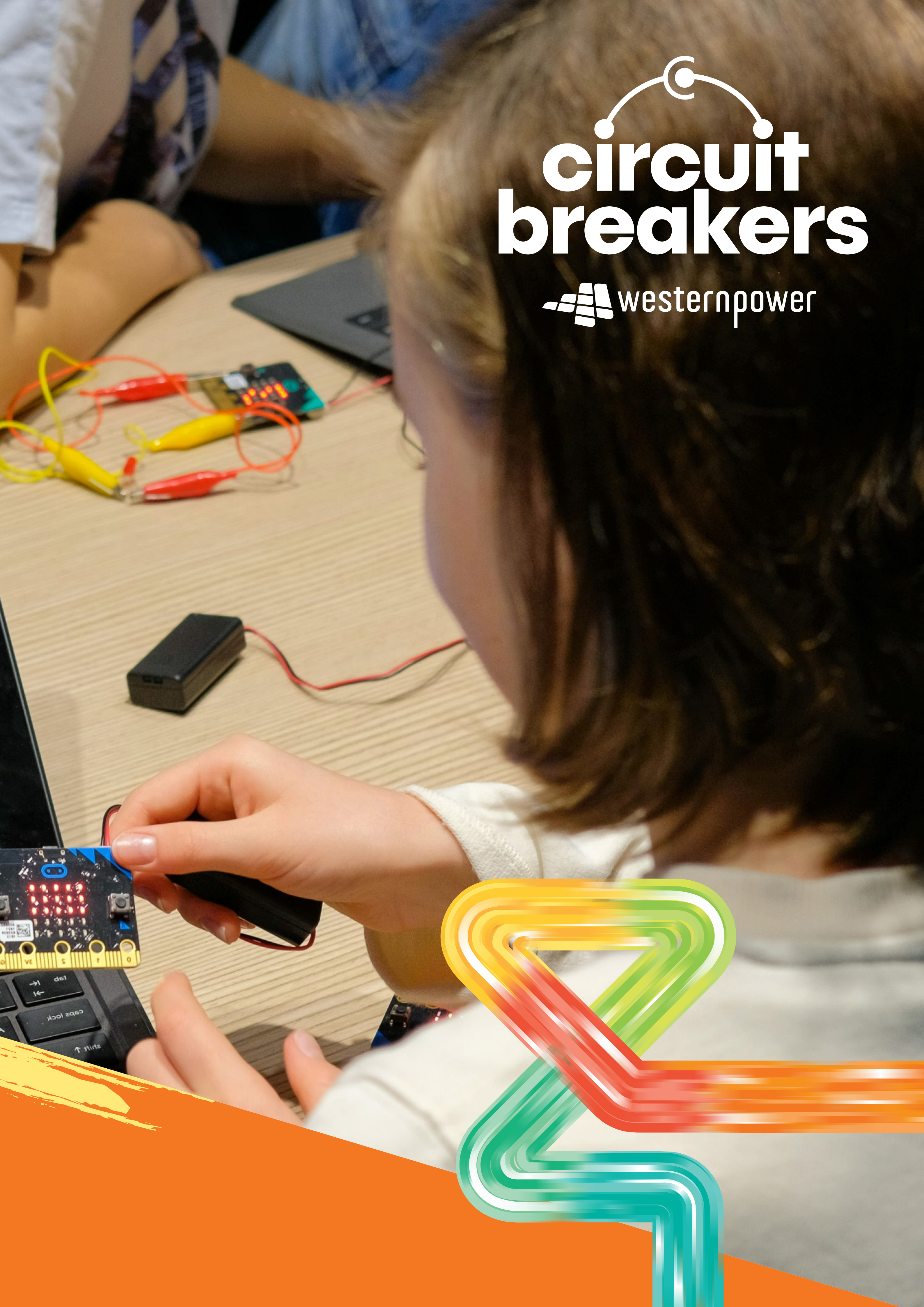
2020 Learning & Lesson guide.

Thinkers • Makers • Innovators


circuit
breakers
westernpower

Contents

Program Overview

Using this guide

This guide contains guide contains everything you need to know to deliver the Circuit Breakers program in your school. Each activity will teach you and your students something new about digital technologies and how they are used in the Western Power network. At the end of the program, your students will use what they have learnt to construct a working scale model which showcases their vision for the Western Power network of the future.

Support from STEM professionals

The activities in this guide are designed to be led by the teacher but each school participating in the Circuit Breakers program will be linked with a Western Power STEM professional, to answer questions from the teacher or students.

A Circuit Breakers video channel will have Western Power STEM professionals talking through activity subject matter and drawing the parallels with their jobs. Content will be added as it is ready so may not be linked in this document. Check the channel before each activity:

www.westernpower.com.au/community/our-education-program/circuit-breakers

Expanding or modifying activities

The activities contained in this guide are designed as an introduction to electronics and digital technologies that can be delivered with a minimum of technical experience and background knowledge.

There is no specified duration for each activity. Activities can be conducted as a single lesson or span multiple lessons. Teachers are welcome to adapt activities to suit their class and teaching style. More confident teachers should feel free to expand upon or modify these activities as needed. You are encouraged to share your extension ideas with other schools via the Circuit Breakers Facebook group. If modifying activities significantly, please bear in mind the overall program goal that students produce a working scale model representation of their Western Power network of the future. This model is required to be a video or slide presentation presented and uploaded to Western Power website.

micro:bits

The Circuit Breakers program involves the use of micro:bits, miniature computers which are contained entirely on a circuit-board about half the size of a credit card. Although micro:bits do not have a traditional keyboard or screen or run a desktop operating system, they are still considered computers due to the fact that they can be programmed to perform different tasks. A micro:bit is also an example of an embedded controller: a small computer with a specific dedicated function in a larger system such as your fridge, your car, your home's electricity network, or your local power grid.

Micro:bits can be easily programmed by students and used in a nearly endless variety of projects. Each activity includes exploring a different way to use micro:bits, along with links to resources and further learning opportunities. micro:bits remain the property of your school. Teachers are encouraged to experiment with micro:bits and think about how you can use them in other curriculum areas or with different year levels. Further information on micro:bits can be found at **www.microbit.org**

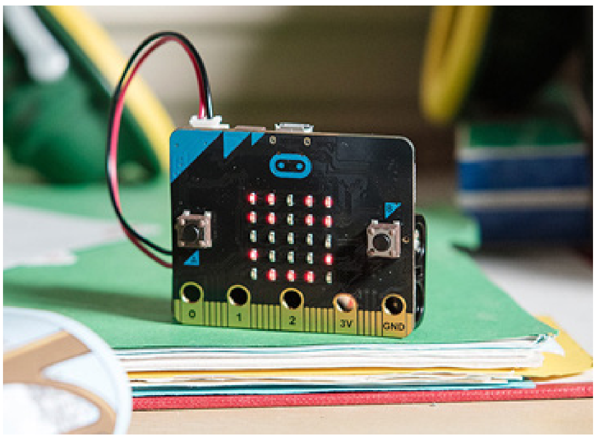
Devices for programming micro:bits

micro:bits can be programmed using either:

- laptop computers or desktop computers (e.g. Windows PC, Mac or Chromebook)
- iPads or Android tablets
- mobile devices such as iPhones, iPod touches or Android phones

Windows PCs, Macs or Chromebooks allow students' code to be downloaded to micro:bits over USB, just like copying a file to a USB thumb drive. This option is strongly recommended in the first instance as it requires no wireless connection and is therefore significantly easier to manage in a busy classroom setting. Further information is available here: **https://makecode.microbit.org/device/usb**

If laptop computers or desktop computers are not available, micro:bits can also be programmed from a tablet or mobile device such as an iPad. If using a mobile device, the micro:bit app must be downloaded in advance and Bluetooth must be enabled on all devices. Each micro:bit will also need to be paired over Bluetooth. Downloading code to micro:bit from tablets and mobile devices uses a process called "flashing". Further information is available at **https://microbit.org/guide/mobile**



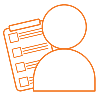
Program Overview

Important Info

Practicing activities in advance

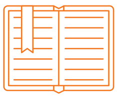
This program involves significant hands-on use of digital technologies, including coding and electronics. Although all instructions are simple and designed for absolute beginners, it is strongly recommended that teachers rehearse the sections of each activity that involve technology and ensure they are familiar with the steps to be followed.

Sections which teachers are recommended to practice in advance will be marked with this icon:



Student journals

Over the course of the program, student work may be collated in either a physical workbook, or a digital portfolio. The exact nature of student journals is left to the teacher's discretion. Activities involving the use of student journals will be marked with this icon:



Digital portfolios may be created using any software or online tools that teachers and students are comfortable with. Examples include:

- WA Department of Education Connect **(https://connect.det.wa.edu.au)**
- Seesaw **(http://web.seesaw.me)**
- Google Classroom **(https://classroom.google.com)**
- ClassDojo **(https://www.classdojo.com)**
- Microsoft OneNote **(https://www.onenote.com)**

Facebook group

To stay updated with the latest information, how-to videos and program updates, as well as to share teaching tips and student experiences - teachers are encouraged to join the Circuit Breakers Facebook group, located at:

https://www.facebook.com/groups/307989786327041/

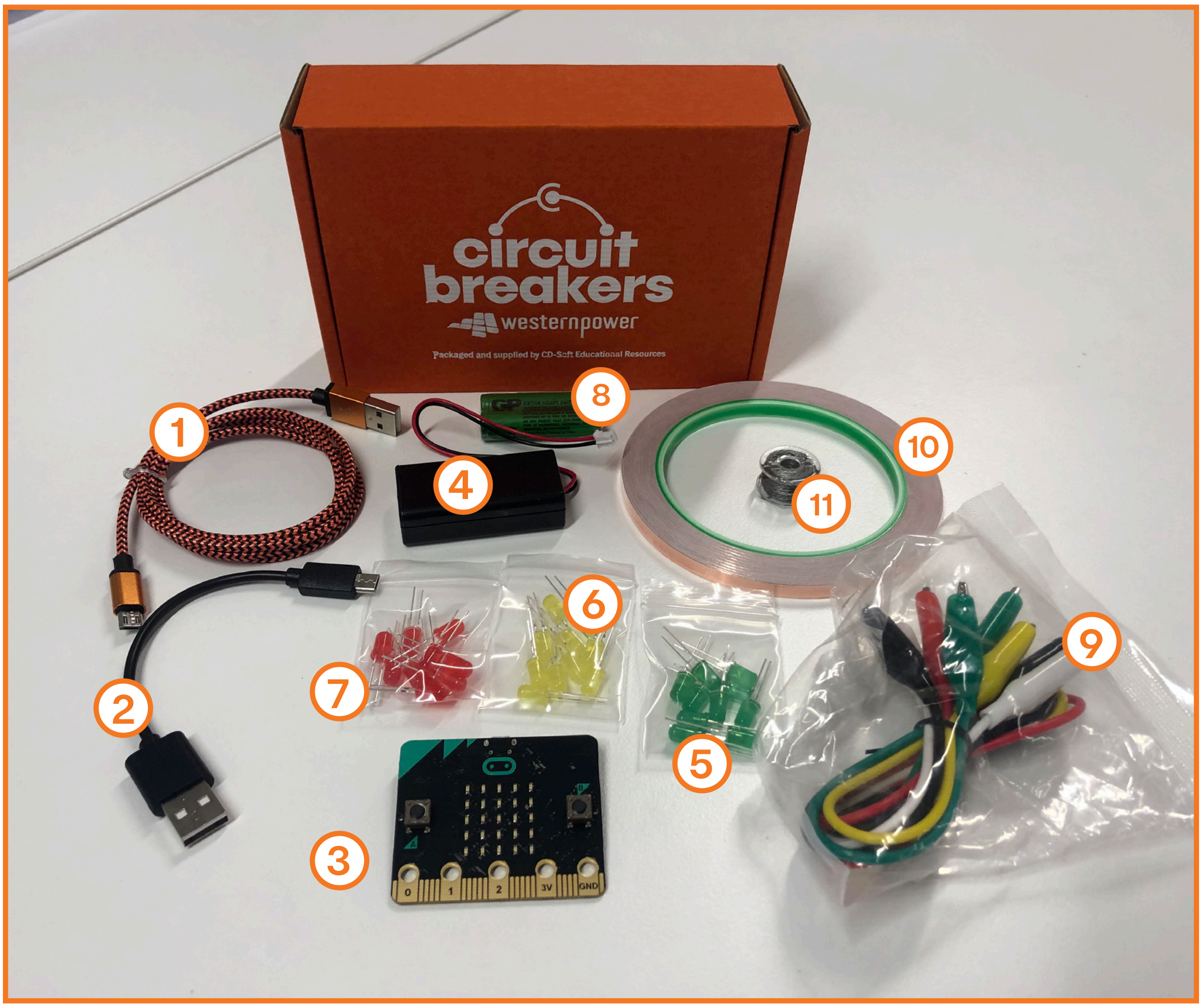
This is a closed group for schools participating in the Circuit Breakers program. The Facebook group will also include Western Power STEM professionals, who will assist teachers with any questions that may arise between visits.

What's in the box?

micro:bit digital technologies kits

Every school participating in the Western Power Circuit Breakers program will be provided with a class set of micro:bit digital technologies kits at a subsidised cost.

Each kit is provided in its own box, which contains the following items



1. USB cable (short)
2. USB cable (long)
3. Micro:bit
4. Battery pack
5. 10 x green LED
6. 10 x yellow LED
7. 10 x red LED
8. 2 x AAA battery
9. 5 x alligator clips
10. 1 x roll copper tape
11. 1 x stainless conductive thread

Links to the Western Australian curriculum

Year 4 Science

Science as a human endeavour	
Nature and development of science	
Science involves making predictions and describing patterns and relationships	ACSHE061
Use and influence of science	
Science knowledge helps people to understand the effect of their actions	ACSHE062
Science inquiry skills	
Questioning and predicting	
With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge	ACSIS064
Planning and conducting	
With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment	ACSIS065
Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately	ACSIS066
Processing and analysing data and information	
Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends	ACSIS068
Compare results with predictions, suggesting possible reasons for findings	ACSIS216
Evaluating	
Reflect on investigations, including whether a test was fair or not	ACSIS069
Communicating	
Represent and communicate observations, ideas and findings using formal and informal representations	ACSIS071

Year 4 Mathematics

Number and algebra	
Number and place value	
Recognise, represent and order numbers to at least tens of thousands	ACMNA072
Recognise that the place value system can be extended to tenths and hundredths. Make connections between fractions and decimal notation	ACMNA079
Using units of measurement	
Use scaled instruments to measure and compare lengths, masses, capacities and temperatures	ACMMG084
Data representation and interpretation	
Select and trial methods for data collection, including survey questions and recording sheets	ACMSP095

Year 4 Technologies

Design and Technologies Knowledge and Understanding Technologies and Society	
Role of people in design and technologies occupations	ACTDEK010
Ways products, services and environments are designed to meet community needs, including consideration of sustainability	ACTDEK010
Digital Technologies Knowledge and understanding Digital systems	
Digital systems and peripheral devices are used for different purposes and can store and transmit different types of data	ACTDIK007
Representations of data	
Data can be represented in different ways	ACTDIK008
Processes and Production Skills Collecting managing and analysing data	
Collect and present different types of data for a specific purpose using software	ACTDIP009
Digital implementation	
Use simple visual programming environments that include a sequence of steps (algorithm) involving decisions made by the user (branching)	ACTDIP011
Creating solutions by Investigating and defining	
Define a sequence of steps to design a solution for a given task	WATPPS21
Identify and choose the appropriate resources from a given set	WATPPS22
Designing	
Develop and communicate design ideas and decisions using annotated drawings and appropriate technical terms	WATPPS23
Producing and implementing	
Select, and safely use, appropriate components and equipment to make solutions	WATPPS24
Evaluating	
Use criteria to evaluate and justify simple design processes and solutions	WATPPS25
Collaborating and managing	
Work independently, or collaboratively when required, to plan, create and communicate ideas and information for solutions	WATPPS26

Year 5 Science

Science as a human endeavour	
Nature and development of science	
Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions	ACSHE081
Use and influence of science	
Scientific knowledge is used to solve problems and inform personal and community decisions	ACSHE083
Science inquiry skills	
Questioning and predicting	
With guidance, pose clarifying questions and make predictions about scientific investigations	ACSIS231
Planning and conducting	
Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks	ACSIS086
Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate	ACSIS087
Processing and analysing data and information	
Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate	ACSIS090
Compare results with predictions, suggesting possible reasons for findings	ACSIS218
Evaluating	
Reflect on and suggest improvements to scientific investigations	ACSIS091
Communicating	
Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts	ACSIS093

Year 5 Mathematics

Number and algebra	
Number and place value	
Use efficient mental and written strategies and apply appropriate digital technologies to solve problems	ACMNA291
Compare, order and represent decimals	ACMNA105
Shape	
Connect three-dimensional objects with their nets and other two-dimensional representations	ACMMG084
Data representation and interpretation	
Pose questions and collect categorical or numerical data by observation or survey	ACMSP118
Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies	ACMSP119
Describe and interpret different data sets in context	ACMSP095

Year 5 Technologies

Design and Technologies Knowledge and Understanding Technologies and Society	
How people address competing considerations when designing products, services and environments	ACTDEK019
Technologies contexts: Engineering principles and systems	
Forces can control movement, sound or light in a product or system	ACTDEK020
Digital Technologies Knowledge and understanding Digital systems	
Digital systems have components with basic functions that may connect together to form networks which transmit data	ACTDIK014
Representations of data	
Data can be represented in different ways	ACTDIK015
Processes and Production Skills Collecting managing and analysing data	
Collect and present different types of data for a specific purpose using software	ACTDIP009
Digital implementation	
Design solutions to a user interface for a digital system	ACTDIP018
Design, follow and represent diagrammatically, a simple sequence of steps (algorithm), involving branching (decisions) and iteration (repetition)	ACTDIP019
Implement and use simple programming environments that include branching (decisions) and iteration (repetition)	ACTDIP020
Creating solutions by Investigating and defining	
Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task	WATPPS27
Identify available resources	WATPPS28
Designing	
Develop and communicate alternative solutions, and follow design ideas, using annotated diagrams, storyboards and appropriate technical terms	WATPPS29
Producing and implementing	
Select, and apply, safe procedures when using components and equipment to make solutions	WATPPS30
Evaluating	
Develop negotiated criteria to evaluate and justify design processes and solutions	WATPPS31
Collaborating and managing	
Work independently, or collaboratively when required, to plan, develop and communicate ideas and information for solutions	WATPPS32

Year 6 Science

Science as a human endeavour	
Physical sciences	
Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources	ACSSU097
Science as a human endeavour	
Nature and development of science	
Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions	ACSHE098
Use and influence of science	
Scientific knowledge is used to solve problems and inform personal and community decisions	ACSHE100
Science inquiry skills	
Questioning and predicting	
With guidance, pose clarifying questions and make predictions about scientific investigations	ACSIS232
Planning and conducting	
Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks	ACSIS103
Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate	ACSIS104
Processing and analysing data and information	
Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate	ACSIS107
Compare data with predictions and use as evidence in developing explanations	ACSIS221
Evaluating	
Reflect on and suggest improvements to scientific investigations	ACSIS108
Communicating	
Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts	ACSIS110

Year 6 Mathematics

Number and algebra	
Number and place value	
Investigate everyday situations that use integers. Locate and represent these numbers on a number line	ACMNA291
Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers	ACMNA105
Shape	
Using units of measurement	
Connect decimal representations to the metric system	ACMMG135
Shape	
Construct simple prisms and pyramids	ACMMG140
Data representation and interpretation	
Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables	ACMSP147

Year 6 Technologies

Design and Technologies Knowledge and Understanding Technologies and Society	
How people address competing considerations, including sustainability when designing products, services and environments for current and future use	ACTDEK019
Technologies contexts: Engineering principles and systems	
Electrical energy and forces can control movement, sound or light in a product or system	ACTDEK020
Digital Technologies Knowledge and understanding Digital systems	
Digital systems have components with basic functions and interactions that may be connected together to form networks which transmit different types of data	ACTDIK014
Representations of data	
Whole numbers are used to represent data in a digital system	ACTDIK015
Processes and Production Skills Collecting managing and analysing data	
Collect, sort, interpret and visually present different types of data using software to manipulate data for a range of purposes	ACTDIP016
Digital implementation	
Design, modify, follow and represent both diagrammatically, and in written text, simple algorithms (sequence of steps) involving branching (decisions) and iteration (repetition)	ACTDIP019
Implement and use simple visual programming environments that include branching (decisions), iteration (repetition) and user input	ACTDIP020
Creating solutions by Investigating and defining	
Define a problem, and set of sequenced steps, with users making decisions to create a solution for a given task	WATPPS33
Identify available resources	WATPPS34
Designing	
Design, modify, follow and represent both diagrammatically, and in written text, alternative solutions using a range of techniques, appropriate technical terms and technology	WATPPS35
Producing and implementing	
Select, and apply, safe procedures when using a variety of components and equipment to make solutions	WATPPS36
Evaluating	
Develop collaborative criteria to evaluate and justify design processes and solutions	WATPPS37
Collaborating and managing	
Work independently, or collaboratively when required, considering resources and safety, to plan, develop and communicate ideas and information for solutions	WATPPS38

Activity one

A miniature computer with super powers

circuit breakers

Activity one

A miniature computer with super powers

Background context

Western Power relies on a team of STEM professionals to help solve a number of problems that face them every day. These engineers work to ensure that communities across the Western Power network continue to enjoy the power they need to live their lives.

