Oklahoma Celebrates Flight

Poster from "FAA Celebrates Centennial of Flight"

Oklahoma Celebrates Flight

Presented by

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OKAGE Teacher-Consultant

This project was made possible through a grant from the Oklahoma Geography Education Fund, a division of the National Geographic Education Foundation, however, The Oklahoma Alliance for Geographic Education and Pat Smith are solely responsible for its content.

Oklahoma Celebrates Flight

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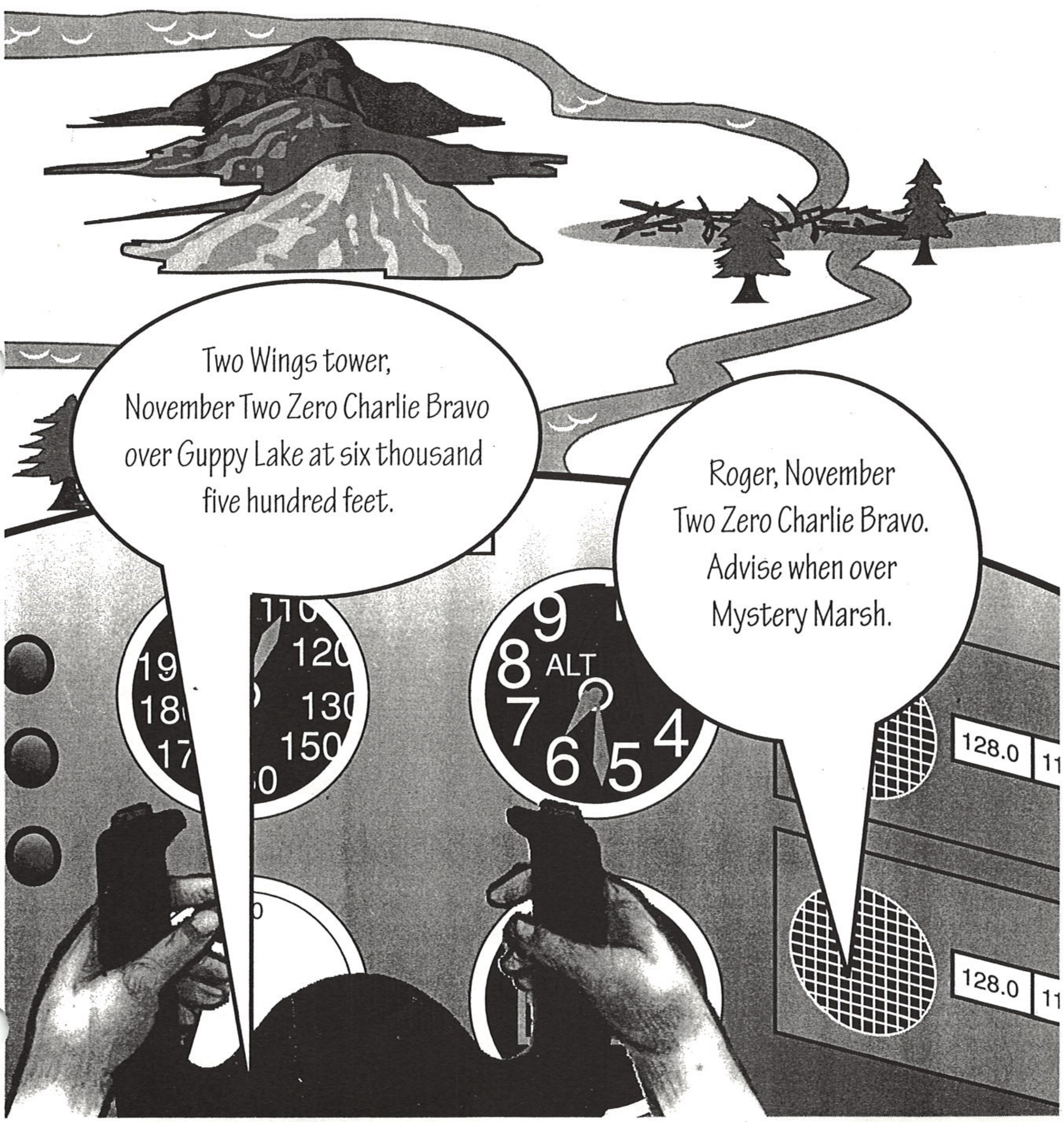
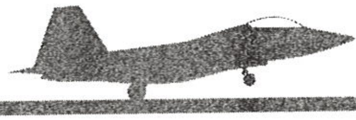
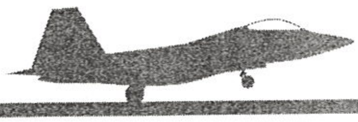
Plan to Fly There



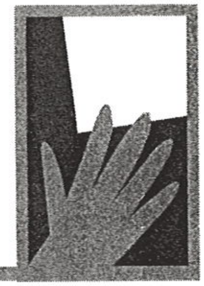


International Phonetic Alphabet

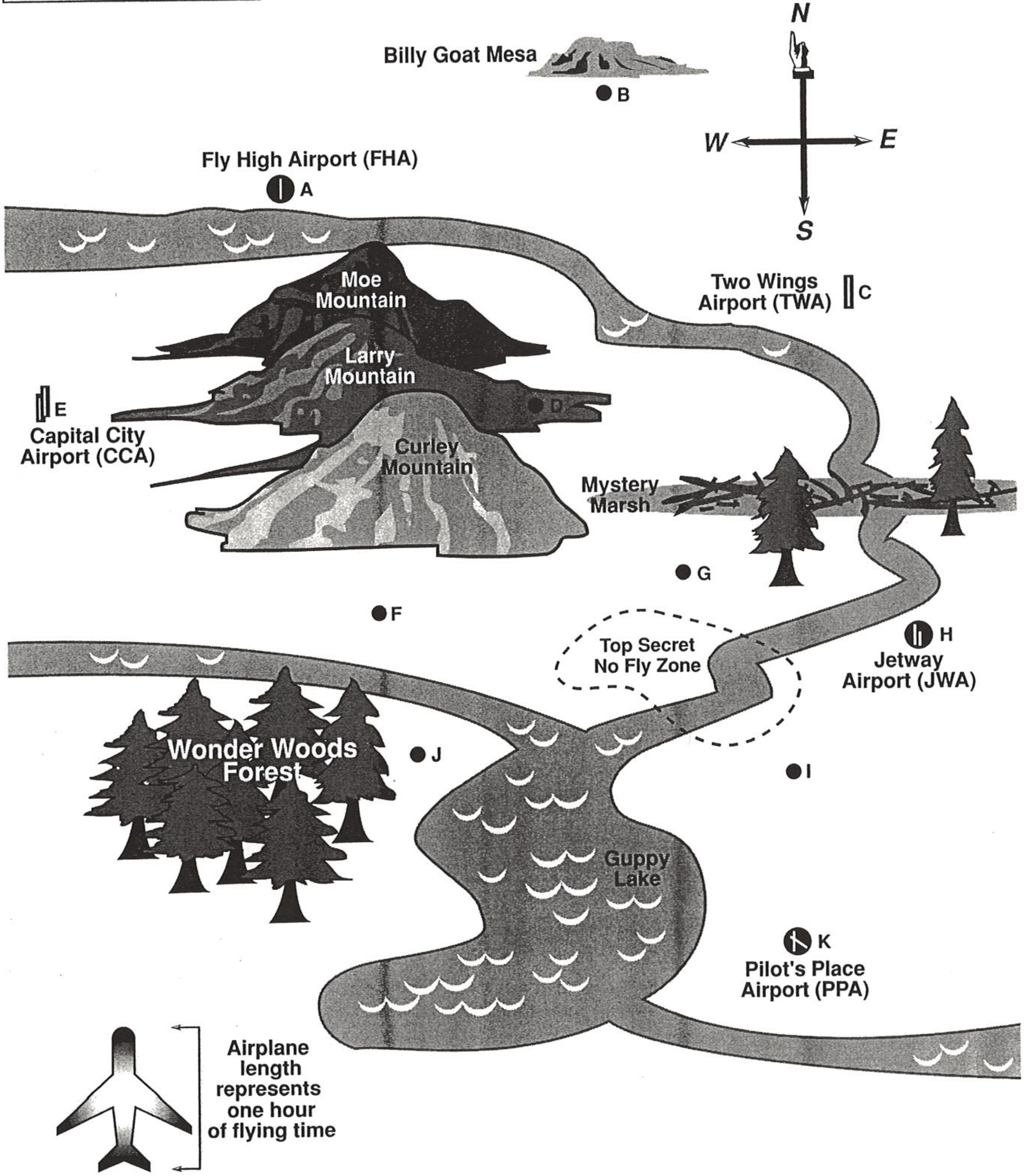
A	ALPHA	N	NOVEMBER
B	BRAVO	O	OSCAR
C	CHARLIE	P	PAPA
D	DELTA	Q	QUEBEC
E	ECHO	R	ROMEO
F	FOXTROT	S	SIERRA
G	GOLF	T	TANGO
H	HOTEL	U	UNIFORM
I	INDIA	V	VICTOR
J	JULIET	W	WHISKEY
K	KILO	X	X-RAY
L	LIMA	Y	YANKEE
M	MIKE	Z	ZULU

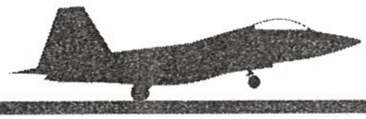


Plan to Fly There

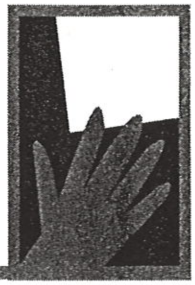


Aero-Chart





Plan to Fly There



Directions

1. Look at the Aero-Chart Student Page and use it as a worksheet to help plan your trip.
2. Use the Aero-Chart to answer some of the questions on the flight plan below.
3. Fill in the blank spaces on the form to create a flight plan.

Aircraft Identification

1. What is my airplane's number?

____

Departure Time

2. What time will we leave?

____

Departure Airport

3. From what airport will we leave?

____

Route of Flight

4. How will we get there?

____

Destination of Trip

5. Where will we land?

____

Estimated Time En Route

6. How many hours will it take to get there?

____

Arrival Time

7. What time will we land?

____

Aircraft Color

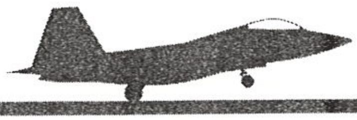
8. What color is my airplane?

____

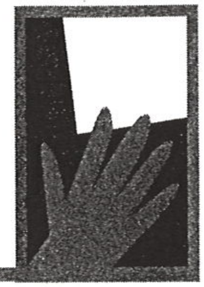
Name of Pilot

9. What is my name?

____



Plan to Fly There



Official Pilot's Flight Plans

Pilot's Flight Plan

Aircraft Number______________ Departure Time____________
Departure Point____________

Route of Flight____
Destination_______________

Estimated Time En Route_____________ Arrival Time________
Color of Aircraft_________

Name and Address of Pilot

____

Pilot's Flight Plan

Aircraft Number______________ Departure Time____________
Departure Point____________

Route of Flight____
Destination_______________

Estimated Time En Route_____________ Arrival Time________
Color of Aircraft_________

Name and Address of Pilot

____

Add a Dash of Space Photography to Your Geography

Pat Smith
Broken Arrow, OK

Students will review and strengthen geographic skills: identify, evaluate and draw conclusions from different kinds of maps, aerial and space photographs, atlases and computer-based technologies.
Develop use of mental mapping to organize information and construct landforms.

Geographic question: Do places look the same on all maps and in pictures?

National Geographic Standard: The World in Spatial Terms

1. How to use maps and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
2. How to use mental maps to organize information about people, places and environments in a spatial context.

Oklahoma PASS: 1. Locate, gather, analyze and apply information from primary and secondary sources using examples of different perspectives and points of view.

7. Identify, evaluate and draw conclusions from different kinds of maps, graphs, charts, diagrams, and other sources and representations, such as aerial and shuttle photographs, satellite-produced images, the geographic information system (GIS), encyclopedias, almanacs, dictionaries, atlases and computer-based technologies.

Geographic Theme: Place

Physical features of an area, landforms and water bodies
Ways of representing places: photos, globe, models, maps
Cultural characteristics of places: buildings, dams, parks, roads

Grade Level: 4^{th} and 5^{th}
Connections: Social Studies, Art, Literature
Resources:
www.ou.edu/okage
www.nationalgeographic.com/education/
www.nationalgeographic.com/xpeditions/
www.geocities.com/HESTEDU
www.geocities.com/monte7dco/
www.nystromnet.com
http://earth.jsc.nasa.gov
http://edspace.nasa.gov
http://science.nasa.gov/ppod

Student Geography Notebooks

1. Choose geographic vocabulary words you wish to teach. Have the students write what they know about each word and draw a picture of it in their Notebooks.

2. Divide the students into small groups. Using Atlases, Encyclopedias and Dictionaries, discover a more scientific definition of each word, add this definition to their Notebook.

3. In small groups, look at globes, different kinds of maps, and real pictures. Using study guides, find answers to all kinds of questions, for example:
   Do all rivers look alike?
   Where does the water come from?
   Is there more water at the headwater (what is headwater?) or at the mouth? (What is the mouth?)
   How do people use the water? Do they change the river? If so, how do they change it?
   Find a delta in the Atlas; tell its name, state and page number.
   What is the difference between a mountain and a volcano?

4. Look at internet pictures, overheads, or both from space. What do you see?
   What can you learn from the images?
   How are these pictures better than the ones taken of the river on the ground?
   (The space pictures come with captions to help you know what the students are looking at and what certain things mean.)

5. Explain: space pictures are taken from different angles and North is not always up in a picture from space as it is on a map. (You may want to demonstrate how the shuttle lifts-off, rolls, ejects its SRB's and External Tanks. Then, it will fly upside down and backwards; astronauts take pictures in all sorts of ways. (See Mission Geography for a picture of this.)

6. Have students repeat step 1. of this lesson, look for a more definitive explanation of rivers and more sophisticated drawings or ask them to do this part as part of their study guide.

7. Build a play-dough model of the picture and "flag" it on the world map. Tell the rest of the class where your model is located, what the area is like and your opinion of this as a place to live. (See Model Landforms next page.)

Assessment: Pass numbered photos from space showing the various vocabulary words of landforms around the class. Ask students to write what landform or landforms they observe. What else can they tell about people, cultures, or habitats from the photo?

Model Landforms, The "Physical" Kind
OKAGE Workshop, 2002

Group Activity Page Directions:

1. Take everything out of the plastic bag and check the contents. You should have: 1 NASA photograph, 1 plate, play-dough, 1 page of directions/activity sheet, toothpicks and tabs, and 1 colored arrow.

2. Read all of the directions before beginning. You must share the responsibilities and work as a team. Decide who will do the different jobs. Scribe, researcher, sculptor/sculptors, materials person.

3. As a group, look at your photograph and decide what your landform is.

4. Use the play-dough to mold your landform on the plate.

5. Label the toothpick tabs using the information from your textbooks, maps, atlases, and the caption that is on the back of the photograph. Insert the tabs at the correct location on your clay image.

6. Label the colored arrow with the correct name, find the correct coordinates of your landform in your student atlas, and attach the arrow to the wall map pointed to the correct location.

7. Plan your presentation to the rest of the class describing your "plate landform". Everyone in the group must say something.

8. Turn this page over and work together to answer the "Group Activity Page" regarding your photograph.

9. Be able to discuss this page with the rest of the class.

10. Restore the materials to the appropriate bags or throw away the toothpick tabs and plates, if they are broken.

Model Landforms, The "Physical Kind"
OKAGE Workshop 2002

Group Activity Page: Photograph # ______________________

Directions: Read all questions first. Working as a group, answer the questions about your photograph. Use your notebooks, encyclopedias, wall maps, atlases, and the caption that accompanies your photograph for help.

1. What is the **specific landform** on your photograph and on what continent is it found?

2. In what **country** is this landform / photograph located? Record the **coordinates** (latitude/longitude) of the landform on this sheet.

3. Compare your photograph with an atlas and give the **specific names** of **all** the landforms you found in the photograph, if there is more than one.

4. Would this be a **good place** to live? Why or why not?

5. Extension: Speculate on the type of **climate, location of settlements** in the area, and possible **economics** of the region.

Members of the Group:

______________ ______________

______________ ______________

EFS, Earth from Space Instructions
OKAGE Workshop 2002

Follow these steps to find images on the Earth From Space (**EFS**) web site.

1. Go to http://earth.jsc.nasa.gov

2. Find the words "**Geographic Regions"** on the left side of the screen under, "**Search By**".

3. Click on **Geographic Regions.**

4. Scroll down to the **US** and click on the **state** where the image is found or to whatever country you plan to study.

5. Click on the **thumbnail and text**, and then click **start search.**

6. At the top you will see the **number of matching images**, scroll down to the image that you need.

7. When you have found the correct image, click the "**Technical Data**" Link.

8. Scroll down to the bottom of the screen.

9. Print photo and data for use with your students. You can also make transparencies of the photos to use in whole-class activities.

10. After experimenting with the **Geographic Regions** link, try some of the others for more specific areas.

Resources: http://www.ameliaearhart.com
http://www.ellensplace.net/eae_intr.html
http://foia.fbi.gov/earhart.htm
http://www.acepilots.com/earhart.html
http://www.ninety-nines.org/earhart.html
http://www.sitesatlas.com/Atlas/PolAtlas/politics.htm
world map
ATLAS

People and Places = Geography

Amelia Earhart

http://manati.wwb.noaa.gov/doc/ssmiwinds.html

http://www.lonelyplanet.com/destinations

Amelia Earhart was born in Atchison, KS on July 24,1897. She loved to read, was fascinated by ferris wheels, and made her own backyard roller coaster. When it jumped the track, she fell from the wreckage saying that it was just like flying! When Amelia was 10, she saw her first airplane and loved it. When WWI was declared in 1917, Amelia left school and worked in a military hospital in Toronto, Canada. She flew her first solo flight in June 1922 in a Kinner Airster.

On June 17-18, 1928, Amelia Earhart was the first woman to cross the Atlantic Ocean. She flew a Fokker Trimoter, named "the Friendship", from Trepassey, New Foundland to Burry Port, Wales.
On an atlas or world map, find Trepassey, New Foundland. What are its latitude and longitude coordinates? ____________________ ____________________
On an atlas or world map, find Burry Port, Wales. What are its latitude and longitude coordinates? ____________________ ____________________

In 1932, Amelia Earhart was the first woman to fly **solo** across the Atlantic Ocean in her Lockheed "Vega". She flew from New York to St. John's NB. Canada, on to Harbour Grace, Newfoundland, and finally into Londonderry, Ireland.
On an atlas or world map, find the latitude and longitude coordinates for each of her stops.
New York: ____________________ ____________________
St. John's N.B. Canada: ____________________ ____________________
Harbour Grace, New Foundland: ____________________ ____________________
Londonderry, Ireland: ____________________ ____________________

In Jan. 1935, Amelia Earhart was the first woman to fly from Hawaii to Mainland, USA. She flew in her Lockheed "Vega" from Honolulu to Oakland, CA.
On an atlas or world map, find how many miles she flew from Honolulu to Oakland.
____________________ miles

In 1935, Amelia Earhart was the first woman pilot to fly from Mexico City to Newark, NJ. She flew a NR 965Y, the "Little Red Bus".
On a map, draw the route she flew: Mexico City to Tampico, Tampico to New Orleans, New Orleans to Mobile, Mobile to Atlanta, Atlanta to Washington, D.C., and Washington D.C. to Newark.

Amelia's last flight log showed her leaving Oakland, CA on May 20,1937. She flew to
Tucson, AZ,
New Orleans, LA
Miami, FL
San Juan, Puerto Rico
Caripito, Venezuela
Paramibo, Dutch Guiana
Fortaleza, Brazil
Natal, Brazil
St. Louis, Senegal
Dakar, Sengal
Gao, Mali
Fort Lamy, Chad
El Fasher, Sudan
Khartoum, Sudan
Massawa, Eritrea
Assab, Eritrea (Ethiopia)
Karachi, India (Pakistan)
Calcuta, Inda
Akyab, Burma
Rangoon, Burma
Bangkok, Thailand
Singapore
Bandoeng, Java
Koepang, Island of Timor (Indonesia)
Port Darwin, Australia
Lae, New Guinea
disappeared between Lae and Howland Island (Baker Island) her next intended stop.

Can you find all of Amelia's stops? If so, mark them on a map. If not, why not?
What are some of the names of places she flew that are different on a new map?
What do you think happened to her and her plane the "Electra"?
How many oceans did she cross?
What were their names?
On how many continents did she land?
What are their names?
On how many islands did she land?
What island is also a continent that she landed on near the end of her flight?

People and Places - Geography
Charles A. Lindbergh

Charles A. Lindbergh received his first flight instruction hours in a Lincoln Standard airplane. He became a wingwalker and parachutist to earn money to buy his own airplane. In 1923, he purchased a Curtiss JN-4 for only $500. After receiving just 30 minutes instruction on the aircraft, Charles soloed in the "Jenny". In the next few months, he logged 325 hours as a barnstormer and instructor and was involved in 5 crashes. During 1924-1925, Charles graduated #1 in his class in the U.S. Army, at Brooks Field, TX as a flying cadet. He was commissioned as 2nd Lieutenant in Mar. 1925 and resigned to become a reserve officer. He joined the Caterpillar Club where he collided in midair with another aircraft and he was forced to bail out.

In 1926, Charles Lindbergh joined the Robertson Aircraft Corporation as pilot on the St. Louis to Chicago Air-Mail route. He flew a Douglas M-2 and completed 99% of all his flights on time.

In 1927, a $25,000 prize was offered for the 1st nonstop flight between New York and Paris. Lindbergh needed only 2 months to have the "Spirit of St. Louis" designed and built with a 200-horse powered engine and an extra fuel tank which obscured his view out of the cockpit. On May 20,1927 Lindbergh departed New York; thirty-three and ½ hours later, he landed in Paris and won the $25,000 prize.

Between July 5 and Oct. 23,1927, Lindbergh flew the "Spirit of St. Louis" 22,350 miles across all 48 states. He visited 82 cities and was only late 1 time on his schedule. After the U.S. tour, Charles went to16 Latin American countries. This tour was 116 flying hours and 9,390 miles in length. On April 30,1928, the "Spirit of St. Louis" made its last flight to Washington, D.C. It was accepted at the Smithsonian Air & Space Museum, it is still there today. The "Spirit of St. Louis" made 174 flights totaling approximately 50,000 miles.

Charles Lindbergh and his family moved to England in 1936. They returned to the U.S. in 1939. At this time, he campaigned against the U.S. involvement in WWII. He resigned his commission in the Army Air Corps Reserve. Many Americans believed that he was unpatriotic. However, when the U.S. entered the war, Lindbergh worked as an aviation consultant to aircraft manufacturers. He also flew 50 combat missions in the Pacific Arena, testing aircraft fighters.

After WWII, Lindbergh became director of Pan American Airlines and an advisor on the U.S. Air Force board. He was reinstated as Brigadier General Lindbergh in the U.S. Air Force Reserves.

During the 1960's, Charles Lindbergh's interest in nature became his top priority. He worked on improving the quality of life. Charles A. Lindbergh died in Aug. 1974 and is buried on the island of Maui.

When Charles A. Lindbergh made his tour of the 48 states of the U.S.A., what 2 current states were not part of the U.S.A in 1927?

Lindbergh did not know the distance from New York to Paris. They went to a library and measured the mileage with a piece of string. How were they able to do that?

Charles Lindbergh traveled many places in his aviation career. Some of them are listed below, using a map or atlas and a string, find the distance between 2 of them.
Azores
Cuba
Belgium
Ireland
Bolivia
Greenland
Newfoundland
Washington, D.C.

Some of the cities Charles Lindbergh flew to on his Latin American tour were:
Havana
San Jose
Port-au-Prince
Panama City
San Juan
Belize
Mexico City
Caracas
In what countries are these cities located?

What tool do you think Charles Lindbergh used to see over the fuel tank in the front of the "Spirit of St. Louis"?

In what state is the city St. Louis located?

In what state is Maui located?

What large lake is located beside the city of Chicago?

Using an encyclopedia or books on Washington, D.C., find 3 landmarks that 5-year old Charles could have seen in 1907 when he visited D.C. with his father.
Using an encyclopedia, books on D.C., and the internet, find 7 landmarks that you could visit today.

People and Places = Geography
Wiley Post

Wiley Post was born on Nov. 22, 1898 in Texas. The family soon moved to a farm in southern Oklahoma near Maysville. Wiley dropped out of school at the advanced age of 12. He hated farming and dreamed of something different; he decided to attend a mechanic school in Kansas City.

In 1921, Wiley's life took a turn for the worse as he took up a life of crime in a small town near Chickasha. His brush with the law was due to steeling cars. He would throw tires in the middle of a rural road, when the driver stopped he would take the car. His unlawful career ended when he tried to hijack a carload of hunters. They turned the tables on him. He was convicted of robbery and sentenced to 10 years in prison at the ripe old age of 23. Fortunately, after just *13 months* Oklahoma's governor, J.B.A. Robertson, paroled him. Ironically *13 years* later when Wiley became famous, Gov. "Alfalfa" Bill Murray gave him a full pardon.

With his criminal life behind him, Wiley Post became a jumper with a barnstormer, Burrell Tibbs. This job allowed him to receive pilot instruction and a love for airplanes was sparked. Even though he nearly crashed on his first flight, Wiley became obsessed with owning his own airplane. By working the oil fields around Seminole, Wiley earned the money for a plane; however, he suffered a rare accident when a roughneck swung a sledgehammer on an iron bolt causing a chip to lodge in Wiley's eye. The eye became infected and it had to be removed. At this time, Wiley was only 28, had a 5th grade education, and one eye. How could he ever become a pilot? He was determined! He trained the good eye to perceive depth and through a loophole was allowed to obtain his license. After 700 flight hours, Wiley Post earned license #3259, signed by Orville Wright.

Wiley Post married Mae Laine, became the company pilot for F.C. Hall in Chickasha, and bought a Lockheed Vega. Wiley named the Vega, Winnie Mae after his daughter. With navigator, Harold Gatty, Wiley began a new chapter in his life. With Gatty he embarked on an around-the-world flight. Leaving New York in the fog and rain, the men flew to Newfoundland, England, Germany, Moscow, Siberia, Alaska, Canada, and back to New York. President Herbert Hoover welcomed them to the White House after a ticker tape parade. Wiley and Harold's flight had broken the old record, 21 days, by completing the task in just 8 days.

Wiley's next challenge was to make the round-the-world trip solo. Forty-one people contributed $41,000 in support of his effort. At dawn, July 15,1933, Wiley Post departed Floyd Bennett Field, Long Island in the Winnie Mae. Will Rogers joked that he wished he was with Wiley instead of that "robot". The "robot" was the first automatic pilot used in flight. When Wiley landed to refuel in Berlin, a squad of German soldiers kept crowds away; Adolph Hitler had just become chancellor of Germany.

The next stop was Moscow. Then, Wiley had to thread his way through the Ural Mountains which were 6,000 feet higher than the Winnie Mae was flying. Rain and fog added to his problems as he headed to Novosibirsk. He said later that if he had had a parachute, he would have used it in the mountains. Flying from Siberia to Alaska, Wiley became hopelessly lost. He flew over central Alaska looking for Nome. Finally he landed at what was Flat, Alaska. He skidded into a ditch, lurched over the on the right wing, crumpled the right landing gear, and bent the propeller. A new propeller and landing gear was shipped from a lumber camp; they repaired the Winnie Mae and Wiley headed to Canada. Exhausted, Wiley tied his finger to the stick with string. When he fell asleep, the stick jerked his finger and woke him up. (Wiley estimated that he fell asleep 200 times during the entire trip.)

When he arrived in New York on July 22, 1933, he was hailed as a one-eyed superman. Fifty thousand people cheered as he raised up out of the cockpit. Wiley had broken his own record by 21 hours, completing the flight in 7 days, 18 hours, and 49 minutes. Wiley became the 1st man to fly around-the-world twice, once solo. This time, President Franklin Roosevelt welcomed him to the White House.

Wiley's new dream was a bit different. He wanted to bread the world altitude record. The Winnie Mae was not pressurized for high altitude, so Wiley designed the 1st pressurized suit. This suit allowed the pilot to maintain normal atmospheric pressure and oxygen content in the stratosphere.

Whit the help and sponsorship of Frank Phillips and the Phillips Petroleum Company, Wiley took off from Bartlesville, OK and reached an altitude of 55,000 feet. This was a new world altitude record. His pressurized suit was a prototype for the suits astronauts would need in the future.

The Winnie Mae was retired in 1935 and placed in the Smithsonian Air & Space Museum in Washington D.C. You can visit it there still.

In August of 1935, Wiley Post and Will Rogers flew a new Orion-Explorer to Alaska. On Aug. 15, 1935 they landed on a shallow river by an Eskimo sealing camp 15 miles from Point Barrow, AL. After receiving directions to Point Barrow, the men took off. Two hundred feet above the ground, the engine caught, sputtered, made an eerie roaring noise, and then silence as the plane fell to the ground. The U.S. Congress approved the burial of Wiley Post in Arlington Cemetery in Washington D.C. But, Mae chose Memorial Park Cemetery in Oklahoma City.

From The Daily Oklahoman on Aug. 17, 1935:

The tragedy that darted down from Artic clouds claimed men who had entrenched themselves in the love and admiration of the whole world…

No greater birdman has ever defied and conquered skies and seas. It is supremely bitter in the fields of broomcorn and among the derricks where Wiley Post firs caught the eagle's spirit and resolved to cross clouds and sky.

People and Places = Geography
Wilbur & Orville Wright

Wilbur Wright, Sept. 3, 1900 stated, "It is my belief that flight is possible and while I am taking up the investigation for pleasure rather than profit, I think there is a slight possibility of achieving fame and fortune from it."

