IMAX® SPACE STATION

A SELECT FEW HAVE BEEN ABOARD...
NOW IT'S YOUR TURN!

EDUCATOR'S RESOURCE GUIDE

Presented By

LOCKHEED MARTIN

In Cooperation With

NASA

IMAX® SPACE STATION

A Unique Field Trip and Learning Experience!

The International Space Station (ISS) is a technical marvel, unparalleled in scope and challenge. A permanent facility focused on studying the effects of long-duration exposure to microgravity, it is the necessary first step toward the global, cooperative effort needed to venture out to Mars and beyond. Truly an international effort, this Earth-orbiting laboratory draws upon the scientific and technological experience of 16 nations.

A field trip to an IMAX theatre to see *SPACE STATION*, sponsored by Lockheed Martin, whisks students 220 miles/354 kilometers above the Earth to visit the ISS. They will feel like they are working side by side with space explorers, orbiting the Earth every 90 minutes, traveling at 17,500 miles/28,160 kilometers per hour.

As astronauts and cosmonauts lift off from NASA's Kennedy Space Center and Russia's Baikonur Cosmodrome, students are on board. They join Space Shuttle and ISS teams moving into their orbiting home, watching them unpack and settle in. Thanks to IMAX cameras, your students can peek in on the daily duties of fellow crew members living and working in space – eating with the crew, catching a glimpse of sleeping astronauts, and enjoying humorous moments in the near weightless world of Earth orbit.

Whether "swimming" in microgravity within the ISS modules or suiting up for a spacewalk and stepping out of the airlock, students learn first-hand what it means to be a space explorer. They understand the challenges of being a free-floating construction worker. They see through the eyes of spacewalkers the spectacular view of our awesome planet, an Earth with no visible borders between countries.

This Educator's Guide, created in cooperation with NASA by the team of IMAX, Lockheed Martin and Barbara Sprungman, a writer of award-winning space science curriculum guides and a credentialed teacher, has been designed to inform and challenge students. It contains a rich assortment of activities you can use to enhance your curricula for the sciences, mathematics, social studies, history, language arts, engineering, technology and art – and to stimulate student discussions before and after a field trip to see *SPACE STATION*.

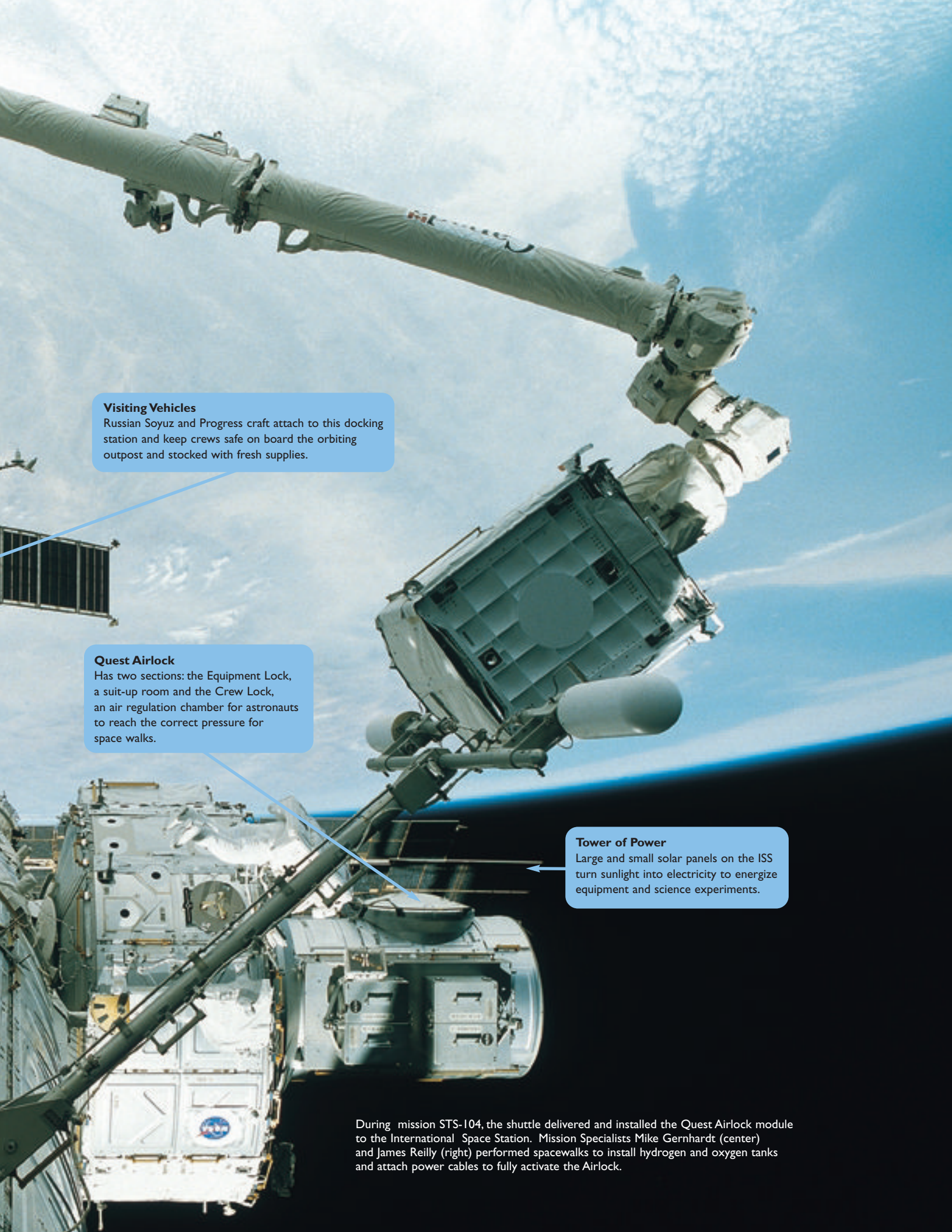
Together, *SPACE STATION* and this Guide provide educators with the ability to give students an insider's look at outer space – as international crews learn to live together while sharing the tensions and triumphs of the world's greatest engineering challenge since landing humans on the Moon.

THE INTERNATIONAL SPACE STATION

Strong Arm in Space
A Canadian-built robotic arm can lend a helping hand, performing maintenance and assembly tasks outside the ISS, and is operated by crews from inside the outpost.

Space Walking
A robotic arm and special pressurized suits allow the astronauts to work outside the ISS.

Destiny in the Stars
The U.S. laboratory – named Destiny – packed with scientific gear to investigate how microgravity may allow the creation of new life-saving drugs, metals and alloys.



During mission STS-104, the shuttle delivered and installed the Quest Airlock module to the International Space Station. Mission Specialists Mike Gernhardt (center) and James Reilly (right) performed spacewalks to install hydrogen and oxygen tanks and attach power cables to fully activate the Airlock.

The International Space Station

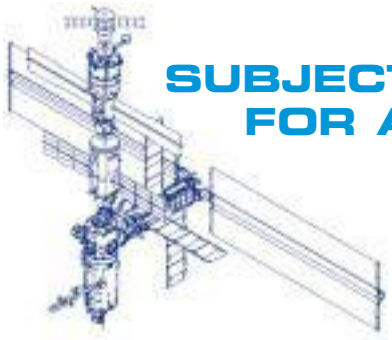
The International Space Station (ISS) is the greatest collaborative project ever undertaken. The orbiting outpost is under construction by 16 nations. Piece by piece – like a giant jigsaw puzzle – segments of the ISS attach to each other. The result is a cozy home-away-from-home for space travelers. The largest structure ever built in Earth orbit, when completed the ISS will have a wingspan of 356 feet/109 meters, and a length of 290 feet/88 meters. Giant solar arrays churn out enough energy to power about 50 average North American homes. That electrical energy is distributed to run six state-of-the-art laboratories when the ISS is fully operational. The ISS whisks above the Earth at 220 miles/354 km in altitude, and at 17,500 mph/28,160 km/h. As a technological star slipping across the backdrop of space, the ISS is the product of more than 100,000 hard working people around the planet.

The IMAX *SPACE STATION* Educator's Guide

This Educator's Guide supplies the academic rocket fuel to help students reach out and become part of the International Space Station. Before viewing *SPACE STATION*, the activities in this guide prepare students to float side-by-side with astronauts and cosmonauts as they move into their new orbiting home. Art, technology and science projects involve students in learning about the space station's design, its many modules, solar array power system, and exploring Earth from space. Also included is a behind-the-scenes look at the technology that makes IMAX giant-screen viewing such an eye-catching experience. If class time is limited, the activities can be used for students as homework, club activities or as a resource for science and engineering fair projects.

For a list of IMAX theatre locations worldwide, visit the official IMAX website at www.IMAX.com.

YOU HAVE ARRIVED!



SUBJECTS AND GRADE LEVELS FOR ACTIVITIES

The activities in this guide are appropriate or adaptable for grades 3 through 9. The subject areas are listed below, followed by the section numbers of the related activities. It is suggested that all students experiencing the IMAX *SPACE STATION* film participate in the activities in sections 2 and 4.

ART: 2, 3, 4, 12

BIOLOGY: 2, 4, 7, 8, 12

CAREER STUDIES: 2, 4, 12

CHEMISTRY: 2, 4, 7, 12

EARTH SCIENCES/GEOLOGY: 2, 4, 8, 9, 10, 12

ENGINEERING: 2, 3, 4, 5, 6, 7, 8, 9, 11, 12

FOREIGN LANGUAGE: 2, 4, 7, 9, 12

GEOGRAPHY: 2, 4, 8, 9, 10, 12

LANGUAGE ARTS: 2, 4, 7, 9, 12

MATHEMATICS: 2, 4, 5, 6, 12

PHYSICAL SCIENCE/PHYSICS: 2, 4, 5, 8, 11, 12

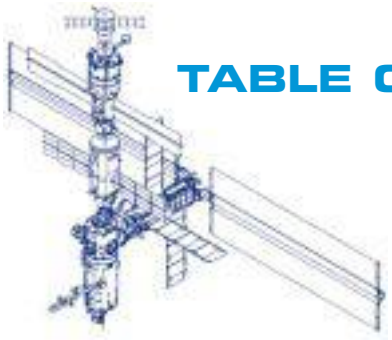
SOCIAL STUDIES/HISTORY: 2, 4, 5, 7, 9, 12

TECHNOLOGY: 1, 2, 3, 4, 5, 6, 8, 9, 11, 12

NATIONAL EDUCATION STANDARDS

The activities in this Educator's Guide address the U.S. national education standards, including:

- National Science Education Standards (NSES), and recent addendums including "Inquiry and the NSES: A Guide for Teaching and Learning" and the National Science Teachers Association's guidelines.
- National council for Teachers of Mathematics' Principles and Standards for School Mathematics.
- International Technology Education Association's Standards for Technological Literacy.
- Other related subject standards including geography standards.



