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.

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. Using your Lunar Thermos design, you will conduct an experiment to compare your insulated cups to unprotected cups (the control). The design constraints are:

1. ***Use any combination of materials available to you to create a protective insulating layer to keep a cup of hot water, and a cup of cold water, at a relatively constant temperatures.***
2. ***Your "Thermos" temperature should change by no more than 5°C over 10 minutes.***
3. ***Your team must pre-determine what is optimal for your Lunar Thermos design: (a) volume of water to use in each cup and (b) how hot or how cold the water should be at the beginning of the experiment and (c) the frequency of measuring the temperature in each cup.***
4. ***You must be able to graph your results.***

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.

lunar thermos

Design
a Lunar Thermos
Student page

ASK IMAGINE & PLAN

What questions do you have about today's challenge?

Today you will conduct an experiment to demonstrate the movement of atoms and molecules through temperature measurements and engineer a design that can slow down that movement. Take a few minutes and find the definitions of these words and phrases:

HEAT ____

____

TEMPERATURE ____

____

EQUILIBRIUM ____

____

THERMAL ENERGY TRANSFER ______________________________

____

Before you begin setting up an experiment, can you predict how the temperature will change in each cup? Using the vocabulary from above, write a hypothesis for what you think will happen in the experiment.

____

____

Design your experiment:

How much water do you plan to use for each cup (in mL)?________

How often will you check the change in temperature of the water?

____

What materials will you use as insulation? ______________________

____

Draw and label your Lunar Thermos.

Approved by: ____

Experiment & Record

1. Record the temperature of the room: ______________ ^oC
2. Using a graduated cylinder, collect the cold water and pour it into one plastic cup. Repeat for the hot water.
3. Record the temperature for each cup of water for the times planned earlier and record the results in the control column.
4. Now build your Lunar Thermos for each cup and repeat the experiment. Record your results for Trial 1.
5. Improve your design by trying another combination of materials and repeat the experiment. Record your results for Trial 2.

Lunar Thermos Data Table

Time (Min:sec)	Cold Water Cup (°C)			Hot Water Cup (°C)		
	Control	Thermos Trial 1	Thermos Trial 2	Control	Thermos Trial 1	Thermos Trial 2
0:00						

Lunar Thermos Data Table Continued

Time	Control	Trial 1	Trial 2	Control	Trial 1	Trial 2

Create a line graph of your results and indicate where your cups of water may have reached equilibrium. Make sure to label your axes and use different colors or line styles to represent the cold and hot water cups.

Trial 1

Trial 2

QUALITY ASSURANCE FORM

Each team is to review another team's design and model, then answer the following questions.

Name of team reviewed: ___________________________________

	YES	NO
Were the cups properly labeled for the hot and cold water?		
Did the team use enough water to perform the experiment properly?		
Did the team graph the data correctly?		
Did the hot or cold water cup ever reach equilibrium?		

How many times was the temperature measured? _____________

List the specific strengths of the experiment.

List the specific weaknesses of the experiment:

How would you improve the experiment?

Inspected by: ________________________________

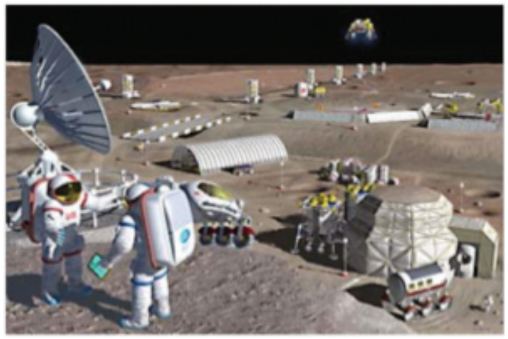
Signatures: ________________________________

____

____

Fun with Engineering at Home

During this session you have learned about the flow of heat and how objects reach thermal equilibrium. You also experimented with a way to slow down that energy transfer. These are all important concepts to understand and implement if humans are to live and work on the Moon or other planet. What would happen if we actually needed to harness solar energy to provide power in a remote location? Talk with your family members about all the ways we could use energy from the Sun to do work for us. Can you think of four methods, man-made or natural?



1.
2.
3.
4.

YOU BE THE TEACHER!

Do you think you can explain the principle of thermal transfer as it applies to boiling water for tea? What happens to the water in the **tea kettle** when you place it on the stove and turn the heat on?

DESIGN challenge

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