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Circuit breakers • Lesson 1 • Blackouts

**Lesson 1**

**Launch**

**F-Y10**

**Year 6**

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# Lesson overview

## Students identify and empathise with people affected by blackouts caused by interruptions in electrical circuits.

## Key learning goals

Students will:

* demonstrate curiosity about electricity.
* identify items that require electricity to function.
* identify how people are affected when there is no electricity.

Students will represent their understanding as they:

* record their predictions and observations in a T-chart.
* participate in and contribute to discussions, sharing information, experiences and opinions.
* drawing a diagram of two batteries connected together.

## Assessment advice

In the launch phase, assessment is diagnostic

Take note of:

* How do students describe the source of electricity?
  + For example, do batteries store electricity, do overhead wires 'bring' the electricity?
* How do students describe energy transformation?
  + For example, do appliances 'use' or 'use up' electricity?
* Have students described different types of batteries and voltages?
  + For example, do big batteries mean they are more 'powerful'?
* What vocabulary are students using?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to create a word wall
* Materials to create a TWLH chart
* Materials to create a wall T-chart

**Each group**

* Small cheap LED torches with AA or AAA batteries (different types of torches are ok) – to examine how batteries are connected together to provide energy for the light.

**Each student**

* Individual science journal (digital or hard-copy)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Experience and empathise | 15 minutes | Whole class |
| Anchor | 10 minutes | Whole class |
| Elicit | 15 minutes | Whole class |
| Connect | 15 minutes | Whole class |

# Launch

## Experience and empathise • The importance of electricity

Optional: Beginning the lesson by having students walk into a darkened classroom with all electricity turned off can have an immediate impact. This can be done by switching off all the electrical appliances/lights in the classroom either manually or at the safety switch.

Pose the question: *How important is electricity?*

Ask students to:

* predict what would happen if there was no electricity at the school, their home, or the local area.
* write their predictions on a sticky note.
* collect their predictions by sticking them in a T-chart.

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Watch the video depicting consequences of a blackout, for example “[Queensland blackout causes chaos](https://www.youtube.com/watch?v=8NTBgb16kyo)”. (<https://www.youtube.com/watch?v=8NTBgb16kyo> 2021, 5:41 minutes, swear word beeped out at 1:46 minutes). Consequences include: no traffic lights, no computers, no electricity for hospitals/airports/television, no lights in shops/hairdressers.

Students share their observations of the way that people were affected when there was no electricity. Record these in the second column of the T-chart.

Compare and discuss the terms ‘blackout’ (there is no electricity at all) and ‘brownout’ (the electricity is restricted making it difficult to keep everything going). In the video, the electricity to some areas was cut so that there would be enough for hospitals.

Watch a video depicting the causes of a blackout, for example "[Why did many Victorians lose power after wild storms?](https://www.youtube.com/watch?v=C2ABBZx6dNw)" (<https://www.youtube.com/watch?v=C2ABBZx6dNw> 2024, 1:32 minutes).

Keep the T-chart for the Act phase of the unit.

## Anchor • Electrical links

Brainstorm all the objects in the classroom that need to be plugged in to electricity to work. If the students need to move, encourage them to put a post-it note or similar on the object.

Discuss how students know if something is ‘working’ when plugged into the electricity.

Potential discussion prompts

* *How do you know a light is working?*
* *How do you know a fan is working?*
* *How do you know a mobile phone is working?*
* *How do you know a speaker is not working?*
* *How do you know an automatic door is not working?*

## Elicit • Eliciting prior knowledge

Elicit students’ previous experiences with electricity by asking questions.

Potential discussion prompts

* *Who needs to know about electricity?*
* *Does anyone have solar panels/batteries/generators at home?*
* *How are they used by the family?*
* *Can anyone tell me about a TV program they have seen that involved people who did not have electricity?*
* *Does anyone know someone who works with electricity in their job?*
* *Have you ever experienced a place with no electricity?* 
  + Camping, power/generator off, etc.
* *From your knowledge outside school, how important would you describe electricity?*
* *What do you know about electric cars? Do they have electricity? Where does their electricity come from?*

Begin a class TWLH chart by recording students’ thoughts about what electricity is in the ‘What we THINK we know’ column.

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Discuss what questions students have about electricity. Record their questions in the ‘What we WANT to know’ column.

Potential discussion prompts:

* *How does electricity get to our power points?*
* *How does the electricity move from our power points to the objects?*
* *How does a switch turn an object on/off?*
* *What could we do if we had no electricity on the power points?*

## Connect • Connecting with electricity

Discuss

* how a torch could be used in a blackout.
* how a torch is different from the light in the classroom (plug-in/not plug-in, moveable).

Ask students where a (LED) torch gets its energy.

Take out the batteries and show the students.

Explain that, throughout the unit, students will also keep a collective record of ideas—an individual or class science journal—and why this might be important:

* it can mirror the practice of working scientists
* it gives us more ideas to consider
* it helps us achieve shared sense-making and build consensus, and a shared/deeper understanding.

Students draw a picture of a battery in their science journals, noting the positive and negative ends.

Replace the torch's batteries, pretending to forget how to correctly insert them (connecting two positive ends together or two negative ends together). Observe that the torch no longer operates.

Note: A LED torch must have batteries connected in a single direction. Older bulb torches are less dependent on the direction of the battery connections.

Discuss:

* observations of the arrangements of batteries in students' torches.
* why the teacher's torch will not operate.
* how the batteries in the teacher's torch should be arranged.
* the importance of observation in science.

Suggest that scientists often draw diagrams so they can remember what they saw.

Invite students to draw a picture of the batteries and how they are connected.

## Reflect on the lesson

You might:

* Begin a class word wall or glossary, including the words from the lesson that students think would be useful to recall throughout the unit. This can also be done throughout the lesson, and referred back to it during this reflection, re-defining terms as appropriate.
* At this stage, the word wall should only include words that students have offered themselves during the lesson. The word wall is added to in subsequent lessons. Thus, new vocabulary is introduced in context.
* Ask students to talk to family members about their experiences of blackouts, especially across generations. They can discuss frequency, length, causes and effects of a blackout and how/why these may have changed over time. What happened? How did they feel without electricity or lights?