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SECTION 1

IMAX: THE ULTIMATE FIELD TRIP

IMAX® theatres offer a unique and economical field trip experience for students and teachers. Utilizing the largest film frame in motion picture history to project breath-taking, crystal-clear images on screens up to eight stories high and by using advanced multispeaker sound, IMAX creates a memorable cinematic experience that makes learning fun. With SPACE STATION, *IMAX continues it's commitment to provide students with a meaningful, exciting and innovative learning experience.*

The Technology Behind IMAX

IMAX Projectors:

IMAX projectors use a Rolling Loop system that horizontally advances the film in a wave-like motion. The film runs through the projector at 24 frames-per-second and is held absolutely steady by fixed registration pins and a vacuum. The projection lamp emits a beam of light so powerful it could be seen from the ISS.

The IMAX Dome Experience

IMAX Dome technology adds another dimension to the viewing experience. The film is projected through a fisheye lens onto a giant dome screen, providing the viewer with the sense of being enveloped by the images.

IMAX 3D

Theatres equipped with IMAX 3D projectors will show *SPACE STATION* in 3D. Based on human vision, 3D technology mimics the way we see the real world. When you look at an object, each of your eyes sees a slightly different view of that object. Through a process known as stereopsis, the brain "fuses" the views into one three-dimensional image.

Right Eye

Left Eye

Brain fuses the image

To enable the 3D effect, the projector's twin lenses alternately project left- and right-eye images onto the giant screen at 24 frames-per-second. Everyone viewing a film wears either special polarized glasses with each lens aligned with the respective "eye" of the projector, or lightweight, cordless headsets. The headsets have liquid crystal lenses that are synchronized with the projector's lenses.

IMAX Cameras

Versatile, flexible and reliable, the IMAX camera is an integral part of the IMAX system. IMAX cameras have been to outer space, explored the ocean floor, climbed Mt. Everest and traveled around the globe. An IMAX camera can weigh as little as 37 lbs/17 kg or as much as 100 lbs/45 kg. The IMAX 3D camera weighs 240 lbs/110 kg and the two lenses of the IMAX 3D camera are precisely spaced to match the distance between our eyes. This allows each lens to "see" a left- and right-eye view. The images register onto two separate rolls of film that run simultaneously through the camera.

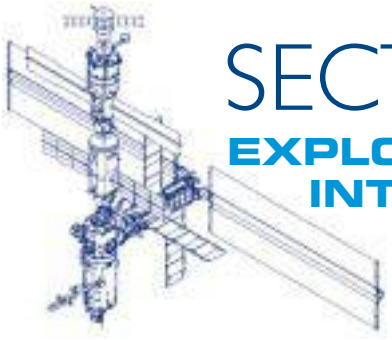
Filming *SPACE STATION*

Twenty-five astronauts filmed the movie with specially designed IMAX cameras, that travelled up and down on three different shuttle flights. One IMAX in-cabin camera caught action inside the orbiting outpost. Another camera was bolted within the cargo bay of a space shuttle.

Astronauts and cosmonauts received special training to operate IMAX hardware. That included new photoflood lights, a laptop computer to operate the camera, as well as digital audio tape recorders. Each astronaut became expert in how to load and unload the large rolls of IMAX film, decide on the right lighting angles, and take "picture perfect" film sequences. The astronauts had to practice special techniques to operate the large cameras. *(See page 6 photo – Expedition One Commander Bill Shepherd).*

Visit the IMAX website for more details about IMAX technology, theatres and other IMAX films at: ***http://www.IMAX.com.***

The IMAX 3D 30-perforation in-cabin flight camera, specially designed to film SPACE STATION *was developed to meet NASA's mass and volume constraints for space flight.*



SECTION 2

EXPLORING THE INTERNATIONAL SPACE STATION

The following activity is especially important as it provides a way for the educator to understand students' current knowledge – as well as misconceptions – about the International Space Station (ISS) and space-related science and technology.

ACTIVITY 1

Students' Questions about the ISS

Goal: To assess students' current knowledge and misconceptions about the ISS.

Key Concepts: Activities on the ISS include science experiments, observing Earth from space, astronomy and the development of space products. There are many interesting and rewarding Space Station-related careers.

Grade Level: All levels.

Subjects: All sciences, engineering, technology, career studies.

Materials: Paper and pens, Resources Section of this guide.

Procedure: This activity can be kept very simple and take just a few minutes by doing only #1 and having students turn in questions to the educator, or it can be expanded to include some or all of the following:

1) Students each list on paper at least five questions they have about the ISS, or what it would be like to live in an Earth-orbiting facility with microgravity. They submit these questions, along with others generated later, to the educator at the end of the activity.

If time allows, students could also do the following:

2) Students form teams of three or four and create a new list eliminating any duplication of questions and improving the quality and detail of the questions.

3) Students look over the questions and share any answers they know with their team.

4) Using the Resources Section at the end of this guide, students work together to make a list under each question of websites, books or other resources that they think might provide the answers.

5) Each student team divides up their list of questions and searches for the answers (on the Internet, if possible) using the resources listed under each question. They write a brief answer for each question that includes the sources they used.

6) There may be a few questions for which students have difficulty finding the answers. These questions can be used in the next activity.

Evaluation: Students are evaluated as individuals and teams on:

- five written questions about the ISS (from #1).
- ability to cooperate with team members and their contributions to discussions.
- list of questions, answers, and sources used (from #5).

ACTIVITY 2

Making a Video on Space or Creating an Internet Website on a Space Topic

Goal: To plan, design and produce (if equipment is available) a video or website on one of the science, technology or engineering topics listed under "Procedure".

Key Concepts: Understanding some aspects of the science, technology and/or engineering involved in the construction of the ISS and the science research that is conducted on the ISS; learning about ISS-related space careers; and video or website planning, design and production.

Grade Level: All levels – can be adapted for any grade level.

Subjects: Biology, chemistry, physics, Earth sciences, astronomy, technology, engineering, computer skills, careers, language arts (writing script for video or text for website).

Materials: Students can do this activity on paper, but it is more effective if they have use of a video camera and editing equipment, or a computer for the website design.

Procedure: Planning a video or designing a website on an ISS-related topic requires students to become more deeply involved in understanding an aspect of the Space Station. Students work in teams of three or four to plan a video project or design a website on one of the space-related topics below. Links to websites with images, drawings and resources are provided in the Resources Section, and at the Space Station Gallery website at: ***http://spaceflight.nasa.gov/gallery/images/station.***

BIOLOGY, CHEMISTRY OR PHYSICS: *Designing a Science Experiment*
For science students, science experiments similar to those being conducted on the ISS can be videotaped. (For more information about the ISS science experiments, see Section 8)

EARTH SCIENCES: *Modeling Earth from Space*
For Earth science students, after studying images taken of Earth from the ISS, the space shuttle, the high-resolution IKONOS satellite, or other satellites, various geological features can be modeled in miniature for videotaping from above. (For more information, see Section 10)

ASTRONOMY: *Exploring the Solar System*
Where should we go beyond the ISS? After choosing and researching a solar system exploration mission that could use the assistance of the ISS, students explain their mission on video, using visual aids such as models and drawings. (For more information, see Section 12, Stellar Activity)

ENGINEERING: *Building a Home in Space*
After experiencing *SPACE STATION*, students can make models of the ISS, videotape their assembly and explain the activities planned for each of the modules. (For more information, see Section 3)

TECHNOLOGY EDUCATION: *Designing a Space Product*
For students studying technology, a space spin-off product developed as a result of space research, could be designed and explained on video. Students could also choose several spin-off products to video or describe on paper or for a presentation. For current or past issues of the NASA spin-off publication either online as a PDF file or to send for the printed edition, go to:
http://www.sti.nasa.gov/tto/spinoff.html

CAREERS IN SPACE
If available locally, students can interview space scientists, engineers or others in the ISS or space-related careers on video or audio about their work. A good resource website is: ***http://quest/nasa.gov.***

Evaluation: Students are evaluated as individuals and teams on:

- their plan for a space-related video, and on the video itself, if they have access to equipment and time to produce the video.
- the quality of their website design and content on a space-related topic, or if a computer is not available, text and artwork showing their design submitted on paper.

STELLAR ACTIVITIES

Enter your Video in the NASA Student Involvement Program Competition

Choosing one of the topics on the previous page, students can enter NASA's AERONAUTICS AND SPACE JOURNALISM competition by creating a five-minute video in one of the following formats: newscast, investigative or special report, or documentary. News articles can also be submitted. For more information, visit this website: ***http://www.nsip.net.***

Expedition One Commander Bill Shepherd operating the IMAX 3D in-cabin camera.

Expedition One Commander Bill Shepherd communicating from the ISS to students on earth.

Ask an Astronaut, Scientist or Engineer

Students can ask astronauts, scientists or engineers appropriate questions.

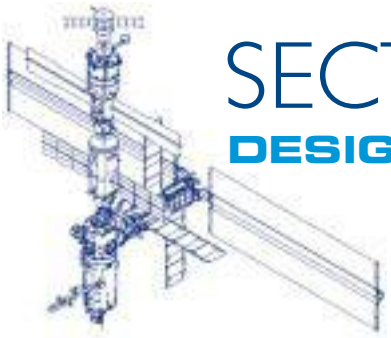
Ask an Astronaut

They can submit their questions to the "Ask an Astronaut" website at ***http://www.ari.net/nss/askastro***, or search through more than 250 archived questions about space, answered by those who have been there. The site also has photos, sounds and movies from each astronaut's missions. These files are free to use in students' projects.

Ask a Scientist or Engineer

Many scientists and engineers from universities, NASA Field Centers (website for list – ***http://spacelink.nasa.gov/ercn***), or aerospace companies are very willing to help students. Lockheed Martin Corporation, for example, sponsors an event called Space Day, celebrated each year in early May, during which hundreds of their scientists and engineers all over the United States go into classrooms and talk to students, or help them with space-related projects.

