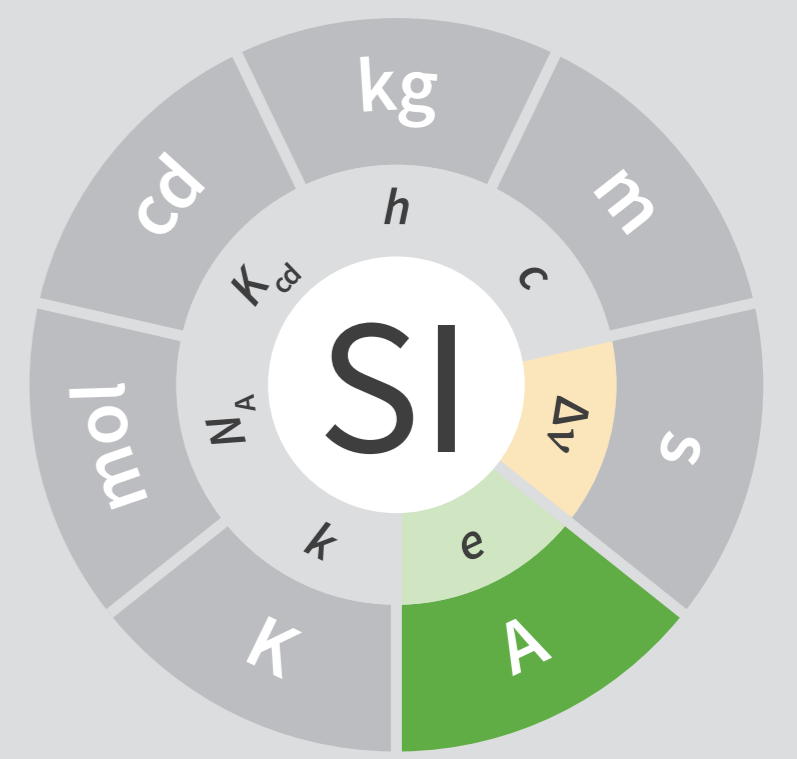


# electrical measurement A ampere



## Electrical measurement matters

Electrical measurements are important in lots of areas of science and engineering:

- They include measurements of current, voltage, resistance and capacitance.
- Changes in the electrical resistance of platinum wires are used to detect changes in temperature.
- Changes in electrical capacitance are used to detect changes in humidity.
- Many sensors convert changes in pressure, or temperature, or other quantities into voltage changes that can be read by computers.
- Measurements of current and voltage are used to measure electrical power.
- Microphones convert sound pressure oscillations into tiny voltage and current oscillations.

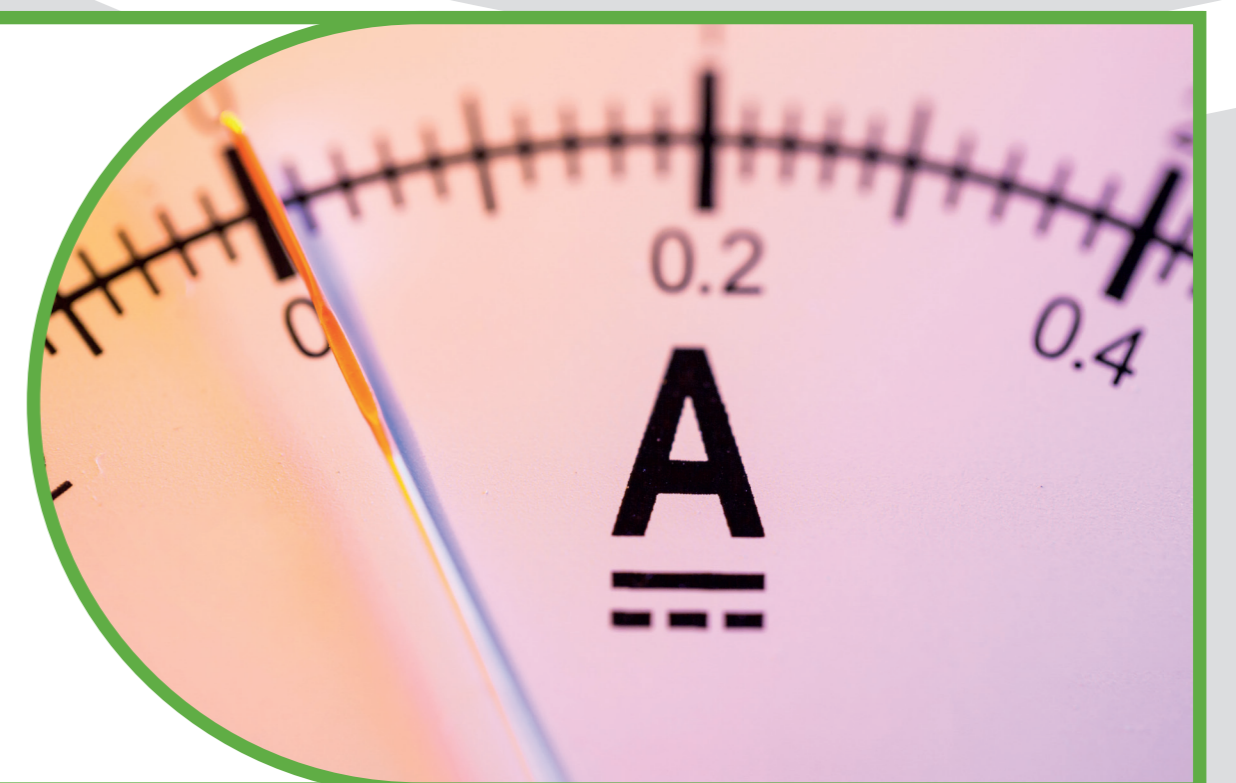
## Electrical measurements

Electrical measurements used to be made by passing an electrical current through a coil in a magnetic field to cause a meter indicator to move.

Now we normally make electrical measurements in terms of voltages using an analogue-to-digital converter (ADC) chip.

Some ADCs act very quickly and can measure 1 billion voltages every second.

Some ADCs act slowly and can measure voltages very precisely.



## Definition

The SI base unit for electrical current, the ampere, is defined in terms of two fundamental constants

- $e$
- $\Delta v$

The units for voltages, the volt, and resistances, the ohm, use an additional fundamental constant

- $h$

Standard voltages are created using quantum mechanical devices called Josephson junctions. When microwave radiation with frequency  $f$  is shone on a Josephson junction, it produces a DC voltage with the exact value

$$V = \frac{h}{2e} f$$

Standard resistances are created using quantum mechanical devices called 'quantum Hall effect' devices. These have resistances which are exact multiples of

$$R = \frac{h}{e^2}$$

Standard currents are created using standard voltages and resistances.



## Did you know?

A typical lightning strike has a current of 20 000 A for about 1/10 000 of a second. There are 300 000 a year in the UK, but only 15% reach the ground.