

# Edexcel GCSE in Science

## Producing and Measuring Electricity (Concept approach)

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## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 1: AC and DC							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.13 P1a 9.1	9I Energy and electricity.	Discuss the impact that the electric telephone and electricity have had on making the modern world.  Direct current passes in only one direction around a circuit.	<b>Starter</b> Construct a timeline of electrical developments, appliances. Take a look at milestones in the development of electricity plus a survey of the range of devices that use electricity.  <b>Main</b> Electricity circus — students use batteries, solar cells, dynamo, laboratory power pack (ac and dc), battery powered devices, eg torch, fan, radio, etc. For several stations, use a CRO to show the difference in output between ac and dc. Complete a worksheet answering questions on each station.  <b>Plenary</b> Draw diagrams showing ac and dc current and discuss.	Energy conversion kit sent out to schools during Science Year 2001/2002 (alternatively examples of dynamo, solar cell, etc).  For electricity circus, try to arrange that some stations show cells in use, eg torch, radio, personal stereo, personal fan, power screwdriver, electrical toys with wires attached to battery compartment allowing output to be measured whilst in use.	Discuss the impact that the electric telephone and electricity have had on making the modern world.  Distinguish between the two types of current (alternating and direct).	C 2.1 WO 2.2	Ensure that cells and batteries cannot be short-circuited.
<b>Homework:</b> Students could write up a summary of the electricity circus.							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 2: What do we mean by electric current?							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.2 P1a 9.8	7J Electrical circuits. 9I Energy and electricity.	Know how to build series and parallel circuits. An electric current is a flow of negatively charged electrons. Be able to use an ammeter correctly.	<b>Starter</b> Show sources of direct current. Ask students what they would experience if they were small enough to get into a wire carrying electricity. Define electric current as a flow of negatively charged electrons. <b>Main</b> Students set up circuits and measure current using ammeters. Students draw circuits using correct symbols and discuss their findings. <b>Plenary</b> Students make a 'human circuit' with roles such as batteries, electrons, bulbs, ammeters and switches. Ask students to describe the patterns found when putting an ammeter in various places in a series/parallel circuit.	Information on cells and batteries available from <a href="http://www.energizer.com/learning">www.energizer.com/learning</a> <a href="http://www.duracell.com">www.duracell.com</a> <a href="http://www.howstuffworks.com">www.howstuffworks.com</a> <a href="http://www.vectorsite.net/ttfu_elc.html">www.vectorsite.net/ttfu_elc.html</a>	Describe sources of direct current, including batteries and solar cells. Explain that current is a rate of flow of negatively charged electrons and that it can be measured by an ammeter placed in series in a circuit.	WO 2.1 2.2	Circuits should be checked by teacher before being turned on. Ensure that ammeter is connected in series and that voltmeter is connected in parallel.
<b>Homework:</b> Students to learn the definition of electric current for a test.							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 3: Making electricity							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.3 P1a 9.4	9I Energy and electricity.	Direct current passes in only one direction around a circuit.  Describe how a dynamo works including factors that affect the size and direction of an induced voltage.	<b>Starter</b> Revisit some of the circus experiments from lesson 1 and discuss.  <b>Main</b> Demonstrate how to produce an electric current by rotating a magnet in a coil of wire, as in a dynamo. Ask students to describe the factors that affect the size and direction of an induced voltage (demonstration 9.1: Generating electricity).  <b>Plenary</b> Students conduct experiment similar to demonstration.	Demonstration 9.1: Generating electricity  Equipment for class to conduct similar experiment to demonstration.	Describe how to produce an electric current by rotating a magnet in a coil of wire, as in a dynamo.  Describe the factors that affect the size and direction of an induced voltage.	C E2.1 WO E2.2	
<b>Homework:</b> Set questions on dynamos from a suitable textbook, eg Longman Science 1 F17							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 4: Current, voltage and resistance							
Spec. Code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.5 P1a 9.10 P1a 9.11	7J Electrical circuits. 9I Energy and electricity.	Know that an increase in the resistance of a circuit will impede the flow of electrons leading to a decreased current. Understand and recall Ohm's Law, $V = IR$ . Collect results using different methods and explain advantages and drawbacks of each method.	<b>Starter</b> Demonstrate the use of different values of fixed resistor at a fixed voltage to show relationship between I and R. Students to complete a worksheet table and try to work out relationship between V, I and R. Teacher to give an example of how to do the calculations. <b>Main</b> Use ammeters and voltmeters to investigate current/voltage characteristics of a filament lamp. This could be compared to the current/voltage characteristics of a fixed resistor. More able students to calculate resistance from Ohm's Law. Less able can put data into spreadsheet which calculates resistance for them. If possible, use cell and low voltage lamp and use datalogger with voltage and current probes as an ICT opportunity, or data plotted using graphing on spreadsheet. <b>Plenary</b> Discuss results and seek explanation for non-ohmic behaviour of lamps. Compare results from datalogger with those from meters.	Fixed value resistors, filament lamps, ammeters, voltmeters, power supply. Datalogger with current and voltage sensors (eg Data Harvest Easysense). <a href="http://www.channel4.com/learning">www.channel4.com/learning</a> <i>Science Bank</i> : Physics video clips and support material.	Explain how changing the resistance in a circuit changes the current. Use primary data to explain how current varies with voltage for fixed value resistors and filament lamps and how this can be investigated experimentally. Use the relationship between the voltage, current and resistance: $V = I \times R$ .	N 2.2 2.3 ICT 2.2 WO 2.1 2.2	Use higher value fixed resistors to avoid dangers of overheating.
