# **Activity Title:** Launch Your Satellite!

***NOTE: This activity was adapted from NASA educational products:***
***Rockets Educator Guide** EG-2003-01-108-HQ*
***http://www.nasa.gov/pdf/58269main_Rockets.Guide.pdf***

**Activity Objective(s):** The teams' challenge is to launch the lunar satellite that they built last week using a balloon rocket. The objective is to get the satellite to go as far as possible.

**Grade Levels:** 6 - 8

**Lesson Duration:** One 60-90 min session

**Process Skills:** observing, communicating, measuring, collecting data, inferring, predicting, making models


**Materials and Tools (per group**

Satellite model from last week's activity
General building supplies
binder clips or clothes pins
large long balloons (several per group)
round balloons (several per group)

**Pre-Activity Set-up:**

- The fishing line apparatus should be at least 5 meters in length. Clamp or tie one end at table height and stretch the line across the space to another table at the same level. Holding the free end of the line taut for each trial enables easily restringing the successive balloon rockets. The line must be very taut for best results. Shoot the rockets toward the c-clamped end. Two fishing line set-ups should be sufficient for most clubs. (See Diagram on Teacher page 5)

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

1. Rocket Elements
2. Balloon Rocket Assembly Design
3. Data Tables and Graphs
4. Experiment Notes
5. Improvement Phase of Rocket Design
6. Summary
7. Fun With Engineering at Home
8. Quality Assurance Worksheet

# Club Facilitator or Teacher Notes by Stage:

*(Based on those running 60-minute Clubs)*

## Stage 1: Meet and Motivate (Approx 10 minutes)

- Keep the same grouping of children from week #1. Ask everyone to retrieve their satellite that they created last week during club session #1.
- Re-share the **Design Story** orally with the students (provided in teacher pages in Activity 1). Re-reading this story provides the context and motivation for trying to accomplish this week's challenge. This week the **ASK** phase of the Engineering Design Process is, *How can we best launch our satellite to go to the moon?* We need for it to go <u>far</u> to get into orbit around the moon. *The objective is to plan and create a rocket that will take our satellite as far as possible.*
- After the stage is set, move on to Stage 2 of the engineering challenge.

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

- 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.
- Talk about the need for a rocket to launch their satellite from last session. The engineer-students must now imagine, plan and create a way to attach their satellite to a balloon rocket. The balloon rocket is attached to a straw that slides along the fishing line.
- Demonstrate how a balloon rocket works by sending a balloon connected to a straw along the fishing line using a push from your hands. Do not model how best to attach the satellite or how best to power the rocket, other than releasing the air by using your fingers.
- Hand out the ***Rocket Elements Data Table*** and the ***Rocket Design Sheet*** (1 of each of these worksheets per team). Ask them to think about the different rocket elements on the *Rocket Elements* data table – which ones will they concentrate on as a team? <u>Make sure they understand that they may only change ONE variable during any set of trials.</u>
- Let the challenge begin - Encourage them to **IMAGINE and PLAN** before building. Ask them to use their worksheets to sketch their design ideas.

## Stage 3: Create and Experiment (Approx 20 minutes)

- Challenge the teams to **CREATE** or build their rockets based on their plans. Remind them to keep within specifications.
- Ask members of each team to check designs and models to make sure they are within specified design constraints.
- Hand out **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.
- Send each team to their assigned launch sites to test their rockets, filling in the data table as they conduct each trial launch. Make sure they understand that they may only change ONE variable during any set of trials.

## Stage 4: Improve (Approx 10 minutes)

- Teams return to their rockets and satellites to make adjustments to their rockets. Hand out the ***Improvement Phase of Rocket Design*** worksheet.
- Teams re-launch satellites for one last measurement to try to improve their rocket's launch distance using the data from all of their trials to optimize the design. Write down the new data.
- At the end of the session, teams report out how far their rocket traveled, and explain which combination of variables gave the best results.

## 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 WORKSHEETS AND SAVE THEM 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:
    - Deciding which rocket elements to change and why
    - Considering how to change the rocket elements
    - Working as a team, communicate
    - Imagine, plan, create, experiment, improve steps
    - Launching the rocket with the satellite

  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.

