# AEX I

## Aerospace Education Excellence

Volume 2

Hands-on Aviation and Space Activities
for Elementary Educators (K-5)

AEX I

**VOLUME TWO**

# *The Aerospace Education EXcellence Award Program*

## AEROSPACE ACTIVITY BOOKLET
*for* Elementary Educators in Grade Levels K-5


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A special acknowledgement goes to Ms. Judy Rice, Deputy Director of Aerospace Education, National Headquarters, CAP. Ms. Rice came to CAP with an impressive background in aviation and space. She is a professional writer, educator, pilot, planner, organizer and program development specialist. Under her leadership, the Aerospace Education taskforce has climbed to a "much higher altitude."

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Dr. Ben Millspaugh,
AEX Author & Project Director

# *Contents*

# A Complete Unit in Aerospace Education—

*Our Children Should Know America leads the world in aerospace technology.*

**They Should Know**

- ...about man's first flight in **kites**. Some historians believe that the Chinese invented kites around 400 B.C. There is new evidence that kites were used by South Seas island natives to catch fish before the Chinese.
- The Chinese are credited with the development of **solid fuel rockets**, 1220 A.D. This type of rocket launches the Space Shuttle today.
- The great works of **Leonardo da Vinci**, 1485, should be included. Although the technology of his lifetime would not allow their construction, he designed a parachute, a helicopter and a flapping wing **ornithopter**.
- **Daniel Bernoulli** (1700-1782) and **Sir Isaac Newton** (1642-1727) developed scientific theories that were eventually used as the basis of flight within the atmosphere.
- Man's first true powered flight was in a **hot air balloon**. This occurred in 1783 and the inventors were two brothers, Joseph and Etienne Montgolfier, in Paris, France.
- The first successful manned free-flight in a **heavier-than-air-machine**, 1853, is credited to Englishman, Sir George Cayley.
- Otto Lilienthal was the first to build and fly **a glider with true control** (1891). It was a primitive hang glider and steering was by shifting body weight. He died in an accident when his glider stalled and plummeted to the ground in 1896.
- By extensive testing, the **Wright brothers developed a full three-axis control** of their glider in the wind conditions on a beach near Kittyhawk, N.C. (1900).
- After thorough flight tests, the Wright brothers built their own engine and achieved the **first controlled, sustained and powered flight**. This occurred on the 17th of December 1903. The craft rose 12 feet in altitude, went 120 feet in distance and the flight took 12 minutes.
- Ms. Harriet Quimby was a very brave young woman who became the **first American female (2nd in the world by just a few days) to attain an internationally recognized pilot's license**. She also became the first woman to fly the English Channel (unfortunately not very well recognized because her epic flight was two days after the sinking of the Titanic in 1912).
- Ms. Bessie Coleman was **the first African American**, of either gender, to obtain an internationally recognized pilot's license. She was a role model heroine in her own time and was tragically killed in an airshow accident (1926).
- Dr. Robert H. Goddard is considered to be the **Father of Space Flight**. He learned how to control a rocket engine through the use of liquid fuels (1926).
- Charles A. Lindbergh made aviation credible. He is the Father of Commercial Aviation and his epic trans- Atlantic flight was **the beginning of modern air travel** (1927).
- Amelia Earhart helped establish **a place for women in the world of aviation**. She did this by her pioneering achievements and world records. (1932-1937).
- The propeller era, which began with the flight of the Wright brothers, ended in World War II when the **first jets arrived**. A jet engine was invented and developed by Englishman Frank Whittle (patented 1930-first flight 1941).
- By breaking the sound "barrier" on October 14, 1947, Charles E. "Chuck" Yeager **opened the Space Age**. He did this in a rocket-powered aircraft called the Bell XS-1. The speed of sound is approximately 761 miles per hour at sea level and the speed to go into orbit is 18,000 miles per hour. To go into orbit around the Earth, an air/space craft has to go through the speed of sound first. That is why Yeager's flight was so important.
- The next step was our first aerospace plane. It was known as the X-15 and was test flown by aerospace pioneer, A. Scott Crossfield. He is considered by many aviation / space authorities to be **America's first true astronaut.** The X-15 routinely flew up and back from the edge of space. (1959)
- The great **Space Race** was initiated by the Soviet Union when they put a satellite into orbit on October 4, 1957. The satellite was known as Sputnik and it changed the course of history.
- America temporarily lagged behind in the technology of space; however, a concentrated effort was initiated by President John F. Kennedy to land a man on the moon and this task was accomplished on the 20th of July 1969. Astronaut Neil Armstrong was the **first human to walk on the moon.**
- First flown in 1981, the American Space Shuttle, was developed to cut the cost of taking cargo into orbit and returning to Earth. The Shuttle is essentially **a space "truck."**
- America's **satellites** are directly responsible for the "giant leap" in telecommunications and weather technology. The space program has brought us closer to being a human race of "one people." (The last three decades of the Twentieth Century)
- The International Space Station will be **our "stepping stone" to the stars**. Incredible new technology will be developed as a result of the scientific work planned under the microgravity conditions of space. (1999- and beyond)

# *Aerospace Education—Exactly What Is It?*

**FACT:** It has been found that flight, whether it's in the sky above, or the space beyond Earth, excites the imagination of children.

**FACT:** The pure science and technology of atmospheric and space flight is known as AEROSPACE. This combines the terms "aeronautics" and "space."

**FACT:** AEROSPACE, either in isolated examples, or full curriculum units, has been found to make children actually WANT to learn more about science and technology. AEROSPACE as a learning incentive, WORKS!

## SO, WHAT'S AEX?

**FACT:** AEX stands for **A**erospace **E**ducation E**X**cellence Award Program

**FACT:** This is a program that offers educators and CAP AEOs standards-based, hands-on, inquiry-based learning tools that excite children. Above all, you can get an award for being a hero and having fun!

**SIX & ONE!** These are your magic numbers! A teacher or aerospace education officer must select SIX activities out of the AEX Activity Booklet and use them in a classroom or squadron setting. The AEX activity report has to be provided to LMA, National Headquarters, CAP. This must be done by sending, or emailing the required information to AEX Program/LMA, National HQ, CAP. You are also required to do ONE, 2-HOUR Aerospace Education related activity. An example would be an airport field trip. Once you've finished all the requirements, you receive a beautiful award plaque for your classroom and award certificates for participants. AND IT'S FREE TO MEMBERS….!!

***The fine print!***

Teachers must be a current Aerospace Education Member to participate. Application can be found on page 91. Enrollment and completion of the program must be within the same school year.

Agreement form and reporting forms must be sent to AEX Program Manager, Civil Air Patrol National Headquarters, 105 S. Hansell St., Bldg. 714, Maxwell AFB, AL 36112-6332. Email: aex@cap.gov or FAX 334-953-4235.

## activity one

# *Parachutes, Candy and the Great Uncle Wiggly Wings*

**OBJECTIVE**

*This activity covers the construction of a toy parachute, and the story of how little parachutes brought joy and happiness to thousands of German children after the end of WWII. The primary hands-on objective is to build one or more parachutes that can carry a Popsicle® stick or a miniature chocolate candy bar.*


**CREDIT -** Ms. Alice Faye Noble, an outstanding aerospace educator from the state of Kentucky, developed this activity around the heart-warming story of Col. Gail Halvorsen, an Air Force pilot. Ms. Noble has conducted numerous workshops featuring this activity and now thousands of children know the technology of a parachute and the story of the famous "Candy Bomber" during the period known as the Berlin Airlift!

## NATIONAL SCIENCE STANDARDS

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

**Content Standard B: Physical Science**
- Position and motion of objects

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

## SOCIAL STUDIES STANDARDS

1. Culture
2. Time, Continuity, and Change
3. People, Places, and Environments
6. Power, Authority, and Governance
9. Global Connections
10. Civic Ideals and Practices

## BACKGROUND

### *THE CANDY BOMBER STORY*

At the end of WWII, a defeated Germany was divided amongst the victors, the United States, the Soviet Union, Great Britain, and France. The Soviet Union (USSR) took control of the Eastern half of Germany and the Western half was divided amongst the Allied forces of the USA, Great Britain, and France. The city of Berlin was sitting in the middle of the Eastern sector and it was governed by a union of the four powers, called the Allied Control Council. The objective of this council was to control and rebuild the war-torn city of Berlin.

Generally traffic moved throughout the city and much-needed supplies for everyday living for the 2,008,943 Berliners came in without any difficulty. There were many disagreements, on the Council, as to how the city should be rebuilt. As a result, Joseph Stalin, the leader of the USSR, wanted the US, Great Britain and France out and on the morning of April 9th, 1948, ordered all American Military personnel maintaining communications equipment out of the Eastern Zone. On June 21st, a US military supply train was halted and it was moved back to the Western sector by a Soviet engine. On the 24th of June 1948, all land and water access to West Berlin was cut off by the Soviets. There were to be no more supplies to be moved into Berlin. The Allies were certainly not going to stand for this. Diplomacy failed, ground invasions were planned and World War III was eminent. U.S. military commander, General Lucius Clay had a plan by which an armed convoy through Soviet-controlled Berlin would break the blockade and this action would almost certainly create a war.

British Commander Sir Brian Robertson offered an alternative plan: supply the city by air. It was determined that the city's daily food ration would be 646 tons of flour and wheat; 125 tons of cereal; 64 tons of cooking fat; 109 tons of meat and fish; 180 tons of dehydrated potatoes, 180 tons of sugar; 11 tons of coffee; 19 tons of powdered milk; 5 tons of whole milk for children; 3 tons of fresh yeast for baking; 144 tons of dehydrated vegetables; 38 tons of salt; and 10 tons of cheese. In total, 1,534 tons would be needed daily to keep over 2 million people alive. These figures did not include other necessities, like coal and fuel.

Earlier, in 1945, an agreement was made between all of the powers including the Soviet Union, that three 20 mile-wide air corridors would be established providing access to Berlin. The pact was signed and agreed upon by all the allied powers including the USSR. When the blockade began, the Soviets thought that surely the U.S., Great Britain and France would leave. They were wrong and on June 26, the first American C-47 Skytrain cargo planes landed at Templehof Airport, foreshadowing the great operation that was to come. The great Berlin Airlift began.

This great undertaking was commanded by General William H. Tunner and he was known as the "transportation expert to end all transportation experts" by his commander, General Curtis LeMay.

Life for the people of Berlin was very difficult and had it not been for the Airlift, thousands would have died from starvation and disease. One of the most poignant stories to come out of the Berlin Airlift was that of 1st Lt. Gail Halvorsen, a pilot for the US Air Force. Lt. Halvorsen had a hobby of making home movies and on one of his days off, decided to visit the city he was saving. At Templehof, he noticed, near the end of one of the main Airlift runways, a group of children watching the planes land. He went over to them and started a conversation. They were especially fascinated with him once they found out he was one of the pilots who was flying in their life-giving supplies. He noticed that they did not ask him for handouts of gum or chocolate. He reached into his pocket and found that he only had two sticks of Wrigley's Doublemint gum. He told them that if they didn't fight over it, he would drop some candy to them, by parachute, the next day when he flew over. They were very courteous and distributed the pieces of gum equally amongst themselves. Before he left, one child asked him how they would know it was him when he dropped the candy. He said, "I'll wiggle my wings!" True to his word, the very next day, on approach to Berlin, he rocked the airplane and dropped some chocolate bars attached to a handkerchief parachute to the children waiting below. Every day, the number of children would increase and he made several more drops. Soon there was a stack of mail at the Base Operations addressed to "Uncle Wiggly Wings," "The Chocolate Flyer," and the "Chocolate Uncle." Eventually he was "called on the carpet" by his commander because some local newspaper reporter published a picture of Halverson's plane going by with tiny parachutes trailing it. His commander wasn't happy about it, but General Tunner thought it was just the kind of morale boost that the operation needed. It was eventually dubbed, "Operation Little Vittles!" The "Operation" continued and over three tons of candy was dropped over Berlin; some even landed in the Soviet Sector. For this simple, kindhearted gesture, Halvorsen became the most recognized pilot of the Berlin Airlift.


Lt. Gail S. Halvorson
USAF Museum Photo Archives


Gail Halvorson in Ber
USAF Museum Photo Ar


Gail Halvorson reenacting the 'Candy Drop' in 1969 at Templehof Airport, Berlin
USAF Museum Photo Archives

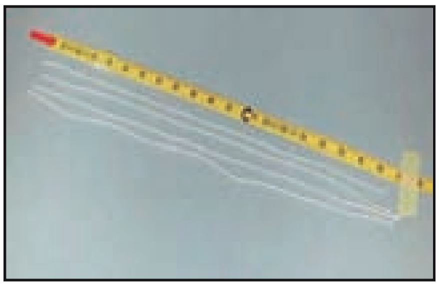

This is a picture of Air Force Colonel, Gail Halvorsen. If a teacher wants to learn more about the Berlin Airlift and its great significance in aerospace history, it is recommended that the following resources be considered:

- Tusa, John & Ann, The Berlin Airlift, 1998, Spellmount Limited ISBN 1-86227-044-9
- Halvorsen, Gail, The Berlin Candy Bomber, 1997. Horizon Publishers, ISBN 0-88290-616-X. (Mailing address is P.O. Box 490, Bountiful, Utah, 84111-0490.
- Video recommended: "Berlin Airlift, The First Battle of the Cold War," The History Channel, ISBN 0-7670-1166-X ( New Video Group, 126 5th Avenue, NY, NY 10011)
- Video recommended: "The Berlin Airlift" (UNAPIX Entertainment Inc., 200 Second Avenue West, Seattle, WA 98119 ISBN 1-57523-571-4 Toll Free- 1.800.245.6742

# AND NOW…A Parachute with a Chocolate Cargo!

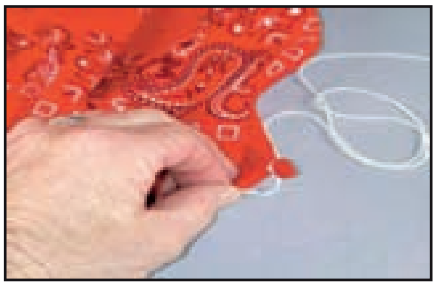
### MATERIALS

- A piece of cloth about the size of a large handkerchief. It can also be made of paper or filmy plastic.
- String will be needed to tie the four corners of the parachute together.
- One candy bar, small or large that can be attached to the parachute.
- Role of masking tape to attach the candy to the parachute.
- A ruler or tape measure for measuring string.

## PROCEDURE

1. Depending upon the size of the parachute you want to make, measure out four equal lengths of household string and cut.



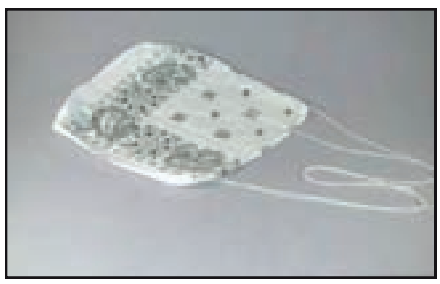
2. One at a time, tie the end of the string to the corner of a square piece of cloth. For this illustration a square bandanna was used.

3. The candy bar is wrapped so that the long end will have some extra string available to attach to the parachute. A piece of masking tape was used to hold the string in place to keep the candy from separating when the parachute opens.

4. The four strings (in parachute terms, these are known as shroud lines) should be tied to the candy bar so that each one is an equal length from the attachment point. The parachute is carefully folded with the candy bar on top. When thrown upward, the parachute should open and float gently to the ground.

## SMALLER 'CHUTES

For a classroom exercise, you can make smaller parachutes with miniature candies attached. A square about ¼ the size of a normal bandanna works well. The one used in this activity was 12" x 12". The string shroud lines were 24" long and the candy was a Hershey's miniature chocolate bar.



1. A smaller parachute and miniature candies work very well for a class project. The one used in this portion of the activity was 12" x 12" with 24" lines.

2. The candy bar is attached end to end so that it hangs straight down from the parachute.

3. A small piece of tape will help keep the candy from separating from the lines.

Fold the parachute and let the fun begin!

### Inquiry and Enrichment-

Ask children to experiment to find the answers to the following questions: (Be sure they understand the words "descent" and "mass")

1. How does the size of the parachute affect its descent?
2. Does the type of material used for the parachute affect its descent?
3. Does the outside temperature affect the descent of the parachute?
4. Does the mass of the object attached to the parachute affect its descent?
5. How does cutting a hole in the middle of the parachute affect its descent?

A children's book has been written about the Candy Bomber. The title is:

***Mercedes and the Chocolate Pilot***

By Margot Theis Raven

Illustrated by Gijsbert van Frankenhuyzen
Sleeping Bear Press, 2002

## activity two

# *Design Your Own Mission Patch*

**OBJECTIVE**

*This aerospace activity is designed to give the children an opportunity to create their own artistic symbol of a mission they would like to take into space.*

## NATIONAL SCIENCE STANDARDS

**Content Standard E: Science and Technology**
- Abilities of technological design
- Understanding about science and technology

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

## PROCEDURE

The procedure is very open on this project. Depending upon the age of the class, the teacher/ AEO is encouraged to:

1. Plan a mission to somewhere in space.
2. This mission can be an orbital experiment involving only the Space Shuttle.
3. It can be a mission to conduct a series of experiments on the International Space Station.
4. It could be a deep space excursion to another planet like Mars.

It is recommended that the teacher show the children various patches of previous NASA missions. Then using whatever color media is most available, produce a patch for each child and showcase it in the classroom.

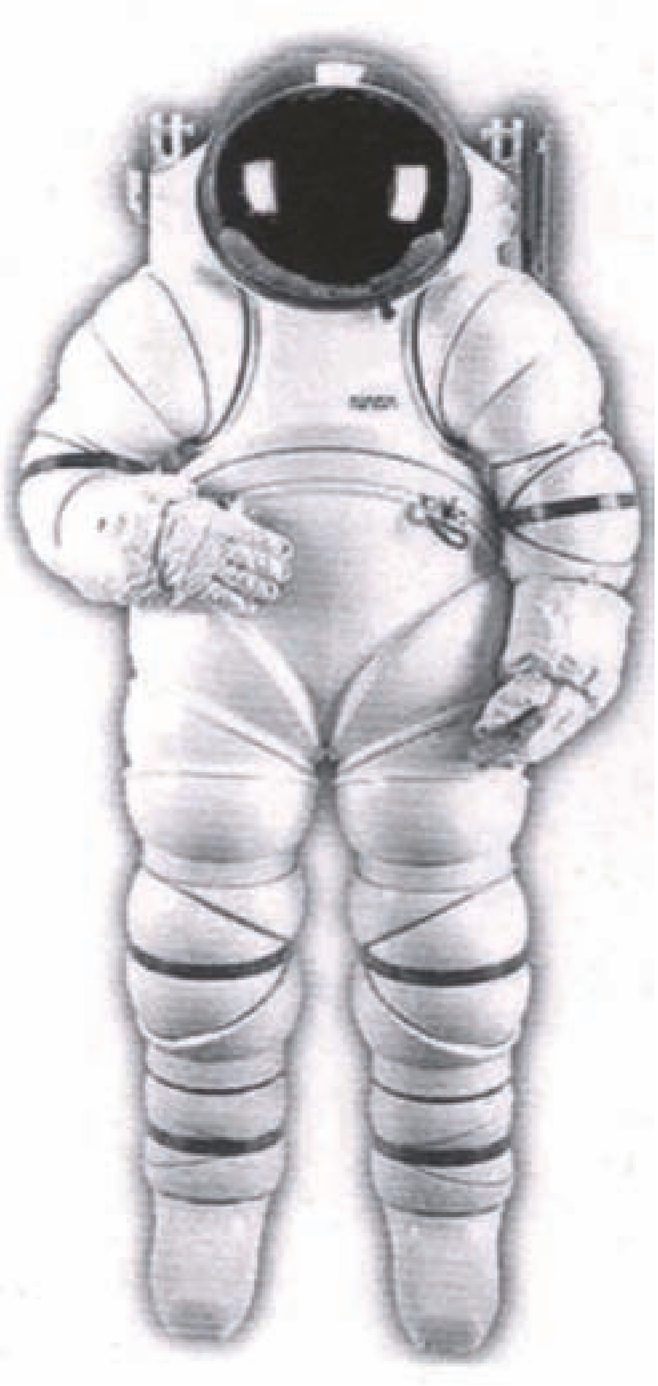
Let's take a look first at a beautiful mission patch (shown at beginning of activity) and the symbolism that it displays for a group of astronauts and the International Space Station. According to the web site that featured this particular patch, the following explanation was given:

"The STS 100 emblem reflects the complex interaction of robotic and extravehicular activity (EVA) on this mission. During the mission, spacewalks will be conducted to deploy the International Space Station Remote Manipulator System (SSRMS). The EVA helmet frames the patch, with the Canadian-built SSRMS shown below the visor. Reflected in the visor is the Space Shuttle Endeavour, with the International Space Station r rising above the horizon at orbital sunrise. Endeavour's payload bay houses a Spacelab pal let, itself holding the SSRMS and the Space Station Ultra High Frequency Antenna, and the Italian-Built Multi-purpose Logistics Module "Raffaello." American, Russian, Canadian, and Italian astronauts compose the crew and flags are stylized in the lower portion of the emblem. Ten stars adorn the sky representing the children of the crew and the future of space exploration. The NASA insignia design for Shuttle flights is reserved for use by the astronauts and for other official use as the NASA Administrator may authorize."

**Examples from the Rich History of Aerospace**

Use this as your sketch pad. It's time to get creative!!!

**Enrichment:**
Read about the Mars exploration project and decide what a patch would look like for the Mars Program.



**What do you think it will look like?**

**Design your own Mars patch.**

## activity three

# *Where Is North?*

**OBJECTIVE**

*Students will build a compass. Students will determine the direction of north, south, east, and west.*


**NATIONAL SCIENCE STANDARDS**

**Content Standard B: Physical Science**

- Properties of objects and materials
- Light, heat, electricity, and magnetism

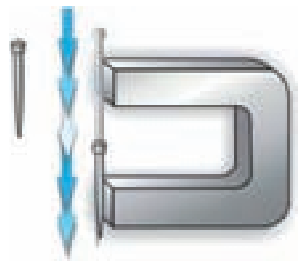
## BACKGROUND

The compass has been used for centuries as a tool for navigation. It is an instrument that aligns a free pivoting bar magnet (called the needle) in Earth's magnetic field.

Since the invisible lines of the magnetic field are oriented in a north/south direction, the needle will orient itself in a north/south direction. The other cardinal points of the compass (east, west, and south) are defined in relation to north.

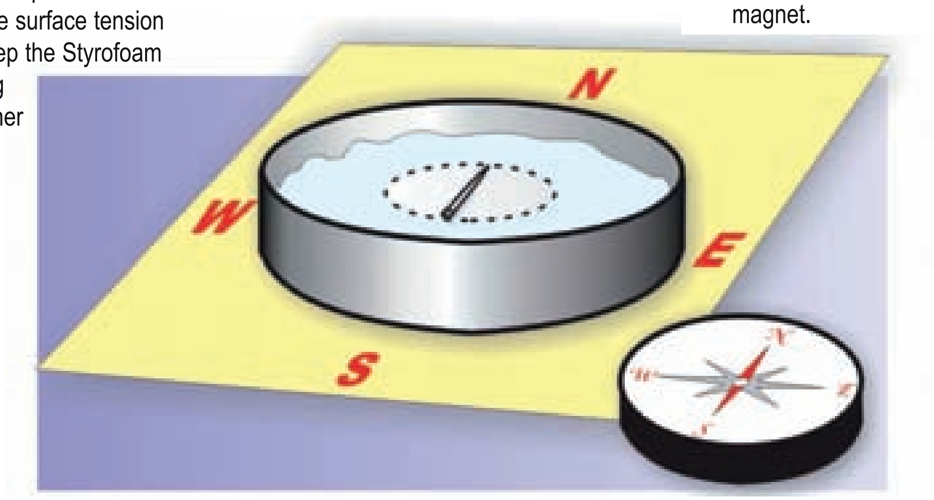
## MATERIALS

- Paper clips
- Fourpenny (4p) finishing nail
- Shallow dish or pan 15-30 cm diameter
- Liquid soap
- Magic markers
- Styrofoam cup, .25 L capacity
- Scissors
- Magnet (must be large and strong in order for this to work properly)



## PROCEDURE

1. Fill a shallow dish with water. Place one drop of liquid soap in the water. This will reduce the surface tension friction and will keep the Styrofoam disk from attaching itself to the container wall.
2. Cut the bottom out of the cup and float it on the water.
3. Magnetize the compass "needle" by rubbing it in one direction on a small magnet.




