EA jnr club

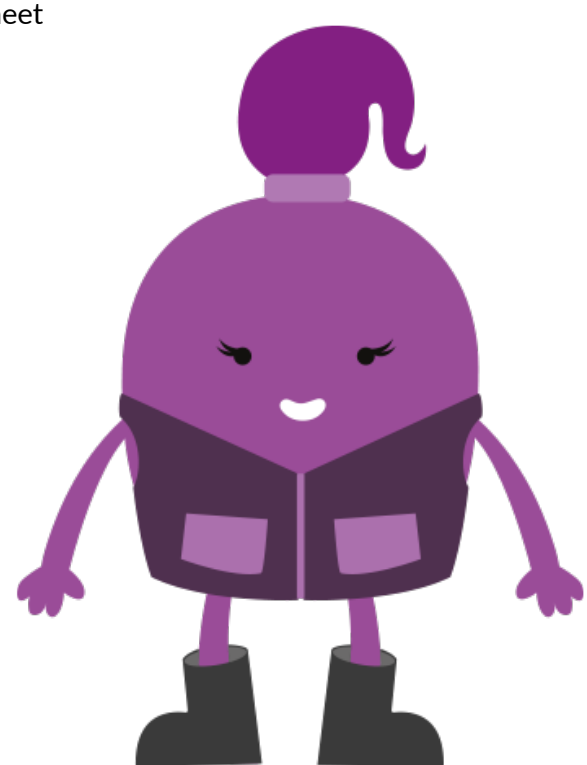
Lower Primary

TEACHER RESOURCE KIT

Construct a solar cooker

This guide includes:

- Background information
- Lesson ideas
- Project instructions
- 'Design your own solar powered robot' activity sheet
- 'How solar power works' activity sheet
- How solar power works - solutions
- Know Want Learnt (KWL) chart
- Think Want Learnt How (TWLH) chart



ENGINEERS AUSTRALIA

Construct a solar cooker: *background information*

Did you know that the sun can cook your food?

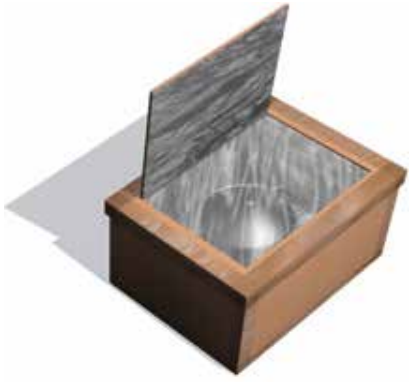
The sun is a giant star and is the centre of our solar system. The energy from the sun *(called solar energy)* is needed by all living things on Earth, including us. Solar energy can power lots of things that we use every day, such as cars and televisions.

The sun can also power solar cookers.

The first solar cooker was made hundreds of years ago in Switzerland and was used to cook a piece of fruit.

Today, solar cookers are used all around the world. There are many good reasons to use solar cookers:

- they are cheap to make and use.
- they help to save trees because they do not burn wood to cook food.
- they do not produce any dangerous gases that can harm our environment.



Solar cooking box

Panel solar cooker

Parabolic solar cooker

Construct a solar cooker: *lesson ideas*

Science

- In teams, students to research the following questions: How is sunlight used to generate energy? What happens on a cloudy day or at night?
- Students to research and record interesting facts about the sun.
- Students to find and sort materials that would be useful for conducting heat for their solar cooker project. Why are some materials more useful for conducting heat than others?
- In groups/pairs students to explore how temperature is affected by light and dark colours. Each group will need two identical containers *(tin cans are suitable)*, and two thermometers. Students to:
    - Paint the outside of one container white *(or any light colour)*, and the other a dull black. Place them both in the sun and record the temperature changes inside the containers at various intervals.
    - Record the results in a table. Answer the following questions: Which container became hotter, and which one stayed cooler? Which colour would be better for the outside of a solar cooker?

Technologies

- Students to complete the **'Design Your Own Solar-powered Robot'** activity sheet.
- Students to complete the **'How Solar Power Works'** activity sheet.
- Students to research solar cells. Introduce the different layers/sections of a solar cell.

Mathematics

- Students to bring in recipes for a meal and share with the class the amount of time needed to cook it. They then predict the time needed to cook the same meal in a solar cooker.
- Students to be given time to investigate and experiment with thermometers. Students to observe different types of thermometers and their components, and talk about why we need thermometers.
- In pairs, students to use thermometers to measure the temperature outside the classroom *(in an area of their choice)* every day for a week. Students to record the temperature at the same time every day. What do the results show? If the school were to install solar cells, what would be the best position for them?

