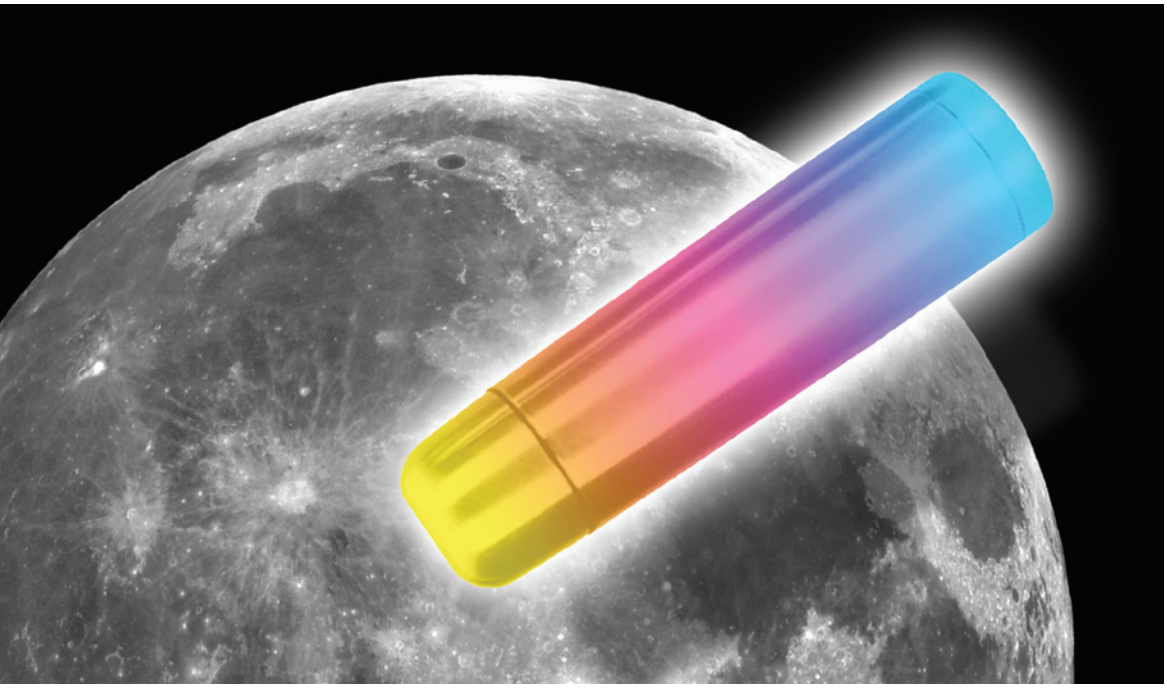
Design a Lunar Thermos



DESIGN challenge

To design an insulator for a cup of hot water and a cup of cold water to maintain water temperature relatively constant. To apply the understanding of how things get warmer and cooler heat transfer.

OBJECTIVE

To demonstrate an understanding of the Engineering Design Process while utilizing each stage to successfully complete a team challenge.

PROCESS SKILLS

Experimental design, measuring, graphing and data analysis

MATERIALS

Glow sticks (2)

Thermometers

Stopwatches

Graduated cylinders

Plastic cups

Insulating materials (e.g. bubble wrap, paper, cloth, sand, water, foil, Styrofoam, etc)

STUDENT PAGES

Design Challenge

Ask, Imagine and Plan

Experiment and Record

PRE-ACTIVITY SET-UP

While the students are using the EDP to create an insulator, they will also be conducting a scientific experiment that requires a control. While the students test their cups, place a cup of hot water and a cup of cold water at the front of the room, un-insulated, each holding a thermometer. Set a timer for every 30 seconds and record the data to share with the students so they may compare their data.

Please note: This activity may require two 60-90 minute sessions to complete.

MOTIVATE

- Ever wonder what is involved in designing today's spacesuits? Check out this interactive site to learn about NASA's spacesuits:

  www.nasa.gov/audience/foreducators/spacesuits/home/clickable_suit.html

SET THE STAGE:

ASK IMAGINE
& PLAN

- Share the *Design Challenge* with the students
- Let students pretend to be molecules. First have them stand still and close together. Then have the students wiggle and then walk and move around to demonstrate more heat energy entering the system. Have them move faster and jump up and down as even more energy enters the system. Then have the students stop to notice where they are standing. (Note: They should be much farther apart and should feel much warmer than they were originally.)
- Place a glow stick in a clear cup of hot water and a clear cup of cold water, then turn off the lights. Using the knowledge they just acquired from the earlier activity, ask the students to select the glow stick with more molecular movement.

