MISSION BRIEFING

Activity: Design Stabilizing Fins

Prep Time: 15 min

Activity Length: 60 min

Task: Create fins for a foam rocket that lands downrange and follows a desired pathway.

NASA's Space Launch System (SLS) will be the most powerful rocket NASA has ever built. When completed, SLS will enable astronauts to begin their journey to explore destinations far into the solar system. For more information on SLS, visit www.nasa.gov/exploration/systems/sls/index.html.

By the end of this activity participants will

- Know that fins can alter the stability of a rocket.
- Understand the relationship between a rocket's stability and its trajectory.
- Be able to improve rocket stability.

Materials

- 30-cm piece polyethylene foam pipe insulation (1 piece per group)
- Foam food trays, cardboard, or stiff poster board
- Long tape measure and/or rolling measure wheel (used to indicate the horizontal rocket range and to measure distances to where the rocket landed)
- Launcher quadrant template printed on cardstock
- Rubber bands (size 64)
- Safety glasses
- Duct tape
- Scissors
- Meterstick
- Masking tape
- Zip ties
- Binder clip
- Pushpin
- 75-cm string

Safety

Remind participants that rockets should never be launched toward anyone. Safety glasses should be worn during launch.

Preparation

Watch the "DIY Space: Build a foam rocket" video tutorial for instructions on building the rocket and conducting the activity.

Build It (Example illustrations below)

1. Using scissors, cut one 30-cm length of pipe foam for each team.
2. Cut four equally spaced slits at one end of the tube. The slits should be about 12 cm long. The fins will be mounted through these slits.
3. Cut a 12-cm length piece of duct tape down the middle to make two pieces. Place one piece over the other, sticky to shiny side, to make the tape double strong.
4. Slip a rubber band over the tape and press the tape around the nose end of the rocket (opposite the end with the slits).
5. Press the tape tightly and reinforce it with another length of tape wrapped around the tube.

MISSION GUIDANCE...

DO

- Keep a protractor nearby to help participants with launch angles.
- Allow participants to design and build unique fins.

MAYBE

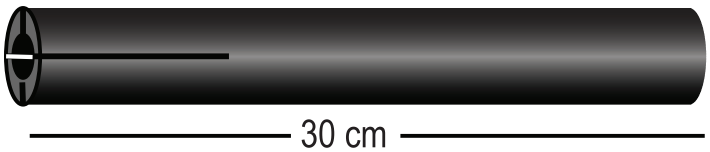
- Create the launcher ahead of time.
- Mark the launch pathway ahead of time.

DON'T

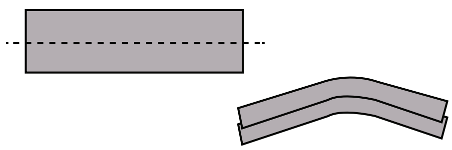
- Give participants templates for fins.
- Let participants launch the rockets toward one another.

6. Cut fin pairs from the foam food tray or stiff cardboard. Refer to the fin diagram. Both fin pairs should be notched so that they can be slid together as shown in the diagram. Different fin shapes can be used, but they should still “nest” together.
7. Slide the nested fins into the slits cut in the tube. Close off the slits with a piece of duct tape wrapped around the foam tube. The rocket is finished.

