



The solar oven project

PROJECT OVERVIEW

Name of Project: Solar Oven		Duration:
Subject/Course: Physics	Teacher(s): Mrs. Y. Cancel-Sánchez School: The Academy of Science and Entrepreneurship	Grade Level: High school
Other subject areas to be included, if any:	Algebra II	
Project Idea Summary of the issue, challenge, investigation, scenario, or problem:	The project purpose is to design an efficient solar oven which is accessible and affordable. The design must be compact and efficient using only the sunlight. The final design must include the drawings, oven area, materials used, shape used, calculations and quantitative explanations that justify the best design. The solar oven diagram must be drawn into a 8.5"x11" paper. The final project must be submitted in the engineering notebook provided in order to complete the project.	
Driving Question	How can the students design an energy efficient solar oven?	
Content and Skills Standards to be addressed:	<p>Physics Standard 3: Temperature and Thermal Energy Transfer Describe and distinguish the concepts of temperature and thermal energy. Use the kinetic-molecular theory to explain some thermal properties of gases and phase changes of solids, liquids and gases.</p> <p>P.3.4 Use examples from everyday life to describe the transfer of thermal energy by conduction, convection and radiation.</p> <p>Chemistry Standard 6: Thermochemistry Apply the law of conservation of energy.</p> <p>C.6.4 Solve problems involving heat flow and temperature changes by using known values of specific heat, phase change constants (i.e., latent heat values) or both.</p> <p>Algebra II Standard 4: Conic Sections</p>	

The solar oven project

		Students write equations of conic sections and draw their graphs.				
		A2.4.1 Write the equations of conic sections (circle, ellipse, parabola, and hyperbola).				
		A2.4.2 Graph conic sections.				
		T+A	E			
21st Century Skills to be explicitly <i>taught and assessed</i> (T+A) or that will be <i>encouraged</i> (E) by project work, but not taught or assessed:	Collaboration	x		Creativity	x	
	Presentation	x		Communication and collaboration	X	
	Critical Thinking:	x		Cross-disciplinary thinking	x	
					Presentation Audience:	
Culminating Products and Performances	Group:	Group will build a solar oven based on their research and development of the final design. Students need to test their prototype by determining the energy absorbed by the water over a determined period of time. Students will build a prototype to evaluate their calculations and oven design. The last trial of the final prototype will be the final product to be evaluated for the group project.			Class:	x
					School:	
					Community:	x
	Individual:				Experts:	
					Web:	
					Other:	

The solar oven project

PROJECT OVERVIEW

Entry event to launch inquiry, engage students:	(See document at the end, copy of project entry document)				
Assessments	Formative Assessments (During Project)	Quizzes/Tests	X	Practice Presentations	X
		Journal/Learning Log	X	Notes	x
		Preliminary Plans/Outlines/Prototypes	X	Checklists	
		Rough Drafts		Concept Maps	
		Online Tests/Exams	X	Other: laboratories related to energy	x
	Summative Assessments (End of Project)	Written Product(s), with rubric: Final design report	X	Other Product(s) or Performance(s), with rubric: Laboratories report of collecting data for heat absorption	x
		Oral Presentation, with rubric	X	Peer Evaluation	X
		Multiple Choice/Short Answer Test	x	Self-Evaluation	
		Essay Test		Other:	
	Resources Needed	On-site people, facilities:	School grounds to test oven prototypes		
Equipment:		Vernier temperature probes, Vernier logger pro			
Materials:		Cardboard, metal sheets, aluminum, water, calculators, spreadsheet software			
Community resources:		Electrical engineers community partners			
Reflection Methods	(Individual,	Journal/Learning Log	x	Focus Group	
		Whole-Class Discussion		Fishbowl Discussion	



The solar oven project

	Group, and/or Whole Class)	Survey		Other:	
--	---------------------------------------	--------	--	--------	--