Western Power people come from all different walks of life and have a wealth of experience that helps them work through the unique challenges they are faced with.

Engineers are often the first involved in projects that tests new technology and new ways of doing things. They develop their ideas and see them come into reality. They are also responsible for evaluating these projects, further developing them to a stage where they could be ready to be implemented into the way things are done in the future.

Data analysts work with lots of information and big numbers to help shape the way Western Power plans for the future. They can look at how people use electricity now to help decide what needs to be built for the future.

Network controllers use computers that talk to each other across the Western Power network to make sure everyone has the power they need to live, work and play. Sometimes they must turn it off to keep people safe or change where it goes if there is damage to the network to reconnect customers during an outage. All of this is undertaken using computers that talk to each other much like your micro:bits can.

Below are some great resources that explain the different type of engineers and what they do.

Links

What is engineering? (Video – 4 mins)

https://youtu.be/bipTWWHya8A

STEM Careers playlist

https://www.youtube.com/playlist?list=PL4pEYLLb7716l-_U_QyhYflQXQgw9WbSk

Learning goals

Working together, teachers and students will:

- Discover what STEM is, what STEM professionals do, and different types of STEM professions
- Explore what Western Power does and what they are responsible for
- Develop understanding of what defines a "computer" and where computers are used
- Introduce micro:bit and its features

Students resources:

- micro:bit
- micro:bit battery pack
- student journals (physical or digital)

Teacher resources:

- one micro:bit
- one micro:bit battery pack

Activity instructions:

Opening discussion

Explain to students what the Circuit Breakers program is about and discuss what the term has in store.

Introduce your Western Power representative to the class (depending on circumstances this may be either, in person, by phoning them in or by playing their Circuit Breakers video). They talk about the role of Western Power, their role within Western Power, how it is a STEM role and how they got to be doing that job.

What is a computer?

Start by asking students a question: What do we use computers for?
(there is no right or wrong answer here… and some of the answers might be quite interesting!)

Did you know that computers aren't just used to type things and watch cat videos on YouTube? Computers are used all around us to control electrical systems, such as your home's lights and heating or your local power grid.

Ask students to use their Circuit Breaker journal or digital portfolio to brainstorm features that define a computer. To get students started, discussion prompts may include:

Ask your STEM professional or Western Power representative to introduce themselves. They may choose to discuss some or all of the following:

- What is STEM?
- Why is STEM important?
- What does a STEM professional do? (e.g. Engineering – what does an Engineer do?)
- What is their role at Western Power?
- Their journey to becoming a STEM professional
- How they use computers in their role

Do all computers have to have a keyboard and a screen?	All computers have inputs and outputs. Can you list some more inputs and outputs that a computer might have?
How big is a computer?	Computers can be any size or shape, from the size of a microchip to computers that fill a room
Where are computers used?	Not all computers are boxes that sit on a desk! For example, your mobile phone is technically a computer. In the world of the 21st century, tiny computers are inside just about everything.

Introducing micro:bit

Show students some photos of things which have computers inside, e.g. calculator, digital wrist watch, a fridge-freezer, modern car, communications satellite, power station, green electrical street cabinet (images of each of these may be found by searching Google Images). Discuss with students how computers are used in each of these examples.

Explain that an embedded controller is a name for a small computer that is part of a larger system such a fridge or a car. Small embedded computers are found in almost everything we use on a daily basis, from street lights to the microchip in your dog.

Show a micro:bit to the class and explain that even though it is very small, it is still technically a computer. Ask students to try and identify some of the features of this "computer". This can be made easier if all students have their own micro:bit already in front of them.

What is the Circuit Breakers program?

Teachers and students will work together with Western PowerSTEM professionals to learn about electricity, electronics, coding, digital technologies and how all these things are used together in the Western Power network. At the end of the program, students will have the chance to design and build their vision of the Western Power network of the future and present it to Western Power.

Activity one

A miniature computer with super powers

Introducing micro:bit

Show students some photos of things which have computers inside, e.g. calculator, digital wrist watch, a fridge-freezer, modern car, communications satellite, power station, green electrical street cabinet (images of each of these may be found by searching Google Images). Discuss with students how computers are used in each of these examples.

Explain that an embedded controller is a name for a small computer that is part of a larger system such a fridge or a car. Small embedded computers are found in almost everything we use on a daily basis, from street lights to the microchip in your dog.

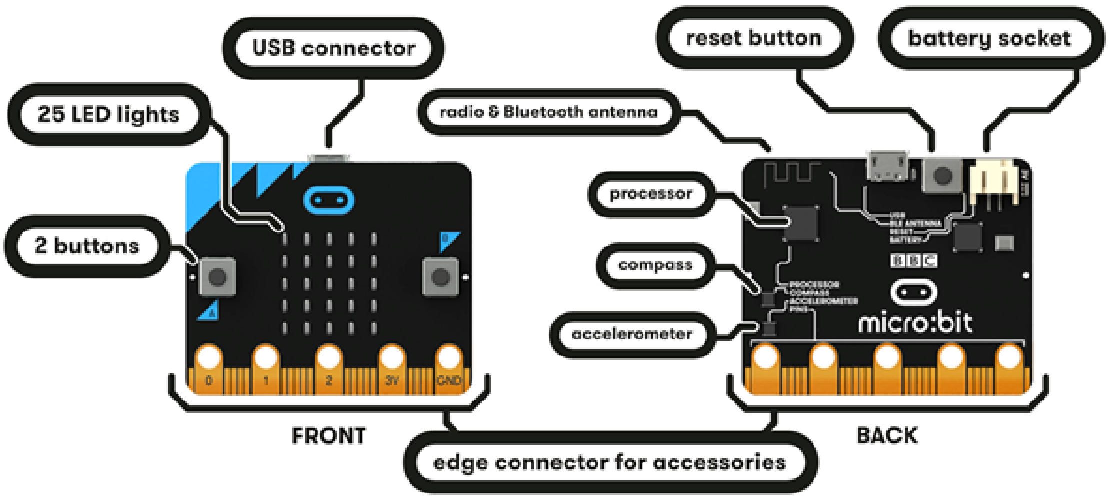
Show a micro:bit to the class and explain that even though it is very small, it is still technically a computer. Ask students to try and identify some of the features of this "computer". This can be made easier if all students have their own micro:bit already in front of them.

Further information on the features of micro:bit can be found at:

https://microbit.org/guide/features

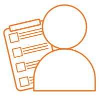
https://makecode.microbit.org/device

Where is the output/screen?	There is a 5x5 grid of red LEDs on the front of the micro:bit, this is the display or "screen"
Where is the keyboard?	There are two buttons on the front of the micro:bit labelled A and B
Where is the power supply?	Power is supplied either by batteries or a computer connected via USB
What other features can students identify?	See diagram below



Experimenting with micro:bit

Now that we're familiar with micro:bit, it's time to power up! Ask students to plug in the battery pack, which will power on the micro:bit (teachers may wish to practice this first).




Allow students 15 minutes to experiment and learn through play. Before starting, explain that students will be required to capture and communicate their observations in either their journal or digital portfolio. At the end of this activity, bring students together and ask them to explain or demonstrate what they discovered about their micro:bits.

Closing discussion

End the activity by asking students to think about how Western Power might use computers or embedded controllers in the Western Power network. Students should note down any initial ideas they may have so that they can revisit them in later activities.

Extension ideas

Watch the YouTube video "Introducing the BBC micro:bit": **https://www.youtube.com/watch?v=Wuza5WXiMkc**

Ask students to brainstorm some ideas for how they can use their micro:bit. Have a look through some of the projects listed on **https://microbit.org/ideas**

Resources

Introduction to micro:bit: **https://microbit.org/guide**

Crash Course Computer Science:
https://www.youtube.com/playlist?list=PLME-KWdxI8dcaHSzzRsNuOLXtM2Ep_C7a

What does the default micro:bit demo program do?

When they first leave the factory, every micro:bit contains a default program which will go through the following demonstration modes:

- Light up and flash all the LEDs
- Scroll the text "HELLO."
- Ask the user to press the A and B buttons
- Scroll the text "SHAKE!" and then light up the LEDs when the user shakes microbit:
- Scroll the text "CHASE THE DOT" and then allow the user to play a game.

The final demonstration, the "chase the dot" game, is controlled using the micro:bits tilt sensor. By tilting the micro:bit, players have to "rolling" a dot around the 5x5 LED screen to reach the goal (which is represented by the flashing dot).

Note: If you would like to restore a previously used micro:bit to its factory settings, download and copy the following .hex file to your micro:bit:
https://support.microbit.org/helpdesk/attachments/19033089764

Activity two

Code and download

circuit breakers

Activity two

Code and download

Background context

Computers are everywhere, not just classrooms and offices, but inside nearly every electronic device or system we interact with on a daily basis, helping to keep our world and our lives running smoothly. Computers help Western Power manage the flow of energy across Western Australia so that we have things like lights, heating, television, video games and the internet. Without computers, our lives would be very different.

Every single computer in the world relies on a sequence of instructions which are written in a special language or code so that computers can understand them. Creating a program or sequence of instructions for a computer to follow is called programming or coding. In the 21st century, being able to code is just as important as being able to read and write.

Links

Why is coding important? – code.org
https://code.org/promote

Scratch – design your own video games!
https://scratch.mit.edu/

Learning goals

Working together, teachers and students will:

- Develop essential skills for working with micro:bits
- Learn how to use the MakeCode website
- Learn how to code a simple program
- Learn how to download and run programs on the micro:bit
- Learn how to access MakeCode tutorials

Students resources:

- Micro:bit
- Micro:bit battery pack
- Student journals (physical or digital)

Teacher resources:

- One micro:bit
- One micro:bit battery pack

Activity instructions:

Opening discussion

Begin with a 5 minute recap of the previous activity: micro:bits are miniature computers that can be used in to control all sorts of projects. This is similar to the real world, where embedded computers are used to control everyday systems like your fridge, an elevator, your computer or the power grid.

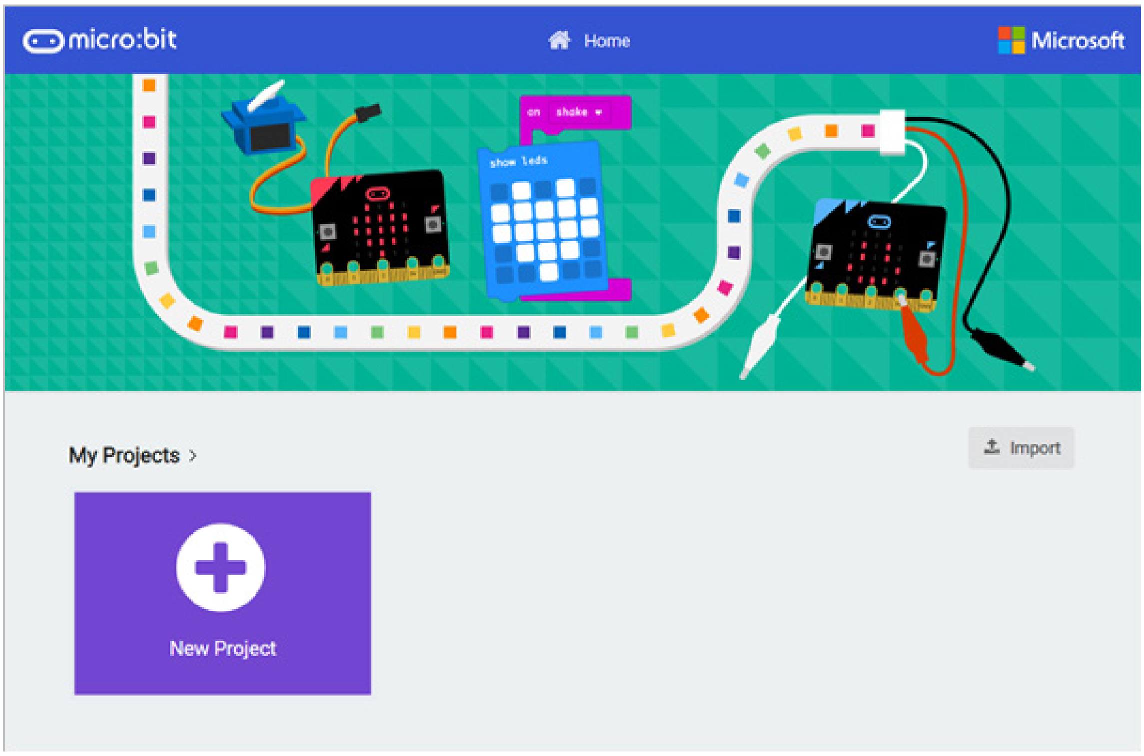
Show students the micro:bit demo program as a reminder of the last activity.

Creating and downloading a simple program

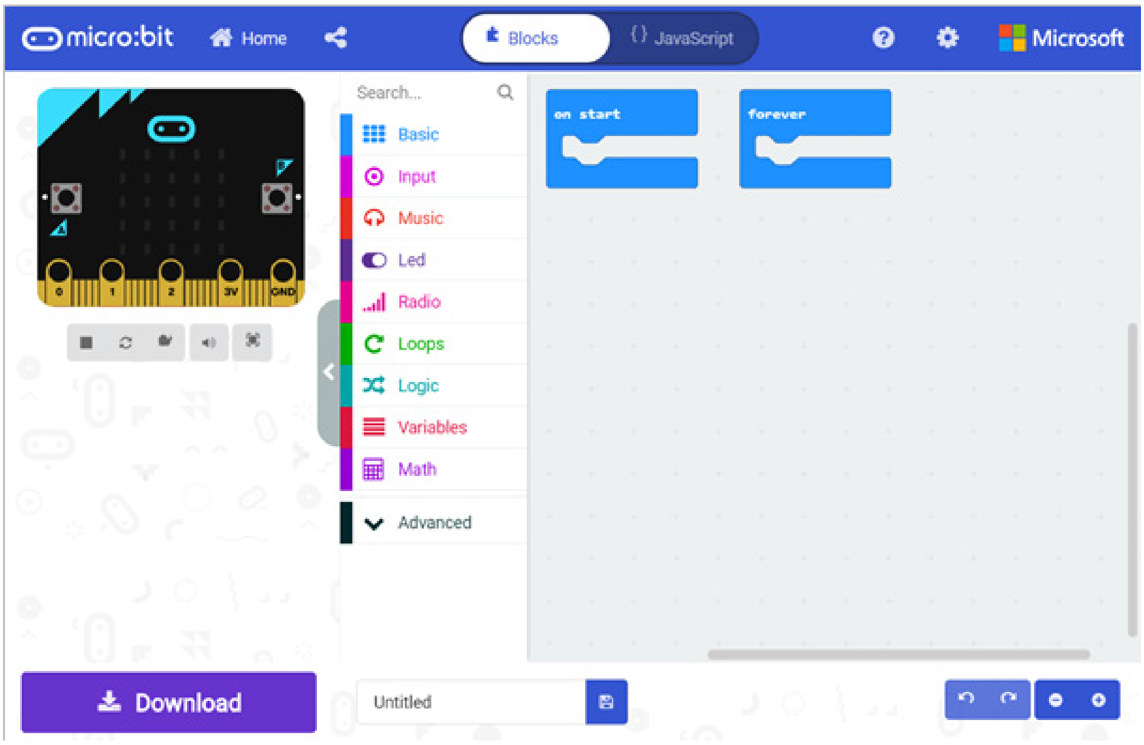
Now that we have had a play with the micro:bit demo program in the previous activity, it's time to learn how to change the program and start coding our own programs. This will help us develop important skills that we will use later when we start creating more complicated projects.

Instructions for teacher and students to work through together as a class: (teachers are recommended to practice these steps in advance)

1. On your computer, tablet or mobile device, go to the website **https://makecode.microbit.org**
2. Click or tap on “New Project”



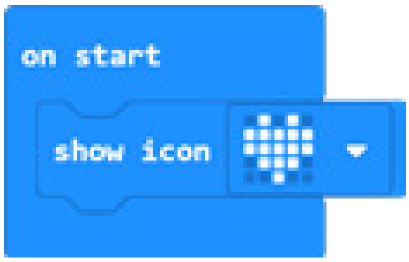
3. This will take you to the main programming screen:



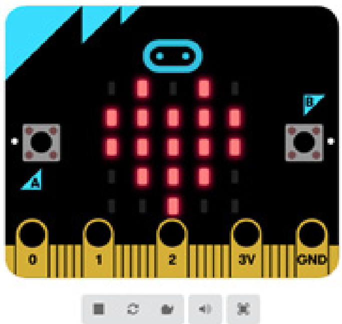
Activity two

Code and download

4. Click or tap on the “Basic” tab in the toolbox.
5. Drag the “Show Icon” block from the toolbox and place it inside the “on start” loop.



6. Notice that the simulator window on the left shows a virtual micro:bit which is now running the program we have written.



