Voltage and Current Worksheets

A Curriculum Resource for the Voltage and Current Sensors

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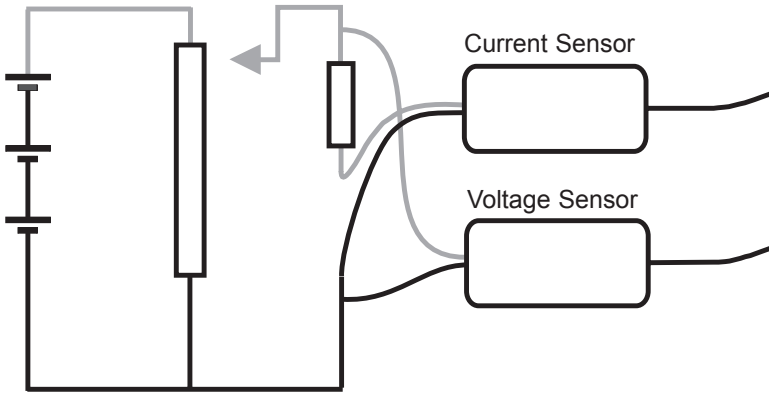

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Voltage and Current Worksheets

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Getting the best from your Voltage and Current Sensors

The Voltage and Current Sensors, supplied by Data Harvest, are self-identifying and calibrated.

Component values for each practical are suggested within the teachers notes for the practical.

In situations where changing voltages are required, students should be encouraged to use a potentiometer so that the current can be increased and then decreased. This should mean that large currents are only supplied for short periods.

With the on screen version there are hyperlinks to additional pages of explanation, background or help with calculations.

The circuits shown use batteries as the source of electrical energy. An alternative to batteries is to use a fully isolated mains power supply.

When using cells, a push switch (that turns off when pressure is released) could be placed in series, to help avoid over-discharging of the cells.

EasySense, Smart Q, Voltage and Current sensors:-

Product numbers:-

Voltage: +/- 20 volts (3160), 0 to 10volts (3161), +/- 1 volt (3162)

Current: +/- 1 Amp (3165), +/- 100mAmp (3166), +/- 10 Amp (3167)

Voltage Sensors should be connected across a component (in parallel). Current Sensors should be placed in series with the circuit component. The Voltage and Current sensors can be used in conjunction with each other anywhere in a circuit. For reasons of accuracy, if more than one Voltage Sensor is being used in a circuit they must share a common earth.

NEVER connect the Sensors direct to a power source without a resistive component to limit the current to within the range of the Sensor. Using Sense and Control Voltage and Current Sensors:-
Voltage (product number 6230, range 0-15V)
Current (product number 6240, range 0-1A)
If two Sensors are used together care should be taken to prevent any interaction due to common node problems. This interaction will cause no harm but may affect the accuracy of any measurements being taken.

Voltage and current experiments

Suitability

Practicals V1 - A and V1 - B fit the KS3 requirements for students to measure current.

Practicals V2 - V11 cover the following requirements of KS4:-

1. Show how changing the number of components in a circuit can change current / voltage.
2. That the current in circuit depends upon the number of cells; and that current is not used up by components.
3. That resistors are heated up when charge flows through them.
4. Describe the qualitative effect of changing the resistance on the current in a circuit.
5. Describe the quantitative relationship between resistance, voltage and current.
6. Show how current varies with voltage in a range of devices (e.g. resistors, filament bulbs, diodes, light dependent resistor and thermistors.
7. That voltage is the energy transferred per unit charge.
8 The shape of current voltage graphs for resistors, lamps and diodes.
9. The quantitive relationship between power, voltage, and current.
   Practicals V12 - V14 Cover the following requirements of KS4:-

1. The difference between alternating current and direct current.
2. The principles of magnetic induction.
3. Understand how the principles of electromagnetic induction are applied in a generator.

Additional notes

Practicals V12 - V14 use the Fast mode capability of the *EasySense* Advanced and logger. They are not suitable for loggers without this capability e.g Sense and Control, *EasySense* interface, *EasySense* Realtime and logger or Flash Logger.

The practicals on electromagnetic induction (V12 - V14) are suitable for AS level. Further mathematical treatment of results will extend the depth of study.

The capacitor practicals (V15-17) are suitable for AS level and could provide a useful project for students. These experiments could also be used in KS4 as extension materials.