The solar oven project

PROJECT TEACHING AND LEARNING GUIDE

Project: Solar oven	Course/Semester: End 1st semester until beginning 2nd semester
<p>Knowledge and Skills Needed by Students to successfully complete culminating products and performances, and do well on summative assessments</p>	<p>Scaffolding / Materials / Lessons to be Provided by the project teacher, other teachers, experts, mentors, community members</p>
<p>Determine area of an object. Write equations of conic sections.</p>	<p>→ Workshop on conic sections.</p>
<p>Describe and distinguish the concepts of conduction, convection and radiation.</p>	<p>→ Workshop on heat exchange processes.</p>
<p>Describe and distinguish the concepts of temperature and thermal energy.</p>	<p>→ Workshop on heat capacity. Perform a laboratory of heat capacity of a substance.</p>
<p>Apply the law of conservation of energy.</p>	<p>→ Workshop on Law of conservation of energy.</p>
<p>Determine the heat absorbed by a material.</p>	<p>→ Solve problems involving heat flow and temperature changes by using known values of specific heat, phase change constants (i.e., latent heat values) or both.</p>



The solar oven project

PROJECT ENTRY DOCUMENT

Dear students of the Academy of Science and Entrepreneurship,

Many countries lack of resources such as electricity. One of the natural resources which is most available to these countries is the sun. However, the habitants can not afford expensive equipment and resources to take advantage of the sunlight and radiation. It is our purpose to design an efficient solar oven design that is accessible and affordable to the person living on these places. The design must be compact and efficient using the sunlight. Your final design must include the design drawings, calculations and a quantitative explanation that justifies the best design that can be replicated on these countries.

The final design must include the drawings, oven area, materials used, shape used, calculations and quantitative explanations that justify the best design. The solar oven diagram must be drawn into a 8.5"x11" paper.

Your final project must be submitted in the engineering notebook that our community partner provides in order to complete the project.

The solar oven project

PROJECT RUBRIC DOCUMENT

GROUP MEMBERS

CONTENT (60%)

Design Evaluation:

Area	Description				TOTAL
LEVEL	ADVANCED	PROFICIENT	DEVELOPING	EMERGING	
<i>Dimensions</i>	Dimensions of solar collector are consistent with design dimensions. (less than 15% error) (10—9—8)	Dimensions of solar collector are consistent with design dimensions with an error of less than (30%) (7—6—5)	Dimensions of solar collector are consistent with design dimensions with an error of less than (50%) (4—3—2--1)	There was no second prototype built by group (0)	
	Oven area improved from 1 st prototype and met the product requirements for performance (10—9—8)	Oven area improved from 1 st prototype and met the product requirements but did not improve the performance (7—6—5)	Oven area did not improve from 1 st prototype and did not meet the product requirements for performance (4—3—2--1)	There was no second prototype built by group (0)	
<i>Specifications sheet</i>	Spec Sheet is complete. All calculations are accurate and relevant with no errors for final prototype (10—9—8)	Spec Sheet is complete. Most calculations are accurate and relevant with few errors for final prototype (7—6—5)	Spec Sheet is not complete. Most calculations are accurate and relevant with few errors for final prototype (4—3—2--1)	There was no second prototype built by group (0)	
	Spec Sheet diagram of the solar trough includes an accurate description of the shape and the dimensions of the apparatus. (10—9—8)	Spec Sheet diagram of the solar trough includes a description of the shape and the dimensions of the apparatus. Minor information is missing. (7—6—5)	Spec Sheet diagram of the solar trough includes a description of the shape and the dimensions of the apparatus. Many information is missing. (4—3—2--1)	There was no second prototype built by group (0)	

The solar oven project

	Description of the method used to recreate the geometrical shape on the apparatus is mathematically accurate. (10-9-8)	Description of the method used to recreate the geometrical shape on the apparatus is mathematically accurate. Minor information is missing. (7-6-5)	Description of the method used to recreate the geometrical shape on the apparatus is mathematically accurate. Many information is missing. (4-3-2--1)	There was no second prototype built by group (0)	
	Diagram includes how the sun's rays interact with the solar collector. (10-9-8)	Diagram includes how the sun's rays interact with the solar collector. Minor information is missing. (7-6-5)	Diagram includes how the sun's rays interact with the solar collector. Many information is missing. (4-3-2--1)	There was no second prototype built by group (0)	
Engineering notebook					
Design testing	Solar collector effectively heats water (equal or higher than control sample) (10-9-8)	Solar collector heats water with a difference of +/- 3 °C (7-6-5)	Solar collector heats water with a difference of +/- 4 °C (4-3-2--1)	There was no second prototype built by group (0)	
	Solar collector is made of mostly recycled materials. (10-9-8)	Solar collector is made of mostly recycled and/or low cost materials. (7-6-5)	Solar collector is made of none recycled and/or low cost materials. (4-3-2--1)	There was no second prototype built by group (0)	
	Solar collector is durable. (10-9-8)	Solar collector is made mostly of durable materials. (7-6-5)	Solar collector is not durable. (4-3-2--1)	There was no second prototype built by group (0)	
Design requirements	Solar oven design meets needs other than those presented in the entry document. (5)			There was no second prototype built by group (0)	