7. It’s time to download this program to our micro:bits and try it out for real!

If you are using a Windows PC, Mac or Chromebook:

- Plug your micro:bit into your computer’s USB port using the included USB cable
- The micro:bit should appear in the same way a USB thumb drive or portable hard drive does.
- In the MakeCode browser window, look for the big purple Download button. Type a name for your project in the box, then click save button. This will download a .hex file to your computer.

- Find the .hex file in your computer’s downloads folder and copy it to your micro:bit USB drive
- That’s it! In a few seconds the micro:bit will reboot and run your program.

If you are using a mobile device such as a tablet or phone:

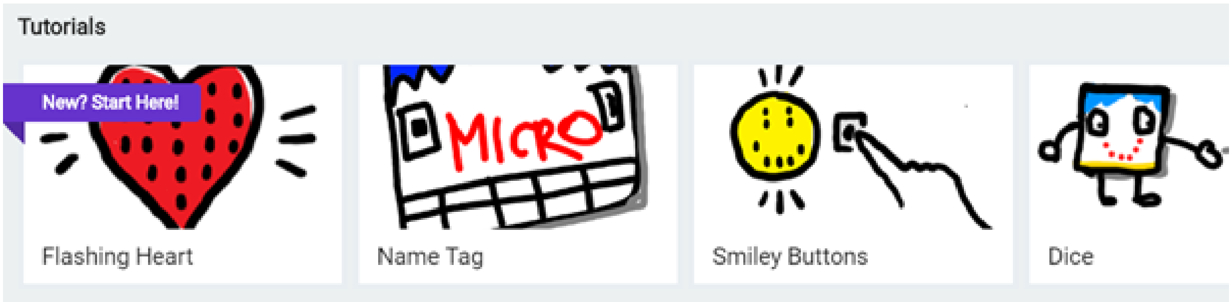
Follow the steps described here: **https://microbit.org/guide/mobile**. Make sure you practice this first and be patient, as it can sometimes take a couple of tries before you get it to work.

Now that you’ve created your first program and got it to play on the micro:bit, it’s time to experiment! Try changing your program and download it again. What else can you make it do? Give students some time to experiment.

Using MakeCode tutorials

When you feel it's time to move on, introduce the MakeCode tutorials. At the top of the MakeCode programming window, click on the home button (or simply close your browser window and open a new window at - **https://makecode.microbit.org/**).

Look for the Tutorials section. This has a collection of easy beginner's projects for micro:bit along with step by step instructions.



By way of introduction, ask students to try the Name Tag tutorial. When they are finished, students should document their completed program in their student journals.

If using a paper journal, students should write down their code in the journal. If using a digital portfolio, students may take a photo of their code. Underneath they should write a brief explanation of what it does.

Students who are finished this can continue to work through subsequent tutorials and learn other features of the micro:bit.

Closing discussion

End the activity by providing a recap of the skills we have learnt together. We have:

- Learnt how to use the MakeCode website
- Learnt how to code a simple program
- Learnt how to download and run programs on the micro:bit
- Learnt how to access MakeCode tutorials

Extension ideas

Ask students to develop a micro:bit version of the traditional game "Rock, Paper Scissors". Start by explaining the basic concept of Rock, Paper Scissors that is traditionally played by two people using their hands (students may not be familiar with this game).

There is a step-by step tutorial for Rock, Paper Scissors in the Games section of the MakeCode homepage, underneath the Tutorials section:

Alternatively there is a printable version of the tutorial all on one page (along with solutions) at: **https://makecode.microbit.org/tutorials/hour-of-code/rock-paper-scissors**.

When they are finished, students can pair up and use two micro:bits to play Rock, Paper, Scissors with each other. Ask students if they think this digital version of the game is better or worse than playing it the old fashioned way using hands.

Activity three

Complete the circuit, control the power

circuit breakers

Activity three

Complete the circuit, control the power

Background context

Western Power is an electricity distributor, which means we don't generate any electricity. We are responsible from transporting electricity from its source of generation to the community. However it is important to understand how electricity generation works.

The fundamental principles of electricity generation were discovered in the 1820's by British scientist Michael Faraday. He generated electricity by moving a loop of wire between the poles of a magnet. This method is still used today.

Modern power plants generate electricity in a variety of ways. It is most often generated by heat engines fuelled by burning fossil fuels or radioactive elements, but it can also be generated by water, wind, solar and geothermal power.

Power plants generate steam to power a turbine which spins a huge magnet inside a copper wire, producing electricity. The electricity flows from the power plant through wires to the transformer. The transformer raises the pressure so it can travel long distances – it is raised as high as 500,000 volts in Australia.

The electric current then runs through the power lines to the substation transformer where pressure is lowered to between 11,000 and 132,000 volts. Electricity is then taken through the lines to a pole transformer and pressure is lowered again to between 240 and 415 volts. From here electricity comes into your home through a meter box. Wires take electricity around your home powering your lights and appliances.

Links

Introduction to Electricity
https://youtu.be/Uf76pThNXZc

Wind generation
www.synergy.net.au/Our-energy/Electricity/Electricity-generation/Wind-energy

Solar generation
www.synergy.net.au/About-us/Who-we-are/What-we-do/Electricity-generation/Solar-energy

Power Stations
www.synergy.net.au/About-us/Who-we-are/What-we-do/Electricity-generation/Power-stations

Learning goals

Working together, teachers and students will:

- Learn how to create a simple electrical circuit using coin batteries, copper tape and LEDs
- Recognize the need to complete a circuit to allow electricity to flow
- Simulate disruption to circuits such as a power line being cut or a switch being opened
- Incorporate micro:bit into circuits as an embedded controller and power source
- Write a program which allows micro:bit to control power flow in a circuit

Students resources:

- Micro:bit
- Micro:bit battery pack
- Conductive copper tape
- LEDs
- Crocodile-clip wires
- Cardboard or paper for sticking circuits to
- Sticky tape
- Student journals (physical or digital)
- Computer, tablet or mobile device for programming micro:bits

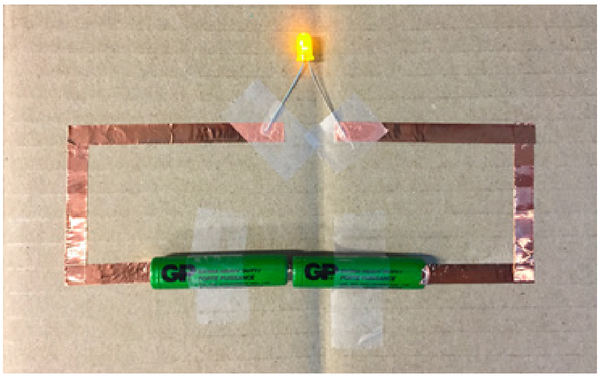
Teacher resources:

- Previously assembled demonstration circuits (optional)

Activity instructions:

Opening discussion

Show students the image below of a simple cardboard circuit, which can be built using the components included in each micro:bit kit.



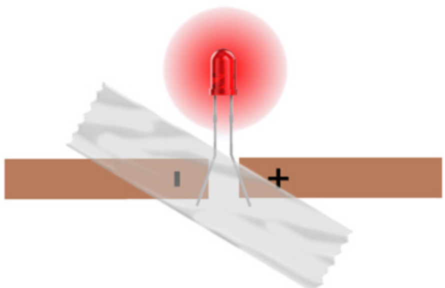
In order to provide a more engaging demonstration, teachers may wish to try making this circuit themselves prior to starting the activity with students. Note that two AAA batteries are required in order to provide sufficient voltage, and you will need to press the two batteries firmly together by hand to ensure a connection (this is why battery holders normally contain springs).

Using the image or demonstration circuit as a prompt, discuss the following questions with students:

What is an electrical circuit?	A circle, loop or continuous path for electricity to flow through
What does a circuit need to work?	A continuous unbroken path, power source and conductive material
What happens if the power line is cut?	The electricity stops flowing
Where is the power source in this circuit?	The batteries
Is power flowing right now? How can we tell if power is flowing in the circuit?	The LED light is on
What does "conductive" mean?	Electricity can move through certain materials but not others; in this example the electricity only moves through the copper, but not the paper
What do we call the opposite of a conductor?	An insulator
Is a human a conductor or an insulator? Could I use a person to close the circuit?	Good question! why not test it out?
How does the circuit need to be connected to the battery?	All power sources have a plus and a minus end (or "positive and negative terminal" in more advanced language), power flows out one side of the battery and into the other side

At this point is it important to talk about how to connect the LED. Ask students to examine their LEDs and have a brief discussion about them.

- What do you notice about the LEDs? (the wires are bendy and one is shorter than the other)
- It's okay to bend the pins to make them connect to your circuit, this will help and they are designed to do this.
- All LEDs have a plus and a minus side ("positive and negative terminal") just like a battery. The shorter wire on the LED is the minus wire. Make sure you connect your LED the right way around or it won't work!



Activity three

Complete the circuit, control the power

Making a cardboard circuit

Ask students to build the same circuit for themselves and test it out. Conductive tape should be stuck to cardboard or paper in order to provide a backing for the circuit, with other elements affixed via sticky tape. **Note that you will need to press the batteries firmly together to ensure a connection**.

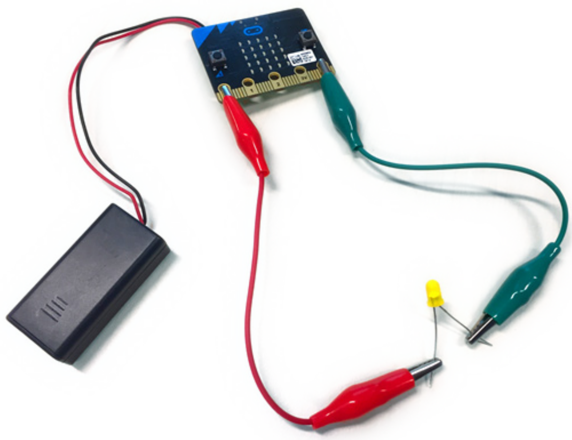
Students who finish quickly may create a second more complicated circuit with multiple LEDs.

Discussion

After everyone in the class has accomplished this, gather students together and ask them to consider other ways that we could control the LEDs. What if we had lots of different LEDs and we wanted to make them turn on one at a time?

Introduce the idea of using micro:bit as an embedded controller in an electrical circuit. The micro:bit will be part of the circuit and provide a way to control the flow of power in the circuit. Show the below circuit to students (as before, the teacher may set up a similar circuit to demonstrate with, or simply show students the supporting image).

IMPORTANT:
NO ACTIVITIES IN THE CIRCUIT BREAKERS PROGRAM USE THE 3V PIN. EXPLAIN TO STUDENTS THAT THEY SHOULD NOT USE THE 3V PIN. THE 3V PIN IS NOT DANGEROUS TO HUMANS, BUT IT MIGHT HURT THE MICRO:BIT IF THEY CONNECT THE 3V PIN IN THE WRONG WAY.



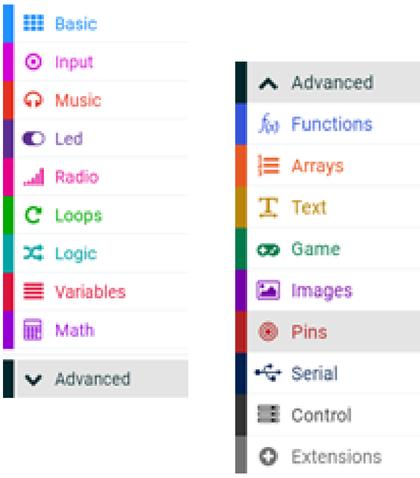
Where are the wires connected to the micro:bit?	On the copper part where it says “0” and “GND”, this is short for “pin zero” and “ground”
Why does the battery pack have two wires going in and out of it?	One is for the power to go out, one is for the power to go back in
Which way around is the LED connected?	“Ground” is connected to the shorter minus wire. This is because ground is the same as minus (or the “negative terminal”)
How can we give the micro:bit instructions to turn the LED on and off?	We have to code it using MakeCode like we did in the previous lesion

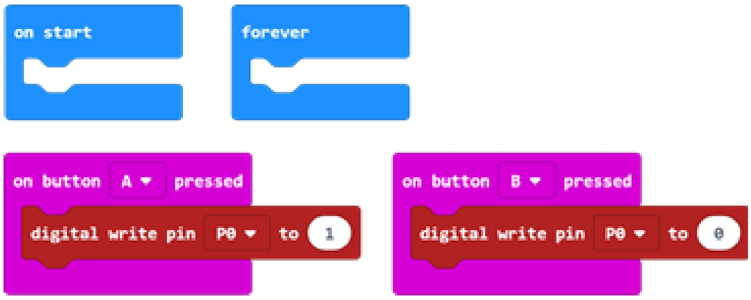
Controlling LEDs with micro:bit

Ask students to go to the MakeCode website **(https://makecode.microbit.org)** and start a new blank project. Students should copy the program below. The "digital write pin" block can be found by expanding the "Advanced" tab and selecting "Pins".

When they have finished creating their program, students should download it to their micro:bit (following the same process as Activity 2).

Students may then add crocodile clips and LEDs to their micro:bit in order to build and test the circuit shown in the photo above. By pressing the A and B buttons on the micro:bit, students should be able to turn the LEDs on and off.





When they have finished creating their program, students should download it to their micro:bit (following the same process as Activity 2).

Students may then add crocodile clips and LEDs to their micro:bit in order to build and test the circuit shown in the photo above. By pressing the A and B buttons on the micro:bit, students should be able to turn the LEDs on and off.

Ask students to document what they have done in their student journals. They should either take a photo of their circuits or draw a diagram, and underneath write an explanation of how each circuit works.

Activity four
Fully charged up

Activity four

Fully charged up

Solar energy

Solar energy can be used to make electricity. Solar energy comes from the sun. The system commonly positioned on your roof uses sunlight to make electricity. Solar collectors used for this process are called Photovoltaic (PV) cells (Photo= light, and voltaic=electricity). When the sun hits the PV cell, the little particles of light excite the electrons in the cell, and cause them to flow, generating electricity. The electricity is converted using an inverter which allows it to be utilised in your home.

In Western Australia we get a lot of sunlight so we can get a lot of electricity from the sun. Often you can make enough electricity to power your house during the day.

What happens at night or after a cloudy day?

Solar panels will work best on sunny days without too many clouds. During winter this can be a problem. That's where the electricity network helps out. On days without much sun or at night time houses often draw their power from the traditional electricity network. Working hand in hand this ensures that everyone has a reliable electricity supply.

Trading electricity

Any excess electricity can also be fed back into the electricity network helping to supply additional electricity during high demand and peak times. Customers are paid an amount for this excess electricity creating a two way supply of electricity that benefits everyone.

Battery storage

Batteries in houses and larger scale community batteries are becoming increasingly popular. Large batteries will allow households to store their excess electricity and utilise it when sunlight is low or at night time. This will also allow for storage and trading of excess stored electricity.

This can only occur however with the assistance of the Western Power electricity network as it facilitates this process or trading electricity between individuals or back into the network to be reallocated where needed.

Links

How solar generation works

www.synergy.net.au/Our-energy/Electricity/Electricity-generation/Solar-energy

Distributed Energy Resources Roadmap

https://www.youtube.com/watch?v=I8AukIuLxSI

Powering Our Lives

https://youtu.be/I0j95hb6Oq8

Western Power projects and trials

https://www.youtube st=PLxSq3PaF6joERYeQYZ1i0yJ34VxEW6nL7

Grid Tech – How it works?

https://www.youtube.com/ylist?list=PLxSq3PaF6joFoNiDXLeb0AEXAtM_U9JaQ

Learning goals

Working together, teachers and students will:

- Explore the concept of voltage as a way of measuring the amount of electricity in a system
- Measure voltage level provided by a computer over USB
- Measure voltage level provided by the micro:bit's battery pack
- Record voltage levels in a table and produce appropriate graphs from voltage data
- Practice the recording and representing data in tables and graphs

Students resources:

- Micro:bit
- Micro:bit battery pack
- Student journals (physical or digital)
- Computer, tablet or mobile device for programming micro:bits

Teacher resources:

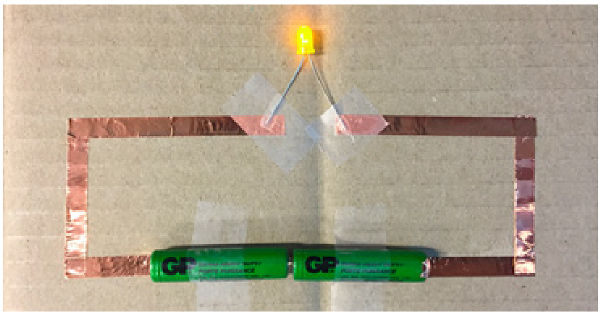
- One micro:bit and battery pack for demonstration purposes (optional)

Activity instructions:

What is electricity?

Begin the activity by asking students to answer to the question “What is electricity?” Students should produce a diagram or infographic in their journals explaining their idea of what electricity is.

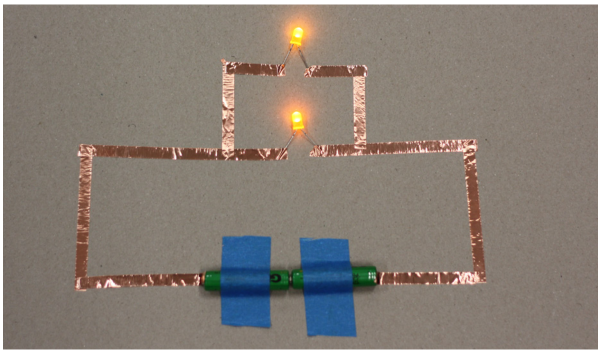
Return to previously demonstrated example of a cardboard circuit or micro:bit circuit with LED.

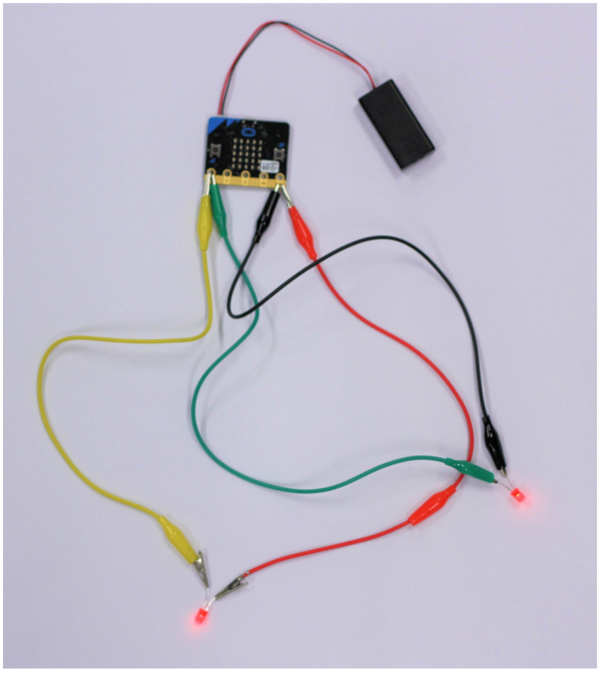


Add a further LED to your circuit.

Do this so that both LEDs are connected in the same way to the battery (not one before the other) this is called ‘in parallel.’

Be careful to have the short legs of the LED towards negative (or ground) end of power supply.





Record in your journal what your circuit looked like. Compare the LEDs when there is only one connected with when there are two connected. Discuss:

- What do you think would happen if we kept adding more and more LEDs to our circuit?

