

Planning & conducting investigations

Teachers Notes - Lesson 2 - Slide 1

Unit Overview

Sequence	At a glance
Investigating conductors and non-conductors	Students investigate scientifically to confirm an hypothesis
Demonstrating the fuses	Teacher demonstration
Exploring the design task	Students undertake a 'design-and-make' task applying their understanding of electric circuits and electricity to satisfy a personal need
Generating design ideas and realising solutions	To provide opportunities for students to make their design task and solve the initial design brief
Evaluating products and processes	To provide opportunities for students to reflect on their learning during the unit and to share their findings and understanding of electricity

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Hypothesising and predicting

(define a problem that can be investigated scientifically)

The greater the number of batteries connected in series the greater the voltage.

Equipment/Materials

- role badges for manager, safety officer and speaker
- each team member's SciTech journal
- 2 x 1.5 volt batteries
- multimeter
- Discuss with students ways of accurately testing the hypothesis.
- Teacher introduces, explains and demonstrates the use of the multimeter to the students.
- Have students reconstruct their series and parallel circuits from the previous activity replacing the light bulb with multimeter to complete the circuit.
- Have students construct a table to record their observations in their SciTech Journals (sample below).

Type of circuit	Number of batteries	Multimeter reading (DCV)/(DCA)
	1 battery	
Series	2 batteries	
	3 batteries	
Parallel	4 batteries	
	5 batteries	

- Using the multimeter have students measure record and compare the voltage and amps of each circuit.

Analysing and drawing conclusions

(reach a conclusion which is communicated to others)

- Have students construct a graph using the collected data.
- Discuss with students what type of graph would best represent the data in a way that best addresses their hypothesis.
- What labels must they include on the X and Y axis?
- Once students have constructed their charts discuss the results and construct a statement summarising what they have learnt about batteries set in series and parallel circuits. Add the statements to the KWL chart and any new words should be added to the word wall.

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Sample hypothesis

Increasing the number of coils in the electro-magnet will increase the strength of the electro-magnet.

Increasing the voltage in an electro-magnet will increase the strength of the electro-magnetic (sample procedure not provided).

Devising and testing

(describe a procedure for collecting data, identify appropriate equipment to carry out the procedure)

Varying the number of coils

- wind a length of copper wire around 3 nails a) 10 times, b) 20 times, c) 30 times.
- Space the coiled wire so that the coils are separate.
- Connect a battery to the ends of the copper wire to complete the circuit.
- Test the strength of the electro-magnet by picking up various metal objects such as a paper-clip, staples.
- Students should independently develop a method of measuring and recording their observations
- regarding the strength of the tested magnet.

Analysing and drawing conclusions

- Which electro-magnet was the strongest?
- Was your test fair?
- How could you improve your investigation?
- Why was sticky tape used on the nails?

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Investigating Conductors and Insulators

Task: Identify materials that conduct electricity.

Hypothesising and predicting

(define a problem that can be investigated scientifically)

Hypothesis

Metal objects conduct electricity.

Equipment

- role badges for manager, safety officer and speaker
- each team member's SciTech journal
- 1.5 volt battery
- light bulb and lampholder
- multimeter (if available, but not essential for experiment)
- 3 connecting wires
- variety of items for testing, e.g. paper-clips, aluminium foil, rubber band, string, texta, wooden ruler and other classroom items.

Devising and Testing

(describe a procedure for collecting data, identify appropriate equipment to carry out the procedure)

- How do we know that electrons are flowing in a circuit? (We could use an indicator such as a light bulb or a buzzer, when there is a flow of electrons the light bulb will glow or the buzzer will sound).
- Discuss with students how they could test different materials for electrical conductivity.
 - Guide students to suggest constructing an open circuit that includes a battery, wires and a light bulb. The items being tested should then be used to complete the circuit. If the light glows, then the material is a conductor of electricity.
- Discuss with students:
 - the idea of a "fair test".
 - how can we ensure that the test is fair?
 - what variables must we keep the same? (length of wires, same battery, etc.)
 - how will we record our observations?