4. Place the magnetized compass needle on the floating Styrofoam disk. To minimize compass errors, place the compass away from metals, magnets, or electrical wiring.
5. Ask students to observe the compass needle as it aligns parallel with the invisible magnetic field.
6. Discuss ways to verify which end of the needle is pointing north and which end is pointing south. (Sunrise, sunset, shadows, commercial compass).
7. Place a piece of metal near the compass and observe changes in the needle orientation.
8. Write or cut the letter N and position to indicate the north direction. Follow this by placing the letters S, E, and W around the edges of the compass.

### EXTRA

Hide "prizes" at different locations in the classroom. Have students locate the prizes using a compass while following teacher's directions (north, south, southeast, etc.).

### ASSESSMENT

Identify an object in the classroom and ask students to state what direction the object is from the student by using the compass.

## activity four

# *What's In the Box?*

*(This activity is courtesy of NASAexplores.com)*

**OBJECTIVE**

*Students will learn that they can make a topographic map of an object without being able to see it.*

**Topography of New Zealand**

## NATIONAL SCIENCE STANDARDS

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

**Content Standard B: Physical Science**
- Properties of objects and materials
- Position and motion of objects

**Content Standard E: Science and Technology**
- Abilities of technological design
- Abilities to distinguish between natural objects and objects made by humans

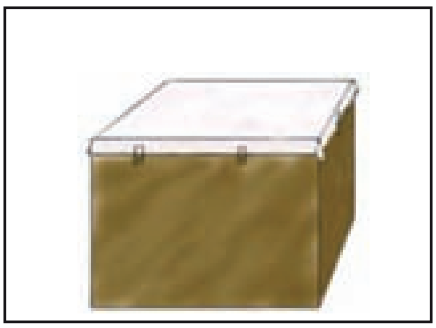
**Unifying Concepts and Processes**
- Evidence, models, and explanation
- Form and function

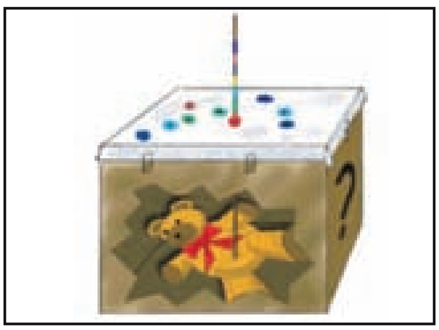
## BACKGROUND

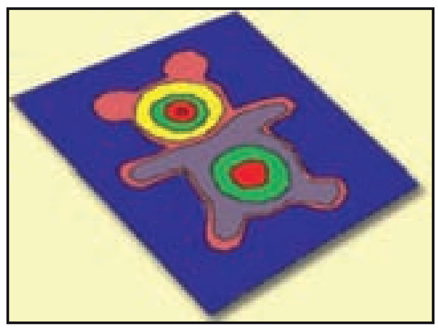
We can use a technology called imaging radar to help create a picture of the terrain on Earth - or any other planet (such as Mars). Imaging radar instruments are either flown over the surface of the planet in an airplane or launched into orbit around the planet. Imaging radar works by bouncing a radar signal off the ground, then measuring the strength of the signal that comes back and how long it takes.

## MATERIALS

- Box with paper over the top so you can't see inside
- An object such as a Teddy Bear or other simple shaped object
- Sharp, straight stick such as a wooden skewer or knitting needle (**Safety**: be sure you instruct students on the safe use of the skewer and perhaps attach an eraser or other soft end to the sharp skewer.) If you add an end that will not stick into the box, you may have to pre-cut the holes for measurement.
- Markers
- Ruler







## PROCEDURE

1. Tell students that the box contains a mysterious object. They have to figure out what is in the box without looking at or touching the object. They can poke small holes in the paper on top of the box with a sharp, straight stick of some kind, like a long skewer or knitting needle, but they can't look inside.

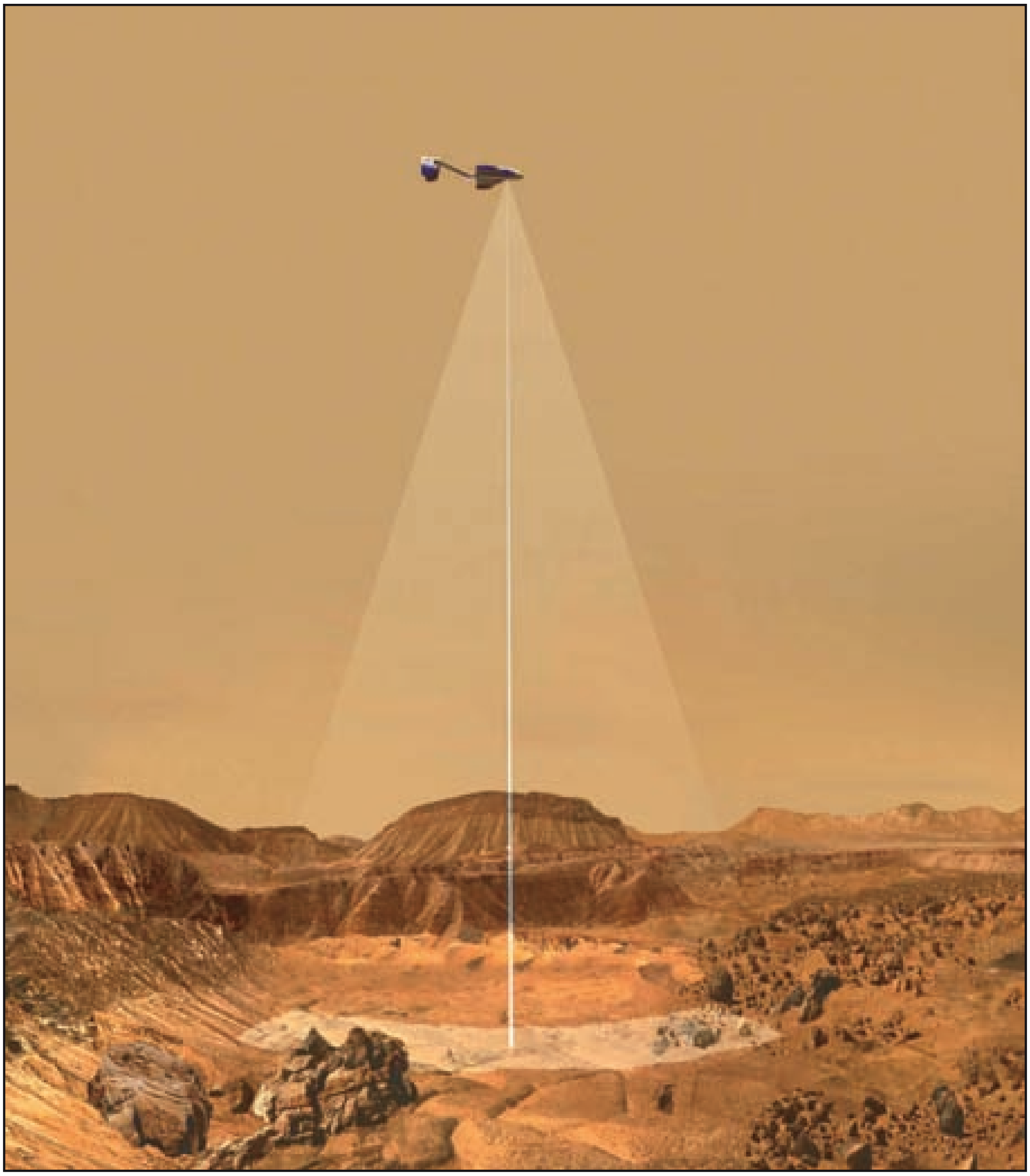
2. One way to make a topographic map of the contents of the box is to poke the stick straight down into the box until it touches something. Have students mark with their fingers how far the stick went in. Have them take out the stick and measure how far it went into the box. Mark that hole with that measurement. They could use numbers for the measurements, but an easier way is to use colors. For example, 5 inches is blue, 6 inches is purple, etc.

3. After they have almost covered the paper with color-coded holes, they could color in the areas with same-colored holes. They would then have a topographical map of the object inside the box! They might not be able to tell exactly what the object is even from its "topo" map. But, if they know what colors stand for what heights, they can imagine how the object might look in three dimensions.

4. Another idea would be for them to use grid paper over the top of the box and measure each grid section. They can then transfer the color-coding to another piece of grid paper.

**ASSESSMENT**

Use each student's drawing as an evaluation of the measuring of the object.



Artist's Concept of ARES (Aerial Regional-scale Environmental Survey) over Mars.

## activity five

# A Comet for the Littlest Astronomers

**OBJECTIVE**

*This is a very simple hands-on project that students in K-2 classes can enjoy. The objective is to teach the astronomy of our solar system using a comet as a learning tool.*

## NATIONAL SCIENCE STANDARDS

**Content Standard B: Physical Science**

- Properties of objects and materials
- Properties of objects and materials

**Content Standard D: Earth and Space Science**

- Objects in the Sky

**Unifying Concepts and Processes**

- Evidence, models, and explanation

## MATERIALS

1. A small Styrofoam® ball
2. A skewer stick with the ends blunted by clipping
3. Holiday tinsel, preferably in an "ice blue" color
4. Household tape such as Scotch® brand

## BACKGROUND

Comets have been known since ancient times and there are Chinese records of Halley's Comet that go back two hundred years before Christ. As of 1995, 878 comets have been cataloged and their orbits calculated.

Comets are sometimes called "icy mudballs" or "dirty snowballs." They are a mixture of ice both water and frozen gases, and dust particles that date as far back as the beginning of the solar system. Comets have "parts." They are:

a. **Nucleus** -This is a center made up of ice, gas, dust and a few other solids.
b. **Coma** - The coma is a dense cloud of water, carbon dioxide and other gases that have sublimed from the nucleus.
c. **Hydrogen cloud**- Some comets have a huge envelope of hydrogen around it.
d. **Dust tail** - This tail can be millions of kilometers long and composed of dust particles driven off the nucleus by escaping gases.
e. **Ion tail** - This is a tail that is composed of plasma with rays and streamers caused by the comet's interaction with the solar wind.

Comets are invisible except when they are near the Sun. Most comets have an eccentric orbit which takes them far beyond the orbit of Pluto. Most are seen once and then disappear for hundreds of years (only the short and intermediate-period comets, like Halley's, stay within the orbit of Pluto for a significant fraction of their orbits).

## PROCEDURE

1. Before using any skewer stick with students, cut the pointed end so that is less of a hazard in case of an accident.
2. One end of the blunted skewer stick is thrust into the Styrofoam ball as a holding stick.
3. Pieces of tinsel about a foot long are taped to the ball opposite the skewer stick insertion.
4. The tinsel pieces are pulled down around the ball as shown in the photograph.

## Follow-up Fun!

### Make an Edible Ice Cream Comet

1. Collect these materials:
   - vanilla ice cream
   - paper baking cup like those for cupcakes
   - vanilla wafers
   - chocolate wafers
   - ice cream cones
   - a rolling pin
   - spoons
   - zipper-locking plastic bag
   - wax paper

> Even though this is not an accurate model of a comet, it is fun and an easy way to remember the concept that a comet is made of ice and rock.

2. Make some dirt!
Put your wafers inside the plastic bag, push out the air, and seal the top. Roll it with the rolling pin to make your dirt.

3. Make a comet!
Pour your dirt onto the wax paper and then roll a scoop of ice cream in it until it is completely covered with crumbs. Then take the comet and place it in a paper cupcake cup and put it in the freezer for 20 minutes.

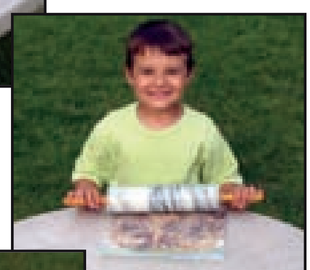
4. Eat your comet!!!!
Remove the comet from the freezer and place it on your ice cream cone. Pretend to be the sun and melt that comet in your mouth and enjoy.

This activity came from ***http://kids.msfc.nasa.gov/solarsystem/comets/makecomets.asp***

### COMET TIDBITS:

- Comets follow a regular orbit around the Sun.
- Bits of comets crossing the Earth's path become meteoroids.
- Scientists think that about 100,000 million comets orbit the Sun.
- A comet is made of dirty ice, dust and gas. Think of it as a very dirty iceberg.
- A comet's tail can be millions of kilometers in length, but the amount of matter it contains can be held in a large bookbag.
- The three main parts of a comet include the coma, nucleus and tail.

1



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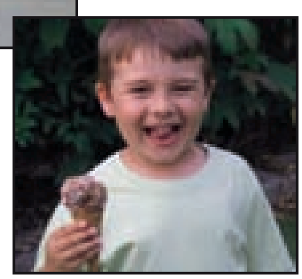

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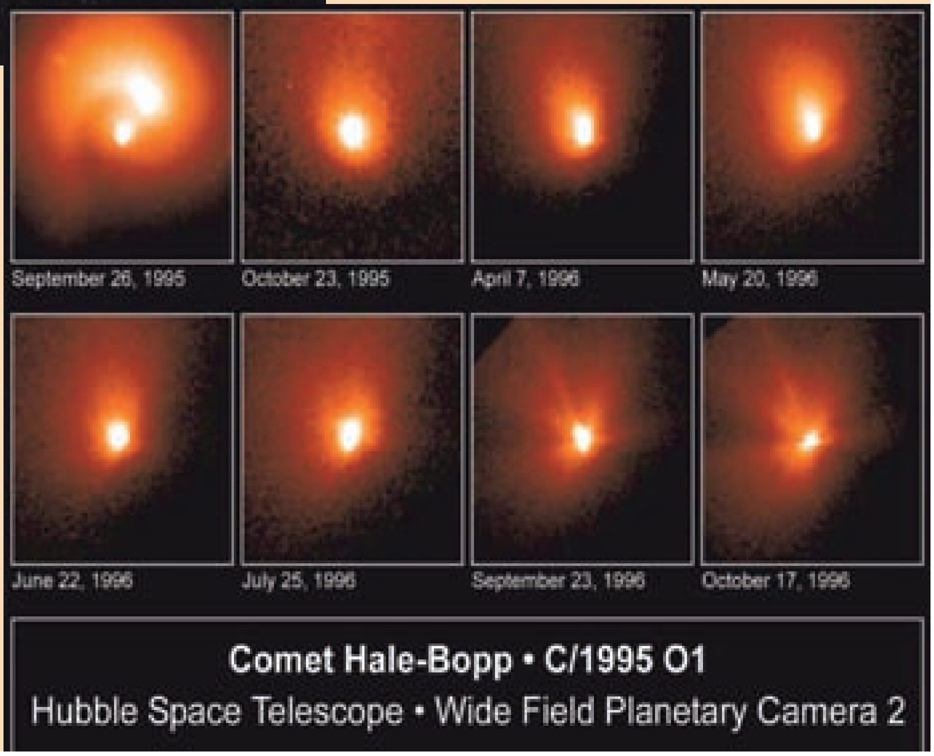
**EXTRA:**

- Show students pictures of comets from books and posters.
- Discuss the parts of a comet, which include the coma, nucleus, and tail.
- Have students draw a comet on their own paper, and label the three main parts.

A really neat close-up of Comet NEAT, pictured on the left, from Kitt Peak Observatory near Tucson, AZ on May 7, 2004



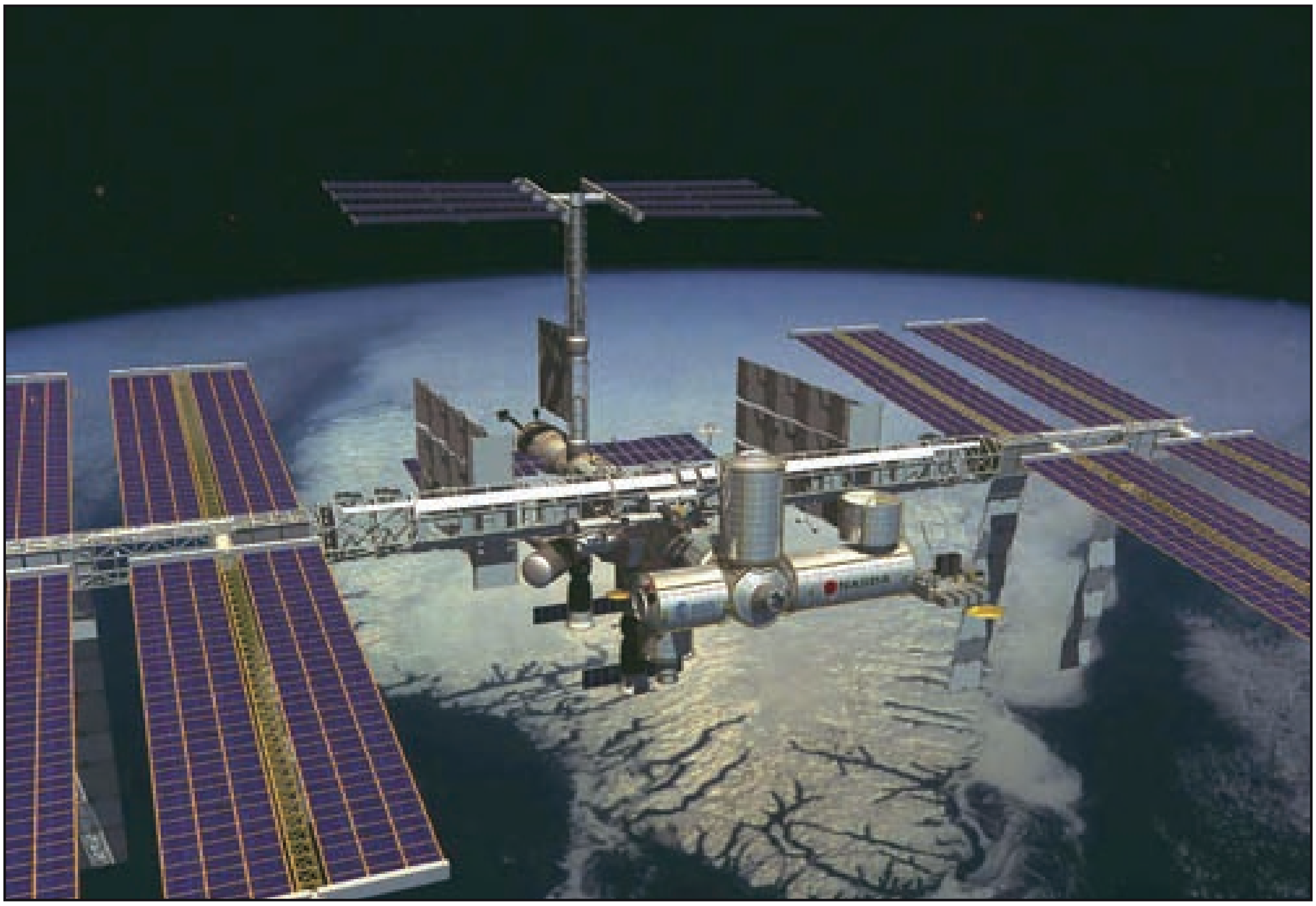

Comet Hale-Bopp, 2004 C/1995 01 Hubble Space Telescope Wide Field Planetary Camera 2

# activity six

# *Building the International Space Station*

**OBJECTIVE**

*Students will be introduced to the International Space Station as a topic of study. The secondary objective is to build a model of the ISS that will hang in a classroom, or meeting site, in the form of a mobile.*



**NATIONAL SCIENCE STANDARDS**

**Content Standard E: Science and Technology**
- Understanding about science and technology

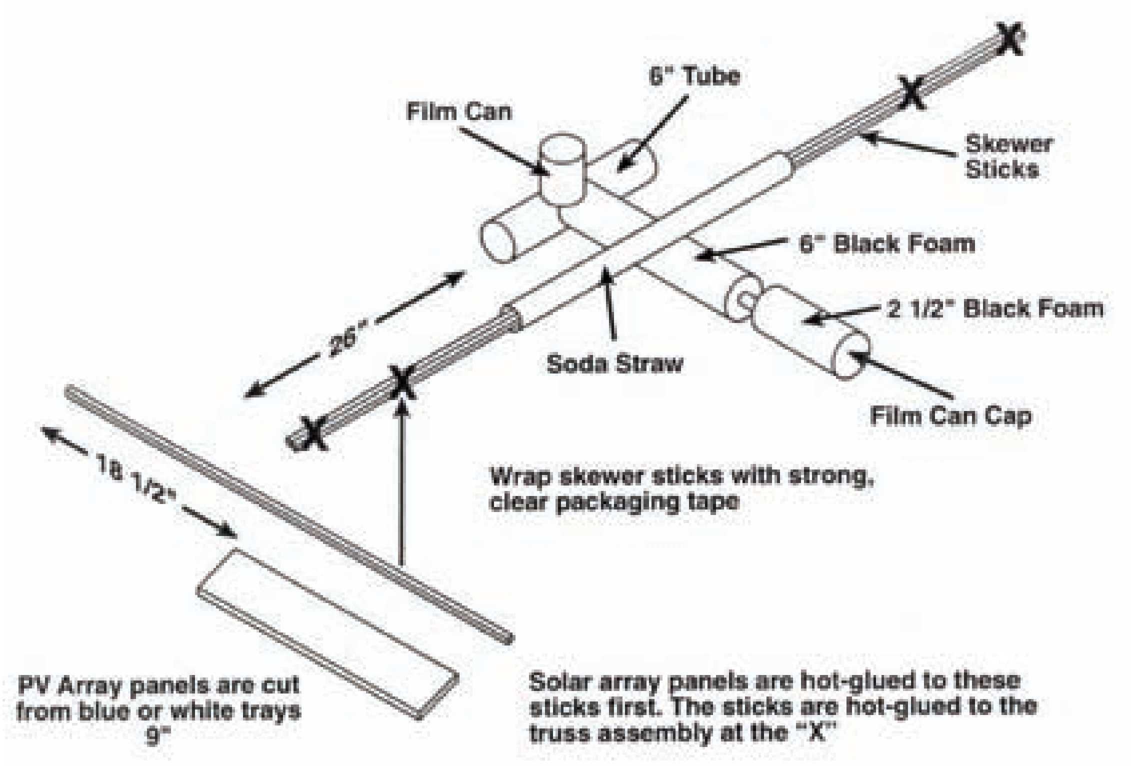
**Content Standard G: History and Nature of Science**
- Science as a human endeavor

## BACKGROUND

The first module of the International Space Station, known as Zarya, was placed in orbit on the 20th of November, 1998, by a Russian Proton Launch system. On December 3 of that year, a second module, known as Unity, was put into orbit by our Space Shuttle and the two units were joined together.

This was the culmination of a long, turbulent process of funding problems and international cooperation. Actual planning began in the 1980s; however dominance of the program by the U.S. didn't set well with many of the countries scheduled to be involved in the project. Over a period of several years, projected costs forced many of the potential partner nations to withdraw support and funding. A continuous down-sizing and arguments over its mission almost brought about cancellation of the project.