**Year 6**

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Circuit breakers • Lesson 2 • Making a torch

**lesson 2**

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# Lesson overview

Students explore and identify the necessary components of an electric circuit. They represent their circuits using accepted circuit symbol conventions.

## Key learning goals

Students will:

* identify the essential components of a circuit.
* explain how electrical energy moves around a circuit.

Students will represent their understanding as they:

* connect a simple circuit of a battery, wires and bulb.
* draw a labelled circuit diagram to describe electricity moving through wires.
* participate in and contribute to discussions, sharing information, experiences and opinions.
* update the TWLH chart.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* Can students identify a battery as a source of energy?
* Can students identify the different components of an electrical circuit?
* Have students identified that all connections need to be made for electricity to flow around a circuit?
* Are students reasoning and making justifications based on evidence they have collected?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Demonstration copy of **Testing circuits Resource sheet** (or create your own)
* Stripping pliers (to strip the insulation from the wires if required)
* Materials to create a word wall

**Each group**

* 1 x 1.5 VAA battery
* 1 x 1.5V battery holder
* 1 x light bulb holder
* 1 x 1.5V light bulb (+ spares)
* 2 x 10 cm length of insulated wire, with the ends stripped of insulation (+ spares)
* Cardboard
* Sticky tape
* Note: If no electrical equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used. (<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>)

**Each student**

* Individual science journal (digital or hard-copy)
* **Testing circuits Resource sheet**(or create their own)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 20 minutes | Collaborative teams, Individual |
| Integrate | 10 minutes | Whole class |
| Investigate | 10 minutes | Whole class, Individual |
| Integrate | 15 minutes | Whole class, Individual |

# Inquire

## Re-orient

At the end of the previous lesson students were encouraged to ask their family members about experiences with blackouts. Discuss the different responses students might have received, focusing on how the person involved felt when the lights went out and what they did during the blackout.

Recall the challenges with the torch not switching on in the previous lesson and ‘wonder’ how a torch works.

## Question • Torchlight

Draw on a student question (if one has been asked) as a jumping off point for the following investigation about how a torch works.

If students haven’t asked a question like this themselves, add it to the list of class questions and discuss how answering this question will be the centre of today’s investigation.

## Investigate • Wiring a circuit

Discuss:

Using the **Testing circuits Resource sheet**, discuss the Predict and Reason steps of the PROE strategy.

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  Ask students to:

1. Draw different arrangements of a battery, wire/s, and a bulb.
2. Predict (P) an arrangement of equipment that will make the bulb light up.
3. Record the reasons for their thinking.
4. Share their predictions and reasons with a collaborative team.

Explain that when using low-voltage batteries (e.g. 9V or less) in their investigation, it is safe for students to touch bare wire because there is only a small amount of electrical energy coming from the battery. Any bare wires carrying mains electricity or high voltage (electrical energy) are extremely dangerous.

**Note:** If no electrical equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used.

<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>

Allow students time to test their ideas of equipment arrangements in a collaborative team. They should:

1. Construct and test the arrangement of equipment predicted by each student.
2. Discuss their observations as a team.
3. Record their observations (O) in the PROE.

As a class, draw or place the ‘successful’ and ‘unsuccessful’ connections in two separate groups.

## Integrate • Circular arrangements

Discuss what the ‘successful’ arrangements had in common (a circular unbroken connection) and what the ‘unsuccessful’ arrangements were missing (broken connections or gaps in the connections).

Potential discussion prompts

* *Which arrangements of battery, wires, and bulb made the light bulb light up?*
* *What happened when there was a single wire connected between the battery and the bulb.*
* *What was the same or similar about the arrangements that worked?*
* *What was the same or similar about the arrangements that didn’t work?*
* *Why do you think that arrangement worked?*
* *What do you think each component of the arrangement does?*

Students record their representation of what a ‘successful’ arrangement needs in their Explain section of the PROE.

Compare (without making judgments) the different representations of batteries, wire/s, and bulbs that students predicted might work.

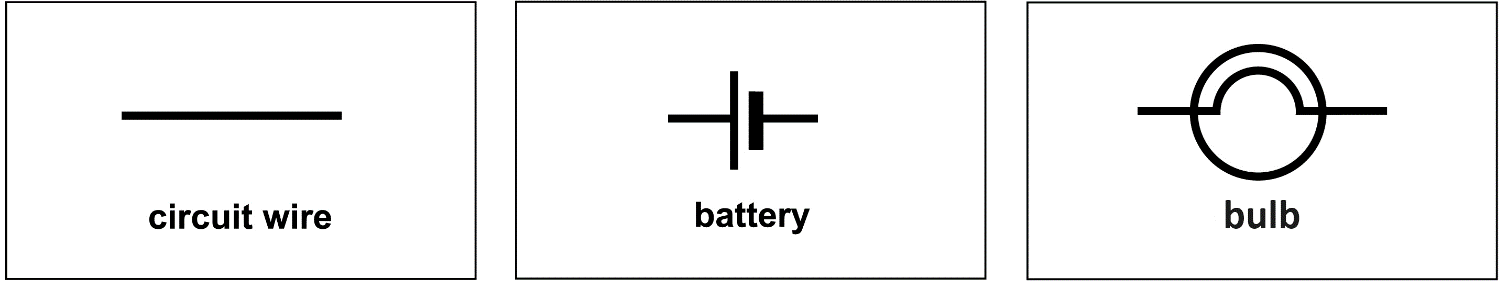
Compare the similarities and differences in how students represented the components.

Discuss:

* why it might be confusing, or even dangerous, for people to use different symbols to represent wires, batteries, etc.
* how might students represent the components so that everyone can understand what we’ve drawn.

## Investigate • Electrical symbols

Introduce the standard electrical symbols used in circuit diagrams to represent how components are connected.  Introduce these symbols.



Discuss:

* other examples of a common/known symbol that is essential (e.g. Stop sign = car stop).
* emojis to represent emotions (happy, sad, angry).
* the challenges that occur when the wrong symbol is used.
* how all representations are only useful sometimes.