Western Power has a giant circuit that needs to supply everyone with electricity as soon as they need it. The power available in the grid must be high enough to supply everyone.

- What could you do to make sure there is enough electricity to power everything we need?
- What are some ways that there might not be enough electricity in the Western Power grid?
- What are some times of day where everyone might use lots of electricity at the same time?
- Can you think of any ways to make sure that there is enough power in the grid?
- How many students have solar panels at home?
- Could this be the only way to get electricity in the future? Why? Why not?
- How could we store electricity?
- Ask your Western Power STEM Professional about large scale batteries

Activity four

Fully charged up

Measure electricity

So that we always have enough electricity, we need a way to measure electricity.

Electricity (specifically, electric potential difference) can be measured in Volts. Ask students to try and guess how many volts their micro:bit uses *(hint: it uses two AAA batteries - what is the voltage of each battery?)*

By now we have been using our battery packs a lot and we need a way to check how much battery we have left. Which battery packs are the most full and which need their batteries changing?

Before we start, it is important not to get our battery packs mixed up! Ask all students to label their own battery packs so they will know which one is theirs later.

Once all battery packs are labelled, instruct students to download the following .hex program onto their micro:bits.

https://support.microbit.org/helpdesk/attachments/19033089623

Also available from the Circuit Breakers webpage teaching resources section **www.westernpower.com.au/community/our-education-program/circuit-breakers/**

This is a special program which will measure how much power the micro:bit is receiving. Test the program while it is still plugged into your computer via USB (make sure the battery pack isn't plugged in at the same time). How many volts is the micro:bit receiving from the computer?

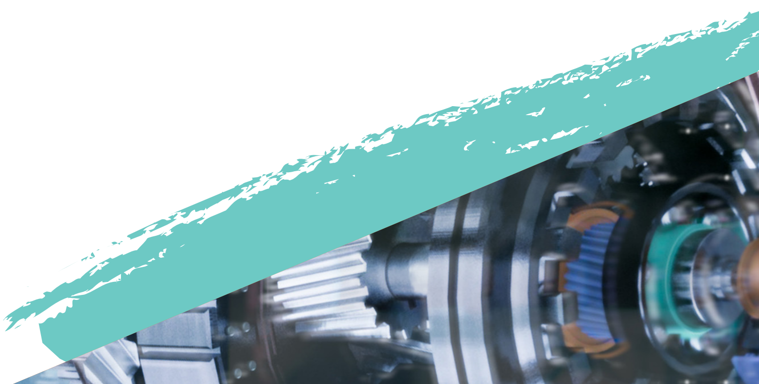
Now unplug the micro:bit from your computer and plug in your battery pack instead. How many volts is your micro:bit receiving from the battery pack?

Once you have tested your own battery pack, start testing the battery packs of other students in their class. Students should aim to measure at least 10 battery packs.

Students should begin to collate this information in their journals using a table, example below;

Electricity Source	Voltage (V)
Computer	
Andy's battery pack	
Becky's battery pack	
Chris's battery pack	
....	

When students have finished compiling their table, the next step is to produce a graph of their results. Students should choose the appropriate type of graph and ensure that their graph has all the correct features (headings, labelled axes etc.)



Closing discussion

If time allows, ask students to present their graphs to the class and explain what they have noticed. Are all the battery packs the same?

End the activity with a discussion of how else we could use this program to measure battery levels.

- What will happen to the battery packs over time?
- How long will the battery packs last?
- What could we do to better understand how the battery voltages change over time?
- How often should we replace the batteries in the battery packs?
- How much will it cost us per year to maintain fresh batteries in all of our micro:bits?(this is a good maths problem!)

Extension ideas

Encourage students to measure and write down the voltage of their battery packs on a regular basis (e.g. every day, every 3 days, or on the same day every week). If resources allow, teachers may wish to leave a special micro:bit set aside in the classroom for this task. After recording this data over the course of a term, students may then produce graphs showing battery degradation and comparing battery packs to see if any are wearing out quicker.

Micro:bits may also be used to check voltage of old batteries directly by using crocodile clips connected to Pin 0 and Ground. Instructions on this experiment can be found here: **https://makecode.microbit.org/courses/ucp-science/electricity**

Activity five

What's your reaction time?

Activity five

What's your reaction time?

Background context
Below are some great resources that explain the different type of engineers and what they do.

Conductors
Electrical conductors allow electric current to flow easily because of the make-up of their atoms. In a conductor, the outer electrons of the atom are loosely bound and can freely move through the material when an electric charge is applied.

Conductive materials
In general, the best electrical conductors are metals. They tend to have electrons in the outer layer of their atoms that are freely shared. The most conductive of all the elements is silver. The Most commonly used electrical conductor is copper. Copper is used in electrical wiring and electrical circuits throughout the world.

Insulators
The opposite of a conductor is an insulator. An insulator resists the flow of electricity and are important to keep us safe from electricity. The wire that carries electricity to your computer or television is covered with a rubber-like insulator that protects you from getting electrocuted. Good insulators include rubber, glass, the air, and paper.

Learning goals
Working together, teachers and students will:
- Use technologies to conduct a simple science experiment
- Discover the fact that humans conduct electricity and can be used to complete a circuit
- Design and test a physical system incorporating a micro:bit as an embedded controller

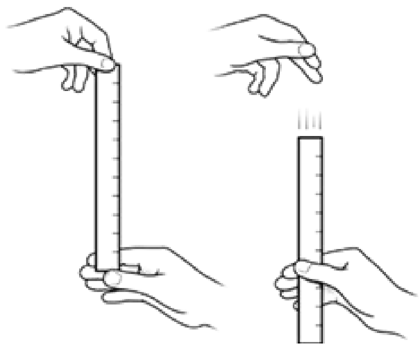
Students resources:
- Micro:bit
- Micro:bit battery pack
- Crocodile-clip wires and/or conductive copper tape
- 30cm ruler
- Large piece of cardboard (at least A4 size, but larger is better)
- Aluminium kitchen foil
- Texters or permanent markers
- Student journals (physical or digital)
- Computer, tablet or mobile device for programming micro:bits

Teacher resources:
- One micro:bit and battery pack for demonstration purposes (optional)

Activity instructions:

What is reaction time?
Begin by discussion reaction time. What is reaction time? What are some ways that we can measure reaction time?

Group students in pairs. One student from each pair holds a 30cm ruler vertically while the other student positions the ruler with the 0cm mark between their open thumb and forefinger.



The student holding the ruler should wait a short amount of time, then drop the ruler without warning. The other student has to try and catch the ruler; the distance in cm that they take to catch it is a measure of how quick their reaction was.

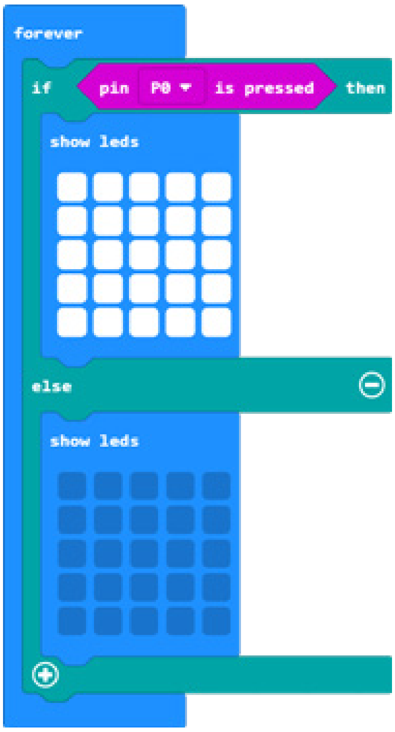
Gather students back together and discuss ideas for how we could use micro:bit to test reaction time. What features of the micro:bit will we use? (e.g. screen, buttons, sensors) How will we use them? How could we use what we know about electric circuits to test reaction time?

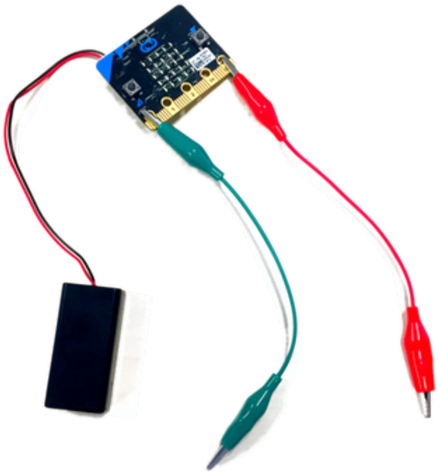
Do humans conduct electricity?

Did you know that humans can conduct electricity? Demonstrate this for students by setting up a micro:bit as shown below, then download and run the program shown.

Ask students what will happen when you connect the loose ends of the red and green wire. Then test it out to see if their predictions are accurate. Next ask students what will happen if you hold the loose ends of the red and green wire in opposite hands (the circuit will be completed by the person holding the wires). Test it out!

How could we use human conductivity to test reaction times? Ask students for their ideas.





What should happen:

The circuit will be completed, which means electricity will flow and the micro:bit will detect that Pin 0 has been “pressed”, so the screen will light up.

Activity five

What's your reaction time?

Making a reaction time game

Explain to students that we are going to use the rest of this activity to build a two player reaction time game that uses the fact that humans can conduct electricity.

A very short video on YouTube from Microsoft MakeCode called **micro:bit reaction game** shows the concept.

This activity involves two parts: making and coding.

Part 1: Making

Students may work individually, in pairs or in groups. Note that each game will need only one micro:bit but will require two students to play.

Provide each team with a large piece of thick cardboard and four pieces of aluminium foil. Aluminium foil may be cut up by students during the activity or prepared by the teacher in advance. Each piece of foil should be roughly the size of students' hands.

The four pieces of aluminium foil will each serve a different purpose in the game and should be attached at four different locations on the cardboard. One possible layout is shown in the diagram below. Note that students are free to experiment with where they place the foil.

If students are gluing foil to the carboard, they will need to leave a small flap sticking up from each piece in order to connect the crocodile clips.

The next step is to connect foil to the micro:bit using crocodile clips as follows:

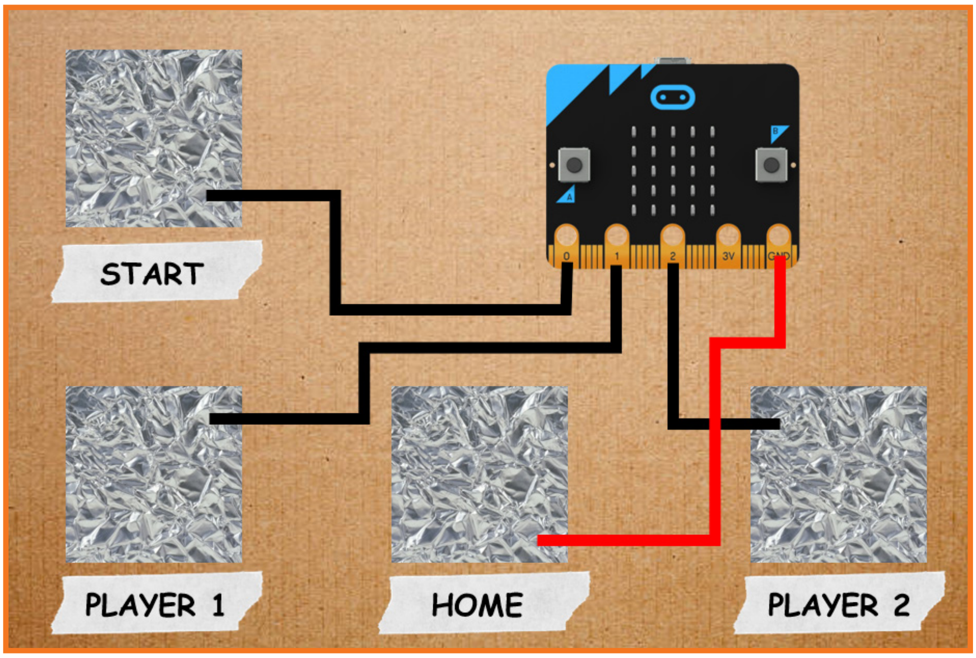
1. Start – connect to Pin 0
2. Player One – connect to Pin 1
3. Player Two – connect to Pin 2
4. Home – connect to Ground

The correct wiring of the completed game is shown in the supporting diagram.

Don't forget to also connect the battery to the micro:bit.

This completes the making section of the activity. Students who finish early are free to decorate the game board however they like.

The next step is to provide the micro:bit with the code required to make the game work.



Part 2: Coding

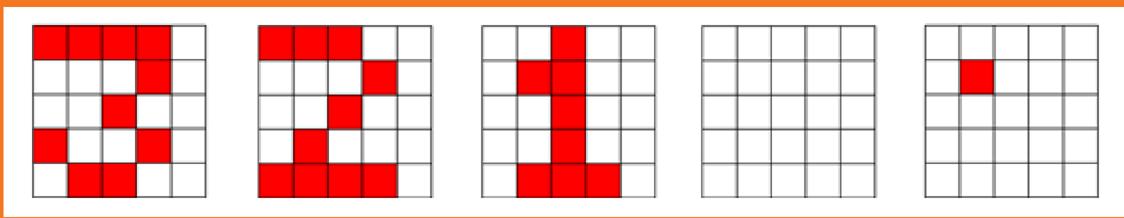
Due to the complexity of the code required to make this activity work, it is recommended that students simply download the ready-made sample code and copy it to their micro:bits. Teachers are welcome to discuss this code with their class and explore how they think it works. If students have time, they should end the activity by documenting their games in their student journal.

The code for this activity can be found in the teaching resources section of the Circuit Breakers webpage and here: **www.westernpower.com.au/media/3365/activity-5-reaction-time.hex**

How to play your micro:bit Reaction Time game

Both players place one hand on the "Home" pad and keep it there throughout the game. Do not touch the Player 1 or Player 2 pads yet. To start the game, one of the players needs to hit the "Start" pad with their free hand.

The micro:bit will display a countdown timer: 3… 2… 1… then the screen will go blank, and after a random time interval, an LED will turn on. That is the signal! Which player will react quicker?



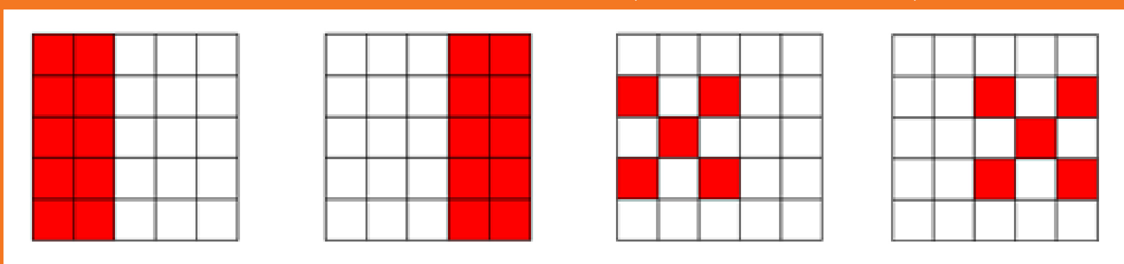
The micro:bit will display a countdown timer: 3… 2… 1… then the screen will go blank, and after a random time interval, an LED will turn on. That is the signal! Which player will react quicker?

- If player 1 spots the LED first, they keep their hand on home and hit the Player 1 pad.
- If player 2 spots the LED first, they keep their hand on home and hit the Player 2 pad.

The micro:bit will show the results on the left hand side of the "screen" for player 1, and the right hand side of the "screen" for player 2.

The winner's side of the screen will show a solid rectangle, followed by their response time in seconds. If a player tries to cheat or accidentally presses their pad too soon, they will get an X on their side of the screen instead. Keep your hands on the Home pad and press the Start pad to try again.

If player 1 wins: | If player 2 wins: | If player 1 presses too soon: | If player 2 presses too soon:



(followed by their response time) | (followed by their response time)

Activity five

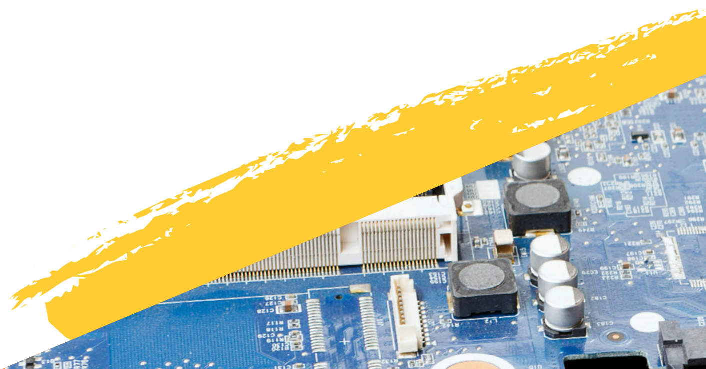
What's your reaction time?

Extension ideas

How can you use this activity in a more scientific way? For example, how do reaction times change in a noisy distracted environment vs. a quiet environment.

For more ambitious students (and teachers), full instructions on how to write the required code can be found here: **https://makecode.microbit.org/projects/reaction-time/code**

How would you change this code?



Activity six

Bringing power safely to your community

circuit breakers

Activity six

Bringing power safely to your community

Background context

Learning goals

We all like to play outside, but there are electrical hazards that we need to know about. Electricity poles and wires are all around us. They can be above us, next to us, and even below us. Play in open spaces away from electricity poles, towers and powerlines.

Remember:

- If you fly a kite and it gets caught in the overhead powerlines, live electricity could travel down the string and seriously hurt you. Don't fly kites around power lines!
- Never climb a tree that is near powerlines. Look up before you climb!
- After a storm if you see fallen powerlines stay well clear of them. There is a strong chance they are still live with electricity and are extremely dangerous.

.

Safety around water

Water can conduct electricity because electrons can flow by hitching a ride on atoms and molecules in the water. Water contains dissolved substances, such as salt. These greatly increase the ability of water to conduct electricity. That's why electricity passes easily through our bodies – because our bodies contain water and salt. This is also why it's important to keep water away from electrical appliances.

Electricity substations

You will find electricity substations and power equipment all over the place. They are behind fences, in buildings or on the side of the footpath and most have danger signs. Substations transform the voltage generated at power stations so it can be distributed to homes, schools and businesses. Sometimes they are near parks and play areas. Substations are safe, but you must follow the rules and stay away from them.

Remember:

- Sometimes it's tempting to ignore signs and fences around substations. Remember, the warnings are there for everyone's protection, so make sure you follow them!
- Substations contain special equipment with invisible hazards. You don't even have to touch anything to get hurt. Just being too close to some substation equipment can be dangerous.

Reporting incidents

It's really important to report any damage you might see to any Western Power infrastructure. Computers that we use to control the network will sometimes recognise an issue and turn power off. However, if we haven't had a call from anyone to tell us there's a problem the people working in our control room will see whether there was a smaller problem to blame and turn it back on again. Now think about what would happen if you were close by or even touching the powerline, green dome or underground cable when they turned it back on?

The safe call is to stay 8m away, call Western Power and don't go any closer until someone from Western Power has come out to make the area safe.