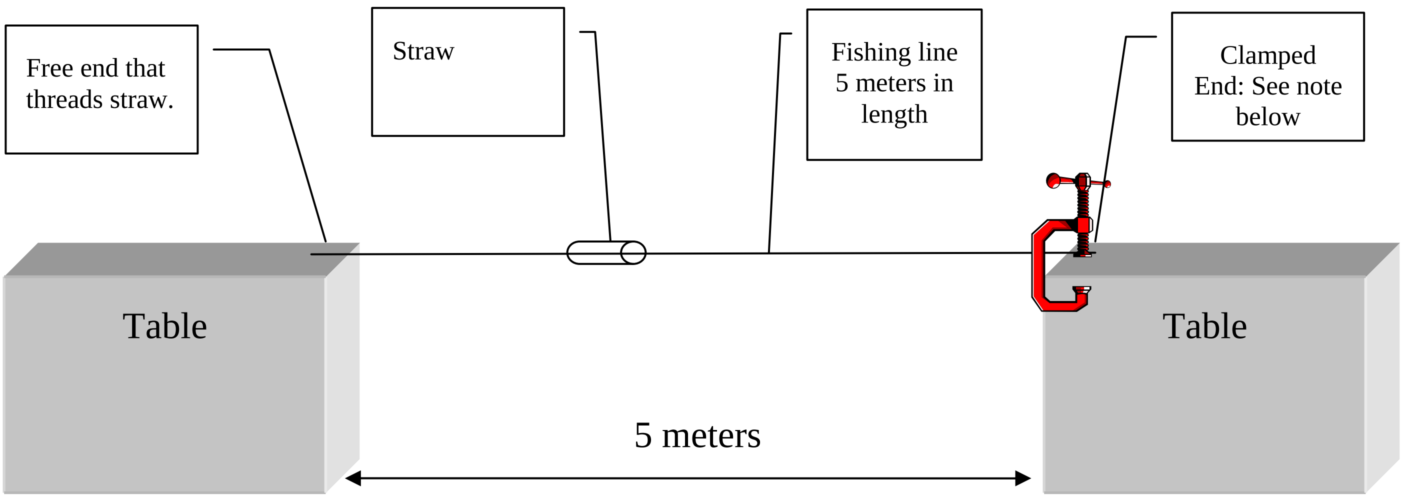
## Stage 6: Previewing Next Week (Approx 5 minutes)

- Ask students to think about how their satellite design would have to change in order to carry human beings. Next week they will build a Crew Exploration Vehicle model to take people to the Moon.

## *Special Notes: For Those with 90 minute Clubs*

## Quality Assurance

- Hand out the ***Quality Assurance*** worksheets (1 per team) and ask them to fill out the top section with team name and participants' names.
- Ask each team to take their satellite, rocket and their quality assurance test worksheet to their assigned launch site. Ask each team to move one notch clockwise to offer feedback to the neighboring team, using the Quality Assurance Test worksheet.
- Ask each team to test their neighbor's rocket and offer them feedback on the quality assurance test worksheet.




**For the clamped end:** the fishing line maybe difficult to clamp. To help, wrap a piece of duct or masking tape around the fishing line then clamp down on the taped end. See diagram below:


Separate here for Student Pages

## *1. Rocket Elements – Imagine, Plan, Create*

**Design Notes**

Last session, you designed and built your NASA satellite to orbit the Moon. This session, you will **plan** and **create** a balloon rocket assembly, attach your satellite to the balloon and launch it. **The objective is to shoot the rocket the farthest distance.**

The rocket elements that you can control are:

1) type of balloon(s) (long or round)
2) number of balloons, and
3) length of straw for sliding along the fishing line.

You can choose to test any one of the rocket elements by changing it for each set of three trials. But, you need to keep the other rocket elements the same during those trials if you are to learn about the element you are changing.

Think about your design. Make some sketches, and then build your rocket. For the first set of trials, try changing the length of the straw. Fill in the Data Table (Worksheet 3) as you go along. After you have filled in the Data Table, if there is time, plot your data in a graph: distance traveled (cm) vs straw length (cm) or distance traveled (cm) vs number of balloons.

Once you have found the length of the straw that allows your balloon rocket to go farthest, then you could try changing something else, like the shape or number of balloons. Fill in the second Data Table for these next three trials. Remember, only change one element for each set of trials.