<b>Homework:</b> Set questions involving $V=I \times R$ from a textbook, eg Longman Science 1 F4.							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 5: Resistance of different components							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.5 P1a 9.10 P1a 9.11 P1a 9.16	7J Electrical circuits. 9I Energy and electricity.	Know that an increase in the resistance of a circuit will impede the flow of electrons leading to a decreased current. Understand and recall Ohm's Law, $V = IR$ .	<b>Starter</b> Test on $V = I \times R$ questions, units and symbols. <b>Main</b> Investigate how resistance changes with different materials, or different lengths/thicknesses of wire. Take measurements of current and voltage and calculate resistance. Less able students could be provided with a spreadsheet that does the calculation for them. <b>Plenary</b> Demonstrate the use of a variable resistor to control intensity of lamp and volume of a bell/buzzer and compare to dimmer/volume control. Explain how change in resistance controls flow of electricity.	CD resource from Aspire may be used for more able students. <a href="http://www.aspire-ma.com">www.aspire-ma.com</a> Leads, lamps, power supply, ammeters, voltmeters, heatproof mats, resistance wires (22, 24, 26, 28, 30 swg constantan gives good thickness range), rules, Vernier or micrometer gauge to check thickness Using batteries as an electricity source would allow use of dataloggers, voltage and current sensors.	Explain how changing the resistance in a circuit changes the current. Use primary data to explain how current varies with voltage for fixed value resistors and filament lamps and how this can be investigated experimentally. Use the relationship between the voltage, current and resistance: $V = I \times R$ Demonstrate an understanding of how ICT can be used to collect and display data from electric circuits for analysis, and compare this with traditional methods in terms of reliability and validity of data.	N E2.1 E2.2 E2.3 WO E2.1 E2.2 PS E2.1 E2.2	Lengths and gauges of wire must be controlled to ensure overheating doesn't occur. Wires must be kept on a heat-proof mat or suspended.
<b>Homework:</b> Students to write up investigation.							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 6: Batteries							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.9  P1a 9.12	9I Energy and electricity.	Predict how long a battery will last given its capacity and the current drawn from it.  Measure the output of a battery in a circuit.  Understand the environmental concerns about the disposal of used batteries.	<b>Starter</b> Set up and show the results of a test to compare the time taken for rechargeable batteries to run out compared to non-rechargeable batteries in a given device.  <b>Main</b> Students compare costs of running each type of battery. Discuss capacity in terms of amp-hours and carry out a series of calculations showing how long a battery might run typical devices. A number of devices could be set up allowing measurements of current drawn to be made and hence predictions of battery life.  <b>Plenary</b> Class discussion of advantages and drawbacks of rechargeable and non-rechargeable batteries, including problems to do with disposal of used batteries.	Create a 'Which is the cheapest way to run my battery powered device' worksheet.  Number of devices set up to enable current drawn to be measured while in use, eg torch, radio, personal fan, power screwdriver, electrical toys. Ammeters. Datasheets on capacity of batteries. Copy of online book detailing history of battery available at <a href="http://www.buchmann.ca/">http://www.buchmann.ca/</a> Disposal of batteries: <a href="http://www.wasteonline.org.uk">www.wasteonline.org.uk</a> <a href="http://www.envirogreen.co.uk">www.envirogreen.co.uk</a>	Interpret a battery's stated capacity in terms of amp-hours and use it to predict the number of hours it should last when supplying a given current.  Investigate practically or otherwise the voltage and current output, and advantages/disadvantages of battery technology (dry cell or rechargeable), including considerations of their cost/performance and impact on the environment.	N 2.2 C 2.1 ICT 2.1	
<b>Homework:</b> Students to do a worksheet giving experience of calculations involving battery capacity and life; rechargeable versus non-rechargeable options, eg for torch/Walkman™							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 7: Light Dependent Resistors							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.6	7J Electrical circuits. 9I Energy and electricity.	Know that electrical devices can be subject to automatic control.	<p><b>Starter</b></p> <p>Give students a circuit to set up containing an LDR and ask them to find out what this component does without giving any hints. Then give them the correct name and symbol.</p> <p><b>Main</b></p> <p>Practical 9.8: Using light dependent resistors. Challenge students to find out how many sheets of tracing paper you have given them (edges sealed together in a packet with tape) using an LDR and ammeter. They measure current produced when light is shone through one piece of tracing paper, replace it with 2, 3, 4, etc and then try the mystery packet you have given them.</p> <p><b>Plenary</b></p> <p>Students write down textbook definitions of what the component does and discuss other possible applications for next lesson.</p>	LDR, tracing paper, tape, bulbs. Dataloggers could be used to collect data.	Describe how the resistance of a light-dependent resistor (LDR) changes with light intensity and the resistance of a thermistor changes with a change of temperature.	N E2.2 E2.3 ICT E2.2 E2.3 WO E2.1 E2.2	
<p><b>Homework:</b> Set questions on LDRs from an appropriate textbook.</p>							

