



Sunshine in a Box

Grade: 4

Subject Areas:

Life Science, Physical Science, Social Studies

Skills: discussing, predicting, modeling, observing, role playing, critical thinking

Duration: 2-3 hours

Connections: geography, energy, environment, resource management

Vocabulary

nuclear fusion

solar energy

thermal energy

chemical energy

light energy

visible light

conduction

convection

radiation

desertification

deforestation

clear cut

solar ovens

Objective:

Students will construct solar boxes as an investigation into solar energy and will learn how deforestation affects habitats.

Materials

- pictures of deforested areas
- large cardboard boxes that can fit at least 1 large pot
- aluminum foil to line each solar box
- scissors or box cutters for cutting cardboard
- strong tape
- black cooking pots (Dutch ovens work best)
- assorted recipes and ingredients for cooking (Options include cookie dough, muffins, soup, and quick bread)
- water and tea bags (optional)
- large glass jars for making sun tea (optional)
- thermometers (optional)
- a globe (optional)

Standards

Strands: Excellence in Environmental Education Guidelines

Strand 1 — Questioning and Analysis Skills: B) Designing investigations: Learners are able to design simple investigations. **G) Developing explanations:** Learners can develop simple explanations that address their questions about the environment.

Strand 2.1 — The Earth as a Physical System: C) Energy: While they may have little understanding of formal concepts associated with energy, learners are familiar with the basic behavior of some different forms of energy.

Strand 2.3 — Humans and Their Societies: D) Global connections: Learners understand how people are connected at many levels—including the global level—by actions and common responsibilities that concern the environment.

Strand 2.4 — Environment and Society: A) Human/environment interactions: Learners understand that people depend on, change, and are affected by the environment. **C) Resources:** Learners understand the basic concepts of resource and resource distribution.

Strand 3.1 — Analyzing and Investigating: B) Sorting out the consequences of issues: As learners come to understand that environmental and social phenomena are linked, they are able to explore the consequences of issues.

California State Educational Standards:

Life Sciences 3a: Students know ecosystems can be characterized by their living and nonliving components. **3b:** Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

Investigation and Experimentation (I and E) 6c: Students will formulate and justify predictions based on cause-and-effect relationships.

Background

Source of Energy

The sun is a star that is big, bright and hot. Its relationship to Earth sets the seasons and the daily rhythm between night and day. The sun is the ultimate source of energy. Life would not be possible without it since it provides both light and heat.

Like other stars, the sun goes through **nuclear fusion** during which hydrogen atoms are forced together releasing energy in the process. The sun is an average sized small star, but it is massive compared to any of its planets. It makes up 99% of the mass of the entire solar system. From Earth, the sun lies approximately 93 millions miles (110 million kilometers) away. Even at this great distance, Earth receives enormous amounts of energy from it.

Most people think of **solar energy** in terms of solar collectors that heat water. Another type of solar collector is called a photovoltaic cell. These panels collect the sun's energy using silicon, a common chemical element, to convert sunlight into electricity. However, the sun, like other stars, gives off many forms of energy including x-rays, radio waves, and ultraviolet or UV.

Mass is converted to energy in the sun. Once the sun's energy reaches earth it can only change from one form to another. Heat is a form of energy also referred to as **thermal energy** or infrared. The amount of heat received on any given day from the sun depends on how much is lost back into space. In order for a day to feel warm, more heat has to be absorbed than is lost. More heat is absorbed by darker

colored objects compared to light colored ones. Today, people often heat the places in which they live and work by burning fossil fuels like propane or natural gas. In this case **chemical energy** is changed into heat energy. Conversely, if a building is warmed directly from the sun, **light energy** is converted into heat energy.

Visible light is the spectrum of energy that our eyes can see. Visible light can be broken up into its various wavelengths using a prism. Raindrops can act as little prisms; each one breaking up light. This is what causes a rainbow to appear. Plants absorb

red and blue wavelengths of light and reflect green. This is why most plants are green in color. They use the absorbed wavelengths of light (red and blue) to convert sunlight into food. In this case, light energy is converted into chemical energy.

Moving Energy

Sources of energy are very important to humans especially when modern technologies are used, like running electrical appliances and tools. As resources become scarce, humans continually search for new energy

Local Connection

The last largest privately held old growth redwood forest was preserved in 1999 after a long and arduous struggle between politicians, preservationists and Maxxam, the parent company of the Pacific Lumber Company (PL). Today, this fragmented reserve lies six miles south of Eureka and is called the Headwaters Forest Reserve. It occupies 7,472 acres and is protected and managed by the Bureau of Land Management (BLM). It is part of BLM's National Landscape Conservation System and restoration efforts have been implemented.

