Solar Energy

This lesson will introduce students to the concept the Sun provides energy to Earth and all living things. Through experiments, students will see how people can capture its energy to create heat.

Grade Level: 2nd Grade

Phenomena:
How can we use the sun to create energy?

Objectives:

- Students will examine the Sun as a source of power that creates heat for living things on Earth.
- Students will analyze the conditions that cause heat absorption from the sun.
- Students will accurately formulate observations and record procedures in science journals.
- Students will analyze and justify three things that need the sun's energy to live.

Materials:

- Two thermometers
- One black & one white cup
- Rubber bands (package)
- 10 black & 10 white laminated index size cards
- Crushed ice
- Two solar ovens
- One Solar booklets/students
- Sun picture cut out
- Small tortilla chips
- Shredded cheddar cheese

Time Considerations:
Preparations: 15 minutes
Lesson Time: 50-60 minutes
Activity 1: 10 minutes
Activity 2: 5 minutes
Activity 3: 5 minutes
Activity 4: 10 minutes
Activity 5: 10 minutes
Activity 6: 10 minutes
Conclusion: 10 Minutes

Related Lesson Plans:

Nevada Outdoor School . org

Next Generation Science Standards

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function
as needed to solve a given problem.

Science and Engineering Practices (SEP):
Developing and using models.

Disciplinary Core Ideas:
Developing possible solutions.

Crosscutting Concepts:
Structure and Function

Excellence in Environmental Education Guidelines

Strand 1—Questioning, Analysis, and Interpretation Skills :
F) Working with models and simulations—Learners
understand many of the uses and limitations of models

Describe how models are used to think about long-term processes

Background

Earth has received solar energy since its formation four billion years ago. All living and non-living things rely on energy from the Sun to carry out their daily processes and activities. Plants directly rely on sunlight to create food through photosynthesis. Plants then pass this on through food webs via consumers. Non-living things also rely of solar energy to complete their processes that are relied upon by living things, such as the movement of water through the water cycle. Without the continual radiation from the Sun, water would be locked up in ice and life would cease to exist as we know it.

So what exactly is solar energy and why do people depend on it so much? "Solar energy is the sun's rays (solar radiation) that reach the Earth. This energy can be converted into other forms of energy, such as heat and electricity" *(U.S. Energy Information Administration Energy Kids).*

People across the world are seeking alternative energy sources in an effort to decrease the use of fossil fuels, restore the ozone layer, and reduce the overall dependence upon one type of energy source. Solar energy is one renewable resource that meets this goal.

Solar energy is used primarily as thermal (heat) energy, and electricity. Thermal energy can be use to “heat water — for use in homes, buildings, or swimming pools” or to “heat spaces — inside homes, greenhouses, and other buildings” *(U.S. Energy Information Administration Energy Kids).*
Electricity is produced using solar energy in two ways, photovoltaic cells and concentrating solar power plants. “Photovoltaic cells change sunlight directly into electricity” . . . which can be “used in a wide range of applications ranging from single small cells that charge calculator and watch batteries, to systems that power single homes, to large power plants covering many acres” *(U.S. Energy Information Administration Energy Kids).*

Concentrating solar power plants “generate electricity by using the heat from solar thermal collectors to heat a fluid which produces steam that is used to power the generator. Out of the 11 known concentrating solar power generating units operating in the United States at the end of 2008, 9 of these are in California, 1 in Arizona, and 1 in Nevada” *(U.S. Energy Information Administration Energy Kids).*

People also use solar energy for more recreational activities, such as solar ovens. Solar ovens have been used for a long time. One of the first known uses of solar hot boxes was by the cooks of the Roman Emperor Tiberius, who wanted to eat cucumbers all year round. The cooks satisfied his regal appetite by using a solar hot box, a kind of flat plate collector, to grow the cucumbers all winter long! In the 1830s, the British astronomer John Herschel used a solar collector box to cook food during an expedition to Africa. Nowadays, one can buy commercial solar ovens, ranging from small single dish units, to large units that can feed many people at once and that have to be hauled around on a trailer.

The ovens students will explore utilize the concept of passive solar design. Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces. Two main principles of passive solar design that are demonstrated by the pizza box solar ovens are solar gain and insulation.

