Introduction:

Part of the Eisco series of hand held sensors, the temperature sensor allows students to record and graph data in experiments on the go.

This is one of our most versatile sensors. It can be used in biology to monitor ecological systems, microbiological cultures and to study the effect of temperature on photosynthesis and enzymatic reactions. In chemistry, to study exothermic or endothermic reactions and how the rate of reaction is affected by temperature; in physics it can be used to study heat/energy transfer.

The sensitive element is within a 180 mm long, 3.2 mm diameter stainless steel tube. This sensor can be used for temperature measurements in solids, liquids or gases.

Sensor Specs:

Range -35 to 150 °C | 0.1 °C resolution | 100 max sample rate
Range -31 to 238 °F | 0.1 °F resolution | 100 max sample rate
Activity – Harnessing the Sun’s Rays for Heat

General Background:

The Greek scientist Archimedes (whom you might be familiar with his work on principles of buoyancy) reputedly repelled a Roman invasion in the third century by using an array of mirrors that focused the Sun’s rays to set the attacking ships on fire. In more modern times, solar furnaces are constructed to generate electricity or melt metals on large scales, or on smaller scales can be used as solar cookers.

Simple to construct, the solar furnace is constructed of a single parabolic shaped mirror or an array of plane mirrors arranged in a parabolic dish shape. The solar furnace is pointed directly towards the Sun, and the light from the Sun concentrates onto a single focal point due to the geometrical curvature of the parabolic shaped mirror.

Required Materials:

Eisco Temperature Sensor & Handheld Unit
Eisco Solar Furnace [PH0467SF]
Eisco Metalware Set (base retort stand, rod, clamp with bosshead) [MS-ST1]
100 mL Graduated Cylinder [CH0354D]
Digital Timer

Procedure

1. Assemble the Solar Furnace Kit as shown in Figure A. Keep the apparatus pointed away from the sun so the cup does not start heating before desired.
2. Using a base retort stand and a four prong clamp retort, assemble the clamp stand as show in Figure A. Place the Eisco Temperature Sensor probe in the clamp, but do not over tighten.
3. Change the Eisco Temperature Sensor to measure the ambient temperature by touching the thermometer symbol at the top of the screen. Record the ambient temperature.

4. Pour 30 mL water into the cup. Change the Eisco Temperature Sensor to measure temperature using the probe. Insert the probe into the water to measure and record its initial temperature.

5. Situate the clamp so that it is directly above the cup. Hold the temperature probe in place inside the cup with the clamp. Make sure the probe does not touch the bottom of the cup.

6. Rotate the Solar Furnace apparatus so it faces the sun. It may be necessary to adjust the angle of inclination of the parabolic disc to point directly at the sun as well. Keep the cup level when adjusting the angle of inclination. When the parabolic dish is properly situated, the reflection of the Sun’s rays should be visible on the surface of the cup.

7. Record the initial temperature of the water, and then every 60 seconds for five minutes.

**Safety:**
Do not stare directly into the dish! When the dish is collecting the Sun’s rays, avoid pointing the dish at anything flammable.
Data

Ambient Temperature = _________ (°C)

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Water Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Analysis

1. Make a plot of the water temperature in degrees Celsius versus time in minutes.
2. What temperature do you think the water would heat to if it was placed in the shade?
3. What are potential issues with using a solar furnace as a source of heat for cooking?
Sample Results

These are examples of possible results. Similar results should be seen, but exact numbers will vary due to weather conditions.

Ambient Temperature = 24.4°C

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Water Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>18.6</td>
</tr>
<tr>
<td>1</td>
<td>33.8</td>
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<tr>
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<tr>
<td>3</td>
<td>47.4</td>
</tr>
<tr>
<td>4</td>
<td>51.1</td>
</tr>
<tr>
<td>5</td>
<td>53.6</td>
</tr>
</tbody>
</table>

Answers to Questions

1. See above plot.
2. The water would eventually heat up to the ambient air temperature that it is in contact with.
3. The Sun moves along a trajectory in the sky, so one would need to make sure the dish always points so the Sun’s rays focus on the cup to keep heating the water.