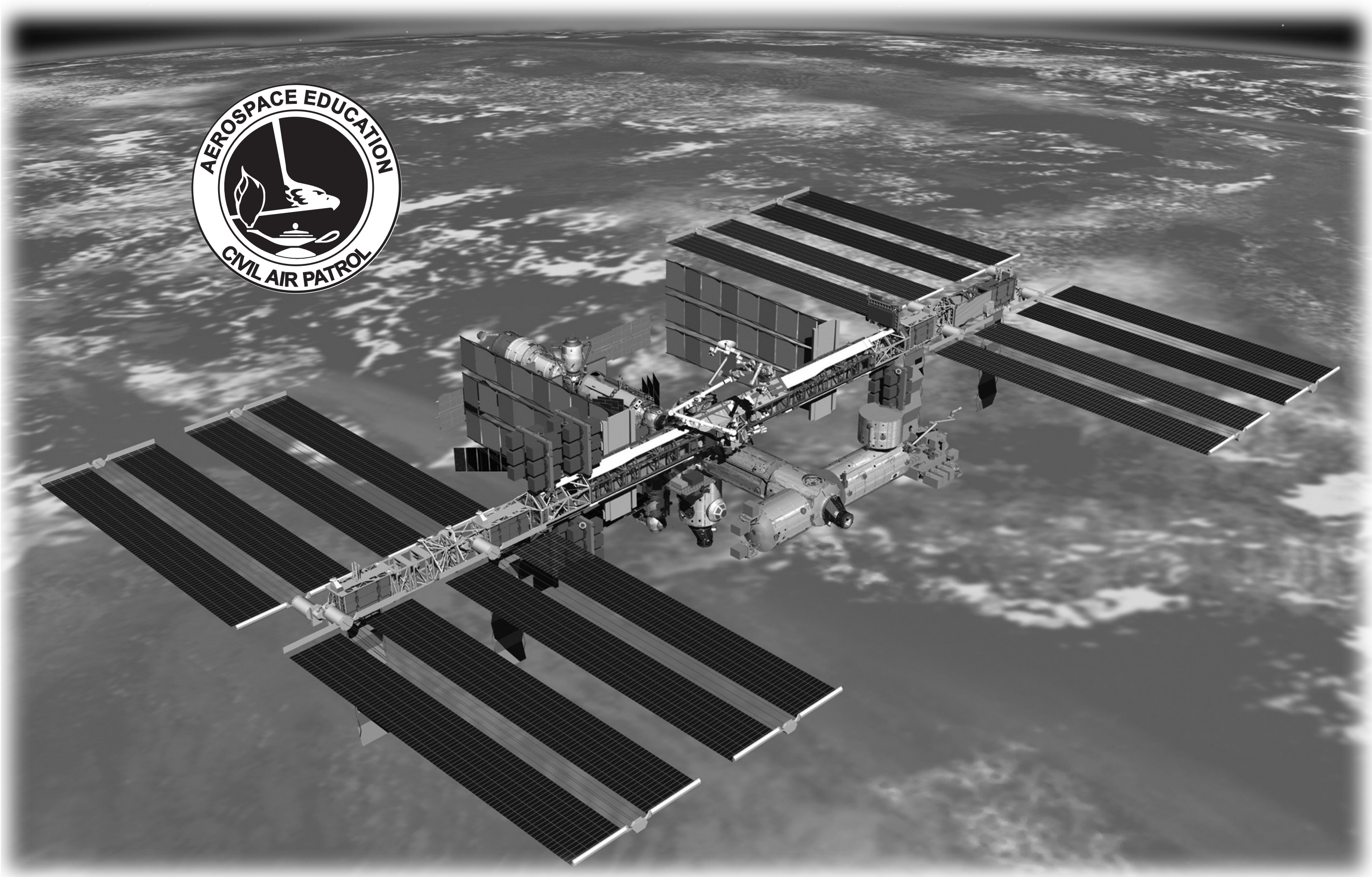
The International Space Station

Teacher Lesson Plans



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INTERNATIONAL SPACE STATION

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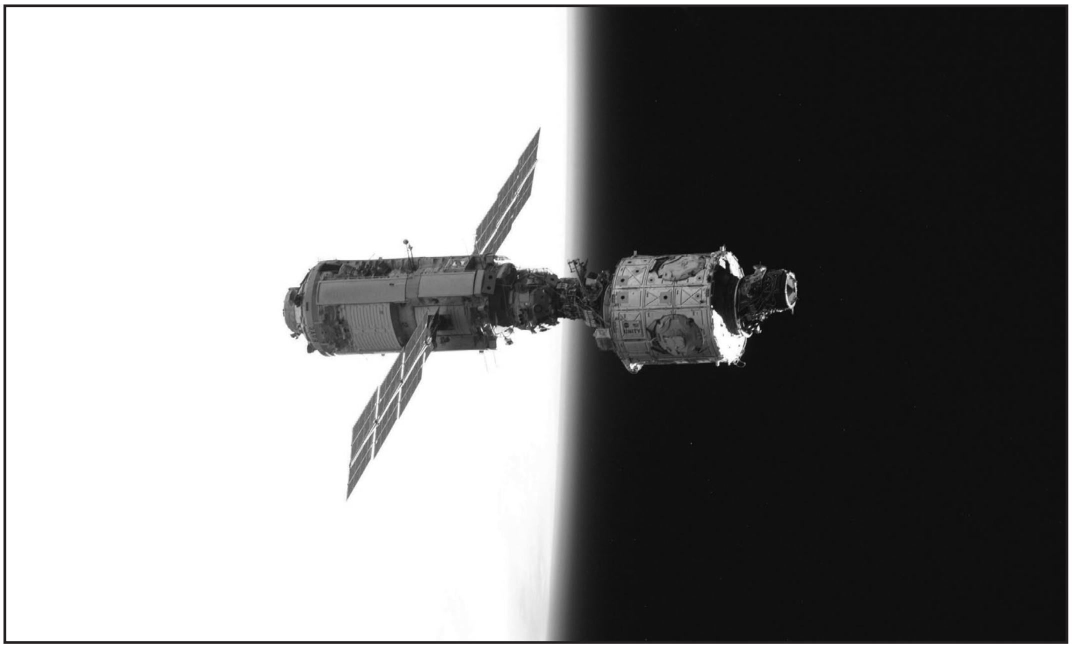
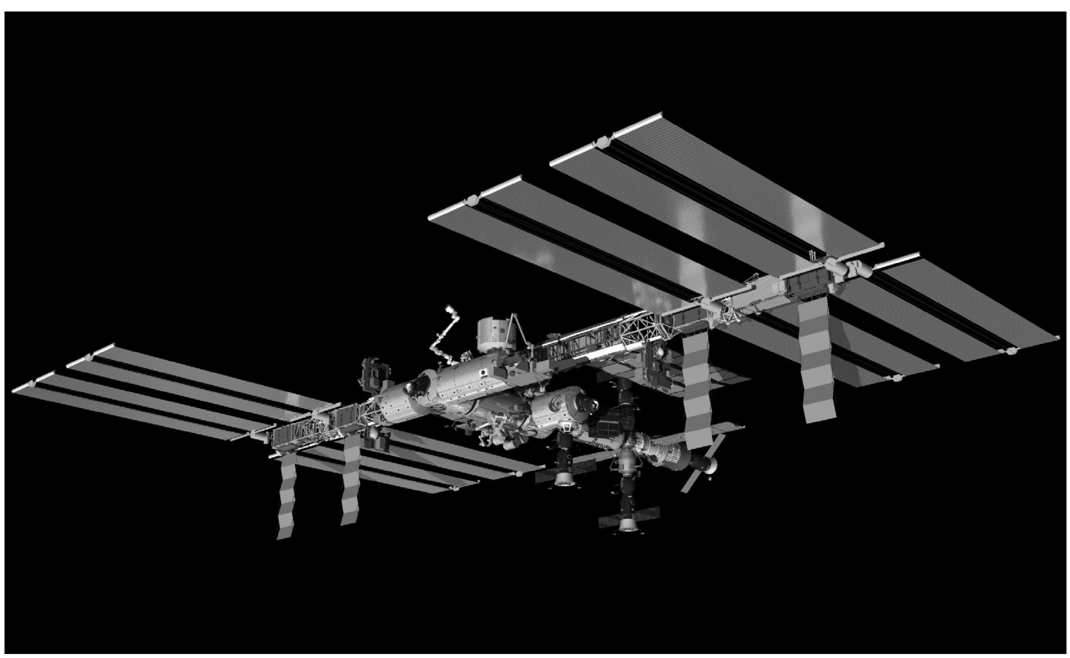
FROM 1998 TO THE PRESENT



ISS 1998



Artist computer generated rendering if the ISS – April 2010

Introduction

Civil Air Patrol's Aerospace Education Division has provided classroom teachers and Aerospace Education Officers with materials to aid them in teaching about the aerospace world for decades. The continued quest for the best in products for inspiring students to excel in mathematics, science, technology, and other subjects has been a high priority for us.

This thematic unit contains information on the International Space Station (ISS). We want this unit to inform and excite students about the possibilities of future space endeavors through our look at the International Space Station. The ISS represents a global partnership of 16 nations. It will be a permanent orbiting laboratory enabling long-duration research in the unique microgravity environment of Earth's orbit.

Understanding any subject requires a knowledge of the terminology and structure associated with the subject. A background of the subject's origin and subsequent development is also required. This unit on the International Space Station provides information in narrative form, and students will experience reinforcement of their knowledge as they complete the various activities and study the accompanying visual displays.

We have compiled this thematic unit to incorporate across the curriculum disciplines with corresponding National Content Standards. Included are background information, teacher lesson plans, student information sheets, a section with examples of how to evaluate and/or answer each activity, and a unit test with answer key. This unit may be used in its entirety for a portfolio assessment or individual activities may be selected at random and evaluated by rubric or other method of assessment. The optional test can be used as a pretest and/or posttest for the unit. Each activity may be used for a total class lesson, or by small groups in a learning center, or by individual students. Although developed for the middle school, this material can be adapted to upper elementary or high school students.

This packet includes an aerospace education achievement award with a dual signature line for leader signatures; a student record sheet; and posters for display. The record sheet may be used for portfolio contents and how, when, and by whom each activity was evaluated.

Feel free to adapt this material to fit your specific situation and need. The purpose of this unit is to learn about the International Space Station and the history, humans, and science behind it. To accomplish this, each activity urges creativity and provides information designed to emphasize National Content Standards. Subjects addressed include science, social studies, mathematics, language arts, careers, art, music, and physical education.

Teaching Tips

PREPARATION:

- To use activities repeatedly, you may want to laminate them.
- Provide materials and supplies in a designated place.
- Display the enclosed posters (artwork) on a bulletin board where they will be visible and can serve as a source of information.
- Laminate an instruction information card that can be placed between the Student Information folder box and the box of student folders. The directions should read:
    1. Take an activity from the Student Information box.
    2. Enter the date on your record sheet when you start the activity.
    3. After you have finished the activity, enter the date on your record sheet.
    4. Place your finished work in your folder.
    5. Place the activity back in the Student Information box.
- Prepare a personalized folder for each student or let him or her design his or her own folder.
- Provide a copy of the student record sheet for each student.

PRESENTATION:

- Introduce the material by using the introductory material on the International Space Station.
- Instruct the students on:
    - The text
    - How to use the activity sheets
    - Where the materials are located
- Instruct the students to select the activity sheets in the order of their choice (or in the order assigned by you).
- Hand out personalized folders and copies of students' record sheets.
    - Explain how to fill out the record sheets.
    - Assign a location for the folders.
- Administer the pretest before the students begin their activities. The test key is included. Record the scores on the students' record sheets.

Note: If small groups will be doing the activities, it is beneficial to have heterogeneous groups with a stronger reader assigned to a weaker reader.

EVALUATION:

- Suggestions for assessment:
    - Student Portfolio (the folders kept by each student along with a summary of what was learned).
    - Teacher Rubric (especially for group work). A good site for rubric help is ***http://teachers.teach-nology.com/web_tools/rubrics/ .***
    - Performance Grading
    - Pre and Post Test
- Go over assignments, and initial students' record sheets.
- Meet with small groups to evaluate and schedule future plans.
- Administer the posttest and record the scores on the students' record sheets.
- Award certificates of achievement to students who have satisfactorily completed the activities given on the activity sheets and who have shown a gain in knowledge of the International Space Station.

REMEMBER!!!

1. If your students are doing an Internet based assignment, be sure you review the Internet usage policy of your school. A list of kid's safe search sites can be found at: ***http://www.sldirectory.com/searchf/kidsafe.html*** **.**
2. Always discuss with your students safe science practices in a classroom or laboratory situation.
3. Disclaimer: The Internet sites listed in this publication are subject to change and we do not take responsibility for changes made by the site owners.

LET'S GET STARTED!!!

Student Record Sheet

The International Space Station

Name:____

Activity Number	Date Started	Date Finished	Teacher Comments	Teacher Initials
Activity 1 Language Arts, Geography, and Social Studies				
Activity 2 Science and Mathematics				
Activity 3 Language Arts and Visual Arts				
Activity 4 Social Studies and Geography				
Activity 5 Language Arts, Careers and Science				
Activity 6 Language Arts				
Activity 7 Language Arts				
Activity 8 Science				
Activity 9 Language Arts				
Activity 10 Science				
Activity 11 Social Studies				
Activity 12 Physical Education				
Activity 13 Mathematics				

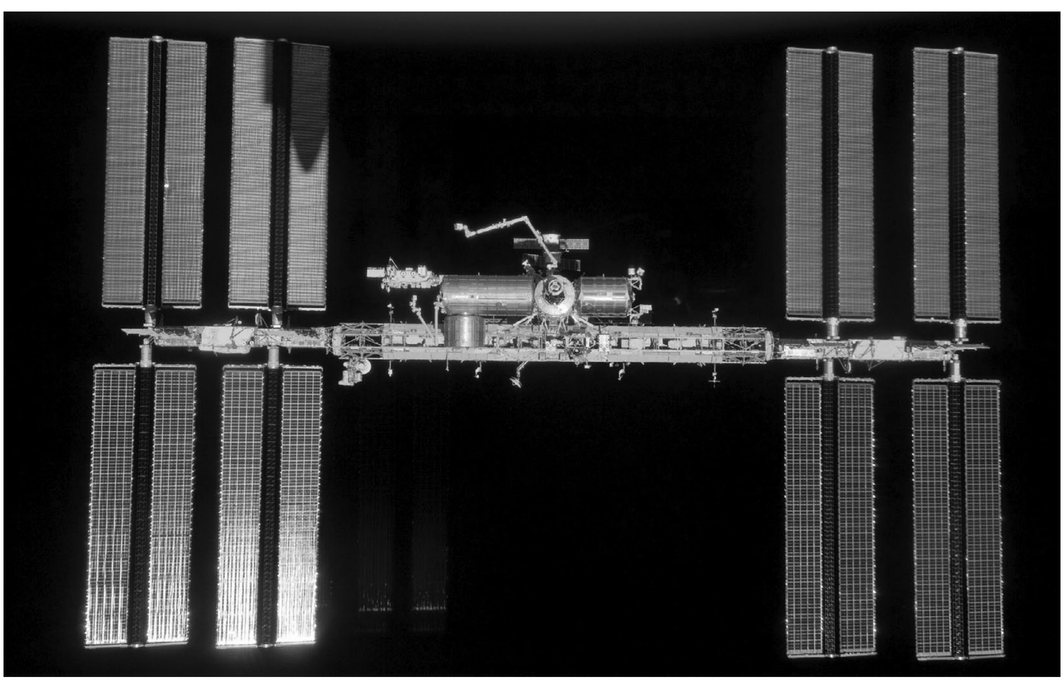
Student Record Sheet
The International Space Station
(Page 2)

Name:____

Activity Number	Date Started	Date Finished	Teacher Comments	Teacher Initials
Activity 14 Science and Visual Arts				
Activity 15 Science				
Activity 16 Music				
Activity 17 Mathematics				
Activity 18 Careers and Technology				
Activity 19 Science				
Activity 20 Language Arts				

Pretest Score ______________________

Posttest Score ______________________



International Space Station History and Facts

President Ronald Reagan, in his State of the Union message to Congress in January 1984, officially established the goal of developing a permanently inhabited station in orbit. Canada, Europe and Japan were issued invitations to join in this effort. Agreements with the Canadian Space Agency and the European Space Agency were reached in September 1988. Japan joined in March 1989. Cooperative relationship in human spaceflight between the U.S. and Russia led to the incorporation of Russia into the International Space Station program in December 1993.

Today, the ISS Program is a cooperative international effort based on a multi-lateral Intergovernmental Agreement between all of the involved governments, and on a bilateral Memoranda of Understanding between NASA and the International Partner Space agencies that represent these governments.

Assembly of the International Space Station began with the launch of the U.S.- owned, Russian-built Zarya control module on November 20, 1998, from the Baikonur Cosmodrome in Kazakstan. The launch of the Space Shuttle Endeavor from the Kennedy Space Center, Florida, followed on December 4, 1998, carrying the U.S. built Unity connecting module. Endeavor's crew attached Unity and Zarya during a 12-day mission to begin the station's orbital construction. Since that time, many missions have provided additional components and support for the International Space Station.

The ISS is an exciting gateway to new frontiers in human space exploration, sustaining U.S. leadership in exploration and the use of outer space that has inspired a generation of Americans and people throughout the world. In the area of research, the ISS is a unique world-class laboratory providing an international platform for advances in science and technology. For business, it provides a stunning opportunity to enhance U.S. economic competitiveness and creates new commercial enterprises. Education uses the ISS as a virtual classroom in space to the benefit of educators and students alike.

Facts and Figures of The International Space Station:

Wingspan width:	**365 feet (108.5 meters)**
Length:	**290 feet (88.4 meters)**
Mass (weight):	**About 1 million pounds (453,592 kilograms)**
Operating Altitude:	**220 nautical miles average (407 kilometers)**
Inclination:	**51.6 degrees to the Equator**
Crew size	**3**

The International Space Station is an Earth-orbiting laboratory drawing upon the scientific and technological expertise of 16 nations: the United States, Canada, Japan, Russia, 11 member nations of the European Space Agency (ESA) and Brazil.

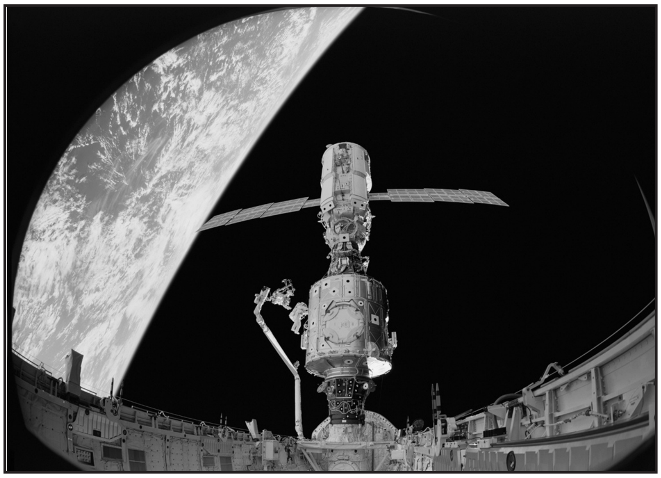
The living and working space will be the size of three average American homes. The giant solar arrays of the ISS will generate the electricity needed to power about 50 average American homes.

SPACE STATION ASSEMBLY

The International Space Station, or ISS, represents a global partnership of 16 nations. This project is an engineering, scientific and technological marvel ushering in a new era of human space exploration. The million-pound space station will include six laboratories and provide more space for research than any spacecraft ever built. Internal volume of the space station will be roughly equal to the passenger cabin volume of a 747 jumbo jet.

It will take more than 40 spaceflights over a five-year period and at least three space vehicles - the Space Shuttle, the Russian Soyuz rocket and the Russian Proton rocket - to deliver the various space station components to Earth orbit. Assembly of the more than 100 components will require a combination of human spacewalks and robot technologies.

Twenty flights, which include 16 space shuttle missions, have already occurred in the International Space Station era. The first flight was a Russian Proton rocket that lifted off in November 1998 and placed the Zarya module in orbit. In early December of that same year, the STS-88 mission saw Space Shuttle Endeavour attach the Unity Module to Zarya initiating the first ISS assembly sequence. The third ISS mission was STS-96 in June 1999 with Discovery supplying the two modules with tools and cranes.



The STS-88 crew uses the robotic arm to mate the Unity module to the Zarya module.

The fourth flight to the space station was STS-101, which launched May 19, 2000. The seven-member crew of STS-101 performed maintenance activities and delivered supplies in preparation for the arrival of the Zvezda Service Module and the station's first permanent crew. Zvezda, the fifth flight, docked with the station on July 25 at 7:45 p.m. CDT (July 26 at 00:45 GMT), and became the third major component of the station. Then, STS-106 visited the station in September to deliver supplies and outfit Zvezda in preparation for the station's first permanent crew, which arrived at the station on Nov. 2. Prior to the Expedition One crew's arrival, STS-92 delivered the Z1 Truss, Pressurized Mating Adapter 3 and four Control Moment Gyros in October.

STS-97 was the last shuttle mission of the 20th century. Space Shuttle Endeavour and its five-member crew installed the first set of U.S. solar arrays onto the station and became the first shuttle crew to visit Expedition One. The solar arrays set the stage for the addition of the U.S. Destiny Laboratory Module, which arrived at the station in February 2001 on STS-98. The five STS-98 astronauts also relocated Pressurized Mating Adapter 2 from the end of Unity to the end of Destiny to set the stage for future shuttle missions.

In March 2001, the first crew rotation flight arrived. STS-102 delivered the Expedition Two crew to the station and returned Expedition One to Earth. Also, STS-102 carried the first Multi-Purpose Logistics Module, Leonardo, to the station. Logistics modules are reusable cargo carriers built by the Italian Space Agency. Expedition One spent 4.5 months on the station.

STS-100 delivered the station's robot arm, which is also known as the Space Station Remote Manipulator System, and the Raffaello Multi-Purpose Logistics Module in April. The delivery of the arm set the stage for the arrival of the station's joint airlock, which was installed during STS-104's visit to the station in July 2001. The next shuttle mission to visit the station was STS-105 in mid-August 2001. STS-105 delivered the Expedition Three crew to the International Space Station and returned the Expedition Two crew to Earth. The Leonardo Multi-Purpose Logistics Module made its second trip to the station during STS-105.

ISS expansion continued with the arrival of the Russian Docking Compartment on September 16, 2001. The docking Compartment is called Pirs, which is the Russian word for pier. The next flight to visit the space station was STS-108. It arrived at the station in early December 2001 and delivered the Expedition Four crew. Expedition Three returned to Earth on STS-108.

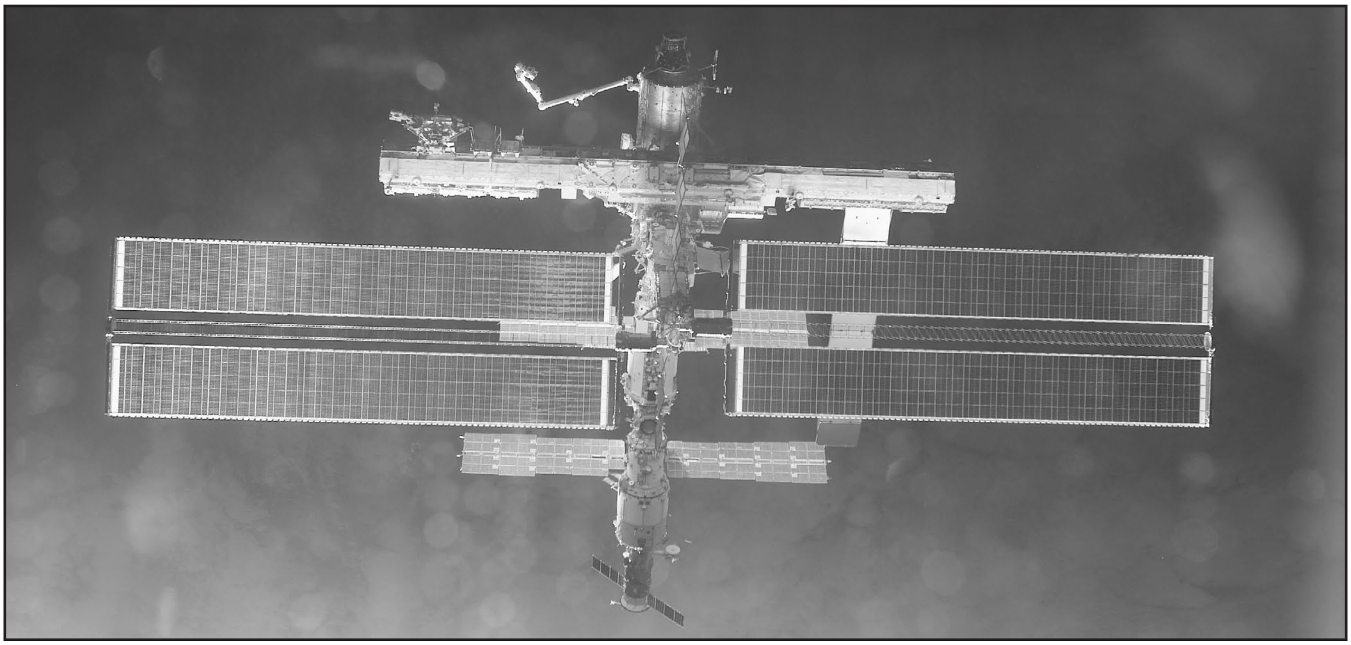
The first shuttle mission to visit the station in 2002 was STS-110. The seven-member STS-110 crew installed the S0 (S-Zero) Truss onto the station. The S0 was the second piece of the 11-piece Integrated Truss Structure delivered to the station.