The Space Day website has many resources and interesting ideas for exploring space and astronomy at: ***http://www.spaceday.com.*** You can also visit the Lockheed Martin website for information on Space Day at: ***www.lockheedmartin.com.***



SECTION 3

DESIGNING A SPACE STATION

In the 1950s, scientists, engineers and space artists envisioned a space station design that looked like a huge wheel. Their plan was to rotate it one revolution every 22 seconds to produce a gravity one-third of our gravity on Earth. Their vision was a spacefaring crew of 80. The 1960s movie "2001: A SPACE ODYSSEY" *also featured a space station as a large, rotating wheel design.*

Artwork: *Chesley Bonestell*
NASA

Decades later, designers of the ISS decided that using modules and coping with microgravity – instead of creating artificial gravity – were the best design for our times. The module segments and other sections of the ISS could easily be hauled into orbit within a space shuttle's cargo bay and atop Russian rockets. *(For a definition of microgravity – see page 16)*

Having a laboratory in microgravity, rather than one-third gravity, meant that the extra hours of astronaut and cosmonaut time would be spent exercising. By "working out" within the ISS, crews protect their hearts and prevent bone loss. In the past, a cosmonaut aboard the Mir space complex spent more than a year in Earth orbit. He provided medical data showing that humans can cope with some 12 months of exposure to microgravity.

ACTIVITY

Designing a Space Station

Goal: Understand what systems and supplies are necessary for humans to survive in space, as well as on Earth.

Key Concepts: Although the systems and supplies necessary for human survival in space are similar to those on Earth, many factors – microgravity, heat when in the sunlight and cold when in the shade, living in a confined space, as well as the weight and cost of putting hardware into orbit – are important when designing systems for a space station. The space environment has unique factors that must be considered for survival. (Much radiation, for example, is shielded from us on Earth by the atmosphere.) Adequate protection is required. The interior of the ISS must be designed for ease of crew use in microgravity.

Grade Level: All levels can be adapted for any grade level.

Subjects: Engineering, technology.

Materials: Paper and pen for each team's list and illustrations (if requested by educator).

Procedure: Before learning details about the specific systems used on the ISS, students work in teams of three or four to generate a list of critical equipment and supplies needed for humans to live comfortably in space.

Considering what systems and supplies are needed in their own homes, they first generate a list similar to the one below:

Power	**Waste management**
Temperature control	**Crew showers**
Water supply	**Sleeping quarters**
Food preparation	**Communications**

Students discuss how they would provide these necessities, writing a brief description after each topic. They will need to keep in mind the following factors:

- microgravity
- heat when their space station is in the sunlight and in the shade.
- living in a confined space.
- keeping the weight of the system as light as possible.
- keeping the cost as reasonable as possible.

They can also create illustrations of how their systems would work. Older students can choose one of the topics and develop a more detailed description of their system.

Students will learn more about how the ISS systems provide these needs in *SPACE STATION* and in the next section.

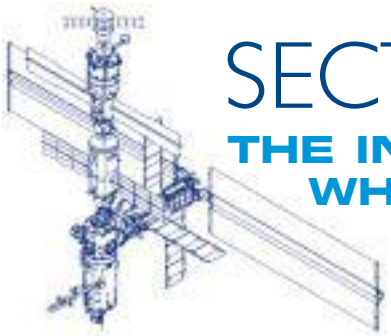
Evaluation: Students will be evaluated on their team's list, with descriptions and how they handle the listed factors (and illustrations, if requested by educator).

STELLAR WEBSITE

Exploring Space History and Future Space Exploration through Space Art

Students can explore the visions of the past and see into the future through the eyes of space artists by visiting The Gallery at the International Association of Astronomical Artists (IAAA) website at: ***http://www.iaaa.org.***

Future bases on the Moon require construction crews.
NASA/Pat Rawlings

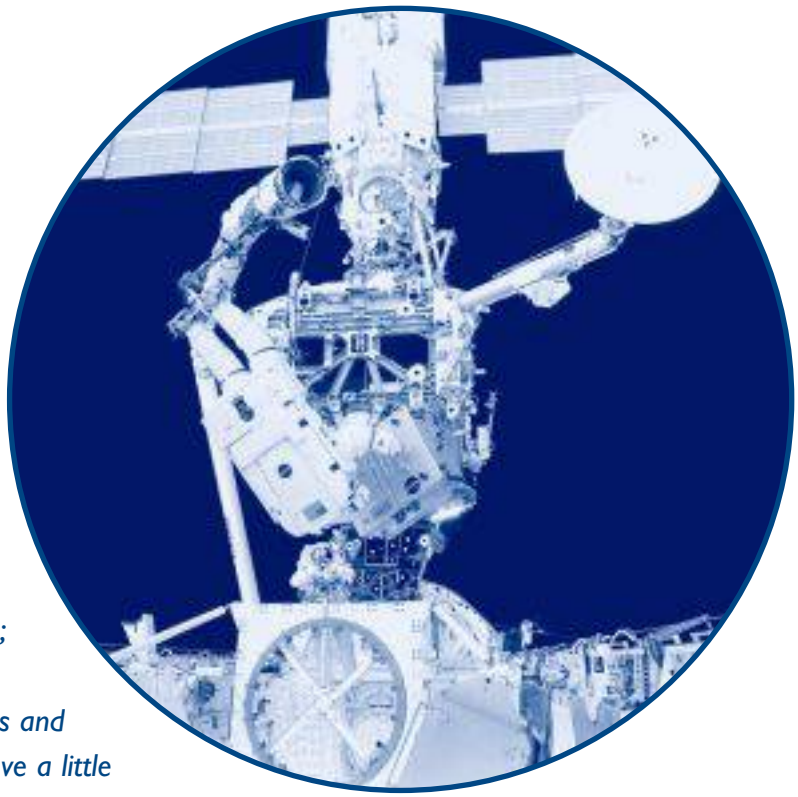


SECTION 4

THE INTERNATIONAL SPACE STATION: WHAT IS IT?

This section provides resources for understanding the ISS modules and its systems and their functions. When students experience SPACE STATION, *they will learn what is involved in constructing a space station, moving in and unpacking, and what happens during daring, exciting, and dangerous spacewalks.*

Students also learn what it is like to live and work on the ISS; how orbiting scientists conduct microgravity experiments; how important astronaut training is to the success of a spacewalk; and that astronauts and cosmonauts actually do get a chance to have a little microgravitational fun.



Mission Specialist Leroy Chiao of STS-92 lifts a toolbox out of the cargo bay of the shuttle. Chiao is lifted by Japanese Mission Specialist Koichi Wakata, who manipulates the shuttle arm from inside the shuttle. Chiao's EVA (Extravehicular Activity) partner Mission Specialist Bill McArthur is in the background taking a photo.

ACTIVITY

Touring the ISS via the Internet

Goal: To provide a virtual tour of the ISS so students can better understand the Space Station either before or after experiencing the IMAX *SPACE STATION* film.

Key Concepts: The International Space Station is an amazing engineering feat. In addition to attending to the daily housekeeping chores of living in microgravity, astronauts and cosmonauts will conduct research in the following areas: life sciences, human support technology, Earth and space sciences, engineering technology, materials science, fundamental and fluid physics, combustion science, biotechnology and space product development.

Grade Level: All levels – see appropriate level for each tour listed below.

Subjects: Suggested for all subjects as an introduction to the ISS.

Materials: Access to the websites listed on the next page.

Procedure: Students take one of the exciting tours of the ISS at the following websites either as a class or individually. Students then engage in a class discussion about living and working on the ISS. As a class or in small groups, students discuss what daily life will be like for ISS astronauts and cosmonauts, and what kinds of science research they will be conducting.

NASA's VIRTUAL TOUR OF THE ISS *(for older students)*
http://spaceflight.nasa.gov/gallery/vtour

MEET ME AT THE SPACE STATION *(for younger elementary school students)* MC, an internet robot, leads a tour of the ISS at:
http://spaceflight.nasa.gov/gallery/video/station/mmats/index.html.

ISS – THE VRML TOUR
If your computer has a browser with a Virtual Reality Markup Language (VRML) plug-in, you will be able to explore the Virtual Reality-based models at this website:
http://spaceflight.nasa.gov/gallery/vrml/station.

LIVE ESCORTED VIRTUAL TOURS OF THE ISS from NASA Johnson Space Center (JSC) are offered several times a year. A tour guide walks students through the JSC mockup and training facility. Questions can be asked of the tour guide via the Internet during the tour. For the next event, visit this website:
http://quest.arc.nasa.gov/ltc/sto/tours.

THE SPACE STATION GALLERY
Check out the ISS photo gallery at:
http://spaceflight.nasa.gov/gallery/images/station.

THE ISS: A HOME IN MICROGRAVITY
This great NASA website keeps you posted on the latest ISS news, plus webcasts, forums and chats with the ISS scientists and engineers. Check out:
http://quest.arc.nasa.gov/projects/space/iss2001/index.html.

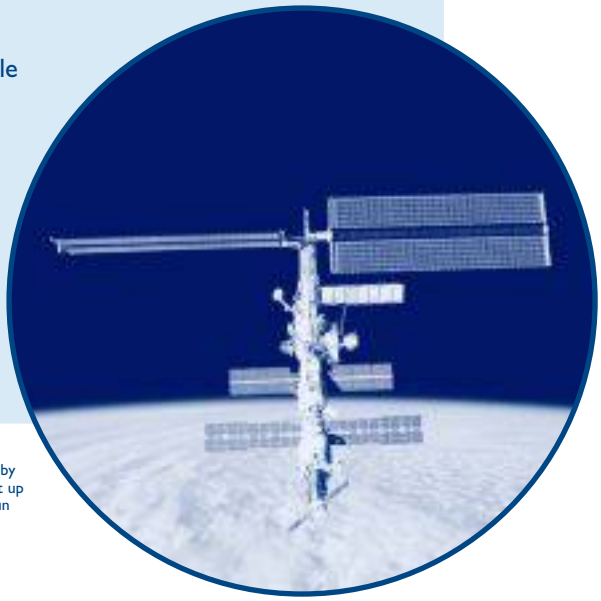
Evaluation: Students are evaluated on their participation in class discussion after taking a virtual tour of the ISS.

