Solar Oven Design Challenge

Teacher Notes

Secondary (7-10)

ACTIVITY DESCRIPTION

In this project students design and build a solar oven utilising passive solar design principles to warm up the oven and then sustain the temperature for as long as possible. The aim of the design is to cook or dehydrate food as sustainably as possible. Students need to take sustainability into account when researching the materials for their design. Once students have researched their design and created a draft, they build a prototype to test and evaluate the design's effectiveness. At the end, students present their design process, results and evaluation to the whole class.

Please see Student Worksheet for the 'Solar Oven Design Brief' and 'Analysis and Results' table and questions.

INSTRUCTIONS

1. Tune in and Design Brief

1. Ask students to share what they already know about solar energy and design. Discuss the difference between active and passive solar
2. Watch short Youtube clip on Cooking Steaks with Sunlight in South Africa
   In groups, discuss:
   a) How does the solar oven work?
   b) What are the environmental benefits of this solar oven?
   c) What are the social benefits?
   d) What are the design limitations and/or advantages?
3. Divide students into groups of 2-3 and provide a set of materials per group (see materials list below)
4. Explain the design objective and provide students with their 'Design Brief' handout
5. Student groups start to research and develop a design. They need to agree on the sustainable materials they will use and write/draw their plan.

2. Building, Testing and Evaluating

Students continue to research and draft their designs for a prototype

1. Students can begin to build their prototypes
2. Students may conduct tests on their prototype and make changes/updates. They may need to rethink their plan, request materials or trade materials with other teams. Teams need to document this process
3. Once built, students test and evaluate their solar ovens using the 'Analysis and Results Worksheet'

3. Presenting

Students present their design process, results and evaluation to the whole class

4. Discussion

1. Did this design achieve the aim of cooking/dehydrating food items?
2. How could your design be improved to achieve greater cooking/dehydrating efficiency?
3. Could you think of other ways solar energy could be used to cook food?

MATERIALS

Students need to take sustainability into account when researching the materials for their design. Some of the materials listed below are not considered sustainable as they have a negative impact on the earth's natural resources e.g: plastic comes from oil which is a finite resource. So for this design students should Repurpose items from home or school (cannot be new/bought products)

Each student group needs a selection of some/all of the following:

- Foam core board, bubble wrap, felt and/or cotton wool: to mimic insulation
- Cardboard boxes: for structure or other building material
- Thin clear plastic: to let light in, heat up space
- Aluminium foil: to imitate metal surfaces, reflect heat and light
- Thin rubber: to imitate thermal mass
- Black fabric: to absorb heat from light
- Glue: holding structure together and functioning as a final insulator/draft proofer
- Mirrors, car screen reflectors, plastic bottles

Shared items

Glue/blue tack/plasticine, Scissors, Utility Knife, Thumbtacks, Sticky tape, Masking tape, Protractor, Metal ruler, Thermometers, Watch or timer, Compass

Safety

When cutting the board use a Safety Cutting Ruler to protect fingers

Food for cooking or dehydrating

Marshmallows, nachos, thinly sliced fruit

SUGGESTIONS FOR ASSESSMENT

Formative

1. Participation in the research, design and construction of a Solar Oven
2. Students test and evaluate their design and formulate recommendations
3. Participation in the Discussion questions above

Summative

1. Students present their design process and results to the class

See suggested Evaluation Rubric on Student Design Brief

BACKGROUND NOTES

Passive solar technologies use sunlight without active mechanical systems (such as solar PV). Such technologies convert sunlight into usable heat (in water, air, and thermal mass). Passive solar is often used in building design to take advantage of the climate to maintain a comfortable temperature range in the home. It eliminates the need for auxiliary heating or cooling, which accounts for about 40% of energy use in the average Australian home or school.

In this design challenge, students will learn about and observe passive solar heating through the design and operation of a solar oven. Below is a list of key concepts and definitions to support this.

Thermal insulation:

Thermal insulation is the reduction of heat transfer between objects in thermal contact. Thermal insulation can be achieved with particular engineering methods as well as with suitable object shapes and materials. If students wish to get some ideas around how to insulate their ovens, they can research examples of insulation in our world from animals bodies to buildings or space crafts and mechanical

