Instruments in Space

Overview:

This lesson focuses on the Advanced Composition Explorer (ACE) satellite, which provides information that helps measure the sun's activity and Earth's magnetosphere. Managed by the National Aeronautics and Space Administration (NASA), the ACE satellite provides information that helps scientists forecast the aurora. Students build a cardboard model of the ACE satellite, then use mathematical equations and data from the Internet to measure solar wind velocity and density.

Objectives:

The student will:

- use mathematical formulas to calculate the speed of solar wind;
- construct a model of the ACE satellite;
- identify and understand the function of spaceborne instruments and sensors carried by the ACE satellite; and
- increase their awareness of science and technology.

Materials:

- ACE Model template (two pages per student)
- Thin cardboard
- Scissors
- Glue sticks (or other low-moisture glue)
- Ruler
- VISUAL AID: "ACE Satellite"
- VISUAL AID: "Solar Wind Worksheet"
- STUDENT INFORMATION SHEET: "ACE Model"
- STUDENT WORKSHEET: "Solar Wind"

Instruments in Space

Activity Procedure:

1. Lead students in a general discussion about satellites and their uses. Explain that satellites contain instruments that can be used to measure a variety of processes in Earth's atmosphere and space.

2. Using VISUAL AID: "ACE satellite," explain that the Advanced Composition Explorer (ACE) satellite measures the speed of solar wind. The satellite is located 92,218,500 miles from the sun and 931,500 miles from Earth (point out location on the VISUAL AID). The Solar and Heliospheric Observatory (SOHO) satellite monitors the sun with a variety of instruments, and is at the same location. Both ACE and SOHO satellites maintain this distance as they orbit the sun. This position is known as L1, a position where the gravitational pull of Earth is equal to the pull from the sun.

3. Hand out the STUDENT WORKSHEET: "Solar Wind," and use VISUAL AID: "Solar Wind Worksheet" to review the *Introduction*. Ask students to use the mathematical formulas on the STUDENT WORKSHEET to answer questions about the speed of solar wind traveling through space.

4. Distribute copies of the STUDENT INFORMATION SHEET: "ACE Model" and ACE model template, along with glue sticks, scissors, cardboard, and rulers. Explain that the model ACE satellites will be 1/32 the size of the actual ACE satellite.

Answers to Student Worksheet:

1. 48 hours

2. 1,921,219 miles per hour = 92,218,500 miles ÷ 48 hours

3. 1,921,219 miles per hour

4. .48 hours or approximately 29 minutes = 931,500 miles ÷ 1,921,219 miles per hour

Name:_____ **Student Worksheet**

Solar Wind

Introduction:

On April 4, 2000, the SOHO satellite captured with cameras a Coronal Mass Ejection (CME) at 1600 Universal Time (UT). Because light travels at 186,000 miles per second, the SOHO satellite detected the CME minutes after it occurred. Scientists predicted that the ACE satellite would soon measure an increase in solar winds, which would result in an aurora display on Earth. As expected, at 1600 UT on April 6, the ACE satellite recorded an increase in solar wind. Shortly thereafter, beautiful aurora displays occurred on Earth.

How fast did the solar wind travel through space?

Use the formula: Speed = Distance ÷ Time

Distance from the sun to the ACE satellite = 92,218,500 miles

1) Time it took for ACE to detect the increase in solar wind **=** _____ *hours*
(from 1600 on April 4, to 1600 on April 6)

2) _____ **=** _____ **÷** _____

Speed *(miles per hour)* **Distance** *(from Sun to satellite)* **Time** *(hours)*

How long after ACE detected the increase in solar wind did solar wind arrive at Earth?

Use the formula: Time = Distance ÷ Speed

Distance from the satellite to Earth **=** *931,500 miles*

3) Speed the wind is travelling *(see question 2 above)* **=** _____ *miles per hour*

4) _____ **=** _____ **÷** _____

Time *(hours)* **Distance** *(from satellite to Earth)* **Speed** *(miles per hour)*

ACE Model

1. Cut out the ACE template pieces.
2. Glue the Top (+Z) panel to cardboard, then cut it out. Flip the cardboard over, and glue the Underside of Top (+Z) panel onto the other side.
3. Glue the Bottom (-Z) panel (outside) to a piece of cardboard and cut to fit. Flip the cardboard piece over and glue the Bottom (-Z) panel (inside) onto the other side. Let these dry as you go on to the following steps.
4. Glue the side panel pieces to cardboard, then cut around the gray tabs on the top and bottom of the side panels, so you can fold them in later.
5. Fold the side panel piece to make an octagonal (eight-sided) ring.
6. Use a glue stick to make a ring of glue on the dotted line-shapes on the Underside of Top (+Z) panel. These shapes show you where to glue the tabs from the side panels. The tabs have labels so that the side panels can be lined up the way they are on the real satellite. Fold down the tabs on the top of the side panels, then glue the panels in place.
7. Use a glue stick to make a ring of glue on the dotted line-shapes on the Bottom (-Z) panel (inside). Fold down the tabs on the bottom of the side panels, then glue the panels in place.
8. After the glue dries, label the following parts on the satellite model.