## *2. Balloon Rocket Assembly Design*

Top View of Our Balloon Rocket Assembly

Side View of Our Balloon Rocket Assembly

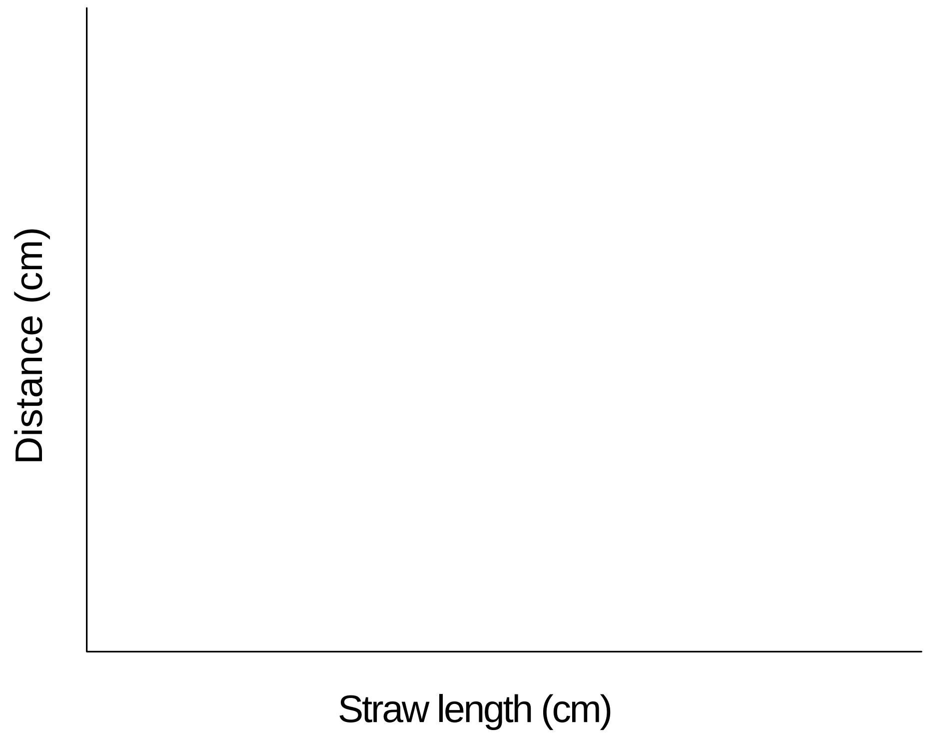
## *3. DATA TABLES and GRAPHS*

| **Rocket Elements** | **Trial 1** | **Trial 2** | **Trial 3** |
|---|---|---|---|
| **Straw Length (cm)** | | | |
| Number of Balloons (hold constant) | | | |
| Shape of Balloon(s) (hold constant) | | | |
| **Distance traveled (cm)** | | | |

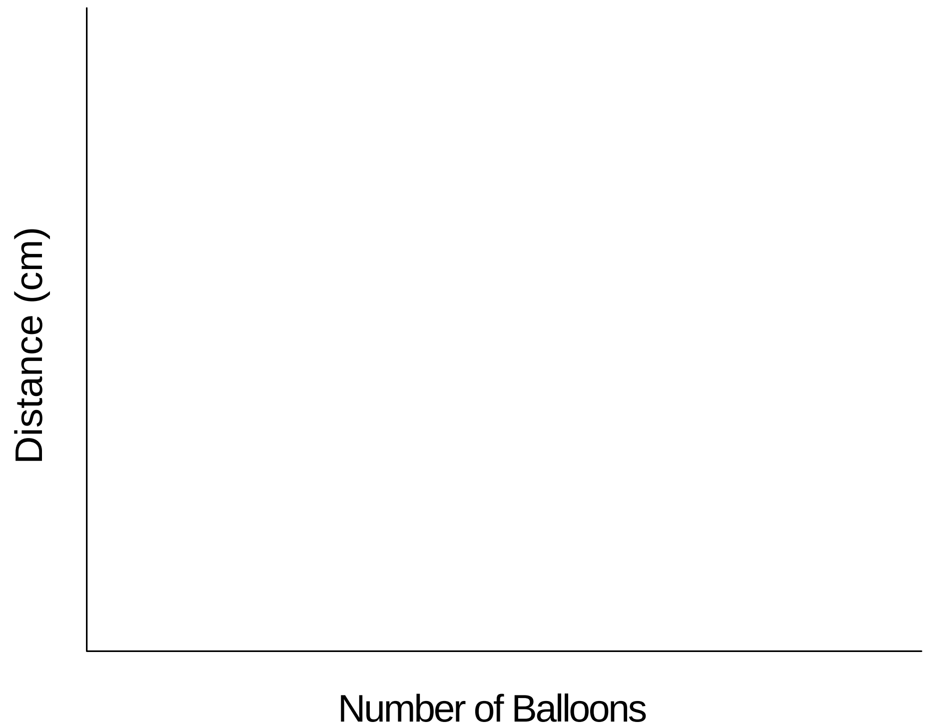
| **Rocket Elements** | **Trial 4** | **Trial 5** | **Trial 6** |
|---|---|---|---|
| Straw Length (cm) (hold constant) | | | |
| **Number of Balloons** | | | |
| Shape of Balloon(s) (hold constant) | | | |
| **Distance traveled (cm)** | | | |