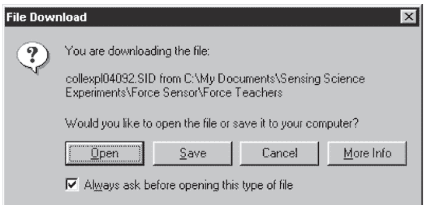
Viewing sample data files

The sample data files (.sid) are provided for viewing in the Graph application. The sample files were produced during the testing of the experiments in the Voltage & Current collection. In most cases the only change that has been made is the scale of the axis. The files have all been made read only through the properties tab of the file in explorer. If the files need to changed and the changes saved then they should be copied to another folder and the read only attribute removed. Renaming the file is advisable to prevent confusion with the original file. The files are located in the folder that contains the teachers notes and are all in .sid format.

Accessing the files

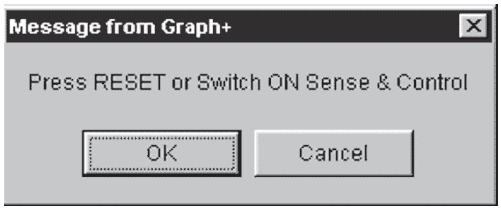
The files can be viewed by clicking on the screen shot of the graph or a named hyperlink in the online documentation . The file will open Graph and the data will be displayed. All the functions of graph can then be used. Depending on how your system is set up you may see several information panels before the data is loaded into Graph.

Screen message 1



File download message, click on the OPEN button for the file to be loaded into graph. If the "always ask before opening this type of file" tick box is unselected then in future this panel will not reappear.

Screen message 2



Message from graph. This type of communication message will appear if a datalogging interface is not attached to the computer. If an interface is attached follow the instructions and continue loading the file. If there is no datalogging interface attached click on "cancel" to continue loading the file.

Voltage & Current

Teachers' notes

V1 What changes the current in a circuit?

To simplify the circuits, it is possible in most activities to change the current by changing the number of cells in the circuit. This activity looks at the effect of the number of cells on the size of the current.

V1-A

This activity uses the **Meters** application. Readings are supplied in a **Gauge**, **Dial** and **Number** format for the sensor attached.

V1-B

This activity uses the **Graph** application. Readings are collected in **Snapshot** mode to enable pupils to collect data without any regular time interval between readings.
The bar graph enables students to search easily for a pattern and then to use the graph to interpolate and extrapolate using the pattern they have identified.

Components

It is important to use cells which are not run down if simple patterns are to be observed. It may help pupils to understand the circuit if it is first introduced using a bulb in place of the Current Sensor. This can lead on to replacing the bulb with the Current Sensor in the circuit prior to connecting it to the datalogger. Make sure you observe the correct polarity i.e. connect the black lead from the Current Sensor to the negative terminal of the cells. With larger quantities of cells the current flow can cause low value resistors to become very hot. 100 ohm 3 watt resistors were found to produce good results without generating heat. With large resistances the *SmartQ* +/- 100mA Current Sensor gave the best results. Check the suitability of the components to be used with Ohms law. For example:-
A 6 volt power source with a 10 Ohm resistor = 0.6 amp current flow. Power 0.6 x 6 = 3.6W.
A 6 volt power source with a 50 Ohm resistor = 0.12 Amp current flow. Power 0.12 X 6.0 = 0.72W.
The heat generated in the second choice is much more manageable.

Voltage & Current

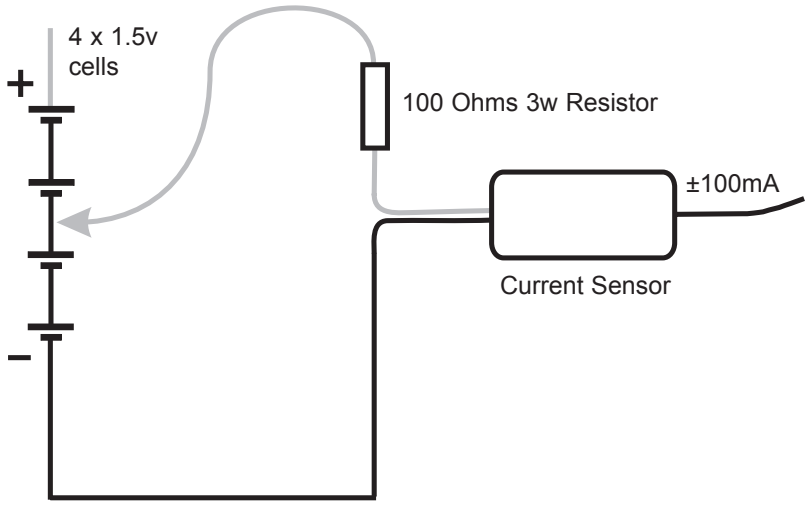
Investigation V1- A

What changes the current in a circuit?