Prior to 2009, PL located in Scotia, managed the largest remaining area of unprotected redwood forests in the world. Before being owned by Maxxam, the company had good relations with its employees and attempted to log somewhat sustainably. Once Maxxam was in charge however, yield was increased in an attempt to pay off junk bonds and other debt. Clear cutting of redwood forests reached an unprecedented level. Destructive logging practices choked nearby salmon spawning rivers and created massive landslides including one that ruined 6 houses outside of Stafford.

Tension between the logging community and local preservationists heightened and national attention was brought to the cause. After more than a dozen years of hard work, dedication and collaboration between activists, environmental organizations and politicians a deal was reached. The state and federal government spent \$480 million dollars to buy out Maxxam and other land owners through the Headwaters deal. Much of the land has restricted access in an attempt to provide critical habitat for several endangered species including the marbled murrelet, the northern spotted owl and the Coho Salmon.

sources. Today, we are digging deeper for oil, converting food crops and waste material to biofuels, and erecting wind farms in more places. It is easy to overlook the fact that all of these energy sources are directly linked to the sun too.

Energy is transferred between objects three main ways; conduction, convection and radiation. **Conduction** transfers energy through direct touch. When heating a pot of water on a stove top for example, the pot touches a burner. **Convection** is the transfer of energy by movement of materials of different densities. This energy transfer is harder to see, but happens all the time in fluids like air and water. During convection, warm layers rise and cold layers sink; mixing as they move. **Radiation** transfers energy across open spaces through waves, as when you feel heat from the sun. You don't need to touch a hot object to feel the heat radiating from it. In this case, your hand is warmed by the travelling heat waves that have reached it. Our weather is influenced by how the sun's energy transfers heat through space to the surface of the earth and the surrounding atmosphere.

Areas near the equator receive the most direct sunlight throughout the year, and the polar regions the least. Abundant heat energy at equatorial regions causes water to evaporate from the surface. Evaporation creates moisture in the air, increasing humidity. Because of abundant moisture and mild temperatures all year long, tropical rainforests can support a high number of plants and animals or species diversity. Unfortunately, most tropical rainforests are being cut down at alarming rates to clear land for agriculture, lumber and road

building due to growing human population pressures.

From Forest to Desert

Desertification is the process by which a landscape is changed to desert-like conditions by the removal of vegetation or poor land management practices. One way this happens is through **deforestation**; the removal of forests. When trees are removed, the relationship of solar radiation with the land changes. An increase in solar exposure heats up land and surface water and reduces humidity. Such places not only become warmer but drier too. Some scientist fear so many tropical forests are being cleared that a certain threshold will be reached whereby the land will change into a savannah-like environment. Today, many tropical regions are experiencing droughts. These droughts may be directly tied to decreased forest cover.

The forests of northern California have felt the impacts of deforestation as well. A common timber practice is to clear cut patches of forests. A **clear cut** removes all trees in a cut over region instead of selectively cutting trees. Clear cuts, especially large ones, heavily impact the environment in many ways. For instance, plants that normally rely on shade are suddenly exposed to a lot more solar radiation. Excess exposure to the more heat and less humidity causes stress and some plants die, including tree seedlings. In addition, many animals depend on trees, especially mature ones. Large trees and other vegetation provide necessary food, shelter and protection for wildlife.

One area that has been negatively impacted by logging is the Mattole River watershed. Here, 91% of the old growth timber is gone. Clear cuts and other poor land management practices have increased erosion and have decreased the quality of water in the local streams. When vegetation is removed from the edges of streams, fish, especially salmon, are negatively impacted. By removing shade,

water temperature is increased. Salmon need cool water to survive. In addition, leaves that fall into a stream provide food for insects—the main food for salmon. Lastly, trees when they die may fall into the water creating woody debris. Pieces of wood provide hiding places for fish and slowwater creating calm pools of water where fish can rest. Without trees, fish and other animals that depend on fish, become stressed and may eventually die.

Half of all people living today still depend on wood fires for cooking. Where deforestation is high, so many trees have been removed people must travel miles every day to collect wood. In some places wood is so scarce firewood rations have been reduced to a few sticks every two weeks. Over population and exploitation have put pressure on diminishing resources. An alternative to using firewood is the use of solar ovens. **Solar ovens** collect sunlight to cook food or heat water. They save money, decrease deforestation, and provide food to otherwise desperate families. Many non-profit organizations are helping by replanting trees, educating people and supplying materials to make solar ovens.

When food is cooked, all three ways of energy transfer are used. If you bake cookies in a solar oven, for instance, solar energy is transferred to the oven through radiation. The cookies receive heat directly from the metal cookie sheet they sit upon through conduction. As an oven heats up, the different temperatures circulate the air inside the oven warming it through convection. When solar ovens are used to cook food, the food may take a little longer to cook, but resources like trees are saved and deforestation is reduced. Utilizing the sun's energy in a passive way is free and can be one step closer to promoting a more sustainable way of life.

