BRIGHT HORIZONS™

Year 8 Students

HORIZON POWER

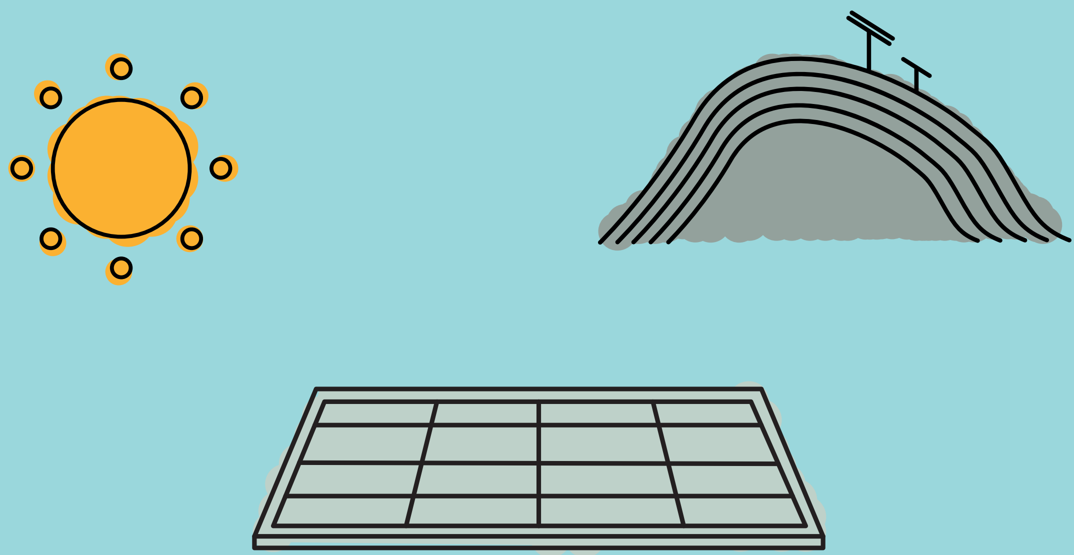
STAWA SCIENCE TEACHERS' ASSOCIATION OF WESTERN AUSTRALIA

Name ______________________________

Horizon Power acknowledges the traditional custodians throughout Western Australia and their continuing connection to the land, waters and community. We pay our respects to all members of the Aboriginal communities and their cultures; and to Elders both past, present and emerging.

Acknowledgement

The following teaching and learning materials have been modelled on the STEM Learning Project resources template. The STEM Learning Project resources were produced by a consortium of STAWA, MAWA, ECAWA and Scitech under contract to the Education Department of WA.



Activities

Activity 1
Research

Solar electricity

Research solar panels and battery storage for community electrical energy needs.

Activity 2
Investigate

Investigating factors affecting the power output of solar panels

Conduct investigations into conditions that affect the electrical power output of solar panels.

Activity 3
Imagine & Create

What a car!

Explore the design process and apply it to designing and building a model solar car. You'll get to race your car against other teams.

Activity 4
Evaluate & Communicate

What's the verdict?

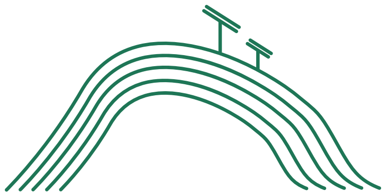
Demonstrate, test and evaluate the model solar car. Present your model and conclusions to an audience using multimedia.

Activity 1

Research

Solar Electricity

Research solar panels and battery storage for community electrical energy needs.



1. My country

Look around you.

What do you see? Make a list. You can use words and or pictures, paper or on the ground.

Form a yarning circle. One at a time share with others one thing you see. Continue in the circle so everyone gets a chance to add to the discussion. Keep going until you run out of things to add.

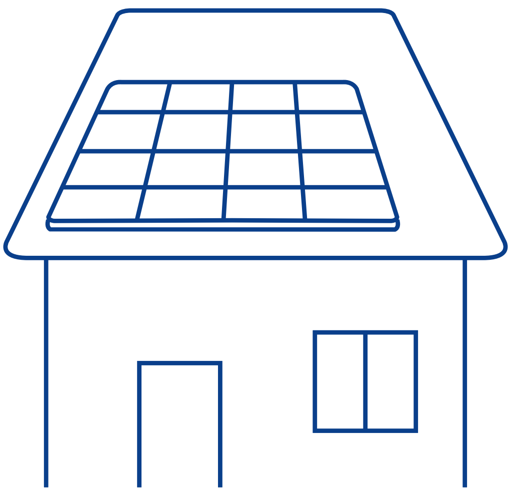
How big is your list?

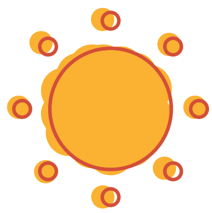
Narrow the list down to the most important 8 things. Create a tournament sheet from your list. Each item will compete until we get a winner. The winner is what you think is the most important thing.

Round 1 you compare 1 and 2 and decide which is more important. The more import item wins and moves to round 2. Repeat for 3 and 4; 5 and 6; 7 and 8; 9 and 10.

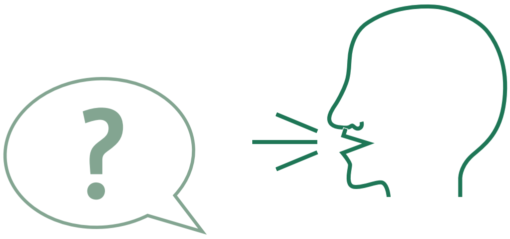
Round 2 you compare the winner of Round 1 [(1 and 2 with 3 and 4) (5 and 6 with 7 and 8)]

Round 3 you compare the winners of Round 2.





