Solar Heating Experiment

How does the color of a cup affect the way it heats in the sun?

Abstract: This investigation studies the relationship between the color of a cup and the rate at which the cup heats when placed in the sun, which is an important in understanding how light behaves in general. In the experiment, three cups of different colors were filled with equal amounts of water. They were then placed in the sun and temperature data was taken with NXT temperature sensors running a LabVIEW program on the NXT brick for half an hour. Data collected in this experiment suggests that, as expected, a darker cup will absorb more heat from sunlight than will a lighter cup.

Problem: Does the color of a water-filled cup affect the way it heats in the sun?

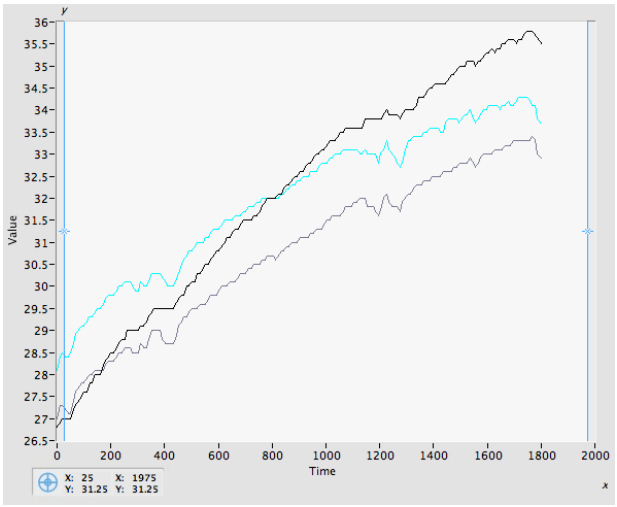
Hypothesis: The cup with the darker color will heat the most quickly because it will absorb more sunlight than the other cups.

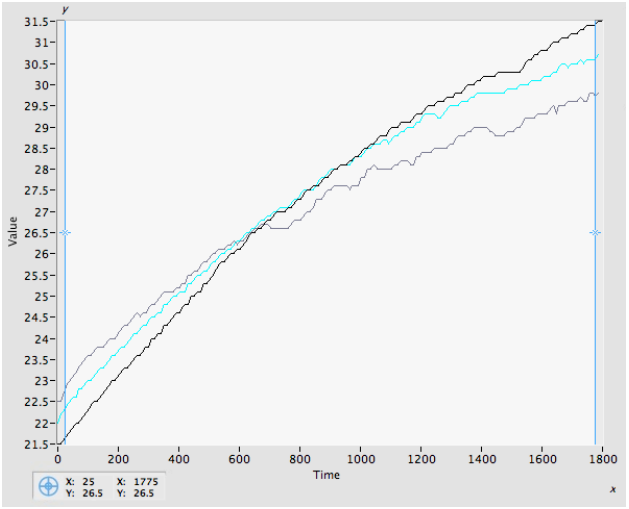
Materials:
3 clear plastic cups
3 small, clear food storage containers
NXT brick
3 NXT temperature sensors
Colored construction paper
Scissors
Tape

Procedure: First, cup covers were cut out of the construction paper and assembled with tape to fit around the bottoms of the plastic cups. A little less than half of the cup's outer surface was covered with the paper when the cover was placed on the bottom of the cup. Then equal amounts of water were placed in each cup, bringing the water level about a quarter of the way to the rim of the cup. The cups were left at room temperature so that they would each cool to the same temperature. When the cups had time to equalize, they were taken outside and each one was placed on an upside-down food storage container so that any heat from the ground would not be transferred to the cup. Finally, a temperature sensor connected to the NXT was placed in each cup and temperature data was taken on the NXT every ten seconds for half an hour. This data was uploaded to a computer using the LabVIEW Data Viewer.

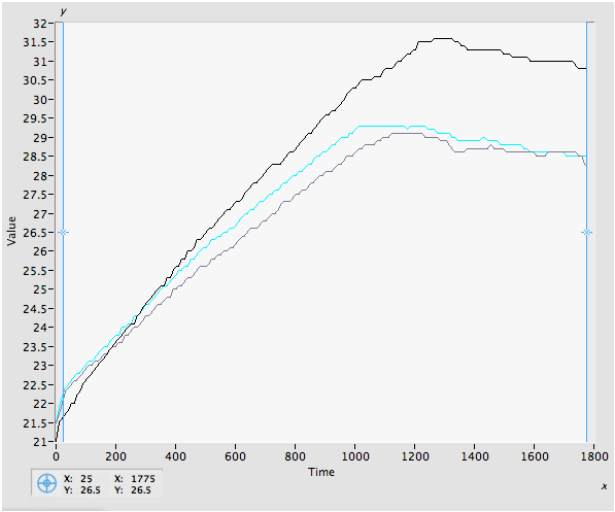
Results: Below are the three trials conducted with a black-covered, a white-covered, and a clear cup. The black line represents the temperature of the black cup, the gray line represents the gray cup, and the light blue line represents the clear cup.

Trial 1 Trial 2

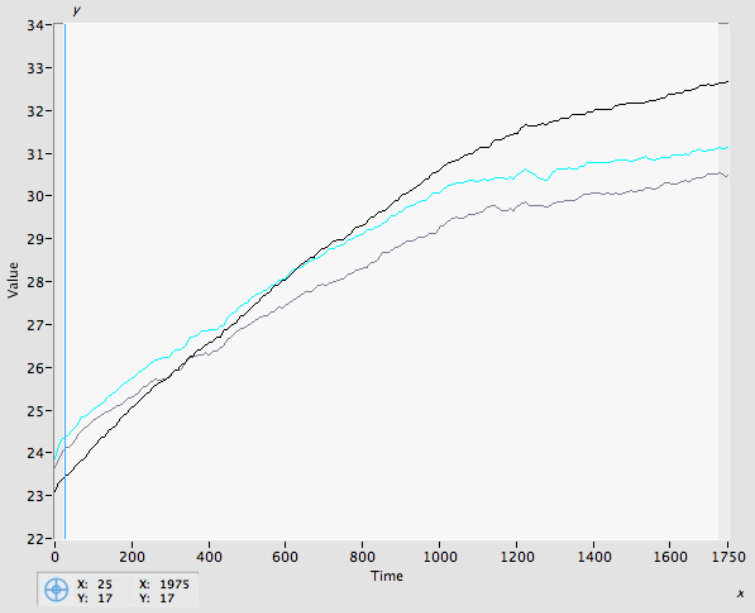




Trial 3



Discussion: Below is a graph of the average temperatures over the three trials, using the same color scheme.



For these trials, the blue line can be seen as the control, since the clear cup did not have any kind of cover on it. The graph of trial 2 provides the most compelling evidence that color does indeed have an effect on the way these cups absorb heat. In trial 2, the white cup started out as the warmest cup, and the black cup started off coolest. However, as the experiment ran its course, the black cup became the warmest and the white cup because the coolest. This is the complete opposite of how they started. Because the covers on the cups are the only differences between the cups, it is safe to attribute the heat-absorbing effects to the covers. Also, it appears that the white cover actually prevented the cup from absorbing some of the light, since the white line crossed the clear line as well. In the graph of the averages, a slight separation between the clear and white lines is also visible, reinforcing the idea that the white cover reflects light from the sun back away from the cup. However, the most noticeable result from this data is that the black cup absorbed significantly more heat than the other two cups.

Conclusion: This experiment gives compelling evidence that the heat absorption of a cup is indeed influenced by the color of the cup. Darker cups will absorb more heat from sunlight than will lighter cups, supporting the original hypothesis.