

EDUCATOR'S Activity Guide



Kennedy Space Center

VISITOR COMPLEX

Activities Meet:

Florida
Sunshine
State
Standards

National
Education
Standards



Grades 9-12

Dear Educator:

The first person to set foot on the planet Mars may be sitting in your classroom today. At Kennedy Space Center Visitor Complex, we recognize the awesome responsibility you shoulder in preparing young people for the future. We stand ready to partner with you by offering exciting enrichment experiences that inspire students and enlighten inquisitive minds.

At Kennedy Space Center (KSC), you and your students will relive the excitement of the first voyages into space, the Apollo missions to the Moon, and the great explorations of the Voyager spacecraft and the Hubble Space Telescope. This is the home of the Space Shuttle and the staging point for assembly of the International Space Station. We are working to make KSC the stepping stone for the first humans traveling to Mars.


This curriculum guide has been designed to assist you in preparing your students for their visit to Kennedy Space Center. It contains dynamic classroom-ready experiences:

- Cooperative Learning
- Problem Solving
- Hands-on, Minds-on Activities
- Guided Research
- Low-cost Materials

The field trip and the activities in this guide meet Florida Sunshine State Standards and will help you prepare your students for FCAT tests. They also meet national standards and state standards from across the country. You will find a Florida standards matrix in the front of this guide and references to specific Florida standards in the activities themselves.

We eagerly look forward to your visit. Kennedy Space Center makes space exploration come alive. This is the portal where real people and real space vehicles leave Earth to explore the unknown. There is no doubt that you and your students will be inspired by the adventure. It is our privilege and responsibility to be your host.

Sincerely,



Rick Abramson
President & Chief Operating Officer

Acknowledgements:

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TEACHERS

HOW TO USE THIS GUIDE



This section provides a brief preview of the content and outcomes of the activities.

SUBJECTS: Subjects covered by each interdisciplinary activity are listed here.

MATERIALS: The low-cost list of supplies and tools needed for each activity.

TEACHER OVERVIEW: The activity is summarized here.

FLORIDA SUNSHINE STATE STANDARDS: A detailed list of specific standards addressed by each activity are listed here. Because Kennedy Space Center is located in Florida, Florida Sunshine State Standards are featured. However, the activities also address national standards in mathematics, science, and technology standards as well as the standards of many other states.

SPACE KNOWLEDGE: This is a capsule summary of relevant background information.

ACTION: Procedures and teaching strategies are outlined in a step-by-step format.

TEACHER ANSWER KEY: When needed, a teacher answer key is included.

GET CONNECTED!: Get more information and support for the activity by connecting to the Internet sites listed.

DEEP SPACE EXTENSIONS: Additional ideas for expanding and enhancing the activity are found here.

	MAA.1.4	MAC.1.4	MA.D.2.4	SC.B.1.4	SC.C.2.4	SC.E.2.4	SC.F.1.4	SCH.1.4	SC.H.3.4	SS.B.1.4	TH.D.1.4	VAA.1.4	VAC.1.4	PE.A.3.4	PE.B.1.4
Falling For Microgravity			▲		▲										
Growing Concerns							▲	▲							
Keeping Track of the ISS	▲	▲									▲				
The Future Has Arrived								▲	▲				▲	▲	
From A Point of View				▲											▲
Keeping Fit					▲										▲

FLORIDA SUNSHINE STATE STANDARDS

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GLOSSARY OF SPACE TERMS

FREE-FALL – A condition that occurs when an object falls without any resistance.

GEOTROPISM – The tendency of plant stems and leaves to grow away from gravity and roots to grow toward gravity.

GRAVITY – A force that attracts all matter together.

GROUND TRACK – This is a line on Earth's surface that lies directly beneath a spacecraft such as a Space Shuttle or space station as it orbits.

HYDROTROPISM – The tendency of plant roots to grow toward water.

INTERNATIONAL SPACE STATION (ISS) – A giant Earth-orbiting laboratory and home in space that is being constructed by the United States and 15 other nations.

MICROGRAVITY – This is an environment created by free fall in which gravity's effects are greatly reduced. It occurs inside a spacecraft in orbit.

OSTEOPOROSIS – A degenerative bone disease caused by a loss of calcium. The disease is most common in elderly women but microgravity can lead to similar damage in the bones of astronauts.

ORBIT – The path of an object or celestial body as it revolves around another body.

PHOTOTROPISM – The growth response of a plant toward light.

SHUTTLE ORBITER – The winged vehicle occupied by the astronauts and designed to carry payloads into space. It is the only component of the Shuttle that orbits Earth. It takes off like a rocket, orbits like a space ship and lands like a glider.

SPACE DEBRIS – Earth-orbiting fragments from rockets and satellites that present a collision hazard with space walkers and spacecraft.

VANISHING POINT – An art term describing the point in a picture toward which objects seem to converge in order to gain a sense of depth.

TEACHING SUGGESTIONS FOR GLOSSARY TERMS:

Task your students with a creative writing assignment. Ask them to write a newspaper article about current space activities using at least five glossary words. Information on space missions and future space programs can be obtained at the NASA web site. Go to www.nasa.gov

FALLING FOR MICROGRAVITY

OBJECTIVES:

- Students will understand that gravity is not a force that shuts off when astronauts reach Earth orbit.
- Students will learn how gravity and a spacecraft's motion work together to produce microgravity (apparent weightlessness)

SUBJECTS:

- Physics
- Mathematics

MATERIALS:

- Empty aluminum soft drink can
- Punch (sharp nail, awl, etc.)
- Water
- Open space
- Wastebasket

Teacher Overview:

Students will observe how dropping water-filled soft drink cans will create microgravity.

Florida Sunshine State Standards:

Mathematics – Algebraic Thinking

The student uses expressions, equations, inequalities, graphs, and formulas to represent and interpret situations. (MA.D.2.4)

Science – Force and Motion

The student understands that types of motion may be described, measured, and predicted. (SC.C.1.4)

The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted. (SC.C.2.4)

Space Knowledge:

There is much misinformation about the topic of astronauts "floating" in space. Perhaps the most commonly asked question of guests at NASA visitor centers is, "Where is that room where you push a button and everyone floats?" No such room exists but people have gotten that idea through video released by NASA that shows astronauts training inside a padded room. One moment, the astronauts are on the floor and the next moment, they appear to be floating. It looks like someone flipped a switch, shutting gravity off.

The floating seen in the videos is called microgravity and is one of the important reasons NASA sends astronauts from Kennedy Space Center into space. Microgravity can be thought of as an environment in which gravity's effects are greatly reduced. In this activity, students will be learning how NASA "flips the switch."