| **Rocket Elements** | **Trial 7** | **Trial 8** | **Trial 9** |
|---|---|---|---|
| Straw Length (cm) (hold constant) | | | |
| Number of Balloons (hold constant) | | | |
| **Shape of Balloon(s)** | | | |
| **Distance traveled (cm)** | | | |

As you do your trials, fill in the *Distance Traveled* box for each rocket trial then fill in the graphs on the next pages. You'll need to add the number scale for each axis.




| Conclusions from data and graph: How does changing this rocket element affect how far the rocket flies? |
| --- |
| |




| Conclusions from data and graph: How does changing this rocket element affect how far the rocket flies? |
|---|
| |

## *4. Experiment Notes*

How did you choose what lengths to make the straw?

What do you predict will happen to your rocket as you change the length of the straw for each trial?

What do you think is happening with the straw that changes how far the rocket flies?

What is the next rocket element that you would like to test?

What do you predict will happen as you make your changes?

## 5. *Improvement Phase of Rocket Design*

Make final adjustments to your rocket to maximize the distance it will fly, based on all of your previous data.

| |
|---|
| Our team chose to adjust the following rocket elements:<br><br><br>We made this choice because: |

**DATA TABLE**

| **Rocket Elements** | **New Trial after re-design** |
|---|---|
| **Straw Length (cm)** | |
| **Number of Balloons** | |
| **Balloon Shape** | |
| **Distance traveled (cm)** | |

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## *6. Summary: Questions/Discussion for Understanding*

What was the greatest challenge today for your team?

Why is the balloon forced along the string?

Which rocket element or variable seemed to have the greatest effect on the rocket distance traveled?

What would you predict would happen if the fishing line were set at an angle (such that there is now some vertical elevation)? If there is time, test it!

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Team Name:_______________________________________

**Fun with Engineering at Home**

Activity 2: Launch your Lunar Satellite

Today we designed and built a rocket model to send our lunar satellite to 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 rocket. Finally, we **EXPERIMENTED** or tested our rocket by having other groups look at it, launch it and give us feedback. Last, we went back to our team station and tried to **IMPROVE** our rocket. 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 rockets – how they work, what they are used for, and how we get them up into space. You may even want to see if you can find out what kind of satellites rockets carry into orbit. What kinds of rockets carry people?

You can find this information in books, magazines or even on the Internet.

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

American rocketry was pioneered by Dr. Robert Goddard. NASA's Goddard Space Flight Center is named after him. For further reading about Dr. Goddard:

http://www.nasa.gov/centers/goddard/about/dr_goddard.html

To read about the Ares V rocket, check out this link:

http://www.nasa.gov/mission_pages/constellation/ares/rocket_science.html

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## *Quality Assurance*

## *Checking Each Other's Balloon Rocket Assembly*

Team Name:______________________________________________

Participants' Names: ______________________________________

______________________________________

______________________________________

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

Fill out the table below and launch the rocket. Then fill out the distance traveled.

| | |
|---|---|
| **Balloon Shape** | |
| **Number of Balloons** | |
| **Straw Length (cm)** | |
| **Distance traveled (cm)** | |

| What are some of the strengths of this team's design? |
|---|
| |

What are some weaknesses of this team's design?

List 2-3 recommendations you have for this team to consider:

1.

2.

3.

Inspected by Team: ______________________________

Participant Signatures ______________________________

______________________________

______________________________