Lesson 1: Solar Cooker

Summary

In this lesson students are introduced to a solar cooker as an example of a device that captures light energy and transforms it into thermal energy. Students observe a simple solar cooker set up by the teacher and try to figure out what makes it work, i.e. how the sunlight is converted to thermal energy (which, at this point, they will probably refer to as "heat") that reaches temperatures hot enough to cook (or at least heat) the food inside.

Access to direct sunlight is essential for this lesson. If this is not possible or practical, then video record or photograph the solar cooker in advance and use the video or photographs during the lesson. As a last resort, you can rely on heat lamps as a substitute for sunlight, but this is not recommended.

Students create a model, a diagram of the cooker with representations of what they think is happening inside, and to try to explain what is happening in terms of cause and effect.

As students go through this unit, they will connect new knowledge to the solar cooker. At the end of the unit, students will apply their new knowledge by redesigning the solar cooker to incorporate their new ideas about energy.

Vocabulary

- temperature
- energy
- light energy
- thermal energy
- model
- transfer

Next Generation Science Standards - Performance Expectations:

This lesson supports students in ***progressing toward*** *the NGSS Performance Expectation.*

MS-PS3-3.	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
MS-ETS1-2.	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3.	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Planning and Carrying Out Investigations Constructing Explanations and Designing Solutions Engaging in Argument from Evidence --- ***Connections to Nature of Science*** Scientific Knowledge is Based on Empirical Evidence	**PS3.A:** Definitions of Energy **PS3.B:** Conservation of Energy and Energy Transfer **ETS1.A:** Defining and Delimiting an Engineering Problem **ETS1.B:** Developing Possible Solutions	Scale, Proportion, and Quantity Energy and Matter

California Common Core State Standards Connections:

ELA/Literacy –

WHST.6–8.1.a–e	Write arguments focused on discipline-specific content.
WHST.6–8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Mathematics –

MP.2	Reason abstractly and quantitatively.
6.RP.1	Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities.

Materials

For solar cooker

- ★ shoebox
- ★ black construction paper to cover the inside
- ★ plastic wrap to cover the top
- ★ tape
- ★ 3 extra shoeboxes to act as controls: One empty, one just lined with black paper, one just covered with plastic wrap
- ★ something to cook inside the cooker (tortilla and shredded cheese to make a quesadilla, english muffins with sauce and cheese to make mini pizzas, etc.)
- ★ 6 thermometers
- ★ one oven thermometer that reads up to 200 °C or more

For model drawing

- ★ drawing paper (optional)
- ★ poster paper or large white boards
- ★ drawing supplies (pens, pencils, markers, etc.)

Preparation:

Access to direct sunlight is essential for this lesson. If this is not possible or practical, then video / photograph the solar cooker in advance and use the video / photographs during the lesson. (As a last resort, you can shine heat lamps to simulate solar radiation, but this will lack the elegance of using natural sunlight to cook food.) Make the solar cooker and controls in advance and set them up in a sunny location at least 1 hour before the start of class so the cooker has time to start working. It is highly recommended you try this out ahead of time to test out your cooker, the thermometer, your location, access to direct sunlight, etc.

Make a simple solar cooker. Line the inside of a shoebox with black construction paper and cover the top tightly with plastic wrap. Better yet, cut a window in the top of the shoebox and tape plastic wrap tightly across the opening. Then you will be able to easily open and close the lid.

Place 2 thermometers inside— a regular thermometer and an oven thermometer— and some food to heat. Set it up in a sunny location at least 1 hour before the start of class so it has time to start working. (**NOTE:** This small simple solar cooker will only get up to about 120-150 °F. It will be hot enough to melt cheese and produce some steam, but it will not really *cook* anything. Students' new and improved solar cookers, which they will redesign at the end of the unit, should get hot enough to cook something small.)

Set up the controls as well. Set up thermometers in each one, and one thermometer in a sunny location outside the oven (regular thermometers are fine for the controls, since these won't get very hot).

Plan how students can observe the setup— you might place it on a table that students can walk around. They should have an observation sheet to draw and write their observations and ideas.

EL Let English learners work with a thought partner who can help them verbalize their observations.

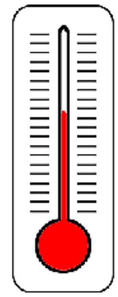
Engage (5 min.)

OPENER

- How do you bake cookie dough? Normally, you put it in the oven.
- What temperature do you think you need to cook the dough? Estimates will vary. Normally you need at least 200 °F (93 °C) to start cooking. If you're using an oven, you will set it to around 350 °F (175 °C) to bake something.
- How hot do you think it is outside today?

