ACTIVITY 3: ENGINEER A THERMOS

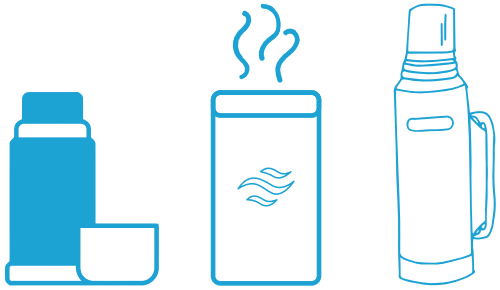

Image Credit: Gary Abud, Jr.

The purpose of this experiment is for students to build a container (thermos) that can hold a 16oz Styrofoam cup containing 250mL of hot water and maintain the temperature of the water as high as possible for 30 minutes.

Context:
During winter months in the Great Lakes, ice fishermen and other winter sport enthusiasts want to enjoy a hot beverage but don't want their beverage to cool down before they can drink it. So, students will be researching materials that can help to keep a hot drink hot over a half-hour time period by engineering a thermos container for a styrofoam cup.

This is an engineering challenge that can be done outside of class individually by students or with one partner. Any Household materials are acceptable. Alternatively, the teacher can gather a variety of materials to have in class and students can design their thermos in class after researching the available materials.

Guidelines:
1. The thermos may be any shape, but no larger than 0.25m x 0.25m x 0.25m in size
2. The container must be able to fit a 16oz Styrofoam cup (which will hold the water)
3. The teacher will provide the styrofoam cup to students on thermos testing day
4. The container should be completely closed on all sides, e.g., should have a lid, but needs to have an access point on the lid for a thermometer to reach the water
5. Thermometers will be provided on test day
6. Thermos designs may not include a device that transfers energy into the system (e.g., a hot plate) of your thermos
7. Thermos designs should be pre-tested by students before bringing it in for test day.

First, communicate the project, with its guidelines and timeline, to students. Emphasize that the objective is not as much to create a portable usable thermos but to keep the water as warm as possible for the entire testing period.

Then, allow students time to research materials in, or outside of, class and make their build.

Next, have students create a write up or presentation that explains the research and design behind the thermos they created. Later, after test day, they'll include their test results.

Last, on thermos test day, provide students one 16oz styrofoam cup filled with 250mL of boiling water and have students complete the testing procedure listed below:

Testing Procedure:
1. Each thermos group will be provided a 16oz Styrofoam cup and 250mL of boiling water
2. Thermometers should be inserted into the thermos immediately after adding hot water through the opening directly into the water
3. Record initial temperature of the water
4. Record the temperature of the water every 30 seconds for 30 minutes.
5. After recording the final temperature, students should create a line graph showing how their temperature changed over time.
6. Students should calculate their relative temperature change from start to finish and determine what percent temperature change they had overall. For example, 100˚C starting, 70˚C final temperature would be a 30˚C change and a 30% temperature decrease from original temperature, e.g., a 70% heat retention
7. All groups should list their data on the board so that each thermos can be compared and ranked for evaluation on the contest criteria by temperature change (ΔT).
8. Divide groups' data into quartiles to compare how each performed to others
9. Remember the lower the ΔT the better!

**Note: teachers can choose to evaluate these projects and their thermos outcomes according to a criteria that best suits the format of their learning setting.*