Measuring

Most experiments involve taking measurements of physical quantities, such as temperature, volume, mass, or time. To obtain accurate data, you need to use an instrument suited to the size of the quantity you are measuring.

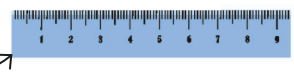
Key facts

- ✓ **Most experiments involve measurements of physical quantities, such as temperature, volume, mass, or time.**
- ✓ **Instruments that can measure large quantities are usually not accurate when measuring small quantities.**

Length and distance

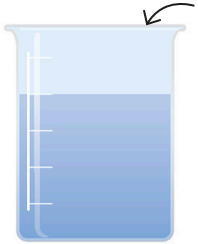
Use a tape measure to measure longer distances, such as when finding your walking speed over 10 meters.

Use a ruler to measure the length of a small object.



Volume

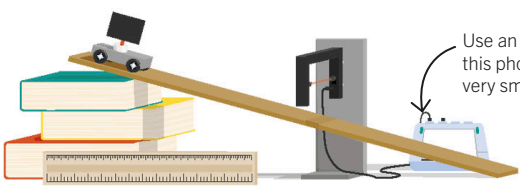
Use a beaker or large measuring cylinder for measuring large volumes of liquid.



Use a small measuring cylinder for small volumes of liquid.

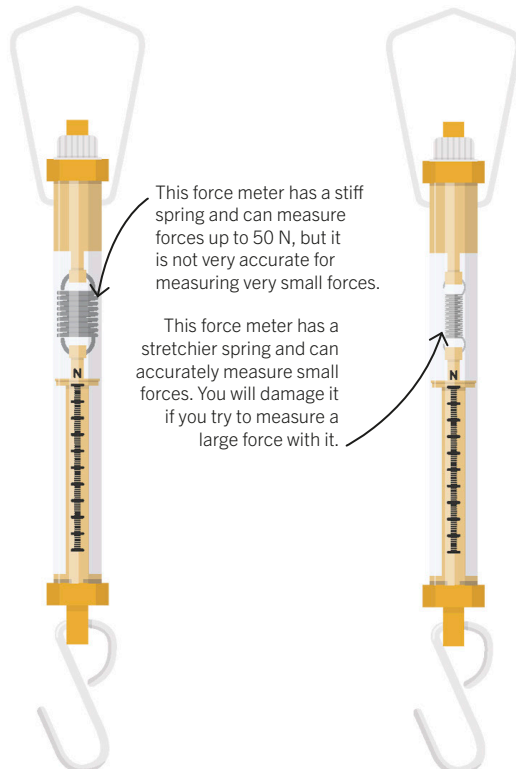
Time

Use a stopwatch to measure periods of time greater than 10 seconds.



Use an electronic timer, like this photogate, to measure very small time intervals.

Force



This force meter has a stiff spring and can measure forces up to 50 N, but it is not very accurate for measuring very small forces.

This force meter has a stretchier spring and can accurately measure small forces. You will damage it if you try to measure a large force with it.

Electronic instruments

Electronic instruments are often more accurate than manual versions. However, this doesn't always make them the best choice. They are more expensive and easier to damage, so they should only be used in experiments where greater accuracy is necessary.

A digital multimeter can measure voltage, current, and resistance.

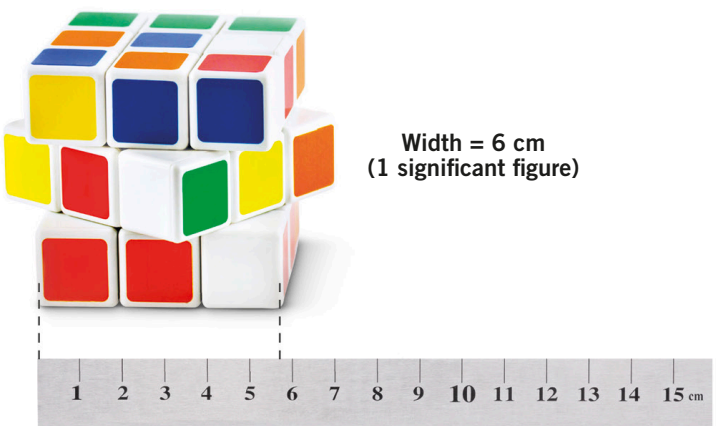
Test leads are connected to circuits.

Significant figures

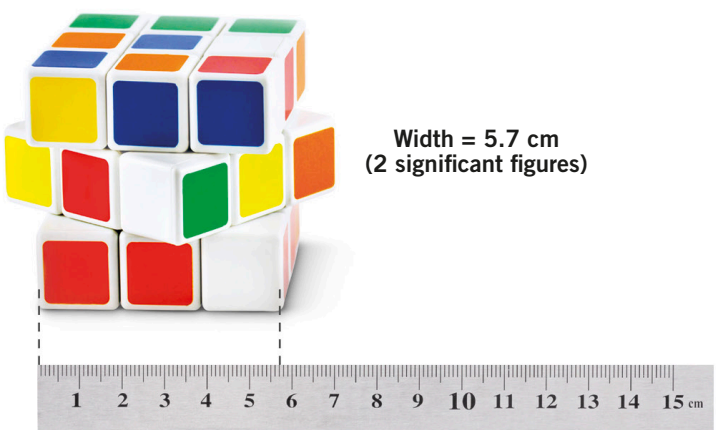
The significant figures in a number are the digits that have meaningful information. More accurate measuring devices produce values with more significant figures. When collecting data or doing calculations, we often need to round numbers up or down to just a few significant figures.

Recording data

The number of significant figures depends on the measuring instruments you use. For instance, a ruler with a scale divided into centimeters gives fewer significant figures than a ruler with a scale divided into millimeters. Digital instruments often give more significant figures than traditional ones (but this doesn't necessarily mean they are more accurate).



Width = 6 cm
(1 significant figure)



Width = 5.7 cm
(2 significant figures)

Key facts

- ✓ **More accurate measuring instruments produce values with more significant figures.**
- ✓ **When multiplying or dividing, round answers to the same number of significant figures as the least accurate starting value.**
- ✓ **When adding or subtracting, round answers to the same number of decimal places as the least accurate starting value.**

Using calculators

Sums done on calculators may give you more significant figures than you need. Suppose you calculate the resistance of a light bulb using the formula below. You use readings from a voltmeter and an ammeter that each show values to three significant figures.

$$R = \frac{8.12\ \text{V}}{1.04\ \text{A}}$$

The answer on a calculator is 7.8076923.

Writing your answer like this implies you know the resistance to 8 significant figures, but the measuring instruments were only accurate to 3 significant figures, so your answer should be too:

$R = 7.81\ \Omega$ (3 s.f.)

When multiplying or dividing, round your answer to the same number of significant figures as the least accurate starting value. When adding or subtracting, round your answer to the same number of decimal places as the least accurate starting value.