Item Tournament

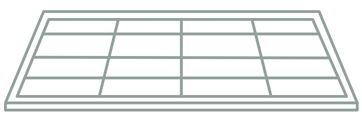


Is your winner a source of energy?

If not, Step back to Round 3: **Which of the choices is the more important as a source of energy.**

Tournament 2: **Which energy source for electricity would be the best for your community and Country**

- ▢ **Diesel**
- ▢ **Solar**
- ▢ **Hydro electricity**
- ▢ **Coal**
- ▢ **Geothermal**
- ▢ **Wind**



Activity 1

2. My school's rooftop solar panel plans

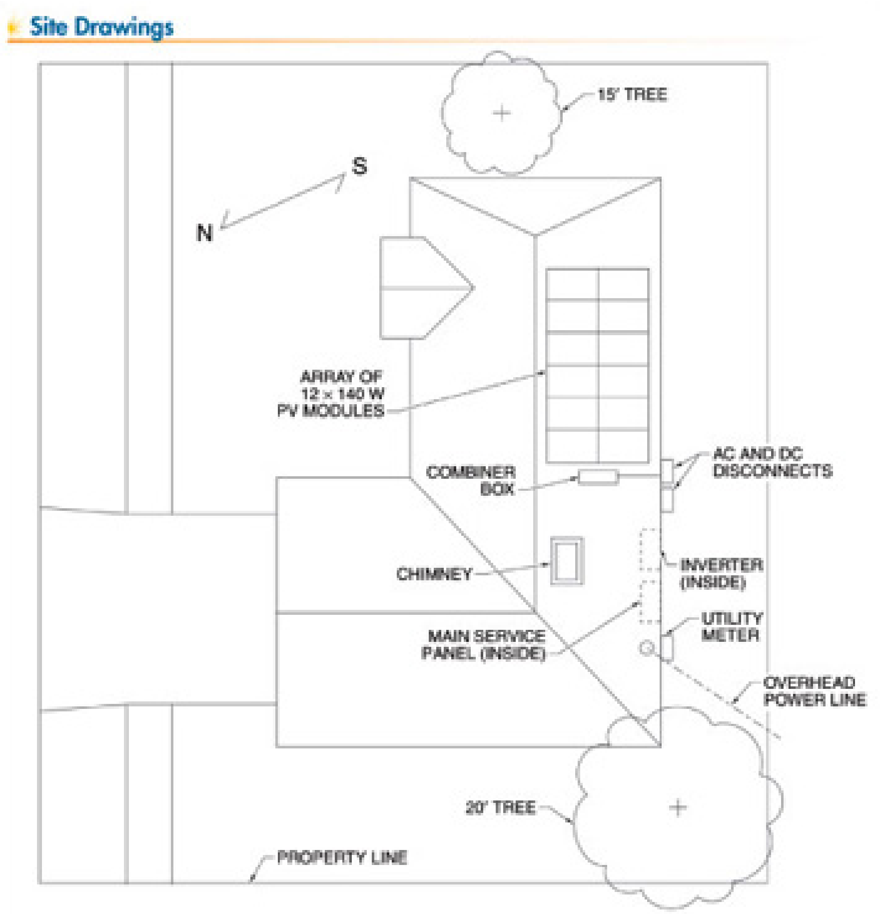
Present your findings and understanding of a school solar PV system as a set of plans or drawings. If you can do it to scale, excellent, otherwise create a sketch with approximate measurements. This can be done on either an A3 or an A4 sheet of paper. Your teacher will decide if you are to do an individual plan or a group plan.

Title your plan and label all parts. The following should be included in your plan:

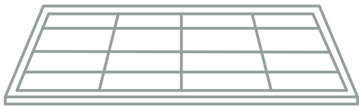
- compass bearings (North, South, East and West)
- locations of building on which the rooftop solar PV panels will be/are installed
- location of large trees
- measurements (estimates or actual)
- a separate diagram showing the angle of the panel
- any other important items.

At the bottom or back of your plan write a purpose for your plan.

This plan can be used to identify things that need to be considered when installing rooftop solar PV panels, including *(Make a list of everything on your plan).*



3. Energy from the Sun



Energy from the sun is called solar energy.

The original source of **energy** on earth is the **sun**. The suns energy is transferred from the sum to the earth as light energy. Plants transform light energy from the sun into chemical energy stored in the food they make. Plants use the food energy they make to grow and reproduce. Animals rely on plants and other animals for their food. Our energy comes from the food we eat.

Draw a diagram to show the flow of energy from the sun to you..

