Solar Oven

Curriculum
Levels 5-6
Science

Activity Description

Students will make a solar oven to investigate how solar energy can be harnessed for heating and to learn about how heat is transferred and the physical properties of everyday materials.

Teaching rationale

Students will:

- Experience, observe, identify and describe the core scientific principles involved in a solar oven (reflection, transmission, absorption, conduction, convection and radiation)
- See how scientific concepts are applied in the design and construction of effective science-based technologies

Curriculum Links

SCIENCE	Objectives	Student Learning Outcomes
Nature of Science	**Investigating in science** Develop and carry out more complex investigations, including using models. **Communicating in science** Use a wider range of science vocabulary, symbols, and conventions.	Construct and test a basic solar energy collector. Identify and describe the key science behind the oven's design: • Conduction (of heat energy from the surrounding materials inside the oven to the food) • Convection (of heat energy from the convecting air trapped inside the oven) • Radiation (of heat energy from the sun to the food via the reflective foil, from the oven/ food to the cooler surroundings) • Reflection (of radiant energy by the reflective metal foil) • Transmission (of radiant energy by the plastic film) • Absorption (of the sunlight's energy by the black paper/card) • Low conductivity (insulation by the paper etc) • High conductivity (of heat by the metal foil)
Physical World	Physical inquiry and physics concepts: identify and describe the patterns in physical phenomena found in simple everyday situations involving… light, waves and heat.	
Using Physics	Explore a technological application of physics. Investigate how physics knowledge is used in a technological application.	

Useful support material

- The activity implicitly involves heat transfer processes, energy transformation, and properties of matter (such as reflection and absorption), and provides a practical context to make these concepts explicit.
- See other links noted under supporting resources.

Running the activity

The scientific concepts that are applied in the context of the solar oven (and which should be covered before and after this activity) are:

- **Energy transformations**
- **Heat transfer** processes (radiation, conduction and convection)
- **Physical properties** of materials that help/hinder energy transfer (reflection, transmission and absorption of light, thermal conductivity (insulation))
- **Particle theory** of matter

Pre-activity focus

- How can we collect solar energy to heat houses and buildings etc?
- Brainstorm the materials required to construct a solar oven to heat food.
- Discuss the properties of those materials chosen and why they might work.

Activity

- Use the 'How to make a solar oven steps' on schoolgen.co.nz.
- Use the student worksheet below.
- Divide the class into teams of three.
- Provide each group with the diagram, instructions, materials, and equipment to make a solar oven.
- Check the students are clear about the purpose of the activity and their roles. Allow the students 10 minutes planning time before assembling the solar oven.
- Allow plenty of time to build and test models (2 - 3 hours total).

Discussion starters

- How was the food heated?
- What happened to the food (chemical/ physical changes)?
- What are the main features of an efficient solar energy collector?
- What things could you do to enhance the effectiveness of your solar collector?

Extending your students

These are some suggestion that may seed further inquiry:

- Use a thermometer or temperature sensor and data logger to record the increase in temperature over time inside the solar oven.
- Find the maximum/minimum temperature inside the oven and locate areas of heat loss with an infrared thermometer.
- Investigate how the optimum angle of the reflector flap relates to the angle of the sun.
- Provide the students with the opportunity to redesign their solar energy collector or build a different design. Does the redesigned/new solar energy collector work better? Explain why it works better than before.
- How could the solar oven be modified to become a solar water heater? Students could be provided with plastic tubing and black paint. Use convection or possibly a small pump to circulate water through the water heater and into an insulated storage 'tank'.
- How does the design features of the solar oven compare to those of an energy efficient house? (windows with double glazing, internal absorbers, thermal mass, insulation, radiant barriers).

Supporting resources

- Use the 'How to make a solar oven video and steps on schoolgen.co.nz.
- Find out how solar ovens can be used in developing countries to reduce the need for collecting and burning scarce wood resources, improving safety and the environment and reducing time, effort and money (for fuel). http://www.solarcookers.org/
- A short video clip from National Geographic showing the use of solar ovens in developing countries http://solarcooking.wikia.com/wiki/Solar_Cookers_International
- Plans for building a simple but powerful solar oven http://solarcooking.wikia.com/wiki/Cookit
- Build a parabolic solar collector using a curved mirror to concentrate radiant energy. http://hilaroad.com/camp/projects/solar_energy/Hila_Solar_Energy.html
- Build a Parabolic Solar Water Heater and explore renewable and non-renewable energy http://www.infinitepower.org/pdf/10-Lesson-Plan.pdf
- Read how a solar thermal power station is using concentrated solar rays to turn water into steam and power a generator: http://news.bbc.co.uk/2/hi/science/nature/6616651.stm http://www.largescalesolar.org/technology.php
- Find out more about solar ovens and renewable energy in general at Green Learning Canada. http://www.re-energy.ca/solar-oven