STELLAR ACTIVITY

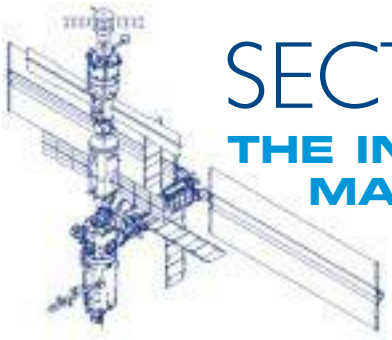
See the Space Station as it Passes Over your City

Most students can catch a view of the ISS when it passes over their home or school. The space shuttle can also be spotted when it is on a mission – either on its own as it flies to the ISS, or after a mission is complete, when the shuttle heads for home. A great way to see the ISS is when the shuttle is docked to it. When coupled, the shuttle and station become a larger and brighter "star" crossing the heavens.

Dates and times for cities all over the world are available on the Internet under "Sighting Opportunities" at:
http://spaceflight.nasa.gov/realdata/sightings.



The ISS solar arrays built by Lockheed Martin can light up the night sky when the sun reflects on them.



SECTION 5

THE INTERNATIONAL SPACE STATION MATH TRAIL

Your students could be among the first to create the new International Space Station Math Trail. The National Math Trail project is establishing a new "trailhead" on their website for students using the IMAX SPACE STATION *Educator's Guide.*

The ISS Math Trail is based on the National Math Trail project, which provides the opportunity for K to 12 educators and students to discover and share the math that exists in their own neighborhood. Students explore their communities and create one or more math problems that relate to what they find. Educators submit their math problems and their students' solutions to the National Math Trail website (see below), along with photos, drawings, sound recordings, videos – whatever can be adapted to the Internet.

Russian Expedition One Flight Engineer Sergei Krikalev and Soyuz Commander Yuri Gidzenko demonstrate how they "swim" in microgravity. Russia is one of the 16 countries to participate in the building of the International Space Station.

ACTIVITY

Mapping Out the ISS Math Trail

Goal: Students will be able to create mathematics problems and solutions related to the ISS.

Key Concepts: The use and importance of mathematics is everywhere, not only in our daily lives, but also in the daily lives of astronauts and cosmonauts on the Space Station.

Grade Level: 3 to 9.

Materials: Photos and/or videos of the modules and systems of the ISS. The ISS Gallery provides photos at: ***http://spaceflight.nasa.gov/gallery/images/station.***

Other visuals are listed in the Resources Section. The *SPACE STATION* poster can also be used, if available.

Procedure: Since we have not been able to arrange flights for students to the ISS as yet, the ISS Math Trail uses photographs and illustrations of the Station. A good resource for general use by students is the Station section of ***http://spacelink.nasa.gov***. From the website listed below, provide students with photo images of the Station. Some of the better photos can be printed to use. The ISS websites, listed in the activity in Section 4, are also a great resource. One of the best websites for photos is The Space Station Gallery at: ***http://spaceflight.nasa.gov/gallery/images/station***.

Another great educator resource of printed materials, photos and graphics, as well as videos, is the NASA Regional Educator Resource Centers at ***http://spacelink.nasa.gov/ercn.*** Ask students to think of mathematics problems related to what they see:

- the launch pad at NASA Kennedy Space Center and the Space Shuttle.
- Russia's Baikonur Cosmodrome launch site and their Soyuz and Progress spacecraft.
- the ISS modules and other parts, like the robotic arm, solar panels, truss structures, etc.
- inside the various modules of the ISS.
- looking at the Earth from the ISS.

Younger students might come up with problems involving measurement and finding geometric shapes. With a little research, older students could create and solve problems related to:

- the motion of the ISS around the Earth.
- the technology used to create an environment that will support life outside the Earth's atmosphere.
- the properties of the geometric shapes they see. *(Example: How would you determine the approximate volume of the space shuttle?)*
- ratios. *(Example: How could you find the height of the structure without measuring it directly?)*

Students should visit the National Math Trail website and select the "How-to" section. Take a hike on one of the many math trails created by students to discover ideas for the kinds of mathematics problems that could be adapted to the ISS.

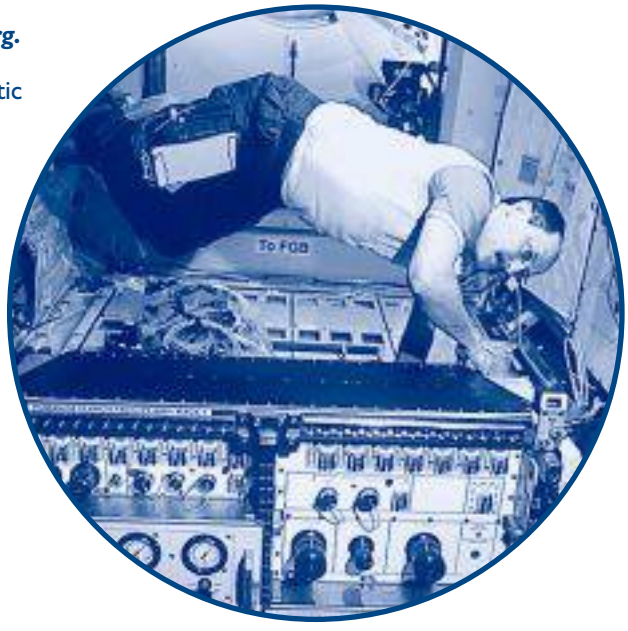
Be sure to submit your students' ISS math trails to the Math Trail site. Students should check back often to see the ISS math trails that other students have submitted.

Visit the National Math Trail website at: ***http://www.nationalmathtrail.org.***

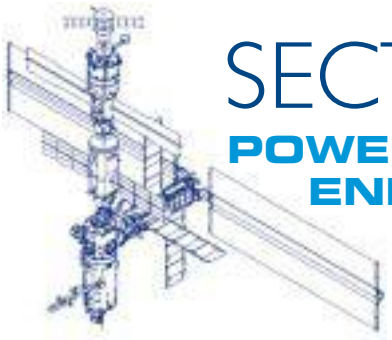
Evaluation: Students are evaluated on their ability to create mathematic problems and solutions related to the ISS. If possible, students from each team design a web page to submit to the National Math Trail website. Innovative and unusual math problems deserve extra credit.

The National Math Trail is produced by the Foundation for Advancements in Science & Education (FASE Productions) and web hosted by The Futures Channel (email: racquel@fasenet.org). If you do not have access to the Internet, their phone number is (323) 937-9911.

The description of the National Math Trail above is used with the permission of FASE Productions and The Futures Channel.



Expedition Two Commander Yury Usachev moves the Human Research Facility rack into the Node en route to the Lab. The rack was built by Lockheed Martin Corporation.

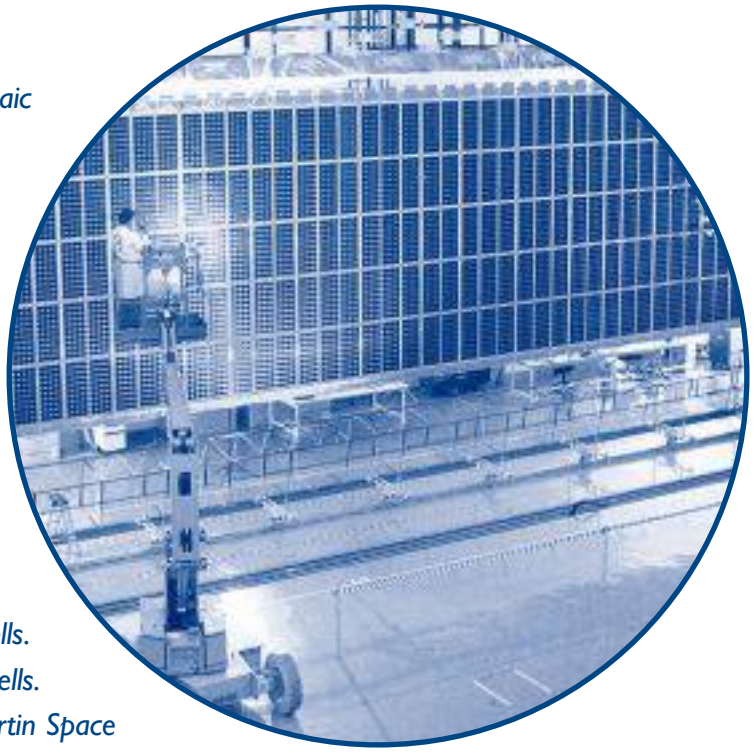


SECTION 6

POWER TO THE PEOPLE ON THE ISS: ENERGY FROM SOLAR ARRAYS

The ISS's solar arrays – also called photovoltaic modules – are dedicated to generating and storing power. This electrical power system distributes power for all the ISS functions: command and control, communications, lighting and life support.

When the ISS is completed, it will have eight solar array "wings." Each of the eight wings has a mast assembly and two solar array "blankets." Each blanket has 84 panels, of which 82 are populated with solar cells. Each panel contains 200 solar cells. So, the ISS sports a total of 262,400 solar cells. The solar arrays were built by Lockheed Martin Space Systems. They will provide power to the ISS for 15 years.



The ISS solar array under construction at Lockheed Martin Space Systems, Sunnyvale, California.

ACTIVITY

Building a Better Battery

Goal: To understand how batteries function and to creatively think about how they might be improved.

Key Concepts: There are a number of breakthrough technologies needed in the near future to further space exploration and to improve life on Earth. One of these breakthroughs will need to be more efficient batteries that store energy for longer periods of time.

Grade Level: 5 to 9.

Subjects: Engineering, technology.

Materials: Access to the website article listed under "Procedure."

Procedure: Students research the technology of various types of batteries in books and on the Internet (if possible), then try to come up with new ideas for designing a battery that is more efficient. Hold a class discussion, if time permits.

To learn more about power and batteries on the ISS, read the article at this SCIENCE@NASA website: ***http://science.nasa.gov/headlines/y2001/ast13nov_1.htm.***

Evaluation: Students will be evaluated on their comments in class discussion and by demonstrating an understanding of how batteries function, and on any new ideas they might have for improving this technology.

STELLAR ACTIVITIES

Making a Solar Panel

Students could ask a solar cell supply company for contributions, or purchase supplies from Edmund Scientific (see "Science Stores" at the end of the Resources Section) or another science supply store, and build a small solar panel that could provide at least some of the power for their classroom.

The ISS: Mathematics Problem

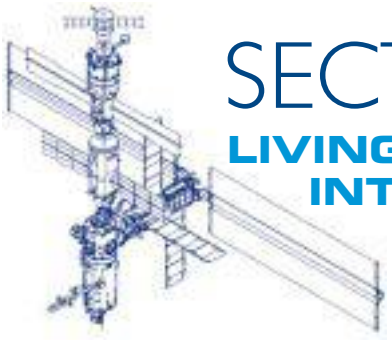
(for middle and upper elementary school level)

As preparation for making a solar panel, students estimate the power needed to light their classroom. Then they determine the number of solar cells needed for their panels by researching on the Internet, or calling a science supply store. They can also estimate how much power the entire school would require, then check with the school financial office to find out how much their power bill shows they use a month, and how close their estimates came.

