

Earth Systems Standard 6, Objective 1

Title: Solar Cookies

Background Knowledge:

Students should be familiar with the green house effect and global warming. They should have had some experience with heating and cooling different surfaces.

Brief Activity Description:

Students will build solar ovens to bake a cookie. This activity is best scheduled at the very end of the school year when the weather is consistently warmer. The last couple weeks in May is best.

Objective:

Students will better understand how solar radiation is reflected and absorbed by different surfaces. They will also learn how to model the greenhouse effect and global warming to their advantage as they heat an oven.

Materials:

It is best to have students bring in the majority of their materials from home, and grade them on their preparedness with materials each class workday. You should provide: 20 glass thermometers (130 C), TI-83's, CBL temperature probes (these can be somewhat slow in monitoring, and should be used by those students for whom the glass thermometers are insufficient in reading the high temperatures their ovens reach), computer lab/library, raw cookie dough, one cooked cookie. Warn student NOT to bring boxes larger than 50 cm by 50 cm.

Time Needed

Time	Activity
55 minutes	Computer Research/Planning
50 minutes	Oven Building
25 minutes/25 minutes	Oven Building/Oven Testing
25 minutes/25 minutes	Oven Changes/Oven Testing
50 minutes	Final Testing/Cookie Baking
Total: One Week*	

*Although this activity can be finished in one week, it is safe to plan at least a two-week span to place this activity, reason being, it is weather sensitive. Warm sunny days are much more effective and pleasant for teacher and student. You should be flexible about scheduling your trials on days that are warm and sunny.

Safety/Security Issues:

Be sure students treat computers/calculators/CBL's with respect. Make sure all the equipment is signed out by the students using it. At the end of the class period be sure all equipment is accounted for. Encourage students to be careful with the glass thermometers, they have a tendency to break easily being transported in and out of the building. You should also encourage students to be careful with all of their materials. With so many students building ovens materials tend to get misplaced/stolen/borrowed

etc. Also when students are testing their ovens be sure they protect themselves appropriately from the sun, wear sufficient clothing, sunscreen etc.

Teacher Procedures:

1. Run off student sheets.
2. Reserve computer/library time.
3. When students arrive in class pull out a warm chocolate chip cookie and begin eating it in front of them. Allow them to groan and claim “unfair” until you have finished eating the cookie.
4. Tell your students that in a couple weeks they will each get their own cookie to bake, but how delicious it turns out will be determined by their hard work and ingenuity.
5. Pass out the student sheet to students. Allow them to read through the “background information” and “purpose.” Discuss the lab with students.
6. You may want to give the students the option of doing this activity with a partner or alone.
7. Explain to students that they will be in charge of providing and keeping track of all of their own materials. They will be graded 10 points for participation/preparedness/efficiency each day.
8. Go over the grading rubric with students so that they are aware of all the project requirements. The size limitation will help your room from filling up with huge ovens.
9. Allow students their research time. Monitor student progress and ideas.
10. Test ovens outdoors. Students should bring thermometers with them. The thermometers should be inside their oven in a readable position so they do not have to remove them to record the temperature data.
11. Call out the minutes for students to record. Encourage them to look for problems with their ovens, to look at other student’s ovens that are successful and see what works. Students should use all available resources, parents, boy-scout manuals etc. You might also help students understand how to tilt their ovens towards the sunlight to allow the maximum radiation inside.
12. Note: An oven can be made to accomplish this. One very important key to a successful oven is insulation. Usually you will find 2-3 ovens per class period will be able to cook the cookie in the allotted time.
13. Stress to students the importance of learning from each trial and modifying their plan to make their oven better each time.
14. If you find your students need something besides their ovens to focus their attention on while they are outside, make sure they bring their labs with them and they can work on their analysis questions.
15. Obtain cookie dough from grocery store the night before the final test.
16. Allow cookie dough to come to room temperature before the testing. Cut cookie dough and give one cookie to each oven.
17. Give students as much time as the class period allows to bake their cookies. The more success the better!!