English

- Students to brainstorm as many engineering words as possible and then create a page in their science books on which to record these words. Students will add to this as they learn new words. These words could be used to create a class word wall.
- Students to complete the **'KWL'** or **'TWLH'** activity sheet.
- Students to write a short explanation of how solar cookers work.
- Students to create an illustrated, non-fiction book, explaining how solar cookers work. Use the KidPix program, a book-making app, or just cardboard, pens and/or paints and paper.

Humanities and Social Sciences

History

- Energy from the sun has been used for various purposes for thousands of years. Students to brainstorm how early civilisations may have used solar energy in their daily lives.

Geography

- Students to brainstorm what 'environmentally-friendly' means, then walk around their school and/or community and look for environmentally-friendly indicators. Students could assess how environmentally-friendly their area is and list some recommendations for their principal or local council.

The Arts

- Students to make a diorama of a scene containing a solar cooker.
- Students to cut out pictures from magazines of solar cookers (or objects relating to solar energy). Paste onto a large piece of paper to create a class collage on the topic.

Health and Physical Education

- Students to investigate why our bodies need a healthy amount of sunlight.
- Students to learn about, and think of, all the ways in which they can be 'sun smart'. Students to come up with some sun smart slogans.

Languages

- Students to investigate the origin of the word 'engineer'.
- Students to learn how to say and write words such as 'solar', 'cooker' and 'energy' in various languages.

Construct a solar cooker: *Project instructions*

Important safety information

Allow plenty of time to assess possible risks that might occur during this project, and how they should be managed.

It is strongly recommended that construction and, in particular, operation of solar cookers be done under the strict supervision of teachers and other responsible adults.

Consideration needs to be given to the following aspects:

- Precaution against burns. The temperatures reached inside a solar cooker are capable of causing burns, so great care should be taken. This might include the provision and use of heatproof gloves/oven mitts to handle any hot materials. Inexpensive cotton gloves *(such as those suitable for working with hot glue guns)* are usually readily available and may be appropriate.

  Please be aware that the solar cookers can become very hot inside. Students should not lean over the cookers when removing the glass/plastic/plastic film from the top of the cooker as any heat trapped inside will escape.
- Precautions against consuming undercooked food. The required temperature to adequately cook certain foods *(e.g. meat and dairy)* may not be reached inside the solar cookers. Therefore, it is recommended that foods placed in the solar cookers are not consumed by students as they may contain harmful bacteria.
- Precautions against glare. The reflective materials often used in solar cookers can reflect sunlight very brightly and cause temporary eye irritation. Students should be aware of this and be cautioned to avoid looking at bright reflections from the sun. Suitable eye protection should be considered for students.
- Precautions regarding the safe handling of any tools used during construction activities and in particular, sharp cutting blades.

As a class, discuss how students can keep themselves and others safe. These ideas should be presented on a class poster and displayed in the classroom before construction commences. All students should agree to the rules before beginning production, and accept that safety precautions and guidelines must always be observed.

Getting started - investigation activities

- Students to participate in the **'Construct a solar cooker'** lessons and complete the associated activity sheets.
- Students to investigate energy from the sun *(solar energy)*.

Engage

The purpose of these 'Engage' activities is to promote student interest in solar energy and solar cookers, and to encourage them to want to pursue the topic further.

Concentrating the light from the sun

In this activity, students will begin to explore how sunlight can be reflected to concentrate it and raise the temperature.

You will need:

- an open cardboard box such as a shoe box
- a thermometer *(a spirit-filled thermometer that reads up to 110 degrees is suitable)*
- aluminium foil.

What to do:

Part 1:

- Poke a small hole in the end of the box *(about half way up)* and push the thermometer through it so that the bulb of the thermometer is in the middle of the box.
- Place the box in the sun.
- Regularly read and record the temperature *(this step should be carefully supervised by an adult)*.

Shoebox with a thermometer

Part 2:

- Take a length of foil and fix it inside the box *(in a curve)* so that it acts as a reflector behind *(but not touching)* the thermometer *(see diagram)*.
- Place the box back in the sun.
- Regularly read and record the temperature *(this step should be carefully supervised by an adult)*.

Discuss the results. Ask students why they think the inside of the box becomes hotter when the foil is there.

WARNING: A trial saw the temperature rise from 28 degrees to 47 degrees.

As an alternative, you could use two clear, plastic soft drink bottles *(with thermometers in each)*. One is lined with foil and the other is not. Compare the temperatures reached in each bottle.

WARNING: A trial saw the temperature rise from 28 degrees to 53 degrees.

