Activity Title: Build a Satellite to Orbit the Moon!

This activity was adapted from
http://www.lpi.usra.edu/education/explore/moon/lro.shtml

Courtesy NASA

Activity Objective(s): The teams' challenge is to design and build a satellite which falls within certain size and weight limits. This satellite will be designed to orbit the Moon. It will have to carry some combination of cameras, gravity probes, and heat sensors to look at or probe the Moon's surface. The satellite should deploy at least two instruments upon launch from a balloon rocket (next week). The satellite should be able to withstand a 1-meter Drop Test.

Grade Levels: 6-8

Lesson Duration: One 60-90 min session

Process Skills: measuring, calculating, designing, evaluating

Materials and Tools (per group of three students):

- General building supplies
- 1 Bag "Shockers" candy
- 1 Bag "Chewy Sweet Tarts" candy
- 1 4" mailing tube

Club Worksheets: (Make copies for each student to put in binder)

1. Engineering Design Process Sheet
2. Detector or Instrument Table of Uses and Weights
3. Satellite IMAGINE and PLAN Sheets
4. EXPERIMENT Notes
5. Satellite Re-design Sheet
6. Summary Sheet - Questions/Discussions for Understanding
7. Fun with Engineering at Home Sheet
8. Quality Assurance Sheets - Checking Each Other's Satellite Models

Club Facilitator or Teacher Notes by Stage:

(Based on those running 60-minute Clubs)

Stage 1: Meet and Motivate (Approx 10 minutes)

- Welcome the students!
- Give students nametags and have them go around and share their names – it is important that everyone get to learn the names of the club participants.
- Set the stage by telling them how excited you are about the club – let them know that they are very special; they will be learning how to become ENGINEERS.
- Spend a few minutes asking them if they know what engineers do….. then let them know that we will be experiencing what engineers do during our time together today….. Take a few minutes to go over the Engineering Design Process steps – hand out the ***Engineering Design Process*** Worksheet.

Stage 2: Set the Stage, Ask, Imagine, Plan (Approx 10 minutes)

- Share the **Design Story and Challenge** orally with the students (provided in teacher pages). This story provides the context and motivation for trying to accomplish the challenge. This is the **ASK** phase of the Engineering Design Process.
- Put the students in teams of 3 around the room – try to separate the teams so they are not working "on top" of one another.
- Place building materials (not the glue, tape, or scissors) in the middle of each team's area.
- Hand out the ***Detector or Instrument Table of Uses and Weights*** worksheet and the ***Satellite IMAGINE and PLAN Worksheet*** (1 of each of these worksheets per team)
- Let the challenge begin - Encourage them to **IMAGINE and PLAN** before building. Do not hand out the scissors, tape or glue until this section is completed. Ask them to use their worksheets to capture their design ideas.

Stage 3: Create and Experiment (Approx 15 minutes)

- Give out the scissors, glue and tape. Challenge the teams to **CREATE** or build their satellites based on their designs. Remind them to keep within specifications.
- Ask members of each team to check mathematical calculations and check designs and models to make sure they are within specified design constraints.

- Hand out the **EXPERIMENT Notes** worksheet. Discuss how important **EXPERIMENTING** and feedback is for engineers. The *imagine, plan, create, experiment, improve* loop is key for engineers to be successful.

Stage 4: Improve (Approx 10 minutes)

- Use experiment results to **IMPROVE** (Re-Design and Re-Build) satellite models.

Stage 5: Challenge Closure (Approx 10 minutes)

- Give out the ***Summary: Questions/Discussion for Understanding*** worksheet (1 per team). Ask each team to fill out the worksheet.

- PLEASE COLLECT THESE SUMMARY SHEETS AND SAVE IN A FOLDER FOR NASA.

- In summary have a short discussion with all teams. Ask them, "What was the greatest challenge for your team today?" Expect answers such as:
    - Planning and creating a satellite with detectors that fits within a certain space and weight set of specifications
    - Calculate weights of instruments/detectors, making sure that our instruments do not add up to more than the allowed weight limit
    - Getting the instruments to deploy properly
    - Consider what it means to build something that will be launched into space
    - Work as a team, communicate
    - Imagine, plan, create, experiment, improve steps

  If you do not get these types of answers, try to facilitate an interaction where you put these thoughts in play and ask for feedback. Encourage all teams to offer thoughts. Collect Summary Sheets for your review to see how students are doing with comprehension. Put these sheets in student notebooks after reviewing them.

Stage 7: Previewing Next Week (Approx 5 minutes)

- Ask teams to bring back their satellite model for use in next week's club challenge. They will be launching the satellite using a balloon rocket. You may want to store them in the classroom or have one of the facilitators be responsible for their safe return next week.
- Ask teams to think about satellites during the next week, ask their parents about satellites, look up satellites in books or on the Internet. (See Internet Resource List)
- There is really no homework, but you do want to encourage students to stay engaged mentally during the next week so they are ready for the club when it comes club time once again in 7 days. Please give each student the *Fun With Engineering at Home* worksheet. Tell them to share this sheet with their family. Tell them to ask their family to help them with the Home Challenge found on this sheet.

