# Assignment Summary

For this assignment, you will research how to design and build a solar cooker. Search reliable online sites for “solar cookers.” After getting the materials you need from your teacher, you will present your initial design as a drawing or illustration. You will then build your device and test its efficiency by warming up a hot dog until it reaches an internal temperature of 165°F, recording how long it took you to reach this temperature. Based on your tests, you will make recommendations on how to improve the design of your solar cooker, and then present your final design and the logic that supports it in a lab report. Your lab report should include a title, a list of materials that you used to build your solar cooker, a drawing of your initial design, observations from your experimental tests, recommendations for a final design based on what you know about radiation, a drawing of your final design, and the results of the efficiency test. To help you write your lab report, there is a Student Worksheet on the last few pages of this document.

Background Information

# To warm up and cook food, heat is required. Heat is the thermal energy that flows from one substance to another because of a temperature difference. The Sun’s rays transfer its thermal energy to Earth. Your goal is to focus and trap these rays to warm up a hot dog. You will do this by applying what you know about thermal energy. Objects can absorb or reflect thermal energy. Absorption occurs when an object’s surface takes in thermal energy, while reflection is thermal energy bouncing off as the Sun’s rays hit the object’s surface. Two factors that affect the absorption and reflection of thermal energy are the color and texture of the object’s surface. Dark colors absorb more thermal energy than light colors, and smooth surfaces reflect more thermal energy than rough surfaces. Consider these factors as you build your device. This is an engineering challenge because it combines physics principles with real building materials and design constraints. It provides you with the opportunity to think about a problem, construct a solution, and evaluate your solution’s effectiveness.

# Safety

* A solar cooker is like the stove or oven in your home, so be careful in your actions to keep yourself and the people around you safe.
* Avoid looking directly into the solar cooker to protect your eyes from the radiation that will be reflected by it.
* Always use pot holders or heat-insulated gloves to protect your hands from hot objects and surfaces.
* Use an apron to protect your clothes.
* If your solar cooker has a lid, be careful when opening it, because steam can cause burns.
* Watch over your device while you are testing its efficiency to address any issues.
* Notify your teacher immediately if accidents happen.

Materials

|  |  |  |
| --- | --- | --- |
| * Cardboard boxes or pieces of cardboard
* Five pieces of black construction paper
* A sheet of plastic
* A roll of aluminum foil
* Poster board
 | * Wooden barbecue skewers
* Cooking thermometer
* Three hot dogs
* Timer
* 250 g white school glue
 | * Single hole puncher
* Clear tape
* Pair of scissors
* Box cutter
* Thermometer
* Lab notebook
* Pencil
 |

# Assignment Instructions

**Step 1: Gather materials.**

1. Collect the materials from your teacher. Put them on the table so you can see everything.

**Step 2: Design your prototype.**

1. Study your building materials and think about a design that would best warm a hot dog. Write some basic ideas on the Student Worksheet under “Ideas for Prototype Design.”
2. There are four criteria to consider in your design:
3. The device needs to warm the hot dog while the hot dog is in suspension. The hot dog cannot touch the bottom of the solar cooker or be placed in a pan.
4. The hot dog needs to be rotated while being cooked.
5. The device needs to include parts that will reflect or focus the Sun’s rays into the cooking area.
6. The device needs to reach temperatures well above that of its surroundings.
7. Sketch at least three ideas on the Student Worksheet for a device that would efficiently warm your hot dog.
8. On the Student Worksheet, consider the advantages and disadvantages of each device and list them under each diagram.
9. Decide on the design you will use for the prototype.
10. Use your knowledge of thermal energy absorption and reflection in the evaluation of each design.
11. Select a design that you can build within the time limit provided by your teacher.
12. Fill in the Student Worksheet to indicate which design you will use for your prototype and explain your reasoning for selecting that particular design based on physics principles.

**Step 3: Build your prototype.**

1. Use the materials provided by your teacher to construct the device. Write down any modifications that you made to the basic design during the construction process on the Student Worksheet.