## Scheme of work for Topic 9: Producing and Measuring Electricity

<b>LESSON 8: Thermistors</b>							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.6 P1a 9.7	7J Electrical circuits. 9I Energy and electricity.	Know that electrical devices can be subject to automatic control. Know that bimetallic strips allow switching action at specific temperature. Know that the resistance of a thermistor decreases as the temperature increases. Know that the resistance of an LDR decreases as the light intensity increases.	<p><b>Starter</b></p> Give students a circuit to set up containing a thermistor and ask them to find out what this component does without giving any hints – they usually hold it. Then give them the correct name and symbols. <p><b>Main</b></p> Students could use a thermistor to find out the mystery temperature of a beaker of water, having been given a selection of samples at set temperatures (care needed that samples don't change temperature as students work). <p><b>Plenary</b></p> Show digital photos and invite suggestions as to how light sensitivity controls the camera. Demonstrate temperature-sensitive devices that control electricity. Point out that some are physically controlled by bimetallic strips, eg kettle, thermostat. If available, demonstrate the bending of bimetallic strip in hot water and explain principles of their use.	Thermistor, beaker, Bunsen burner or kettle, ammeter, voltmeter, power supply. Ice could be used to extend the temperature range. Dataloggers could be used to collect data. Information on how digital cameras work available from <a href="http://www.shortcourses.com">www.shortcourses.com</a> <a href="http://electronics.howstuffworks.com/">http://electronics.howstuffworks.com/</a> <a href="http://www.apogeephoto.com">www.apogeephoto.com</a>	Describe how the resistance of a light-dependent resistor (LDR) changes with light intensity and the resistance of a thermistor changes with a change of temperature. Recognise and explain applications depending on resistance change, such as controlling how long the shutter should be open on a digital camera.	N 2.2 2.3 ICT 2.2 2.3 WO 2.1 2.2	There is a danger of insulation being melted if Bunsen burners are used to directly heat water. Mixing hot water from kettles with tap water to achieve set temperatures may be safer.
<p><b>Homework:</b> Students to find a person who can remember living without a telephone and find out what was different for them because of this.</p>							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 9: The future							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.15		Use data relating the size of electric circuits to the processing speed of computers and suggest future applications.	<p><b>Starter</b> Discuss history of computers, especially size of machine compared to speed/ functions available. For example, days of no hard drive, loading programs from tape, etc.</p> <p><b>Main</b> Students use the internet or other sources of information to research on a typical computer from the 1990s, 80s, 70s 60s etc. Find out its typical speed and the size/weight of the machine. Put these findings on a timeline.</p> <p><b>Plenary</b> Students predict what will happen next in terms of size and speed of computers.</p>	Computer room with internet access and printer or other sources of information. <a href="http://www.en.wikipedia.org/wiki/Moore's_law#Future_trends">www.en.wikipedia.org/wiki/Moore's_law#Future_trends</a>	Use data relating the size of electric circuits to the processing speed of computers and suggest future applications.	N 2.1 C 2.2 2.3 WO 2.1 2.2 2.3 ICT 2.1 2.3	
<p><b>Homework:</b> Students to research what the computer companies are marketing at present as the latest technology.</p>							