Students select one of the diagrams of an arrangement of equipment that lit up the light bulb and represent it in their science journals as a diagram, using electrical symbols.

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Sample diagram

## Integrate • Integrated circuits

Students share their diagrams as a class.

Potential discussion prompts

* Does it matter if the battery’s positives and negatives are changed around?
  + Most light bulbs can have the flow of electricity move in either direction. This means the batteries can face either direction as long as they are connected to each other correctly.
  + LEDs are unidirectional which means the flow of electricity needs to move in one direction only. This means the batteries must point in the correct direction.
* Should the wire lines be continuous?
  + Yes. If the wires are not connected in the diagram, it means the wires are not connected in real life. This will interrupt the flow of electricity.

Introduce and discuss the term ‘circuit’:

* comparing it with other meanings of the word ‘circuit’ that students know, such as a fitness circuit or a course or track used in racing.
* what needs to be included in an ‘electric circuit’ for a bulb to work (compared to a non-working group of wires, battery and bulb).
* the meaning of ‘electric circuit’ and what needs to be included to meet this meaning.

## Reflect on the lesson

You might:

* Re-examine the intended learning goals for the lesson and consider how they were achieved.
* Update the TWLH chart by inviting students to add what they have learned (L) and the evidence/observations that show how (H) they now know that.

For example: “I learned that the metal part of the wires must be touching the battery for the bulb to light up. I know this because when we connected the part of the wires covered in plastic to the battery the bulb did not light up, but when we connected the metal parts the bulb did light up”.

Students may need guidance in constructing these statements, particularly if they are not experienced with this.

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**Year 6**

**lesson 3**

**INQUIRE**

Circuit breakers • Lesson 3 • Modelling electrical circuits

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# Lesson overview

Students use and develop their own models and representations to explore how current moves around an electrical circuit.

## Key learning goals

Students will:

* understand that batteries store chemical energy.
* model the way a current transfers electrical energy around a circuit.
* discuss the way electrical energy can be transformed into light energy, heat energy, or sound energy.

Students will represent their understanding as they:

* model the movement of energy around an electrical circuit.
* describe the transfer and transformation of energy in an electrical circuit.
* participate in and contribute to discussions regarding the advantages and limitations of modelling.
* use the TWLH chart to consider what they have learned.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* Are students able to describe the batteries as storing chemical energy?
* Are students able to describe how electrical energy travels around a circuit?
* Are students reasoning and making justifications based on evidence they have collected?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Stripping pliers (to strip the insulation from the wires if required)
* Materials to create a word wall
* To build the bicycle chain model
  + Bicycle (with chain)
* To build the delivery model B
  + Blu tack
  + 8-10 Toy cars
  + 2 x A4 paper

**Each group**

* 1 x 1.5V AA battery
* 1 x 1.5V battery holder
* 1 x light bulb holder
* 1.5V light bulb (+ spares)
* 2 x 10 cm length of insulated wire, with the ends stripped of insulation (+ spares)
* Note: If no electrical equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used. (<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>)

**Each student**

* Individual science journal (digital or hard-copy)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | 25 minutes | Whole class |
| Integrate | 20 minutes | Collaborative teams, Whole class |

# Inquire

## Re-orient

Revisit the effects of a blackout on people. This can be done by switching off all the electrical appliances/lights in the classroom/school at the safety switch.

Students can recreate the circuits they built in Lesson 2 to provide light in the room.

## Question • Electrical sources

**Pose the question:** *Where does the electrical energy for a circuit come from?*

If students haven’t asked this question themselves in the TWLH chart, add it to the list of class questions and discuss that answering this question will be the centre of today’s investigation.

Use students' circuits to prompt discussion.

Potential discussion prompts

* *What does each part of the circuit do: the light bulb? The wires? The battery?*
* *In Year 5 you learned light is a type of energy. Where does the light bulb get the energy to produce light?*
  + Common answers: the wires; electricity; the battery.
* *What is the energy source in the circuit? What does the energy source do?*
  + The battery transfers energy to the wires.
* *Where does the battery get its energy from?*
  + There is nothing connected to the battery, so the energy must be stored inside it.

Discuss:

* the battery in the circuit is full of chemicals that store chemical energy.
* the chemicals in the battery produce small particles called electrons.
* when the battery is connected into a circuit, it ‘pushes’ the electrons around the circuit.
* the movement of electrons along the wires is called the current.
* the moving current transfers the electrical energy to the bulb.

## Investigate • Modelling electrical flow

Discuss

* how models can be used to show how energy can be moved and transferred from one object to other objects.
* how models can show some things well but may not be able to show other things as well. Use an example that is known by students to illustrate this, for example:
  + A model car shows the shape and colour of a car, but does not have the same engine.
  + You can build cars using Lego or in Minecraft, but it is difficult to have rounded edges like real cars.
  + Plastic food can show the colour and shape of the food but not the smell.

Demonstrate both of the following models and compare them with the students' electrical circuits. Encourage students to use reasoning or provide evidence to support their comparisons, such as "I think the ... model is better because...", or "I think model ... is not very good at showing ... because ..."

**Bicycle chain model**

A person pushing on the pedals of a bicycle (battery) transfers their energy to the chain. This pushes the chain (current) around the loop. The moving current transfers/moves energy from the pedals to the wheels (light bulb) almost instantaneously. The chain (current) keeps being pushed evenly and does not get lost. If the breaks are put on, the wheel (light bulb) stops moving.

Discuss the limitations of this model:

* When riding a bike, if the rider stops pedalling, the wheel keeps moving. This can suggest that the light will keep working if the battery is flat.
* If a circuit adds another wheel/bulb, the person has to push harder to make the chain go around. Batteries cannot push harder.



**Delivery model**

In this model, moving toy cars are used to represent a current. The toy cars will "transfer" the energy from the battery to the lightbulb.

Arrange the toy cars in a circle (like a circuit). Draw a battery on one sheet of paper, and a light bulb on one sheet. Place the battery on one side of the car circle, and the light bulb on the other side. Ask students to move the toy cars around in a circle. As they move through the battery, students place a small piece of Blu Tack (energy) on the car. The toy car moves around the circuit to the light bulb. Once there, the Blu Tack energy is transferred to the light bulb. The toy car then moves back to the battery to have more energy transferred onto it.

