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ABSTRACT

This curriculum supplement introduces students in the early childhood classroom to the International Space Station and the role rockets play in its construction. The guide uses these topics as the basis for interdisciplinary activities for the early learner. Each activity features objectives, a material list, educator information, procedures, and suggestions for assessment and enrichment. A glossary of terms and acronyms is also included. Activities include: (1) "Station Information"; (2) "Destination: Station"; (3) "Countdown Begins"; (4) "Simple Rocket Science"; (5) "More Rocket Science"; (6) "Launch Time"; (7) "The Right Order"; (8) "Good Enough to Eat"; (9) "Rocket Construction"; (10) "Rocket Alphabet"; (11) "Rocket Rhymes and Songs"; (12) "Rocket Math"; (13) "Rocket Patterns"; (14) "Number Rockets"; (15) "Rockets By Size"; (16) "Getting in Shape"; (17) "Getting in Shape Again"; (18) "Hide and Seek Rocket"; (19) "Rocket Problems"; and (20) "Fact and Fiction". (MVL)

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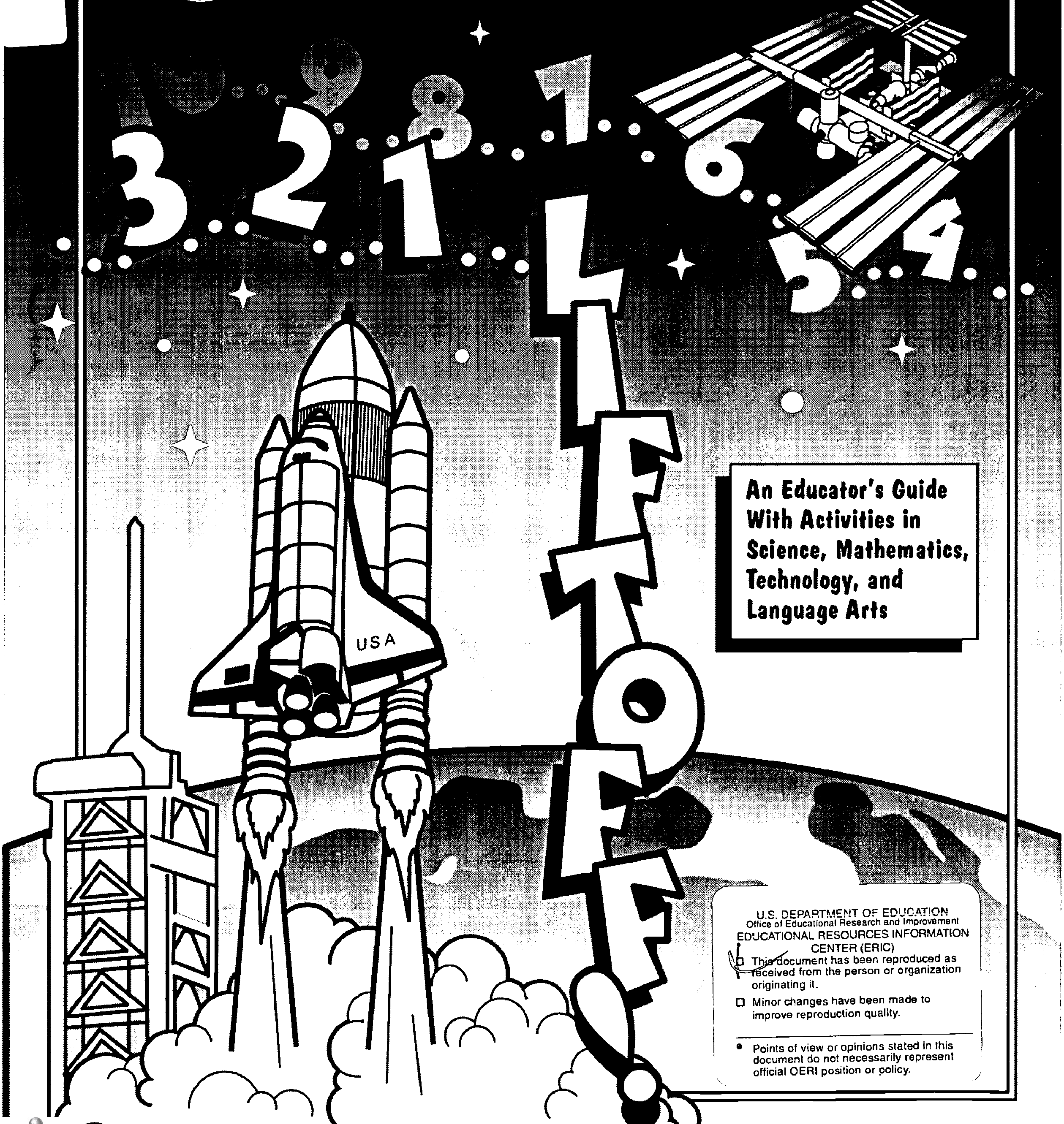

3..2..1.. LIFTOFF!

An Educator's Guide With Activities in Science, Mathematics, Technology, and Language Arts

3...2...1...Liftoff! – An Educator's Guide With Activities in Science, Mathematics, Technology, and Language Arts is available in electronic format through NASA Spacelink—one of the Agency's electronic resources specifically developed for use by the educational community.

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An Educator's Guide With Activities in Science, Mathematics, Technology, and Language Arts

National Aeronautics and Space Administration

NASA Johnson Space Center
Houston, Texas

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How to Use This Guide

The construction of the International Space Station (ISS) is one of humankind's most exciting and challenging endeavors. Numerous rocket launches are required to build this orbiting science laboratory.

The purpose of this curriculum supplement is to introduce students in the Early Childhood classroom to the International Space Station and the role rockets play in its construction. The guide uses these topics as the basis for interdisciplinary activities for the early learner.

The product begins with background information for educators. To better understand the activities that follow and to provide insight to students, educators should read these pages before beginning the lessons. This section provides information on the construction and the purpose of the International Space Station, as well as additional information on the history of rockets and the role of rockets in space station assembly.

Activities that follow the background information are designed to allow students to develop science, mathematics, technology, and English language arts skills. The activities in this guide are for use individually or as part of a more concentrated space or transportation unit. Educators may choose the sequence of lessons to best fit the requirements of their classrooms.

The activities require a minimum of preparation time and use materials that are usually available in the Early Childhood classroom. These activities emphasize hands-on involvement, data collection, observation, exploration, prediction, interpretation, problem solving, and development of language skills.

Each activity features objectives, a material list, educator information, procedures, and suggestions for assessment and enrichment. When appropriate, the guide provides illustrations and graphics for activities. Each activity correlates to national science, mathematics, technology, and English language arts standards. Because many lessons are interdisciplinary, matrix charts relating activities to national standards are included.

Following the activities, the guide includes a glossary of terms and acronyms.

Literature selections play an important role in classroom activities for the early learner. There are many excellent age-appropriate books available, both fact and fiction, on rockets and space exploration. Books can enhance activities in this guide. A list of titles, representing a small selection of appropriate books, follows the glossary.

NASA provides a variety of educational resources to support the activities contained in this publication. Resources include printed materials, electronic resources, videotapes, and software. This guide contains information on how to obtain these resources.

An Educator Reply Card, or evaluation, is included. To help improve this product in the future, please complete the form and make suggestions for changes or additions. Submit the evaluation by mail or electronically through the Internet site provided on the included evaluation card.

NATIONAL EDUCATION STANDARDS

ACTIVITY MATRIX

SCIENCE STANDARDS

ACTIVITIES

STANDARDS		1	2	4	5	7	8	19	20
Science as Inquiry	Abilities necessary to do scientific inquiry	🚀	🚀	🚀	🚀	🚀	🚀	🚀	
	Understandings about scientific inquiry	🚀	🚀	🚀	🚀	🚀	🚀	🚀	
	Position and motion of objects		🚀	🚀	🚀	🚀	🚀		
	Objects in the sky	🚀	🚀			🚀	🚀		
Science and Technology	Abilities of technological design			🚀	🚀	🚀	🚀	🚀	🚀
	Understanding about science and technology	🚀	🚀	🚀	🚀	🚀	🚀	🚀	🚀
	Abilities to distinguish between natural objects and objects made by humans	🚀	🚀			🚀	🚀		
History and Nature of Science	Science as a human endeavour	🚀	🚀	🚀	🚀	🚀	🚀	🚀	🚀

NATIONAL EDUCATION STANDARDS

ACTIVITY MATRIX

MATHEMATICS STANDARDS

ACTIVITIES

STANDARDS		2	3	5	6	7	8	9	11	12	13	14	15	16	17	18
Numbers and Operations	Understand numbers, ways of representing numbers, relationships among numbers, and number systems	✓							✓	✓		✓				✓
	Understand meanings of operations and how they relate to each other								✓	✓						
	Compute fluently and make reasonable estimates									✓						
Algebra	Understand patterns, relations, and functions		✓							✓	✓	✓				
Geometry	Analyze characteristics and properties of 2- and 3-dimensional geometric shapes and develop mathematical arguments about geometric relationships													✓	✓	
	Specify locations and describe spatial relationships using coordinate geometry and other representational systems													✓	✓	
	Apply transformations and use symmetry to analyze mathematical situations													✓	✓	
	Use visualization, spatial reasoning, and geometric modeling to solve problems													✓	✓	
Measurement	Understand measurable attributes or objects and the units, systems, and processes of measurement			✓	✓								✓			
	Apply appropriate techniques, tools, and formulas to determine measurements			✓	✓								✓			
Data Analysis and Probability	Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them	✓		✓	✓								✓			
	Select and use appropriate statistical methods to analyze data	✓		✓	✓								✓			
	Develop and evaluate inferences and predictions that are based on data			✓	✓								✓			

NATIONAL EDUCATION STANDARDS

ACTIVITY MATRIX

MATHEMATICS STANDARDS
(CONTINUED)

		ACTIVITIES														
STANDARDS		**2**	**3**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Problem Solving	Build new mathematical knowledge through problem-solving			X							X	X	X			
	Solve problems that arise in mathematical and in other contexts			X							X		X			
	Apply and adapt a variety of appropriate strategies to solve problems			X							X		X			
	Monitor and reflect on the process of mathematical problem solving			X							X		X			
Communication	Organize and consolidate mathematical thinking through communication			X	X			X		X	X			X	X	X
	Communicate mathematical thinking coherently and clearly to peers, teachers, and others			X	X		X	X		X	X	X	X	X	X	X
	Analyze and evaluate the mathematical thinking and strategies of others									X	X	X	X			X
	Use the language of mathematics to express mathematical ideas precisely			X	X	X	X	X		X	X	X	X	X	X	X
Connections	Recognize and apply mathematics in contexts outside of mathematics	X			X	X	X	X	X				X	X	X	
Representation	Create and use representations to organize, record, and communicate math ideas						X				X		X			
	Select, apply, and translate among mathematical representations to solve problems										X		X			
	Use representations to model and interpret physical, social, and mathematical phenomena						X	X			X		X			

NATIONAL EDUCATION STANDARDS

ACTIVITY MATRIX

TECHNOLOGY STANDARDS

ACTIVITIES

STANDARDS		1	2	3	4	5	6	7	8	9	19
Characteristics and Scope	Natural world and human-made world	🚀	🚀	🚀				🚀			
	People and technology	🚀	🚀	🚀				🚀			
Cultural, Social, Economic, Political Effects	Helpful or harmful	🚀									🚀
Role of Society in the Development and Use	Needs and wants of individuals	🚀									🚀
Attribute of Design	Everyone can design										🚀
	Design is a creative process										🚀
Engineering Design	Engineering design process										🚀
	Engineering design ideas to others										🚀
Troubleshooting, Research, Development, Invention, Innovation, Experimentation in Problem Solving	Asking questions and making observations				🚀	🚀					
Apply Design Processes	Solve problems through design				🚀	🚀	🚀				🚀
	Build something				🚀	🚀	🚀		🚀	🚀	🚀
	Investigate how things are made	🚀			🚀	🚀		🚀			
Use and Maintain Products and Systems	Discover how things work	🚀			🚀	🚀		🚀			
Transportation	Transportation systems	🚀		🚀	🚀	🚀		🚀	🚀		
	Individuals and goods	🚀						🚀			
	Care of transportation products and systems	🚀						🚀			

NATIONAL EDUCATION STANDARDS

ACTIVITY MATRIX

ENGLISH LANGUAGE ARTS STANDARDS

ACTIVITIES

STANDARDS	1	2	3	4	5	7	8	9	10	11	13	14	15	17	18	19	20
Students read wide range of print and nonprint texts to understand texts, themselves, cultures; to acquire new information; for personal fulfillment; texts are fiction, classic, and contemporary	🚀									🚀							🚀
Students read a wide range of literature in many genres to build understanding																	🚀
Students apply wide range of strategies to comprehend, interpret, evaluate, and appreciate texts; draw on prior experience; interactions; show knowledge of word meanings; apply word identification strategies; show understanding of textual features									🚀	🚀				🚀			🚀
Students adjust use of spoken, written, and visual language to communicate effectively with different audiences for variety of purposes	🚀	🚀	🚀	🚀	🚀	🚀	🚀	🚀			🚀	🚀	🚀		🚀	🚀	🚀

NATIONAL EDUCATION STANDARDS

ACTIVITY MATRIX

ENGLISH LANGUAGE ARTS STANDARDS (CONTINUED)

ACTIVITIES

STANDARDS	1	2	3	4	5	7	8	9	10	11	13	14	15	17	18	19	20
Students employ a wide range of strategies as they write and use different writing process elements to communicate effectively with different audiences for variety of purposes	🚀															🚀	
Students apply knowledge of language structure, conventions, media techniques, figurative language to create, critique, discuss print and nonprint texts										🚀							
Students conduct research by generating ideas and questions; posing problems; gathering, evaluating, synthesizing data from variety of data sources to communicate discoveries to suit their purpose and audience	🚀			🚀	🚀	🚀											
Students participate as knowledgeable, reflective, creative, critical members of literacy communities																🚀	🚀
Students use spoken, written, visual language to accomplish their own purposes	🚀	🚀		🚀	🚀	🚀	🚀	🚀			🚀		🚀		🚀	🚀	🚀

PREFACE

International Space Station

The International Space Station (ISS) (Figure 1, page 73) represents the most complex international scientific endeavor in history. It is also the most ambitious construction project ever undertaken in space. Sixteen international partners, including the United States, are working together, sharing resources and expertise, to build this orbiting research facility. International partners include Canada, Russia, Japan, Brazil, and the eleven nations of the European Space Agency. In the United States, the organization responsible for building the ISS is the National Aeronautics and Space Administration (NASA).

Constructing the ISS is a complex and challenging task. The station, when complete, will be 108.5 meters wide and 88.4 meters long. It will be approximately the size of two football fields placed side by side. The completed station will weigh approximately 453,500 kilograms. There are no launch vehicles or rockets capable of carrying an object of this size into space at one time.

Individual components or pieces make up the space station. The components come in all shapes and sizes. Different nations build different components of the ISS. Each piece has a special purpose. Components are laboratories, living areas, and equipment and storage areas. Important parts of the space station are the large, shiny solar arrays. These solar arrays provide power to the space station.

The living and working areas on board the completed space station will be about the size of three average American homes. Giant solar arrays will provide electricity for the space station. The electricity generated would power about 10 average American homes. Water will be recycled on the space station. While astronauts float in the microgravity environment, they will find the station to be at "shirt sleeve" temperatures.

Due to its size, the ISS must go to space in pieces. Rockets carry these pieces to space. At an average distance of approximately 407 kilometers above the Earth, traveling at 28,163 kilometers per hour, and circling the Earth every 90 minutes, humans must put these components together to build the station.

Construction of the Space Station began in 1998. Since then, the station has continued to grow in size. In 2000, the first international crew of three people went to live and work on board the station. Habitation of the space station marked the resumption of a long-term human presence in space.

The ISS is a science laboratory in space. The space station allows research in a microgravity environment. Research in biology, chemistry, physics, ecology, and medicine will result in benefits for people on Earth. ISS crews are already conducting scientific research on orbit.

The ISS will eventually be home to as many as seven people. Crews, who live and work on the station for four to six months, must be ferried back and forth to Earth. Rockets are needed to carry both cargo and people.

For more information and activities on the space station, check the educational materials at *http://spacelink.nasa.gov/products*.

Space Shuttle

American and Russian launch vehicles, or rockets, deliver individual ISS components to space. These vehicles also ferry crews, supplies, hardware, and station components from Earth to the station. NASA uses a reusable space transportation system (STS), the space shuttle (Figure 2, page 74, and Figure 3, page 75), to transport station components, hardware, supplies, and personnel to and from the ISS.

The space shuttle consists of several parts. One of the parts is the orbiter. The crew lives and works in the orbiter. There may be as many as seven people on a crew. The orbiter is the only part of the space shuttle that orbits the Earth. The orbiter needs special rockets to reach Earth orbit. Two solid rocket boosters attach to the external tank. The external tank attaches to the orbiter and supplies fuel to the three main rocket engines at the aft end of the orbiter.

The payload bay of the orbiter stores new components bound for the space station. A docking port in the payload bay allows the orbiter to join, or dock, with the ISS. After docking, a robotic arm lifts a new piece or module out of the payload bay and attaches it to the station. Astronauts then perform spacewalks, or extravehicular activities (EVAs), to help attach new components to the ISS.

Russian Rockets

Two different Russian rockets also take people, supplies, and parts to the ISS. The Proton rocket sends pieces of the space station to space (Figure 4, page 76). A Proton rocket launched the first ISS component, the Russian-built Zarya control module.

A smaller Russian rocket, the Soyuz (Figure 5, page 77), takes crews and cargo to and from the station. The crew, usually three people, travels in a small Soyuz capsule launched on a Soyuz rocket. When it arrives at the station, the capsule docks to a port on a Russian-built component. In addition, a Soyuz rocket launches a Progress spacecraft.

The Progress does not carry people; it carries supplies, or cargo, to and from the station. The Progress also docks to a port on a Russian-built part of the ISS. In the future, a variety of new vehicles will visit the station to ferry crews and supplies.

ISS Completion

Building the ISS will take many years. Its construction will require more than 40 launches of the space shuttle, Proton, and Soyuz rockets. Assembling more than 100 space station components will require the use of robot technology and many hours of spacewalks by astronauts. When complete, scientific research will continue on the station for many years.

For more information on the International Space Station and the space shuttle, visit *http://spaceflight.nasa.gov*. Information on launches, missions, crews, and shuttle and station sightings is available at the Spaceflight web site.

Rocket History

American and Russian rockets carry the parts and the crews needed to construct the ISS in space. The space shuttle and the Proton and Soyuz rockets are all necessary for its construction. These modern rockets are the result of centuries of experimentation by people around the world.

Although it is not clear when true rockets were first developed, historical records indicate that the Chinese developed simple rockets as early as the 13th century. They invented a form of gunpowder to create fireworks for special events. Eventually, the Chinese put gunpowder in a bamboo tube. When lit, this gunpowder-filled tube launched, creating a simple rocket.

More than 300 years ago, in the 17th century, scientists began to study rockets. Sir Isaac Newton (1642-1727) was a scientist who tried to explain how rockets work. He stated three scientific principles, called Newton's Laws of Motion, which describe the motion of objects, either on Earth or in space. To successfully build rockets, scientists have to understand these laws.

Early in the 20th century, one of the scientists who conducted rocket experiments was an American named Robert Goddard (1882-1945). People call Goddard "the father of modern rocketry." His research helped give humans the ability to send rockets to space. As a result of the research of Newton and Goddard, modern rocket scientists are able to design and build sophisticated rockets like the space shuttle, the Proton, and the Soyuz.

Modern rockets took the first humans to space and then to the Moon. Rockets launch satellites into orbit around the Earth and send unmanned spacecraft to explore the universe. Rockets are necessary to transport crews, parts, and materials to build the International Space Station.

For more information on the history of rockets and additional rocket activities, visit the Spacelink web site at *http://spacelink.nasa.gov*.

NASA Educational Resources

NASA provides a variety of educational resources to support these lessons on the ISS and rockets. The section of this guide titled *NASA Resources for Educators* contains detailed information on how to obtain these materials, including visual resources, videotapes, Internet sites, and instructional products. For additional information on how to access NASA educational resources, contact the Educator Resource Center that serves your area. A listing of these offices is found in the resource section of this guide.

Activity 1

Station Information

Objective

Students share and evaluate their knowledge of the International Space Station (ISS).

Standards

Science, Mathematics, Technology, Language Arts

Materials

- Chart paper, 1 piece
- Drawing of the ISS (Figure 1, page 73), colored
- Individual journal or paper, 1 piece per student
- Markers, crayons, and pencils
- Photographs of the ISS

Educator Information

- Read the background information provided on the ISS and rockets. Be prepared to share this information with students.
- Have books on the International Space Station available to share with the class. See the *Suggested Reading* section for suggestions or select books from other sources.
- Use this activity as the opening and closing lesson on the International Space Station. This lesson can be used to enhance the review found in *Activity 20*, page 68.
- This lesson is designed to find out what students know, what they want to learn, and what they learned about the space station.

Procedure

Opening Activity:

1. Students will create a KWL (Know Want Learn) chart to organize information on the ISS.
2. Write the words *International Space Station* on chart paper. Explain to the class that the ISS is another name for the International Space Station. Tell the students that the ISS is a science laboratory and home for astronauts in space.

3. Draw three columns under the words. Label one column, *What We Know*. Label the second column, *What We Want to Know*. Label the third column, *What We Learned*.
4. Ask the students what they know about the space station. Answers will vary. Write the answers in the *What We Know* column. Some students will know little or nothing about the station.
5. Share some background information on the space station. Ask students what they would like to learn about the ISS. Write these answers in the column labeled, *What We Want to Know*.
6. Leave the final column, *What We Learned*, blank. Complete this column as part of a closing lesson when students share what they have learned. Refer to *Activity 20*, page 68.
7. Display the chart in the classroom.
8. Share background information on the ISS with students. Have drawings and photographs available to show students. Read books on the ISS to the class.
9. To help students better understand the space station, relate it to something familiar in their lives, their homes. Ask students where they live. Explain that the ISS is a home in space. Encourage students to describe their homes. Compare the ISS to the places where students live.
10. Compare the rooms in a home to the parts of the space station. Both have kitchen areas, bathrooms, and bedrooms.
11. Ask students about the materials that make up their homes. Compare them to the materials that make up the ISS.
12. Ask students to describe how they think their homes were constructed. Encourage discussion on who built the homes and how the parts were put together. Ask students if there was a plan or design for their home that ensured it was built correctly. Compare the construction of the ISS with the construction of homes on Earth. Discuss the plans that are used for both homes and space stations. Ask why having a plan is important in construction.
13. Compare the people who build homes and the people who build the ISS. Discuss the challenges of construction in space in a microgravity environment.
14. Share with the class that the space station is also a place for people to work. It is a science laboratory in space. Compare the ISS to the school building in which students and educators work.

Closing Activity:

1. Use this activity as the final lesson on the ISS. Use this activity as a review. Refer to *Activity 20*, page 68.
2. Ask students to look at the comments in the column, *What We Want to Learn*, on the chart created in the opening lesson. Read the comments to students. Ask the class if they learned more about these topics.
3. Ask students what they learned about the ISS. List their comments in the *What We Learned* column of the chart created in the opening lesson.
4. Encourage students to discuss and evaluate what they learned.

Assessment

- Evaluate students during the opening lesson. Listen as they orally share information about the ISS. After the closing lesson on the ISS, listen as students share what they learned.

- In a journal or on a piece of paper, have students draw a picture of the ISS. Depending on the ability level of the student, the student or the educator writes a student-generated fact about the ISS under the picture. Using the drawing and sentence, evaluate what the student learned.

Enrichment

- If appropriate, have students create and complete individual KWL (Know Want Learn) charts.
- Students draw a picture of the ISS. The student or the educator writes a student-generated ISS fact on the paper. Put the drawings together into a class book. Read together as a class or have students read individually.
- Use this same activity to determine what students know about rockets. Ask students to list what they know about rockets and list what they wish to learn. At the conclusion of the lessons selected, repeat the activity. Have students share what they learned about rockets.
- Students create a class book using the large rocket drawing (Figure 6, page 78). Give the class a "writing prompt" such as *"A rocket has..."* or *"My rocket is ..."* Either the student or educator writes a student-generated sentence on the rocket pattern using the prompt. Students color and decorate the rockets. Put rockets together in a class book. Read together as a class or have students read individually.
- Find books on the ISS to share with the class. See the *Suggested Reading* list for selections. Students may enjoy reading or listening to *The International Space Station* by Franklyn M. Branley or *Space Stations* by Diane M. and Paul Sipiera. Discuss with students what they learned from the books.

