



Interstellar Boundary Explorer

Public Outreach

What You'll Need

- Scissors
- IBEX mission poster

Per participant group:

- Two long party balloons that can inflate to approximately 1 foot (30 cm) long; Note: Do not use animal shape twist balloons.
- 20 feet (6 meters) of vinyl craft lacing, any bright color
- Two 4 inch (10 cm) long plastic, non-bendable straws
- Masking tape
- One 3 inch (8 cm) rubber band that is at least .125 inch (.25 cm) wide
- One 1.25 inch (3 cm) binder clip
- Hand-operated balloon pump

Achieving Orbit

About this Activity

Often, a single-stage rocket does not have enough power to place a satellite in its intended orbit. The IBEX mission uses a multi-stage system consisting of a Pegasus rocket launched from an airplane and another solid fuel rocket that propels the satellite to a high orbit. In this Engineering Design Challenge activity, museum visitors will use balloons to investigate how a two-stage rocket, like that used in the IBEX mission, can propel a satellite to a specific orbit. Participants will construct a two-stage balloon rocket that will be required to reach a particular location on the balloon track, simulating the proper orbit to be reached by the IBEX satellite. This activity is adapted from the NASA Rockets Educators Guide (EG-2003-01-108-HQ) and the NASA Glenn Research Center's online Learning Technologies Project for facilitation with an informal museum audience. *If the reader is in need of additional background information about rocketry, it is strongly suggested that these two resources be used.*

After completing the activity, participants will be able to state that:

- The IBEX satellite will launch using a multi-stage rocket system.
- A satellite like IBEX needs to reach a particular location or orbit in space for it to function properly.

Preparation

1. Select a space for this activity that is at least 20 feet (6 meters) long and at least 10 to 20 feet (3 to 6 meters) wide to allow for multiple visitor groups to participate.
2. Stretch a piece of thin vinyl craft lacing the length of the space and attach it at both ends. Use one line for each visitor group. Allow for one end of the line to be attached and detached for use during the activity.
3. Mark a 3 foot (1 meter) long space on the floor with masking tape around 15 feet (4.5 meters) from the start of the plastic line. This will be the satellite target "orbit".
4. There should be at least two participants per line. Consider this when inviting visitors to participate. Single visitors may need to be paired up or may need additional assistance from facilitators to complete the activity.

To Do and Notice

1. Introduce participants to the Design Challenge and the IBEX mission using information in the "About this Activity" and "Activity Notes" sections, as well as the IBEX mission educational poster entitled "IBEX: Exploring the Edge of our Solar System".
2. Construct a sample two-stage balloon rocket to show visitors how they will create their own and explain the construction process:
 - a. Inflate the first balloon using the balloon pump and clamp the nozzle carefully with the binder clip. Ensure that no air escapes.
 - b. Wrap the rubber band around the opposite end of the balloon. The rubber band is now on the front of the first rocket stage. If the rubber band is not snug enough, twist and double wrap it.
 - c. Inflate the second balloon. Place the nozzle under the rubber band so that no air escapes. You may have to adjust or twist it a bit, depending on how well the air is held inside the balloon. This balloon is the second stage, which will deflate after the first stage has emptied itself of air, propelling the second stage farther.

Assessment

Finish the demonstration by asking questions that assess whether participants can state the following:

- The IBEX satellite will launch using a multi-stage rocket system.
- A satellite like IBEX needs to reach a particular location or orbit in space for it to function properly.

Questions can be asked to allow for a verbal response or allow for a written or hand-drawn response so that visitors with various abilities can be included in the activity assessment.

- d. Tape a length of straw to each of the balloons. The straws should be in a relatively straight line.
 - e. String the vinyl craft lacing through the straws to attach the balloons to the vinyl craft lacing.
 - f. Hold onto the nozzle of the first balloon stage and unfasten the binder clip. Continue to hold the balloon nozzle and make sure it is not stuck together.
 - g. Demonstrate how the IBEX rocket staging works by letting go of the balloon.
3. Explain to the audience that the IBEX spacecraft must reach a specific orbital height for it to work properly. If it is in too low of an orbit, it will spend too much time close to Earth and will be unable to gather data properly, and if it is in too high of an orbit, the Moon's gravity will have too much of an effect on the satellite's position or it may escape Earth orbit completely.
4. Next, invite the participants to construct their own balloon stages. It is recommended that visitors work in pairs or groups, whenever possible. The Design Challenge will be for the second stage to reach the location on the line indicated by the masking tape on the floor, simulating the IBEX satellite reaching its proper orbit. Several adjustments to the system may be needed for the second stage to successfully reach the target area, and teams should be encouraged to try the activity multiple times.
5. When visitors are finished, bring the activity to a close by explaining the main points of the activity again to the participants and any visitors who are watching the activity, highlighting the IBEX mission, and referring to the information on the IBEX mission poster.
6. Thank visitors for participating.
7. Note: If visitors do not wish to do the design challenge portion of the activity more than once prior to a successful completion, facilitators should engage them in a conversation to inquire how they would change the balloon system to allow the target to reach its intended orbit (more or less air in balloon(s)) to assess their understanding of the educational objectives of the activity.
8. At-home extension: Each satellite that is launched must be placed in a specific orbit, and most of the orbital locations are different from one another. Participants can recreate the activity at home, altering the location and size of the "orbital target" to simulate the different orbits that satellites must reach.

Activity Notes

The IBEX satellite will begin its ride to space on an airplane called an L-1011. The L-1011 will carry a Pegasus rocket to high altitude. Then, the Pegasus rocket will fire its own engines to propel it and the attached IBEX spacecraft into space. When the Pegasus' fuel is expended, it will fall away, and the IBEX satellite will use its own smaller rocket engine to climb even higher into an orbit that is about 200,000 miles (320,000 kilometers) from Earth, or more than 80% of the way to the distance of the Moon's orbit. This orbit is very high, which will allow the satellite to make its observations without too much interference from Earth's magnetic field.

Related Websites

Rockets Educator Guide (EG-2003-01-108-HQ) contains background and description:
<http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html>

The IBEX mission page discusses launch information.
<http://ibex.swri.edu>

IBEX's "Museums and Planetaria" page includes more activities to use in the museum.
<http://ibex.swri.edu/planetaria/index.html>

NASA Glenn Research Center's Learning Technologies Project provides a "Balloon Staging" classroom activity:
http://exploration.grc.nasa.gov/education/rocket/TRCRocket/balloon_staging.html

NASA provides upcoming launch information:
<http://www.nasa.gov/missions/highlights/schedule.html>

Setup of "Achieving Orbit" Activity (closeup)