In 1993, President Clinton gave NASA the task of reorganizing and restructuring the ISS program. Using expertise and existing space hardware, the US and Russia were able to cut projected costs by nearly 40%. The U.S. was able to negotiate an agreement with Russia as a result of this new partnership—the former Soviet Union agreed to stop the sale of ballistic missile components to other countries and to maintain strict control over the export of strategic weapons technology. Another benefit was the expertise and technology gained by the Russians from their experience in long term manned flight aboard the MIR space station.




## MATERIALS

The class can build this in stages; however, it is recommended that the instructor get all of the supplies together ahead of time. These include:

1. At least a dozen long bamboo skewer sticks. These can be purchased at grocery stores.
2. One or two large soda straws are required.
3. 6-8 foam meat trays, preferably the ones that have one side "waffled." Usually, meat markets have these available. If you will shop around, waffled trays can be found in blue and that makes the PV array panels look more realistic!
4. A length of pipe foam insulation, similar to the kind used in the Goddard Rocket, will be needed to make the modules. Toilet paper or kitchen paper towel cylinders can be used for modules.
5. The tubular modules can be capped with black or gray 35mm film canister caps.
6. A roll of high-strength packaging tape will be used to hold the "station" parts together.
7. A length of nylon fish line can be used to hang the ISS from a ceiling in a classroom or CAP squadron.
8. Hot glue guns can be used to bond tubes and end caps.
9. Epoxy glue works very well to bond areas that tend to get broken easily.

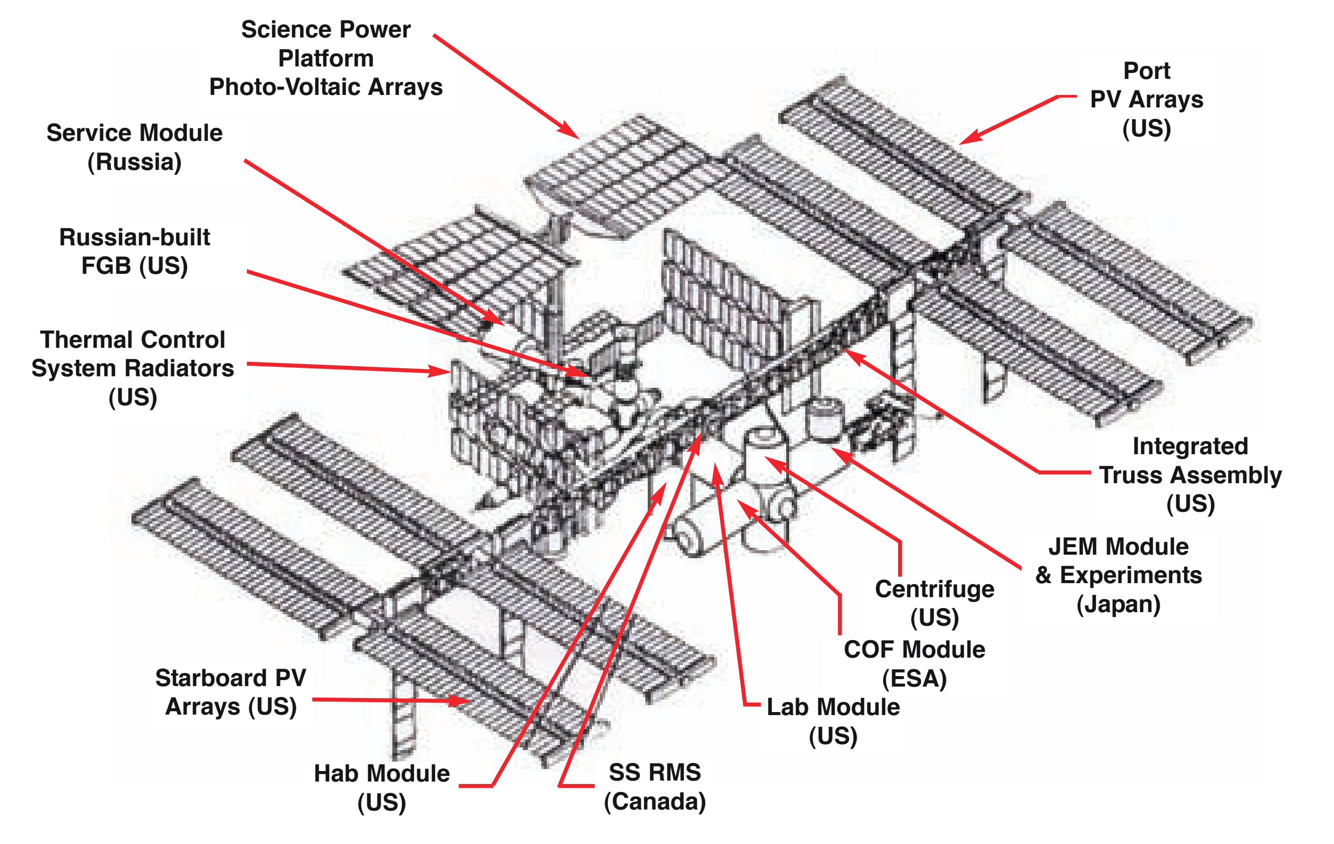
## PROCEDURE

The instructor is urged to follow this sequence of construction:

1. The bamboo skewer sticks are "stacked" together for the integrated truss assembly component shown in the "International Space Station Assembly Complete" illustration.
2. These skewer sticks (4-6) are first taped together in the center to hold them in a bundle. This is done by wrapping them with a long, single piece of packaging tape.
3. If your bundle isn't too bulky, you should be able to push a large soda straw over the bundle covering the tape. Check the illustration and you will see how it is supposed to look at this stage.
4. Using a hot glue gun, bond four skewer sticks at the positions shown on the illustration. These will be the frames for attaching the PV Array Panels.
5. Cut out at least 8 PV Array Panels from your supply of foam meat trays. These are 9 inches long and about 2 inches wide.
6. The PV Array Panels are bonded to the bamboo skewer sticks as shown in the illustration.
7. Lengths of pipe foam tubing are used to make the main modules. Use the illustration as a guide.
8. Film canister lids are used to "cap" the open foam tube "modules."
9. Using the ISS Assembly Complete illustration as a guide, students can make more modules and arrays to improve accuracy.
10. Once complete, nylon fish line can be used to hang this replica in a classroom.

**Note:** For younger children, the teacher may want to construct the mobile with the children as a small group and discuss the parts and purpose of the International Space Station as they work. As a culminating activity, students can be required to draw a future Space Station, using the knowledge they now have of what a Space Station is.

**The Completed International Space Station Will Look Like This.**



**INTERNATIONAL SPACE STATION ILLUSTRATION**

(See illustration on the left page at the bottom.)

This is the most current layout of the International Space Station. It should be noted that ISS assembly launches have been on hold awaiting the Space Shuttle's return to flight following the Columbia's tragic loss.

This is a guide to the basic construction of the ISS. It is recommended that teachers and AEOs build the Station in stages so that students can study each module as an individual lesson. Cylinders made of cardstock or those found in paper products work quite well. Foam tubing was used because it is very light and weight is a factor in how the ISS "mobile" will look when completed. (Illustration by Seth Stewart)

## Discussion

1. By using library, or Internet sources, students can study each component as it is built into the ISS.
2. This project can be expanded using clear plastic soda pop bottles. The smaller Coke® or Pepsi ® bottles can be used instead of the foam pipe insulation material. Bamboo is very strong and will support quite a bit of weight. To keep the main Integrated Truss Assembly from bending with the additional weight, it is recommended that more sticks be used.
3. Each of the larger bottles can be filled with tiny "Astronauts" and equipment so that students can see how each module is being used. The complexity depends upon the age level of students involved in the project.
4. Teachers and AEOs are urged to use the "Gallery" section of Boeing's web site to see some very dramatic images of the Space Station. This site has a tremendous amount of information about the ISS.

## Another type of Space Station Model:

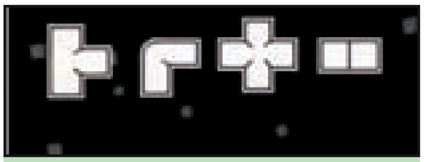
**MATERIALS**

1. PVC pipe connectors
2. 2-liter soft drink bottles
3. cardboard
4. foil
5. sharp scissors (for younger children, the teacher should do the cutting)
6. glue
7. other materials

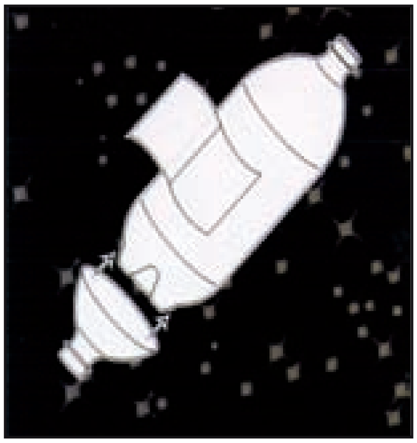
To build the International Space Station using soft drink bottles: Connect bottles with PVC joints, then cut the bottles and design the compartments. Equip your Space Station with:

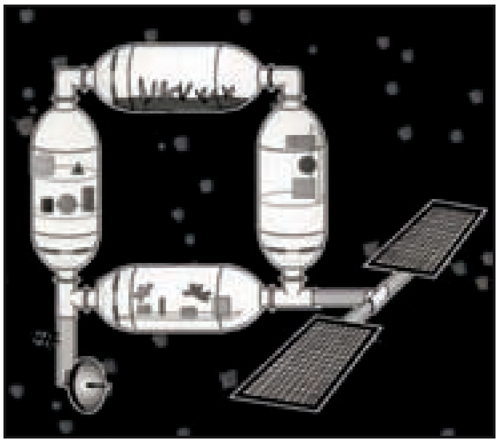
- a laboratory
- an equipment and supply storage unit
- living quarters
- and a solar array to power the Station.

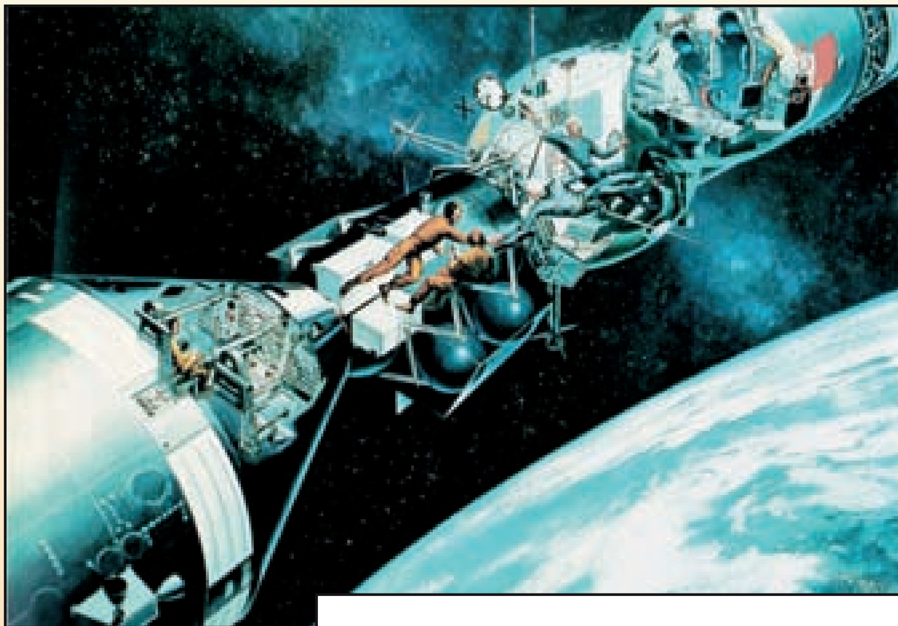
Try adding a robot arm to service all parts of the Station.



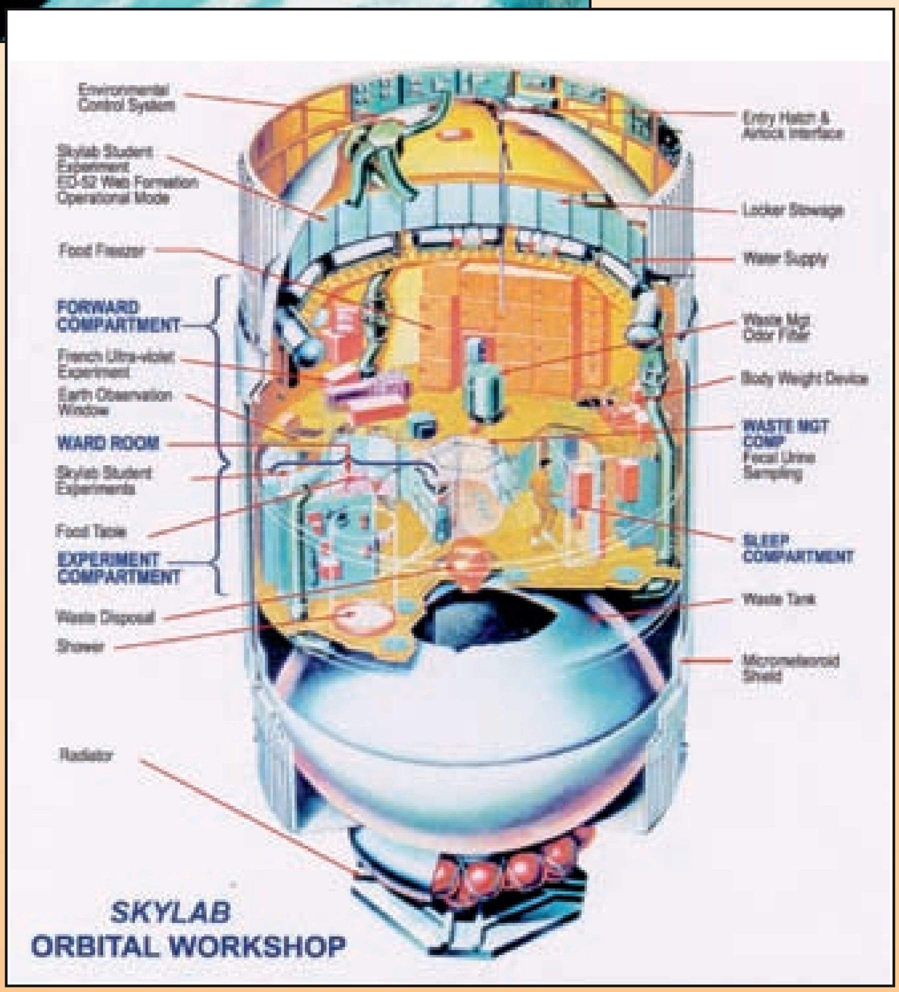
This shows the building process and just one sample of how it could look.







These drawings show the *Appollo-Soyuz at left* and *Skylab* orbital workshop below with their many compartments.



## activity seven

# *Air Rockets for Elementary Students*

**SAFE HIGH FLYERS FOR CHILDREN K-5**

**OBJECTIVE**

*Students will learn the basics of rocketry.*


**Pictured above is the RamRocket with launcher, a product of the Poof Company, manufacturers of the well-known "Slinky."**

**To the right is the Estes Compressed Air Rocket.**

## NATIONAL SCIENCE STANDARDS

**Content Standard B: Physical Science**
- Position and motion of objects

**Content Standard E: Science and Technology**
Abilities of technological design
- Unifying Concepts and Processes
- Evidence, models, and explanation

## BACKGROUND

For years, the Estes Company has provided young and old with model rockets that have a solid propellant fuel. This system requires an igniter and a source of electricity for launching. Thousands of teachers have used these model rockets as a supplement to their traditional curriculum.

On the other hand, many teachers at grades kindergarten through second, have been reluctant to let children launch model rockets simply because expense and to some extent the possibility of burns.

In the summer of 2001, Estes introduced a model rocket that was powered by compressed air. The source of air is from a pump that functions much like a traditional bicycle pump.

These little rockets work great and they go quite high. It is recommended that elementary teachers consider introducing a unit on rocketry to their students and to let each student have a "go" at launching a very exciting model.

## MATERIALS

This activity requires the purchase of an Estes GL-X2000 Air-powered Launch System. (Cost is approximately $30). The RamRocket is a product of the Poof Company (rocket and launcher is approximately $13).

### The RamRocket

The RamRocket is a toy that launches a small foam projectile by compressed air. The rocket goes about 50 feet and lands safely. The RamRocket can be used in a classroom for various applications. Rocketry can be taught in many ways. Some of the concepts include:

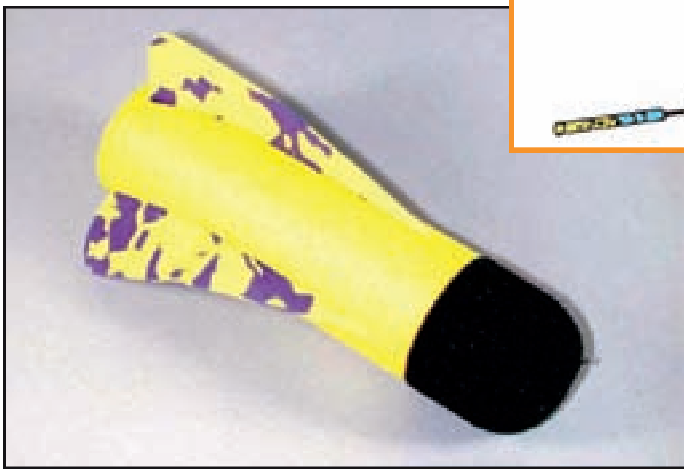
1. Newton's Laws of Motion
2. Propulsion using compressed air
3. The concept of apogee, or that point where a rocket stops flying and returns to Earth.
4. Why a projectile, like a rocket or a football, goes straighter when it spins. Upon close examination, the teacher will notice that the fins of the RamRocket are bent to cause the projectile to spin in flight.
5. Games of skill as shown in the illustrations.

## PROCEDURE

1. Use the inquiry method to hypothesize or guess what the two systems have in common and how they are different. Also, which will perform best and why?
2. For the Estes Rocket, ask students to experiment and discuss the following:
   - Compare the pressure to the height of the rocket. How do they relate to one another?
   - Discuss Newton's Third Law of Motion - For every action, there is an equal and opposite reaction.
   - How is Newton's Third Law of Motion demonstrated by the air rocket?
   - How does the air rocket work? Draw a diagram and label it.
3. For the RamRocket, ask students to experiment and discuss the following:
   - Does the distance you pull back on the RamRocket affect **how far** the rocket will fly?
   - Does the distance you pull back on the RamRocket affect the **speed** of the rocket?
   - How does the angle at which the fins are bent affect the **distance** of the RamRocket?
   - How does the angle at which the fins are bent affect the **speed** of the RamRocket?

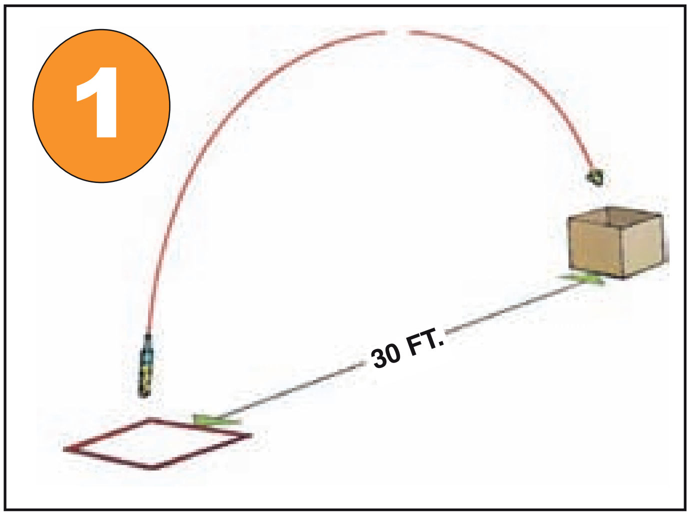
To the left is the Estes Compressed Air Rocket launching mechanism. It uses a bicycle-like pump to insert pressure. Once the desired pressure is reached, a button is pushed and the rocket launches.

**SAFETY TIP:** The person doing the launch should be a safe distance from the rocket. **NEVER** stand over the rocket when it ready to be fired.

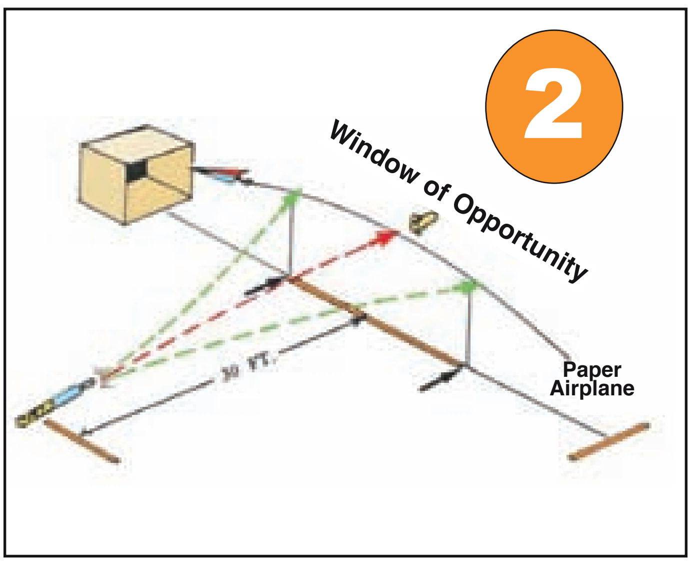


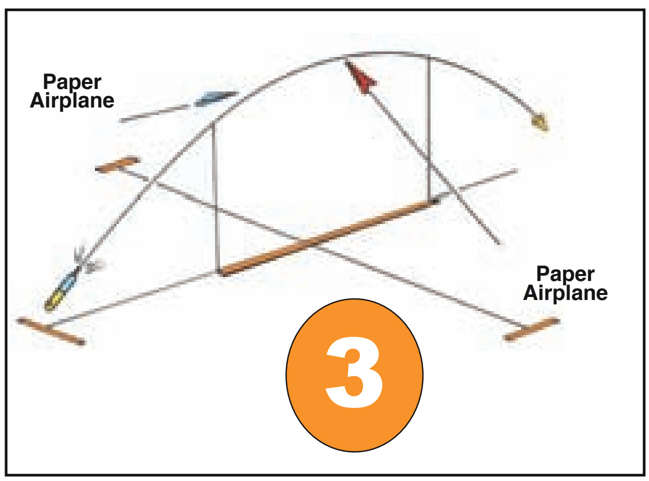

To the left is the RamRocket projectile. As you can see, it is all soft foam and quite safe for classroom use. Note the curvature of the fins—this makes it spin in flight.

**To the left and below are illustrations for the games of skill for the RamRocket.**




1. Using the RamRocket as a surface-to-air missile (SAM), you can set up targets, as in illustration 1 to the left, to test your accuracy.
2. The degree of difficulty is harder in illustration 2 when paper airplanes are shot at a target (box) and the missile is launched attempting to hit the plane on it's way to the target.
3. To add a little more difficulty and interest, see illustration 3. Two paper airplanes are launched crossing the same path trying to reach their target without getting hit by the SAM.



# activity eight

# *Staying in Shape —in Space*

**OBJECTIVE**

*To emphasize the importance of exercising when humans are exposed to long periods of weightlessness in space.*

Paris learns how to exercise in space using a rubber band (bicycle tube) and a piece of PVC tubing.

## NATIONAL SCIENCE STANDARDS

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

**Content Standard F: Science in Personal and Social Perspectives**
- Personal health

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

## BACKGROUND

Here on planet Earth, our muscles and bones work as a unit against the forces of gravity. This "bone-muscle" effort keeps us balanced and able to do work. In space, on the other hand, muscles are not used to any degree and as a result, will atrophy after a short period of time. Bones decrease in diameter and become less dense. Muscles also become smaller and weaker. The actual muscle changes due to the nature of their use in space. As a result, astronauts not only have to exercise their muscles, they must also stretch them to maintain length and density. If astronauts don't maintain a strict regimen of exercise, they will, upon return to planet Earth, find that they are unable to function as before.

