Solar Oven – Teacher Resource

Intended Use of Resources

This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

There are three **student workbooks - Open, Guided and Scaffolded,** that go along side this resource; all have the same suggestions for activities, however they have been written and edited to provide differentiated learning options to support good teaching practice**.** Teachers may pick and choose which versions they give which students, and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open-ended investigation then you could just give the students the challenge and background information section of the Student Workbook.

The Woodside Australia STEM Project aims to be accessible and supportive for teachers and students, please contact us if you have questions, require assistance or would like to arrange an incursion or a professional development workshop - www.wasp.edu.au

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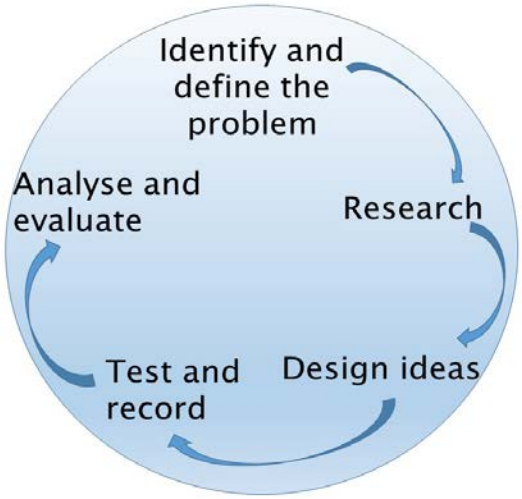
The Challenge

Can you cook a meal without using electricity or gas? Is it possible to use just the power of the Sun to cook food?

The student challenge is to investigate solar ovens and then use their findings to design and make a working oven.



Background Information

Solar ovens are designed to harness energy from the Sun to cook food without the need of gas or electricity, this makes them very environmentally friendly. Solar ovens can be bought in camping stores, but they can also be made using everyday household equipment.

Figure 1. Hot Pot solar cooker with panel reflector (Wikipedia, photograph by Paul Averson, June 27, 2011)

The Sun emits infrared (heat) and light radiation as waves which travel to the Earth through space. It is the infrared waves which a solar cooker uses to heat food. These infrared waves can be focused to a point by using reflective material, like in the image above. By focusing the rays they concentrate the heat and so make the oven more efficient.

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Activities

This booklet contains extra information on each activity including syllabus links, the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links. Please note that any reference websites provided in the entirety of our resource documents were current at the time of publication. Please advise if links are no longer accessible.

The syllabus links have been colour coded – please see the colour key below:

Covered in Scaffolded, Guided and Open student workbook
Covered in Guided and Open Student workbook
Covered in Open student workbook

List of Activities

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Background Research

Objective

In this activity students will gain more understanding of the advantages and disadvantages of using a solar oven, through internet research. They will find out more about the safety precautions required for using a solar oven as well as what can be cooked on one. Students will find out when might be the best time of day and year to use a solar oven. In their research they should find that solar ovens are very environmentally friendly, as they do not need any fuel. They usually take a lot longer to heat food than a normal oven, and are also quite unpredictable, as cloud cover and the amount of sunlight will greatly affect their efficiency. This means you can't really just leave things to cook in it for a set amount of time, you have to be observant and check on the food regularly. It is not recommended to cook high risk food, like chicken, which could make you very ill if not cooked through properly. Solar ovens can get very hot, so it is important that oven gloves are used to put food in and out of them.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the Sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted
Technologies	ACTDEK019 How people address competing considerations when designing products, services and environments

Useful website:

- Article on the advantages of using solar ovens https://www.solarovens.org/about-solar-ovens/six-critical-ways-that-solar-ovens-impact-worldwide-disease-hunger-water-contamination-and-the-environment/
- Information on the disadvantages of solar ovens http://www.alternative-energy-geek.com/solar-powered-cooker.shtml
- Information about safety precautions required when using a solar oven https://www.doityourself.com/stry/advantages-and-disadvantages-of-using-a-solar-cooker
- Website with recipes for solar ovens https://www.solarovens.org/recipes/
- Website with the hours of sunlight received in each town https://www.timeanddate.com/sun/australia/perth

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Cooking Pot Colour

Objective

In this activity, students will conduct and investigation to determine how the colour of a cooking pot affects the rate at which food/liquid is heated. In the Scaffolded and Guided book students are given a full method and equipment list, whereas in the Open book students are asked to come up with this on their own.

