Solar Heating – Elementary LQ

Theory

Heating of objects that are placed in the sun takes place along their surface. Changing the color of an object may affect the rate at which it absorbs sunlight and thus the rate at which it heats up.

Purpose

Compare the heating rate for objects of different color.

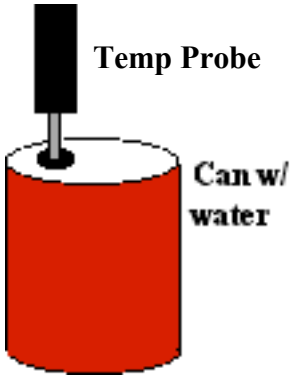
Equipment

Temperature probe(s), LabQuest, cans of same size but different color, water

Procedure

1. Plug the Temperature Probe(s) into your LabQuest then launch *LabQuest app* by starting the LabQuest. The software will set up to collect temperature versus time data. Note that you can have up to 4 Temperature probes connected at once. If you wish to change from Celsius to Fahrenheit, tap the red rectangle on the Sensor screen and choose "F".

2. Tap on the Data Collection rectangle on the right-hand side of the Sensor screen. In the window that appears, tap and drag across the "180" in Length and set the experiment length to 600 seconds using the keyboard that appears. Set the Rate to 1 sample per second. Tap [OK].



3. Pour room temperature water into the can(s), filling close to overflowing. Place the can(s) in the direct sunlight. Place a Temperature Probe as close to the center inside each can as possible and hold it/them there. (You could use ring stand(s) to hold the probe(s).) Wait approximately a minute for the probe(s) to adjust to the temperature of the water. Tap the Collect icon or press the Collect button to begin data collection.

4. When data collection is complete, remove the Temperature Probe(s) from the can(s). Dispose of the warm water carefully. Return the can(s) to the place indicated by the instructor. If you only used one Temperature Probe, obtain a second can that is a different color for your second run and move on to steps 6-8.

5. Once you are done collecting data, move on to the Analysis section.

6. Tap the Store icon (file cabinet to the right of "Run 1"). This stores the data you just gathered in memory allowing you to make another run.

7. Fill your second can with water. Repeat Steps 3-4. A new graph line should appear.

8. After tapping the Store icon again, repeat Steps 3-4 with a third can, if it is available.

Analysis

1. Tap on the Data Table icon at the top of the screen.
    a. If you used one Temperature Probe: Go to the column labeled "Run 1". Tap and drag across the "Run 1". Type in the color of the can using the keyboard. Repeat for Run 2 and Run 3.
    b. If you used multiple Temperature Probes: Go to the column labeled "Temp 1". Tap and drag across the "Temp 1". Type in the color of the can using the keyboard. Repeat for Temp 2 and Temp 3.

2. Tap on the Graph icon at the top of the screen to go back to the graph. Tap on the space labeled "Run 1" (or other number). Tap on "All Runs" to show all of your data runs at the same time. Did the cans heat at a steady rate? Did they heat fastest at the beginning or at the end? How did you determine your answer?

3. Compare the graphs from your cans. Which heated the fastest? Which heated slowest? How did you determine this from your graph? In the Data Table below, record "fastest", "medium" or "slowest" for the Heating Rate of each can.

4. Formulate a reason why you think one heated faster than the other. Think of other situations where objects heat (or cool) fast or slow depending solely on their color. Explain these situations as part of your report.

5. If you were going to rely on the heat you absorbed from sunlight, what are some changes you might make in your experiment to get a greater heat gain? Explain why you think this would work. Describe an experiment to test your idea.

Data Table

Color:			
Heating Rate			

Extensions

Change the graph so it shows only one of your runs. Tap and drag across a section of the graph near the beginning and where the graph is relatively straight. Tap on **Analyze** then Curve Fit then Temperature. On the next screen, tap on "Choose Fit" then "Linear". The result is the equation giving the best straight line fit to your data. From the equation, the value of **m**, the slope, gives the rate at which the temperature changed. Compare the mathematical rates for your different cans.

Reverse the process. Put hot water into the cans and watch them cool off. Before you start, predict which one will cool fastest. Does it? How do the rates for heating and cooling compare?

Can you figure out a way to maximize how hot the water gets in a limited amount of time? Make some suggestions, do them, and then report on your results.

No mention is made in these instructions about keeping the water stirred up during the experiment. How much will stirring or not stirring affect the results? Test your hypothesis.

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