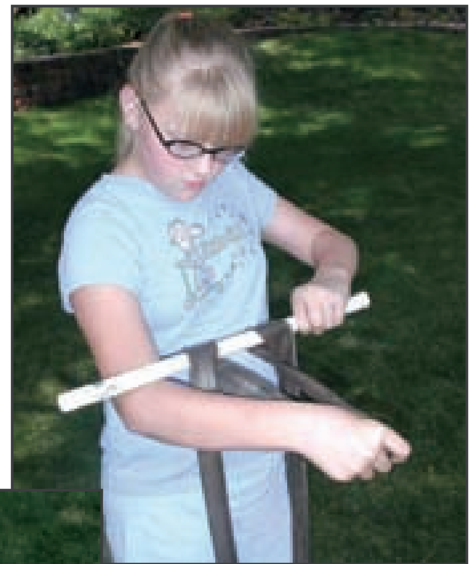
Similar situations exist when bedridden patients are not able to move about for long periods of time.

**This Russian Cosmonaut is exercising to keep his bones and muscles from losing strength for his return to Earth's gravity.** (Photo Courtesy of NASA)

## MATERIALS

1. A set of elastic exercise bands
2. A bicycle tube
3. A broom handle stick about 24 inches long. This may also be substituted with a piece of PVC pipe tubing.

## PROCEDURE



1. The bicycle tube is slipped around the broom handle stick to make a slip knot.
2. This can be used by having the student step through the loop and exercising by pulling the stick toward the chest. The bands can be used in several ways to exercise the upper and lower body.
3. There are numerous exercises that can be done "on orbit" with a device such as this. Essentially what the astronaut is doing is using one set of muscles against another. In this case, the straightened legs are providing the base for the band and the arm muscles are pulling away from the feet. This exercise can be done in complete microgravity.

**Paris is doing the same exercise as the astronaut pictured on the right.** (Photo Courtesy of NASA)

## EXTRA

Students can design an exercise that astronauts could do in orbit. This exercise must help strengthen muscles in microgravity. (Show students how to take their pulse). Why would this exercise work?

### Staying in Shape - In Space

Name:________________________________________

Create an exercise that astronauts could do in space. Compare male and female results of your exercise by filling in the following chart:

| Time Chart | Resting heart rate | Heart rate after 30 sec. | Heart rate after 1 min. | Heart rate after 10 reps. | Heart rate after 20 reps. |
|---|---|---|---|---|---|
| Female | | | | | |
| Male | | | | | |

# activity nine

# *"Puffy Head, Bird Legs"*

**_Human Physiology in Space_**

**OBJECTIVE**

*This activity will make students aware that the human body will experience changes in space flight.*

Astronauts experience a cold-like sinus and nasal stuffiness and a rounder, fuller face called "Moon face" when the barrier that normally prevents fluids from passing from blood vessels into surrounding tissues on Earth becomes ineffective in microgravity.

**CREDIT** - Human Physiology in Space (pp 63-66) by R. J. White & B.F. Lujan, NASA Life and Biomedical Science and Applications Division, 1994. Online at http://www.nsbri.org/HumanPhysSpace/

Ms. Lauren Allwein, aerospace teacher at the Nationally-acclaimed Euclid Middle School, Littleton, Colorado attended an extensive summer course put on by the Baylor University College of Medicine. This course is known as "From Outerspace to Innerspace" and has the theme, "What can we learn in space about bodies here on Earth?" This outstanding program is highly recommended by the Civil Air Patrol's Aerospace Education Division. For more information about the National Space Biomedical Research Institute K-8 education programs, please contact the Center for Education Outreach Baylor College of Medicine, Houston, Texas. 800-798-8244 or visit the NSBRI Web site at www.nsbri.org.

## NATIONAL SCIENCE STANDARDS

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

**Content Standard C: Life Science**
- Organisms and environment

**Content Standard F: Science in Personal and Social Perspectives**
- Personal Health

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

## MATERIALS

1. A piece of tape (like masking)
2. Soft tape measure (found at a fabric store)
3. Pencil and chart for recording measurements
4. Stop watch

## BACKGROUND

All astronauts and cosmonauts experience a phenomenon known as the "Puffy-Head, Bird Legs." When in a condition of microgravity, astronauts report a feeling of "stuffiness" especially in the sinuses, and a "fullness" in the head. There is also a puffiness of the face that can be easily measured. Where aerospace medical specialists measure various parts of the body, such as face and legs, it clearly shows that changes occur in the shape of the legs. Astronauts call this condition "bird legs."

Measurements taken of the leg circumference during space flight on astronauts with larger legs show a proportionally larger decrease in leg volume than those with smaller legs. This is explained by the fact that the more muscle a person has in his/her limbs, the more fluid and blood flow is required to nourish those muscles. The more fluid and blood there is, the more there is to lose. It has shown that a fluid shift actually begins during the launch sequence. This is due to the astronaut having been seated in the space shuttle in a reclining position with his/her leg elevated, sometimes for several hours prior to launch.

## PROCEDURE

1. In this activity, the students will break out into teams of three. Two will be the aeromedical scientists and the other will be the astronaut.
2. A piece of tape (like masking) and a soft tape measure (found at fabric stores) will be used to make the measurements.
3. Data will be collected from measurements of the astronaut standing and reclining. It might be pointed out that during the early portions of the head-down orientation, a student's stroke volume increases from about 75 ml/beat to about 90 ml/beat. This is entirely expected because there is a rush of fluids to the upper part of the body and the heart then has more blood to force out during each beat. In addition, to compensate for this increase in stroke volume (to keep cardiac output relatively stable), the subject's heart rate decreases. Therefore, during the portion of this student investigation where you are determining cardiac output, don't be surprised when you obtain lower values for the subject's heart rate. This is normal.

***1. Students are given a full briefing before beginning the activity. If they know the importance of the data gathered, they will tend to take it more seriously.***

***2. Student Joe Winne has volunteered to become the astronaut. Teacher Lauren Allwein places a piece of masking tape on his forehead and this will become the point where measurements are taken. This tape is left is position throughout the experiment.***

***3. A similar piece of tape is placed on the subject's calf muscle. This will be the point where another source of data is gathered.***

***4. Chelsea Frommer and Rachel Winne carefully measure Joe's forehead in a standing position. It is important to get accurate circumference measurements from the test subject's leg and forehead in millimeters. Have the person (s) doing the measuring be accurate and record the data on a data table. Be neat and make sure that numbers are accurate.***

The next step is to get an accurate standing pulse rate. The scientists at the Baylor College of Medicine say, "…To get the test subject's STANDING pulse, have the test subject stand up for 3 minutes, then sit down and the 'pulse taker' should take the test subject's pulse for 15 seconds. Multiply this pulse rate times 4 to get the standing pulse rate. Record this pulse on the data table in the 'standing pulse rate' box."

The astronaut is allowed to lie down with his feet propped up on a chair. After several minutes, the pulse is taken again in this position. Instructions say, "…Obtain a LYING FLAT pulse rate for the test subject by having the test subject lie flat on the floor for three minutes. Take his pulse for 15 seconds. Multiply this number times 4. Record this pulse rate on the data sheet as the lying-flat pulse rate."

Using a method similar to that used on the forehead, Joe's calf muscle is measured in the standing position.

**The important "Lying Down" Phase is conducted in several parts:**

(1) To begin, the test subject should lie on the floor with his feet or legs elevated on the seat of a desk. A timer should being timing for 5 minutes now. You should record the starting time here.

(2a) After 5 minutes have passed, while the test subject is still lying down, re-measure the calf and forehead in millimeters on the tape in exactly the same spot. Be accurate. Record this measurement in the "after 5 minutes-head down-feet up" calf and forehead boxes.

(2b)While the test subject is still lying down, observe his facial characteristics and record these on the data sheet in the "facial observations after 5 minutes."

(2c) While the test subject is still lying down, question him about his own feelings or sensations. Record these sensations under "test subject's sensations after 5 minutes" box on the data sheet.

(2d)Again, while the test subject is still lying down, take his PULSE FOR 15 SECONDS. Multiply this pulse by 4 and record it on the data sheet under "pulse rate after 5 minutes."

***5. Standing pulse rate taken***

***6. Pulse rate taken lying down***

(3) After another 5 minutes have passed, while the subject is still lying down, repeat the same procedure and record in the "After 10 minutes" boxes.

(4) Repeat the same procedure and record in the "After 15 minutes boxes" and finally repeat and record in the "After 20 minutes" boxes.

(5) After recording data at the 20 minute time, the test subject should sit up and reorient themselves slowly.

*7. All of the measurements are recorded and a conclusion is made regarding fluid shifts in the body during standing and reclining positions.*

***NOTE:* Even though the pictures show middle school students doing this activity, younger students can also perform this experiment with a little more guidance. Here is a sample chart that will help them record their observations:**

## Puffy Head, Bird Legs Data Chart
## (Teacher can time all groups)

**Name** ______________________________________________

**Standing position**

Forehead measurement= __________ cm
Calf muscle measurement = _________cm
Pulse rate = _____________

**Lying flat**

Pulse rate = ____________
Calf muscle measurement = _____________cm

**After 5 minutes with head down and feet up**

Calf measurement = ______________cm
Forehead measurement = _____________cm
Facial observations = ____________________________________
Sensations = __________________________________________
Pulse rate = _____________________

**After 10 minutes with head down and feet up**

Calf measurement = ______________cm
Forehead measurement = _____________cm
Facial observations = ____________________________________
Sensations = __________________________________________
Pulse rate = _____________________

**After 15 minutes with head down and feet up**

Calf measurement = ______________cm
Forehead measurement = _____________cm
Facial observations = ____________________________________
Sensations = __________________________________________
Pulse rate = _____________________



85684 Civil Air Patrol.indd 44 7/12/12 9:55 AM

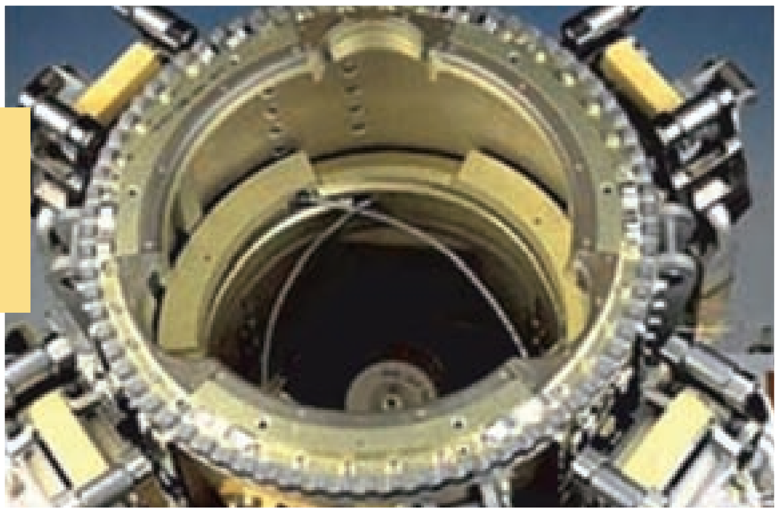
## activity ten

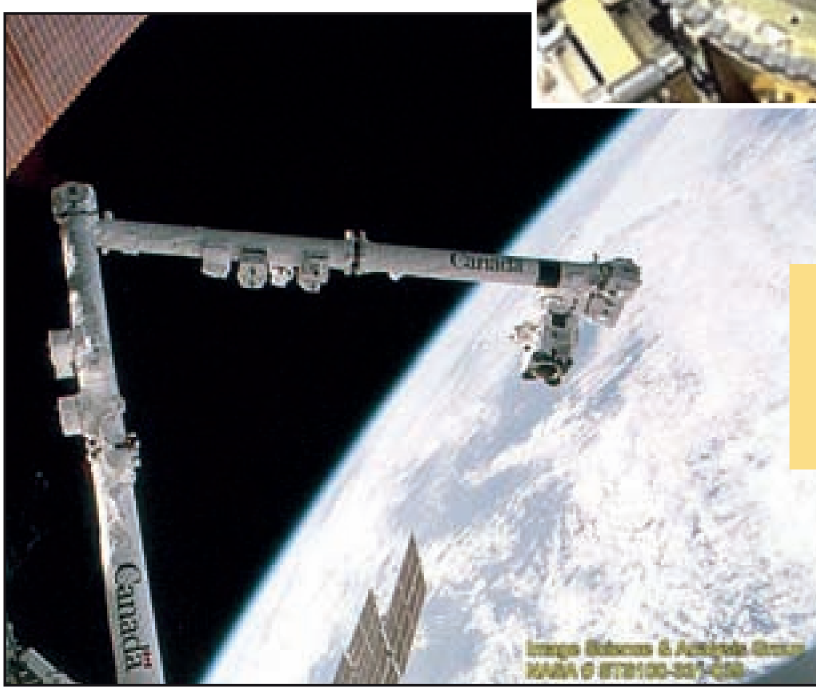
# An Introduction to Robotics

**OBJECTIVE**

*Students will learn how a device, called the "Effector" can be used to pick up and move items much like the Space Shuttle's Robotic Arm. Students will also learn about how to work as a team to create and use a robotic hand.*

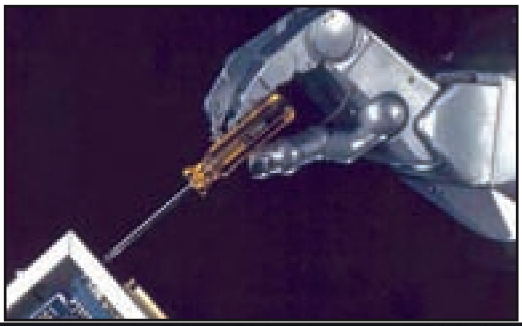
**The Latching End-Effector**

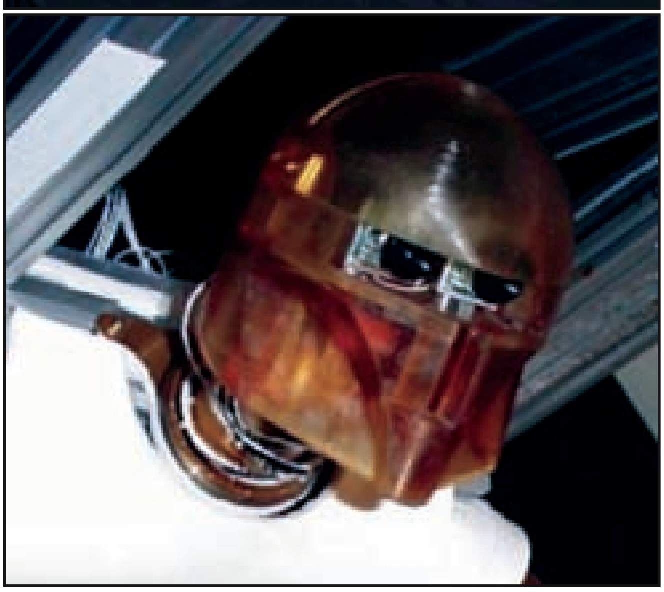





**Shuttle With Canadian Robotic Arm**

# Robotics Activity One
## *End Effector*



### NATIONAL SCIENCE STANDARDS

**Content Standard E: Science and Technology**
- Abilities of technological design

**Unifying Concepts and Processes**
- Evidence, models, and explanation

### BACKGROUND

The word robot comes from the Czech word robota that means forced or repetitive labor. Czech playwright Karel Capek coined the term for his 1920 play R.U.R. (Rossum's Universal Robots). In the play, the human-like robots take over the world.

Today's robots usually look very different from humans. They are found in manufacturing, research, medical treatment, entertainment, and space. NASA uses robots to explore Earth and the other planets and to manipulate payloads on the Space Shuttle and the International Space Station.

The definition of what a robot is varies with the source referenced. Generally, robots are machines that operate by computer controls. On Earth, robots are often used for dangerous, dirty, or dull jobs. Examples include painting and welding robots in automotive assembly lines and robots used to dismantle old nuclear power plants. In NASA-sponsored experiments, walking robots were used to explore active volcanoes in Alaska and the Antarctic.

One of the most important objectives in the development of robots is to enable robots to interact with their environment. Interaction is often accomplished with some sort of arm and gripping device or end effectors. This type of robotic activity was used aboard the Mars Rovers, Spirit and Opportunity.

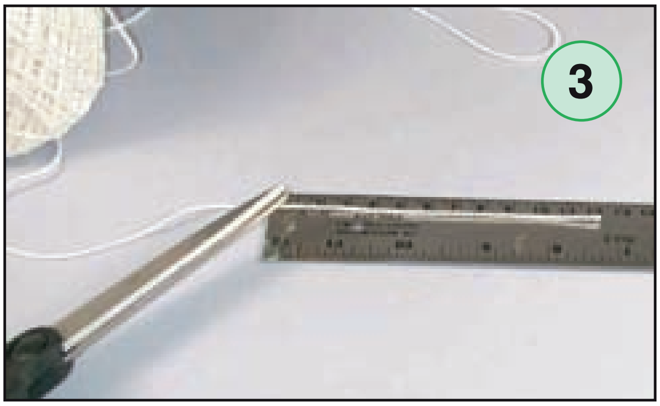
## MATERIALS

1. Two Styrofoam® coffee cups
2. Three pieces of string
3. Scotch or similar household tape
4. One serrated plastic picnic knife


*These are the only materials you need to make an end effector.*


**PROCEDURE:**

*Two coffee cups are held together and a plastic knife is used to cut both in a line as shown in this photo.*



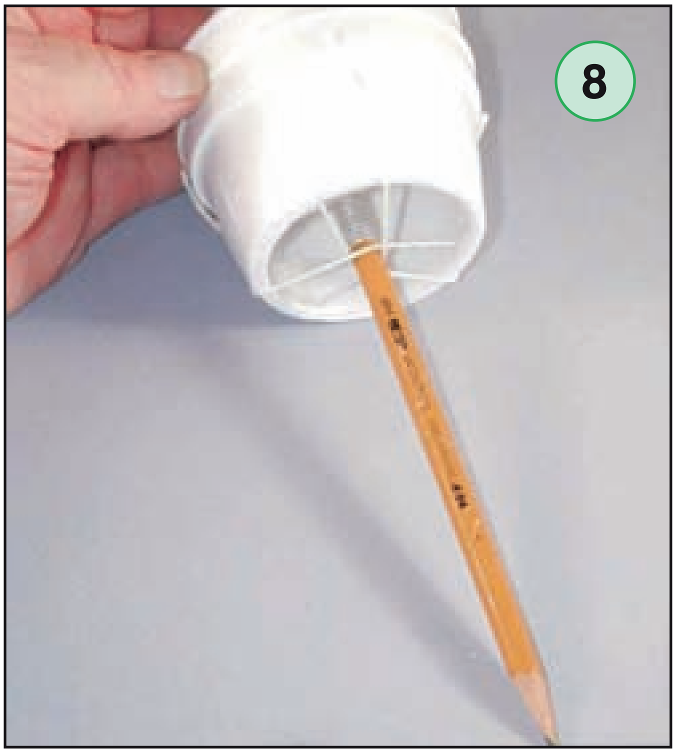

*Next, three pieces of string are cut to a length of 12 cm.*


*The string pieces are taped first on the inside just below the cut edge. The other end of the string is positioned outside but the tape is not pressed down.*


*While holding the rim of the inner cup, rotate the outer cup until the three strings cross each other. The strings will have some slack. Pull the end of the strings on the outside until they are straight and intersect in the middle. Now press the tape on the outside to hold the strings.*



***You have now created an "Effector" and it will pick up a small object like a pencil. Have someone hold the pencil upright. Open the end effector so that the strings are not crossing each other. Slip the end effector over the pencil so that it extends down the center and not through any of the loops. Rotate the outer cup until the strings grasp the pencil. You should now be able to pick up the pencil.***

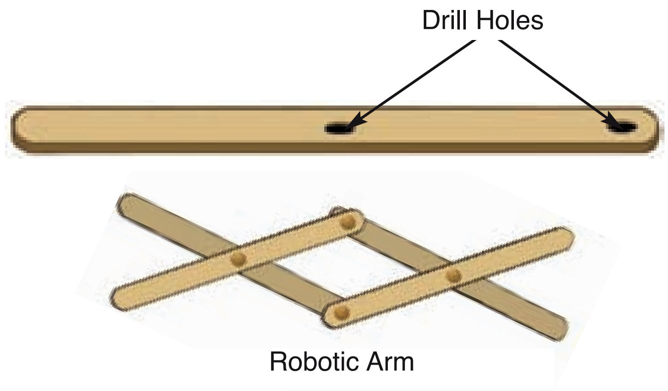


# Robotics Activity Two
## *Robotic Arm*

(A NASAexplores activity)

**MATERIALS**

- Wooden craft sticks
- Drill
- Small brass paper fasteners
- Assorted small materials (such as erasers, packing peanuts, etc.




**Procedure:**

1. Discuss robots and the students' current knowledge of what a robot is and what it does.
2. Define "end effector" by referring to the previous activity.
3. Pre-drill holes through the craft sticks as shown in the diagram to the right.
4. Each student will need four drilled sticks and four brass paper fasteners.
5. Assemble robotic arms as shown in the illustration to the right.
6. Try to pick up a pencil or some other object with the arm.
7. Next, design some sort of end effector for the end of the arm that will enable you to pick up different objects. (A suggestion would be to break a craft stick in half and glue each piece to one of the ends facing inward).
8. Attach the effector to the ends of the arm with glue.
9. Write a paragraph evaluating your design by picking up different objects.
10. Would the arm and effector have to be modified to pick up sediment and pebbles on Mars?

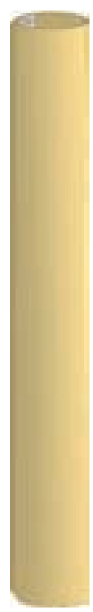
***A student from Head Elementary School, Montgomery, AL, demonstrates the procedure. Left, the robotic arm is put together with brass paper fasteners. Right, the effector is attached to the ends of the arm with glue.***

# Robotics Activity Three
## *Robotic Fingers*

In this activity, students will individually construct a single robot finger that resembles a finger on a human hand. Working in teams, robot fingers will then be combined together to pick up objects (such as marshmallows or styrofoam balls).

### MATERIALS

- Stiff paper (60 pound card stock) preprinted with pattern (see pattern)
- Cellophane tape
- String
- Paper punch (one-hole)
- Scissors
- Marshmallows or other light weight objects to pick up



***1.*** *Roll paper into a tube so that the left edge is next to the line.*

***2.*** *Tape the tube together where the edge meets the line.*

***3.*** *Punch out a hole with the hole punch.*

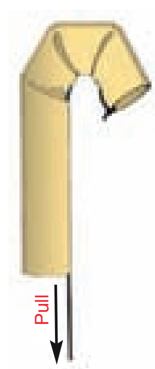
***4.*** *Cut out the three diamond shapes through all layers of the tube.*

### PROCEDURE

1. Using the pattern on the next page, roll the paper into a tube. Use the guide line on the paper to determine the diameter of the tube. When rolled, the three diamonds and the small circle should be on the outside.
2. Tape the tube together along the entire seam.
3. Pinch the tube slightly and cut out the diamond shapes through all layers of the tube.
4. Punch a hole through the tube where the circle is located.
5. Tie a string to the tube through the punched hole. Drop the other end of the string through the tube to the other end.
6. Pre-bend each finger joint (diamond cutouts).
7. While holding the bottom of the tube in one hand, pull the string with the other to cause the finger to bend. When you release the string, the fingers will straighten out again.