## Scheme of work for Topic 9: Producing and Measuring Electricity

LESSON 10: The past and the future of electricity							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1a 9.13 P1a 9.14		<p>Know the time scale involved in the development of electricity as a resource globally.</p> <p>Consider the ways that the use of electricity contributes to the way we live our lives.</p> <p>Be able to say how Maglev trains have developed as a result of scientific advances.</p>	<p><b>Starter</b> Discuss findings from homework.</p> <p><b>Main</b> Students find out what a Maglev train is and how this technology has developed as a result of the discovery of superconductivity. Give groups question(s) to research. For instance, what is a Maglev train? When was superconductivity discovered? How does a Maglev train make use of superconductivity?</p> <p><b>Plenary</b> Students present findings to rest of class.</p>	<p><a href="http://www.channel4.com/learning">www.channel4.com/learning</a> <i>Science in Focus Special: Beyond the Square Window</i> future developments in TV <a href="http://library.thinkquest.org/22522">http://library.thinkquest.org/22522</a> <a href="http://en.wikipedia.org/wiki/Moore's_law#Future_trends">http://en.wikipedia.org/wiki/Moore's_law#Future_trends</a> <a href="http://www.ecglibrary.com">www.ecglibrary.com</a> 'Electric Universe' by David Bodanis <a href="http://www.maglev.com">www.maglev.com</a> <a href="http://superconductors.org/">http://superconductors.org/</a> <a href="http://en.wikipedia.org/wiki/Superconductivity">http://en.wikipedia.org/wiki/Superconductivity</a></p>	<p>Discuss the impact that the electric telephone and electricity have had on making the modern world</p> <p>Explore how a new technology, such as Maglev trains, develops as a result of scientific advances, such as the discovery of superconductivity.</p>	<p>C</p> <p>2.1 2.2 2.3</p> <p>ICT</p> <p>2.1 2.3</p> <p>WO</p> <p>2.1 2.2</p>	
<p><b>Homework:</b> Students to research a technology that interests them and describe how it has developed as a result of scientific advances.</p>							

## Demonstration 9.1: Generating Electricity

### What you will learn from this demonstration

In this demonstration you will find out how electricity can be generated.

### What you will know after you see this demonstration

- 1 How a current can be induced in a wire.
- 2 How the current can be made larger.

### What you do

- 1 Watch what happens when your teacher moves a magnet in and out of a coil of wire.
- 2 Draw diagrams to illustrate the demonstration and label them. Show the direction that the magnet is moving and the direction that the needle moves on the galvanometer.

### Questions

- 1 What is an induced current?
- 2 What are the two ways to change the direction of the induced current?
- 3 How can you make the current larger (suggest at least three ways)?

# Demonstration 9.1: Generating Electricity

## Notes for teachers and technicians

### Aim

In this demonstration students will find out how electricity can be generated.

### Skills, knowledge and understanding to be gained

- 1 How a current can be induced in a wire.
- 2 How the current can be made larger.
- 3 Observation skills.

### Previous skills, knowledge and understanding required

- 1 Key Stage 3 magnets.

### Equipment and chemicals required

- 1 Magnet.
- 2 Coil of insulated wire.
- 3 Crocodile clips.
- 4 Galvanometer (sensitive ammeter).
- 5 Possibly a video camera, laptop and data-projector to enlarge the display on the galvanometer.

Connect galvanometer to coil of wire using crocodile clips and leads. Move magnet into and out of the wire.

### Delivery strategies

- Ask students to watch carefully as you move the magnet in the coil and draw what they see. Move the magnet in and out of the coil then keep the magnet stationary in the coil. Finally turn the magnet so that the other pole goes in first and do the same again giving time for students to draw each situation.
- Make sure students draw what happens as the magnet is moving. Repeat if necessary.
- This can be done as a class practical if enough sensitive meters are available.
- Ask students how the current can be increased. Try their suggestions if they are safe.
- Explain how this links with generators and power stations.