Activity 2

Destination: Station

Objective

Students identify the International Space Station (ISS) and different types of rockets as objects in the sky built by humans.

Standards

Science, Mathematics, Technology, Language Arts

Materials

- Drawing of the ISS (Figure 1, page 73), colored
- Drawings of space shuttle (Figure 2, page 74, and Figure 3, page 75), colored
- Drawings of Proton (Figure 4, page 76) and Soyuz (Figure 5, page 77), colored
- Photographs of the ISS, rockets, and space shuttle
- Picture or drawing of the Sun
- Pictures or drawings of objects in the sky, some built by humans and some not built by humans
- Globe
- Chalkboard and chalk
- Bulletin board paper or floor graph
- Markers, crayons, and pencils
- Paper, 2 pieces per student

Educator Information

- This activity requires two class periods to complete.
- Before the lesson begins, read the background information on the ISS, the space shuttle, and rockets. Be prepared to share this information with students.
- Collect pictures or drawings of objects in the sky, some built by humans and some not built by humans. Laminate drawings and photographs for future use.
- Prepare a floor graph with two columns or make a graph out of bulletin board paper. Draw a line to create two columns on the bulletin board paper. Label columns on the graphs with the titles, *yes* or *no*.

Procedure

First Class Period:

1. Introduce the drawing of the ISS. Ask students if they can identify the drawing. Have students share what they know about the space station.
2. Share the background information provided on the ISS. Discuss that humans are building the station in space. If necessary, define the word, *human*.

3. Ask students to think about where the ISS is at this moment. Remind students that the station is constantly circling or orbiting the Earth. Use a globe to demonstrate how the station continuously circles the Earth. If appropriate, introduce the word, *orbit*.
4. Discuss the size of the space station. Ask students to generate ideas about how the station goes to space. Share with them that the station goes to space in pieces. Tell them that rockets play an important role in building the station.
5. Share the drawings of the Proton and Soyuz rockets and the STS (Space Transportation System), or space shuttle. Tell students that these are all rockets that go into space and take people, supplies, and parts to the ISS.
6. Look at the drawings of the ISS, Proton, Soyuz, and space shuttle. Ask students to generate ideas about who made these objects in the sky. Explain to students that people from different countries construct these space vehicles. The ISS, Proton, Soyuz, and space shuttle are all objects in the sky built by humans.
7. Ask students to think of other objects in the sky that people build. Ideas may include airplanes, hot air balloons, helicopters, satellites, and kites. Write a list of student ideas on the chalkboard.

Second Class Period:

1. Using the drawings and pictures of the ISS, Proton, Soyuz, and space shuttle, review the concept of objects in the sky built by people. Review the list of human-built objects in the sky that students generated.
2. Show students a picture or drawing of the Sun. Ask students if people built the Sun. Explain to students that there are objects in the sky that are not built by humans. People are building the ISS, but people did not build the Sun. Introduce the word, *natural*, if appropriate, to describe objects not built by humans.
3. Have students think of other objects in the sky that people did not build. Ideas may include birds, clouds, stars, lightning, and rainbows. Write a list of student ideas on the chalkboard.
4. Show students the pictures or drawings of objects in the sky. Explain to students that they will use a graph to sort or classify the pictures as objects in the sky built by people or not built by people. Use the floor graph with two columns or the bulletin board paper with two columns. One column is labeled with the title, *yes*. The second column is labeled with the title, *no*. Read and discuss the titles with the class.
5. Show students a picture or drawing of an object in the sky. Ask the question, "Is this object built by people?' Discuss the answer and look at the words, *yes* and *no* on the graph. Demonstrate placing the picture in the appropriate column.
6. Distribute the remaining pictures and drawings to students. Have students look at their picture or drawing, and ask, "Is this object built by people?" Students then answer the question. Have students place the picture or drawing in the appropriate column. Continue until each student has a turn.

Assessment

- Observe students as they place the pictures or drawings in the appropriate columns.
- Request that students draw two pictures, one of an object in the sky built by humans and one of an object not built by humans. Observe as students complete the drawings. The educator or the student can write the

name of the object on each drawing. Observe students as they place their drawings in the appropriate column on the floor graph or the bulletin board paper graph.

Enrichment

- Have students collect and bring in magazine pictures of objects in the sky. Allow them to share the pictures with the class. Ask students to determine whether the picture is of an object built by humans.
- Allow students to sort the collected pictures using the floor graph or the bulletin board paper graph. Ask students if they can think of other methods to sort the pictures. Ideas may include placing pictures in circles or in boxes with appropriate labels.
- When complete, the ISS will be the largest object built by people in space. The completed ISS will be the brightest object made by humans in the night sky. If a football field is available close to the school, take students outside to look at the field. Tell them that when it is complete, the space station will be approximately the size of two football fields placed side by side. Ask them to imagine how large a rocket would have to be to carry the ISS into space at one time.
- Students can see the space shuttle and the ISS in the sky. The Spaceflight web site, *http://spaceflight.nasa.gov*, has information on sighting opportunities.
- Begin a class discussion about the size of objects in the sky. Using an airplane as an example, ask students if a plane appears smaller on the ground or in the sky. Based on their experience, most students will state that the plane appears smaller in the sky. Encourage students to generate ideas about why the plane looks smaller in the sky. Objects that are farther away appear smaller than objects that are closer. Help students reach the conclusion that the plane appears smaller because it is far away. If appropriate, take students outside to the playground. Have one student hold a drawing of the space station. Request that the other students stand close to the drawing and then slowly walk away. Ask students if the drawing appears smaller, the farther away they are. Remind students that when they see the space shuttle or the ISS in the sky, these objects will appear to be very small because they are far away.
- Choose books from the *Suggested Reading* list or from other sources on space travel, rockets, and the space station. Share the books with the class. Ask students to look at the books and find pictures or drawings of objects in the sky. Encourage students to decide whether humans built these objects.

Activity 3

Countdown Begins

Objective

Students associate a countdown with a rocket launch and practice counting from 10 to 1.

Standards

Mathematics, Technology, Language Arts

Materials

- 11 copies of large rocket drawing (Figure 6, page 78), colored
- Videotape of a rocket or shuttle launch with audio of a countdown
- VCR and television
- Copies of small rocket drawings (Figure 7, page 79), 11 rockets per student
- Chart paper
- Markers or crayons
- Scissors
- 2 classroom chairs
- Clothesline
- 11 spring clothespins
- Pocket chart or chalkboard tray
- Strips of paper or sentence strips, 1 per student

Educator Information

- Make 11 copies of the large rocket. Copy rockets on index-weight paper if available.
- On each large rocket, write one numeral from 10 to 1. On one rocket, write the word, *liftoff*. Color. Laminate rockets for future use.
- Copy the page with the small rocket drawing. Each student will need 11 small rockets. Use these rockets for student independent practice. The educator may write numerals from 10 to 1 and the word, *liftoff*, on the rockets before copying. If appropriate, students can write numerals and words on their individual rockets.
- Review the information on the International Space Station (ISS) and rockets. Be prepared to share information with students.
- Choose a location in the classroom to place the rockets in a countdown sequence.
- This activity requires two class periods.
- Review a countdown sequence from 10 to 1 and repeat selected activities for several days.

Procedure

First Class Period:

1. Remind students that construction of the ISS requires more than 40 rocket launches.
2. Tell students that a rocket launch begins with a countdown. As the rocket prepares to launch, we hear an announcer counting, "...10, 9, 8, 7, 6, 5, 4, 3, 2, 1, liftoff!"
3. Orally demonstrate a countdown sequence for students. If appropriate, have students practice with the educator.
4. Have students view a videotape of a rocket launch or watch a televised rocket launch. If possible, the videotape should have audio of the countdown sequence. If watching a real-time launch on television, record this event. Play the videotape several times.
5. Discuss why it is important to have a countdown. Ideas could include safety and timing issues. Countdowns allow everyone to know when the rocket launches. Write the ideas on chart paper and display in the classroom. Discuss what could happen if there was no countdown for a rocket launch.
6. Review a countdown sequence. Have students practice counting orally from 10 to 1.

Second Class Period:

1. Review a countdown sequence before a rocket launch. Demonstrate a countdown sequence orally for students. Practice a countdown together.
2. Introduce the large rockets with numerals and the word, *liftoff*, written on them.
3. Use a pocket chart or the chalkboard tray to place the rockets in a countdown sequence. Have the class orally practice counting backwards while the educator puts the numerals in the correct order. Place the rocket with the word, *liftoff*, after the 1. Remember to always model sequencing from left to right.
4. Have students practice placing the rockets in the correct sequence on the chalkboard or in a pocket chart.

Review

1. Have the students practice counting backwards each day until they become comfortable with the activity. Practice a countdown to get ready to go to recess, to prepare to clean up, or as a cue to become quiet. Incorporate a countdown into daily classroom routines.
2. As a class activity, students practice placing the rockets in the correct sequence. Students may independently practice putting the numerals in the correct countdown sequence. Encourage sequencing from left to right.
3. To vary the sequencing activity, tie a length of clothesline between two chairs. Attach eleven spring clothespins. Using the clothespins, have students attach the rockets to the clothesline placing the numerals in the correct countdown sequence. Monitor sequencing from left to right.
4. After students become comfortable with the correct sequence, put the rockets in scrambled order in a pocket chart, on the chalkboard, or on the clothesline. Select students to put the rockets in the correct order. Students may repeat the activity independently.

Assessment

- Observe students as they independently practice sequencing the rockets with numerals from 10 to 1.
- Evaluate students as they independently practice a countdown sequence orally.

- Use the small rocket drawings to assess students. Before copying, the educator may write the numerals, 10 to 1, and the word, *liftoff*, on the rockets. As part of the activity, if appropriate, students may write the numerals, 10 to 1, and the word, *liftoff*, on the eleven small rockets. Have students color and cut out the rockets. Observe students as they independently place rockets in a countdown sequence. Students may glue rockets in the correct order on a strip of paper or on a sentence strip. Monitor sequencing from left to right.

Enrichment

- Empty one box of table salt on a tray or in a small plastic container. A student uses a finger or unsharpened pencil to practice writing the numerals in a countdown sequence in the salt. Students may also practice writing the numerals in a countdown sequence in sand on the playground, with shaving cream on a table, or with fingerpaint on paper.
- In a journal or on a piece of paper, students write the numerals in a countdown sequence. Students may write the word *liftoff* and draw a picture of a rocket taking off.
- Encourage students to use creative movement while practicing a countdown. For example, the student may squat while counting and jump up or "launch" when the word, *liftoff*, is spoken.
- Use the chants and rhymes in *Activity 11*, page 44, to review a countdown sequence.
- On the playground, students practice a countdown while jumping rope or drawing numerals on the pavement with sidewalk chalk.
- Before liftoff, there is a countdown. After liftoff, a clock begins counting upwards. It shows how much time has elapsed in the mission. Have students practice a countdown and then say, *liftoff*. After liftoff, ask students to practice counting upwards like the mission clock. Encourage students to count slowly while counting up and down. Students can count slowly to determine how long a minute is.
- Using the words, *countdown* and *liftoff*, introduce or review the concept of compound words. Compound words are two words that when placed together, form a new word. Write the word, *count*, on an index card. Write the word, *down*, on another card. Repeat this process with the word, *liftoff*. Ask students to look at the card with the word, *count*, and talk about what it means. Repeat with the word, *down*. With the words toward the class, hold the two cards next to each other. Ask students to form a new word with the two cards. Discuss its meaning. Repeat the process with the word, *liftoff*. Have students orally generate a list of other compound words. To assist younger students, the educator may find magazine pictures of items that are compound words, such as mailman, backyard, and baseball. Write the list on chart paper and display in the classroom. Divide these compound words into two words and write on index cards. Students practice forming compound words by putting the cards together.
- Select counting books to share and discuss with the class. *Blast Off! A Space Counting Book* by Norma Cole, listed in the *Suggested Reading* list, is a counting book with a space theme. Compare a countdown sequence to the numbers in the counting books.

Activity 4

Simple Rocket Science

Objective

Students perform a simple science experiment to show how a rocket works and to demonstrate Newton's Third Law of Motion.

Standards

Science, Technology, Language Arts

Materials

- Pictures, drawings or videotapes of rocket launches
- 1 plastic straw (milkshake size)
- 10 long party balloons
- Clear cellophane tape
- 6 – 8 meters of nylon monofilament fishing line (any size)
- Scissors
- 1 spring clothespin
- 1 straw rocket drawing (Figure 8, page 80), colored and cut out
- Chart paper, 3 pieces
- Journal or a sheet of paper, 1 per student
- Markers, crayons, and pencils
- 2 classroom chairs
- Pieces of paper
- Camera and film

Educator Information

- Carefully review the setup of the experiment and gather all required materials.
- Decide where the experiment needs to be set up in the classroom.
- This activity may need additional adult assistance.
- Because of safety concerns, an adult should blow up the balloon.
- Read the information about the International Space Station (ISS). The ISS is a science laboratory in space where the crew performs science experiments.
- Read information on the history of rockets and on the scientists who studied rockets. Be prepared to share this information with students.
- Read the following information and be prepared to share it with the class.

  Sir Isaac Newton described the principles of rocket science in three laws of motion. A simplified explanation of his third law of motion helps young students understand how rockets work. This law states that every action has an equal and opposite reaction. When a rocket expels fuel or propellant out of its engine, the rocket moves in the opposite direction. The rocket pushes the propellant *out, and the propellant then pushes the rocket. The propellant comes out of the engine. This is the action. The rocket lifts off the launch pad in the opposite direction. This is the reaction.*

- Explain to the class that this experiment shows how rockets work. The balloon experiment and a rocket both demonstrate Newton's Third Law of Motion, which states that for every action there is an equal but opposite reaction.
- For additional simple rocket demonstrations, view the *Rockets* guide at *http://spacelink.nasa.gov/products/Rockets.* In this guide, the activity, *3, 2, 1 Pop*, is an excellent demonstration of how a rocket works.

Procedure

1. Remind students that rocket launches are necessary to build the ISS. Share pictures, drawings, or videotapes of rocket launches with students. Discuss what they see in the pictures, in the drawings, or on the videotape. Note the direction that the rockets move. Note where the engines are and where the flames or fire comes out.
2. Ask students if they know how a rocket works. Explain to them that they will be conducting a simple demonstration or science experiment to show how a rocket lifts off the launch pad. Students, just like the astronauts in space and scientists on Earth, will conduct an experiment to gather information.
3. Thread the fishing line through the straw. Attach each end of the line with the straw on it to the back of a classroom chair. Stretch the line tightly.
4. Have an adult blow up a balloon and keep it tightly closed with fingers or with a clothespin.
5. Tape one part of the rocket pattern (Figure 8, page 80) to the balloon. Tape the balloon carefully to the straw while keeping it tightly closed. See *Figure 9.*
6. Show students the position of the balloon on the fishing line. Place the balloon near one end of the fishing line with the open end closest to the chair. Explain to the class that in this experiment, an adult will release air from the balloon.
7. The word, *hypothesis*, is introduced if appropriate. Show the class the word written on a piece of chart paper. For scientists, a

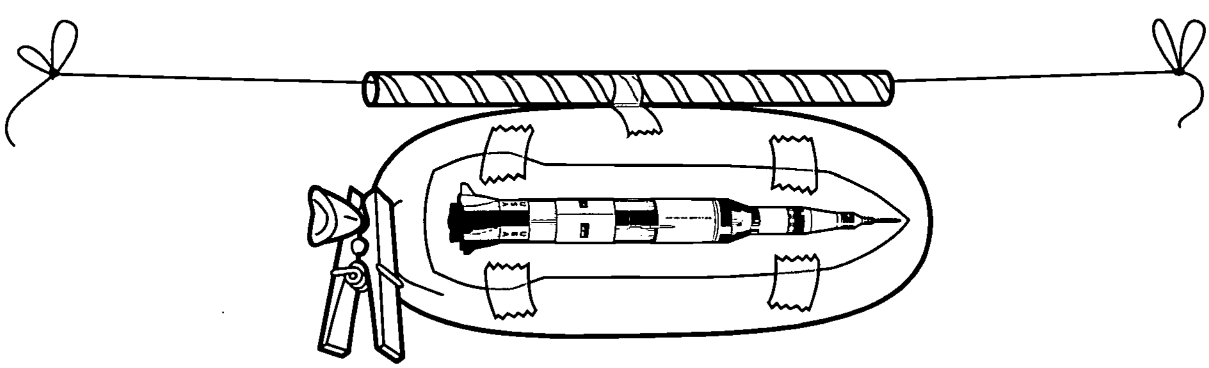


Figure 9. Balloon Experiment Diagram

hypothesis is a reasonable or good guess about what they think will happen in an experiment.

8. Tell the class that the air will be released from the balloon. Discuss in which direction the air will move. The balloon will also begin to move. Based on their prior experiences, ask the students to make a good guess about the direction the balloon will travel when air is released. Ask the class to verbalize a hypothesis, or guess, about the movement of the balloon. Students point with their fingers to indicate the direction in which they think the rocket will travel.
9. Write the hypothesis developed by the class on the chart paper.
10. When discussing directions, encourage the class to use the word, *opposite*. Introduce or review the concept of opposites.
11. To help students remember the correct sequence of events in the experiment, write directions or draw pictures to represent the steps on chart paper. Display the directions in the classroom.

Experiment

1. Prepare to launch, or release, the air from the balloon. Just like a rocket launch, practice a countdown, *10,9,8,7,6,5...*, before the air is released.
2. Carefully remove fingers or the clothespin from the balloon and release the air. The balloon will travel in the opposite direction from which the air escaped.
3. Ask students if their guess or hypothesis was correct.
4. Explain to the students that scientists must repeat an experiment many times. Repetition of an experiment ensures that the results are accurate. Like scientists, the class must repeat the experiment with the balloon to determine that the results are always the same.
5. Let students choose a reasonable number of times to repeat the experiment. Scientists need to have many repetitions to increase the reliability of their results.
6. Before repeating the experiment, tell the class that scientists need a method to record the results from experiments.
7. Ask the class to devise a simple way to record information or data from the experiment. For example, if the experiment repeats five times, ask students to write the numerals from 1 to 5 on an individual sheet of paper or in a journal.
8. Students sit in front of the experiment and observe. Have students draw an arrow next to the numeral to indicate the direction the balloon traveled each time. Data collection could also be a class activity.
9. Be ready to repeat the experiment the number of times suggested by the class. If necessary, use a new balloon blown up by an adult. When attaching the balloon to the straw, be certain that the open end of the balloon is always facing the same direction. Remember to practice a countdown. Collect data from the experiment.
10. As the experiment repeats, let students participate by holding the balloon closed and releasing the air. Remind the class to observe the balloon's movement and to record the data.
11. Allow students to compare their data. Ask students if they can learn something or draw a conclusion from this information.
12. If appropriate, introduce the word, *conclusion*. Write the word, *conclusion*, on chart paper. A *conclusion* is a statement of the results from the experiment. Ask the class what they learned from the experiment. Write their conclusion on the paper. For example, the conclusion could be, "*When the air was*

released from the balloon, the balloon moved in the opposite direction."

13. Discuss whether the original hypothesis or guess was correct. Have students verbalize why they think the balloon traveled in the opposite direction.
14. Explain to students why the movement of the balloon is like a real rocket's movement. If appropriate, introduce the information about Newton's Third Law of Motion. In a rocket, propellant escapes from the bottom of the rocket. In the balloon experiment, air escapes from the end of the balloon. The rocket lifts off due to the escaping propellant. The balloon moves due to the escaping air. Like a rocket, the balloon travels in the opposite direction.
15. Display the chart paper with the hypothesis, the chart paper with the conclusion, and the data collection sheets in the room. If a camera is available, add pictures of the students conducting the experiment to the display.

Assessment

- Observe students as they answer questions about the experiment. Have students draw a picture of the experiment in their journals or on a piece of paper. Ask them to explain their drawing and explain the relationship between the balloon's movement and the released air. Ask students to describe how a rocket works.

Enrichment

- Challenge students to apply what they learned in this experiment. Repeat the experiment with one change. When attaching a balloon to the straw, reverse the placement of the open end of the balloon. If the open end was to the left, place it to the right. Ask students to form a hypothesis about the movement of the balloon when the air releases. Conduct the experiment. Repeat if necessary. Discuss whether the hypothesis was correct. Talk about the similarities and differences in this experiment and the original experiment. Ask the students if the balloon, in both experiments, moved in the opposite direction from the release of the air. Discuss how students applied what they learned or their conclusion from the first experiment to a new situation.
- Repeat the experiment with another variation. Change the position of the fishing line. Attach one end to the ceiling. Place the straw on the line and stretch the line tightly. Attach the balloon. Attach the other end of the line to a chair or object in the room. Repeat the experiment. Ask students to apply what they learned to a new situation.
- In a journal or on a sheet of paper, or as a group exercise with the educator writing on chart paper, ask students to list the steps needed to conduct the experiment. Discuss the importance of completing the steps in the right order. Encourage the use of ordinal numbers, such as *first, second*, and *third* in their descriptions.
- Have students use directional words to describe the movement in the balloon experiment or a rocket launch. Discuss words such as *up* and *down*, *left* and *right*, and *forward* and *backward*. Introduce or review the concept of words that are opposites. Have students generate a list of words that are opposites.
- From the *Suggested Reading* list or other sources, select books that feature pictures and drawings of rocket launches. Encourage students to look at the depictions of rocket launches and think about what they now know about how a rocket works. Ask students to look at the pictures and note the direction in which the rockets move.

Activity 5

More Rocket Science

Objective

Students gather data and create a simple graph to show the results of a science experiment.

Standards

Science, Mathematics, Technology, Language Arts

Materials

- Balloon experiment as outlined in *Activity 4*, page 21
- Chart paper, 3 pieces
- Interlocking cubes, assorted colors
- Markers, crayons, and pencils
- Journal or piece of paper, 1 per student

Educator Information

- This activity works well as a follow up to *Activity 4*, page 21.
- Be sure to have all materials ready before the activity begins.
- Because of safety concerns, an adult should blow up the balloons.
- Review the experiment in *Activity 4*. In *Activity 5*, the experiment will be set up in the same way. There will be one variation in the experiment. In this lesson, students will evaluate whether the amount of air in the balloon changes the distance the balloon travels on the fishing line. Students will develop a graph to collect this data.
- Read the directions for this activity carefully. Be prepared to share this information with students.
- Draw a line on chart paper to create two columns. Label the two columns with the appropriate titles, *Number of Breaths* and *Distance Traveled.* For non-readers, drawings may be more appropriate.
- Decide where to set up the experiment in the classroom.

Procedure

1. Set up the experiment as described in *Activity 4*. Discuss with students what they learned from the experiment in *Activity 4*.

2. Explain to students that in this lesson, the balloon experiment will also be repeated several times. Let students know there will be one difference in the experiment in *Activity 5*. Each time the class conducts the experiment, there is a different amount of air in the balloon. An adult blows the balloon up each time with a different number of breaths. The air is then released. Students observe how far the balloon travels on the fishing line. They determine whether the amount of air in the balloon changes the distance it travels on the fishing line.
3. After explaining the procedure, ask the students to develop a good guess, or *hypothesis*, about what will happen. Discuss whether the distance the balloon travels will change with the amount of air in the balloon.
4. Decide on a reasonable number of times to repeat the experiment.
5. Ask students to devise a method to collect the data from the experiment. All scientists, on Earth and in space, need to have a method to collect data. Discuss the type of data students need to record. Each time the class conducts the experiment, students need to record the number of breaths and the distance the balloon travels when the air releases. Use a simple two-column graph on chart paper. Label one column, *Number of Breaths*. Label the second column, *Distance Traveled*. Use drawings for non-readers. Students can also collect data individually.
6. Ask students to generate ideas about how to gather the data. Students can simply count the number of breaths. Record breaths on the graph by using tally marks.
7. Tell the students that they will need to measure the distance the balloon travels each time the experiment repeats. To measure the distance, create a nonstandard measurement tool out of interlocking cubes.
8. Have students put interlocking cubes of one color together in a group of 10. For example, make sets of *10 blue, 10 green, 10 yellow*. Connect the groups of ten together, alternating colors, on the floor underneath the fishing line. Make the line of cubes long enough to reach from one end of the fishing line to the other end. Students can measure the distance traveled by counting the interlocking cubes in groups of 10's and 1's.
9. To help students remember the sequence of events in the experiment, write directions or draw pictures to represent steps on chart paper. Display the chart in the classroom.