The second shuttle mission of 2002 to visit the station was STS-111 in mid-June. STS-111 delivered the Expedition Five crew and the Mobile Base System to the orbital outpost. Also, STS-111 returned the Expedition Four crew to Earth. Flight Engineers Carl Walz and Dan Bursch set the record for the longest U.S. space flight with 196 days in space during Expedition Four.

Outward expansion of the station occurred during STS-112, which is also known as ISS Assembly Flight 9A, with the delivery of the S1 Truss. The S1 was attached to the starboard side of the S0 Truss.

The last shuttle mission to visit the ISS during 2002 was STS-113, which delivered the Expedition Six crew and the P1 (P-One) Truss. The STS-113 crew performed three spacewalks to activate and outfit the P1 after it was attached to the port side of the S0 Truss. Expedition Five returned to Earth on Endeavour, wrapping up a six-month stay in space.

The United States and Russia have partnered together since 1994 performing nine Shuttle-Mir dockings. That experience provided valuable insight and team work necessary for building and maintaining the International Space Station. When the space station is completed an international crew of up to seven will live and work in space between three and six months. Crew return vehicles will always be attached to the space station to ensure the safe return of all crewmembers in the event of an emergency.



The International Space Station is seen from Space Shuttle Endeavour just after undocking. During STS-113, the orbiter delivered the station's newest element -- the P1 (P-One) Truss.

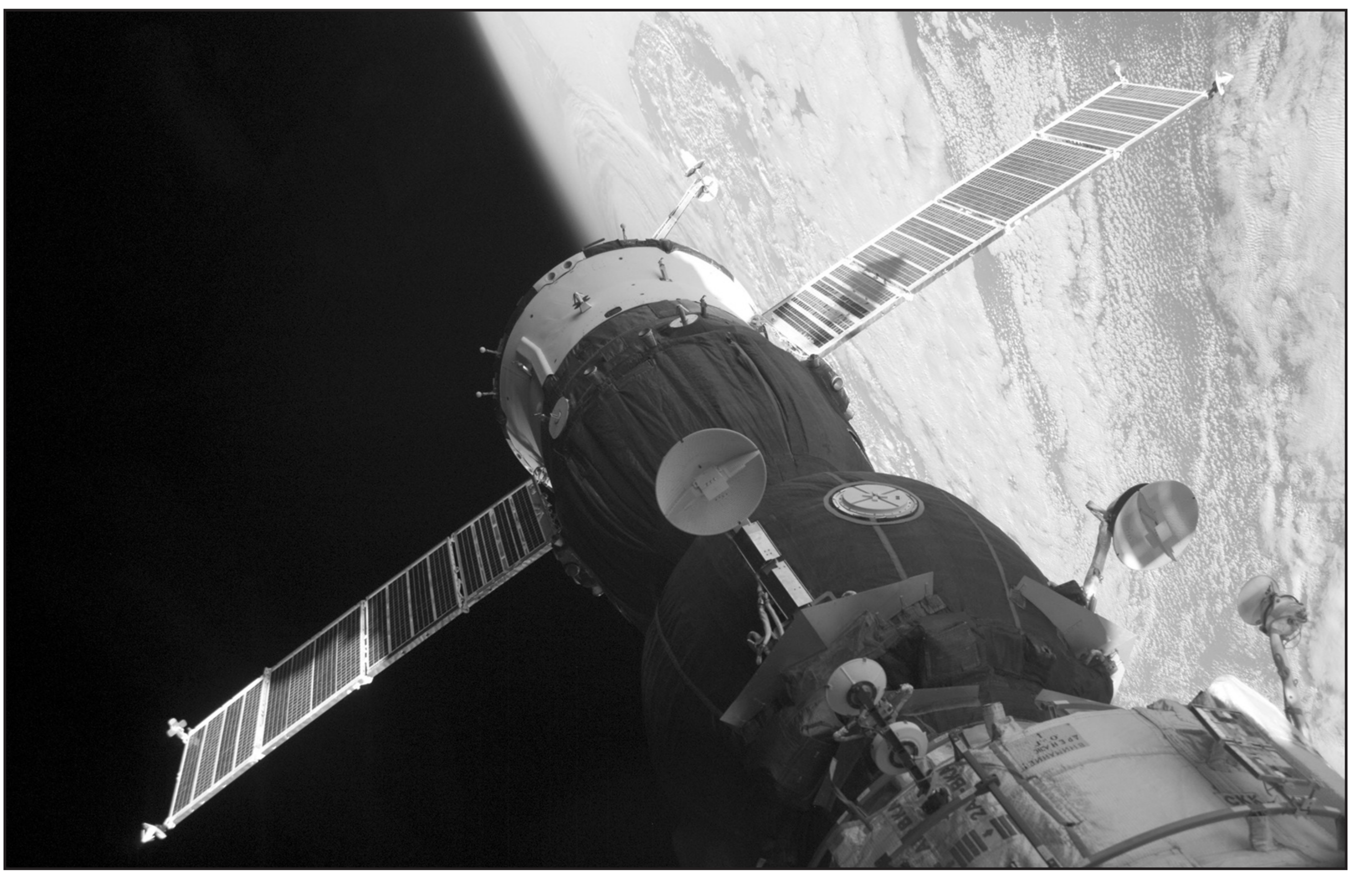
INTERNATIONAL SPACE STATION UPDATE

Since the Columbia tragedy on February 1, 2003, the International Space Station has been manned by a contingency caretaker crew of two personnel to help keep the Space Station operational and to perform the science missions on board. Expeditions Seven, Eight, and Nine arrived at the International Space Station by way of the Russian spacecraft called the Soyuz. (NASA is targeting no earlier than spring 2005 for the shuttle's return to flight with *Discovery* flying for STS-114.)

- Expedition Seven began work on the Space Station in April 2003. They were replaced by the Expedition Eight crew in October 2003.
- Expedition Eight on the International Space Station began in October 2003 when the Station's eighth crew arrived at the Station aboard a Russian Soyuz spacecraft. Expedition Eight Commander Michael Foale and Flight Engineer Alexander Kaleri arrived at the Space Station on October 20 and began to transition Station activities from the former Expedition Seven crew.
- Expedition 9, the ninth science research mission on the International Space Station, began in April 2004, when the ninth crew arrived at the Station aboard a Russian Soyuz spacecraft.

- Expedition 10 replaced Expedition 9 in October 2004.
- Expedition 11 began their mission in April 2005 followed by Expedition 12 (October 2005 to April 2006).
- Expedition 13 saw the station return to a three-person crew with Commander Pavel Vinogradov, Flight Engineer Jeff Williams and European Space Agency astronaut Thomas Reiter.
- From 2006 to early 2010, Expedition crews 14 through 22 manned the ISS. Space walks, repairs to satellites and the Hubble Space Telescope, science experiments, and new components and repairs have been achieved by these crews. A six person crew was established in 2009.
- The ISS is expected to continue its mission with Space Shuttle visits until the end of 2010. The last shuttle expected to visit the ISS is STS-133 with former CAP cadet, Eric Boe, as pilot. This will be the 36th shuttle mission to the station and the 134th and final shuttle flight. The Russian Soyuz will continue taking crews to and from the station after the shuttle is retired. The Space Station is expected to remain in operation until 2020.
- In March 2010, the International Space Station won the Collier Trophy (the top award in aviation).

The objectives of the International Space Station include: to develop a world-class, international orbiting laboratory for conducting high-value scientific research for the benefit of humans; to provide access to the microgravity environment; to develop the ability to live and work in space for extended periods; and to provide a research test bed for developing advanced technology for human and robotic exploration of space. Hopefully, future Space Station missions will continue to accomplish these objectives.



Soyuz *Spacecraft docked to the International Space Station in April 2004.*

Activity #1

LANGUAGE ARTS, GEOGRAPHY and SOCIAL STUDIES

Teacher Lesson Plan

Objective(s):

Students will learn the nations contributing to the International Space Station and how these nations are able to work together.

National Standards:

English Language Arts:

2. Understanding the Human Experience
4. Communication Skills
5. Communication Strategies
8. Developing Research Skills
9. Multicultural Understanding
12. Applying Language Skills

Social Studies:

1. Culture
4. Individual Development and Identity
8. Science, Technology, and Society
9. Global Connections

Materials:

Paper, Pencils, Computer with Internet Connection, World Map.

Estimated Time:

Two, 1-hour sessions

Background Information:

Different nationalities and cultures, as well as being isolated for months at a time on the International Space Station (ISS), can cause stress. Before astronauts travel into space, they are briefed on the cultural differences they may encounter with crewmembers from other countries. The list of possible conflicts grows shorter and shorter as the years progress, notes Janice Voss, who traveled on the Space Shuttle with Russian cosmonaut Vladamir Titov as they conducted a MIR flyby on STS-63 in 1995. Voss and Titov also worked with crewmembers Gerhard Thiele from Germany and Mamoru Mohri from Japan on mission STS-99 in 2000.

Some examples of cultural differences are: Japanese generally don't shake hands, but bow slightly when meeting someone new. Russians value face-to-face interaction instead of memos and large gatherings. The most obvious difference is the language barrier. Efforts are made to speak slower or use simpler phrases.

Procedure/Activity:

1. Have students find out the names and locations of the 16 nations involved in the International Space Station. Which continent does each belong to?
2. Have students select one nation and research customs and language. Have them compare customs and language of the country they selected to those of the United States.
3. Have students write a short dialog between someone from the United States and someone from the country selected (demonstrating customs and language being respected) on the International Space Station.

Rationale:

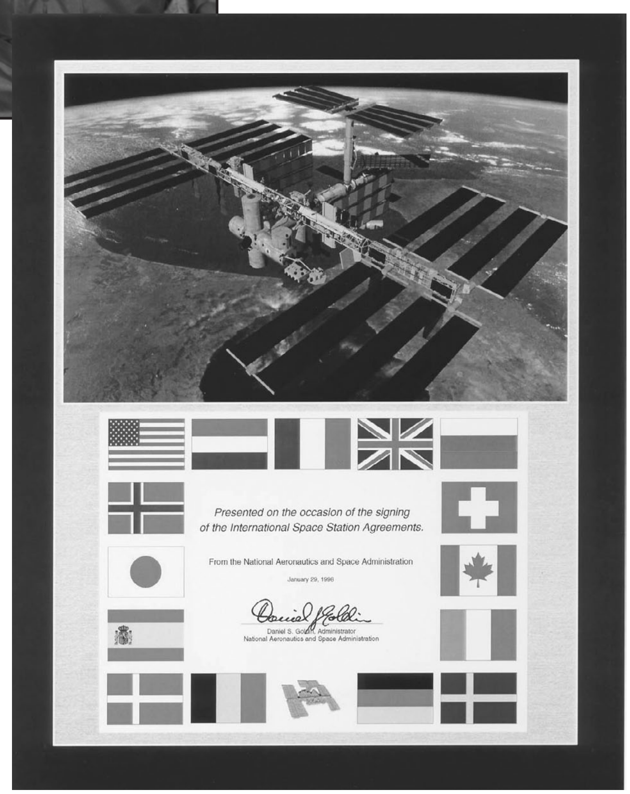
This lesson will encourage students to accept cultural differences as those on the International Space Station do.

Assessment:

Use a rubric to evaluate the qualities you look for in a culturally diverse dialog. Students should identify and locate the 16 nations involved in the ISS.

Additional Information:

- Web sites for countries involved in ISS: ***http://spaceflight.nasa.gov/station/reference/partners/***
- Free Blank Outline Maps of the Countries and Continents of the World: ***http://www.eduplace.com/ss/maps/world.html***
- For special education and ESL students - partner with another student. They can also work on maps and flags for countries involved and compare to United States.
- ESL students can be receiver of dialog from English speaking student. Then reverse roles.



Activity #1

LANGUAGE ARTS, GEOGRAPHY and SOCIAL STUDIES

Student Information

Materials:

Paper, Pencils, Computer with Internet Connection, World Map.

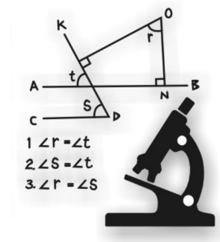
Directions:

1. Find out the names and locations of the 16 nations involved in the International Space Station. Which continent does each belong to?
2. Select one nation and research customs and language. Compare customs and language of the country you selected to those of the United States.
3. Write a short dialog between someone from the United States and someone from the country selected (demonstrating customs and language being respected) on the International Space Station.

Activity #2

SCIENCE and MATHEMATICS

Teacher Lesson Plan



Objective:

Students will explore the weight water adds to certain foods and how dehydrated foods are one method of preparing food for the International Space Station.

National Standards:

Science:

A: Science as Inquiry
- Abilities necessary to do scientific inquiry

B: Physical Science
- Properties and changes of properties in matter

F: Science in Personal and Social Perspectives
- Personal Health

Mathematics:

1. Number and Operations Standard
   - Compute fluently and make reasonable estimates
4. Measurement Standard
   - Apply appropriate techniques, tools, and formulas to determine measurements
5. Data Analysis and Probability Standard
   - Develop and evaluate inferences and predictions that are based on data
9. Connections Standard
   - Recognize and apply mathematics in contexts outside of mathematics

Materials:

Balance (triple-beam), several dehydrated food items, small plastic bowl, water, Rehydration Worksheet, pencil

Estimated Time:

1 hour

Background Information:

Freeze-drying and other drying methods remove most of the water in foods. This food type (once rehydrated) provides a more solid-type diet and adds variety to a space meal.

In order to get food supplies to the International Space Station, the Space Shuttle must deal with weight. Removing water from foods helps with the weight problem. To rehydrate food aboard the Space Shuttle is no problem due to the fact that water is a byproduct produced by the fuel cells. However, for the ISS, electrical requirements are best met by a renewable energy source. Solar arrays, which convert solar energy into electrical energy, do not produce water as a byproduct. The ISS food manifest has reduced the amount of food rehydratables significantly. Drinks, however, are still best handled in a rehydratable package for storage ease. To add to the ISS water supply, if needed, the Shuttle dumps all its water into ISS holding tanks, prior to undocking.

Procedure/Activity:

1. Students should weigh the bowl (the bowl is used to keep the scales from getting dirty. Remember to subtract the weight of the bowl from the total weight of the bowl and food to get the actual food weight).
2. Students should weigh a dehydrated food placed inside the bowl.
3. Students should place the dehydrated food in a container of room temperature water.
4. Students should allow the food to completely rehydrate. They should then remove the food from the container and blot dry.
5. Students should weigh the rehydrated food product in the bowl.
6. Students should calculate the percentage of rehydration using the following formula:

$$\%\ \text{Rehydration} = \frac{\text{gain in mass + original mass}}{\text{Original mass}} \times 100$$

7. Students should fill out the Rehydration Worksheet and determine which food gained the most weight and why they think so.
8. Extension: At the bottom of the worksheet, write a paragraph on the different types of foods on the International Space Station and how they are prepared to last for up to three months as well as packaged for minimum cleanup and disposal.

Rationale:

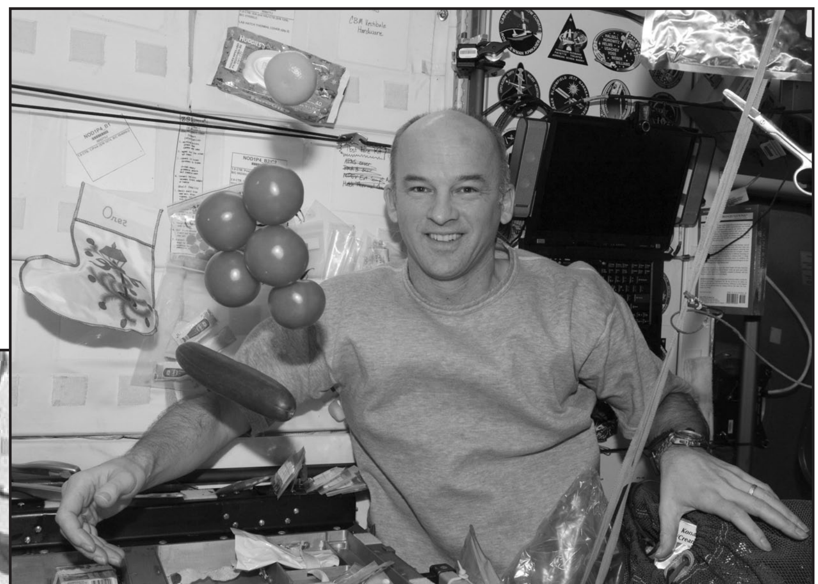
This lesson will use the inquiry method to study the effects water has on food weight.

Assessment:

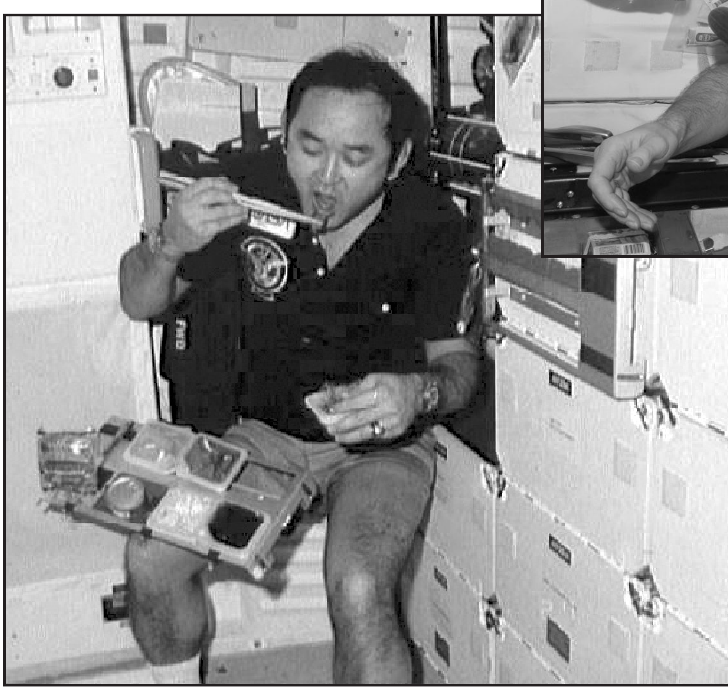
Students should accurately fill out the Rehydration Worksheet and do the math percentages correctly.

Additional Information:

- Special education students can work with a peer partner or work on illustrating a before and after of each food rehydrated.
- Another article and lesson activity about food in space can be found at http://ksnn.larc.nasa.gov/21Century/p2.html



Fresh produce on the ISS



Astronaut/Mission Commander Lu eats meal with chopsticks

Rehydration Worksheet

Name: ____

Weight of bowl (in grams): ____

Food Item	Dried Weight (in grams)	Rehydrated Weight (in grams)	Percentage of Rehydration

Formula: % Rehydration = $\dfrac{\text{gain in mass + original mass}}{\text{Original mass}}$ X 100

Paragraph on Food Preparation for the ISS

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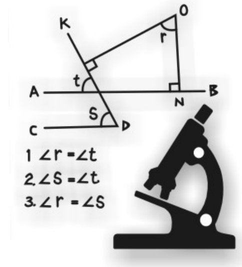
Activity #2

SCIENCE and MATHEMATICS

Student Information



Materials:

Balance (triple-beam), several dehydrated food items, small plastic bowl, water, Rehydration Worksheet, pencil

Procedure/Activity:

1. Weigh the bowl (the bowl is used to keep the scales from getting dirty. Remember to subtract the weight of the bowl from the total weight of the bowl and food to get the actual food weight.)
2. Weigh a dehydrated food placed inside the bowl.
3. Place the dehydrated food in a container of room temperature water.
4. Allow the food to completely rehydrate. Then remove the food from the container and blot dry.
5. Weigh the rehydrated food product in the bowl.
6. Calculate the percentage of rehydration using the following formula:

   $$\%\ \text{Rehydration} = \frac{\text{gain in mass} + \text{original mass}}{\text{original mass}} \times 100$$

7. Fill out the Rehydration Worksheet and determine which food gained the most weight and why you think so.
8. **Extension:** At the bottom of the work sheet, write a paragraph on the different types of foods on the International Space Station and how they are prepared to last for up to three months as well as packaged for minimum cleanup and disposal.
9. Use article at ***http://ksnn.larc.nasa.gov/21Century/p2.html*** to help with your paragraph.

ISS 7 crew share a meal.

Activity #3

LANGUAGE ARTS and VISUAL ARTS

Teacher Lesson Plan

Objective:

Students will create and illustrate a poem about life on the International Space Station.

National Standards:

English Language Arts:

1. Reading for Perspective
8. Developing Research Skills
11. Participating in Society
12. Applying Language Skills

Visual Arts

I. Understand and apply media techniques and processes.

VI. Make connections between visual arts and other disciplines.

Materials:

Computer with Internet access, pen, paper, video from Discovery Channel Video (or other source) to introduce life on the International Space Station.

Estimated Time:

Two, 1 hour sessions

Background Information:

Space is the most hostile environment for humans to inhabit.

Food - The crew helps select the foods they want from a wide-ranging menu. Most food is processed and packaged in pouches or cans. Fresh food including fruits and veggies, can be delivered by the American Space Shuttle or Russian Progress vehicle. All food is stored at room temperature at this time.

Communication - Crew members have a video telephone call from home each week as well as sending and receiving e-mail messages to and from family and friends. This keeps astronauts from feeling isolated from home and family.

Chores - Bags and containers of sealed trash return to Earth aboard the Space Shuttle or Russian Progress. After eating, most food packaging is disposable, but eating utensils are cleaned with sanitary wipes.

Entertainment - Exercise and physical activity take a great deal of the crew members' free time. Crew members take personal entertainment gear with them such as checkers or chess sets, CDs and tape players, or DVD movies for viewing.

Procedure/Activity:

1. Students will view a video about life on the International Space Station to understand what life is like onboard. Classroom discussion of background information and video will further stimulate thinking.
2. Students can use the Internet to find daily journals or interviews with crew members.
3. Students will create a poem about life on the Space Station. Students can use free verse or some type of sonnet.
4. Students will illustrate the poem and share it with a peer.
5. Students will read their poem to the class.

Rationale:

This lesson will provide a creative way to view life on the International Space Station.

Assessment:

Use a rubric, emphasizing creativity and accuracy, to grade the poem.

Additional Information:

- ESL and Special Education students should work with a peer on research and discussion of like on the International Space Station.
- For more information on living in space, go to ***http://spaceflight.nasa.gov/living/index.html***
- Resource video called "Mission to Mir" can be ordered from NASA Central Operation of Resources (CORE): ***http://corecatalog.nasa.gov/item.cfm?num=006.4-22D***

Activity #3

LANGUAGE ARTS and VISUAL ARTS

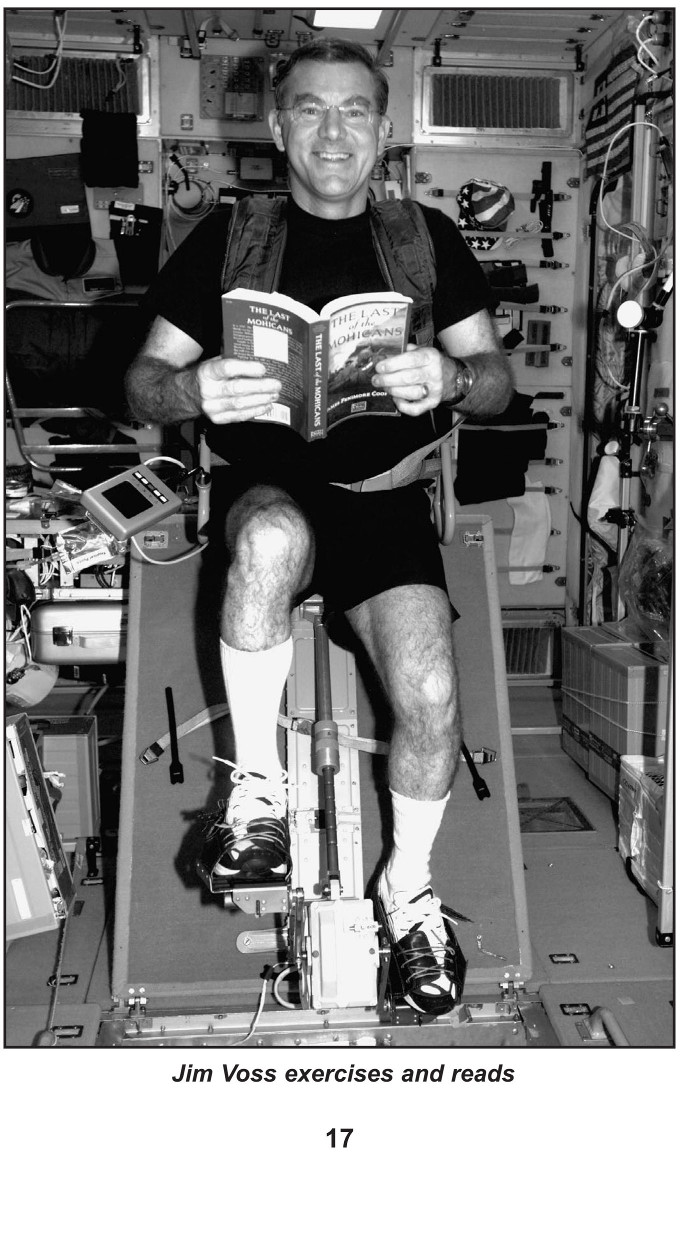
Student Information

Materials:

Computer with Internet access, pen, paper, video from Discovery Channel Video (or other source) to introduce life on the International Space Station.

Directions:

1. View a video about life on the International Space Station to understand what life is like onboard. Classroom discussion of background information and video will further stimulate thinking.
2. You may use the Internet to find daily journals or interviews with crewmembers.
3. Create a poem about life on the Space Station. You may use free verse or some type of sonnet.
4. Illustrate the poem and share it with a peer.
5. Read your poem to the class.