Solar gain is arranging for sunlight to enter a device as a source of energy. In this case, the gain is accomplished both by reflection and direct gain of sunlight. This principle includes using dark colored surfaces to absorb the solar energy entering the device.

Insulation is containing heat by trapping air inside and reflecting thermal radiation back into the device. This principle is reached by covering the inside of the pizza box completely in tin foil and taping plastic wrap over the opening.

Solar gain and insulation is also seen in the Water Baths experiment. The use of a dark color cup (black preferably), absorbs solar energy entering the cup and heat is captured or kept insulated by the plastic wrap covering the top of the cup.

The principle of solar gain is again reinforced in the Melting Color experiment. The ice cube on the black piece of paper melts faster due to the larger amount of solar energy absorbed in the dark colored paper.

In this lesson, students will have the opportunity to explore the properties of solar energy and become aware of how this renewable resource is used in our everyday lives.
Before the lesson, construct all needed supplies for the experiments. Building instructions and pictures of the experiment designs can be found on page 6 and 7 of this lesson. Before the lesson, test each experiment.

Preparation

Locate a sunny place outside and set up the solar oven experiment. This location should be large enough to host the other experiment outdoors, *melting colors.*

Solar Oven Set Up*:* Place small tortilla chips inside the oven. Sprinkle cheese over the chips. Raise the reflective flap at an angle so that sunlight is being directed inside the box.

Post a note on or next to the experiment that directs people to leave the experiment alone.

An overcast sky will still allow enough solar energy to stream through to conduct the experiment. (If the weather prevents the lesson from being outdoors, you can bring a heating lamp to conduct the experiment indoors.)

***Water Baths Set Up**:* (This experiment can be done indoors or outdoors.) Since time management is essential, set up the experiment prior to the lesson in the window sill inside the classroom. Be sure to use water out of a water bottle we bring in not the tap water (temperature will be too cold). In one black and white cup put equal amounts of water and place it in the window sill in a sunny location.
Place one solar booklet on each desk for students to use immediately.

Doing the Activity

Activity 1: Introduction
Begin by writing the word energy on the board. Ask students to quickly share with their neighbor what energy is and its meaning. Allow students to then share their thoughts with the class. Ask how does energy affect you?

Summarize and pick out key points from their thoughts, and finally write the definition on the board. ***Energy is the ability for living things to change and move.***

Ask students if there are many types of energy or does all energy come in one form. Students may list electricity, solar, wind, fuel, etc… all of which is
correct. Explain today the class is going to investigate one type of energy that all living things on Earth need every day - the Sun (Solar Energy).
Students will conduct two solar energy experiments, make hypotheses, record their observations and interpret their results. The goal of each experiment is to attempt to harness or use solar energy to do work.

Summarize each of the experiments to the class: 1) will test whether or not solar energy can be used to cook food, and 2) will test whether certain

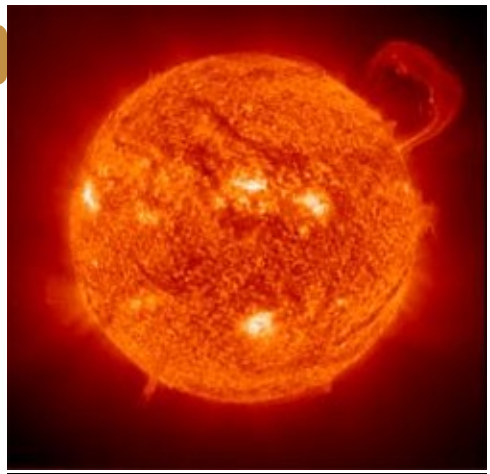


Fig. 1—Solar Energy http://www.energyquest.ca.gov/story/

colors collect more solar energy than others.

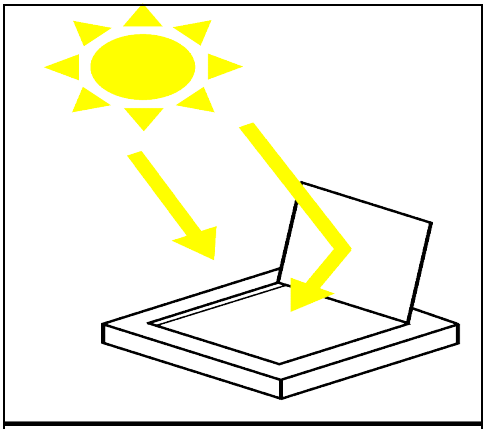
Students will record their observations and results in their solar booklets. At the completion of the lesson, students will be able to answer the summary questions found on page 4. Before beginning the experiments review how these booklets will be used with the class.

