Coordinator Notes:

Module 4.1: Electronics - Energy

This session explores energy. Students learn about the different forms of energy and how energy transformations can occur. This knowledge is then expanded upon and utilised in a Battery Challenge.

Session Length:

This Module can be presented in different session durations per your needs.

Lesson plans are provided for:

- A 120 minute session, or, 2 x 60 minute sessions
- 45 minute, 75 minute, and 90 minute sessions

Technology:

PowerPoint: If you do not have access to a data projector and cannot display the PowerPoint presentation, we recommend that you print the most important slides before the session, and either enlarge them onto cardboard to use in place of slides, or create a booklet that students can share in small groups.

The session can be conducted without slides all together, but they offer visual aid in explanation of concepts.

Videos links: The suggested links to online videos within the session can be helpful with explanation. Notes have been included in the slides if there is an essential component to a video which the facilitator should discuss or demonstrate, if the video cannot be played.

Please read the Module 4 Risk Assessment before proceeding with the activity

Contents	Page

Module 4.1: Electronics - Energy

Overview

This session explores energy: types of energy, conversion / change of energy types, and storage of energy.

Content overview:

Concept / Activity	Session Duration (minutes)			
	120	90	75	45
Energy – What is Energy?	*	*	*	*
Types of Energy	*	*	*	*
Activity 4.1.1: Kinetic and Potential Energy	*	*	*	-
Heat, Electrical and Chemical Energy	*	*	*	-
Activity 4.1.2: Lemon Power	*	*	*	-
How batteries work. Electrodes, Electrolytes, Cells.	*	*	*	*
Connecting batteries. Positive and Negative Terminals	*	*	*	*
Challenge 4.1: Battery Challenge	*	*	*	*

Slides:

PowerPoint Slides are available to support the delivery of this module. Slides explain concepts visually, and include short, engaging videos relevant to the topic.

A full list of slides and recommended inclusions for each session duration are provided in the table below. Appropriate slides are also noted in lesson plans for each duration.

PowerPoint Presentation: 'M 4.1 - Master Slides 120 minute Session Duration'		**Session Duration (minutes)**			
Slide	**Content**	**120**	**90**	**75**	**45**
1	Introductory title page for Module 4.1	*	*	*	*
2	Prompt Slide: How do lights stay on, how do engines run?	*	*	*	*
3	Prompt Slide: What is energy?	*	*	*	*
4	Overview: Energy is all around us	*	*	*	*
5	**Activity 4.1.1: Kinetic and Potential Energy**	*	*	*	-
6	Overview: Heat Energy and Electrical Energy	*	*	*	-
7	Overview: Chemical Energy	*	*	*	-
8	**Activity 4.1.2: Lemon Power**	*	*	*	-
9	Overview: How do batteries work	*	*	*	*
10	Overview: Connecting batteries	*	*	*	*
11	Introduction to **Challenge 4.1** Battery Challenge	*	*	*	*
12	Overview: Electrolytes and Electrodes	*	*	*	*
13	Overview: Battery Cells	*	*	*	*
14	Challenge 4.1 Rules	*	*	*	*
15	Session References	*	*	*	*

Module 4.1 Electronics - Energy

Lesson Plan

120 minute session or 2 x 60 minute sessions

High Tech: Use PowerPoint Presentation 'M4.1 - Master Slides'