Jim Voss exercises and reads

Activity #4

SOCIAL STUDIES and GEOGRAPHY

Teacher Lesson Plan

Objective:

The student will observe Space Station pictures of Earth and attempt to identify places and features associated with these places.

National Standards:

Social Studies:

3. People, Places and Environments
8. Science, Technology and Society
9. Global Connections

Materials:

Space Station pictures of Earth from the internet, worksheet, Atlases, pencil.

Estimated Time:

40 minutes

Background Information:

One of the experiments conducted onboard the Space Station is the Crew Earth Observations (CEO) which provides people on Earth with data needed to better understand our planet. The photographs - taken by crew members using 35 and 70 mm handheld cameras - record observable Earth surface changes over a period of time, as well as more fleeting events, such as storms, floods, fires and volcanic eruptions.

This experiment on the Space Station began during Expedition One, and will continue through the life of the Space Station.

Data gathered as part of the Crew Earth Observations experiment will be coupled with other types of data, such as images from satellites and aircraft, when available for public, research or commercial applications. This data will be added into a database of 30-plus years of human observations forming a record of Earth.

***Astronaut Taking picture of earth aboard* Expedition I.**

The colors found on the pictures can indicate the following:

- ***Blues=Water***
- ***Black, dark blue, or dark green=Vegetation***
- ***White=Clouds, snow, or human impact***
- ***Red, orange, peach, or brown=Ground, soil, or sediment***

Procedure/Activity:

1. Have students observe a sample Space Station picture as a group from the over head. Discuss how to interpret the photograph, the features, and where on Earth this picture could have been taken.
2. Give groups of students 2 Space Station pictures to identify.
3. Have students answer worksheet by describing the photographs.
4. Have them exchange with another group after 15 minutes; then compare answers from both sets of pictures.

Rationale:

This lesson will enhance geographical observation skills and illustrate another use for the ISS.

Assessment:

Evaluate worksheets and correct thought processes for identifying each place.

Additional Information:

- Special needs students could be given a list of features to look for as clues to identifying each place and work with a partner.
- Websites for pictures: ***http://eol.jsc.nasa.gov/newsletter/PhotographyfromISS/***

NOTE: You will need to download these pictures and make color transparencies and copies.

Photo of Earth from Expedition 2

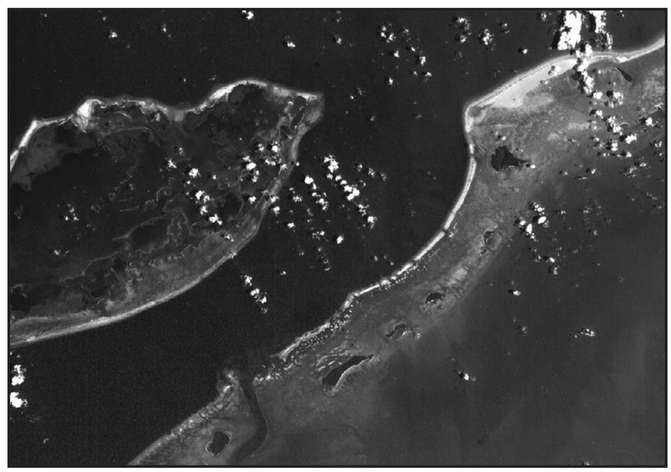


Photo of Earth from Expedition 6

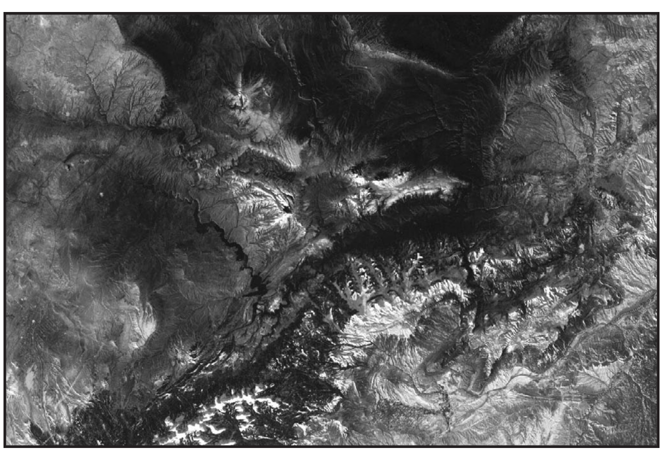


Photo of Earth from Expedition 6

Photo of Earth from Expedition 4

Activity #4

SOCIAL STUDIES and GEOGRAPHY

Student Information

Materials:

Space Station pictures of Earth from the internet, worksheets, Atlases, pencils.

Directions:

1. Observe a sample Space Station picture as a group from the overhead. Discuss how to interpret the photograph, the features, and where on Earth this picture could have been taken.
2. Get 2 Space Station pictures for your group to identify.
3. Answer worksheet by describing the photographs.
4. Exchange with another group after 15 minutes; then compare answers from both sets of pictures.

***Astronaut taking pictures of earth aboard* Expedition I.**

Expedition 13 astronaut taking pictures of topography of a point on Earth

SPACE STATION PHOTOGRAPHS

Student Worksheet

Name(s)____

1. What shapes, colors, textures and patterns do you see?

2. What features, such as rivers, mountains or cities, can you identify?

3. What continent do you think this is?

4. Is there any event happening in this photograph (weather, man-made, etc.)?
   If so, what is it?

5. What place on Earth do you think this is?

Find out the location of your photograph(s) from your teacher. Now look in atlases or the Internet and locate this place.

1. How does the location you guessed compare to the exact location?

2. Describe this place so that someone else could find it in an atlas.

3. What is the longitude and latitude of this location?

Activity #5

LANGUAGE ARTS, CAREERS and SCIENCE

Teacher Lesson Plan

Objective:

Students will explore certain careers associated with the International Space Station.

National Standards:

English Language Arts:

1. Reading for Perspective
3. Evaluation Strategies
4. Communication Skills
5. Communication Strategies
6. Applying Knowledge
8. Developing Research Skills
12. Applying Language Skills

Science:

Standard A: Science as Inquiry
- Understandings about scientific inquiry

Standard E: Science and Technology
- Understandings about science and technology

Standard F: Science in Personal and Social Perspectives
- Science and technology in society

Standard G: History and Nature of Science
- Science as a human endeavor

Materials:

Computer with Internet access, activity cards, pencil/pen.

Estimated Time:

60 minutes

Background Information:

There is a wide scope of opportunities in the field of aerospace. Many of these professions try to provide technologies that will add value to improve people's quality of life by strengthening the nation's economy, improving the environment, increasing our mobility and safety, and ensuring the continued national security. Many organizations work together to accomplish these goals including NASA, the Federal Aviation Administration, U.S. industry, the Department of Defense, and the university community.

The crews of the International Space Station (ISS) and the Space Shuttle have inspired many people to pursue careers as astronauts. However, the astronauts will tell you that their jobs would be impossible without the support people that work hard to make astronauts' jobs easier.

Many thousands of support staff provides skill and dedication to successful missions. Many are classified as aerospace technology workers, and their work falls into roles that include physical, life, and social scientists, pilots, mathematicians, engineers, technicians, designers, and quality control inspectors. Many of these careers require a college degree with an emphasis on mathematics and science, but there are plenty of positions available to anyone with general knowledge and a desire to achieve.

Procedure/Activity:

1. Divide students into groups of three people — "engineers," "astronauts," and "scientists" — and provide each with a description of the job and some questions that relate to that job.
2. Students should research and answer questions; then share the answers with the rest of the class.

Rationale:

This lesson will provide a better understanding of some aerospace career fields.

Assessment:

Use a rubric to evaluate research skills and career knowledge.

Additional Information:

- ***ESL students should research someone involved in the aerospace industry from their part of the world.***
- Have special needs students work with a group that will be supportive and assist with the information. These students can also research one question about one career or do a web graphic organizer.
- Helpful websites concerning careers:
  http://www.dfrc.nasa.gov/Education/Educator/OnlineEducation/Careers/
  (NASA Aerospace careers online)
  http://www.nasa.gov/audience/foreducators/robotics/careercorner/index.html
  (NASA Robotics Careers)
  http://spaceflight.nasa.gov/shuttle/support/people
  (Biographies of people with careers associated with the space program)
  http://www.kids.gov/6_8/6_8_careers.shtml
  (NASA career information for grades 6-8)
  http://profiles.jsc.nasa.gov
  (Professionals answering questions about careers in space flight – videos)
  http://nasajobs.nasa.gov/ASTRONAUTS/
  (Astronaut selection information)
  http://quest.arc.nasa.gov/projects/astrobiology/astroventure/teachers/fact_sheets.html#generic
  (generic career fact sheets)

For other resources and activities, go to Space Center Houston at: http:/www.spacecenter.org/

Activity #5

LANGUAGE ARTS, CAREERS and SCIENCE

Student Information

Materials:

Computer with Internet access, activity cards, pencil/pen.

Directions:

1. Your teacher will assign you to a group of three - "engineer," "astronaut," and "scientist" - and provide each with a description of the job and some questions that relate to that job.
2. Research and answer questions; then share the answers with the rest of the class.

ACTIVITY CARDS FOR CAREERS

Engineer Activity Card

Your responsibility is to investigate the design and construction of ISS components that will support astronauts living and working in space. Think about what materials you will need, and work with scientists and astronauts to determine priorities of power, life support and other requirements. Report on what international partners are currently doing to prepare for ISS.

- What does it take to become an engineer for the ISS?
- How are ISS engineers currently training for the missions?
- What role might you play in how meals are determined for Space Station?

Internet Resource
Space Station Home Page
http://quest.nasa.gov/aero/background/careers/
http://weboflife.nasa.gov/faq.htm

Astronaut Activity Card

Your responsibility is to become an expert on microgravity and work with scientists and engineers to coordinate how your duties will be completed in the space environment. Your job may include scientific experiments, performing upgrades on the station or computer software, or keeping track of your health. Report on training for spacewalks, countermeasures for staying healthy, and collaboration with international partners.

- What does it take to become an astronaut for the ISS?
- How are ISS astronauts currently training for their missions?
- What are some of the psychological effects of prolonged periods of time in space?
- What role might you play in how meals are determined for Space Station?
- What effects does microgravity have on the body?

Internet Resource:
Space Station Crew
http://nasajobs.nasa.gov/astronauts/

Scientist Activity Card

Your responsibility is to investigate the types of research proposed for the Space Station. Report on how microgravity will benefit this research, and how this research will benefit life on earth. Work with engineers and astronauts to investigate how research will be conducted differently on ISS, considering weight, size, and power restrictions, as well as, the human interaction required.

- What does it take to become a scientist for the ISS?
- How are ISS scientists currently planning for the missions?
- What role might you play in how meals are determined for Space Station?
- What effects does microgravity have on the body?

Internet Resource:
Space Station Science
http://www.nasa.gov/mission_pages/station/science/
http://weboflife.nasa.gov/faq.htm

Activity #6

LANGUAGE ARTS

Teacher Lesson Plans

Objective:

Students will use research skills to find information on daily routines aboard the ISS and write a journal entry on "A Day in the Life of _________ " (student's name as the astronaut or cosmonaut).

National Standards:

English Language Arts

1. Reading for perspective
4. Communication Skills
5. Communication Strategies
6. Applying Knowledge
7. Evaluating Data
8. Developing Research Skills
12. Applying Language Skills

Technology:

17. Students will develop an understanding of and be able to select and use information and communication technologies.

Materials:

Computer with Internet access, paper, pencil

Estimated Time:

Two class periods (45 minutes each)

Background Information:

Crews began living onboard the ISS in November of 2000 and are still carrying out missions on the ISS in crews of three. The crews conduct experiments and do research onboard the space station. They also do routine housekeeping, eat, work as a part of a team, exercise, relax, maintain hygiene, and sleep. Many problems had to be solved for crewmembers to be able to perform normal daily routines.

When the space station is completed, an international crew of up to seven will live and work in space between three and six months. Crew return vehicles will always be attached to the space station to ensure the safe return of all crewmembers in the event of an emergency.

Procedure/Activity:

1. Tell students they will research what life is like for crewmembers aboard the ISS.
2. Students should then organize information and write a journal entry for a day in the life of an ISS crewmember (with themselves as the crewmember).
3. The entries can then be read to the class or compiled in a book for everyone to read.

Rationale:

This lesson provides information on how daily activities are accomplished onboard the ISS and gives practice in creative writing.

Assessment:

Students should be evaluated by rubric or some other scale on accuracy of information and proper use of writing and grammar skills.

Additional Information:

- ESL (English as Second Language) students can work with a partner or ESL teacher to complete work. They may also wish to write a letter to a friend in their native language describing a day onboard the ISS.
- Special Education students can work with a partner to complete the activity.
- Website useful for information on life on the ISS: ***http://spaceflight.nasa.gov/living/index.html***

Astronaut Pamela A. Melroy getting some good camera shots

Garbage disposal Astronaut Kent Rominger's way

Bathing in space is not so easy.

Cosmonaut organizing food storage in Space

Sleeping in Space

A time for relaxation in space with a little music

Cardio-vascular experiments are carried out in Space.

Activity #6

LANGUAGE ARTS

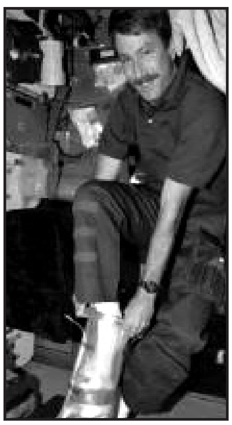
Student Information

Materials:

Computer with Internet access, paper, pencil

Directions:

1. Research what life is like for crewmembers aboard the ISS.
2. You should then organize information and write a journal entry for a day in the life of an ISS crewmember (with yourself as the crewmember).
3. The entries can then be read to the class or compiled in a book for everyone to read.



Garbage disposal Astronaut Kent Rominger's way

Sleeping in Space

Astronaut Pamela A. Melroy getting some good camera shots

Bathing in space is not so easy

Cosmonaut organizing food storage in Space

A time for relaxation in space with a little music

Cardio-vascular experiments are carried out in Space.

Activity #7

LANGUAGE ARTS

Teacher Lesson Plan

Objective:

Students will solve a crossword puzzle about the International Space Station and finish a paragraph about the space station.

National Standards:

English Language Arts:

3. Evaluation Strategies
6. Applying Knowledge
12. Applying Language Skills

Materials:

Dictionary or access to space dictionary from internet, pencil, puzzle, and ISS paragraph.

Estimated Time:

45 minutes

Background:

The International Space Station orbits at an average altitude of 354 kilometers (220 miles) at an inclination of 51.6 degrees to the equator. Assembly began with the launch of the first element, the Russian Zarya Control Module, on Nov. 20, 1998. Cargo aboard the Space Station can vary from The Human Research Facility (a rack that has a lot of different experiment equipment) to communication and navigation equipment. The onboard laboratory can study the absence of gravity as well as life support systems. Each mission takes astronauts and cosmonauts on an expedition of scientific adventure. From the propulsion to get the space shuttle into orbit to the space walks to reentry and touchdown, there is no greater adventure. Some of the parts of the Space Station include docking ports, solar panels, and modules which are supplied by the 16 countries which make up the International Space Station project including 11 countries from the European Space Agency.

Procedure/Activity:

1. Have students read the paragraph on the International Space Station.
2. Give students the word list and ask them to locate 4 terms that are missing from the paragraph. They should define all terms.
3. Have students add a sentence or two to the end of the paragraph to include the missing terms.
4. Have students complete crossword puzzle.

Rationale:

This lesson allows students to increase their space vocabulary and learn more about the International Space Station in the process.

Assessment:

Evaluate students on the use of terms and the correct completion of the crossword puzzle.

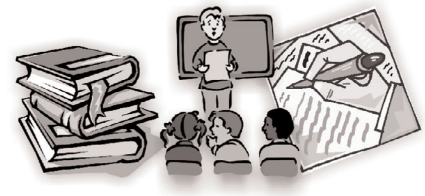
Additional Information:

- Special education students can work with a partner and decrease the number of words to 10.
- ESL students can work with a partner or learn to pronounce words into a tape recorder and find visual examples of the terms from books and magazines or by drawing them.
- To create a crossword puzzle, a helpful website is: **http://www.edhelper.com/crossword.htm**

Activity #7

LANGUAGE ARTS,

Student Information



Materials:

Dictionary or access to space dictionary from internet, pencil, puzzle, and ISS paragraph.

Background:

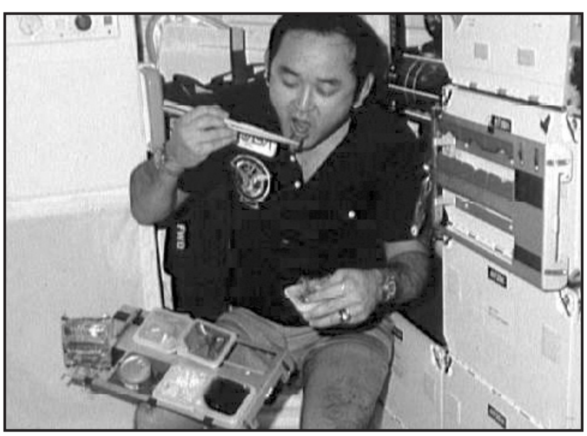
The International Space Station orbits at an average altitude of 354 kilometers (220 miles) at an inclination of 51.6 degrees to the equator. Assembly began with the launch of the first element, the Russian Zarya Control Module, on Nov. 20, 1998. Cargo aboard the Space Station can vary from The Human Research Facility (a rack that has a lot of different experiment equipment) to communication and navigation equipment. The onboard laboratory can study the absence of gravity as well as life support systems. Each mission takes astronauts and cosmonauts on an expedition of scientific adventure. From the propulsion to get the space shuttle into orbit to the space walks to reentry and touchdown, there is no greater adventure. Some of the parts of the Space Station include docking ports, solar panels, and modules which are supplied by the 16 countries which make up the International Space Station project including 11 countries from the European Space Agency.

Directions:

1. Read the paragraph on the International Space Station.
2. Look at the word list and define all terms. Locate 4 terms that are missing from the paragraph.
3. Add a sentence or two to the end of the paragraph to include the missing terms.
4. Complete the crossword puzzle.

Word List for ISS Terms

1. altitude
2. assembly
3. cargo
4. centrifugal force
5. communication
6. compartment
7. cosmonaut
8. docking ports
9. European Space Agency
10. expedition
11. experiment
12. laboratory
13. launch
14. life support
15. gravity
16. mission
17. module
18. navigation
19. orbit
20. propellant
21. propulsion
22. solar panels
23. space shuttle
24. space station
25. space walk



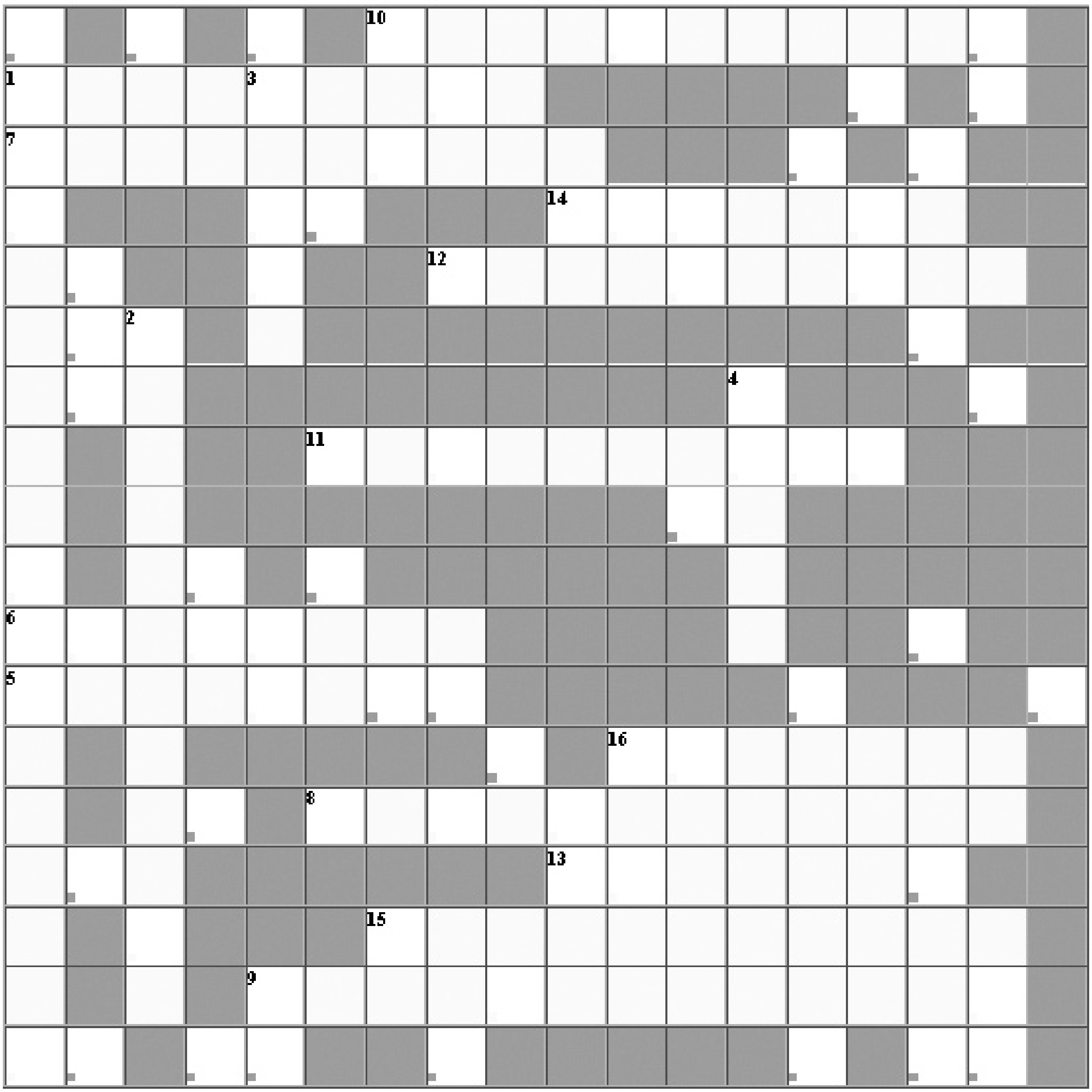
Eating with chopsticks in space

Extravehicular activity (EVA)

NAME____ DATE ______________________

International Space Station

Complete the puzzle

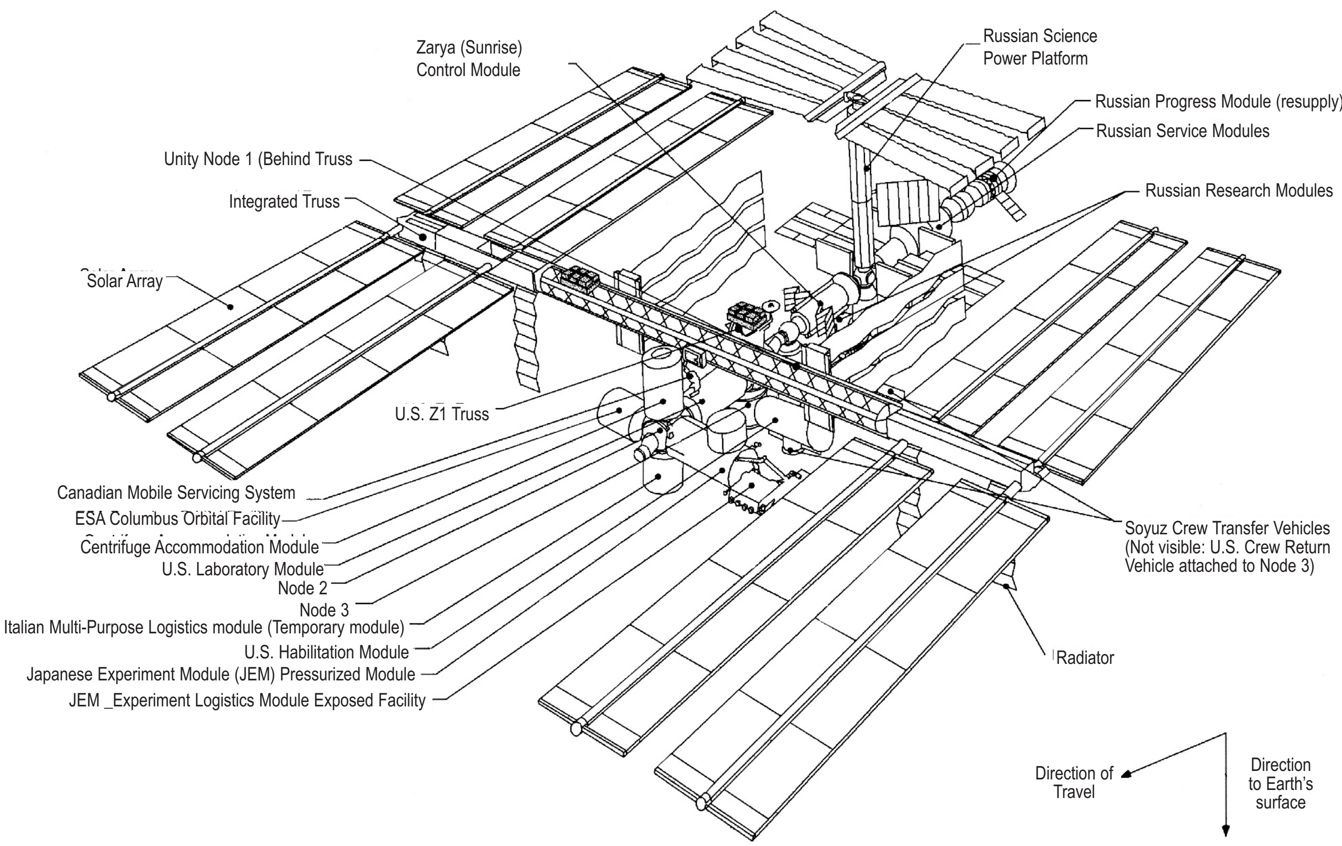


Down

1. the force in a rotating system, deflecting masses radially outward from the axis of rotation (2 words - include space in puzzle)
2. providing support necessary to sustain life (2 words - include space in puzzle)
3. the path of a body or particle under the influence of a gravitational or other force
4. the load of commodities carried by the Space Shuttle into space

Across

1. a Russian astronaut
5. to send off a rocket vehicle under its own rocket power, as in the case of guided air craft rockets, artillery rockets, and space vehicles
6. a fitting together of parts to make a whole as in the ISS
7. a test or trial of something
8. devices that convert light into electricity (2 words - include space in puzzle)
9. a large artificial satellite designed to be occupied for long periods and to serve as a base for scientific observation (2 words - include space in puzzle)
10. a place used for scientific experimentation
11. a period of activity spent outside a spacecraft by an astronaut in space (2 words - include space in puzzle)
12. embarking upon a voyage with a definite purpose
13. a self-contained unit of a launch vehicle or spacecraft which serves as a building block for the overall structure
14. a specific activity with which a person or a group is charged
15. any of the divisions into which a space is partitioned off
16. a fundamental physical force that is responsible for interactions which occur because of mass between particles



Activity #8

SCIENCE

Teacher Lesson Plan

Objective:
Students will learn about growing crystals on the ISS and grow crystals of their own.