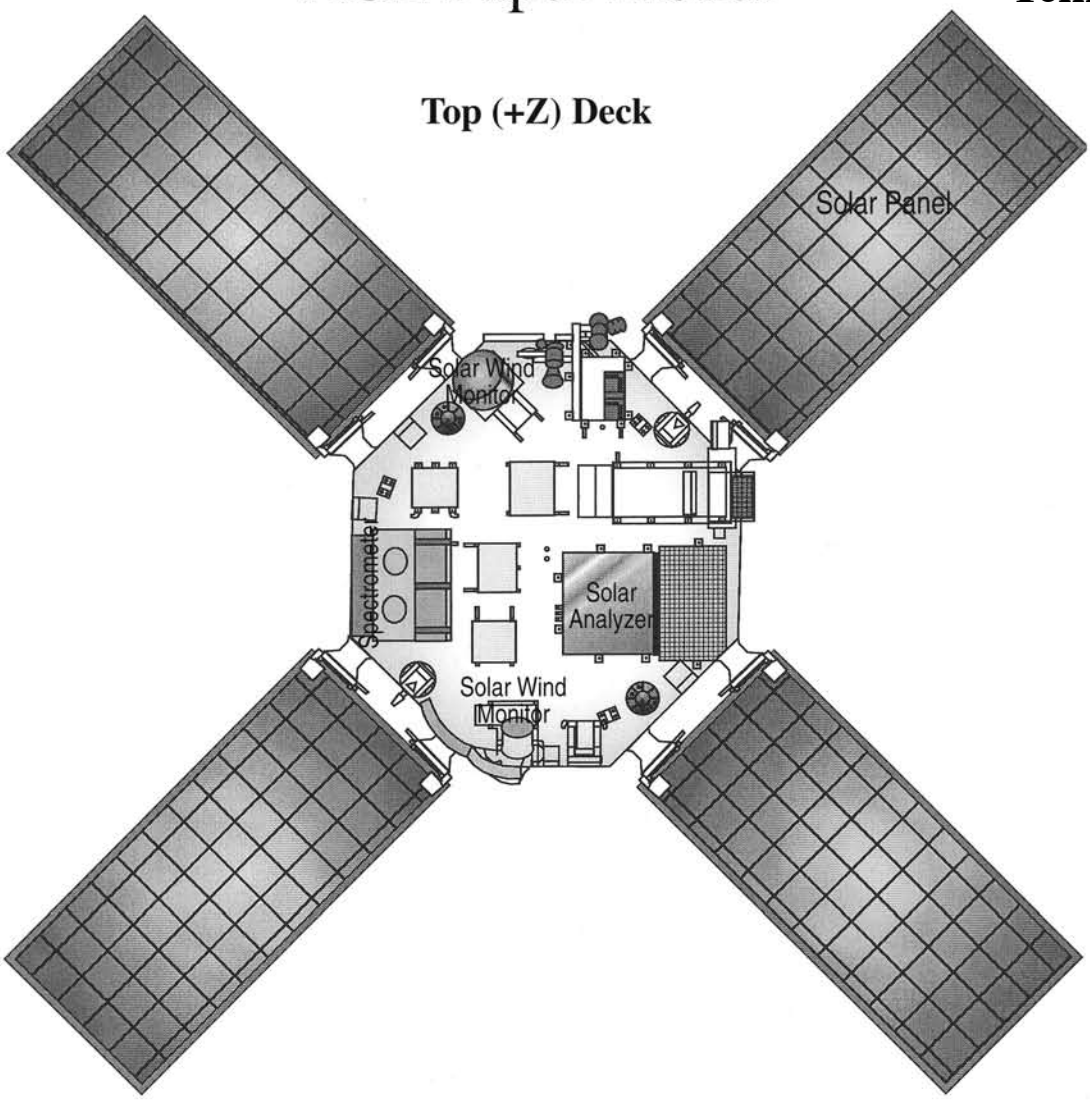
Satellite Parts and Functions:

Solar Wind Monitors:	measure the flow of solar wind particles.
Spectrometers:	measure various properties of sunlight.
Solar Analyzer:	measures the state and energy of solar particles.
Solar Panels:	change sunlight into electricity.
Propulsion Tanks:	allow satellite to move.
High Gain Antenna:	allows satellite to communicate with and send data to scientists on Earth.
Power System Electronics:	coordinate which instruments are running. (They don't all operate at the same time).
Fire component:	safety system that responds in the event of an emergency.
Battery:	stores energy.