Wilbur Wright was born in 1867 near Richmond, IN. The family moved to Dayton, OH in 1869 and Orville was born in 1871. When Wilbur was 11 and Orville was 7, their father gave them a toy helicopter that could fly. This was the toy that sparked their interest in flight. As young men, Wilbur and Orville started out in the newspaper business by building their own printing press using a tombstone and buggy parts. Meanwhile, as a side line, the brothers began to repair and race bicycles. In 1892, the brothers opened a bicycle shop named the Wright Brothers Manufacturing Company which made two models: the 'Van Cleve" and the "St. Clair". In 1899, the brothers began to study flying by reading everything they could find on the subject. This led to the building of their first glider in 1900. The glider had 2 wings about 17 feet long and 5 feet deep. One set is about 4 feet above the other, both wings are made of a tightly woven white material stretched over a light wooden frame. Wire bracing keeps the structure tight. There is an open space in the lower wing which is where the pilot rides, lying on his stomach.

They needed a place that was steep with strong, steady winds to test their glider. The weather bureau suggested the sand dunes at Kitty Hawk, NC. The glider, which weighed almost 100 pounds with the chains, just floated in the air as the strong breezes blew taking the glider 500-600 feet. Orville struggled to hold onto the cables that control the direction of flight. Wilbur was behind the glider pulling on another set of wires, the wings twist and the glider tilted and drifted to the side. This control is truly wonderful, but, the brothers haul the heavy glider up the hill over and over carefully watching how it descends each time. When the brothers pack up to return to Dayton, they leave the glider behind. It is too heavy to take back with them. A local woman took the sateen fabric off the wings and made dresses for her daughters.

In 1901, the Wright brothers return to Kill Devil Hills with a much larger glider. The wings are 7 feet by 22 feet. The glider itself weighs 100 pounds this year. The brothers used data from Otto Lilienthal to design the new wings, but the glider is disappointing. It only glides about 300 feet. The front rudder doesn't have much control of the pitch and the when the wings are warped to turn the glider, it settles backward and spins out of control. At the end of the 2 weeks, the brothers return to Dayton very discouraged.

In 1902, Orville used a machine very much like a wind tunnel to test the shape of the 1901 glider. He found that Otto Lilienthal's data tables were faulty. When the brothers arrive in Kill Devil Hills in 1902, the new glider has a wingspan of 32 feet and the width has decreased to 5 feet. A device called a hip cradle allows the pilot to operate controls for the wing-warping by moving his hips. The new glider weighed about 120 pounds and performs much better than the previous one. However, 1 out of every 50 flights spins out of control; Wilbur and Orville reasoned that in low-speed turns, the tail was acting like a vertical wing. It provided a sideways force that caused the glider to spin. They worked on the difficulty and achieved better and better results with control of the glider. The brothers felt that the only thing their craft needed was an engine and propellers.

In 1903, Wilbur and Orville Wright have built a 12 horsepower engine weighing 170 pounds for their aircraft. Neither of them had ever built an engine before. They spent 5 months designing the propellers to be shaped like rotating wings.
On Dec. 14th the brothers hoist the red flag to signal for the Lifesaving crew to come. With the restraining ropes in place, they start the motor and propellers. The brothers flip a coin to see who will be the first pilot, Wilbur wins. He pulls up the nose a bit too sharply and it stalls, settles back in the sand, breaking a few parts. It was airborne for 3 seconds.
On Dec. 17, 1903, the red flag is again hoisted. The wind is blowing much harder and it is Orville's turn to be the pilot. The wind blows so strong that Wilbur runs alongside the airplane to steady the wing as Orville takes off. Orville flies for 12 seconds for a distance of 120 feet. Three more flights were made that day, the longest of which was 59 seconds, covering 852 feet. As the brothers prepared for a 5th flight, a huge gust of wind picked up the airplane and rolled it over and over. It was so damaged that more flights were not possible. The Wrights walked 4 miles up the beach to telegraph their father of their success.

Why didn't the brothers attempt to fly their glider or airplane in Dayton, OH?

Where else could they have attempted such flights?

How far did they travel to get from Dayton to Kill Devil Hills?

Later the Wright brothers went to France, Germany, Austria, Italy, and England to sell their invention. Find all of these countries and their capitals on a map. List the country with its capital.

In 1906, the Wright brothers were granted a patent on their airplane design. Using the internet, find out how to apply for a patent today. Find out how a patent protects the inventor under the law and any other information you think is important about patents.

Oklahoma Astronauts – 1966-Present

Lt. General Thomas A. Stafford

Thomas A. Stafford, Lt. General USAF and NASA astronaut, was born in Weatherford, OK. He graduated with honors in 1952 from the U.S. Naval Academy, Annapolis, MD and was commissioned as a second lieutenant in the USAF. In 1953, he received his pilot wings at Connally AFB, Waco, TX. He finished advanced interceptor training and was assigned to the 54th Fighter Interceptor Squadron, Ellsworth AFB, Rapid City, SD. In 1955 his new assignment was to the 496th Fighter Interceptor Squadron, Hahn, AFB, Germany. His duties included flying F-860's as pilot, flight leader, and flight test maintenance.

General Stafford was in the 2nd group of astronauts chosen by NASA to participate in the Gemini and Apollo Projects. In Dec. 1965, he piloted Gemini VI, the 1st craft to rendezvous in space. In June 1966, he commanded Gemini IX and performed a demonstration of the optical rendezvous and a lunar orbit abort rendezvous. From Aug. 1966-Oct. 1968, he headed mission planning analysis for Project Apollo. General Stafford was commander of Apollo 10 in May 1969. It was the 1st flight of the lunar module to the moon, the 1st rendezvous around the moon, and the entire lunar landing procedures except for the actual landing. General Stafford was in the Guiness Book of World Records for the highest speed ever reached by man, attained during his Apollo 10 reentry at 24,791 statute mph.

In 1970, General Stafford became Deputy Director of Flight Crew Operations. However, in July of 1975, he took to the skies again as Commander of the Apollo-Soyuz Test Project mission. It was a historic, joint space flight venture; the 1st mission between American astronauts and Soviet cosmonauts.
General Stafford was promoted to Lieutenant General, Mar. 15,1978; he retired in 1979. In June of 1990, Vice President Quayle asked Gen. Stafford to Chair a team to advise NASA on President Bush's vision to return man to the moon and start the exploration of Mars.

Throughout his distinguished career, Gen. Stafford earned many special honors. Just a few of many ore: 2 NASA Distinguished Service Medals, 2 NASA Exceptional Service Medals, the Air Force Distinguished Service Medal with 3 Oak Leaf Clusters, and the Congressional Space Medal of Honor. He was inducted into the Oklahoma Commerce and Industry Hall of Fame, the National Hall of Fame, and the Aerospace Walk of Honor in 1997.

Oklahoma Astronauts

Colonel Stuart Allen Roosa

Stuart Allen Roosa, Colonel U.S.A.F. and NASA astronaut, was born Aug. 16,1933 in Durango, Colorado. He moved early in life to Claremore, Oklahoma and studied at Oklahoma State University. Later, he attended the University of Arizona and graduated with honors from the University of Colorado.

Stuart Roosa's active duty in the Air Force was from 1953 to 1976. He was an experimental test pilot at Edwards Air Force Base, CA. He was a maintenance flight test pilot at Olmstead Air Force Base, PA flying F-101 aircraft. Also during his Air Force career was assigned as a fighter pilot at Langley Air Force Base, VA flying F-84F and F-100 aircraft. He logged 5,500 hours flying time.

Col. Roosa was 1 of 19 astronauts selected in April 1955. He was on the support crew for Apollo 9; his 1st space flight was aboard Apollo 14, Jan. 31 - Feb. 9, 1971. Roosa remained in the lunar orbit avoard the command module, "Kittyhawk". While in orbit Roosa performed visual and photographic assignments.

On the moon, Shepard and Mitchell deployed and activated scientific equipment and experiments. The eventually collected about 100 pounds of lunar samples to bring on the return to Earth. Apollo 14 achieved the 1st use of the MET, Mobile Equipment Transporter. It delivered the largest payload placed on the lunar surface, performed the longest lunar EVA, 9 hours 17 minutes, accomplished the1st use of a shortened lunar orbit rendezvous technique, 1st use of color tv on the surface, and the1st extensive orbital science period conducted during CSM solo operations.

Col. Roosa was backup command pilot for Apollo 16 and 17 and was later assigned to the STS program. He retired from NASA in 1976. He served as Corporate Vice President International Operations, U.S. Industries, Inc. and President U>S>I> Middle East Development Co. Ltd., Athens, Greece. Until his death on Dec. 12, 1994, Stuart Roosa was President and owner of Gulf Coast Coors, Inc., Gulfport, MS.

Among many special honors Stuart Roosa received are the: NASA Distinguished Service Medal, the Air Force Commendation Medal, the Air Force Distinguished Service Medal, the Command Pilot Astronaut Wings, the Robert Goddard Trophy, and was inducted in the Oklahoma Aviation and Space Hall of Fame.

Oklahoma Astronauts

Owen Garriot Ph.D.

Owen Garriot was born Nov. 22,1930 in Enid, Oklahoma. He graduated from Enid High School, received a BS from the University of Oklahoma and his MS and Ph.D. from Stanford University. He completed 1 year in the US. Air Force Pilot Training Program.

Owen Garriot served as electronics officer for the U.S. Navy 1953-1956. In 1965, he was 1 of the 1st 6 scientists/astronauts selected by NASA. His 1st space flight was aboard Skylab in 1973. While aboard he set a new record of about 60 days in space. The focus of the flight was studies of the sun, earth resources, and human adaptation to weightlessness in space.

Between his flights, Garriot served as Deputy, Acting, and Director of Science Applications at JSC. From 1984 to 1986, he held the position of Project Scientist in the Space Station Project Office. He advised the project as to the scientific suitability of the Space Station design.

Owen Garriot's 2nd flight was aboard Spacelab-1 in 1983 which lasted 10 days. Over 70 experiments in 6 science disciplines were conducted. He operated the 1st Amateur Radio Station from space, W5LFL which is now common aboard STS flights and the ISS.

Later, Garriot served on NASA and National Research Council Committees. He was Vice President of Space Programs Teledyne Brown Engineering. This division provided payload integration for all Spacelab projects and was involved with the U.S. Laboratory for the ISS.

Much of Owen Garriot's time has also been spent assisting in various charity activities in Enid, Oklahoma, including the Enid Arts and Sciences Foundation. He was a co-Founder in 1992. As Adjunct Professor in the Laboratory for Structural Biology at the University of Alabama, he has participated in research activities involving new microbes. His research has taken him to exotic places such as the Azores and 3 trips to Antarctica from which they retrieved meteorites for study.

Owen Garriot has received many special honors, a few of them are: the National Science foundation Fellowship, NASA's Distinguished Service Medal, NASA's Space flight Medal, and the Goddard Memorial Trophy. He was inducted into the Oklahoma Air and Space Hall of Fame, the U.S. Astronaut Hall of Fame, and Oklahoma's Military Hall of Fame.

Oklahoma's Astronauts

Colonel William Pogue

William Reid Pogue, Col. U.S. Air Force and NASA astronaut was born Jan. 23, 1930 in Okemah, Oklahoma. He resides now in Sand Springs, OK and is an Honorary Board Member for the Tulsa Air and Space Museum. He received a BS degree from Oklahoma Baptist University and a Master of Science degree in Mathematics from Oklahoma State University.

Col. Pogue enlisted in the Air Force in 1951 and was commissioned in 1952. From 1953 to 1954, he completed a combat tour in the Korean conflict, then was a member of the USAF Thunderbirds for 2 years. He flew over 50 types of American and British aircraft and is qualified as a civilian flight instructor.

Col. Pogue is 1 of 19 astronauts selected by NASA in April 1966. He was a member of the astronaut support crews for Apollo 7, 11, and 14. On Nov. 16,1973, he was the pilot of Skylab 4, the final manned visit to the Skylab orbital workshop. His mission concluded Feb. 8, 1974 and set a new record for the longest manned flight: 84 days, 1 hour, and 15 minutes covering a record number of miles: 34.5 million miles. They successfully completed 56 experiments, 26 science demonstrations, 15 subsystem detailed objectives, and 13 student investigations. They acquired extensive earth resource observations data, information on long-term physiological effects of weightlessness on crew members, logged 338 hours of operations of the Apollo Telescope Mount, and performed 2 EVA's lasting13 hours, 31 minutes.

William Pogue retired from the USAF on September 1, 1975 and is now retired from NASA. William Pogue is self-employed as a consultant and producer for aerospace, general viewer videos on space flight.

Col. Pogue received may honors during his distinguished career, a few of them are: the NASA Distinguished Service Award, Johnson Space Center Superior Achievement Award, the Air Medal, the Air Force Commendation Medal, the Dr. Robert Goddard Memorial Trophy, the Air Force Distinguished Service Medal, the General Thomas White USAF Space Trophy, and was inducted into the Oklahoma Aviation and Space Hall of Fame.

Oklahoma Astronauts

Shannon W. Lucid Ph.D.

Shannon W. Lucid, Chief Scientist, NASA Headquarters, was born January 14,1943 in Shanghai, China; but Shannon considers Bethany, Oklahoma her hometown. She graduated from Bethany High School in 1960 and received a BS in chemistry from the University of Oklahoma in 1963. She continued her education earning a master of science and doctor of philosophy degrees in biochemistry from the University of Oklahoma in 1970 and 1973.

Dr. Lucid's career includes a wide variety of endeavors. She was a teaching assistant at the University of Oklahoma, senior laboratory technician at Oklahoma Medical Research Foundation, chemist at Kerr-McGee, graduate assistant at University of Oklahoma Health and Science Center
S Department of Biochemistry and Molecular Biology, research associate with the Oklahoma Medical Research Foundation, and astronaut candidate training program.

Dr. Lucid was selected by NASA in January 1978 and became and astronaut in 1979. She's qualified as a mission specialist on Space Shuttle flight crews. A few of her technical assignments have been Shuttle Avionics Integration Lab, the Flight Software Laboratory, Astronaut Office interface at KSC, spacecraft communicator at JSC, Chief of Mission Support, and Chief of Astronaut Appearances.
A veteran of **5** flights, Dr. Lucid has logged 5,354 hours (223 days) in space. She served

as Mission Specialist on:	STS-51G, June 17-24, 1985
	STS-34, Oct. 18-23, 1989
	STS-43, Aug. 2-11, 1991
	STS-58, Oct. 18-Nov.1, 1993.
Her most recent flight:	Board Engineer 2 on Russia's Space Station Mir, launched Mar. 22, 1996 aboard STS-76, returning Sept. 26, 1996 aboard STS-79.

Dr. Lucid holds an international record for the most flight hours in orbit by any non-Russian and the most flight hours in orbit by any woman in the world. In completing her mission onboard Mir, Dr. Lucid logged 75.2 million miles in 188 days, 4 hours, 0 minutes and 14 seconds in space.

In Feb. 2002, Dr. Lucid was selected as NASA's Chief Scientist. She's stationed at NASA Headquarters in Washington, D.C. Her responsibilities are developing and communicating the agency's science and research objectives to the outside world.

Dr. Lucid is the recipient of numerous awards; the most recent is the Congressional Space Medal of Honor by the President of the United States. She is the first woman to receive this prestigious award. Dr. Lucid was also awarded the Order of Friendship Medal by the Russian President Boris Yeltsin. This is one of the highest Russian civilian awards and the highest that can be presented to a non-citizen.

Oklahoma Astronauts

Commander John Bennett Herrington

John Bennett Herrington, Commander U.S. Navy and NASA astronaut, was born September 14,1958 in Wetumka, Oklahoma. He grew up in CO, WY, and TX; currently, he resides in Spicewood, TX. He received his BS degree from the University of Colorado in 1983 and a Master of Science in aeronautical engineering from the U.S. Naval Postgraduate School in 1995.

John Herrington received his commission from Aviation Officer Candidate School and was designated a Naval Aviator in 1985. His 1st operational assignment was with Patrol Squadron Forty-Eight, VP-48, where he made 3 operational deployments. While assigned to VP-48, he was designated a Patrol Plane Commander, Mission Commander, Mission Commander, and Patrol Plane Instructor Pilot. His next assignment was VP-31 as Fleet Replacement Squadron Instructor Pilot. During this time, he attended the US Naval Test Pilot School; after graduation, he reported to Force Warfare Aircraft Test Directorate as test pilot for the Joint Primary Aircraft Training System. He flew numerous variation of the P-3 Orion, the T346, and the DeHavilland Dash 7. Commander Herrington was then assigned to the Bureau of Naval Personnel Sea Duty Component.

NASA selected Commander Herrington for the astronaut corps in April 1996. He trained for 2 years at Johnson Space Center and was assigned to the Flight Support Branch of the Astronaut Office. He served on the Astronaut Support Personnel Team and was responsible for shuttle launch preparations and post landing operations. Recently, he flew aboard STS-113, logging 330 hours in space and 3 EVA's totaling 19 hours and 55 minutes. His flight aboard Endeavour began on Nov. 23 and ended Dec. 7, 2002. It was the 16th STS mission to dock with the ISS. The mission included delivery of the Expedition 6 crew, delivery and installation of the P1 Truss, and cargo transfer from the shuttle to the Station. Commander Herrington performed 3 EVA's for a total of 19 hours, 55 minutes. STS-113 brought home the Expedition 5 crew from their 6 month mission onboard the ISS. STS-113 spent 13 days, 18 hours, and 47 minutes in space.

In his relatively short career, Commander Herrington has received the: Navy Commendation Medal, the Navy Meritorious Unit Commendation, the Coast Guard Meritorious Unit Commendation, the National Defense Medal, and 3 Sea Service Deployment Ribbons.

Commander John Herrington is currently in the NASA Astronaut Program.

Astronaut or Aviation,
Suggestions for Study Questions for Students

1. Have students find the birth or special locations for each astronaut on an Oklahoma map.

2. Find the Direction finder or compass rose on the map. What direction from your town are the places in question #1?

3. Find the map grid on the Oklahoma map. Locate the towns from question #1 and note their map grid coordinates.

4. Using the map grid system find the closest airport to your city or one of the birth cities of the astronauts.

5. Is there an airport located at **0-8?**

6. What direction is Shannon Lucid's "hometown" of Bethany from Tulsa, OK?

7. On the reverse side of the Oklahoma map there are several cities and towns that are enlarged. On the Oklahoma City and vicinity map, describe how airport symbols in the enlargement are different than those on the other side.

8. Divide the class into small groups. Assign a flight from 1 destination to another within the state of Oklahoma to each group.
   What is the distance of the flight?
   What route would the pilot take? (Often pilots follow roads in their flight plan.)
   Assign a refuel scenario, where would each team need to land and refuel?
   If your plane developed engine trouble ½ way to the destination, where would they need to land? Where should they NOT land? Why?

9. Mark 7 locations on the Oklahoma map that you have learned are important to historic Oklahoma pilots or astronauts.

10. What do the some of the NASA acronyms stand for that are in the previous pages about astronauts?

11. Divide the class into 5 groups. Assign each group one of Dr. Shannon Lucid's space flights to research, discovering the activities and accomplishments of each flight. Have each group share with the class. It is truly amazing what she has accomplished.

International Space Station

Find the names of all the International Space Station partner countries.

Mark each country on the world map.

Draw the flag of each country.

Using an encyclopedia, atlas or books, find:
- the capital of each country.
- the population of each country.
- the climate of each country.
- the products made in each country.
- the sports or activities enjoyed.
- the language spoken in each country.

Using photos taken from space by astronauts onboard the International Space Station or the Space Shuttle, have students identify:

Rivers
Lakes
Islands
Deltas
Peninsulas
Mountains
Volcanoes
Bays
Valleys
Deserts
Oceans
Seas
Cities
Highways
Bridges
Plateaus

Divide the class into small groups.
Using play-dough, have groups of students make the landform or landforms they found in their photo. Using the coordinates given with each photo, mark the location of the photo on the map. Using an atlas, have the groups research their location. Have the groups discuss the quality of life in their photo. For example, kinds of things you could do in this location, the climate, population, and resources.

Have the groups share their findings with the class.

Oklahoma Celebrates Flight

Aviation Lessons

Air Plane Wings and Why They Fly!
Sled Kite
Rotor Motor
Right Flight
How Is a Plane Controlled?
Delta Wing Glider
Bag Balloons
Paper Airplane Ideas
Air Engines

Air Plane Wings and Why They Fly!

This activity demonstrates how the shape of an airplane's wing creates lift and allows the aircraft to fly.

Materials: ruler
a strip of paper (28 cm by 8 cm)
tape

Procedure: Fold the strip of paper in half and tape the top edge about 3 cm from the bottom.

This will make the top surface curbed and gives the paper the shape of an airplane wing.

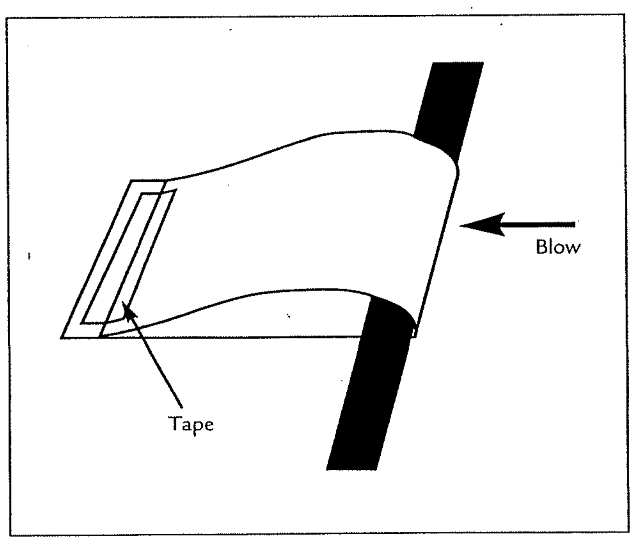
Slide the ruler into the fold of the paper.

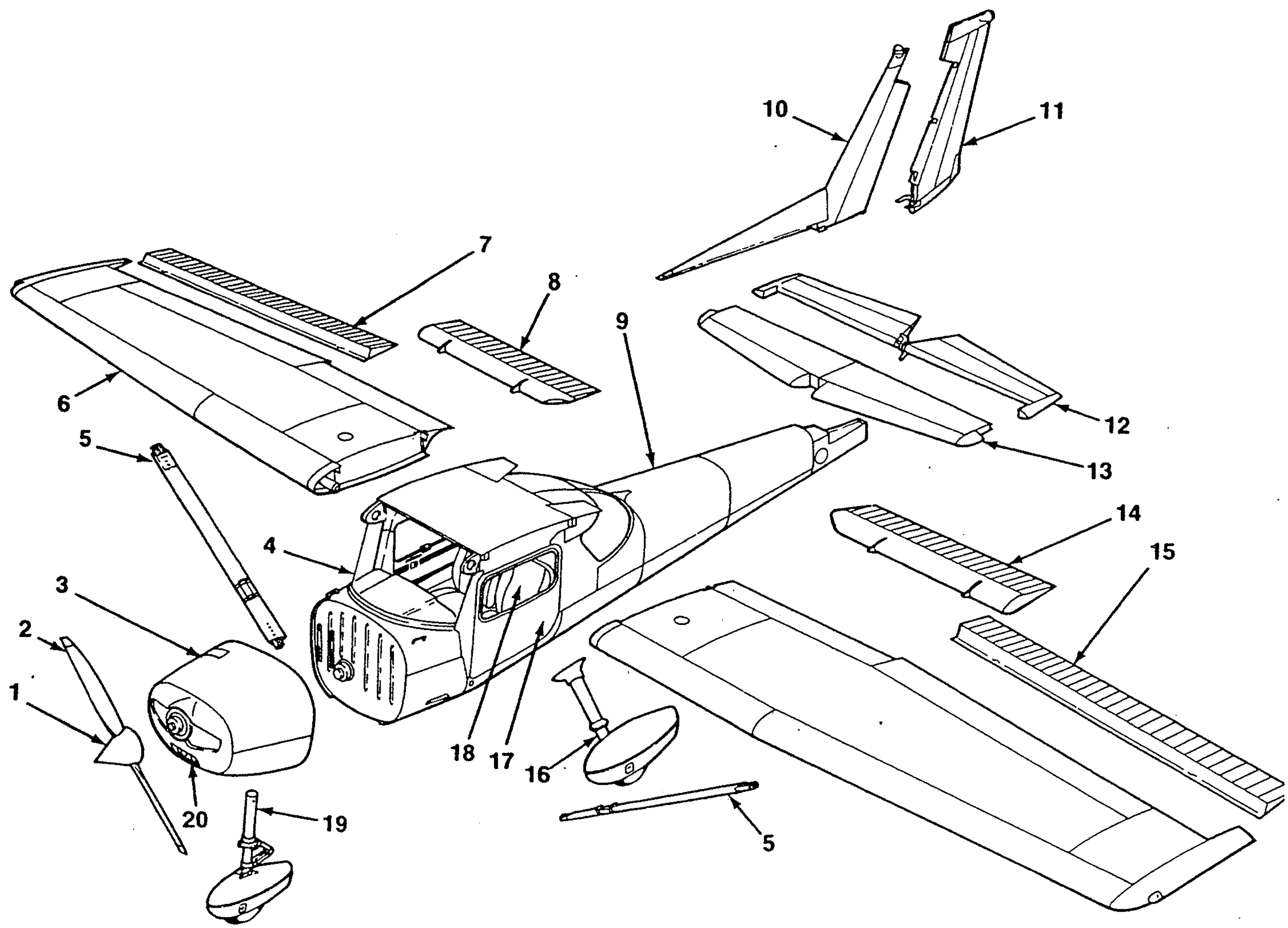
Blow on the front of the wing.

Discussion: Discuss what the students saw. Write their observations on the board or a chart. What do these observations show them?

Extension: Vary this activity by increasing the size of the curve in the wing by taping the paper farther away from the bottom. Does this make a difference in the lift?

Explanation: Because the top surface of the wing is curved, the air has to go faster over the top than under the bottom. This causes a pressure difference. There is more pressure on the bottom than on the top of the wing, which results in lift.