National Standards:
Science:

A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

B: Physical Science
- Properties and changes of properties in matter

E: Science and Technology
- Understandings about science and technology

F: Science in Personal and Social Perspectives
- Science and technology in society

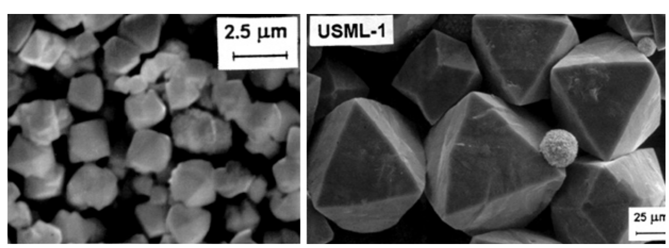
G: History and Nature of Science
- Nature of science

Materials:
- Alum (about 4 ounces or 112 g) - available in spice section of grocery stores. Alum is not toxic but is very astringent.
- Salt (about 4 tablespoons - 130 g)
- Glass containers (pint mason jars or small Pyrex beakers)
- Thread
- Hot plate
- Water
- Mini-microscopes or magnifying glasses
- Samples of mineral crystals (quartz, halite, etc.)
- Lab sheet and pencil
- **Optional:** NASA pictures of crystals grown in space compared to those grown on Earth.

Estimated Time:
- 1 hour to set up and discuss
- Two to three days to allow for crystal growth
- a few minutes each day to observe (students should not disturb the jars in any way until you remove the crystals at the end of the session).

Background Information:
The Space Shuttle and/or the International Space Station have been involved with growing crystals since the early 1990s. Zeolite crystals (crystals that are used to produce nearly all of the world's gasoline) and protein crystals (crystals from proteins that play vital roles in nourishment or fight disease) are being experimented with onboard the ISS.

Space Research conducted by such Commercial Space Centers as the Center for Advanced Microgravity Materials Processing at Northeastern University in Boston, MA are learning how to make life better on Earth. This research center has cranked up its furnace on the Space Station three times in 2002 and grown batches of zeolite crystals. These crystals have the potential to reduce the cost of petroleum and store new types of fuels like hydrogen, which is abundant and pollution-free. Research indicates that better zeolite crystals can be grown in microgravity.



Zeolite Crystals on the left were grown on earth. The ones on the right were grown in microgravity.

Procedure/Activity:

1. Discuss ISS crystal growing with students. ***http://www.nasa.gov/centers/marshall/news/background/facts/zeolites.html***
2. Tell students there are many kinds of crystals and today they will grow crystals from two different substances: alum and salt.
3. Have students observe sample crystals and the alum and salt with a magnifier. Discuss similarities and differences.
4. Encourage students to hypothesize whether crystals formed from the salt and alum will be similar or different in color, size or shape from each other.
5. To prepare the alum: heat 2 cups (500 ml) of water and dissolve about 4 ounces (112 g) of alum in the water. When the alum is dissolved, pour about one inch of the solution into a clean jar and set aside (uncovered) where it will not be disturbed. Within an hour, you should see small crystals begin to form. Pour the rest of the solution into a clear jar and cover it (this can be used for later experimints).
6. To prepare the salt: heat one cup of water and dissolve as much salt as possible in the water (about 3-4 tablespoons). Pour about one inch of the salt solution into a clean jar and set aside (uncovered). Within an hour small crystals of salt will form.
7. Have students examine both crystals and answer questions from lab sheet. Have students formulate an experiment with crystal growing, present the idea to the teacher, and proceed when approved. (Students should research crystal growing on the internet and work in pairs or small groups).
8. Safety concerns: Teacher should prepare solutions using hot plate and demonstrate safe use of heat.
   Safety goggles or glasses should be used.

Rationale:

This lesson will demonstrate crystal growing and discussion will teach students why the ISS crystal growing experiments are important.

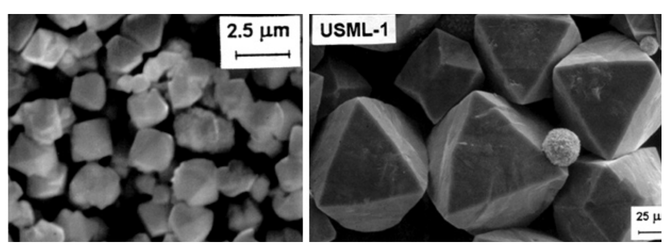
Assessment:

Use the lab sheet as the evaluation tool.

Additional Information:

- ESL and Special Education students should work with a partner.
- Additional web sites on crystal growing: ***http://www.nasa.gov/centers/marshall/news/background/facts/zeolites.html***
- Zeolite granules can be obtained from a pet shop. The granules are used for filtering ammonia from aquarium water. "Zeolite" comes from Greek words zeo (to boil) and lithos (stone), literally meaning "the rock that boils." There are nearly 50 different types of naturally occurring zeolites. Zeolite crystals are highly absorbent. To learn more and see terrestrial versus microgravity grown zeolite crystals, go to:

Protein Crystals Grown in Space



Zeolite Crystals on the left were grown on earth. The ones on the right were grown in microgravity.

Activity #8

SCIENCE

Student Information

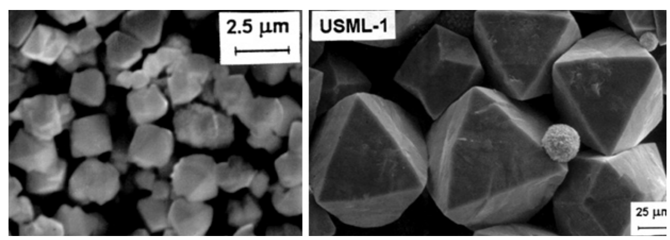
Materials:

- Alum (about 4 ounces or 112 g) available in spice section of grocery stores. Alum is not toxic but is very astringent.
- Salt (about 4 tablespoons - 130 g)
- Glass containers (pint mason jars or small Pyrex beakers)
- Thread
- Hot plate
- Water
- Mini-microscopes or magnifying glasses
- Samples of mineral crystals (quartz, halite, etc.)
- Lab sheet and pencil

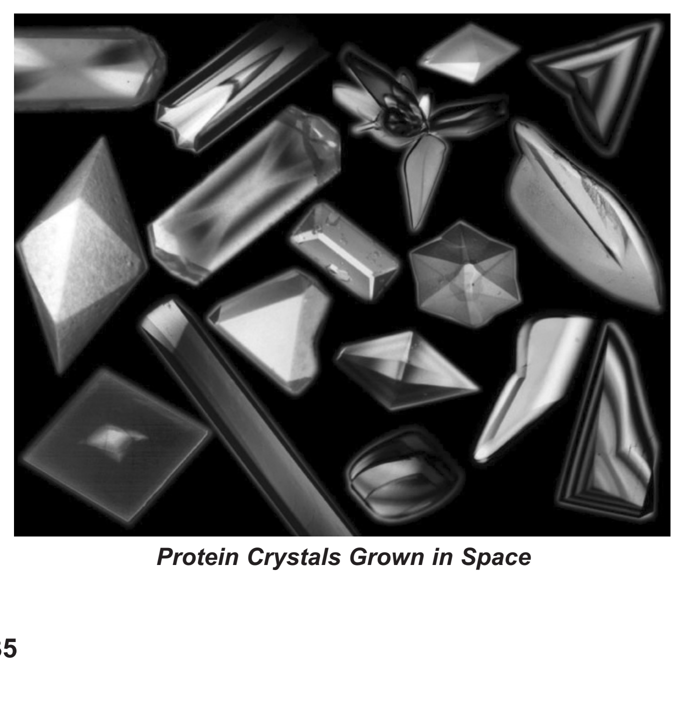
Optional: NASA pictures of crystals grown in space compared to those grown on Earth.

Directions:

1. Discuss ISS crystal growing with your class. **http://www.nasa.gov/centers/marshall/news/background/facts/zeolites.html**
2. There are many kinds of crystals and today you will grow crystals from two different substances: alum and salt.
3. Observe sample crystals and the alum and salt with a magnifier. Discuss similarities and differences.
4. Hypothesize whether crystals formed from the salt and alum will be similar or different in color, size or shape from each other.
5. To prepare the alum: heat 2 cups (500 ml) of water and dissolve about 4 ounces (112 g) of alum in the water. When the alum is dissolved, pour about one inch of the solution into a clean jar and set aside (uncovered) where it will not be disturbed. Within an hour, you should see small crystals begin to form. Pour the rest of the solution into a clear jar and cover it (this can be used for later experiments).
6. To prepare the salt: heat one cup of water and dissolve as much salt as possible in the water (about 3-4 tablespoons). Pour about one inch of the salt solution into a clean jar and set aside (uncovered). Within an hour small crystals of salt will form.
7. Examine both crystals and answer questions from lab sheet. Formulate an experiment with crystal growing, present the idea to the teacher, and proceed when approved.(Research crystal growing on the internet and work in pairs or small groups).
8. **_Safety concerns:_ Teacher should prepare solutions using hot plate and demonstrate safe use of heat. Safety goggles or glasses should be used.**



Zeolite Crystals on the left were grown on earth. The ones on the right were grown in microgravity.



Protein Crystals Grown in Space

Crystal Growing Lab Sheet

Before crystals are grown:

1. Describe the alum granules.

____

____

____

2. Describe the salt granules.

____

____

____

3. How are the alum and salt similar and different.

____

____

____

After crystals are grown:

4. Draw the alum crystals and salt crystals (magnified).

Alum Crystals	Salt Crystals

5. What causes the solutions to form crystals?

____

____

____

6. On the back of this sheet, using the scientific method, design your own crystal growing experiment. Present your idea to your teacher. When approved, proceed with the experiment and present your idea and results to the class.

Activity #9

LANGUAGE ARTS,

Teacher Lesson Plan

Objective:

Students will use research, writing and speaking skills to prepare and deliver an oral presentation on an astronaut/cosmonaut of the International Space Station.

National Standards:

Language Arts

1. Reading for Perspective
4. Communication Skills
5. Communication Strategies
6. Applying Knowledge
7. Evaluating Data
8. Developing Research Skills
12. Applying Language Skills

Technology

17. Develop an understanding of and be able to select and use information and communication technology.

Materials:

Internet (computer), paper, pencil, note cards

Estimated Time:

Two, 45-minute class periods

Background Information:

Sustained human exploration began with the International Space Station. The astronauts and cosmonauts who serve onboard the space station will increase humankind's knowledge of what it is like to live in space. The space station crews rotate during crew exchange flights. As an incoming crew prepares to replace the outgoing crew there is a handover period. The current station crewmembers communicate by telecon to the crew on Earth any unique situations they have encountered, new techniques learned or any topic necessary for life aboard the space station. Once the new crewmembers arrive onboard the space station, the outgoing crew briefs them on safety issues, vehicle changes and payload operations.

In its first year of operation, three crews, made up of four American astronauts and five Russian cosmonauts, have called the space outpost home. In year two, 33 people visited or lived aboard the orbiting complex. As of October 2002, a total of 112 visitors have been aboard the station since the first permanent occupancy (November 2, 2000), including men and women from 6 nations. Note: As of 24 November 2009, the ISS had hosted a total of 266 visitors (185 different people). Mir had 137 visitors (104 people).

Procedure/Activity:

1. Tell students they will research an astronaut/cosmonaut to learn his/her biography and his/her part in the ISS mission.
2. Students will then organize information on note cards and prepare oral reports on their astronaut/cosmonaut.
3. Students will present their reports in the 1st person (they are the astronaut/cosmonaut) using note cards for a guide. The students may want to dress as their person.

Rationale:

This lesson provides a way for the students to learn what it takes to be an astronaut and what activities are being done aboard the space station while increasing their research, writing and speaking skills.

Assessment:

Students can be evaluated by a rubric containing such points as content, organization of information, preparedness, knowledge of subject, and speaking skills such as eye contact, poise, and voice projection.

Additional Information:

- ESL students may be given a longer time to complete research; work with a partner to prepare the report; or work with ESL teacher on project.

- Special Education students may be given extra time to complete the research and oral report and given specific information to look for on their astronaut/cosmonaut.
- Websites: ***http://www.jsc.nasa.gov/Bios/astrobio.html*** Current Astronaut bios

http://www.jsc.nasa.gov/Bios/cosmo.html Current Cosmonaut bios

http://spaceflight.nasa.gov/station/crew Crew info on the ISS

Expedition 22 crew: From the left (front row) are NASA astronaut Jeffrey Williams, commander; and Russian cosmonaut Oleg Kotov, flight engineer. From the left (back row) are NASA astronaut T.J. Creamer, Russian cosmonaut Maxim Suraev and Japan Aerospace Exploration Agency (JAXA) astronaut Soichi Noguchi, all flight engineers.

Expedition 9 crew, Astronaut Edward M. (Mike) Fincke and Cosmonaut Gennady Padalka. They join the Expedition 8 crew, Cosmonaut Alexander Y. Kaleri, Astronaut Michael Foale, and European Space Agendy Astronaut Andre Kuipers aboard the International Space Station.

Activity #9

LANGUAGE ARTS,

Student Information

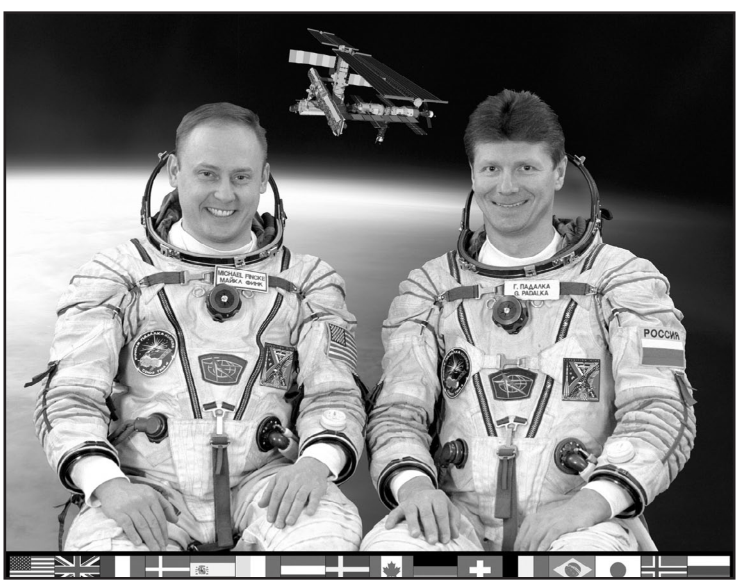
Materials:

Internet (computer), paper, pencil, note cards

Directions:

1. You will research an astronaut/cosmonaut to learn his/her biography and his/her part in the ISS mission.
2. Organize information on note cards and prepare oral reports on your astronaut/cosmonaut.
3. Present your report in the 1st person (you are the astronaut/cosmonaut) using note cards for a guide. You may want to dress as your person or use other visual aids.

Expedition 22 crew: From the left (front row) are NASA astronaut Jeffrey Williams, commander; and Russian cosmonaut Oleg Kotov, flight engineer. From the left (back row) are NASA astronaut T.J. Creamer, Russian cosmonaut Maxim Suraev and Japan Aerospace Exploration Agency (JAXA) astronaut Soichi Noguchi, all flight engineers.



Expedition 9 crew, Astronaut Edward M. (Mike) Fincke and Cosmonaut Gennady Padalka. They join the Expedition 8 crew, Cosmonaut Alexander Y. Kaleri, Astronaut Michael Foale, and European Space Agendy Astronaut Andre Kuipers aboard the International Space Station.

Activity #10

SCIENCE

Teacher Lesson Plan

Objective:

Students will observe different materials ability to reflect or absorb sunlight giving them an understanding of what solar energy is and how it is used to power the Space Station.

National Standards:

Science

A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

B: Physical Science
- Transfer of energy

E: Science and Technology
- Abilities of technological design
- Understandings about science and technology

Unifying Concepts and Processes
- Form and function

Materials:

For each group:
- Three identical jars
- Paper and pencil
- Black paper
- Aluminum paper
- Tape
- Three thermometers
- Sand
- Chart

Estimated Time:

Two hours and 20 minutes

Background Information:

Power is being generated for the International Space Station by utilizing the energy of the sun. Solar arrays and batteries (for when the Earth blocks the Sun's light) are used to produce electricity to power lights, communication systems, control systems, and the computer systems that run the experiments. Electricity is also used for cooking. Arrays are built to last about 15 years. Once they're done producing energy, they will be retracted and replaced with a new array system.

Solar arrays are the huge "wings." They are the largest part of the Space Station. Solar arrays are solar cells bundled together and attached to masts. The masts keep the solar cells facing the Sun. There are a total of eight solar arrays on ISS, measuring about 34 meters by 11 meters. The solar cells convert sunlight to electricity to supply 105 kilowatts of power. That's enough power to light a town.

If we can construct solar sails or arrays out of lightweight, reflective materials to power spacecraft, we can do more distant exploration to the outer planets and beyond. It is important to understand how different materials reflect or absorb sunlight.

Procedure/Activity:

1. Ask students questions to stimulate discussion on solar energy such as:
   a. What is solar energy?
   b. Why should we try to tap and use solar energy for space travel?
   c. Are there any disadvantages?
   d. How can solar energy make life better here on Earth?

2. Tell students that they will begin an experiment to see what materials reflect or absorb sun light. Discuss the procedure, trouble-shoot and ask for additions to the experiment. The procedure is:
   a. Fill the three jars with sand.
   b. Cover the first jar with black paper, including the top, and tape paper in place.
   c. Cover the second jar with aluminum foil,

including the top, and tape the foil in place.

d. Leave the third jar uncovered.
e. Record the temperature of the thermometers on the chart. Be sure all three indicate the same temperature.
f. Insert one thermometer into the sand of each jar. With the two covered jars, puncture a hole in the top covering and insert the thermometer through the hole.
g. Place all three jars in the sunlight. All should receive the same direct sunlight.
h. Check and record the temperature of the three thermometers every 10 minutes for about an hour on the chart.
i. How do the temperatures compare? What can you say about the effect of a black surface and a shiny surface on absorption of energy from the Sun?
j. Remove the jars from the sunlight, and continue to record the temperatures of the three thermometers for another hour.
k. How do the temperature changes compare? What can you say about the effect of a black surface and a shiny surface on heat loss?

Rationale:

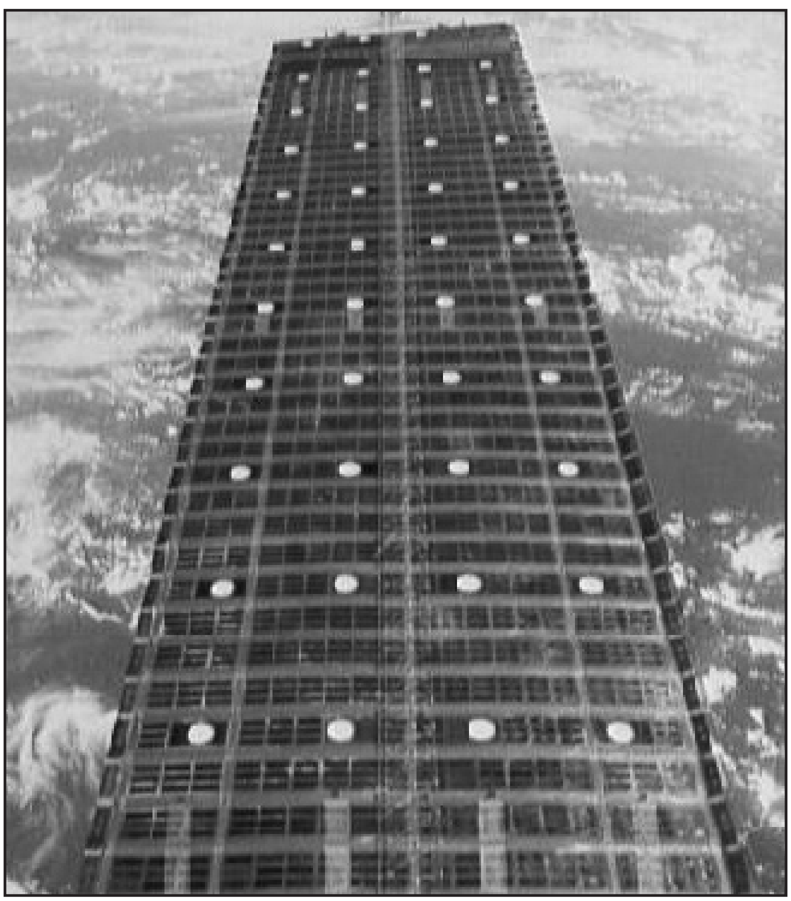
This lesson and experiment will give students a chance to use the scientific method in learning about solar energy and the ISS.

Assessment:

Students should be evaluated on the way they follow the scientific method and proceed with the experiment.

Additional Information:

- ESL students should review key terms with another student and discuss any uses of solar energy that may be different in their country of origin than in the United States.
- Special Education students should work with a partner and draw the steps in the procedure. Extend time for completion.
- Website on solar energy projects: ***http://www.energyquest.ca.gov/library/documents/NREL_Solar_Projects.pdf***



Solar Arrays

Activity #10

SCIENCE

Student Information

Materials:

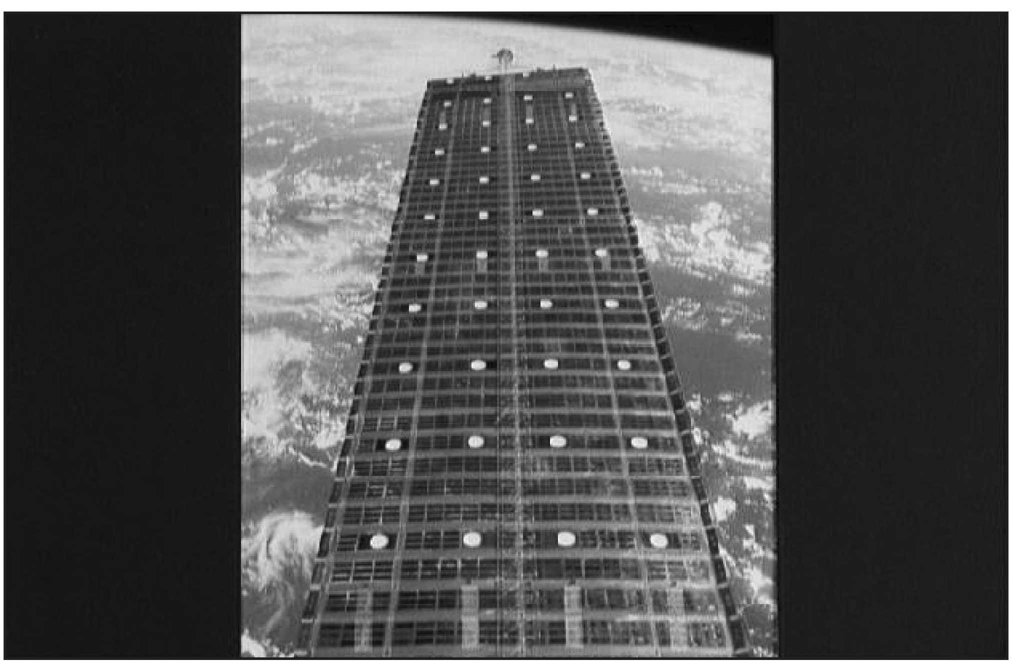
For each group:

- Three identical jars
- Paper and pencil
- Black paper
- Aluminum paper
- Tape
- Three thermometers
- Sand
- Chart

Directions:

You will begin an experiment to see what materials reflect or absorb sunlight. The procedure is:

a. Fill the three jars with sand.
b. Cover the first jar with black paper, including the top, and tape paper in place.
c. Cover the second jar with aluminum foil, including the top, and tape the foil in place.
d. Leave the third jar uncovered.
e. Record the temperature of the thermometers on the chart. Be sure all three indicate the same temperature.
f. Insert one thermometer into the sand of each jar. With the two covered jars, puncture a hole in the top covering and insert the thermometer through the hole.
g. Place all three jars in the sunlight. All should receive the same direct sunlight.
h. Check and record the temperature of the three thermometers every 10 minutes for about an hour on the chart.
i. How do the temperatures compare? What can you say about the effect of a black surface and a shiny surface on absorption of energy from the Sun?
j. Remove the jars from the sunlight, and continue to record the temperatures of the three thermometers for another hour.
k. How do the temperature changes compare? What can you say about the effect of a black surface and a shiny surface on heat loss?



