Build a Satellite

Learning Objectives

- Students will learn the use, structure, and power systems of satellites.
- Students will explore the process of designing, building and testing that real-life satellites must go through.

Activity Overview

- Students will design and create a model satellite that can successfully overcome vibration testing.

Standards Addressed

- ***SC.4.E.5.3***– Recognize that Earth revolves around the sun in a year and rotates on its axis in a 24-hour day.
- ***SC.4.E.5.4***– Relate that the rotation of Earth and apparent movements of the Sun, Moon, and stars are connected.

Materials

Item	Quantity Needed	Notes
Rulers	6	*1 per group*
Aluminum foil	1 roll	
Toilet paper tubes	12	
Construction paper	1 ream	
Index cards	100	
Craft sticks	100	
String	1 skein	
Masking tape	2 rolls	
Scissors	1 per group	*As needed*
Trays	2	*Shake Table*
Marbles	4	*Shake Table*
Rubber Bands	2	*Shake Table*

Preparation

- Set the materials at the front of the room to create a materials station.
- Create a shake table by putting rubber bands around 2 trays, with marbles in each corner of the trays. Place this in a designated testing area.

Science Content

The U.S. Navy uses satellites for various thigs such as navigation, communication, and intelligence.

All robotic explorers have some parts in common, including the main bus (body of the spacecraft), a communications antenna and a power system. The **main bus** can be of any shape and contains the primary electronics and computer modules for the spacecraft. **Antennas** commonly used are low-gain antennas and high-gain antennas. **Low-gain antennas** often look like short flag poles and communicate at a low data rate. **High-gain antennas** are parabolic in shape and generally communicate at a higher data rate.

Satellite instruments can also perform a variety of science experiments including spectral analysis, gravity measurements and radar observations, just to name a few. **Spectral analysis**, or the study of the light emitted or reflected by various surface materials, can be used to characterize surface materials. **Gravity measurements** can give scientists clues about the density of the various materials the satellite is flying over. **Radar** can provide information about surface features by way of reflectivity, and it can also penetrate the ground to determine subsurface features such as cracks and voids.

Once a satellite is built, it is tested for its ability to sustain the vibrations of launch. If it fails this test, the satellite must be redesigned. A NASA vibration test is conducted on a shake table, a device to which the satellite is attached and shaken back and forth, simulating the forces that will be encountered during launch. Additional environmental testing, including thermal and acoustic testing, is also conducted on spacecraft.

Source: nasa.gov; navy.mil

Facilitation Guide

Engage (10 minutes)

1. Assess students' prior knowledge by asking them what a satellite is, what satellites look like, what they do and what we use them for.
2. Discuss the similarities and differences between natural satellites such as GPS, communications, weather and planetary exploration satellites.
3. Show students images of satellites from the PowerPoint. Explore different satellites, what they do, and what they look like. Note that satellites orbit or fly by an object, but are not designed to land.
4. Explain the main parts of a human-made satellite and point out examples: main bus, power system, science instruments, communication antennas.
5. Explain to students that they are going to work in teams to design and build a model of a satellite that meets the following goals:
    - **Is at least 10 cm tall and 7 cm wide.**
    - **Passes a vibration test.**

Activity (30 minutes)

1. Before students begin working, show them the materials they can use to build their satellite.

2. Explain that a lot of vibration occurs during a launch and their satellite models must be able to pass a shake test upon build completion. Demonstrate how the makeshift shake table works.
3. Give teams about 5 minutes to plan their design, passing out a worksheet for them to draw their design.
4. Once teams have planned their design, have one team member come to the materials table to grab what they need to build their model satellite.
5. Give teams about 15 minutes to build their model satellite.
6. Have each team come up to the shake table to test their design. First, measure each team's satellite to see if it reaches the height and width goal. Place their design on the shake table. Move the shake table for 10-20 seconds to see if the model satellite remains stable.
7. Give teams 7 minutes to improve their satellite before retesting.

Reflect (10 minutes)

1. How did you make your satellite withstand the vibration test?
2. Why did you choose the materials you did?
3. If you had more time, how would you further improve your design?