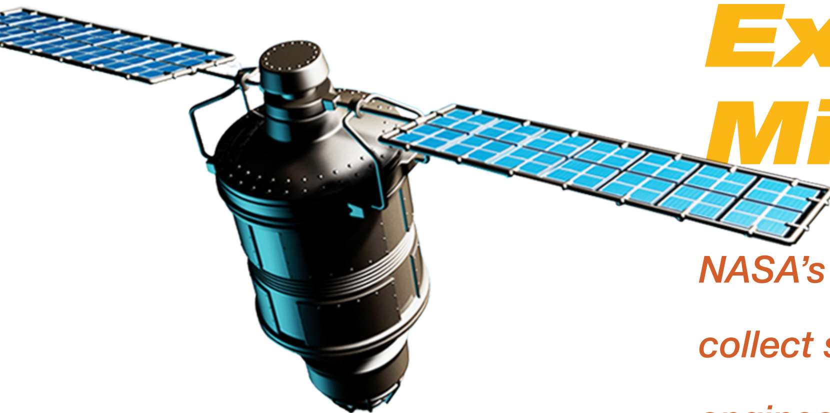
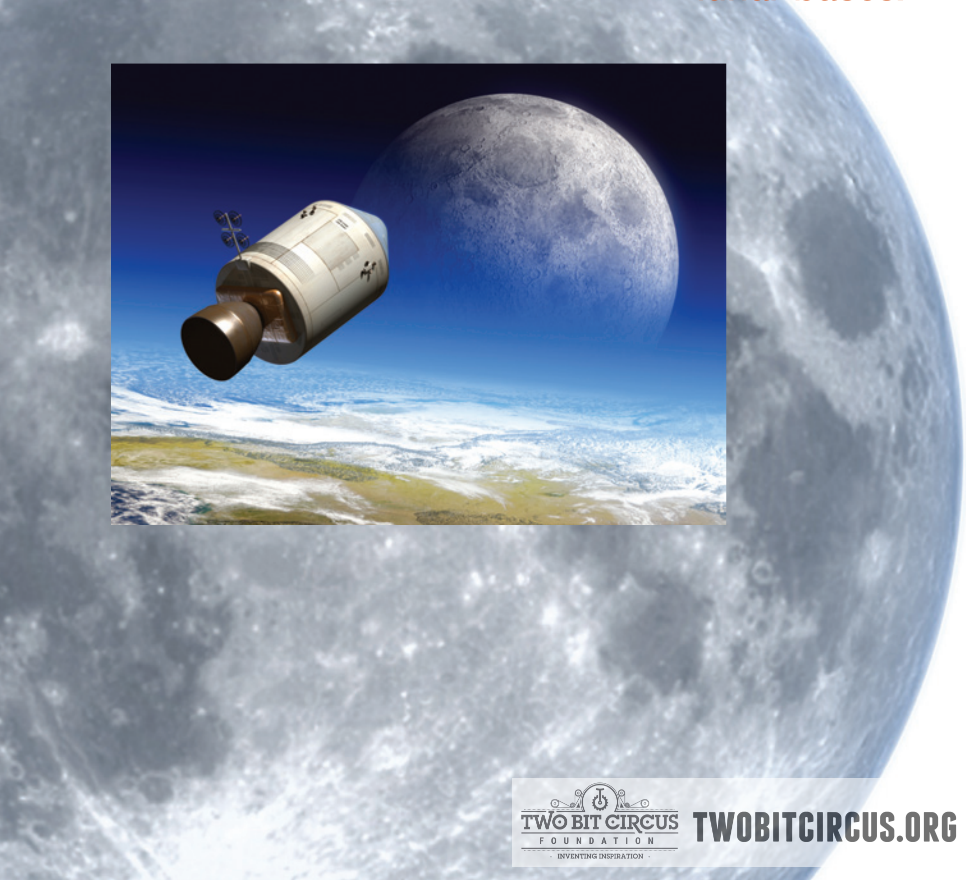
NASA's Lunar Exploration Missions

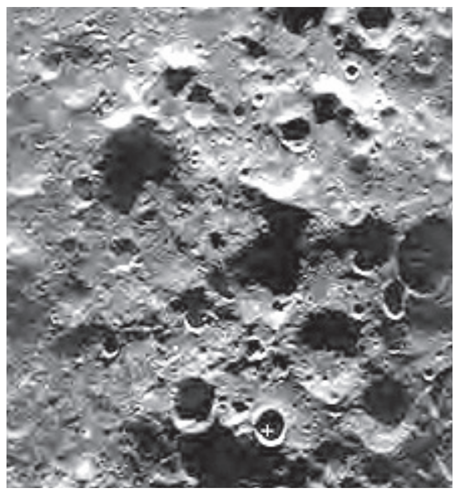


NASA's lunar exploration missions will collect scientific data to help scientists and engineers better understand the Moon's features and environment. These missions will ultimately help NASA determine the best locations for future human exploration and lunar bases.



SATELLITE INSTRUMENTS

The information gathered by lunar exploration missions will add to information collected during earlier missions. Some of these missions gathered data that caused scientists to have more questions — questions they hope to solve with new instruments on new satellites. For example, NASA has recently sent a satellite to look for water ice on the Moon. Thus, that satellite carried instruments (sometimes called "detectors" or "sensors") to look for the ice. Other instruments will help collect data to make exact maps of the Moon's surface and make careful measurements of the radiation falling on the lunar surface for the safety of future lunar explorers.