### To Create the Robotic Hand

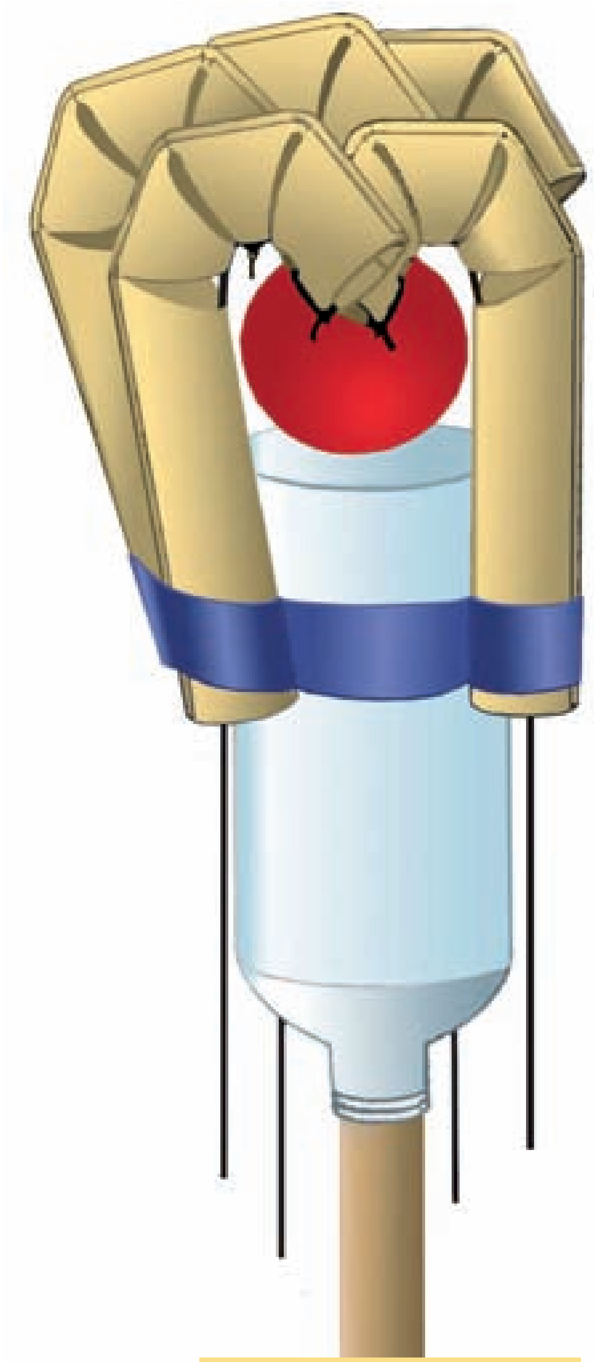
1. Create the five-finger hand by taping five fingers around a plastic 1 liter water or soda bottle.
2. A dowel fitted into the bottle opening can be used for a robot arm. Tape the dowel to the bottle opening.
3. **Note**: Tie loops at the free end of the strings and insert fingertips into the loops to control the motion of the fingers like a regular hand.
4. Have teams test their hand when completed and compete to see which team can pick up the most marshmallows from a plate and put into a bowl in a given amount of time.



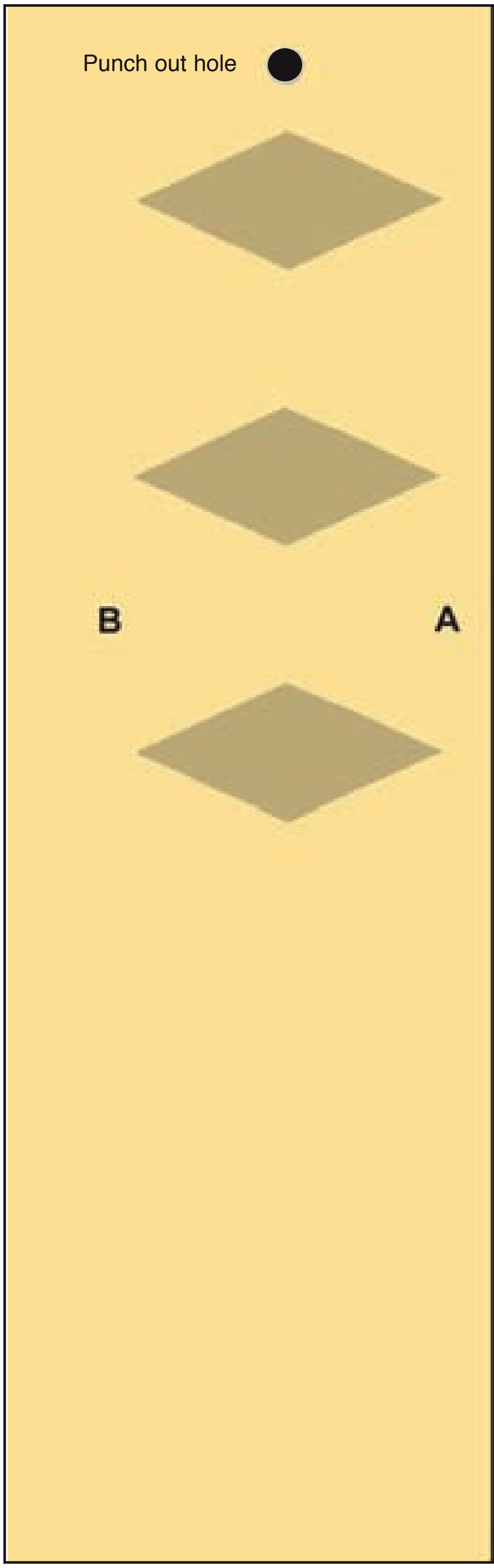

***5.*** *Tie a string through the hole and run the string down through the finger.*

*6. Pull on the string to bend the finger.*

*The children pictured here are from Head Elementary School in Montgomery, Alabama.*



*Teams build completed robotic hand as seen here.*




Enlarge this pattern to 8.5”X11”. Print on 60 pound (or heavier) card stock. Use the whole sheet of paper to roll the tube for the robotic finger. The diamonds should be on the outside and the letters A and B next to each other. Tape the tube together from top to bottom along the line.

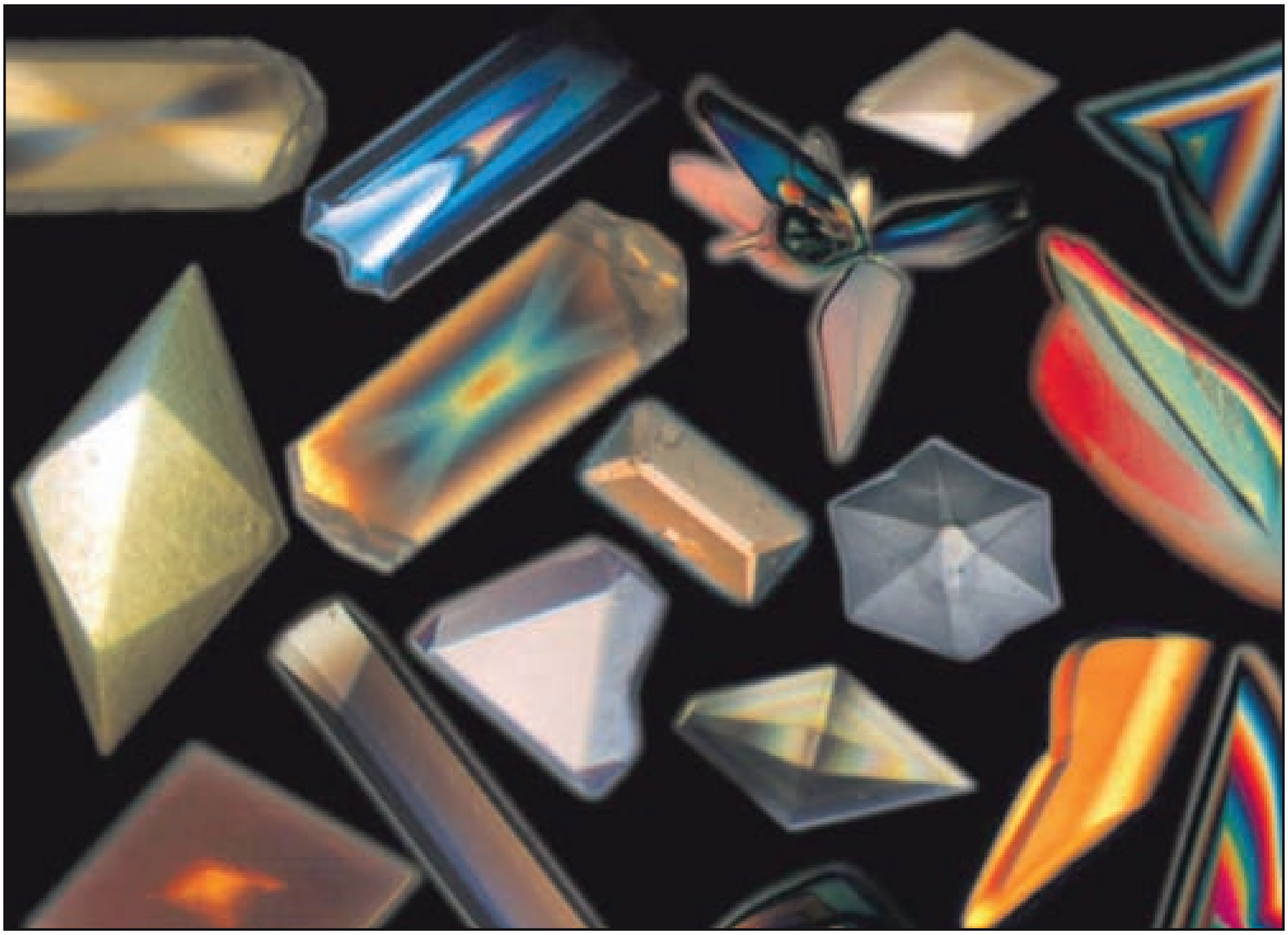
# activity eleven

## *Sweet Crystals*

***(This activity is courtesy of NASAexplores.com)***

**OBJECTIVE**

*Students will grow crystals and relate this activity to growing of protein crystals in space.*



**BACKGROUND**

One of the most widely used methods of studying protein structures is protein crystallography. Proteins can be made to crystallize in much the same way sugar crystals can be formed from sugar water to make rock candy. Scientists then use X-rays to determine the three-dimensional molecular structures of proteins.

Crystals of all kinds exhibit regular patterns in their shapes. A small version of a crystal has the same shape as a large crystal of the same substance. Until they run out of space or materials to continue growing, crystals retain a constant shape.

## NATIONAL SCIENCE STANDARDS

**Content Standard B: Physical Science**
- Properties of objects and materials

## MATERIALS

1. Heat-safe class measuring cup
2. String
3. Spoons
4. Pencils
5. Sugar
6. Boiling Water
7. Student recording sheets

## PROCEDURE

1. Discuss benefits of growing crystals on the International Space Station.
2. Distribute the Student Recording Sheets. Ask students to label the first box with today's date.
3. Remind students to stay in their seats as you complete this experiment (due to the fact that a heat source will be used).
4. Pour boiling water into the cup.
5. Add the sugar, and stir the mixture. Keep adding sugar until it no longer dissolves.
6. Tie the string to the pencil, and put it in the cup so that the string dangles in the water.
7. Ask students to draw a picture of the beginning of the experiment.
8. Put the cup in a place where it will not be disturbed. Crystals will not form properly if the mixture is moved!
9. After 4 days, display the cup to the students. Discuss what has happened. Ask students to label the date and draw a picture of what has happened in the cup.

**Answer the following questions with your students:**
1. What happened to the water? (It evaporated).
2. What is left? (Sugar crystals).

**EXTRA:**

If you can locate some mini-microscopes (30x magnification), allow students to look at the sugar crystals and draw what they see. Mini-microscopes can be found at Radio Shack for about $10.

### Student Sheet for Sweet Crystals

Name ______________________________________________

| Beginning Date: ______________________ | Ending Date: ______________________ |
|---|---|
| | |

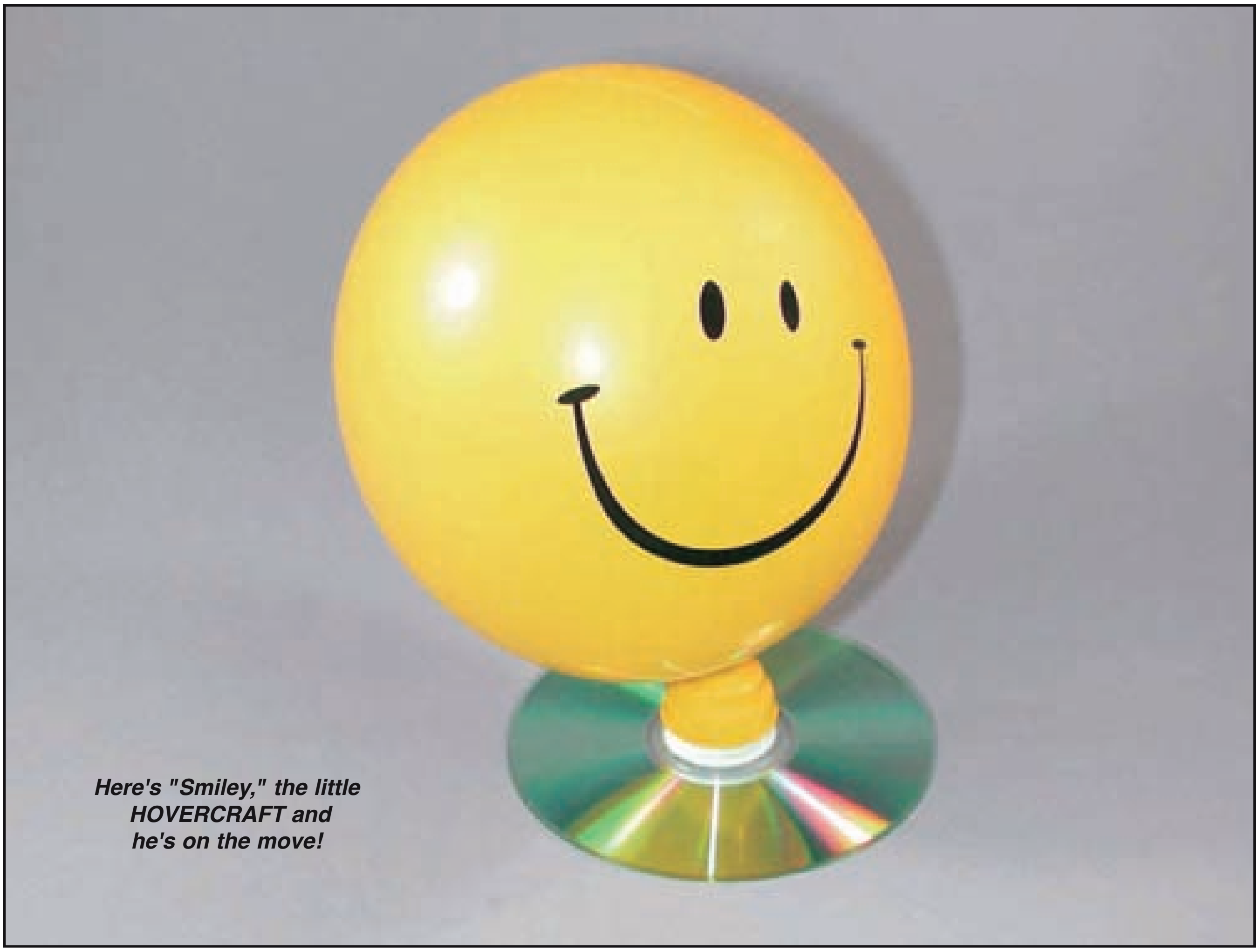
# activity twelve

# CD Hovercraft

***(This activity is courtesy of NASAexplores.com)***

## OBJECTIVE

*The purpose of this activity is to build a simple hovercraft from inexpensive, everyday supplies.*



***Here's "Smiley," the little HOVERCRAFT and he's on the move!***

## BACKGROUND

A hovercraft is also known as an ACV or "air cushion vehicle." It travels on a layer of compressed air that keeps it just above the surface of the Earth. The compressed air serves as an invisible cushion that eliminates almost all of the friction between the vehicle and the ground.  Numerous hovercraft are used around the world for civilian and military purposes.

## NATIONAL SCIENCE STANDARDS

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

**Content Standard B: Physical Science**
- Position and motion of objects

**Content Standard E: Science and Technology**
- Abilities of technological design

**Unifying Concepts and Processes**
- Evidence, models, and explanation

**CREDIT**

*This wonderful activity was taken from the "Energy and Control - Energy From Wind and Water" by the Quinte School Group, WOW Science Initiative- May 2001.*

*Related web sites:*
*http://www.jameshovercraft.co.uk/Frames/index.htm*
*http://www.hoverclubofamerica.org/*

## MATERIALS

1. A toy balloon
2. A pop-up lid from a water bottle
3. A hot glue gun
4. A used CD

## PROCEDURE

1. The pop-up lid is hot-glued to the CD. Be sure that your glue is applied only to the perimeter of the lid and that you make a good air-tight seal to the CD.
2. Make sure the lid is in the closed position.
3. Install the balloon onto the bottle lid.
4. Inflate the balloon from the opposite side after opening the sliding lid seal; once full, seal.
5. Try sliding the balloon along and you will notice a resistance to movement.
6. Now carefully release the lid sealer and let the air flow through the CD. You will notice the little hovercraft starts to move.
7. Blow the balloon up again and when the pressure is released, flick it with your finger and you will be amazed to see it glide away.
8. Variations on this project include a larger balloon and various surfaces.
9. Fun Stuff!

**Extra science information**

A hovercraft works by being propelled forward by the downward thrust of air being propelled backwards through special vents or by propellers mounted on top of the craft. The craft is steered by rudders that direct the back thrust or by propellers that produce a sideways thrust.

A hovercraft is a vehicle supported on a cushion of air supplied by a powered fan mounted on the craft. A hovercraft minimizes friction and drag. The hovercraft was one of the most successful inventions of the 20th century. British engineer, Christopher Cockerell's experiments with coffee cans, kitchen scales, and a hairdryer in the early 50's led to the first manned Hovercraft 'flight' in 1959.

## HOVERCRAFT EXPERIMENTS

Record the results of changes and ideas you have about your hovercraft.
Samples:

| Experiment # | Temperature of Air in Balloon | Size of Balloon | Type of Balloon | Type of Surface |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |

## *activity thirteen*

# *Sound Waves and How They Travel*

**OBJECTIVE**

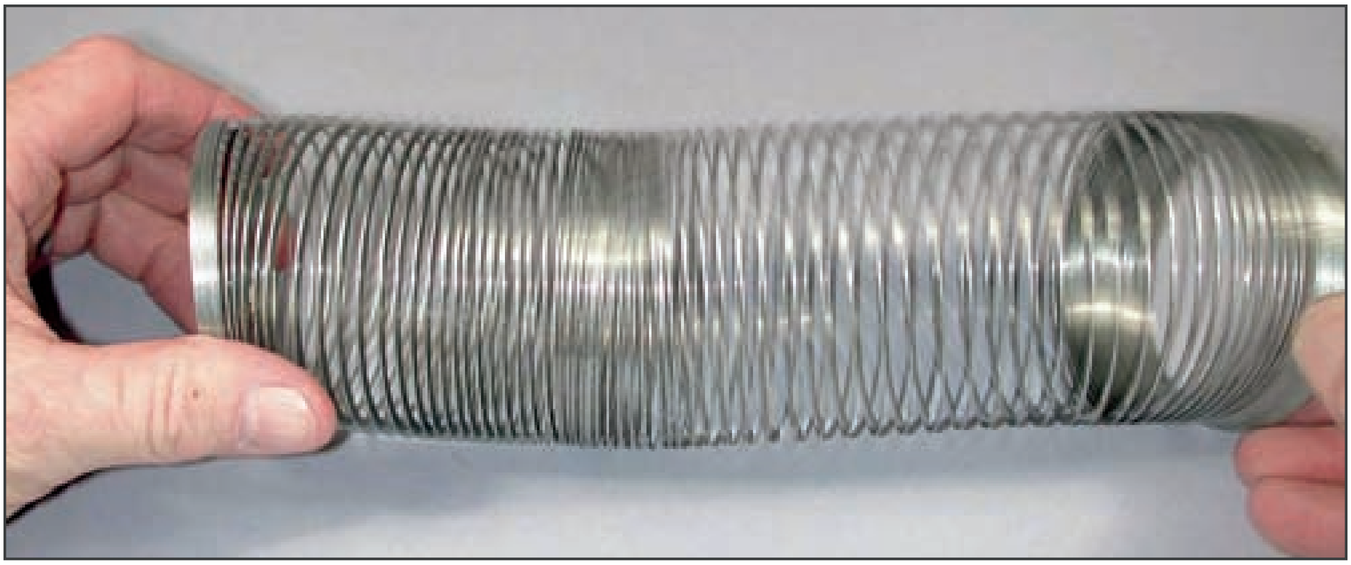
*The object is to give students a visual image of how sound waves travel.*


***The original Slinky® has been around for years and, and not only are they fun, they're an excellent learning tool.***

## NATIONAL SCIENCE STANDARDS

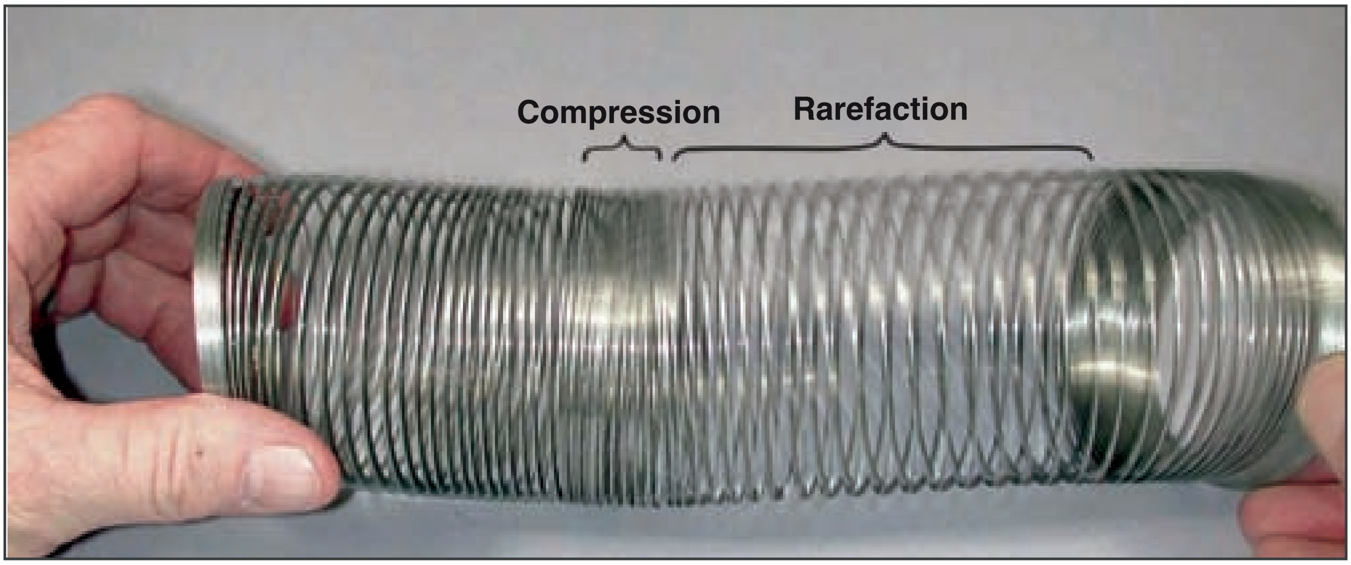
**Content Standard A: Science as Inquiry**
- Abilities necessary to do scientific inquiry

**Unifying Concepts and Processes**
- Evidence, models, and explanation



## BACKGROUND

In science classes everywhere, teachers try to explain how sound travels, but students don't often see how it all works. They seem to have difficulty visualizing the series of compressions and rarefactions that occur as the sound moves away from its source. It is also difficult for students to see these compressions and rarefactions traveling at a rate of 1100 feet per second. The speed of sound, at sea level, on a standard day, is close to 761 miles per hour (1100 fps) and it changes with temperature and altitude. Using one of the famous Slinky® toys, a teacher can make an outstanding visual demonstration of how sound travels and once they see it, students are awestruck!