General principles for solar cookers

- In order for a solar cooker to work, there needs to be a means of concentrating sunlight. In the same way that a magnifying glass can concentrate the sunlight from a larger area and focus it on a small spot which becomes very hot, many solar cookers catch the sunlight from a larger area and focus it on a smaller area where the food is to be cooked. This is usually done by using shiny reflective metal surfaces or mirrors. Lenses can also be used.
- There needs to be a means of changing sunlight into heat. Black or dark-coloured objects absorb the sunlight and turn it into heat better than light-coloured objects. Light-coloured objects reflect more of the sunlight. Many solar cookers use black cooking pots or containers.
- The heat needs to be trapped inside the solar cooker, allowing it to reach higher temperatures. Many solar cookers have a sealed box with a clear glass or plastic lid. The sunlight passes through the clear lid and heats up the inside of the solar cooker. However, the heat rays cannot pass out through the glass, so the heat is trapped inside the cooker. This is the same effect that causes the inside of a car to get very hot when it is parked in the sun.

The temperature inside the solar cooker will rise until it reaches a point at which the amount of heat entering the cooker is exactly balanced by the amount of heat being lost. Heat loss can be reduced by having the solar cooker well sealed and insulated.

Advantages of using solar cookers

- Inexpensive to make or buy, and available to many people.
- Inexpensive *(free)* to operate.
- Do not produce greenhouse gases or other forms of pollution.
- Can replace other non-renewable forms of energy.

Disadvantages of using solar cookers

- Cooking times are longer than in ordinary ovens.
- How well they cook food varies according to the conditions *(e.g. whether it is sunny or cloudy, warm or cold, rainy or fine, windy or still)*.
- They operate best around the middle of the day, and not at all at night.

Explore

The purpose of these activities is to provide an opportunity for student teams to further explore how solar cookers work, and to begin to form their own understandings of the principles that are involved.

Changing sunlight to heat, and trapping the heat

In this activity students investigate the effect of having a clear panel on the top of their solar oven. If you have not already completed the 'Concentrating the light from the sun' activity *(in the 'Engage' phase)* you will need to do so.

What you will need:

- the cardboard box, foil and thermometer from the 'Engage' activity
- clear plastic film *(food wrap)*
- adhesive tape.

What to do:

- Complete the 'Engage' activity.
- Cover the open top of the box with a layer of plastic film, taping it in place and sealing it as well as possible.
- Place the box in the sun again.
- Observe what happens to the temperature inside the box. Record the temperature regularly.

Discuss what happened. Did the inside of the box become hotter with the plastic film in place? Did the clear window on the top of the box help it to trap heat? Why did students think this was so?

WARNING: A trial saw the temperature rise from 28 degrees to 72 degrees.

Explain

This section provides opportunities for the student teams to explore the concepts they have encountered, and to develop more detailed explanations and understandings.

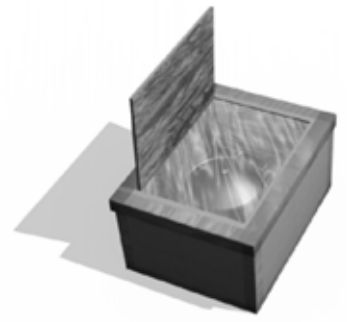
Some possible research topics:

- The sun and solar energy.
- The 'greenhouse effect': what is it and how is it affecting our environment?

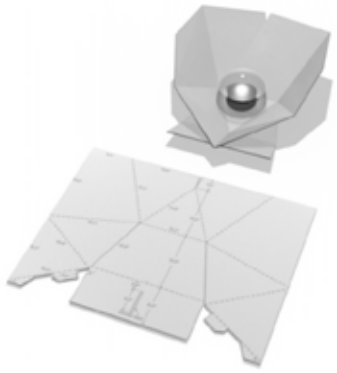
Types of solar cookers

There are a number of common types of solar cookers, including some that are manufactured for sale. These can be described as follows:

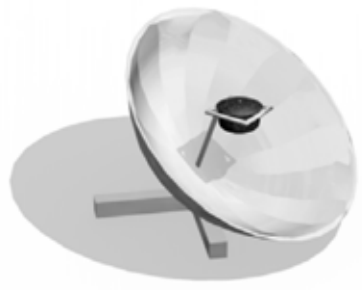
- **Box solar cookers:** These have a sealed box with a clear *(glass)* top, and use dark-coloured cooking pots inside. They can reach temperatures of over 100 degrees.
- **Panel solar cookers:** These use large reflective panels to direct the sunlight on to a dark-coloured cooking pot enclosed in a clear plastic bag or container. The panels often fold out and can be dismantled for storage or transport. The panels can be made of foil-covered cardboard, making them light and inexpensive. These can also reach temperatures of over 100 degrees.
- **Parabolic solar cookers:** These use parabolic-shaped mirrors to focus the sunlight on to a small spot. They can reach very high temperatures quickly, but need to be accurately positioned according to the direction of the sun. On a large scale they can be used to create steam, which is then used for cooking.