Solar Arrays

Experiment: Materials That Absorb Or Reflect Solar Energy

Prediction (Hypothesis): What materials do you think will store energy the best and reflect energy the best? Why?

Jars in Sunlight Observation Chart

	Initial Temp. Reading	10 Minute Reading	20 Minute Reading	30 Minute Reading	40 Minute Reading	50 Minute Reading	60 Minute Reading
Jar With Black Paper							
Jar With Aluminum Foil							
Jar Uncovered (Control)							

Jars Not in Sunlight Observation Chart

	Initial Temp. Reading	10 Minute Reading	20 Minute Reading	30 Minute Reading	40 Minute Reading	50 Minute Reading	60 Minute Reading
Jar With Black Paper							
Jar With Aluminum Foil							
Jar Uncovered (Control)							

Conclusion: What materials stored energy the best and reflected energy the best? Why?

What would you add or change about this experiment?

Activity #11

SOCIAL STUDIES

Teacher Lesson Plan

Objective:

Students will practice reading longitude and latitude as well as exploring sighting days and times for the ISS at specific locations.

National Standards:

Social Studies:

3. People, Places, and Environment
8. Science, Technology, and Society
9. Global Connections

Materials:

Computer with Internet access, world map or atlas, pencil, and chart to fill in.

Estimated Time:

60 minutes

Background Information:

If you look in the sky at the right time and right place, you can see the International Space Station. Except for the Moon, it's the brightest object in the nighttime sky. The Space Station is in orbit at about 200 miles above the Earth's surface, and moves at about 17,000 miles an hour. Moving at that speed means the ISS makes about 16 complete trips around the Earth each day. The Space Station remains visible in any given section of the sky for 10 minutes or less. If it's not moving it's not the ISS. It moves at approximately the same rate as an airplane, but an airplane blinks. And a plane follows a linear path. The Space Station follows an arc. If you live in the 60 to -60 degree latitudes, you've got the best circumstances to view the ISS and that's just about everyone in America. For sighting information, go to: **http://spaceflight.nasa.gov/realdata/sightings/index.html .**

Procedure/Activity:

1. Review latitude and longitude and how to use an atlas.
2. Give students the chart to locate places and fill in the name of the city for each longitude and latitude.
3. Next, have students go to the j-track web site: ***http://spaceflight.nasa.gov/realdata/sightings/index.html*** and find the day and time the Space Station can be seen at this location (have them choose three days- the same three days - for all locations).
4. Extension: Students can create a graph showing the times and days for each location (locations can be color coded).

Rationale:

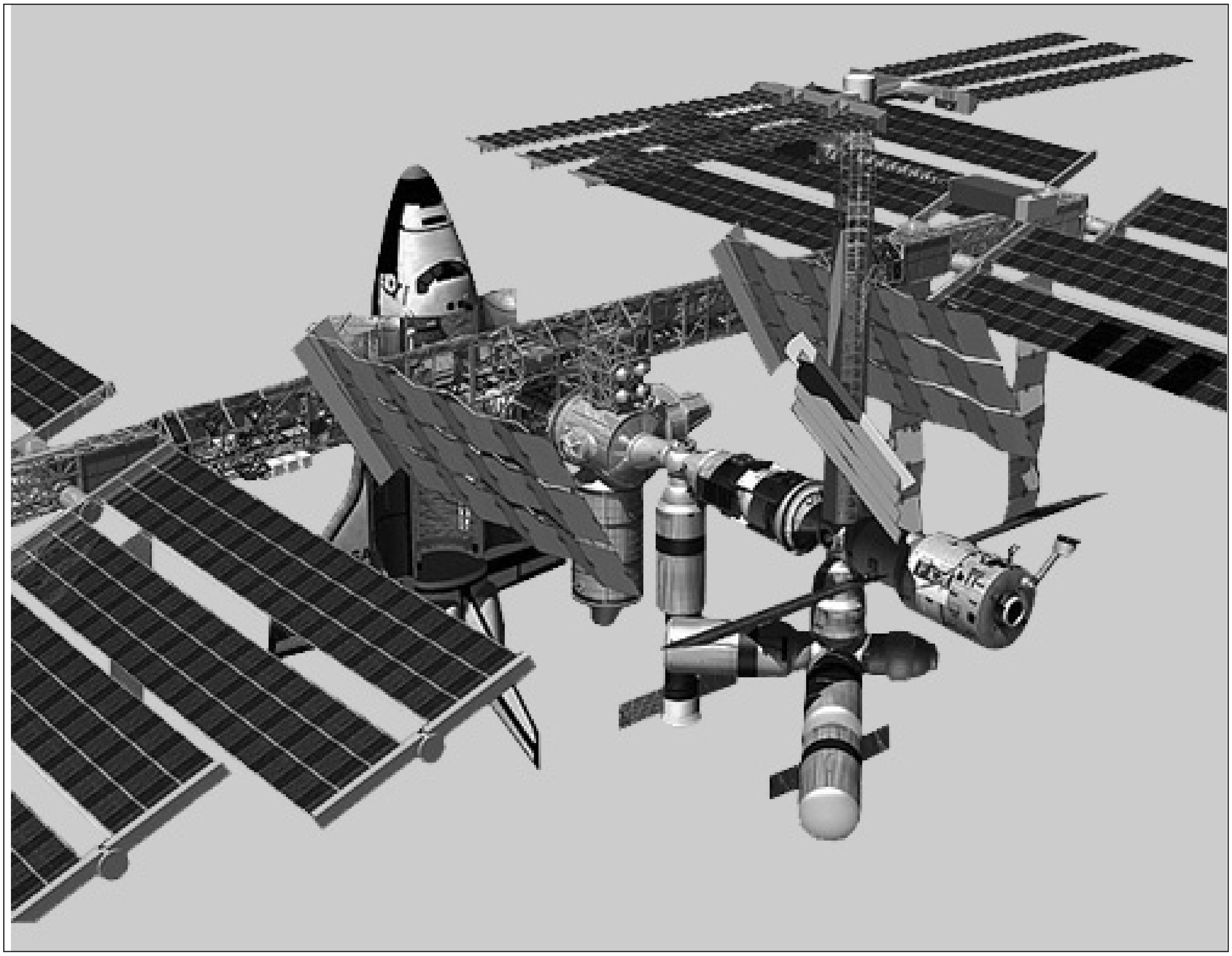
This lesson will strengthen latitude and longitude skill as well as create interest in locating the ISS in the sky.

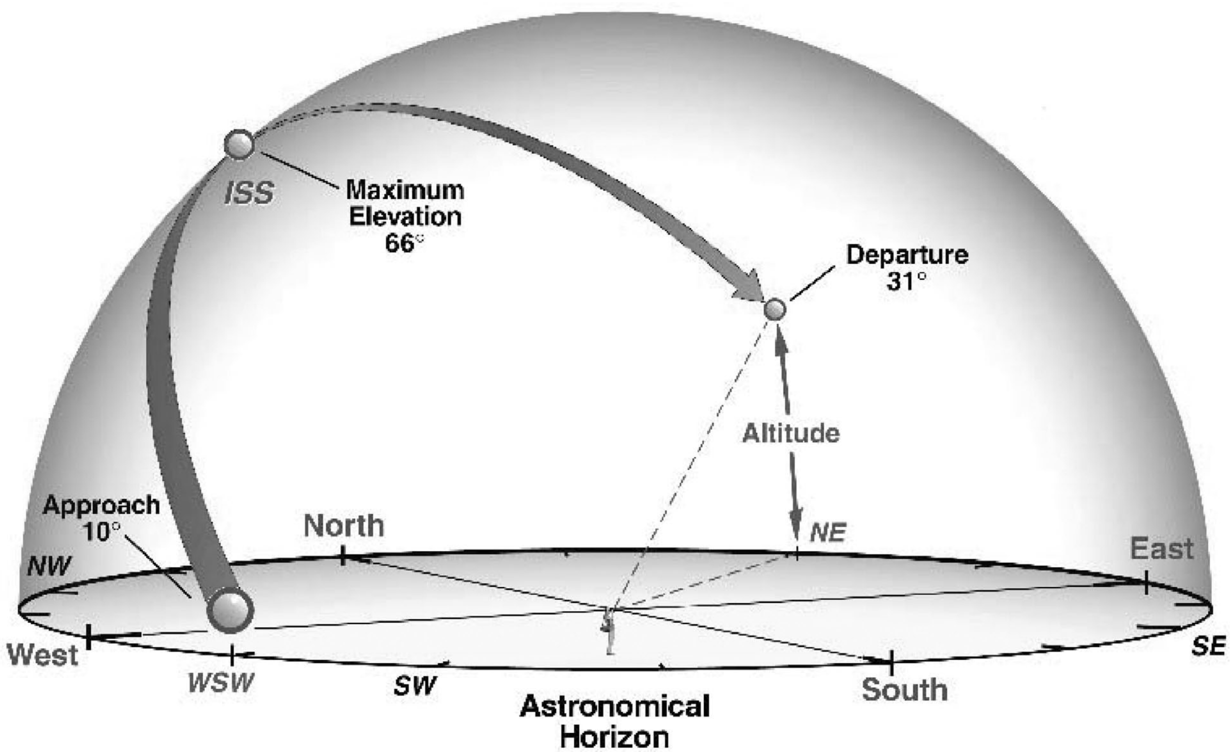
Assessment:

Students will be evaluated according to accuracy in identifying and labeling the cities from the chart.

Additional Information:

- ESL students can locate places with the help of the ESL teacher or another student.
- Special Education students can locate fewer places (half of the chart).
- Website: ***http://liftoff.msfc.nasa.gov/realtime/jtrack/spacecraft.html*** (Skywatch - see satellite paths over the Earth).
- Website concerning longitude and latitude: ***http://www.infoplease.com/homework/latlongfaq.html***
- Website for maps: ***http://www.edplace.com/ss/maps/***




ISS
Maximum
Elevation
66°
Departure
31°
Altitude
Approach
10°
North
NE
East
NW
West
WSW
SW
SE
South
Astronomical
Horizon

Activity #11

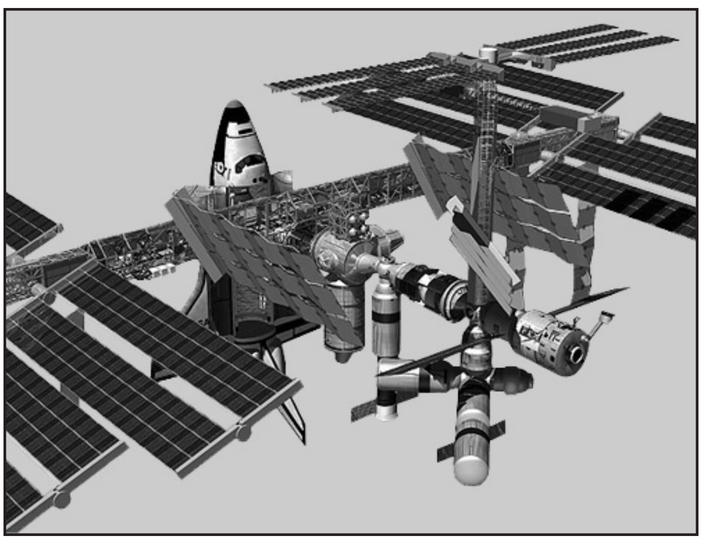
SCIENCE

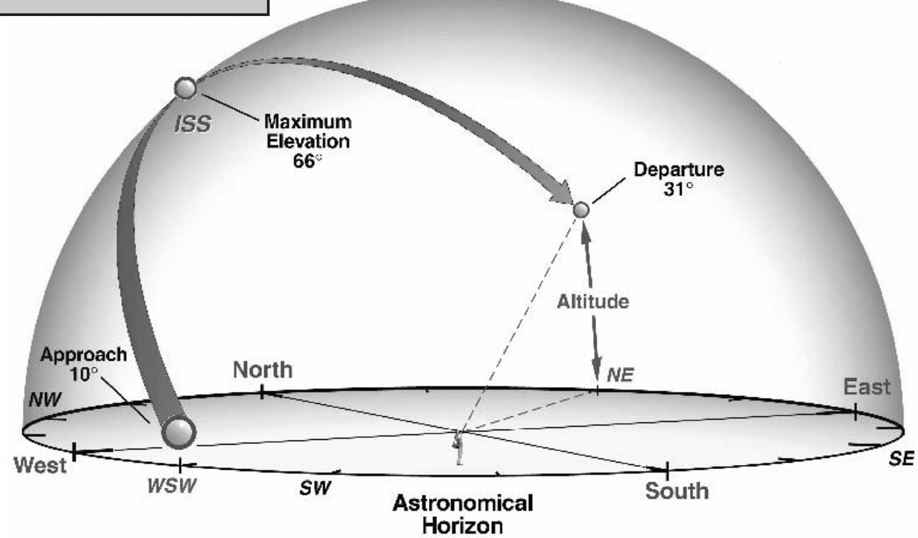
Student Information

Materials:
Computer with Internet access, world map or atlas, pencil, and chart to fill in.

Directions:

1. Review latitude and longitude and how to use an atlas with your teacher.
2. Get the chart to locate places and fill in the name of the city for each longitude and latitude. Place a mark on the map for each location.
3. Go to the j-track web site: ***http://spaceflight.nasa.gov/realdata/sightings/index.html*** and find the day and time the Space Station can be seen at each location (choose three days - the same three days - for all locations).
4. Extension:
   - Create a graph showing the times and days for each location (locations can be color coded).





Name: ____Date: __________________

Web site: ***http://spaceflight.nasa.gov/realdata/sightings/index.html***

Latitude	Longitude	Location	Date(s)	Corresponding Time(s)
57:12:00 N	2:12:00 W			
33:45:46 N	84:25:21 W			
39:55:00 N	116:23:00 E			
33:31:40 N	86:47:57 W			
42:20:10 N	71:01:04 W			
42:53:23 N	78:51:35 W			
53:30:00 N	113:30:00 W			
53:34:00 N	10:02:00 E			
58:23:19 N	134:08:00 W			
38:42:00 N	9:05:00 W			
36:36:05 N	121:52:54 W			
40:46:38 N	111:55:48 W			
30:18:21 N	97:45:02 W			
18:58:00 N	72:50:00 E			
34:20:00 S	58:30:00 W			
30:00:00 N	31:17:00 E			
21:02:00 N	105:51:00 E			
41:02:00 N	29:00:00 E			
37:52:00 S	145:08:00 E			
48:13:00 N	16:22:00 E			

On a world map, place an X on the cities in this chart.

Activity #12

PHYSICAL EDUCATION

Teacher Lesson Plan

Objectives:

- Students will learn the importance of cardiovascular fitness, and design and implement a cardiovascular workout schedule.
- Students will design a game given specified equipment and write rules for the game.

National Standards:

Science:

F: Science in Personal and Social Perspectives
- Personal health

Physical Education:

3. Exhibits a physically active lifestyle.
4. Achieves and maintains a health-enhancing level of physical fitness.

Health:

1. Students will comprehend concepts related to health promotion and disease prevention.
3. Students will demonstrate the ability to practice health-enhancing behaviors and reduce health risks.
6. Students will demonstrate the ability to use goal-setting and decision-making skills to enhance health.

Materials:

- Objective one: Pencil and Student Sheet
- Objective two: a variety of game equipment, such as balls of different sizes, dice, jump ropes, bats, nets, paddles or bats, timers or stopwatches, beanbags, plastic hoops, and relay batons as well as paper and pencil.

Estimated Time:

3 class periods

Background Information:

We read every day about how important exercise is to our health. In space, the need for exercise is different, and sometimes the way astronauts exercise is done differently than on Earth. The reason so much attention and importance is placed on fitness in the microgravity of space is that the reduced physical activity deprives muscles such as those in the thighs, calves, quadriceps, and backs of needed exercise. Without exercise, these muscles begin to atrophy - that is, they start shrinking away. Bone loss is similar to the effects of osteoporosis, the loss of muscle mass means decreased size and strength, and the loss of aerobic capacity means a reduced ability to do physical work because of a weakened cardiovascular system.

On the International Space Station (ISS), exercises are centered around three pieces of equipment.

- ***The cycle ergometer looks much like an exercise bicycle, and gives aerobic conditioning to legs and arms while also conditioning the heart. With monitors to record vital signs and straps to keep the feet and torso in place, pedaling the ergometer provides toning and conditioning the astronauts need.***
- ***The treadmill used in space is a bit different than one used on Earth. Because astronauts are nearly weightless, they need to be harnessed to the machine and weighted down as they walk. Otherwise, even if they managed to stay in place on the treadmill, their exercising***

would be nearly effortless - and ineffective.

- ***The Interim Resistance Exercise Device (IRED) used cylinders filled with disks to create a push-pull resistance to exercise the muscles that don't get much action in microgravity. As muscles and bones work against high resistance, minerals are synthesized into the body, and the cardiovascular system is strengthened.***

Earth-bound humans who live a lifestyle with little or no exercise experience many of the physical degenerations that astronauts encounter in space. Using techniques similar to the ones astronauts use can help non-astronauts develop healthier bodies as well. Several fitness devices have been developed for use on Earth, and the technology for them springs from space fitness needs. Fitness centers around the United States are shifting focus to resistance exercises, finding that their success equals - and sometimes surpasses - the use of weights and machines. Several books have been published advocating alternating bursts of concentrated exertion and milder recovery movements, which astronauts use to maximize their workout results.

Procedure/Activity:

Activity 1:

1. Explain to the class that just like astronauts have to work to keep their heart strong, there are things we can do on Earth to maintain our cardiovascular system.
2. Ask students, "What is cardiovascular activity?" (It is exercise that makes your heart stronger by making your heart beat harder and faster.)
3. Explain to students that fitness is important, and list some of the benefits of cardiovascular activity. (It makes muscles stronger; it increases endurance; it can even help you live longer, etc.)
4. Tell students that doctors recommend that people exercise for at least 20 minutes three times a week.
5. Divide students into groups of four or five, and have them think of as many cardiovascular activities as they can. Hand out the Student Sheets to allow students to record their ideas on the sheets.
6. Bring the group back together and discuss the activities they wrote down. Discuss each activity (Does it increase your heart rate? Is it a cardiovascular activity?)
7. Have each student chose one of the activities they listed, and design a weekly workout using that activity.
8. To schedule a time for their workout, students should first cross out all the times on the Student Sheets that they are busy (at school, asleep, etc.), and then fill in a time that they can work out.

Activity 2:

1. Discuss how astronauts look for interesting ways to stay in shape while they are in space.
2. Tell the groups from activity 1 that they will take turns selecting items from the athletic equipment available until each person has selected an item. (Don't tell them what they are going to be doing yet).
3. When each group has about four or five items, explain that their assignment is to design a game that uses the equipment they have chosen. All games should involve some kind of physical activity.
4. Once each group has decided on a game, have them write detailed rules for playing it (this can be done as a take-home project).
5. Set up a time for each group to share their game with the class. Give them time to demonstrate the game and explain the rules.

Extensions:

- Have students design an exercise plan and develop a game for people with different disabilities. Or they can modify their original plan or game to include people with different disabilities.
- Have students play their game with the class, stopping every 5 minutes to take their pulses. What do you observe? What does this tell you about your activity level?

Rationale:

These two activities will emphasize the importance of physical activity to a healthy lifestyle and use imagination to create an interesting game for physical activity.

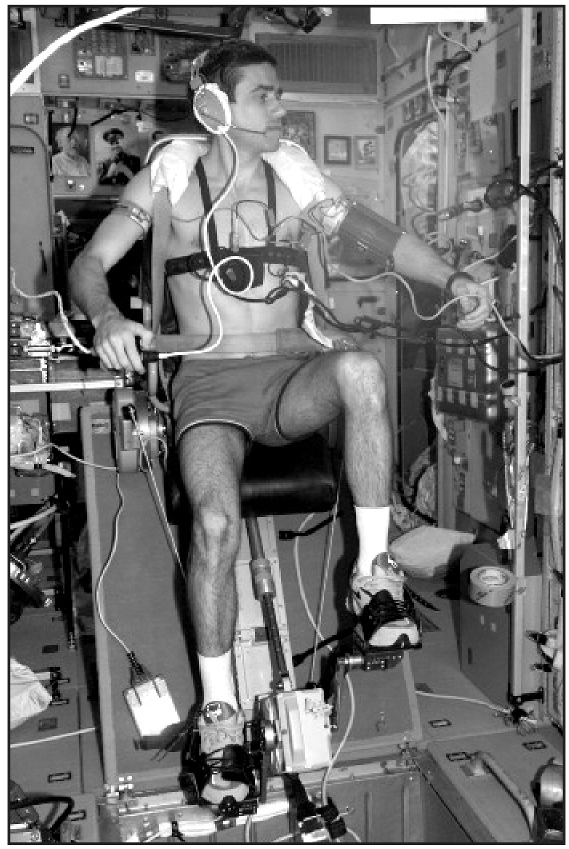
Assessment:

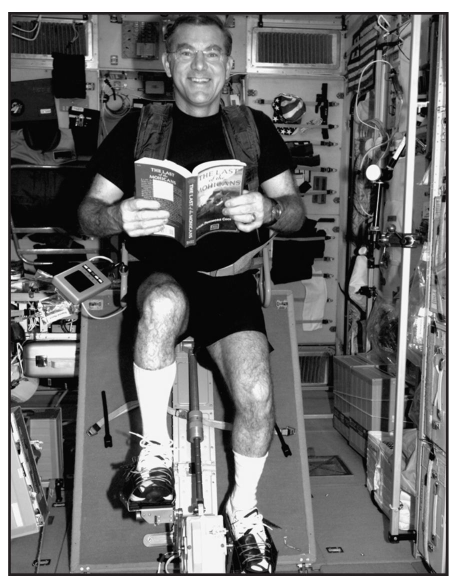
Use a rubric to evaluate each group's ability to work together and accomplish their goal.

Additional Information:

- For ESL students, get them to demonstrate a physical activity done in their country of origin that may be different from the ones in the United States.

EXERCISING IN SPACE





Activity #12

PHYSICAL EDUCATION

Student Information

Materials:

- Objective one: Pencil and Student Sheet
- Objective two: a variety of game equipment, such as balls of different sizes, dice, jump ropes, bats, nets, paddles or bats, timers or stopwatches, beanbags, plastic hoops, and relay batons as well as paper and pencil.

Directions:

Activity 1:

1. Just like astronauts, you have to work to keep your heart strong. There are things we can do on Earth to maintain our cardiovascular system.
2. What is cardiovascular activity?
3. List some of the benefits of cardiovascular activity.
4. Doctors recommend that people exercise for at least 20 minutes three times a week.
5. Think of as many cardiovascular activities as you can. Record your ideas on the student sheets.
6. Discuss the activities you wrote down with the class. Discuss each activity (Does it increase your heart rate? Is it a cardiovascular activity?)
7. Chose one of the activities you listed, and design a weekly workout using that activity.
8. To schedule a time for your workout, you should first cross out all the times on the Student Sheets that you are busy (at school, asleep, etc.), and then fill in a time that you can work out.

Activity 2:

1. Discuss how astronauts look for interesting ways to stay in shape while they are in space.
2. Your group will take turns selecting items from the athletic equipment available until each person has selected an item.
3. When your group has about four or five items, your assignment is to design a game that uses the equipment they have chosen. All games should involve some kind of physical activity.
4. Write detailed rules for playing your game (this can be done as a take-home project).
5. Each group will share their game with the class. Demonstrate the game and explain the rules.

Extensions:

- Design an exercise plan and develop a game for people with different disabilities. Or you can modify your original plan or game to include people with different disabilities.
- Play your game with the class, stopping every 5 minutes to take your pulse. What do you observe? What does this tell you about your activity level?

Student Sheet
Cardiovascular Fitness

Name ____Date____________________

Activity 1:

List some cardiovascular activities:

____

____

____

____

____.

The activity I picked for my workout schedule is: ____

____.

Use this chart to make a workout schedule. First, cross out the times that you are already busy (at school, asleep, eating, etc.), and then write in a time you can work out. Try to find three times during the week that you can exercise.

This is my schedule:

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
6:00 am							
7:00 am							
8:00 am							
9:00 am							
10:00 am							
11:00 am							
12:00 pm							
1:00 pm							
2:00 pm							
3:00 pm							
4:00 pm							
5:00 pm							
6:00 pm							
7:00 pm							
8:00 pm							
9:00 pm							

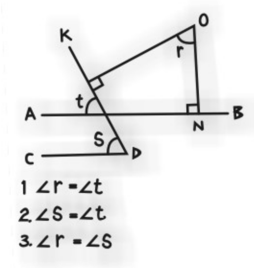
Activity 2:

Use the space below and the back of this sheet to write the rules of the game you and your group developed. What are the results of the game as far as being a cardiovascular activity?

Activity #13

MATHEMATICS

Teacher Lesson Plan



Objective:

Students will review and perform geometric operations involving cylinders and cubes.

National Standards:

Mathematics:

3. Geometry
   - Analyze characteristics and properties of two-and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
   - Use visualization, spatial reasoning, and geometric modeling to solve problems.
4. Measurement
   - Apply appropriate techniques, tools, and formulas to determine measurements.
6. Problem Solving
   - Solve problems that arise in mathematics and in other contexts.
9. Connections
   - Recognize and apply mathematics in contexts outside of mathematics.

Materials:

Calculators (optional) and student sheets

Estimated Time:

45 minutes.