➔ Have the students share out their responses. Prompt the students to think about how the temperature of the cookie dough changes and why. (Depending on whether the oven is gas or electric, energy is converted to heat energy and cooks the food. How this all happens is the focus of this unit and doesn't need to be stressed right now.)

→ Discuss temperature and temperature scales. For reference:
  - ◆ 100 °F is a hot day (that's about 38 °C)
  - ◆ 100 °C is hot enough to boil water (that's 212 °F).



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Explore (15 min.)

→ Invite and encourage the students to observe the solar oven set up. Direct them to think about Questions 1-3.
→ Once back inside, distribute drawing paper and drawing supplies to the students and have them complete the questions.

1. What is happening inside the cooker? How can you tell? (The food is getting hotter. You can tell from temperature readings, the fact that the cheese is melting, or steam accumulating on the inside of the plastic wrap.)
2. Why is the temperature higher inside the cooker than above the cooker? (answers will vary and may be incomplete but this affords you an opportunity to elicit current conceptions)
3. What changes do you observe in the food? (answers will vary)
4. Draw a diagram of the cooker and explain how it works (how the food gets hot/cooks).

→ Debrief Question 2. Heat from the sun is not directly reaching the cooker. Even on a cool day, it will be hot inside the cooker. So there is another form of energy coming from the sun that changes to heat energy inside the cooker. **Ask:** How is this happening?
→ Discuss the word model. If students are unfamiliar with the concept, ask them for examples and what they model: model train set, model rockets, modeling clay, etc. A model is a representation, in this case, a representation of how you are thinking about a concept, or how you think something happens. It makes something easier to visualize, understand, or predict. A model doesn't have to be 3D; it can also be a diagram, a graph, a drawing, a skit, etc.
→ Have the students work in groups of 2-4 to discuss and decide on a model of the energy transfer to the solar cooker, and then have them draw a poster. Be sure the student diagrams include how the thermal energy moves into and within the cooker system.
→ Walk around as the students are working to insure that all students share out designs and contribute to the design and construction of the poster.

Explain/Elaborate (20 min.)

5. Share your diagram with your group members and, as a group, draw a poster showing how the cooker works.

- ➔ When students are finished with their posters have the groups share them out with the class.
- ➔ **Ask:** What causes the oven to increase in temperature? Students might say the sun. Ask what is coming from the sun to the oven— light energy.
- ➔ **Ask:** What type of energy is causing the temperature to increase? Students might say light energy again. Point out that the solar cooker isn't glowing, so it must not be light energy anymore. What type of energy does it become? Students will probably say heat energy. Accept this answer, but explain to students that we are going to more correctly call that thermal energy. Tell them we'll be exploring a lot more about thermal energy in this unit.
- ➔ **Ask:** What *is* energy? Energy is the ability to do work. See if students can think of examples of this. Solar energy can cook food, as in the solar cooker. It can also be used to supply electricity for homes. Electrical energy allows appliances to work. Thermal energy can be used to heat your house. Our bodies use the chemical energy in food to do work.

- ➔ ***Tell students that in this unit we'll be exploring how solar cookers work in order to design the best possible cooker at the end of the unit.*** The solar cooker they saw today got hot, but not that hot. They will learn more about energy in order to make one that works much better. Their challenge will be to make mini pizzas (or other food of your choice) using a solar cooker they build in class.

Extend

EXTENSION

- ❖ What world problems do you think could be solved by solar cookers, and why?
- ❖ How do solar panels work?

Evaluate (5 min.)

EXIT CARD

- What 2 types of energy are involved in a solar cooker? Light energy and thermal energy

Homework

HOMEWORK

Later in this unit you will design your own solar cooker.

- What is one thing you would change about the solar cooker to make it cook better? Why would this improve how well it cooks? Answers will vary. Use this as an elicit to gain insights into students' current thinking.

Pages to project or print for students appear on the following pages.

Lesson 1: Solar Cooker

OPENER

❖ How do you bake cookie dough?

❖ What temperature do you think you need to cook the dough?

❖ How hot do you think it is outside today?

Lesson 1: Solar Cooker

1. What is happening inside the cooker? How can you tell?

2. Why is the temperature higher inside the cooker than above the cooker?

3. What changes do you observe in the food?

4. Draw a diagram of the cooker and illustrate how it works (how the food gets hot/cooks).

5. Share your diagram with your group members and as a group, draw a poster showing how the cooker works.

Lesson 1: Solar Cooker

EXIT CARD

- ❖ What 2 types of energy are involved in a solar cooker?

HOMEWORK

Later in this unit you will design your own solar cooker.

- ❖ What is one thing you would change about the solar cooker to make it cook better? Why would this improve how well it cooks?