Solar cooking box



Panel solar cooker



Parabolic solar cooker

Elaborate

This is an opportunity for the student teams to take the concepts already learned and extend them into new areas. There is a strong component of scientific investigation and science inquiry skills in this section.

This section is set out in two parts:

1. Applying science investigation skills: Students engage in 'fair testing' of some of the variables to determine how they might best construct and use their solar cooker.
2. Construction of a model solar cooker: Students construct their model solar cooker, using the knowledge they have gained from earlier investigations and activities.

Part 1: Applying science investigation skills

This is an opportunity for students to engage in the 'fair testing' of some variables that may affect the design and use of their solar cooker, then apply what they learn.

Students will need an understanding of the nature of 'fair testing' and science investigation. This includes the nature of 'variables' *(anything that can vary or be changed)*, and the importance of only changing one variable at a time to ensure a 'fair test'.

Students can brainstorm what the possible variables might be in the construction and use of a solar cooker. For example:

- the colour of the cooker *(inside and outside)*
- the insulation of the cooker box
- the size of the reflecting surfaces
- the material used in the reflecting surfaces
- the shape *(flat, curved or parabolic)* of the reflective surfaces
- the size of the cooker box
- how well the cooker box is sealed to prevent hot air escaping
- the angle of the cooker with respect to the position of the sun in the sky
- the weather or the time of day at which the cooker is used.

From these variables, the next step is for the student teams to formulate questions that they can investigate, such as:

- Will the solar cooker get hotter if...
    - we insulate the box?
    - we fully seal all the air gaps?
    - we use larger reflecting panels?
    - we paint the inside of the box black?

Student teams should then investigate their questions using 'fair testing' methods. In this testing, they change only one variable at a time, keeping everything else the same, and measure the resultant variable *(probably the temperature reached by the solar cooker)*. If this is being done as a class activity, different teams within the class can be investigating the effects of different variables, after which they can share their findings.

This information can then be applied to the construction of their solar cooker.

Part 2: Constructing the model solar cooker

Student teams use the information they have learned from their investigations to construct their model solar cookers.

Materials

Solar cookers are to be constructed out of recycled or readily-available materials that can be cheaply and easily purchased from supermarkets, hardware stores or stationery suppliers. These could include:

- shoe boxes
- cereal boxes
- plastic soft drink bottles
- aluminium foil
- clear plastic film *(food wrap)*
- masking tape
- rubber bands
- wooden skewers

When gathering materials, students will need to consider their properties such as their strength, absorbency and insulation.

How to construct a simple solar cooker

These designs are general suggestions only, and can easily be modified or improved. They will need to be varied to suit the materials available, and the ages and skills of the students. Students do not need to adhere to these designs; they are suggestions only.

The designs are based on two commonly-used types of solar cookers:

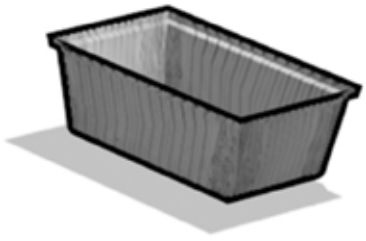
1. The Panel Cooker: This uses large reflective panels to direct the sunlight onto the cooking pot.
2. The Box Cooker: This uses an insulated box with a clear lid to create a 'greenhouse effect' inside the box.

Either of these cookers can be fitted with reflector panels to improve their efficiency. How well a solar cooker is working can be measured using thermometers to record both the outside air temperature and the temperature reached inside the cooking pot. *(Be sure to close off air gaps around the thermometer to prevent heat from escaping.)*

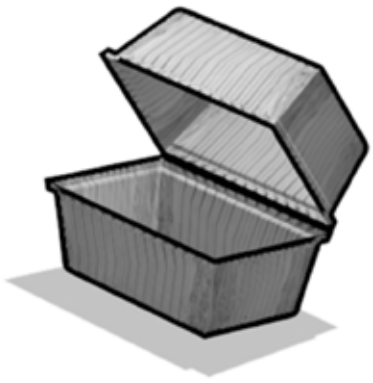
Constructing a panel cooker

What you will need:

- a simple metal cooking pot with a lid. If you do not have a small metal pot with a lid, you can use a small aluminium foil pie tray or container *(cheaply available from supermarkets)*, with a foil lid, or you can use two foil pie trays joined together.
- black craft paint and paintbrushes *(if using foil trays)*
- oven bag *(available from supermarkets)* or a plastic bag
- scissors
- tape or twist ties
- piece of thick cardboard
- aluminium foil *(or a silver heat reflector – such as those used for car windscreens)*



Aluminium foil tray

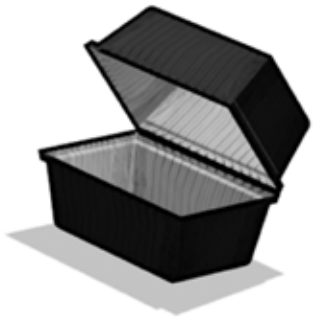


Two aluminium foil trays

What to do:

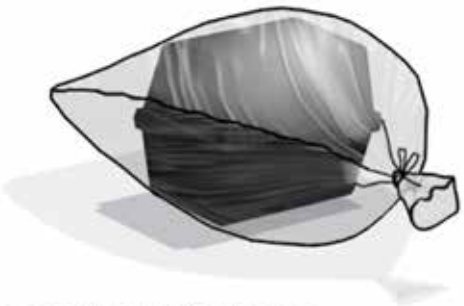
- If using the foil trays, they will need to be painted black. If the paint will not stick to the foil, clean it with detergent or roughen the surface with some sandpaper first.

Painting aluminium foil tray



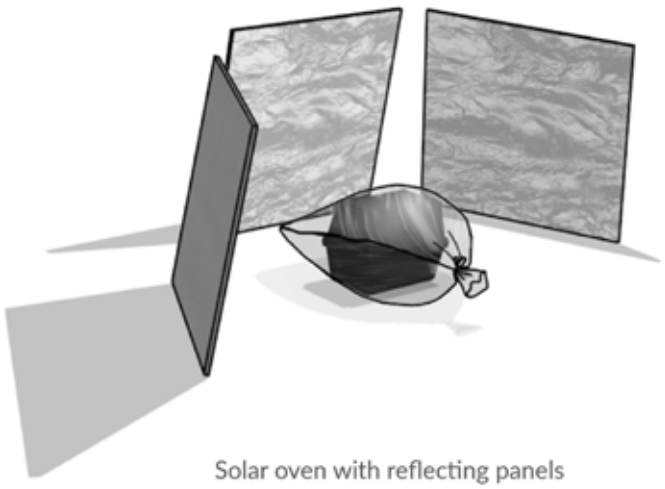
Painted aluminium foil trays

- Trim the oven bag *(or plastic bag)* so the cooking pot *(or foil trays)* are a tight fit when they are put inside it.
- Place the cooking pot, or foil trays, inside the oven bag and secure it with adhesive tape or twist tie. It should be a tight fit.



Solar oven sealed in oven bag

- Make your reflective panel by covering the cardboard with foil. You will not need to do this if you are using a silver heat reflector.
- Place the bag with cooking pot in a sunny position.
- Position the reflector panels so they catch and direct sunlight on to the cooking pot. The larger the area of sunlight the reflectors catch and direct on to the pot, the more heat it should receive.

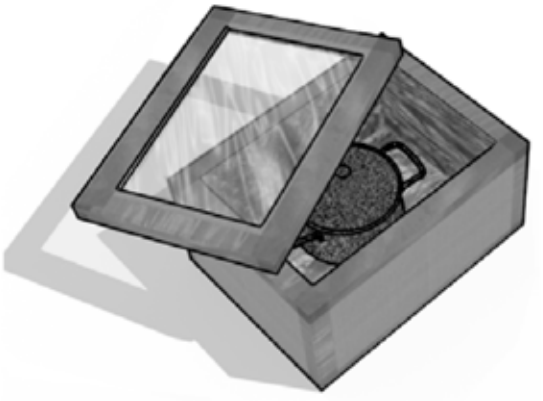


Solar oven with reflecting panels

Constructing a simple 'box' solar cooker

What you will need:

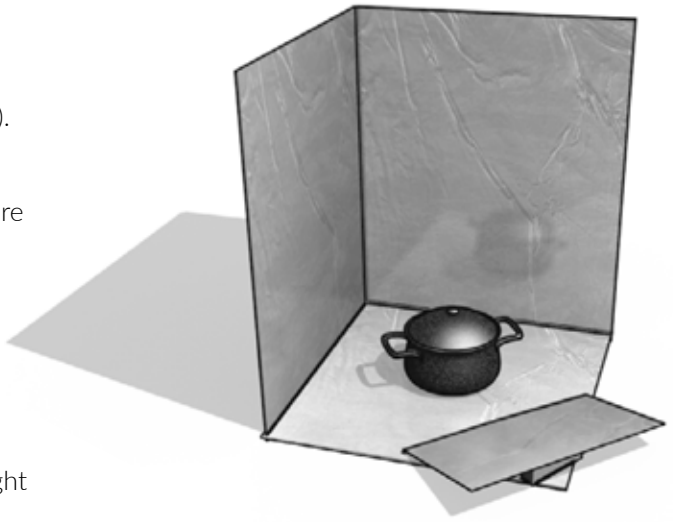
- a simple metal cooking pot with lid. If you do not have a small metal pot with a lid, you can use the aluminium foil pie trays as described in the panel cooker instructions.
- a cardboard box that is big enough to hold the cooking pot or foil trays.
- scissors or Stanley knife
- clear plastic film *(food wrap)*
- tape or rubber bands
- piece of thick cardboard
- aluminium foil *(or a silver heat reflector – such as those used for car windscreens)*



Box solar cooker

What to do:

- If using the foil trays, they will need to be painted black. If the paint will not stick to the foil, clean it with detergent or roughen the surface with some sandpaper first.
- Cut a piece out of the box to form an opening *(see diagram)*.
- Place the pot or foil tray inside the box.
- Stretch the plastic wrap across the top of the box and secure it with tape or rubber bands. Make sure all the air gaps are sealed so heat cannot escape.
- Make your reflective panel by covering the cardboard with foil. You will not need to do this if you are using a silver heat reflector.
- Place the box in a sunny position.
- Position the reflector panels so they catch and direct sunlight on to the box. The larger the area of sunlight the reflectors catch and direct on to the pot, the more heat it should receive.



Reflecting panels

An alternative 'box cooker' design

A simple 'box' solar cooker can be constructed using a large, clear soft drink bottle *(see diagram)*. One end can be cut away to allow the black painted foil 'cooking pot' to be placed inside. The chamber will need to be sealed with clear plastic wrap, or similar material, fixed over the end with a rubber band or tape. Aluminium foil, or similar reflective material, can then be placed behind the curved surface of the bottle to reflect heat back into the inside of the bottle.

Again, this design can be improved by adding larger reflective panels to catch and direct more light from the sun into the cooking area.

An alternative design

A ‘no-touch’ solar cooker design

Here is a solar cooker design which allows students to see the cooking process without handling the solar cooker or cooking pot.

Shoebox with a skewer

What you will need:

- a cardboard shoe box
- aluminium foil
- black paint
- paint brush
- glue
- wooden skewers
- clear plastic film *(food wrap)*
- masking tape or rubber bands
- foods to ‘cook’ *(e.g. chocolate, marshmallows, cheese)*

What to do:

- Paint the outside of the box black.
- Once dry, cover the inside of the box with aluminium foil *(glue may be required to keep the foil in place.)*
- Create a hole in each of the long sides of the box using a skewer. The holes will need to be approximately 2cm from the top of the box *(see diagram)*.
- Remove skewer.
- Push the skewer through one of the holes, thread pieces of food *(e.g. chocolate, cheese or marshmallow)* onto it, then push it through the hole on the opposite side of the box *(to create a ‘rotisserie’)*.
- Once the skewer is in place, cover the top of the shoe box cooker with clear plastic wrap, sealing it with masking tape or a rubber band to ensure there are no gaps through which the heat can escape.
- Place the solar cooker/s out in the sun, and turn the wooden skewer every now and then to allow the chocolate/cheese/marshmallow etc. to melt.
- Check the solar cookers regularly, to monitor the melting process.

Discuss what melts the quickest? Why might this be the case?

After the experiment is complete, place the solar cookers in a cool place and allow them to completely cool down before removing the plastic wrap, skewer and foil. The cookers can be used again if new foil is used.

As an alternative activity, students could try cooking an egg in their oven.

Evaluate

In this section the student teams will evaluate the success of their model solar cookers, and consider possible improvements.

Having designed and constructed their 'best' solar cookers, the student teams can now test them out under a variety of different conditions and assess their effectiveness. This is an opportunity for them to reflect on their designs, critique the performance of their solar cooker, and to make suggestions for modification and improvement. These modifications can then be carried out and the models re-tested.

It is important that the performance of the solar cookers is measured and recorded in a meaningful way. This could include drawings, photographs, oral explanations, written details and reflections etc.