Gravity is not shut off during astronaut training, or in Earth orbit. Gravity is a fundamental property of all matter that exists throughout the known universe. It is a force that causes all matter to be attracted to each other. The greater the mass of an object, the greater the attraction it has on other matter. On Earth, we sense gravity as weight. When falling, objects accelerate toward each other. The amount of that acceleration is described by an equation that was devised by Sir Isaac Newton in the 17th century and modified by Henry Cavendish in the 18th century. The equation, called the Law of Universal Gravitation, has three parts.



FALLING FOR MICROGRAVITY

Gravitational law states that the force of gravity between two bodies is directly proportional to the product of the masses of the two bodies divided by the square of the distance between their two centers. To make the equation work, a constant is added like the constant of pi (π) in geometry formulas.

$$F = G \frac{m_1 m_2}{r^2}$$

$$(G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2)$$

The most powerful part of this equation is the distance (r^2) between the center of mass. This is an inverse square. If the distance between the centers of two bodies is doubled, the gravitational attraction is 1/4th as much. If it is tripled, it is 1/9th as much. From the equation, you can see that while gravity is reduced with increasing distance, it never goes away completely. In the orbit of the International Space Station (approximately 360 kilometers), the gravitational pull is still about 94% of what it is at Earth's surface. To make a significant reduction in the gravity between Earth and astronauts in space, astronauts have to be many thousands of kilometers from Earth. (Remember, distance or "r" in the equation is the distance between the centers of the two objects. In orbit, the space station is actually more than 6,000 kilometers from Earth's center.)

Considering that gravity is still a powerful force at the orbital altitude of the International Space Station, why do astronauts appear to float? Notice that the word "appear" is used. Astronauts really do not float in space. Instead, they fall. An orbit is actually a continuous fall. During the launch of the Space Shuttle, the Shuttle does not travel straight up into space. Instead, it climbs in an arcing path that carries it out over the Atlantic Ocean as it increases altitude. By the time the Shuttle reaches the altitude of the International Space Station, it is traveling at a rate of approximately 8 kilometers per second with respect to the ground. Whenever an object is thrown horizontally off a high place, it travels on an arcing path caused by its forward motion and the downward pull of gravity. The arcing path of the Space Shuttle at its orbital speed becomes a circle concentric with the circle that represents the surface of Earth. In other words, the Shuttle is falling but its forward motion carries it around Earth and this creates an orbit.

It is the falling motion of the Space Shuttle that creates microgravity. The spacecraft and the astronauts inside are all falling together which reduces the relative forces objects have on each other. What is happening can be understood by thinking of an elevator. The person standing on the scale feels heavier when the elevator goes up and lighter when the elevator goes down. If the elevator goes downward at the acceleration of gravity (free-fall), the person feels weightless. During the fall, the relative forces between the person and the scale go away and the scale reads zero.

Falling produces the floating effect seen in orbiting spacecraft. It offers many opportunities for scientific research. Scientific research on the International Space Station is looking at the effects gravity has on fundamental biological and physical processes. This is possible because scientists can look at what happens to these processes when gravity's effects are greatly reduced.

Now, about that astronaut training room.... the room actually does exist but it is not a typical room. It is the cabin of a KC-135 jet aircraft that flies steep parabolic arcs. The path of the aircraft repeatedly takes astronauts in 2000-meter arcs so that they can experience free-fall (microgravity) for periods lasting up to about 25 seconds before the aircraft has to level out. (The KC-135 is sometimes known as the "Vomit Comet" because of the stomach-wrenching effects it can have.)

Action:

1. Locate an open space to conduct the demonstrations. A stairwell, balcony, or stepladder can be used.
2. Ask your students to write the following questions on a piece of paper and use these questions to describe their observations and ideas.

What happened when the hole in the can's side was uncovered?
What do you think will happen to the water if the hole is uncovered at the same time the can is dropped?
What actually happened? Why?
What do you think will happen to the water if the can is tossed upward?
What actually happened? Why?
3. Punch a small hole on the side of the can near its bottom.
4. Cover the hole with a thumb and fill the can with water.
5. Have a volunteer student prepare to drop the can by standing in a high place. The student should momentarily remove his or her thumb to see what happens to the water. (It will make an arcing stream out of the hole.) The student should cover the hole again.

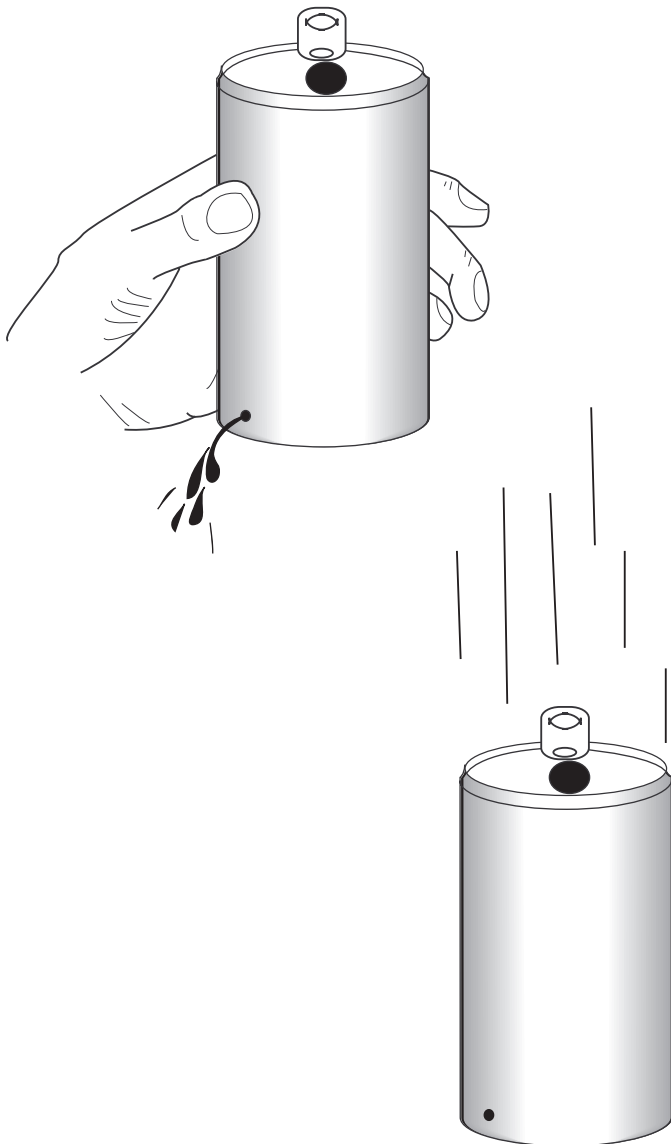
6. Conduct a brief discussion and have students predict what will happen when the can is dropped. Will the water continue to pour out of the hole? Why or why not?

7. Have a brief countdown and then have the student drop the can into a wastebasket below. All students should observe the hole and whether or not water comes out of it. If you are outside, it is not necessary to have a wastebasket to catch the can.