Key Learning Area	**Topic**
Physics, Chemistry	Energy

Timing	Running Time (hh:mm)	Procedure	Materials
2 min	00:02	**Lesson Introduction** Welcome! Have you ever wondered…	M4.1 PowerPoint (Slides 1-2)
		Body of Lesson **(Lesson 1, 2 x 60 minute sessions)**	
3 min	00:05	What is energy? Why do we need it?	M4.1 PowerPoint (Slide 3)
2 min	00:07	Types of energy.	M4.1 PowerPoint (Slide 4)
8 min	00:15	Potential and kinetic energy. Activity 4.1.1 Balloon experiment and discussion.	M4.1 PowerPoint (Slide 5) Balloons
5 min	00:20	Other forms of energy: heat, electrical, chemical.	M4.1 PowerPoint (Slides 6-8)
20 min	00:40	Activity 4.1.1 Lemon Power experiment	M4.1 PowerPoint (Slide 8) Per group: 2 - 4 lemons (or potatoes), 1 LED Light, Alligator clips and insulated electrical wire, copper wire, galvanised nails
5 min	00:45	Discuss outcomes of Activity 4.1.1. What was discovered? What challenge were faced?	
5 min	00:50	Batteries. How do they work? How do they connect?	M4.1 PowerPoint (Slides 9-10)

10 min	01:00	Introduce Battery Challenge. Discuss materials available for use as electrolytes and electrodes. Discuss materials available for connecting battery cells. Watch Vinegar Cell Battery Video. If unable to play video, ensure you watch prior to the session to describe to students. **(Break for 2 x 60 minute sessions)**	M4.1 PowerPoint (Slides 11-14)
		(Lesson 2, 2 x 60 minute sessions)	
5 min	00:03/ 01:03	Recap and discuss the previous session. Who can remember some of the different types of energy? Who can remember the parts of a battery, and how batteries work?	
40 min	00:45/ 01:45	Undertake the Battery Challenge. Discuss responsible use of materials, rules and aims. Encourage each group to take 10 – 15 minutes to find a working solution to light up 1 LED, then move on to making additional or more powerful cells.	M4.1 PowerPoint (Slides 11-14) Lemons, potato, gold coin, galvanized nail, aluminium foil, alligator clip leads, copper wire, 5mm LEDs, multimeter (optional), cans of coke, salt water, plastic/foam/paper cups, moist dirt, paper towel.
10 min	00:55/ 01:55	Test each group's device with multiple LEDs and / or the multimeter.	Multimeter or LED's
		Lesson Conclusion	
5 min	01:00/ 02:00	Announce winner, discussion, recap, questions, clean up.	

Activity 4.1.1: Kinetic and Potential Energy

Aim: To visualise and discuss kinetic and potential energy

Equipment:

- Balloons, 1 per student

Procedure:

1. Hand out balloons.
2. Ask students to blow up balloons and hold them closed.
3. Ask students to vote which type of energy the balloons currently have.
4. Allow students to release air out of balloons and observe result. Ask which type of energy was used in this process.
5. Discuss energy types with students using other examples.

Expected Result:

The inflated balloons will move out of the students hands once released.

Explanation:

Balloons have potential energy once they are inflated. When the air is released that potential energy is converted to kinetic energy and the balloon will fly around the room.

The same thing can be said of a rock at the top of a hill. The rock, prevented from rolling by another object, has a great deal of potential energy as gravity will pull it down the hill when any obstacles are removed. When the force of gravity pulls the rock down the hill the energy is transformed to kinetic energy.

Activity 4.1.2: Lemon Power

Aim: To harness the power stored in a lemon

Materials (per group):

- 2 - 4 lemons (or potatoes)
- 1 LED Light (3mm – 5mm)
- Alligator clips and insulated electrical wire
- 4 pieces of copper wire (4 cm long each)
- 4 galvanised nails (4cm long each)

Procedure (after forming groups and collecting materials):

1. Roll and squeeze 2 of the lemons by hand, making them juicy inside (don't cut them open, keep the juice in!)
2. Into each rolled lemon, insert 1 nail, and a 4 cm piece of copper wire. Leaving a small section of each sticking out.
3. Using electrical wire and the alligator clips, connect the nail in the first lemon to the copper wire in the second.
4. Connect the copper wire sticking out of the first lemon to the longer leg of the LED light (using the electrical wire and the alligator clips).
5. Connect the nail sticking out of the second lemon to the shorter leg of the LED light (using the electrical wire and the alligator clips).
6. Observe!