The ISS: Mathematics Problem

(for lower elementary level)

Students research the amount of power the ISS solar arrays generate when they are all installed, then calculate how many 100-watt light bulbs might be powered by the arrays.



SECTION 7

LIVING AND WORKING ON THE INTERNATIONAL SPACE STATION

What is it like to work, eat, sleep, bathe and breathe when you are floating in microgravity? Students will find out when they experience IMAX SPACE STATION.

One very important system on the ISS is the Trace Contaminant Control System, built by Lockheed Martin. It processes and filters the air to ensure that more than 200 various trace chemical contaminants remain within allowable concentration levels. Contaminants on board the ISS are generated from material off-gassing – similar to that "new car" smell – and metabolic functions inside the ISS.

STS-104 Mission Specialist James Reilly on exercise bicycle, performs a pre-breathe exercise prior to suiting up for a space walk. His space walk partner Mike Gernhardt works on a checklist.

ACTIVITY

What Chemicals and Contaminants are in your Water?

Goal: To learn what chemical elements (besides hydrogen and oxygen) are present in tap water at their school or home, and to determine its quality.

Key Concepts: Water contains many other elements besides hydrogen and oxygen. Water quality is important not only on Earth, but also on the ISS.

Grade Level: 5 to 9.

Subjects: Chemistry, biology, Earth sciences/geology, technology.

Materials: Sterile container for water sample, address of laboratory for water analysis.

Procedure: Students can obtain an analysis of the water at their school or home. Water samples can be sent to a local laboratory, for a small cost, that will return a detailed analysis of chemicals and contaminants in the sample. Students identify each of the chemical elements and possible contaminants.

Evaluation: Students will be evaluated on their ability to identify each of the chemicals and possibly contaminants in the water sample.

STELLAR FACTS

The Language of the Space Station

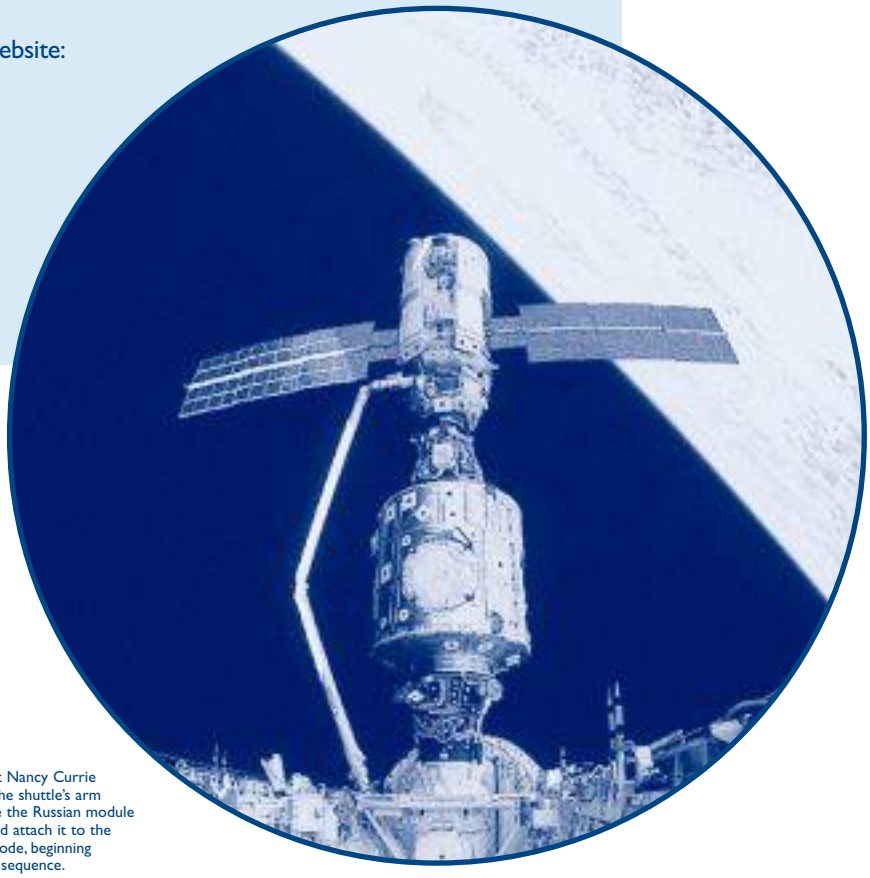
NASA is famous for using acronyms to describe everything. When the ISS astronauts and cosmonauts communicate with Mission Control, it can sound like they are speaking a foreign language. As in any profession, acronyms are helpful in speeding up communications – and in an emergency those seconds saved could be the difference between life and death.

Add a few Space Words to your Vocabulary

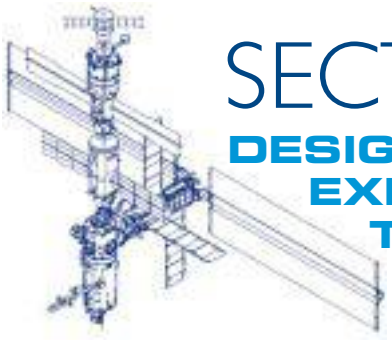
Here are a few words and acronyms that can be added to spelling and vocabulary test lists:
NASA – National Aeronautics and Space Administration.
Microgravity – is an environment created by free fall in which gravity's effects are greatly reduced.
g (gravity) – the acceleration Earth's gravitational field exerts on objects at Earth's surface (approximately 9.8 meters per second squared). Earth is "one g".

Another aspect of language on the ISS is the names of the various international modules, for example:
Zarya – the name of the control module means "sunrise" in Russian.
Zvezda – the name of the service module means "star" in Russian.
Kibo – the name of the Japanese Experiment Module means "hope" in Japanese.

For a lengthy list of NASA acronyms, visit this website:
http://spaceflight.nasa.gov/station/reference/acronyms/index.html.
Then click on "Browse Full Acronym List."



Mission Specialist Nancy Currie of STS-88 used the shuttle's arm (RMS) to capture the Russian module Zarya (above) and attach it to the US-built Unity Node, beginning the ISS assembly sequence.



SECTION 8

DESIGN AN ISS-RELATED SCIENCE EXPERIMENT – AND ENTER A CONTEST TO HAVE IT FLOWN IN SPACE!

Research on the ISS in science, engineering and technology involve the following areas of study. Choose a topic for an experiment or research project, then enter your experiment in one of the competitions that follow.

LIFE SCIENCES
Including biology, chemistry and biomedical research the effects of gravity and microgravity on humans, animals, plants, organs, tissues, cells and molecules, and protein crystal growth.

HUMAN SUPPORT TECHNOLOGY
Including advanced life support, space human factors, engineering and advanced environmental monitoring and control.

EARTH SCIENCES
Including remote sensing of atmospheric conditions, regional and global climate, geologic activity, land use, land cover, and ocean and fresh water measurements.

ENGINEERING RESEARCH AND TECHNOLOGY
Including research on new technologies such as communication via laser beams and telescopes, and flywheel energy storage that could some day replace batteries on the ISS.

MICROGRAVITY RESEARCH
Including biotechnology, combustion science, fundamental physics, fluid physics and materials science.

SPACE SCIENCE
Scientific instruments on the ISS in the future will study the Sun, cosmic rays and other exotic particles.

SPACE PRODUCT DEVELOPMENT
Products made in space, and products developed through space research.

ACTIVITY

Enter a Contest to have your Experiment Flown in Space!

Goal: To design a space science experiment that meets the requirements of one of the contests listed on the following page.

Key Concepts: Microgravity research in the scientific areas listed above that is (or will be) conducted on the ISS.

Grade Level: 5 to 9.

Subjects: Chemistry, biology, Earth sciences/geology, geography, physical science/physics, technology, engineering.

Materials: Access to the websites on the next page.

Procedure: NASA, aerospace companies, space organizations and universities are reaching out to students and offering them the chance to become real scientists. Working in teams of three or more, students review the requirements of the competitions listed on the following page. The list above provides some suggested topics for experiments directly related to ISS research. They then design their own microgravity experiment according to the guidelines of one of the competitions listed below. Each of the following programs provides a wealth of resources on their website.

NASA's Shuttle Small Payloads Project (SSPP)

Managed by the Goddard Space Flight Center and its Wallops Flight Facility, SSPP provides international K to 12 and university students (as well as others) space for flying their experiments in a number of carriers that ride in the space shuttle's cargo bay. They are called The Hitchhiker, Complex Autonomous Payload, Get Away Specials (GAS) and Space Experiment Module (SEM).

One of the Space Experiment Module experiments flown recently teamed elementary school students with retirement community residents to examine how microgravity affects the growth of soy seeds. For more information, check out their website at: ***http://sspp.gsfc.nasa.gov/carrier.***

S.T.A.R.S – An International Student Space Experiment Program

The S.T.A.R.S Program – Space Technology And Research Students – has launched a number of student experiments on the space shuttle, as well as to the ISS aboard a Russian rocket. Students in grades 3 to 12 from schools around the world have participated. S.T.A.R.S is sponsored by Space Media, Inc., a subsidiary of the aerospace company SPACEHAB. The S.T.A.R.S Academy website also has other programs and activities for grades 3 to 12. ***http://www.starsprogram.com.***

These two students and their teacher participated in an International Student Space Experiment Program called the S.T.A.R.S. Program - Space Technology and Research Students. Sponsored by SPACEHAB, their butterfly experiment was flown on the Space Shuttle. S.T.A.R.S. experiments are also flown on the ISS. ***Space Media, Inc./SPACEHAB***

NASA Student Involvement Program (NSIP)

One of the six NSIP competitions is the Space Flight Opportunities Competition – for teams of two to four in grades 9 to 12. Although the ISS is not yet soliciting student experiments, teams of students can design an experiment and enter it in a competition to be flown on a sounding rocket or the space shuttle.