Discuss the limitations of this model:

* Students may assume that once the energy/Blu Tack is gone, the cars will not move. Remind students of the bicycle chain model where the pedals push the current around the circuit.
* Students may assume that the Blu Tack energy is ‘used up’ at the light. Remind students that the Blu Tack changes/transforms into light energy.

Invite students to share examples of a device or toy that did not work because the battery was flat. What happens when the battery goes flat? Where did the energy go? How do rechargeable batteries get their energy back?

Discuss:

* how the amount of chemicals that react in the battery is limited.
* when batteries have all passed on their chemical energy, there will be no more electrical energy produced.
* this means there will be no more ‘push’ on the electrons.
* if the current stops moving, it cannot transfer the electrical energy.
* recharging a battery involves 'pushing' the electrons in the opposite direction and storing them as chemical energy.

In the bicycle chain model, a flat battery is similar to putting on the bike brakes. In the delivery model, a flat battery means there are no students to push the toy cars around.

Support students, through questions, to conclude that the energy does not 'disappear’ but rather is changed into other types of energy.

## Integrate • Transfer and transformation

Invite students to draw their own model of the circuit and how the energy is transferred between objects. Add labels and descriptions of what is happening at each stage.

Potential discussion prompts

* *I have a question about this part of your circuit. Why have you included this?*
* *Can you describe how your circuit works for me?*
* *I wonder how your circuit is the same/different to \_\_\_\_\_\_\_\_\_\_\_\_.*
* *I wonder what would happen if \_\_\_\_\_\_\_\_\_.*
* *I have a question about \_\_\_\_\_\_\_\_\_\_\_\_\_.*
* *I wonder why \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.*
* *What cause \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_?*
* *How would it be different if \_\_\_\_\_\_\_\_\_\_\_\_\_\_?*
* *What do you think will happen if \_\_\_\_\_\_\_\_\_\_\_\_\_?*

Compare the students’ models as a class, carefully selecting models that are different but illustrate the key idea of transfer of energy. Remind the students of the limitations of the bicycle chain model and the delivery model. Ask students to determine one limitation of the models they have drawn.

Introduce the term ‘transform/transformed/transformation’. Contrast this term with ‘transfer’ (passing energy from one object to another). Discuss the meaning of ‘transform’ and provide some examples, such as:

* Cooking a cake mix transforms it into a cake.
* Caterpillars transform into butterflies.
* Cars transform petrol into movement.
* Light bulbs transform electricity into light and heat.
* A battery transforms chemical energy into electrical energy.

Add the terms ‘transform’ and ‘current’ to the class word wall/glossary.

* Transform = changes the type of energy from one form to another.
* Current = the flow of electrons around a circuit.

Ask students to revise their drawn model to include explanations of the energy transformations that are occurring.

## Reflect on the lesson

You might:

* Re-examine how models can be used by scientists to explain what happens in the real world.
* Update the TWLH chart by adding what students have learned (L) and the evidence/observations that show how (H) they now know that. For example: “I learned that models can explain how electrical current moves around a circuit. I know this because my models shows .... I learned that models have limitations. My model does not show...“

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**Year 6**

Circuit breakers • Lesson 4 • Causing a blackout

**lesson 4**

**inquire**

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# Lesson overview

Students pose a question that can be investigated, make reasoned predictions, and plan and conduct an investigation into the factors that affect the transfer and transformation of energy in an electrical circuit.

## Key learning goals

Students will:

* plan and conduct an experiment into the factors that affect the flow of electricity in a circuit.
* understand that electrical energy is ‘shared’ in a circuit.
* understand that electrical energy can be transformed into light energy, heat energy, or sound energy.

Students will represent their understanding as they:

* describe factors that affect the brightness of a bulb.
* describe why a house might need more electrical energy at night.
* participate in and contribute to discussions, sharing information, experiences and opinions.
* update the TWLH chart.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* Are students able to describe how they used variables in the experiment?
* Are students able to use the model of electric circuits to provide explanations for their results?
* Are students reasoning and justification based on evidence they have collected?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Stripping pliers (to strip the insulation from the wires if required)
* Demonstration copy of **Light it up investigation planner Resource sheet**
* Materials to create a word wall

**Each group**

* 3 x 1.5V AA battery
* 3 x 1.5V battery holder
* 3 x light bulb holder
* 3 x 1.5V light bulb (+ spares)
* 6 x 10 cm length of insulated wire, with the ends stripped of insulation (+ spares)
* High Tech option: a light meter to test the amount of light (lux) provided by a bulb
* Note: If no electrical equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used. (<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>)

**Each student**

* Individual science journal (digital or hard-copy)
* **Light it up investigation planner Resource sheet**

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 35 minutes | Collaborative teams, Whole class |
| Integrate | 20 minutes | Collaborative teams, Whole class |

# Inquire

## Re-orient

Remind students of the bicycle chain model and the delivery model of electricity from the previous lesson.

Ask students to imagine that a blackout interrupted the energy travelling to the school. Discuss how the bicycle chain model or the delivery model could be used to demonstrate an interruption to the energy flow.

Potential discussion prompts

* *What happened to the wheels in the bicycle chain model when you pushed on the pedals?*
* *What could you do to stop the wheels from moving?*
* *What about the delivery model? How could you stop the cars delivering the Blu Tack to the bulb?*
* *What would both of these look like in real life?*

## Question • Supply and demand

**Pose the question**: *What affects the supply of electrical energy and causes a blackout?*

If students haven’t asked this question themselves in the TWLH chart, add it to the list of class questions and discuss how answering this question will be the centre of today’s investigation.

Discuss and list factors that could affect the supply of electricity to the school and students' homes.

Remind students that a brownout is a reduction in electricity that means the remaining electricity needs to be redirected to key areas such as hospitals. Discuss what areas/industries that need electricity might be considered essential.

