

Coffee Cup Experiment

What kind of coffee container will keep coffee hot most effectively?

Abstract: This experiment investigated the insulation properties of three different coffee containers. This kind of problem would be of special interest to coffee shop owners, who would like to figure out which cup insulates the best with the lowest cost. In the experiment, hot water was placed in each of the cups in equal amounts and left on a counter to cool. Temperature data was taken over the course of half an hour while they were cooling, with data points of the three cups taken every ten seconds. Experimental data gathered from these experiments suggests that a Styrofoam cup insulates slightly better than a plastic mug, and that both insulate better than a paper cup.

Problem: Which coffee container insulates a hot liquid most effectively?

Hypothesis: The plastic mug will insulate heat the best because it is the bulkiest and is designed especially for holding hot liquids.

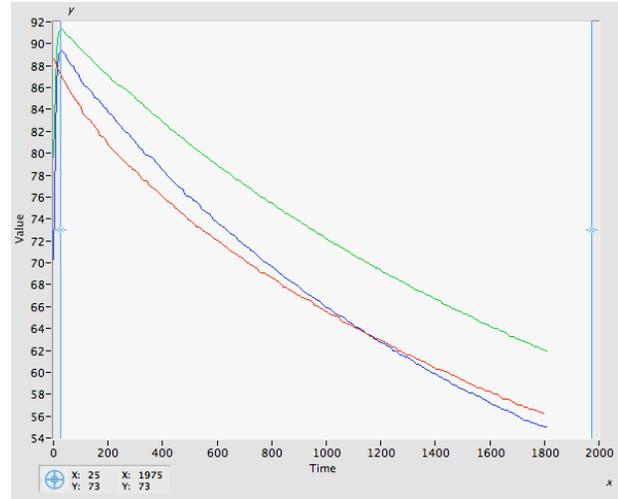
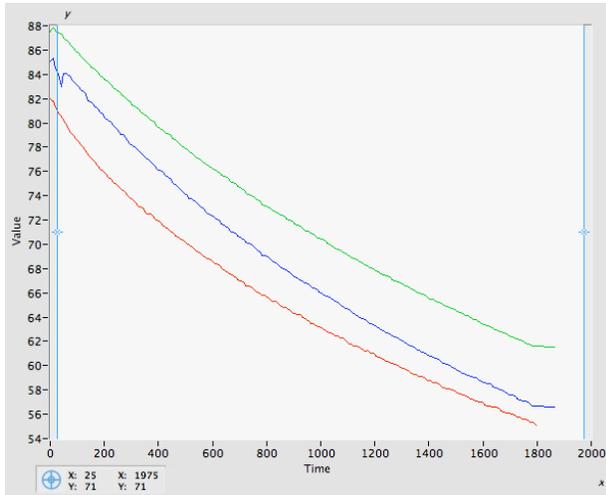
Materials: 3 coffee containers with lids (plastic cup, Styrofoam cup, plastic mug)
NXT brick
3 NXT temperature sensors
Large beaker
Hot plate
Permanent Marker

Procedure: First, the three containers were filled with an equal amount of water, and the marker was used to mark the water level in each. Then, the containers were emptied and water was heated in the beaker on the hot plate. In this experiment, the water was heated until boiling, but this does not need to be the case. Then the containers were filled to the previously marked line with the hot water and a temperature sensor connected to a single NXT was placed in each. The containers were capped with their respective lids and then set on a counter, and a LabVIEW program was run on the NXT to take the temperature of each container every 10 seconds. At the conclusion of the experiment, the data from the NXT was uploaded to the LabVIEW Data Viewer. This procedure was repeated three times to check the consistency of results.

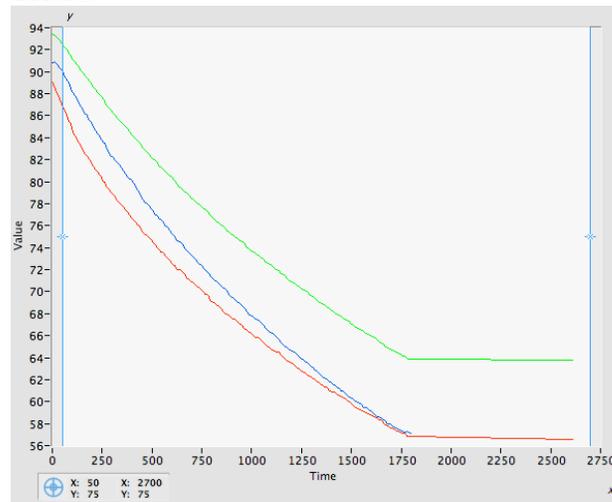
Results: Below are graphs of the three separate trials. For reference, the green curve represents the Styrofoam curve, red represents the plastic mug, and blue is the paper cup.

Trial 1

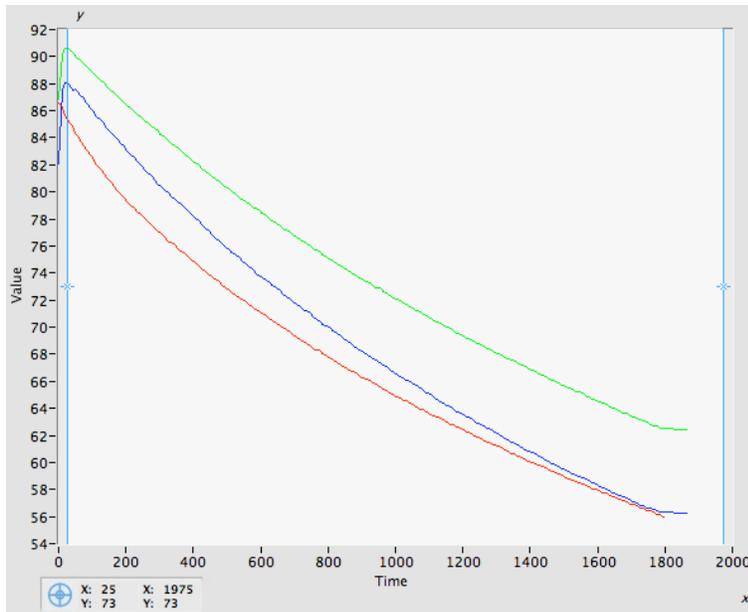
Trial 2



Trial 3



Discussion: Below is a graph of the averages of each of the three graphs. Once again, green represents the Styrofoam curve, red represents the plastic mug, and blue is the paper cup.



As shown by the graph, the Styrofoam cup remains hotter than the other two cups for the entirety of the experiment. The paper cup starts hotter than the plastic mug, but cools faster than the mug. This is most likely because the mug is bulkier than the paper, so immediately after the hot water is poured into the mug, a lot of the heat is transferred into heating the mug to the temperature of the water. In the paper cup and Styrofoam cup, less heat is needed to bring the cups to the temperature of the water, so at the beginning of the experiment, the paper and Styrofoam cups are already hotter than the plastic mug. In terms of net temperature change from pouring the water to half an hour after the water has been poured, the Styrofoam insulates water the most effectively, and the paper cup and plastic mug are about equal.

Conclusion: In all regards, the Styrofoam cup was shown to be the best container of the three for keeping a liquid hot. The hypothesis that the plastic mug would insulate the best because of its size can therefore be rejected, meaning that the level of insulation that a cup provides is due to more than just its bulkiness. The material from which the cup is composed clearly has a large impact. In regards to the other two cups, the paper cup initially absorbs less heat from the hot liquid, but the plastic mug retains heat more effectively over a large amount of time.