### Links with other GCSE Science topics

- Topic 10: Evaluate whether renewable energies such as solar power and wind power can meet the UK's future electricity needs, and evaluate their economic, environmental and social impact.

### Links with KS3

This demonstration builds on the following skills, knowledge and understanding from KS3:

- Y8 Magnets.

### Suggestions for further work/homework

- 1 Students could make a generator.
- 2 Longman Science 1 F17.
- 3 Longman Science 1 F18 Generators.

## Activity 9.3: Voltmeters

### What you will learn from this activity

In this activity you will find out the pattern formed when voltmeters are placed in series and parallel circuits.

### What you will know when you finish this activity

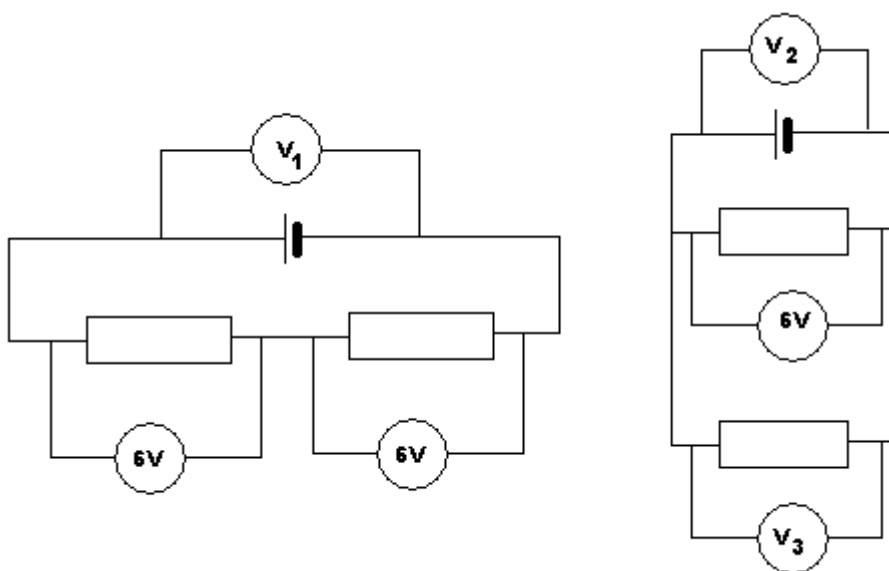
- 1 Voltmeters are placed in parallel to other components.
- 2 The potential difference (voltage) in a series circuit is shared between the components in the circuit.
- 3 The voltage in a parallel circuit is the same across each route.

### How you may be assessed

Answers to the questions may be assessed.

### What you do

- 1 Look at the following circuits. Some of the voltmeter readings are missing. Can you predict what they will be? You may have done some practical work investigating this question.



- 2 Check your answers with your teacher.
- 3 Either from your practical work or by looking at a textbook write down the rules for voltmeters in series and parallel circuits.
- 4 Now make a worksheet for another GCSE class to test them on voltmeters in series and parallel circuits. Produce answers for your worksheet.

## Activity 9.3: Voltmeters

### Notes for teachers and technicians

#### Aim

In this activity students will find out the pattern formed when voltmeters are placed in series and parallel circuits.

#### Skills, knowledge and understanding to be gained

- 1 Voltmeters are placed in parallel to other components.
- 2 The potential difference (voltage) in a series circuit is shared between the components in the circuit.
- 3 The voltage in a parallel circuit is the same across each route.

#### Previous skills, knowledge and understanding required

- 1 How to set up series and parallel circuits.
- 2 Some experience of placing voltmeters in circuits would be useful.

#### Materials required

It would be useful to have circuits set up for students to examine.

#### Health and safety issues

Take care with electricity.

Leaking cells should not be touched.

#### Delivery strategies

- It would be useful if this activity was given as a reinforcement exercise after students have practically investigated voltmeters.
- Might be a useful homework or revision exercise.
- Less able students will probably need to see the circuits built.
- The teacher could draw the circuits on the bench in chalk for the students to follow when building them!
- More able students could make up worksheets for ammeter rules too.

#### Assessment strategies

Students could be assessed on:

- Their answers to questions.
- The quality/accuracy of materials produced.

#### Links with KS3

This activity builds on the following skills, knowledge and understanding from KS3:

- 7I electrical circuits.