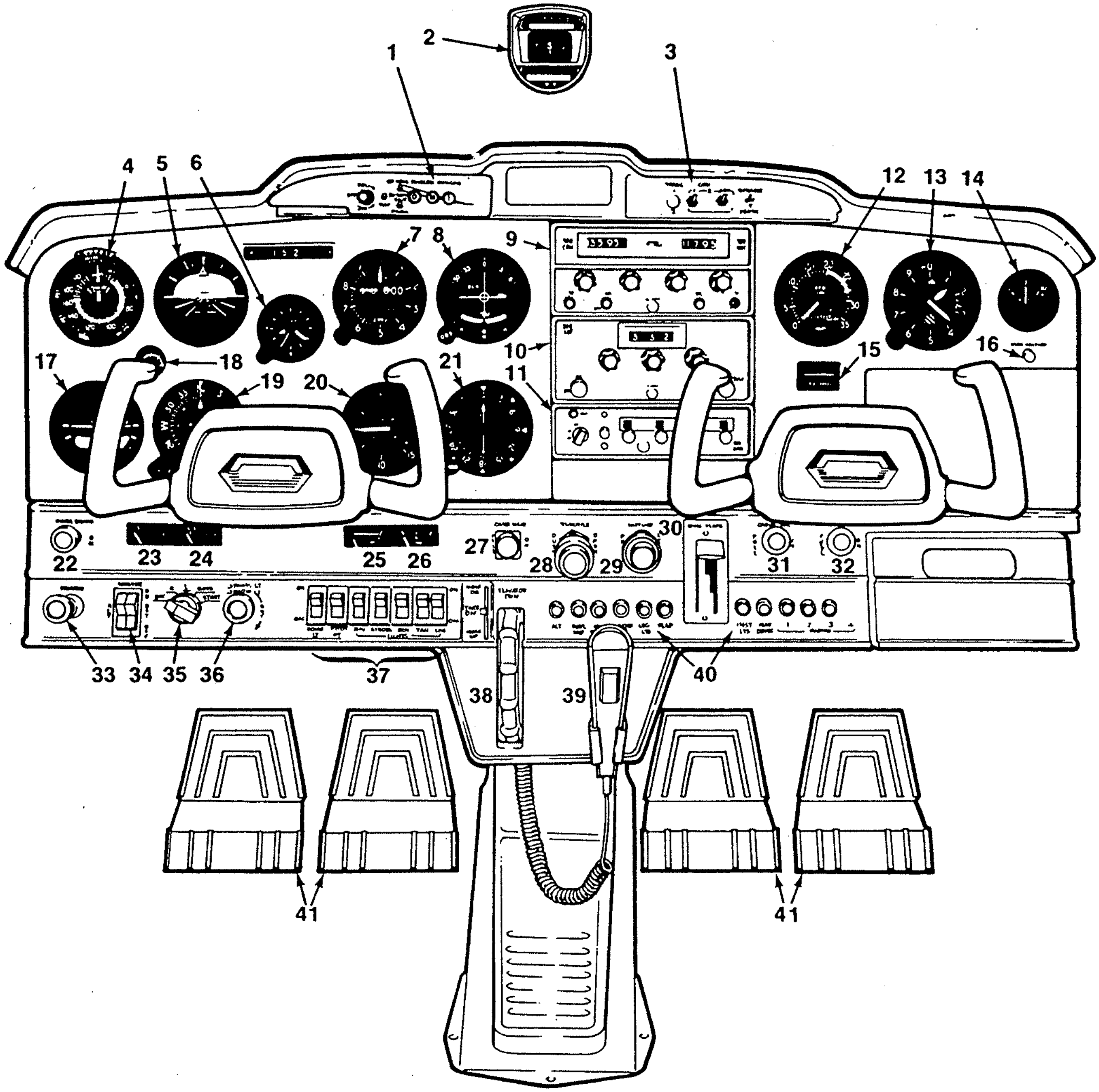




The Main Parts of an Airplane

1. Spinner
2. Propeller
3. Engine Cowl
4. Windshield
5. Wing Strut
6. Wing
7. Right Aileron
8. Right Flap
9. Fuselage
10. Vertical Stabilizer
11. Rudder
12. Elevator
13. Horizontal Stabilizer
14. Left Flap
15. Left Aileron
16. Main Landing Gear
17. Door
18. Seat
19. Nose Gear
20. Landing Lights

(over)



Instrument Panel

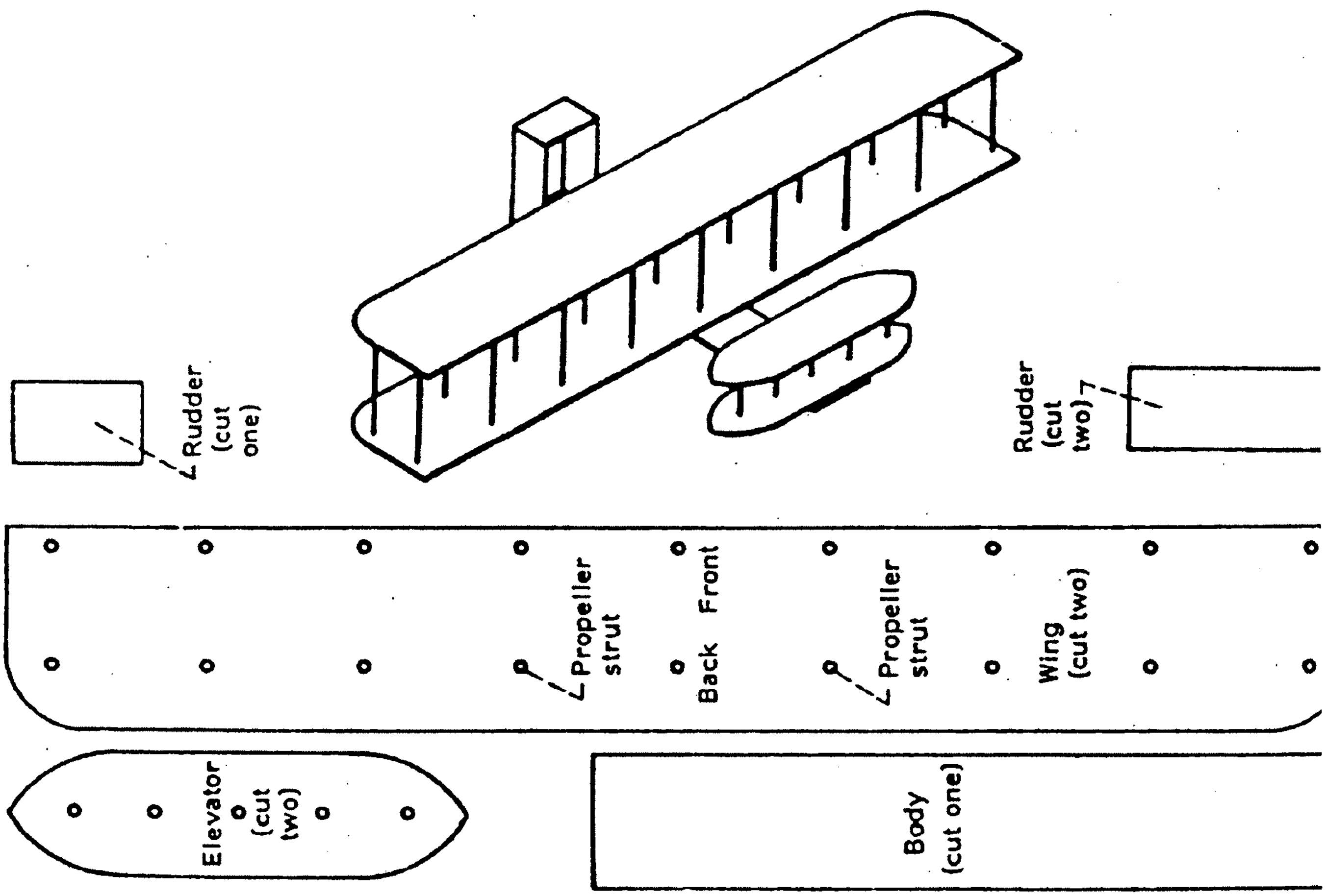
1. Marker Beacon Lights
2. Magnetic Compass
3. Audio Switching Panel
4. Airspeed Indicator
5. Attitude Indicator
6. Clock
7. Encoding Altimeter (Electric)
8. Omni Bearing Selector
9. NAV/COM (Radio)
10. Automatic Direction Finder (Radio)
11. Transponder
12. Tachometer
13. Altimeter (Barometric)
14. Battery/Alternator Indicator
15. Hour Meter
16. High Voltage Warning Light
17. Turn-and-Bank Indicator
18. Suction Indicator
19. Heading Indicator
20. Vertical Velocity Indicator
21. ADF Indicator
22. Parking Brakes
23. Fuel Gauge (Left Tank)
24. Fuel Gauge (Right Tank)
25. Oil Temperature Gauge
26. Oil Pressure Gauge
27. Carburetor Heat Control
28. Throttle Control
29. Fuel Air Mixture Control
30. Wing Flaps Control
31. Cabin Air Control
32. Cabin Heat Control
33. Engine Primer
34. Master Switch
35. Ignition Switch
36. Panel Light Control
37. Interior & Exterior Lights
38. Trim Tab Control
39. Microphone
40. Circuit Breakers
41. Rudder/Brake Pedals

HOW TO BUILD A MODEL WRIGHT FLYER

1 styrofoam meat tray or
2 styrofoam egg carton tops
tape
wooden toothpicks

1 dime
scissors
carbon paper
white glue

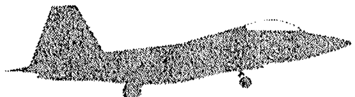
1. Trace pattern onto the styrofoam.
2. Cut out all parts. Shape the wings and elevators by cutting along the dotted lines.
3. Push toothpicks, lengthwise, through the center of each rudder. Glue each rudder upright at one end of the body - one to the right edge and the other to the left. Then glue on the rudder top.
4. Dip 18 toothpicks in glue and place the toothpicks upright on the dot marks. Dab glue on the toothpick tops and lay the second wing carefully on them, using the dots as a guide. Press together carefully. Cut a toothpick in half and glue one piece each to two middle toothpicks to look like propellors. Set aside to dry.
5. Assemble the elevator by dipping 5 half toothpick ends in glue. Place the toothpicks upright on the dots. Dab glue on the tops and place the second elevator on them. Press together carefully.
6. Glue the wings to the center of the body.
7. Glue the elevator to the other end of the body.
8. Tape a dime to the bottom of the Flyer between the wings and elevator.
9. Wait for the glue to dry. Now you are ready for take-off. Kneel down and fly your model - nice and low, just like the Wright Brothers flew their first flyer.



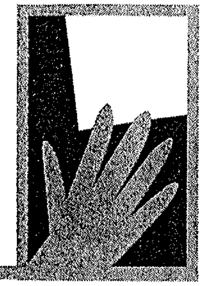
Credit to:

Take Me Out to the Airfield by Robert Quackenbush
Parents' Magazine Press, New York 1976

Sled Kite



Sled Kite



Sled kite flying journal

Date ______________________ Student name ______________________

Weather ____

Sled Kite Flight

What happened when I...

1. When I walked with my sled kite, my sled kite:

2. When I ran with my sled kite, my sled kite:

Sled Kite Tail, What if...

What if I add a tail to my sled kite? I think a tail will make my sled kite fly like this:

After I added a tail to my sled kite, it flew like this:

What if I shorten the tail, I think it will make my sled kite fly like this

What if I lengthen the tail, I think it will make my sled kite fly like this:

Conclusions

If the tail is shortened, then the sled kite will fly like this:

If the tail is lengthened, then the sled kite will fly like this:

SLED KITE

Objectives

The students will:
Construct and fly a simple sled kite.
Demonstrate how to make the kite fly at varying heights.

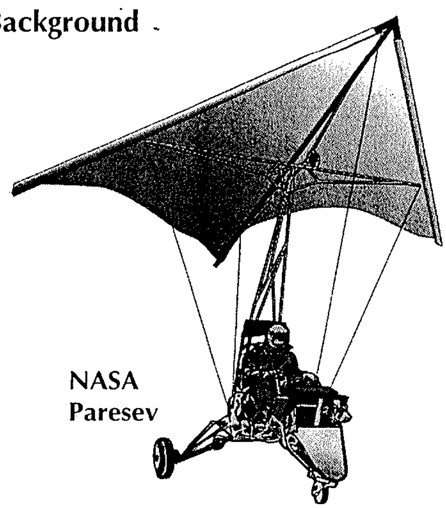
Standards and Skills

Science
Science as Inquiry
Unifying Concepts and Processes

Science Process Skills
Observing
Measuring
Predicting
Controlling Variables

Mathematics
Connections
Estimation
Measurement

Background



NASA Paresev

The sled kite in this activity is a model of a type of airfoil called a parawing. Like any wing, the parawing depends on the movement of air over its shape to generate a lifting force. (Parasails, parafoils, and paragliders are similar lift-generating devices.)

The NASA Paraglider Research Vehicle (Paresev) was the first flight vehicle to use the Francis Regallo-designed parawing. The little glider was built and flown by NASA during the early 1960's to evaluate the parawing concept, and to determine its suitability to replace the parachute landing system on the Gemini spacecraft. Although the parawing was never used on a spacecraft, it revolutionized the sport of hang gliding. Hang gliders use a parawing to glide from cliffs or mountain tops.

There are kites of all shapes, sizes, and colors. The sled kite in this activity is made from a piece of cloth or paper and two drinking straws. The straws are attached parallel to each other on opposite sides of the cloth or paper. This arrangement shapes the kite like a sled when it catches the air. The string attachment points are placed toward one end of the kite, which causes the opposite end to hang downward, and stabilizes the kite in flight.

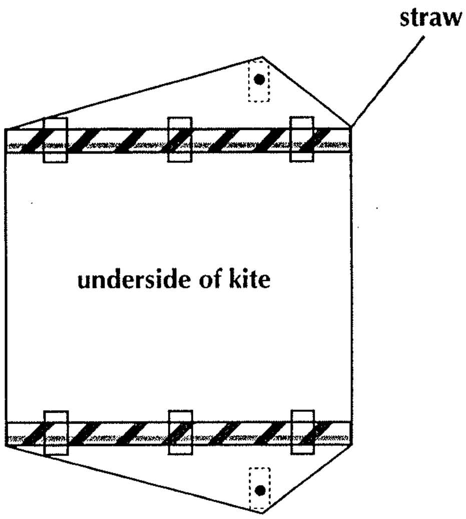
Materials (per kite)

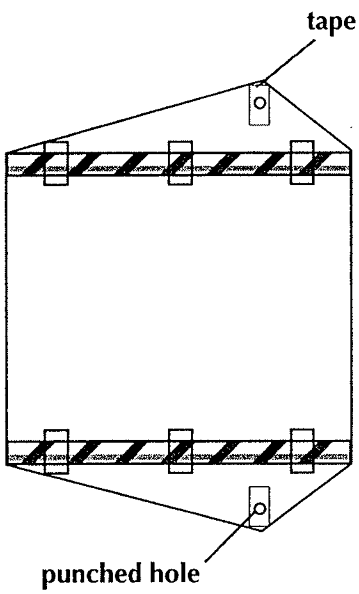
Sled Kite Template
Two drinking straws
Cellophane tape
Scissors
Two 45 cm lengths of string
One 1 m length of string
Metric ruler
Single-hole paper puncher
One paper clip
Markers, crayons, pencils
Selection of paper (crepe, tissue, newspaper)

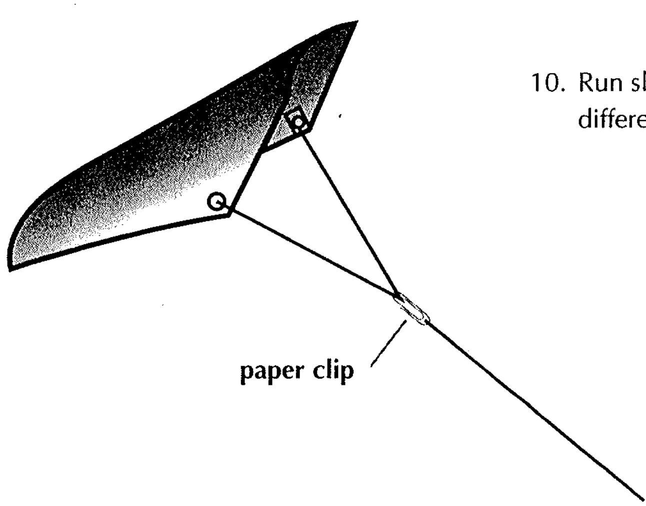
Management

Approximately 30 minutes are needed to build the sled kite. Additional time is needed to allow the students to fly and evaluate their sled kites outside.

Activity







1. Make a copy of the Sled Kite Template. Carefully cut out the sled kite.

2. Decorate the top of the sled kite using crayons, markers, or other media.

3. Trim the length of the two drinking straws so they will fit in the area marked for the straws. Tape them in place.

4. Place two or three pieces of tape in the marked areas covering the black circles.

5. Using a single-hole paper puncher, carefully punch the two holes marked by the black circles.

6. Cut two pieces of kite string 45 cm each. Tie a string through each hole. Tie them tight enough so you do not tear the paper.

7. Tie the opposite end of both strings to a paper clip.

8. Pick up the 1 m long piece of string. Tie one end of this string to the other end of the paper clip. Your sled kite is ready to fly!

9. Outside in a clear area, hold the 1 m length of string and run with the kite to make it fly.

10. Run slow and run fast, and observe how the kite flies at different towing speeds.

Discussion

1. Can kites be used to lift objects? *Yes, a popular beach activity uses a large kite (parasail) towed by a speed boat to lift a person high into the air.*

2. Why are kites made of lightweight material? *Lightweight materials insure the kite will weigh less than the "lift" produced by the kite.*

Assessment

1. Have students explain how their kite was built.

2. Have students demonstrate ways to make the kite fly higher, and to fly lower.

Extensions

1. Have the students decorate their kite using a minimum of three colors.

2. Record the length of time for each flight.

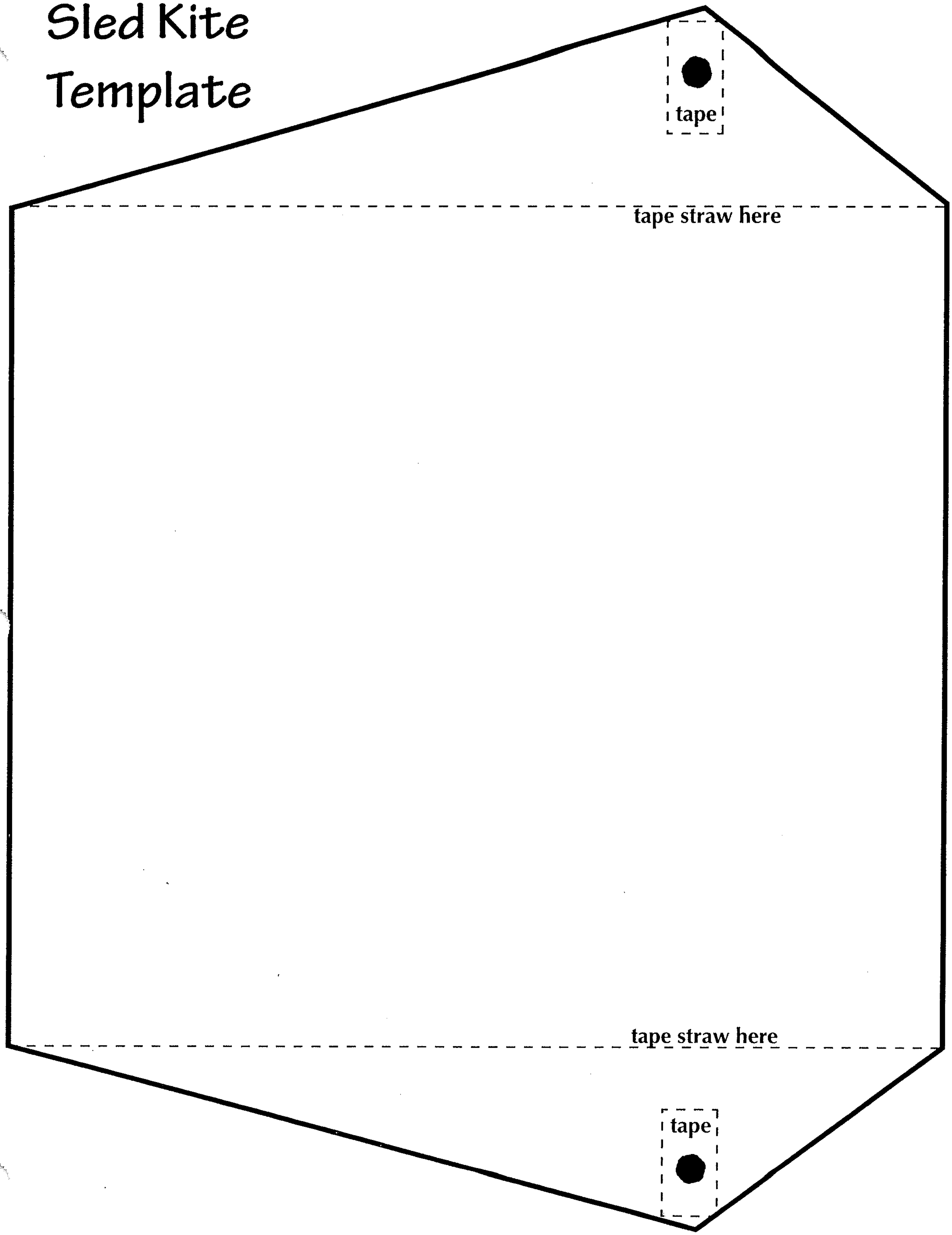
3. Have the students run a relay with a kite as a means to sustain its flight.

4. Design a kite and write the directions on how to build it.

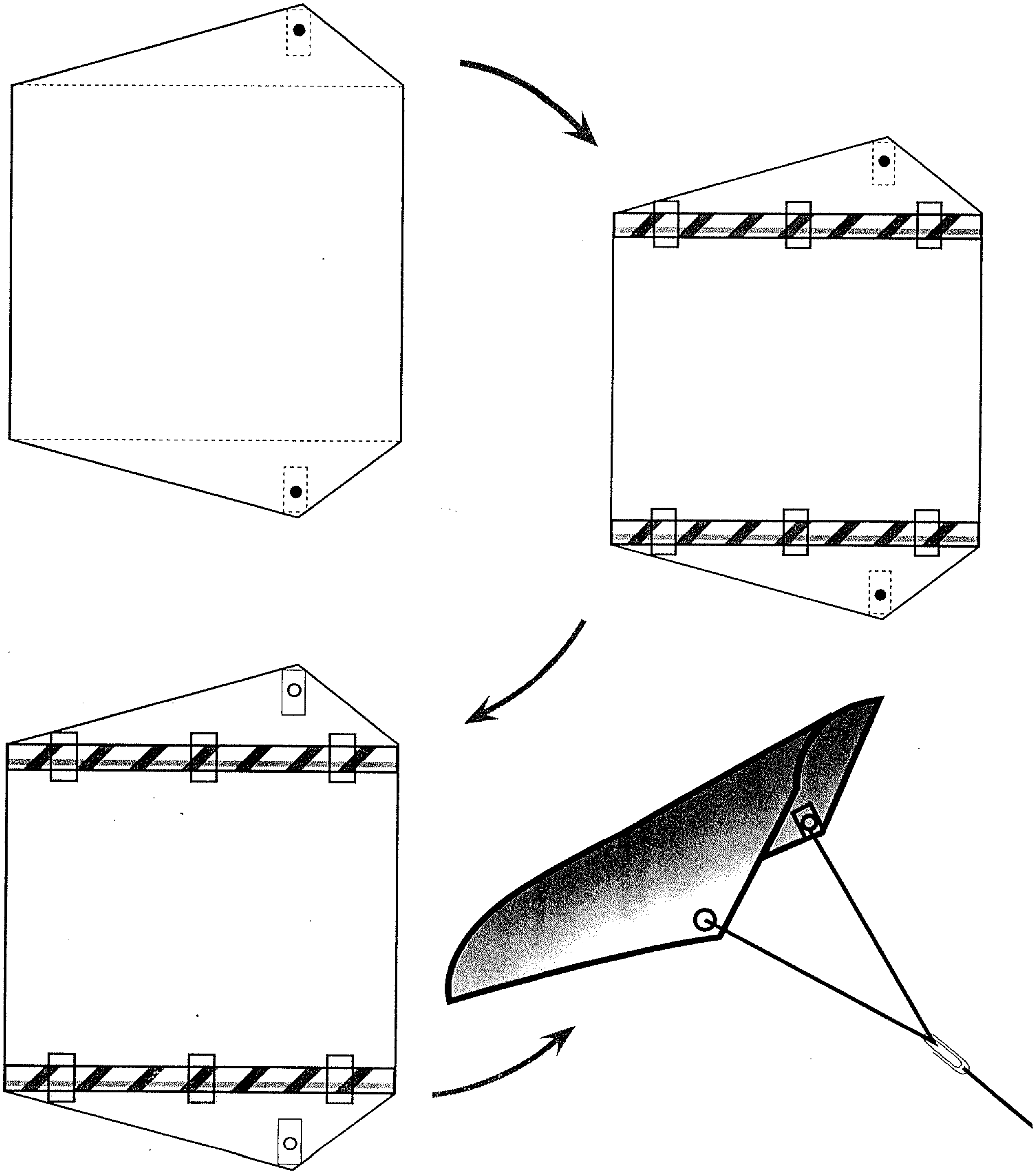
5. Add a tail to the sled kite using crepe paper, strips of newspaper, tissue paper, or garbage bags. Have students predict what, if any, changes will occur in the kite's flight characteristics. Conduct flights to test the predictions.

6. Research the history of kites.

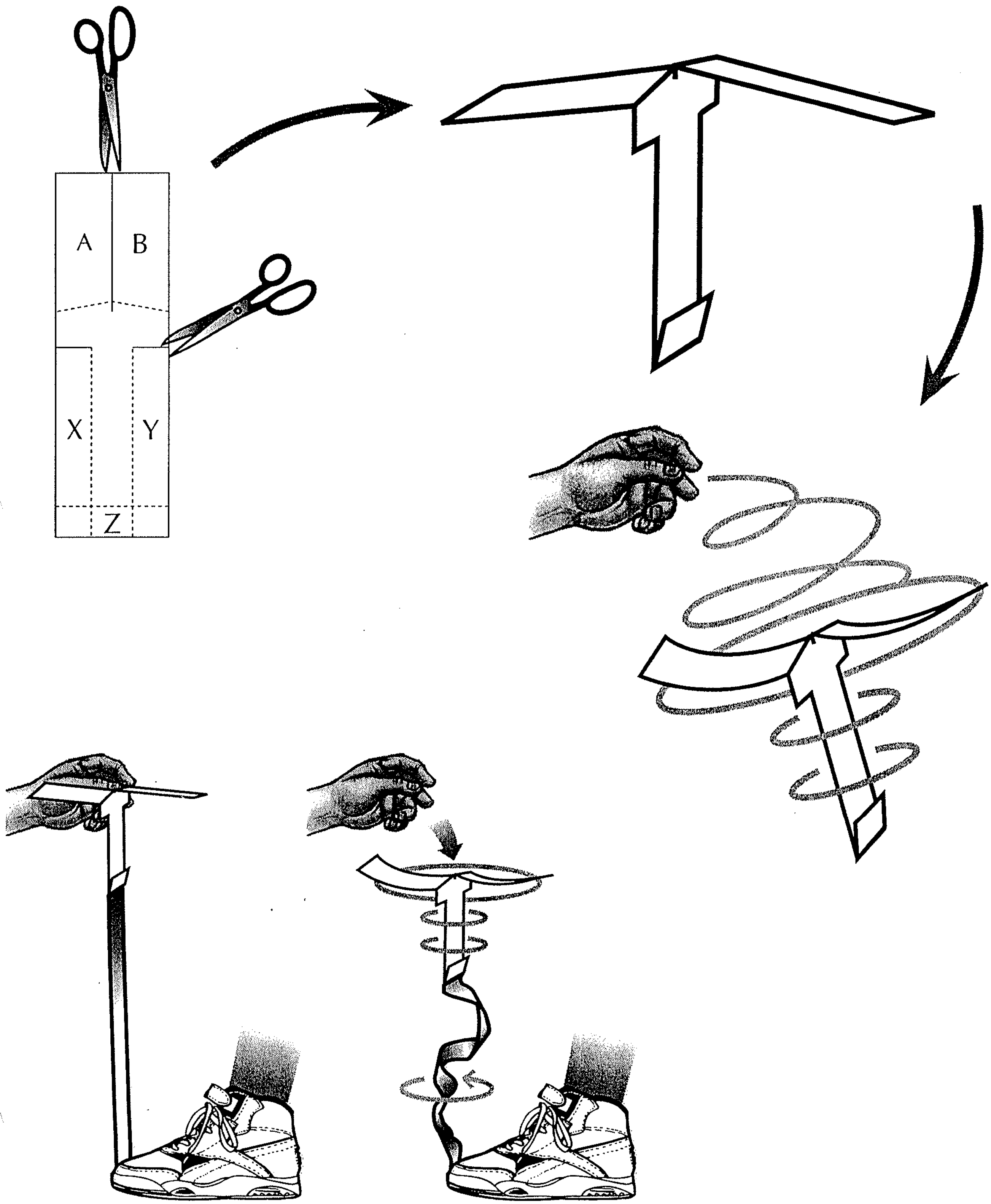
Sled Kite Template



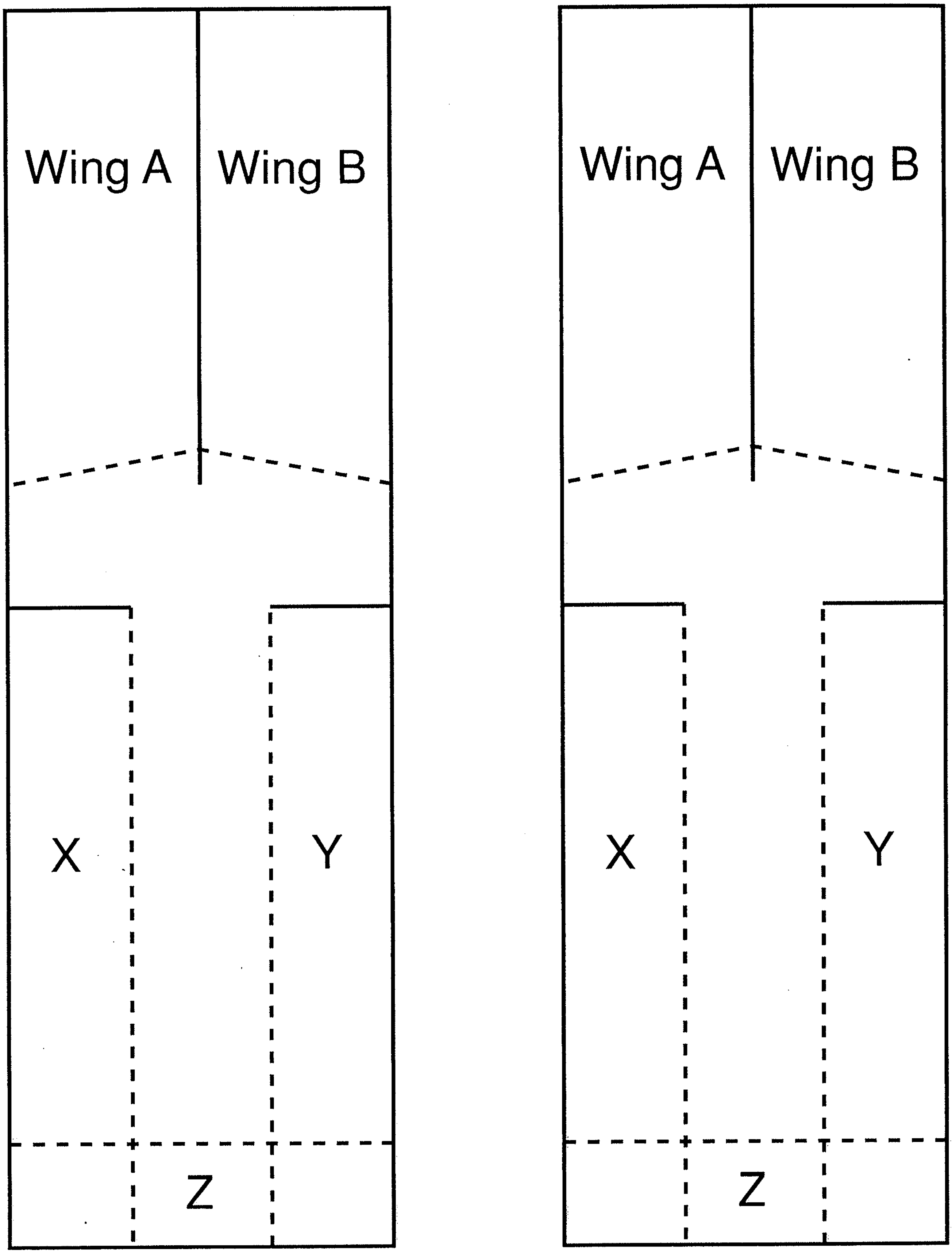
Sled Kite



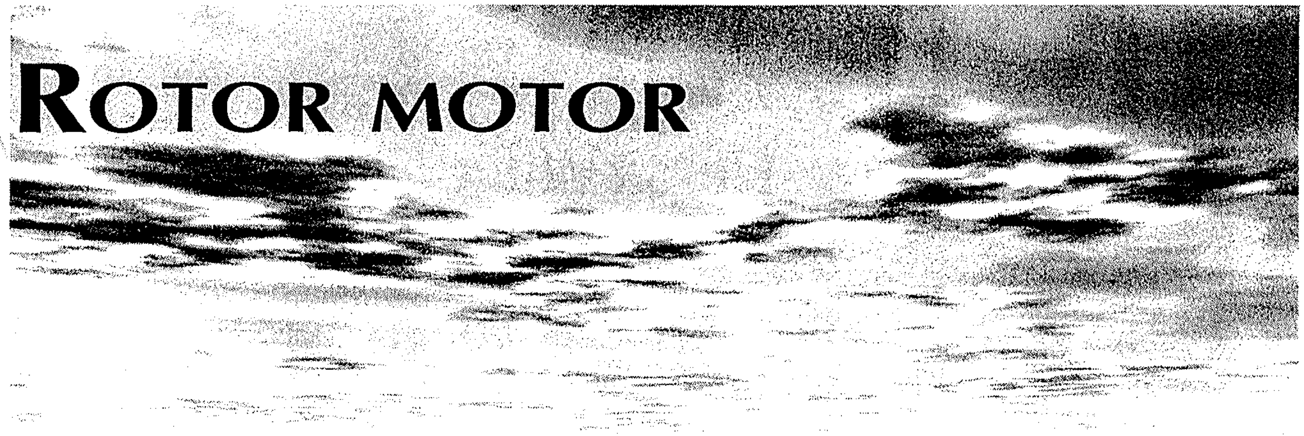
Rotor Motor



Rotor Motor Templates



ROTOR MOTOR



Objectives

The students will:
Construct a rotary wing model.
Define a mathematical relationship using a model.