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- Have students construct a table in their SciTech journal with a list of approximately ten objects in the left hand column. Have them predict conductivity. Example shown below:

Object	Material	Prediction: Will it conduct electricity? Yes/No	Does the light bulb glow?
Paper-clip	steel		
Plastic ruler	plastic		

- Allocate roles to the students and have students construct the open circuit.
- Ask students, in groups, to test their circuit by using the object to complete the circuit. If the light globe glows then the object is a conductor of electricity. If the object did not allow the light to glow then it is a non-conductor.
- Have students test the provided objects. Ensure students record their observations.
- Have students present their findings to the class.
 - list the conductors and non-conductors.
 - is there a pattern in the results?
 - was the outcome different to their predictions?
 - do the results support their hypothesis?
 - what difficulties did they experience when completing this investigation?
 - how could they improve this investigation?

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Discussion points:

Why is it useful to know which materials conduct electricity?

- Why are electrical wires coated in plastic? Why should frayed cords be replaced?
- Will the human body conduct electricity? What injuries may happen to a person who has received an electric shock?

What can electricity do to the body?

Conductors are things that electricity travels through very easily.

- Conductors are materials like metal, water and anything with lots of water in them, such as animals or people.
- Salt is another type of conductor, and as the human body contains a lot of water and salt, it is a very good conductor.
- If you touch electricity or something that is conducting electricity you will get hurt.

Electricity can:

1. Shock you and give you a painful zap
2. Burn you
3. Damage your internal organs
4. Kill you

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Teacher Demonstration

How does a fuse work?

Equipment

- role badges for manager, safety officer and speaker
- each team member's SciTech journal
- 2 x 1.5 volt batteries
- low amp fuse wire (1 amp) or strands of steel wool
- connecting wires
- dinner plate

Activity steps

- Revise open and closed circuits with students.
- Discuss what may happen to wires if too much electric current flows through them.
 - Wires would melt and may cause a fire.
- Teacher creates an open circuit using the battery and connecting wire.
- Place a short length of fuse wire on the dinner plate.
- Connect the wires to each end of the fuse wire to close the circuit.
- Have students observe:
 - What happened to the fuse wire?
- Have students suggest:
 - an explanation for their observation (too much electricity flowing through the fuse wire).
- Have students draw and label a diagram of the demonstration.
- Discuss:
 - Ask students to explain the simile "a fuse is like an electrical watch dog."
 - Why should you not plug too many appliances into a wall socket.
- Most modern houses have circuit breakers or safety switches.
Research one of the devices.

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Task: Devise an electrical switch (open ended task)

Teachers may allow students to design, make and test their own electrical switch.

Suggested equipment

- role badges for manager, safety officer and speaker
- each team member's SciTech journal
- 1 x 1.5 volt battery
- 1 x bulb and lampholder (or buzzer)
- wire cutters, paper-clip and split pins
- a small piece of cardboard
- connecting wires

Activity steps

- Review previous sessions (open and closed circuits), refer to word wall and KWL chart.
- As a class, discuss the criteria for successfully constructing a switch, i.e. the switch must be:
 - safe.
 - able to be switched on and off repeatedly.
- Have students in groups draw a labelled diagram of their design.
- Allocate roles to the students and obtain equipment from teacher.
- Have students construct and present their designs to the class.
- Have students discuss the safety features incorporated in their designs and how their design could be improved.

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Teachers Notes

Observing and exploring

(ask questions, pose problems, find out what is currently known)

Task: Create an electro-magnet.

Equipment

- role badges for manager, safety officer and speaker
- each team member's SciTech journal
- 1 x 1.5 volt battery
- copper wire
- nail
- sticky tape
- wire cutters
- paper-clip
- connecting wires

Activity steps

- Review previous sessions (open and closed circuits), refer to word wall and KWL chart.
- Have students cover approximately half of the nail with sticky tape.
- Ask students to wind a length of copper wire around the sticky taped section of the nail.
- Space the coiled wire so that the coils are not touching (just separated).
- Test the electro-magnet without the battery connection.
- Connect the ends of the copper wire to a battery to complete the circuit.
- Test the strength of the electro-magnet by picking up various metal objects such as a paper-clip, staples, etc.
- Once the students have constructed their electro-magnets have them independently investigate how they could increase the strength of their electro-magnet.
- Revise the steps involved in the process of investigating scientifically.