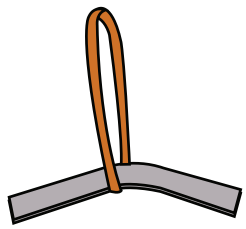
Steps 1 and 2



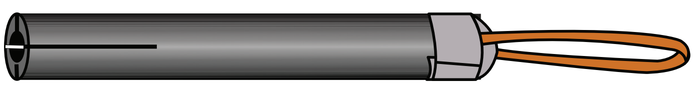
Step 3



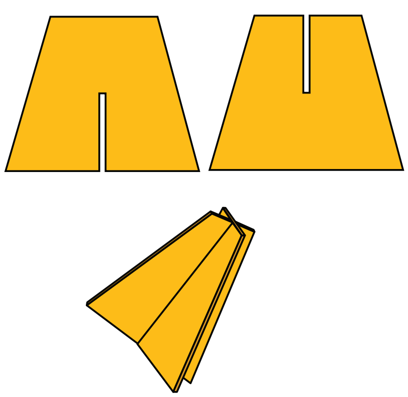
Step 4



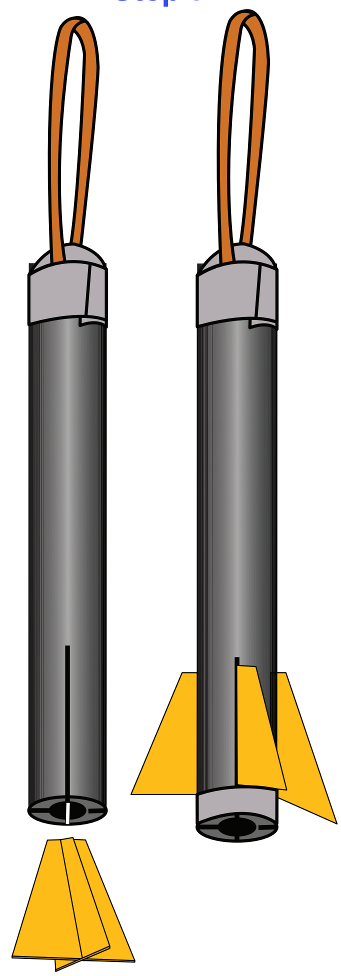
Step 5



Step 6



Step 7

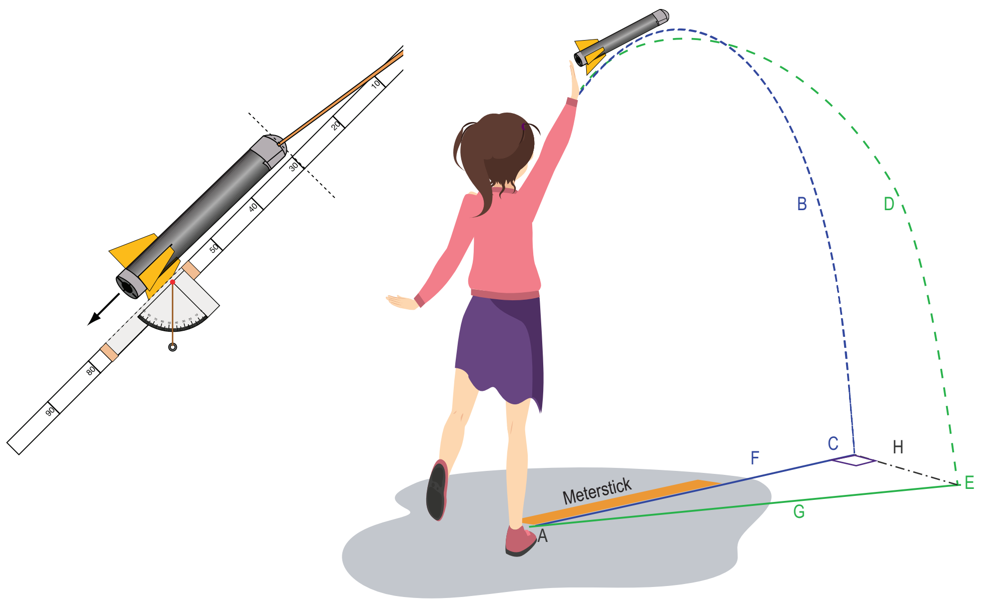


Quick Tips and Tricks

- Some participants may struggle with “nesting fins.” Assist them with fins that nest/slide together.
- To ensure that vertical launch height is unchanging, place the bottom edge of the launcher on a table.
- Participants should measure two distances ONLY: downrange distance and distance off course.

Test It

1. Build the model rocket launcher (pattern included at the end of this activity).
2. Put a piece of string or tape on the ground in a straight line directly in front of the launcher. This line will be used to measure the distance the rocket flew from the launcher and how far off course the rocket traveled.
3. Have participants launch the rockets at a specified angle using the rocket launcher.



A. Launch site
B. Ideal or planned trajectory
C. End point of planned trajectory
D. Actual trajectory of launched rocket
E. Point where rocket landed
F. Downrange distance traveled
G. Straight line from launch site to point where rocket landed
H. Distance off course

4. After they have launched, participants will record the distance the rocket traveled (line segment F) and how far off course the rocket went (line segment H).

Improve

1. Give each team additional supplies to redesign and build another set of fins. Ask them to consider the stability and trajectory of their first set of launches and think of what improvements could be made to their fin design.
2. Discuss different variables that may impact their results, including the elasticity of the rubber band.
3. The goal is to increase the stability of their rocket, which is measured by how close they are to landing near the tape measure or meterstick without a significant decrease in the range of their rocket or how far the rocket traveled from the launch site.
4. Teams will repeat steps 4 to 6 of the rocket “Build It” procedure, conduct three launches, and then compare the results of their redesigned fins with the results of their original design.

Extension

- Ask participants to add weight to their rockets by taping pencils to them. Give participants a limited number of pencils they can use. Consider limiting where they can add the weight.
- Ask participants to consider the center of mass and investigate how it impacts rocket stability.
- Ask participants to measure the dimensions of each fin and use geometry to find the area. Gather data from the entire class. Plot a graph comparing the area of a fin with the horizontal distance traveled by each rocket.
- For advanced participants, apply the rules of sine, cosine, or tangent to find angle CAE (in degrees) between the planned path of travel and the actual path of travel for the rocket. By finding angle CAE, teams can compare results across different fin designs, launch angles, and so forth.
- For advanced participants, capture video of the launch and use the open-source Tracker Video Analysis and Modeling Tool (https://physlets.org/tracker) to collect data about position, velocity, or acceleration.

Challenge Questions

- How does a rocket’s stability affect trajectory?
- Why was it important to launch from different angles?
- How do you think the size, shape, weight, or location of fins on a rocket can affect its stability?

Launch Quadrant Pattern

(Actual size)

Making the Launcher

1. Print the quadrant pattern on cardstock paper.
2. Cut out the pattern and fold it on the dashed line.
3. Tape the quadrant to the meterstick so that the black dot lies directly over the 60-cm mark on the stick.
4. Press a pushpin into the black dot.
5. Tie a string to the pushpin and hang the binder clip on the end of the string. The weight should swing freely.