Plugging In to the Sun Unit Plan

Unit Overview

Unit Title

Plugging into the Sun

Unit Summary

This hands-on construction project gets students cooking during a solar energy science unit. The class study begins by acting out the Earth's rotation around the sun to see how that causes shadows. Students conduct several investigations of the Earth's position and shadows with compass and thermometer measurements and observations. They research the dilemma of using fossil fuels and how solar energy might solve the problem. Students work as engineers, and their task is to build solar cookers that can successfully cook an egg. If the cookers work, they may be the basis for more exploration on using solar energy as an alternative to fossil fuels. Students display their learning in multimedia presentations or newsletters.

Subject Area

Physical Science

Grade Level

6–8

Higher-Order Thinking Skills

Decision Making, Evaluation, Analysis

Approximate Time Needed

5–10 weeks, 2-hour lessons, 1 or 2 times per week

Unit Foundation

Targeted Content Standards and Benchmarks

Maryland Standards

- Give examples that show that energy can warm a substance
- Describe the observable effect of energy, such as heating and cooling
- Describe heat properties of different materials
- Give examples of materials that conduct heat energy better than others
- Explain that heat energy moves from a warm object to a cooler object by contact or at a distance until they reach the same temperature

American Association for the Advancement of Science (AAAS) Project 2061 benchmarks:

- The sun is the main source of energy for people, and they use it in various ways.
- The energy in fossil fuels such as oil and coal comes from the sun indirectly, because the fuels come from plants that grew long ago.
- Some energy sources cost less than others and some cause less pollution than others.
- People try to conserve energy or use renewable sources of energy in order to slow down the depletion of energy resources and/or to save money.

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Student Objectives/Learning Outcomes

Students will be able to:

- Apply scientific knowledge of heat transfer and solar energy: convection, conduction, and radiation
- Develop a rationale for the use of solar energy based on research
- Explain how solar energy is the basis of natural energy on Earth
- Evaluate models and incorporate features into their own design
- Accurately use scientific instruments when conducting experiments
- Collect, organize, display, interpret, and draw conclusions from experimental data
- Compare and contrast the use of fossil fuels versus solar energy

Curriculum-Framing Questions

Essential Question	What causes people (scientists) to consider new alternatives to solve problems?
Unit Questions	• Why should solar energy be considered as an alternative to fossil fuels? • How can you design a device that will transfer the sun's energy for a useful purpose?
Content Questions	• What are the factors that limit solar heat transfer? • What effect does solar energy have on different materials, and how can we make use of these effects? • How is heat transferred? • How does the Earth's rotation and the sun's position affect heat and temperature on Earth?

Student Assessment Plan

Assessment Summary

Assessment is ongoing throughout the course of study. Assessment is based on journal responses to the probing understanding questions and the final media project. Students use the solar rubric to self-assess the project. Use the same rubric to assess final presentations. The project checklist helps students plan and then keep track of their progress on the project they choose. After a class discussion, assess student understanding through written responses to the final questions from the probing understanding sheet.

For students with writing or language difficulties, allow for dictated responses or writing in the students' first language.

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Assessment Timeline

Before project work begins		Students work on projects and complete tasks		After project work is completed	
• Brainstorm	• Anecdotal Notes	• Prompts • Journals	• Conferences • Solar Rubric • Project Checklist	• Solar Rubric	• Reflections

Unit Details

Prerequisite Skills

- Experience using a compass to orient objects on Earth
- Familiarity using a thermometer to monitor temperature change in a variety of materials
- Skill in applying mathematics in the context of science
- Basic keyboarding and computer navigation skills (including opening and saving documents, launching programs, documenting research, and finding information on the Internet)

Instructional Procedures

Prior to this unit:

- Review the terms and general concepts in the background information document
- Ensure students know how to use a compass and a thermometer
- Confirm that students have experience transferring math skills into a science context
- Verify that students know how to research and document information on the Internet
- Select student volunteers for sessions 7 through 9 (as described later in this unit plan)

Session 1

Begin by asking students the Essential Question, *What causes people (scientists) to consider new alternatives to solve problems?* Students can brainstorm in groups and reflect on what causes scientists to develop new inventions and find alternatives. Ask students, *What would happen if we always did things in the ways they have always been done?* Students also reflect back on this question at the end of the project.

Begin with a project introduction slideshow, and follow the presentation with a class discussion framed around the following questions:

- *How can you design something that will transfer the sun's energy for a useful purpose?*
- *How does a conventional oven cook food?* (Probe for and develop two ideas—oven cooking requires a heat source and an insulated box that holds heat. A temperature gauge is a helpful additional feature.)