Background Information:

The Multi Purpose Logistics Modules are important elements of the International Space Station (ISS). They are used to take supplies and equipment to the ISS. The modules are Italy's contribution to the ISS. The modules are cylinder-shaped. Each module is about 21 feet long and 15 feet in diameter. Each one weighs almost 4 long tons (4.5 short tons). They are taken to the Space Station in the Space Shuttle's cargo bay. After the Shuttle has docked with the ISS, the Shuttle's robotic arm lifts the module from the cargo bay to the ISS. Once it is in place, the astronauts bolt it to the Station and connect power cables to make it an extra work area.

Each module can carry 16 equipment racks that hold experiments and supplies. The modules can be used to carry supplies from Earth to the ISS and can be loaded with new cargo and sent out again and again.

The dimensions of each module had to be carefully figured so it would fit into the Shuttle's cargo bay.

Procedure/Activity:

1. Hand out student sheets and review the geometric equations needed to solve the problems. Work together as a class on number 1 and then work with a partner on the other questions.
2. Enrichment:
   - Have students create their own word problems after researching the components of the ISS.
   - Have students do a scale model of one of the modules.

Rationale:

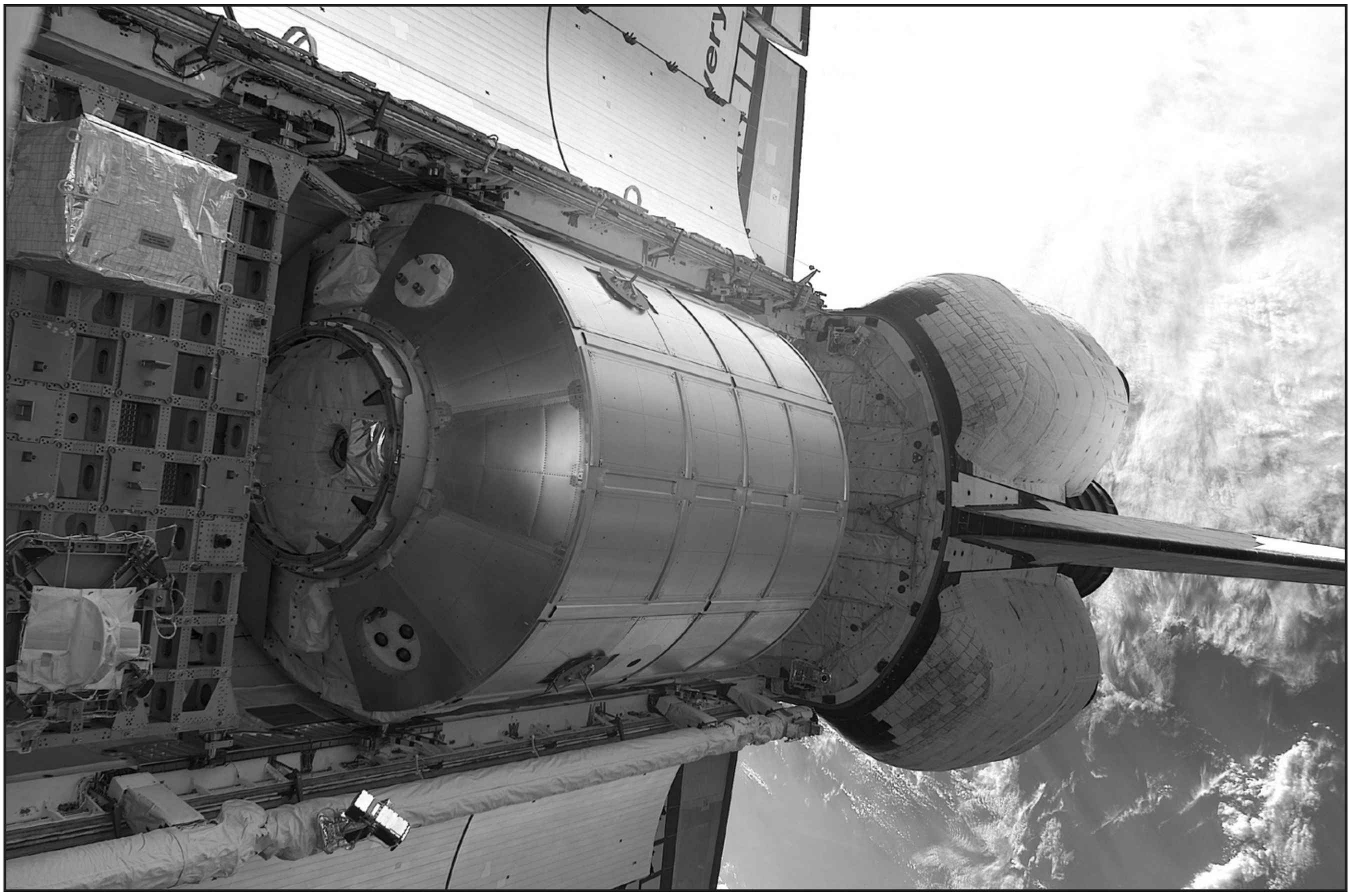
This lesson will give students practice with geometric formulae involving cylinders and cubes.

Assessment:

Evaluate on the correctness of their answers.

Additional Information:

- Special Education students can work with a stronger math student and do fewer problems.



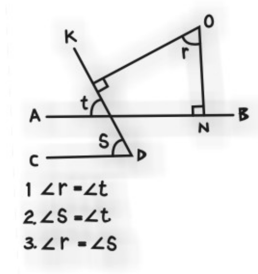
Multi-Purpose Logistics Module in Shuttle Cargo Bay

A view from inside the Multi Purpose Logistics Module,* Leonardo, *which is a pressurized reusable cargo carrier to ferry supplies to the International Space Station. The MPLM was built in Italy.

Activity #13

MATHEMATICS

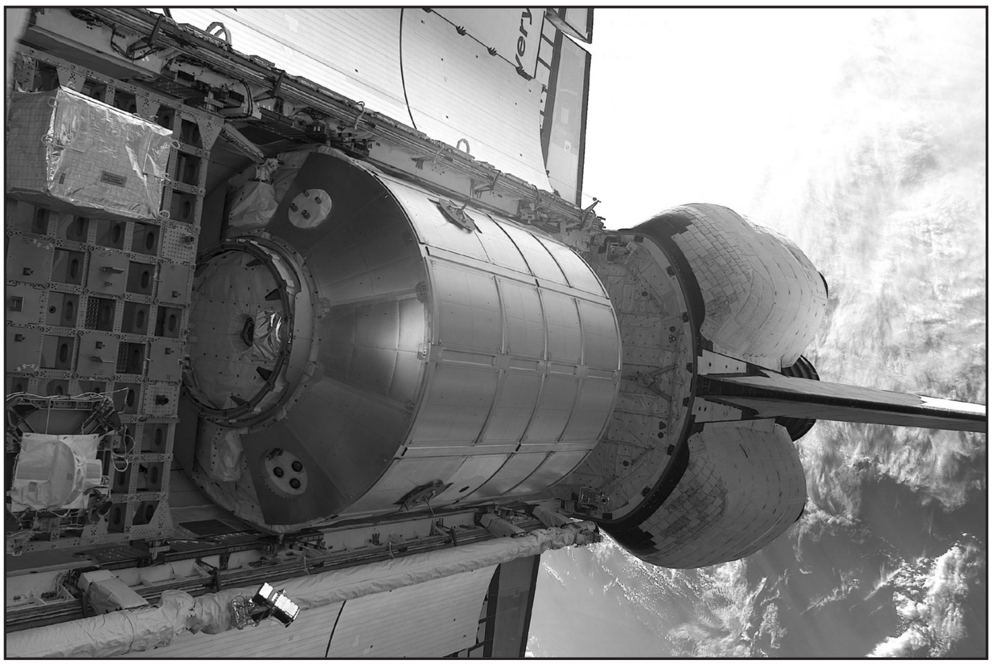
Student Information



Materials:
Calculators (optional) and student sheets

Directions:
1. Work with your class to answer number 1 on the Student Sheet.
2. Work with a partner to answer the rest of the questions.

Multi-purpose Logistics Module in Shutle Cargo Bay



A view from inside the Multi Purpose Logistics Module,* Leonardo, *which is a pressurized reusable cargo carrier to ferry supplies to the International Space Station. The MPLM was built in Italy.

ISS Multi-Purpose Logistics Module Worksheet

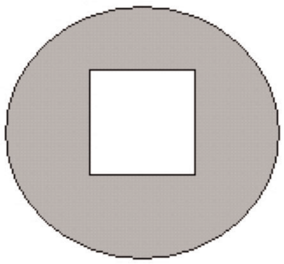
Student Sheet - (Answer the following questions about cylinders and cubes. Be sure to show all of your work, draw diagrams, and double check your answers.) Use the back of your sheet if you need more room.

Name ____

1. You will be using many equations to answer the next questions. Write the equations needed to find the following:
   - Area of a circle:
   - Circumference of a circle:
   - Area of a square:
   - Surface area of a cube:
   - Surface area of a cylinder:
   - Volume of a cube:
   - Volume of a cylinder:
2. What is the circumference of a circle with a diameter of 4 meters?
3. What is the volume of a cube with 9-inch sides?
4. The hatch on the Multi Purpose Logistics Module (MPLM) is square. It has an area of 30.25 square feet. How long is each side of the door?
5. The circumference of a circle is 201 centimeters. What is the diameter of the circle?

6. A cylinder has a volume of 785.4 cubic feet and a radius of 5 feet. How tall is the cylinder?

7. If the circle has a radius of 5 inches and each side of the square has a length of 3 inches, what is the area of the shaded part of the figure?



8. Your company wants to build an exact replica of the Multi Purpose Logistics Module. The module is shaped like a cylinder. It is 21 feet in length and has a diameter of 15 feet. Find the surface area of the module to find out how many square feet of metal you will need to build it.

9. NASA needs to launch some supplies to the International Space Station. The Multi Purpose Logistics Module is going to be used. It is 21 feet long and 15 feet in diameter. If NASA wants to launch 3000 cubic feet of supplies, will it all fit in one module? Prove your answer.

10. Each day, one astronaut creates 10 cubic feet of trash, used supplies, and completed experiments. There are three astronauts on the Space Station at a time. If the Space Shuttle left a MPLM at the Space Station, how many days would it take for the Space Station crew to fill it?

Activity #14

SCIENCE and VISUAL ARTS

Teacher Lesson Plan

Objective:

Students will create travel brochures designed to attract tourists to space travel using writing, research, and artistic skills.

National Standards:

Science Standards:

E: Science and Technology
- Understandings about science and technology

F: Science in Personal and Social Perspectives
- Risks and benefits
- Science and technology in society

G: History and Nature of Science
- Science as a human endeavor

Visual Arts Standards:

I. Understanding and applying media techniques and processes.
II. Using knowledge of structure and functions.
III. Choosing and evaluating a range of subject matter, symbols, and ideas.
VI. Making connections between visual arts and other disciplines.

Materials:

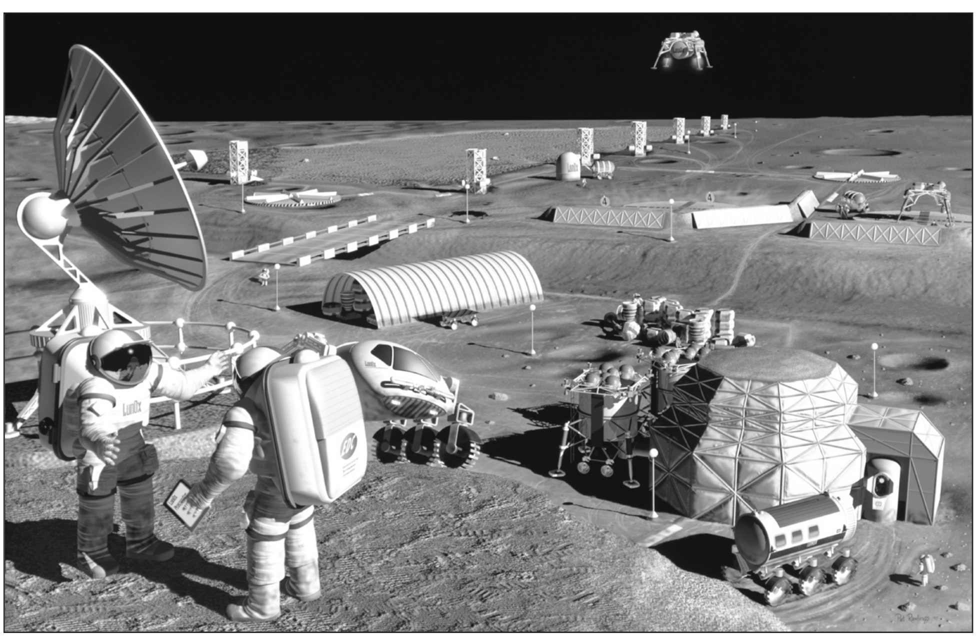
- Websites and print materials on Civilian Space Travel
- Drawing paper, crayons, markers, and/or colored pencils

Estimated Time:

- Research and collect data (1 class period)
- Create brochure (1 class period)

Background Information:

With civilians like Mark Hollingsworth and Dennis Tito becoming citizen space travelers, as well as the quest for the X-Prize, future space travel for civilians seems to be on the horizon. Government and private companies are developing ideas such as space elevators, stage and a half concept, air breathing launch vehicles, and other technologies. Whether your dream of future space travel involves living and working on the moon or Mars, exploring the far reaches of our solar system, or building space colonies and satellite solar power stations, you can be a part of "The Future of Space."



Future Lunar Commercial Base

Procedure/Activity:

1. Have students research (using the Internet or current magazines on space) Space Tourism or Civilian Space Travel. They should explore the problems and possibilities related to future space travel.
2. Have students create travel brochures designed to capture the imagination and interest of civilians and encourage them to plan vacations in space.

Rationale:

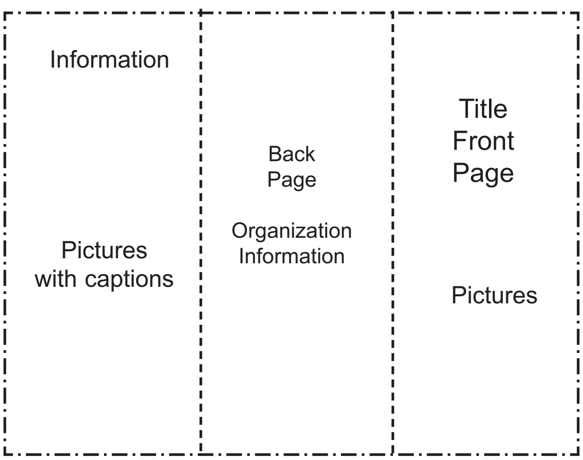
This lesson will provide better understanding of the problems and possibilities of space travel as well as encourage creativity in visual arts.

Assessment:

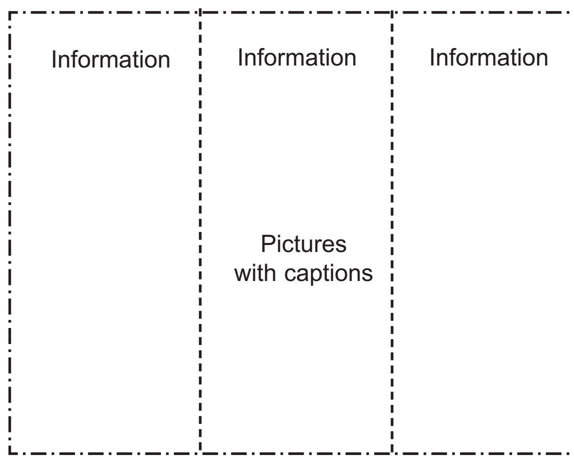
Use a rubric to evaluate the research and creativity of the brochure. A helpful website for rubric information is: ***http://teachers.teach-nology.com/web_tools/rubrics***

Additional Information:

- Students can work in small groups. This will help the ESL student and the special needs student. Be sure rubric includes evidence that all group members were respected and involved in the creation of the brochure.
- Helpful websites:
  http://www.howstuffworks.com/space-tourism.htm (This website tells how space tourism works).
  http://www.xprize.org/ (Website of the X-Prize foundation).



Brochure sample, tri-fold, front and back pages



Inside pages of brochure

Activity #14

SCIENCE and VISUAL ARTS

Student Information

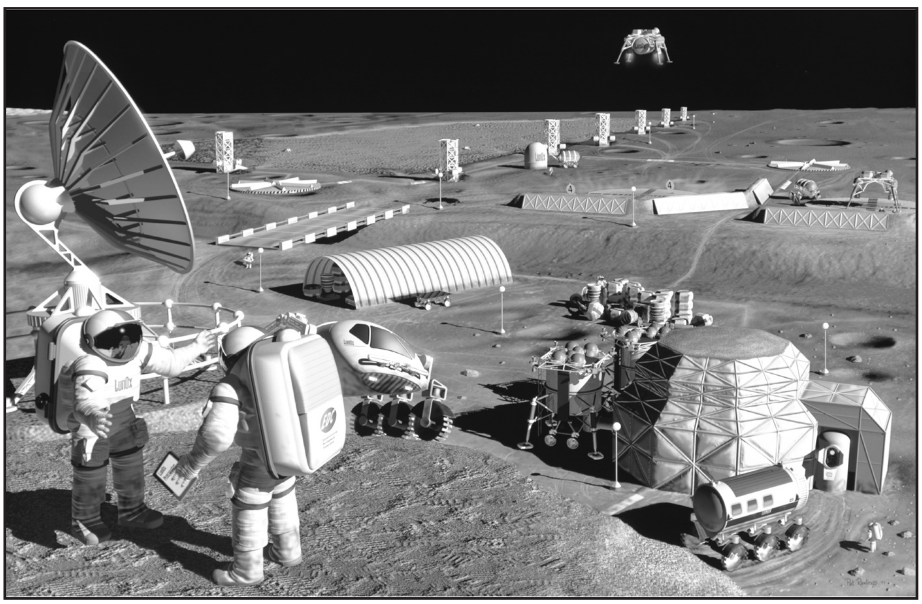
Materials:

- Websites and print materials on Civilian Space Travel
- Drawing paper
- Crayons
- Markers and/or colored pencils

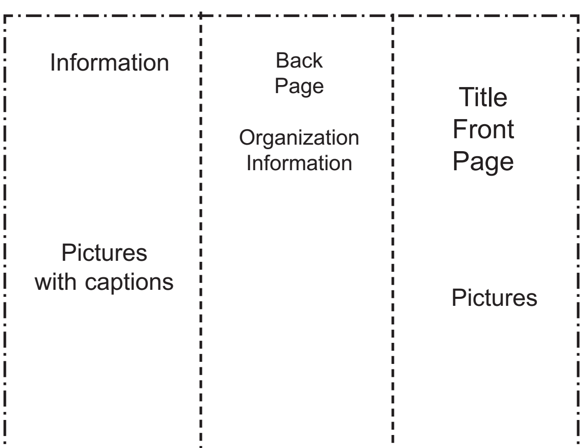
Directions:

1. Research (using the Internet or current magazines on space) Space Tourism or Civilian Space Travel. Explore the problems and possibilities related to future space travel.

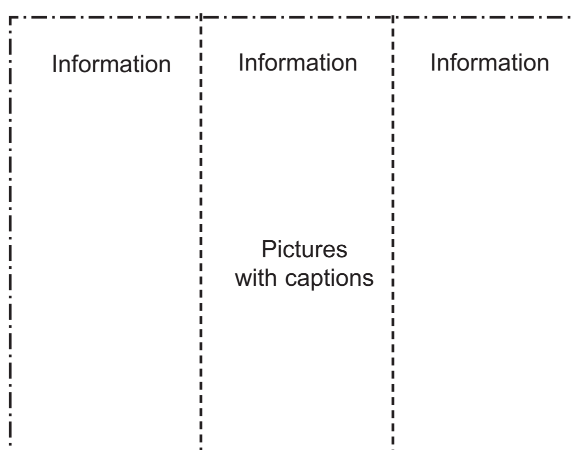
2. Create travel brochures designed to capture the imagination and interest of civilians and encourage them to plan vacations in space.



Future Lunar Commercial Base



Brochure sample, tri-fold, front and back pages



Inside pages of brochure

Activity #15

SCIENCE
Teacher Lesson Plan

Objective:
Students will model the problems space walkers have when doing jobs that involve finger dexterity and look for solutions to the problems.

National Standards:
Science Standards:

A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

E: Science and Technology
- Abilities of technological design

G: History and Nature of Science
- Science as a human endeavor

Unifying Concepts and Processes
- Form and function

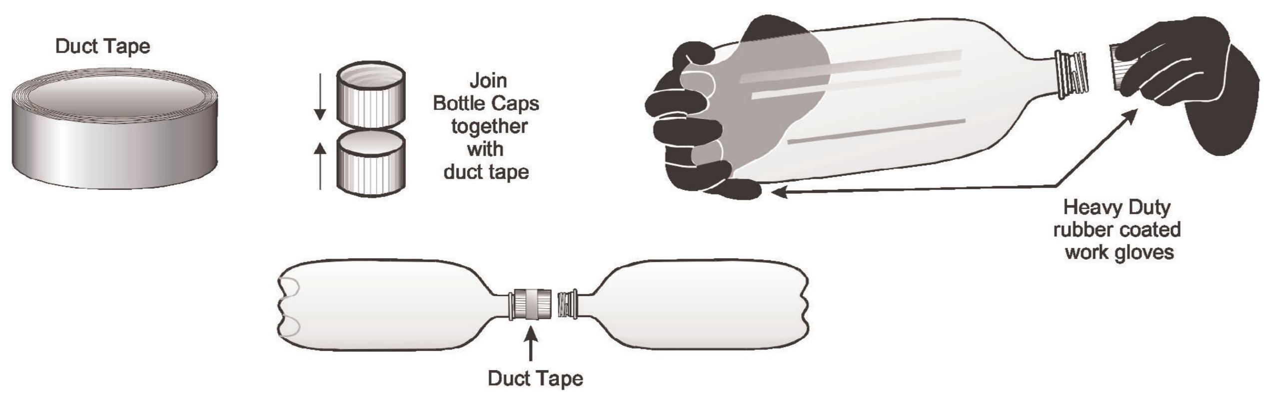
Materials:
- Two soft drink bottles (2-liter size) with caps
- Duct tape
- Scissors
- Heavy-duty (rubber-coated) work gloves

Estimated Time:
One class period.

Background Information:
The greatest challenge in making spacesuits flexible is to construct flexible gloves. When a spacesuit is pressurized, the glove fingers tend to pop out and become stiff. Although it is possible for the astronaut inside to bend the fingers to grab things, fingers get very tired in time, causing the astronaut's efficiency to diminish.

As astronaut and spacewalker James F. Reilly II (STS-104) explains, "The gloves are especially difficult. They're built so they fit your relaxed hand. But when you open your hand you push against the glove. Imagine every time you opened your hands, you had to push against a rubber band holding your fingers closed. After a while, your arm would start to feel tired……"

Procedure/Activity:
1. Have students remove the caps from two clean, empty 2-liter bottles. Tape the caps together with duct tape so that the screw ends point outward in opposite directions.
2. Have a student put on heavy work gloves and try to assemble the two bottles and the joined caps into a single structure. Also have the student try the procedure without gloves. Have students time both procedures and graph the results of each team member's efforts to assemble the structure. Include a comment from each team member concerning the difficulty experienced and a possible solution.



Sample Chart

Name ____ Date __________________

Class ____

Team Members	Time with Gloves	Time without Gloves	Comment	Possible Solution
Team Member #1				
Team Member #2				
Team Member #3				
Team Member #4				

Graph results on back of chart.

Rationale:

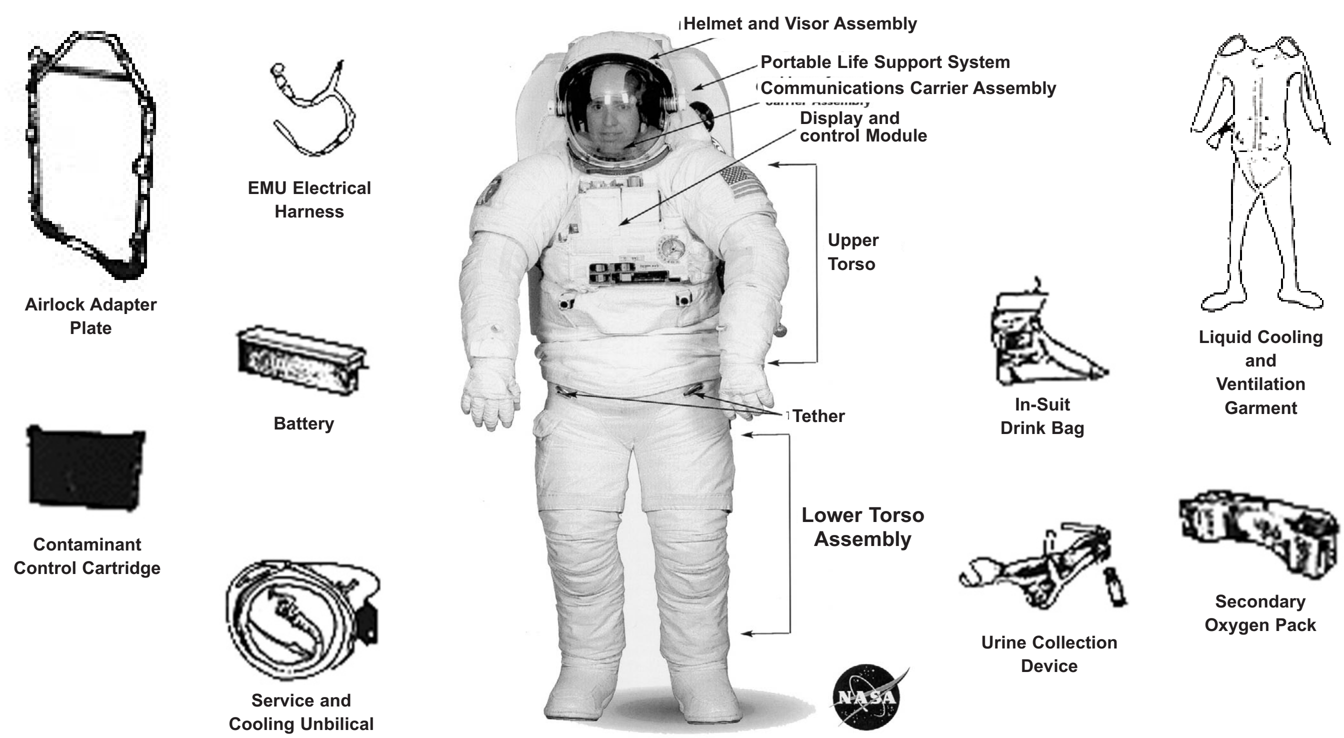
This lesson gives students an opportunity to experience some of the difficulties of working in space and suggest possible solutions.