Activity 2: Experiment Intro
Experiment 1: Solar Ovens
Explain the goal of this experiment is to test whether or not solar energy can be used to cook food. This experiment is already in the process outside.

Show the class a replica of the experiment (minus the food). Allow students to carefully observe the different parts. Open up discussion at tables about how a solar oven can 1) capture
energy and 2) how that energy is used to cook food.

Bring the class back together and quickly call on 2-3 students to share their thoughts. Students then are to record their predictions in their booklets and sketch the solar oven under observations.
Experiment 2: Melting Colors
Explain to students the second experiment will test if certain colors collect more or less of solar energy than other colors. This experiment will be set up outside and completed by the students. More information as to how to do this experiment will be given outdoors in a sunny place.

Once these introductions are made, remind students to bring their solar booklets and pencils with them as the class moves outdoors. As the class moves outdoors, have students focus



http://www.nmsea.org/Curriculum/4_6/pizza_box_oven/pizza_box_ovens.htm

their thoughts on the first experiment: Solar Ovens.

Activity 3:
Solar Oven Experiment

Gather students around the solar oven. Depending on class size, have students peer into the oven or walk the oven around the group. Ask students to share their observations with the class. Is anything happening inside? Were the predictions made inside correct?

On a sunny day, students should see condensation on the plastic wrap and feel the warmth of the oven especially on the bottom side.

Take two minutes for students to write or draw their observations in their solar booklets. Explain to the class this experiment will continue and the final results will be viewed at the end class.

Activity 4: Melting Colors

Gather students in an open area near by the other experiments. Explain that in partners, they will be setting up their final experiment! This one will test to see if certain colors can collect more solar energy than others colors.

Before dismissing students and handing out materials demonstrate the experiment should be set up and what students need to record in their solar booklets. Also, designate where students should meet when they are finished.

To begin partners will receive two laminated cards (one white & one black), and two rubber bands.

Groups can then find a ***sunny*** space of their own to set up their experiment. Partners next will lay both cards beside each other on the ground. Next, lay open one rubber bands, on the top of each card. *The rubber bands act as a fence that keeps the ice on the paper as it begins to melt.*

After these materials are set up, ***one partner*** needs to return to the instructor to get 2 pieces of similar size ice to bring back to their experiment. The ice is then placed inside the stretched out rubber band.

When these steps are done, students are to draw their experiment in their solar booklet.

As groups finish, remind students to leave their pencils/ booklets by their experiment. Gather students in an open area to play a short running activity. Explain to the class, that in a few minutes they will return to this experiment and discuss the results. Groups may need to place rocks on their experiments if it is a breezy day.

Activity 5: Sunlight, No Sunlight
Sunlight, No Light Game

Direct students to stand in a straight line, shoulder to shoulder preferably along a crack in natural line in the ground. This line will act as the starting line for the next activity. Ask the class, what things on Earth require the Sun's energy? ALL LIVING THINGS!

In this activity, students will demonstrate with motions, the idea that all living things need energy from the Sun. Students will choose and act out a living thing of their choice during the course of the game. During the debrief, students will share how their living thing actually uses the Sun's energy.

How to play: Similar to the childhood game, *Red Light, Green Light* the goal is to be the first to tag the person calling out instructions. In this case, this person will be known as the "Sun" (the instructor). The Sun should stand roughly 20 yards from the starting line. This line is where the students or living things stand to start the game.

Students may only move forward when the Sun shouts ***Sunlight!*** As soon as ***No Sunlight!*** is called, all students must freeze. Any person caught moving is sent back to the starting line to start again. The students motion towards the Sun, represents their living thing use of solar energy.

Activity 6:
Experiment Round Up

Gather the class and tell students it is time to collect the results from each experiment. Students will actually only collect results from Melting Colors. The instructor will bring

the solar oven inside the classroom to discuss results.

Melting Colors
When dismissing students back to this experiment, explain each person is to observe which ice cube melted more and sketch a final picture of the experiment in their Solar Booklet. As the materials are gathered, allow students to freely discuss how and why the ice melted as it did with their partner or group mates.
Further discussion will happen back inside the classroom.