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Student worksheet

Solar oven

In this activity, you will learn

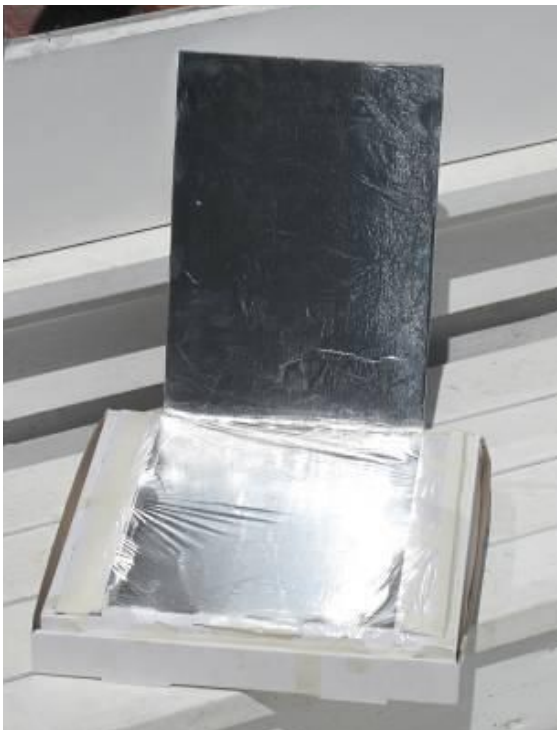
1. How to make and test a simple solar powered oven that heats food.
2. About important scientific concepts of heat transfer (conduction, convection, radiation) and how the physical properties of the materials in the oven help this happen

Equipment & Method

- Use the 'How to Make a Solar Oven' video and steps on schoolgen.co.nz.

Instructions for testing your Solar Oven

1. On a sunny day, carry the box outside with your food and find a sunny spot.
2. If it's cold, place a towel or blanket under the box so the bottom doesn't get cold.
3. Open the box, place the food to be heated in the centre (a small square of cooking paper underneath keeps the oven clean), and close the box.
4. Open the reflector and turn the box so that it is directly facing the sun.
5. Adjust the angle of the reflector so that sunlight optimally reflects into the box.
6. Expect heating time to take twice as long as conventional methods and allow about 20 -30 minutes to cook.
7. Foods with a high moisture content may fog up the window with condensation, so either use low moisture foods or put the food in a sealed plastic bag.



1. Results table (A)

Relate oven features to physical function
Indicate what the feature does using the following scientific terms:

Absorbs, Insulates, Reflects, Transmits

Material	Function	Notes
Foil (on mirror)		
Plastic film (window)		
Black card		
Rolled paper		
Foil (backing)		
Air trapped between plastic film		
Cardboard box		

2. Results Table (B)

Explain how each feature of the solar oven works
Use the terms above and write a sentence to explain what is happening in each part of the solar oven.
Example: The foil is a metal which is a good reflector of light (radiant energy) and it reflects the radiant energy from the sun towards the oven.

Other terms which could be helpful to you are:

Radiant energy, transforms, heat energy, convection, conduction

Material	Explanation of how it works
Foil (on flap)	
Plastic film (window)	
Black card	
Rolled paper	
Foil (backing)	
Air trapped between plastic film	
Cardboard box	

3. Questions

(a) State which material/s are poor conductors (good insulators)

(b) State which material is both a good conductor and a reflector.

(c) Identify and describe a design feature which minimises heat loss by conduction.

(d) Identify which design feature minimises heat loss by radiation

(e) Identify a design feature that minimises heat loss by convection

(f) Explain why the black plate becomes hot

(g) Explain using the particle model why the rolled paper reduces heat loss

Reflecting on the Activity

Discuss this with your classmates

- What did this activity tell you about how solar energy can be used?
- Is there anything you might change to improve the oven and why?
- What other applications are there for solar energy that don't involve cooking?

Explore further

- Solar ovens can be used in developing countries to reduce the need for collecting and burning scarce wood resources, improving safety and the environment and reducing time, effort and money (for fuel). Find out more at: http://www.solarcookers.org/
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- Plans for building a simple but powerful solar oven can be found here: http://solarcooking.wikia.com/wiki/Cookit