8. Ask students to predict what would happen if another can was tossed into the air in an arcing path like that followed by the KC-135.

9. Prepare another can and have the student toss it into the air. It is important that the can is not tumbled or spun as it is tossed. This will produce centrifugal acceleration that will cause the water to be thrown out of the can.

10. Have a brief countdown and then toss the can in the air while students observe what happens.



Teacher Answer Key

What happened when the hole in the can's side was uncovered? Water streamed out.

What do you think will happen to the water if the hole is uncovered at the same time the can is dropped? Individual answers.

What actually happened? The water did not stream out.

Why? The can and the water were falling at the same rate. In free-fall, the relative forces between the can and the water are greatly reduced. There was no reason for the water to leave the can.

What do you think will happen to the water if the can is tossed upward? Individual answers.

What actually happened? The water remained in the can.

Why? The moment the can was released by the student, it was in free-fall.

Get Connected!

Check this web site to learn more about microgravity:

[http://spacelink.nasa.gov/Instructional.Materials/](http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Physical.Science/Microgravity/.index.html)

[Curriculum.Support/Physical.Science/Microgravity/.index.html](http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Physical.Science/Microgravity/.index.html)

Deep Space Extensions:

- Ask students to speculate on what the effects of microgravity would be on the human body.
- Examine the modules at the International Space Station Center stop on the bus tour. How have the designers of the station taken advantage of microgravity?
- Discuss student ideas for the kinds of scientific research that might benefit us here on Earth by being conducted in the microgravity environment on the International Space Station.

Things to See at Kennedy Space Center Visitor Complex

- International Space Station Center
- Launch Complex 39

GROWING CONCERNS

OBJECTIVES:

- Students will identify the challenges of growing plants in microgravity.
- Students will design and construct a prototype chamber for growing plants on the International Space Station.

SUBJECT:

- Biology

MATERIALS:

- Cardboard boxes
- Cellophane
- Soil
- Seeds
- Water
- Trays or pots
- Other materials as needed

Teacher Overview:

Small groups of students will identify the needs of plants and how those needs can be met in microgravity. They will construct and test a prototype growth chamber for the International Space Station and explain how the chamber will enable successful plant growth in space.

Florida Sunshine State Standards:

Science - Processes of Life

The student describes patterns of structure and function in living things. (SC.F.1.4)

Science - The Nature of Science

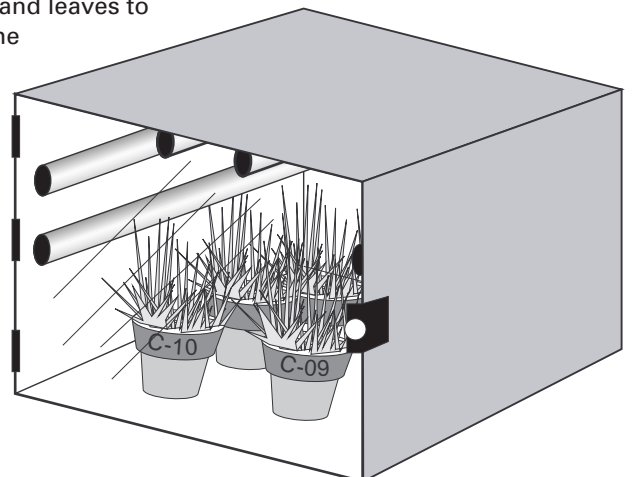
The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.4)

Space Knowledge:

Microgravity poses some interesting challenges for long-term space missions. If the spacecraft remains in Earth orbit, fresh supplies can be brought to orbit periodically. The cost of carrying these supplies is approximately \$22,000 per kilogram. Providing supplies from Earth to a long-term lunar orbiting space station would be many times that amount.

NASA biologists are experimenting with ways of growing high-yield crops in space to supplement food supplies brought from Earth. Although a slow process, plant growth also helps replenish oxygen and can assist in recycling water and solid wastes generated on a spacecraft. Doing so would reduce the cost of space exploration.

There are problems with growing plants in space. The microgravity environment of Earth orbit produces a situation in which there is no up or down and this lack of a gravity stimulus can confuse growth system's inside plants. In particular, the plant's geotropism system becomes disoriented. Geotropism is a plants response to gravity. In simple form, it is a process that causes plant stems and leaves to grow upward and the root system to grow downward. In microgravity, roots and



stems grow in awkward directions. Some plant growth experiments have actually produced roots that have grown out of the soil.

Other tropisms are also affected by a lack of gravity. Hydrotropism, the tendency of roots to grow towards water, can be altered because of the difficulty of handling water in microgravity. The cohesion of water to the space "watering can" prevents it from pouring. Water is difficult to handle in space and can end up in odd places, causing unusual root growth.

Biologists and engineers have teamed up to create growth chambers for the International Space Station that will help them investigate the best ways to grow crops in space and evaluate crops that have the highest yields in space. One model is available for viewing in the walk through laboratory module at the International Space Station Center.

Action:

- 1.** Introduce the topic of plant growth in space. Explain the challenges microgravity causes for plant growth.
- 2.** Divide your students into groups of three or four and have them pick a Principle Investigator (space experiment version of a team leader). Tell them it is their objective to design and construct a prototype plant growth chamber that could be flown on the International Space Station. The chamber will have to deliver water, nutrients, CO², and light to the plants. Discuss how microgravity may interfere with their objectives and challenge them to counteract microgravity's effects in their design.
- 3.** Provide student groups with the study questions that follow to use as a guide. Encourage groups to use Internet resources to learn about plant growth in space.

How will microgravity affect stem growth?
Will phototropism be affected by microgravity?
Are there optimum levels of CO² for plant growth?
How will plant stems and leaves be affected by microgravity?
How can water be delivered to plants in microgravity?
How will nutrients be delivered to plants in microgravity?
How should temperatures be maintained?
Which plants produce high food yields?
How much plant growth is needed to provide 50% of the food needs for a crew of seven?

- 4.** Set up the growth chambers in your classroom and have students conduct a growth experiment that includes monitoring water, nutrients, light, and production. At the completion of their experiment, groups should submit a science journal entry describing their equipment and experiment. The entry should include recommendations for chamber improvements and new experiments.



Get Connected!