Educators of younger students could make contact with a high-school team to follow the development of their experiment, and design a similar experiment. For details and resources on this competition and the other five, for all grade levels, visit their website at: ***http://www.nsip.net.***

STARSHINE – Student Tracked Atmospheric Research Satellite for Heuristic International Networking Experiment

STARSHINE is an education program for students around the world who help construct a satellite and learn about satellite orbits and natural events that affect these orbits. The satellites are covered by nearly 1000 small aluminum mirrors that are polished by tens of thousands of students worldwide. Sunlight flashing from its mirrors is naked-eye visible against a star background. STARSHINE is an SSPP "Hitchhiker" payload aboard the space shuttle (see SSPP above). For the details on participating, see their website at: ***http://www.azinet.com/starshine.***

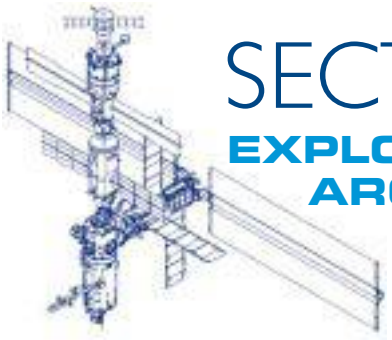
In addition to the extensive lists provided by each of the competitions here, see the "Resources Section."

Evaluation:

Students are evaluated as individuals and teams on their ability to meet the requirements of the competition they enter.

Note to Students outside the U.S.

Some of the U.S. competitions are only open to U.S. students. Contact a U.S. educator through ***http://www.epals.com*** to ask about either teaming with their students on an experiment, or possibly being a site for conducting "ground truth" experiments related to their mircrogravity experiment (see "Resources Section" for contact information for international space agencies).



SECTION 9

EXPLORING WITH OTHER STUDENTS AROUND THE WORLD

Learn about your country's ISS contributions as well as components that other countries have built. There are 16 international partners working together to create the ISS – the United States, Russia, Canada, Japan, Brazil, and the European Space Agency, which represents the 11 countries – United Kingdom, Italy, France, Germany, Belgium, Denmark, Netherlands, Norway, Spain, Sweden and Switzerland.

Mission Specialist Koichi Wakata on board space shuttle flight STS-92. Wakata represents the National Space Development Agency of Japan, or NASDA. During STS-72 in 1996, he became the first NASDA astronaut to fly as a mission specialist aboard the space shuttle.

ACTIVITY

Learning about the Space Station Components

Goal: To increase knowledge of the ISS modules, solar panels, robotic arm and other equipment, and understand how they function; to communicate with students in other countries around the world.

Key Concepts: The ISS is a complex system containing modules and components that function to support human life and microgravity research. Communication can be established with other students studying the ISS around the world.

Grade Level: 3 to 9.

Subjects: Engineering, technology, social studies, language arts, foreign language.

Materials: An illustration showing all the components of the ISS, which can be found at: ***http://spacelink.nasa.gov/instructional.materials/nasa.education.products/international.space.agency.assembly/index.html.***

Procedure: 1) Student teams of two or three choose an ISS module, other components like Canada's Mobile Space Servicing System, or a scientific instrument contributed by their country or another ISS country.

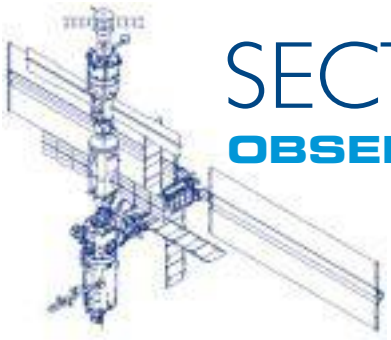
2) They research details, then write a description and select illustrations from this guide or websites listed in the Resources Section. Students could also create a web page or a poster on the project topic. For example, students might choose one of the modules and would describe all equipment inside and outside, and explain what tasks or experiments will be conducted there. ***For example***, a favorite with students is likely to be Canada's dual-armed robot called the Special Purpose Dexterous Manipulator. This amazing robot will work in conjunction with Canadarm2, the Space Station Remote Manipulator System that Canada built, launched in 2001. Students describe their robot's capabilities and list the tasks that the arms are responsible for in constructing the ISS.

3) Your students can communicate and even work jointly on ISS projects with students across the country and around the world. Students can email or send by mail their research, web page or poster to students in another country and ask them by email or letter about the ISS projects they are working on.

Evaluation: Students will be evaluated on their written descriptions of an ISS component and its functions.

For Foreign Language Students:

Students studying foreign languages can help translate emails to students in other countries when necessary.



SECTION 10

OBSERVING EARTH FROM SPACE

In addition to filming the IMAX film SPACE STATION, *astronauts snapped hundreds of high-quality still photographs.*

STS-98 Mission Specialists Tom Jones (upper left) and Bob Curbeam (lower right) wave at the Expedition One crew through the window of the newly arrived U.S. "Destiny" Lab. The lab was brought to the ISS in the cargo bay of the shuttle Atlantis by the STS-98/5A crew. The bottom of the shuttle cargo bay is visible behind Jones and Curbeam.

ACTIVITY

Geography from Space: Locating the Space Station International Partners

Goal: To demonstrate knowledge of geography in locating all the ISS partner countries; and to identify geological features in images of Earth from space.

Key Concepts: Many countries are contributing to the development and success of the Space Station. The ISS has cameras and sensors that are providing valuable information about Earth.

Geological features can be identified in the ISS images taken of Earth.

Grade Level: 3 to 9.

Subjects: Earth sciences/geology, geography.

Materials: World map, Internet access. An excellent resource for image exploration is the Exploring Earth from Space image set available at: ***http://spacelink.nasa.gov/instructionalmaterials/NASAeducationalproducts/exploringearthfromspace/.index.html.*** The set includes instructional materials and 13 pictures of Earth taken from aboard the Shuttle as part of the NASA EarthKAM program. This resource will enhance studies of science, mathematics, technology and geography. An entire listing of image archives is available at: ***http://spacelink.nasa.gov/instructionalmaterials/curriculumsupport/earthscience/earthimagesfromspace.***

Procedure: 1) Using a world map as an aid, students identify where each of the nations participating in the ISS are located:

United States	Russia	Canada	Japan
Belgium	Denmark	France	Germany
Italy	The Netherlands	Norway	Spain
Sweden	Switzerland	United Kingdom	Brazil

2) Either as a classroom activity, or students teaming with a partner using a computer, explore images taken of Earth from the ISS and the Space Shuttle. As they study the images, students should try to identify at least three geological features in each image. Many images that students were actually involved with acquiring from the Space Shuttle are available on the NASA EarthKAM website at: ***http://earthkam.ucsd.edu***

Evaluation: Students are evaluated on their ability to locate the 16 ISS partner countries and identify geological features in Earth remote sensing images.

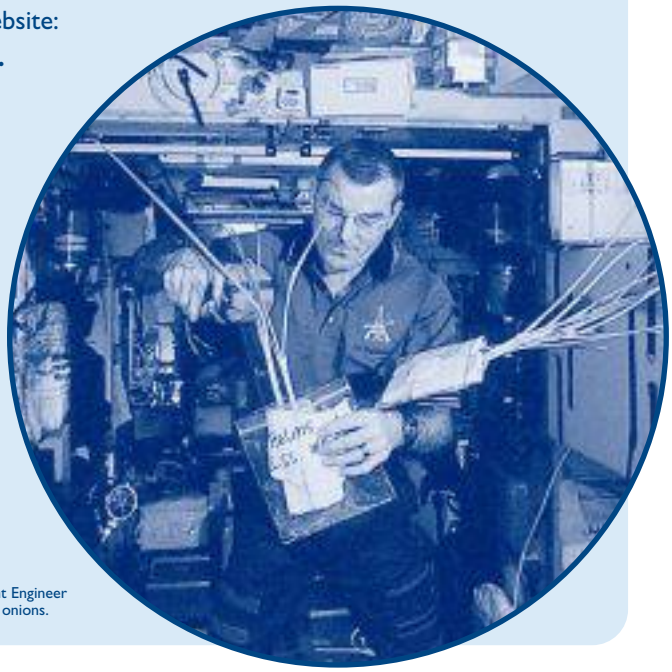
STELLAR ACTIVITIES

Geology and Meteorology from Space

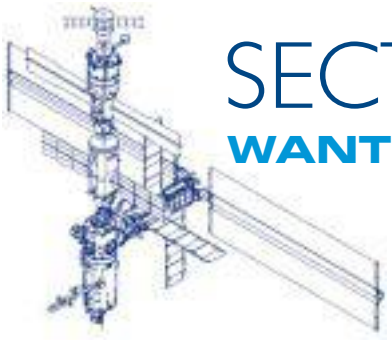
Students pick an environmental condition to research using images taken from the ISS or the Space Shuttle. Topics could include evidence of deforestation, global warming, ozone depletion, water pollution/oil spills, or weather phenomena such as hurricanes. Check the EarthKAM website at: ***http://earthkam.ucsd.edu.***

Enter a Competition for Earth Sciences Research: Watching Earth Change

A competition of the NASA Student Involvement Program for grades 5 to 12. For details, check their website: ***http://www.nsip.net/competitions/watching.***



Expedition Two Flight Engineer James Voss watering onions.



SECTION 11

WANTED: INNOVATIVE ROCKET SCIENTISTS

Another major exploration "speed bump" is cheaper access to space. We need rockets that can carry payloads and people into space for far less than the many millions of dollars per rocket that it currently costs. Maybe one of your students will be inspired to become a rocket scientist and help design future rockets that will allow space tourism to become a reality.

Expedition Two Flight Engineers Susan Helms and James Voss use the space station's robot arm, Canadarm2, to lift the Quest Airlock from the orbiter's payload bay to be installed on the station's Unity Node.

The Airlock provides station-based Extravehicular Activity, or space walking, capability for both U.S. and Russian spacesuits.

ACTIVITY

Become a Rocket Scientist

Goal: To understand the design and dynamics of model rockets.

Key Concepts: Model rockets simulate many aspects of full-scale rocket design and provide a hands-on opportunity for students to understand the dynamics of rocket flight.

Grade Level: 4 to 9.

Subjects: Mathematics, physics, technology, engineering.

Materials: The Rocket Guide is a good resource for educators and contains many activities for students. It is available at: ***http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Rockets.***

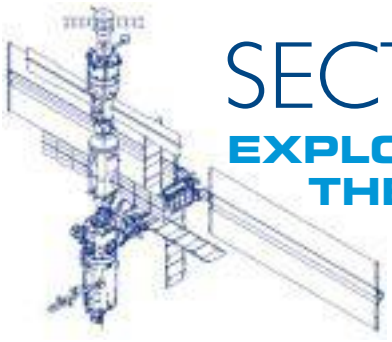
Procedure: Students build model rockets and test different rocket designs for height and speed. This can be an after-school or weekend activity sponsored by the local Young Astronauts Club, and/or involve a regional adult large-scale model rocket club, or a nearby NASA Field Center model rocket. Two- and three-stage model rockets are also available, as well as a rocket that carries a small camera. Students will also learn about safety in launching model rockets.

