**Experimental Design: What Solar Cooker Design Factors Are Best for Absorbing and Radiating Heat?**

**PURPOSE**

The purpose of this lesson is to learn how to set up an experiment *and* determine the solar cooker design factors for optimal heat absorption.

**EXPERIMENTAL DESIGN**

In this experiment, you will design a solar cooker that will answer the following question:

**What Solar Cooker Design Factors Are Best for Absorbing and Radiating Heat?**

**Hypothesis**

After reading through the methods section below, write a hypothesis to answer the question above.

*Hypothesis:*

**Method**

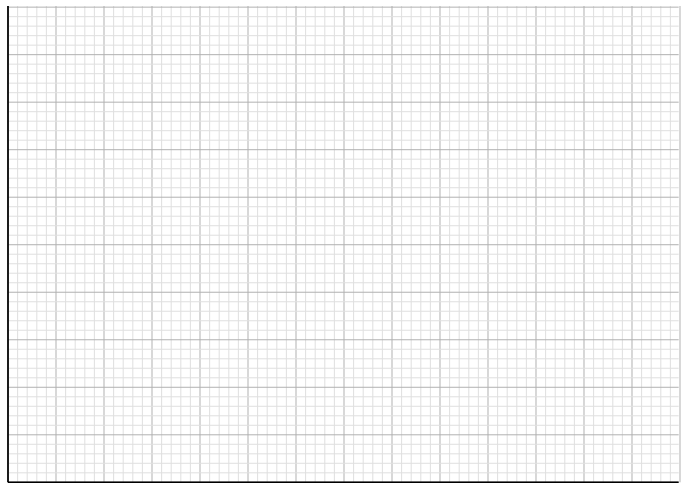
1. Set up the light stand, at about a 45° angle. Place the shoebox, without the lid, beneath it. Sketch the layout in your journal.
2. Put 50 mL of water in the beaker*.* Place the beaker in the shoebox.
3. Put the thermometer in the beaker and record the initial temperature.
4. Turn on the light, and record temperature readings (°C) every minute for twenty minutes. **This is your control.**
5. Make one modification to your design, and repeat steps 3 to 7. Draw a sketch of your layout. **Only add one factor to modify the solar cooker.** *\*Remember to put fresh water in the beaker before taking an initial temperature reading.*
6. Remove the modification. If time permits, repeat the procedure for another modification and record the temperature change over ten minutes.
7. Record your data in the table below and provide a title for the table.
8. Construct a line graph that summarizes your results. Include a title, label the axes and include a legend.

**Results**

**Table – Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Temperature (°C) of Water** | | | | | | | | | | |
| **Time (min)** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Control |  |  |  |  |  |  |  |  |  |  |  |
| Design Factor 1 |  |  |  |  |  |  |  |  |  |  |  |
| Design Factor 2 |  |  |  |  |  |  |  |  |  |  |  |

**Graph *-* Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**Findings**

Write a summary of your results.

**CONCLUSIONS: DEVELOPING EXPLANATIONS FROM EVIDENCE**

1. What was the temperature change of your control?
2. What was the change after the first modification? The second?
3. Why do you do the experiment the first time with no modifications?
4. What is the independent variable in this experiment?
5. What is the dependent variable?
6. Why is it important to replace the water each time you run the experiment instead of using the water you had from before?
7. Why would you remove the first modification before doing the second one instead of just adding it?

**THE SCIENTISTS’ EXPLANATION**

Energy from the sun that reaches the Earth is known as solar radiation. Although the sun emits radiation at all wavelengths, approximately 44% falls within visible light wavelengths. You will learn about this in more depth in the module - **Energy: The Driver of Climate.**

This solar radiation is converted to heat energy when photons (particles of light) moving around within light waves interact with molecules moving around in a substance. The electromagnetic rays emitted by the sun have a lot of energy in them. When they strike matter, whether solid or liquid, all of this energy causes the molecules in that matter to vibrate. This activity generates heat. Solar cookers reach higher temperatures when the heat gain inside the box is greater than the heat losses. As students experiment with modifications to their boxes, they may observe the following.

* Dark colors absorb more heat than light colors––lining the beaker with dark construction paper, or sitting the beaker on a dark surface should allow more of the heat to be absorbed. In the video, students may have observed the cookers used a black pot to cook the food.
* The sun’s rays can be reflected and concentrated into the box––lining the box with shiny foil should allow more of the “sun’s” rays to be angled towards the beaker. Students must be careful with the angle and texture––crinkled foil or foil at an incorrect angle can actually reflect the rays away from the beaker. Some students may try and cover the beaker with foil, but that can also reflect the rays away from the water.
* Changing the angle of the box so that the beaker gets more direct (90 degrees) exposure to the “sun’s” rays will assist in heat retention.
* A clear lid or plastic wrap can help trap the heat energy inside the box, while allowing the sun’s rays to radiate through. Note: This is similar in principle to *the greenhouse effect,* which you will learn about in a later module.
* Adding insulation to the outside of the box may decrease the heat loss. Students may add construction paper or foil to the outside of the box.
* Elevating the beaker to allow for additional heat flow by convection currents should cause additional heat absorption in the water.