Match the word with its definition

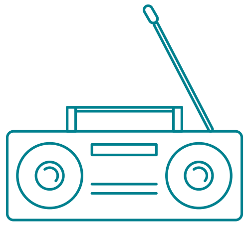
Transfer

Transform

Move

Change

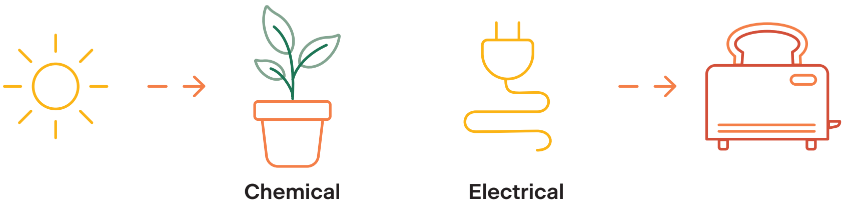
Activity 1



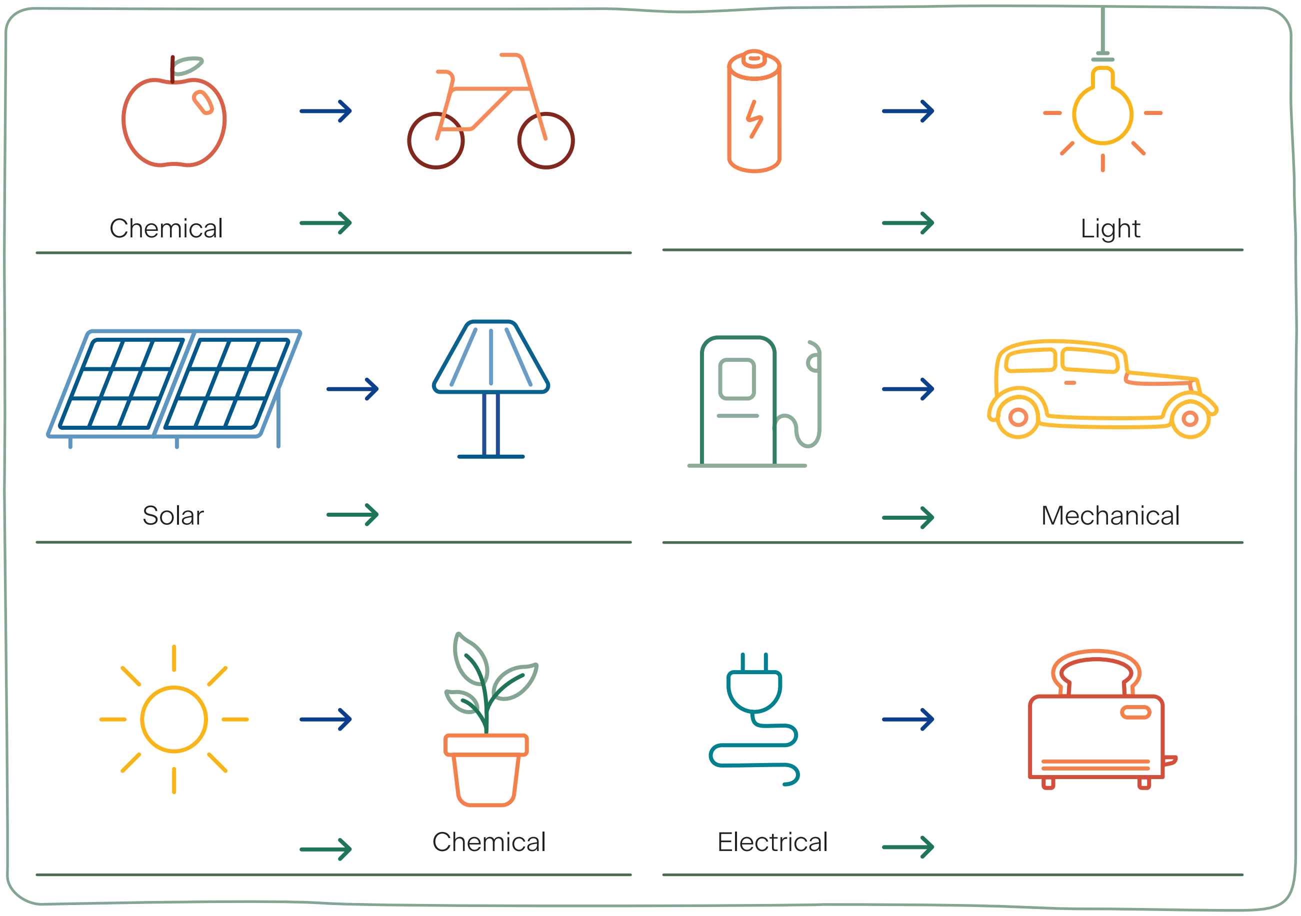
Exercise:

Diagrams can be used to show how energy is transformed from one form to another. They are called energy flow diagrams. An energy flow diagram uses arrows to show the energy changes. Arrows starts at one energy form and points to the new energy form. This shows the energy transfer and how it has been transformed. The diagrams below are examples of energy flow diagrams.

Something that can transform energy is called an energy converter. For example, the energy flow diagram shows light energy from the sun is transformed to chemical energy by the plant.



1. Complete the diagrams showing how one form of energy can be transformed to a different form of energy.

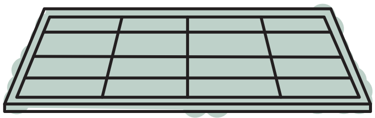


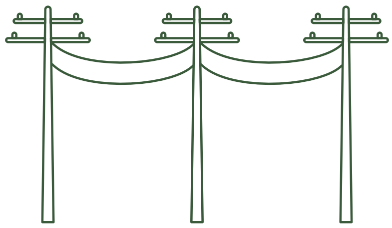
2) Where does your community get their electricity from?

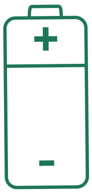
☐ **Take photographs of things related to electricity, such as**

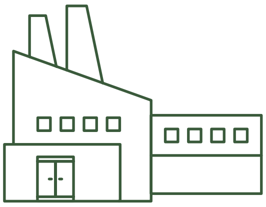
- Power lines,
- Solar panels and
- Things that use electricity, like fridges and ovens

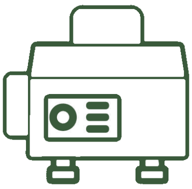
☐ **Tick the energy source or sources that provide your electricity?**

☐ 

☐ 

☐ 

☐ 

☐ 

Watch a video of how remote communities are powered:
https://bit.ly/3n8gxlA

Activity 1

4. Electricity

Your body needs energy so that you can run around. Running is doing work. Where do we get the energy needed so that we can run?

