

Passive Solar Water Heater Design STEM Challenge Ontario SNC1W



NO PREP - Just
download & Go!

Engineering
& STEM



Students design, build,
and test a passive
solar water heater to
explore solar energy,
engineering design,
temperature data, &
graphing.

SCROLL
to take a look inside!



HOW THIS ACTIVITY HELPS YOU

- **Saves Prep Time** - Everything is pre-made, ready to go, and fully editable.
- **Provides Built-In Assessment** - The analysis questions, conclusion task, and rubric let you quickly check for understanding.
- **Supports Real-World Science Skills** - Students collect temperature data, create graphs, and use evidence to explain how design choices affect solar heating.

STEP-BY-STEP INSTRUCTIONS

Passive Solar Water Heater Challenge - Student Handout

Your challenge
Design and test a simple device that warms water using only sunlight or a lamp that provides light.

Learning targets

- I can explain how solar energy can be used on Earth.
- I can conduct a fair test.
- I can design and improve a prototype.
- I can use data to support a scientific claim.

Success criteria

- My group identifies one clear design goal.
- We keep important variables constant.
- We record temperature data carefully.
- We explain which design feature worked best and why.

Materials
Cup or container, 200 mL water, thermometer, cardboard, foil, black paper, plastic wrap, tape, scissors, timer.

Procedure

- Research two to three design ideas that could help warm water.
- Sketch your design and label the important features.
- Build your prototype.
- Test a baseline cup and your prototype under the same conditions - Measure the same amount of water, such as 200 mL, for both the baseline cup and the prototype.
- Record temperature every two minutes.
- Answer the analysis questions
- Create Your Graph

Create a line graph
Your graph should show:
• A clear title
• Time on the x-axis
• Temperature on the y-axis
• Units or labels
• A scale
• Two lines
• A legend
Your graph should show the temperature of the baseline cup and your prototype. After more quickly, L.

Optional: You can also use a thermometer to measure the temperature of the water in the prototype.

Data Table: Record your data in the table below.

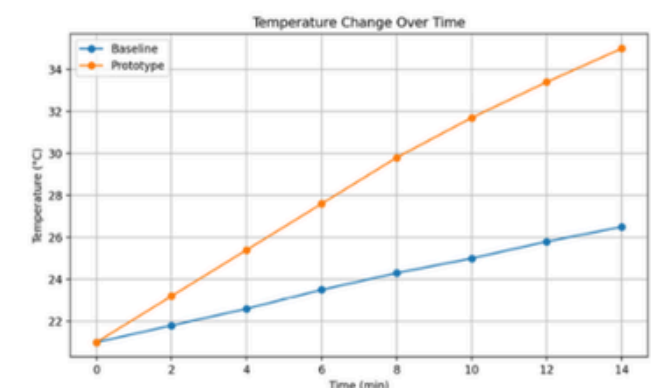
Time	Baseline temperature (°C)	Prototype temperature (°C)
0 min		
2 min		
4 min		
6 min		
8 min		
10 min		
12 min		
14 min		

Reflection
Our prototype increased water temperature by: _____ °C
The feature that helped most was:
Our evidence is:
One improvement for next time is:

Student Analysis Questions

1. What was the main goal of this lab?
2. Identify the independent variable and dependent variable in this investigation.
3. List three variables that needed to be kept constant to make this a fair test.
4. Why was it important to compare your prototype to a baseline model?
5. Calculate the total temperature increase for the baseline model.
6. Calculate the total temperature increase for your prototype.
7. How much more did your prototype warm the water compared with the baseline?
8. Which model warmed the water more quickly? Use data to support your answer.
9. Which design feature helped your prototype the most? Explain using science ideas such as absorption, reflection, insulation, or heat loss.
10. Write a conclusion using the format:
Claim:
Evidence:
Reasoning:

- Students build and test their solar water heaters
- Record their data
- Graph their results



What Will Your Students Learn?



- ✓ **Solar energy and renewable energy**
- ✓ **Passive solar heating**
- ✓ **How sunlight can be used to warm water**
- ✓ **Heat absorption by dark surfaces**
- ✓ **Reflection using foil and other materials**
- ✓ **Insulation and reducing heat loss**
- ✓ **Baseline model vs improved prototype**
- ✓ **Fair testing and controlled variables**
- ✓ **Temperature change over time**
- ✓ **Creating line graphs from temperature data**
- ✓ **Total temperature increase**
- ✓ **Average rate of warming**
- ✓ **Engineering design and prototype improvement**
- ✓ **Real-world applications of solar energy and sustainable design**

- A complete passive solar water heater design challenge where students research, build, test, and improve a working prototype
- Student-friendly investigation pages with design planning, data collection, graphing expectations, analysis questions, and a CER-style conclusion
- Complete teacher supports including curriculum alignment, lesson plan, safety notes, differentiation options, answer key, sample data, example graphs, and grading rubric

What You Get

STEP-BY-STEP INSTRUCTIONS

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• Water temperature on the y-axis
• Units on the y-axis
• A scale on the y-axis
• Two lines
• A legend
Your graph should show the temperature of the prototype and the baseline cup over time. After more quickly, L.