Standards and Skills

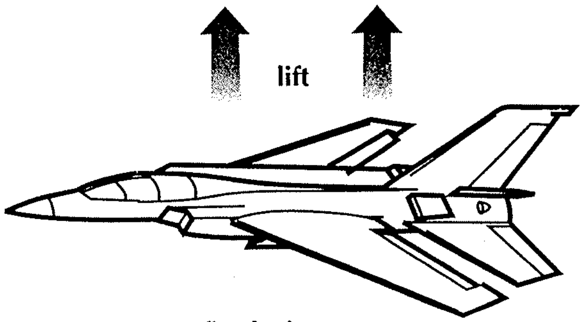
Science
Science as Inquiry
Physical Science
Position and Motion of Objects
Science and Technology

Science Process Skills
Observing
Making Models
Controlling Variables

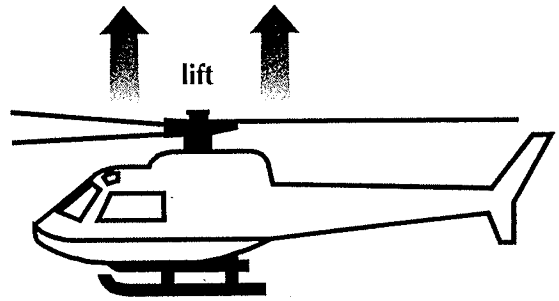
Mathematics
Problem Solving
Estimation
Measurement
Graphing

Background

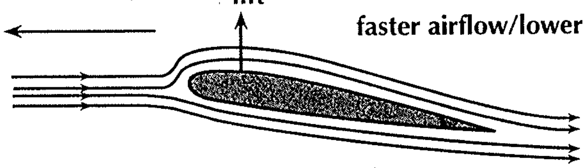
Air must move across the surface of a wing to produce lift. To fly, birds and insects use a flapping motion to move the air over and around the wing surface. The wings of airplanes are attached to the fuselage in a fixed position. Lift is generated by moving the entire wing and body through the air. *Helicopters* are *rotary wing aircraft*; they rotate the wing surface through the air to produce lift.



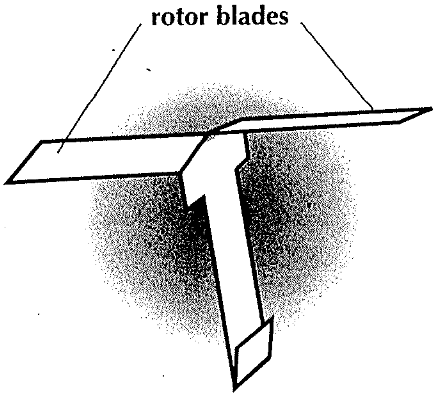
fixed wings



rotating wings



cross section of aircraft wing, or a rotor blade



paper model

Lift is produced by the pressure differences caused by the shape of rotating blades; this is the same way lift is produced by aircraft wings. The rapidly moving air over the top of the blade creates low pressure; the air beneath the blade is moving slower, so it creates higher pressure (see "Paper Bag Mask" pages 26-27, Bernoulli's principle, for more information). High pressure under the rotor blades creates lift which causes the aircraft to rise.

Since the paper models have no motor, they only have one source of lift. As the paper models fall they will spin, imitating the rotation of the rotor blades of a helicopter. Because there is no thrust to produce upward movement, the helicopter will not fly upward, but the spin will reduce the rate of fall by producing lift, resisting the force of gravity.

NASA builds and tests experimental helicopters and *tiltrotor* airplanes in an effort to achieve lower noise levels and greater fuel efficiency. Models are tested in NASA's wind tunnels at Langley, Lewis, and Ames Research Centers.

Materials

Plain white paper
Graph paper
Student Page with template and graph
Scissors
Measuring tape
Pencil or marker
3 m length of lightweight paper ribbon (or a strip of audiotape or videotape)

Management

The activity will take approximately 30-45 minutes.

Preparation

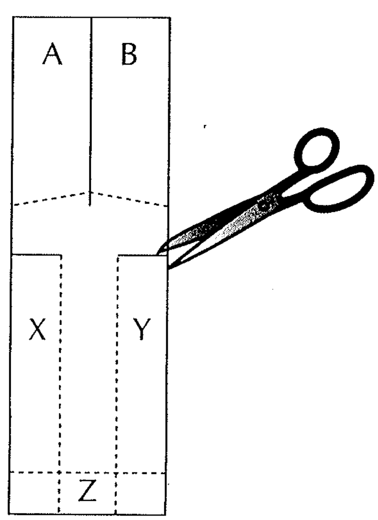
Open an old audio or videotape cassette and show the class the tape inside the cassette. The tape will be used for the activity.

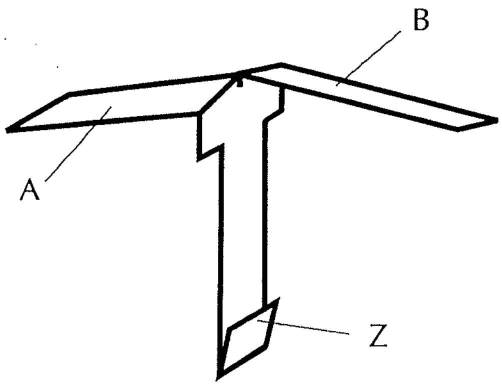
Team students with a partner or in cooperative groups of three or four.

Make enough copies of the rotor motor template so each team may construct a rotor motor. Have students use the template to construct rotor motors.

Activity

1. Cut along the solid lines of the template.



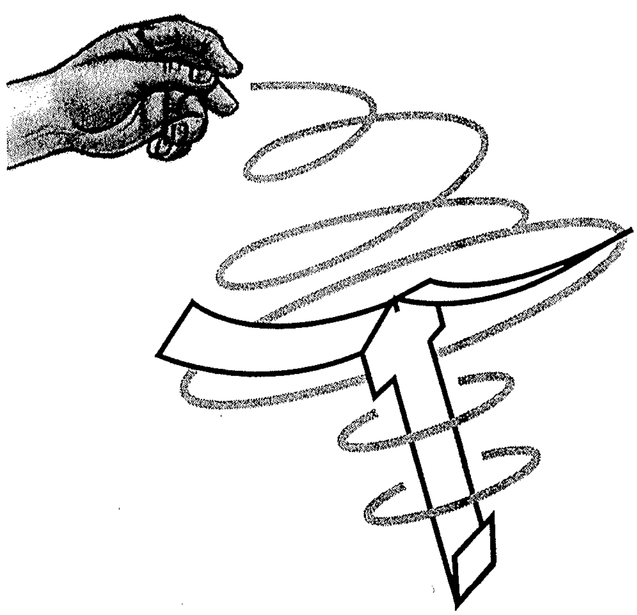


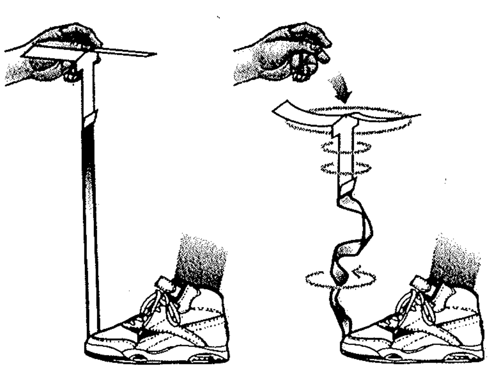
2. Fold along the dotted lines. The propeller blades should be folded in opposite directions. X and Y fold toward the center, and Z is folded up to give the body rigidity, and lower the *center of gravity.*

3. Stand up and drop the rotor motor. Have the students write or draw what they observed.

4. Drop an unfolded piece of paper and the rotor motor. Which one falls faster? *The paper falls faster because it is not continuously generating lift. The spinning rotor motor reduces the rate of fall by producing lift, resisting the force of gravity.*

5. Have the students predict what will happen when they wad up the paper and drop it. *It will drop faster than the sheet of paper and the rotor motor. The sheet of paper falls slower mainly because its larger surface area offers more resistance to the air than the compact, wadded paper.*





6. Can you accurately count the number of rotations the rotor motor made as it descended? *No—the rotations are fast and that makes accurate counting very hard.*

7. To determine the number of rotations, (1) tape the cassette ribbon to the rotor motor, (2) stand on the loose end, and pull the rotor up so there are no twists in the ribbon, and (3) drop the rotor as usual. How does the cassette ribbon make counting the rotation easier? *Each twist in the ribbon represents one rotation of the rotor motor. Counting the total number of twists equals the total number of rotations.*

Assessment

1. The teacher can observe the construction activities in progress.

2. Formulate a rule describing the relationship between the number of twists and the drop height of the rotor motor.

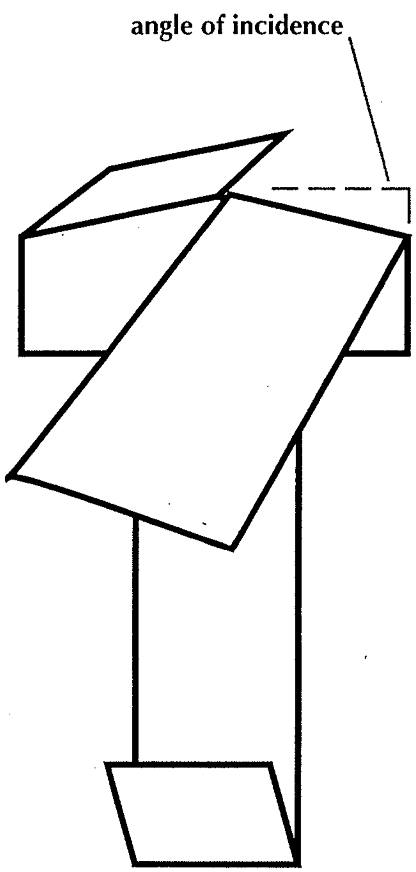
Extensions

1. Have students experiment with helicopters made from different weights of paper. Graph the results.

2. Have students design a new rotor motor.

3. Have students determine relationships between the weight, height of launch, shape, and length of the blades.

4. Have students determine whether the blades turn in a clockwise or counterclockwise direction.



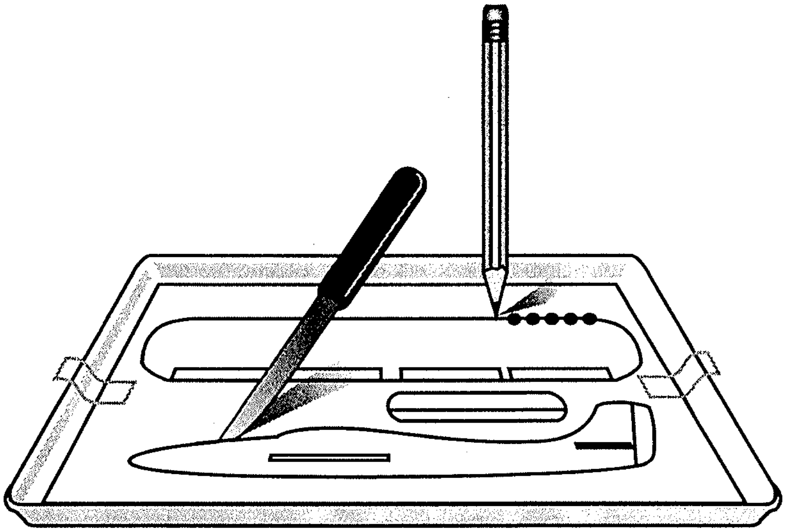
5. Have students increase and decrease the angle of incidence (see illustration) of the rotor blades, and determine if the new angles make the rotor motor rotate faster or slower, and if it flies longer.

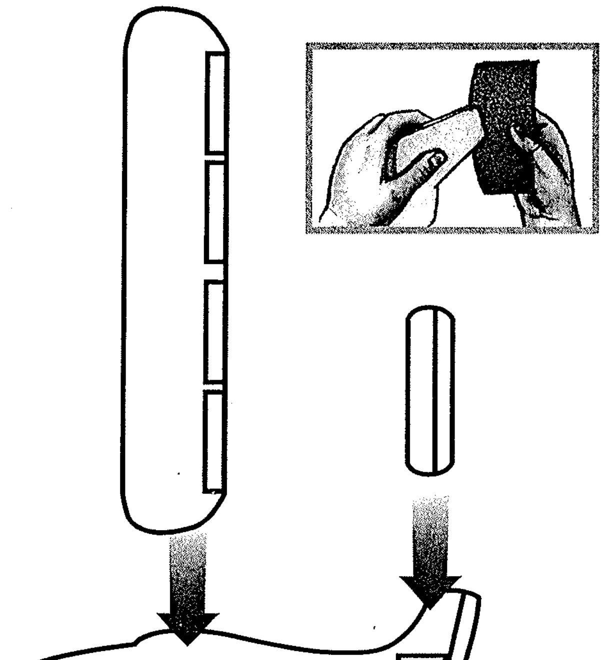
6. Have students compare the flight of the rotor motors to that of a maple seed or a dandelion.

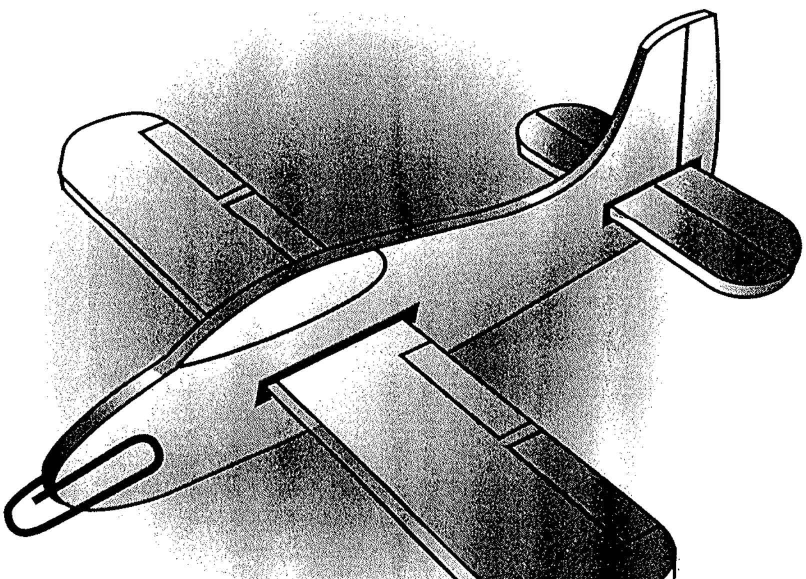
7. Seasonal variation: design paper helicopters shaped like bunnies, ghosts, or reindeer.

8. Construct a bar or line graph that shows the relationship between the number of twists and the drop height of the rotor motor.

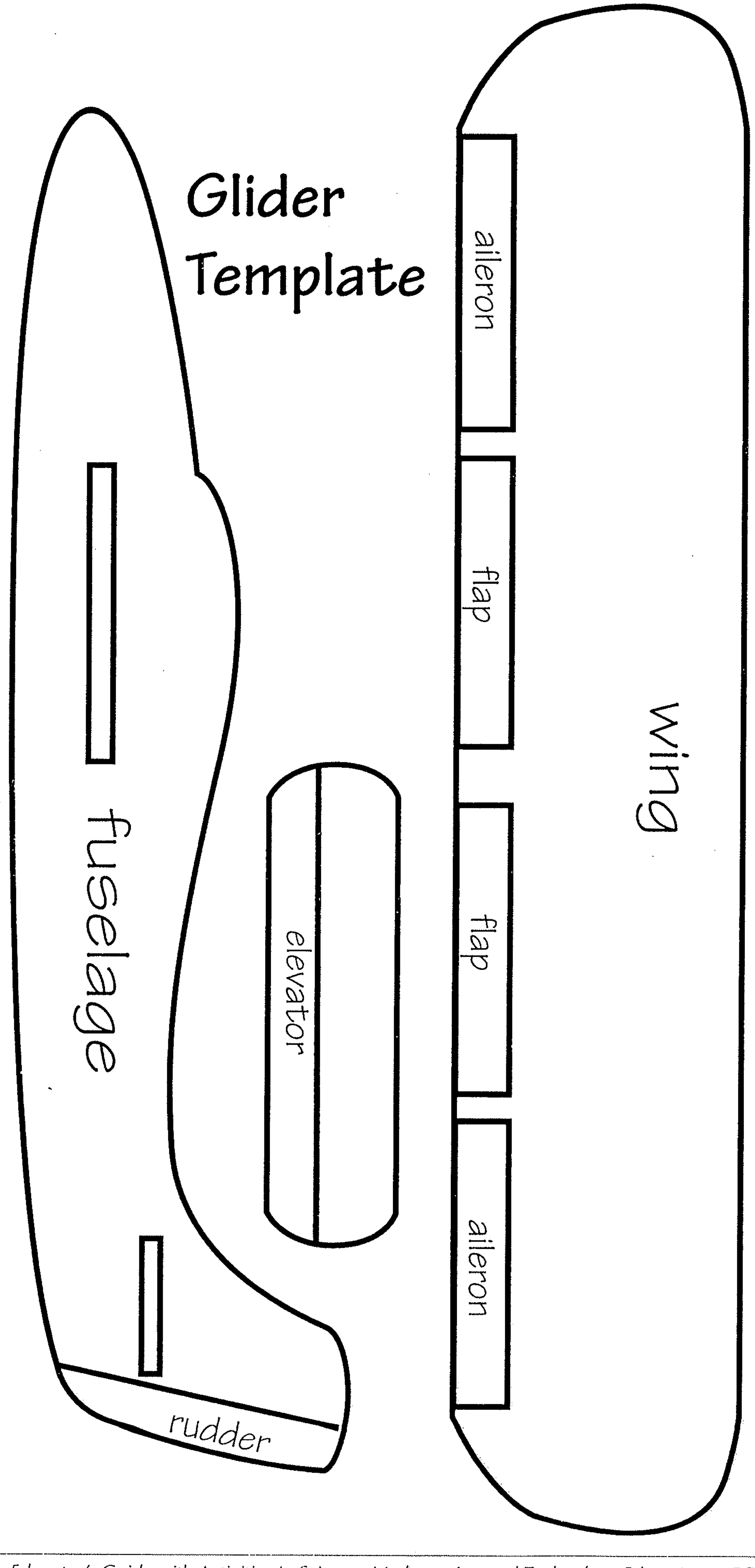
Right Flight



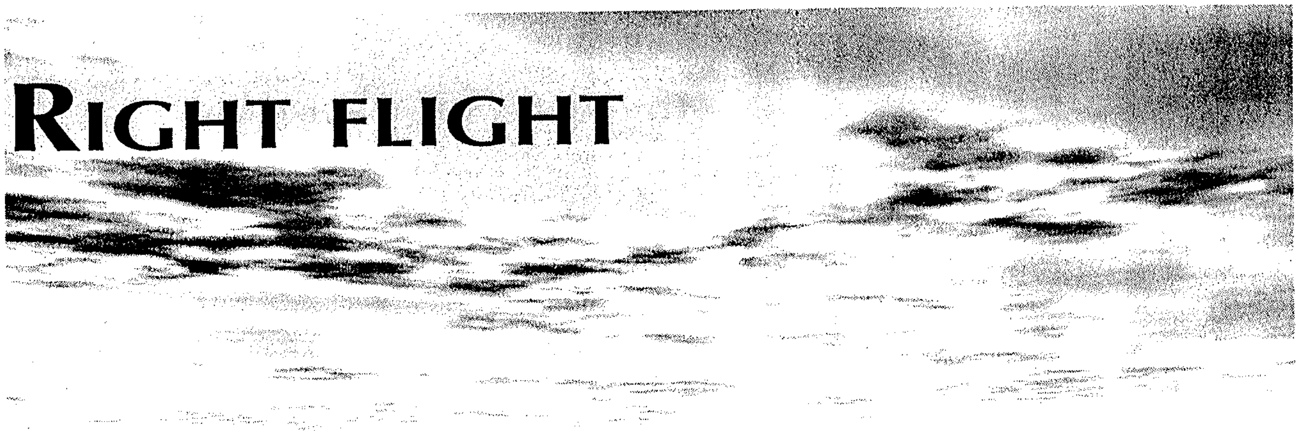




Glider Template



RIGHT FLIGHT



Objectives

The students will:
Construct a flying model glider.
Determine weight and balance of a glider.

Standards and Skills

Science
Science as Inquiry
Physical Science
Science and Technology
Unifying Concepts and Processes

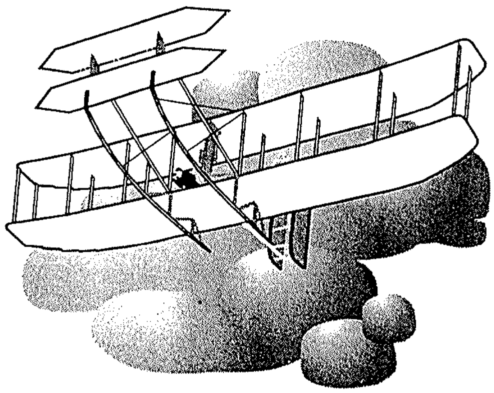
Science Process Skills
Observing
Measuring
Collecting Data
Inferring
Predicting
Making Models
Controlling Variables

Mathematics
Problem Solving
Reasoning
Prediction
Measurement

Background

On December 17, 1903, two brothers, Wilbur and Orville Wright, became the first humans to fly a controllable, powered airplane. To unravel the mysteries of flight, the Wright brothers built and experimented extensively with model gliders. *Gliders* are airplanes without motors or a power source.

Building and flying model gliders helped the Wright brothers learn and understand the importance of *weight* and *balance* in airplanes. If the weight of the airplane is not positioned properly, the airplane will not fly. For example, too much weight in the front (nose) will cause the airplane to dive toward the ground. The precise balance of a model glider can be determined by varying the location of small weights.

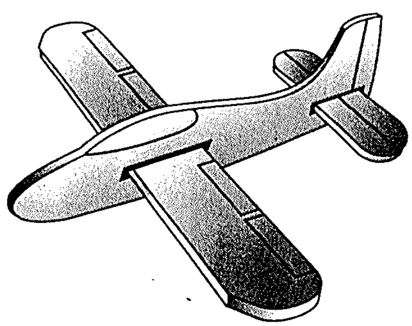


Wright Flyer

Wilbur and Orville also learned that the design of an airplane was very important. Experimenting with models of different designs showed that airplanes fly best when the *wings, fuselage,* and *tail* are designed and balanced to interact with each other.

The Wright Flyer was the first airplane to complete a controlled takeoff and landing. To manage flight direction, airplanes use control surfaces. *Elevators* are control surfaces that make the nose of the airplane *pitch* up and down. A *rudder* is used to move the nose left and right. The Wright Flyer used a technique called *wing warping* to begin a turn. On modern airplanes, *ailerons* are used to *roll* the airplane into a turn.

At NASA, model airplanes are used to develop new concepts, create new designs, and test ideas in aviation. Some models fly in the air using remote control, while others are tested in wind tunnels. Information learned from models is an important part of NASA's aeronautical research programs. The goals of NASA research are to make airplanes fly safer, perform better, and become more efficient.



Right Flight Glider

This activity is designed to help students learn about basic aircraft design and to explore the effects of weight and balance on the flight characteristics of a model glider. Students use science process skills to construct and fly the Styrofoam glider.

Management

This activity will take about one hour.

Materials

Styrofoam food tray, size 12
Glider template
Plastic knife
Toothpicks
Sand paper or emery board
Binder clips
Paper clip
Markers
Goggles (eye protection)

Part 1
Building the Glider

Preparation

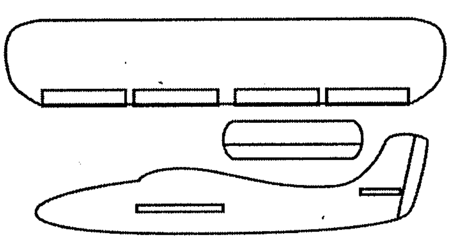
1. Ask students to name some materials that might be used to build a model glider. *Responses might include balsa wood, paper, cardboard, plastic, and Styrofoam.*

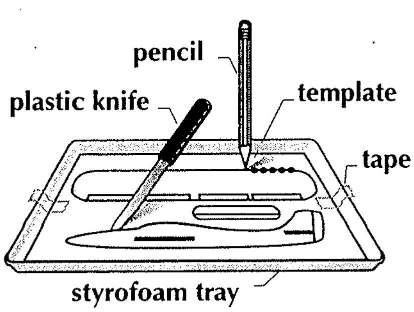
2. Gently toss a Styrofoam tray into the air and ask the students to describe how the tray "flew." *The tray does not fly because it is not designed to fly. Instead of flying (gliding) it drops.*

3. Explain to students that Styrofoam is lightweight and strong which makes it an ideal material to construct model gliders. Styrofoam trays can be obtained from the meat department of a grocery store.

Activity

1. Hand out the materials (Student Page 1, tray, template, cutting and marking devices). Follow the steps listed on the Student Page.





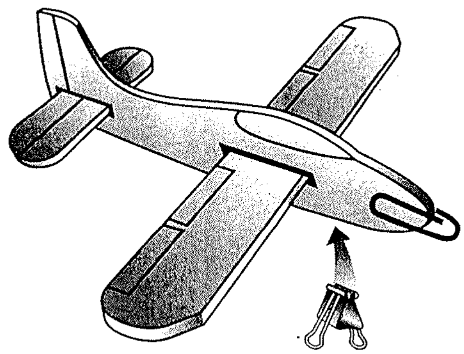
2. Explain that the template is a guide to cut the wings, fuselage, and elevator from the Styrofoam. Cutting can be done in a variety of ways depending on grade level.

   For younger students, the teacher or older students can cut out the parts beforehand and have the students assemble the glider. For older students, the teacher can demonstrate cutting out the parts using a serrated plastic knife.

   Another way to cut out the parts is by punching a series of holes approximately 2 mm apart around the outside edge of each piece and then pushing the piece out. A sharp pencil or round toothpicks can be used to punch the holes.

Part 2

Caution students not to throw gliders toward other students. The teacher may want to provide eye protection for each student.



1. The model glider's weight must be balanced or distributed properly before it will fly. To demonstrate this, ask a student to launch a glider before adding weight and balance. Have students describe the flight characteristics.

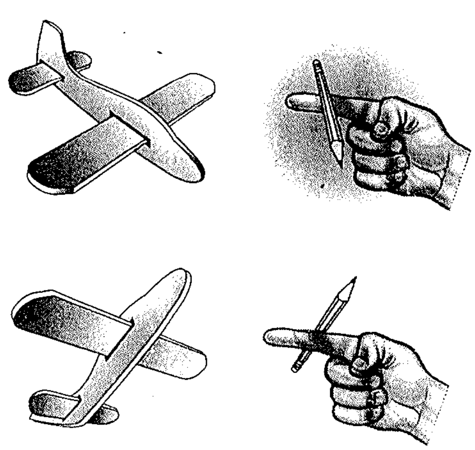
2. Add weight to the model using paper clips, binder clips, or a penny. Attach the paper clip or penny to the nose of the glider. If a binder clip is used, attach it to the bottom of the fuselage. Ask the students to test fly the glider and observe the flight characteristics.

3. Move the weight (clips) forward or backward on the fuselage to determine the best weight and balance for the glider. The best weight and balance combination can be defined as one that allows the glider to fly the greatest distance.

Discussion

1. Is weight and balance important on "real" airplanes? *Yes, all airplanes are required to have correct weight and balance. The pilot is responsible for making sure the total weight of the cargo and passengers is within certain limits and is distributed to keep the plane properly balanced. Flights should not be attempted if the aircraft is overloaded, or if the cargo distribution makes the plane too "nose heavy" or "tail heavy."*

2. Why does the model glider fall erratically during test flights before its proper weight and balance is determined? *Lift is a force generated by the wing. This force must be in balance with the weight distribution of the airplane before the model will fly successfully.*



Aircraft weight is balanced as a pencil is on your finger.

Assessment

1. Students will successfully meet one objective of the activity by constructing the model glider.

2. Using the model glider, have students explain how they determined the weight and balance for their glider.

Extensions

1. Set up a flight course and have the students demonstrate the flight characteristics of their gliders.

2. Have students cut 2 cm off of each wing tip, and begin a new series of flight tests.

3. Have students design and make new wings for the glider. Experiment with wings of various sizes and shapes.

How is a Plane Controlled?

To control which way a plane turns and moves in the air and on the ground, a pilot moves parts on the wings and tail called control surfaces. **The control surfaces are the ailerons, rudder, and elevator.** You can see these in action by using folded paper gliders and balsa gliders.

EQUIPMENT: a sheet of paper and a paper clip

DESCRIPTION

Folded paper glider: Fold a piece of paper following the diagram A. You can use a paper clip to hold together the finished glider at the bottom. You can also use the paper clip for a balance on the airplane. Experiment with the glider, moving the clip up or back as needed to get it in balance.