For our body to do work it needs to be supplied with energy. We fuel our body with the energy stored in ________.

Energy is the ability to do work.

What is power?

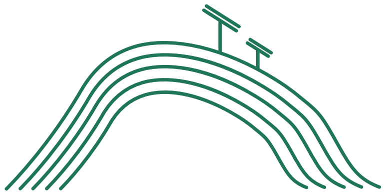
Energy and Power are not the same, but they are related.
Power is the amount of energy used in a given amount of time.
Power has the unit's joules per second or watts. 1 J/s = 1 W.

Watch a video about energy to learn more:
https://vimeo.com/548221149/8b88e1f2d6

Electrical energy is needed to do the work of running a fridge or a TV.
The basic unit of energy is the Joule, abbreviated to J.
A Joule is a small amount of energy, so the unit kilojoules (kJ) is used when we talk about larger amounts of energy. 1,000 J = 1 kJ.

Machines and appliances are labelled with their wattage, how much power it uses in watts (W). For example, an 1,800 W toaster or a 10 W LED light bulb.

Question

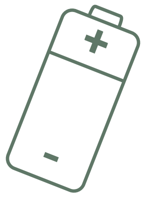


1) Match the word with its definition:

Definition	Match the word to its definition by drawing a line between them
The ability to do work	Watt (W)
The amount of energy used in a given amount of time	Energy
The basic unit of energy	Joule (J)
The original source of energy on earth	Power
The unit of power	Sun

2) Electrical power can be calculated using the equation:

P = V x I



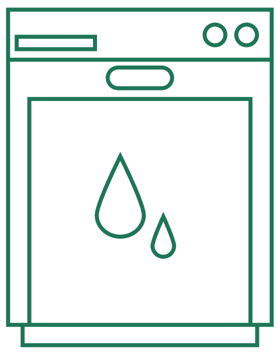
Voltage (V) is measured in volts and has the unit symbol V.
Current (I) is measured in amps and has the unit symbol A.
Power (P) is measured in watts and has the unit symbol W.

Calculate the electrical power output of each of the small solar panels.
Check with your teacher to see if you can use a calculator.

a) rooftop solar panel: **V =** 25 V **I =** 10 A
P = V x I
= 25 x 10
= ______ **W**

b) caravan solar panel: **V =** 12 V **I =** 16 A
P = V x I
= 12 x 16
= ______ **W**

c) fold up solar panel: **V =** 12 V **I =** 11 A
P = V x I
= 12 x 11
= ______ **W**



3) Which solar panel in question 2 has the:

a. Greatest voltage (V)? ____________

b. Greatest current (I)? ____________

c. Gave the greatest power output (W)? ____________

5. Appliance labels

Machines and appliances are labelled with their wattage, how much power it uses in watts (W). For example, an 1,800 W hair dryer or a 10 W LED light bulb.

For most appliances this information will be on a label similar to that in Figure 1.

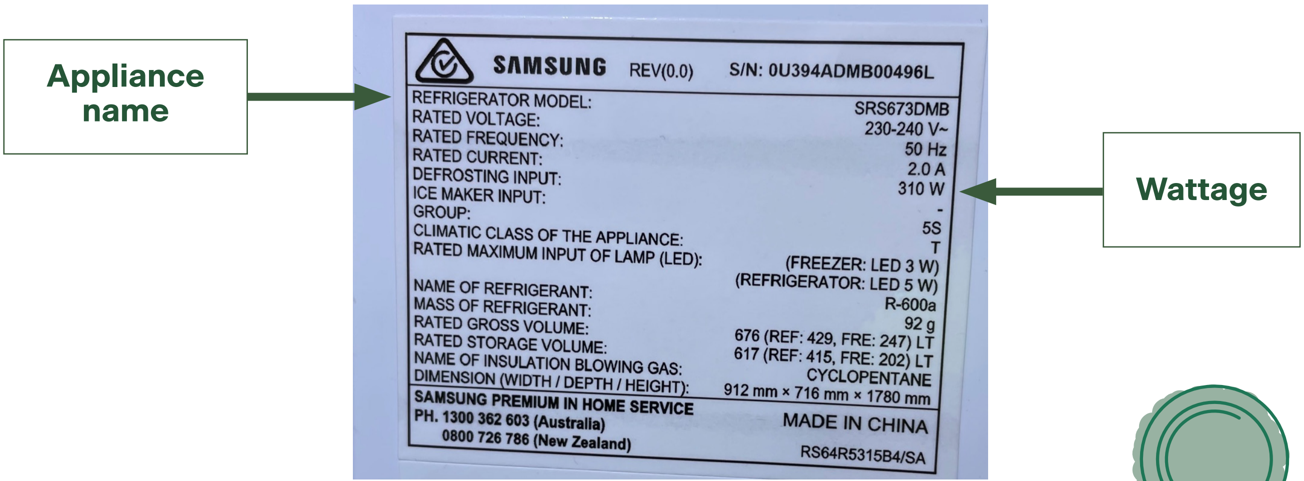


Figure 1: Room Heater model and electrical label with its name and wattage pointed out.

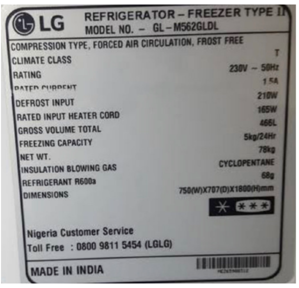
The higher the wattage reading the more power an appliance uses when working.

For example, a 2,000 W hair dryer uses more power than an 1,800 W hair dryer.

In a table below, photos of the Electrical labels of different household appliances are shown.