To demonstrate how sound travels, hold the Slinky in two hands. With either the left or right, "snap-it" and you will see a compression followed by a rarefaction. To really get a good visual image, have another person hold the other end of the Slinky at least two or three feet away. The compressions and rarefactions will follow each other until all of the energy is expended. Cool!

## Hanger Noise Activity

Children can learn how sound is made and how it travels in different states of matter - solid and gas.

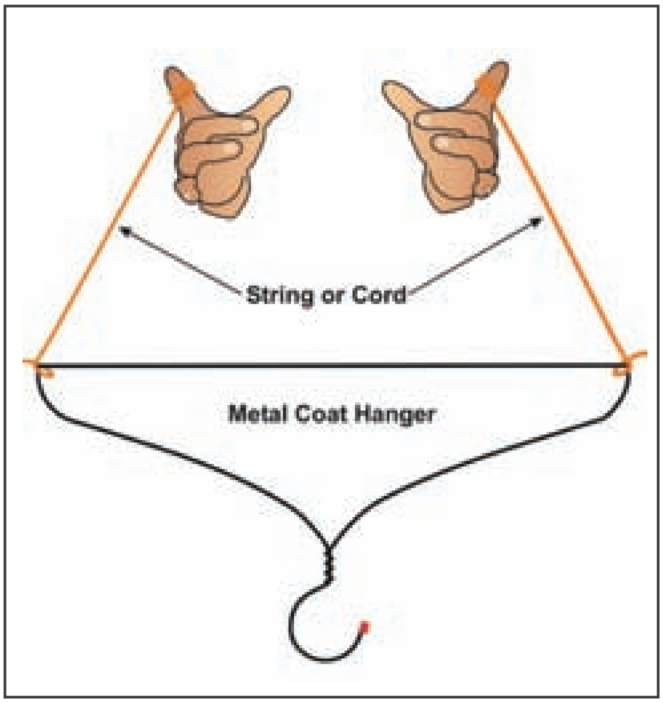
**MATERIALS**

1. Metal coat hanger
2. 2 pieces of heavy string 60cm long

### PROCEDURE

1. Take a metal coat hanger and tie a piece of yarn to each side so that the curved hook hangs down.
2. Wrap the yarn around the index finger of each hand and let the hanger swing back and forth and hit against a desk or table.
3. Next, put the fingers that the yarn is wrapped around in your ears and hit the hanger against a desk or table again. How is the sound different? What causes it to be different?

***Explanation:*** Because sound travels faster in solids than in gases (such as air), the sound is faster and louder when you put your fingers in your ears. The more rigid a substance, the faster sound travels through it. The sound traveling through the string is much louder because most of the wave energy is directed through the string only, and not dissipated in surrounding air.



## activity fourteen

# Bernoulli Activities—Wing on a stick

**OBJECTIVE**

*This time, we're going to make an airfoil (wing) that actually flies with the power of a hair dryer. It's simple, fun and it can be an activity that fits in a 30 minute class room or CAP squadron meeting.*

## MATERIALS

- A quality piece of paper such as card stock works very well for the airfoil.
- A sturdy soda straw will be needed.
- You'll need household tape such as Scotch brand by 3M.
- There are several ways you can go about getting the airfoil to "fly." You can use a piece of piano wire, welding rod, fish line or string as its "Vertical Axis." This is the piece it slides up and down upon.
- A source of air flow will be needed such as a fan or a hair dryer (cool setting).

## BACKGROUND

Daniel Bernoulli gave us a principle that is used to explain how a wing flies. However, it was the Wright Brothers' wind tunnel that proved invaluable for gathering important, accurate lift data. The brothers built a device that would provide a steady air flow to test small wing shapes. A number of designs were tested and the best tunnel-developed airfoil shape was used in actual flight tests at Kitty Hawk, North Carolina. From that time on, aerodynamicists have been testing various airfoil shapes to determine lifting capabilities and drag coefficients.

## NATIONAL SCIENCE STANDARDS

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

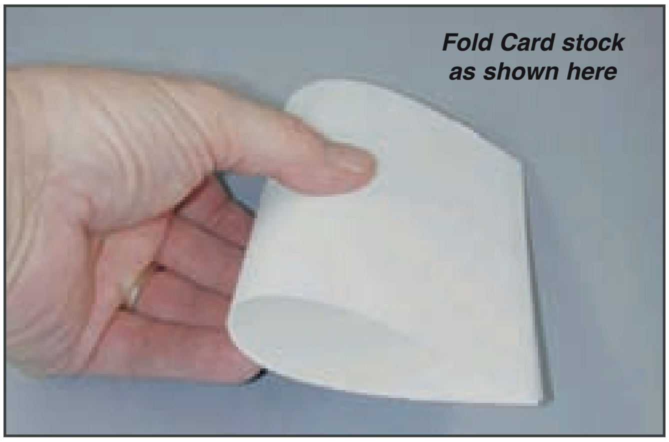
**Content Standard B: Physical Science**
- Position and motion of objects

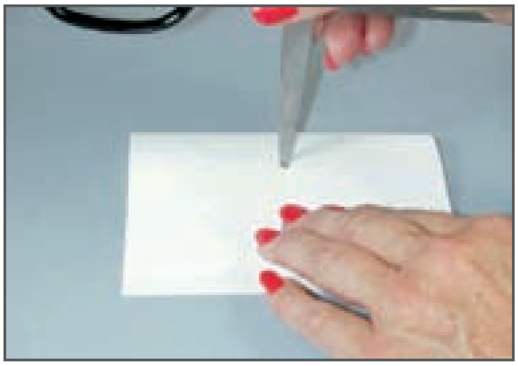
**Content Standard E: Science and Technology**
- Abilities of technological design
- Understanding about science and technology

**Unifying Concepts and Processes**
- Evidence, models, and explanation
- Form and function

## PROCEDURE

1. To make the airfoil, use about ½ of a sheet of card stock.
2. Fold the paper so that the chord (a line from the front to the rear of a wing) is about 4 inches long. Tape the trailing edge together with Scotch or similar household tape.
3. Don't crease the leading edge. Create a gentle curve for both top and bottom, when viewed from the side as seen below.
4. At the point of maximum curvature in the airfoil shape, mount a soda straw by punching a hole using a snap-knife, sharp pencil or pen. Spend some time shaping the airfoil so that the leading edge (closest to the hand in this photo) is gently rounded.


*Fold Card stock as shown here*



***Scissors or a hobby knife can be used to cut a hole in the upper and lower curved surface (called the camber)***

5. Repeat #4 on the bottom side. This will allow the soda straw to slide through the wing at exactly 90 degrees to its chord.
6. A little hot glue will hold the straw in place. CA or "Super Glue" can also be used to bond the straw to the wing. Be aware that CA glues can bond fingers together. If you plan to use this activity with students, and you're using CA glue, use extra caution.
7. Next, cut the straw so that only about 4 inches stick out on the top and bottom. This may even be trimmed down to about 2 inches on each side.
8. Set up a rod, so that the airfoil can be mounted.

## It's ready to fly!

9. When you get everything together, and the little wing is ready, provide a source of wind and watch it climb the rod.
10. If the little wing wants to go round and round, you might add a "rudder" by taping a piece of card stock to the back, or trailing edge.
11. Experiment with it until you make the wing rise right up the line. This will fascinate students and then, of course, every one will want to make a wing of their own design!


**This is a picture of a Civil Air Patrol Cessna. It clearly shows the shape of a wing. Notice how it is curved on the top. This is what gives the wing most of its lifting capability.**

# *Bernoulli Beach Ball*

**OBJECTIVE**

*This is a "demo" activity, yet it is all "hands-on!" The objective is to show students how the blast from a fan can be used to demonstrate Daniel Bernoulli's famous principle.*

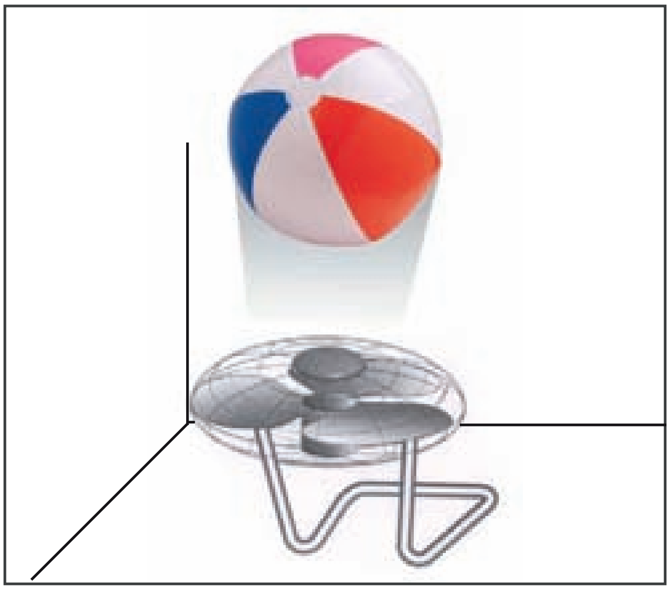
## BACKGROUND

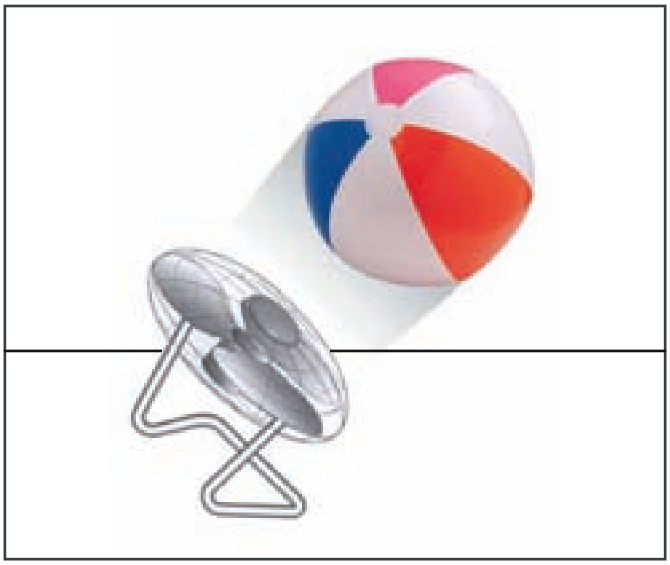
Daniel Bernoulli's Principle deals with pressure differentials. As a fluid in motion (air in this case) accelerates, the pressure within drops. In our example, there is a low pressure surrounding the ball because the air flow from the fan is accelerating. This is because of change of direction. As gravity tries to pull the ball to the ground (or toward the fan), a pressure differential is exerted across the surface of the ball and this keeps it in midair.  The low pressure above the ball plays a major role in suspending the ball in the atmosphere.

## PROCEDURE

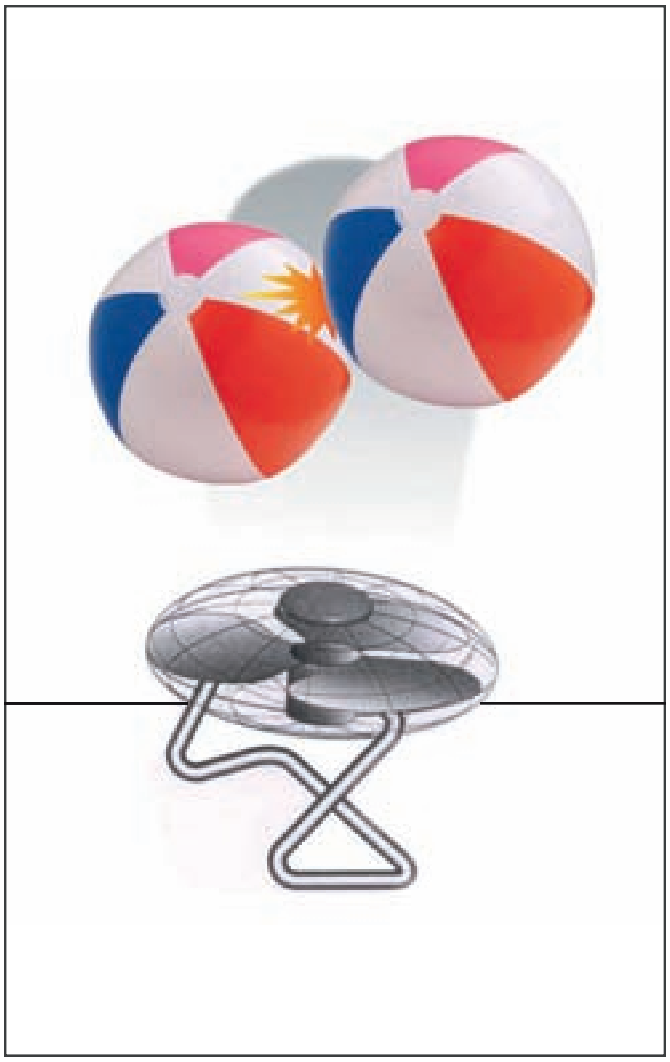
To make this a meaningful learning experience, the teacher/AEO should give the following explanations to the variations on the experiment:

1. First, you should have your fan in a position where the airflow will be moving upward.
2. Your fan should have some power---wimpy fans just don't work well.
3. Turn the fan on and place the beach ball in the air stream. Note how the ball remains suspended. At this point, explain to the students Bernoulli's Principle. You might try using these words: "Class, there is a flow of air moving around the ball. It is going faster because it has to change direction and this creates acceleration. As a result of this acceleration, there is a pressure drop (suction) in the stream and this is acting upon the ball."
4. Now, gently grab the beach ball with both hands and slowly pull it toward you. As the ball is pulled from the air stream, you will feel a force trying to pull it back into the airflow. This reaction is due to the pressure differential generated between the surface of the beach ball exposed to the accelerated airflow and the relatively stationary air outside the perimeter of the fan's blast.
5. As revealed by Bernoulli, the moving air mass on one side of the ball has less pressure than the stationary air on the other side. The action produces a pressure differential. Gently release the beach ball and note how it darts back into the airflow!
6. Now, try tilting the angle of the air blast from vertical to another angle. If the flow generated by your fan is strong enough, the ball will float in midair. The low pressure above the ball plays a major role in suspending the ball. Move the fan around and note that the ball follows the airflow.





7. If your fan has enough power, place two beach balls in the air stream. Note how they battle for the center of the air stream. As they bounce off each other, observe how they move toward the center of the air blast only to bounce off each other in a repeated fashion.
8. Remember from the previous demonstration using a single beach ball, when you gently and slowly pulled the ball from the air stream, a portion of the beach ball exited the air stream and produced a pressure differential that pulled the ball back to the center of the following air mass. In this demonstration, the two beach balls are trying to occupy the same location as they see the area of low pressure!



### Another Bernoulli activity:

**What to do:** Hold a ping-pong ball over a flexible straw. As you blow into the straw, let go of the ball. What happens? Experiment with holding the straw in different ways. For example, can you tilt the straw and still keep the ball in the air? Hint: You can use any lightweight ball or a small balloon, but you may need to blow harder.

**Explanation:** Air is pretty pushy stuff. It never pulls or sucks, it pushes. Air is pushing on you right now from every direction. We are so used to air being around us that we often don't notice it. The constant push of air is called air pressure. As you blew through the straw, the air had to go around the ball. The air above the ball was pushing the same as before, but the air under the ball was moving faster, reducing air pressure.

# activity fifteen

# *NASA Technology Spin-offs*

*(This activity is from NASAexplores)*

**OBJECTIVE**

*Students will learn about the every day spin-offs that come as a direct result of NASA technology.*

***Pictures show NASA spin-offs: (Left to right) Invisible braces, bicycle helmets, and scratch resistant sunglasses.***

**NATIONAL SCIENCE STANDARDS**

**Content Standard E: Science and Technology**
- Abilities of technological design

**Content Standard F: Science in Personal and Social Perspectives**
- Science and technology in local challenges

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

**MATERIALS**

- Four items such as gum, ruler, 2-liter bottle and straw.
- Paper and pencil

## BACKGROUND

A spin-off is a secondary application or use for a technology created for another purpose. In the case of NASA, the primary purpose of a new technology has something to do with the Space Program. However, this same technology can be used in the commercial or private sector to make life better for all of us. Things used to build rockets can help us everyday. Examples of spin-offs are:

- Dentists use a lot of things from NASA. One of them is used in braces. This material is stronger than steel. It is hard to break. It even lets the dentist make the braces invisible.
- Racing swimsuits use a NASA spin-off. NASA found a way to make airplanes fly faster. Small lines were cut into the metal used to cover airplanes. The same ideas can be used to make swimsuits. The suits help swimmers move through the water a lot faster.
- Sports shoes are better because man walked on the Moon. Moon boots were made to protect astronauts' feet when they walked on the Moon. The same kind of padding helps protect us when we run and jump.
- NASA has helped make riding bikes safer. Bicycle helmets have saved many lives. They are made from foam used in aircraft seats.
- Everyone loves shiny balloons. Mylar balloons are made with material used on satellites. It makes them shiny. Mylar is also put on space suits. It keeps astronauts from getting too hot or cold in space.
- Sunglasses have been changed thanks to NASA. The great thing about these glasses is that they let in the good light. They keep the bad light out! Some light from the Sun can cause eye problems. The new sunglasses are great for people who spend a lot of time outdoors. They don't scratch or break like other glasses. This helps them last longer, too. The film used on the glasses was first made for space helmets and windows.

## PROCEDURE

1. Discuss NASA spin-offs and how they are useful to us.
2. Set up four stations in the classroom. Put one item in each station. The items could be gum, a 2-liter bottle, a ruler and a straw. These items are optional.
3. Divide the students into groups.
4. Have students think of 5-10 different ways to use the objects, besides their common current uses. Tell students they can redesign the objects if necessary.

## SUPPLEMENTAL ACTIVITIES

1. Read each story that follows. Choose for which use you think NASA invented it. Cut out the strip provided that best describes that use and glue it in the box under the story.

| |
|---|
| **Used in space suits** |
| **Used to peotect the eyes of welders** |
| **Used on heat pumps for satellite cooling** |
| **Used in space telescopes** |
| **Used on spacecraft to help control flight** |
| **Used as a smoke and fire detector for Skylab** |

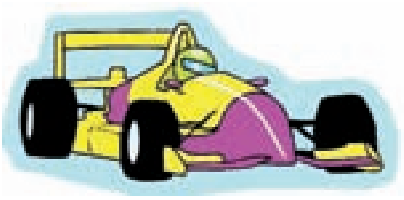
Life can be tough for a baby pig. A mother pig can squash a piglet by accident. Or, she may not feed it. These problems cause hog farmers to lose a lot of pigs.

NASA has come up with a solution. It is a robotic mother pig. The robot keeps piglet formula cool until it is needed. Then, the robot pours the formula into a heating chamber. At feeding time, a heat lamp warms up the machine to hog-body temperature. The robot pig then lets the piglets know it's time to eat. It does this by grunting like a mother pig!

In the past, farmers would have needed a lot of machines to do this job. These machines take up a lot of room. They need to be worked on a lot. The NASA machines are about the size of a quarter. It has no moving parts. It can heat and cool the milk.

It may not look like a pig, but it's warm and tasty like a pig. The best part is it says a piglet's favorite words - "dinner time"!

Hopefully, you've never had to get up in the middle of the night because of a smoke detector. By law, smoke detectors have to be placed in all new homes. They help save lives. Does your house have a smoke detector?



The powerful engines on race cars make a lot of heat. This can cause the drivers' temperature to rise. That makes them tired and dried out. The driver might even get sick. So, more and more drivers are wearing cool suits. Cold liquids move through tubes in the suits. This keeps the drivers' temperature down.

A group of kindergarten kids are standing in a line. They're getting ready for a test. You would never know it by looking at them. It's an eye test. But, this one is as quick as taking a picture.This machine takes pictures of the children's eyes.

The system includes a special camera, lens, and electronic flash. The flash sends light into the child's eyes. The light is reflected from the back of the eye to the camera lens. Once the picture is made, it is studied.

The pictures show many kinds of vision problems. What is so special about this system? During most eye exams, the doctor asks questions. The answers are used to see what problems the child is having. The new system isn't like the old ways of eye screening. It doesn't need an answer from the child, and it takes only a few seconds for the test.

These sunglasses protect your eyes. The great thing about these glasses is that they let the good light in. They keep the bad light out! Some light from the Sun can cause eye problems. The new sunglasses are great for people who spend a lot of time outdoors. They don't scratch or break like other lenses. This helps them last longer, too.

Joystick controllers are used for lots of things now. They are used for computer games. People with disabilities can use them to steer cars and wheelchairs. The grip of the joystick goes back and forth. This lets users make the most of their natural hand movements. This lets them play their best game. The joystick can move like a plane's control stick. This makes it seem as if you are really flying. This new joystick makes playing three-dimensional games a lot more fun.