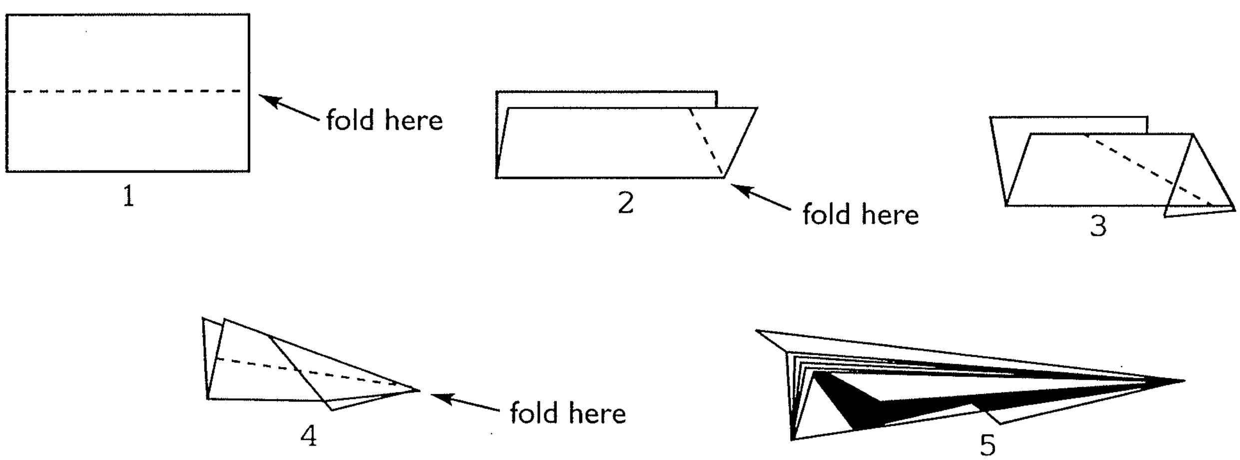


Diagram A

Control Surfaces: Real planes have movable parts inserted in the wings, in the vertical stabilizer, and in the horizontal stabilizer. These are called ailerons, rudder, and elevator. The pilot controls their position from the airplane cockpit. When he or she moves them into the airstream, they cause the plane to react to air pressure. By using them he can go to the right or left and also up and down.

Up and Down: Fold the back edges of the paper glider up, as in the diagram B. When you throw the glider, the tail should go down and the nose should point up. It may take some practice to get the controls set so the glider does what you want it to do.

When the pilot wants her plane to climb, she moves the airplane controls so that the **elevators** tilt up in the same way that you folded the back edges of the glider. The air hitting the **elevators** pushes the tail of the plane down, tilting the nose upward, so that the plane can climb.

Next, fold the back edges of the glider down. When you throw the glider, the tail should go up and the nose should go down. This same thing happens when the pilot tilts the **elevators** downward.

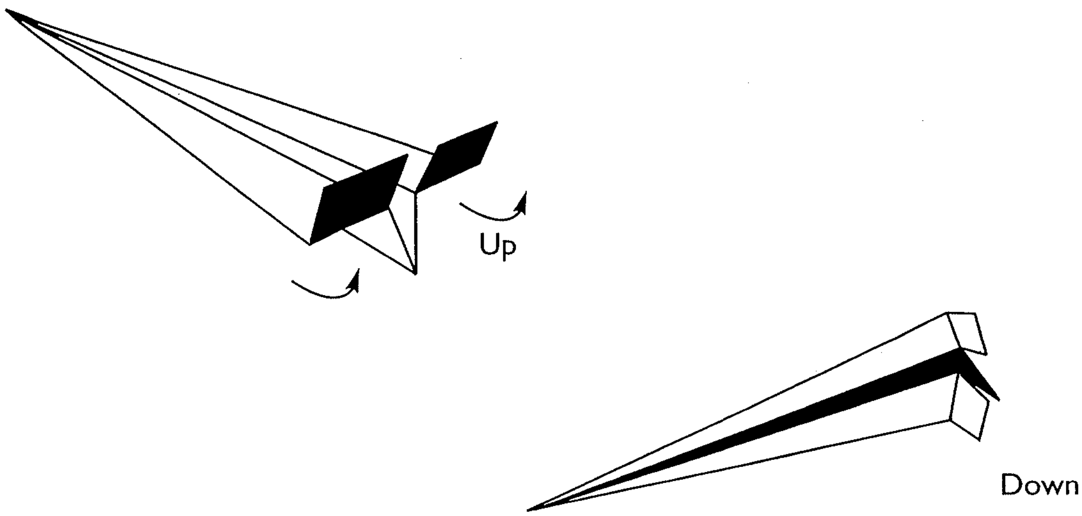


Diagram B

Right and Left: Turn the vertical fin on the glider a little to the right. This will make the glider fly toward the right (Diagram C). The pilot moves the airplane's **rudder** to the right for a right turn, but he must also bank his plane for the turn, the same as you would do if you were turning on a bicycle. (You would lean to the right for a right turn.)

he pilot tilts her plane to one side by using the **ailerons**. When one tilts up the other tilts down. To tilt the plane to the right, the pilot tilts the left **aileron** down so the left wing is pushed up. The right **aileron** is tilted up so the right wing will be pushed down. You can do the same thing with a paper glider. For a left turn, the pilot reverses the process described above.

Balsa glider: You can also use a balsa glider to see how **control surfaces** affect an airplane. Put the glider together and launch it a few times for practice. Make **ailerons, elevators,** and **rudder** from paper and glue them to the wings and stabilizers. Now practice bending these paper control surfaces until you can make the glider fly where you want it to.

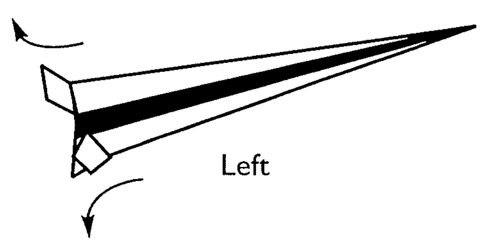
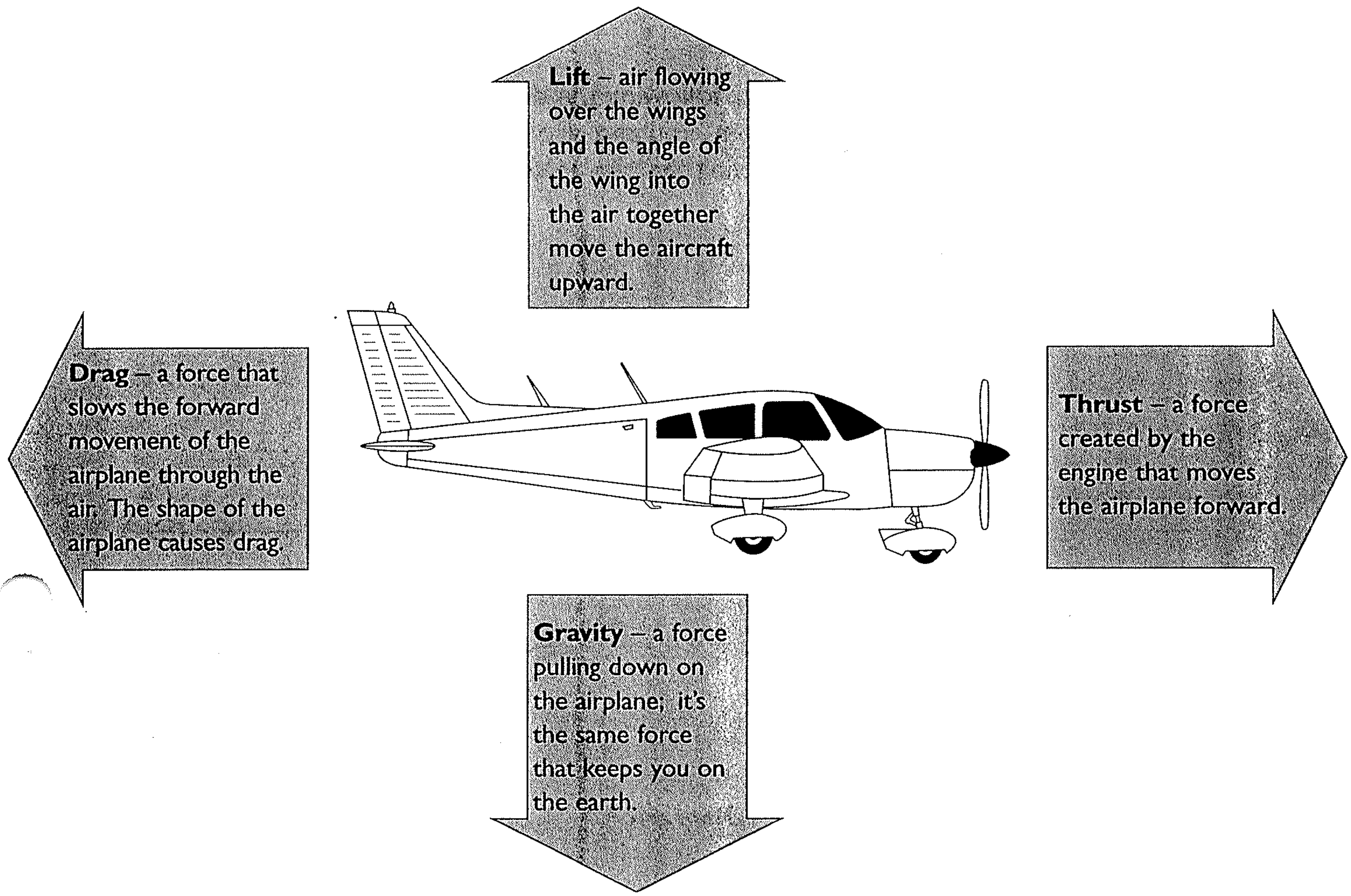


Diagram C

What Makes an Airplane Fly?

An airplane's movement through the air is affected by the ***four forces of flight***:



Wings

Experiments to demonstrate how aircraft wings work

The force that lifts an airplane and holds it up comes in part from the air that flows swiftly over and under its wings.

Bernoulli's principle states that an increase in the velocity of any fluid is always accompanied by a decrease in pressure. Air is a fluid. If you can cause the air to move rapidly on one side of a surface, the pressure on that side of the surface is less than that on its other side.

Bernoulli's principle works with an airplane wing. In motion, air hits the leading edge (front edge) of the wing. Some of the air moves under the wing, and some of it goes over the top. The air moving over the top of the curved wing must travel farther to reach the back of the wing, so it must travel faster than the air moving under the wing to reach the trailing edge (back edge) at the same time. Therefore the air pressure on top of the wing is less than that on the bottom of the wing.

You can see **Bernoulli's principle** in action in an experiment with two strips of paper.

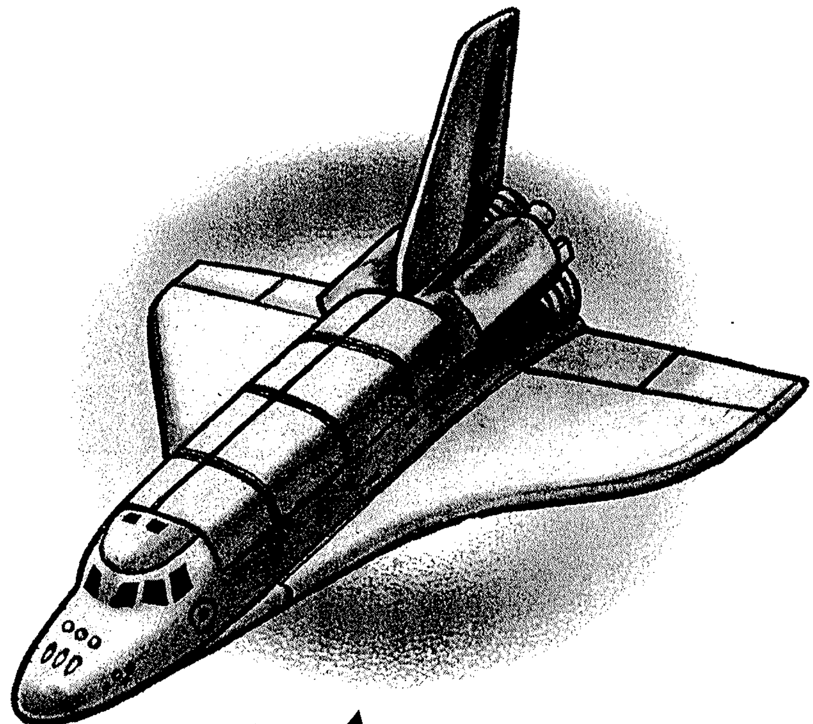
EQUIPMENT: Strip of notebook paper or newspaper, about 2 inches wide and 10 inches long; a book; and paper clips

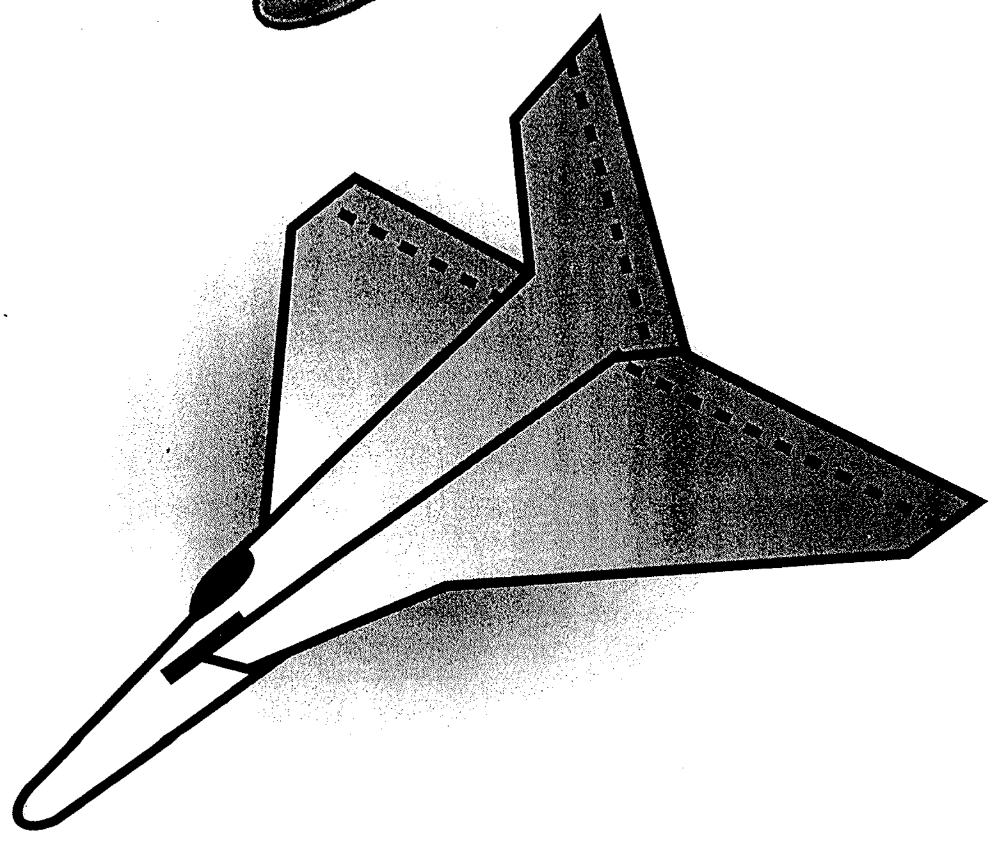
Make an airfoil (wing) by placing one end of the strip of paper between the pages of the book so that the other end hangs over the top of the book. Move the book swiftly through the air, or blow across the top of the strip of paper. It flutters upward. Hold the book in the breeze of an electric fan so the air blows over the top of the paper.

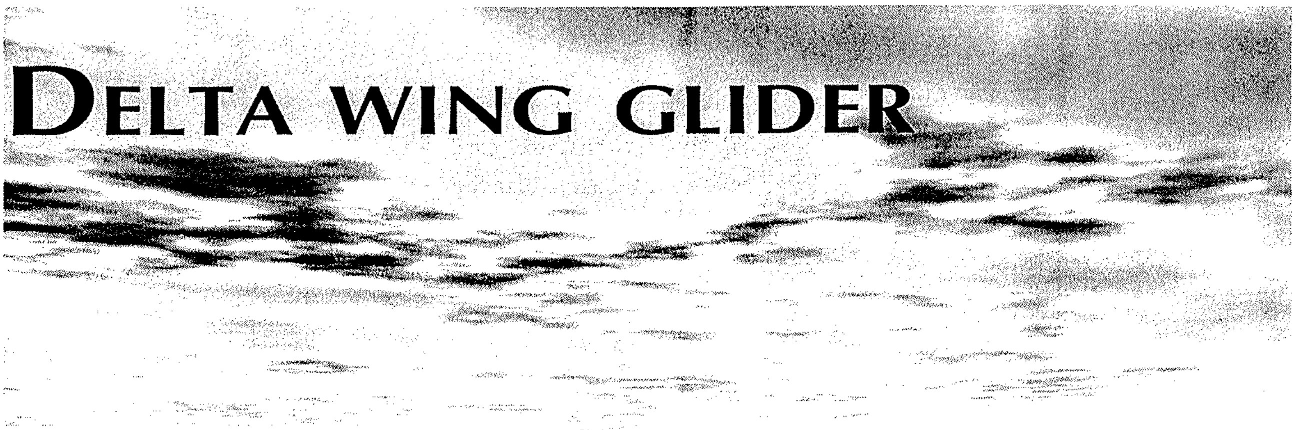
Take the strip of paper out of the book. Grasp one end of the paper and set it against your chin, just below your mouth. Hold it in place with your thumb and blow over the top of the strip. The paper rises. Try the same thing after you have fastened a paper clip on the end of the strip. See how many paper clips you can lift in this way.

Hold the strip of paper in your hands and run around the room. It doesn't matter whether you move the air over the strip of paper by blowing or whether you move the paper rapidly through the air - either way it rises.

Delta Wing Glider







DELTA WING GLIDER

Objective

The students will:

Learn how to change the flight characteristics of a glider.

Conduct an experiment to answer a question.

Standards and Skills

Science

Science as Inquiry

Physical Science

Science and Technology

Mathematics

Measurement

Problem Solving

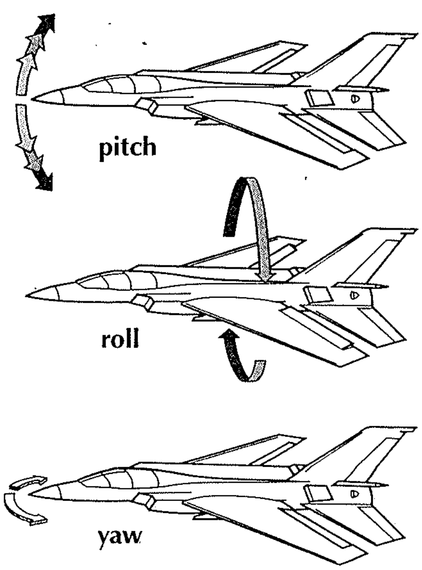
Science Process Skills

Making Models

Investigating

Predicting

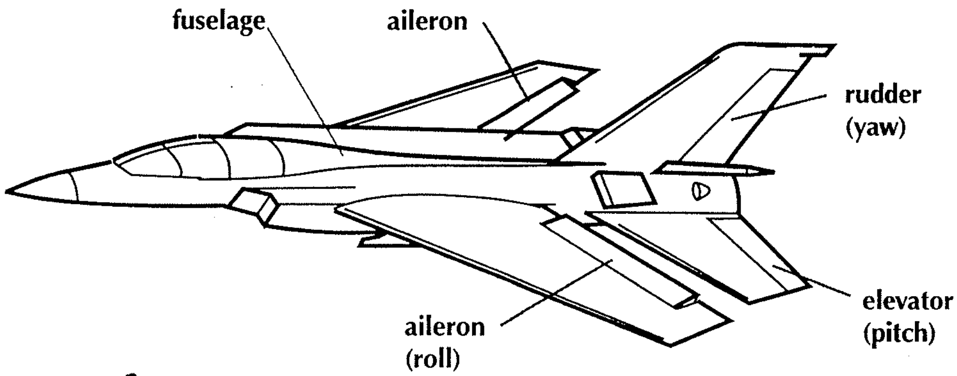
Background

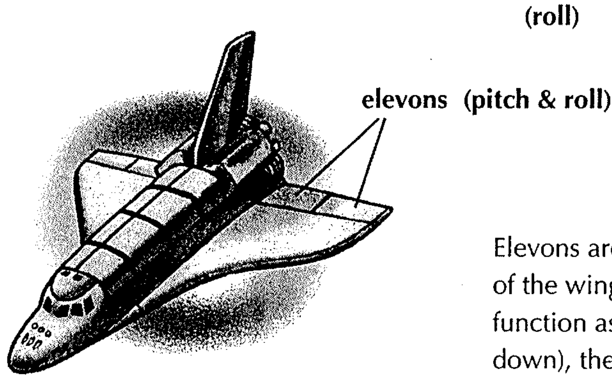


There are many types of vehicles used to transport people and objects from place to place on Earth. How are these vehicles guided to a destination? Turning the steering wheel changes a car's direction. The rudder is used to control the direction of a boat. A bicycle is controlled by turning the handle bars and shifting the rider's weight. For most land and sea vehicles, directional control is accomplished by moving the front end right or left. Movement in this one axis of rotation or direction is called *yaw*.

Flying an airplane requires control of three axes of rotation or movement. The nose of the plane can be moved right and left (*yaw*), rotated up and down (*pitch*) and the fuselage can be rolled left and right (*roll*). A pilot uses the control wheel or stick inside the airplane to move control surfaces on the wings and tail of the plane. These control surfaces turn the airplane by varying the forces of lift.

Airplanes with conventional wings use *ailerons* to control roll, a *rudder* to control yaw, and *elevators* to control pitch. Airplanes with delta or triangular shape wings have a rudder, but only one control surface (*elevon*) to control pitch and roll. An elevon serves the same function as an *el*evator and an aileron.





Elevons are moveable control surfaces located on the trailing edge of the wings. Working in unison (both up or both down) they function as elevators. Working differentially (one up and one down), they function as ailerons. The Space Shuttle uses elevons for control in the air close to the Earth as it descends from space.

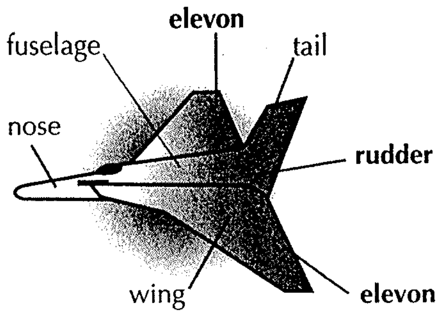
Materials

Styrofoam food tray, about 28 cm X 23 cm (Size 12)
Cellophane tape
Paper clip
Ball point pen
Plastic knife or scissors
Toothpicks
Goggles (eye protection)
Emery boards or sandpaper

Preparation

1. Show the class a Styrofoam food tray and ask them to identify it. Ask the students to list other uses for Styrofoam. Responses may include cups, fast food containers, egg cartons, packaging material, and insulation.

2. Discuss with the students some reasons for using Styrofoam in the construction of a model glider. Materials for building airplanes must be lightweight, strong, and readily available. These qualities make Styrofoam a good material for the

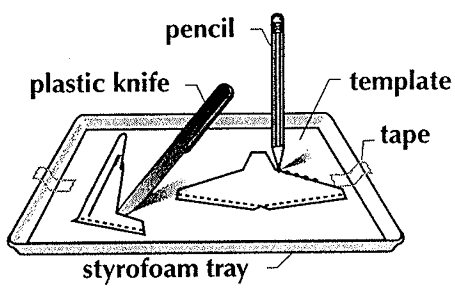


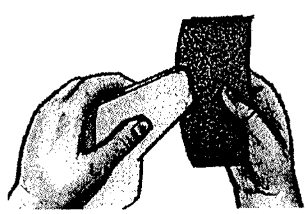
construction of flying models. Real airplanes are made from another lightweight, strong, and readily available material called aluminum.

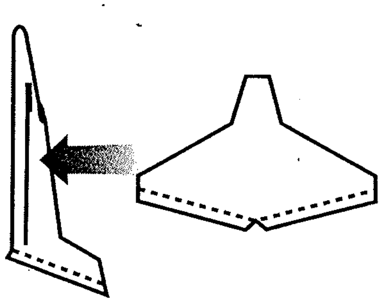
3. Styrofoam can be cut using scissors or a serrated plastic knife. Students can also use a sharp pencil or round toothpick to punch a series of holes approximately 2 mm apart around the outside edge of the part. The part can then be pushed out from the tray. Pre-cut the Styrofoam parts for younger students.

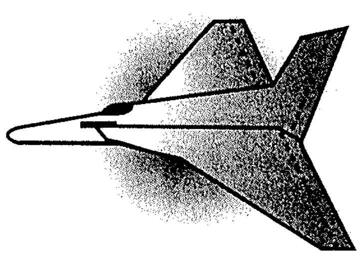
4. Provide the student with a word list for parts of the glider. *Fuselage (body of the glider), wing (provides lift), rudder (yaw control), elevons (roll and pitch control).*

Activity









1. A student page contains a template used to cut out the Styrofoam parts of the glider, and instructions for assembling the parts. Educators of K-2 students may want to cut out the gliders ahead of time.

2. Ask the student to write the name of each airplane part on the template.

3. Tape the glider template to the Styrofoam meat tray.

4. Use a sharpened pencil or toothpick to punch holes around the outline of the wing and fuselage. Make sure the hole goes through the Styrofoam.

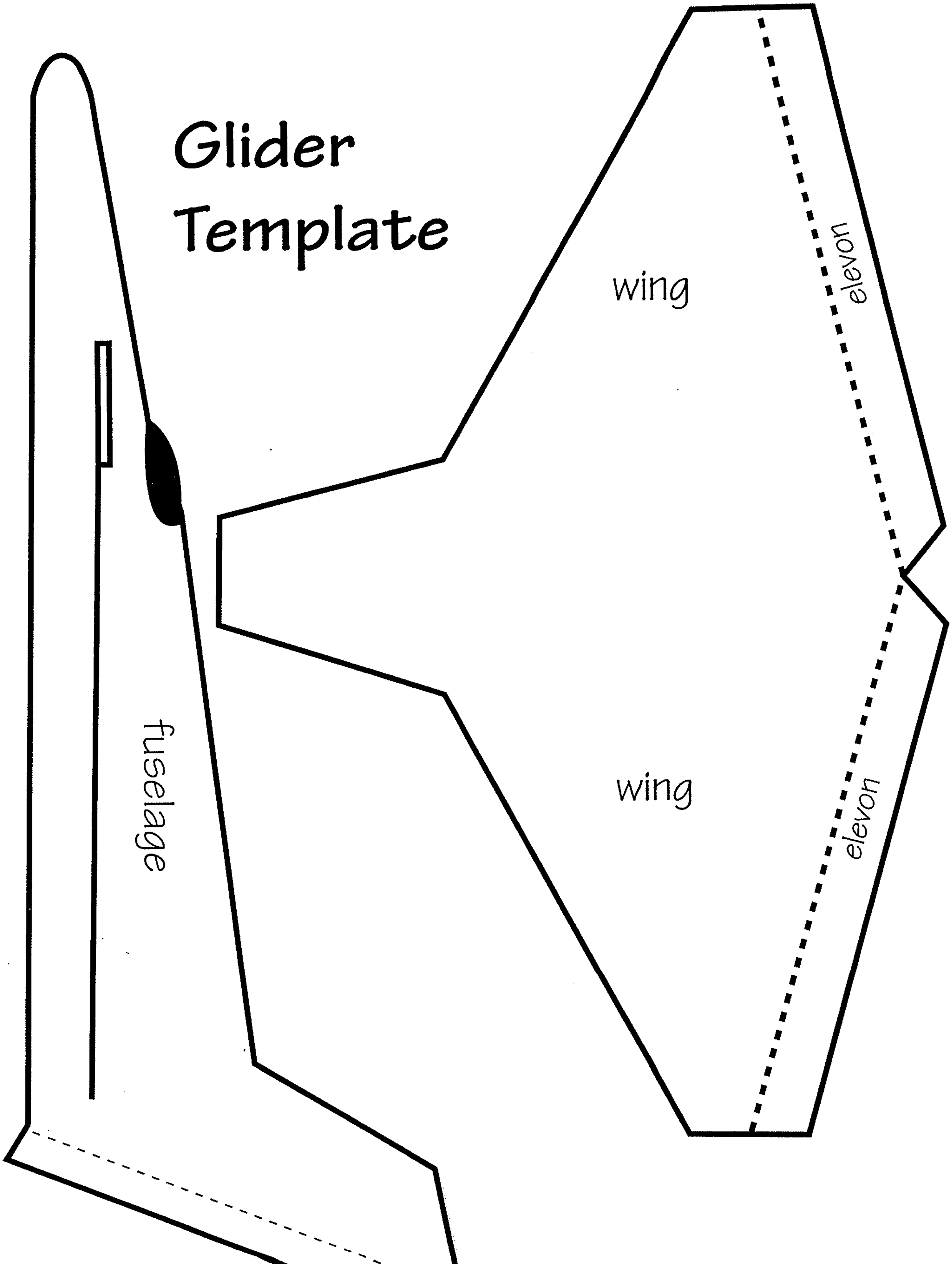
5. Remove the template and trace around the outline of the wing and fuselage on the tray using a pencil or toothpick. Punch out each part.

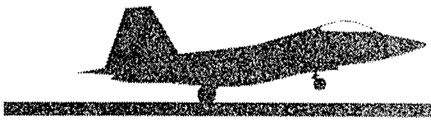
6. Smooth the edges of each part using sandpaper or an emery board.

7. Mark both elevon hinges with a pencil. (Note: to make the elevons hinge up and down, use a pen to lightly score the hinge line on the Styrofoam wing. If a break occurs at the hinge line, use clear tape to repair the break.)

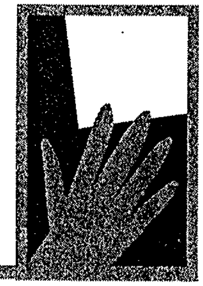
8. Carefully cut a slot in the fuselage and slide the wing into it.

Glider Template





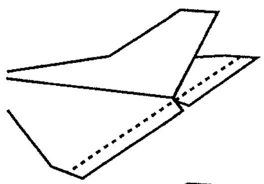
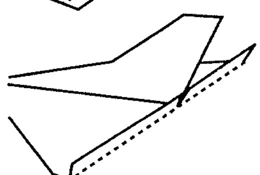
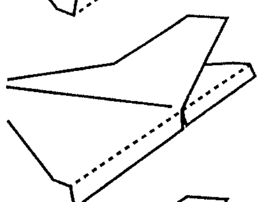
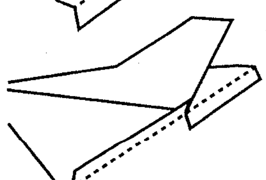
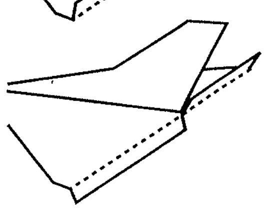
Delta Wing Glider



Test Question: Does changing the position of the elevons on a delta wing glider change its flight path?