Special Notes: For Those with 90 minute Clubs

Quality Assurance

- Hand out the ***Quality Assurance Test*** worksheets (1 per team) and ask them to fill out the top section with team name and participants' names.
- Ask each team to put their satellite model together with their Quality Assurance Test worksheet around the edges of the room. Ask each team to move one notch clockwise to offer feedback to the neighboring team, using the Quality Assurance Test worksheet.
- The Quality Assurance Team conducts the Drop Test and records their findings.

Design Story and Challenge: (*For Teacher Use)*

This is the story you will tell the students to paint the picture or set the context for this first challenge. It is important that you set the context with this story before jumping into the challenge. It is this story that makes the science, mathematics and engineering come to life; it is the story that makes the hands on activities have relevance and meaning.

NASA's Lunar Reconnaissance Orbiter

Launch Date: October 2008

NASA's Lunar Reconnaissance Orbiter (LRO) will launch in 2008, thrust into orbit aboard an Atlas 401 rocket. The LRO will spend at least a year orbiting the Moon. It will collect scientific data to help scientists and engineers better understand the Moon's features and environment, and will ultimately help them determine the best locations for future human missions and lunar bases.

The information gathered by LRO 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. For example: scientists and engineers need to know if there is any ice on the Moon. Humans need lots of water to live, and it is <u>way</u> too heavy to carry with us up to the Moon! The LRO will carry instruments (sometimes called "detectors" or "sensors") to look for ice (water in solid form). Additionally we need to make exact maps of the Moon's surface. And, for safety, we need to make careful measurements of the radiation falling on the lunar surface.

The different instruments are designed, tested, and assembled by different teams of engineers and scientists. The separate teams have to work together to make sure that the instruments are the right weight, fit correctly, and make proper measurements.

Overall, the <u>weight</u> of anything we want to send into space is the most challenging problem for the engineers. The more an object weighs the more energy it takes to launch it.

Design Challenge

The students must build a model of the LRO with the general building supplies, using the candies as the various instruments. The total weight of the instruments, detectors, probes, sensors and solar cells (that provide electricity) can be no greater than **45 kilograms**. The satellite cannot be launched if the instruments, detectors, probes and solar cells weigh more than a total of 45 kilograms, so choose your instruments carefully (the satellite infrastructure is weighed separately and the engineers need not be concerned with its weight for this activity). Also, the satellite must **fit within the provided cardboard mailing tube**. 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. Additionally the orbiter must withstand a 1-meter Drop Test without any pieces falling off.

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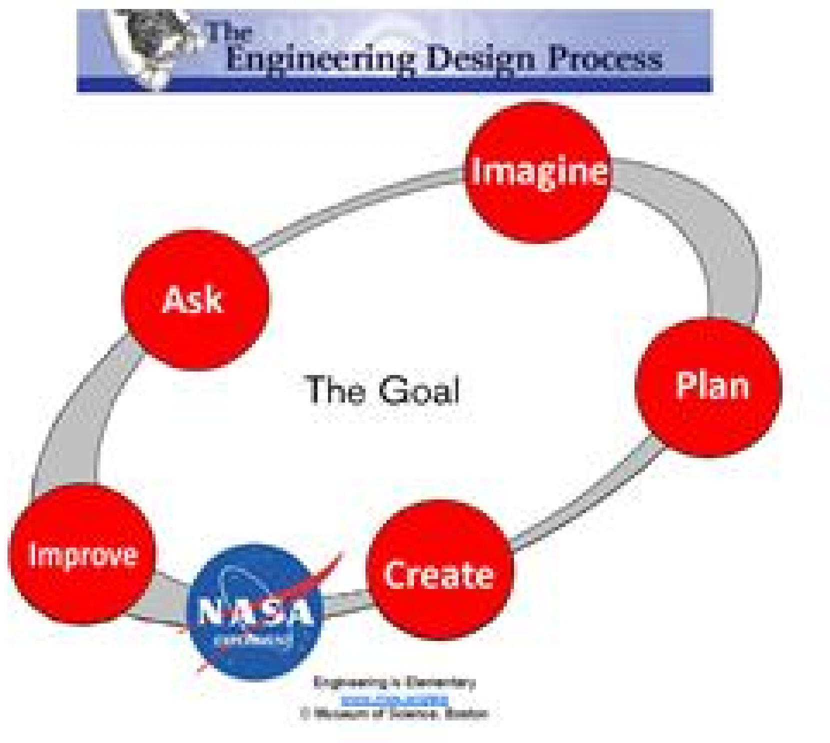
1. Engineering Process



The Engineering Design Process is a series of steps that engineers use to guide them as they solve problems.