Activity: Making Solar Ovens

Preparation

Students will have the greatest success cooking food on a sunny day. It is recommended to make a solar oven ahead of time to bring in as an example. If you don't have black pots, black paper can be wrapped around a pot or the pot can be painted black. Get necessary ingredients together ahead of time for selected menu.

Materials

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- large glass jars for making sun tea (optional)
- thermometers (optional)
- a globe (optional)

Procedure

1. First discuss with the students types of energy emphasizing solar energy. Encourage them to give examples of how the sun benefits people and other organisms. Ask the students questions about the sun, the different types of energy it radiates, and how different parts of the globe receive different degrees of solar radiation.

- *Has anybody ever been sun burned?*
- *What causes a sun burn?*
- *What are some different forms of energy we receive from the sun? (UV, heat, light)*
- *What do you think of when I say the words "solar energy"?*
- *What can we use solar energy for?*
- *Can all places in the world use solar energy for power?*
- *What parts of Earth receive the majority of sunlight?*
- *What parts receive very little sunlight during most of the year? (Optional: hold up a globe as you discuss different areas)*
- *What would happen if we left water out in the sun?*
- *Can somebody alter a landscape to allow it to get more light?*
- *Why is the sun considered the ultimate source of energy for life?*

2. During questioning, write some students responses on the board.

An option is to write a KWL chart. (K = What they already know, W = What they want

to know, L = What they have learned). Begin to discuss various ecosystems (deserts, rainforests, tundra, etc.) and compare ones that receive more light and heat than others.

For instance, polar regions receive very little energy from the sun versus tropical regions. An option is to have the students take notes.

3. Next, focus on some ecological differences between different regions. Have the students predict what types of vegetation might live



Activity continued...

in various places that receive more or less light. Explain, how humans can change the landscape as they convert forests to cropland or timber. Define deforestation and desertification. Give some examples of each.

4. Spend some time talking about local forest issues and the effects clear cuts can have on an environment. Next, share with the students the fact that 50% of people today, depend on firewood for cooking. Ask them to predict what would happen if a lot of people year after year harvest wood from the same region. Ask the students to come up with solutions to deforestation. What types of things can be done to decrease the amount of wood needed by people especially people who live in places that receive plenty of sunshine?

5. Next, turn the attention towards solar ovens

and the benefits they have especially in deforested regions. Before they begin, have them write down the three ways energy is transferred. You may want to relate these things to a solar oven and draw a quick sketch on the board. Break the students into groups and set some clear guidelines and expectations. Every student should have a specific duty.

6. Take the students outside. Explain to them how to make a solar cooker and what they will be cooking. The menu needs to be selected ahead of time. An easy thing to make is sun tea. This can be started now and then drunk with their muffins at the end.

7. After the solar ovens are assembled, have the students think about the three ways energy is transferred and how they apply to cooking their food. During the waiting period necessary for cooking, you may want to ask them what they have observed.

Solar Cooker Instructions

1. Have the students work in groups. An adult or responsible student should cut away one side of a box using a box cutter. The box should open up on one side so that it becomes triangular in shape. Have another student or two line the inside with foil using tape. While a few students are lining the box, have others prepare the food. Have them place the food in the cut-away box and tilt it in order to receive the most direct sunlight. It should be in the open away from shadows.

2. Place the food in a black pot and cover. Let sit for proper cooking time. You may want to have a

thermometer in each oven to record temperatures.

3. Once the solar ovens are set up, have the students monitor cooking. While the students wait for the food to cook, have something for them to do during idle time. Here are some options:

a. Have the students sketch their oven including where the sun is relative to their solar oven. They should label ways of energy transfer.

b. Have the students compare oven temperatures and times for cooking food. They should predict ahead of time which oven will heat the fastest and why. Share these student predictions and evaluations at the end of the activity.

c. Vary the types of food put in each oven and have students make predictions about which ones will cook faster or slower and why they think so. Once all food has been cooked, have the students eat the solar cooked food.

4. In conclusion, have the students share what they have learned during the cooking process. Relate the solar ovens to deforestation and how cooking with solar power can help reduce logging and collection of firewood. Review some of the early concepts about clear cutting and how it changes the forest.

Extensions

- Compare the different temperatures of dark vs. light colored containers. Have the students graph their results.
- Chart the angle and direction of the sun over a few weeks time to note the change in seasons.
- Make a sundial and place it on campus.
- Promote a solar day at school by having a variety of resources supporting solar energy.
- Research the amount of solar radiation and/or rainfall for different parts of the world.
- Study different types of cooking fuels, where they are from, and their effects on the environment.
- Raise money to help promote and distribute solar ovens to needed communities around the world.

References

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