Resistance in a wire vs length.
(Snapshot version)

Technician and teacher sheet

Apparatus

- Voltage and Current sensor 20V 1.0 A
- Metre rule
- Dry cell power pack (3 cells, 4.5V)
- Crocodile clips.
- 4 mm plugged patch leads.
- Masking tape.
- Vernier calipers or micrometer gauge.
- 1.2 metres constantan wire per group. Typically 0.236 mm diameter (34 SWG) 11.2 ohms/metre.

Data recording setup.

Use snapshot data collection with “prompt for value” active. This will be the distance measurement.

Practical outline.

This activity looks at the relationship between the resistance of a wire and its length and cross sectional area.

The data logger will be used to collect, store and present the data.

Voltage, current and distance are collected. A plot of resistance (calculated) against distance is produced.

Practical notes

The recommended wire 34 S.W.G. Constantan gives a reading of just under 1 A at 10 cm with a 1.5 V cell. The current will vary with the condition of the cell being used and the cell technology. On this basis we would recommend instructing the students to go no closer than 30 cm from zero. Data will be a good straight line and a line that passes through 0/0 is easily achievable as a value for the resistance per meter that is within 5% of the given specification for the wire.

The crocodile clip connected to one end of the wire will remain fixed, the other crocodile clip will be used as a jockey along the length of the wire. The position of the jockey relative to the fixed crocodile clip will be the length measurement, this can be taken direct from the metre rule. It may be necessary to show students and reassure them of the language used to describe the set up and use of the apparatus.

The wire is bound to the ends of the ruler with masking tape (to make a semi permanent setup, can be removed easily after use with limited residue)

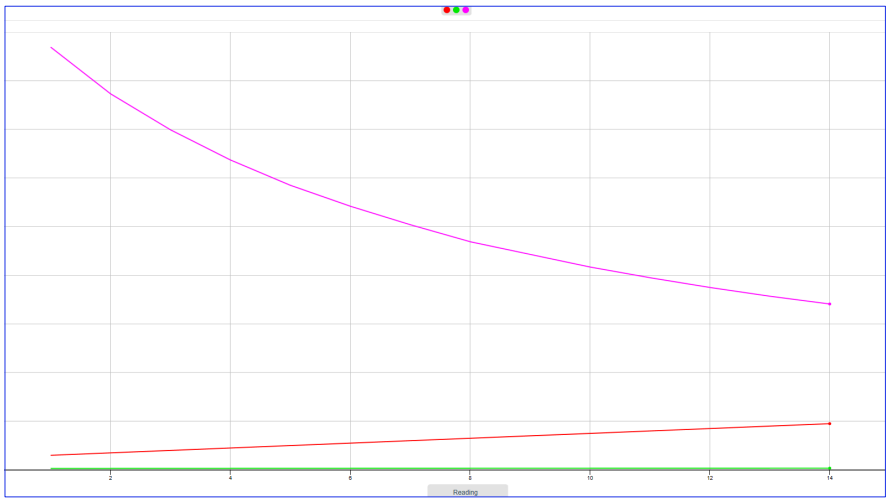
The resistance of the wire is proportional to the length of the wire. Constantan wire has defined values of resistance per metre, the information should be on the spool. You can use a resistance meter to find the ohms / metre value for reference.

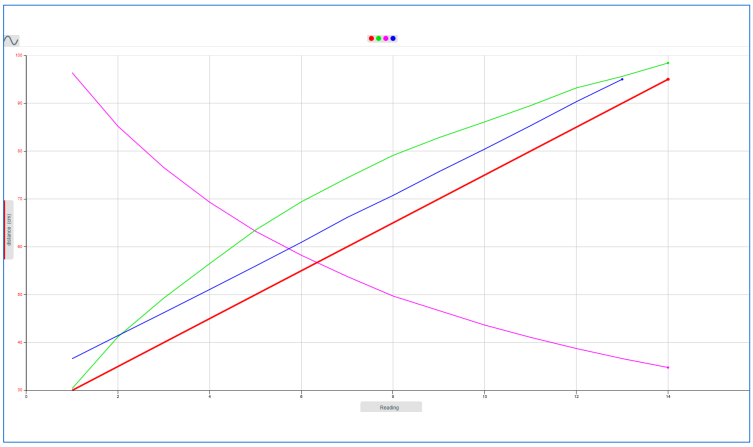
This activity uses the logger and software as a two channel multimeter, (voltage and current). Values will be recorded by the snapshot recording.