Assessment:

Use the chart and graph as evaluation tools.

Additional Information:

- For ESL or special needs students, have them explain their observations orally or using an interpreter.
- For more information on spacewalking and spacesuits go to: ***http://www.nasa.gov/audience/foreducators/spacesuits/home/index.html***

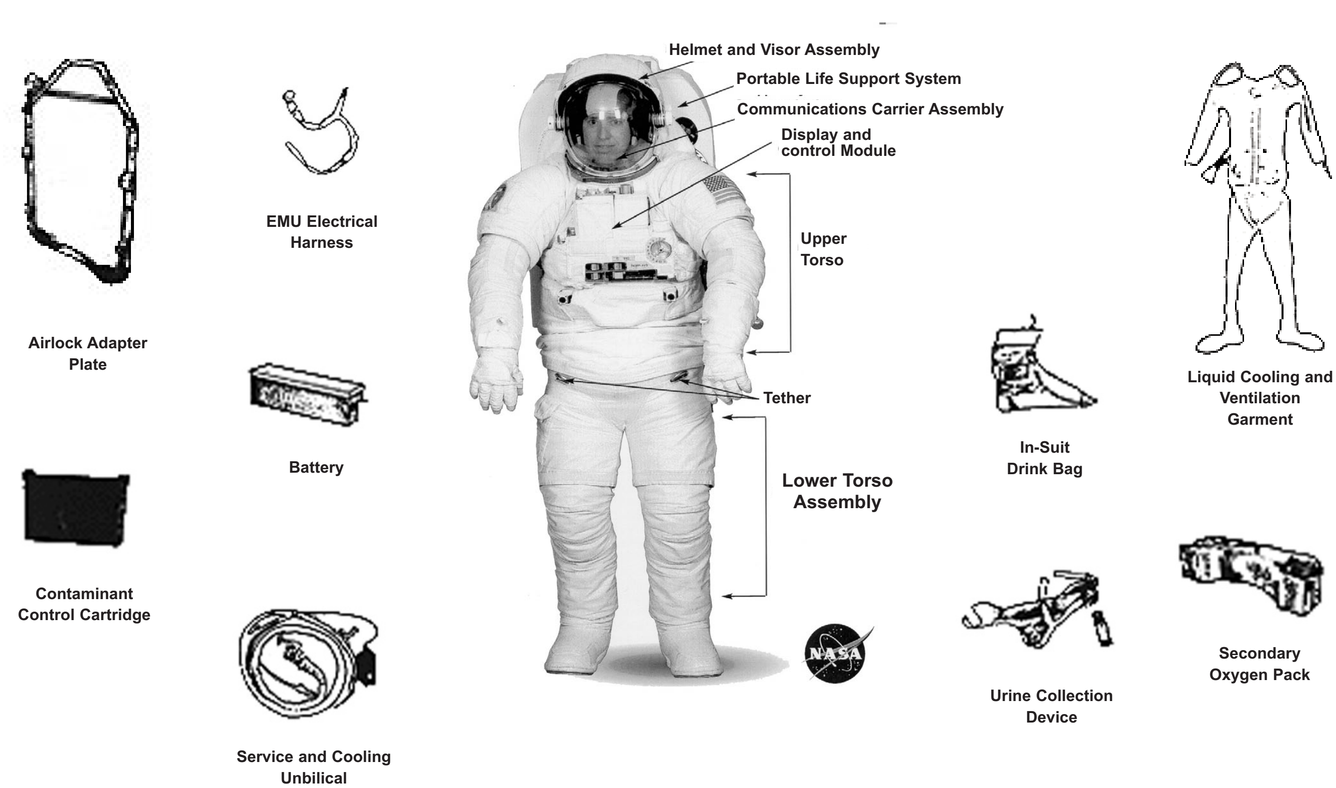


Activity #15

SCIENCE
Student Information

Materials:
- Two soft drink bottles (2-liter size) with caps
- Duct tape
- Scissors
- Heavy-duty (rubber-coated) work gloves

Directions:
1. Have students remove the caps from two clean, empty 2-liter bottles. Tape the caps together with duct tape so that the screw ends point outward in opposite directions.
2. Have a student put on heavy work gloves and try to assemble the two bottles and the joined caps into a single structure. Also have the student try the procedure without gloves. Have students time both procedures and graph the results of each team member's efforts to assemble the structure. Include a comment from each team member concerning the difficulty experienced and a possible solution.



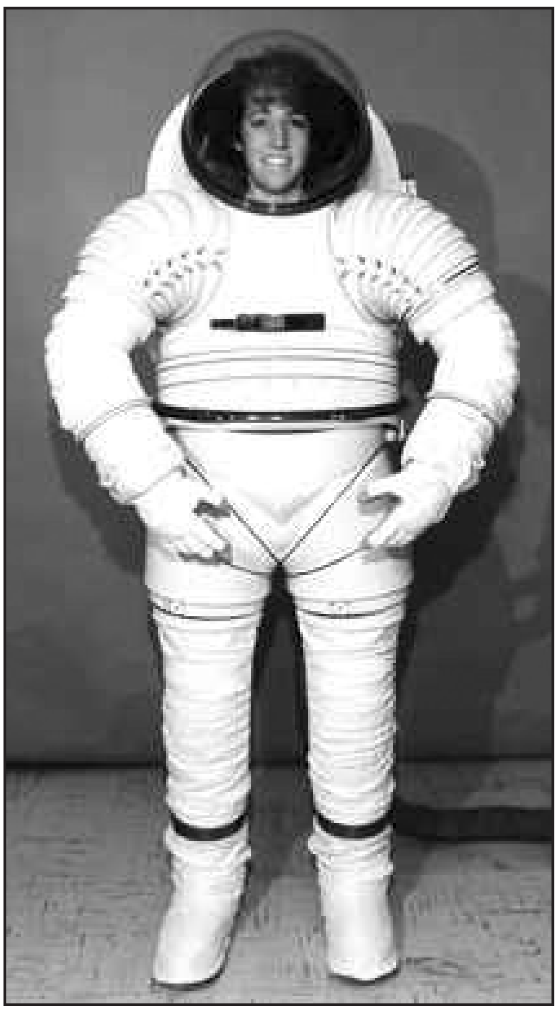
Sample Chart

Name ______________________________ Date ____________

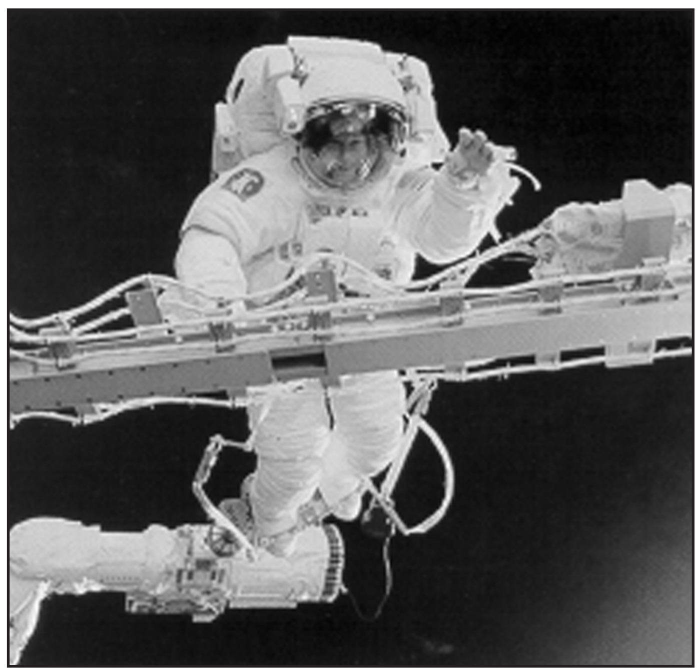
Class ______________________________

Team Members	Time with Gloves	Time without Gloves	Comment	Possible Solution
Team Member #1				
Team Member #2				
Team Member #3				
Team Member #4				

Graph results on back of chart.



The Future of Spacesuits



Today's Spacesuit

Activity #16

MUSIC
Teacher Lesson Plan

Objective:
Students will use their imaginations and creativity to draw interpretations from music based on space.

National Standards:
Music Standards:

6. Listening to, analyzing, and describing music.
8. Understanding relationships between music, the other arts, and disciplines outside the arts.
9. Understanding music in relation to history and culture.

Materials:
- Art supplies (paper, crayons, markers, etc.)
- Selections of music pertaining to space such as 2001: A Space Odyssey, Star Wars, Apollo 13, The Right Stuff, etc.

Estimated Time:
One class period.

Background Information:
Space music has many meanings. Gustav Holst with his "The Planets" is an example of the love of astronomy and space. Modern artists such as Elton John ("Rocket Man") and David Bowie ("Space Oddity") have also left their mark on space music.

Soundtracks from popular movies about space have also inspired us. Such movies as 2001: A Space Odyssey, Star Wars, Apollo 13, and The Right Stuff have carried us from the beginning of space history to the present and beyond.

Jonn Serrie is the foremost composer of space music. His genre of electronic music has been commissioned for planetariums around the world. He is an FAA licensed pilot and lives in Atlanta.

Procedure/Activity:
1. Have students listen to selections of "space" music. Have them discuss how this music brings space to mind.
2. Have students draw visual representations of what the music seems to say to them.
3. Extension Activity: Have students create their own "space" music selection. They could even create a "space" instrument. Discuss how sound travels. Could you actually hear music in space (outside of an artificial Earth environment)?

Rationale:
This lesson allows students the opportunity to be creative and think about how their own experience and history influence their interpretation of music.

Assessment:
Evaluate students on their participation and completed assignment.

Additional Information:
- NASA and music from space article - ***http://www.jpl.nasa.gov/releases/2002/release_2002_196.cfm***
- You may want to have a "Space" art show and include some of the comments about the music made by students. The "Space" music can be played while parents visit the exhibit.

Music is entertainig and relaxing.

Activity
#16

MUSIC
Student Information

Materials:
- Art supplies (paper, crayons, markers, etc.)
- Selections of music pertaining to space such as 2001: A Space Odyssey, Star Wars, Apollo 13, The Right Stuff, etc.

Directions:
1. Listen to selections of "space" music.
2. Discuss what this music brings to your mind.
3. Draw a picture of what the music says to you.
4. Extra: Create your own "space" music. Create your own "space" instrument to play on.
5. Answer the following questions:
   a. How does sound travel?
   b. Could you actually hear music in space (outside of an artificial Earth environment)?

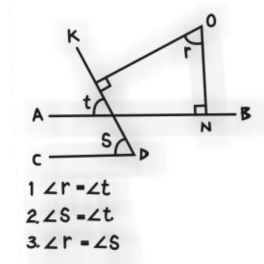
Music is relaxing and entertaining for Astronauts and Cosmonauts alike.

Cosmonaut Sergei Treschev, Expedition Five Flight Engineer, performs on a guitar in the Zvezda Service Module on the International Space Station.

Activity #17

MATHEMATICS

Teacher Lesson Plan



Objective:

Students will create a labeling device/navigation system used to give directions to a robot on the International Space Station.

National Standards:

Mathematics Standards:

3. Geometry Standards
   - Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
   - Use visualization, spatial reasoning, and geometric modeling to solve problems.
6. Problem Solving Standard
   - Solve problems that arise in mathematics and in other contexts.
   - Apply and adapt a variety of appropriate strategies to solve problems.
8. Communication Standard
   - Organize and consolidate their mathematical thinking through communication.
   - Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
9. Connections Standard
   - Recognize and apply mathematics in contexts outside of mathematics.

Materials:

Maze student sheets, paper, pencils.

Estimated Time:

1 class period

Background Information:

The word robot comes from the Czech work robota, which means forced or repetitive labor. Robots today usually do not look like humans (as in science fiction). They can be found in manufacturing, research, medical treatment, entertainment and space. NASA uses robots to explore Earth and other planets and to manipulate payloads on the Space Shuttle. They are also used on the International Space Station. Assembly robots will help build and maintain the International Space Station during the next few years.

Robots in space come in all shapes and sizes. An example is the large, red, spherical flying Personal Assistant Robot (PSA) being developed to help astronauts keep track of progress of experiments, note unusual circumstances and provide feedback. There is also the Serpentine Robotics Project at NASA Ames Research Center in California where "snake robots" are being tested. Mars exploration has brought about rover robots and NASA is also working on a "Robonaut".

Robots follow only commands that have been programmed in their microprocessor brains. Robots are not able to think for themselves, but their programming often allows them to make decisions through a process called feedback.

Procedure/Activity:

1. Have students discuss the directions robots in space would/would not understand. Directions like left, right, north, south, up and down have no meaning because they rely on the initial orientation of the robot and/or the location of the maze.
2. Have students look at the maze and decide how to give instructions to a robot to move from the start square to the finish square.
3. Have students list the directions for the robot to follow in the space provided by the maze.
4. Next, have students try the same thing on the expanded maze.
5. Ask students how they could change their system to make it better.

Rationale:

This lesson encourages students to use their problem solving skills to come up with a labeling device/navigation system with robots in space receiving their instructions.

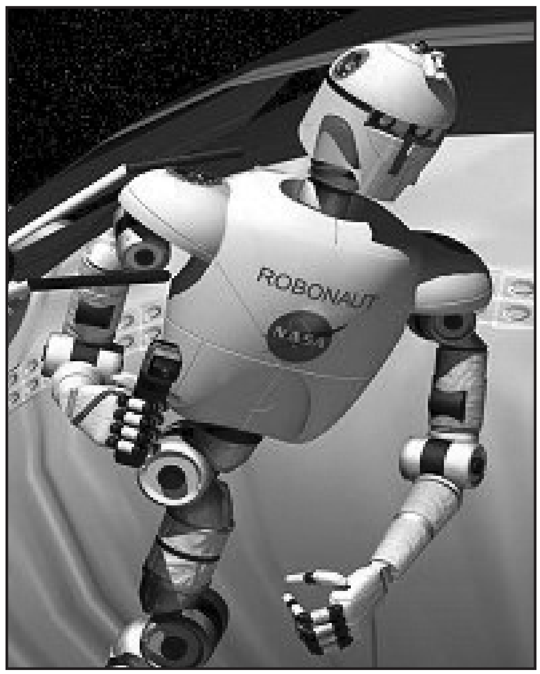
Assessment:

Use a rubric to evaluate the labeling device/ navigation system according to guidelines provided.

Additional Information:

- ESL and Special Needs Students should use pictures or symbols in their mazes to direct their robots.
- Compare different uses of robots in industry and space. Write a journal entry on your research and share your observations with the class.
- Build a "safe" maze outside or in the class room and let one blindfolded student be given directions through the maze by the rest of the class. Each person gives one direction.

Personal Assistant Robot (PSA)

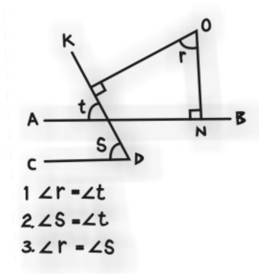


Robonaut

Snake Robot

Activity
#17

MATHEMATICS
Student Information



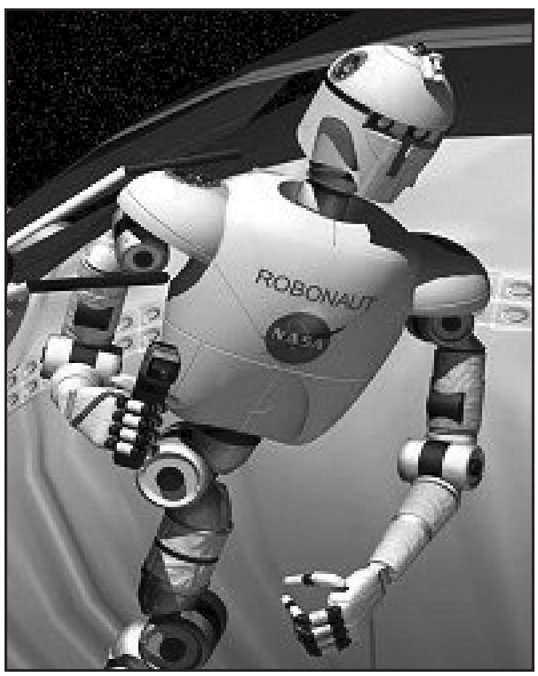
Materials:

Maze student sheets, paper, pencils.

Directions:

1. Discuss the directions robots in space would/would not understand. (Directions like left, right, north, south, up and down have no meaning because they rely on the initial orientation of the robot and/or the location of the maze).
2. Look at the maze and decide how to give instructions to a robot to move from the start square to the finish square.
3. List the directions for the robot to follow in the space provided by the maze.
4. Next, try the same thing on the expanded maze.
   How can you change your system to make it better?

Personal Assistant Robot (PSA)



Robonaut

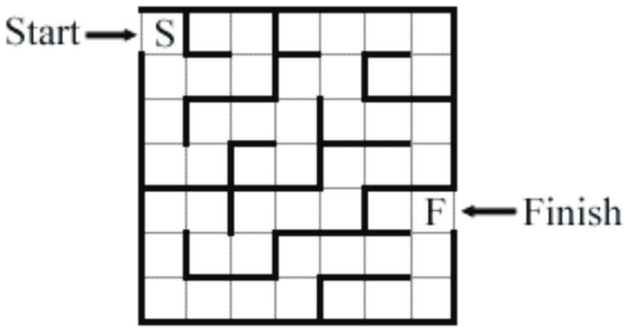
Snake Robot

Maze Student Sheet

Student Name____

Class____

Original



Directions to complete maze:

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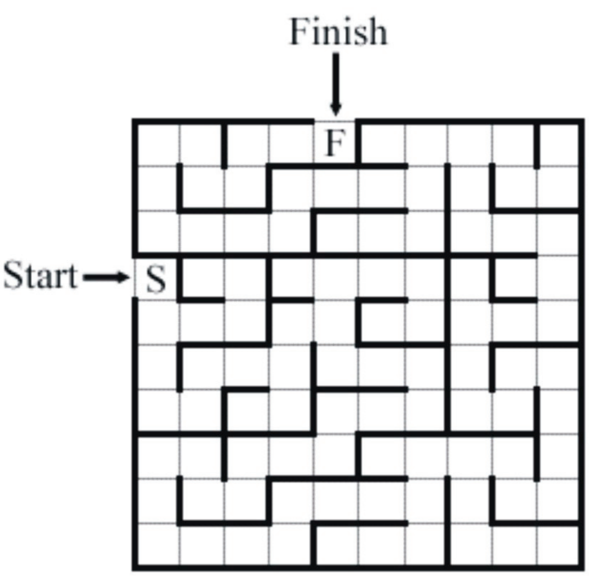
Expanded Maze



Directions to complete maze:

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Activity #18

CAREERS and Technology

Teacher Lesson Plan

Objective:

Students will research aerospace careers and create a poster on one using a program such as Microsoft Publisher.

National Standards:

Technology Standards:

8. Students will develop an understanding of the attributes of design.
11. Students will develop abilities to apply the design process.

Social Studies Standards:

4. Individual Development and Identity

Materials:

Computer with Internet access, Microsoft Publisher or similar program.

Estimated Time:

One class period to research aviation careers and one class period to create poster.

Background Information:

Consider a career in aerospace! With the X-Prize and Mars exploration the hot topics for the future of flight and space travel, the career fields involved with these endeavors are open to explore. From engineering to mathematics to piloting, we see many opportunities for science, math, and technology to become more and more essential in school curricula.

Procedure/Activity:

1. Have students research the Internet for aerospace careers. Some possible web sites to explore are:
   - ***http://kids.earth.nasa.gov/archive/career/index.html*** (Careers in Earth Science)
   - ***http://wings.avkids.com/Careers/index.html*** (Careers in aviation and aerodynamics)
   - ***http://www.airforce.com/opportunities/enlisted/careers/*** (Air Force careers)

2. Have students answer such questions as:
   - What is the name of the job/career you have chosen for your poster?
   - Define the job/career. Include a picture if possible.
   - How does this job/career relate to the aerospace field?
   - What are the requirements needed to do this job/career?
   - What are the pros and cons of this particular job/career? What are the challenges?
   - How much does the job pay?

3. Have students use the data they have collected to create a job poster using Microsoft Publisher or similar program.

Rationale:

This lesson gives students an opportunity to explore career fields as well as create a product using the computer.

Assessment:

Use a rubric to evaluate the creativeness of the poster and the thoroughness of the research.

Additional Information:

- ESL students can work with a partner to complete this assignment. They may also research international type careers in aerospace.
- Give special needs students extra time to complete the questions. They may also be given two or three items to look for instead of all.

Activity #18

CAREERS and Technology

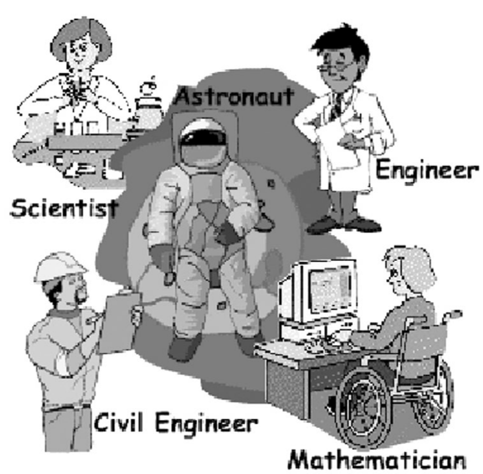
Student Information

Materials:

Computer with Internet access; Microsoft Publisher or similar program.

Directions:

1. Research the Internet for aerospace careers. Some possible websites to explore are:
   - ***http://kids.earth.nasa.gov/archive/career/index.html*** (Careers in Earth Science)
   - ***http://wings.avkids.com/Careers/index.html*** (Careers in aviation and aerodynamics)
   - ***http://www.airforce.com/opportunities/enlisted/careers/*** (Air Force careers)
2. Answer these questions as part of your research:
   a. What is the name of the job/career you have chosen for your poster?
   b. Define the job/career. Include a picture if possible.
   c. How does this job/career relate to the aerospace field?
   d. What are the requirements needed to do this job/career?
   e. What are the pros and cons of this particular job/career? What are the challenges?
   f. How much does the job pay?
3. Use the data you have collected to create a job poster using Microsoft Publisher or similar program.



Activity #19

SCIENCE
Teacher Lesson Plan

Objective:

Students will investigate the systems of the ISS and create a "How it Works" poster and explanation detailing how one of these systems helps create a human-friendly environment in the ISS.

National Standards:

Science Standards:

A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

C: Life Science
- Diversity and adaptations of organisms

E: Science and Technology
- Abilities of technological design
- Understandings about science and technology

F: Science in Personal and Social Perspectives
- Populations, resources, and environments

G: History and Nature of Science
- Science as a human endeavor

Unifying Concepts and Processes
- Systems, order, and organization

Materials:

Computer with Internet access for research, art supplies (paper, pencil, markers, crayons, and/or colored pencils).

Estimated Time:

One class period for research and one class period to create "How it Works" poster.

Background Information:

For astronauts aboard the International Space Station, the workday is a combination of sitting in front of the computer, building or fixing things, and studying our planet and the universe around us. The biggest differences are there is no gravity and their "office" is traveling at 28,000 kilometers per hour (17,500 mph).

A space station crew has two main jobs: make sure all the space station's systems keep working properly and to do science experiments.

Station crews spend a lot of time taking care of the space station such as checking station systems, cleaning air filters and updating computer equipment to make sure their "home" stays in good shape.

Space is a difficult place to live and work. There is no air to breathe, or water to drink. The International Space Station has to provide an Earth-like environment with abundant power, clean water, and breathable air for the humans, animals, and plants aboard 24-hours a day, indefinitely.

Procedure/Activity:

1. Have students work in groups to study, research, and create a "How it Works" poster explaining one of the following:
   - life support
   - atmosphere control, supply and recycling
   - water recycling
   - temperature control
   - food supply
   - waste removal
   - fire protection
   - propulsion - move the station in orbit
   - communications and tracking - talk with ground-based flight controllers
   - navigation - find its way around
   - electrical power
   - computers - coordinate and handle information
   - resupply - methods of getting new supplies and removing waste
   - emergency escape route

2. A good source of information is: ***http://www.howstuffworks.com/space-station.htm.***

Rationale:

This lesson will inform students about the hazards and adjustments of living in space versus our Earth environment and how human beings have adapted to this hostile environment.

Assessment:

Use a rubric for evaluating the poster and related research.

Additional Information:

- ESL students should be in a group with a bilingual or English-speaking study buddy. Have ESL students help the group with the graphics and pictures.
- Encourage special needs children to think of things they need each day to survive and ask them to find out how one of these needs is met for astronauts on the space station.

A FEW NECESSITIES

EXERCISE

COMMUNICATION

FOOD

WATER

Activity #19

SCIENCE
Student Information

Materials:

Computer with Internet access for research, art supplies (paper, pencil, markers, crayons, and/or colored pencils).