An electro-magnet is simply a coil of wire. It is usually wound around an iron core. When connected to a voltage source, the electro-magnet becomes energized, creating a magnet just like a permanent magnet.

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Investigating series and parallel circuits

Observing and exploring

(ask questions, pose problems, find out what is currently known)

- Discuss with students the terms series and parallel

Batteries in series

5. Have students construct a closed circuit that includes 1 battery, 2 wires and a light bulb.
 6. Place a dark coloured card behind the light bulb and observe its brightness.
 7. Have students repeat step 1 using 2 batteries connected in series.
 8. Place a dark coloured card behind the light bulb and compare the brightness of the light bulbs in each circuit.
- Discuss with students what they observed and have students suggest explanations for their observations.

Batteries in parallel

1. Have students construct a closed circuit that includes 2 batteries set in parallel, 2 wires and a light bulb.
 2. Place a dark coloured card behind the light bulb and compare the brightness of the light bulb with the previous circuit.
 3. Ask students to place a third battery in parallel and compare the brightness of the light bulb.
- Discuss with the class:
 - did the additional battery make the bulb glow brighter?
 - what do you think is happening to the flow of electrons in a series and parallel circuit?

Teachers Notes

The word series means “following on from the previous one”, like a TV series.

It's important to connect the batteries with their terminals in the correct order. Batteries in series need to be connected with the positive end of one battery to the negative end of the next battery.

If they are incorrectly connected, the batteries will cancel out each others energy and quickly flatten each other. This can be dangerous.

Batteries correctly placed in series, positive to negative, will add their output voltages, producing a greater voltage.

The word parallel means “alongside each other”. When batteries are placed in parallel all the positive terminals are joined together with a single wire to one part of the circuit, and all the negative terminals are joined with a single wire to the rest of the circuit.

Remember the voltage increases when batteries are in series, but with batteries in parallel this is not the case. When two or more batteries are placed in parallel, the voltage in the circuit is the same as each individual battery. That is two, three, four or more 1.5 volt batteries in parallel will produce a voltage of 1.5 Volts!

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Investigating series and parallel circuits 2

Observing and exploring

(ask questions, pose problems, find out what is currently known)

- Revise the previous activity of placing batteries in series or parallel.
- Ask students to predict what may happen to the brightness of 2 light bulbs if they were placed in series.
- Ask students to predict what may happen to the brightness of 2 light bulbs if they were placed in parallel.

Equipment/Materials

- role badges for manager, safety officer and speaker
- each team member's SciTech journal
- 1.5 volt battery
- 2 x light bulbs and lampholders
- connecting wires

Devising and Testing

(describe a procedure for collecting data, identify appropriate equipment to carry out the procedure)

- Have students construct a closed circuit that includes 1 battery, wires and 2 light bulbs connected in series.
- Place a dark coloured card behind the light bulbs and observe their brightness.
- Ask students to predict what would happen if 1 light bulb was removed from its holder.
Discuss the student's answers.
- Remove one light bulb from its holder, observe what happens.
- Have students construct a closed circuit that includes 1 battery, wires and 2 light bulbs connected in parallel.
- Place a dark coloured card behind the light bulbs and observe their brightness. Compare the brightness of the light bulbs from both the parallel and series circuits.
- Ask students to predict what would happen if 1 light bulb was removed from its holder.
- Discuss the students' answers.
- Remove one light bulb from its holder, observe what happens.
- Have students record their observations using a table (sample below).

Type of circuit	Number of bulbs	Brightness of bulbs	Circuit when on bulb removed (yes/no)
Series	One bulb		
	Two bulbs		
Parallel	Three bulbs		
	Four bulbs		

- Discuss with students the advantages of each of the circuits and list some of their uses.
 - Christmas tree lights used to be connected in series, what problems did this present?
 - How are house circuits connected?
- Add new learning to the KWL chart and to the word wall.
- Have students draw, label and write a short description of their observations in their SciTech journals.

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Design Task

In SciTech, students demonstrate understanding gained through a scientific investigation by resolving a design brief.

Design brief: Design and make a product that uses the ‘transformation of electrical energy’ as an essential feature of its operation. The product must meet a personal need of students, i.e. be designed for self.