Check these web sites to learn more about plant growth and microgravity:

<http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Life.Science/Educator.Guides.and.Activities/Investigating.Plants.in.Space/index.html>

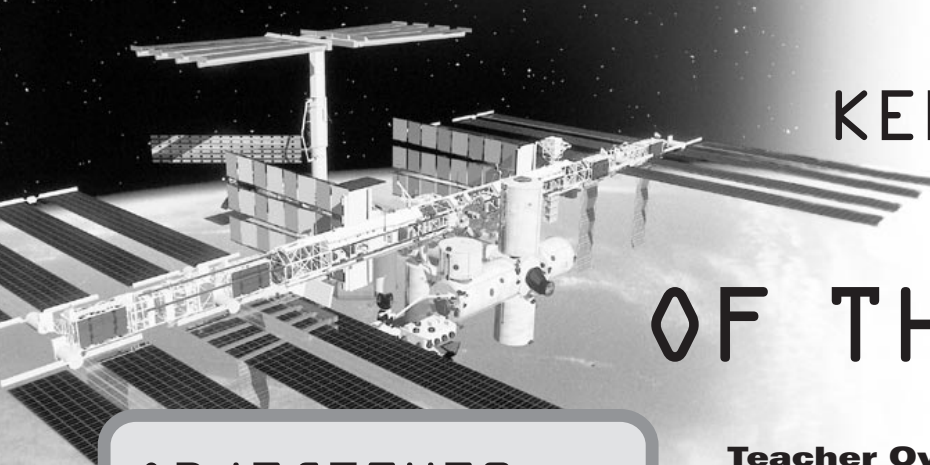
<http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Physical.Science/Microgravity/index.html>

Deep Space Extensions:

- Ask your students to design a greenhouse that could be used to provide food for a crew of explorers on the planet Mars.
 - What materials for the greenhouse can be obtained on Mars?
 - What has to be brought from Earth?
- Discuss how growing plants in space could lead to new high-yield crops and techniques for feeding the world's expanding population.

Things to See at Kennedy Space Center Visitor Complex

- International Space Station Center
- Exploration In the New Millennium



KEEPING TRACK OF THE ISS

OBJECTIVES:

- Students will learn how NASA tracks the orbit of the International Space Station.
- Students will use Internet resources to determine when the International Space Station will pass overhead and observe it when it does.

SUBJECTS:

- Geography
- Mathematics

MATERIALS:

- World globe
- White paper (long enough to wrap around globe)
- Cotton clothesline or similar rope (long enough to tie loop around globe)
- Fat black marker pen
- Cellophane tape
- Scissors

Things to See at Kennedy Space Center Visitor Complex

- International Space Station Center
- Apollo/Saturn V Center (Mission Control)

Teacher Overview:

Students will learn how NASA tracks the International Space Station.

Florida Sunshine State Standards:

Mathematics – Number Sense, Concepts, and Operations

The student understands the different ways numbers are represented and used in the real world. (MA.A.1.4)

Mathematics – Geometry and Spatial Sense

The student describes, draws, identifies, and analyzes two- and three-dimensional shapes. (MA.C.1.4)

The student uses coordinate geometry to locate objects in both two and three dimensions and to describe objects algebraically. (MA.C.3.4)

Social Studies – People, Places, and Environments (Geography)

The student understands the world in spatial terms. (SS.B.1.4)

Space Knowledge:

NASA keeps track of its spacecraft with as much diligence as air traffic controllers. NASA knows to the second or meter where the International Space Station (ISS), the Space Shuttle, and its satellites are located and how fast they are traveling. This information is essential for a variety of reasons. One is simply to make sure space vehicles do not collide. On Earth, a collision of two cars will result in property damage and personal injury if the collision speed is great enough. In space, a collision between two spacecraft traveling in opposite directions will cause immediate and complete destruction of the craft. The International Space Station travels at a velocity of 7,700 meters per second. The altitude of its orbit determines this velocity. Each orbit altitude requires a specific velocity. A space vehicle coming the opposite direction will also travel at the same velocity, resulting in a closing speed double that of either vehicle. Keeping vehicles out of each other's way is a matter of life and death. If two spacecraft are on a collision course, altitude changes can be made to prevent the collision providing the exact orbits of the craft are known in advance.

Another reason for tracking the ISS is to maintain quality communications between the station and mission control. Knowing exactly where the station is located at all times facilitates the accurate pointing of radio antennas.

A third reason for tracking is to permit efficient maneuvering leading to successful rendezvous and docking of the Space Shuttle or Russian Progress spacecraft. Since the International Space Station will operate for at least 15 years in Earth orbit, it will require visits of Earth ships carrying supplies, equipment, and crew members.

Many visitors to NASA centers get a chance to see the status board for spacecraft such as the ISS. The board is an electronic map of the world with several orbits of the Space Shuttle or International Space Station plotted. If local cable television systems carry the NASA TV channel, these maps are frequently displayed on TV screens during Shuttle missions.

Confusing to many people is the shape of the orbits displayed. Rather than being circles, the orbits take the shape of sine curves. Each orbit shifts several degrees to the west of the previous one. This leads to a graceful "spiderweb" of curves across the map. The cause of the sine curves is simply the result of a three-dimensional portrayal of a spacecraft orbit on a two-dimensional surface. The spreading of the orbits is caused by Earth's rotation between the start of one orbit and the end of the next. The lines represent ground tracks (the place immediately beneath the spacecraft as it orbits).



Action:

1. Tie a loop of rope snugly around your globe. Incline the rope at an approximate angle of 30 degrees to the equator. This represents an orbit of Earth. Display the globe and rope to your students. Make sure the rope forms a plane that passes through the globe's center. (Note: at the scale of your globe, the thickness of the rope represents the actual altitude of the International Space Station above Earth.)
2. Tape together a cylinder of white paper that snugly wraps around the globe. The halfway or middle line of the cylinder should match the equator of the globe beneath.
3. Use the marker pen to transfer the equator of the globe to the paper cylinder above it. Also use the pen to trace the rope loop.
4. Remove the cylinder of paper from the globe. Open the cylinder to form a flat map by making a straight cut with the scissors from one open end to the other. The equator line will be straight but the orbit will form a sine curve. Discuss the geometry of how the orbit is shown on the map. What will happen to the shape of the curve if the rope loop is inclined at an angle of less than 30 degrees? What will happen to the shape if it is greater than 30 degrees?
5. Go to the Internet resources listed in the Get Connected! Section of this activity and visit the NASA tracking sites. They include finders that permit you to determine when the International Space Station can be seen passing overhead. (The orbit path has to be above your local horizon and the time has to be after sunset or before sunrise so that the station is illuminated by sunlight even though your sky is dark.) Extensive details on the mathematical description of orbits are also found here as well as software to display orbital tracks on your computer.

Get Connected!