Experiment

1. Have an adult fill the balloon with air. Make sure the adult stops between each breath so students can count the number of breaths. As the adult fills the balloon, ask students to count the number of breaths and record the data on the graph.
2. Tell students to observe the experiment closely. Release the balloon. Students note where the balloon stops on the line. Using the interlocking cube measuring stick and counting by 10's and 1's, the class measures how far the balloon traveled on the fishing line. Record the data on the chart paper. Be sure students practice using the correct unit of measurement when they record or talk about distance traveled. For example, *the balloon traveled 32 interlocking cubes*.
3. Repeat the experiment the number of times suggested by the class. Each time, the adult varies the number of breaths. Students count and record the number of breaths each time. Students observe where the balloon stops on the line. Count and record the number of interlocking cubes that represent the distance the balloon travels.

4. Carefully look at the information on the graph. Discuss the information on the graph and evaluate what students learned from the experiment.
5. Help students use the information to reach a *conclusion* about the experiment. Students should be able to determine that more breaths result in the balloon traveling a greater distance.
6. As students evaluate the results of the experiment, guide them in using math comparison words such as *more* and *less* in their statements.
7. Write the statements on the graph.

Assessment

- Request that students draw a picture of the experiment in their journal or on a sheet of paper. Ask them to write a sentence about the results of the experiment or describe the results orally. Evaluate.

Enrichment

- Repeat the experiment using groups of five interlocking cubes as a nonstandard measuring tool. Students gain experience counting by 5's.
- Encourage students to think of other forms of nonstandard measurement to determine the distance the balloon traveled. Suggestions could include plastic links, tiles, new crayons, and scissors. Repeat the experiment. Remind students to use the unit of measurement when they talk about distance traveled. For example, *the balloon traveled a distance of 17 crayons.*
- Set up two balloon experiments side by side in the classroom. Let the students "race" two balloons at one time. Vary the number of breaths in the balloons. Let students evaluate the number of breaths and the distance the balloons travel.
- Have students apply what they learned in this experiment. Ask students to consider whether the amount of fuel in a rocket determines how far it travels. Ask students to consider other factors such as size and weight that may affect the distance a rocket travels.
- From the *Suggested Reading* list or other sources, select books that feature pictures and drawings of rocket launches. Encourage students to look at the depictions of rocket launches and think about what they now know about how a rocket works.

Activity 6

Launch Time

Objective

Students construct and launch paper rockets, and use graphs and nonstandard measurement to show how far the rockets travel.

Standards

Mathematics, Technology

Materials

- 2-piece straw rocket (Figure 8, page 80), 1 set per student
- Plastic straws, 1 per student
- Glue sticks or glue
- Drawing of International Space Station (ISS) (Figure 1, page 73), colored
- Bulletin board paper, approximately 3 meters long
- Crayons and markers
- Markers or small photograph of each student
- Interlocking cubes, assorted colors
- Chart paper, 2 pieces

Educator Information

- Three class periods are required for the completion of this activity.
- This activity may need additional adult supervision for rocket construction. Construction of the rockets may work best in a small group environment.
- For each student, copy 2-piece straw rocket pattern.
- Review information on using rockets to construct the ISS.
- Be prepared to demonstrate how to make and launch a paper rocket. Color and cut out the 2-piece rocket. Place the two pieces together with the drawings on the outside. Carefully seal the edges with glue, leaving the bottom edge open. Make sure no air can escape. Insert the straw into the bottom edge and blow into the straw to launch the rocket. Use one short, strong breath to launch the rocket.
- It is important that students carefully seal the edges of the rocket with glue. Students need to leave the bottom edge of the rocket open and unsealed. Adults may need to assist with the application of glue.

- Select an open area to launch the rockets. Plan to carry straws, student rockets, and markers or individual photographs of students to the rocket launch area.
- Color and cut out the ISS drawing. Glue the ISS drawing at the end of the bulletin board paper.
- Draw a line to divide a piece of chart paper into two columns. Label one column with the title, *Name*, and the second with the title, *Distance*. For non-readers, use drawings instead of words to label the columns.

Procedure

First Class Period:

1. Remind students that constructing the ISS requires more than 40 rocket launches. Rockets also carry supplies and people to and from the station.
2. Demonstrate how to make and launch the paper rocket.
3. Demonstrate how to insert the straw into the opening at the bottom of the rocket. Begin a countdown, "*10,9,8,7,6,5...*" Demonstrate how to use a short, strong breath to blow into the straw and launch the rocket.
4. Have each student construct a paper rocket, color, and decorate it. Instruct students to write their name on the rocket.
5. Each student cuts out the 2–piece rocket and places the two pieces together, colored sides facing out.
6. Carefully apply glue to make sure no air escapes. To insert straw, leave bottom edge of the rocket unsealed. Adult supervision may be required. Younger students may need assistance in using glue to seal the edges. Let the rocket dry.
7. Collect rockets and save for the next class period.

Second Class Period:

1. Take the class to the selected location to launch the rockets. A room or area with open floor space is preferable.
2. Talk about safety rules during a real rocket launch. People must avoid being close to a rocket when it launches. Have students develop safety rules for the launch of their paper rockets. Be sure to talk about eye protection.
3. Lay the long piece of bulletin board paper with the ISS drawing on the floor.
4. Explain to students that they will stand at the end of the paper and launch their rocket toward the ISS drawing. The class will practice a countdown for each launch. Demonstrate a rocket launch while the students count from 10 to 1 and then say liftoff.
5. Tell students to note the spot on the paper where the rocket lands. When they launch their rocket, they will either write their name at the spot or mark it with an individual photograph.
6. Tell students that everyone will have a turn to launch a rocket. Wait to launch until directed by the teacher.
7. Distribute rockets and straws to students.
8. A student steps to the end of the paper to launch a rocket toward the station drawing. Before launching the rocket, have students predict whether their rocket will reach the space station. Ask the class to repeat a countdown sequence before classmates launch their rockets. Students insert the straw into the rocket and blow air through the straw to launch their rocket. Remind students to use a short, strong breath. Each student has a turn.
9. If the rocket does not land on the paper, pick it up and place it on the paper at a similar distance from the launch point.

10. At the spot on the paper where the rocket lands, have each student write their name with a marker or glue a small individual photograph.
11. After each student has had an opportunity to launch a rocket and mark where it landed, explain to students that the bulletin board paper is a graph that shows how far each rocket traveled.
12. Ask the class to look at the graph and evaluate what they see. Have students generate sentences to describe what the graph shows them. Use comparison words such as *longer* and *shorter*, and *closer* and *farther*, in the sentences. Sentence examples include: *Patrick's rocket is closest to the ISS; Laura's rocket traveled a longer distance than John's rocket.* Write the sentences on the bulletin board paper graph or chart paper.
13. Save the bulletin board paper graph and sentences for the next class period.

Third Class Period:

1. Students can measure how far their rockets traveled using nonstandard measurement. Explain to students that they will use interlocking cubes to measure how far their rocket traveled.
2. Lay the bulletin board paper graph with the distances marked on the floor.
3. Ask students to sort interlocking cubes by color. Count 10 interlocking cubes of one color and connect them. For example, make sets of *10 blue, 10 green, 10 yellow.* On the floor, connect the sets of 10 cubes alternating different colored groups of 10. Repeat this process until the class has enough sets of 10 interlocking cubes to reach from one end of the paper to the other. The cubes should stretch from the end where the rockets launch to the end where the ISS drawing is located.
4. Let each student take turns finding the spot on the paper where their rocket landed. Have the student count interlocking cubes by 10's and 1's to see how far the rocket traveled. For example, *a rocket traveled a distance of 106 interlocking cubes*. Encourage students to state the unit of measurement.
5. On the chart paper, record the name of each student in the *Name* column. Then record the number of interlocking cubes the rocket traveled in the *Distance* column.
6. After each student's information has been recorded, have students look at the chart to make comparisons and draw conclusions about the distance the rockets traveled. Encourage them to use comparison words and the correct unit of measurement.

Assessment

- Observe students and listen to their comments as they use the graphs and nonstandard measurement to describe how far their rocket traveled.

Enrichment

- Have students predict how far their rocket will travel. Students place an object on the floor at the point where they think the rocket will land. Launch the rocket. Ask students to compare where the rocket landed to the spot they predicted. Use comparison words.
- Have students discuss ways that they could increase the distance their rocket travels. Ideas may include changing the position of the rocket or blowing differently into the straw. Repeat the activity. Compare and contrast the performance of the rocket. Use comparison words to describe the differences in rocket performance.

- To encourage practice counting by 5's, repeat this activity using interlocking cubes sorted into groups of 5. Connect the cubes in groups of 5, alternating colors, in a line on the floor. Use this line of cubes to practice nonstandard measurement and see how far the rockets travel. Encourage students to use the unit of measurement when stating how far their rocket traveled.
- Have students think of other items to use for nonstandard measurement. Examples include wooden blocks, pattern blocks, plastic links, counting rods, shoelaces, and new pencils. Have students launch their rockets again. Use another type of nonstandard measurement to measure the distance the rockets travel. Encourage students to always state the unit of measurement when describing the distance their rocket traveled.
- Another paper and straw rocket is found in the *Rockets* guide at *http://spacelink.nasa.gov/products/Rockets*. Younger students will need adult assistance to construct this rocket.
- From the *Suggested Reading* list or other sources, select books that feature descriptions and pictures of rocket launches, such as *The Space Shuttle* by Jacqueline Langille and Bobbie Kalman or *Rockets and Spaceships* by Karen Wallace. Read the books to the class or have students individually read the books. Encourage the students to find similarities and differences in their paper rocket launches and the launches described in the books.

Activity 7

The Right Order

Objective

Students become familiar with the space transportation system (STS), its parts, and the sequence of a space shuttle launch.

Standards

Science, Mathematics, Technology, Language Arts

Materials

- Drawings of space shuttle (Figure 2, page 74 and Figure 3, page 75), colored
- 1 set of shuttle sequence cards (Figure 10, page 81), enlarged, colored and cut out
- Drawing of space shuttle parts (Figure 11, page 82), colored and cut out
- Diagram of shuttle launch to orbit sequence (Figure 12, page 83), colored
- Shuttle sequence cards (Figure 10, page 81), 1 set per student
- Model of the space shuttle, available from toy stores
- Pictures of a shuttle launch
- Videotape of a shuttle launch
- VCR and TV
- Small closeable plastic bags, 1 per student

Educator Information

- This activity may require two class periods.
- Review the background information on the International Space Station (ISS) and the space shuttle. Be prepared to share it with students.
- Read the following additional information on the space shuttle. Be prepared to share it with the class.
- Be prepared to show students drawings, pictures, or models of the space shuttle. Be able to point out the different parts to the class.

NASA uses the space transportation system (STS), or space shuttle, to take people, supplies and hardware to the ISS. It has a unique design. The space shuttle is a special type of rocket. It consists of several different parts. The orbiter is the white triangular shaped piece, the only part of the shuttle that travels into space. The orbiter houses the crew and carries the components of the ISS in the payload bay. The orbiter needs two white solid rocket boosters and a large orange external tank to reach space. Like many rockets, the space shuttle has several different steps in its launch sequence.

Refer to Figure 12, page 83, featuring the shuttle launch to orbit sequence. The *countdown begins, and the rocket engines ignite. The space shuttle lifts off the launch pad at Kennedy Space Center in Florida. Kennedy Space Center is located near the Atlantic Ocean, on the coast of Florida, close to Cape Canaveral. The space shuttle travels into the sky, leaving a trail of smoke. The solid rocket boosters contain solid propellant. This solid fuel is the consistency of a pencil eraser. The solid rocket boosters burn for about two minutes and help the orbiter to travel high into the sky. The propellant is then completely used. There is no longer any need for the solid rocket boosters. At approximately the two-minute mark, the boosters jettison, or separate, from the external tank and orbiter. They descend into the Atlantic Ocean beneath large parachutes. Ships are waiting to recover the solid rocket boosters and pull them back to shore. People carefully check the boosters and prepare them for launch again on another shuttle flight.*

The large orange external tank remains attached to the orbiter. Inside the external tank are liquid hydrogen and oxygen. Hydrogen and oxygen are normally found in gaseous form. In the external tank, hydrogen and oxygen are so cold that they exist in a liquid state. Liquid hydrogen and oxygen are good rocket propellants. The external tank supplies fuel to the three main rocket engines at the aft end of the orbiter. At approximately eight minutes after liftoff, the external tank has no more propellant. The external tank has completed its task to get the orbiter into space. There is no longer any need for the external tank. It separates from the orbiter and tumbles to Earth. As it falls through the Earth's atmosphere, it becomes very hot. The external tank burns up before it reaches the Earth's surface.

Approximately 40 minutes later, the orbital maneuvering system (OMS) engines fire to complete the vehicle's trip to orbit. The orbiter circles, or orbits, the Earth. It often brings hardware, people, and supplies to the ISS.

After the orbiter finishes its mission in space, it returns to Earth. The orbiter lands on a runway. A parachute is used to help the orbiter stop. At Kennedy Space Center, the orbiter is serviced and prepared to return to space. It is a reusable launch vehicle.

- Enlarge, color, and cut out one set of shuttle sequence cards. Write numerals on the back to indicate the correct order of a shuttle launch. Laminate for future use.
- Copy and color the diagram of a shuttle launch to orbit sequence. Laminate for future use.
- Copy and color drawings of the space shuttle and shuttle parts. Laminate for future use.

Procedure

First Class Period:

1. Use videotapes, models, drawings or photographs to show students a shuttle launch to orbit sequence. Share information on the sequence of a shuttle launch.
2. Look at the launch to orbit sequence drawing. Name each part of the space shuttle. Discuss with students the sequence and talk about each part as it separates from the orbiter. Use the drawing of the shuttle parts to demonstrate how each part separates.
3. Review the launch to orbit sequence using the drawings of the space shuttle and its parts. Remind the students that the orbiter is the only part of the shuttle that travels into space. Use ordinal numbers, like *first, second,* and *third*, to describe the sequence of events.
4. Introduce the enlarged versions of the shuttle sequence cards. Use the cards to describe the events in the launch to orbit sequence. Use them to put the events in the correct order.
5. Let students practice the sequence of events during a shuttle launch using the cards. Have students refer to the numerals on the back of the cards to self-check.

6. Remember to tell students that one of the missions of the space shuttle, after launch, is to carry hardware and people to and from the ISS.

Second Class Period:

1. Review the sequence of a space shuttle launch using models, videotapes, diagrams, and drawings.
2. Let students practice the correct sequence of a space shuttle launch using the enlarged space shuttle launch to orbit sequence cards. Encourage them to self-check using the numerals on the back of the cards.
3. Have students review the sequence of events using an individual set of shuttle sequence cards. Give students a set of cards to color and cut apart.
4. Ask students to place the cards in the correct sequence. Monitor the activity to make sure students place cards in order and sequence from left to right.
5. Ask students to orally describe the steps in a shuttle launch using the shuttle launch to orbit cards. Encourage students to use ordinal numbers, such as *first, second*, and *third* when describing each step. Have students store the cards in a plastic bag.

Assessment

- Observe students as they place the shuttle sequence cards in order. Ask students to describe each step in the launch to orbit sequence.

Enrichment

- Have students draw the sequence of events in a journal or on a sheet of paper. If appropriate, have students label the parts of the shuttle.
- Use a map or globe to show students where they live. Locate the Kennedy Space Center in Florida. Find the Atlantic Ocean. Use labels or stickers to mark these locations. Remind students that the solid rocket boosters fall into the Atlantic Ocean. Have the class generate ideas about why the space shuttle launch pad is located close to the ocean. Ideas should include safety issues.
- Use a globe to demonstrate the orbiter circling or orbiting the Earth. Ask students to remember that the orbiter is the only part of the space shuttle that orbits the Earth. Mention that the ISS also orbits the Earth. In space, the orbiter will dock, or join, with the space station and deliver supplies, people, and hardware. Review the concept, introduced in *Activity* 2, page 15, of objects in the sky made by humans.
- The space shuttle has both solid and liquid propellants or fuel. The solid rocket boosters have solid propellant, and the external tank has liquid propellant. Discuss the differences between a solid and a liquid. Encourage students to generate a list of the characteristics of a solid and a separate list of the characteristics of a liquid. Compare and contrast the lists. Make a list of things that are solid and things that are liquid. In their journals or on a sheet of paper, have students draw pictures of objects that are solids or liquids. Have students or the educator label the drawings. Students may also collect pictures of solids and liquids. Use the pictures to practice sorting or classifying.
- From the *Suggested Reading* list or other sources, select books that feature descriptions and pictures of shuttle launch to orbit sequences. Examples include *The Space Shuttle* by Jacqueline Langille and Bobbie Kalman, *Space Shuttle* by Mark Bergin, and Jan Graham's *Best Book of Spaceships*. Read to the class or let students read individually. Ask students to describe the sequence of events in a shuttle launch using pictures in the books.

Activity 8

Good Enough to Eat

Objective

Students construct an edible model of the space transportation system, or space shuttle, and use it to demonstrate a launch sequence.

Standards

Science, Mathematics, Technology, Language Arts

Materials

- Carrots, cleaned and cut in half, lengthwise, 1 per student
- Celery, 2 equal sized pieces per student
- White bread, 1 slice per student
- Knife
- Peanut butter, marshmallow cream, or softened cream cheese
- Plastic knives, 1 per student
- Templates of the orbiter (Figure 14, page 84), copied on index-weight paper or an orbiter cookie cutter
- Paper plates, 2 per student
- Paper towels
- Drawing of shuttle launch to orbit sequence (Figure 12, page 83)
- Drawing of space shuttle parts (Figure 11, page 82)
- Journal or piece of paper, 1 per student
- Chart paper
- Markers or crayons
- Model of the space shuttle, available from toy stores

Educator Information

- **Before beginning this activity, determine if any student has an allergy to peanuts.**
- This activity may require additional adults to assist the educator. It may work best in a small group environment.
- Make copies of the orbiter template. Use index-weight paper, if available. Cut out. Laminate for future use.
- Depending on the ability level of the students, an adult may need to cut orbiters out of white bread using the orbiter template provided. Use an orbiter cookie cutter if available.

- Before beginning the activity, have an adult wash and cut the vegetables. Cut the carrot in half lengthwise. Cut crosswise to make two large pieces with the large end of the carrot. Place the carrot flat side down on a paper plate. This represents the orange external tank. It is the longest part of the space shuttle.
- For each student, have an adult cut two equal-sized pieces of celery. The celery sticks represent the two equal-sized solid rocket boosters. Make sure they are shorter than the carrot that represents the external tank and longer than the orbiter made out of bread.
- Prepare a paper plate for each student with the vegetables, bread, a plastic knife, and a small amount of peanut butter or alternative spread.
- Before the activity begins, the educator or other adults should practice putting the vegetable and bread orbiter together.
- Review background information on the space shuttle and its parts. Be prepared to share this information with students.
- Refer to the drawing of the shuttle and its parts. Be prepared to name each of the parts and talk about the sizes of the parts.
- Read the following information and be prepared to share it with students.

  There are four orbiters currently in use. Atlantis, Columbia, Discovery, and Endeavour are the names of the orbiters. NASA built two other orbiters. The Enterprise flew only as a test vehicle. In 1983, an accident destroyed the orbiter Challenger.

  The orbiter is the shortest part of the space transportation system. It is 37 meters in length. The two solid rocket boosters are equal in size. They are taller than the orbiter. Each solid rocket booster is 45 meters long. The orange external tank is the tallest part of the shuttle. It is 47 meters in length.

- To help students put the vegetables and bread together in the correct order, create a chart using pictures. In addition to oral directions, have students use the pictures on the chart to help them remember the correct sequence. Make another chart with pictures to show students the order in which the vegetables are removed from the bread orbiter to simulate a launch to orbit sequence.

Procedure

1. Review background information on the space transportation system or space shuttle and its parts with students.
2. Refer to the drawing of the shuttle and its parts. Ask students to name each of the parts. Discuss the size of each part. Compare the sizes of the parts. Ask students to name the tallest part and the shortest part of the space shuttle.

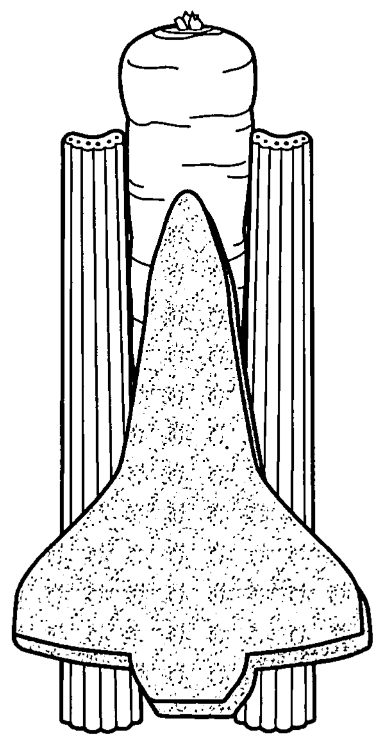


Figure 13. Edible Space Shuttle

3. Pass out paper plates with one carrot stick, two pieces of celery, one bread orbiter, a plastic knife, and peanut butter or alternative spread. Tell students they are going to build a space shuttle out of food. Explain the directions orally and also share the picture charts.
4. Ask students to examine the parts of the vegetable and bread space shuttle. Ask students to guess which food represents each shuttle part. Share that the carrot represents the external tank. The celery sticks represent the two solid rocket boosters. The bread represents the orbiter.
5. Introduce or review the word, *equal.* Discuss that the two celery sticks are *equal* in length.
6. Look at the parts of the space shuttle and describe them using comparison words such as *tallest* and *shortest*, and *taller* and *shorter*.
7. Students attach the celery sticks to the carrot with a small amount of peanut butter or alternative spread.
8. Spread peanut butter or an alternative spread on one side of the bread orbiter and attach it to the carrot external tank. At this point, if necessary, provide a clean plate to each student.
9. When students have completed assembling their space shuttle, it is time for a countdown. Review the diagram of the space shuttle launch to orbit sequence. Demonstrate how to launch the edible shuttle. If possible, hold the vegetable space shuttle upright. Count from 10 to 1 and get ready to liftoff.
10. Soon after launch, simulate the separation of the two solid rocket boosters. Lay the celery sticks back on the plate.
11. Next, simulate the separation of the carrot external tank. Lay it back on the plate.
12. Simulate the orbiter orbiting or circling the Earth and landing back on the plate.
13. Ask students to describe the sequence of events using ordinal numbers such as *first, second* and *third.*
14. When the class discussion is finished, students eat the space shuttles they made.

Assessment

- In a journal or on an individual sheet of paper, students draw a picture of the vegetable and bread space shuttle. Encourage students to draw the vegetables to represent a launch sequence. Have students look at their drawing to determine if the parts are the correct size when compared to each other.
- Using a commercial model of the space shuttle, have students reenact the launch sequence. Ask students to make a comparison of the heights of the space shuttle parts.

Enrichment

- Count the number of celery sticks in the class by 2's. Count the number of external tanks in the class by 1's.
- Have students draw a picture of a space shuttle launch to orbit sequence in a journal or on an individual sheet of paper. If appropriate, ask students to label the parts and to write numerals under each step.
- Have students build a model of the space shuttle out of blocks, wood, or cardboard boxes. Ask them to sequence a shuttle launch using their model. Help students evaluate and compare the sizes of each part.
- From the *Suggested Reading* list or other sources, select books that feature descriptions and pictures of shuttle launch to orbit sequences. Examples include *The Space Shuttle* by Jacqueline Langille and Bobbie Kalman, *Space Shuttle* by Mark Bergin, and Jan Graham's *Best Book of Spaceships*. Read to the class or have students read individually. Ask students to describe the sequence of a shuttle launch using pictures in the books.