Exploring the task

(Define purpose of the product, develop criteria and find out what is currently available)

- In groups, students use the table below to review uses of electrical energy explored in earlier activities. Students identify the need addressed by the product or the system, and the energy transformations involved in its operation e.g.

Product/System	Need/Purpose	Energy transformations
Home security alarm	Warn off intruders Dissuade intruders Protect people and property	Sensor (light/sound energy) > electrical energy > sound energy
Vacuum cleaner	Remove dust and dirt Remove dust mites that cause allergies	Electrical energy > mechanical energy
Stove (electric)	Heat or cook food	Electrical energy > heat energy
Solar garden lights	Provide lighting for paths Provide security Increase enjoyment of garden	Light energy > electrical energy > chemical energy (battery) > electrical energy > light energy

- Discuss the personal needs of students and how designing and making a product that transforms electrical energy may solve a personal need.
- In pairs/groups students brainstorm problems, difficulties and interests that reflect a personal need, e.g.
 - My little brother reads my diary.
 - Everyone barges into my room. I have no privacy.
 - I like reading in bed at night but the light disturbs my little sister.
 - We get very hot in our tree house.
 - The mosquitoes always bite me when I am in the garden.
 - How can I make a game that keeps my younger brother/sister amused?

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- From the brainstorm, each pair of students prepares a list of problems/needs and decides which one they would like to work on together. The selected problem/need should have the potential to transform electrical energy as part of its design solution.
- Revise earlier design tasks and review the stages of the design process each group must work through. Discuss with each group how they will apply a design process to this product development task.
- Without pre-empting a solution, each group will generate a list of criteria to be used to judge the success of their solution. Ensure that each group includes in its list a criterion that states: 'uses the transformation of electricity as a feature of its operation'. All designs must identify their safety features.
- In pairs, students draft questions that will be addressed as they work through their design process e.g.
 - what products exist that address similar problems or needs? How do they work?
 - what resources are available to construct our product?
 - how will we test and evaluate our design solution?
 - how will we manage the time available to develop our product?
 - how much time do we have to design our product, to make it and to evaluate it?
 - is there a 'technical expert' who can provide assistance?
 - where can we purchase components and materials?
 - are there electrical safety issues?

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Aim of this flash activity:

- Show students the design elements of a torch
- Show students how the electrical circuit works in the torch
- Gets students thinking about designing their own product

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Aim of this flash activity:

- Show students the design elements of a home door bell system
- Show students how the electrical circuit works in the door bell system
- Gets students thinking about designing their own product

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Generating ideas and realising solutions

(explore and refine options and decide upon a design option, choose resources and equipment to plan and produce the design)

- Students sketch initial ideas for their product and annotate their sketch to explain how the product works. With each group the teacher discusses the method to be used to evaluate the initial idea, e.g. prepare questions for friends in another group, consult a mentor.
- Remind students to consider the circuit required to operate the product. Review earlier activities in which students constructed a circuit, e.g. to illuminate a light globe. To explore possible solutions for the circuit, provide students with a greater variety of functioning components, e.g. batteries, battery holder, switch, lampholder, globe, buzzer (piezo), solar panel, electric motor.
- Ensure that students understand that their product must be housed in a suitable casing. Discuss what functions the casing must perform, e.g. hold the circuit in place, hold the working parts, protect the product from dirt and damage, be easy to handle, be aesthetically pleasing, convey information about the operation of the product. Provide students with a wide range of materials that can be used to complete the product e.g. paddle pop sticks, construction blocks, elastic bands, cardboard, adhesive tape.

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Evaluating products and processes

(evaluates success of the design against the criteria and considers the effectiveness of the process)

- As each group completes the construction of its product, have group members prepare a survey to be used for the purposes of evaluation. Check each group to ensure that the questions in the survey clearly relate to the criteria for success established at the commencement of the project.
- Have each group work with another group to test its product, i.e. user testing. Ensure that comments collected during user testing are included in the group's evaluation of its product.
- Provide all students with questions to be used when reflecting on their project.

Questions you might ask students to consider:

- what part of the project was most enjoyable?
- what part of the project was least enjoyable?
- what was learned?
- what part of the learning was most important? Why is it important?
- what other things could have been done to assist groups?
- if you were to undertake the task again what would you do differently and why?