In this experiment students fill coloured cans with a set volume of water and measure the change in temperature over time. It is important that they swirl the water in the tin before each temperature reading as the water on the outside will generally be warmer than that in the middle, so swirling will even out the temperature. If it is not very hot or sunny where you are, you could use less water, which will show a bigger difference in temperature.

Students should find that the black can results in the largest change in temperature. This is due to the fact that black absorbs all wavelengths of light. The white and the silver cans should produce the smallest change in temperature as they should reflect the most light. Any other colours should be intermediate.

Students collect data from the investigation and in the Guided and Open book are asked to plot their results in a column graph. Students reflect on the fairness of the experiment, and consider what their results mean in terms of the colour of the cooking pot they should use when using a solar oven.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the Sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS086 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate

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	ACSIS090 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 ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task WATPPS28 Identify available resources WATPPS30 Select, and apply, safe procedures when using components and equipment to make solutions WATPPS32 Work independently, or collaboratively when required, to plan, safely develop and communicate ideas and information for solutions
Mathematics	ACMMG108 Choose appropriate units of measurement for length, area, volume, capacity and mass. ACMSP119 Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies. ACMSP120 Describe and interpret different data sets in context

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Investigating Reflection

Objective

Students will see that light rays can be reflected in such a way that they can focus the light like using a satellite dish.
By focusing the light in a solar oven you should be able to heat the food more quickly.

Subject area	Australian syllabus links
Science	ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS090 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 ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted

Useful websites:

- Website with information regarding reflection and focusing light.
  https://www.bbc.co.uk/bitesize/guides/zdwnb9q/revision/2

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Reflecting the Rays

Objective

The aim of this experiment is for students to investigate if using a reflective lining inside their solar oven will help to heat the food (or liquid) more quickly. In the Scaffolded book students are given an equipment list and method, in the Guided book they are asked to come up with their own equipment list to follow a method and in the Open book students come up with both a method and equipment list. Students evaluate their investigation and discuss if it was a fair test or not.

In the method it suggests using chocolate chips and observing in which oven they melt faster, however if you want to save money and get more scientific data they could use a set volume of water and measure the temperature change.

Students should find that the lined box heats the food or liquid more quickly as it reflects the incoming light into the centre of the box.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations. ACSIS086 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task

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	WATPPS28 Identify available resources WATPPS30 Select, and apply, safe procedures when using components and equipment to make solutions WATPPS32 Work independently, or collaboratively when required, to plan, safely develop and communicate ideas and information for solutions
Mathematics	ACMMG108 Choose appropriate units of measurement for length, are, volume, capacity and mass. ACMSP118 Pose questions and collect categorical or numerical data by observation or survey

Covering the Cooker

Objective

Students will investigate if having a clear lid on the oven helps to heat the food/water faster. In the Scaffolded and Guided books students are given equipment lists and methods. In the Open book students are required to come up with their own method and equipment lists.

Students make predictions about what they think the outcome will be and compare their results to their predictions. They evaluate the investigation and discuss if it was a fair test or not. In the Guided and Open books students are asked to plot their results in bar charts.