Extensions:

- Is there a difference if you change how far the nail and copper wire are pushed in?
- Is there a difference if you add more lemons to the system?
- Does the experiment work with other metals? What about gold coins, aluminium foil?
- Is there an observable difference between using a lemon and a potato?

Expected Result:

The LED lights up.

Explanation:

Wiring up lemons (or potatoes) turns them into an electrochemical battery, a battery in which the power is generated by chemical energy turning into electrical energy.

The lemon (and potato) contain types of acids (citric and phosphoric) that react with metals. When the metals react, they eject electrons from their atoms. Zinc in the galvanised nails reacts with the copper wire, causing electrons to flow through the acid in the lemons (or potatoes). This movement of electrons is the current which lights up the LED. Electrodes (copper/zinc) and electrolytes (acids) are the foundations of a battery.

Challenge 4.1: Battery Challenge

Coordinator notes

Scoring:
A scoring mechanism is included so that the element of 'competition' may challenge all students to participate to their fullest. You may remove the scoring system all together if it does not work with your group of students.

When scoring, it is important to only announce who the winning team is. Consider asking how the students might approach the task differently if asked to do it again, or how they might teach the same things they learned during the club to a younger student. It is important to highlight the good strategies of each team.

Activity notes:

- Students should be encouraged to work in groups of 2-4.
- Students will design a battery system using household materials.
- The battery should either light up multiple LED's, or, generate voltage as measured by a multimeter.
- Provide LEDs for the students to use for their trial testing throughout the session.
- If available use a multimeter for scoring as it is more accurate. Online tutorial for using a multimeter (note: you only need a multimeter that measures voltage): https://core-electronics.com.au/tutorials/how-to-use-a-digital-multimeter.html
- Teams must all be scored using either the multimeter or LEDs, do not used different scoring methods for different groups.
- The amount of each material used / needed will vary depending on what each group decides to build. Some groups may want 6 lemons… while others may want 6 coke cans.
- Encourage teams to use different materials and to share where practical. For example, if a team wants empty coke cans, and another team just wants liquid coke, encourage them to work together to coordinate resource use.
- If students are having trouble, encourage them to think about the 3 things required for a battery cell; 2 electrodes (different metals) and an electrolyte.
- They may need to test different electrodes and electrolytes to find the most effective ones.
- They will also find that a greater number of cells in the circuit provides more electricity to the LED or multimeter.
- If water or any liquid is spilt, it is to be cleaned immediately to avoid slip hazards.
- Encourage each group to take 10 – 15 minutes to find a working solution to light up 1 LED, then to move on to making additional or more powerful cells.
- Connecting LED's together for testing will take some preparation time and should be undertake before the session.

- Inclusion of a resistor in the LED circuit may be required, more information is available at: https://electronicsclub.info/leds.htm

Rules

- The team who can light up the most LED's OR give the highest voltage reading on the multimeter wins.
- Students can use any of the supplied materials to construct your battery.
- Do not drink the coke, or other liquids, especially if it has had coins and nails in it.
- All material must be returned for responsible disposal or recycling.
- Students can test designs using one LED to ensure that current is being produced.

Required Materials

Note: Adjust materials to suit location and availability of items.

- Lemons
- Potatoes
- Gold coins
- Galvanized nails
- Aluminium foil
- Alligator clips
- Copper wire
- 3mm or 5mm LED's
- Coke cans
- Lemonade cans
- Can opener
- Vinegar
- Moist dirt
- Salt water / salt / water
- Plastic/ foam /paper cups
- Paper towel
- Electrical tape
- Multimeter (measuring volts)

Challenge 4.1: Battery Challenge Planning Sheet

To design your battery consider:

ELECTROLYTE – What will you use as the electrolyte? Lemon juice, vinegar, salt water, cola or something else?

ELECTRODES – Which metals will you use as the positive and negative electrodes? Remember, use two different types.

SIZE – Will your battery be more effective as a series of small joined together cells, or one or two large cells?

CONNECTIONS – How will you connect multiple battery cells?

Take a look at the materials available, and design your battery cell!