Evaluation: Students are evaluated on their ability to follow directions in building a model rocket that is capable of being launched.

STELLAR ACTIVITY

The Eggs Prize Contest

This popular contest is sponsored by The X-Prize Foundation. The Eggs Prize is one of their educational projects and involves students in preparing a raw egg for a launch on a water rocket that will return to Earth without breaking the egg. Visit their website for details and to learn how the X-Prize is trying to help bring you closer to a rocket ride into orbit. ***http://www.xprize.org***



SECTION 12

EXPLORING CAREERS IN SPACE: WHY DO THESE PEOPLE LOVE THEIR JOBS?

It has taken more than 100,000 people, working over many years at almost every job imaginable, to place the ISS in orbit. Learn why these people love their work.

ACTIVITY

Interviewing a Space Scientist, Engineer or Artist

Goal: To understand how many different kinds of professions have been involved in creating the ISS and to learn about the many choices available in space exploration-related careers.

Key Concepts: Biographies, journals and interviews show what daily life is like in various space-related careers and convey the scientist's or engineer's perspective and attitude about their work.

Grade Level: 5 to 9.

Subjects: All subject and career studies.

Materials: Access to the Internet.

Procedure: 1) Students choose an ISS or space-related career that interests them, and then locate and read related biographies and journals at the Men and Women of NASA website at: ***http://questdb.arc.nasa.gov/bio_search.htm*** or, for space artists, at the International Association of Astronomical Artists (IAAA) website at: ***http://www.iaaa.org.***

2) Students generate four or five questions related to the career of the person they have read about and, if possible, send them their questions. Alternatively, a speaker in an ISS or space-related field could be invited to the school to speak about their career, and students could formulate questions in advance.

Evaluation: Students are evaluated on their ability to generate four or five good questions related to the journal or biography that they are most interested in.

STELLAR ACTIVITY

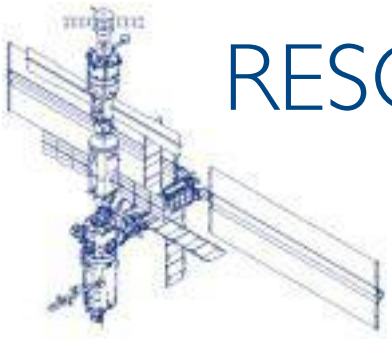
Envisioning the Future: Where do we go from Here?

How will the ISS help in the exploration of the Moon, Mars and other planets, comets and asteroids? What is the next big step – could you and your friends become space tourists of the future?

Creating a Mural of a Future Space Mission

Students explore the current plans for how the ISS may assist in future solar system exploration. In teams of two or three, they decide on a destination to travel to, or what celestial objects they want to know more about.

Team members choose whether the mission will be robotic or human, where they would land or orbit, and what science and exploration they would want to do there. Students could also design a space hotel for Earth orbit, the Moon, Mars or an asteroid. Student teams create a large poster or mural that illustrates their mission or enterprise.



RESOURCES SECTION

Valuable information for students and educators using this guide.

WEBSITES ON THE ISS

There are numerous websites with amazing resources on subjects related to the International Space Station. Many of them are listed here. From the first three websites listed below, you can travel to most of these other sites quickly by clicking on the links. It is recommended that you visit these sites first:

IMAX® SPACE STATION WEBSITE

This is the official IMAX *SPACE STATION* website. It is a great resource for *SPACE STATION* film information, technology, educational activities, games, recent news and events. The resources found in the sections below can also be sourced through this website.
http://www.IMAX.com/spacestation

NASA OFFICE OF HUMAN SPACEFLIGHT's ISS PAGE

This site is one of the best on the ISS, with numerous links to great resources including updates on the latest news from the ISS.
http://spaceflight.nasa.gov/station

This link also provides updates for the NASA CD-ROM entitled Realizing the Dream: An International Space Station Sampler at:
http://spaceflight.nasa.gov/station/reference.

SPACE STATION INFORMATION FOR GLOBAL SCIENCE & TECHNOLOGY WEEK – A COLLECTION OF INTERNET SITES ABOUT THE ISS

This website is an excellent collection of links to nearly every aspect of the ISS. This list of links was created by NASA for Global Science and Technology Week, a White House Office of Science and Technology Policy endorsed event. Topic areas include Basic Facts, Historical Perspectives, Assembly and Station Systems, Orbital Tracking, International Partners, Crew, Living and Working in Space, and Research.
http://www.nasa.gov/newsinfo/gstw_iss.html

PROGRAMS SPECIFICALLY ON THE ISS

STAR STATION ONE

An excellent ISS program at museums for educators and the public, with ISS displays, workshops and programs.
http://www.bishopmuseum.org/starstation/index.html

INTERNATIONAL SPACE STATION CHALLENGE PROJECT

Focused specifically on the ISS, these challenges involve students in designing elements and systems for a space station.
http://voyager.cet.edu

TRAVELING ISS MUSEUM EXHIBIT INTERNATIONAL SPACE STATION – THE EARTH TOUR

http://www.air-space.com/iss.htm

OTHER VALUABLE ISS-RELATED WEBSITES

LOCKHEED MARTIN CORPORATION

Lockheed Martin Corporation is the sponsor of *SPACE STATION*. They have supported numerous space projects and events for students and educators in the past. The company's scientists and engineers often work directly with students.
http://www.lockheedmartin.com

NASA EDUCATION HOME PAGE

NASA's main education website.
http://education.nasa.gov

NASA QUEST

Great events for students, educators and parents, including live chats with astronauts and other NASA employees, plus webcasts and forums. Special features: The ISS – A Home in Microgravity, Women of NASA, aviation, mathematics-related resources, and NASA TV schedule.
http://quest.nasa.gov

NASA SPACELINK
The general NASA website for most of NASA's resources.
http://spacelink.nasa.gov

NASA EXPLORES
Lesson plans and resources on space topics.
http://www.nasaexplores.com

MEN AND WOMEN OF NASA
Learn about space careers directly from the people working at NASA.
http://quest.arc.nasa.gov/space/team/index.html

NASA CONNECT
Award-winning NASA TV series on a variety of space topics including the ISS. One of their programs is entitled "Functions and Statistics: International Space Station: Up to Us" and an educator's guide is also available.
http://connect.larc.nasa.gov

THE "WHY?" FILES
A NASA TV series covering many space topics including the ISS.
http://whyfiles.larc.nasa.gov

WATCH THE SPACE STATION BEING BUILT – LIVE!
From cameras in the "clean room" at NASA Kennedy Space Center.
http://www.ksc.nasa.gov/shuttle/countdown/video

NASA EARTHKAM
A project in which students on the ground take images by commanding a camera on board the Space Shuttle. Check their website for information on how to get involved.
http://earthkam.ucsd.edu

HAM RADIOS AND ISS
Talk to the astronauts on HAM radio. Check the website for information.
http://spaceflight.nasa.gov/station/reference/radio/index.html

NASA CORE (CENTRAL OPERATION OF RESOURCES FOR EDUCATORS)
NASA's audiovisual/video distribution center for a nominal charge.
http://core.nasa.gov

REGIONAL EDUCATOR RESOURCE CENTERS
Find the NASA resource center for educators nearest you – with videos, slides, printed resources and more.
http://spacelink.nasa.gov/ercn

NASA SPINOFF PUBLICATION
Articles on products that have successfully commercialized NASA technology. Publication is available in print and online.
http://www.sti.nasa.gov/tto/spinoff.html

THE ISS GENERAL INFORMATION

NASA's VIRTUAL TOUR OF THE ISS
(for older students)
http://spaceflight.nasa.gov/gallery/vtour

MEET ME AT THE SPACE STATION
(for younger elementary school students) MC, the robot, leads a tour of the ISS.
http://spaceflight.nasa.gov/gallery/video/station/mmats/index.html

ISS – THE VRML TOUR
If your computer has a browser with a Virtual Reality Markup Language (VRML) plug-in, you will be able to explore the Virtual Reality-based models at this website.
http://spaceflight.nasa.gov/gallery/vrml/station

LIVE ESCORTED VIRTUAL TOURS OF THE ISS
Tours from NASA Johnson Space Center (JSC) are offered several times a year. A tour guide walks students through the JSC mockup and training facility. Questions can be asked of the tour guide via the Internet during the tour. For the next event, visit the website.
http://quest.arc.nasa.gov/ltc/sto/tours

THE SPACE STATION GALLERY
Check out the ISS photo gallery.
http://spaceflight.nasa.gov/gallery/images/station

THE ISS: A HOME IN MICROGRAVITY
This great NASA website keeps you posted on the latest ISS news, plus webcasts, forums and chats with the ISS scientists and engineers.
http://quest.arc.nasa.gov/projects/space/iss2001/index.html

SEEING THE SPACE STATION AS IT PASSES OVER YOUR CITY
Students can catch a view of the ISS when it passes over their home or school. The space shuttle can also be spotted when it is on a mission – either on its own as it flies to the ISS, or after the mission is complete, when the shuttle heads back for home. A great way to see the space station is when the shuttle is docked to the ISS. When coupled, the shuttle and station become a larger and brighter "star" crossing the heavens.

Dates and times for cities all over the world are available on the Internet.
http://spaceflight.nasa.gov/realdata/sightings

NASA OFFICE OF HUMAN SPACEFLIGHT THE ISS REFERENCE PAGE
http://spaceflight.nasa.gov/station/reference

SPACE SCIENCE EXPERIMENTS ON THE ISS
This page contains links to information about various experiments conducted on the ISS.
http://spaceflight.nasa.gov/station/science/experiments/index.html

WHERE IS THE SPACE STATION NOW?
http://liftoff.msfc.nasa.gov/temp/StationLoc.html

CLICKABLE SPACE STATION MAP
http://www.space.com/news/spacestation/stationmap.html

"CITY IN SPACE" – CNN.COM
Features a 360-degree tour of the ISS.
http://www.cnn.com/SPECIALS/space/station

MSNBC.COM – THE ISS 3D MODEL
http://www.msnbc.com/modules/station/iss.asp

THE ISS INTERNATIONAL PARTNERS

These are the general websites for the ISS partner countries. In most cases, their ISS material is easily found on the opening site page. Most space agencies have an educational section, and these can be found through their websites.