Design Evaluation score: ____/ points

TOTAL value:____/ points



The solar oven project

Written communication (10%) - possible points in parentheses

- Uses appropriate level of language (formal) (5) _____
- No use of slang or informal abbreviations (5) _____
- No offensive or questionable content/language (5) _____
- Uses correct capitalization and punctuation (10) _____
- Uses correct symbols and units (50) _____
- Presentation includes:
 - A title (4) _____
 - Group members full names (4) _____
 - Class period (2) _____
 - Group number (2) _____
 - Date submitted (2) _____

TOTAL POINTS FOR WRITTEN COMMUNICATION (possible) _____

ORAL COMMUNICATION (10%) - possible points in parentheses

- Students completed the presentation (10) _____
- Students used appropriate level of language (formal) (10) _____
- Students did not use slang or informal abbreviations(10) _____
- Students did not use offensive/questionable content/language (10) _____
- Students spoke at appropriate volume for the setting(10) _____
- Students maintained eye contact with the audience(10) _____
- Length of presentation was appropriate(10) _____
- Students presented with appropriate body language and posture (10) _____
- Students pronounced words clearly and correctly (10) _____
- Students avoided verbal fillers (5) _____
- Students used proper inflection (5) _____

TOTAL POINTS FOR ORAL COMMUNICATION (possible) _____

WORK ETHIC (10%) - possible points in parentheses

- Work Habits
 - Student(s) work on time (12) _____
 - Student(s) has /have required materials (12) _____
- Time management
 - Student(s) has /have leading role and work without distractions(9) _____
 - Student(s) has /have leading role and makes sure all team members complete responsibilities on time (9) _____
 - Student(s) took lead role in reminding group to put in extra time and effort to make group's task as good as possible(9) _____
- Attendance
 - Student on time to class (12) _____
 - Not absent or checked out during class time (12) _____
- Accountability
 - Student(s) made up for work left undone by other group member(s) and demonstrated willingness to spend significant time outside class to complete project (25) _____

TOTAL POINTS FOR WORK ETHIC (100 possible) _____



The solar oven project

PROJECT CALENDAR

Project: Solar oven			Start Date:	
MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
PROJECT WEEK ONE				
Project roll out <ul style="list-style-type: none"> • Entry document • Knows and Need to Knows 	<ul style="list-style-type: none"> • Next steps • Group contract • Review Knows and Need to know 	Workshop <i>Types of energy</i>	Workshop <i>Using heat from the sun</i>	Workshop <i>Insulators</i>
PROJECT WEEK TWO				
Workshop <i>Renewable and nonrenewable energy</i>	Workshop <i>Review of parabolas</i>	Work time <ul style="list-style-type: none"> • Build prototype 	Work time <ul style="list-style-type: none"> • Test prototype 	<ul style="list-style-type: none"> • Benchmark on prototype • Work time building final solar oven
PROJECT WEEK THREE				
Work time <ul style="list-style-type: none"> • Build final solar oven 	Work time <ul style="list-style-type: none"> • Build final solar oven 	Benchmark for final prototype	Collect data for final solar oven	Analyze data for solar oven and write final report for community partner
PROJECT WEEK FOUR				
Analyze data for solar oven and write final report for community partner	Analyze data for solar oven and write final report for community partner	Present final product of solar oven to community partner.		



The solar oven project

Supplies and estimated cost

Materials required and estimated cost per group (group should be 3-4 students)

18" x 18" x 24" box	\$4.00
Spray paint	\$4.69
Recycled coffee can	\$0.00
2" general purpose tape	<u>\$2.50</u>
TOTAL COST	\$11.19/group