ACTIVITY 9

ROCKET CONSTRUCTION

Objective

Students build rockets out of wooden blocks and use comparison words to describe the height relationships.

Standards

Mathematics, Technology, Language Arts

Materials

- Wooden blocks
- Die with numerals 1 to 6 or corresponding number of dots
- Drawings of Proton (Figure 4, page 76) and Soyuz (Figure 5, page 77), colored
- Drawing of space shuttle (Figure 3, page 75), colored
- Photographs of different types of rockets

Educator Information

- This activity may work best in a small group environment.
- The educator may wish to limit the size and number of blocks used in this activity.
- To avoid accidents, the teacher may wish to limit the height of the rockets. For example, a rocket can only be as tall as the table, the bookcase, or a student.
- Review information on different types of rockets. Be prepared to share this information with students.
- Copy and color drawings of Russian rockets and the space shuttle. Laminate drawings and pictures for future use.

Procedure

1. Show students pictures, photographs, and drawings of different types of rockets. Tell students that rockets are different shapes and sizes. Show students drawings of the Russian Proton and Soyuz rockets and the American space shuttle.
2. Tell students that several types of rockets carry supplies, people, and parts to the space station. Ask them to compare and contrast the drawings. Look at the rocket pictures and discuss similarities and differences in rocket design. Remind students that rockets do not all look the same and are not all the same size or shape.

3. In small groups, have students use wooden blocks to create their own rockets. Allow students to independently explore building rockets out of wooden blocks.
4. Add a die to the block area in the classroom. Tell students that they must roll the die to determine the number of blocks they will use to build a rocket. Each student will roll the die three times and build three rockets. For example, a student rolls a six, and uses six blocks to build a rocket. Make sure that the rockets have the same base, such as a table or the floor, to be sure that comparisons will be accurate.
5. Direct students to roll the die three times. Each time students roll the die, they build a rocket with the appropriate number of blocks. Leave the rocket standing after each roll. The student should have three rockets standing after three rolls.
6. Compare the rockets' height using comparison words, such as *taller* and *shorter*, and *tallest* and *shortest*. Introduce or review the word, *equal*. Have students place the block rockets in order from tallest to shortest, and shortest to tallest.
7. Challenge students to evaluate the way the blocks are stacked or placed. Blocks stacked the "tall way" rather than the "long way" may change the height of the rocket.

Assessment

- Listen and evaluate students as they use comparison words to describe their rockets. Observe students as they place rockets in order by height.
- Students draw the rockets they built. Observe students to see if the depiction of rocket heights is correct. Students or educators write a student-generated sentence to describe the drawing.

Enrichment

- Have students build three rockets of different heights out of blocks. Label the rockets 1, 2, and 3. Have students compare the heights of the rockets and use good reasoning skills. For example, *if rocket 1 is taller than rocket 3, and rocket 2 is shorter than rocket 3, then rocket 2 must be shorter than rocket 1*. Encourage students to look at other possible comparisons using rockets of varying heights.
- Two students build individual rockets using the same die roll. Ask them to compare the heights of the rockets. Decide if the rockets are equal in height. Have students evaluate the way blocks are placed and decide if the rocket height changes if blocks are stacked a different way. Use comparison words to describe the heights of the rockets. Increase the number of blocks used in the activity by using a pair of dice instead of one die.
- To practice numeral or number word recognition, repeat this activity with students selecting cards with number words or by using a spinner with numerals.
- Select an object in the room. Compare the height of a block rocket to the height of the object. Use comparison words. Ask students to build a rocket *taller*, *shorter*, or *equal* to the height of this object.
- Use nonstandard measurement tools, such as interlocking cubes or plastic links, to measure the height of the rockets built out of blocks.
- Introduce or review the concept of *symmetry*. Ask students to examine their block rockets. Decide whether the rockets have *symmetry*. Look for other symmetrical objects in the room. Ask students to build a symmetrical rocket.
- Have students use different materials to construct rockets. Students could construct rockets out of cardboard tubes and scrap

paper. Use scraps of wood and glue to create rockets. Use small cardboard boxes for individual rockets. Use large cardboard boxes to create a child-sized rocket for the classroom. Encourage students to use comparison words to describe the rockets.

- Find and read books to the class on building rockets. Examples from the *Suggested Reading* list may include *Ritchie's Rocket* by Joan Anderson, *Mooncake* by Frank Asch, or *Rocket* by Mike Inkpen. Have students compare and contrast the rockets they built with the rockets built in the books.

Activity 10

Rocket Alphabet

Objective

Students practice uppercase letter recognition and sequencing uppercase letters in the correct order.

Standards

Language Arts

Materials

- 26 large rocket drawings (Figure 6, page 78), colored
- Alphabet chart
- Drawing of space shuttle launch to orbit sequence (Figure 12, page 83), colored

Educator Information

- Write an uppercase letter, A to Z, on each one of the 26 rockets. Color and decorate the rockets. Laminate the rockets for future use.
- Decide on a location in the classroom to place the rockets in alphabetical order.
- Be prepared with a familiar alphabet song for students to sing.
- This activity requires one class period. Students should review the activity over several days.
- Review the sequence of a space shuttle launch and be prepared to share information with students.

Procedure

1. Explain to students that, in space shuttle and rocket launches, events have to take place in the right order or sequence. Refer to the drawing of the space shuttle launch to orbit sequence. Remind students that, like the events in a space shuttle launch, the letters in the alphabet have a certain order or sequence.
2. Introduce the rockets with the letters of the alphabet. Using the rockets, demonstrate how to sequence the alphabet on the floor or on a chalkboard tray. Use the term, *alphabetical order.*
3. Distribute the rockets to the students. If there are fewer than 26 students in the class, keep the extra rockets or give two rockets to some students. Ask students to place their letter in the correct order. Remember to always

monitor sequencing from left to right. If students require extra help, call out the next letter or have students refer to an alphabet chart.

4. Using an alphabet chart or an alphabet song, have students check that the sequence is correct.
5. As the activity becomes more familiar, encourage students to sequence the alphabet independently using the rockets. If necessary, have students refer to an alphabet chart for assistance.
6. To vary the activity, tell students to hold the rockets, stand, and then line up in alphabetical order. Hand out the rockets to students. If you have fewer than 26 students, keep the extra rockets and be prepared to place the rockets in the correct order. Remember to monitor sequencing from left to right. The educator may need to prompt students with the next letter.
7. As the activity becomes more familiar, encourage students to sequence the alphabet without assistance. Have one student check that the sequence is correct using an alphabet chart or song.

Assessment

- Observe students as they practice recognizing uppercase letters and putting them in the correct order.

Enrichment

- Distribute the rockets with uppercase letters to the students. If you have fewer than 26 students, give two rockets to some students. Play a simple alphabet game using the letters. Call out certain letters. Students hold up their letter when appropriate. For example, the educator requests: *the letter W; all vowels; the letter in the alphabet before C; the letter in the alphabet after R*. Repeat using variations of the activity. For students familiar with sounds, the game could include: *the first letter in hat; the last letter in mop.* Repeat using variations of the activity.
- For emerging spellers, hand the rockets with uppercase letters to students. Name a simple word. Ask students holding the letters that spell the word to stand, come forward, and place themselves in the correct order. Remember to sequence from left to right. Repeat using other simple words. To practice rhyming words, name a simple word. Ask students to come forward with their letters and spell the word. Name a word that rhymes. Change the first letter in the word. Ask the student with the first letter, or initial sound, in the word to sit down. Ask the student with the new first letter, or initial sound, to come forward. For example, start with *cat*; then *hat*; then *pat*. Repeat using other simple rhyming words.
- Make copies of the small rocket drawings (Figure 7, page 79). Color and cut out 26 copies of the rocket. Write a lowercase letter on each rocket. Laminate for future use. Use the rockets with uppercase letters, and allow students to practice matching uppercase and lowercase letters on the chalkboard tray or the floor.
- Using the small rocket drawings (Figure 7, page 79), create activities for independent practice on letter recognition and sequencing the alphabet.
- Using the paper rockets in *Activity 6*, page 28, students practice letter recognition. Lay rockets with uppercase letters end to end on the floor. Depending on the capabilities of students, letters may be in alphabetical order or randomly placed. Place a piece of paper tape on the floor at the end of the line of letters. Position the rockets so that students

standing on the tape can read the letters. Students launch their rockets from the line. They note the letter nearest the spot where their rocket lands. Repeat the activity changing the order of the letters or using lowercase letters.

- The space program uses many acronyms or initials, including NASA (National Aeronautics and Space Administration), ESA (European Space Agency), EVA (extravehicular activity), STS (space transportation system), SRB (solid rocket booster), and ET (external tank). Review what these acronyms mean. Write them on the chalkboard. Introduce the concept of using the first or initial letter of a word. Have students apply this to their names and figure out their initials. For example, *the initials for Robert James Smith would be RJS*. Ask students to think of other acronyms. Examples could include *U.S. (United States)*, *VCR (video cassette recorder)*, and *CD (compact disc)*.
- Choose alphabet books to read to the class. Use the books to check that students correctly sequence the alphabet rockets.

Activity 11

Rocket Rhymes and Songs

Objective

Students use rhymes, chants, songs, and creative movement to practice rhyming words.

Standards

Mathematics, Language Arts

Materials

- Chart paper
- Sentence strips
- Pocket chart
- Craft sticks, 5 per student
- Drawing of International Space Station (ISS) (Figure 1, page 73), colored
- Drawing of Proton (Figure 4, page 76) and Soyuz (Figure 5, page 77), colored
- Small rocket drawings (Figure 7, page 79), 5 rockets per student
- Markers and crayons

Educator Information

- Use songs, rhymes, and chants to enhance other activities in this guide.
- Write the songs, rhymes, and chants on chart paper or sentence strips.
- Explore additional resources for appropriate songs, rhymes, and chants.
- Color drawings of ISS, Proton, and Soyuz. Laminate for future use.
- Make enough copies of small rocket drawings so that each student has a set of 5. Have a set colored, cut out and glued on craft sticks to show students.

Procedure

1. One at a time, introduce songs, rhymes and chants about rockets and the space station. Examples of songs, rhymes, and chants follow. Have students develop movements to accompany the songs, rhymes, and chants.

Songs

Tune: ***"Have You Ever Seen a Lassie?"***

Did you ever see a rocket,
a rocket, a rocket?
Did you ever see a rocket go
this way and that?
Go this way and that way, go
this way and that way,
Did you ever see a rocket go
this way and that?

Repeat the song. Substitute the word station for the word rocket. Hold and move a drawing of a Proton or Soyuz rocket or the ISS while singing the song.

Tune: ***"I'm a Little Teapot"***

I'm a little rocket,
Tall and thin,
Here is my nose cone.
Here is my fin.
When I get all fired up,
Launch begins.
Watch me rise,
And see me spin!

Develop movements to accompany the song.

Tune: ***"Twinkle, Twinkle Little Star"***

Rocket, rocket in the sky,
Flying fast and flying high,
Off to find the ISS,
What's in it? Can you guess?
Rocket, rocket in the sky,
Flying fast and flying high.

Substitute the words Proton, Soyuz, or shuttle for the word rocket. Develop movements to accompany the song. Hold and move a drawing of a Proton, Soyuz, shuttle, or the ISS while singing the song.

Chants and Rhymes

I'm a little rocket, *(child squats)*
Pointing toward the sky *(points arms upward)*
4...3...2...1 *(repeats slowly)*
Blast off! Fly! *(springs into the air)*

---

5 little rockets ready to zoom,
The first one says, "There's not enough room."
It starts its engine; ready to fly,
Looks at the others and
waves good-bye.

4 little rockets...
3 little rockets...
2 little rockets...
1 little rocket...

Students may use their fingers or five copies of the small rocket to represent the five rockets in the rhyme. Have students color, cut out the rockets, and glue them to wooden craft sticks. Discuss the simple subtraction problems in this rhyme. Have students create movements to go with the words in the rhyme.

Many nations,
Build a station,
A science place,
A home in space,
Where people stay,
And work each day.

2. Display the chart paper or sentence strips with the songs, chants, and rhymes written on them. Read from the sentence strips or chart paper, and encourage students to follow the words. Model reading from left to right.
3. Mix up the order of the sentence strips. Have students place the strips in the right order. Depending on the ability level of the students, have students place individual words in the correct sequence. Encourage students to review initial sounds in rhyming words.
4. Practice the songs, rhymes, and chants daily.

Assessment

- Ask students to identify words that rhyme. Ask them to generate a list of additional rhyming words. Read together or individually. Evaluate individual students.

- In a journal or on a sheet of paper, have students draw pictures of rhyming words. If appropriate, have them write the rhyming words under the pictures. Read together or individually.

Enrichment

- Let the class create original songs, chants, and rhymes. Write the new songs, chants and rhymes on charts or sentence strips and display in the classroom. Read together.
- Choose books of poems and rhymes to share with students. *Blast Off! Poems About Space* by Lee Bennett Hopkins is a poetry book with a space theme. Select rhyming books from the *Suggested Reading* list or other sources. *Roaring Rockets* by Tony Mitton and Ant Parker is one of many rhyming books about space. Encourage students to identify words that rhyme in the books.

ACTIVITY 12

ROCKET MATH

Objective

Students find missing addends in simple number sentences.

Standards

Mathematics

Materials

- Paper plates, 1 for every two students
- 5 copies of the small rocket drawing (Figure 7, page 79), colored, cut out, and ready to attach to chalkboard or flannel board
- 1 large rocket drawing (Figure 6, page 78)
- Copies of small rocket drawing (Figure 7, page 79), 1 set of 5 rockets for every 2 students
- Chalkboard or flannel board
- 1 paper plate, ready to attach to chalkboard or flannel board
- Journal or a piece of paper, 1 per student
- Paper, 2 pieces per student
- Markers, pencils, or crayons
- Colored chalk

Educator Information

- Copy, color, and cut out 1 set of 5 small rockets.
- Prepare rockets and paper plate to attach to chalkboard or flannel board.
- Read the directions for the activity and be prepared to share information with students.
- Copy, color, and cut out small rockets, 1 set of 5 rockets for every 2 students. Laminate for future use.
- This activity may require two class periods.

Procedure

First Class Period:

1. Show the set of five small rockets to the class. Have the class count the number of rockets.
2. Attach the rockets to the chalkboard or the flannel board so that students can see them.
3. Show students the paper plate. Cover all the rockets with the plate. Attach the plate to the chalkboard or flannel board.
4. Take 2 rockets out from under the plate. Have the class count the rockets they can see.

5. Ask the students to figure out the number of rockets left under the plate. The answer is 3.
6. Remove the plate and confirm that the answer is correct. Ask the students how they determined the answer.
7. Tell students that they need to draw a picture or representation of what they see. Demonstrate how to draw the representation on the chalkboard. Draw a big circle to represent the plate. Use one chalk color to draw 3 small rockets or dots inside the circle. These represent the rockets hidden under the plate. Label with the appropriate numeral. Use another chalk color to draw two rockets or dots outside of the circle. These represent the rockets removed from under the plate. Label with the appropriate numeral. Write the numeral 5 to show the total number of rockets.
8. Hand out a journal or a sheet of paper to each student. Let them practice drawing the representation.

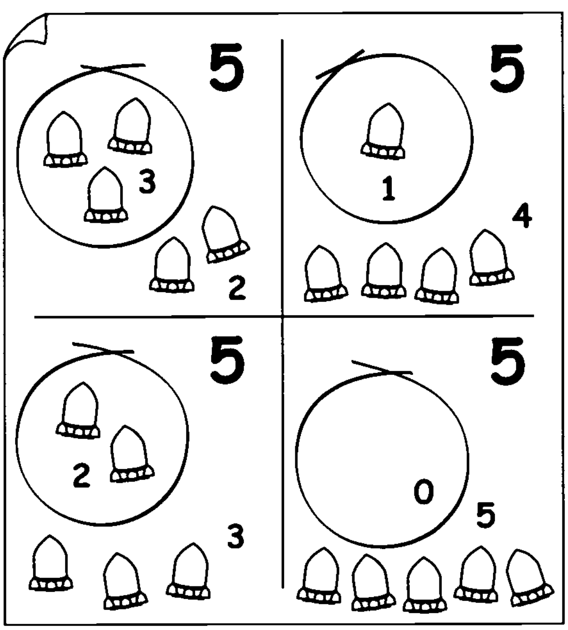


Figure 15. Sample Page From Journal

9. Repeat the activity several times changing the number of rockets removed from under the plate. Each time, have students draw a picture to represent what they see. To save paper, suggest that they draw two lines to divide the paper into four sections. See *Figure 15.*

Second Class Period:

1. Divide the class into groups of two students. Distribute one paper plate and five rockets to each pair. Hand out journals or one sheet of paper to each student.
2. Have students practice the activity independently taking turns placing and removing the rockets. Students take turns telling how many rockets are under the plate. Encourage them to tell how they figured out how many rockets were left under the plate. Repeat several times.
3. As the activity is repeated, have students draw a picture in their journal or on the paper to represent what they see. Remind them to label the picture with the appropriate numerals.
4. Have students share their pictures with the class. Look at the many different combinations of covered and uncovered rockets they found.
5. As students become familiar with the game, vary the total number of rockets used. Repeat the activity.
6. Depending on the ability level of the students, have them write simple addition and subtraction sentences. For example, students could write $1+4 = 5$ or $5 - 1 = 4$ to represent their drawings.

Assessment

- Observe students as they repeat this activity. Discuss and evaluate their drawings.

Enrichment

- Allow students to practice finding the missing addend using a number line from 0 to 10. Place a number line on the floor. Introduce or review the concept of a number line. Color and cut out the large rocket (Figure 6, page 78). Laminate for future use. Students place the rocket at the start of the number line, ready to launch. Roll a die. Move the rocket the appropriate number of spaces on the number line. Continue to roll the die and move the rocket the appropriate number of spaces. Continue to roll until the rocket reaches 10. For example, the student rolls a 6 and moves the rocket to the 6. The student rolls a 1 and moves the rocket to the 7. Continue to roll the die until a 3 is rolled. If the numeral is greater than the number needed to reach 10, roll again. Move the rocket to the 10. When the rocket reaches 10, have students reverse the direction of the rocket. Roll the die until the rocket returns to 0. Help students develop ways to record the data. Encourage them to use the data in simple addition and subtraction sentences. If more appropriate, fold the number line in half, and have students roll a die to reach 5.
- On the playground, draw a line of 11 squares on the pavement with sidewalk chalk. Label each square with a numeral from 0 to 10. Demonstrate to students how to play a math version of hopscotch. The hopscotch squares become a number line. A student stands in the 0 square. Roll a die. The number on the die determines the number of squares that the student jumps. Students roll the die and jump the appropriate number of squares until they reach 10. If the numeral is greater than the number needed to reach 10, roll again. When the student reaches 10, turn around and repeat the activity to reach 0. Encourage students to use the data in simple addition and subtraction sentences.
- Have students practice counting using the rhymes and chants in *Activity 11*, page 44. Select appropriate books with rhymes and chants to encourage additional practice.

Activity 13

Rocket Patterns

Objective

Students use paper rockets to practice recognizing, creating, and extending patterns.

Standards

Mathematics, Language Arts

Materials

- Copies of the small rocket drawing page (Figure 7, page 79), copied on different colors of paper; each student will need approximately 12 rockets
- Small closeable plastic bags, 1 per student
- Small plastic containers or bowls
- Pieces of paper
- Long strips of paper or sentence strips, at least 1 per student
- Journal or piece of paper, 1 per student
- Pencils, markers, or crayons
- Glue or glue sticks
- Assorted math manipulatives such as interlocking cubes, plastic links, or counters
- Variety of items from the classroom, appropriate for making patterns

Educator Information

- This activity may need four class periods to complete.
- Reviewing the concept of a pattern requires several days.
- Copy the small rocket drawing page on different colored paper. Be sure there are an adequate number of rockets for students to use in patterns. Each student will need approximately 12 rockets. If colored paper is not available, copy the page on white paper. Have students or adults color the rockets, using a single color, before the activity begins. To make patterns, rockets must be in assorted colors. The educator may have adults or students cut out the rockets before the activity begins.
- Sort the rockets by colors and place in plastic bowls or plastic containers.
- Assemble math manipulatives and items from the classroom appropriate for making patterns.
- Be prepared to review or introduce the concept of a pattern using math manipulatives. Be prepared to discuss sequencing from left to right.

Procedure

First Class Period:

1. Introduce or review the concept of a pattern. Use math counters, plastic links, interlocking cubes or other math manipulatives to demonstrate patterns. Color patterns are often easiest for young students to identify. Have students orally identify the pattern. For example, students say *green, blue, yellow, green, blue, yellow, green, blue, yellow.*
2. Be sure that students understand that there must be a least two repetitions before a pattern can be determined. Create a pattern using one of the suggested materials. Cover everything except the first element in the pattern. Ask students if they can guess what the pattern is. Continue revealing elements until students recognize repetition.
3. Discuss how students know what element comes next in the pattern. Ask how many times the pattern had to repeat. To help students visualize repetitions, the educator may wish to separate the elements in each repetition. Practice using ordinal numbers, *first, second,* and *third*, to describe the position of the elements.
4. Have students practice making and predicting patterns. Allow students to make a pattern out of math manipulatives. To help pattern recognition, have students orally repeat or draw the pattern. Ask students if they can predict what the next element of the pattern will be. Continue until they have extended the pattern several repetitions. Repeat the activity several times.
5. Allow students to practice this activity in groups of two. Students take turns being the pattern maker or the person to predict and extend the pattern. Have students draw or repeat the pattern orally. Monitor the activity.

Second Class Period:

1. Review the concept of making a pattern using math manipulatives. Allow students to practice making patterns.
2. Discuss the concept of a pattern that does not repeat or is "broken." Make a pattern with math manipulatives. Be sure that one of the elements is incorrect. Let students look at the pattern.
3. Have students apply what they have learned about patterns. Have them identify the element that is not in the right place. Have students correct the pattern so that it repeats.
4. Depending on the ability of students, allow practice making and correcting "broken patterns" independently in groups of two. Students may use math manipulatives to make the patterns. Monitor the activity.

Third Class Period:

1. Demonstrate a simple pattern made out of math manipulatives. Use three different colors. Ask students to identify the pattern. Ask them to say or draw the pattern. For example, *red, white, blue, red, white, blue, red, white, blue.*
2. Tell students that patterns are created from items with many different attributes, not just color. Create simple patterns out of math manipulatives using different attributes such as size. Ask students to identify the patterns. Ask students to say or draw the patterns. For example, *big, little, big, little, big, little.*
3. Make a pattern using different shapes such as triangles, squares, and circles. To help students recognize the patterns, let them orally repeat or draw the pattern.
4. Show students patterns made with different objects found in the classroom. Make a simple pattern using crayons, chalk, and pencils. Have students say or draw the pattern.

5. Ask students if they can find objects in the room to use to make a pattern. Have them create and share the pattern with the class. Ask the class to say or draw the pattern.
6. Ask students if they can find patterns in the classroom. For example, find a pattern on a poster or on someone's clothes. Ask students to say or draw the pattern.
7. Encourage students to identify a pattern in the classroom that is similar to one that they created.

Fourth Class Period (or at any appropriate time in the lesson cycle):

1. Review pattern concepts. Allow students to practice making patterns.
2. Tell students that they will use paper rockets to make a pattern. Demonstrate how to make a simple pattern using different colored paper rockets. For example, *red rocket, blue rocket, red rocket, blue rocket, red rocket, blue rocket*. Repeat using other colors of rockets. Repeat using more than two elements.
3. Students sit at tables or desks. The educator distributes the rockets, already sorted by color. Students select 12 rockets, 6 of one color, 6 of another color.
4. Request that students create a simple pattern using the rockets. For example, *yellow, orange, yellow, orange, yellow, orange*.
5. Ask students if they can change the pattern by changing the repetition of the elements. For example, *yellow, yellow, orange, yellow, yellow, orange, yellow, yellow, orange*. The complexity of the pattern will depend on the ability of the student.
6. Students can also make their pattern more complex by increasing the number of colors. For example, *green, red, white, green, red, white, green, red, white*. The complexity of the pattern will depend on the ability of the student.
7. When students are satisfied with their patterns, distribute the strips of paper or sentence strips.
8. Direct students to place the paper above or below the rocket pattern they created.
9. Have students carefully glue their pattern on the paper. Monitor sequencing from left to right. Some students may want to use more than one strip of paper.
10. Display the patterns in the classroom. These strips make excellent borders for bulletin boards.