Investigation

To get a current to flow through a circuit, there must be a complete circuit and a source of electrical energy. In this experiment, the electrical energy is supplied by electrical cells. You will measure the current flowing in a circuit when different numbers of cells are connected.

What you need



What you need to do

1. Assemble the apparatus as shown. Connect the Current Sensor to **Input 1.**
2. Click the **Launch** button to start the *Meters* application.
3. Connect different numbers of cells into the circuit and see what happens to the **Gauge, Dial** and **Number** displays.

!SAFETY: Be careful with resistors. As the voltage is increased they can become **hot**

Question

1. What happens to the readings as more cells are added?

Glossary Sheet V1-A, B

Electronic and electrical devices operate by the movement of electric charge. The quantity, rate of flow and driving force for electric charge are described by the following basic quantities.

Word	Symbol	Explanation
Voltage	E or V	Also called potential difference or electromotive force (emf) voltage is the electronic potential energy between two points. It is the driving force pushing the electricity around a circuit.
Volt	V	The unit of voltage. One volt is defined as the potential difference between two points in a circuit if one joule of energy is transferred when one coulomb of charge moves from one point to another.
Current	I	The rate of flow of electrical charge past a point per second.
Amp (Ampere)	A	The unit of current. The full unit is the amp (A). In most of the (Ampere) experiments current flow is in milliamps (mA) or a 1000th of an amp.
Resistance	R	The ability of a material to restrict the flow of energy.
Ohms	Ω	The unit of resistance. R = Voltage ÷ Current.
Cell		A unit that transforms other forms of energy into electrical energy. Most cells convert chemical energy into electrical energy. A collection of cells is called a battery. An AAA "battery" is a single cell, a 9 volt battery is a collection of 6 cells and really is a battery.
Charge	Q	Charge is an amount of electric charge.
Coulomb	C	The unit of charge, one coulomb is the charge of 6×10^{18} electrons or protons.

Voltage & Current

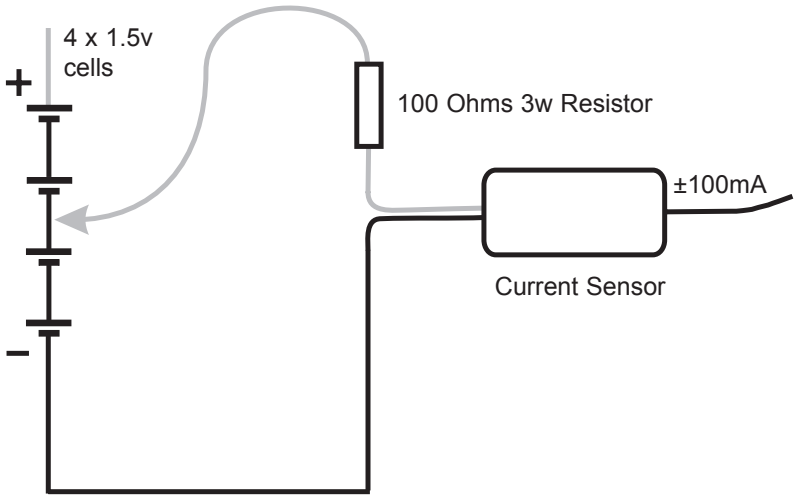
Investigation V1- B

What changes the current in a circuit?

Investigation

To get a current to flow through a circuit, there must be a complete circuit and a source of electrical energy. In this experiment, the electrical energy is supplied by electrical cells. You will measure the current flowing in a circuit when different numbers of cells are connected.

What you need



What you need to do

1. Assemble the apparatus as shown. Connect the Current Sensor to **Input 1.**
2. Click on the **Launch** button to start the Graph application.
3. Click 0n the **Start** ▶ icon to begin taking snap-shot readings.
4. Click in the bar graph area to store the first reading.
5. Double click in the first row of the comments column and type 'No cells' in the dialogue box.
6. Add the first cell to the circuit and take another reading by clicking in the graph area. Type 'one cell' into the comment for this sample.
7. Repeat with two, three and four cells.

! SAFETY: Be careful with resistors, as the voltage is increased they can become **hot**

Questions

Use your results to estimate:-

1. What current would you get if you connected a fifth cell?
2. What current would you get if you could connect 2.5 cells?

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