Directions: Bend the elevons into the positions listed below. Be sure to predict the flight path before flying the glider. Test fly the glider and record the results (up, down, left, right).

Student Test Pilot Record Sheet (What I Observed**)**

Position of elevons		Predicted Flight Path	*Path of Test Flight*
Right and left straight			
Right and left up			
Right and left down			
Right down, left up			
Right up, left down			

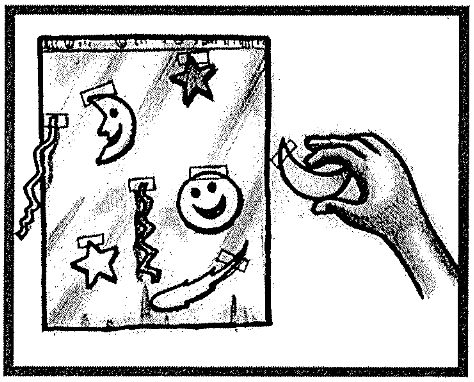
Does moving the elevons change the way the glider flies?

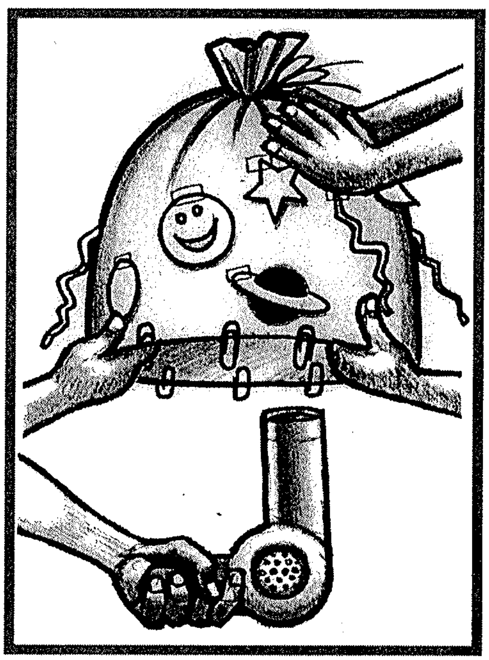
What happens when both elevons are in the up position?

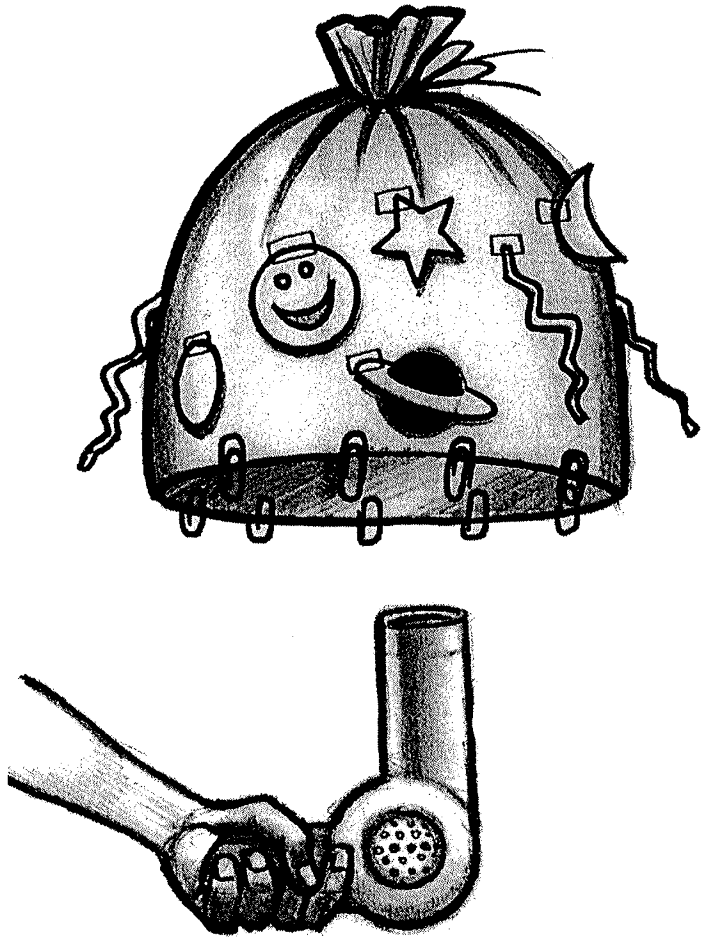
What happens when both elevons are in the down position?

Does changing the position of elevons on a delta wing glider change its flight path?

Bag Balloons







BAG BALLOONS

Objectives

The students will:
Demonstrate that heat can change air.
Determine that hot air rises.
Construct a working model of a hot air balloon.

Standards and Skills

Science
Science as Inquiry
Science and Technology

Mathematics
Estimation

Science Process Skills
Communicating
Observing

Background

Hot air balloons are one type of aircraft. (The four categories of aircraft are airplanes, gliders, rotorcraft, and hot air balloons.) In this activity, students construct a working model of a hot air balloon.

There are two ways a balloon can rise: it can (1) be filled with a gas that is lighter than air, such as helium, or (2) it can be inflated with air that is heated sufficiently to make it "lighter" than the air outside of the balloon.

Helium is the second-lightest element, and the main sources for helium are natural gas fields (especially those in the states of Texas, Oklahoma, and Kansas). Heating air makes it less dense, rendering it essentially "lighter." Gas balloons and hot air balloons float because they are lighter than the air they displace.

Materials

Plastic bag ("dry cleaners" bag or 5-gallon trash bag)
Paper clips (used for weight)
Small pieces of paper or stickers (decorations)
String
One hair dryer per classroom (heat source)
Party balloons

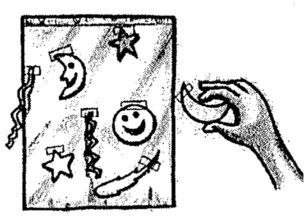
Preparation

Show students pictures of hot air balloons. Ask the students to share their ideas about how the balloons rise. Also ask students to share what they know about hot air balloons, or what they think about the uses of hot air balloons.

Show the students a helium balloon. Ask the students to share what they think makes the helium balloon rise when you let go of the string.

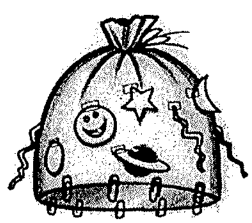
Activity

1. Divide the class into groups of four, and provide each team with a set of materials.



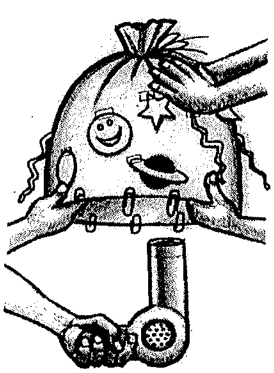
2. Have the students decorate their plastic bags. Decorations should be small and light, such as small scraps of paper or stickers.

3. Have the students tie a string around the top of the plastic bag.



4. Add paper clips evenly spaced around the bottom of the plastic bag.

5. Have the students hold the plastic bag over the hair dryer (on the high setting) and let the plastic bag fill with hot air.



6. The plastic bag becomes buoyant as it fills with hot air. When the students feel the bag tugging, have them release it. *The hot air inside the balloon is lighter than the air in the classroom and begins to float.*

Paper Airplane Ideas:

1. Give each student a similar piece of paper. Allow each of them to design his/her own paper airplane or use the ideas on the Paper That Flies Sheet.

2. After each student has a paper airplane to test let them rotate around the 3 test sites measuring their airplane's: accuracy, distance, and time in the air. Have them record their measurement.

3. Let each student adjust their design or make a new plane. They may retest their plane, record their data, and compare the results. If time and you desire to do so, let them try one more time. If not, have each student share with the class his/her measurement results and conclusions about the style of their airplane.

4. If time, test the conclusions of the students.

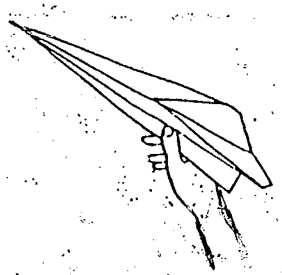
Test Area 1.
Using tape, place a line of tape wherever you want in your room or hall. Then, mark a circle or square on the floor about 10 feet in front of the "starting tape". The circle is the target area for the accuracy test. Use rulers or yardsticks to measure how close each airplane is to the center of the target. If no airplane is in the target, measure to find the distance from the edge of the target to each plane. Record the results.

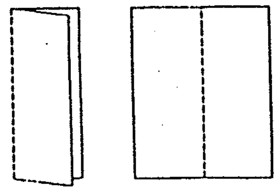
Test Area 2.
Using tape, place a line of tape wherever you want in your room or hall. Lay several yardsticks along the "flight path" to show how far each airplane travels. After each flight, record the distance.

Test Area 3.
This area takes 2 people to measure each airplane. The first person says "go" and the student who made the airplane throws his plane. The other person watches the clock or a stopwatch for the length of time the airplane is in the air. The first person must say "STOP" when the airplane hits the floor. Record the time of each airplane's flight.

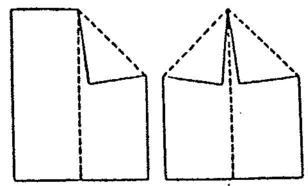
PAPER THAT FLIES

Follow the directions below to make two paper airplanes and one flier called a *bishop's cap.*

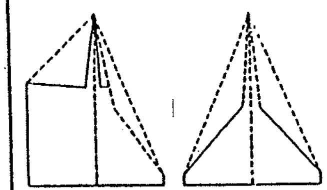




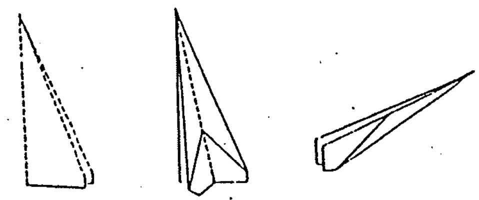
1. Fold paper in half lengthwise. Open it up.



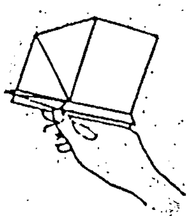
2. Fold one corner down to the middle line. Do the same with the other corner.

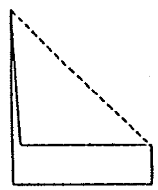


3. Fold one side down to the middle line. Do the same with the other side.

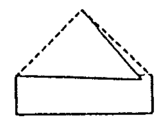


4. Fold the airplane along its center line. Make the wings by folding diagonal lines on either side of the center line.

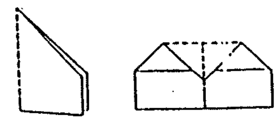




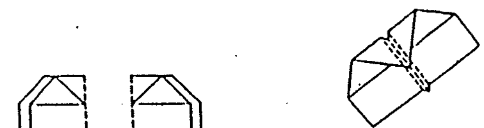
1. Fold the right corner down to the left edge. Leave about 2½ inches at the bottom.



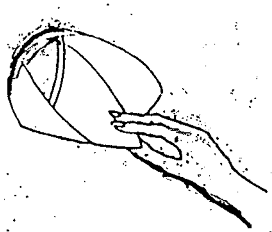
2. Fold the left corner down to the right side, at the 2½-inch point.

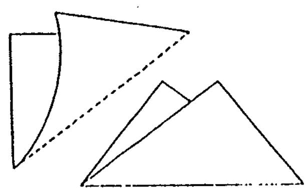


3. Fold in half. Open up this fold. Fold the top corner down so the point is below the paper line.

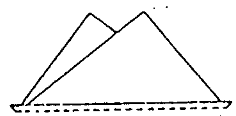


4. Turn the paper over. For the wings, make two folds. Fold the right side about ½ inch from the center line. Open up this fold. Then fold the left side about ½ inch from the center line. (Make sure you fold inward for these two folds.)

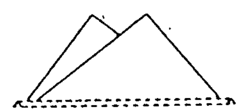




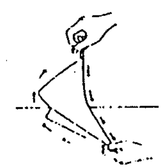
1. Make a diagonal fold as shown in illustration 1.



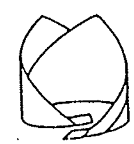
2. Fold up the bottom about ½ inch.



3. Fold up the bottom again.



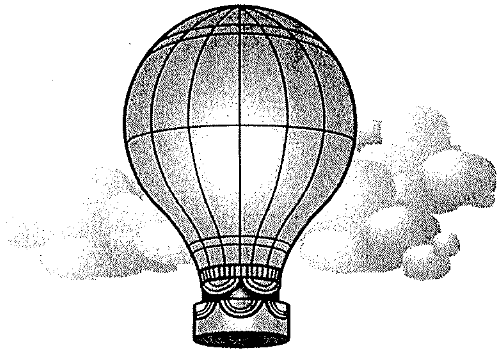
4. Run the folded edge along the corner of your desk to give the paper a slight curl.



5. Wrap around the edges and insert one tab into the other one as far as it will go. Hold flier between the two points and launch upward.

JOAN WALSH

Discussion



1. Have the students identify the different parts of the hot air balloon: plastic bag—hot air balloon; hair dryer—heat source; paper clips—weights for balance and stability.

2. Ask the students to explain why the hot air balloon works. *The hot air balloon rises when the air inside the balloon becomes heated. The heated air is lighter than the classroom air and enables the balloon to float.*

3. Ask the students to tell how hot air balloons are different from balloons filled with helium. *Helium is a gas that is lighter than air, even when it's not heated. Helium though, just like heated air, floats in the surrounding air because it's lighter. Helium should not be confused with hydrogen, which is an inflammable gas that was often used in balloons and airships until the explosion of the airship Hindenburg in 1937.*

4. Have the students inflate a party balloon. Ask them to explain why it does not rise. *A person's breath may be warmer than room temperature, but it is not hot enough to overcome the weight of the balloon.*

Assessment

Using their actual models, have the students explain why their hot air balloons rise.

Extensions

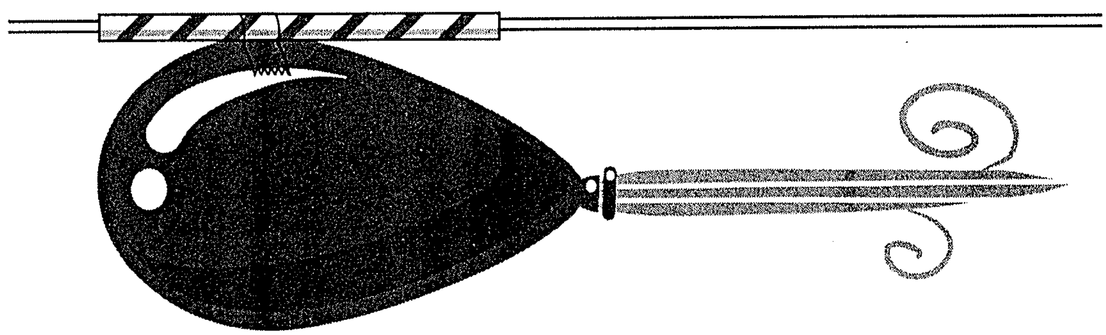
1. Have the students construct another hot air balloon using different sizes and types of plastic bags.

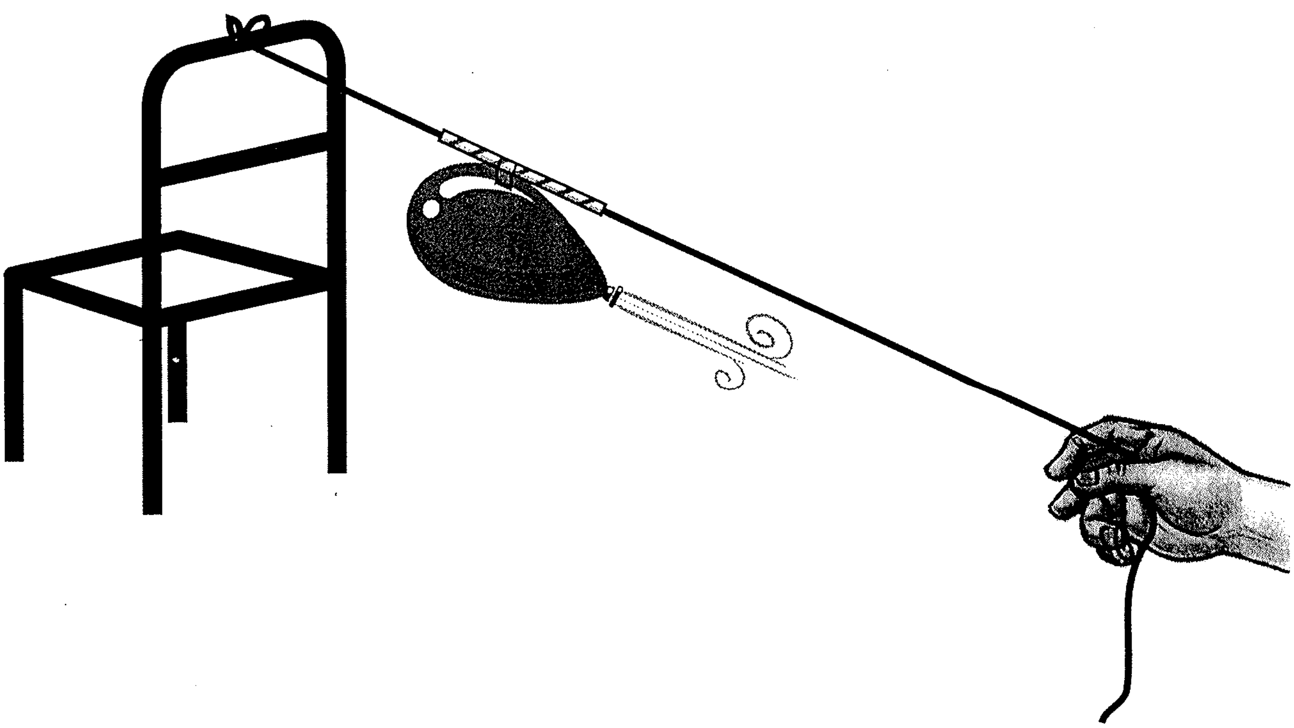
2. Have students experiment with paper clips—different sizes and numbers—to see the effects of weight on their model balloons.

3. Have the students research the part that balloons played in the history of flight.

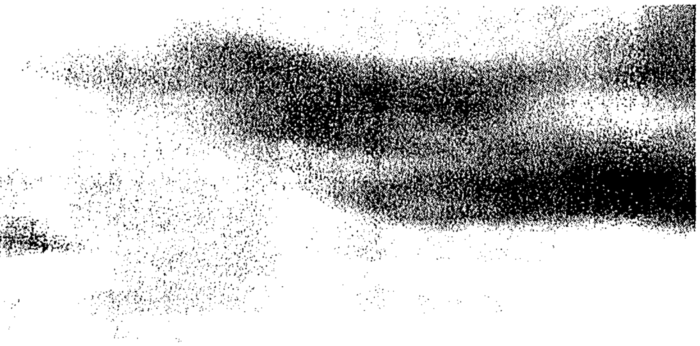
4. Have the students role play a reporter interviewing one of the Montgolfier brothers. (Refer to background information included in this guide about the Montgolfier brothers.)

Air Engines





AIR ENGINES



Objectives

The students will:
Observe how unequal pressure creates power.
Explain that air power can help airplanes fly.
Construct a working model of an air engine.

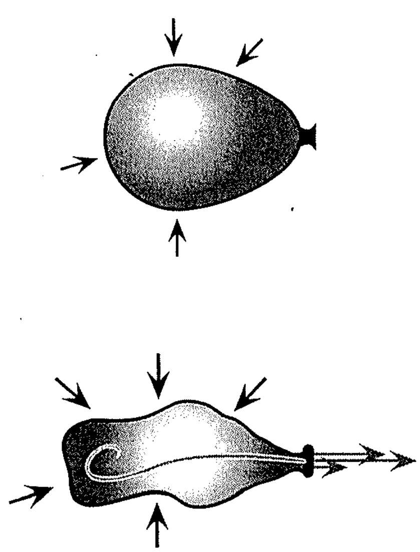
Standards and Skills

Science
Science as Inquiry
Science and Technology
Position and Motion of Objects

Science Process Skills
Making Models
Observing

Mathematics
Math as Problem Solving
Measurement

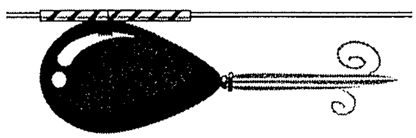
Background



Aircraft powered by jet, piston, or rocket engines are capable of sustained flight. Remaining aloft longer means the aircraft offers greater utility and convenience to users. The aircraft engine provides a constant source of thrust to give the airplane forward movement.

This activity will allow students to build and demonstrate a source of thrust found in some research aircraft: the rocket engine. The straw represents the fuselage and the balloon represents the aircraft engine. Once the balloon is filled with air, there is a difference in air pressure between the outside and the inside of the balloon.

The inside of the balloon has higher pressure than the outside of the balloon. The air on the inside of the balloon equalizes with the air on the outside of the balloon when the balloon is released. Energy is generated as air equalizes from high pressure areas to low pressure areas.

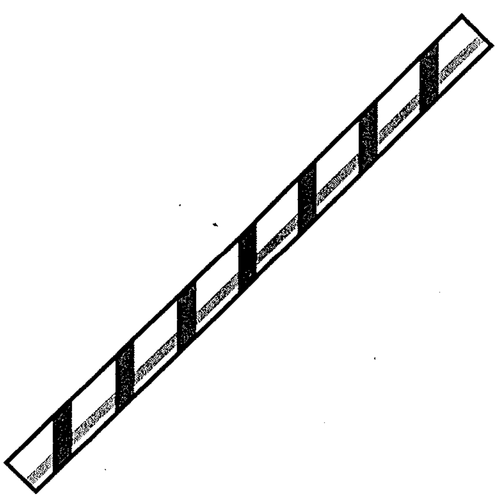


The balloon moves in the opposite direction of the flow of the released air because every action has an opposite and equal reaction. Since the air is released from one small hole, the release of the air is focused in one direction. Because it is focused in one direction, the balloon and straw are forced to move down the string in the opposite direction.

Materials

Balloon
Drinking straw
Fishing line
Tape

Preparation



1. Place a drinking straw inside a mystery container. Play a game of 20 questions with the students to see if they can identify what is in the container.

2. Share with them that what is inside has something to do with learning about how airplanes fly. After the students have asked all of the questions, show them the straw inside of the box. Let them know that they will be using the straw to build a model of an air engine.

3. Give the students a few minutes to investigate the straw. Give each student a straw and ask them to describe the straw and see if they can figure out a way to make the straw travel from one place to another (e.g., from the desk to the floor, or from one part of the room to another).

   Tell the students that they'll be learning another way to make the straw move—by making an air engine.

Activity

1. Group students in teams of four and provide each team with a set of materials.

2. Have the students inflate a balloon and let it go.
   Ask the students to make observations about what happened to the balloons when they were released.

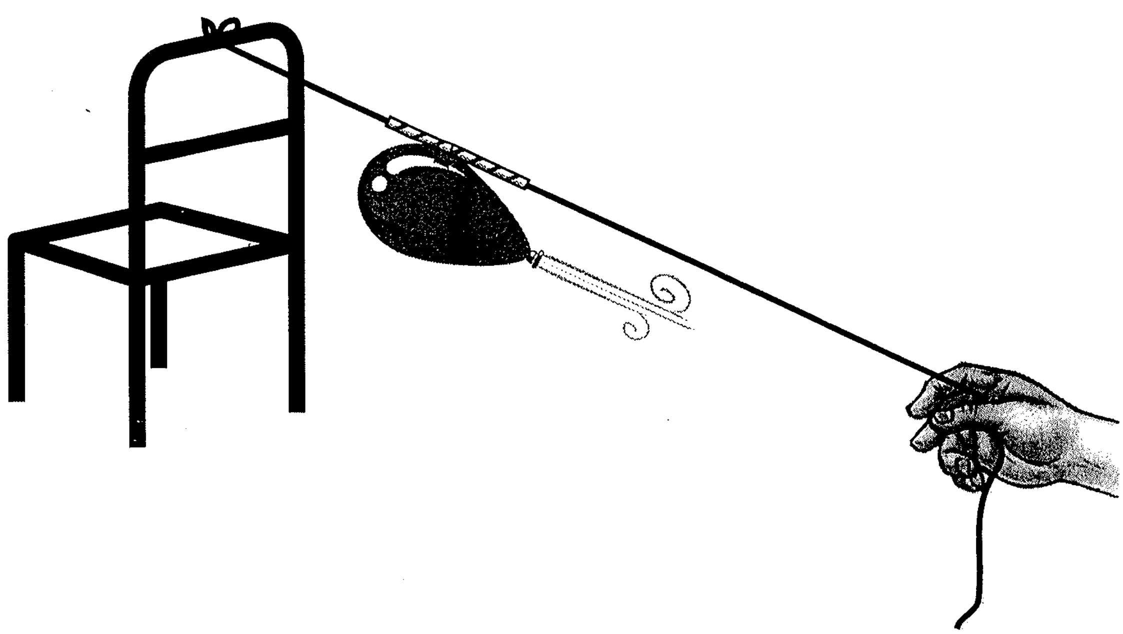
   Explain to the students that the balloons move because the air pressure on the outside and the inside is different. Have the students observe how the balloons go off in all different directions.

   The balloons will move. The energy inside the balloon propels it. Tell the students that the movement of the balloon can be directed toward one place.

3. Now have the students assemble their models.

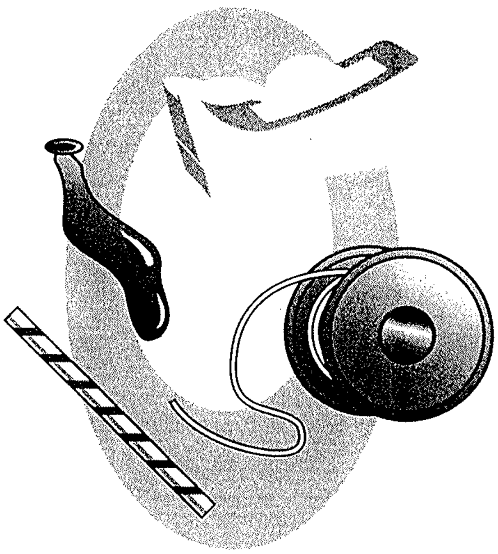
   Have the students place the fishing line through the straw. One student will hold one end of the fishing line, and the other end of the fishing line should be tied to the back of a chair. Then, have the students inflate a balloon with air and hold the end tight while another team member tapes the balloon to the straw. Once this is done, the students can release the balloon nozzle, and observe the balloon (air engine) as it moves across the fishing line.

   Have each team tape their engine parts (straw, balloon, and fishing line) to a piece of paper. Have the students use this to explain how the activity worked.



Discussion

1. Have the students identify the different parts of the air engine model: straw (fuselage), balloon (air engine), fishing line (track).



2. Ask the students to explain why the straw moved along the string. *The balloon moves along the string when the air pressure inside the balloon escapes out of the nozzle. Since the balloon is taped to the straw, the straw moves with the balloon when the air is released.* Help the students make the connections between this and airplanes moving through the air.

3. Ask the students to tell how moving the balloon along the string is different from how they tried moving the straw in the pre-activity. *In the pre-activity, students did not use directed air pressure to move the straw. They moved the straw by throwing it or dropping it. In the air engine activity, the students move the straw when they focus the air power.*

Assessment

Have the students make a drawing of their air engines, and then write or tell about how the air engine worked.

Have the students write how air power helps airplanes fly.

Extensions

1. Have the students construct another air engine model, but this time let them investigate with different sizes and shapes of balloons.

2. Have the students make a longer track and record the distance the engine moves the straw along the track.

3. Have the students make a vertical track and observe how the air engine moves the straw from the floor to the ceiling.

4. Hold air engine contests to see which team can make the air engine straw go the farthest distance.

Oklahoma Celebrates Flight

Space Lessons

Space Station Construction Activity
Photographs from Space– Transmitting Images to Earth
A Walk Around the Space Shuttle
Space Shuttle Model
How Do Rockets Work?
Paper Rockets
Pop Bottle Water Rockets
3-2-1 POP!
Match Stick Rocket
Connecting in Space:
  Docking with the International Space Station
Construct a Parafoil
Saturn V Launch Vehicle
Paper Rockets

Final Design (student section)

1. The first task is to decide where all of the components of the Space Station will be in your model. Using centimeter paper, make a sketch of each part and where you would like to put it. Design the truss according to where the PV arrays and thermal radiators will be. Remember the truss requirements.

2. Construct a truss. Take the food trays and, if necessary, cut them to meet your specifications. Connect them together. Popsicle sticks can be used to help support connections. The truss does not need to be in one line, but according to the constraints, it cannot be longer then 50 cm.

3. Glue the modules together and connect them to the truss in the proper position.

4. Connect the PV arrays in their proper position.

5. Place the thermal radiators in their proper position.

6. Put the docking port (toilet paper roll) on one of the modules.

7. Glue the control jets (buttons) on any of the Space Station components except the radiators or PV arrays. Remember to check the requirements.

8. Place the robotic arm (flexible straw) on the Space Station. Do not put it on the PV arrays or radiators. Maximize the distance it can reach on the other parts of the Space Station.

Weight Calculations (student section)

1. Find the total weight of your Space Station.

2. First, take the sum of the weights for the modules, PV arrays, thermal radiators, and truss structure:

Weight		Modules	______________grams
	+	PV arrays	______________grams
	+	Thermal Radiators	______________grams
	+	Truss Segments	______________grams
Weight =			______________grams

Getting a total weight for the International Space Station will be done this way. It will be impossible to get a total weight of the Space Station at one time. The International Space Station will never be assembled here on Earth. It will be assembled on orbit.

3. If possible, weigh your entire model. Use this figure to compare the accuracy of weighing individual pieces as compared to the entire Space Station.