Links

Play safe and stay Shockproof (video)
https://www.youtube.com/watch?v=uhRmP-mpHkQ

Make the Safe Call (TV Commercial)
https://www.youtube.com/watch?v=eYDbZ5VA808

Step potential (why stay 8m away?)
https://www.youtube.com/watch?v=jDU8XQkmDeQ

Learning goals

Working together, teachers and students will:

- Identify different Western Power assets and how they work
- Understand how to live safely near the Western Power network and what to do in an emergency
- Learn how micro:bit sensors can be used to detect problems in a system such as a power grid
- Explore how radio signals can be used to communicate between multiple micro:bits and trigger an alarm in emergency situations

Students resources:

- Micro:bit
- Micro:bit battery pack
- Crocodile-clip wires
- Student journals (physical or digital)
- Computer, tablet or mobile device for programming micro:bits and accessing Shockproof website

Teacher resources:

- Set up class on the Shockproof website prior to commencing activity: **www.westernpower.com.au/community/our-education-program/shockproof**

Activity instructions:

Opening discussion

Start with a recap of the discussion from the end of Activity 3. How are the circuits that we have made similar to the Western Power grid? (the battery is like the power station, the LEDs are like electricity consumers, e.g. houses, and the micro:bit is like Western Power's control system).

What can we see outside that helps bring power to our houses?

- Poles, powerlines, underground cables (conductors)
- Transformers/Substations (micro:bits)
- Power stations, wind turbines (power source)

Electricity is an important part of all of our lives, but it can also be dangerous and we must be careful around it.

Ask your Western Power STEM Professional to explain:

- Some of the safety features that are built into the network
- How Western Power manages the network from a central location to keep the community and their workers safe at all times

Shockproof website

Students should be directed to log on to the Shockproof website where they can work through the activities to learn more about Western Power and the various components of the network.

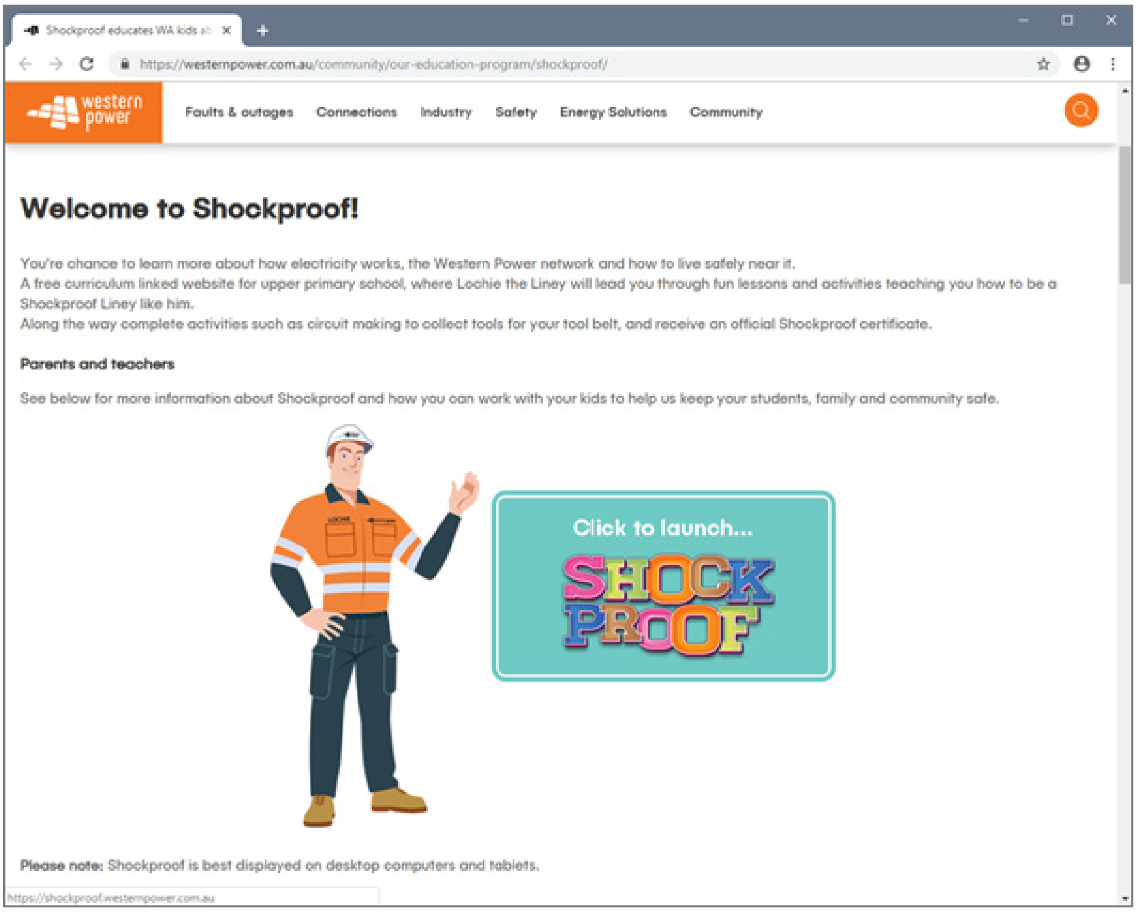
When students have completed all activities on the Shockproof website, ask students to describe some of the different Western Power assets in their journal and describe what they do.

Activity six

Bringing power safely to your community

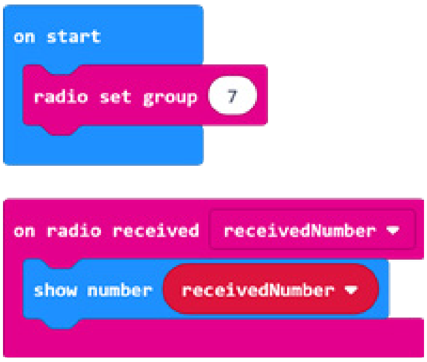
Shockproof website

Students should be directed to log on to the Shockproof website where they can work through the activities to learn more about Western Power and the various components of the network. When students have completed all activities on the Shockproof website, ask students to describe some of the different Western Power assets in their journal and describe what they do.



Emergency alarm notifications

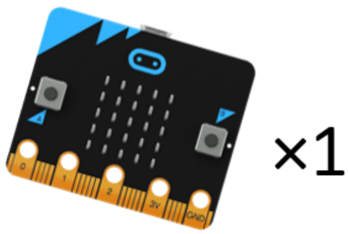
Introduce this activity by talking about how Western Power needs a way to know whenever an emergency has occurred, such as a power pole falling in a storm or a line breaking. Why would this be dangerous? How does Western Power find out about these types of emergencies?



This activity will use micro:bits to simulate sensors and receivers and send messages between multiple micro:bits. Students should work together in groups, with approximately four students and four micro:bits in each group.

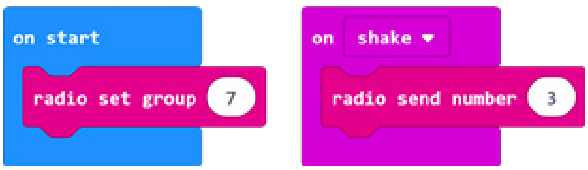
In each group, one micro:bit will be designated as the receiver. The receiver micro:bit should be set up with the following program:

Receiver micro:bit



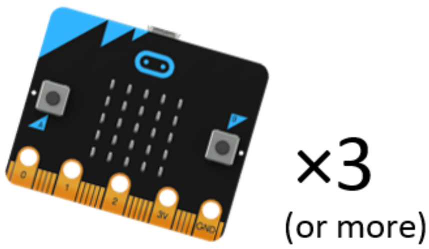
Note that the radio group number (7 in the above example) needs to be different for each group so that the micro:bits in that group can all talk to each other. The radio number can be any number between 1 and 128. The idea is similar to walkie talkies which all need to be on the same radio frequency.

The other micro:bits in the group will act as sensors and should start with this basic program.



The radio group number needs to be the same as the receiver micro:bit. The “radio send number” is like an error code. When this micro:bit shakes, it will broadcast the error code 3 which will then be displayed on the other micro:bit.

Sensor micro:bits

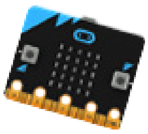


Activity six

Bringing power safely to your community

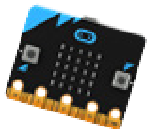
Emergency alarm notifications

Each micro:bit that is acting as a sensor should broadcast a different “radio send number”, so we know which one is going wrong. Download and run the programs on all of the micro:bits in the group at the same time. Try randomly shaking one of the micro:bits and see what happens.



Sensor 1

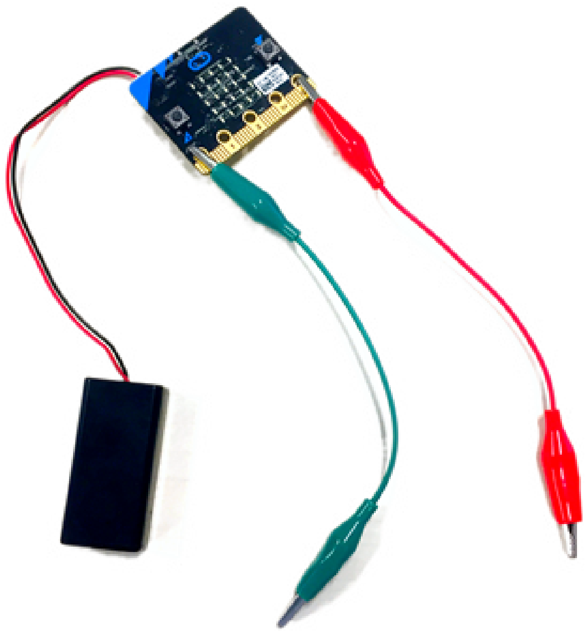
Sensor 2

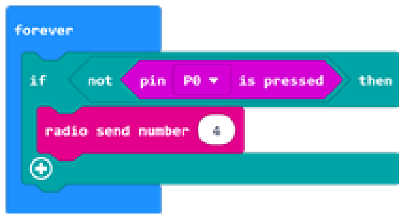


Sensor 3

Receiver

Each micro:bit has multiple sensors and can report multiple different types of information simultaneously. Ask students to try and come up with a program which will send a different code number if a circuit is broken. One possible solution is shown below.





Student journals

End the activity by asking students to document what they have done and what they have learnt in their journals..

Extention Dates

What other ways can you use the radios to communicate information between micro:bits? Can you use the radio function between two micro:bits to remotely turn an LED on and off? More ideas on how to use the micro:bit radio can be found at:

https://makecode.microbit.org/projects/radio-games

Did you know you could attach any standard pair of headphones to the micro:bit and use them to generate sounds? Try adding some sound effects to your emergency alerts (this will be covered in full in Activity 8):

https://makecode.microbit.org/projects/hack-your-headphones/make

Activity seven

Emergency warning sensors

circuit breakers

Activity seven

Emergency warning sensors

Background context

Sensors are devices which allow computers to understand what is going on in the world around them. Humans have only five senses, and all information we get about the world comes from these five senses. By comparison, the range of sensors available to a computer or digital system is far too long to list here. Sensors can be used to measure things like movement, direction, brightness, temperature, weight, or magnetic field.

Sensors also have advantages over human senses because they are able to provide number values. For example, if you look out the window, you can observe if it is raining or sunny, but you cannot immediately say how much rain is falling in millimetres per hour. Instead you would need to consult an instrument like a rain gauge. By comparison, a digital sensor that is connected to a computer system can immediately provide a number value, which can be useful in knowing what is happening in the world.

Western Power uses sensors in many areas of its network to detect problems, identify hazards and diagnose faults. For example, if a power line gets knocked over in a storm, a sensor can immediately identify the problem and notify someone so that they can fix it. Sensors are used everywhere in our modern world, including on the tops of buildings, inside vehicles, on bridges and on street lights. You are probably even wearing or carrying some sensors at this very moment; many people now wear fitness tracking watches, and a typical smart phone can have as many as 40 different sensors.

Learning goals

Working together, teachers and students will:

- Discuss the role of sensors in a system such as a power grid
- Identify the various sensors on a micro:bit
- Learn how to measure sensor values from the micro:bit
- Write and describe simple programs that use sensor data in different ways

Students resources:

- From the micro:bit kits:
- Micro:bit
- Micro:bit battery pack
- Student journals (physical or digital)
- Computer, tablet or mobile device for programming micro:bits

Teacher resources:

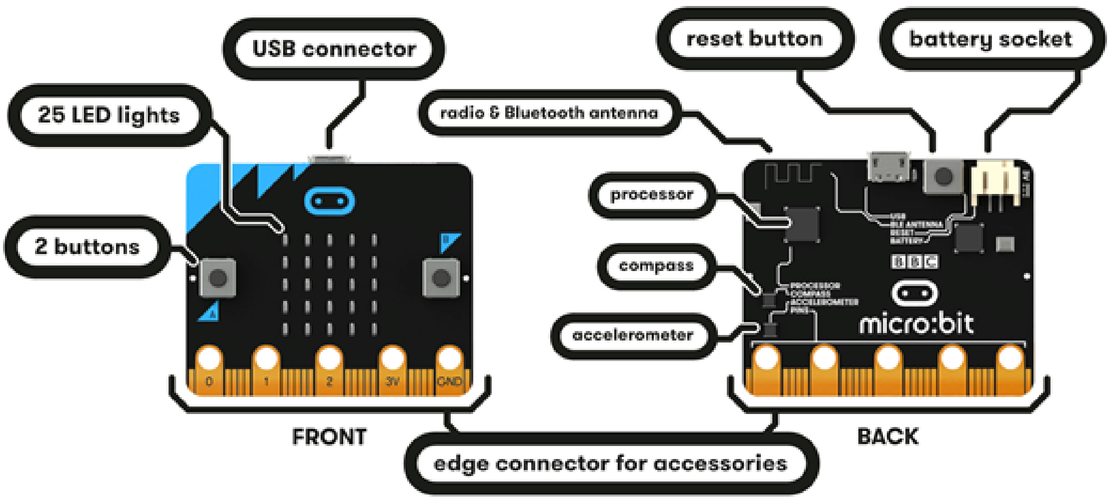
- One micro:bit and battery pack for demonstration purposes (optional)

Activity instructions:

Opening discussion

Start with a recap of discussion from the previous activity:

Why does are sensors important in a large system such as the Western Power network?	So that we can detect faults or emergencies and respond quickly
Why does are sensors important in a large system such as the Western Power network? (so that we can detect faults or emergencies and respond quickly)	Sensors are widely used in forms of transportation such as cars, aeroplanes or even space rockets. Sensors are also used on bridges and buildings to detect structural problems
What sensors are included on the micro:bit?	The list of sensors on the micro:bit can be found at https://microbit.org/guide/features/ and at https://makecode.microbit.org/device



Sensors on the micro:bit include:

accelerometer	measures acceleration in a straight line, e.g. shaking forwards and backwards
gyroscope	measures if the micro:bit is turning
light level	uses LEDs as a sensor to measure brightness in the room
temperature	uses processor microchip (also known as the CPU) to measure air temperature
compass	uses Earth's magnetic field to measure which way the micro:bit is pointing
magnetometer	measures how strong the magnetic field is
buttons	detect if A and B buttons are being pressed

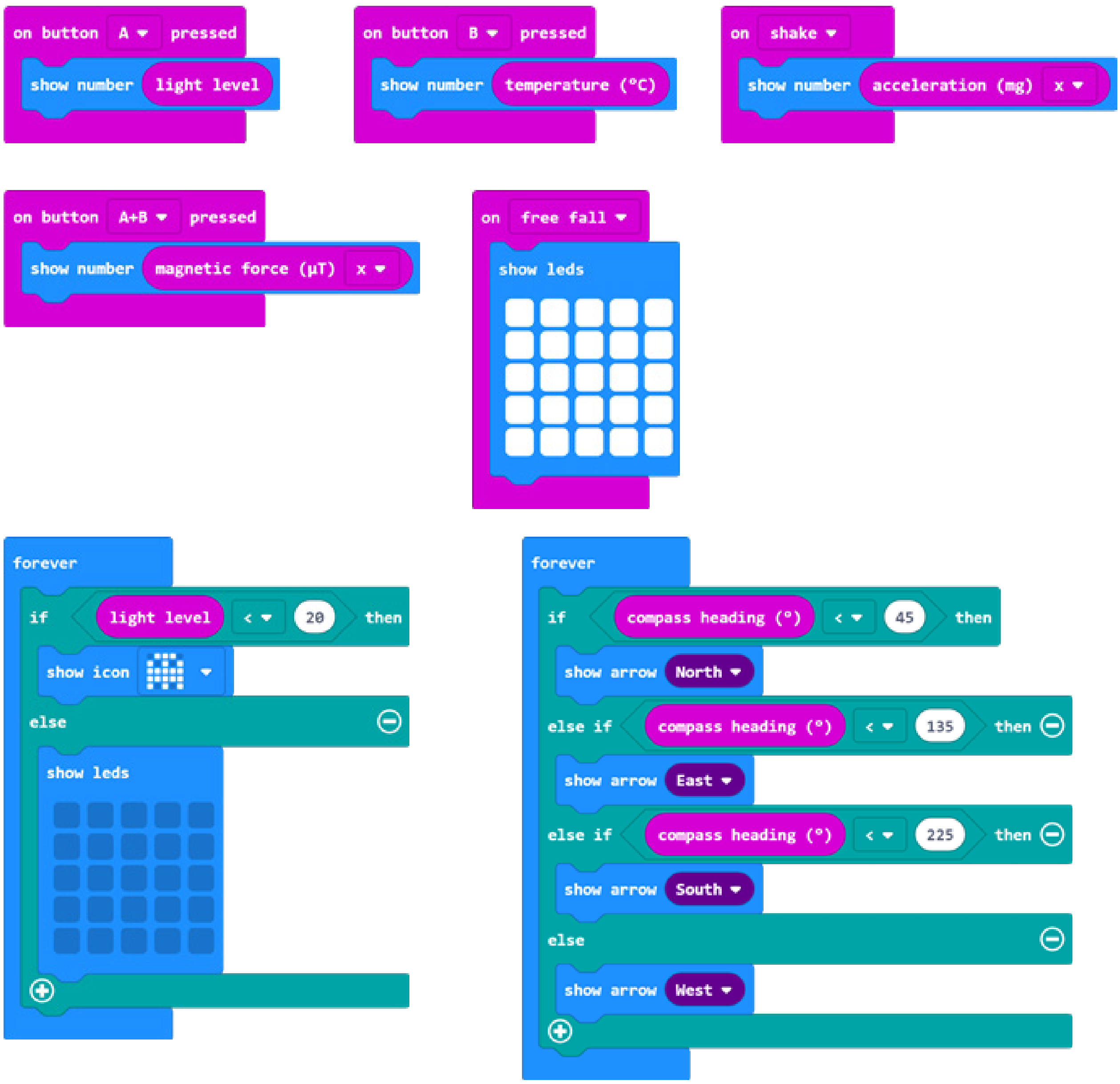
Activity seven

Emergency warning sensors

Discuss ways in which these sensors could be used. For example why might it be useful to know when the light level is changing? What could we do with a sensor which measures temperature? How can we add more sensors to our micro:bit? (by connecting wires to the copper input/output pins along the bottom of the micro:bit).

Reading the sensors

On the next page are some example programs. Students should try writing these programs, downloading them to their micro:bit and then testing them out.