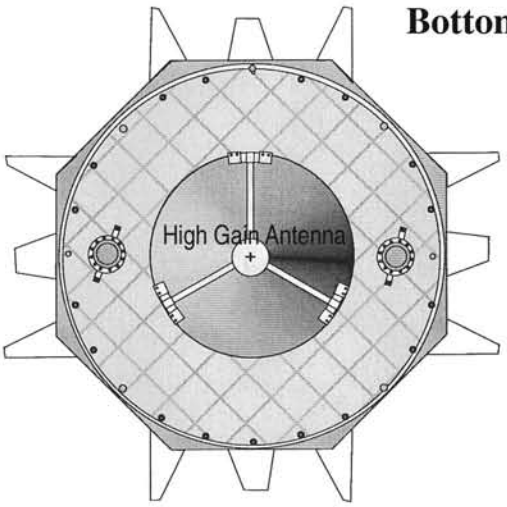
ACE Paper Model

Template

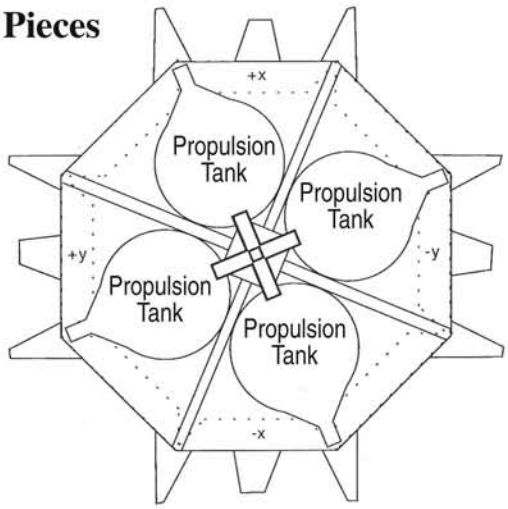
Top (+Z) Deck



Bottom (-Z) Panel Pieces



Bottom (-Z) panel piece—outside

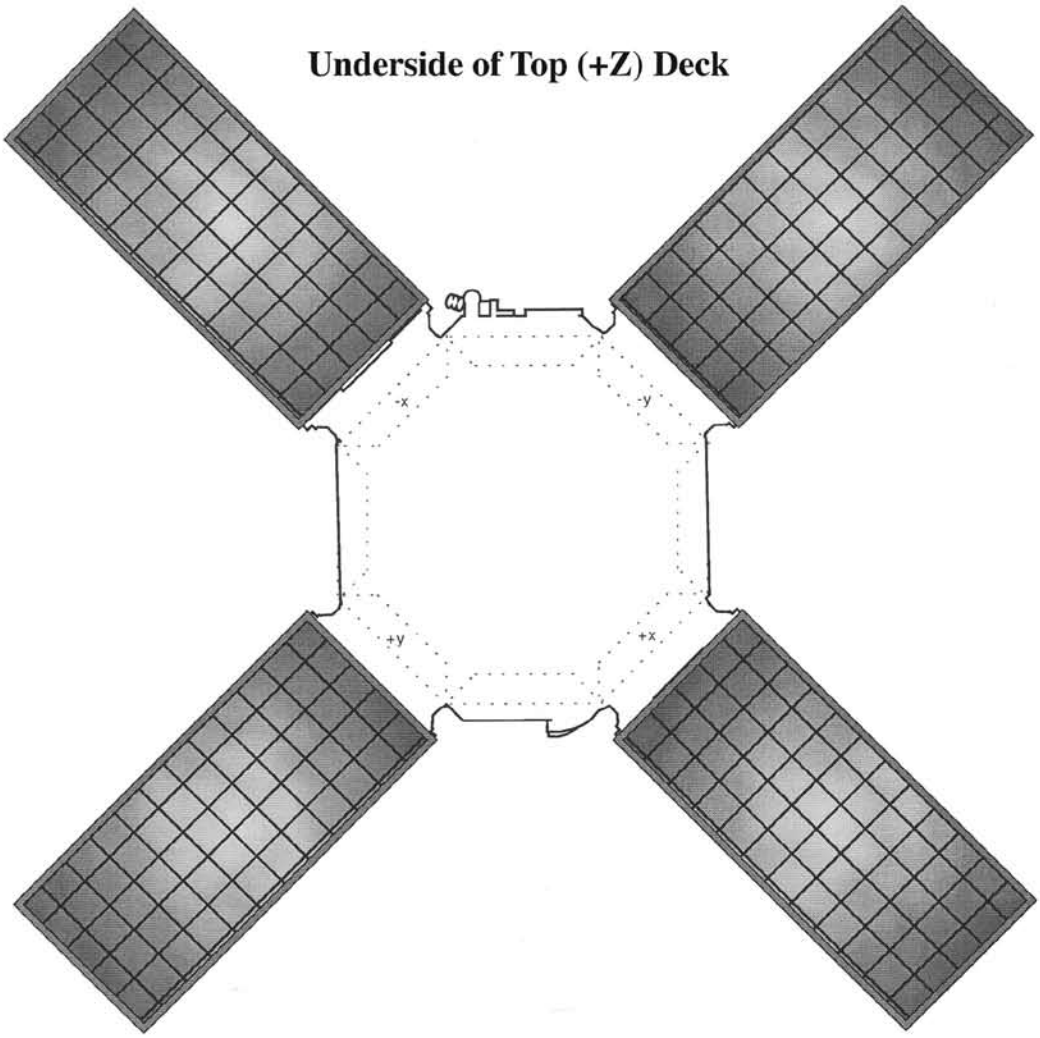


Bottom (-Z) panel piece—inside

ACE Paper Model

Template

Underside of Top (+Z) Deck



Side Panel Pieces