**Step 4: Test your prototype.**

1. Make predictions about your device and record them on the Student Worksheet.
* Will your device warm the hot dog to a temperature of 165°F? How will your device do this?
* Will your device efficiently warm the hot dog in 20 to 25 minutes? How will your device do this?
* Will your device reach a temperature well above that of its surroundings?
1. Take your device, hot dogs, the cooking thermometer, lab notebook, and pencil to the testing area designated by your teacher. You will have up to three opportunities to test your device.
2. Record your observations each time you test your device on the Student Worksheet for later evaluation of your design. Record the temperature of the air outside the solar cooker and the maximum temperature reached inside the solar cooker, as well as the internal temperature of the hot dog every 2 minutes until it reaches a temperature of 165°F. Write this information on the Student Worksheet under “Observations.”

**Step 5: Evaluate your prototype’s design.**

1. On the Student Worksheet, record what worked well with your design under “Evaluating Your Prototype.”
2. Record which features can be improved upon under “Evaluating Your Prototype.”
3. Make at least one suggestion in the design process that would improve your device. Provide a reason, based on the concepts of thermal energy transfer, to explain why this change would be an improvement. Record this information on the Student Worksheet under “Suggestions.”

**Step 6: Propose a final design for the device.**

1. Draw a labeled diagram of your improved design on the Student Worksheet.
2. Base your improved design on the information gained through testing your first device, as well as from research, observations, and/or further testing.
3. The final design can use the initial materials list or include materials not included in the first design.
4. This revised drawing should be part of your lab report’s conclusion.

**Step 7: Write your lab report.**

1. Combine your data and observations to write your lab report.
2. Your lab report should include:
	1. A title
	2. Three rough sketches showing your initial design ideas
	3. The advantages and disadvantages of each design idea
	4. The design idea you decided to build, and why you chose that design
	5. Data and observations from the experimental tests
	6. At least one suggestion that would improve your device, and a reason why this change would be an improvement
	7. One labeled drawing of your final design

**Step 8: Evaluate your lab report using this checklist.**

If you can check below, you are ready to submit your lab report.

* Does your lab report include a title?
* Does your lab report include three rough sketches of your initial design ideas?
* Does your lab report include the advantages and disadvantages of each design idea?
* Does your lab report include an explanation of why you chose to build your initial design?
* Does your lab report include data and observations from the experimental tests of your device?
* Does your lab report include at least one suggestion of how to improve your device, and an explanation of why this suggestion is an improvement?
* Does your lab report include one labeled drawing of your final design?

**Step 9: Revise and submit your lab report.**

1. If you were unable to check off all the requirements on the checklist, revise your final lab report and save it before submitting.
2. When you have completed your lab report, return to the Virtual Classroom and use the “Browse for file” option to locate and submit your assignment, or turn it in to your teacher, if required. Congratulations! You have completed your engineering design challenge.

Solar Cooker Student Worksheet

Use this worksheet to design your device and record your data. You can then use this form to help you write your lab report.

**Ideas for Prototype Design**

**Preliminary Sketches (attach separate paper, if needed)**

Option A:

Advantages: Disadvantages:

|  |  |
| --- | --- |
| ● | ● |
| ● | ● |
| ● | ● |

Option B:

Advantages: Disadvantages:

|  |  |
| --- | --- |
| ● | ● |
| ● | ● |
| ● | ● |

Option C:

Advantages: Disadvantages:

|  |  |
| --- | --- |
| ● | ● |
| ● | ● |
| ● | ● |

Which of the three designs will you move forward with? Explain your reasons for selecting this design.

**Building the Prototype**

What modifications, if any, did you make to the basic design during the construction process?

**Predictions**

Will your device warm the hot dog to a temperature of 165°F? How will your device do this?

Will your device efficiently warm the hot dog in 20 to 25 minutes? How will your device do this?

Will your device reach a temperature well above that of its surroundings? How will your device do this?

**Observations**

Record your observations and the results of the experimental tests of your device below.

Temperature of the surroundings (in °F): \_\_\_\_\_\_\_\_\_\_\_\_\_

Maximum temperature reached inside the solar cooker (in °F): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Use this table to record the internal temperature of the hot dog every 2 minutes. Use a separate sheet of paper, if necessary.

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| --- | --- |
| **Time** | **Temperature (°F)** |
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**Evaluating Your Prototype**

What worked well?

Which features can be improved upon?

**Suggestions**

How could the overall design of this device be improved?

Why would this change be an improvement? What concepts related to thermal energy transfer is this improvement based on?

**Sketch of Your Final Design**

Draw a well-labeled sketch of the final design.