Students should document each of these programs in their journals and explain what they do. When they are finished, students can try combining different programs together. For example can you make a program that tells you the temperature when it gets dark?

Extension ideas

Can you incorporate the radio feature used in Activity 6 to get micro:bits to transmit their sensor readings to each other?

If you have iOS mobile devices available (e.g. iPads), the micro:bit mobile app can now be used to conduct live sensor readings: **https://itunes.apple.com/au/app/micro-bit/id1092687276**

This app requires your iOS device to be paired with your micro:bit over Bluetooth. Instructions on this process can be found here:

https://microbit.org/guide/mobile

https://microbit.org/guide/ble-ios

Once you have successfully paired your micro:bit with your iOS device, you need to copy across the code which will make the live sensor monitoring work. In the app, select "Flash" from the main menu. On the next screen, select "monitor services" and then tap the button that says "Flash". Wait a few seconds while the code uploads to the micro:bit.

When the upload has finished, go back to the main menu of the app and select "Monitor and Control", then tap "Start". Try adding some control panels for Accelerometer and Temperature. What else can you do with the app? (hint: there is a way to use the micro:bit to remotely take photos on your iOS device's camera).

Activity eight

Electric light orchestra

Activity eight

Electric light orchestra

Background context

Think about how sound is used to provide warnings about problems or emergencies. Fire trucks, police cars, ambulances and even Western Power emergency response vehicles are fitted with lights and sirens. This is to get peoples attention and to pay attention. Would it be useful to have alarms that tell you when there's something wrong with your electricity or when there's a power outage?

Electricians use devices that light up to find out whether the power is on or not before they start their job. Western Power uses a long pole with a device on the end that makes noise if it detects electrical current. Even after we've turned the power off in an emergency situation we'll use one of these to make sure the area is safe.

Does electricity make a sound? Well yes and no. Technically speaking electricity is silent. Sometimes when electricity interacts with the external environment like a humid day with lots of moisture in the air, the discharge from a high voltage powerline may cause a crackling sound. This is similar to what you hear when lightning strikes. It's the external environment that helps create the noise rather than that being the sound of electricity itself.

So if we can't see electricity and we can't hear electricity, using light and sound to detect the presence of, problems with or when they power is out is a useful idea.

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Learning goals

Working together, teachers and students will:

- Explore how micro:bit sensors can be used to control LEDs
- Control LEDs in a sequence to create flashing lights or simulate traffic lights
- Learn how micro:bit can produce sounds using a standard pair of headphones

Students resources:

- Micro:bit
- Micro:bit battery pack
- LEDs
- Crocodile-clip wires
- Student journals (physical or digital)
- Computer, tablet or mobile device for programming micro:bits

Teacher resources:

- One micro:bit and battery pack for demonstration purposes (optional)

Activity instructions:

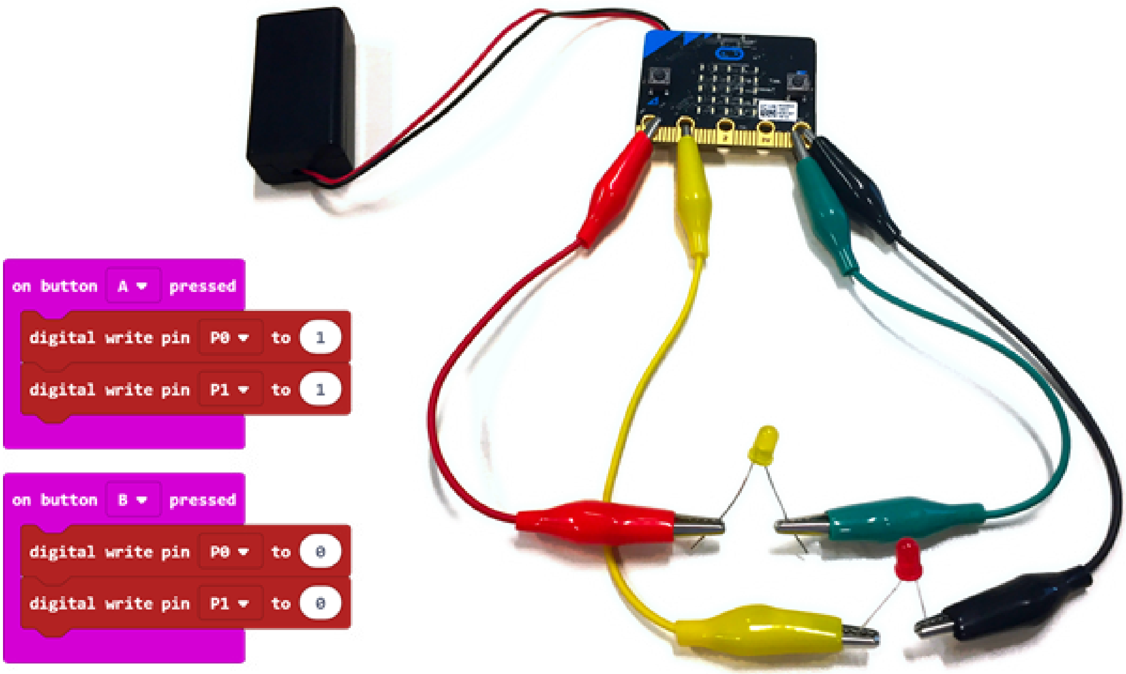
Programming with multiple LEDs

Recap what we have done so far:

- Use micro:bit to control LEDs
- Write programs which take a reading from micro:bit sensors

Now it's time to combine the two. Can you make a program which uses the sensors to control multiple LEDs?

Look at the micro:bit circuit and code on the next page. What will the system do?



After students have made their predictions, ask them to build the circuit and test it out. Note that the minus end of the LEDs must always be connected to Ground, so the first LED will be connected to Pin 0 and Ground, the second LED will be connected to Pin 1 and Ground, and so on (this was previously explored in the extension ideas for Activity Three).

If students have wired up their circuits and written their code correctly, then button A should turn both LEDs on, and button B should turn both LEDs off. Did this result match student predictions?

Students should then work through the following challenges and document their work in their journals:

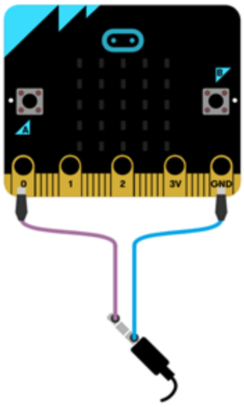
- Change the program so that there is a way to switch the LEDs on one at a time, and also a way to switch them off
- Change the program so that the LEDs flash on and off
- Add a third LED and simulate the sequence of a traffic light (red, amber and green)
- Try out some other ways of switching on the LEDs using the micro:bit's sensors instead of buttons. Can you make different LEDs respond to different sensor inputs?

Activity eight

Electric light orchestra

Adding sound and music

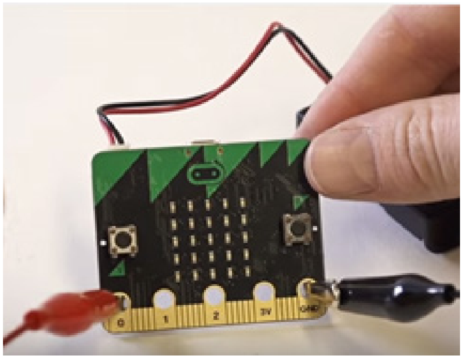
The next part of the activity looks at how the micro:bit can be used to produce sounds. For this the teacher will need access to at least one pair of standard headphones to demonstrate with (any headphones will do).



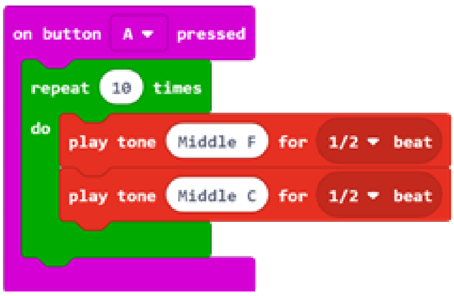
If you would like students to experiment with sound themselves, then you will need one pair of headphones for each micro:bit. Alternatively, if you do not have enough headphones available, students can still write their programs in MakeCode and simulate the results using the MakeCode virtual micro:bit on the left hand side of the screen.

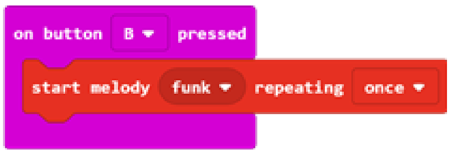
Connect your headphones to your micro:bit using crocodile clips as shown right:

The crocodile clips from Pin 0 and Ground need to be connected to different ends of the headphone connector. You may notice that there is a line running around the headphone connector. Connect the crocodile clips to either side of this line.



Students are now able to use the “Music” tab in MakeCode to create programs which use sound (and also music!). Try copying the program below. Can you guess what it will do?





Ask students to design a program for their micro:bit which uses:

- at least 2 LEDs (connected to 1/GND and 2/GND)
- at least two different micro:bit sensors
- at least two different types of sound (headphones connected to 0/GND)

Students should document their finished program and explain what it does in their journals.

Closing discussion

Close the activity by discussing sound in the context of Western Power's electricity network.

Can you think of how sound is used to provide warnings about problems or emergencies?	Examples might include home security alarms, car alarms, fire alarms, power failure alarms
Does electricity make a sound?	Think about when you stand next to a power transformer station or when you see lightning
Why does it make that sound?	This is a good research question for students to go away and figure out for themselves

Extension ideas

Could you get multiple micro:bits to perform music in harmony? How could you make sure they all start at exactly the same time? (hint: use the radio feature that we looked at in Activity 6)

Activity nine

Designing and engineering the network of the future

circuit breakers

Activity nine

Designing and engineering the network of the future

Background context

As the needs of the entire community changes, so must the way electricity is supplied. This means that Western Power is undertaking a number of trials that are starting to explore what the network of the future looks like.

Kalbarri Micro Grid Project

A new $5 - $10 million project which will improve electricity reliability for residents and holiday makers in the coastal town of Kalbarri, over 500km north of Perth. Kalbarri is currently supplied by a 140km long rural feeder from Geraldton which is exposed to environmental factors. The feeder's length and remoteness can lead to extended outages.

Learn more about Micro Grids
www.westernpower.com.au/about/electricity-innovation/microgrids

Perenjori – Battery energy storage system trial

The town of Perenjori, 380 kilometres north of Perth, is one of our reliability hotspot locations and frequently experiences electricity outages.

The two year trial will incorporate a one megawatt hour battery storage system consisting of a battery and an inverter. The system will be connected to the network via a transformer and switching equipment. During an electricity outage the system will switch on to automatically supply the town until the network is restored.

Analysis has shown that this innovative solution should eliminate around 80% outages and reduce the length of remaining outages.

Ravensthorpe – Stand-alone power system trial

Edge of grid customers in Ravensthorpe, West River, Lake King and Ongerup experience frequent outages due to the remoteness of their supply lines. The Stand-alone Power Systems Pilot provides six of these customers with an individual stand-alone solar, battery and generator system.

Learn more about stand-alone power systems
www.westernpower.com.au/about/electricity-innovation/stand-alone-power-systems

Check out the Energy Solutions page **(www.westernpower.com.au/energy-solutions)** on the Western Power website for information about new technology that's changing the electricity network as we know it. Choosing a few examples from this page that are relevant to your school could be a great way of understanding what the future holds.

Learning goals

Working together, teachers and students will:

- Discuss design needs for planning a community of the future (e.g. sustainability, renewable energy)
- Identify types of 3D shape including cubes, cuboids, cylinders, cones, pyramids and prisms
- Identify types of 3D shape that are frequently used in architecture and engineering
- Learn how 3D shapes such as can be created from 2D nets
- Print and assemble 3D nets in order to produce a scale model of a future community

Students resources:

- Network of the future design worksheet (see Appendix 1)
- Nets of 3D shapes, printed on different coloured paper or card (see Appendix 2)
- Scissors and glue

Teacher resources:

- Full size community board

Activity instructions:

Opening discussion

This activity involves three phases: imagine, design and build.

Phase one: Imagine the community of the future

Begin this activity with a conversation about the community of the future. What will the community of the future look like?

What will the buildings of the future look like?	This is a good chance to conduct a Google image search for futuristic buildings and discuss how buildings will use energy more effectively (e.g. solar panels, insulation, trees and green spaces)
What renewable sources of energy will future communities use?	Solar power, wind power, hydro-electric power, wave power, battery storage (and there will probably be many more)
How can we use micro:bits to represent different parts of an electricity network?	micro:bits could be used to represent: • lighting for homes and buildings • street lights • traffic lights • electric vehicle charging stations • outdoor displays such as advertising • micro grids

Activity nine

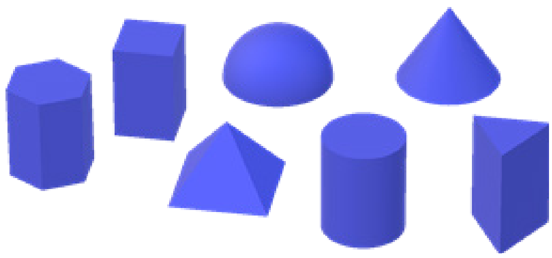
Designing and engineering the network of the future

Introducing micro:bit

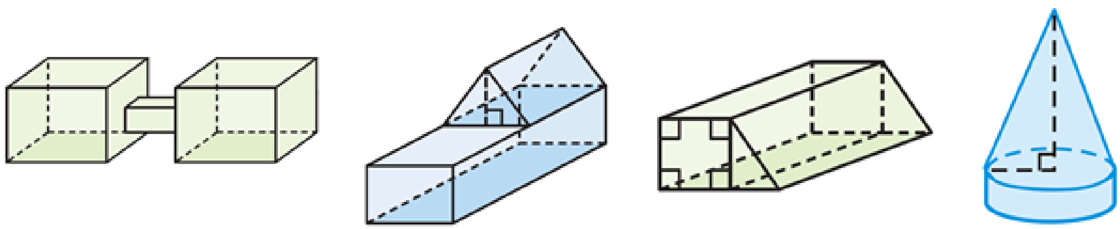
In the final two activities, teachers and students will combine everything they have done so far. Working together as a class, they will use their knowledge of electronics and digital technologies to design and build a working scale model of the community of the future incorporating 3D models and powered by micro:bits.

Show students the board or table onto which they are going to build their class model

What size will the buildings be?	As all students will be working on the same board, it is important to agree upon the size of the model so that elements are consistent (for example, students should try to avoid making street lights that are bigger than a skyscraper)
What scale will we use?	The discussion about size presents an excellent opportunity to talk about scale and ratios. If possible, ask students to decide upon a simple scale for their model such as 1cm = 1m
What shape will the buildings be?	Use this as an opportunity to discuss 3D shapes. All buildings are composed of different 3D shapes. How many different 3D shapes can students name?



Explain that students will be making their models by printing out nets onto coloured paper, then cutting them out and sticking them together to make 3D shapes. Multiple 3D shapes can be joined together to create more complex shapes.



Nets of the following 3D shapes are available in Appendix 2:

- Cube
- Cuboid
- Triangular Prism
- Cylinder
- Triangle Based Pyramid
- Square Based Pyramid
- Pentagon Based Pyramid
- Cone

The teacher may wish to print a selection of these nets in advance, either at A4 size, or enlarged to A3, or a mixture of the two. Alternatively, more ambitious students may choose draw their own nets (either independently or using the provided nets as a guide). This is a good opportunity for students to demonstrate an understanding of scale.

Discuss construction techniques and design considerations that students will need to be aware of:

How can we use 3D nets to represent different parts of our community?	3D nets can be used to create a variety of buildings (homes, skyscrapers, factories, power stations) or to represent other objects which might be found in the power network of the future (e.g. solar panels, battery storage, or electric vehicle charging stations)
Are there any ready-made 3D shapes or objects we could include in our model?	Empty food containers, match boxes, LEGO pieces, any other construction materials that may be found in the classroom. (see Appendix 3)
How can we make power lines, street lights or traffic lights?	Brainstorm some simple construction materials with students, such as pop sticks, drinking straws and string. One way to construct a traffic light is with a straw and a ping-pong ball (wiring can be placed inside the straw, allowing the LED to light up the ping-pong ball from the inside)
Where will micro:bits be placed on the model?	micro:bits can be left on the surface of the board, or concealed inside a building, or even attached to the bottom of the board (with a hole made for the wires to go through)

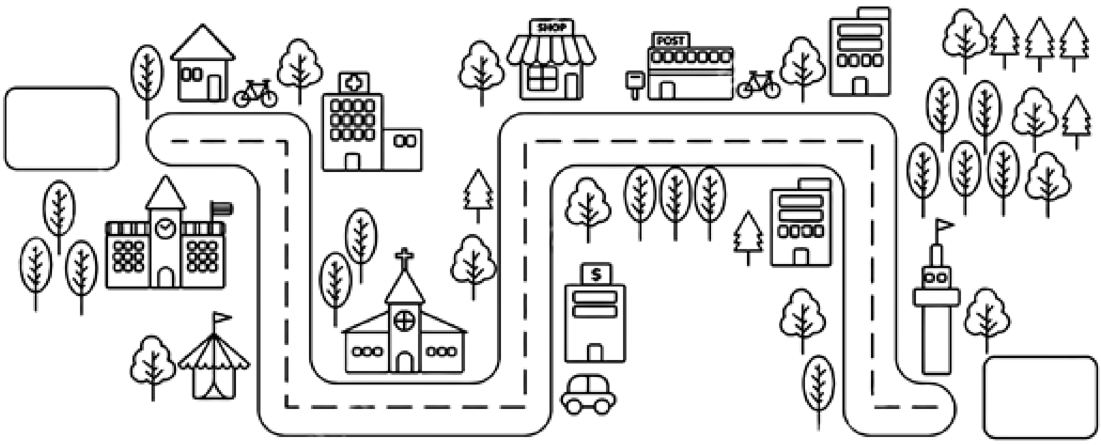
Activity nine

Designing and engineering the network of the future

Phase 2: Design the community of the future

Before students can start building, they need to draw a plan of their network. Provide each students with a blank copy of the Network of the future worksheet (see Appendix 1).

Students should use this worksheet to draw an overhead plan or map of their imagined community. Designs should include and indicate the following:



At least 3 different types of building	Plans should indicate what each building will be, e.g. house, swimming pool, factory, apartment block, power station
At least 5 different 3D shapes from the provided list	Plans should indicate what combinations of 3D shapes they are going to use for each building
At least 2 functional demonstrations of how energy will be used	Plans should indicate where these demonstrations will be and what type of energy use they will demonstrate. Examples might include: • interior lighting for homes and buildings (using LEDs) • street lights (three different colours of LED) • traffic lights (LEDs in ping pong ball at the top of a straw) • electric vehicle charging stations (rows of LEDs) • outdoor advertising screens (micro:bit scrolling text)
At least 2 micro:bits systems	Plans should indicate how micro:bit systems will utilise a combination of LEDs, sensors and sound to demonstrate how energy will be used and controlled in the network of the future

This worksheet is the final individual piece of work that students will produce in this program.

When teachers are happy that students have produced an acceptable plan, students may be given the go ahead to begin collaborative work on the whole-class project.

Phase 3: Engineering the community of the future

Once students have created a map or overhead plan for their community of the future, they may proceed to start building elements which will be affixed to the physical model.