Assessing the projects

On completing the construction and the testing of their solar cooker, students should be engaged in assessing the successes of their projects. They should consider:

- Which particular designs were more successful? Why?
- What have they learned whilst doing the project?
- What else would they like to learn about solar energy?
- What would they do differently if they undertook the project again?

Design your own solar powered robot

Name: _____

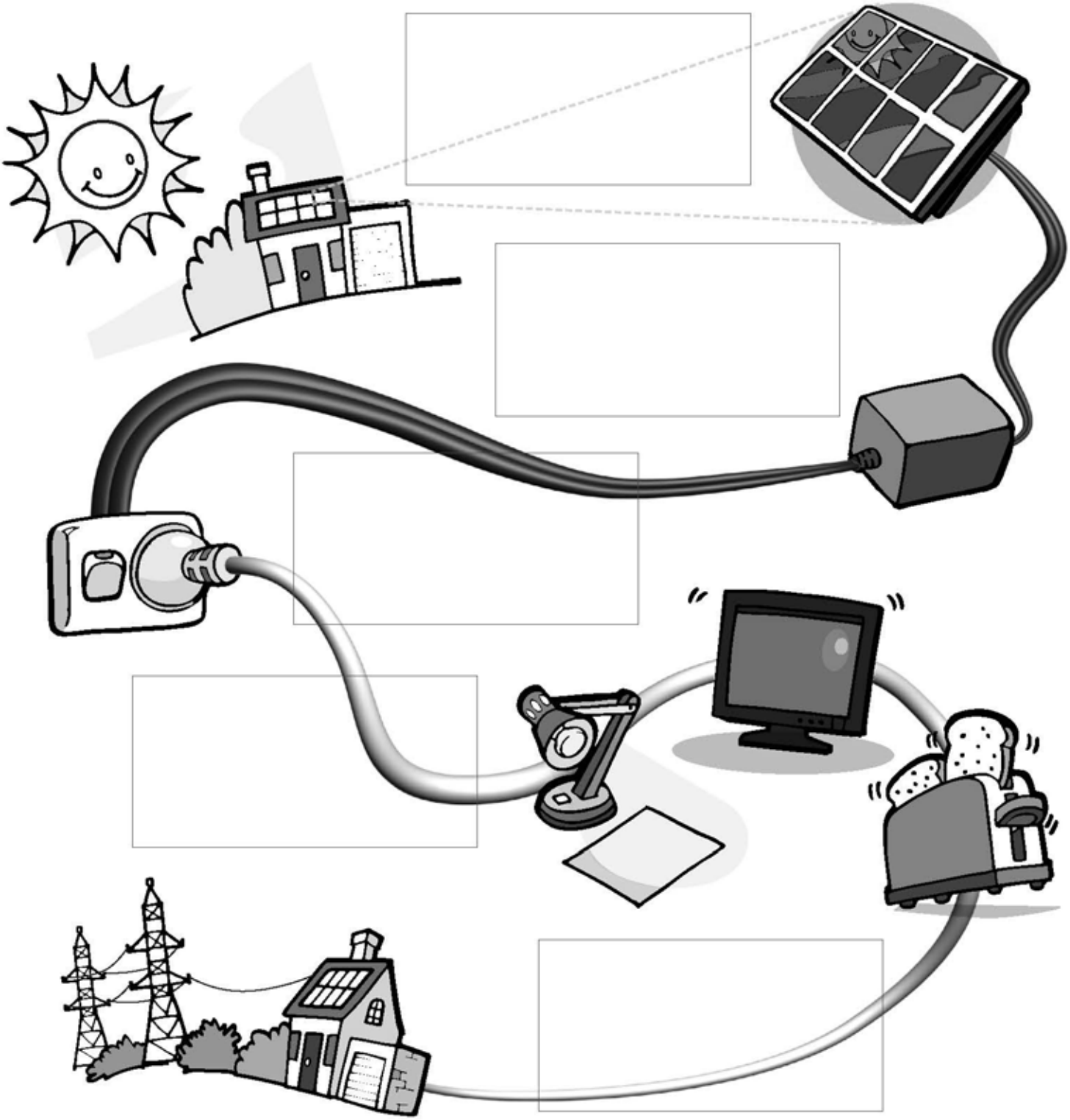
In the space below design, draw and label a robot that could be your helper.

Don't forget, your robot must be solar powered.

How solar power works

Name: _____

The following diagram shows the solar energy process.



How solar power works

Name: _____

Cut out the boxes below and paste them onto the diagram to correctly tell the story of solar energy.

The sun shines on solar panels.

Solar panels turn sunlight into electricity.