Conclusion

Conclusion
In the classroom, discuss the two experiment's results beginning with Melting Colors and finishing with the Solar Oven. Discuss the solar oven last, so students can use their conclusions from the Melting Colors experiment to explain their ideas as to how the solar oven actually works.

Refer to the background information on page one and two of this lesson for a description of how each experiment works.

Melting Colors
Continue the discussion that began outside about why one ice cube melted more than the other.
Connect the thought that there is more energy absorption in dark colors than light colors and how it may feel to wear a black shirt versus a white shirt on a hot summer day.

Solar Ovens
Connect students to the Solar Oven Experiment by asking them if they think color may have played a role in how the solar oven captures energy and how it works.

Before allowing students to look inside the solar oven, close the flap and ask students what they believe should have happened to the food inside?

Direct students to their sketch of the oven in their solar booklets. Based on their sketches, observations, and new found knowledge have students explain to their neighbor how this solar oven works. Allow one or two
students to share their thoughts and summarize their findings with how the oven functions using solar energy.

After having some students share, explain clearly how the solar oven captures energy and creates heat. Question students on what a the difference would be if the solar oven were made with white paper inside instead of black/dark paper. Conclude the lesson by asking students what kind of energy source did we study today?

Have various students share with the class/pair share what they learned about solar energy today.

As a class, call on students to name something that needs the Sun's energy to live, and why. Pass out chips and cheese after asking for allergies among students.

**Time permitting: Share with students that you have set up one more experiment in the classroom and now to test their knowledge on solar energy, you are going to observe the experiment and record their thoughts.

Share with students the set up of the experiment with a black and white cup, explaining that it is the same amount of water and started at the same temperature.

Tell students it is called the Water Temperature Experiment.

Ask students to record in the Solar Booklets what they think may have happened during the time we were working on the other two experiments?
Assess students with this experiment having students choose which cup would have the warmer water based on what they have learned today.

If they think the black cup is warmer, have them stand on one side of the room and if they think the white cup is warmer, have them stand on the other side of the room.

Question students on why they chose what they did and if any students are unclear on this idea have another student explain their knowledge in different words.

Assessment

Assess students are their responses throughout the lesson in regards to how the experiments are connected to one another.

Collect and review information recorded in the solar booklets. Assess the student's ability to use terms in their notes and

explanation of their observations.

Extensions

Sunlight/Heat Game:

Review the fact that color can play a major role on the sun either being absorbed or reflected and compare students based on what they are wearing.

Hand motions showing sunlight/ heat being reflected, and being absorbed can be done to help students better make that connection.

Walk around the room or have a few students come to the front of the room and point at one with a light colored shirt. Look for students to do the reflected motion. Then use a student wearing a dark shirt and have students show the absorbing motion.

Vocabulary

Solar Energy: energy from the sun that can be used for heating and generating electricity.

Sunlight: the light of the sun

Thermal: to do with heat or holding in heat.

Insulation: a material that reduces or prevents the transmission of heat or sound or electricity.

Renewable Resource: power from sources that can never be used up, such as wind, waves, and the sun.

Sources

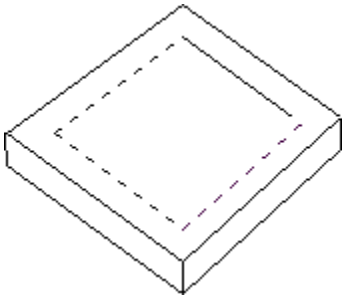
- In *U.S. Energy Information Administration Energy Kids*. Retrieved Dec. 1, 2010, from http://www.eia.doe.gov/kids/energy.cfm?page=solar_home-basics
- (2003, Jul. 27). In *Make A Pizza Box Solar Oven*. Retrieved Dec. 3, 2010, from http://www.solarnow.org/pizzabx.htm
- Glasthal, J. B, & S. Wolinsky. (1996). *Scholastic Children's Dictionary*. New York, New York: Scholastic Inc..