## Investigate • Multiple bulbs

Discuss

* how electrons transfer the electrical energy around the entire circuit
* how the electrical energy is transformed into light energy by the bulb.

Ask students to reflect on the electrical circuits they made in Lesson 2. What factors could interrupt the supply of enough electrical energy for the bulbs to transform into light energy?

Using a variables grid in the class science journal, record possible elements of the circuit that could be changed. Variables might include the length of wire, number of wires, number of bulbs, number of batteries, and arrangement of bulbs and batteries.

**Pose the investigation question:** *What happens to the brightness of the bulb when we change\_\_\_\_\_\_\_\_\_\_\_\_\_?* Invite teams to complete the question by selecting their own variable to test.

Each team should complete the Predict (P) and Reason (R) sections of the Predict, Reason, Observe, and Explain (PROE) strategy.

If any teams decide to add multiple bulbs to the circuit, they should also explain which of their bulbs they will use to measure changes in the light brightness.

Suggest that students make comparisons to their original circuits that contain a single light bulb.

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Decide how students will measure the brightness of the bulb:

NO TECH: If no equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used. (<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>). The varying brightness of the bulb is represented by the length of the lines emanating from it.

LOW TECH: The brightness of the original circuits containing a single light bulb can be represented as: ++. A brighter lightbulb can be represented with +++ and a dimmer bulb with +.

HIGH TECH: A light meter (or appropriate app) can be used to measure light in ‘lux’ units. This is an opportunity to discuss why using eyesight can be subjective and affected by looking at a bright object for a few minutes and then looking away.

Allow time to conduct the investigation and record results.

## Integrate • Lighting the way

Invite teams to report their findings to the rest of the class, including presenting a claim that answers their specific investigable question with supporting evidence and reasoning.

Potential discussion prompts

* *What did you predict would happen?*
* *What did you observe?*
* *Was your prediction different from what you observed?*
* *Why do you think that happened?*
* *What claim might you make to answer your question “What happens to the brightness of the bulb when we change (teams selected variable)?”*
* *What evidence do you have to support your claim?*

Compare the results of teams who changed the same variable to see if they achieved the same results, and discuss how this may or may not have happened. Encourage students to question each other using the [science question starters](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/facilitating-evidence-based-discussions).

Compare the findings of the student teams to the models of electrical circuits from the previous lesson. Use their models to explain their findings.

* Adding more lights to a single circuit means the energy carried by the current needs to be shared. This means the individual light bulbs have less light energy.
* A light bulb in a single circuit will be brighter if there are two batteries to provide energy.
* After some time, the battery goes flat and provides no energy to the bulb.

If any team tested adding more bulbs to the circuit, did they find that this resulted in the bulbs not producing light? Discuss and link this to a potential cause for a blackout or a brownout.

Potential discussion prompts

* *What happened when light bulbs were added to the circuit?*
* *Why do you think the bulbs were not able to produce light?*
  + There was not enough electrical energy to be transformed into light energy.
* *Have you ever had the lights go out when too many things were plugged in?*
* *How could you make sure there was enough electrical energy for the lights in the circuit?*
  + We could add more batteries, or use fewer bulbs.
* *Do you think this could cause a blackout (or brownout)?*
* *Who do you think needs electricity the most…schools…homes…shops…hospitals?*
* *If you controlled the electricity in a town, how would you decide who should be disconnected if there was not enough current for everyone?*

## Reflect on this lesson

You might:

* Discuss examples of where the concepts of this lesson might apply in daily life.
* Record teams' claims and evidence about circuits from their investigations in the L and H columns of the TWLH chart.

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**Year 6**

Circuit breakers • Lesson 5 • Conductors and insulators

**lesson 5**

**inquire**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit:  [https://primaryconnections.org.au/teaching-sequences/year-6/circuit-breakers/lesson-5-conductors-and-insulators](https://primaryconnections.org.au/teaching-sequences/year-6/circuit-breakers/lesson-5-conductors-and-insulators?utm_source=docx&utm_medium=lesson_5&utm_campaign=circuit_breakers) |

# Lesson overview

Students pose an investigable question and plan and conduct an investigation to identify the best material for a conductor in an electric circuit.

## Key learning goals

Students will:

* plan and conduct a repeatable investigation including identify and control variables in a fair test.
* identify and describe materials that act as electrical insulators or conductors.

Students will represent their understanding as they:

* describe how to identify an electrical conductor or insulator.
* participate in and contribute to discussions, sharing information, experiences and opinions.

## Assessment advice

In this lesson, assessment is summative.

Students working at the achievement standard (science inquiry) should have:

* identified variables to be changed, measured and controlled.
* used equipment to generate and record data with appropriate precision.
* organised, recorded and processed their data in an appropriate table.
* constructed representations that organise and process data and information and described patterns, trends and relationships.
* recognised possible sources of error and suggested improvements in the method.

Refer to the Australian Curriculum content links on the [Our design decisions tab](https://primayconnections.org.au/teaching-sequences/year-6/circuit-breakers) for further information.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Demonstration copy of **Testing insulators Resource sheet**
* Stripping pliers (to strip the insulation from the wires if required)
* Materials to create a word wall
* Torch

**Each group**

* 1 x 1.5V AA battery
* 1 x 1.5V battery holder
* 1 x light bulb holder
* 1 x 1.5V light bulb (+ spares)
* 6 x 10 cm length of insulated wire, with the ends stripped of insulation (+ spares)
* Sticky tape
* Wooden items (eg, toothpicks, corks)
* Plastic items (eg, straws)
* Rubber items (eg, rubber bands, balloons)
* Metal items (eg, paperclips, thumb tacks, alfoil, split pins)
* Optional: electric buzzer
* High Tech Option: Multimeter to test either resistance or current through materials
* Note: If no electrical equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used. (<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>)

**Each student**

* Individual Science journal
* **Testing insulators Resource Sheet**

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 15 minutes | Whole class, Collaborative teams, |
| Investigate | 25 minutes | Collaborative teams, Whole class |
| Integrate | 15 minutes | Whole class |

# Inquire

## Re-orient

Recall the experiment from the previous lesson, exploring how different circuit arrangements affected the brightness of a bulb. Discuss the factors that affected the flow of electricity around the circuit.