## Activity 9.3: Voltmeters

### Suggestions for further work/homework

- 1 This activity could be done for ammeters in series and parallel circuits too.
- 2 Questions on ammeters and voltmeters.

### Resources

Longman Science 1 F3 and F6.

## Experiment 9.8: Using Light Dependent Resistors (LDRs)

### What you will learn from this experiment

In this experiment you will find out how an LDR might be used in a factory.

### What you will know when you finish this experiment

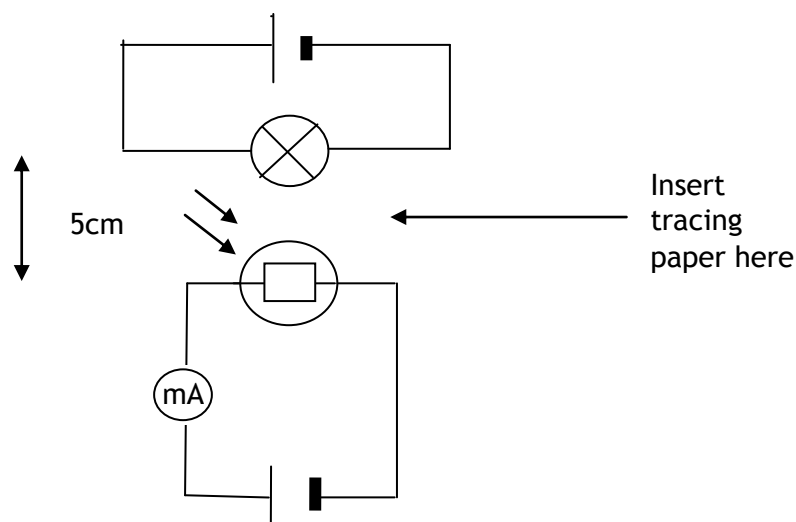
- 1 How to set up a circuit using an LDR.
- 2 How to gauge the thickness of tracing paper using electronics.

### How you may be assessed

Your teacher will give you a mystery packet of several sheets of tissue paper. You will tell him/her how many sheets there are without opening the packet.

### What you do

- 1 Set up the circuits as shown in the following diagram. Clamp the bulb about 5 cm away from the LDR.



- 2 Place a sheet of tracing paper between the bulb and the LDR.
- 3 Write down the reading on your ammeter in a results table.
- 4 Continue taking readings, changing the number of sheets of tracing paper each time, until the ammeter stops changing. You should also include a reading when there is no tracing paper inserted.
- 5 Plot a graph of your results (optional).
- 6 Your teacher will give you a mystery packet of tracing paper. The edges are sealed with tape so you can't tell how many sheets there are.
- 7 Use your apparatus to work out how many sheets are in the packet without opening it.

### Suggestions for further work/homework

Research other uses of LDRs.

## Experiment 9.8: Using Light Dependent Resistors (LDRs)

### Notes for teachers and technicians

#### Aim

In this experiment students will find out how LDRs might be used in a factory.

#### Previous skills, knowledge and understanding required

- 1 Key Stage 3 electrical circuits.
- 2 Graph drawing skills.

#### Skills, knowledge and understanding to be gained

- 1 How to set up circuits.
- 2 How to use their results to answer a problem.

#### Equipment and chemicals required

- 1 LDRs.
- 2 Crocodile clips.
- 3 Leads.
- 4 Unilab bulbs.
- 5 Cells.
- 6 Milliammeters.
- 7 Tracing/greaseproof paper.
- 8 Masking tape.

See the diagram on the previous page for circuits. Check the paper is thin enough to get readings for one, two, three, four, and five sheets. Place three sheets of paper on top of each other and seal round the edges with tape so that students will not be able to see how many sheets are in the package. Make some more mystery packets consisting of two and four sheets of paper.

#### Health and safety issues

Take care with electricity.

Beware of leaking cells.

#### Delivery strategies

- Set the scene. The students have been commissioned by a factory to make a sensing device for their paper division.
- Students work in pairs.
- Give students different mystery packets and ask them to sort them all out.
- More able students work with a variety of thicknesses of papers and explain limitations of system.

## Experiment 9.8: Using Light Dependent Resistors (LDRs)

### Assessment strategies

Students could be assessed on:

- Their ability to draw graphs, use results and discuss limitations of the system.

### Links with KS3

This experiment builds on the following skills, knowledge and understanding from KS3:

- 7I electrical circuits.

### Resources

Longman science 1 F5.

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