Images:
Fig. 1. Solar Energy http://www.energyquest.ca.gov/story/
Fig. 2. http://www.nmsea.org/Curriculum/4_6/pizza_box_oven/pizza_box_ovens.htm

Pizza Box Solar Oven Instructions

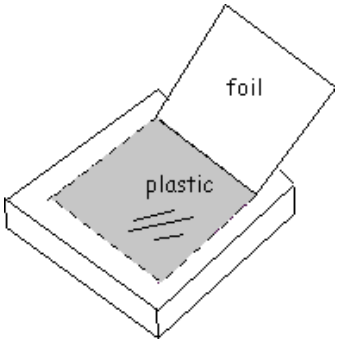
1. Assemble the pizza box and open it up.

2. Glue aluminum foil to all inside surfaces of the sides except the top of the box, with the shiny surface facing in. This will create a "radiation trap" that will trap, by reflection, invisible (low-frequency) radiation that is given off by the food and air inside the box.



3. On the top flap of the pizza box draw a square with edges spaced 1" from the four sides of the box (use a marker to make the square).

4. Cut along three of the lines, on the sides and on the front edge of the box, leaving the fourth line along the box's hinge uncut. Then fold open the flap, making a crease on the fourth line (see the figure below). Note: Extra supervision may be needed during this step, because students often cut along the fourth line as well by mistake.

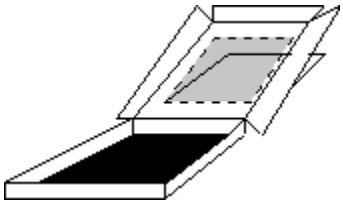


5. Glue aluminum foil to the inside surface of the top flap, with shiny side visible! This will form a reflector, to reflect sunlight into the oven. Be careful to make as few wrinkles as possible and smooth out whatever wrinkles occur.

6. Tape the black construction paper to the bottom of the box. This will help to absorb the incoming sunlight.

7. Carefully stretch the plastic wrap over the opening of the box, sealing the edges with tape to seal the air in.

8. Cover any air leaks around the box edges with tape, making sure that the box can still be opened (so that you can place food inside the box and remove it later).

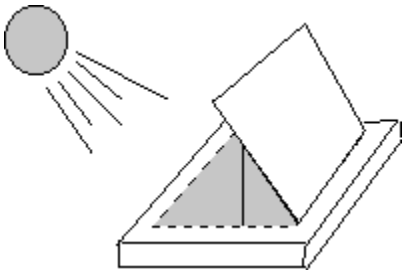


9. Go outside in the sunlight and place oven on a flat, level surface.

10. Place food on some foil (or a paper plate) and place inside the oven.

11. Use string and masking tape to tie back and adjust the reflector, so that sunlight is reflected into the oven, and especially onto the pie tin.