Check these web sites to learn more about tracking spacecraft:

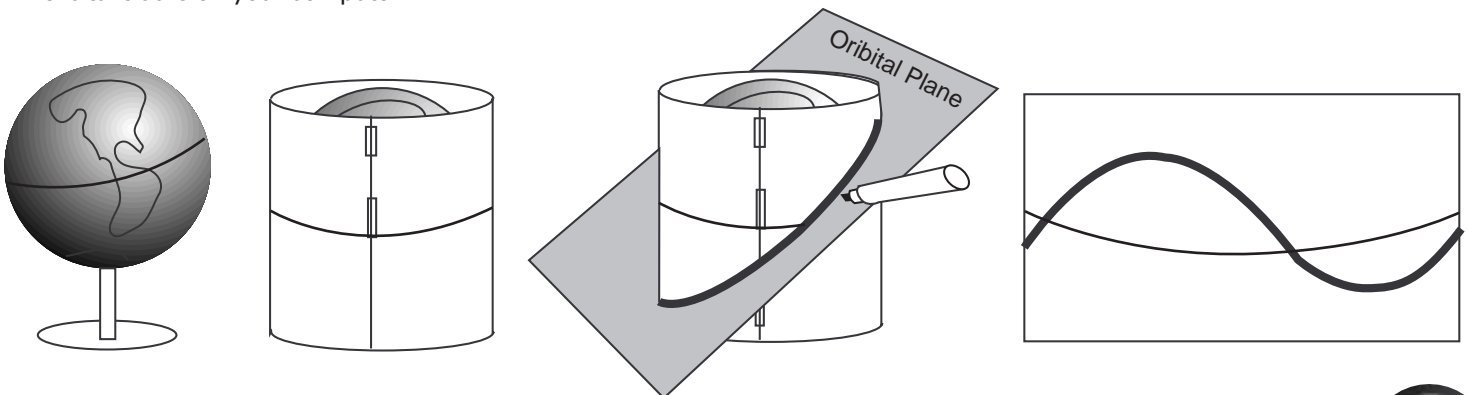
<http://spaceflight.nasa.gov/station>

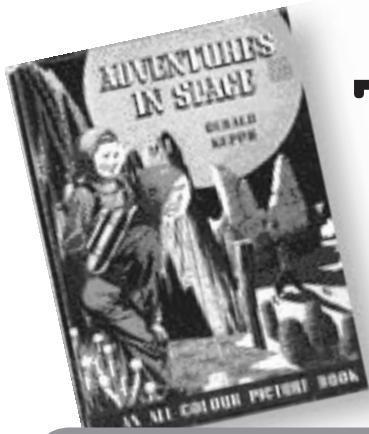
Follow the International Space Station and other NASA activities on NASA Television. Details on receiving NASA TV are found below. To find out about upcoming events, check this web site:

www.nasa.gov/ntv/breaking.html

Deep Space Extensions:

- For more information about orbital tracking, obtain a copy of the NASA videotape *Space Mathematics – Rendezvous* from the Kennedy Space Center Educators Resource Center. Contact information is given at the back of this guide.
- Collision between spacecraft is only one hazard of space flight. Fragments of old rockets and satellites can also threaten the ISS. Learn about the joint U.S. Canadian North American Aerospace Defense Command. NORAD, as it is called, tracks objects in orbit: <http://www.peterson.af.mil/norad>
- Keep track of NASA space activities via television. If your school has a satellite dish, you can pull in NASA TV directly. Otherwise, contact your local cable provider to see if they will pick up the channel for you. NASA Television (NTV) provides real-time coverage of Agency activities and missions, resource video to the news media, and educational programming to teachers, students and the general public. NTV is broadcast on GE-2, transponder 9C, C-Band, located at 85 degrees West longitude. The frequency is 3880.0 MHz. Polarization is vertical and audio is monaural at 6.8 MHz.





THE FUTURE HAS ARRIVED

OBJECTIVES:

- Students will compare space exploration technology predictions of the 1950s and 60s with what actually happened.
- Students will use Internet resources to make predictions for future technology that will be employed to explore space over the next 50 years.

SUBJECTS:

- Science
- The Arts

MATERIALS:

- Classic science fiction movies (see suggested list)
- Internet connection

Teacher Overview:

Students will view selected classic science fiction movies and compare the science and technology portrayed in them with the actual science and technology of today. Following this exercise, students will use NASA Internet resources as a guide for making their own predictions of what the next 50 years will bring.

Florida Sunshine State Standards:

Science – Energy

The student recognizes that energy may change in form with varying efficiency. (SC.B.1.4)

Science – Earth and Space

The student recognizes the vastness of the universe and Earth's place in it. (SC.E.2.4)

Science – The Nature of Science

The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.4)

The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.4)

The Arts – Theatre – Aesthetic and Critical Analysis

The student analyzes, criticizes, and constructs meaning from formal and informal theatre, film, television, and electronic media. (TH.D.1.4)

Space Knowledge:

Film has played an important role in the exploration of outer space. Before humans could travel to space, they had to dream about doing so. They had to imagine what technologies would make the trip possible and what they might encounter when they arrived. Although writers like Jules Verne and Edgar Rice Burroughs wrote about flights to the Moon and other adventures in space, wide public acceptance of these dreams did not occur until stories were set to film.

Starting in the 1930s, movie producers generated a wide body of science fiction work around the space exploration theme. By today's standards, the science, technology, characters, and plots of these movies are sometimes laughable. As silly as some of these movies appear today, the theme of space exploration they promoted was embraced by the public. For political reasons, national pride, and the thrill of adventure, the American public supported the creation of a space program. Although filled with bad science and technology, the films helped make possible the real science and technology of today.

Action:

1. Obtain copies of classic science fiction space movies for student viewing. Video copies are available through movie rental services and for purchase at video stores and online bookstores. Refer to the titles below for a good starter collection.

2. Have students review the selected movies. Provide them with the study questions below as a guide to critical viewing.

What is the title of the movie?

When was the movie made?

What is the plot of the movie?

How was space travel accomplished?

Did the movie employ accurate science? Give some examples.

Did the movie make some scientific mistakes? Give some examples.

Did NASA use similar technologies to explore space?

Did the scriptwriters accurately predict the future?

3. Have students go to the NASA web sites listed in this activity to examine NASA's future plans for space exploration.

4. Write a plot for a science fiction movie that portrays space exploration 50 years from now.

Suggested Movie Titles:

Rocketship X-M (1950): A catastrophic event causes the crew of Moon-bound Rocketship X-M to miss the Moon and go to Mars. Look for the miraculous changing rocket and the way the female scientist is treated.

Conquest of Space (1954): A space expedition to Mars begins from a spinning wheel space station in Earth orbit. Be sure to get out of the way of the flaming asteroid and pay attention to the space suits used by the crew.

The Day The Earth Stood Still (1951): A Martian flying saucer lands in Washington, D.C., with a warning for all nations. Check out the robot, heat rays, and medical technology.

Forbidden Planet (1956): An Earth flying saucer crew attempts to relieve the survivors of an expedition to Altair-IV. Enjoy Robby the Robot and observe that while the robot



Things to See at Kennedy Space Center Visitor Complex

- International Space Station Center
- Apollo/Saturn V Center (Mission Control)
- Exploration In The New Millennium
- IMAX Theaters – "L-5: First City in Space"

can do amazing feats of technology it still has to shuffle to get around.