1. Complete the table by reading the labels and recording the name and wattage of the appliances.

Appliance	Appliance Name	Power
		
	Television	

<table>
<tr><th>Appliance</th><th>Appliance Name</th><th>Power</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>Kettle</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

2. Remember the higher the wattage reading the more power an appliance uses when it is working.

   a) Which appliance in your table uses the most power?

   ____

   b) Which appliance in your table uses the least power?

   ____

Sticker Here

Remember to be safe.
Make sure the appliance is turned off and unplugged.

3. Ask your teacher if you can take your own photos of electrical labels of different household appliances that you might have in the classroom.

Activity 2

Investigate

Investigating factors affecting the power output of solar panels

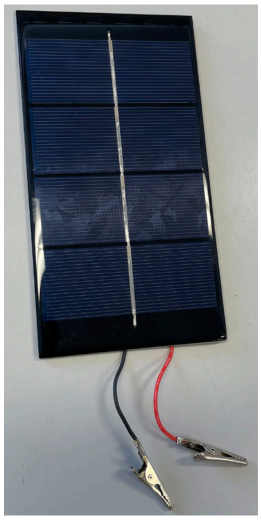
Conduct investigations into conditions that affect the electrical power output of solar panels.

6. Solar Electricity

Electricity from the sun is called solar electricity or solar power.

The sun radiates energy. Solar energy is light energy. We are very familiar with solar energy making us hot. Solar energy can be changed from light energy to heat energy. Plants change the suns energy into chemical energy, store it and use it as food. Solar energy can also be changed to electricity.

Solar PV panels transform solar energy into electrical energy.



Exercise 1: Connecting crocodile clips.

Connect a crocodile clip to each end of the insulated electrical wires coming from the solar panels. The wire can be soldered, or twisted and clamped, onto the crocodile clips. The photo shows a solar panel with crocodile clips attached.

Connect crocodile clips to your battery pack and solar panels.

Exercise 2: How to use a Multimeter.

Be safe - only use the multimeter to test DC circuits. Never use them with AC, your home and school electricity.

Testing DC voltage:

- Plug in the red and black leads as shown in the photograph.
- Turn the multimeter on by moving the switch to the left 20 mark. This measured up to 20 volts.

Testing DC Current (Amps):

- Move the red lead to the 10 A hole. It is the spare hole above the position of the red lead shown in the photograph.
- Turn the multimeter to the right to the 10 A setting. This measures up to 10 Amps. For smaller current you can turn the meter dial back to 200 mA, and if your reading is still too small back further to the 20 mA setting.
- Always turn the multimeter off when not being used, especially when measuring current to avoid blowing its fuse.
- Always connect the multimeter in series when measuring current and in parallel when measuring voltage.

Experiment: Investigating the electrical power output of solar panels

Introduction

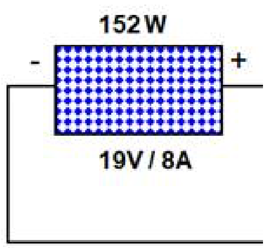
Photovoltaic cells make up solar panels and transform light energy into electrical energy. The electrical output of solar panels can be worked out by measuring their voltage (V) output and current (I) output. When multiplied together these measurements give electrical power output in watts.

P = V x I

Voltage (V) is measured in **volts** and has the **unit symbol V or mV (millivolts).**

Current (I) is measured in **amps** and has the **unit symbol A.**

Power (P) is measured in **watts** and has the **unit symbol W or mW (milliwats).**



Voltage (V)	19 V
Current (A)	8 A
Power (W) **P = V x I**	P = 19 V x 8 A = 152 W

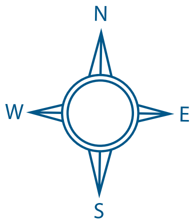
Electrical appliances require a certain amount of power to operate, for example, some LED light globes require 6 watts, while a toaster might need 2,000 watts.

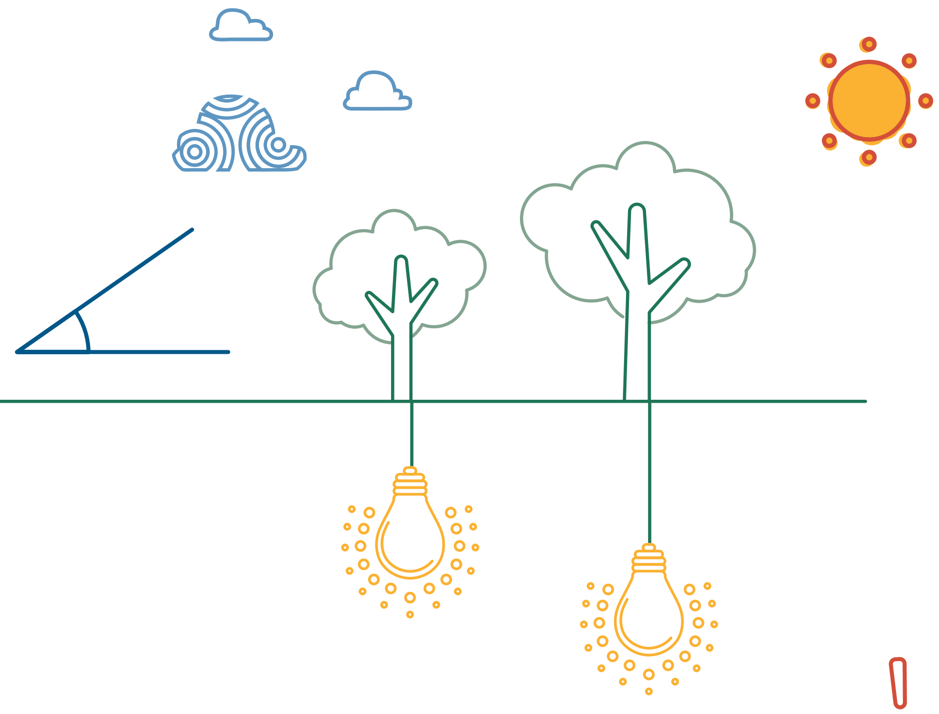
Activity 2

Purpose

The purpose of this experiment is to investigate variables that affect the electrical power output of solar panels. The variables that you will test will be one or more of the following:

