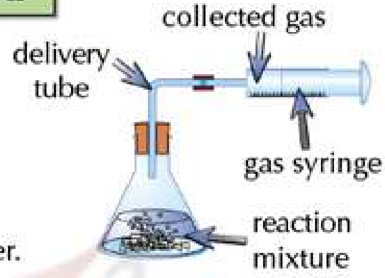
Solids Should Be Measured Using a Balance

1) To weigh a solid, start by putting the container you're weighing your substance into on the balance.
2) Set the balance to exactly zero and then start weighing out your substance.
3) It's no good carefully weighing out your solid if it's not all transferred to your reaction vessel — the amount in the reaction vessel won't be the same as your measurement. Here are a couple of methods you can use to make sure that none gets left in your weighing container...

- If you're dissolving the solid in a solvent to make a solution, you could wash any remaining solid into the new container using the solvent. This way you know that all the solid you weighed has been transferred.
- You could set the balance to zero before you put your weighing container on the balance in order to find the mass of the empty container, then reweigh the weighing container after you've transferred the solid. Use the difference in mass to work out exactly how much solid you added to your experiment.

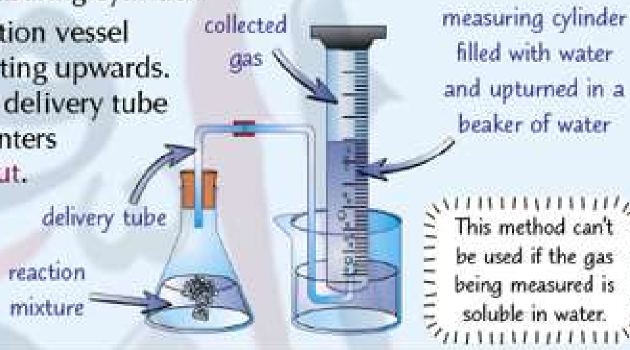
Taking Measurements

To Collect **Gases**, the System Needs to Be **Sealed**



1) There are times when you might want to collect the gas produced by a reaction in order to measure it. For example, to investigate the rate of the reaction.
2) One way to measure the volume of a gas that's been produced is to collect it in a gas syringe (see page 64).
3) You could also collect it by displacing water from a measuring cylinder. Here's how you do it...

- Fill a measuring cylinder with water, and carefully place it upside down in a container of water. Record the initial level of the water in the measuring cylinder.
- Position a delivery tube coming from the reaction vessel so that it's inside the measuring cylinder, pointing upwards. Any gas that's produced will pass through the delivery tube and into the measuring cylinder. As the gas enters the measuring cylinder, the water is pushed out.
- Record the level of water in the measuring cylinder and use this value, along with your initial value, to calculate the volume of gas produced.



This method can't be used if the gas being measured is soluble in water.

4) When you're measuring a gas, your equipment has to be sealed or some gas could escape and your results wouldn't be accurate.
5) If you just want to collect a sample to test (and don't need to measure a volume), you can collect it over water as above using a test tube. Once the test tube is full of gas, you can stopper it and store the gas for later.

If the delivery tube is underneath the measuring cylinder rather than inside it then some of the gas might escape out into the air.

Measure **Temperature** Accurately

You can use a thermometer to measure the temperature of a substance:

1) Make sure the bulb of the thermometer is completely submerged in any mixture you're measuring, but not touching the inside of the container.
2) If you're taking an initial reading, you should wait for the temperature to stabilise first.
3) Read your measurement off the scale on a thermometer at eye level to make sure it's correct.

You May Have to Measure the **Time Taken** for a Change

1) You should use a stopwatch to time experiments. Most of them measure to the nearest 0.01s, so they are sensitive. (You can use a clock to measure time, but these are only accurate to the nearest second.)
2) Always make sure you start and stop the stopwatch at exactly the right time. For example, if you're investigating the rate of an experiment, you should start timing at the exact moment you mix the reagents and start the reaction. If you're measuring the time taken for a precipitate to form, you should watch the reaction carefully so you can stop timing the moment it goes cloudy.

WORKING SCIENTIFICALLY

Have your stopwatch ready before you try to time something

To make sure your results can be trusted by other scientists, you have to make sure all your measurements are accurate. So make sure you learn all the tips on these two pages for improving accuracy — e.g. using the right size of measuring cylinder for the volume of liquid you want.

Purity

Substances are often not 100% pure — they might have other stuff that you can't see mixed in with them.

Pure Substances Contain Only One Thing

1) In everyday life, the word 'pure' is often used to mean 'clean' or 'natural'.
2) In chemistry, it's got a more specific meaning — a substance is pure if it's completely made up of a single element or compound.
3) If you've got more than one compound present, or different elements that aren't all part of a single compound, then you've got a mixture.
4) So, for example, fresh air might be thought of as nice and 'pure', but it's chemically impure, because it's a mixture of nitrogen, oxygen, argon, carbon dioxide, water vapour and various other gases.
5) Lots of mixtures are really useful — alloys (see page 96) are a great example. But sometimes chemists need to obtain a pure sample of a substance.
6) And it's really important that some everyday substances are pure.

For example, in the manufacture of drugs or foods, using impure ingredients could be dangerous for consumers. This means a company might check the purity of the ingredients before using them, or check the product contains the correct ingredients (and nothing else) after it is made.

You Can Test for Purity Using Melting Points

1) Every pure substance has a specific, sharp melting point and boiling point. For example, pure ice melts at 0 °C, and pure water boils at 100 °C.
2) You can use this to test the purity of a sample of a substance, by comparing the actual melting point of the sample to the expected value.
3) If a substance is a mixture then it will melt gradually over a range of temperatures, rather than having a sharp melting point, like a pure substance.
4) Impure substances will melt over a range of temperatures, because they are effectively mixtures.

You can also use the boiling point to test for purity, but boiling points tend to be harder to measure.

Example: The melting points of four powdered solids, A, B, C and D, are shown below.

Solid	A	B	C	D
Melting point / °C	82	72-79	101	63

Which of the four solids, A, B, C or D, is a mixture?

Answer: B — Solid B must be a mixture, because it melts over a range of temperatures (rather than melting at a specific temperature, as the other three solids do).

5) Impurities will usually decrease the melting point and increase the boiling point of a substance. For example, seawater (water containing salts and other compounds) melts at about –2 °C and boils at about 100.4 °C.

Pure substances are made up of one element or compound...

...so their melting points and boiling points are specific. There are many different ways to extract a pure substance from a mixture. You'll learn about some of these techniques over the next few pages.