2001: A Space Odyssey (1968): Slow moving visual experience. The movie predicts space hotels and flights to Jupiter. Watch for the technology used for space food and space walking.

First Man Into Space (1958): The first man to reach outer space is injured by a meteorite storm and comes back to Earth as a blood-sucking monster. Observe the microgravity scenes.

Get Connected!

Check this web site to learn about early rocket history: <http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Physical.Science/Educator.Guides.and.Activities/Rockets/index.html>

Deep Space Extensions:

- Investigate the predictions for space flight that rocket scientists like Werner von Braun made in the 1950s. See how these compare with what actually happened. A good source for information is the book *Blueprint for Space Science Fiction to Science Fact* (1992), Frederick I. Ordway II and Randy Leibermann, Smithsonian Institution Press, Washington, D.C.
- Have your students use video cameras and editing units to create their own science fiction movies.





FROM A POINT OF VIEW

OBJECTIVES:

- Students will observe space art and identify the way the artists employed forced perspective to enhance the portrayal of space vehicles.
- Students will create a work of space art that employs forced perspective.

SUBJECTS:

- Science
- The Arts

MATERIALS:

- Sketchpads
- Art supplies

Teacher Overview:

Kennedy Space Center Visitor Complex has an excellent permanent collection of space art that students will study in order to learn how the artists created the illusion of depth in two-dimensional media.

Florida Sunshine State Standards: **Science – The Nature of Science**

The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.4)

The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.4)

The Arts – Visual Arts – Skills and Techniques

The student understands and applies media, techniques, and processes. (VA.A.1.4)

The Arts – Visual Arts – Cultural and Historical Connections

The student understands the visual arts in relation to history and culture. (VA.C.1.4)

Space Knowledge:

Space art has played an important role in the exploration of outer space. Space artists assist NASA's long range planning by illustrating concepts for future rockets and spacecraft. The illustrations are used with appropriation committees in Washington, D.C. to explain how proposed programs would work. They are also used to educate the public and generate support.

Because of the nature of the topic, many space artists employ a technique sometimes called forced perspective. The technique creates a three-dimensional appearance to the rockets and space stations depicted in their pictures. The artist plots out the picture by creating a horizon line and a vanishing point where seemingly, all the action in the picture begins or ends. Horizon lines and vanishing points are used in many works of art but space themes permit them to be used to greatest effect. For an example of forced perspective see page 16.

Action:

1. Have your students examine the NASA art collection at Kennedy Space Center Visitor Complex. Refer to the list below for artwork that emphasizes depth through the use of forced perspective.

2. Ask your students to make rough sketches of the artwork and identify the horizon line and the vanishing point. Some pictures contain more than one vanishing point. Ask your students how having additional vanishing points enhances the 3-D effect.

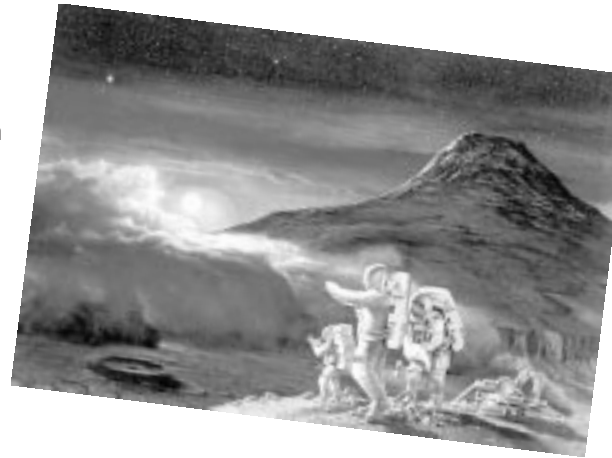
3. Ask your students to create their own space art. Have them make preliminary sketches of their subject or take pictures and complete the work back at school. Some possible subjects for artwork include the rockets at the Rocket Garden, Launch Complex 39, and the Vehicle Assembly Building. Challenge your students to create their work from an unusual angle to emphasize the 3-D effect.

Recommended pieces in the NASA Artwork Collection at Kennedy Space Center Visitor Complex:

2092 A.D. Virtual Reality
Time, Space AND Columbia
Under Construction – Pad 39B
Rollout, Columbia
Baikonur: A Kazakh Sunrise
Weightless
Spaceport
The Landing – Columbia 3
Island In The Sky
Proposed Color Scheme for Shuttle Craft
Inaugural Launch
Inner Space

by Tina York
by Billy Morrow Jackson
by Maria Epes
by Martin Hoffman
by Alan Chinchar
by Jack Kroemke
by Alfred McAdams
by Jack Perimutter
by Charles Schmidt
by Clayton Pond

by Edwin H. Wordell



Get Connected!

Check this web site to learn more about NASA's Art Program and to see samples of space art:
www.nasa.gov/gallery/arts/index.html

Deep Space Extension:

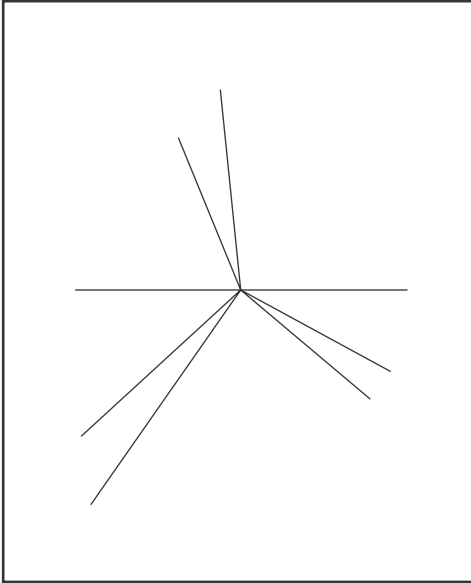
Host a space art fair.

Things to See at Kennedy Space Center Visitor Complex

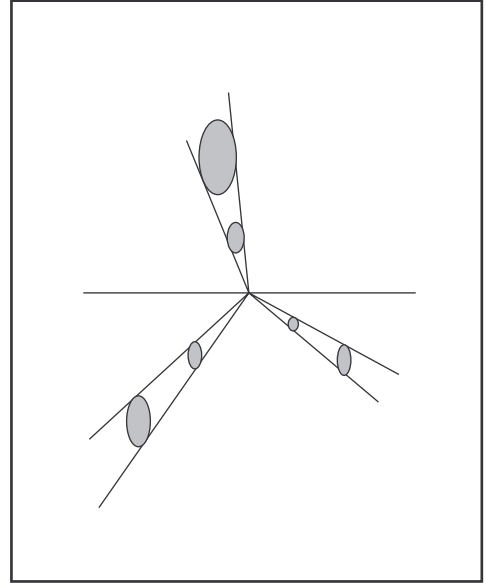
- NASA Art Gallery
- Early Space Exploration
- Rocket Garden