Review

1. Students continue to make and identify patterns.
2. Incorporate the use and identification of patterns into your daily classroom routine and activities.

Assessment

- Evaluate the patterns students create out of paper rockets.

Enrichment

- Encourage students to make their patterns more complex by increasing the number of elements. For independent practice, provide a student with cards numbered *2* to *5* and math manipulatives. Turn the cards face down on the table. Let the student select a card. The numeral on the card will dictate the number of the elements in the pattern. Direct the student to make a pattern with that number of elements out of the math manipulatives. Repeat this activity using cards with number words.

- Challenge students to make a pattern using one color of rocket. Create the pattern by turning the rocket in different directions. For example, students could make a pattern by having the rocket *point up, point down, point up, and point down.*
- Have students look at a pattern created out of colored rockets and count how many of each rocket there is in the pattern. For example, the pattern has *7 green rockets, 7 yellow rockets, and 7 blue rockets.* If the pattern repeats one more time, ask students to figure out the number of each colored rocket.
- Provide students with sidewalk chalk for the playground. Ask them to draw patterns using different colors and shapes on the pavement.
- Students can create different representations of the same pattern. Have students create a pattern out of math manipulatives. The pattern could be *red, blue, yellow, red, blue, yellow, red, blue, and yellow.* Instead of using color words, have students use the letters *A, B, and C* to represent the pattern. Numerals, such as *1, 2, 3*, may also be used. Use movements to represent the pattern. For example, *clapping hands, snapping fingers, and patting the head*, could represent this pattern. Compare and contrast each representation with the others. Have students apply this concept to patterns they create or find in the classroom.
- Have students look carefully at a chart showing numerals to 100. Ask students if they can identify patterns created by the numerals.
- Encourage students to draw a representation of a pattern they create or find in a journal or on a piece of paper. Label the pattern with letters or numerals to create another representation of the pattern.
- Share books with the class that have verbal patterns in them. Help students identify the word patterns that are found in the books. Make a class book using a word pattern. Read books such as *Rockets* by Betsy Buttonwood that help students learn to identify color words. Find additional books that encourage color word recognition. Have students practice identifying color words when describing patterns.

Activity 14

Number Rockets

Objective

Students identify numerals and the number each numeral represents.

Standards

Mathematics, Language Arts

Materials

- 11 large rockets (Figure 6, page 78), colored, with the numerals *0* to *10*
- 11 large rockets (figure 6, page 78), colored, with dot stickers representing numbers, *0* to *10*
- 55 colored dot stickers
- Paper
- Markers
- Pocket chart

Educator Information

- Copy large rockets on index-weight paper, if it is available. Color the 11 large rockets. Write one numeral, *0* to *10*, on each rocket.
- Copy a second set of 11 rockets on index-weight paper, if it is available. On these 11 rockets, place dots to represent numbers 0 to 10. For example, on one rocket, place three dots to represent the numeral 3. On one rocket, place no dots to represent the number 0. If stickers are not available, draw dots to represent the numerals 0 to 10.
- Laminate rockets for future use.
- Decide on the area in the classroom to place the rockets in this activity.
- Read the activity and be prepared to share it with students.
- This activity may take two class periods to complete.
- Students may need to review this activity for several days.

Procedure

First Class Period:

1. Introduce the rockets with numerals to the students. Place the rockets in a pocket chart, the chalkboard tray, or on the floor. Model sequencing in correct order from left to right.
2. Introduce the second set of rockets with dots. Tell students that these dots represent a number. Demonstrate to the class how to match the rockets with numerals to the rockets with the appropriate number of dots. Display the matched rockets in a pocket chart, the chalkboard tray, or on the floor.

3. As a class activity, ask students to correctly match the rockets. Allow students the opportunity for independent practice.
4. Encourage students to place the rockets in numerical order.

Second Class Period:

1. Review the activity with students. Allow them to practice matching rockets with dots and rockets with numerals.
2. Have students generate other variations of this game. For example, students play a memory game. Place all the rockets face down on the floor or table. Students try to match numerals with the correct number of dots. Have students select two rockets at a time. When two rockets match, remove them from play. Play continues until all rockets match.
3. Use tally marks to record the number of turns needed to match all the rockets and remove them from play. Count the tally marks by 5's. Play the game several times to see if the number of turns changes. Use comparison words, such as *more than* and *less than*, to describe the different results.

Assessment

- Observe students as they match the rockets with numerals to the rockets with dots.

Enrichment

- For a more challenging activity, use numerals 0 to 20 on rockets. Make a second set of 20 rockets with the appropriate number of dots.
- To make the memory game more interesting, before playing, suggest that students predict the number of turns it will take to match all the rockets. Write down the prediction. Students can compare their prediction to the actual number of turns.
- Use a third set of rockets. On this set, write the number words from *zero* to *ten*. Students use these rockets with words to match with rockets with the correct numerals or with the correct number of dots.
- Introduce or review the concept of and the symbol (=) for *equal*. Explain to students that matching the dots on the rockets with the numerals on the rockets shows that they are equal or the same. For example, the numeral 5 on a rocket matches or is equal to • • • • •. Write the equal symbol on a card. Place the stack of rockets with numerals face down on the table. Place the stack of rockets with dots face down on the other side. Place the card with the equal symbol between the two stacks. A student turns over the top rocket from each stack. The student looks at the two rockets and the equal symbol and decides if the rockets are equal. Encourage students to view the rockets and the cards as a mathematical statement. For example, *6 equals* • • • • • • or *6 = 6*. Introduce or review the terms, *true* and *false*. Have students read the statement and state whether it is true or false. Remind them that some statements will be true and others false. If it is true, the student removes the cards from play. If it is false, place rockets face down in discard piles next to the original stacks. Play continues reusing the rockets until all rockets match. If appropriate, introduce the concept of, and symbol for, *not equal* (≠). Students can predict the number of turns needed to complete the game. Students track the number of turns by using tally marks. Play the game several times and then compare the number of turns. Vary this activity using rockets with number words.
- Use the small rocket drawings (Figure 7, page 79) to create similar activities for student independent practice.
- Select a variety of books designed to help students learn to count. Share the books with the class. Have students practice counting using the rockets in this lesson.

Activity 15

Rockets by Size

Objective

Students sequence objects from shortest to tallest and tallest to shortest.

Standards

Mathematics, Language Arts

Materials

- Rocket sequence sheet (Figure 16, page 85), 1 per student
- Crayons, markers, or pencils
- Scissors
- Paper, 1 sheet per student
- Glue or glue sticks
- 1 rocket sequence sheet (Figure 16, page 85), colored and cut out
- Journal or sheet of paper, 1 per student
- Drawings of Proton (Figure 4, page 76) and Soyuz (Figure 5, page 77), colored
- Drawing of space shuttle (Figure 3, page 75), colored
- Pictures of different types of rockets
- Objects in the classroom to put in order by height

Educator Information

- Read the information on the International Space Station and rockets. Be prepared to share the information on different types of rockets with students.
- Gather pictures of different types of rockets. Laminate for future use.
- Copy and color drawings of rockets and the space shuttle. Laminate for future use.
- Color and cut out one rocket sequence sheet. Be prepared to demonstrate the lesson to students. Laminate for future use.
- Find objects in the room to put in order by height.

Procedure

1. Show students the pictures and drawings of rockets. Ask students to compare and contrast the rockets. Remind students that rockets come in different sizes.
2. People also come in different sizes. Have five students in the room stand up and come forward. Tell the class that the selected students should line up in order from shortest to tallest. Let the class choose how to place the students in the correct order. Remember

to model sequencing from left to right. Have the class check the order to see if it is correct. Remind them to use comparison words, such as *shorter, shortest, taller,* and *tallest.*

3. Tell the class that the students now must line up from tallest to shortest. Repeat the procedure.
4. Choose objects in the room and put them in order by height.
5. Show students the rocket sequence sheet. Explain that these rockets must be placed in the correct order. Demonstrate how to sequence the rockets from shortest to tallest then tallest to shortest.
6. Remind students that it is important that the rockets share a common base to ensure they are in the right order. Do a demonstration to show that placement of rockets on the same line or base is important. A line on the chalkboard or the edge of a piece of paper will help students see the importance of a common base.
7. Distribute the rocket sequence sheet and a sheet of paper to students. Have them color and cut out the individual rockets.
8. Let students practice sequencing the rockets from shortest to tallest and tallest to shortest. Suggest that they use the edge of the paper as a baseline for the rockets. Monitor their work. Check that they sequence from left to right and that they use a common base for their rockets. If students have difficulty sequencing from left to right, place a mark on the left side of the paper to remind them where to start.
9. After students have practiced correctly sequencing the rockets, let them glue the rockets to the paper in order from shortest to tallest.

Assessment

- Observe students as they sequence the rockets.
- Have students draw the rockets in order in a journal or on a sheet of paper. Remind them to use a baseline and to sequence from left to right. Have students or the educator write a student-generated sentence about the drawing or orally describe the drawing using comparison words. For example, *the green rocket is the shortest.*

Enrichment

- Sequence objects in the room from shortest to tallest and tallest to shortest. For example, students put counting rods, rows of interlocking cubes, plastic links, toys, and pencils in the correct order. Remind them to use a baseline and to sequence from left to right. A piece of paper tape on the floor or the edge of a table can serve as a common base.
- Use the rockets on the sequence sheet to play a game using position and comparison words. The educator directs students to place a selected rocket in a certain position on the table or on their body. For example: *Put the tallest rocket under your chin. Put the shortest rocket over your head. Put the tallest rocket behind your back.*
- Ask students to take one rocket from the sequence sheet at a time and find an object in the room the same height as the rocket. Begin with the shortest rocket. Develop a graph to record the objects they find. Use a long piece of paper and draw lines, dividing it into five sections. Glue a rocket pattern in each section. Make sure the patterns are in order, shortest to tallest. Have students tell what objects they found that were the same height as their rocket. Write the names of objects in

the correct column. Compare and contrast the objects they found. Repeat the procedure until students have found objects the same height as each rocket.

- Use a rocket from the sequence sheet for students to practice using the words, *taller* and *shorter*. Have students select a rocket and find an object in the room that is taller than the rocket. Repeat and find an object shorter than the same rocket. Repeat the procedure using different-sized rockets.
- Use a rocket from the sequence sheet as a nonstandard measurement tool. Select a rocket to measure objects or people in the room. For example: *The table is 7 rockets long. The cabinet is 5 rockets high.* Remind students to practice saying the unit of measurement. Encourage students to develop a method to collect this data. In a journal or on a sheet of paper, students write the word or draw a picture of the object and record the measurement. Repeat the procedure using different-sized rockets.
- Challenge two students to measure the same object with two different-sized rockets. Have them share their measurements with the class. For example: *Jill measured the table, and it was 6 rockets long. Sam measured the table, and it was 10 rockets long.* Ask the class if one of the students measured incorrectly. Ask the students to measure again using the same rocket patterns. The answers will be the same. Ask the class to figure out why there are different answers. The measuring tools were different lengths. One was shorter than the other. Explain that it is always important to use a consistent unit of measurement.
- From the *Suggested Reading* list or other sources, select books that show rockets that are different sizes. Selections could include *Space Vehicles* by Jon Richards or *Rockets and Spaceships* by Karen Wallace. Share the books and pictures with the students. Encourage students to use comparison words to describe the rockets in the books.

Activity 16

Getting in Shape

Objective

Students create rockets out of shapes and practice shape recognition.

Standards

Mathematics

Materials

- Tangram rocket (Figure 17, page 86), 1 per student
- Tangram pieces (Figure 18, page 86), 1 set per student
- Markers or crayons
- Scissors
- Glue or glue sticks
- Pictures of rockets

Educator Information

- Make copies for each student of the Tangram rocket and the Tangram shapes.
- Be prepared to demonstrate to students how to build a rocket out of Tangram shapes. Have an example ready to share with students.

Procedure

1. Show students rocket pictures. Look at the different shapes that comprise the rockets.
2. Show students the Tangram rocket. Demonstrate how to build a rocket out of the Tangram pieces.
3. Distribute the rocket and shapes to students.
4. As a class, count the number of squares, the number of triangles, and the number of rectangles.
5. Ask students what shapes are not included. There are no circles, diamonds, trapezoids, hexagons or ellipses.
6. Direct students to color each shape a different color. For example, *all squares are red; all rectangles are blue; all triangles are green.* Directions could be oral or written on a chalkboard. Use pictures rather than words for non-readers.
7. Students cut out the shapes.
8. Using ordinal numbers, have students glue the Tangram pieces on in a certain order. For example: *Glue triangles first; second glue rectangles, and third glue squares.* Have students glue the shapes in the correct position on the pattern.

Assessment

- Observe students as they color shapes and glue them on the paper.
- Ask students to point to specified shapes on the rocket. Evaluate.

Enrichment

- Introduce or review the concept of *symmetry*. Ask students to determine if the Tangram rockets have symmetry. Look at individual shapes on the rocket. Decide if they are symmetrical. Look closely at the triangles. Only one is symmetrical. In looking for symmetry in squares and rectangles, encourage students to think of different ways to divide these shapes in half. Find objects in the room that are symmetrical.
- Use the Tangram pieces as a template. Cut the shapes out of cardboard or imitation leather material found at fabric stores. Have students use the shapes to build a rocket on a table. Carefully place a piece of paper over the shapes. Students make a rubbing. Use the long side of an unwrapped crayon to gently rub across the paper. Be careful not to disturb the placement of the shapes. Pick up the paper to view the rubbing.
- Cut large Tangram shapes out of construction paper. Cut the same number and type of shapes as found on the Tangram rocket. Laminate for future use. Make a die with the Tangram shapes on it. Provide students with a copy of the Tangram rocket to use as a guide. Students roll the die and choose a shape. Using the die to direct construction, they build a large Tangram rocket on the floor. If students roll a shape that is not available, simply roll again. Keep rolling the die until all shapes are used and the rocket is complete. Compare the rocket on the floor to the rocket on the page. Ask students if the rockets look the same. Students may use tally marks to track the number of rolls it takes to complete the rocket. Count tally marks by 5's or 10's. Build the rocket several times and compare the number of rolls. Students can also track the number of times they rolled triangles, squares, or rectangles.
- From the *Suggested Reading* list or other sources, select books that depict the building of rockets. Examples include *Rocket* by Mike Inkpen, *Ritchie's Rocket* by Joan Anderson, and *Mooncake* by Frank Asch. Ask students to identify the shapes used to build the rockets in the books. Compare these shapes to Tangram shapes.

Activity 17

Getting in Shape Again

Objective

Students improve shape recognition by using simple directions to build pattern block rockets.

Standards

Mathematics, Language Arts

Materials

- Tubs of pattern blocks
- Assorted math manipulatives
- Chart paper
- Markers
- Journals or a piece of paper, 1 per student
- Pictures of rockets
- Drawing of Proton (Figure 4, page 76) and Soyuz (Figure 5, page 77), colored
- Drawing of space shuttle (Figure 3, page 75), colored

Educator Information

- Assemble a variety of math manipulatives, including pattern blocks, for students to use to create rockets.
- Use chart paper and markers to create a list of directions to build a rocket out of pattern blocks. For example: *Use four green triangles; use one red trapezoid.* Depending on the ability level of students, directions could use pictures and numerals such as 4 Δ or 2 □ instead of words.
- Develop a list of oral directions for the students.
- Copy and color drawings of rockets. Laminate for future use.
- This activity may work better in a small group environment.

Procedure

1. Show students the drawings and pictures of rockets. Have them compare and contrast the way the rockets look.
2. Ask students to practice building rockets with pattern blocks. Allow students to have free exploration time with pattern blocks.
3. Explain to students that they will build a pattern block rocket using simple directions.
4. Show students the chart with the directions. Read the directions together.

5. Let students independently build rockets using the directions. Their rockets, like real rockets, look different.
6. When their rocket is complete, make sure students review the directions to check their work.
7. Ask students if all the rockets look alike. Discuss similarities and differences in the rockets. The rockets may look different, but all should have the same shapes and the same number of each shape. Have students count the number of each shape.
8. Have students draw a picture of their rocket in a journal or on a sheet of paper. If appropriate, have students list the directions.
9. Have the students repeat the activity following oral rather than written directions.
10. Students can use a variety of math manipulatives to build rockets and practice shape recognition. Have students develop new directions to build the rockets.

Assessment

- Observe students as they follow both oral and written directions to build rockets.
- Ask individual students to describe the rocket they built. Evaluate identification of pattern block shapes.

Enrichment

- Encourage students to build a rocket using a specified number of pattern blocks. For example, use 20 pattern blocks to build a rocket. After the rocket is complete, have students count the pattern blocks used in the rocket. Ask students if they used the correct number of pattern blocks. Count the number of each shape. Draw the rocket.
- Using pattern blocks, let students build a rocket independently without specific directions. When the rocket is complete, tell students to sort the shapes to determine how many of each shape was used. Have students count the number of each shape utilized. Use simple graphs to count and compare the number of each shape. Have students develop their own graphs. For example, students make a bar or horizontal graph using ice cube trays. Place shapes in ice cube trays and count the number of shapes used.
- Review opposite words, *short* and *tall*, and *big* and *little*. The students build two rockets that fit those criteria.
- Let students explore trading shapes in their pattern block rocket. For example, have students consider how many green triangles would replace one red trapezoid.
- Encourage students to create 3-D rockets using pattern blocks.
- Compare pattern block shapes to Tangram shapes. Find similarities and differences.
- Have students use position words, such as *over, under*, or *between* to describe the position of shapes in their rockets.
- Select books from the *Suggested Reading* list or other sources that depict the building of rockets. Examples include *Rocket* by Mike Inkpen, *Ritchie's Rocket* by Joan Anderson, and *Mooncake* by Frank Asch. Ask students to identify the shapes used to build the rockets in the books. Compare these shapes to pattern block shapes.

Activity 18

Hide and Seek Rocket

Objective

Students use numeral recognition and position words to locate a hidden rocket.

Standards

Mathematics, Language Arts

Materials

- 10 to 20 small lined envelopes
- Marker
- 1 small rocket drawing (Figure 7, page 79), colored and cut out

Educator Information

- The educator labels each envelope with a numeral from *1* to *10*. Depending on the ability level of students, label the envelopes from *1* to *20*.
- Color and cut out the rocket drawing.
- Laminate the envelopes and rocket for future use.
- Be prepared to demonstrate the activity to students.

Procedure

1. Place the envelopes in a line, in numerical order, flap end down, on a table or the floor.
2. Place the rocket in one of the envelopes.
3. Model for students how to ask questions to determine where the rocket is located. Use position words and the numeral on the envelope in the questions. For example: *Is the rocket in envelope 9? Is the rocket in the envelope before envelope 8? Is the rocket in the envelope after envelope 3?* Continue to ask questions until the rocket is found.
4. Tell students to close their eyes while the educator hides the paper rocket in one of the envelopes.
5. Students take turns asking questions to determine where the rocket is located. Have students use position words, such as *before* and *after* to help find the rocket. When asking questions to find the rocket, have students refer to the numeral on the envelopes. If appropriate, give clues to help students locate the rocket.
6. Repeat the game several times. Help students develop their guessing skills and improve their use of position words.

7. Let students play the game independently. Allow them to hide the rocket in an envelope and give clues to their classmates. Encourage students to provide good clues using position words.
8. Vary the game by putting the envelopes in non-numerical order. Vary the game by placing the envelopes in several rows. Encourage students to use new position words.

Assessment

- Observe students during independent practice of this activity. Monitor their use of position words and numeral recognition when they ask questions or give clues.

Enrichment

- Students predict the number of questions needed to find the rocket. Use tally marks to record the number of questions. Have students decide whether their prediction is *more than* or *less than* the actual number of questions.
- Have students generate different variations of the game. Label envelopes with letters of the alphabet, color words, number words, dots to represent numbers, or sight words. Play the game with the same rules.
- Select books that use position words or numerals as part of a story. Share with the class. Ask students to identify the position words or numerals in the books. Use these books to reinforce the objectives in this lesson.

Activity 19

Rocket Problems

Objective

Students use prior knowledge and creative thinking to solve problems.

Standards

Science, Technology, Language Arts

Materials

- Paper, 1 piece per student
- Markers and crayons
- Wooden blocks
- Items for nonstandard measurement

Educator Information

- Read the following information and be prepared to share it with students.

  NASA scientists, engineers, and astronauts work daily to solve problems associated with International Space Station (ISS) and its construction. They find solutions when equipment does not work and develop designs to handle new challenges. These NASA workers use creative thinking to find solutions. Sometimes the task of finding a solution to a problem is difficult. Often, NASA workers have to try many ideas to find one that solves the problem.
- In this activity, give students an imaginary problem relating to the ISS and its construction. First, they have to identify the problem, and then develop a way to solve the problem. Solutions do not have to be realistic. Encourage students to be creative.
- Based on the ability level of the students, educators develop problems for the students to solve. For younger students, simple problems could include the following:
  1. *Students build a space station out of wooden blocks. Educators may need to limit the number of blocks that are used. Tell students that the space station has to have a laboratory and a living area. When the design is complete, have students describe their creation to the class. Encourage discussion. Use other items in the room to build a space station. Draw a picture of the space station.*
  2. *Ask students to find a way to measure the size of the space station they built. Tell students to find items in the classroom that can be used for nonstandard*

measurement. Encourage students to be creative. Have students measure the space station. Students share and explain measurements.

3. *Tell students they are going to live on the space station. Have them design and draw a picture of their living area on the station. Encourage them to include the items necessary to live on the station and the special items, such as pictures or toys, that they would want to have with them. Have students share design with the class.*

- For older or more advanced students, develop problems that are more challenging. Encourage students to be creative as they think of ways to solve the problems. Students do not have to be realistic. For more advanced students, problems could include the following:
  1. *A new piece of the space station is very large and heavy. Design a new rocket that can carry it into space. Draw the rocket and share it with the class.*
  2. *The robotic arm on the space shuttle does not work. Astronauts have to attach a new component to the space station. A new device to get the piece out of the orbiter payload bay and attach it to the station is needed. Draw a picture of the design and share it with the class.*
  3. *The space shuttle cannot dock, or connect, with the space station. The crew of the space station needs to be replaced with a new crew. Design a new device to get people from the station to the shuttle. Draw a picture of the design and describe it to the class.*
  4. *People from many countries build the ISS. Often these people do not speak the same language. A machine is required that will help people understand another language. Design and draw this machine. Share your ideas with the class.*
- Ask students to tell their classmates about their designs and ideas. Suggest that students compare and contrast their designs.
- Develop additional problems that are appropriate for your students. Encourage students to be creative.
- To learn more about the people who work at NASA, visit the Quest web site, *http://quest.nasa.gov.*

Procedure

1. Share information about people who work at NASA. Explain how they solve problems in space and on Earth.
2. Give students an imaginary problem relating to the ISS and its construction. Use one of the problems listed above or one that the educator develops.
3. Ask students to identify the problem and generate a solution. Encourage students to be creative.
4. Ask students to draw a picture of their solution to the problem. Depending upon their ability level, ask student to describe the solution orally or in writing.
5. Students show the picture to the class and tell or read how they would solve the problem. Encourage students to ask questions as their classmates share their solutions.
6. Have students generate other problems relating to space station construction. Encourage them to offer solutions to the problems.

Assessment

- Observe students as they draw their pictures. Listen as they describe or read their solutions. Ask questions about how they solved the problem.