TEAMWORK IS IMPORTANT

The different instruments are designed, tested, and assembled by different teams of engineers and scientists. The separate teams must work together to ensure instruments are the right mass, fit correctly, and make proper measurements. Working together is an important skill for *everyone* to practice.

DESIGN challenge

To design and build a satellite that meets specific size and mass constraints. It must carry a combination of cameras, gravity probes, and heat sensors to investigate the Moon's surface. The satellite will need to pass a 1-meter Drop Test without any parts falling off of it.

THE CHALLENGE:

Your mission is to build a model of a lunar exploration satellite with the general building supplies provided. Each team should create their own satellite. Use different shape/sizes of buttons or beads to represent the various instruments.

The design constraints are:

1. The total mass of the instruments, detectors, probes, sensors and solar cells can be no greater than 60 kilograms (see Satellite Instrument Data Table, p.18).
    - The satellite cannot be launched if the mass of instruments, detectors, probes and solar cells exceeds a total of 60 kilograms, so choose your instruments carefully.
2. The entire satellite must **fit within the __________ (i.e. mailing tube, oatmeal canister)**. This item is a size constraint. The satellite is not to be stored in this or launched from this item.
3. At least two instruments must "deploy" (unfold or pop out) when the satellite is launched. These instruments must be mounted on a part that moves.
4. The satellite must withstand a 1-meter Drop Test without any pieces falling off.

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ASK IMAGINE & PLAN

What questions do you have about today's challenge?

Use the data in this table to determine which instruments, and how many of those instruments, to include on your satellite.

Satellite Instrument Data Table

Detectors or Instruments	Use	Mass (kg)	Number of solar cells needed to power
Camera	takes pictures	30	1
Gravity Probe	measures gravity	20	2
Heat Sensor	measures temperature	10	3
Solar Cell	collects energy from the Sun to power an instrument, detector, sensor, or probe	1	n/a

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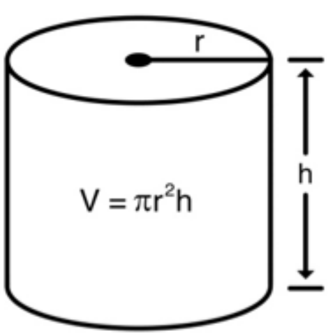
Build a Satelliite
Student page

Our Team's Satellite Instrument Data Table

Instrument	Mass
	kg
	kg
	kg
Total Number of Solar Cells:	kg
Total mass of instrument package	kg
Volume of Payload Container (see hint below)	cm^3
Does your satellite fit within size constraints?	

Hint

– How to calculate the volume of a cylinder:



1. **Find the radius (r) of the circle found at the top and bottom of the cylinder. The radius is half of the measurement of the diameter of the circle.**
2. **Square the radius value and multiply it by π (pi).**
3. **Determine the height (h) of your cylinder and multiply it by the value found in step #2.**

Use the following page for your volume calculations.

Your volume calculations.

How will the instruments on your design deploy when the satellite is launched?

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Student page

satellite

Draw two views of the satellite with its instruments you intend to build:

View 1

View 2

Approved by: ______________________________

Experiment & Record

Pair up with another team to do a Drop Test. Each team should evaluate another team's drop by completing the Quality Assurance Form (page 27). Drop your satellite from a height of 1 meter. If needed, use a meter stick to measure the height.

What happened when you completed the 1-meter Drop Test?

Did any pieces fall off? If yes, which ones?

What kinds of changes are needed to make to your satellite stronger?

Draw your satellite with these new modifications.

What is the total mass of your instruments and solar cells after making these new changes?

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satellite

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
Does the satellite fit within specified size constraint?		
Did the satellite withstand the Drop Test?		
Will the instruments deploy upon launch?		

Total mass of the instruments is: ________ **grams**

List the specific strengths of the design.

List the specific weaknesses of the design:

How would you improve the design?

Inspected by: ______________________________

____

____

____

Fun with Engineering at Home

TWO BIT CIRCUS
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INVENTING INSPIRATION
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Today you designed and built a satellite model to orbit the Moon. You used the same process that engineers use when they build something. You had to **ASK**: what is the challenge? Then you thought, talked and **IMAGINED** a solution to the challenge. You **PLANNED** with your group and **CREATED** a model satellite. Finally, you **EXPERIMENTED** or tested your model by having other groups look at it and give you feedback. Last, you went back to your work stations and tried to **IMPROVE** the satellite. These are the same 6 steps engineers use when they try to solve a problem or a challenge.

While at home, see what you can learn about satellites — how they work, what they are used for, and how scientists and engineers get them up into orbit. You may even want to see if you can find out what kind of sensors, instruments and probes the satellites orbiting the Earth carry.

You can find this information in books, magazines or on the Internet. Here are some Internet links you may want to use:

World Book at NASA: Artificial Satellites
www.nasa.gov/worldbook

The World Almanac for Kids Science: Artificial Satellites
www.worldalmanacforkids.com

NASA Space Place
http://spaceplace.nasa.gov/en/kids/quiz_show/ep001/

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