Invite students to recreate their circuits to provide light in the room.

## Question • Interrupting the flow

**Pose the question:** *Does tying a knot in the wire slow the movement of electrical energy?*

Students try this with their circuits.

Discuss:

* that tying a knot is a variable.
* the definition of a variable.
* that testing the effect of a knot in their circuit required all other variables to be kept the same.
* that the wire allowed electricity to flow very easily, even when knotted.
* that there are some materials that do not let electricity flow through.

Ask students to disconnect and reconnect wires and observe what happens.

Discuss:

* that the electricity stopped flowing when the wires were disconnected.
* that this suggests that electricity does not flow easily through the air.
* that electricity travels more easily along wires.

**Pose the question:** *What materials prevent the flow of electricity?*

If students haven’t asked this question themselves in the TWLH chart, add it to the list of class questions and discuss that answering this question will be the centre of today’s investigation.

## Investigate • Testing materials

Brainstorm materials that could be tested to see if electricity does or does not flow through. Identify materials that could be tested for their ability to allow electricity to flow, using the materials in the equipment list or objects around the classroom as a guide.

Using Testing insulators Resource sheet, discuss and demonstrate the planning of an experiment to test which materials prevent the flow of electricity, including:

* predicting what will happen.
* the variable that will be changed.
* what will be observed.
* what will be kept the same.
* the equipment that will be needed.
* how the equipment will be set up.

A black line drawing of a battery

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Sample equipment set up

Teams might choose to use a light bulb or an electric buzzer to test the conductivity of materials.

High Tech: Students directly test the resistance of materials or the current flowing through the material using a multimeter.

Allow time for each student team to conduct their investigation and record their findings.

## Integrate • Identifying conductors and insulators

Teams report back to the rest of the class on their findings, including presenting a claim that responds to the prediction(s) they made with supporting evidence and reasoning.

Encourage students to probe deeply into groups' results and claims using the [science question starters](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/facilitating-evidence-based-discussions).

Potential discussion prompts:

* *What did you predict would happen?*
* *What did you observe?*
* *Was your prediction different to what you observed?*
* *Why do you think that happened?*
* *What claim might you make to answer your question “What materials prevent the flow of electricity?”*
* *What evidence do you have to support your claim?*

Introduce the terms conductor, insulator and resistance in reference to an electrical circuit.

Suggested definitions might be:

* electrical conductors: materials that allow electrical current to pass through them.
* resistance: the measure of the difficulty of passing electrical current through a circuit.
* electrical insulators: materials that do not allow electrical current to pass through them.

Discuss

* any patterns observed among materials that are good conductors and among those that are good insulators.
* that many metals, such as copper, iron, and steel, are good electrical conductors (low resistance). Whereas plastic, wood, glass, and rubber are good electrical insulators (high resistance).
* how electrical conductors and insulators are used in everyday ways and things.

Potential discussion prompts:

* *What happened when an electrical insulator was introduced into your circuit?*
* *Why do you think that the wires you use are surrounded by plastic?*
* *What would happen if you touched a wire in your house? Would you be an insulator or a conductor?* 
  + As our bodies are mostly water, we are conductors.
* *How are the batteries we use different from the electricity in our houses?* 
  + The batteries are 1.5 volts. Australian houses have 240 volts in their wires)
* *You might have used heat insulators in Year 3. How are heat insulators similar to electrical insulators?*

## Reflect on the lesson

You might:

* add relevant vocabulary to the class word wall/glossary.
* record teams' claims and evidence about circuits from their investigations in the L and H columns of the TWLH chart.

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**Year 6**

Circuit breakers • Lesson 6 • Making a switch

**lesson 6**

**inquire**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit:  [https://primaryconnections.org.au/teaching-sequences/year-6/circuit-breakers/lesson-6-making-switch](https://primaryconnections.org.au/teaching-sequences/year-6/circuit-breakers/lesson-6-making-switch?utm_source=docx&utm_medium=lesson_6&utm_campaign=circuit_breakers) |

# Lesson overview

Students examine the purpose of a switch and develop criteria to evaluate a switch design.

## Key learning goals

Students will:

* use their knowledge of conductors and insulators to make an electrical switch.

Students will represent their understanding as they:

* design and make an electrical switch.
* draw a labelled diagram of an electrical switch.
* participate in and contribute to discussions, sharing information, experiences and opinions.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* Are students able to collaborate to design criteria to evaluate the effectiveness of their switch design?
* Are students able to test a range of materials and equipment to determine their effectiveness in meeting the criteria?
* Are students able to generate, iterate, and communicate their design ideas and decisions?
* Are students able to use evidence and reasoning to justify the decisions they made in their designs?

## Resources

**Whole class**

* Class science journal (digital or hard-copy)
* Stripping pliers (to strip the insulation from the wires if required)
* Demonstration copy of **Switch planner Resource sheet**
* Materials to create a word wall

**Each group**

* Small torch
* 2 x 1.5V AA battery
* 2 x 1.5V battery holder
* 4 x light bulb holder
* 4 x 1.5V light bulb (+ spares)
* 10 x 10 cm length of insulated wire, with the ends stripped of insulation (+ spares)
* sticky tape
* Wooden items (eg, toothpicks, corks)
* Plastic items (eg, straws)
* Rubber items (eg, rubber bands, balloons)
* Metal items (eg, paperclips, thumb tacks, alfoil, split pins)
* Optional: electric buzzer
* Note: If no electrical equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used. (<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>)

**Per student**

* Individual science journal (digital or hard-copy)
* **Switch planner Resource Sheet**

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 15 minutes | Whole class, Individual |
| Integrate | 15 minutes | Whole class |
| Investigate | 15 minutes | Collaborative teams, Whole class |
| Integrate | 20 minutes | Collaborative teams, Whole class |

# Inquire

## Re-orient

Present students with the collection of items used to test conductivity in the previous lesson and ask them to sort the materials into insulators and conductors.

Remind students of the torch examined in the Launch phase and its switch. Discuss what it would be like trying to switch on a torch in the dark during a blackout.

