# M1.11 Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined

### Tutorials

Learners may be tested on their ability to:

* calculate percentage error where there are uncertainties in measurement.

### Uncertainties

Any measurement we make tells us about a property of something. It might tell us how long something is, how heavy it is, how much coverage something has. The measurement gives a number to that property.

To make measurements we almost always need an instrument of some kind: a ruler, a thermometer, a quadrat, a top pan balance etc.

The measurement is recorded as both a number and a unit:

e.g. how hot is this flask of water?

37, degrees Celsius

When we make a measurement there is always some level of uncertainty. A well-made instrument should be trustworthy and give accurate, repeatable measurements. But for every measurement there is always a margin of doubt. We might describe this as accurate to within a given value of uncertainty. An example might be a measuring cylinder, which measures volumes of liquid to within 0.5 cm3. For example we might measure out 300 cm3 of liquid ±0.5 cm3, which means the true volume might be anywhere between 299.5 cm3 and 300.5 cm3.

For this instrument ±0.5 cm3 is the absolute uncertainty. It doesn’t matter how much liquid we measure; the measurement could always be out by this amount.

The relative uncertainty or **percentage error** is the ratio of absolute uncertainty to the original measurement, expressed as a percentage.

For example, when measuring 300 cm3 the relative uncertainty is

However, if I measured out only 50 cm3 the relative uncertainty is

So we can see that the amount of relative uncertainty is not fixed, it is dependent on the amount of absolute uncertainty afforded by the instrument, **and** the size of the measurement we are making.

When making more than one measurement, we must account for the absolute uncertainty for each new measurement.

If I measure out 65 cm3 of hydrochloric acid then there is an absolute uncertainty of 0.5 cm3, If I measure out and add 30 cm3 of sodium hydroxide solution, then there is also an absolute uncertainty of 0.5 cm3. Giving a total absolute uncertainty of 1 cm3. Therefore my combined volume is 95 cm3 ± 1 cm3.

My relative uncertainty for this measurement is

The same idea applies when we are looking at the change in a value, by subtracting the initial value from the final value.

For example we could use a top pan balance for simple potometry (measuring the water loss from a plant by change in mass).

For this example assume we are using a top pan balance with an absolute uncertainty of +/- 0.1 g

We take our initial mass measurement: 117.3 g

24 h later we take our final measurement: 110.0 g

To find the change in mass we subtract the initial value from the final value:

110.0 g – 117.3 g = - 7.3 g

The plant has changed mass by – 7.3 g (i.e. its mass has fallen by 7.3 g)

The **absolute** uncertainty associated with this figure is the sum of the absolute uncertainties of each measurement:

* 1. g + 0.1 g = 0.2 g

The **percentage error** or **relative uncertainty** is found, as in the previous examples, by dividing the absolute uncertainty by the measured value and expressing the result as a percentage:

**Document updates**

v1.0 April 2017 Original version.

v1.1 June 2019 Changed how the word accuracy was used in order to be in line with the ‘Language of measurement’

**OCR Resources**: *the small print*OCR’s resources are provided to support the delivery of OCR qualifications, but in no way constitute an endorsed teaching method that is required by the Board, and the decision to use them lies with the individual teacher. Whilst every effort is made to ensure the accuracy of the content, OCR cannot be held responsible for any errors or omissions within these resources.   
© OCR 2019 - This resource may be freely copied and distributed, as long as the OCR logo and this message remain intact and OCR is acknowledged as the originator of this work.

OCR acknowledges the use of the following content: n/a

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: [resources.feedback@ocr.org.uk](mailto:resources.feedback@ocr.org.uk)

We’d like to know your view on the resources we produce. By clicking on ‘[Like’](mailto:resources.feedback@ocr.org.uk?subject=I%20liked%20the%20A%20Level%20Biology%20Maths%20resource%20M1.11%20Text%20Tutorial) or ‘[Dislike’](mailto:resources.feedback@ocr.org.uk?subject=I%20disliked%20the%20A%20Level%20Biology%20Maths%20resource%20M1.11%20Text%20Tutorial) you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click ‘Send’. Thank you.

If you do not currently offer this OCR qualification but would like to do so, please complete the Expression of Interest Form which can be found here: [www.ocr.org.uk/expression-of-interest](http://www.ocr.org.uk/expression-of-interest)

Looking for a resource? There is now a quick and easy search tool to help find free resources for your qualification:   
[www.ocr.org.uk/i-want-to/find-resources/](http://www.ocr.org.uk/i-want-to/find-resources/)

This resource has been produced as part of our free A Level teaching and learning support package. All the A Level teaching and learning resources, including delivery guides, topic exploration packs, lesson elements and more are available on the qualification webpages.

If you are looking for examination practice materials, you can find the Sample Assessment Materials (SAMs) on the qualification webpages: [Biology A](http://www.ocr.org.uk/qualifications/as-a-level-gce-biology-a-h020-h420-from-2015/) / [Biology B](http://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/)

### Produced in collaboration with the University of East Anglia