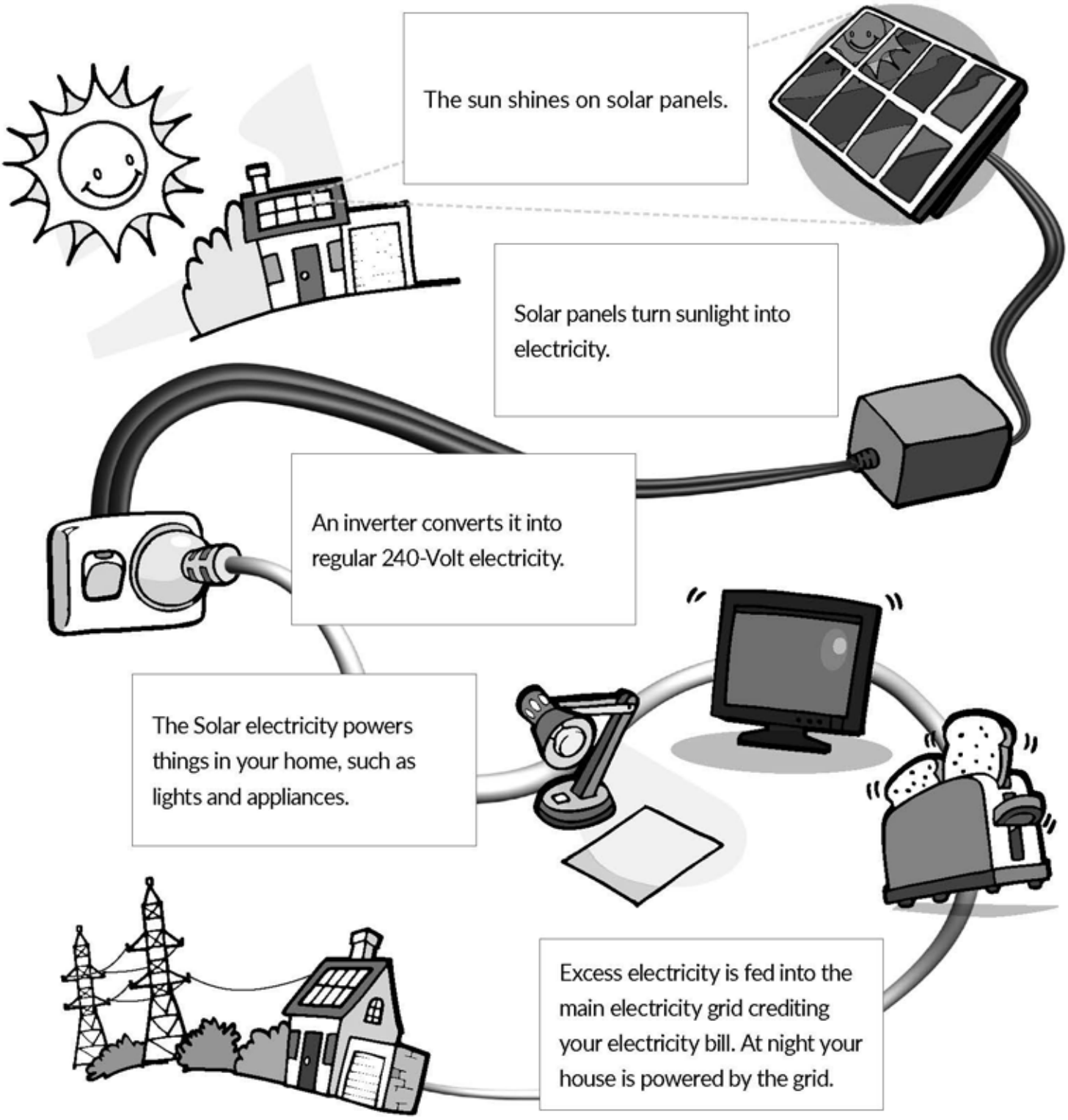
Excess electricity is fed into the main electricity grid crediting your electricity bill. At night your house is powered by the grid.

An inverter converts it into regular 240-Volt electricity.

The Solar electricity powers things in your home, such as lights and appliances.

How solar power works - Solutions

Name: _____



Know Want Learnt (KWL) Chart

Name: _____

What I **KNOW** about solar energy	What I **WANT** to know about solar energy	What I have **LEARNT** about solar energy

Think Want Learnt How (TWLH) Chart

Name: _____

What we **THINK** we know about solar energy	What we **WANT** to know about solar energy	What we have **LEARNT** about solar energy	**HOW** we learnt it