- Panel angle
- Panel direction
- Shade



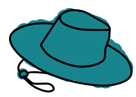


Equipment:

- ▢ Solar panel
- ▢ Multimeter
- ▢ Electrical leads
- ▢ Light bulb and holder
- ▢ Protractor
- ▢ Compass to measure direction
- ▢ Solar Shade Paddle
- ▢ Graph paper

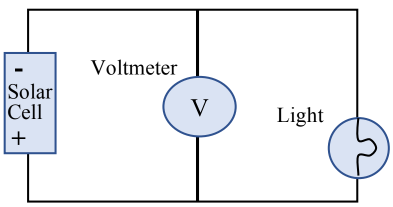
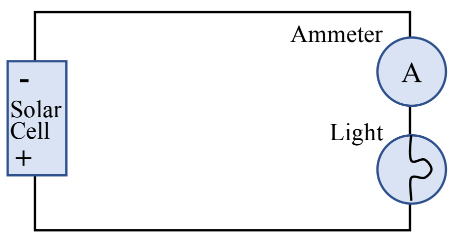
Safety notes

- **Wear sun safe clothing including a hat and sunscreen if collecting data in the sun.**
- **Follow all safety instructions when using cutting tools such as scissors.**



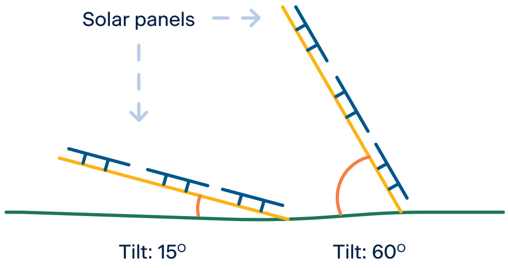
Set up

Set up your electrical circuit as shown in the circuit diagrams below. You will be using the multimeter to measure the voltage and current of the panel so that you can calculate the power output of the panel.

Circuit diagram when testing voltage. Voltage is measured in parallel.	Circuit diagram when testing current. Current is measured in series.
	

Test 1: Solar Panel Angle

Take your panel outside and set up the circuit. Face the panel towards the sun. Make sure you don't have any shade on the panel. Start with the panel lying flat on the ground. Observe the voltage output change as you slowly change the tilt of one end of the solar panel up as shown in the diagram.



Repeat your experiment but this time record the measurements of panel angle and voltage in a table.

Panel Angle	V Voltage (mV)	I Current (A)	Power (mW) P = V x I
0° (lying flat)			

Draw a graph of your results.

Panel angle on the horizontal axis and Power on the vertical axis.

Using your graph identify the angle that gave the greatest power output.

Panel Output (mW)

Panel angle (degrees)

Activity 2

Test 2: Solar Panel Direction

Take your panel outside and set up the circuit. Make sure you don't have any shade on the panel. Keep the panel angle the same for each direction you test. Record the time of day and start with the panel facing North. Measure and record the voltage output. Record the results in a table

Panel Direction Test Results: Time of day ____________________

Date ____________________

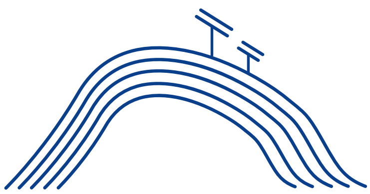
Panel Direction	V Voltage (mV)	I Current (A)	Power (mW) P = V x I
North			
East			
South			
West			

Which panel direction gave the greatest power output. ____________________

Why do you think this direction gave the greatest power output?

If you have solar panels in your community

- Are they on an angle?
- In which direction do they face?



Test 3: Solar Panel and Shade

Take your panel outside and set up the circuit. Make sure you don't have any shade on the panel. Keep the panel angle and the direction you face the panel the same for this experiment.

Use the Solar shade paddles made of cardboard. This is a little like clouds moving across the sky. Move the paddle or card across the solar panel. As you gradually shade the solar panel observe the voltage output. Describe what happens to the voltage output as you increase the amount of shade.

Repeat this experiment. This time measure and record the amount of shade covering and voltage output. Record the results in a table.

Solar Panel and Shade Test Results:

Amount of shade as a fraction	Amount of shade as a percentage (%)	V Voltage (mV)	I Current (A)	Power (mW) P = V x I
No shade	0%			
¼ of the panel in shade				
½ of the panel in shade				
¾ of the panel in shade				
All of the panel in shade				

How does shade affect the voltage output of the solar panel?

Why do you think shade has such a big affect on the amount of electricity produced by the solar panel (voltage output)?

If you have solar panels in your community

Are there any trees nearby?

If trees are nearby what time of the day will they shade the solar panels and reduce the amount of electricity being produced?

If the solar panels get dirty and covered in dust will the dust affect the amount of electricity produced? Explain.

Activity 2

7. Looking after Solar Panels

The top of solar panels facing the sun are made mainly of glass.
Glass is fragile and brittle. This means that it can break easily especially if hit.

You might need to consult your community leaders to help answer the following questions.

- Have your community solar panels been damaged before?
- Do you know what caused the damage?

