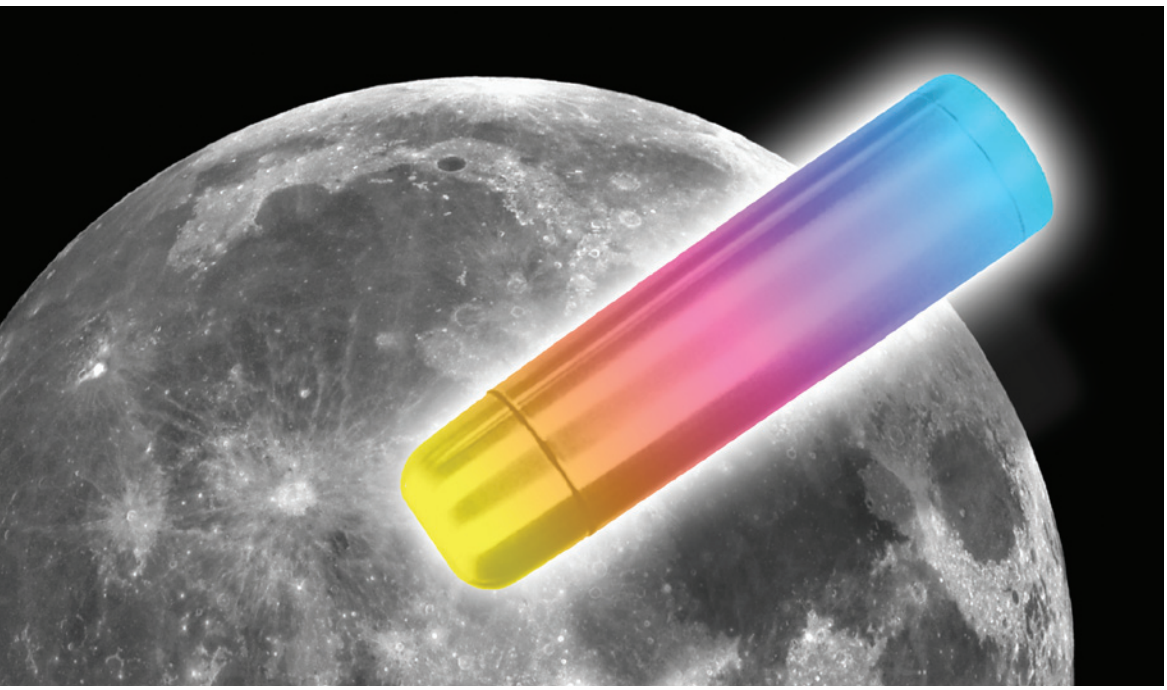
Design a Lunar Thermos



DESIGN challenge

To design an insulator for a cup of warm 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, 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.

MOTIVATE

- Ever wonder what is involved in desiging 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

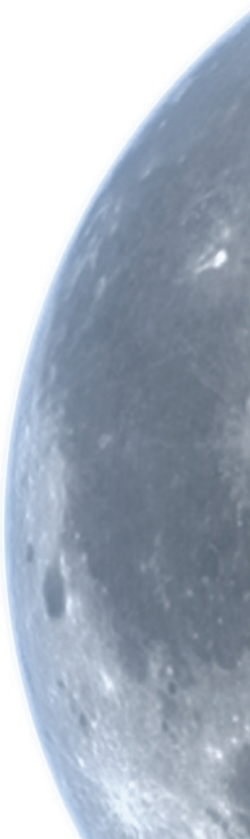
- Share the *Design Challenge* with the students
- Let students pretend to be molecules. First have them stand still and close together. Then have the students wiggle and then walk and move around to demonstrate more heat energy entering the system. Have them move faster and jump up and down as even 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.
- Remind students to ask questions and brainstorm ideas, then break into teams to create a drawing of a lunar thermos. All drawings should be approved before building.

CREATE

- Have students practice measuring temperature on the thermometer.
- Challenge the students to devise an insulation system to keep warm water at a constant temperature.

EXPERIMENT

- Have students follow the directions on the Experiment and Record worksheet to complete their experiment.



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 much did the temperature of the water change in your Lunar Thermos?*
- *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?

DESIGN challenge

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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. We 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 warm 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 warm tap water at a relatively constant temperature.*
2. *Your "Lunar Thermos" temperatures should change by no more than 3 °C over 5 minutes.*

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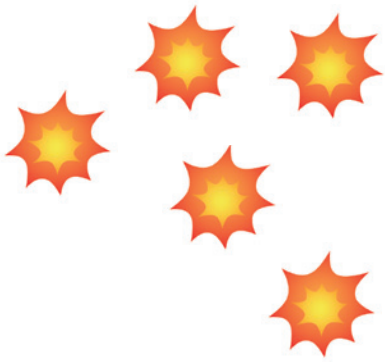
Design
a Lunar Thermos
Student page

lunar thermos

ASK IMAGINE &PLAN

Draw a picture of a warm human standing on the Moon in the cold, lunar night. In your picture, show how heat moves between the human and the air around him or her. Make sure to label the arrows warm and cool.



Now imagine that the sun comes up, and the human is standing on the hot lunar surface. Draw a picture showing how heat moves between the human and the air around him or her. Make sure to label the arrows warm and cool.

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.
2. Using a graduated cylinder, collect 100 mL of warm tap water and pour it into your insulated plastic cup.
3. Use a stopwatch to measure 30 seconds. Record the temperature of the water. Repeat until you reach 5 minutes total.

Lunar Thermos Data Table

Time (Min:sec)	Water Temperature (°C)
0:00	
0:30	
1:00	
1:30	
2:00	
2:30	
3:00	
3:30	
4:00	
4:30	
5:00	