Image Source: https://www.wikihow.com/Make-a-Homemade-Battery

Challenge 4.1: Battery Challenge Score Sheet

Team Name	
Team Work (10 points)	
Return of Materials (10 points)	
Multimeter Reading x 10	
Number of LEDs lit up x 10	
Final Score	

Team Name	
Team Work (10 points)	
Return of Materials (10 points)	
Multimeter Reading x 10	
Number of LEDs lit up x 10	
Final Score	

Team Name	
Team Work (10 points)	
Return of Materials (10 points)	
Multimeter Reading x 10	
Number of LEDs lit up x 10	
Final Score	

Team Name	
Team Work (10 points)	
Return of Materials (10 points)	
Multimeter Reading x 10	
Number of LEDs lit up x 10	
Final Score	

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Module 4.1 Electronics - Energy

Lesson Plan

90 minute session

High Tech: Use PowerPoint Presentation 'M4.1 - Master Slides'

Key Learning Area			**Topic**
Physics, Chemistry			Energy
Timing	**Running Time (hh:mm)**	**Procedure**	**Materials**
2 min	00:02	**Lesson Introduction** Welcome! Have you ever wondered…	M4.1 PowerPoint (Slides 1-2)
		Body of Lesson	
3 min	00:05	What is energy? Why do we need it?	M4.1 PowerPoint (Slide 3)
2 min	00:07	Types of energy.	M4.1 PowerPoint (Slide 4)
5 min	00:12	Potential and kinetic energy. Activity 4.1.1 Balloon experiment and discussion.	M4.1 PowerPoint (Slide 5) Balloons
3 min	00:15	Other forms of energy: heat, electrical, chemical.	M4.1 PowerPoint (Slides 6-8)
15 min	00:30	Activity 4.1.1 Lemon Power experiment	M4.1 PowerPoint (Slide 8) Per group: 2 - 4 lemons (or potatoes), 1 LED Light, Alligator clips and insulated electrical wire, copper wire, galvanised nails
5 min	00:35	Discuss outcomes of Activity 4.1.1. What was discovered? What challenge were faced?	
5 min	00:40	Batteries. How do they work? How do they connect?	M4.1 PowerPoint (Slides 9-10)

5 min	00:45	Introduce Battery Challenge. Discuss materials available for use as electrolytes and electrodes. Discuss materials available for connecting battery cells. Watch Vinegar Cell Battery Video. If unable to play video, ensure you watch prior to the session to describe to students.	M4.1 PowerPoint (Slides 11-14)
30 min **10 min**	01:15 01:25	Undertake the Battery Challenge. Discuss responsible use of materials, rules and aims. Encourage each group to take 10 minutes to find a working solution to light up 1 LED, then move on to making additional or more powerful cells. Test each group's device with multiple LEDs and / or the multimeter.	M4.1 PowerPoint (Slides 11-14) Lemons, potato, gold coin, galvanized nail, aluminium foil, alligator clip leads, copper wire, 5mm LEDs, multimeter (optional), cans of coke, salt water, plastic/foam/paper cups, moist dirt, paper towel. Multimeter or LED's
5 min	01:30	**Lesson Conclusion** Announce winner, discussion, recap, questions, clean up.	

Module 4.1 Electronics - Energy

Lesson Plan

75 minute session

High Tech: Use PowerPoint Presentation 'M4.1 - Master Slides'