12. Let food cook, and check reflector angle now and then to make sure sunlight is getting inside the oven.

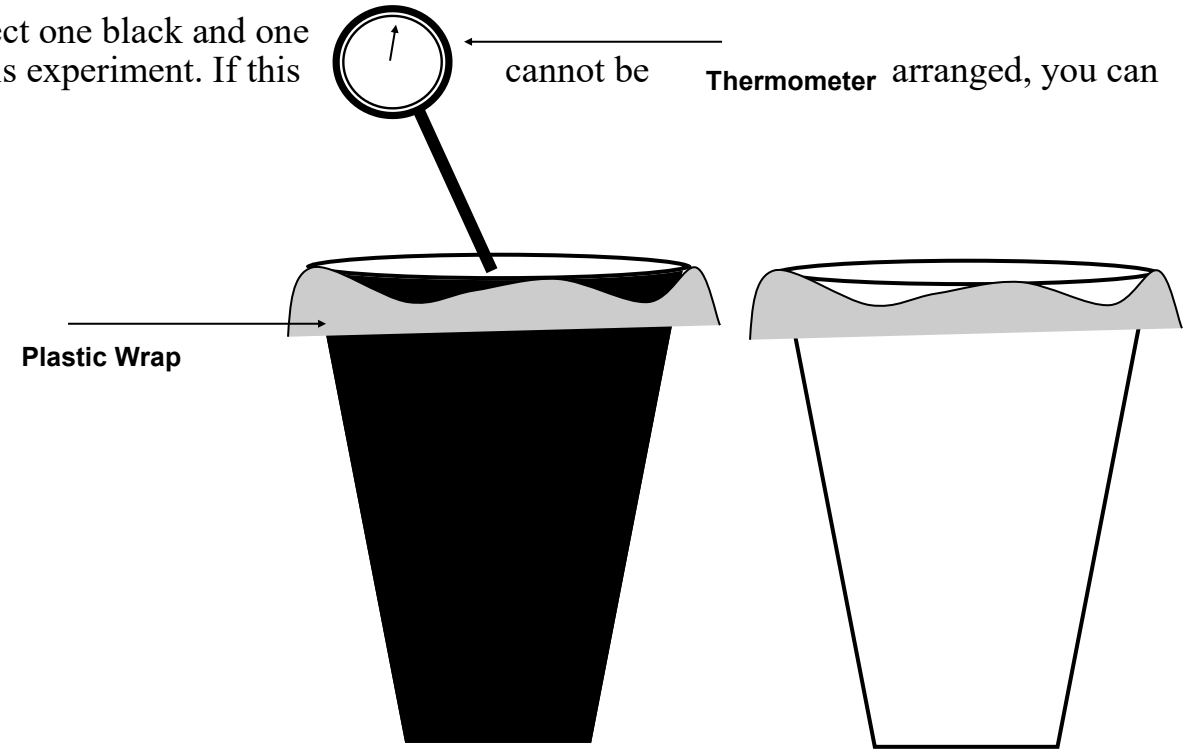


Enjoy your solar treat!

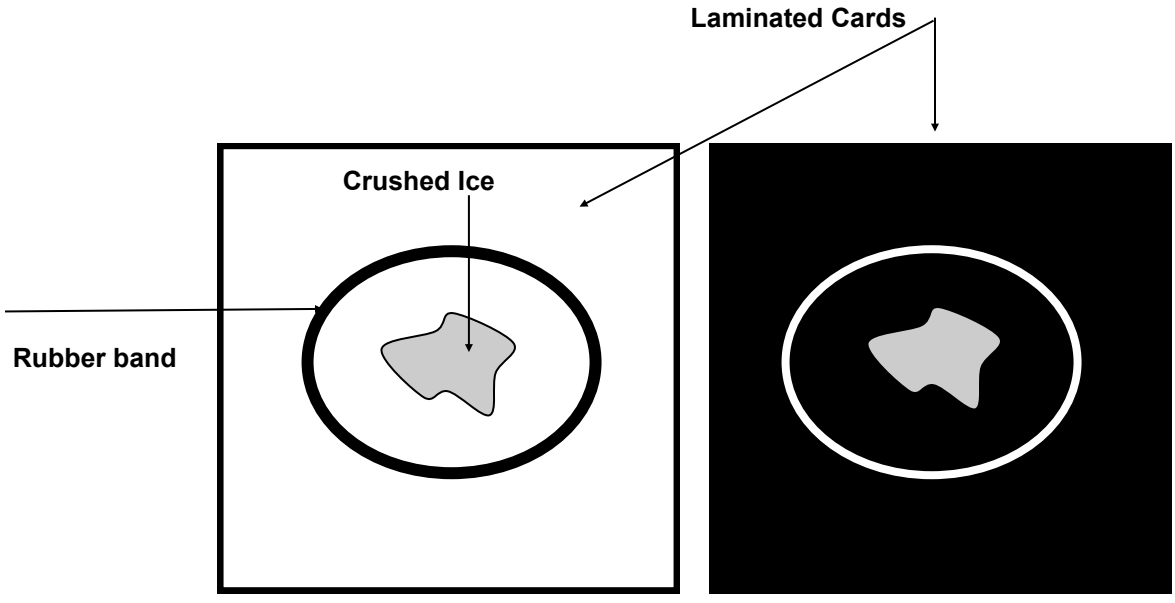
Pictures used from (2003, Jul. 27). In *Make A Pizza Box Solar Oven*. Retrieved Dec. 3, 2010, from http://www.solarnow.org/pizzabx.htm

Water Baths

If possible, collect one black and one white cup for this experiment. If this cannot be arranged, you can



Melting Colors



Solar Booklets

1

Solar Ovens!

Prediction:
Can people use the sun to cook food?
YES or No

Draw it!

What happened?

2

Melting Colors!

Prediction:
Which colored paper will melt the most ice? **Black or White**

Draw it!

What happened?

Water & Sun!

Prediction:
Which water glass will warm faster?
Glass A or B

Draw it!

What happened?

3