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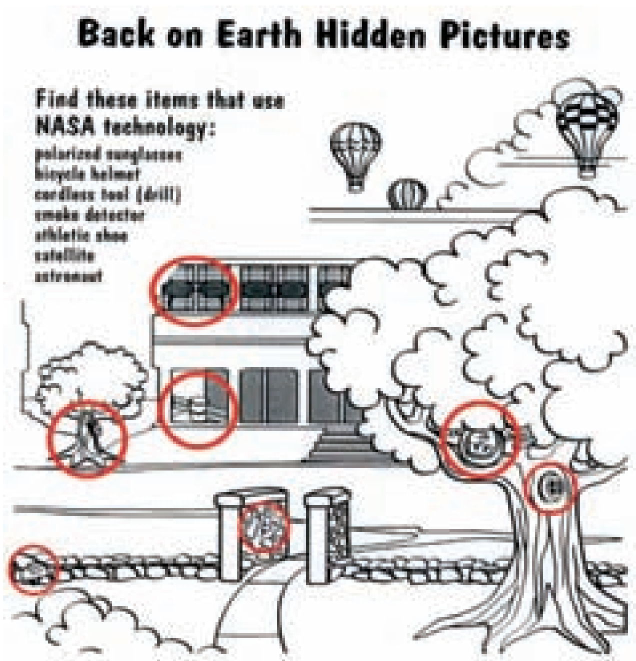
# Back on Earth Hidden Pictures

**Find these items that use NASA technology:**

polarized sunglasses
bicycle helmet
cordless tool (drill)
smoke detector
athletic shoe
satellite
astronaut

**Hidden Picture Answer:**




**Web Resources:**

- Benefits of the Space Program - ***http://techtran.msfc.nasa.gov/at_home.html***
- Spin-offs memory game - ***http://spaceplace.nasa.gov/en/kids/spinoffs.shtml***

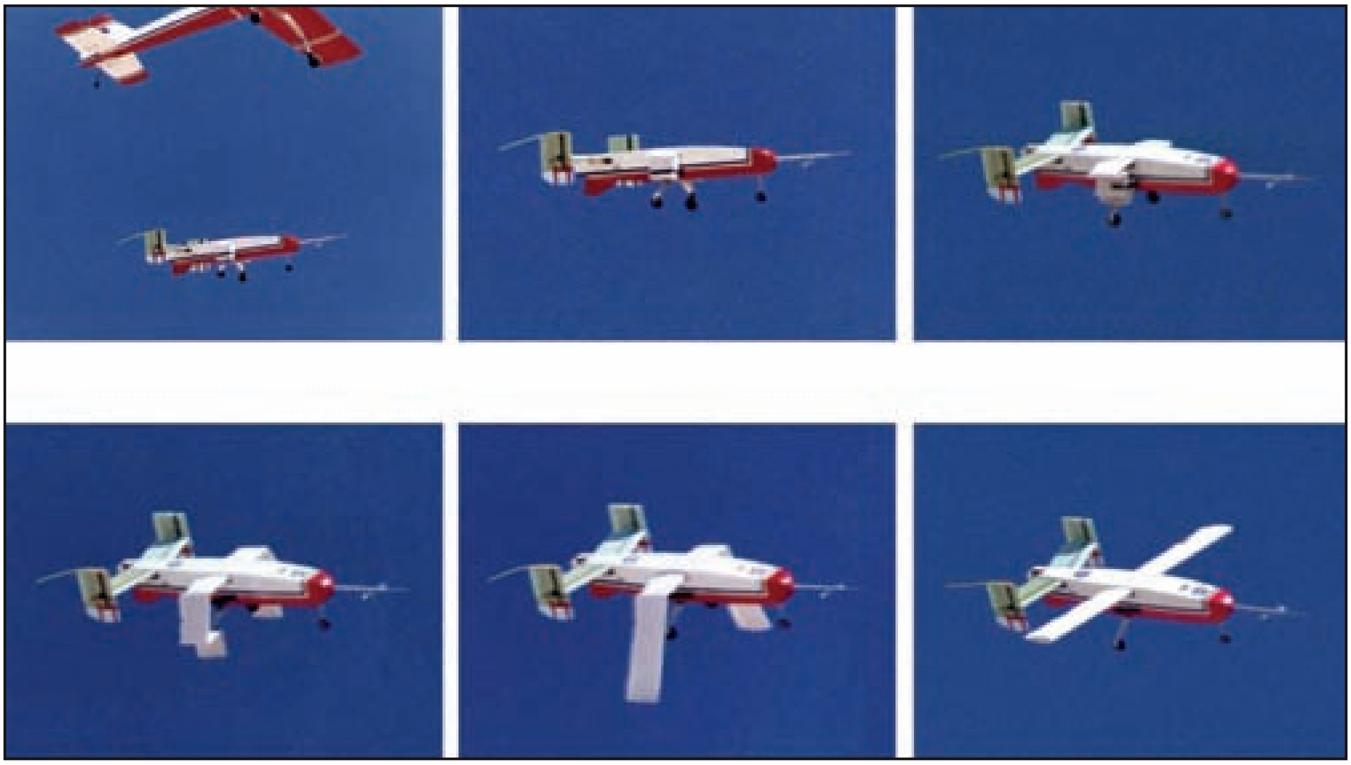
## activity sixteen

# *Collapsible-wing Airplane*

*(This activity is from NASAexplores)*

**OBJECTIVE**

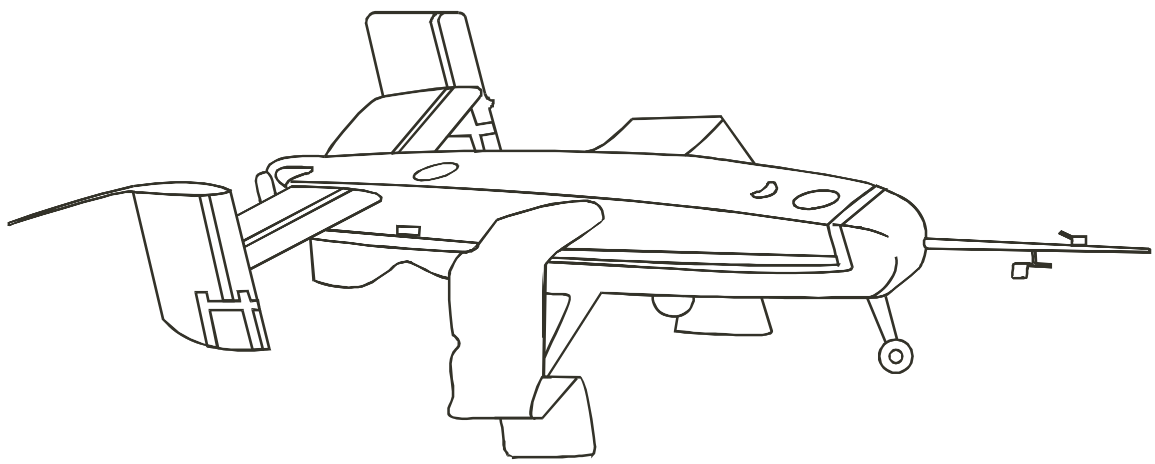
*Students will construct and launch a collapsible-wing airplane.*



**BACKGROUND**

NASA engineers decided to explore the idea of an inflatable wing aircraft. Each inflatable wing is 0.8 meters (2.7 feet), creating a full wingspan of 1.5 meters (just over 5 feet), not including the fuselage. Before the wing is deployed, it can fit in a container the size of a small coffee can. Using compressed nitrogen gas, the wings are inflated in a third of a second, almost faster than the human eye can see. The pressurized nitrogen goes through a valve and regulator, just like ones used in paintball guns, to inflate the wing.

The wing was tested in steps. First, the test airplane was flown with a rigid wing to check its flight characteristics. Then, it was flown with the experimental wing in its inflated position. Finally, the airplane was flown with the inflatable wing folded up, and then deployed in mid-flight. The airplane continued to fly with no change in stability.



This line drawing shows, in a closer view, how the wings unfurl in the inflatable wing aircraft.

**NATIONAL SCIENCE STANDARDS**

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

**Content Standard E: Science and Technology**
- Abilities of technological design
- Understanding about science and technology

**MATERIALS**

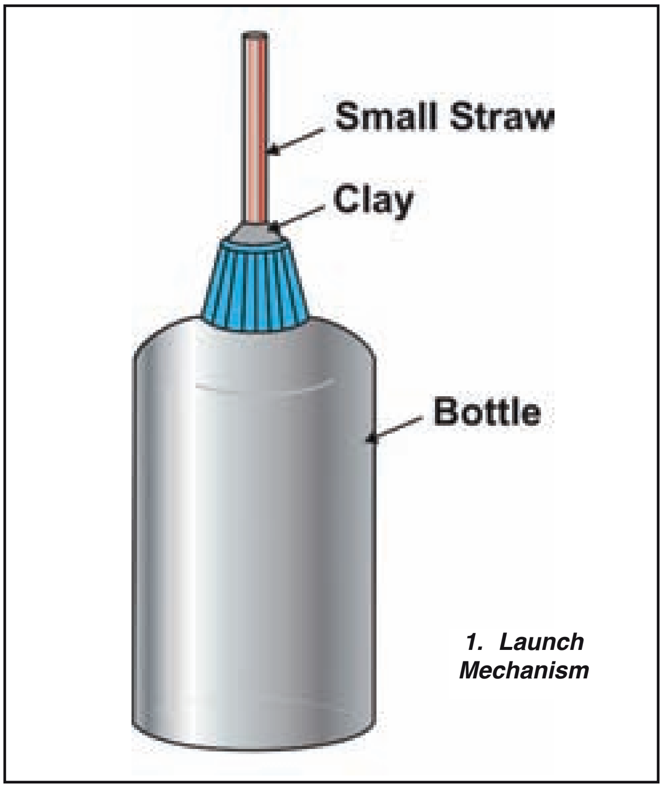
**Per Group**
- Squeeze-spout plastic dishwashing detergent bottles or water bottles (clean and emptied)
- Two sizes of plastic straws (one that will fit over the other)
- Modeling clay or play dough
- Glue
- Scissors
- Construction paper (four sheets)
- 1-inch-thick foam or sponge (one piece per group)
- One large, self-sealing plastic bag, or heavy plastic trash bags
- Paper towel tube or plastic tube the same width
- Tape
- Ruler

**Per student**
- One large straw

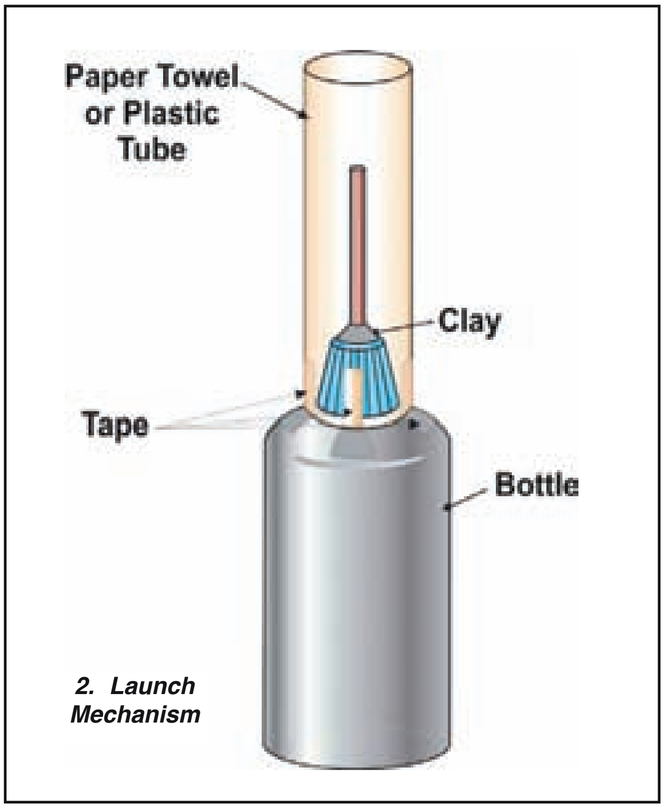
## PROCEDURE

1. Divide the class into groups of four students, and distribute materials to each group to construct their airplane.
2. This activity requires a launch mechanism, which is the plastic squeeze bottle. Younger students may need you to build the launcher for the class to use as a whole, while older students may want to build their own for the group. This mechanism can use air, or to provide more thrust, add water to the bottle. (Take the class outside to launch if you use water).

3. To build the launch mechanism:
    - Fill the bottle with water if you are taking the class outside to launch.
    - Take the top, and pull the spout to the open position.
    - Insert the smaller width straw in the spout.
    - Form clay or play dough around the straw and the spout opening to make a seal. This should secure the straw in place. See the diagram on the right.
    - Place a piece of tape around the clay, the straw, and the spout for added stability.
    - Screw the top on the bottle.
    - Lightly squeeze the bottle to test the launch mechanism. If the straw does not stay in place, add more clay and heavier tape.
    - Place the paper towel tube over the straw, and tape it to the bottle. Your launch mechanism is ready for the collapsible-wing airplane. See the diagram on the right. Use a plastic tube instead of the paper towel tube when using water.
    - Prior to this activity for the younger students, build a collapsible-wing aircraft for them to use as a visual.
4. Discuss how the inflatable wing works.
5. Explain that the class is going to construct an airplane with wings that can be folded up. It will be launched from a mechanism, like a bullet being shot from a plane. You will have to work out design problems if the wings on your aircraft do not open once launched.
6. Hand out the materials.



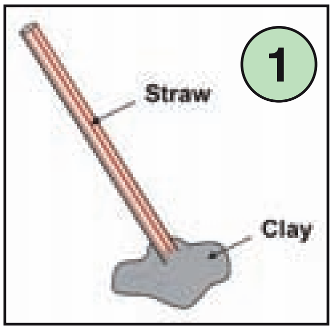

*1. Launch Mechanism*

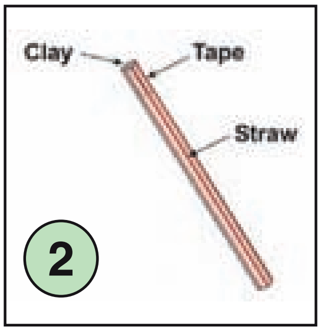



*2. Launch Mechanism*

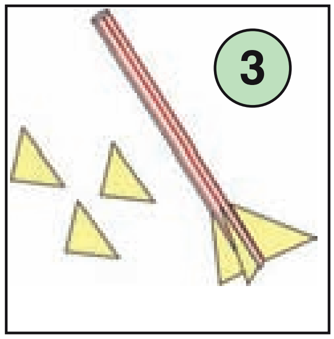
## To build your airplane:

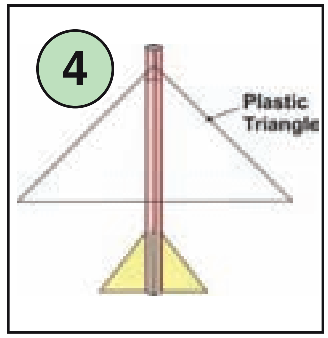
1. Insert one end of the larger-diameter straw in a lump of clay or play dough. Make sure there is clay or play dough inside the straw to form a plug.

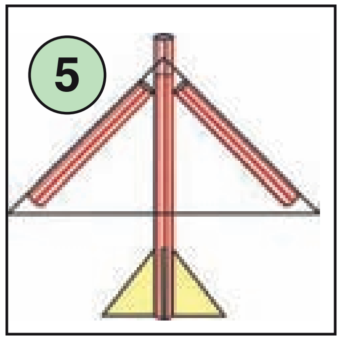


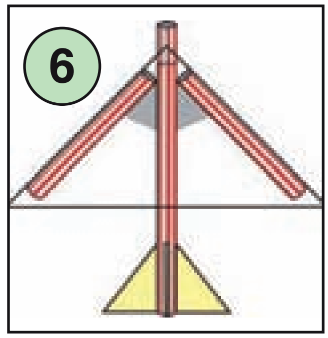



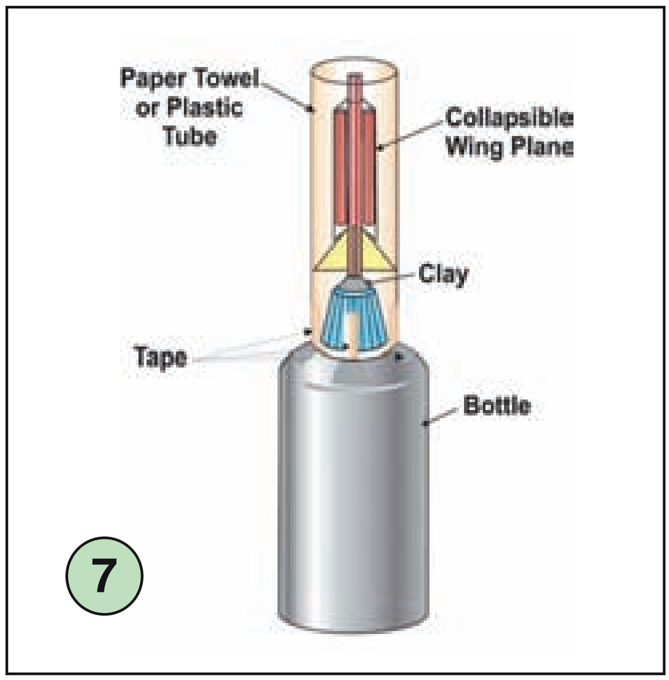
2. Place a piece of cellophane tape over the end of the straw to seal the clay inside.
3. Cut three small triangles out of construction paper, and tape them to the other end of the straw to make the tail fins.
4. Cut a triangular piece of plastic out of the plastic bag. Allow students to increase the size of the wings, by enlarging the triangle. (See pattern on page 76. Lay the plastic triangle on the top of the straw with the center point right below the nose. The straw should be centered on the triangle as shown in the diagram. This should resemble wings. Tape the straw to the center of the plastic triangle.
5. Cut another straw in half. Tape one piece on the outside center of each wing for support.
6. Measure the distance from the body of the plane (the long straw) to the outside support on the wing (cut piece of straw). Measure a piece of foam that will fit snugly between them. Cut out the foam, and tape it to the body and the wing support. This should provide stability for the wing and keep it in a rigid position, but allow you to fold the wing to the body of the plane. Test your collapsible wing by folding the wing to the body of the plane and then releasing it.
7. Fold the wing to the body of the plane, and insert the plane into the tube of the launch mechanism over the smaller straw.



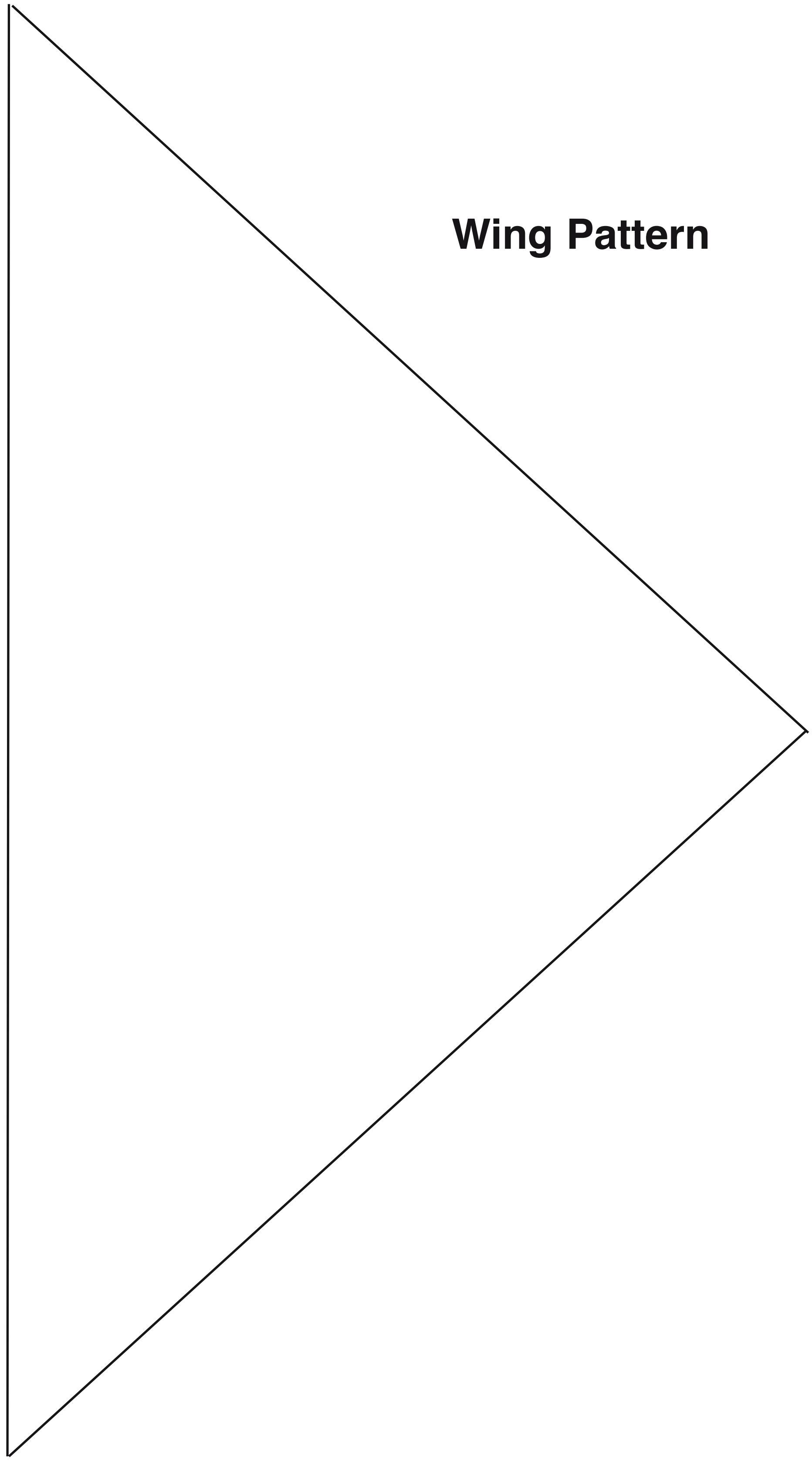



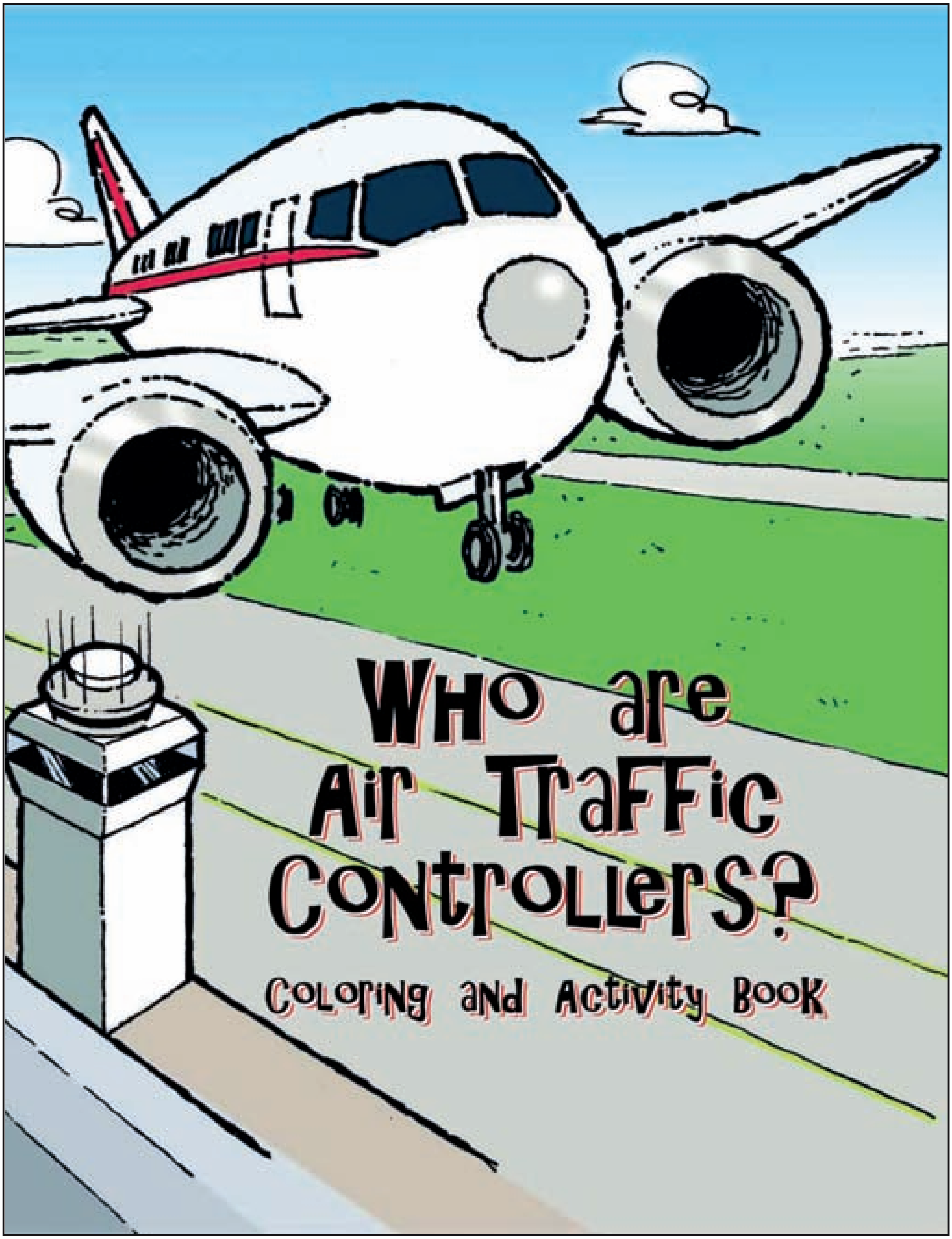




## EXTENSIONS

- Have students test their airplanes in steps with the wing rigid and then by folding the wings and deploying the aircraft in mid-flight. Then have them insert the plane into the launching tube over the launch straw and test the launching device and flight of the airplane.
- Hold a contest to see whose collapsible-wing air craft can travel the farthest. Measure the distance each traveled and graph the results.