CANADIAN SPACE AGENCY
http://www.space.gc.ca

EUROPEAN SPACE AGENCY
http://www.esa.int/export/esaCP/index.html

DANISH SPACE RESEARCH INSTITUTE
http://www.dsri.dk/

DLR (GERMANY)
http://www.dlr.de/

CNES (FRANCE)
http://www.cnes.fr/WEB_UK/index.htm

ASI (ITALY)
http://www.asi.it/

INTA (SPAIN)
http://www.inta.es/

NORWEGIAN SPACE CENTER
http://www.spacecenter.no

SWEDISH NATIONAL SPACE BOARD
http://www.snsb.se/English.html

NASDA (JAPAN)
http://www.nasda.go.jp/index_e.html

NASDA EDUCATION
http://spaceboy.nasda.go.jp/index_e.html

ROSAVIAKOSMOS (RUSSIA)
http://www.rosaviakosmos.ru/english/eindex.htm

INPE (BRAZIL)
http://www.inpe.br/programas/iss/ingles/default.htm

SPACE ORGANIZATIONS INVOLVED IN SPACE EDUCATION

CHALLENGER CENTER FOR SPACE SCIENCE EDUCATION
Challenger Centers across North America provide simulated space missions. Students role play officials in the Mission Control room. They communicate with other students who are working on a simulated space station. The Challenger Center also provides related curricula and educator workshops. Check their website for the Challenger Center nearest you.
http://www.challenger.org

NATIONAL SPACE SOCIETY
Publishes AD ASTRA magazine and hosts an annual space conference. The organization has many members from the education community.
http://www.nss.org

SPACE FOUNDATION
Provides excellent educator workshops and in-services plus space education resources and an annual conference.
http://www.spacefoundation.org

AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS
Space professionals organization that also provides space education programs.
http://www.aiaa.org

YOUNG ASTRONAUT COUNCIL
Information on starting a Young Astronauts Club.
http://www.yac.org

FUTURE ASTRONAUTS OF AMERICA
Activities for students and adults.
http://www.faahomepage.org/main.html

SPACE CAMP
Space Camps are located at the U.S. Space & Rocket Center in Alabama, and near Kennedy Space Center in Florida, and at NASA Ames Research Center in California.
http://www.spacecamp.com

EXPLORING SPACE HISTORY AND FUTURE SPACE EXPLORATION THROUGH SPACE ART
Students can explore the visions of the past and see into the future through the eyes of space artists by visiting The Gallery at the International Astronomical Artists Association's (IAAA) website.
http://www.iaaa.org

ESTES MODEL ROCKETS
Online or printed catalog of model rocket kits.
http://www.estesrockets.com

THE EGGS PRIZE CONTEST AND THE X-PRIZE FOUNDATION
The popular Eggs Prize Contest is sponsored by The X-Prize Foundation and involves students in preparing a raw egg for launch on a water rocket that will return it to Earth without breaking.
http://www.xprize.org

SPACE-RELATED COMPETITIONS

THE NASA STUDENT INVOLVEMENT PROGRAM
Students can enter NASA's AERONAUTICS AND SPACE JOURNALISM competition by creating a five-minute video in one of the following formats: newscast, investigative or special report, or documentary. News articles can also be submitted. WATCHING EARTH CHANGE is another competition related to Earth sciences. For more information, visit the website.
http://www.nsip.net

NASA's SHUTTLE SMALL PAYLOADS PROJECT (SSPP)
SSPP designs, develops, tests, integrates and flies a group of small payload carrier systems for the Space Shuttle. These carriers – the Hitchhiker, Get Away Specials (GAS), and Space Experiment Module (SEM) – support payloads supplied by high schools, universities, foreign governments and others.
http://sspp.gsfc.nasa.gov/carrier

S.T.A.R.S – AN INTERNATIONAL STUDENT SPACE EXPERIMENT PROGRAM
The S.T.A.R.S Program – Space Technology And Research Students – has launched a number of student experiments on the space shuttle, as well as to the ISS aboard a Russian rocket. Students in grades 3 through 12 from schools around the world have participated. S.T.A.R.S is sponsored by Space Media, Inc., a subsidiary of the aerospace company SPACEHAB. The S.T.A.R.S Academy website also has other programs and activities for grades 3 to 12.
http://www.starsprogram.com

STARSHINE – STUDENT TRACKED ATMOSPHERIC RESEARCH SATELLITE FOR HEURISTIC INTERNATIONAL NETWORKING EXPERIMENT
STARSHINE is an SSPP "Hitchhiker" payload aboard the space shuttle. For the details on participating, see their website.
http://www.azinet.com/starshine

NASA FIELD CENTERS MOST INVOLVED WITH THE ISS
For a complete list of NASA Field Centers and for the NASA Regional Educator Resource Center nearest you, visit their website.
http://spacelink.nasa.gov/ercn

NASA JOHNSON SPACE CENTER
SPACE CENTER HOUSTON is the official visitor center for Johnson Space Center.
http://www.spacecenter.org

NASA KENNEDY SPACE CENTER VISITORS CENTER
Official visitor center for NASA Kennedy Space Center. Also provides information on upcoming Space Shuttle and rocket launches and how to visit a launch.
http://www.kennedyspacecenter.com

NASA MARSHALL SPACE FLIGHT CENTER AND U.S. SPACE & ROCKET CENTER
http://www.spacecamp.com/museum
Education site.
http://education.msfc.nasa.gov

NEWS ABOUT THE ISS AND SPACE
NASA TV
Available through satellite television, on some cable TV providers, and on the Internet.
http://www.nasa.gov/ntv

SPACE.COM
Breaking news, features and resources on space and astronomy.
http://space.com

SPACE NEWS
http://spacenews.com

SCIENCE@NASA
http://science.msfc.nasa.gov

FLORIDA TODAY – SPACE
http://www.flatoday.com/news/space/

CNN.COM – SPACE
http://www.cnn.com/TECH/space/

HOUSTON CHRONICLE – SPACE CHRONICLE
http://www.chron.com/content/chronicle/space/index.html

SPACE WEBSITES FOR KIDS

Also see the ISS INTERNATIONAL PARTNERS list for their education websites.

NASA KIDS
http://kids.msfc.nasa.gov/

THE SPACE PLACE
http://spaceplace.jpl.nasa.gov/spacepl.htm

YOUNG ASTRONAUT COUNCIL
http://www.yac.org

SPACEKIDS
http://www.spacekids.com

ASK AN ASTRONAUT, SCIENTIST OR ENGINEER
Students can submit questions that are appropriate for an astronaut, scientist or engineer to the Ask an Astronaut website.
http://www.ari.net/nss/askastro

YAHOOLIGANS SPACE
http://www.yahooligans.com/Science_and_Nature/The_Earth/Space/

NATIONAL MATH TRAIL WEBSITE
Section for students submitting ISS-related math trails.
http://www.nationalmathtrail.org

CANADIAN SPACE AGENCY – SPACE KIDS
http://www.space.gc.ca/kidspace/default.asp

CD-ROMS

The NASA Office of Space Flight is distributing a CD-ROM entitled REALIZING THE DREAM: AN INTERNATIONAL SPACE STATION SAMPLER, while the supply lasts. Most of the information on this CD, as well as updates, are available on their website.
http://spaceflight.nasa.gov/station/reference

NASA SPACE FLIGHT AND SCIENCE
A set of six CDs with video clips reviewing the reality and potential of NASA's space flight and science exploration program including: Shuttling to Space, Living in Space, Science in Space, Laboratory in Space, Business in Space, and the Future in Space.

A FEW ISS-RELATED BOOKS

SPACE STATION SCIENCE: LIFE IN FREE FALL
By Marianne J. Dyson
New York: Scholastic Inc., 1999
Great resource on the ISS for older elementary and middle-school students.

THE INTERNATIONAL SPACE STATION
By Franklyn M. Branley
New York: Harper Collins, 2000
For ages 5 to 9.

HOW DO YOU GO TO THE BATHROOM IN SPACE?
By William Pogue
New York: Tor, 1991
Answers to180 frequently asked questions about space. Although a few of the details are dated, the majority of the book is great for general audiences.

MAGAZINES

ODYSSEY MAGAZINE: ADVENTURES IN SCIENCE
They produced a special issue – OPEN HOUSE FOR THE SPACE STATION – that may be available in your school or local library. The January 2000 issue contains many great articles on the ISS.
http://odysseymagazine.com

AD ASTRA
Magazine sent to members of the National Space Society.
http://www.nss.org

MAGAZINES ON ENGINEERING AND TECHNOLOGY
T.I.E.S.: The Magazine of Design & Technology Education. Published on the Internet. To subscribe go to the website.
http://www.tiesmagazine.org

T.H.E. JOURNAL (TECHNOLOGICAL HORIZONS IN EDUCATION)
Free to educators, subscribe at the website, ***www.thejournal.com***, or by phone (714) 730-4011

ISS-RELATED EDUCATION CONFERENCES AND EVENTS

THE ISS EDUCATORS CONFERENCE

An annual ISS conference devoted to educators usually held in February at Space Center Houston.
http://www.spacecenter.org/iss.html

THE NASA ISS TELECONFERENCE FOR EDUCATORS

An annual teleconference broadcast on NASA TV.
http://www.spacesite.org

NATIONAL SCIENCE TEACHERS ASSOCIATION CONFERENCE

Annual national and regional conferences with many NASA booths and presentations on the ISS and space in general.
http://www.nsta.org/conventions

SPACE DAY – SPONSORED BY LOCKHEED MARTIN

Provides ideas on how to celebrate Space Day and numerous links to space education-related websites. Space Day is a yearly event that takes place in May.
http://www.spaceday.com

SCIENCE STORES

EDMUND SCIENTIFIC STORE

A great source of all science education supplies including solar cells for the Power to the People of the ISS: Energy from Solar Arrays activity. Call (800) 728-6999 or shop online. ***http://www.scientificsonline.com***

MONDO-TRONICS ROBOT STORE

From wings and robotic arms to muscle wire and sensors, this robot store has all the kits and supplies a young experimenter requires. Call (800) 374-5764, or visit the website.
http://www.RobotStore.com

Right: Mission Specialist James Reilly of STS-104 carries tools and a fabric cover as he works in space. His feet are attached to the Space Shuttle's arm. Mission Specialist Janet Kavandi inside the space shuttle moves him around by 'driving' the arm.

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