Sample Scoring Guide:

*See rubric on student sheet. Answers to **Analysis Questions and Conclusions** will vary.*

PROCEDURES:

List all of the steps you will take to build your oven. Remember to include researching steps and revisions. This list of procedures will probably need to be added to as you continue through your project. You may want to use the internet for ideas on how to build your oven. The following are some sample sites:

<http://www.humboldt.edu/~ccat/renew/ovninst.html>, <http://solarcooking.org/plans.htm>,

<http://wattwatchers.utep.edu/cook.html>,

<http://plaza12.mbn.or.jp/%7Esolarcooking/ehowto.htm>,

<http://www.knowledgehound.com/topics/solarcoo.htm#building>

OR. . .Do your own search under “solar ovens” or “solar baking” OR. . .Just be creative and make up your own idea!!

EXPERIMENTAL DESIGN:

Draw a picture of your oven and label all parts and functions.

HYPOTHESIS:

Write an “If and then” statement describing how you will construct your oven, how hot you think it will rise in degrees Celsius, and how long it will take to bake. **(Note: in order to cook a cookie in this amount of time your oven should reach around 130 Celsius in about 5-8 minutes and maintain that temperature for 25 minutes)**

DATA and OBSERVATIONS:

Test Trial 1: Quantitative (numerical) Data

TIME minutes	TEMP celsius	TIME	TEMP	TIME	TEMP	TIME	TEMP
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Test Trial 1-Qualitative (written observations, what worked with your oven, what didn't)
Data:

Test Trial 2:Quantitative Data

TIME minutes	TEMP celsius	TIME	TEMP	TIME	TEMP	TIME	TEMP
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Test Trial 2-Qualitative Data:

Final Cooking-Quantitative Data

TIME minutes	TEMP celsius	TIME	TEMP	TIME	TEMP	TIME	TEMP	TIME	TEMP
1		8		15		22		29	
2		9		16		23		30	
3		10		17		24		31	
4		11		18		25		32	
5		12		19		26		33	
6		13		20		27		34	
7		14		21		28		35	

Final Cooking-Qualitative Data:

DATA ANALYSIS QUESTIONS:

1. Explain how and why your solar oven worked.
2. Explain the difficulties you had to overcome in designing and making it work. What did you change about it and why?
3. Do you think cooking by solar oven is an appropriate way to conserve fossil fuels? Explain your answer.
4. How did you apply what you know about the greenhouse effect to make your oven more efficient?
5. Explain how your knowledge of solar radiation transfer on different surfaces of the earth helped you build an oven that was the most efficient.
6. What resource was most helpful to you in designing your oven and why?

7. What did you learn from this lab about “if at first you don’t succeed, try, try again?”

8. Explain how the steps you undertook to create a working oven are similar or different to the steps scientists take when trying to solve a problem.

9. Explain how you used the scientific method in this lab.

10. Maximum Temperature Reached _____ Time To Bake _____

CONCLUSIONS:

Explain if your hypothesis was right or wrong. If right explain why and elaborate on how you could improve your solar oven. If wrong, explain why and what you could do differently to possibly make it work.

GRADING SCALE/RUBRIC:

Requirement	Points Possible	Points Received
In class participation, effort, preparation, materials present, positive attitude etc (10 points available daily)	50	
Quality (A-temp of 150 reached, cookie cooked; B-temp of 120 reached cookie partially cooked; C-temp of 90 reached)	30	
Originality in design of the oven	7	
Hypothesis: If and then statement describing oven design, specific temperatures and times for anticipated baking	3	
Materials: All listed and purpose and function of each described	5	
Procedures listed: Complete list of all steps taken	5	
Experimental Design: Drawn and labeled	5	
Oven is correct size (no bigger than 50 cm x 50 cm.	5	
Data and Observations: Quantitative recorded and detailed qualitative descriptions	10	
Analysis Questions: Answered thoroughly and correctly	20	
Conclusions: Used complete sentences, elaborated, and proposed ideas for improvement	10	
Total	150	