Key Learning Area			**Topic**
Physics, Chemistry			Energy
Timing	**Running Time (hh:mm)**	**Procedure**	**Materials**
2 min	00:02	**Lesson Introduction** Welcome! Have you ever wondered…	M4.1 PowerPoint (Slides 1-2)
		Body of Lesson	
3 min	00:05	What is energy? Why do we need it? Types of energy.	M4.1 PowerPoint (Slides 3-4)
5 min	00:10	Potential and kinetic energy. Activity 4.1.1 Balloon experiment and discussion.	M4.1 PowerPoint (Slide 5) Balloons
3 min	00:13	Other forms of energy: heat, electrical, chemical.	M4.1 PowerPoint (Slides 6-8)
15 min	00:28	Activity 4.1.1 Lemon Power experiment	M4.1 PowerPoint (Slide 8) Per group: 2 - 4 lemons (or potatoes), 1 LED Light, Alligator clips and insulated electrical wire, copper wire, galvanised nails
2 min	00:30	Discuss outcomes of Activity 4.1.1. What was discovered? What challenge were faced?	
5 min	00:35	Batteries. How do they work? How do they connect?	M4.1 PowerPoint (Slides 9-10)
5 min	00:40	Introduce Battery Challenge. Discuss materials available for use as electrolytes and electrodes. Discuss materials available for connecting battery cells.	M4.1 PowerPoint (Slides 11-14)

20 min **10 min**	01:00 01:10	Undertake the Battery Challenge. Discuss responsible use of materials, rules and aims. Encourage each group to take 5 - 10 minutes to find a working solution to light up 1 LED, then move on to making additional or more powerful cells. Test each group's device with multiple LEDs and / or the multimeter.	M4.1 PowerPoint (Slides 11-14) Lemons, potato, gold coin, galvanized nail, aluminium foil, alligator clip leads, copper wire, 5mm LEDs, multimeter (optional), cans of coke, salt water, plastic/foam/paper cups, moist dirt, paper towel. Multimeter or LED's
5 min	01:15	**Lesson Conclusion** Announce winner, discussion, recap, questions, clean up.	

Module 4.1 Electronics - Energy

Lesson Plan

45 minute session

High Tech: Use PowerPoint Presentation 'M4.1 - Master Slides'. Omit / hide sides 5 – 8.

Key Learning Area			**Topic**
Physics, Chemistry			Energy
Timing	**Running Time (hh:mm)**	**Procedure**	**Materials**
2 min	00:02	**Lesson Introduction** Welcome! Have you ever wondered…	M4.1 PowerPoint (Slides 1-2)
		Body of Lesson	
2 min	00:04	What is energy? Why do we need it? Types of energy.	M4.1 PowerPoint (Slides 3-4)
3 min	00:07	Batteries. How do they work? How do they connect?	M4.1 PowerPoint (Slides 9-10)
3 min	00:10	Introduce Battery Challenge. Discuss materials available for use as electrolytes and electrodes. Discuss materials available for connecting battery cells.	M4.1 PowerPoint (Slides 11-14)
20 min	00:30	Undertake the Battery Challenge. Discuss responsible use of materials, rules and aims. Encourage each group to take 5 - 10 minutes to find a working solution to light up 1 LED, then move on to making additional or more powerful cells.	M4.1 PowerPoint (Slides 11-14) Lemons, potato, gold coin, galvanized nail, aluminium foil, alligator clip leads, copper wire, 5mm LEDs, multimeter (optional), cans of coke, salt water, plastic/foam/paper cups, moist dirt, paper towel.
10 min	00:40	Test each group's device with multiple LEDs and / or the multimeter.	Multimeter or LED's
5 min	00:45	**Lesson Conclusion** Announce winner, discussion, recap, questions, clean up.	

Module 4.1 - References

Batteries:

http://www.wikihow.com/Make-a-Homemade-Battery

https://www.barnesandnoble.com/blog/barnesy/wp-content/uploads/2016/10/Turn-on-a-Light-with-Lemon-Power.pdf

https://www.chromebattery.com/battery-kids/projects/cola-can-battery

https://www.chromebattery.com/battery-kids/projects/make-lemon-battery

http://www.easy-science-experiments.com/lemon-battery.html

https://www.rookieparenting.com/lemon-powered-light/

Energy:

https://www.originenergy.com.au/blog/about-energy/what-is-electricity.html

http://www.eschooltoday.com/energy/kinds-of-energy/all-about-energy.html

https://www.energy.gov.au/

https://www.csiro.au/en/Research/Energy

LEDs and Multimeters

https://core-electronics.com.au/tutorials/how-to-use-a-digital-multimeter.html

https://electronicsclub.info/leds.htm

Module 4.1- Required Materials

- Pens, pencils and writing paper are generally required every session.
- Students may like to bring a note pad to record their observations and ideas.
- A group usually refers to 2 - 4 students.