Construction of this model is intended as a collaborative activity to be worked on by the entire class. Students will need to communicate with each other in order to decide which students are working on which part of the model. To avoid conflict, teachers may wish to assign certain sections of the board to certain students, or allow students to take turns in the role of project manager. Teachers are free to coordinate this aspect of the program in whatever way they find most effective.

Students should construct their model buildings first, then add other physical elements such as power lines, street lights or traffic lights.
After a sufficient number of 3D shapes have been constructed, students are welcome to use any materials available (subject to teacher approval) in order to add finer details their models. Students may get as creative as they like at this point.

When do we add electronics?

The remainder of this activity is intended for students to complete building their model. As the design and physical construction of the model is expected to take a significant amount of time, no electronics work is planned for this activity (although students should already be thinking about where their micro:bit systems are going to be incorporated into their model).

Activity ten

The network of the future

Activity ten

The network of the future

Learning goals

Working together, teachers and students will:

- Complete construction of a scale model representing students' vision of the network of the future
- Add electronic micro:bit systems to their model, incorporating LEDs, sound and sensors

Students resources:

- Construction materials (e.g. scissors, glue, cardboard, straws, pop sticks, sticky tape)
- Micro:bit kits

Activity instructions:

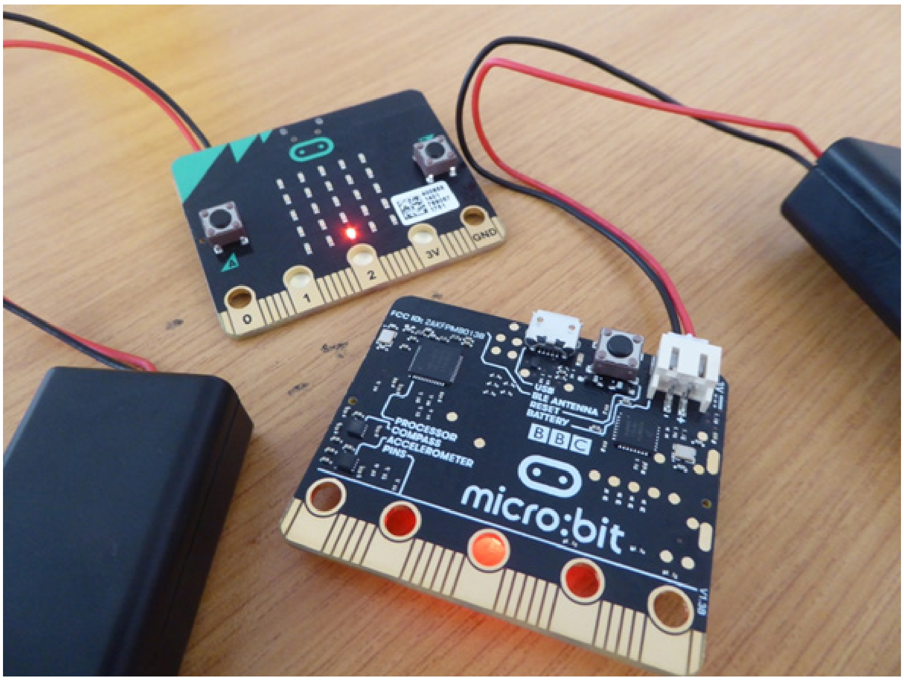
The final activity gives students the chance to show off their new skills with digital technologies by incorporating micro:bit control systems into the model which they finished in the previous activity.

Students are required to design, make and program at least two micro:bit control systems and incorporate these into their model. Micro:bit systems should use some combination of LEDs, sensors and sound to demonstrate how energy will be used and controlled in the network of the future

Students could demonstrate the following considerations in their network model:

Weather	How would the weather affect your network?
Outages	Does your power go out often? How could you fix this?
Safety	Sometimes the network can get damaged, could this be avoided?
Community	How will people safely use the network in their day-to-day lives?

Have fun adding digital technologies to your model and remember, there is no right or wrong answer! This is your opportunity to build on your learning, get creative and show off your STEM skills, creating solutions to real-world problems… just like an engineer would!



What happens next?

Congratulations! You have reached the end of the Circuit Breakers teacher guide. This activity is the last in the sequence.

At the conclusion of your Circuit Breakers program, please present your finished model as a video or slide show and email it to **energyeducation@westernpower.com.au** and we will display it on our Circuit Breakers webpage.

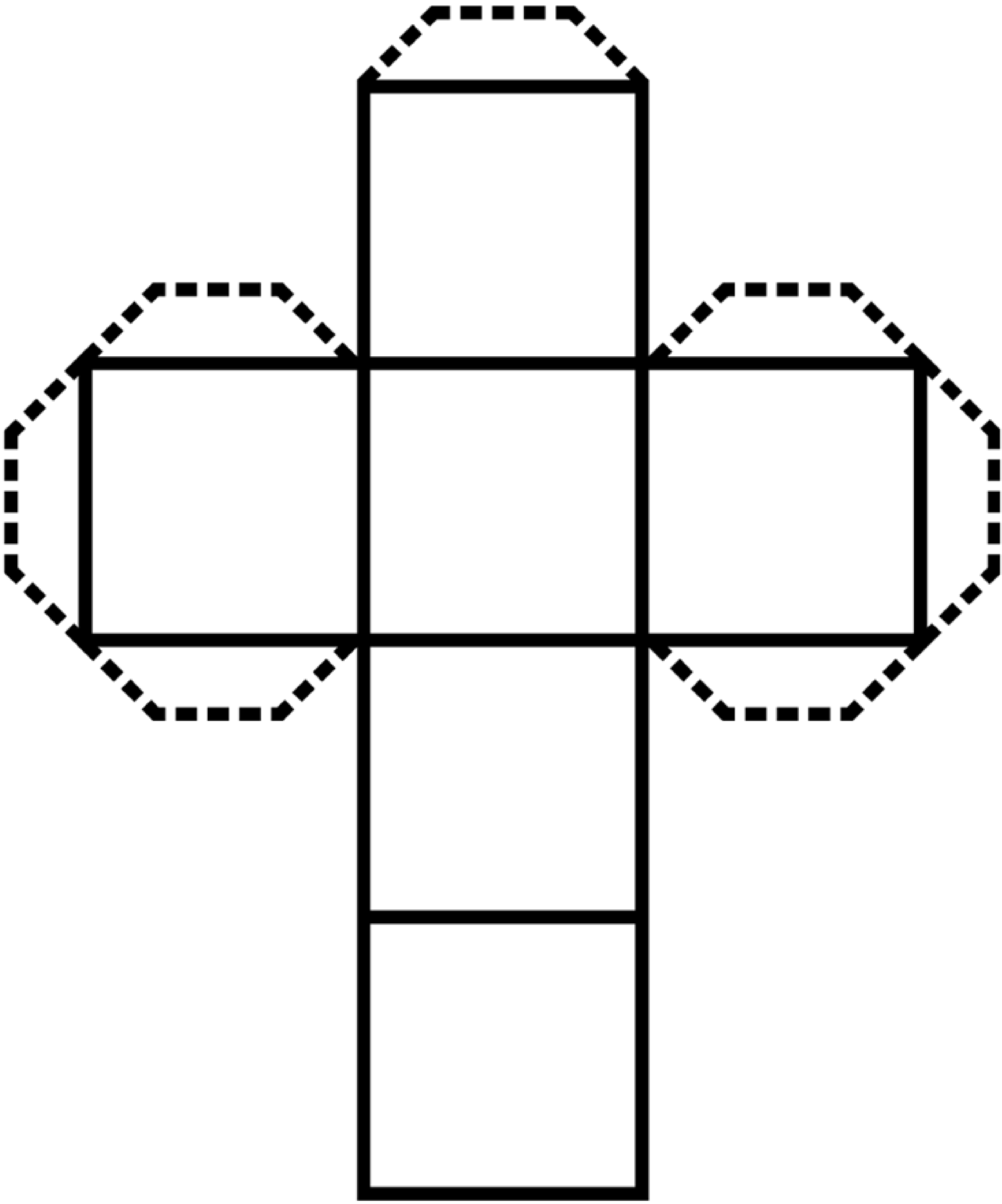
Beyond this, you are free to continue experimenting with your micro:bits and designing even more incredible projects. We can't wait to see what you come up with. The only limit is your imagination!