Optional: You can also use a thermometer to measure the temperature of the prototype and the baseline cup.

Data Table: Record your data in the table below.

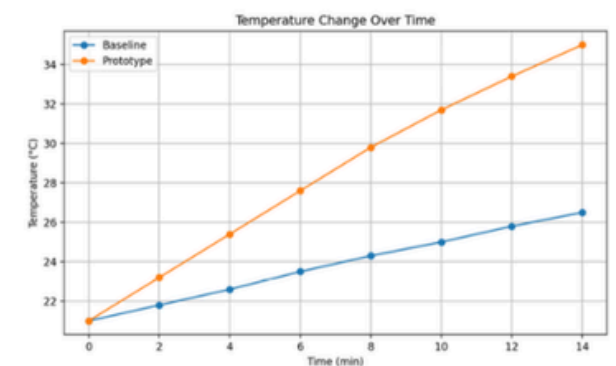
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2. Identify the independent variable and dependent variable in this investigation.
3. List three variables that needed to be kept constant to make this a fair test.
4. Why was it important to compare your prototype to a baseline model?
5. Calculate the total temperature increase for the baseline model.
6. Calculate the total temperature increase for your prototype.
7. How much more did your prototype warm the water compared with the baseline?
8. Which model warmed the water more quickly? Use data to support your answer.
9. Which design feature helped your prototype the most? Explain using science ideas such as absorption, reflection, insulation, or heat loss.
10. Write a conclusion using the format:
Claim:
Evidence:
Reasoning:

- Students build and test their solar water heaters
- Record their data
- Graph their results



Skills Your Students Will Develop



- ✓ Helps students build graphing and data analysis skills using temperature data from a hands-on solar energy investigation
- ✓ Supports science and engineering skills through researching, designing, building, testing, and improving a their design
- ✓ Connects renewable energy concepts like solar heating, absorption, reflection, insulation, and heat loss to a real-world design challenge
- ✓ Encourages evidence-based reasoning by having students use data, graphs, and observations to explain which design features worked best

Teacher Answer Key

1. What was the main goal of this lab?
The goal was to design and test a simple device that could warm water using solar energy or a lamp representing sunlight.
A strong answer should mention:

- warming water
- using solar/radiant energy
- testing a prototype or design

2. Identify the independent variable and dependent variable.
Independent variable:
The type of model being tested: baseline model versus student-designed prototype.
Acceptable answer:
The design features added to the prototype.
Dependent variable:
The temperature of the water, measured in degrees Celsius.

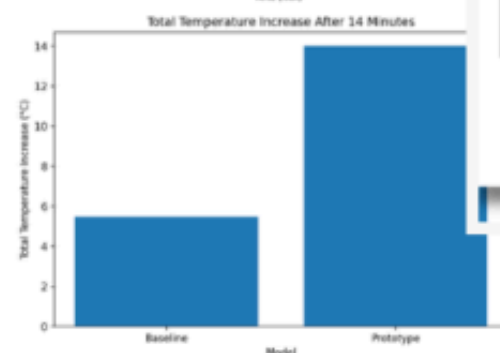
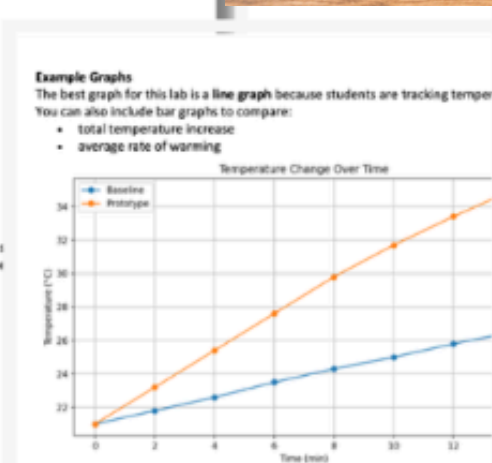
3. List three variables that needed to be kept constant.
Possible answers include:

- amount of water
- starting temperature of the water
- type or size of container
- distance from the lamp or sunlight source
- length of testing time
- angle of the light source
- thermometer used
- time intervals for temperature readings
- indoor/outdoor testing conditions

4. Why was it important to compare your prototype to a baseline model?
The baseline model gave students something to compare their prototype against; without it, they would not know whether their design actually improved the heating of the water.