Enrichment

- NASA scientists, engineers, and astronauts work together to solve problems. This is an example of cooperation. Give students another problem to solve. This time, let them work together in teams. Discuss the advantages of working together or cooperating. Discuss what happens when people do not cooperate well. Think of examples of people cooperating in the classroom.
- Define the word, *international*. Share with the class that the word international means many countries around the world. Many countries are cooperating to build the space station. The name of the space station reflects international cooperation. Share information on the ISS, and tell students the names of the sixteen partner nations (*Belgium, Brazil, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Russia, Spain, Sweden, Switzerland, United Kingdom, United States*). Use a map or a globe to point out the countries that are working together or cooperating to build the station. Use stickers or labels to mark the countries.
- Discuss that building the ISS requires cooperation or working together. Many people and nations have to work together to build the station and solve problems. Crews on the station have to cooperate to work and live together and find solutions to problems. Explain that cooperation is often necessary to accomplish a task or to get a job done. Ask students if they can think of other examples of people who cooperate. Examples may include sports teams or classroom, family, and community situations. Have students discuss what happens when people do not cooperate.
- Apply problem-solving skills to a real or imaginary classroom or home situation. Encourage students to be creative. For example: *There is a lion in the classroom. You have to devise a way to get him back to the zoo.* Another example: *The stapler does not work. You have to figure out a new way to hold papers together.*
- Many people work at NASA centers. They have to work together and cooperate to build the ISS and launch the space shuttle. Talk with students about the many jobs or careers that are available in the space program. Look at the background and qualifications of some people who work at NASA. Talk with students about what NASA workers studied in school. Ask students what job they might want to have at NASA. Have them draw a picture in a journal or on a sheet of paper to depict their future job. Using the sentence prompt, *"I want to be..."* have students or the educator write a student-generated sentence about a NASA job.
- Sometimes people describe creative solutions to problems as "thinking outside the box." Ask students to generate ideas about what that expression means. Tell them it describes people who think of new ideas and creative ways to solve problems. Use the expression to describe students when they think of creative solutions or unique ideas in the classroom.
- Read books that include descriptions of people who work in the space program or at NASA. Selections could include *Astronaut: Living in Space* by Kate Hayden, *I Want to Be an Astronaut* by Byron Barton, or *Curious George Gets a Medal* by H. A. Rey. Encourage students to discuss different jobs in the space program.

ACTIVITY 20

FACT AND FICTION

Objective

Using the concepts of fact and fiction, students review what they learned about the International Space Station (ISS), the space shuttle, and rockets.

Materials

- Educator-generated statements
- 2 pieces of paper, with the word *fiction* on one and *fact* on the other

Educator Information

- Write the word *fact* on one sheet of paper and the word *fiction* on the other sheet of paper. This activity using the terms *fact* and *fiction* is a review for the lessons on the ISS and rockets.
- Generate approximately 20 statements about the ISS, the space shuttle, and rockets. Make some of the statements facts, and some of the statements fiction. Choose statements that reflect important concepts that students should have learned. For example:

The only country building the ISS is the United States. ***(Fiction)***
The space shuttle has three solid rocket boosters. ***(Fiction)***
People live and work on the space station. ***(Fact)***
Rockets take pieces of the space station to space. ***(Fact)***
There is only one kind of rocket. ***(Fiction)***
The International Space Station is going to the moon. ***(Fiction)***
The external tank on the space shuttle is green. ***(Fiction)***

Procedure

1. Introduce or review the words, *fact* and *fiction*. Explain that a fact is something that is true, and fiction is something that is not true. Give students examples of statements that are fact and others that are fiction. If appropriate, instead introduce the words, *true* and *false*.
2. Read the educator-generated statements about the ISS and rockets. Some of the statements will be *fact* and some will be *fiction*.

3. As a statement is read to the class, have students decide whether the statement is *fact* or *fiction*. If it is *fiction*, have them reword the statement to make it a *fact*.
4. Repeat activity with additional statements.
5. Request that students generate their own statements about the ISS, the space shuttle, and rockets. They should make some statements *fact* and some *fiction*.
6. Students stand up and tell or read the statements to the class. Let the class decide whether the statement is *fact* or *fiction*. Reword the statement if it is *fiction*.
7. As a closing activity and review, have students complete the chart they began in *Activity 1*. Encourage students to discuss and evaluate what they learned about the ISS. If students have misconceptions about the ISS, this is an opportunity to correct these ideas.

Assessment

- Listen to students as the class decides if statements about the ISS, rockets, and the space shuttle are *fact* or *fiction*. Evaluate their knowledge of these topics.
- Listen as students share their statements about the ISS, rockets, and the space shuttle with the class. Evaluate their knowledge of these topics and their use of the words, *fact* and *fiction*.

Enrichment

- Draw two columns on a piece of chart paper. Label one column, *Fact*, and one column, *Fiction*. When students decide whether the statements are *fact* or *fiction*, have them place a tally mark in the appropriate column. Count the tally marks by 5's at the end of the activity. Decide whether there were more *fact* or *fiction* statements.
- In a journal or on a piece of paper, have students write statements about the ISS or rockets, one that is *fact* and one that is *fiction*. Draw pictures to accompany their statements.
- Ask students to apply the terms *fact* and *fiction* to books used during these lessons. Explain to students that some books are *fact* and some are *fiction*. Help students decide in which category a book belongs. Discuss ways to discern if the book is *fiction*. For

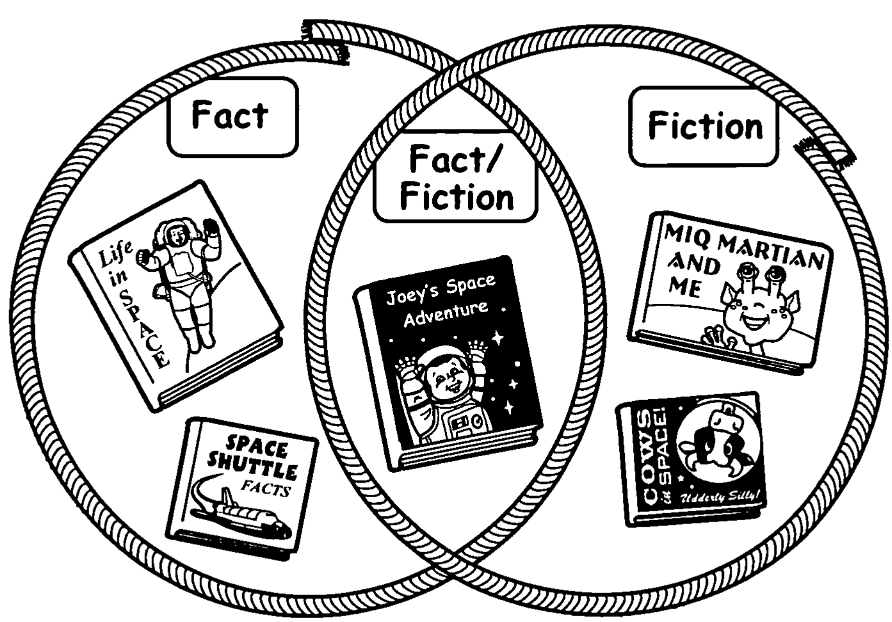
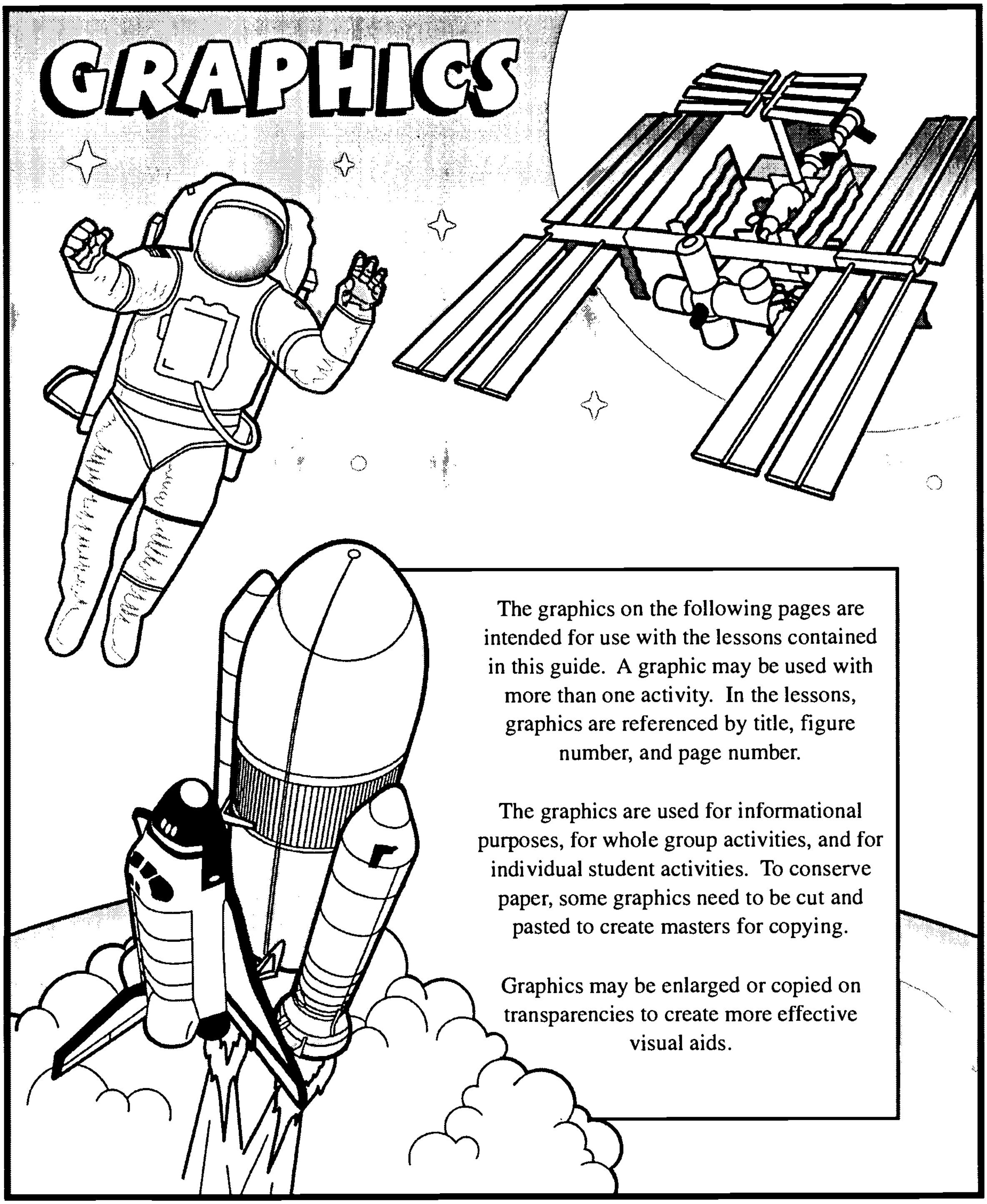


Figure 19. Venn Diagram

example, a book that is *fiction* may include animals talking or wearing clothes, people living on Mars, or cows going to the moon. Make students aware that some books may be part *fact* and part *fiction*. For example, a book has excellent facts about the ISS and the space shuttle. A cow is an astronaut in the book. This book is part *fact* and part *fiction*. Introduce or review the concept of a *Venn diagram*. A Venn diagram is made of two overlapping circles. It allows students to sort items. Make a large Venn diagram on the floor using two pieces of clothesline. Label one circle, *Fact*, and one circle, *Fiction*. Label the area where the two circles overlap, *Fact and Fiction*. See *Figure 19*. Gather the books used during the lessons on rockets and the ISS. Talk about each book. Ask students to decide in which category each belongs. Place the book in the appropriate area in the Venn diagram.

- From the *Suggested Reading* list or other sources, select books that provide information on the ISS. Use these books to evaluate and review what students learned about the space station. Selections could include *The International Space Station* by Franklyn Branley and *Space Stations* by Diane M. and Paul Sipiera.

GRAPHICS



The graphics on the following pages are intended for use with the lessons contained in this guide. A graphic may be used with more than one activity. In the lessons, graphics are referenced by title, figure number, and page number.

The graphics are used for informational purposes, for whole group activities, and for individual student activities. To conserve paper, some graphics need to be cut and pasted to create masters for copying.

Graphics may be enlarged or copied on transparencies to create more effective visual aids.

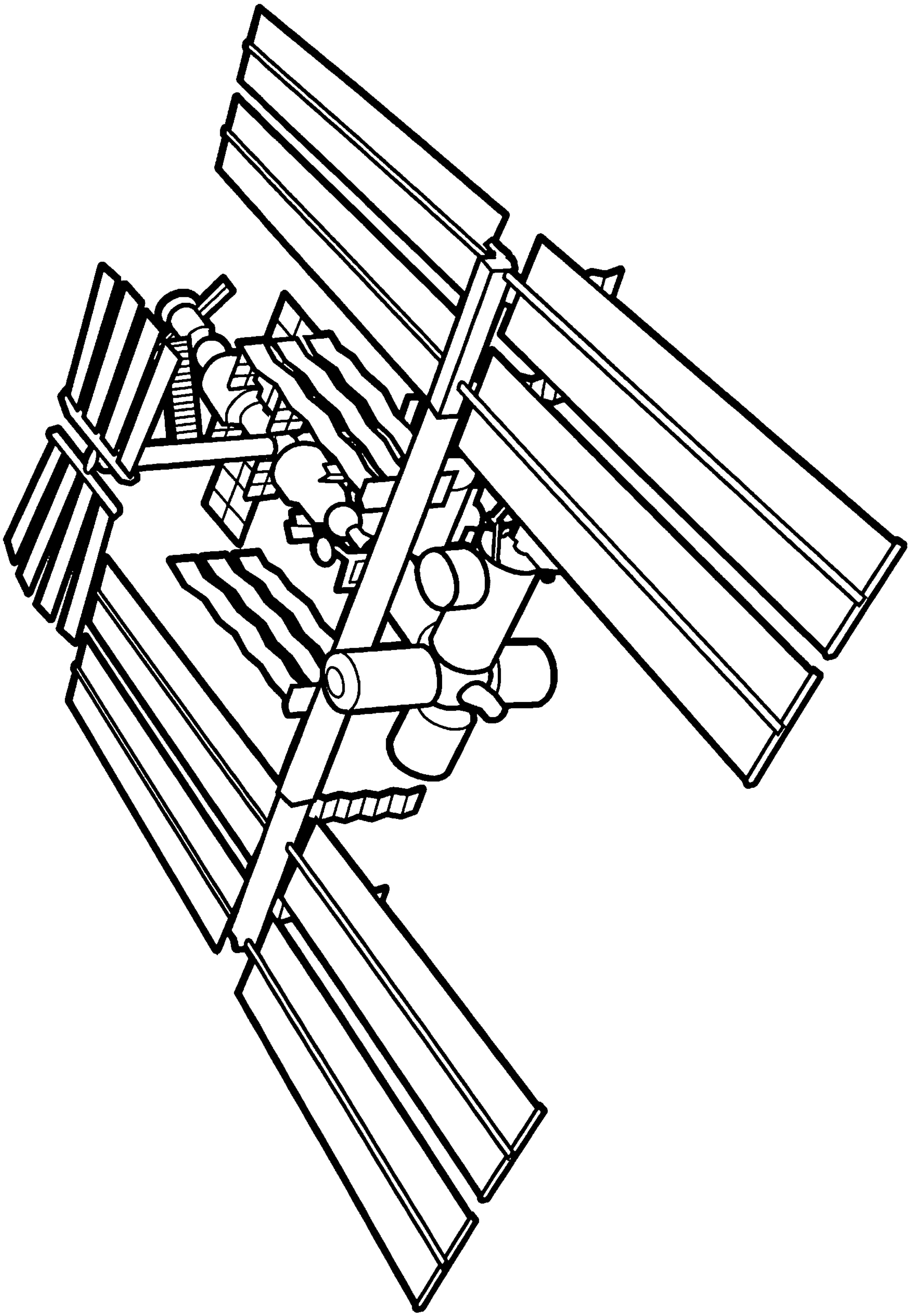


Figure 1. International Space Station (ISS)