Write a list of Do's and Dont's that you need to teach people especially children in your community to:

- Protect the solar panels and your electricity supply.
- Keep them safe around electricity.

Do	Don't

8. Multimedia Presentation

Create a video, power point, wall chart, story book or other multimedia presentation on one of the following:

1) Demonstrate and explain how to use a multimeter to measure DC voltage and current.
2) Demonstrate and explain how the amount of electricity is affected by the installation angle and direction that a solar panel faces.
3) Demonstrate and explain how the amount of electricity is affected by clouds.
4) A safety training video to help protect your community or schools electricity supply and the children and adults to keep them safe around electricity.

Activity 3

Imagine & Create

What a Car!

Explore the design process and apply it to designing and building a model solar car.

Background Information

Most of our cars over the last 100 years have been powered by an internal combustion engine using fossil fuels like petrol and diesel. The power comes from the conversion of chemical energy in the fuel to kinetic energy to move the car. Today we are seeing more and more electric cars. An electric vehicle (EV) uses one or more electric motors as the energy source. An electric car for example can be powered with solar panels and batteries. Some EVs can be plugged into mains power or EV charging stations to charge the batteries.

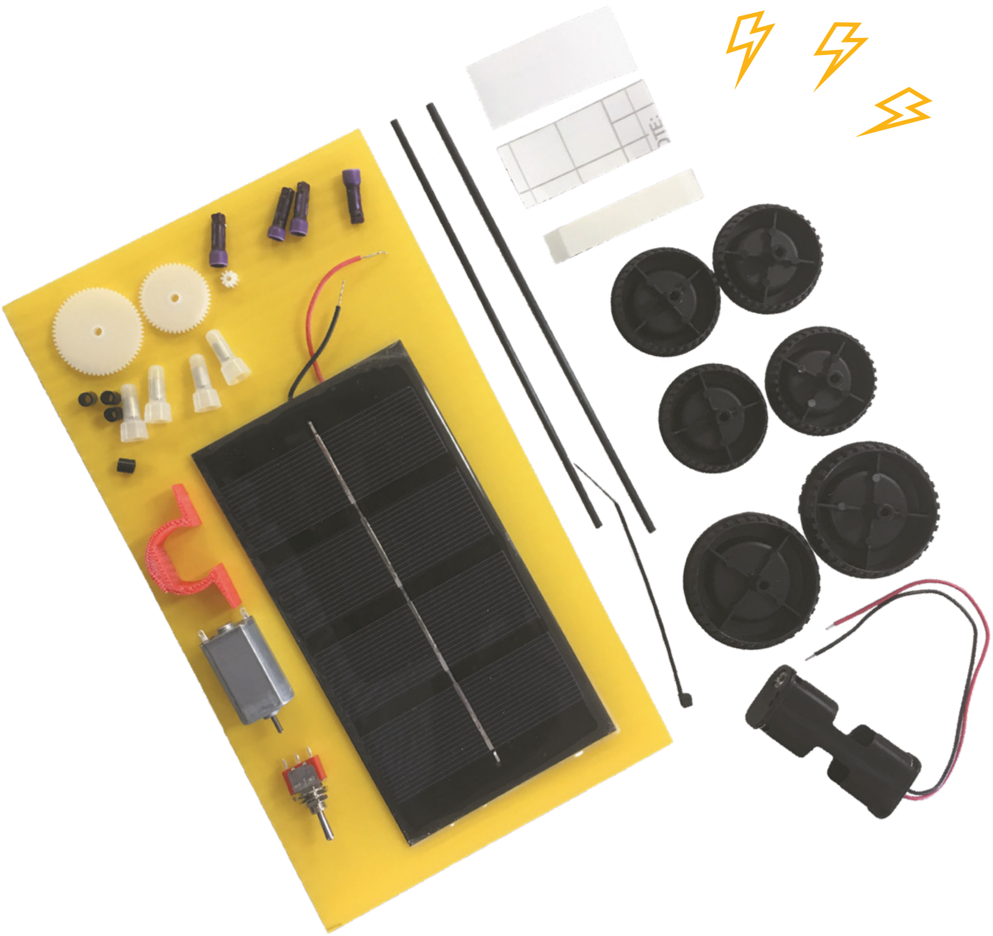
EVs are becoming more important and affordable because of technological developments, an increased focus on renewable energy, climate change and other environmental issues.

This is one of Horizon Power's Electric Vehicles.
It can travel 450km on a single charge.

Build a solar race car!

Solar cars are powered by electricity through the use of solar energy. Solar panels are usually attached to the top of the car. Solar PV panels transform light energy from the sun into electrical energy. When building a car of any kind there are many variables to consider.

In this activity your job is to make your model go as fast as possible.
In your Bright Horizons school pack, you have a model solar car kit provided, it includes a motor, gear panel, chassis material and wheels. But you are allowed to choose the best combination of wheels and gears, front or rear wheel drive to make it as fast as possible.



Activity 3

Design, build, test and modify your model solar car

Development of a design idea before you start building

Choose a starting design for your car

Wheels: I will use ______________________________

Gears: I will use ______________________________

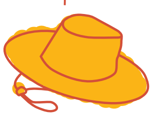
Front or rear wheel drive: ______________________________

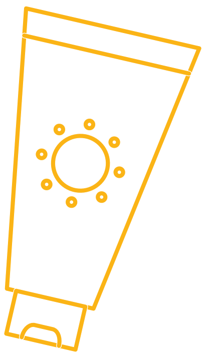
Panel angle: I will use ______________________________

Include a photograph of your starting model.

