



Understanding Energy

Lesson 8: Setting up the Experiment – Solar Water Heating

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DESCRIPTION: Students will set up the experiment that they will use to determine the amount of energy from the sun that can be used to heat water and the variables that can help the exchange of heat most effectively. They will accomplish this through setting up simple water heaters made from water jugs, noting the components that play specific roles in the absorption and trapping of energy received from the sun. During this process, they will discuss these components as specific variables, using scientific language.

GRADE LEVEL(S): 4th, 5th

SUBJECT AREA(S): Energy, solar energy generation, renewable and nonrenewable energy, electricity, light, energy transformation, electricity, photovoltaic

ACTIVITY LENGTH: 40 minutes

LEARNING GOAL(S): Students will use their previous learning about observation and solar power to set up an experiment to determine the amount of heat that can be collected in water containers from the sun. Students will determine three variables that affect the jug's absorption and trapping of energy from the sun. Students will take data measurements from these set ups in order to make evidence-based conclusions from the experiment.

NEXT GENERATION SCIENCE STANDARDS:

- 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

UNIT CONTENT:

- Lesson 1: Energy Sort
- Lesson 2: Brainstorm Energy Sources
- Lesson 3: Energy Basics
- Lesson 4: Home Energy Survey
- Lesson 5: Solar Energy Basics
- Lesson 6: Home Energy Use

- Lesson 7: How to Observe and Keep Records
- **Lesson 8: Setting Up an Experiment**
- Lesson 9: Collecting and Reporting Data, Making Recommendations
- Ongoing Activities: Daily Observations and Record Keeping

Materials List

- Solar energy spiral notebook (1 per student)
- (4) plastic 5-gallon water jugs
- (4) probe thermometers (We used a Hobo onset 4-channel analog logger for our testing)
Note: this logger was purchased with the intention of collecting data remotely from the rooftops. As we only recorded data during the day, outside, regular probe thermometers would have worked just as well)

Vocabulary

- No new vocabulary is introduced in this lesson.

Student Background

- Students will have previous knowledge of the different types of energy and the pros and cons of each type of energy (previous lesson).
- Students will have basic understanding of sources of energy and the fact that solar energy is a renewable source of energy.
- Students will have experience with the probe thermometer and be able to read and record temperature.

Educator Background

- Teacher will need to have knowledge of and access to up to date information regarding solar energy including current uses and the advantages and disadvantages of using solar energy.
- The Solar4RSchools website, solar4rschools.org, has current information and history regarding solar energy production at various sites. Because our school is one of those sites, we will be able to utilize local information from our own school to compare with passive water heater temperature changes.

Lesson Details

Activity – Solar Water Heating

- Class will identify three variables related to the sun heating water.
- Students will prepare and place four water containers in a location at school after recording variables for each container.
- Students will record water temperature in the morning and afternoon for two weeks for

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each container.

- Students will observe recorded information and make inferences about which variable impacted the temperature of the water the most.

Implementation Notes:

- We ended up having each of three classrooms design and construct one container for the experiment and using one unaltered container as a “control”. It turned into a little competition, which worked out fine. The only problem was that two classes had very similar designs.
- We waited until the class designed the water heater and then went out and purchased the supplies. Our classes used black paint, aluminum foil, black duct tape, mirrors, and a large cake pan. It may be simpler to identify supplies that you have available and then give students a list prior to the design process.
- Timing of the experiment is important here. We had to adjust our schedule because we did not have sunshine during the days we had scheduled to collect data. We postponed for one week and got some sunshine and some cloudy days.
- We initially intended on having students design their own water heater but after considering the number of variables that could result we decided to limit the variables by starting with a specific container (five gallon water jug) and limiting design variables to what they did to the jugs. It might be practical to allow more engineering and design with a smaller group of students.



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