CREATE

- Challenge the students to devise an insulation system to keep water at a constant temperature.

EXPERIMENT

- Have students follow the directions on the *Experiment and Record* worksheet to complete their experiment.
- Students should graph the temperature results as a line graph and analyze. Building a graph is not a math standard often taught in 3rd grade, depending on your state. It is your discretion of whether or not to have students graph their data. Feel free to share the graphing video with your students to demonstrate how to build a graph:

  http://svs.gsfc.nasa.gov/goto?10515

IMPROVE

- Have students design other combinations of materials to decrease any temperature fluctuation from their first design.

CHALLENGE CLOSURE

Engage the students in the following questions:

- *How did the temperature of the hot water change? Cold water?*
- *How does your experiment's data compare to the control experiment your teacher conducted at the front of the room?*

PREVIEWING NEXT WEEK

During this session, you explored designing insulation to reduce temperature changes, much like protecting humans from the extreme temperature swings on the Moon's surface. What if you needed to capture heat energy instead? Why would you need to capture heat energy if we wanted to live on the Moon?

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Design a Lunar Thermos
Teacher page

lunar thermos

Oh, to not have an atmosphere!

There is no atmosphere on the Moon, so temperatures fluctuate through a very wide range. In the shadowed areas of the moon, the temperature can be as low as -180°C (or -300°F), and in the sunlit areas, it is about 100°C (or 212°F), which is the boiling point for water! These are serious extremes for human beings! Furthermore, there are spots on the Moon that are permanently exposed to the Sun, and others permanently in shadow. It is in the permanently shadowed areas of some craters that scientists believe water ice may exist.

Protecting Ourselves

Anyone living on the Moon - even for a short while - will have to deal with this temperature variation and be protected properly from its damaging effects. Just think about the number of layers you wear when going outside on a very cold winter's day. The goal in designing a space suit is to create protective layers to keep a human body at a fairly constant temperature. Therefore, we must understand how heat moves. Engineers need to design protective wear to **prevent heat** from being transferred to, or transferred away, from our bodies. How could we **insulate** ourselves from the wide variations of temperature in the lunar environment?

THE CHALLENGE:

Your mission is to design a "Lunar Thermos" – a protective insulator for a cup of hot and a cup of cold water. You must also conduct an experiment to compare your insulated cups to unprotected cups set up by your teacher. The design constraints are:

1. ***Use any combination of materials available to you to create a protective insulating layer to keep 100 ml of hot water, and 100 ml of cold water, at a relatively constant temperature.***
2. ***Your "Lunar Thermos" temperatures should change by no more than 3 °C over 5 minutes.***
3. ***You must be able to graph your results (optional).***

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Design a Lunar Thermos
Student page

lunar thermos

ASK IMAGINE &PLAN

What questions do you have about today's challenge?

What is heat energy transfer? Simply put, it is the method of things warming up or cooling down. We can determine how much heat is transferred, by measuring the change in temperature. Take a few minutes and find the definitions of these two words:

HEAT _____

_____

TEMPERATURE _____

_____

Draw a picture of a warm human standing on the Moon in the cold, lunar night. Label what is warm and cold. Use arrows to show which way the heat moves.

Now imagine that the sun comes up, and the human is standing on the hot lunar surface. Re-draw the picture and label what is warm, cold, and which way the heat moves.

Draw and label the materials you will use to build your Lunar Thermos.

Approved by: _____

Experiment & Record

1. Collect necessary materials and create your Lunar Thermos for each cup.
2. Record the temperature of the room: _____ °C
3. Using a graduated cylinder, collect 100 mL of cold tap water and pour it into one plastic cup. Repeat for hot water (from the tap).
4. Record the temperature for each cup of water every 30 seconds for 5 minutes total. Record your results on the next page for Trial 1.

Lunar Thermos Data Table

Time Min:sec	Cold Water Cup (°C)		Hot Water Cup (°C)	
	Trial 1	Trial 2	Trial 1	Trial 2
0:00				
0:30				
1:00				
1:30				
2:00				
2:30				
3:00				
3:30				
4:00				
4:30				
5:00				

5. Improve your design by trying another combination of materials and repeat the experiment. Record your results for Trial 2.

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Graph the results from your experiment, using the data from either Trial 1 or Trial 2. Time is the independent variable in this experiment. You, as the experimenter, decided when to take temperature readings. The independent variable is plotted on the x-axis. The temperature of the water is the dependent variable in this experiment. The temperature of the water depends on the time it was measured. The dependent variable is plotted on the y-axis. Label the y-axis below and plot your data using dots. Connect your dots to make a line. Draw two lines in two different colors to distinguish the data from each cup.