Measurement

National curriculum objectives:

- take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate

Science in the news today

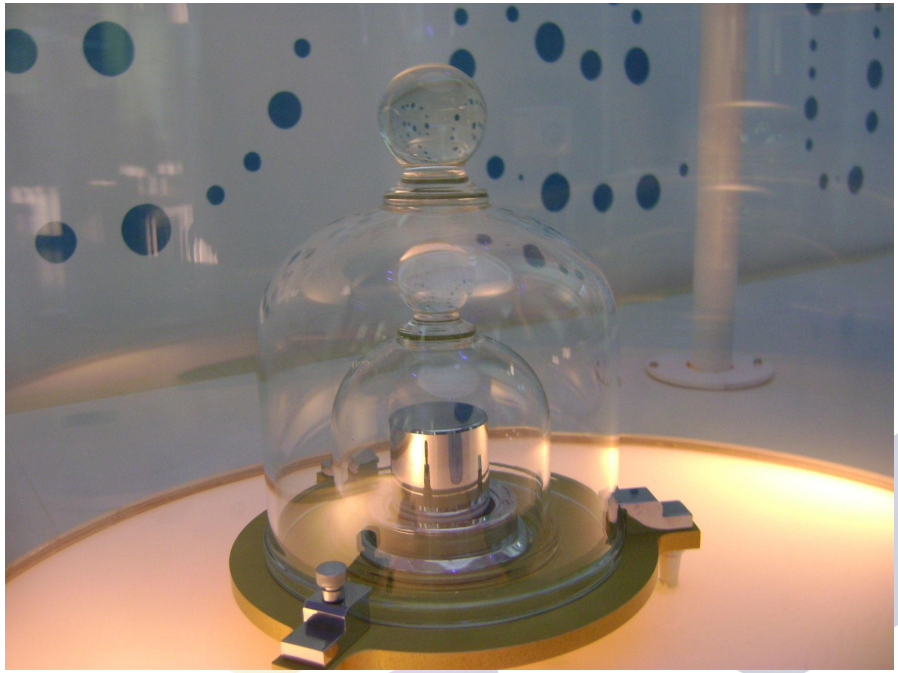
THE KILOGRAM'S REPLACEMENT

The **International Prototype of the Kilogram** (IPK) is a metal cylinder that ***had*** a mass of exactly 1 kilogram. It is impossible to make two objects that weigh exactly the same, so in 1889 it was internationally agreed this single item was the master mass standard which every mass measurement on earth refers to. Even though storage in airtight containers in a basement vault in Paris reduced pollution sticking to its surface increasing its mass, special cleaning was required before use. For enhanced security, three separate keyholders had to unlock the vault.

However, last year was a landmark year in the world of measurement because on 20 May 2019, the way we define mass changed. The new definition replaces the single item with extremely accurate balances that use electricity, magnets and gravity. These balances (invented by NPL scientist Bryan Kibble) can give more accurate results than by comparing against the IPK, and of course there can be many 'Kibble Balances' rather than having to rely on just one IPK.

Here is a picture of the International Prototype of the Kilogram

The International Prototype of the Kilogram, stored under 2 bell jars.



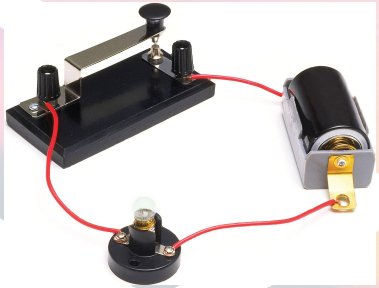
What can we measure?

weight/mass

time

distance

volume/capacity

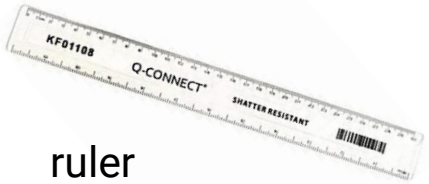


electricity

temperature

How do we take measurements?

bathroom and kitchen scales
grams (g) and kilogram (kg)



ruler
centimetres (cm) and millimetres (mm)

measuring jug
Litres (l) and millilitres (ml)

tape measure
metres (m) and centimetres (cm)

stop clock
hours, minutes and seconds

thermometer
degrees celsius (℃)

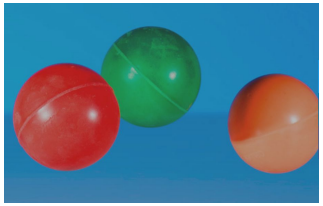
How to take accurate measurements

All of the equipment in the last slide is used to take measurements. However, to get an *accurate* measurement of something, we need to repeat measurements multiple times and compare. Taking an average of the measurements can be the most accurate way of measuring (like in the experiment on the following slide).

	1st bounce	2nd bounce	3rd bounce
Tennis ball			
Cricket ball			
Golf ball			

This is really important to make your data more reliable and accurate.

Temperature bounce



What do you need?

- Flat hard floor next to a wall
- Tape measure or ruler
- Blu-tack
- One or more balls - tennis, ping pong etc.
- Pencil and paper
- Plastic bag

Instructions:

1. First, mark a point 1 metre from the ground on a wall.
2. Next, hold a ball so its lowest point is at the 1 metre point.
3. Then, drop the ball and mark where the lowest part of the ball is after the first bounce. Top tip - When looking at the bounce height, keep your head in the same place each time.
4. Repeat 6 times to obtain 6 marks.
5. Meanwhile, measure (and write down) the average of the 6 tests, and also the range. If the range is 3 cm, write it as +/- 1.5cm.
6. Repeat using as many balls as you wish (and have space to store in your freezer).
7. After that, Put tested balls into a plastic bag and store them in the freezer overnight.
8. After a night in the freezer, repeat the bounce tests with the balls. Make sure you test each one immediately after removing from the freezer, so it doesn't have time to warm up. Again, record the average and the range.
9. Finally, make a comparison - how does temperature affect bounciness?

NPL

Invent a unit

Metres, seconds, newtons, kilograms and amps are all examples of units that we all use to measure things

What do you need?

- **Just your imagination**

Instructions:

1. First think about what a measurement unit is used for.
2. Next, think about what matters to you and how your new measurement unit might help you and others. For instance, a unit to measure a sensible amount of screen time spent each day. What would you call it?
3. Think of a good name for your unit. It could relate to its use, like the candela, which connects to the brightness of a candle. Maybe you could name it after yourself, like the Newton which measures force.

Some examples include the beard-second, a humorous (not internationally recognised) length unit which is how long a beard grows in one second and the Mickey (named after Mickey Mouse) is the length of the smallest detectable movement of a computer mouse.

NPL