## Question • Questioning switches

**Pose the question:** *What makes a good switch?*

Discuss factors which will become success criteria for the successful design of a switch. For example:

* turn the light off and on.
* easy to use.
* not electrocute someone.
* quick to change/switch.
* people of all abilities able to use it (discuss what this means).

## Investigate • Designing switches

Introduce the electric symbols for open and closed switches. Diagram, box and whisker chart

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Ask students which position represents a switch that allows electricity to flow and why they think that. Discuss if the moving part of a switch should be made out of a conductor or insulator.

Students can redraw the circuit they used to test conductors and insulators in the previous lesson, now using the symbols for a switch. They should annotate the diagram to describe the role of the switch in a circuit.

Ask: *What would be an effective design for a switch?*

Students draw different versions of a switch in the Switch planner Resource sheet. Their switch should use their selected materials from the previous lesson and should follow the criteria decided in the **Question** routine.

Example of a criteria table:

A grid of white squares with check marks

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Student teams should build and test their designer switch using a simple circuit from the previous lesson.

Allow students time to complete their investigation.

## Integrate • Identifying success

Discuss the successful design from each student team, comparing them to the identified class criteria.

Potential discussion prompts:

* *Which material did you use to make your switch? Why did you choose that material?*
* *What other material could you have also used? How do you know that?*
* *How does your switch match the criteria we identified?*
* *What part does the switch play in the circuit?*
  + When it is not connected, it stops the flow of the electrical energy. When it is connected, the electrical energy can flow.
* *Why do we use a switch in a circuit?*
  + To have more control over when the electrical energy is flowing; so that energy is not wasted; so that the battery does not go flat.
* *How many switches are there in the classroom? In your house? Is there one switch for everything?*
* *Can some switches be turned on in a room, while other switches in the same room are turned off?*

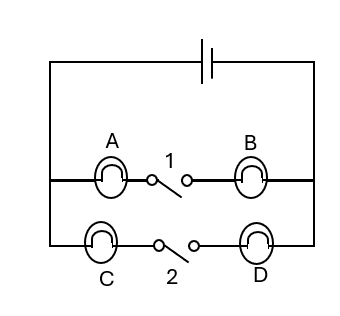
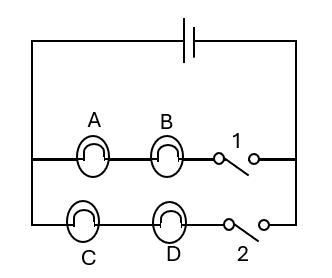
## Investigate • Electrifying rooms

Challenge the student teams to replicate how the electricity might work in their houses. Are they able to have different switches control different lights?

Ask teams to draw a line down the centre of a page to represent two rooms in their house, then place 1-2 bulbs and 1 student switch in each ‘room’. The team should connect the bulbs and switches so that each switch activates the lights in its room only, i.e. the switch in room 1 activates the lights in room 1 and the switch in room 2 activate the lights in room 2. The circuit can only use a single battery.

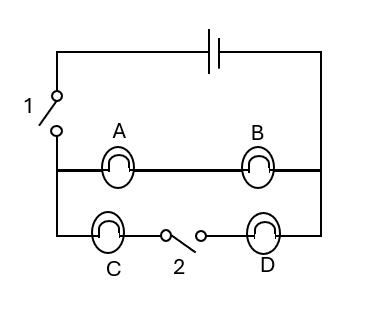
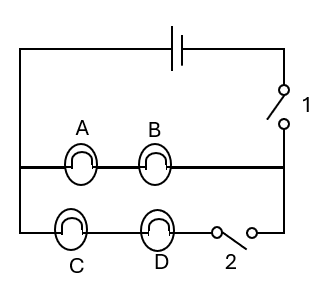
Example circuits include:

Switch 1 controlling light A+B; Switch 2 controlling light C+D



**OR**

Switch 1 controls lights A+B+C+D, and Switch 2 controls lights C+D. For lights C+D, both switches 1 and 2 need to be closed.



**OR**

If students have difficulty, suggest that they follow the flow of electricity with their finger from the battery, along the linked wires and closed switches. This provides an opportunity to reinforce that a circuit requires a ‘closed loop’.

## Integrate • Justifying design decisions

After students have completed their investigations, use the [QCER communication tool](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/facilitating-evidence-based-discussions) to discuss each team's successful designs and correlate them to the functions in a house.

Potential discussion prompts:

* *Did your design meet the criteria?*
* *What evidence do you have to support your claim?*
* *How does your design meet the criteria)?*
* *What could you have connected instead of lights?*
* *Why would it be important to use a switch for more than one thing?*

## Reflect on the lesson

You might:

* Discuss examples of where the concepts of this lesson might apply in daily life.
  + *Have you ever had the electricity go off in one part of your house?*
  + *Why do you think this might happen?*
  + *Is this the same as a blackout?*
  + *Could big electrical circuits connect the houses on one block separately from the block across the street?*
  + *Could this be the reason why one street of a suburb has a blackout and not the next suburb?*
  + *Has this ever happened to you?*
* Record teams' claims and evidence about circuits from their investigations in the L and H columns of the TWLH chart.

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**Year 6**

Circuit breakers • Lesson 7 • Designing for blackouts

**lesson 7**

**ACT**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit:  [https://primaryconnections.org.au/teaching-sequences/year-6/circuit-breakers/lesson-7-designing-blackouts](https://primaryconnections.org.au/teaching-sequences/year-6/circuit-breakers/lesson-7-designing-blackouts?utm_source=docx&utm_medium=lesson_7&utm_campaign=circuit_breakers) |

# Lesson overview

Students design an electrical product that can be used to support people during a blackout, and communicate their design ideas to a selected audience.

## Key learning goals

Students will:

* use the design process to plan and produce an electrical device that could be used during a blackout

Students will represent their understanding as they:

* identify appropriate criteria that can be used to evaluate the effectiveness of a design
* draw a labelled diagram of their electrical device
* communicate their reasoning for the materials used in their design

## Assessment advice

In this lesson, assessment is summative.

