NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE™

Satellite Math – Solar Arrays

Students will practice skills in determining surface area and volume by learning about satellites and solar arrays and building their own model satellites from recycled materials.

LESSON PLAN

Learning Objectives:

The students will:

- Learn about the history, types and purposes of—and the technology behind—satellites.
- Learn the name and function of various components of a satellite.
- Work cooperatively in teams to select appropriate building materials for their satellite.
- Compute proper size and number of solar arrays needed to power their satellite based on volume of the bus selected.
- Design their team satellite, using drawing paper
- Build a team satellite within a given set of parameters

Purpose:

Students will learn about the different types of satellites and their uses and then will work in teams to build their own model satellite, given a set of materials and parameters, using math skills to determine how many and what size solar arrays are required based on the volume of their design.

Introduction:

Satellites—in this case human-made objects that orbit our planet—are amazing feats of technological achievement. Satellites are often described in terms of a payload and a service module or "bus". The bird's-eye view that satellites have allows them to see large areas of Earth at one time. This ability means satellites can collect more data, more quickly, than instruments on the ground. First, a satellite is launched into space by a rocket to get into orbit. A satellite then orbits Earth when its speed is balanced by the pull of Earth's gravity. Without this balance, the satellite would fly in a straight line off into space or fall back to Earth. Satellites orbit Earth at different heights, different speeds and along different paths. Satellites are used for an array of different purposes. They are used for tracking weather, gases in the atmosphere, emissions, geographical changes, human movement, and even space exploration; just to name a few.

Grade Level: 6 – 8

Ohio Learning Standards/Mathematics (2017)

Number System

6.NS.1: Solve problems involving fractions

6.NS.3: Fluently add, subtract, multiply and divide

Geometry

6.G.2: Find volume of a rectangular prism

7.G.6: Solve problems involving area, volume and surface area

8.G.9: Solve problems involving volume of cones, cylinders and spheres

Ratio and Proportional Relationships

6.RP.3: Use ratio/proportions to solve problems

7.RP.1: Ratios of areas, etc.

Ohio Learning Standards/Technology (2017)

Design & Technology

6-8.DT.2.a.: Apply design process to solve problem

6-8.DT.2.c.: Explain the importance of innovation

6-8.DT.3.a.: Collaborate to solve a problem

6-8.DT.3.c.: Evaluate group effectiveness

Materials Required:

- Empty cardboard tubes of various sizes
- Empty, clean pop cans of various sizes
- Variety of small cardboard boxes
- Aluminum foil
- Yellow plastic wrap
- Craft sticks
- Wood glue and/or hot glue guns
- Various types of tape
- Rulers, scissors
- Calculators
- Pencils
- Drawing paper or graph paper

Procedure:

A. Warm-up

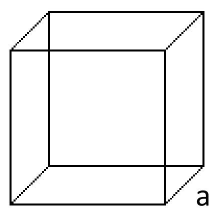
1. Review information on satellites in the introduction, images for students, and resource section.

2. Students should receive all recycled materials needed to build the satellites.

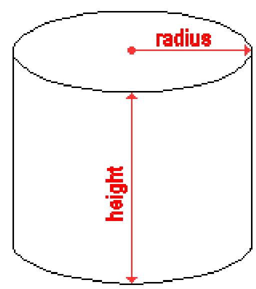
3. Students will work in teams of 4 to 5 students.

4. Review the formulas for determine the volume of a cube and a cylinder (answers will be in cm^3):

Volume of a cube = ***a*** x ***b*** x ***c***



Volume of a cylinder = **π r**^{2} x **h**



B. Activity

1. Students will decide what type of satellite they are building (communications, Earth remote sensing, scientific research, GPS) and what parts are necessary.

2. They can decide if they either use a cardboard tube, box or can and other materials necessary to build their satellite (solar arrays, antenna, etc.) based on their chosen satellite.

3. Compare the total volume of their bus to the given statistic that 100 cm2 of array will support the electrical needs of the payload components in 500 cm3 of bus volume.

$$\frac{100\ cm^2}{500\ cm^3} = \frac{the\ area\ of\ solar\ arrays\ needed\ by\ the\ students\ in\ cm^2}{the\ total\ volume\ of\ the\ students'\ bus\ in\ cm^3}$$

4. After calculating the area of solar arrays needed by the volume of the students' bus, divide by the number of solar arrays required by their design to determine the area needed per solar array.

$$\frac{The\ area\ of\ solar\ arrays\ calculated}{The\ numbe\ of\ solar\ arrays} = \text{area of each solar array}$$

5. Determine what width and length to make the solar arrays in order to reach the desired surface area.

$$Area\ of\ each\ solar\ array = length * width$$

6. Students can then construct their satellite, including all the necessary parts, based on the type of satellite chosen.

Assessment/Evaluation:

Each team of students should prepare a presentation on the type of satellite chosen and the satellite's purpose. All parts should be described and explained. The presentations could involve drawings, dioramas, PowerPoint slides, etc.

Extension:

Students could think of the future and determine new uses for satellites and design their own satellite to meet that purpose. Design constraints would still involve determining the size of the solar arrays based on the volume of the bus and the amount of components. However, they could use additional materials to construct their futuristic satellite.

Resources/References:

Satellites:
https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-satellite-58.html
https://www.nasa.gov/mission_pages/station/research/news/changing-how-solar-power-rolls/
https://www.express.co.uk/life-style/top10facts/717318/Top-10-facts-about-Satellites-Sputnik-moon-planets-space-GPS
https://www.nationalgeographic.com/science/space/solar-system/orbital-objects/
https://www.nasa.gov/missions/science/f-satellites.html
https://www.nap.edu/read/9819/chapter/6
https://www.wired.com/story/facebook-confirms-its-working-on-new-internet-satellite/
https://www.forbes.com/sites/quora/2018/05/18/how-do-satellites-keep-track-of-their-own-position/#751d7e2c6f6d

Images of Satellites for Students