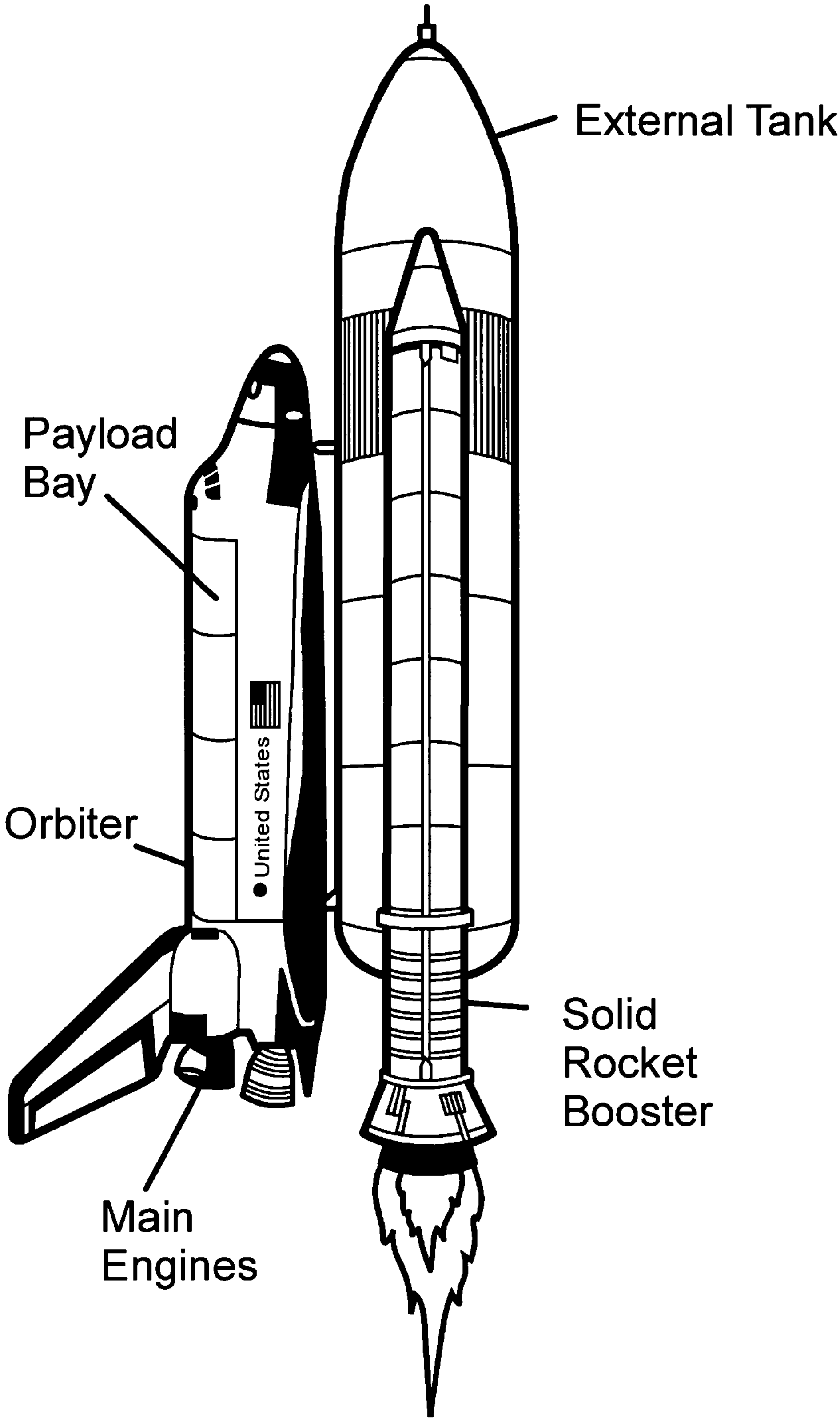


Figure 2. Side View of Space Shuttle

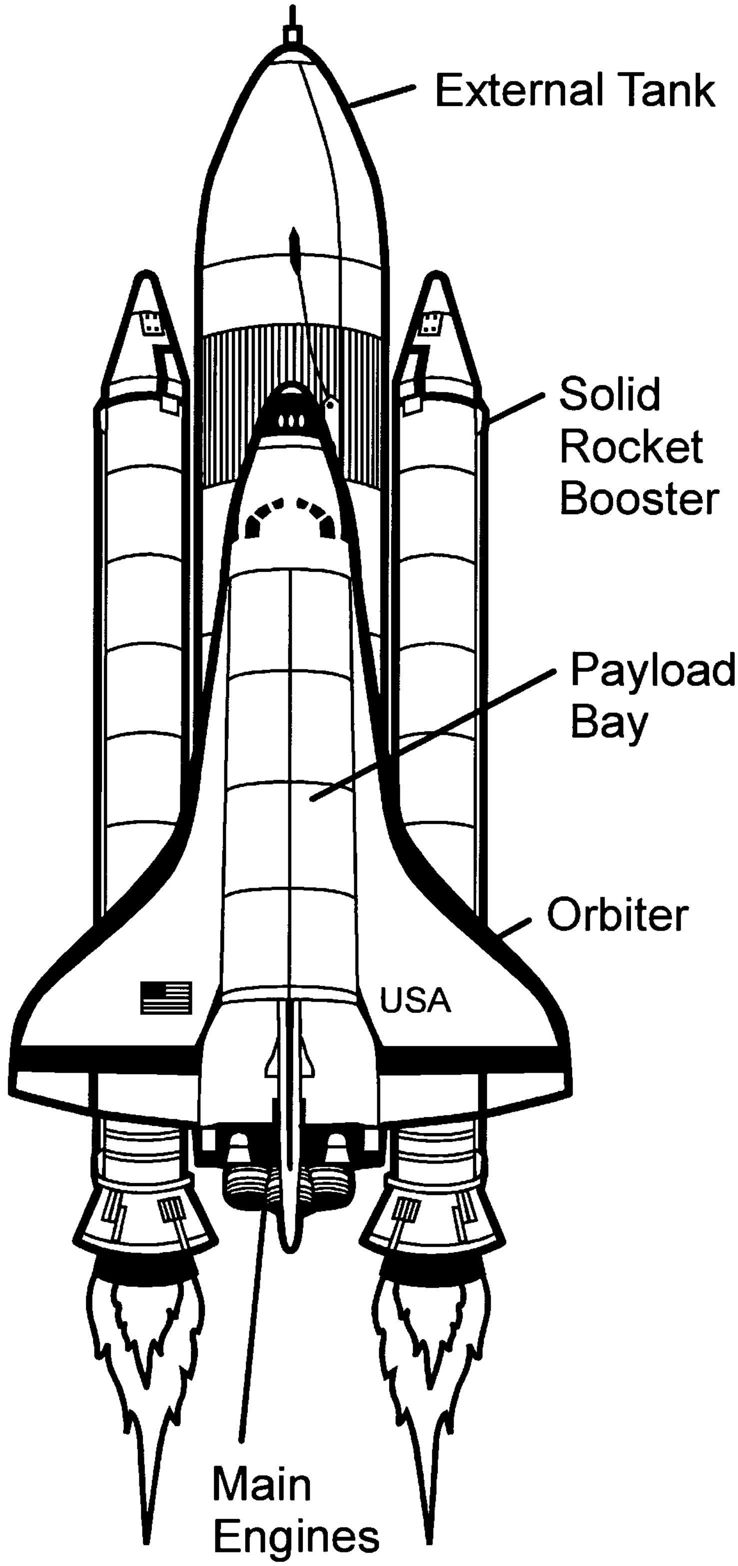


Figure 3. Parts of the Space Shuttle

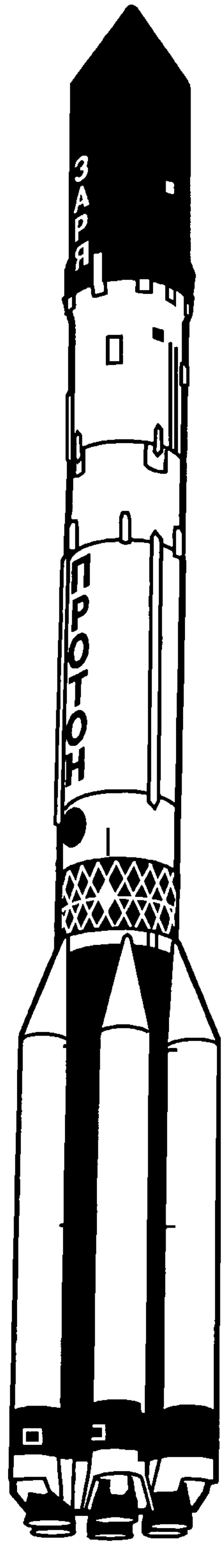


Figure 4. Proton Rocket

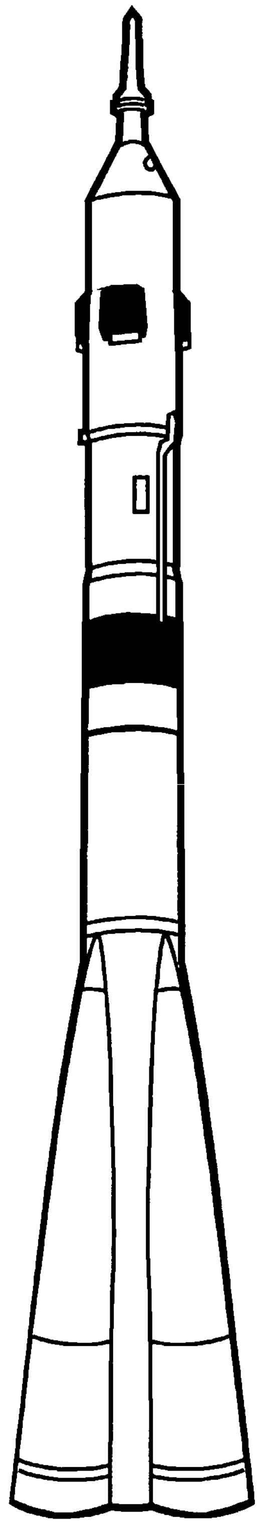


Figure 5. Soyuz Rocket

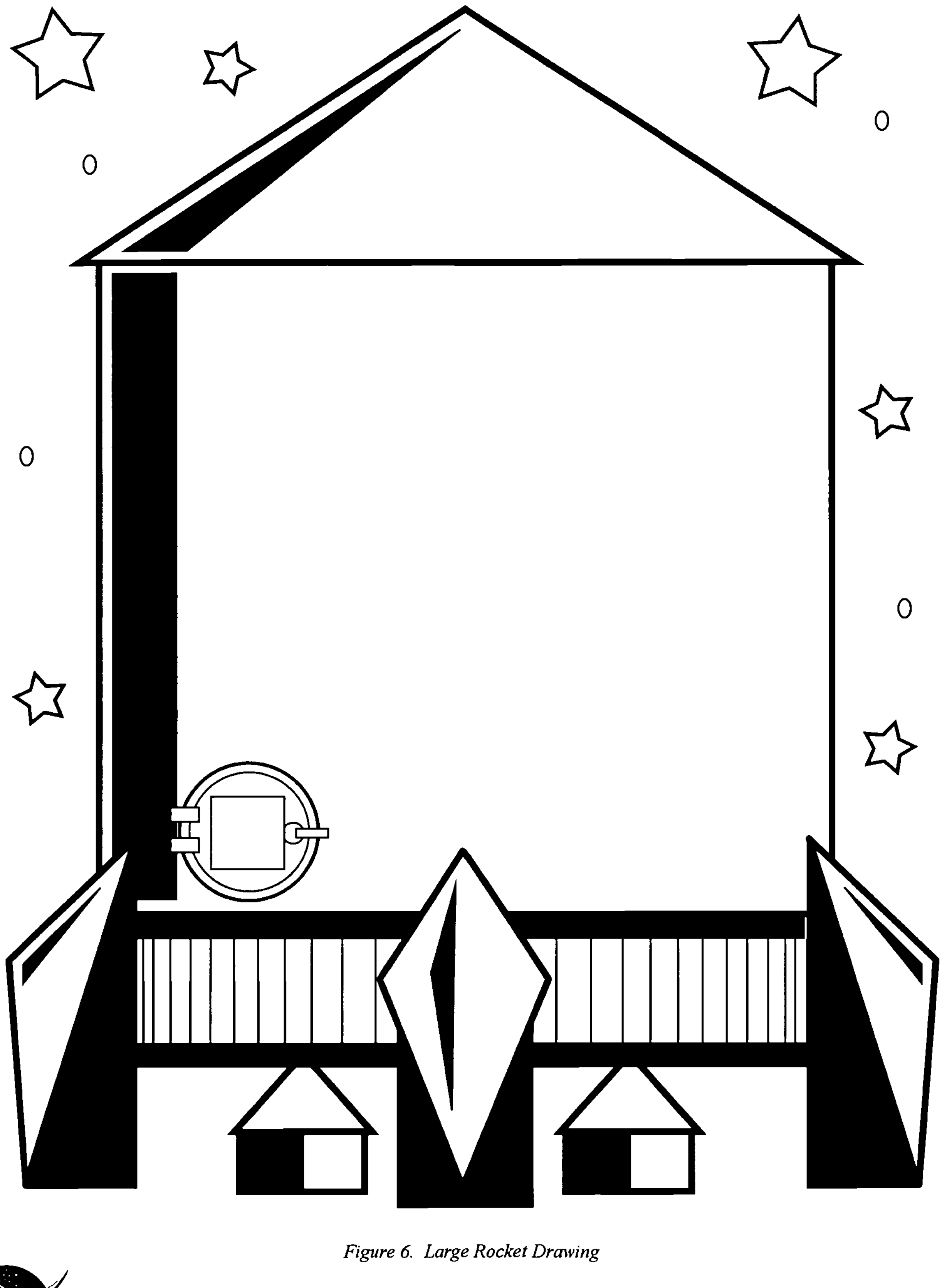


Figure 6. Large Rocket Drawing

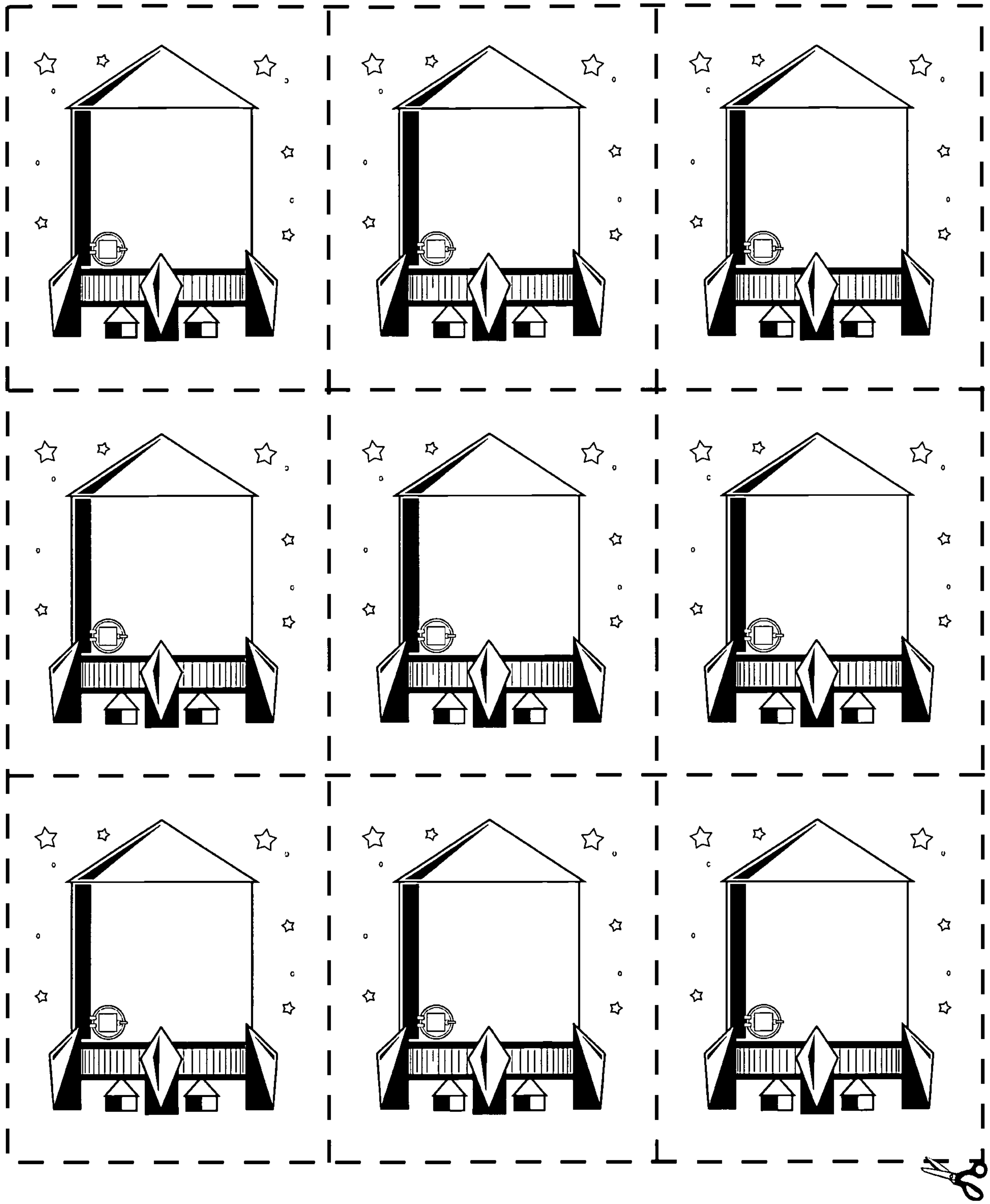


Figure 7. Small Rocket Drawings

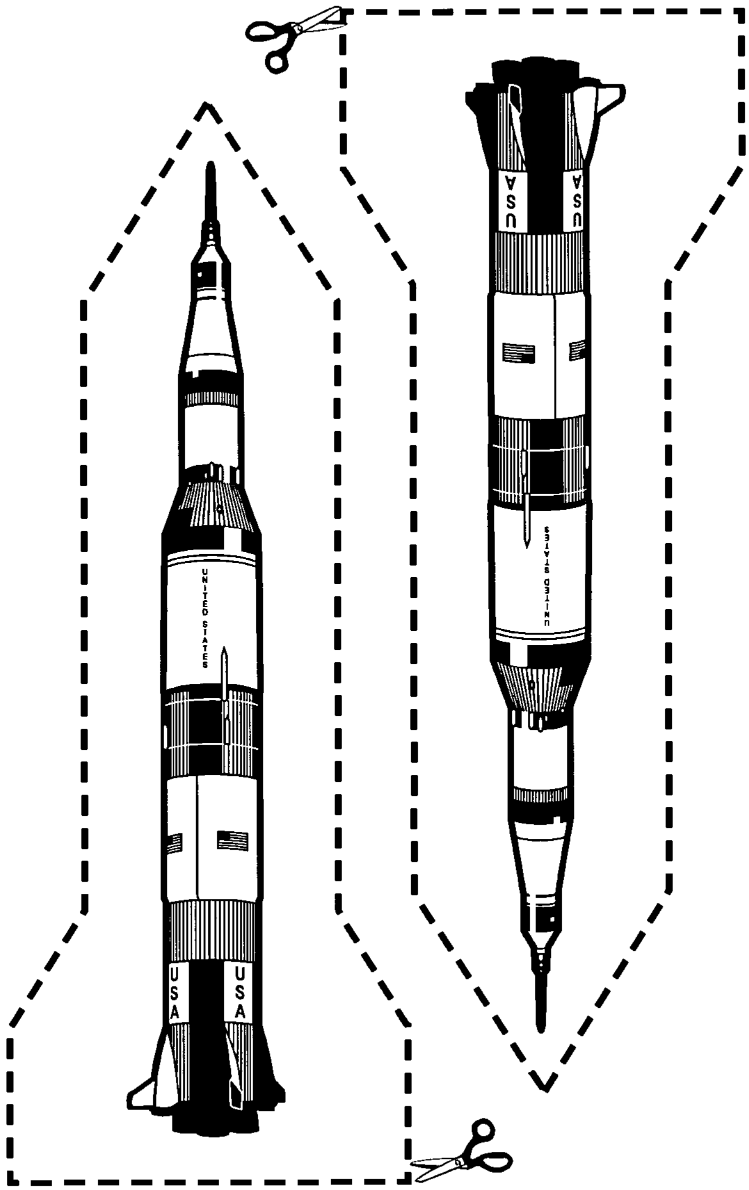


Figure 8. Straw Rocket Pattern

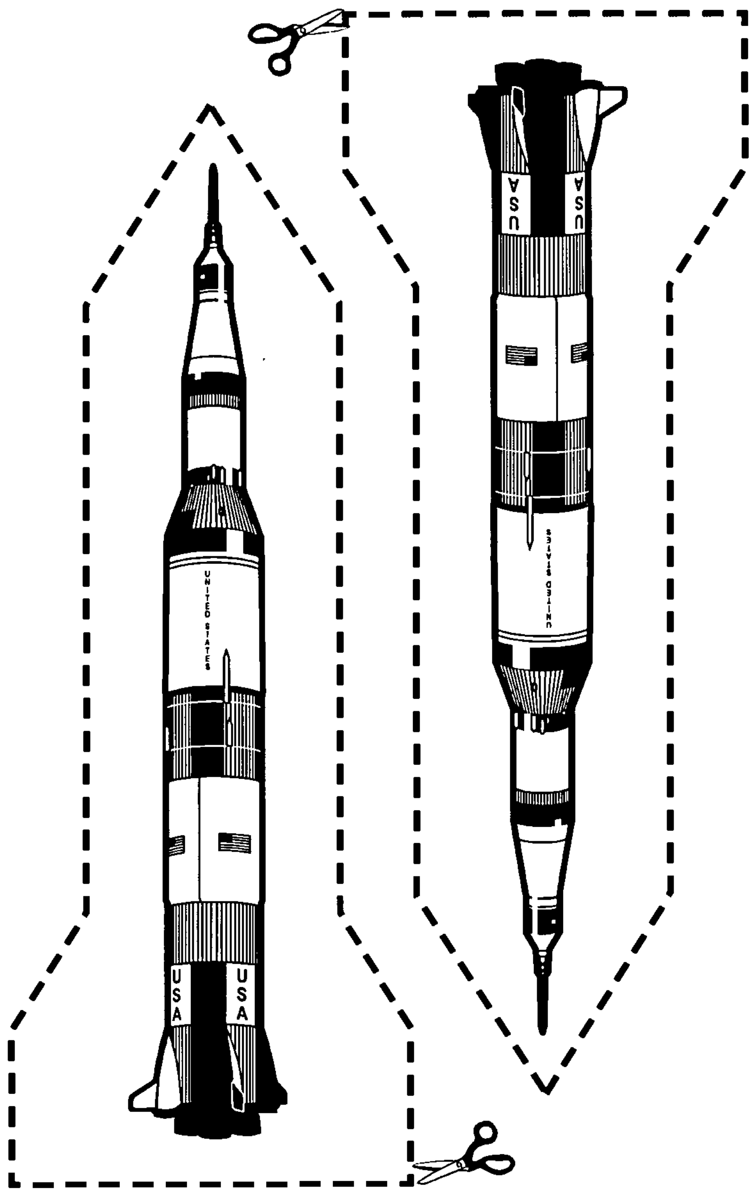


Figure 8. Straw Rocket Pattern

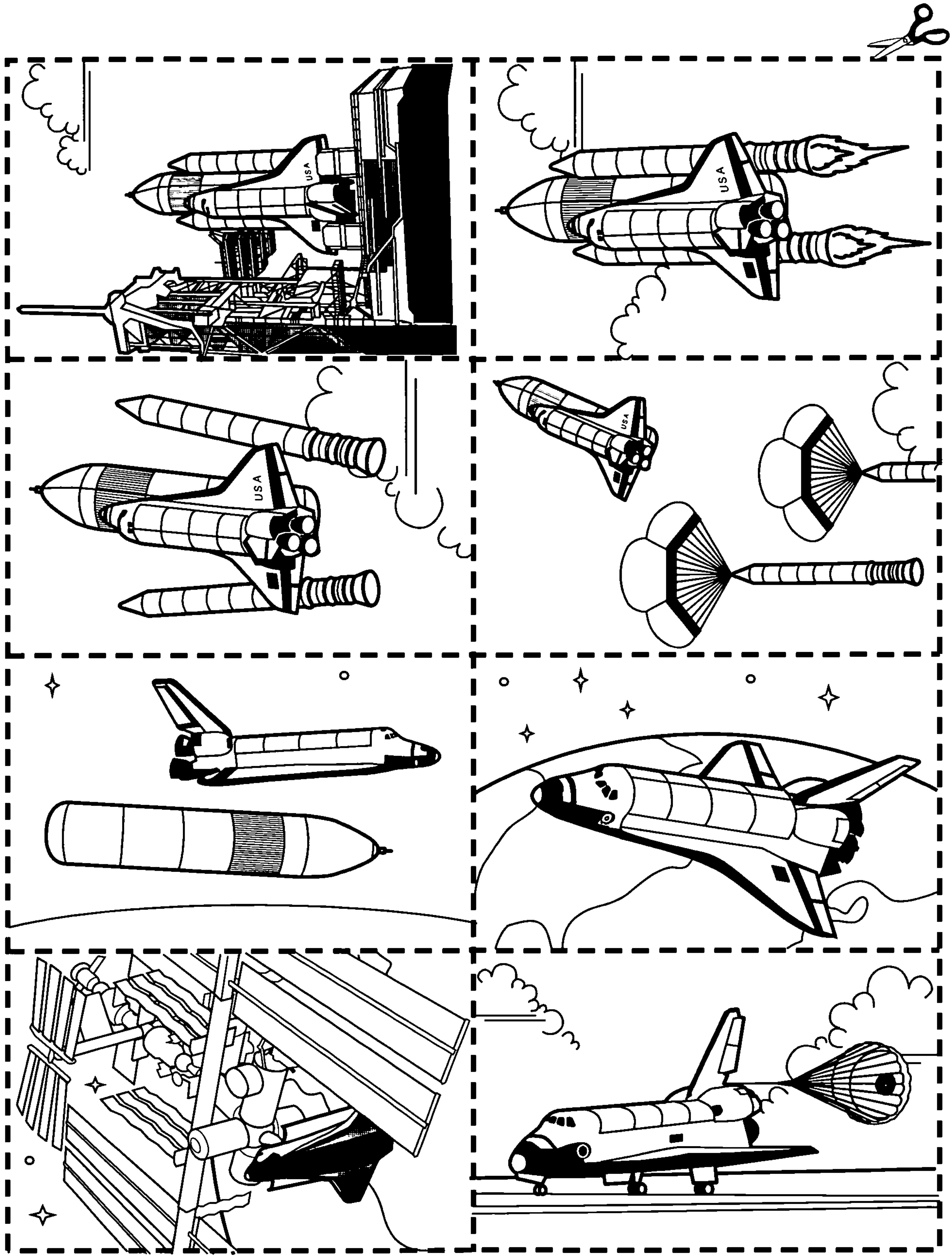


Figure 10. Shuttle Sequence Cards

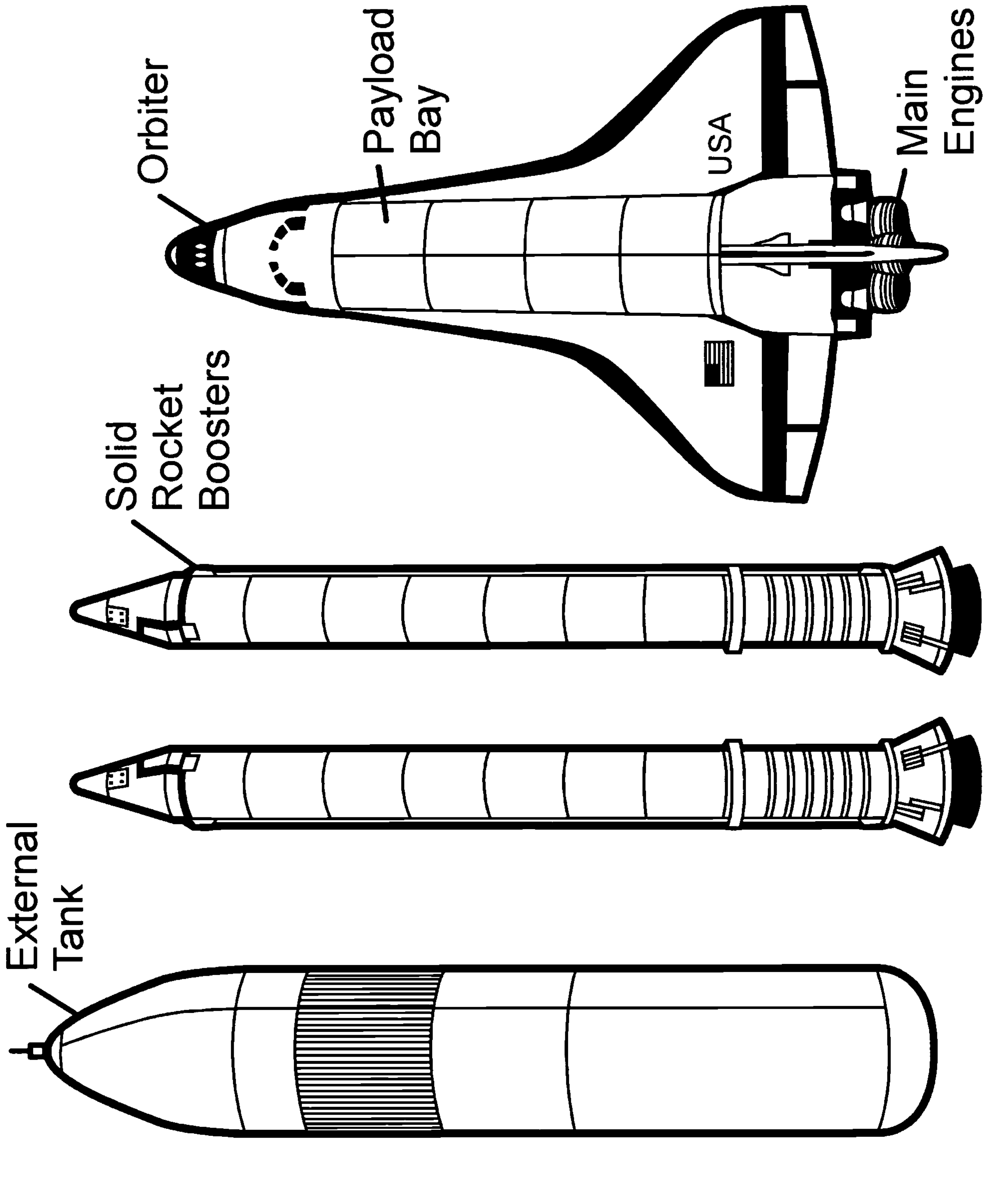


Figure 11. Space Shuttle Parts

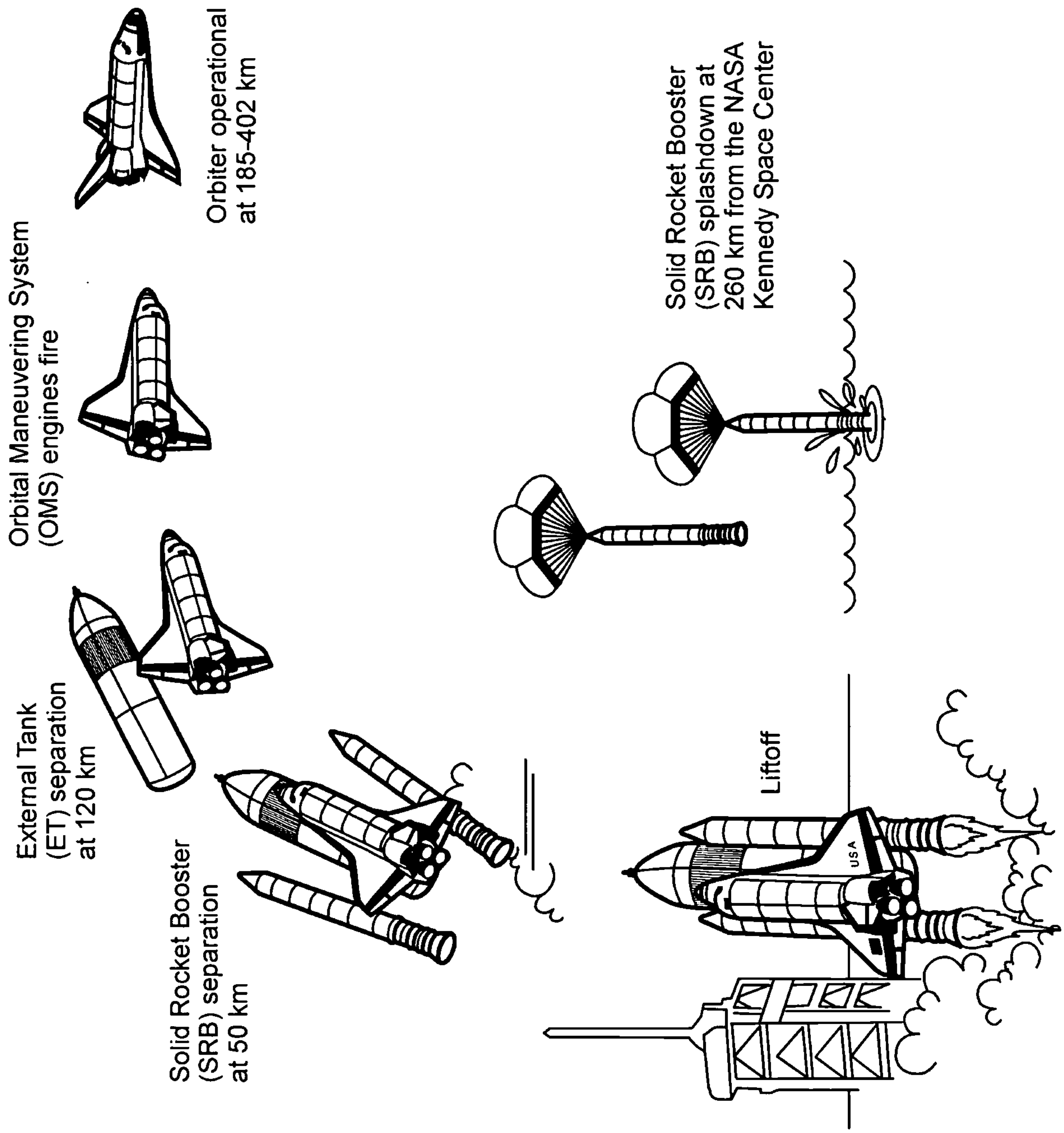


Figure 12. Shuttle Launch to Orbit Sequence

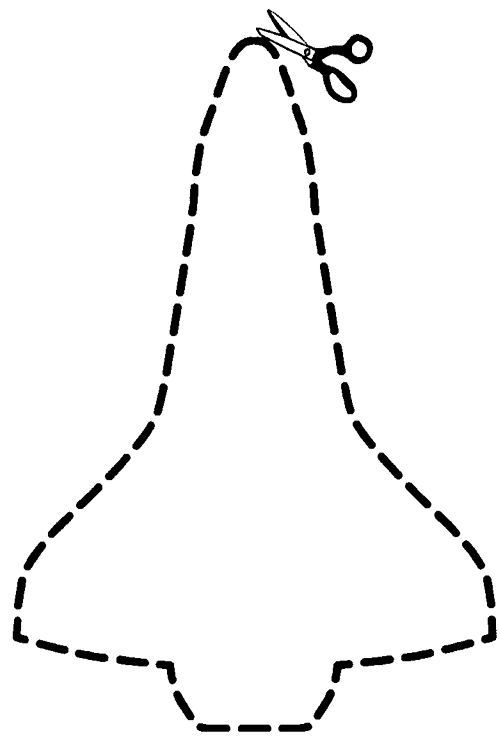


Figure 14. Orbiter Template

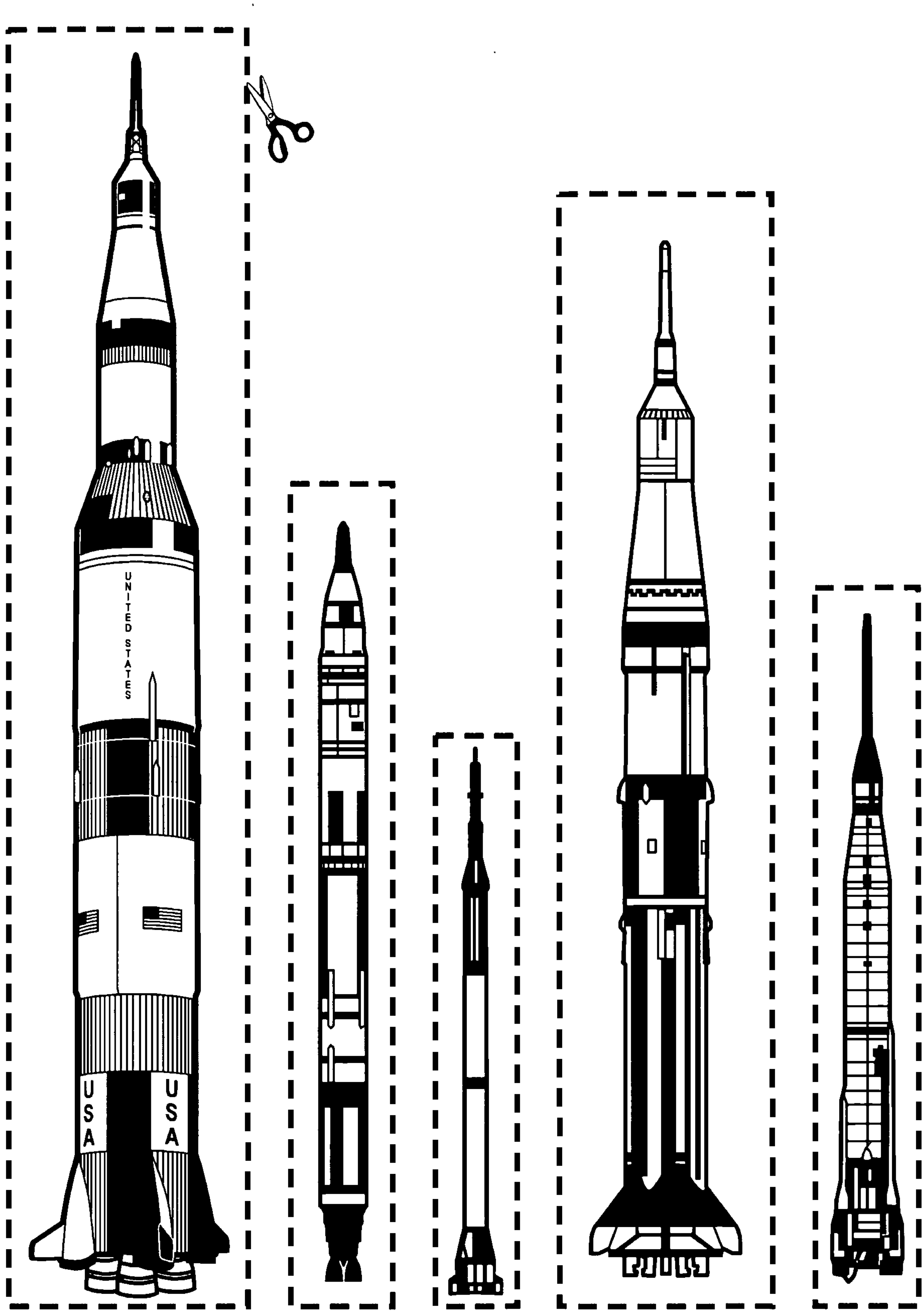


Figure 16. Rockets Sequence

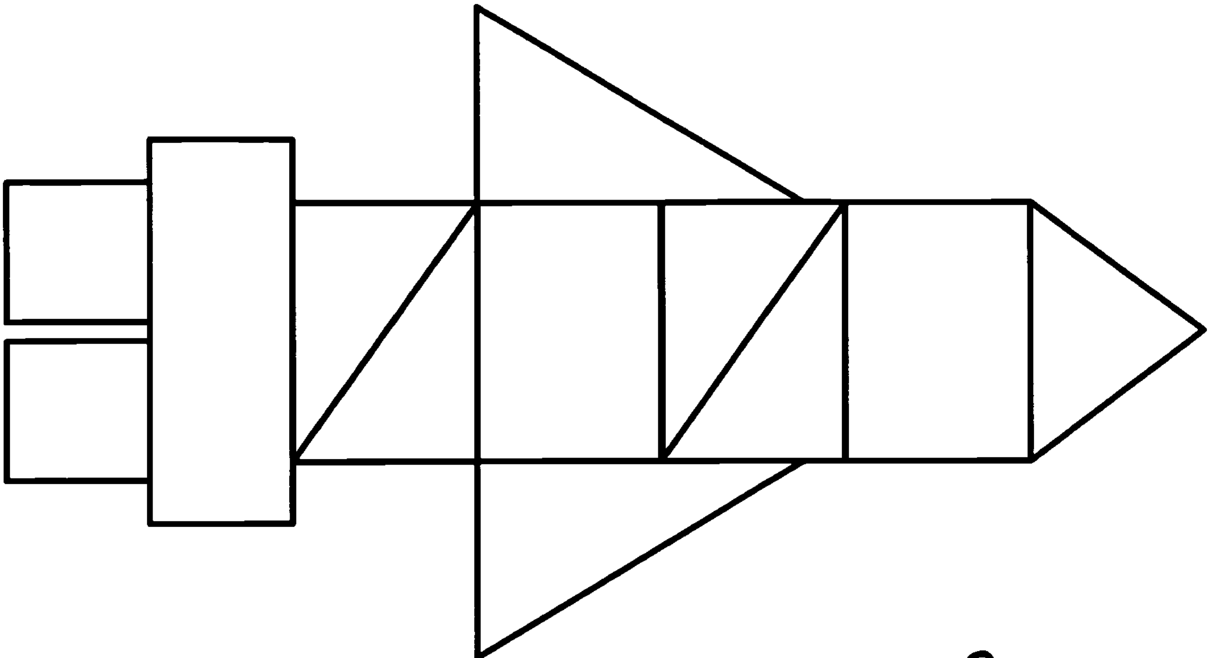


Figure 17. Tangram Rocket

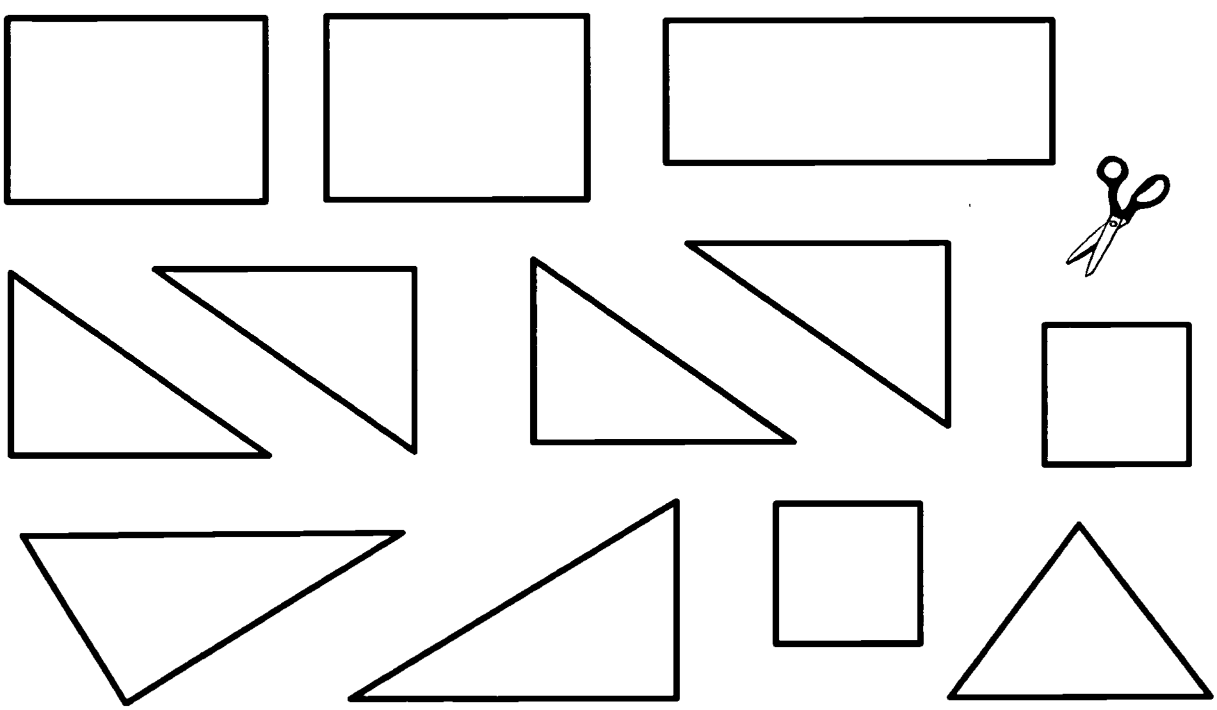


Figure 18. Tangram Pieces

GLOSSARY

Aft – close to the rear of a vehicle such as the space shuttle orbiter

Astronaut – a person trained to travel and work in space

Countdown – the process of counting backward before a rocket launch

Crew – a team of people trained to live and work together in space

Docking – two spacecraft joining or attaching in space

Docking port – the part of a spacecraft where another spacecraft attaches

External Tank - large orange tank filled with liquid hydrogen and oxygen used to power the space shuttle main engines

European Space Agency (ESA) – eleven European countries cooperating to build the International Space Station

Extravehicular Activity (EVA) – a spacewalk performed by an astronaut

Goddard, Robert – American rocket scientist and researcher known as "the father of modern rocketry"

International Space Station (ISS) – orbiting science laboratory built by sixteen nations

Kennedy Space Center (KSC) – NASA center in Florida where the space shuttle is processed and launched

Launch pad - the place from which a rocket launches

Liftoff – the moment a rocket begins to rise above the launch pad

Main engines – three rocket engines on the space shuttle orbiter that are powered by the propellant in the external tank

Microgravity – the presence in space of very little gravity

Mission – the assigned task or goal of a spacecraft or a crew

National Aeronautics and Space Administration (NASA) – the United States government agency that oversees space exploration

Newton, Isaac – scientist that developed three laws to describe and explain motion

Newton's Third Law of Motion – the law that states that for every action, there is an equal and opposite reaction

Orbit – the path an object follows around another object, such as the ISS circling around the Earth

Orbital Maneuvering System – engines used by space shuttle orbiter to adjust orbit

Orbiter – reusable part of the space shuttle that carries people and cargo to and from space

Partner Nations – sixteen nations that work together to build the ISS

Payload Bay – the area in the orbiter that holds cargo, labs, or ISS components

Progress - the Russian built spacecraft that delivers supplies to the ISS

Proton – the Russian built rocket that carries modules or components to the ISS

Robotic Arm – mechanical arm-like device in the payload bay of orbiter; operated by astronauts to lift and maneuver spacewalkers, cargo, or ISS components

Rocket – vehicle that carries people and cargo to space

Solid Rocket Boosters (SRB) – two reusable white rockets on the space shuttle that burn solid propellants

Soyuz – Russian built rocket that takes the Progress spacecraft and Soyuz capsule to space

Soyuz Spacecraft – Russian built spacecraft that carries crews to and from space

Space Shuttle – the reusable United States spacecraft used to transport people and cargo to space; also known as the Space Transportation System (STS)

Space Transportation System (STS) – the reusable United States spacecraft that consists of the orbiter, the solid rocket boosters, and the external tank; the space shuttle

SUGGESTED READING

A list of book titles appropriate for the Early Childhood classroom follows. Children and adults can use these books to learn more about space travel, rockets, and the International Space Station. Many additional books on these topics are also available.

Anderson, Joan. (1993), ***Ritchie's Rocket.*** Morrow Junior Books, New York. ISBN: 0-688-11305-2. *A young boy builds a rocket and travels to space.*

Asch, Frank. (1983), ***Mooncake***. Prentice-Hall, Englewood Cliffs, NJ. ISBN: 0-13-601013-X. *Bear builds a rocket to go to the Moon.*

Barton, Byron. (1988), ***I Want to Be An Astronaut.*** Harper Collins, New York. ISBN: 0-06-443280-7. *A young child becomes an astronaut and travels on the space shuttle.*

Bergin, Mark. (1997), ***Space Shuttle.*** Franklin Watts, Danbury, CT. ISBN: 0-531-14573-5. *Pictures and information on the space shuttle.*

Branley, Franklyn M. (2000), ***The International Space Station.*** Harper Collins, New York. ISBN: 0-06-445209-3. *Information on the ISS for younger students.*

Branley, Franklyn M. (1998), ***Floating in Space.*** Thomas Y. Crowell, New York. ISBN: 0-06-025432-7. *Information on living in space for the early learner.*

Branley, Franklyn M. (1987), ***Rockets and Satellites.*** Thomas Y. Crowell, New York. ISBN: 0-06-445061-9. *Information on and pictures of rockets and the shuttle launch sequence.*

Buttonwood, Betsy. (1996), ***Rockets.*** Goodyear Books, Glenview, IL. ISBN: 0-673-36333-3. *Easy reader using rockets to teach color words.*

Campbell, Peter A. (1995), ***Launch Day***. The Millbrook Press, Brookfield, CT. ISBN: 1-56294-611-0. *A description of the preparation, launch, and landing of a space shuttle.*

Cole, Norma. (1994), ***Blast Off! A Space Counting Book.*** Charlesbridge Publishing, Watertown, MA. ISBN: 0-606-06237-8. *A counting book with a space theme.*

Dyson, Marianne J. (1999), ***Space Station Science: Life in Free Fall.*** Scholastic, New York. ISBN: 0-590-05889-4. *Higher-level book with information, pictures, and experiments relating to the ISS.*

Eugene, Toni. (1999), ***Exploring Space.*** National Geographic Society, Washington, DC. ISBN: 0-7922-6671-4. *Photographs and information about shuttle launches.*

Graham, Jan. (1998), ***The Best Book of Spaceships.*** Kingfisher, New York. ISBN: 07534-5133-6. *Descriptions and pictures of rockets and the shuttle launch sequence.*