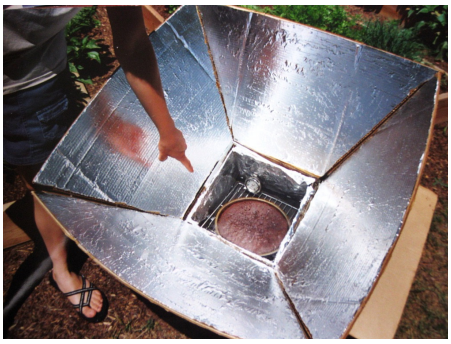
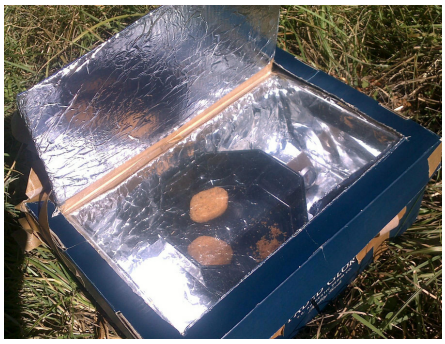
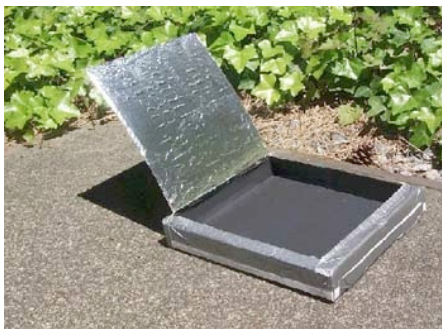
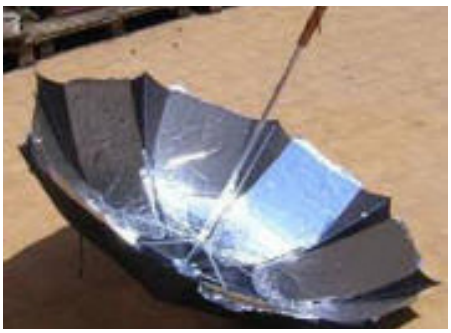
BACKGROUND NOTES (Cont'd)

insulation (pipes, wires). What materials keep us most warm during winter?

Thermal mass:
Thermal mass is the ability of a material to absorb and store heat energy. Materials with a specific heat capacity and/or high density are good for thermal mass. Consider, for example, how much hotter urban environments are than rural ones. This is because of the high volume of thermal mass materials such as bricks and concrete or is often referred to as an 'urban heat island.' How can trees cool our urban environments?

Reflection:
Materials with a reflective surface can help to optimise the amount of sun light in an area. By redirecting sunlight into a concentrated area you can increase the heat.

Orientation:
Orientation refers to the direction you place your oven to take advantage of the sunlight. As the sun is higher in the sky in summer and lower in the sky in winter, the sun's path and potential shading by buildings and trees should be considered when placing the oven.

RESOURCES

Cooking steaks with sunlight in Africa
https://www.youtube.com/watch?v=kiE7pB1uxE0

Article on CERES Scheffler Dish
https://ceres.org.au/wp-content/uploads/2016/05/ReNew-Article-Scheffler-Dish.pdf

ACCESS THIS ACTIVITY

Visit the **Sustainability Hub** to download the activity -
https://sustainability.ceres.org.au/education-resources/curriculum-activities/

Curriculum and RSS Links

KEY CONCEPTS

Renewable Energy, Passive solar, Design, Insulation, Thermal Mass, Orientation, Heat retention

KEY LEARNING INTENTIONS

1. Students will learn the key principles of solar oven design and will identify a range of useful and ideally sustainable construction materials
2. Students will learn the principles of heat gain, heat loss and heat retention
3. Students will follow simple instructions and work in teams to carry out a task

VICTORIAN CURRICULUM

Science

7 – 8	9 – 10
Energy appears in different forms including movement (kinetic energy), heat, light, chemical energy and potential energy; devices can change energy from one form to another (VCSSU104)	Energy flow in Earth's atmosphere can be explained by the processes of heat transfer (VCSSU132)

Design and Technology

7 – 8	9 – 10
Examine and prioritise competing factors including social, ethical, economic and sustainability considerations in the development of technologies and designed solutions to meet community needs for preferred futures (VCDSTS043) Analyse ways to create designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment (VCDSTC048)	Explain how designed solutions evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (VCDSTS055)

SUGGESTED RESOURCESMART SCHOOLS MODULE LINKS

Undertaking the activity as described above links to the ResourceSmart Schools Energy Module - actions B1.2, B1.3, B1.4

Below is a list of extension activities that link to additional actions of the Energy module:

1. Investigate how you can apply these principles of passive solar design to architecture. Research sustainable building design and develop a housing model that includes sustainable materials, insulation, passive solar and other sustainable features. Present your design to the class *(ResourceSmart Schools Energy Module – actions B1.1, B1.3)*
2. Write a learning story about the school's approach to energy efficiency and share these tips in your school newsletter for families to implement at home *(ResourceSmart Schools Energy Module – actions C1.1, C1.3, C3.6)*
3. Students complete an audit of their electricity use at home (see CERES Electricity Use At Home Curriculum Activity) to identify where they can save energy at home and/or where they could improve design features for energy efficiency *(ResourceSmart Schools Energy Module – actions B1.1, B1.2, B1.3, B1.4)*
4. Invite local indigenous community group/s to share sustainable practices for the cooking of food traditionally *(ResourceSmart Schools Energy Module – actions B1.5, B1.6)*

Speak to your CERES ResourceSmart Schools Facilitator about further links to the Energy module.