Activity	Material	Amount	Where can I find it?
All sessions	PowerPoint Slides* (digital, or printed)	1 per coordinator	Coordinator Package
All sessions	Printed PowerPoint* Slide Notes	1 per coordinator	Coordinator Package
All sessions	Printed Lesson Plan	1 per coordinator	Coordinator Package
All sessions	Printed Module 1 Risk Assessment	1	Coordinator Package
All sessions	Computer, Data Projector, Screen	1	Venue
Activity 4.1.1 Kinetic and Potential Energy All sessions except 45 minute duration.	Balloons	1 per student	Supermarket
Activity 4.1.2 Lemon Power All sessions except 45 minute duration.	Lemons (or potatoes)	2 – 4 per group	Supermarket, farmers market, home grown
	LED lights (3mm or 5mm)	1 per group	Online, electronics store, automotive store
	Alligator clips	2 – 8 per group	Online, electronics store, hardware store, automotive store
	Copper wire	4 x 4cm long pieces per group (min)	Online, electronics store, hardware store, automotive store
	Galvanised nails, min 4cm long	4 per group	Hardware store

Materials List continues on next page

* PowerPoint Slides have been provided as a Master Slide Set for a 120 minute (or 2 x 60 minute) session duration. Hide/ omit slides as noted in lesson plans for delivery of shorter session durations.

Activity	Material	Amount	Where can I find it?
Challenge 4.1 Battery Challenge All sessions Note: Adjust materials to suit location and availability of items.	Potatoes	2 per group	Supermarket, farmers market, home grown
	Lemons	1 per group	Supermarket, farmers market, home grown
	LED lights (3mm or 5mm)	Min 1 per group, 5 – 10 for testing	Online, electronics store, automotive store
	Alligator clips and insulated electrical wire pieces	4 - 10 per group	Online, electronics store, hardware store, automotive store
	Copper wire	20 cm per group	electronics / hardware / automotive store
	Galvanised nails, min 4cm long	Min 6 per group	Hardware store
	Gold coins, optional	1 – 2 per group	BYO
	Aluminium foil	1 20cm x 20cm piece per group	supermarket
	Cans of coke	1 per group	supermarket
	Moist dirt	1 cup per group	Hardware store, garden
	Water	1 cup per group	Supermarket, venue
	Vinegar	1/2 cup per group	supermarket
	Salt	1/3 cup per group	supermarket
	Paper towel	2 rolls	supermarket
	Plastic, foam or paper cups	Min 4 per group	supermarket
	Multimeter	1 per coordinator	Hardware store, online, electronics store

Online Shopping Links:
LED Lights (Approx. $5 - $10 for 50 lights)
https://core-electronics.com.au/5mm-led-pack-50-pcs.html
https://www.jaycar.com.au/5mm-red-led-pack-pk-100/p/ZD1690

Alligator clips (approx. $5 - $12 per 10 pack)
https://www.robotgear.com.au/Product.aspx/Details/1029-Alligator-Test-Leads-50cm-Multi-coloured-10-Pack
https://core-electronics.com.au/alligator-clip-with-pigtail-10-pack.html
https://www.jaycar.com.au/standard-jumper-test-lead-kit/p/WC6010

Multimeter (from approx. $25)
https://core-electronics.com.au/digital-multimeter-basic.html
https://www.bunnings.com.au/click-digital-multimeter_p4420326
https://www.jaycar.com.au/low-cost-digital-multimeter-dmm/p/QM1500?utm_campaign=redirect&utm_source=QM1502r&utm_medium=web

Copper Wire (approx. $5 per 7m)
https://www.bunnings.com.au/tic-7-7m-x-20g-picture-hanging-copper-wire_p3930102