   Space Station Weight = ______________grams

4. How close was the weight in number 2 to the weight in number 3? Subtract number 2 from number 3.

	Space Station Weight (number 3)	______________grams
–	Weight (number 2)	______________grams
	Difference =	______________grams

Discussion
1. Why are there restrictions on the individual components of the Space Station?
2. Why is it important for the truss not to be over 50 cm?
3. Why do the control jets need to be pointed away from the Space Station components?
4. Why did you choose the design you did?

Extensions
1. Have the students write instructions for building a Space Station.
2. Design a campaign for advertising the Space Station. Use video and/or print products.
3. Invite parents, faculty, and the local press to a Space Station expo. The completed Space Stations and the advertising campaigns can be displayed. Group members can discuss their designs.

Assessment
Students will comply with all set parameters and complete the needed math functions in order to meet those guidelines.

For more information about the International Space Station, please visit http://spaceflight.nasa.gov

Space Station Construction Activity

Adapted from an activity provided by Space Center Houston.

Topic: Construction of a Space Station

Objective: The students will create a model of the International Space Station given a set of materials and parameters.

Science Standards
Science as Inquiry
Science and Technology: Abilities of Technological Design
History and Nature of Science: Science as a Human Endeavor, Nature of Science

Mathematical Standards
Problem Solving
Communicating
Reasoning
Mathematical Connections
Number Systems and Number Theory
Computation and Estimation
Measurement

Universals of Technology
Designing and developing technological systems
Determining and controlling the behavior of technological systems
Linkages
Physical systems

Materials Needed
Plastic kitchen wrap
Craft sticks
Aluminum foil
Small buttons
Soft drink cans
Toothpicks
Cardboard tubes (toilet paper size)
Styrofoam food trays
Square centimeter paper
Individual serving cereal boxes
Flexible straws
Balances
Rulers
Scissors
Glue
Masking tape

Correlation of Materials to Space Station Components
Plastic kitchen wrap = Photovoltaic (PV) arrays
Craft sticks = Support structure for Photovoltaic (PV) arrays and thermal radiators
Aluminum foil = Thermal radiators
Cylindrical cans = Modules 1 (habitation) and 2 (laboratory)
Cardboard tubes (cut into thirds) = Docking port
Styrofoam food trays (cut into 4-cm wide strips) = Truss segments
Individual serving size cereal boxes = Module 3 (core)
Buttons = Control jets
Flexible straws = Robotic arm
Toothpicks = Miscellaneous decorations, supports, etc.

Procedure

Explain to the students that NASA engineers need their help. They need new ideas for the International Space Station.

1. Collect the necessary materials or instruct students to bring them from home. Display a model of the “old” International Space Station (this poster will do) as you discuss each individual component and its function: Module 1—habitation, Module 2—laboratory, Module 3—core (Resource Node), PV arrays, thermal radiators, docking port, control jets, and robotic arm.

2. Show the constraints that must be followed for the design:
(a) One hundred square centimeters of PV array will support the electrical needs of 500 cm^3 of module volume.
(b) All modules must be connected to at least one other module.
(c) Seventy-five square centimeters of thermal radiators will support the colling needs of 500 cm^3 of module volume.
(d) The length of the truss can not be longer than 50 cm.
(e) The control jets must be positioned so that they will not fire on any component of the Space Station and can move it in any direction.

INTERNATIONAL SPACE STATION

Photographs from Space - Transmitting Images to Earth

This lesson will reconstruct a photograph using blank paper and pencil based upon the verbal description given by a student (or teacher). Next, they will simulate the role of a CCD by creating a graphic in two levels of brightness.

Planetary probes and space telescopes such as Galileo and Hubble photograph pictures using a CCD, or charge coupled device, to convert the images into a sequence of binary digits called bits. These numbers are transmitted to earth via radio waves. Computers on earth then convert each number into a small square called a pixel or picture element. The values range from 0-255, determining the relative brightness of each pixel. A sizable pixel array will eventually compose one photograph. Color can be achieved by taking multiple pictures of the same object through single tint filters. Following transmission, scientists on earth combine these images to produce e a full color photograph.

Students will need:

- 1 piece of plain paper per student
- pencils
- student worksheet paper (graph or grid paper)
- sealed practice pictures (from magazines etc.)
- instructions for CCD picture

Remind students- space probes and telescopes cannot send photographic film back to earth, but must send an accurate description of images using radio waves. Ask students how they most commonly communicate with each other, by written or verbal language? They should agree--verbal.

Give every student a blank piece of paper; ask students to use their own pencils. Have a volunteer or the teacher open an envelope containing a concealed photograph. Without displaying the photograph, the volunteer will carefully describe the image as the others draw their own graphic interpretations. Regardless of the verbal description given, all of the drawings will differ. Language is too imprecise a tool to guarantee the accurate transmission of a photograph.

Part 2: Students will role play the part of an earth based receiver as the teacher simulates a probe transmitting from space. Each student will receive a piece of grid paper, have each student number the columns from one to twenty-two and letter each row from A to O. For each row, the teacher will read a series of digits, zero or one, corresponding to each box. For a value of zero, the student must color the corresponding box black. If the number is one, the box remains white.

When a numeric value for each box has been read, the students will compare pictures to determine the variety obtained. The class is asked to identify this picture, a ringed planet. Those planets with rings in our solar system can be named. Ask students to determine whether variations in their pictures were due to artistic differences or transmission errors. Students should conclude that successful communication would result in every receiver obtaining the same image. This demonstration only allowed for two numeric values: zero or one. Consequently, only a black and white image could be sent. To achieve shadings of gray, more numeric values must be permitted. The maximum employed by CCDs is **256**. For color, multiple images taken with a single color filters are later combined into a photograph.

Students will: demonstrate a simulation of the pixel method of obtaining photographs from space
demonstrate the advantage of pixel photography transmission to an auditory method

Students will use skills:
- observation
- communication
- listening
- prediction
- recording data
- comparing data
- conclusions

FYI: Constructing pictures by pixels is neither new nor restricted to CCDs. Ninetieth century Frenchman Georges-Pierre Seurat painted such masterpieces as A Sunday Afternoon on the Island of La Grande Jatte in 1884-85 using dots of only selected colors. His school of art is known as pointillism or divisionism. Today, televisions and computer monitors display visuals employing pixels of the primary colors: red, blue and yellow.

Sixth Grade Pixel Lesson Directions:

A row: 1-22 all #1``
B row: 1-1, 2-1, 3-0, 4-1, 5-0, all rest #1
C row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-0, 7-1, 8-1, 9-1, 10-1, 11-0, 12-0, 13-0, all rest #1
D row: 1-1, 2-1, 3-0, 4-1, 5-1, 6-1, 7-0, 8-1, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, all rest #1
E row: 1-1, 2-1, 3-1, 4-0, 5-1, 6-1, 7-1, 8-0, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, all rest #1
F row: 1-1, 2-1, 3-1, 4-1, 5-0, 6-1, 7-1, 8-0, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, all rest #1
G row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-0, 8-0, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, 17-0, all rest #1
H row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-0, 8-0, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, 17-0, all rest #1
I row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-0, 8-0, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, 17-0, 18-1, 19-1, 20-1, 21-1, 22-1,
J row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-0, 8-0, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, 17-0, 18-1, 19-0, 20-1, 21-1, 22-1
K row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-1, 8-0, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, 17-1, 18-1, 19-1, 20-0, 21-1, 22-1
L row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-1, 8-0, 9-0, 19-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-0, 17-1, 18-1, 19-1, 20-1, 21-0, 22-1
M row: 1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-1, 8-1, 9-0, 10-0, 11-0, 12-0, 13-0, 14-0, 15-0, 16-1, 17-0, 18-1, 19-1, 20-1, 21-1, 22-1
N row: 1 through 10-1, 11-0, 12-0, 13-0, 14-1, 15-1, 16-1, 17-1, 18-0, 19-1, 20-1, 21-0, 22-1
O row: 1-17 all #1, 19-0, rest-1

1 = white
0 = black (or gray if using pencils)

Lesson provided by: the Broken Arrow Space Experience, Pat Smith

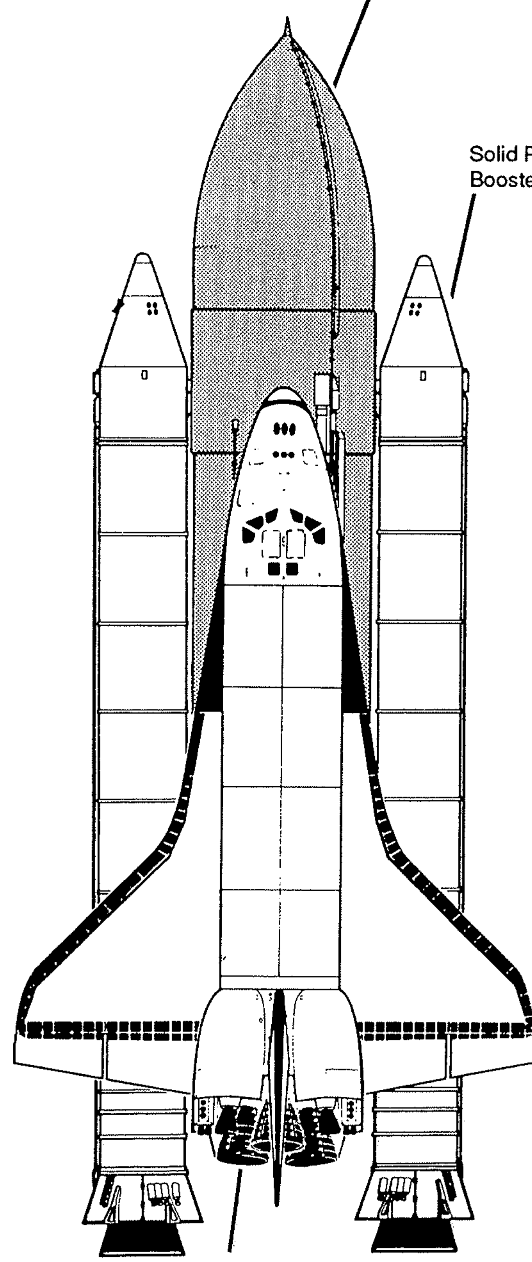
NASA Fact Sheet

ional Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

May 1991

A Walk Around the Space Shuttle



The Space Shuttle's superlative design provides capabilities and a flexibility unmatched by any other launch system. Here is what makes it work.

The Shuttle's major components are: the orbiter spacecraft; the three main engines, with a combined thrust of almost 1.2 million pounds; the huge external tank (ET) that feeds the liquid hydrogen fuel and liquid oxygen oxidizer to the three main engines; and the two solid rocket boosters (SRBs), with their mbined thrust of some 5.8 million pounds, which provide most he power for the first two minutes of flight.

The SRBs take the Space Shuttle to an altitude of 28 miles and a speed of 3,094 miles per hour before they separate and fall back into the ocean to be retrieved, refurbished, and prepared for another flight.

After the solid rocket boosters are jettisoned, the orbiter's three main engines, fed by the external tank, continue to provide thrust for another six minutes before they are shut down, at which time the giant tank is jettisoned and falls back to Earth, disintegrating in the atmosphere.

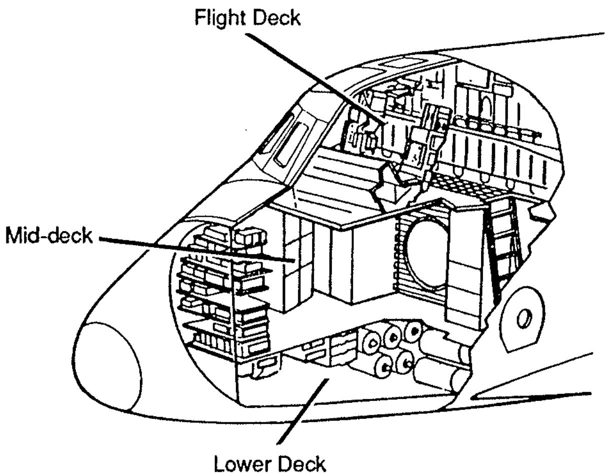
The Space Shuttle Orbiter

The orbiter is both the brains and heart of the Space Transportation System. About the same size and weight as a DC-9 aircraft, the orbiter contains the pressurized crew compartment (which can normally carry up to seven crew members), the huge cargo bay, and the three main engines mounted on its aft end.

The thermal tile system which protects the orbiter during its searing reentry through the atmosphere was a breakthrough nology that proved much more challenging than expected.

(Continued on next page)

There are three levels to the crew cabin. Uppermost is the flight deck where the commander and the pilot control the mission, surrounded by an array of switches and controls. During the launch of a seven-member crew, two other astronauts are positioned on the flight deck behind the commander and pilot. The three other



crew members are in launch positions in the mid-deck, which is below the flight deck.

The mid-deck is where the galley, toilet, sleep stations, and storage and experiment lockers are found for the basic needs of weightless, daily living. Also located in the mid-deck are the side hatch for passage to and from the vehicle before and after landing, and the airlock hatch into the cargo bay and space beyond. It is through this hatch and airlock that astronauts go to don their spacesuits and manned maneuvering units (MMUs) and prepare for extravehicular activities (EVAs), more popularly known as "spacewalks." These excursions have produced some of the most important space firsts in the Shuttle program as well as the most spectacular photographic vistas of the space age.

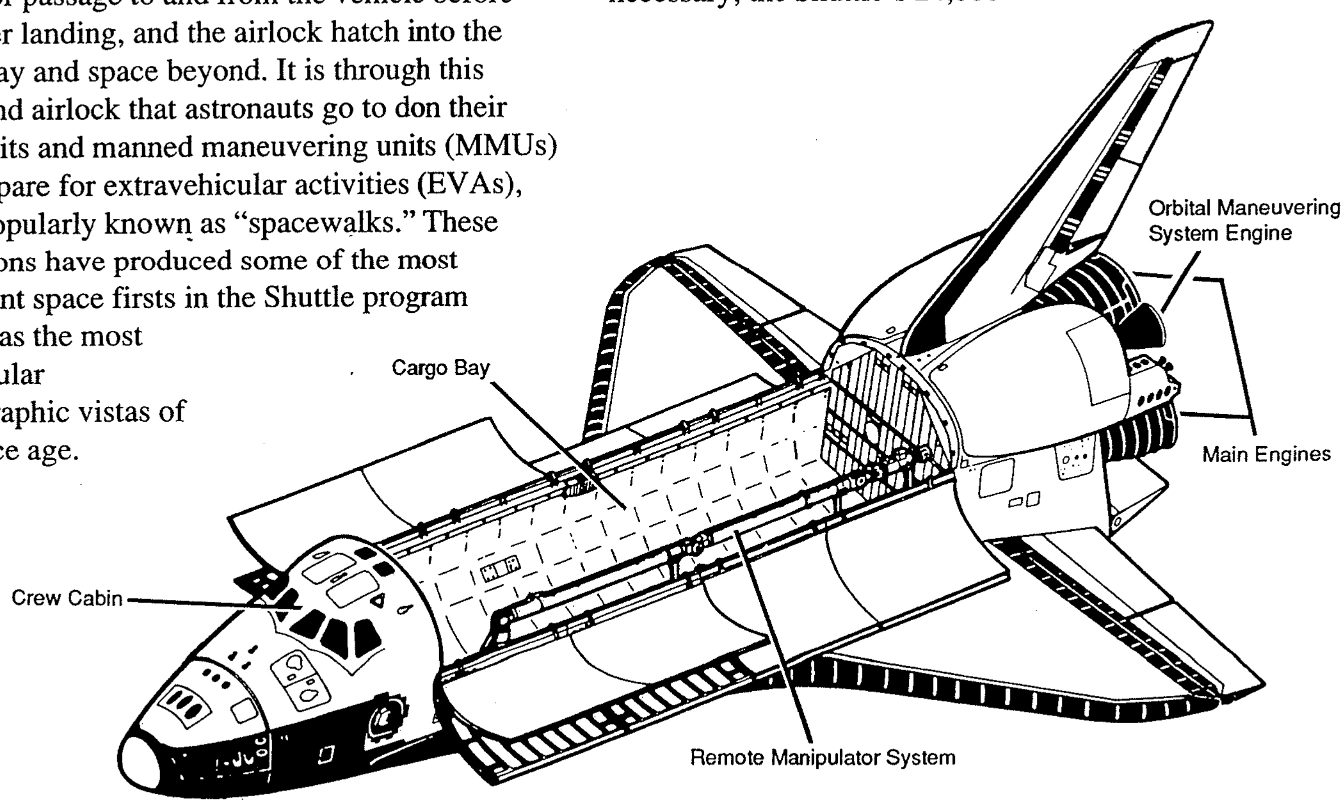
Below the mid-deck's floor is a utility area for the air and water tanks and their ducts.

The Space Shuttle's cargo bay is adaptable to hundreds of tasks. Large enough to accommodate a tour bus (60 x 15 feet), the cargo bay instead carries satellites, spacecraft , and Spacelab scientific laboratories to and from Earth orbit. It is also work station for astronauts to repair satellites, a foundation from which to erect space structures, and a hold for retrieved satellites to be returned to Earth.

Mounted on the port side of the cargo bay behind the crew quarters is the remote manipulator system (RMS). The RMS is a robot arm and hand with three joints analogous to those of the human shoulder, elbow and wrist. It is operated from the aft station of the orbiter's flight deck. The RMS, some 50 feet long, can move anything from satellites to astronauts to and from the cargo bay or to different points in nearby space.

Thermal tile insulation and blankets (also known as the thermal protection system or TPS) cover the underbelly, bottom of the wings, and other heat-bearing surfaces of the orbiter and protect it during its fiery reentry into the Earth's atmosphere.

Designed to be used for 100 missions before replacement is necessary, the Shuttle's 24,000



individual tiles are made primarily of pure-sand silicate fibers, mixed with a ceramic binder. Incredibly lightweight, about the density of balsa wood, they dissipate the heat so quickly that a white-hot tile with a temperature of 2,300 degrees Fahrenheit can be taken from an oven and held in bare hands without injury.

The Main Engines and Orbital Propulsion Systems

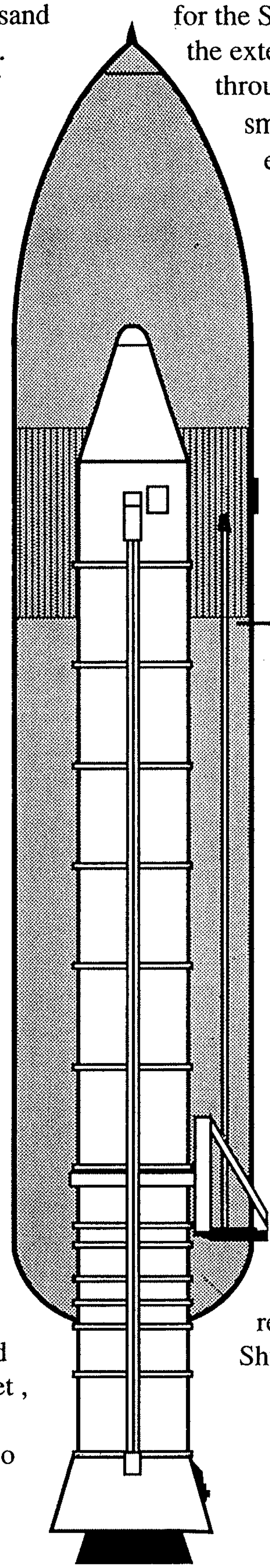
The three main engines are clustered at the aft end of the orbiter and have combined thrust of almost 1.2 million pounds at sea level. They are high performance, liquid propellant rocket engines whose thrust can be varied over a range of 65 to 109 percent of their rated power level. They are the world's first reusable rocket engines, designed to operate for 55 flights, and are 14 feet long and eight feet in diameter at the nozzle exit.

Two orbital maneuvering system (OMS) engines, mounted on either side of the upper aft fuselage, provide thrust for major orbital changes. For more exacting motions in orbit, forty-four small rocket engines, clustered on the Shuttle's nose and on either side of the tail, are used. Together they are known as the reaction control system and are used to aid in retrieving, launching, and repairing satellites in orbit.

The External Tank

The giant cylinder, higher than a 15-story building, with a length of 154 feet and as wide as a silo with a diameter of 27.5 feet , is the largest single piece of the Space Shuttle. During launch the external tank also acts as a backbone for the orbiter and solid rocket boosters to which it is attached.

In separate pressurized tank sections inside, the external tank holds the liquid hydrogen fuel and liquid oxygen oxidizer for the Shuttle's three main engines. During launch the external tank feeds the fuel under pressure through 17-inch ducts which branch off into smaller lines that feed directly into the main engines. Some 64,000 gallons of fuel are consumed by the main engines each minute.



Machined from aluminum alloys, the Space Shuttle's external tank is the only part of the launch vehicle that currently is not reused. After its 526,000 gallons of propellants are consumed during the first eight and one-half minutes of flight, it is jettisoned from the orbiter and breaks up in the upper atmosphere, its pieces falling into remote ocean waters.

The Solid Rocket Boosters

The Space Shuttle's two solid-rocket boosters, the first designed for refurbishment and reuse, are also the largest solids ever built and the first to be flown on a manned spacecraft. Together they provide the majority of the thrust for the first two minutes of flight—some 5.8 million pounds.

The solid propellant mix is composed of 16 percent aluminum powder (fuel) and almost 70 percent ammonium perchlorate (oxidizer), with the remainder made up of a binder, a curing agent, and a small amount of catalyst. A small rocket motor in each booster ignites the propellant at launch. During flight, the solid booster nozzles swivel up to a six degrees, redirecting the thrust and steering the Space Shuttle toward orbit.

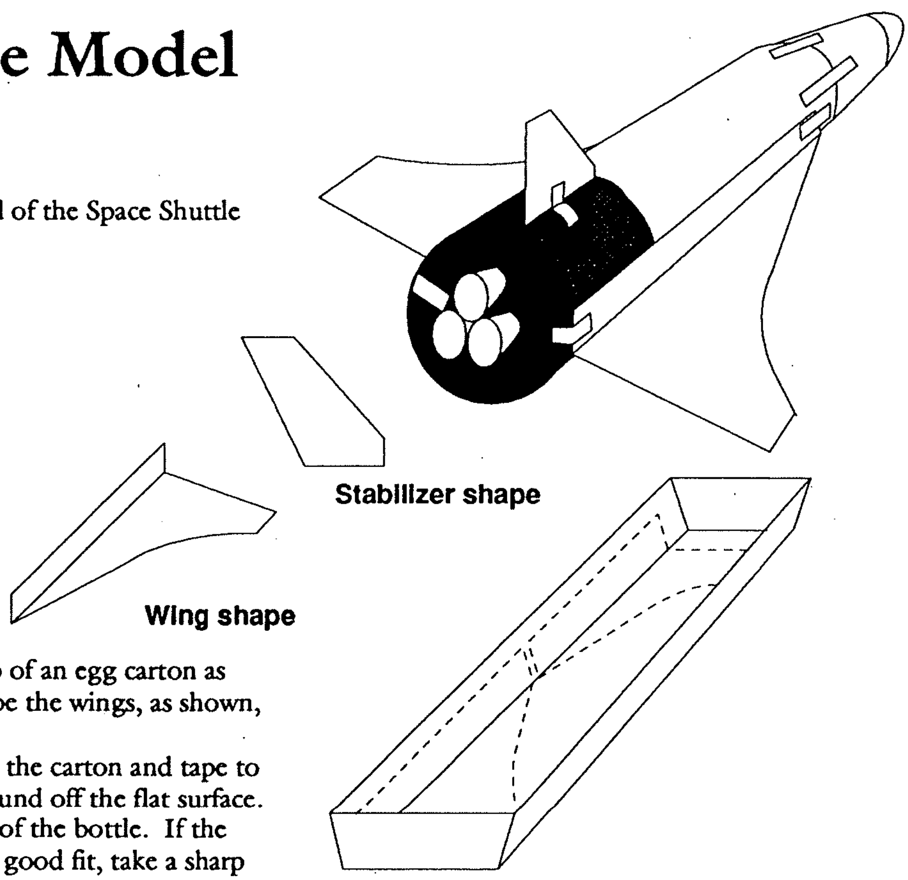
Classroom Activities

Space Shuttle Model

Subject: Manned Space Flight
Topic: Model Building
Description: Construct a model of the Space Shuttle orbiter from scrap materials.

Materials and Tools:

2-Liter plastic soda pop bottle
2 Egg cartons
6-oz Paper cup
Masking tape
Newspaper
Glue for papier-maché
White glue
Scissors

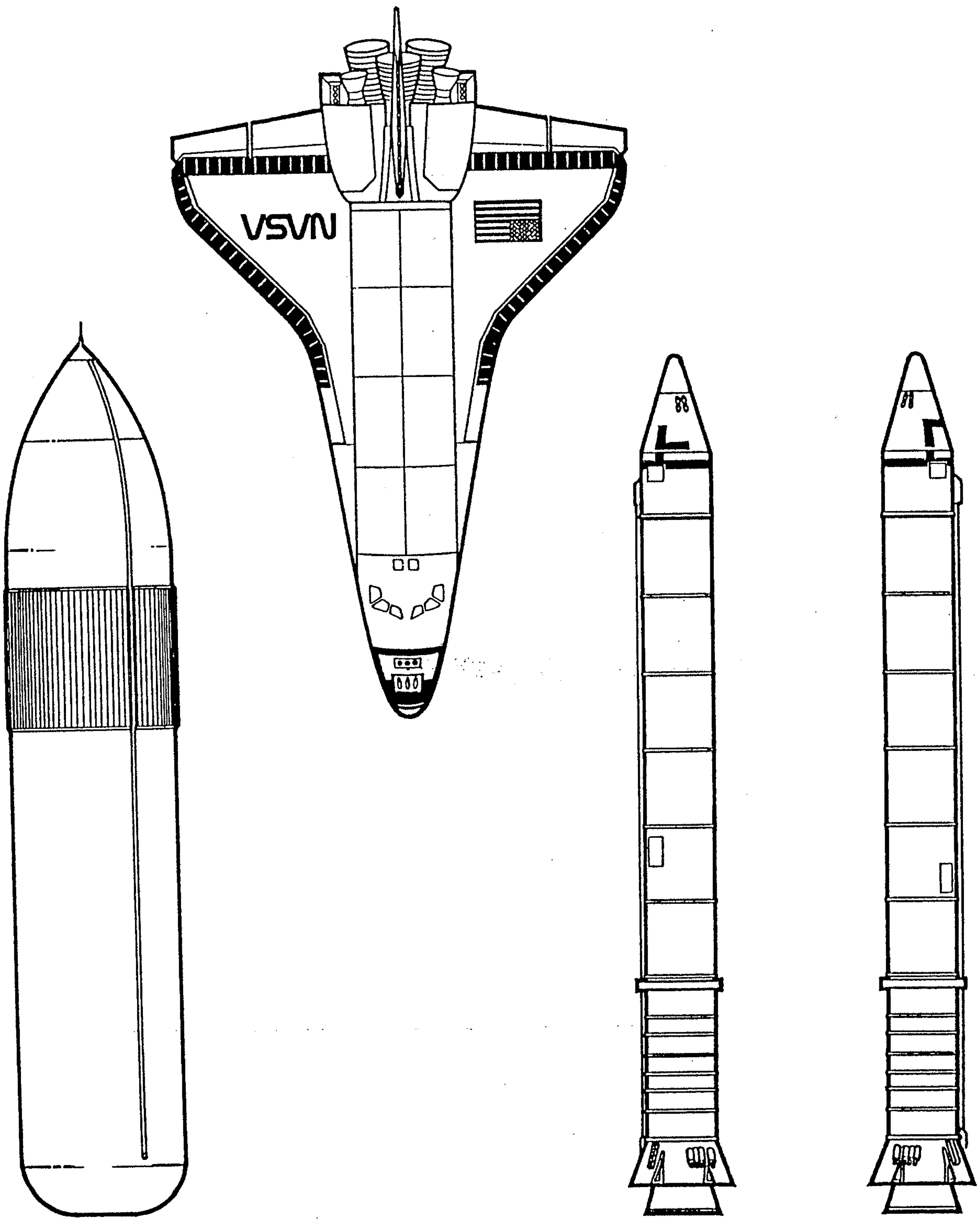


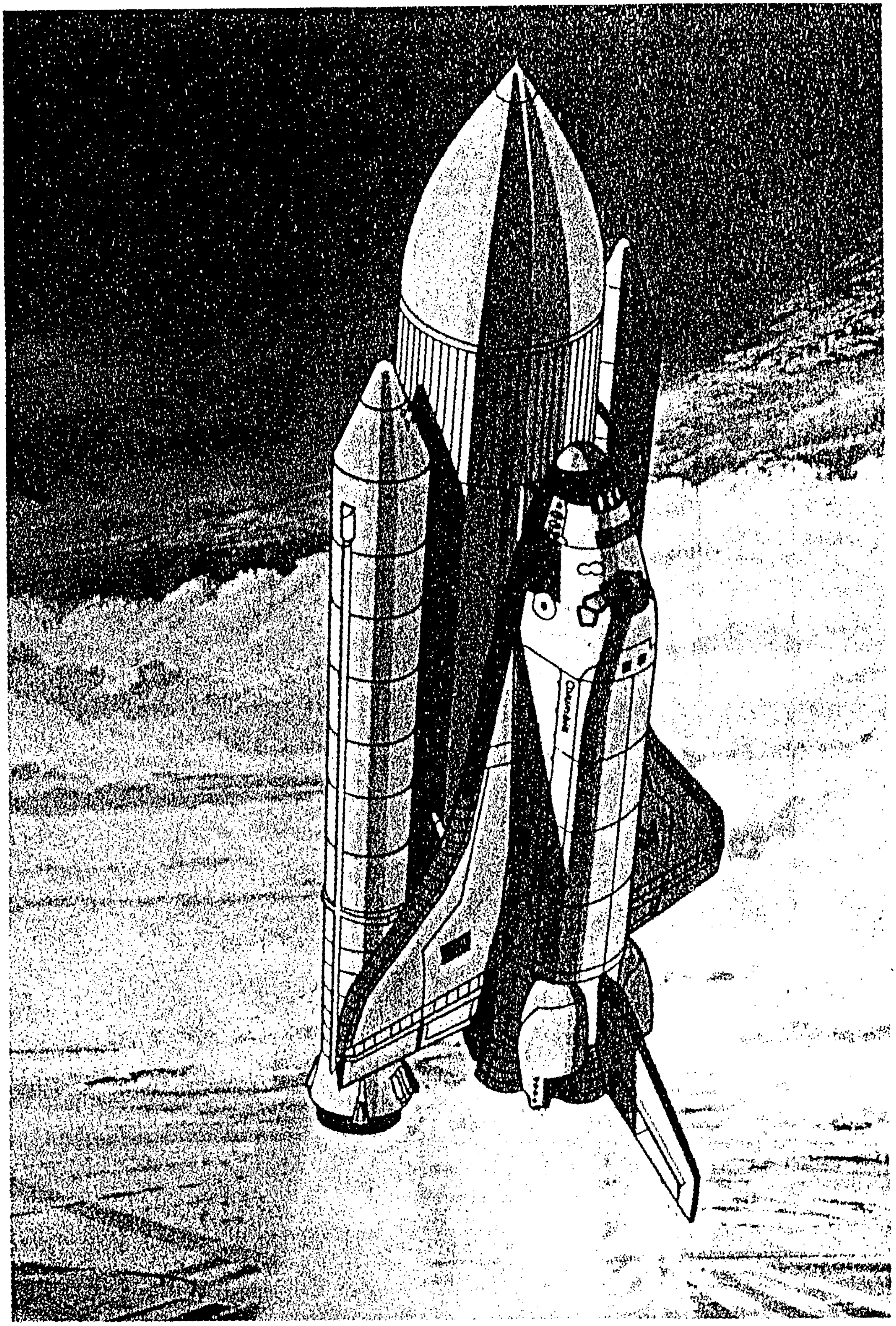
Procedures:

1. Cut two wings from the top of an egg carton as shown in the diagrams. Tape the wings, as shown, to the bottle.
2. Cut out an "egg well" from the carton and tape to the bottom of the cup to round off the flat surface. Tape the cup over the neck of the bottle. If the neck is too long to permit a good fit, take a sharp knife and trim it off a bit.
3. Cut out a vertical tail for the model from the egg carton and tape it onto the bottle.
4. Cover the model with papier-maché. Narrow strips of newspaper are easiest to work with. Let the papier-maché dry and add additional layers for strength.
5. Cut three egg wells to make engines for the orbiter. Cover each well with papier-maché and let it dry.
6. When the body of the orbiter and the engines are dry, glue the engines to the tail end of the model as shown.
7. Paint the model and add decals, stars, and other decorations when dry.