FROM A POINT OF VIEW

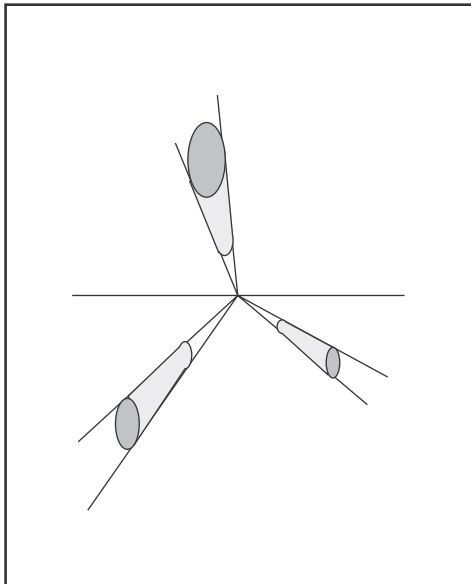
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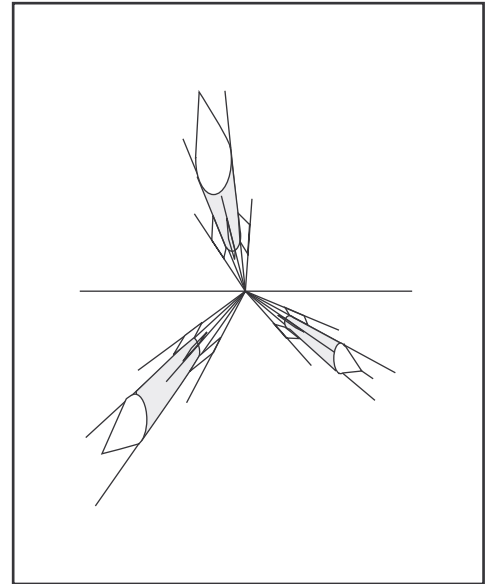
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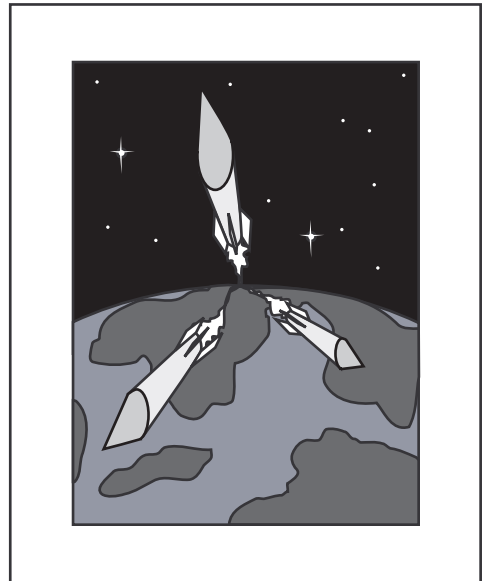
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4



5



Picture Subject: Multiple Rocket Launch

1. Horizon and vanishing point drawn.
2. Ellipses added.
3. Ellipses connected to form rocket bodies.
4. Nose cones and fins drawn.
5. Horizon and vanishing point lines removed and background added.

KEEPING FIT

OBJECTIVES:

- Students will learn about the physiologic changes that affect astronauts in space.
- Students will design a piece of exercise apparatus that will enable an astronaut to maintain fitness while in space.

SUBJECTS:

- Science
- Mathematics
- Physical Education

MATERIALS:

- Computer drafting program or sketchpad, ruler, etc.

Teacher Overview:

Serious physiologic changes take place in astronauts while in the microgravity environment of space. Intensive exercise while in orbit is needed to prevent these changes.

Florida Sunshine State Standards:

Science – Force and Motion

The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted. (SC.C.2.4)

Physical Education – Responsible Health Behavior

The student analyzes the benefits of regular participation in physical activity. (PE.A.3.4)

Physical Education – Responsible Physical Activity Behaviors

The student achieves and maintains a health-enhancing level of physical fitness. (PE.B.1.4)

Space Knowledge:

The microgravity environment of Earth orbit is one of the exciting things about space travel. Astronauts can propel themselves through the air of their spacecraft cabin with just a tiny push of fingers against walls. Food drifts about. Spilled water gathers to form shimmering giant drops that do not fall to the floor.

Unfortunately, the fun of microgravity comes at a physical price. Changes occur in the human body that, if left unchecked, can lead to permanent damage. The spine lengthens, causing astronauts to "grow" several centimeters in flight. Some body fluids shift towards the head. Legs become thinner in what is nicknamed the "chicken leg" effect. The face becomes fuller and there is a sense of stuffiness in the sinuses.

Some changes are more serious. The heart enlarges and then shrinks. The immune system weakens. Sleep patterns are disrupted. Since it is easy to move about the cabin with little effort, muscles weaken and reduce in mass. More importantly, the lack of stress on the musculoskeletal system will lead to the weakening of bones. Body sensors incorrectly interpret fluid shifts as an excess of body fluids. The body responds and excretes what it perceives as excess fluid along with bone calcium, electrolytes, and blood

plasma. Approximately one to two percent of bone mass is lost every month in space. On long space voyages, such as future visits to Mars, astronaut bones could reach the state of severe osteoporosis.

To control negative body changes, astronauts engage in approximately two hours of vigorous exercise every day they are in space. Using an elastic harness, astronauts' feet are held to treadmills for a jog around the world. Elastic cords attached to the floor are used to replace free weights. A stationary bicycle (ergometer) is also sometimes used. The good news is that damage caused by microgravity can be minimized through exercise. Furthermore, a sustained exercise program back on Earth can return body systems to normal after a few months.

Action:

- 1.** Ask students to investigate the physiologic changes that take place in astronauts during microgravity. Go to the web site listed in the Get Connected! section.
- 2.** Lead a discussion on the topic of exercise in microgravity. What are some of the problems astronauts would encounter in space if they attempted to use standard exercise equipment found in most Earth gyms?
- 3.** Form small teams of students and challenge them to design an exercise device that would work in microgravity. Teams should create line drawings of their inventions with a computer drafting program or with paper and pencil. If time permits, have the teams actually construct a prototype exercise device that can actually be used.
- 4.** Have student teams present their ideas to the rest of the class. Presentations should include a description of how the device would work in microgravity. Challenge other students to critique team designs.

Get Connected!

Learn about human physiology in space at this web site:
www.nsbri.org/humanphyspace

Deep Space Extensions:

- Learn about the problems of keeping the elderly fit. Some of the physiologic changes that take place in astronauts in microgravity are very similar to the physiologic effects that accompany aging. How can NASA research in space fitness help elderly people?
- Investigate how a good diet can team with exercise to promote lifelong fitness.
- Obtain a copy of the Liftoff to Learning Video *All Systems Go!* From the Educator Resource Center (see resource section that follows).