Develop the ideas of solar cooking further by posing the following questions:

- *Some say an egg can be fried on a sidewalk on a hot day. Is this true?*
- *Has anyone tried it?*
- *How hot would it have to be to cook an egg?*

As a class demonstration, cook an egg in a small custard cup in a standard preheated 350°F toaster oven. Rest a meat thermometer in the egg and determine the internal temperature. While it is cooking, discuss whether *radiant heat* (heat transferring through space), *conduction heat* (heat

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transferring from direct contact with a heat source), or *convection heat* (heat transferring though moving, heated air) is cooking the egg. When the egg is deemed cooked, read the thermometer. (Note: An egg is cooked when its internal temperature reaches 160°F. Do not measure oven temperature.)

Introduce the following challenge: Students work as engineers, and their task is to build solar cookers that can successfully cook an egg. If the cookers work, they may be the basis for more exploration on using solar energy as an alternative to fossil fuels. Tell students that they must develop a rationale for the use of solar energy based on research and address the question, *Why should solar energy be considered as an alternative to fossil fuels?*

Sessions 2 and 3

Have students meet in groups to determine the features they think their solar cookers will need to meet the challenge.

Reconvene and teach about reflection and absorption of the sun's rays. Discuss the reasons why an egg most likely cannot be cooked on a sidewalk, and have students further refine the necessary features of solar cookers. Discuss answers to the question, *What effect does solar energy have on different materials, and how can we make use of these effects?*

Next, using the students' criteria and a set of print and electronic resources you provide, instruct students to begin evaluating a variety of solar cooker designs. Circulate around the room as groups work, taking anecdotal notes.

During the last 10 minutes, have students respond in their science journals to Questions 1 and 2 on the probing understanding sheet. Review the journals and provide further instruction as necessary.

Session 4

Instruct groups to choose a preliminary solar cooker design from their Internet research. Tell them to be prepared to defend their choices.

Using Question 3 from the probing understanding sheet, have each group develop a short paper describing how the design of their oven relates to its function. This could be framed as a defense of the design they chose as compared to an oven design they rejected.

Session 5

Have students read their papers to the class, and, informed by the discussion, make their final design selection.

Prior to constructing the designs, have students sketch their designs in journals, labeling each feature and describing its function.

Session 6

Develop the concepts of heat transfer relating to radiant, convection, and conduction heat. Tell students to use this information when choosing the method of cooking they want to use (baking, broiling, boiling, or frying; in shell or out of shell).

Have each group assign tasks within their group and begin collecting materials. Pose Question 4 from the probing understanding sheet. Again, review the journals and modify instruction as necessary.

Sessions 7 through 9

Provide ample time for students to construct their cookers.

During these days, have students investigate the effects of the Earth's rotation and the sun's position on heat and temperature on Earth by completing the finding north activity, using the shadow plot procedures.

Have students respond to Question 5 on the probing understanding sheet.

Session 10

Spend one period troubleshooting cookers and measuring interior temperatures. Students should create a chart or graph of temperatures and corresponding times. The temperatures can be compared

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to a temperature guide for foods found in their research.

Using Question 6 on the probing understanding sheet, ask students to interpret a solar cooker graph. Later, their data can be graphed using spreadsheet software. This activity, along with the shadow plot procedures, helps students fine-tune the function of their ovens and choose the time and position for cooking.

Conference with students to help answer any questions they have and to probe for understanding of the concepts they have encountered any difficulty with.

Session 11 (or the next sunny day)

Cook-Off! Students use their solar cookers to cook eggs.

Take lots of conventional, digital, and video images! *Safety precaution: If eggs are eaten,* make sure *they have been cooked to at least 160^{o}F and are consumed immediately after cooking.*

Sessions 12 through 14

Explain that students will now share their learning in a project.

In small groups or pairs, have students develop a slideshow presentation, brochure, or newsletter.

Distribute the project checklist to help students plan and keep track of their progress. Inform students that all projects should include:

- Rationale for design choice and reasons why a person would want to use solar energy over fossil fuels
- One or more digital photos of the cooker, preferably in stages of development
- Graph showing oven temperature over time plus a caption interpreting the graph
- Discussion of the process and results (including introduction, process, troubleshooting, challenge results, and final thoughts)
- Citations for the cooker design and other information

Provide the solar rubric and review with students to help ensure they understand the assessment criteria before they start to work.

Session 15

Conduct a class discussion that revisits the Essential Question, *What causes people (scientists) to consider new alternatives to solve problems?* Students should be more enlightened on the factors that cause scientists to explore new solutions to problems.

Ask students to write responses to Questions 7 through 9 on the probing understanding sheet.