Students should find that by using a lid the warmth is trapped inside the oven, so will heat the water faster – like a conventional oven. However, if the layers are too thick it can make it harder to heat up in the first place. If you have time you could run this experiment over a few hours, just taking readings every half hour or so.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations. ACSIS086 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS090 Construct and use a range of representations, including table and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate. ACSIS218 Compare data with predictions and use as evidence in developing explanations

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	ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS28 Identify available resource
Mathematics	ACMMG108 Choose appropriate units of measurement for length, are, volume, capacity and mass. ACMSP118 Pose questions and collect categorical or numerical data by observation or survey ACMSP119 Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

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Increasing Insulation

Objective

In this activity students find out if using an insulated oven helps to heat food/ liquid faster. In the Scaffolded book they are given a full method and equipment list, in the Guided they are asked to come up with an equipment list from a given method and in the Open they are asked to come up with both a method and equipment list.

In the Guided and Open students are asked to make predictions and compare their findings to their predictions. They are also asked to plot their results in a bar chart. In all booklets students will evaluate the investigation and discuss if it was a fair test as well as discussing what they understand from their results.

Similar to using a lid, students should find that by using insulation the warmth is trapped inside the oven, so will heat the water faster – like in a conventional oven. However, if the layers are too thick it can make it harder to heat up in the first place. If you have time you could run this experiment over a few hours, just taking readings every half hour or so.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations. ACSIS086 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS090 Construct and use a range of representations, including table and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate. ACSIS218 Compare data with predictions and use as evidence in developing explanations

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	ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task WATPPS28 Identify available resources WATPPS30 Select, and apply, safe procedures when using components and equipment to make solutions WATPPS32 Work independently, or collaboratively when required, to plan, safely develop and communicate ideas and information for solutions
Mathematics	ACMSP118 Pose questions and collect categorical or numerical data by observation or survey ACSIS090 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

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Focusing the Sunlight

Objective

In this activity students find out if using flaps on their solar oven helps to focus the heat and heat the food/ liquid faster.

In the Scaffolded and Guided book they are given a full method and equipment list, in the Open they are asked to come up with both a method and equipment list.

In the Guided and Open students are asked to make predictions and compare their findings to their predictions. They are also asked to plot their results in a bar chart. In all booklets students will evaluate the investigation and discuss if it was a fair test as well as discussing what they can learn from their results.

The outcome of this investigation can vary greatly depending on the time of day this is conducted. If this investigation is carried out around midday, when the Sun is directly above, then the more flaps used the faster the heating should occur. However, if the Sun is at an angle then the flaps can actually add shadows and prevent the Sun's rays from entering the box and heating what is inside.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations. ACSIS086 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS090 Construct and use a range of representations, including table and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate.

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	ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task WATPPS28 Identify available resources WATPPS30 Select, and apply, safe procedures when using components and equipment to make solutions WATPPS32 Work independently, or collaboratively when required, to plan, safely develop and communicate ideas and information for solutions
Mathematics	ACMSP118 Pose questions and collect categorical or numerical data by observation or survey ACSIS090 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

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Designing a Solar Oven

Objective

Students will research solar oven designs and evaluate their strengths and weaknesses. Using their evaluation and what they have learnt from their investigations they will design and build a solar oven to bake cookies in (or something else).

Students follow a full design process cycle, from research, to designing, building and evaluating the finished product.

The main difference between the booklets is that the Open students are asked to come up with more designs than the others and to explain their reasoning behind their chosen design over the others. In the Open booklet students are also asked if there is any further experiments that they would like to conduct to test their design.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task WATPPS28 Identify available resources WATPPS29 Develop and communicate alternative solutions, and follow design ideas, using annotated diagrams, storyboards and appropriate technical terms WATPPS30 Select, and apply, safe procedures when using components and equipment to make solutions WATPPS31 Develop negotiated criteria to evaluate and justify design processes and solutions WATPPS32 Work independently, or collaboratively when required, to plan, safely develop and communicate ideas and information for solutions

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Mathematics	ACMMG108 Choose appropriate units of measurement for length, area, volume, capacity and mass. ACMMG111 Connect three dimensional objects with their nets and other two-dimensional representations

Bibliography

Figure numbers from scaffolded booklet

Figure 1. Solar Cooker, https://en.wikipedia.org/wiki/Solar_cooker, accessed on 17/6/2020