Can-Can Lab - LQ

Theory:

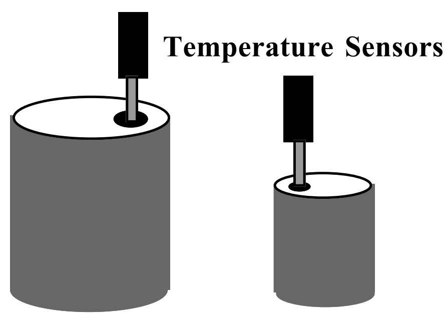
Cooling of objects takes place along their surface. An object with a larger surface area will lose heat faster than an object with smaller area. But larger objects have more mass and therefore more heat energy to release while cooling. Which of these two variables, surface area or mass, increases faster as objects grow in size?

Purpose:

Compare the cooling rate for objects of different size.

Equipment:

Temperature Probes (2 or 3), LabQuest, Cans of similar shape but different size, Hot water, Ring stands, Universal (buret) clamps



Prediction:

1. For the cans of hot water, where does cooling take place? Which can has the most of this and therefore loses heat at the fastest rate?
2. For the cans of hot water, which can had the most heat to lose in order to get back to room temperature? Based on this concept, which can should cool fastest?
3. If your answers to the questions above are different, how can you arrive at the correct prediction of what should happen in this lab?

Procedure:

1. Heat water in a coffee maker or a microwave oven. When handling the cans once you've introduced the water, be careful. Tongs or folded paper towels should be used as the water may be close to boiling!

2. While the water is heating, determine the dimensions of each can you are using. Ignore small features and focus on the volume of water that will be added. Put these values in the Data Table. Calculate the volume of each can and its total surface area, recording those values in the Data Table.

3. Plug the Temperature Probes into your LabQuest. Launch the LabQuest app. The sensor screen should show two or three temperatures depending on how many you used. Keep track of which temperature probe you used with which can.

4. Note that the default setting for data collection (rectangle on right side of screen) is 2 samples/s and 180 seconds. Tap on the Data Collection rectangle. On the screen that appears, set the following:
   Mode: Time Based   Rate: 1 sample/s   Length: 900 s

5. Pour hot water into each of the cans, filling it almost to overflowing. Separate the cans by a small distance, then place a temperature probe as close to the center of each as possible. Use a ring stand and clamp to hold the temperature probe. Wait approximately a minute for the probe to rise to the temperature of the water, then press the collect icon or the collect button to begin data collection.

6. When data collection is complete, remove the temperature probes from the cans. Dispose of the hot water carefully. Return all equipment to the place indicated by the instructor.

Analysis:

1. Tap on the Data Table icon at the top of the screen. Tap and drag across the label at the top of the first set of temperature data. Using the keyboard that appears, type in a description of the can you were measuring (smallest, largest, medium, etc.). Tap in the space above the second and then third sets and label them accordingly.

2. Go back to the graph. Compare the graphs from your different cans. Which cooled the fastest? Which cooled slowest? How did you determine this from your graph? Can you determine a mathematical value for the cooling rate, how fast the can cooled?

3. Formulate a reason why one cooled faster than the other(s). Compare the relative cooling rates to the SA/V Ratio, the ratio of surface area to volume. For the same amount of volume, which can had the most surface area? Did it also have the fastest cooling rate?

4. Think of other situations where objects cool (or heat) faster or slower depending solely on their size. Explain these situations as part of your report.

Data Table:

	Smallest	Medium	Largest
Diameter (D)			
Height (H)			
Volume (V)			
Surface Area (SA)			
SA/V Ratio			
Cooling Rate			

Radius (R) = Diameter (D) / 2   Volume (V) = $\pi R^2 H$ Surface Area (SA) = $\pi D H$

Clarence Bakken
Updated February 2009