Accommodations for Differentiated Instruction	
Special Needs Student	• Team the student with stronger readers • Allow the student to dictate journal entries or test answers • Narrow assignments to the most important features • Allow the student to make selections from multiple choice answers or respond orally rather than producing essay responses. • Ask support personnel for assistance • Provide a daily outline of tasks to aid organization and work completion
Nonnative Speaker	• Provide visual models when possible • Ask for translation help from more proficient bilingual students • Ask ELL support personnel to develop a two-language glossary of terms to aid vocabulary development • Allow written work to be completed in the student's first language for later translation

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Gifted/Talented Student	• Provide opportunities for extended activities, such as constructing a more complex parabolic cooker, studying atomic fusion as it relates to the sun's energy, or studying how microwaves agitate molecules to heat food • Present the problem of storing solar energy and have the student investigate solutions

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Materials and Resources Required For Unit

Technology – Hardware (Click boxes of all equipment needed)

☐ Camera	☐ Laser Disk	☐ VCR
☒ Computer(s)	☒ Printer	☐ Video Camera
☒ Digital Camera	☒ Projection System	☐ Video Conferencing Equip.
☐ DVD Player	☐ Scanner	☐ Other
☒ Internet Connection	☐ Television	

Technology – Software (Click boxes of all software needed.)

☒ Database/Spreadsheet	☐ Image Processing	☐ Web Page Development
☐ Desktop Publishing	☐ Internet Web Browser	☒ Word Processing
☐ E-mail Software	☒ Multimedia	☐ Other
☐ Encyclopedia on CD-ROM		

Printed Materials

- Asimov, I. (1981). *How did we find out about solar power?* New York: Walker and Company.
- Brooke, B. (1992). *Solar energy*. New York: Chelsea House.
- Catherall (Ed.). (1982). *Solar power*. NJ: Silver Burdett Company.
- Gadler, S., & Adamson, W. W. (1980). *Sun power facts about solar energy.* Minneapolis, MN: Lerner Publications.
- Hufbauer, K. (1991). *Exploring the sun: Solar science since Galileo*. Baltimore, MD: Johns Hopkins University Press.
- Spence, M. (1993). *Solar power*. New York: Gloucester Press.

Supplies

FOSS Science Kit "Solar Energy" or similar materials for solar study

Internet Resources

Solar Cooker Designs

- Tamara's Solar Cooking
  www.exoticblades.com/tamara/sol_cook*
  Covers the science of solar cooking, including supplies and tools needed to create your own cooker, instructions on making a solar cooker, tips for using the box cooker, and links to other sites
- The Solar Cooking Archive
  http://solarcooking.org/plans*
  Pictures of solar cookers and examples

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Internet Resources	*Solar Energy Resources* • The Sun: A Multimedia Tour www.astro.uva.nl/demo/od95* A variety of sun facts with pictures and videos • YPOP Classroom www.lmsal.com/YPOP/Classroom/index.html* Activities that teach a physical concept, like rotation, using the sun as an example • The Nine Planets: A Multimedia Tour of the Solar System http://seds.lpl.arizona.edu/nineplanets/nineplanets/sol.html* Overview of the history, mythology, and current scientific knowledge of each of the planets in our solar system • Newton's Apple, Solar Energy Activities www.tpt.org/newtons/14/olympicsolar09.html* Explains how the sun is used for power from a historical perspective • U.S. Department of Energy http://www.eere.energy.gov/* Solar energy, solar cells, solar water collectors, and solar heating principles • Zoom's Astronomy: The Sun www.enchantedlearning.com/subjects/astronomy/sun* Explains Earth's orbit, temperature of the sun, nuclear energy, and the age of the sun; includes sun activities and offers ideas for studying solar exploration • Exploratorium, www.exploratorium.edu/science_explorer/sunclock.html* Explains the changing shadows caused by Earth's revolution on its axis and how to make a sun clock *For the Teacher* • University of Exeter: School of Physics http://newton.ex.ac.uk/teaching/CDHW/egg/ - intro* Science of cooking an egg, background information for teachers, and graphs for students • U.S. Department of Energy, Solar Basics www.eren.doe.gov/RE/solar_basics.html* General information about the use of solar energy • Solar Cookers International http://solarcooking.org* A newsletter format that includes directions for solar cookers • University of Missouri: Drying Foods http://muextension.missouri.edu/xplor/hesguide/foodnut/gh1562.htm* Benefits and methods to drying foods • University of Georgia: Sun Drying www.agen.ufl.edu/~foodsaf/he520.html* Process of drying foods with a solar dryer
Other Resources	

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