## Wing Pattern



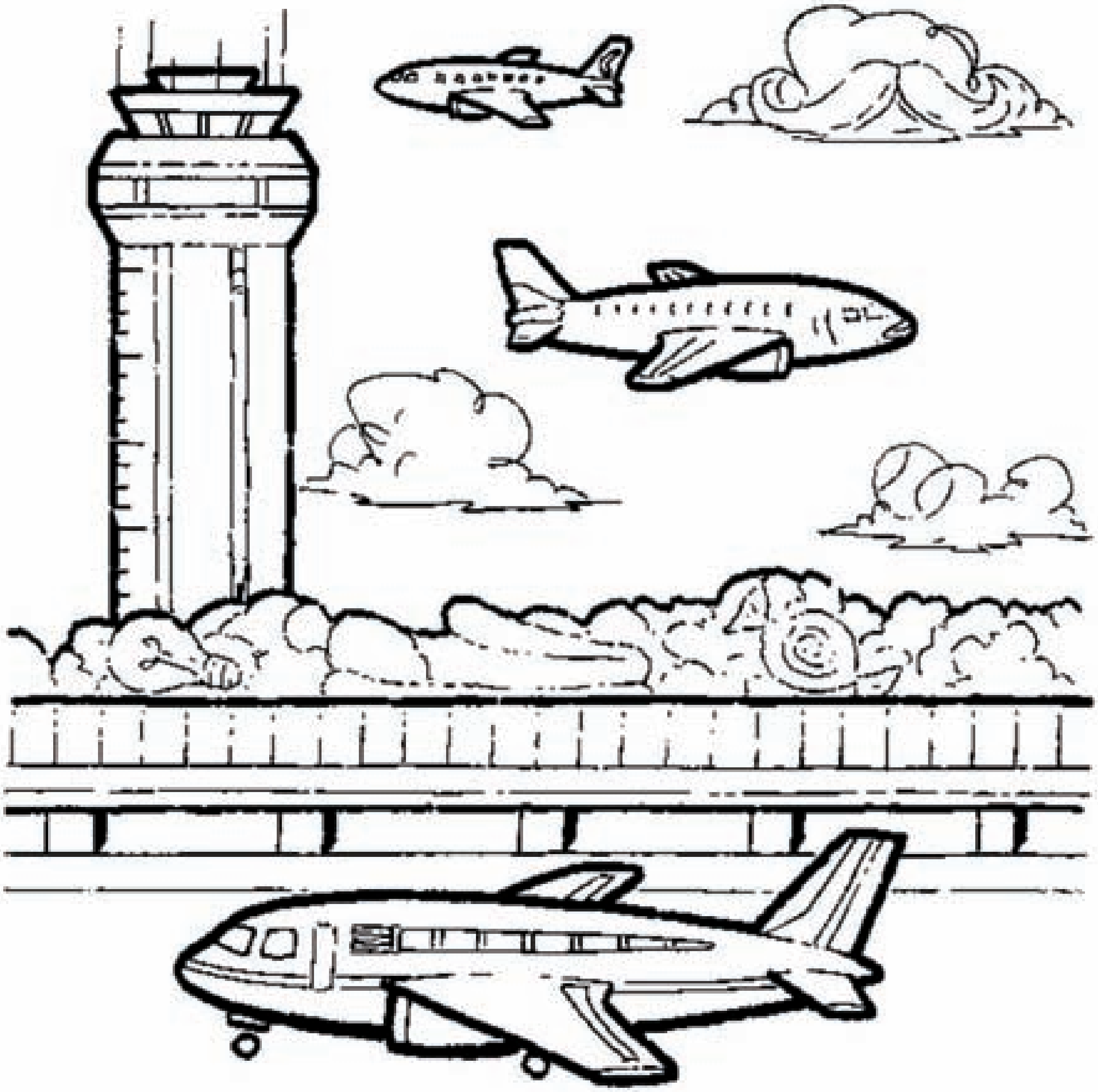

Who are Air Traffic Controllers?
Coloring and Activity Book

Everyday, over 2 million people travel across our nation's skies.


Can you spot the six things wrong with this picture?

Answers: upside down clock, deer with purse, octopus in suitcase, pant leg cut off, ticket agent holding sock, deer wearing necklace

And everyday, air traffic controllers are at work keeping air travelers safe.



Can you find the 10 objects hidden in this picture?

Answers: paintbrush, lightbulb, ruler, pencil, baseball, fish, loafer, candy, mustache, boomerang

**Air traffic controllers work to safely separate aircraft as they travel across the sky.**

**Unscramble the letters to see some of the equipment controllers use.**

**RDAAR** ___ ___ ___ ___ ___

**PASM** ___ ___ ___ ___

**OIARD** ___ ___ ___ ___ ___

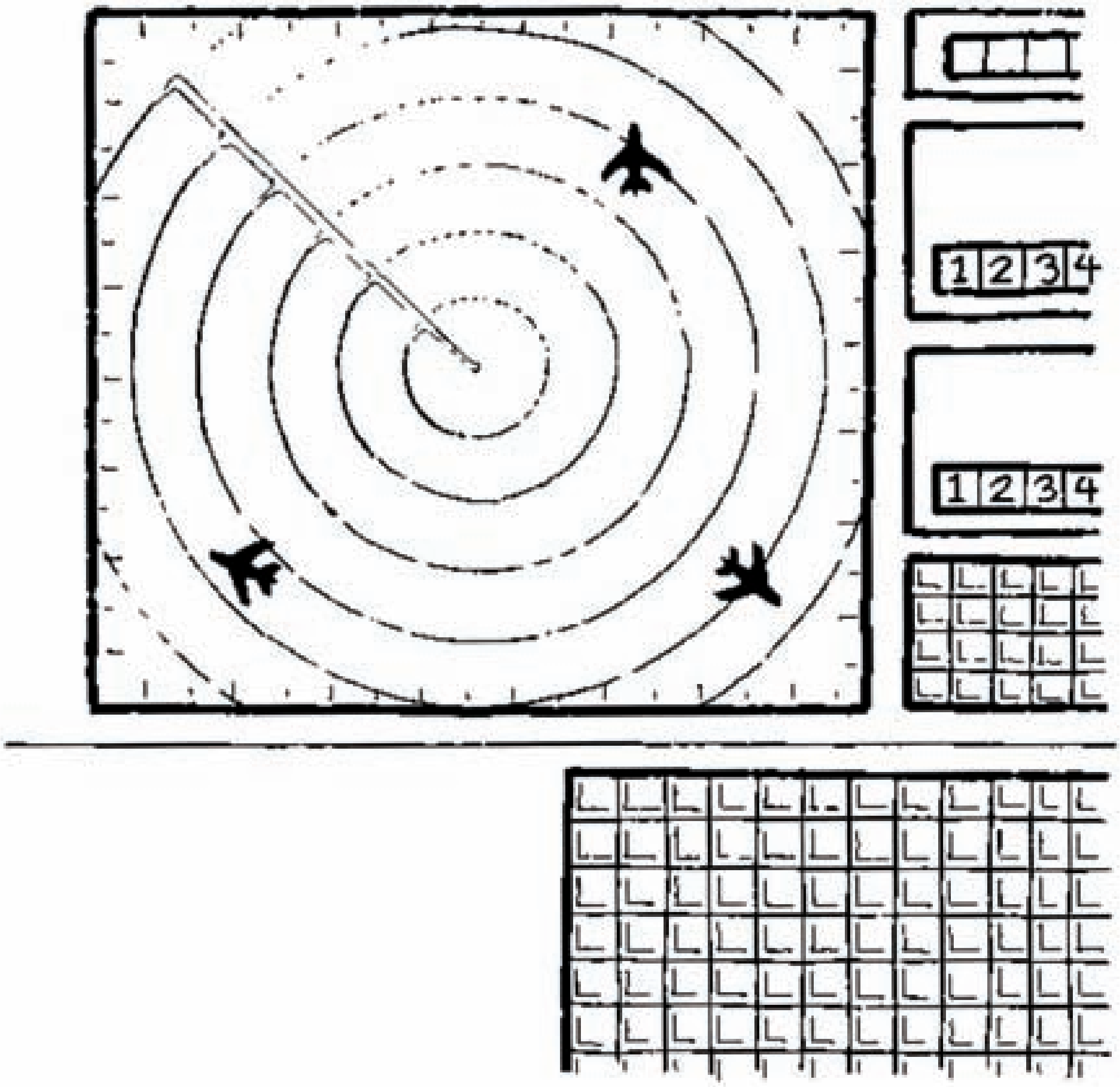
**PUMOCRTE** ___ ___ ___ ___ ___ ___ ___ ___

**SHATEDE** ___ ___ ___ ___ ___ ___ ___

**OLUCBNSIRA** ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

Answers: RADAR, MAPS, RADIO, COMPUTER, HEADSET, BINOCULARS

Air traffic controllers use radar to track aircraft.




Can you draw five more airplanes on the controller's radar scope? (And remember keep them safely separated.)

Air traffic controllers work together in a rhythm similar to runners in a relay race.

A controller will work an aircraft until it reaches the end of his defined airspace - and then will hand it off to the next controller - similar to a runner handing the baton off after running his leg of the race.


Can you follow the plane's journey as the air traffic controllers work together to move the aircraft from Washington, D.C. to Los Angeles, California?

Air traffic controllers work in three different types of facilities.

## Tower

Some controllers work in the glass enclosed towers you see at airports. They give pilots taxi and take off clearance. Once the aircraft reaches the edge of the tower's jurisdiction - it is handed off to the controller in the TRACON.

## Terminal Radar Approach Control (TRACON)

Controllers also work in radar rooms called TRACONs - which are located either at the base of the airport tower or in a building completely separate from the airport.

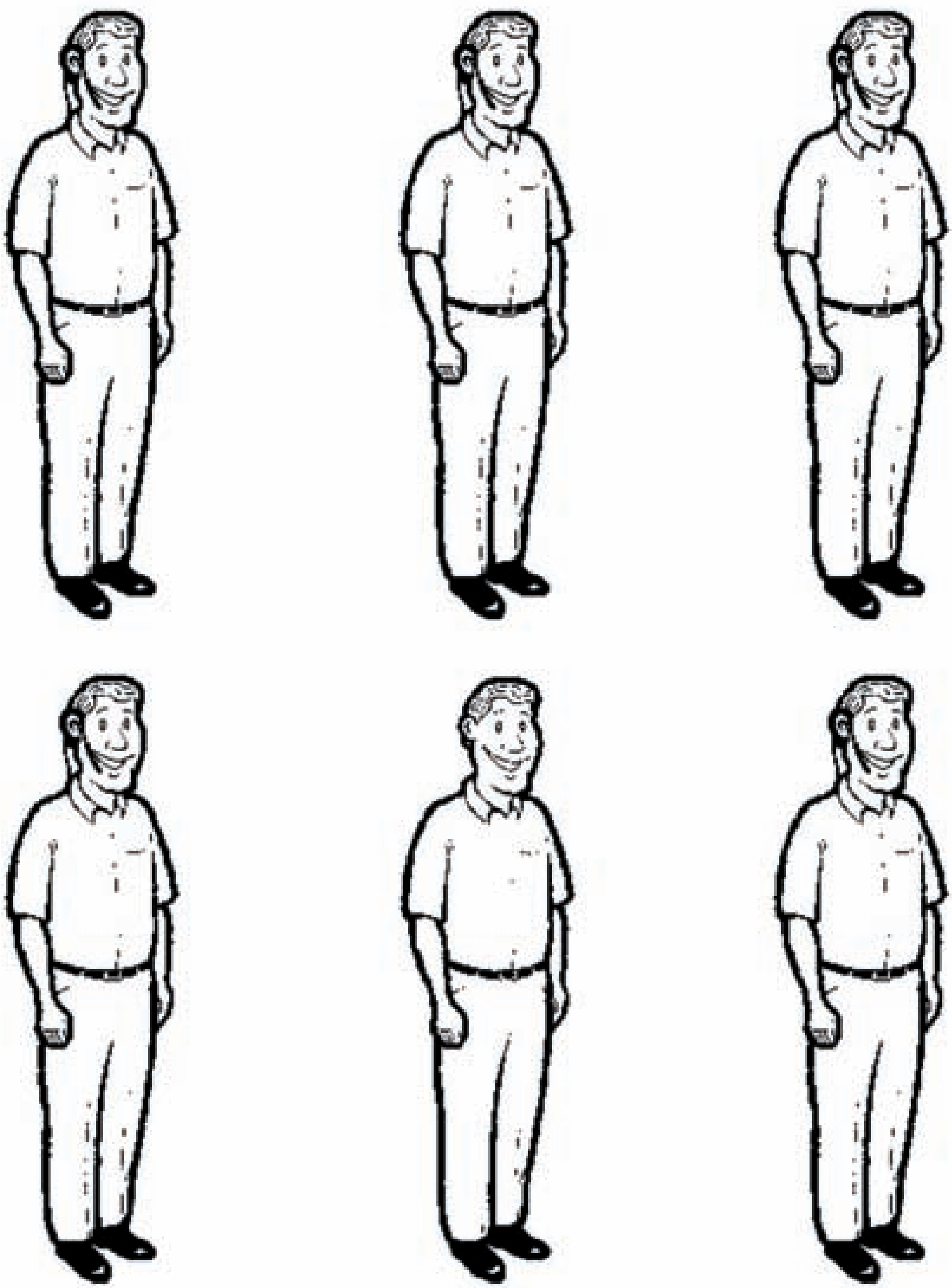
These controllers provide service to the aircraft until it reaches the edge of the facility's airspace then they hand it off to the center.

## Air Route Traffic Control Center

Controllers in centers work at 20 facilities across the country, and will provide service to the aircraft for the majority of its journey.

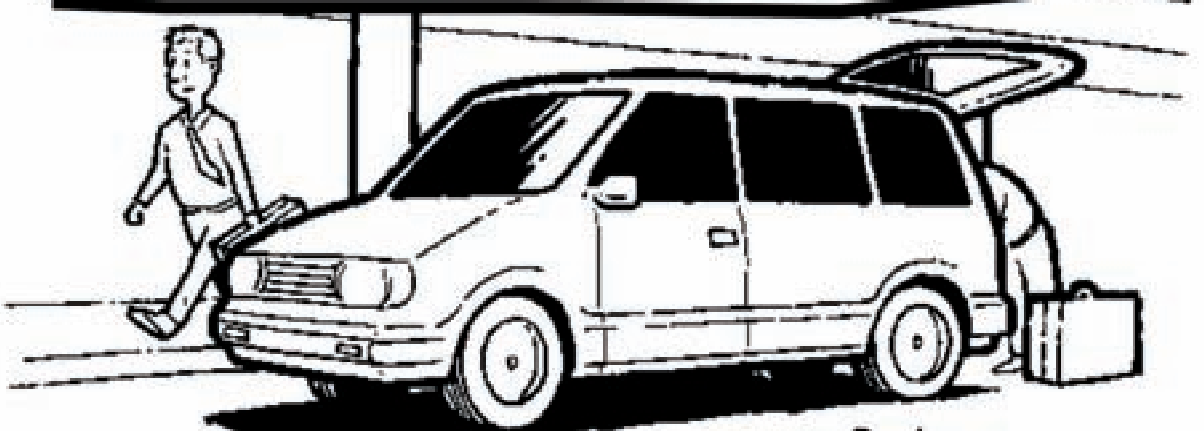
A typical center is responsible for more than 100,000 square miles of airspace generally extending over a number of states.

Which air traffic controller is different from the others?



**Find the aviation-related words.**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | Y | A | W | N | U | R | M | I | Y | Y | X | I | E | V | H | G | K | E | H |
| E | U | O | J | B | N | K | E | B | T | D | U | G | P | S | A | F | E | L | M |
| S | H | L | Q | R | G | A | Q | A | J | I | W | F | J | C | U | N | F | N | K |
| A | I | R | U | T | E | R | M | P | V | V | T | O | W | E | R | J | G | R | L |
| H | R | P | H | R | A | F | R | L | K | O | A | D | T | K | N | E | J | E | T |
| I | A | Z | T | D | Z | C | R | C | I | L | K | N | H | I | M | C | G | G | R |
| T | L | B | A | D | S | W | D | F | P | L | E | C | G | M | D | X | F | N | A |
| A | I | R | T | R | A | F | F | I | C | C | O | N | T | R | O | L | L | E | R |
| S | A | G | I | G | O | Y | N | J | Y | T | F | K | C | D | L | U | I | S | O |
| H | R | T | A | P | T | A | K | O | F | R | F | M | B | K | S | T | O | S | P |
| I | X | A | T | P | L | A | R | X | B | E | E | C | A | P | S | R | I | A | Y |
| Z | U | J | T | W | E | E | A | I | R | P | L | A | N | E | W | B | P | P | Z |



Taxi
Air Traffic Controller
Runway
Passenger

Radar
Safe
Tower
Take off
Airspace
Airplane

The National Air Traffic Controllers Association is the union that represents air traffic controllers and other aviation safety related personnel.

NATCA strives to improve its members working conditions.


All the things in the boxes are in the picture above. Can you find and color them in?

**NATCA continually works to improve and enhance aviation safety, and we proudly provide the safest air traffic control system in the world.**

*National Air Traffic Controllers Association: We Guide You Home*

**Help the air traffic controller guide the airplane passengers through the maze to get home.**


NATCA®
1325 Massachusetts Ave., N.W.
Washington, D.C. 20005
www.natca.org

# Civil Air Patrol Aerospace Education Membership Application

| | |
|---|---|
| Social Security Number | |
| Name | |
| Residence Address | |
| Daytime Phone | **E-mail address** |
| ☐ Male ☐ Female | Birth Date |

| **EDUCATION** | **EMPLOYMENT** | **EXPERIENCE** | **CLASSROOM TEACHING LEVEL (S)** |
|---|---|---|---|
| ☐ AA | ☐ Teacher | ☐ 1 Year | ☐ Kindergarten - grade 2 |
| ☐ BA or BS | ☐ Counselor | ☐ 2-5 Years | ☐ Grades 3-6 |
| ☐ MA or MS | ☐ Principal | ☐ 6-10 Years | ☐ Junior High School |
| ☐ Ed.D. / PH.D. | ☐ Superintendent | ☐ 10- More Years | ☐ High School ☐ AFJROTC |
| | | | ☐ College ☐ AFROTC |

☐ Homeschool ☐ Organization Name______________________________

**BACKGROUND**

| | | | |
|---|---|---|---|
| 1. Citizen of the United States? | ☐ Yes | ☐ No | |
| 2. If no, are you a resident alien with green card? | ☐ Yes | ☐ No | If "no," attach explanation. |
| 3. Ever convicted of a felony? | ☐ Yes | ☐ No | If "yes," attach explanation. |
| 4. Are you **currently** charged with any felony? | ☐ Yes | ☐ No | If "yes," attach explanation. |
| 5. Served in the armed forces? | ☐ Yes | ☐ No | |
| 6 If yes, were you honorably discharged? | ☐ Yes | ☐ No | If "no," attach explanation. |

**MEMBERSHIP FEE $35.00 per year**

☐ School Purchase Order attached

☐ Check ---- payable to National Headquarters, Civil Air Patrol

☐ Credit card --- complete the form below: ☐ Visa ☐ Master Card

| | |
|---|---|
| Credit Card Number | |
| Expiration Date | |
| Daytime Telephone | |
| Name as it appears on credit card | |
| Signature of credit card holder | |

*Send To:*

**CIVIL AIR PATROL/LMA**
Aerospace Education Membership
105 South Hansell Street, Building 714
Maxwell Air Force Base, Alabama 36112-6332
FAX: (334) 953-4235
E-mail: aex@capnhq.gov
Information: (334)953-5004/4213

**SIGNATURE OF APPLICANT** ________________________ **DATE** ________________

I certify that this applicant is accepted as a member of Civil Air Patrol. Membership commences on the date processed by National Headquarters and the individuals name appears on the National Headquarters data base.

**NATIONAL COMMANDER'S DESIGNEE / NATIONAL HEADQUARTERS REVIEW: INITIAL / DATE** ________________

Special Application Form - 07703 **CAP UNIT CHARTER 99004**

# Aerospace Education Membership Criteria and Benefits

***Aerospace Education Membership (AEM) is a special category of Civil Air Patrol membership. It is open to any reputable individual or organization that has an interest in supporting CAP's Aerospace Education Program.***

## Priviledges and Benefits of Membership *

Membership entitles you to…

- Civil Air Patrol membership card
- Aerospace Education Membership certificate
- "CAP News" (bimonthly newspaper)
- "AE News" (bimonthly newsletter)
- E-news (on-line monthly AE news update)
- Free national standards-based aerospace educational materials - upon request (see enclosed list in welcome packet new members receive)
- Low-cost aerospace textbooks
- Fly A Teacher orientation flights in powered aircraft
- Eligibility to apply for grants to teach aerospace education
- Access to CAP regional and national conferences as well as CAP sponsored workshops
- Access to Satellite Tool Kit computer software
- Aerospace education speakers and resources nationwide
- Scholarships for teachers and students interested in aerospace and aviation careers
- AEX Program
- AEX College Course (opportunity to earn college credit)
- Continuing education or professional development opportunities
- Availability of aerospace education materials to be purchased through CAPMart
- Tax benefits, including deductible membership dues and mileage to conferences and activities

…and much more.

*Children at Head School, Montgomery, Ala., make and demonstrate an AEX project called the rotorcopter.*

## Membership Eligibility Criteria

**Individuals** (1) Citizen of the United States or alien admitted for permanent residence. (2) Never convicted or pled guilty to a felony (State or Federal) or currently charged with a felony. (3) Honorably discharged from the armed forces, if served. (4) Student memberships are only offered to undergraduate college students.

**Organizations** Any reputable group, organization, business, club, or association. Examples include PTAs, PTOs, schools, school districts, businesses, science clubs, aero clubs, public libraries, nonprofit organizations, aerospace industry groups, etc. No particular affiliation with aerospace is required for membership, only the desire to promote and support aerospace education in America. Each organization joining CAP as an AEM must assign a point of contact (POC) individual. Only the organizational POC is authorized to receive the benefits of membership listed below.

### Restrictions

(Individuals and the Organizational Point of Contact)

a. Not authorized to wear CAP uniform, hold CAP grade, or participate in the senior member program.
b. May not serve in authorized senior member positions in a CAP unit at any level.
c. Special permission is required for flights in Civil Air Patrol aircraft.
d. Aerospace Education Membership time is not creditable towards retirement in CAP.

### Screening

Each application will be screened for completeness and eligibility. Membership must be approved by the CAP Executive Director or his designee.

### Membership Year

The member year starts on the date the AEM application is approved by CAP and is processed by National Headquarters and the individuals name appears on the National Headquarters data base. It terminates 1 year later on the last day of the application approval month. **Note:** If the AEM application is disapproved, the applicant's dues are refunded.

### Transfer to regular Civil Air Patrol Membership

To transfer from AEM to regular CAP membership (at no additional cost for the membership year) submit a **CAP Form 12, "Application for Senior Membership in Civil Air Patrol,"** with "AEM to Senior - No Charge" annotated across the top, along with an FBI fingerprint card, through your local CAP unit.

* **Note: A current CAP ID card is required to receive CAP AEM benefits.**

**Educators and Aerospace Education Officers are invited to participate in the Aerospace Education Excellence (AEX) Award Program!**
**This program is FREE to CAP members. For more information, go to www.capmembers.com/ae.**

• Become a CAP member or AEM and enroll in the AEX program in eServices.
• Select the AEX grade level activity books to receive.
• Conduct the activities and the 2-hour aerospace-related activity.
• Receive certificate for each student/cadet and plaque for classroom/unit.

• Supports the education of America's youth in math and the sciences.
• Assists the Air Force in meeting its educational requirements.
• Keeps the American public informed about aerospace issues.
• Advocates the importance of aerospace technology to the economic health, security and survival of our nation.
• Increases the quality and quantity of America's aerospace workforce.

For additional information, AFA's Web site is http://www.afa.org.

AFA has $250 educator grants for CAP teacher members that are designed to promote aerospace education activities in classrooms from kindergarten to twelfth grades. The program encourages development of innovative aerospace activities within the prescribed curriculum. The program also encourages establishing an active relationship between the school and the local Air Force Association organization.
To find out more about these grants, go to the www.capmembers.com/ae and click on grants under the AEM column.