Directions:

1. Work in groups to study, research, and create a "How it Works" poster explaining one of the following:
   - life support
   - atmosphere control, supply and recycling
   - water recycling
   - temperature control
   - food supply
   - waste removal
   - fire protection
   - propulsion - move the station in orbit
   - communications and tracking - talk with ground-based flight controllers
   - navigation - find its way around
   - electrical power
   - computers - coordinate and handle information
   - resupply - methods of getting new supplies and removing waste
   - emergency escape route
2. A good source of information is: ***http://www.howstuffworks.com/space-station.htm***.

A FEW NECESSITIES

EXERCISE

FOOD

COMMUNICATION

WATER

Activity #20

LANGUAGE ARTS

Teacher Lesson Plan

Objective:

Students will research technology and future plans for the exploration of space and write an article for a newspaper in the year 2050.

National Standards:

English Language Arts:

1. Reading for Perspective
4. Communication Skills
5. Communication Strategies
6. Applying Knowledge
8. Developing Research Skills
12. Applying Language Skills

Materials:

Reference materials and/or Internet sites relating to space technology and future space exploration, paper, pen.

Estimated Time:

1 hour to research and 45 minutes to write, proof, and correct article.

Background Information:

People are by nature explorers. They are curious about what is around them and that includes space. For decades, space has been a successful national priority. We have landed on the moon, built the shuttle, and are building the International Space Station. This is only the beginning - where will our exploratory nature take us in the decades to come? Conducting integrated human and robotic space exploration will enable humans and robots to explore deep space in an affordable and safe manner. The capabilities we need to accomplish further space exploration are: in-space transportation; robotic/human tools; crew health and safety; and space systems performance being low mass, self-healing and self-assembling. To reach these capabilities and beyond, we are only limited by our own desire and creativity.

Procedure/Activity:

1. Have students use current science/space periodicals, books, and Internet sources to research the future of space vehicles, technology, and space exploration.
2. Have students use their research to write, proof, and correct an article for a futuristic newspaper (2050).
3. Students should share their articles with the class. The entire class set of articles can be compiled and used to showcase writing skills and scientific research.

Rationale:

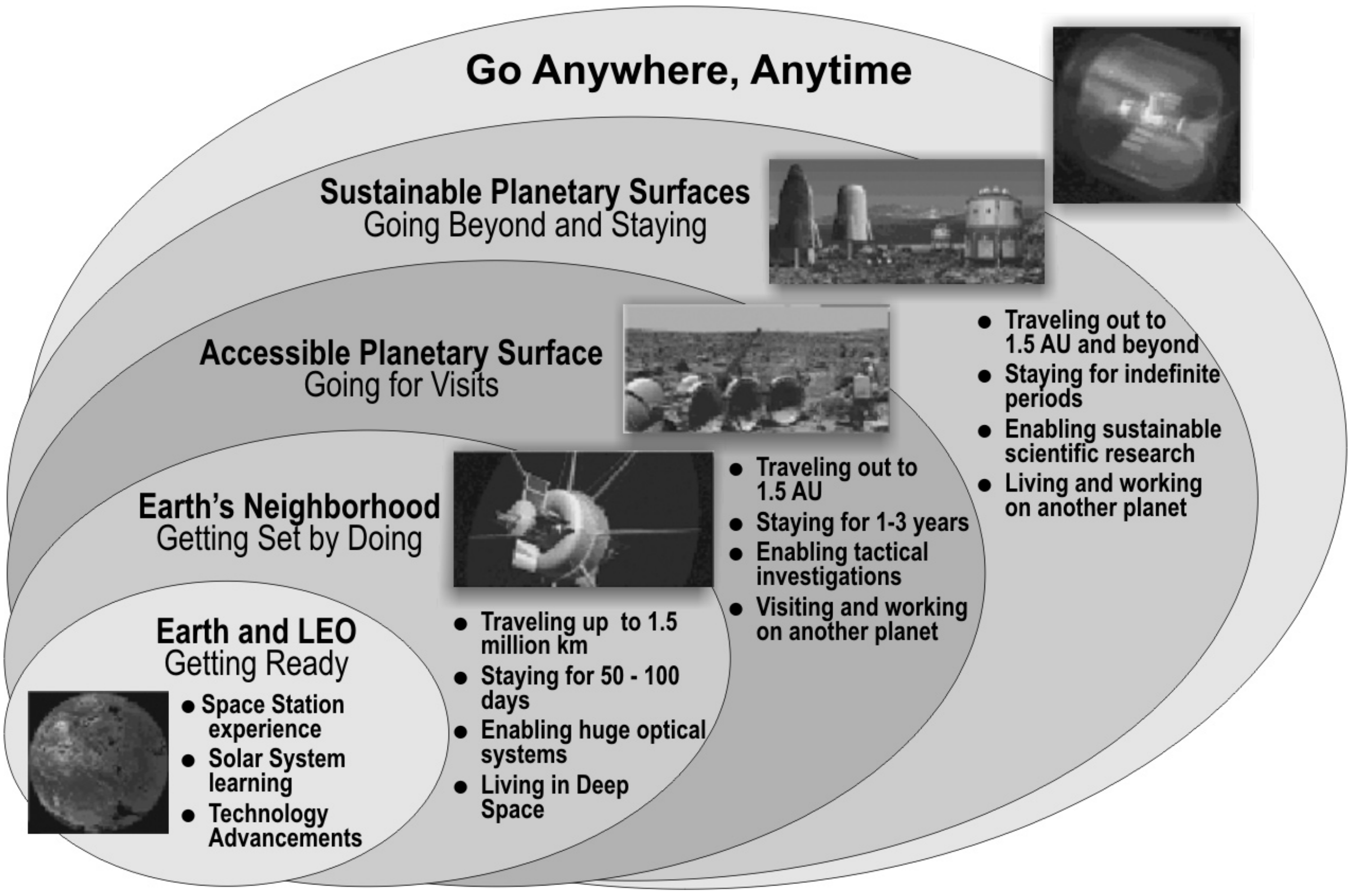
This lesson will give students an opportunity to practice their writing skills as well as use their imagination in a scientific context.

Assessment:

Use a rubric to evaluate the article.

Additional Information:

- ESL students can present a paragraph explaining how their native country will participate in future space exploration. Have them get assistance from the specialist or a bilingual student.
- Special needs students can present a picture with a caption describing a future space endeavor. Have them work with a partner on the research segment.
- Some helpful sites are : ***http://www.marsnews.com/news/20030204-futurespace.html http://www.nasa.gov/exploration/home/index.html***


Go Anywhere, Anytime
Sustainable Planetary Surfaces
Going Beyond and Staying
Accessible Planetary Surface
Going for Visits
Earth's Neighborhood
Getting Set by Doing
Earth and LEO
Getting Ready
• Space Station experience
• Solar System learning
• Technology Advancements
• Traveling up to 1.5 million km
• Staying for 50 - 100 days
• Enabling huge optical systems
• Living in Deep Space
• Traveling out to 1.5 AU
• Staying for 1-3 years
• Enabling tactical investigations
• Visiting and working on another planet
• Traveling out to 1.5 AU and beyond
• Staying for indefinite periods
• Enabling sustainable scientific research
• Living and working on another planet

Activity #20

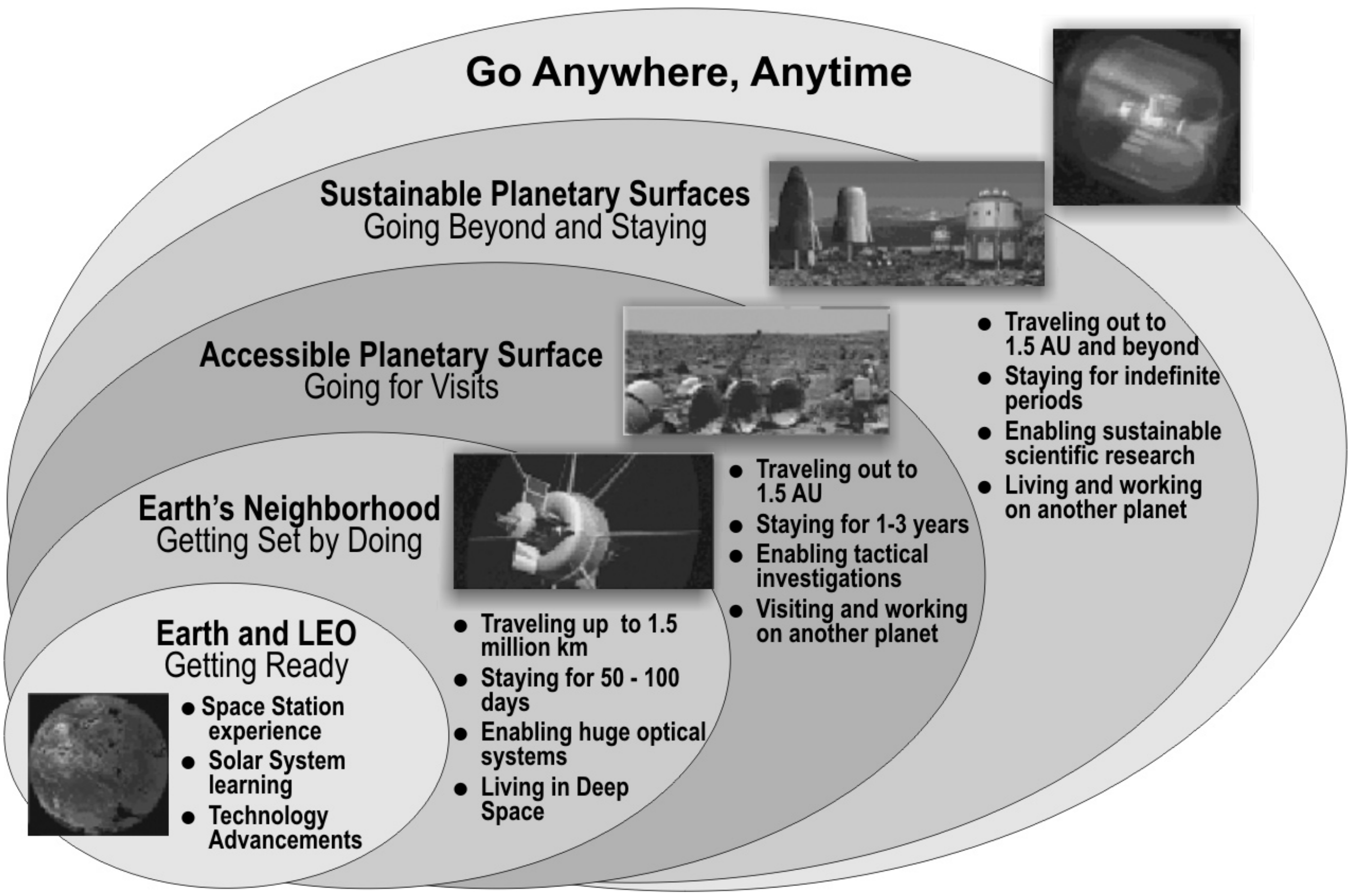
LANGUAGE ARTS
Student Information

Materials:

Reference materials and/or Internet sites relating to space technology and future space exploration, paper, pen.

Directions:

1. Use current science/space periodicals, books, and Internet sources to research the future of space vehicles, technology, and space exploration.
2. Use your research to write, proof, and correct an article for a futuristic newspaper (2050).
3. Share your article with the class. The entire class set of articles can be compiled and used to showcase writing skills and scientific research.



EVALUATION TECHNIQUES AND/ OR ANSWERS TO ACTIVITIES

Activity #1

- United States (North America)
- Norway (Europe)
- Canada (North America)
- Spain (Europe)
- Belgium (Europe)
- Sweden (Europe)
- Denmark (Europe)
- Switzerland (Europe)
- France (Europe)
- United Kingdom (Europe)
- Germany (Europe)
- Russia (Europe/Asia)
- Italy (Europe)
- Japan (Asia)
- Netherlands (Europe)
- Brazil (South America)

For information on countries and languages of the world:

- ***http://www.atlapedia.com/online/country_index.htm***
- ***http://www.education-world.com/foreign_lang/world_languages/index.shtml***

Activity #2

Results vary. Paragraph may include:

"Most of the food for Space Station is frozen, refrigerated, or thermostabilized. Many beverages are in the dehydrated form. Food can be heated in a microwave/forced air convection oven. Daily menu foods are based on their commonality to everyday eating, the nutritional content and their applicability to use in space. The packaging system is based on single service, disposable containers."

Good websites for more information about food in space are:

- ***http://spaceflight.nasa.gov/shuttle/reference/factsheets/food.html*** (Food for Space Flight)
- ***http://www.ag.iastate.edu/centers/ftcsc/index.htm*** (NASA Food Technology - Commercial Space Center)

ACTIVITY #3 - Poetry Rubric Sample

Name: ______________________________ Teacher: ______________________________

Date: ______________________________ Title of Work: ______________________________

	Criteria				Points
	1	2	3	4	
Accurate information about life on the Space Station	No knowledge about life on the Space Station	Some knowledge of life on the Space Station	Proficient knowledge of life on the Space Station	Outstanding knowledgeof life on the Space Station	_____
Creativity in applying sonnet or free verse style	Did not follow Sonnet or free verse style	Partial Sonnet or free verse application	Sonnet or free verse style evident, but lacking creativity	Sonnet or free verse style and creativity evident	_____
Spelling	5 or more mistakes in spelling	3-4 mistakes in spelling	1-2 mistakes in spelling	No mistakes in spelling	_____
					_____
					_____
				Total →	_____

Teacher Comments:

____

____

____

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(*www.teach-nology.com)*

Activity #4

Use Earthcam pictures from this website:
http://datasystem.earthkam.ucsd.edu/GEO_SRCH/ZOOM1_ROW0/GEO_001.shtml
Answers will vary depending on photographs used.

Activity #6

Use a rubric for accuracy of information and creativity in presentation of journal entry.

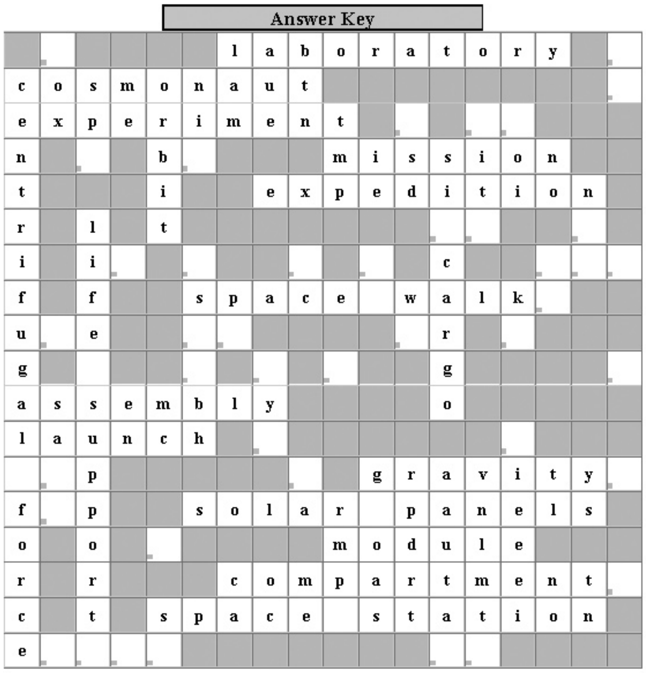
Activity #5 - Sample Rubric for Careers Research

Name: ______________________ Teacher: ______________________

Date: ______________________ Title of Work: ______________________

	Criteria				Points
	1	2	3	4	
Specific career research	No question researched and answered correctly.	One question researched and answered correctly.	Two questions researched and answered correctly.	Three or more questions researched and answered correctly.	____
Spelling and grammar	More than 5 spelling and grammar mistakes.	3-4 spelling and grammar mistakes.	1-2 spelling and grammar mistakes.	No spelling and grammar mistakes.	____
Presentation of information to class	Showed no interest in career and gave very little information.	Showed some interest in career and gave some information.	Showed good interest in career and gave sufficient information.	Showed high interest in career and gave interesting and complete information.	____
					____
					____
				Total--->	____

Activity #7- Answers to International



Activity #8 - Results and Discussion:

When a solute such as salt or alum is dissolved in the solvent (water) so that the most that can be dissolved at a certain temperature is dissolved, you have a saturated solution. Generally, the higher the temperature of the solvent, the more soluble the substance. When a solution saturated at a higher temperature is cooled to a lower temperature, either some of the excess solid will crystallize out of the solution or all the solid may remain in solution. Students should come up with variations including adding color to the crystal solution, trying a mixture of salt and alum, using another type of substance such as sugar to grow crystals, vary temperature as to how fast the cooling takes place, etc. Explain control and variables to students as they design their experiments.

Shapes of crystals of salt and alum are different - salt crystals are cubical and alum crystals will be various octahedrons. Salt crystals are also considerably smaller than the alum crystals.

Activity #9

Use a rubric containing points such as content, organization of material, preparedness, knowledge of subject, and speaking skills such as eye contact, poise, and voice projection.

Activity #10

Evaluate students for completing the chart in the scientific method and how they recorded their observations. Also, how did the hypothesis compare with the conclusion?

Activity #11

Quick and easy sightings of ISS by city can be found at http://spaceflight.nasa.gov/realdata/sightings/index.html Go to ***http://www.indo.com/cgi-bin/dist*** and type place in "From" box and nothing in "to" box. Click "Look it up!"

Lattitude	Longitude	Location	Date(s)	Corresponding Time(s)
57:12:00 N	2:12:00 W	Aberdeen, Scotland		
33:45:46 N	84:25:21 W	Atlanta, Georgia		
39:55:00 N	116:23:00 E	Beijing, China		
33:31:40 N	86:47:57 W	Birmingham, Alabama		
42:20:10 N	71:01:04 W	Boston, Massachusetts		
42:53:23 N	78:51:35 W	Buffalo, New York		
53:30:00 N	113:30:00 W	Edmonton, Alberta		
53:34:00 N	10:02:00 E	Hamburg, Germany		
58:23:19 N	134:08:00 W	Juneau, Alaska		
38:42:00 N	9:05:00 W	Lisbon, Portugal		
36:36:05 N	121:52:54 W	Monterey, California		
40:46:38 N	111:55:48 W	Salt Lake City, Utah		
30:18:21 N	97:45:02 W	Austin, Texas		
18:58:00 N	72:50:00 E	Bombay, India		
34:20:00 S	58:30:00 W	Buenos Aires, Argentina		
30:00:00 N	31:17:00 E	Cairo, Egypt		
21:02:00 N	105:51:00 E	Hanoi, Vietnam		
41:02:00 N	29:00:00 E	Istanbul, Turkey		
37:52:00 S	145:08:00 E	Melbourne, Australia		
48:13:00 N	16:22:00 E	Vienna, Austria		

Activity #12

Use a rubric to evaluate each group's ability to work together and accomplish their goal. Also, use the completed cardiovascular fitness student sheet to show each student's efforts.

Activity #13

1.

Area of a circle	πr^2	$\pi = 3.14$
Circumference of a circle	πd	r = radius
Area of a square	a^2	d = diameter
Surface area of a cube	$6a^2$	h = height
Surface area of a cylinder	$(2\pi r^2)+(\pi d)h$	a = length of side
Volume of a cube	a^3	
Volume of a cylinder	$(\pi r^2)h$	

2. 12.57 meters
3. 729 inches3
4. 5.5 feet
5. 64 centimeters
6. 10 feet
7. 69.5 inches^2
8. 1343.03 feet^2 of metal
9. Yes, the module can hold up to 3711 ft^3.
10. 123.7 days

Activity #14

Use a rubric to evaluate the research and creativity of the brochure. You can create your own rubric on:
– *http://teachers.teach-nology.com/web_tools/rubrics/*

Activity #15

Chart answers will vary.

Activity #16

Rate students on participation and completion of assignment.

Activity #17

Methods will vary. Evaluate according to how effective the solution was in navigating the robot.

Activity #18

Use a rubric to evaluate the creativeness of the poster and the accuracy of the research.

Activity #19

Use a rubric to evaluate the poster and related research.

See next page for Activity 20

International Space Station Test Key

1. c	**11. b**
2. d	**12. d**
3. d	**13. d**
4. a	**14. b**
5. b	**15. c**
6. c	**16. a**
7. c	**17. b**
8. d	**18. c**
9. a	**19. d**
10. b	**20. d**

Activity #20

Name: ______________________________ **Teacher:** ______________________________

Date: ______________________________ **Title of Work:** ______________________________

Criteria					Points
	1	2	3	4	
Use of periodicals, scientific reference, and reliable Internet resources	No reliable references were used.	One reliable reference was used.	Two reliable references were used.	Three or more reliable references were used.	____
Grammar and Spelling	Five or more mistakes were made in grammar and spelling.	Three -four mistakes were made in grammar and spelling.	One - two mistakes were made in grammar and spelling.	No mistakes were made in grammar and spelling.	____
Creativity	Article shows no creativity.	Article shows some creativity.	Article showed average creativity	Article showed exceptional creativity.	____
					____
					____
				Total	____

Teacher Comments:

____

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Notes:
Portfolio information can be found at ***http://www.ed.gov/pubs/OR/ConsumerGuides/classuse.html***
If you choose to use a portfolio assessment, you may choose to use the forms on the next page to give a summary of the International Space Station unit:

What I Learned about the International Space Station

History:

Humans on the ISS:

The Craft:

ISS Research:

International Space Station Test

1. Which of the continents below are NOT represented in the International Space Station project?
   a. North America
   b. Asia
   c. Africa
   d. South America

2. Removing ______________ from foods helps with the weight problem of transporting them into space.
   a. minerals
   b. sugar
   c. vitamins
   d. water

3. Astronauts aboard the ISS entertain themselves by:
   a. looking at the Earth
   b. exercising
   c. playing games
   d. all of the above

4. On most of the color photographs of Earth taken from the ISS, the red, orange, peach, or brown colors usually indicate:
   a. ground, soil, or sediment
   b. water
   c. vegetation
   d. clouds, snow, or human impact

5. Many scientists associated with the ISS do experiments involving:
   a. aliens
   b. effects of microgravity
   c. atmospheric conditions
   d. gravitational pull

6. When the Space Station is completed, an international crew of up to ______ will live and work in space between three and six months.
   a. 4
   b. 5
   c. 7
   d. 10

7. The average altitude of the Space Station is ____.
   a. 55 miles
   b. 120 miles
   c. 220 miles
   d. 1000 miles

8. __________ crystals (which are used to produce nearly all of the world's gasoline) are being experimented with aboard the ISS.
   a. Salt
   b. Alum
   c. Sugar
   d. Zeolite

9. In its first year of operation, three crews made up of four American astronauts and _______ Russian cosmonauts, have called the Space Station home.
   a. five
   b. seven
   c. two
   d. ten

10. Power is being generated for the International Space Station by utilizing the energy of ________.
    a. batteries
    b. the sun
    c. wind power
    d. none of the above

11. Moving at approximately 17,500 miles per hour, the ISS can make about ____ complete trips around the Earth each day.
    a. 10
    b. 16
    c. 25
    d. 32

12. Without exercise, human muscles can atrophy in the microgravity of the ISS. Atrophy means ____
    a. get stronger
    b. turn to fat
    c. get an award
    d. start shrinking away

13. The Multi Purpose Logistics Modules are used to _
    a. escape in case of an emergency
    b. provide a boost into orbit for the ISS
    c. view Earth from the ISS
    d. take supplies and equipment to the ISS

14. One civilian that traveled to the International Space Station was:
    a. Bill Gates
    b. Dennis Tito
    c. Willie Gary
    d. Warren Buffet

15. When a spacesuit is pressurized, the glove fingers ________________________.
    a. collapse
    b. bend easily
    c. pop out and become stiff
    d. get longer

16. Where would you commonly hear "space" music?
    a. In a planetarium
    b. In a grocery store
    c. In an elevator
    d. In a doctor's office

17. Robots are allowed to make decisions through a process called ___________________________.
    a. sensory examination
    b. feedback
    c. processing
    d. perception

18. The subject most likely to help you in a career in aerospace is:
    a. music
    b. art
    c. science
    d. spelling

19. One major problem with living and working in space is:
    a. getting bored
    b. keeping your food from floating away
    c. getting the proper tools to work with
    d. no air to breathe or water to drink

20. As the future of space exploration continues, what planet are we likely to investigate with humans and robots next?
    a. Venus
    b. Saturn
    c. Jupiter
    d. Mars

International Space Station
Thematic Unit for Interdisciplinary Study
Evaluation Form

To continually improve our educational products, CAP needs your suggestions and evaluation. Your feedback will help us achieve our goal of educational excellence in aerospace education materials.
Please take a moment to respond to the statements and questions below. Send your completed evaluation to :

Civil Air Patrol National Headquarters/AE
105 South Hansell St., Bldg. 714
Maxwell AFB, AL 36112-6332

Thank you!

1. Indicate the grade level(s) that used the ISS unit. 3 4 5 6 7 8 9 10 11 12

2. Number of students: ________________

3. What part(s) of this unit did you use?
_____ Background information only
_____ Selected lessons. If so, which ones? ______________________ ____________________________
_____ Complete thematic unit

4. What did you find especially useful about the unit? Why?____________________________________

____

5. Which parts of the guide were less useful? Why? ____

6. Additional Comments: ____

____

	Strongly Disagree				Strongly Agree
7. The lessons were complete and easily understood.	1	2	3	4	5
8. The activities and materials were appropriate for grade level.	1	2	3	4	5
9. The unit was a valuable instructional opportunity.	1	2	3	4	5
10. The unit content was easily integrated into the curriculum.	1	2	3	4	5
11. My students gained skills and information from studying this unit.	1	2	3	4	5

Please send copies of student pre and post tests or complete the following:
Number of students taking pre-test = ___________________________________
Number of students passing pre-test (60% or higher) = _____________________
Number of students taking post-test = __________________________________
Number of students passing post-test (60% or higher) = ____________________