**Things to See at
Kennedy Space Center
Visitor Complex**

- International Space Station
Center

SPACE SHOP

The Kennedy Space Center Visitor Complex Space Shop contains a large collection of educational products and space memorabilia. The Space Shop features a wide range of age-appropriate books and interactive CD ROM software. Also available are posters, photographs, and activity kits. Space memorabilia includes NASA mission patches, autographed astronaut pictures, clothing, and even space food samples. Special Note: Educators receive a 10% discount on all educational materials!



SPACE EXPLORATION RESOURCES FOR STUDENTS:

Recommended Web Sites to Visit:

Astronaut Fact Book: www.jsc.nasa.gov/pao/public/astronauts.html

Kennedy Space Center History: www.pao.ksc.nasa.gov/kscpao/history/history/history.html

Kennedy Space Center Homepage: www.ksc.nasa.gov

Kennedy Space Center Visitor Complex: www.kennedyspacecenter.com

NASA Home Page: www.nasa.gov

NASA Spaceflight (Shuttle/ISS): <http://spaceflight.nasa.gov>

Solar System Images: <http://photojournal.jpl.nasa.gov>

Space Flight Images: <http://images.jsc.nasa.gov>

Spacelink: <http://spacelink.nasa.gov>



RESOURCES ABOUT NASA AND SPACE EXPLORATION

Just for Educators:

NASA has designed specialized curriculum and information detailing the huge variety of space travel related subjects. Listed below are some of the resources available to you. Additional information can be obtained at:

NASA Educators Resource Center at KSC

Mail Code: ERC

Kennedy Space Center, FL 32899

(321) 867-4090

NASA Internet Resources for Educators:

Kennedy Space Center Visitor Complex: www.kennedyspacecenter.com

Learn about the exciting exhibits, presentations, field trips and education programs such as Camp KSC spring & summer day camp programs, Overnight Adventures, special Salute to Scouting programs, Space Patch programs, Special Interest Tours and educator training programs.

NASA Spacelink: <http://spacelink.nasa.gov>

Access news about current programs, activities and other space-related information.

Kennedy Space Center Home Page: www.ksc.nasa.gov

Access to information about Kennedy Space Center, Gateway to the Universe. Visit this page for launch updates, space shuttle information, online facility tours and unmanned rocket launches.

NASA CORE: <http://core.nasa.gov/>

Access information on NASA's audio-visual educational materials.

NASA Quest: <http://quest.arc.nasa.gov>

Access information about educational grants, interact with other schools and explore links to other NASA educational resources.

NASA Television (NTV)

NTV features live Space Shuttle launches, historical footage, news events, and educational programming. If you have a satellite dish, connect to the GE2 satellite, Transponder 9C at 85 degrees west longitude, vertical polarization, with a frequency of 3880.0 megahertz and audio of 6.8 megahertz. If you do not have a dish, request that your local cable TV provider connect to NTV for you.

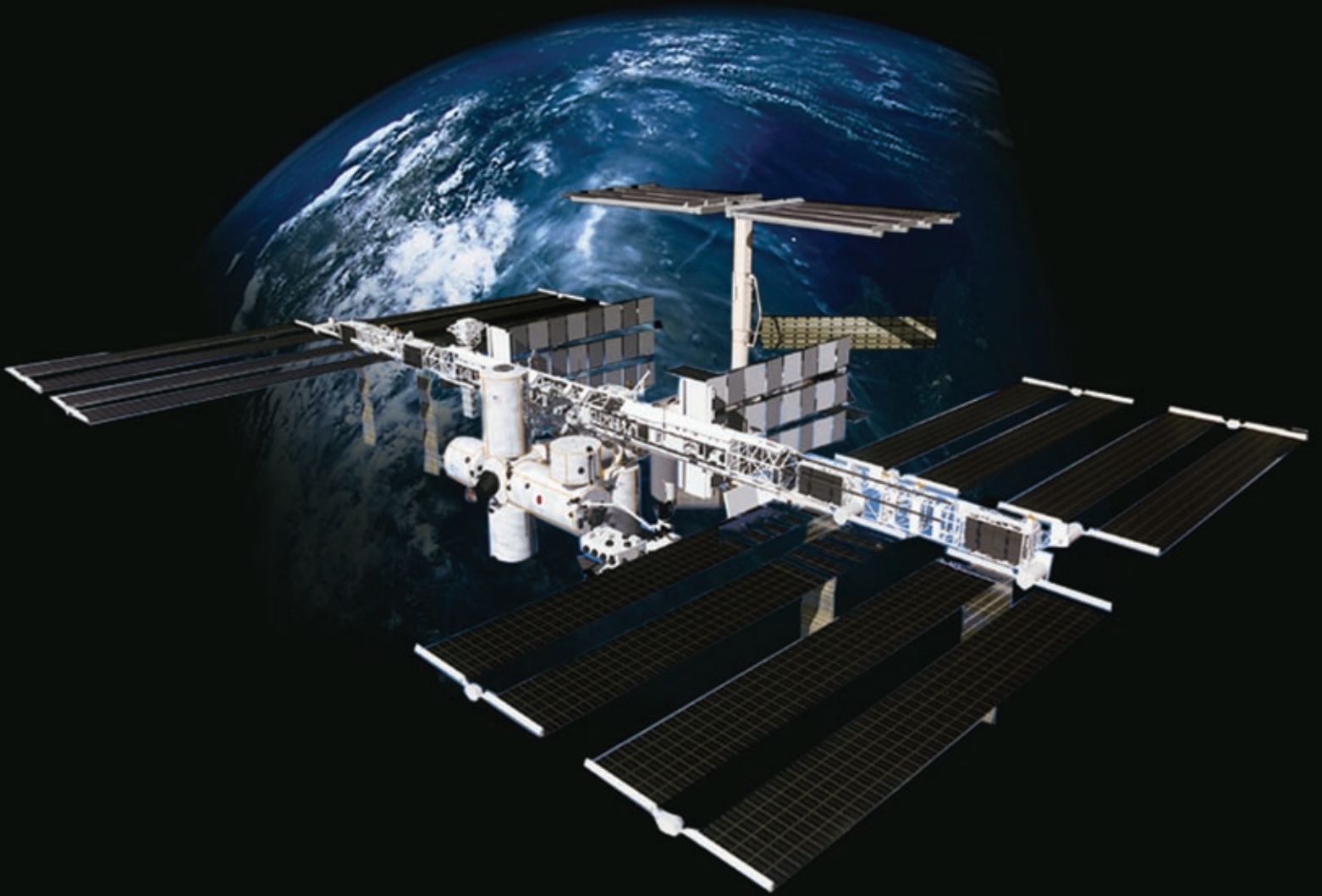




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EDUCATOR'S
Activity Guide



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