Safety notes

- **Wear sun safe clothing including a hat and sunscreen if collecting data in the sun.**
- **Follow all safety instructions when using cutting tools such as scissors.**





Build: Carefully build your model solar car. Follow the instructions and ask your teacher for help if needed.

Write down the names of the members of your solar race car team.

Materials

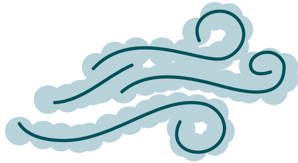
Model Solar Car kit

Foam or cardboard (optional).

When testing your car you will need a

- Stopwatch
- Tape measure
- Solar shade paddle
- Pliers (optional)

Activity 3



Testing your model solar car

You need to race and test the speed of your model car before you make any modifications. Your first design might be your fastest car.

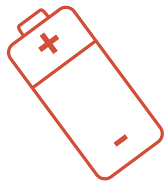
Record your results in a table similar to the following:

Model Solar Car Modification	Independent Variable	Time (s) for car to travel 20 m				Light intensity (lux)	Rank fastest modification to slowest modification
		Trial 1	Trial 2	Trial 3	Average		
No modifications							
Modification 1							
Modification 2							

Modifying your model solar car

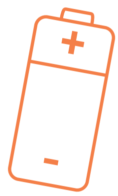
Variables to test:

Wheels: Your kit has 6 wheels. This means that you can build your model with three different wheel combinations.



Gears: Your kit has 3 gear wheels. The smallest is a pinion gear that goes onto the motor shaft. This leaves the two larger spur gears for the axel. You can build your model with one of the different spur gears.

Front and rear wheel drive: By changing connections between motor and panel you can change your vehicle between front or rear wheel drive.



Solar panel angle: Use your findings from investigations in Activity 2.

Other possible variables:

To test your car you need a sunny day and a smooth track area. Your track will need open space outside, such as a tennis court or outside basketball court or a wide and long pathway.

Remember for a fair test and for good investigation design test only one variable at a time.

Make sure that you keep all other variables constant. Test as many variables as possible.

You need to practice using the stopwatch to time your car. You may wish to have a group member stand to the side of the track to measure time as the car travels the desired distance of 20 m.

Modification 1 - Investigation (Variable 1)

What are you going to investigate? (Write this as a question)

What is your independent variable?

What observations or measurements will you make of your independent variable?

What is your dependent variable?

What measurements will you take of your dependent variable?

What are your controlled variables, things you will need to keep the same to make it a fair test?

Investigation 2 (Variable 2)

Repeat the above steps described for Modification 1 for other investigations of as many variables as you have time for.

Activity 4

Evaluate & Communicate

What's the Verdict?

Demonstrate, test and evaluate the model solar car.

Evaluate your results and present your model and conclusions to an audience using multimedia.

Complete the evaluation worksheet below.

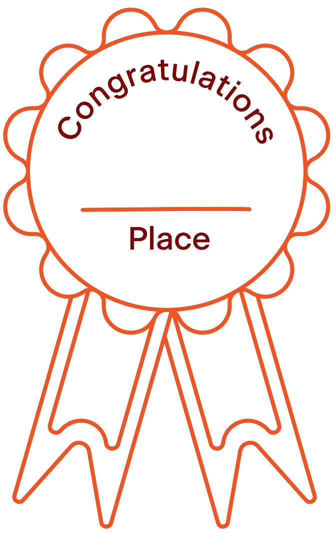
Reflect on the process taken and the success of your design. Write the steps you took to make the fastest model solar car. What place did you finish in your solar car race?

Glue a photograph of your model solar car.
Label the parts you chose to use in your design.

How many modifications did you test? ____________

Describe how your final model different from the first one you build?

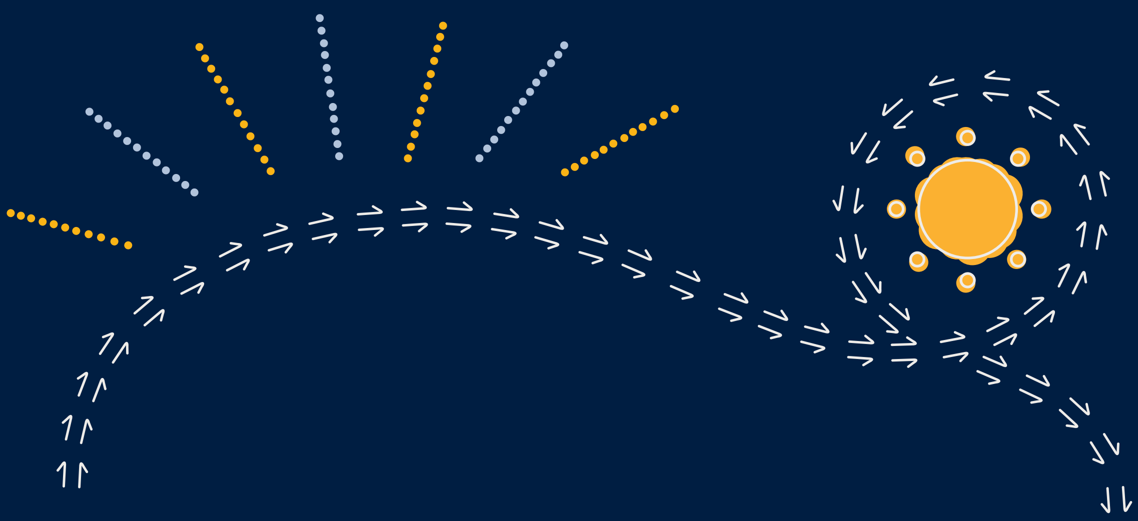
Why did you decide on the final model?



Is it different to your plan? How?

Notes

Notes



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