1. **Ask** a question or set a challenge
2. **Imagine** a solution to the question or challenge
3. **Plan** a solution - Include drawings and diagrams
4. **Create** – Follow your Plan, build your design
5. **Experiment** – Test what you've built
6. **Improve** – Talk about what works and what doesn't; modify your creation

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2. Detector and Instrument Table of Uses and Weights

Detectors or Instruments (Candy Pieces)	**Use**	**Weight**
Camera (3 Blue Shockers)	Takes Pictures (needs 1 solar cell to operate)	30 kilograms
Gravity Probe (2 Orange Shockers)	Measures Gravity (needs 2 solar cells to operate)	20 kilograms
Heat Sensor (1 Purple Shocker)	Measures Temperature (needs 3 solar cells to operate)	10 kilograms
Solar Cell (1 chewy sweet tart)	Collects Energy from the Sun to Power an Instrument, Detector, Sensor, or Probe	1 kilogram

Design Challenge: NASA is sending a satellite to the Moon to take pictures to decide where to build a lunar base for people to live on the Moon. The satellite is also looking for evidence of ice on the Moon. The satellite must fit within the launch tube and the instrument package must weigh no more than 45 kilograms (the satellite infrastructure is weighed separately and the engineers need not be concerned with its weight for this activity). 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. The finished product must withstand a 1-meter Drop Test.

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3. Satellite IMAGINE and PLAN Sheet *Page 1*

Team Name:____

List of Materials That Our Group Will Use:

Data Table for Instrument Package

Instrument	**Weight**
	kg
	kg
	kg
Total Number of Solar Cells:	kg
Total weight of instrument package	**kg**
Approximate Volume of Satellite	**cm^3**
Describe how you approximated the volume of the satellite:	

Satellite IMAGINE and PLAN Sheet Page 2

Top View of Our Satellite with Instruments and Solar Cells

Bottom View of Our Satellite with Instruments and Solar Cells

Satellite Imagine and Plan Sheet Page 3

Left Side View of Our Satellite with Instruments and Solar Cells

Right Side View of Our Satellite with Instruments and Solar Cells

4. EXPERIMENT Notes

What happens when we drop the satellite from 1 meter?

Do any pieces fall off?

How will the instruments deploy when the satellite is launched?

Does the way the satellite gets launched affect how the instruments are deployed?

5. Satellite Re-Design Sheet *Page 1*

Team Name:_______________________________________

We made the following changes to our satellite:

The total weight of our instruments and solar cells is:

Satellite Re-Designs Page 2

Our new drawing of our satellite is:

6. Summary: Questions/Discussions for Understanding

List two things you learned about what **engineers** do through building your satellite today:

1.

2.

What was the greatest difficulty you and your team had today while trying to complete the satellite challenge?

Tell how you solved your greatest team difficulty in 2-3 sentences.

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Team Name:____

Fun with Engineering at Home

Lesson 1: Building a Lunar Satellite

Today we designed and built a satellite model to orbit the moon. We used the same process that engineers use when they build something. We had to **ASK**: what is the challenge? Then we thought, talked and **IMAGINED** a solution to the challenge. Then we **PLANNED** with our group and **CREATED** our model satellite. Finally, we **EXPERIMENTED** or tested our model by having other groups look at it and give us feedback. Last, we went back to our team station and tried to **IMPROVE** our satellite. These are the same 6 steps engineers use when they try to solve a problem or a challenge.

Home Challenge: During this week, see what you can learn about satellites – how they work, what they are used for, and how we get them up into orbit. You may even want to see if you can find out what kind of sensors, instruments, and probes satellites carry that are currently orbiting the earth.

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

1. World Book at NASA: Artificial Satellites
   http://www.nasa.gov/worldbook
2. The World Almanac for Kids Science: Artificial Satellites
   http://www.worldalmanacforkids.com
3. NASA Space Place
   http://spaceplace.nasa.gov/en/kids/quiz_show/ep001/

Ask your parents, grandparents, brothers or sisters to help you find out more about satellites. Have fun!

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Quality Assurance – Checking Each Others Satellite Models

Team Name:____

Participants' Names: _______________________________________

____

____

***To be filled in by the Quality Assurance team*:**

Fits within specified tube: YES or NO

Did the satellite withstand the Drop Test? YES or NO

Will the instruments deploy upon launch? YES or NO

Total volume of the satellite is: _________________cm^3

How did you estimate the volume of the satellite?

Total weight of the instruments is: _______________ grams

List specific strengths of the design.

List the specific weakness of the design:

How would you improve the design?

Inspected by Team:

____

Participant Signatures ______________________________________

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