The EasySense2 software can calculate and display the resistance if required.

Example data.

Three 1.5 volt cells were used in the collection. Snapshot data collection used, user entered distance data after each collection of voltage and current.





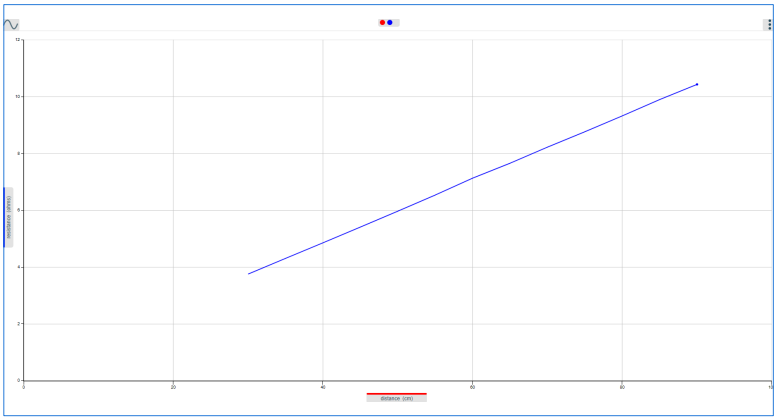
Same data, resistance calculated, multiscale selected to maximise the graph line presentation. Note only one axis (voltage)

Final plot of distance against resistance.

The linear relationship between them is clearly shown.

The gradient of the slope is R/L.

This value should match the specification on the source reel or manufacturers / suppliers specification sheet.



It would be surprising with a metre length to get an exact match to specification. Resistance at junctions between the jockey and wire and wire and crocodile clips will create an off set in the data.

Students may well see error in the line from imprecise length measurement.

Use the Vernier or micrometer to find the diameter of the wire and hence calculate the cross sectional area
The resistivity of constantan wire is.

$$\rho = \frac{RA}{L}$$

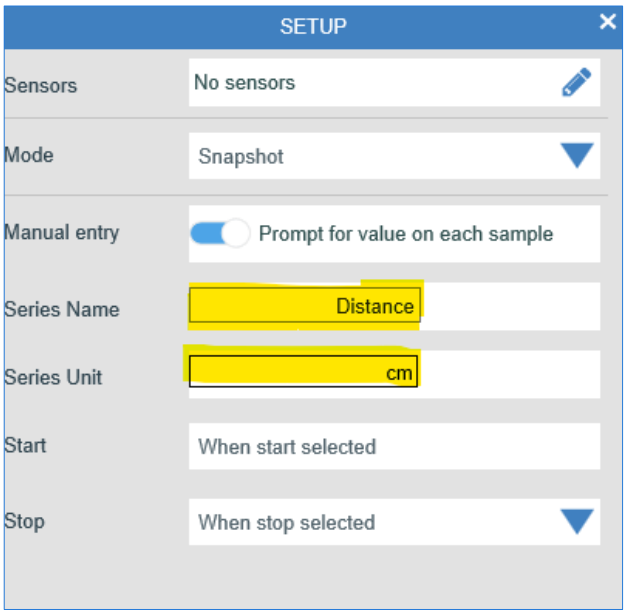
R = Resistance.
A = the cross sectional area.
L = Length

The gradient of the graph gives R/L
So

p = gradient x A in Ωm (accepted value for the suggested wire is 4.9 x 10^{-7} Ωm).

Setting up a snapshot recording.

Select Setup in bottom left of screen.



Follow the details as in the screenshot example.

The sections that have been marked up in yellow are where the user enters information.

The Series name should be Distance or Length (length may be preferred for learning as the equation uses L).

The unit is easiest set to cm, the students can then read the values straight of the ruler.

In final calculations corrections will need to be made for cross sectional area and length to metres.

Software knowledge required.

1. How to connect the sensor to the software.
2. How to set up a snapshot recording with value prompt
3. How to set up a 2 panel numeric display.
4. How rescale axis.
5. How to change axis.
6. How to use the gradient tool
7. How to use values / crosshair to read data off from the plot line.
8. Use calculation tool to create a resistance data set.