Hancock, David. (1998), ***The Amazing Pop-Up Pull-Out Space Shuttle.*** DK Publishing, New York. ISBN: 0-7894-3457-1. *Four-foot 3-D foldout model of the space shuttle.*

Hayden, Kate. (2000), ***Astronaut: Living in Space.*** Dorling Kindersley, New York. ISBN: 0-7894-5421-1. *An easy reader on the life of an astronaut.*

Hopkins, Lee Bennett. (1995), ***Blast Off! Poems About Space.*** Harper Collins, New York. ISBN: 0-06-024261-2. *Poems about space and space travel.*

Inkpen, Mike. (2001), ***Rocket.*** Harcourt, Inc., New York. ISBN: 0-15-216254-2. *Animals build and launch a rocket.*

Kirk, Daniel. (1999), ***Hush Little Alien.*** Hyperion Books, New York. ISBN: 0-7868-0538-2. *A cosmic lullaby with rockets.*

Langille, Jacqueline and Bobbie Kalman. (1998), ***The Space Shuttle.*** Crabtree Publishing, New York. ISBN: 0-86505-678-1. *Pictures of the shuttle and shuttle launch sequence.*

Loomis, Christine. (2001), ***Astro Bunnies.*** G.P. Putnam, New York. ISBN: 0-399-23175-7. *Bunnies travel on a rocket to space.*

Miller, Edward. (2001), ***Rockets.*** Grosset and Dunlap, New York. ISBN: 0-448-42461-4. *Book featuring a variety of rocket stickers.*

Mitton, Tony and Ant Parker. (1997), ***Roaring Rockets.*** Kingfisher, New York. ISBN: 0-7534-5106-9. *Rhyming book about animals traveling on a rocket.*

Rey, H. A. (1957), ***Curious George Gets a Medal.*** Houghton Mifflin, Boston. ISBN: 0-395-16973-9. *George's adventures include a ride on a rocket.*

Richards, Jon. (1998), ***Space Vehicles.*** Copper Beech Books, Brookfield, CN. ISBN: 0-7613-0721-4. *Cut-away views of space vehicles.*

Ride, Sally with Susan Okie. (1986), ***To Space and Back.*** Lothrop, Lee and Shepard Books, New York. ISBN: 0-688-06159-1. *Higher-level book with information and pictures about a trip into space.*

Scieszka, Jon. (2001), ***Baloney (Henry P).*** Viking, New York. ISBN: 0-0-670-89248-3. *A young alien uses his imagination to tell a story of a rocket ride.*

Sipiera, Diane M. and Paul. (1997), ***Space Stations.*** Children's Press, New York. ISBN: 0-516-20450-5. *Book for younger students that examines living and working on space stations.*

Wallace, Karen. (2001), ***Rockets and Spaceships.*** Dorling Kindersley Publishing, New York. ISBN: 0-7894-7359-7. *Beginning reader with rocket pictures and information.*

Weimer, Tonja E. (1993), ***Space Songs for Children: Fun Songs and Activities about Outer Space.*** Pearce-Evetts Publishing, Greenville, SC. ISBN: 0936-823-119. *Book and cassette with space songs and activities.*

Wilson-Max, Ken. (2000), ***Big Silver Space Shuttle***. Scholastic, New York. ISBN: 0-439-13656-3. *A pop-up book on the space shuttle.*

NASA Resources for Educators

NASA's Central Operation of Resources for Educators (CORE) was established for the national and international distribution of NASA-produced educational materials in multimedia format. Educators can obtain a catalogue and an order form by one of the following methods:

NASA CORE
Lorain County Joint Vocational School
15181 Route 58 South
Oberlin, OH 44074-9799
Toll Free Ordering Line: 1-866-776-CORE
Toll Free FAX Line: 1-866-775-1460
E-mail *nasaco@leeca.org*
Home Page: http://core.nasa.gov

Educator Resource Center Network
To make additional information available to the education community, NASA has created the NASA Educator Resource Center (ERC) network. Educators may preview, copy, or receive NASA materials at these sites. Phone calls are welcome if you are unable to visit the ERC that serves your geographic area. A list of the centers and the regions they serve includes:

AK, Northern CA, HI, ID, MT, NV, OR, UT, WA, WY

NASA Educator Resource Center
NASA Ames Research Center
Mail Stop 253-2
Moffett Field, CA 94035-1000
Phone: (650) 604-3574

IL, IN, MI, MN, OH, WI

NASA Educator Resource Center
NASA Glenn Research Center
Mail Stop 8-1
21000 Brookpark Road
Cleveland, OH 44135
Phone: (216) 433-2017

CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT

NASA Educator Resource Laboratory
NASA Goddard Space Flight Center
Mail Code 130.3
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Phone: (301) 286-8570

CO, KS, NE, NM, ND, OK, SD, TX

Space Center Houston
NASA Educator Resource Center for
NASA Johnson Space Center
1601 NASA Road One
Houston, TX 77058
Phone: (281) 244-2129

FL, GA, PR, VI

NASA Educator Resource Center
NASA Kennedy Space Center
Mail Code ERC
Kennedy Space Center, FL 32899
Phone: (321) 867-4090

KY, NC, SC, VA, WV

Virginia Air & Space Center
Educator Resource Center for
NASA Langley Research Center
600 Settlers Landing Road
Hampton, VA 23669-4033
Phone: (757) 727-0900 x 757

AL, AR, IA, LA, MO, TN

U.S. Space and Rocket Center
NASA Educator Resource Center for
NASA Marshall Space Flight Center
One Tranquility Base
Huntsville, AL 35807
Phone: (256) 544-5812

MS

NASA Educator Resource Center
NASA Stennis Space Center
Building 1200
Stennis Space Center, MS 39529-6000
Phone: (228) 688-3338

CA

NASA Educator Resource Center for
NASA Jet Propulsion Laboratory
Village at Indian Hill
1460 East Holt Avenue, Suite 20
Pomona, CA 91767
Phone: (909) 397-4420

AZ and Southern CA

NASA Educator Resource Center for
NASA Dryden Flight Research Center
45108 N. 3rd Street East
Lancaster, CA 93535
Phone: (661) 948-7347

VA and MD's Eastern Shores

NASA Educator Resource Center
GSFC/Wallops Flight Facility
Visitor Center Building J-17
Wallops Island, VA 23337
Phone: (757) 824-2298

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Check the Internet for programs listings at:
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NASA Headquarters - Code P-2
Washington, DC 20546-0001
Phone (202) 358-3572

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3–4 p.m.	4–5 p.m.	5–6 p.m.
6–7 p.m.	7–8 p.m.	8–9 p.m.
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How to Access Information on NASA's Education Program, Materials, and Services
This brochure serves as a guide to accessing a variety of NASA materials and services for educators. Copies are available through the ERC network, or electronically via NASA Spacelink.

Please take a moment to evaluate this product at *http://ehb2.gsfc.nasa.gov/edcats/educator_guide.* Your evaluation and suggestions are vital to continually improving NASA educational materials. Thank You.

3...2...1...Liftoff!—An Educator's Guide With Activities in Science, Mathematics, Technology, and Language Arts

EDUCATOR REPLY CARD

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