Students working at the achievement standard should have:

* demonstrated an understanding that electrical energy can be transferred and transformed. Evidence might include:
  + identification of the role of circuit components in the transfer and transformation of energy.
  + labelled diagrams identifying the movement of electrical current in a circuit.
* described how individuals and communities use scientific knowledge.

Refer to the Australian Curriculum content links on the [Our design decisions tab](https://primayconnections.org.au/teaching-sequences/year-6/circuit-breakers) for further information.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Stripping pliers (to strip the insulation from the wires if required)
* Demonstration copy of **Prototype planner Resource sheet**
* Materials to create a word wall

**Each group**

* Small torch
* 2 x 1.5V AA battery
* 2 x 1.5V battery holder
* 4 x light bulb holder
* 4 x 1.5V light bulb (+ spares)
* 10 x 10 cm length of insulated wire, with the ends stripped of insulation (+ spares)
* Sticky tape
* Wooden items (eg, toothpicks, corks)
* Plastic items (eg, straws)
* Rubber items (eg, rubber bands, balloons)
* Metal items (eg, paperclips, thumb tacks, alfoil, split pins)
* Cardboard
* Scissors
* Optional: electric buzzer
* Note: If no electrical equipment is available, the [Circuit Construction Kit on the PHET website](https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html) can be used. (<https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_all.html>)

**Per student**

* Individual science journal (digital or hard-copy)
* **Prototype planner Resource Sheet**

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Anchor | 5 minutes | Whole class |
| Connect | 10 minutes | Whole class, Individual |
| Design | 40 minutes | Collaborative teams, Whole class |
| Communicate | 50-60 minutes | Collaborative teams, Whole class |

# Act

## Anchor • Revisiting electricity concepts

Review the class science journal and the TWLH chart to review the teaching sequences. Discuss how students’ ideas have changed during the activities.

Discuss:

* the different ways electrical energy is transformed for our needs.
* how energy is transferred from wires to lights, heaters, fridges, phones, electric cars etc.

## Connect • Empathising in a blackout

Revise the T -chart on potential impacts of blackouts from the Launch phase.

Discuss the meaning of ‘empathise’ with students: imagining what it might be like to ‘walk in another’s shoes’ and identifying with other’s feelings, situations, and motivations (ACARA).

Discuss what it would/does feel like to not have any electricity at home or at school, during daytime or nighttime. What problems might people encounter, and how could we solve those problems?

Potential discussion prompts

* *Has anyone been in a blackout?*
* *How did you feel? How might a person feel?*
* *What do you think they found the hardest?*
* *What do they need help with?*
* *Do you think you could solve the problem for them?*

Outline the problem in a simple manner such as:

*How can we make ... (a simple electrical device) ... so that ... (we can help people during a blackout).*

Potential discussion prompts

* *Who are we helping?*
* *What do they need help with?*
* *Why do they need help?*

## Design • Designing electrical prototypes

Explain and discuss

* that students will work in collaborative learning teams to design, produce and evaluate a working prototype that will help someone experiencing a blackout.
* a prototype is definition prototype as a model or version of a device that tests if an idea works.
* that the teams will present their prototype to the rest of the class (or any visitors that might attend).
* the prototypes must include all of the criteria that will be determined by the class (after thinking creatively first).

### Thinking creatively

Remind students of all the ways people were affected during a blackout/brownout. Invite students to consider ideas that would help solve these problems. Encourage students to write every idea down on a whiteboard or sticky note (1 idea/note). Remind them that no idea should be discounted. For example, a magic battery that turns on whenever it is needed is an idea. The practicality of the idea will be considered later. Include all ideas!

### Thinking critically

Discuss the key criteria that would make the electrical device useful in a blackout.

Potential criteria include:

* It should contain a battery, 2-3 bulb/speaker, wires, 1-2 switches.
* Easily switched on by people of all abilities.
* Has a source of electrical energy.
* Is something that is needed during a blackout.
* It uses classroom materials.
* It is sturdy.
* It looks good.
* It is easy to make.

As a class, organise the key criteria from most important to least important from the point of view of the person using the device.

Select all of the ideas from the Thinking creatively phase that do not meet the most important criterion as identified by the students. Remove these unsuitable ideas from the board.

Select the ideas that do not meet the second most important criterion and remove these from the board.

Repeat this process until a small group of ideas remains. Invite student teams to select one from this group of ideas.

Students use the **Prototype planner Resource sheet** to:

* draw a labelled diagram of their electrical device
* plan the equipment and procedure for making their model
* include a description of how it should work.

Discuss the purpose and features of a procedural text: to describe how something is done. It should include a list of materials needed to do the task and a description of the sequence of steps used. It might include annotated diagrams.

For more formal presentations, student teams could prepare a poster that describes the cause and effect of a blackout and guidelines for what to do.

If time allows, teams should present their idea to the class for peer feedback ([download AITSL's guide for more on peer feedback](https://www.aitsl.edu.au/docs/default-source/feedback/aitsl-peer-feedback-stratedy.pdf)).

Encourage the students to use the required materials provided to build their electrical devices. They should check that the device works as intended.

This may include:

* Show (don’t tell) the prototype by giving it to the user to try
* Explaining the prototype design to peers or potential users
* Testing to see if the design prototype works in an intended manner
* Developing a survey for potential users
* Compare the prototype design to an existing model

Potential discussion prompts

* What appears to be the problem? Can you explain it to me?
* How have you tried to solve the problem?
* Have you thought of...? (Provide strong direction)

## Communicate • Sharing the science

Students could share their devices with their peers, other students, an electrician, or parents and carers.

They might share:

* their science journals.
* the labelled diagram of their device.
* the devices they constructed.
* a poster that suggests what to do in the event of a blackout.

Discuss the information that they will need to include in their descriptions (written or verbal) including:

* the electric circuit in their model.
* the materials and components that they have used.
* the source of the electrical energy.
* use the words transferred and transformed.
* a description of what will happen if the circuit breaks.

Students could:

* present their models to the class using appropriate voice, volume and pace skills.
* take photos/videos of their presentations.
* use a ‘Shark Tank’ format with invited judges.
* present it during science week activities.