5. Calculate the total temperature increase for the baseline model.
Using the example data:
Initial baseline temperature = 21.0°C
Final baseline temperature = 26.5°C
Total temperature increase = 26.5°C - 21.0°C
Total increase = 5.5°C

6. Calculate the total temperature increase for your prototype.
Using the example data:
Initial prototype temperature = 21.0°C
Final prototype temperature = 35.0°C
Total temperature increase = 35.0°C - 21.0°C
Total increase = 14.0°C



Reasoning:

Category	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding	Demonstrates limited understanding of solar energy, heat transfer, and renewable energy concepts.	Demonstrates some understanding; explanations are partly accurate.	Demonstrates considerable understanding; explanations are mostly accurate and relevant.	Demonstrates thorough understanding; explanations are accurate, precise, and well-connected.
Thinking and Investigation	Planning is incomplete; testing is inconsistent; data collection is limited.	Planning and testing are partially effective; some relevant data collected.	Plans and conducts a fair test with considerable effectiveness; relevant data collected and analyzed.	Plans and conducts a rigorous, well-controlled investigation; analysis is precise and insightful.
Communication	Communicates ideas unclearly; graph/table may be incomplete or misleading.	Communicates with some clarity; graph/table is partially correct.	Communicates clearly using appropriate scientific vocabulary, tables, and graphs.	Communicates with a high degree of clarity and precision; visuals and terminology are especially effective.
Application	Applies concepts to the prototype with limited effectiveness.	Applies concepts with some effectiveness in a familiar context.	Applies concepts effectively to improve the prototype and explain performance.	Applies concepts with a high degree of effectiveness, including transfer to sustainability/career contexts.
Analysis, Questioning, and Conclusion	Answers are incomplete, unclear, or show limited understanding. Little or no data is used. Conclusion is missing or very weak.	Answers show some understanding but may lack detail or include minor errors. Some data is used, but explanations are limited. Conclusion includes a basic claim.	Answers are mostly complete and accurate. Data is used to compare the baseline and prototype. Conclusion includes a clear claim, evidence, and reasoning.	Answers are thorough, accurate, and clearly explained. Data is used effectively to support conclusions. Conclusion strongly connects design features to science ideas such as absorption, reflection, insulation, and heat loss.

Classroom Fit Guarantee

I want you to feel confident when you purchase from Teach With Fergy. If a resource is not the right fit for your students, simply contact me and I'll provide double your purchase amount in store credit toward another resource in my store.



Your Activity Includes

- Background information for student understanding
- DIGITAL and PRINT ready
- FULLY EDITABLE
- Design planning and data collection pages
- Graphing and analysis questions
- Complete Answer Key
- Grading Rubric



STEP-BY-STEP INSTRUCTIONS

Passive Solar Water Heater Challenge - Student Handout

Your challenge
Design and test a simple device that warms water using only sunlight or a lamp that can be turned on and off.

Learning targets

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- I can conduct a fair test.
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- I can use data to support a scientific claim.

Success criteria

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Your graph should show prototype and baseline data.

Optional: You may want to use a graphing calculator.

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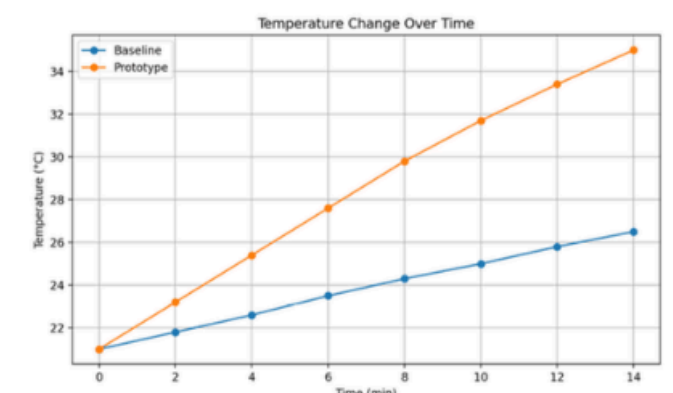
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Thanks
**for your interest
in this resource!**

I am a real person and if
you have any questions,
suggestions, or concerns,
please reach out.



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TWF

Teach With Fergy

*Let's
Connect!*