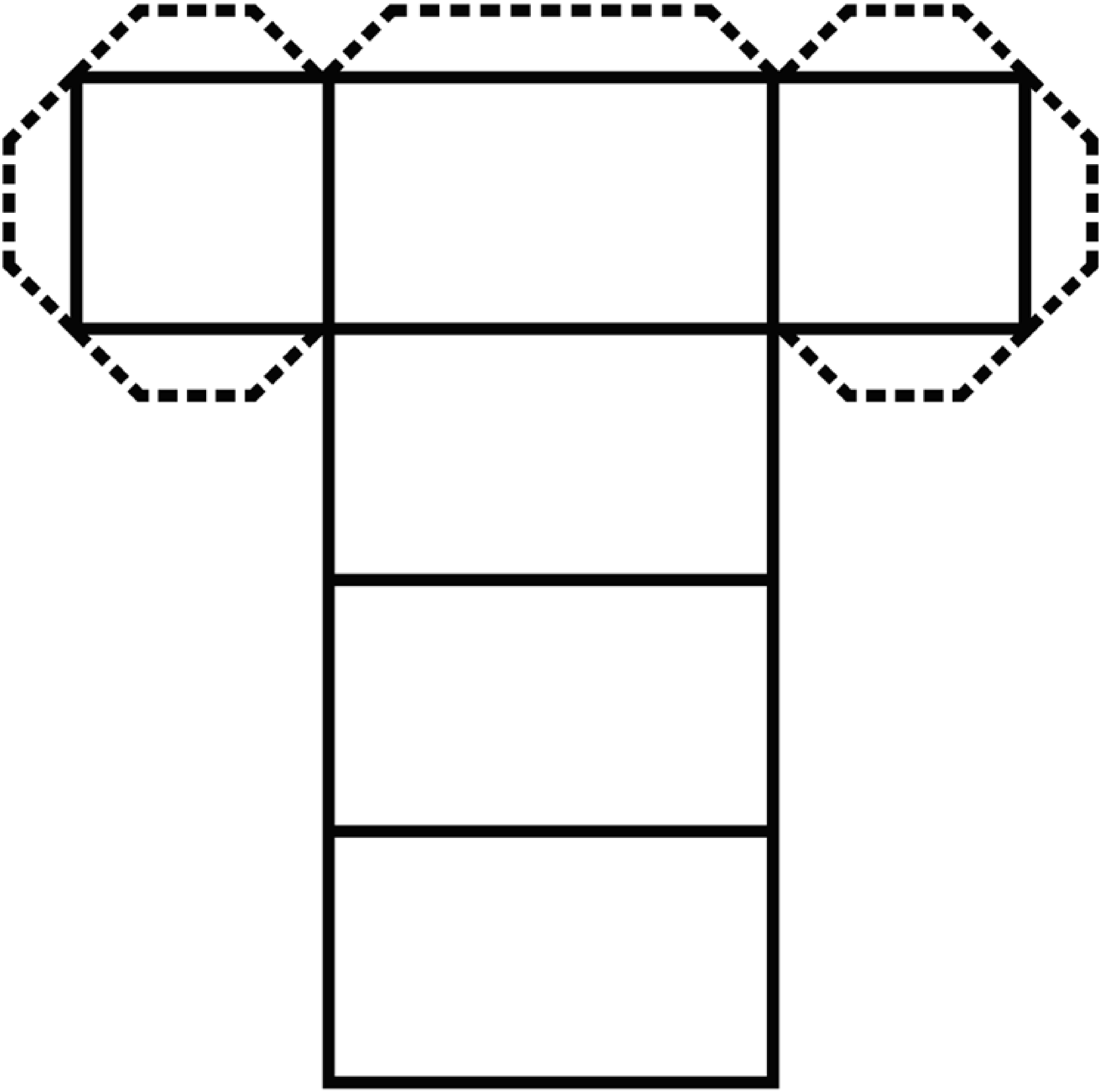
Appendix one

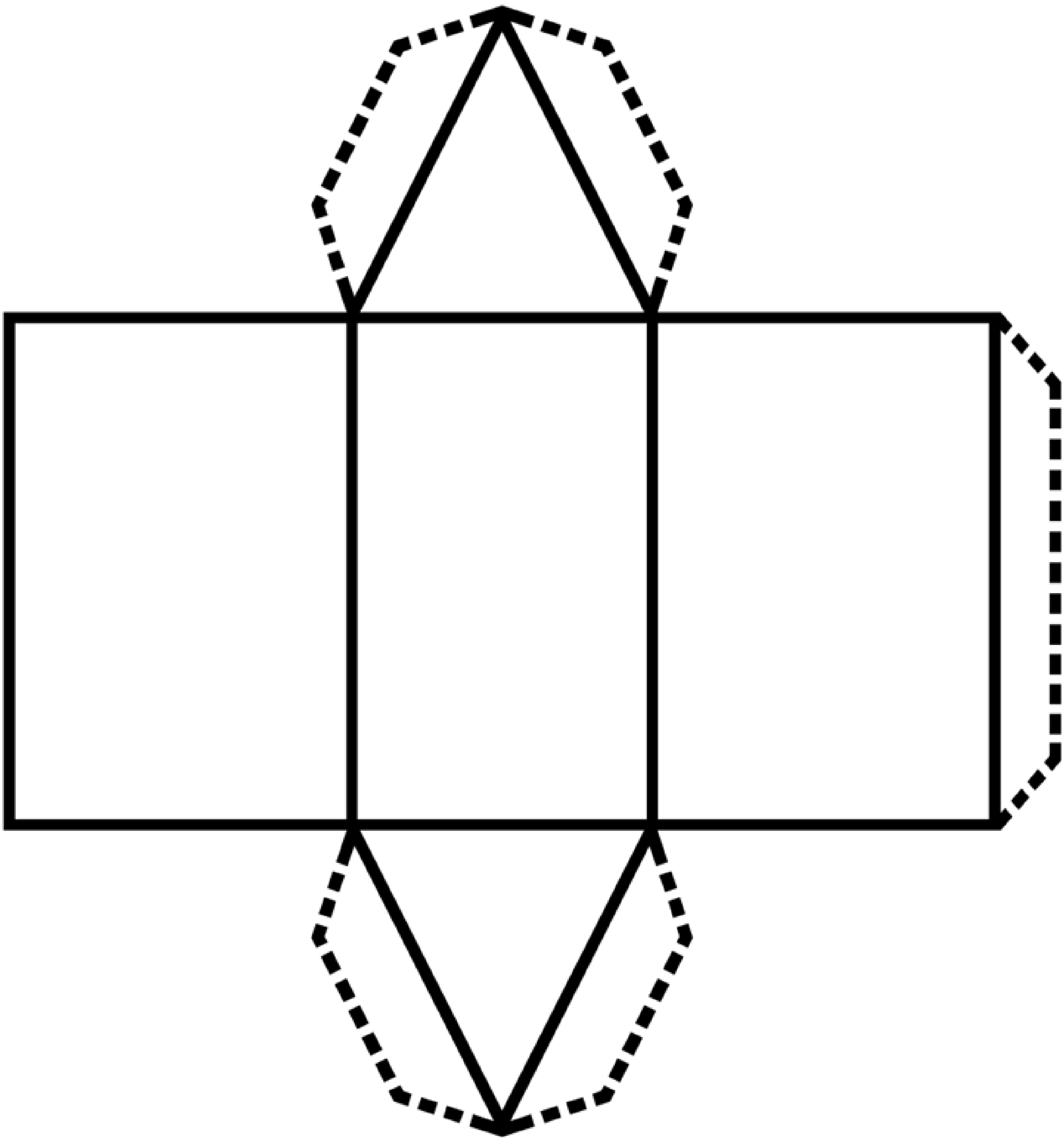
Network of the future design worksheet

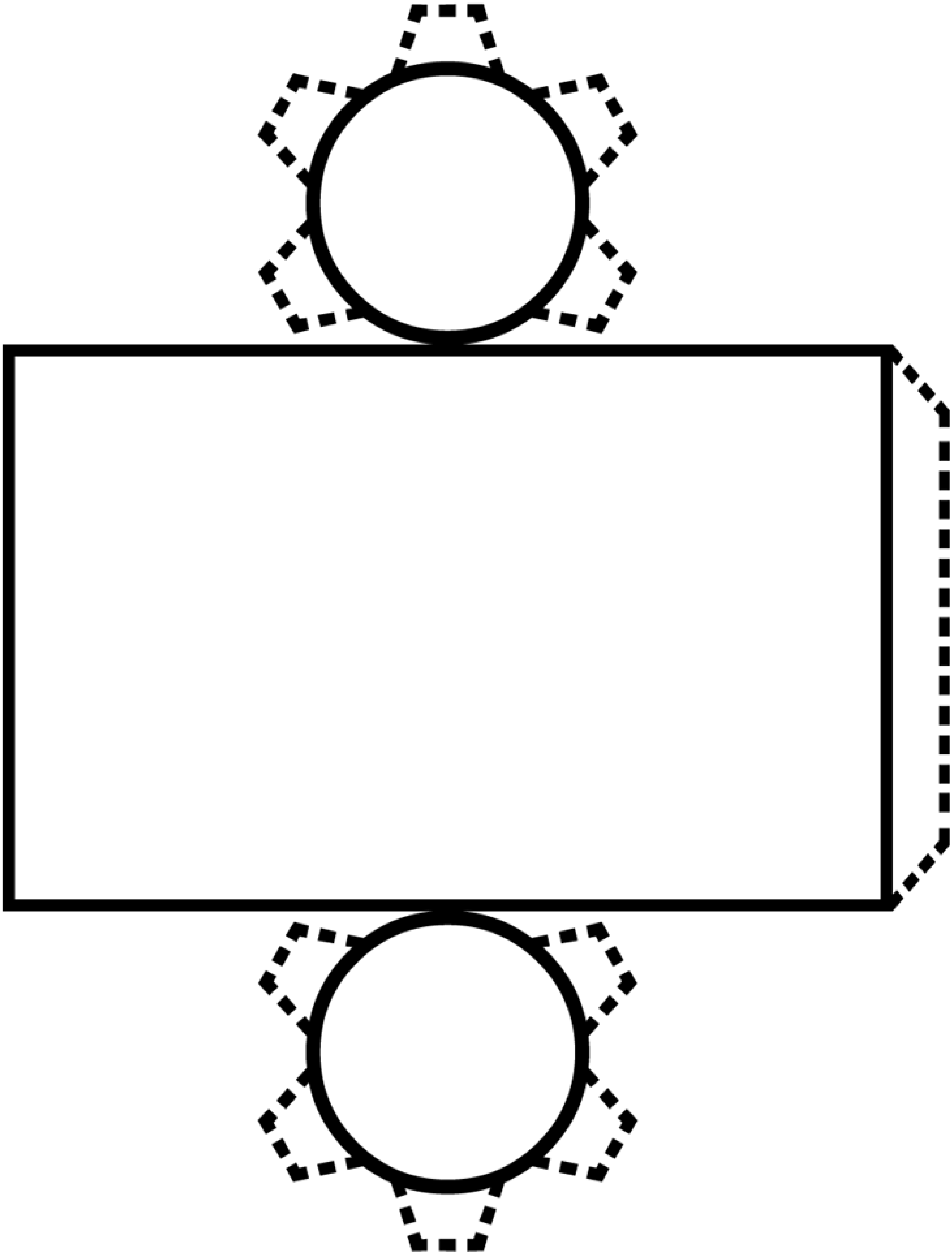
Appendix two

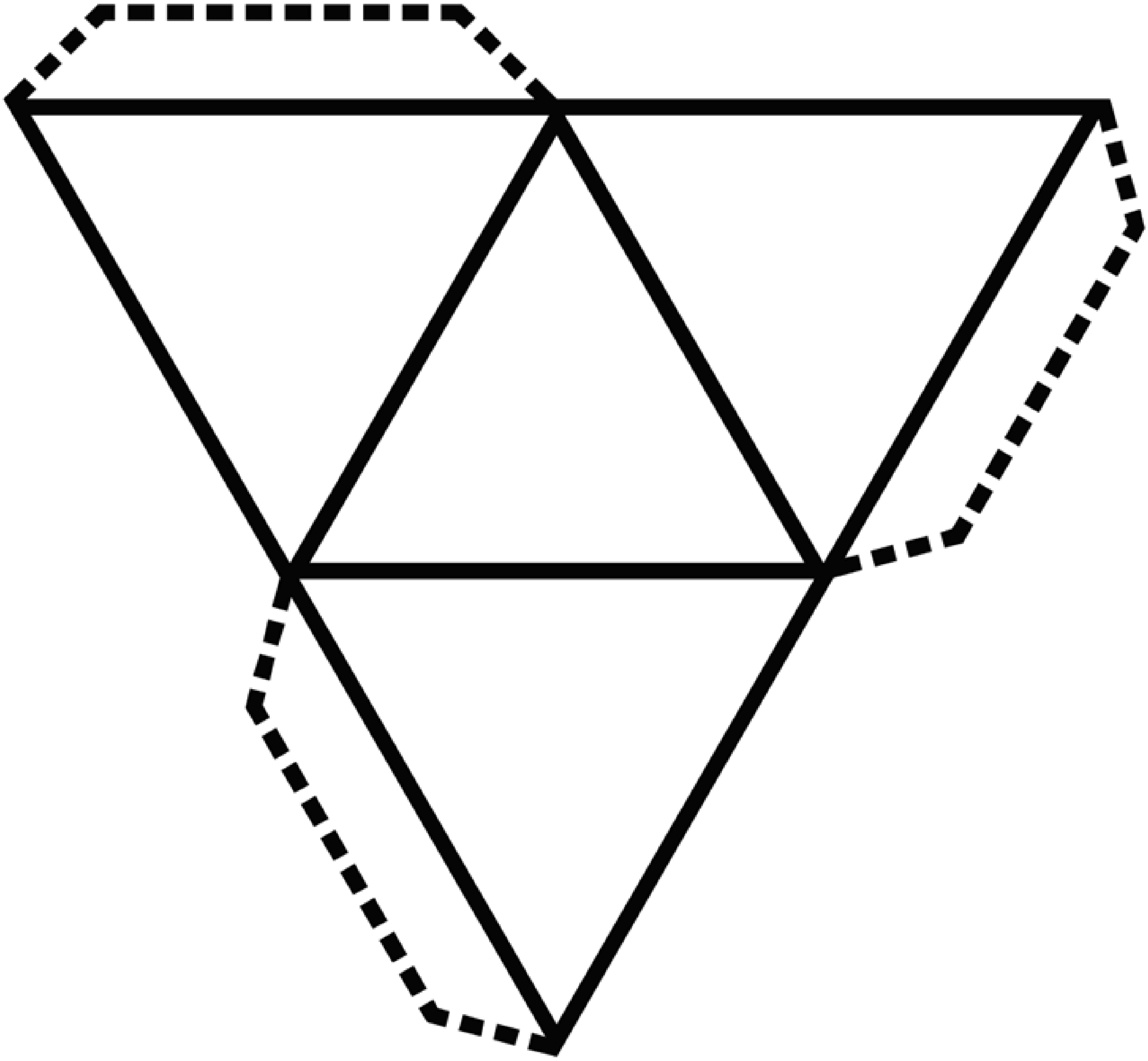
Nets of 3D shapes

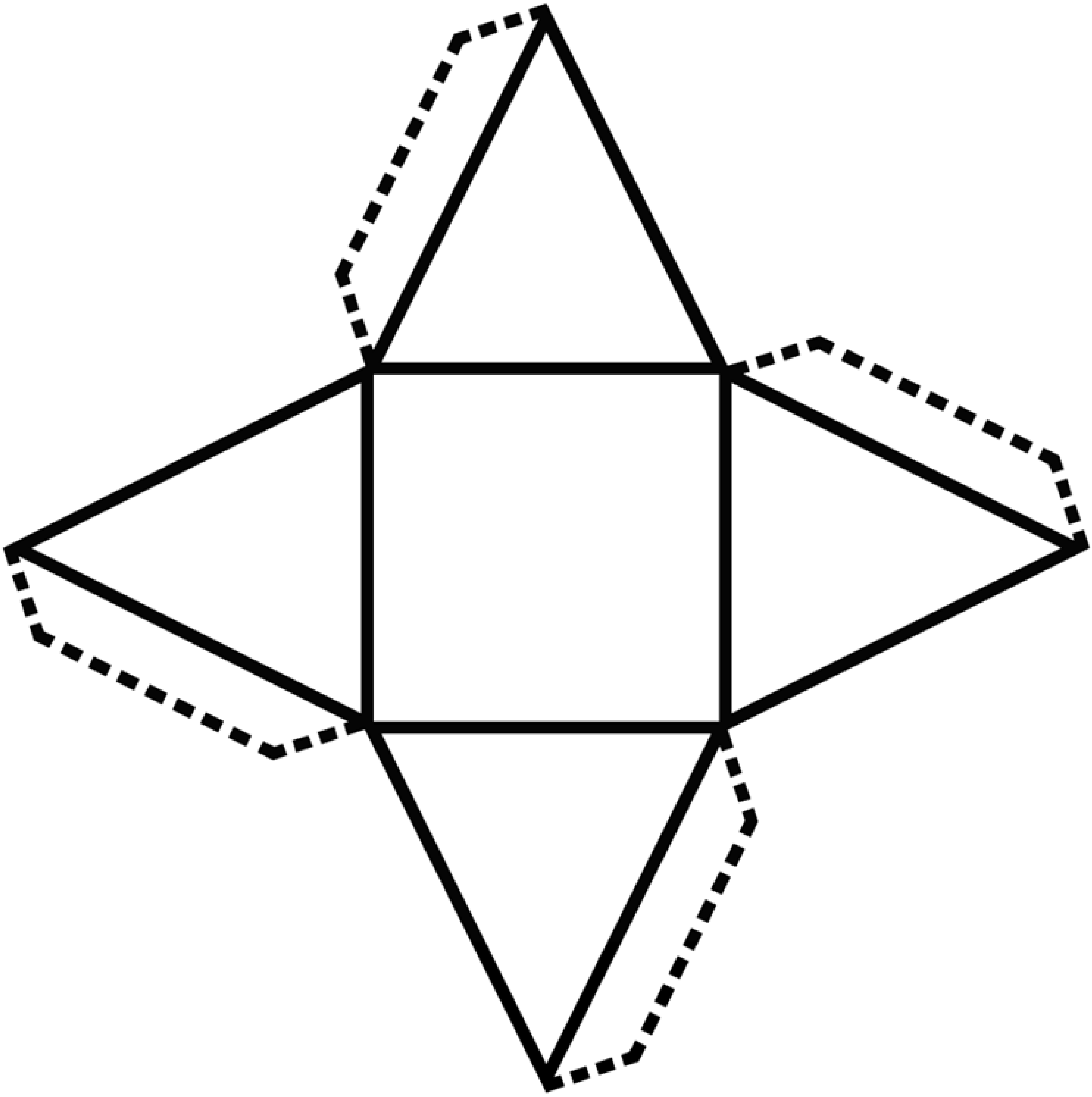


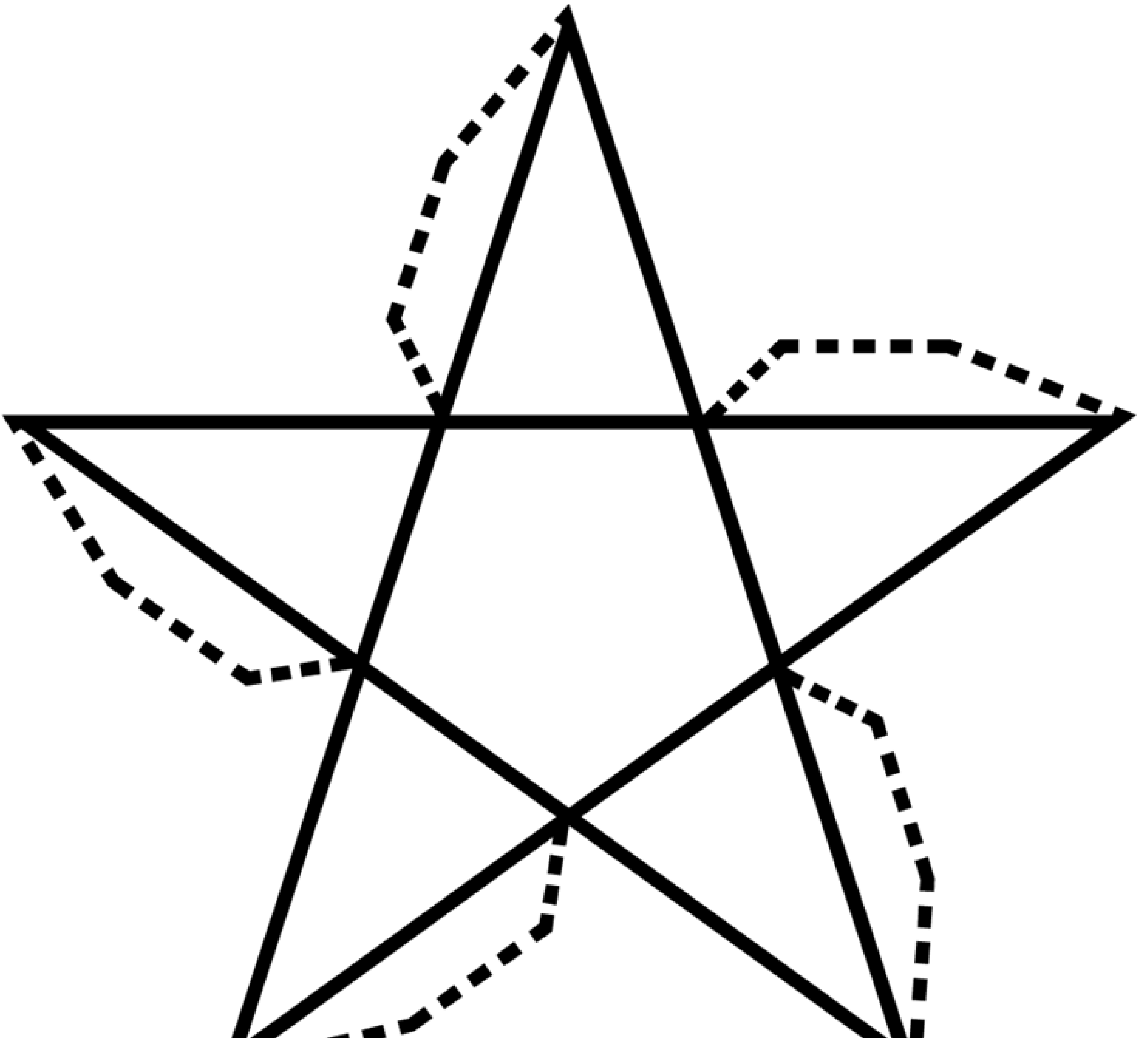


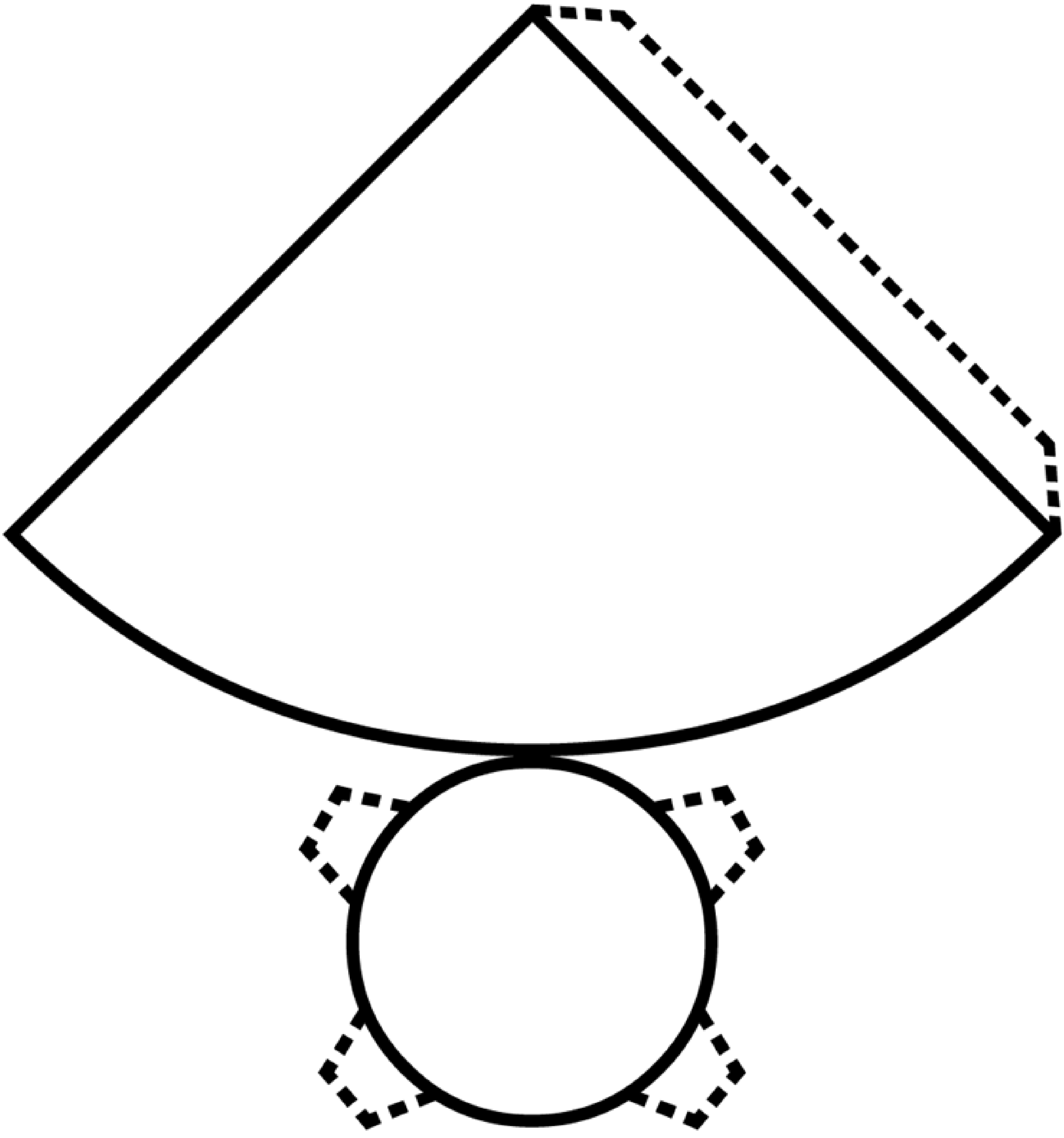












Appendix three

MakerSpace hints and tips

circuit breakers

Appendix three

MakerSpace hints and tips

Suggested MakerSpace shopping list

Learning goals

Consumable resources
Paper
Cardboard
Popsticks
Straws
Rubber bands
Wool and string
Ribbon
Felt and fabric
Rubber and foam
Cardboard tubes
Ping pong balls
Plastic pipes
Wire and twine
Balsa wood
Kitchen foil
Modelling clay
Plastic from food containers
Blu tack
Glue and tape
Pins and fasteners
Velcro
Magnets

Tools

Pencils and crayons
Marker pens
Paints and brushes
Rulers
Measuring tapes
Protractors
Spirit levels
Digital scales
Calculators
Scissors
Pliers
Glue guns

Safety

Safety goggles
Disposable gloves
Heavy duty gloves
Ear protection
Face masks
Disposal bins

Reusable kits and technology

Wood blocks
Interlocking cubes
LEGO
K'Nex
Meccano Junior
Snap Circuits
Little Bits
Robots (e.g. Sphero)
Micro:bit
Batteries
LEDs
Buzzers
Hobby motors
copper wire
Resistors
Conductive tape
Makey Makey
Arduino

Storage

Cardboard boxes
Storage crates
Shelving
Trolleys

Learning goals

Many simple maker space items can be purchased from retail art and crafts stores or office supply stores. Browsing an art and crafts store can also be an excellent source of inspiration.

Riot Art and Craft	**www.riotstores.com.au**
Jacksons Drawing Supplies	**www.jacksons.com.au**
Spotlight	**www.spotlightstores.com**
Office Works	**www.officeworks.com.au**
Eckersleys Art and Craft	**www.eckersleys.com.au**

Educational Suppliers

You may also find it easier or more cost effective to purchase equipment via bulk educational suppliers. Note that these suppliers are catalogue/online only and do not have any retail stores.

Educational Art Supplies (WA)	**www.edartsupplies.com.au**
Zart Art	**www.zartart.com.au**
Modern Teaching Aids	**www.teaching.com.au**

Reused and Recycled Materials

Makerspace materials can often be obtained by recycling or recovering items such as cardboard boxes and food containers. Try saving materials from around your home or school, or establish relationships with local shops, businesses and recycling centres.

If you'd like to take a shortcut to reused materials, you can pay a membership fee to a resource recovery organization like REmida. REmida manage the collection process, allowing you to take advantage of a regularly replenished selection of neatly sorted reused materials.

REmida WA	**www.remidawa.com**

DIY and Hardware

Tools, equipment and storage options can often be purchased from D.I.Y. and hardware stores. Options for online shopping or delivery are fairly limited, making an in-person shopping trip necessary in most cases.

Bunnings	**www.bunnings.com.au**
Mitre 10	**www.mitre10.com.au**
Home Hardware	**www.homehardware.com.au**
IKEA	**www.ikea.com/aa/en**

Appendix three

MakerSpace hints and tips

Background context

It is important to have some clear, simple safety guidelines that can be easily remembered by students and staff. Here are some suggestions.

Before you start:

- Plan what you are going to do
- Make a list of possible risks
- Wear clothing appropriate to the activity
- Wear eye, ear, mouth and nose protection as appropriate
- Tie back long hair

While you are making:

- Use tools only for their intended purpose
- Don't use a broken tool
- Report broken tools immediately
- Turn off power tools before walking away
- Don't remove tools from the safe area
- Don't use a tool unless you've had training on its safe use
- If you're not sure how to do something, ask
- Report any injuries

After you finish:

- Shut off and unplug any machines you have been using
- Return all equipment to its proper place
- Throw away or recycle waste items
- Sweep or mop up spills to prevent slips

Notes