ASSEMBLE A SPACE SHUTTLE
Cut-and-paste Activity

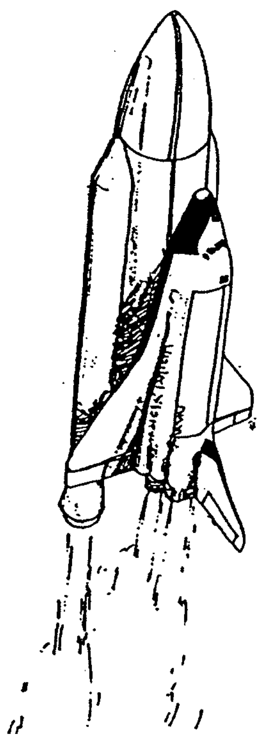
Instructions: Give each student a copy of the shuttle pieces on this page. Have the students cut out the pieces and assemble the shuttle by pasting the pieces on a sheet of construction paper. Pictures elsewhere in this book can be used as a guide for correct placement.



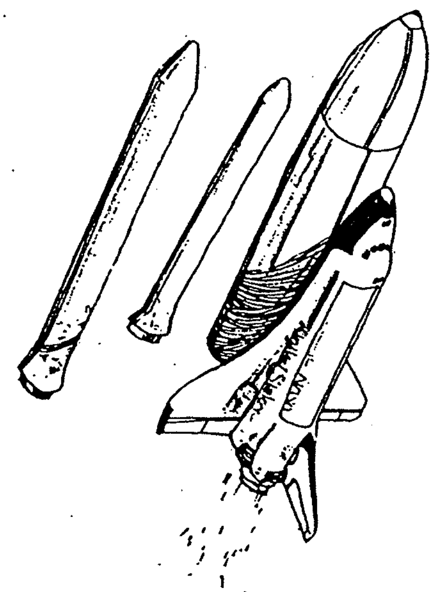


The 4 Stages of a Space Shuttle Launch

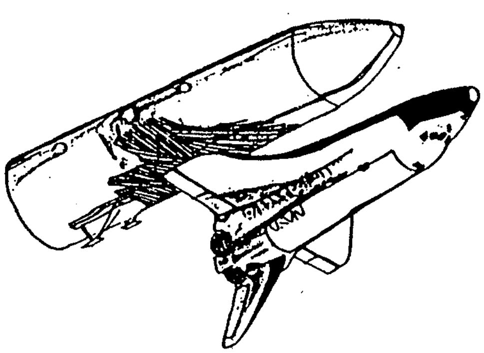
Lift-off



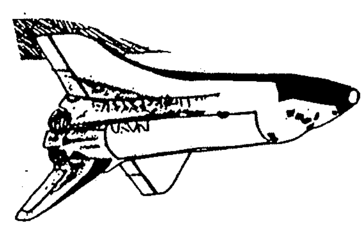
SRB's Detach



External Tank Detaches



Space Shuttle in Orbit



"First I believe that this Nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth."

President John F. Kennedy, Special Message to Congress, May 24, 1961

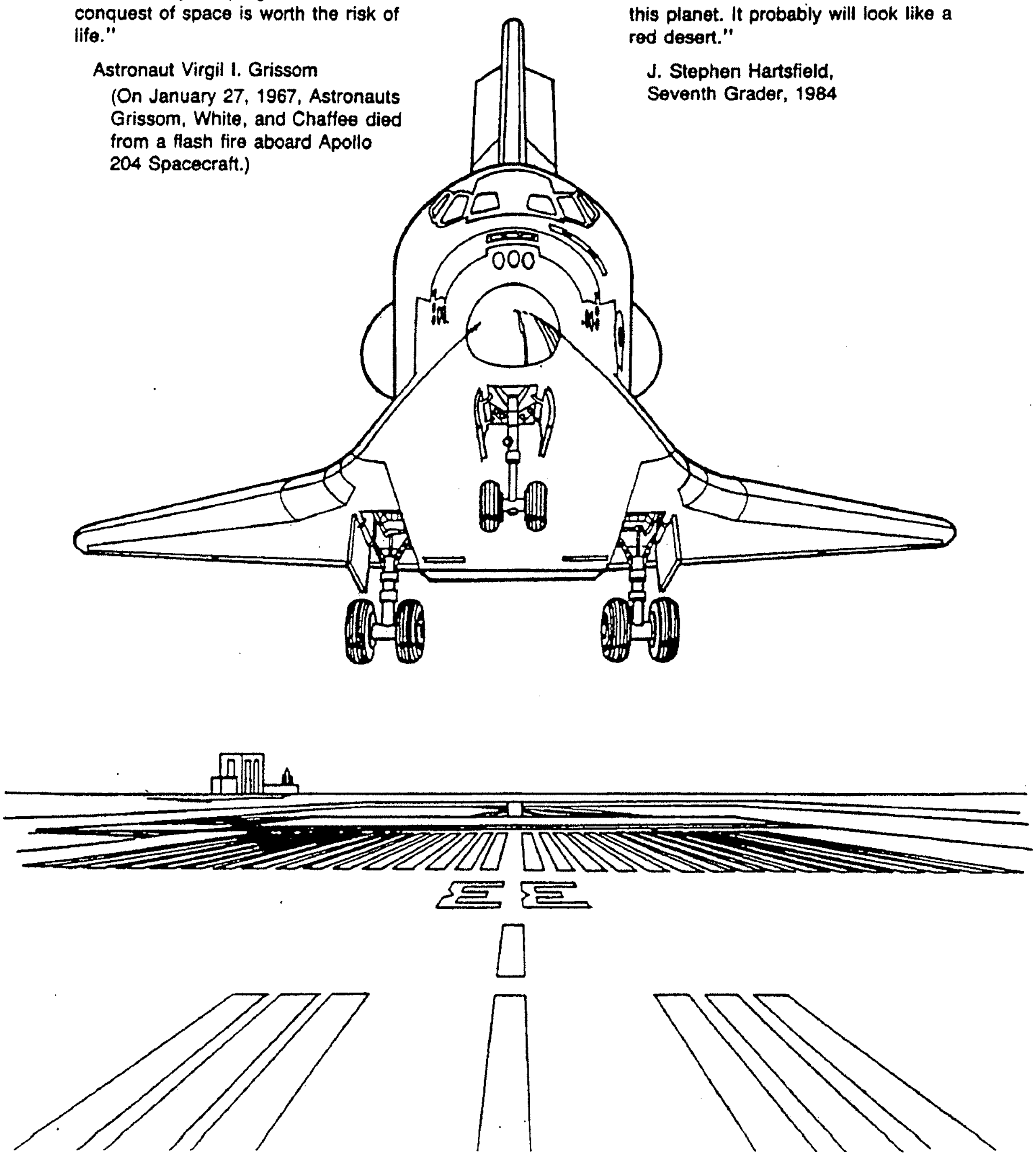
"If we die, we want people to accept it. We are in a risky business, and we hope that if anything happens to us it will not delay the program. The conquest of space is worth the risk of life."

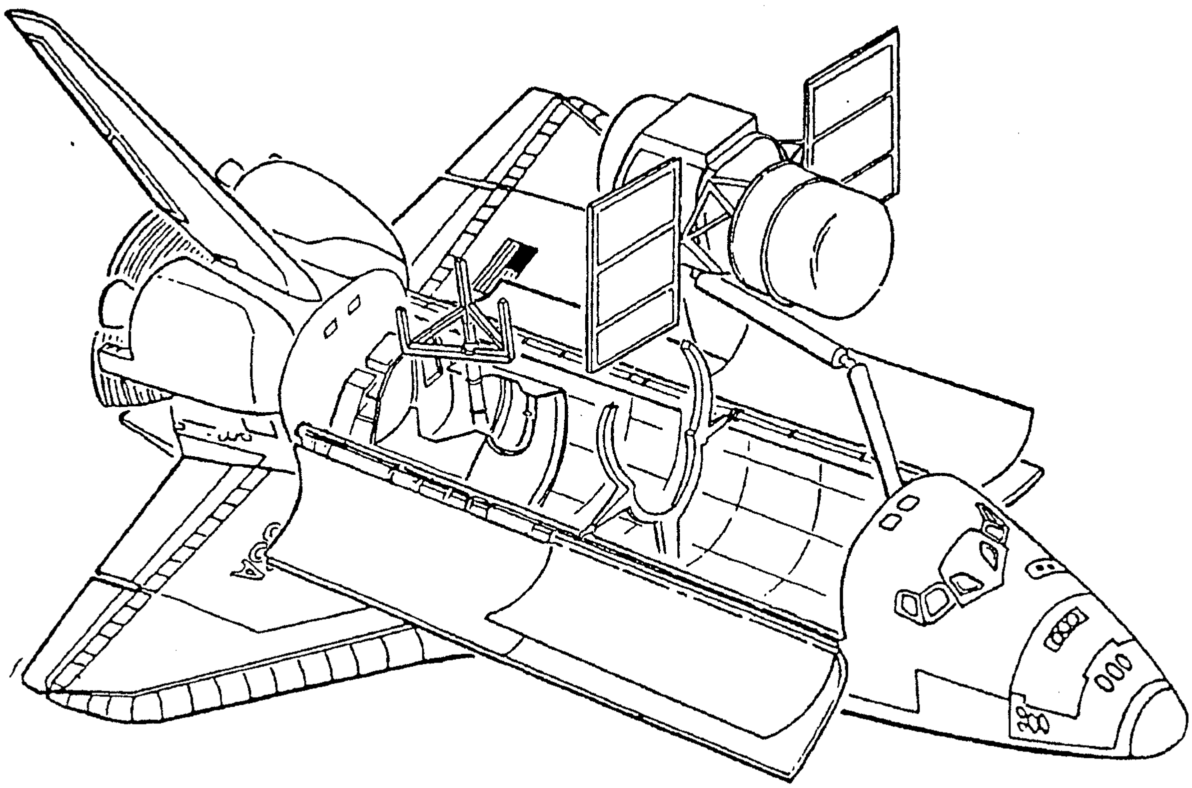
Astronaut Virgil I. Grissom

(On January 27, 1967, Astronauts Grissom, White, and Chaffee died from a flash fire aboard Apollo 204 Spacecraft.)

"Some day people will travel to Mars. It will be a long trip, but fun. This will be a big step for mankind. We would be able to find out if there was life on this planet. It probably will look like a red desert."

J. Stephen Hartsfield,
Seventh Grader, 1984





"The greatest gain from space travel consists in the extension of our knowledge. In a hundred years this newly won knowledge will pay huge and unexpected dividends."

Professor Wernher von Braun

"Science-fiction yesterday, fact today—obsolete tomorrow."

Otto O. Binder, Editor in Chief, *Space World Magazine*

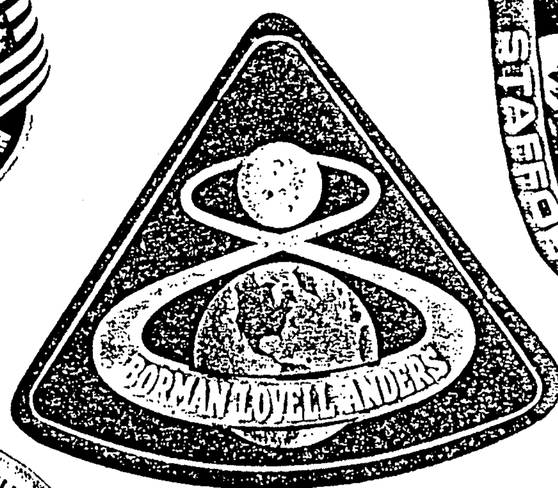
"It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."

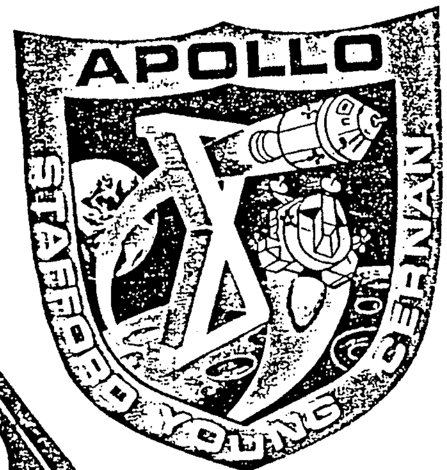
Robert H. Goddard in his high school oration (1904)

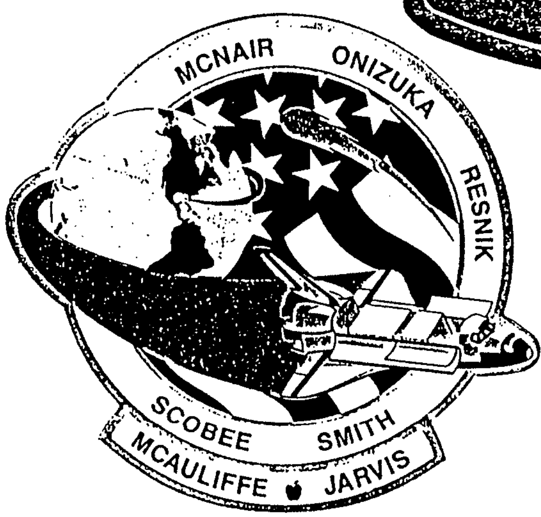
MISSION LOGO

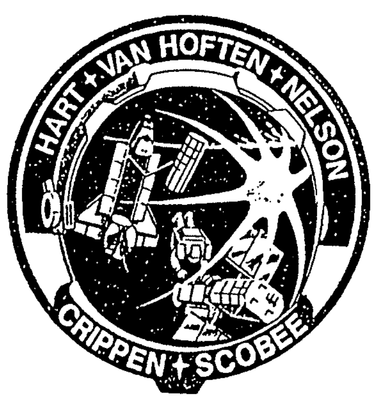
For every space mission a logo is developed for that flight. Incorporated into the logo design are various elements depicting the different phases of that mission. Usually the crew for that flight will design the mission logo. Shown below are logos from former space missions.

Have students design a logo for the first "Student in Space" mission.









On August 28, 1984, President Ronald Reagan directed NASA to begin a search to choose the first citizen passenger for the space program, "...one of America's finest - a teacher." The next citizen will be a journalist. In the not too distant future it is possible that a student might be selected to be aboard a shuttle mission. Perhaps you will be that student. If you were to be selected, these activities could be very helpful in preparing you for the mission.

STUDENT IN SPACE

A. Develop a questionnaire to use in selecting a student in space.

B What type of experiment might the student demonstrate to help classmates better understand a scientific principle.

C. As a class, discuss ways of preparing for your flight.

D. Choose personal items to take on your flight. Primary students could use a backpack as a simulated locker. Intermediate students could use a box the size of a shuttle locker, which is 10 in x 14 in x 20 in.

E. Research the present sleeping arrangements. How might you improve on them?

F. List the music you would take along. You're allowed to take two hours of the music of your choice.

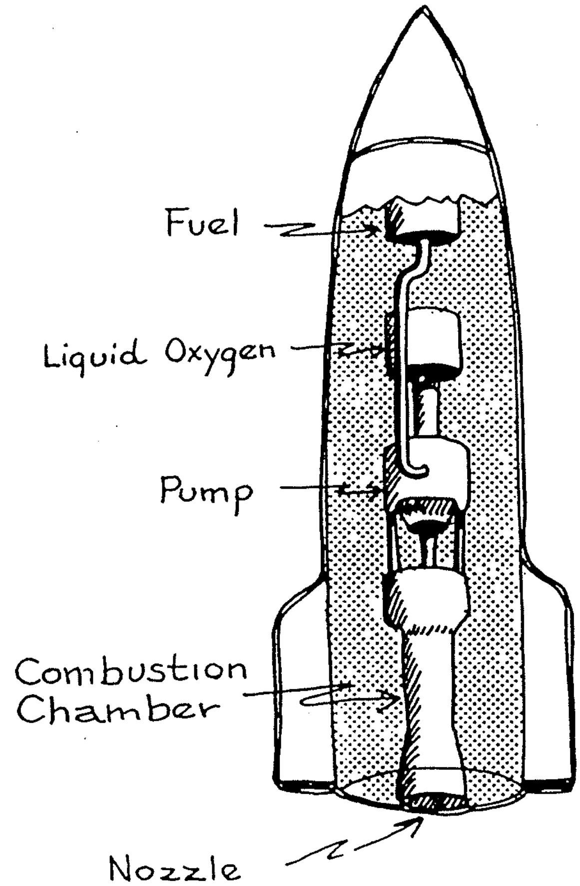
G. Have a class or school contest to choose a student astronaut.

H. What part of your experience of traveling in space are you most excited about?

I. How do you feel about future space flights since the Challenger disaster on January 28, 1986?

HOW DO ROCKETS WORK?

R-2

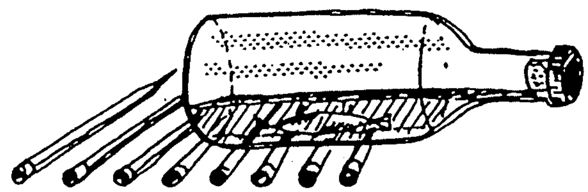


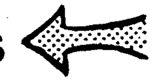
Rockets work like jets, but they do not need air. Therefore rockets work in outer space where jets cannot. Rockets carry their own supply of oxygen in the form of solid or liquid fuel. In a liquid fuel rocket, tanks of liquid fuel and liquid oxygen are pumped into the combustion chamber and ignited. This causes the liquids to expand, become gas, and build pressure rapidly. As the hot gases escape through the nozzle, the rocket shoots ahead.

MATERIALS:

- Bottle and cork
- Baking soda
- Tissue paper
- Vinegar
- Vaseline
- 6 (or more) round pencils

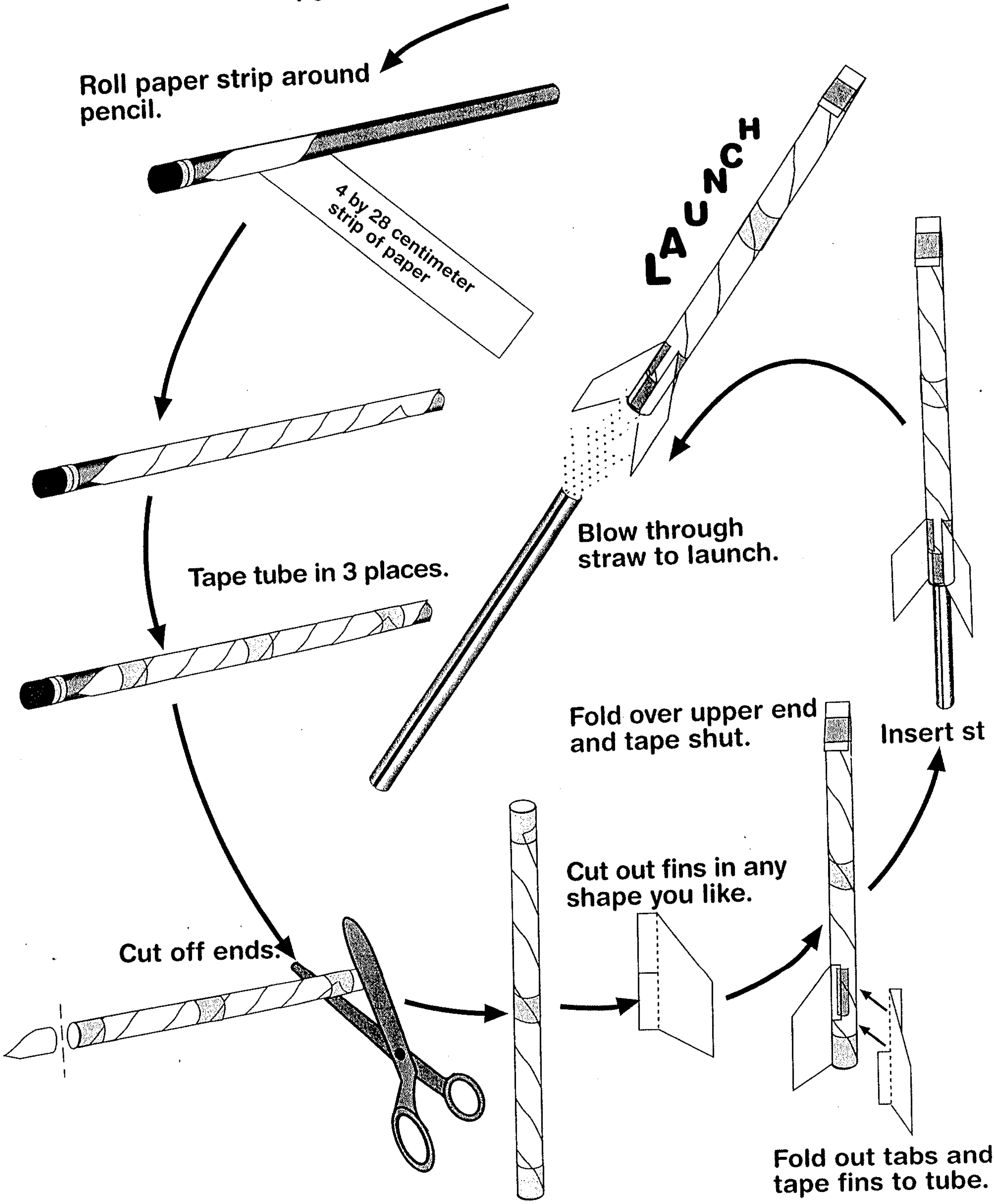
Proceed outdoors!
Lubricate the bottle top and cork with vaseline. Fill bottle halfway with a mixture of 50% water and 50% vinegar (fuel). Put two teaspoons of baking soda (oxidizer) in tissue and twist the ends.  . Slip the baking soda into the bottle and put the cork in place. Place the bottle on its side on the pencils.



When the baking soda mixes with the vinegar, a chemical reaction takes place releasing a large quantity of rapidly moving expanding gases. Then . . . The cork etc. —shoot  forward, the bottle rolls  in the opposite direction.

PAPER ROCKETS

Follow the arrows to build your rocket.



Paper Rocket Test Report

Names: ______________________

____

1. Launch your rocket three times. How far did it fly each time. What is the average distance your rocket flew? Write your answer in the spaces below.
2. Build and fly a rocket of a new design. Before flying it, predict how far it will go. Fly the rocket three times and average the distances. What is the difference between your prediction and the actual average distance?
3. Build a third rocket and repeat step 2.
4. On the back of this paper, write a short paragraph describing each rocket you built and how it flew. Draw pictures of the rockets you constructed.

Rocket 1

	Make notes about the flights here.
How far did it fly in centimeters? 1. ______ 2. ______ 3. ______ Average distance in centimeters? ______	

Rocket 2

	Make notes about the flights here.
Predict how many centimeters your rocket will fly. ______ How far did it fly in centimeters? 1. ______ 2. ______ 3. ______ Average distance? ______ Difference between your prediction and the average distance? ______	

Rocket 3

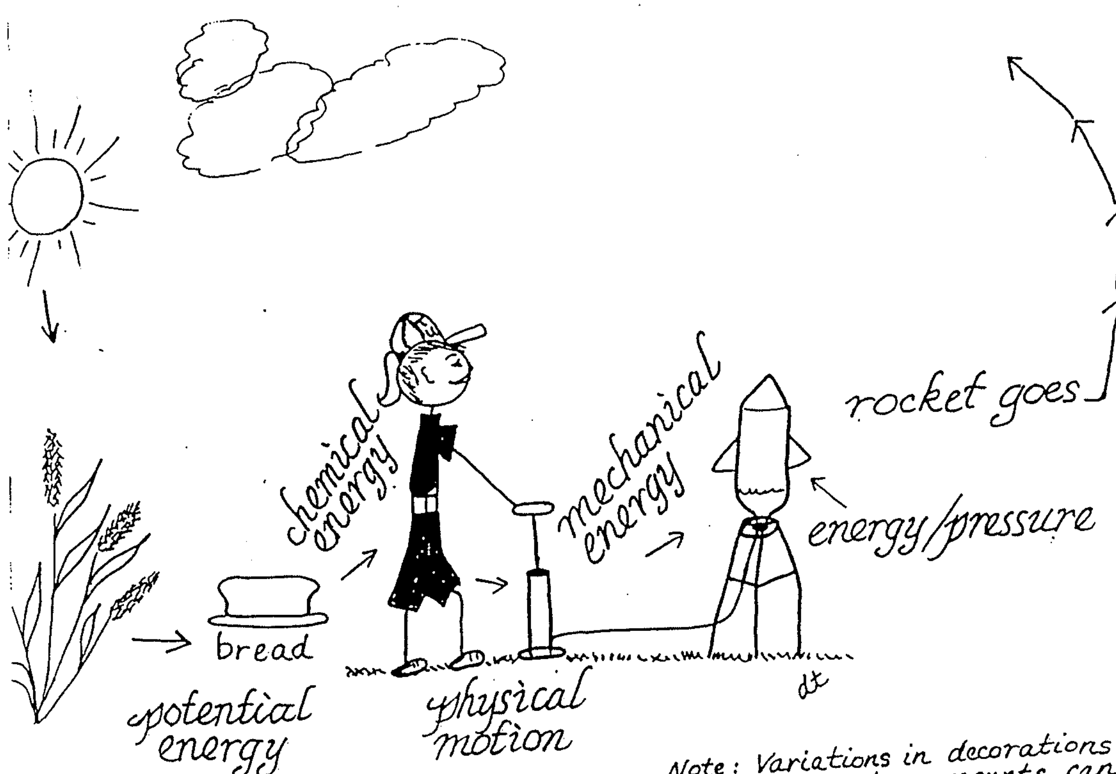
	Make notes about the flights here.
Predict how many centimeters your rocket will fly. ______ How far did it fly in centimeters? 1. ______ 2. ______ 3. ______ Average distance? ______ Difference between your prediction and the average distance? ______	

Pop Bottle Water Rockets

Objectives: Children will observe the transfer of energy flow and sources of energy with an occurring force.

Materials:
Plug with hole
Hamster water bottle with 10" clear plastic tubing
Empty 2 liter bottle (remove lid and bottom cup)
Tire pump or hand pump
Launch pad or stand

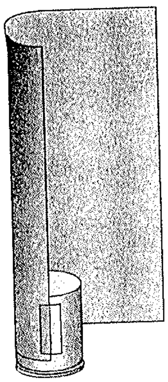
Procedures:
Children decorate bottles as rockets.
Use liquid soap to put tubing into (cork) plug hole.
Put @ 1 1/2—2 cups of water into bottle.
Place plug into bottle opening.
Put pump clasp over plastic tubing.
Pump….and presto!!! A rocket!!!



Note: Variations in decorations and water amounts can determine the distance the rocket travels upward.

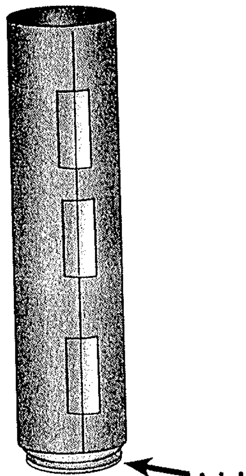
3-2-1 POP!

1

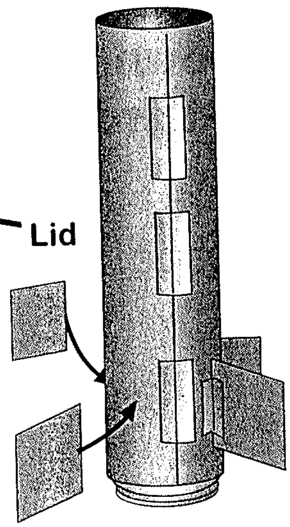


Wrap and tape a tube of paper around the film canister. The lid end of the canister goes down!

2

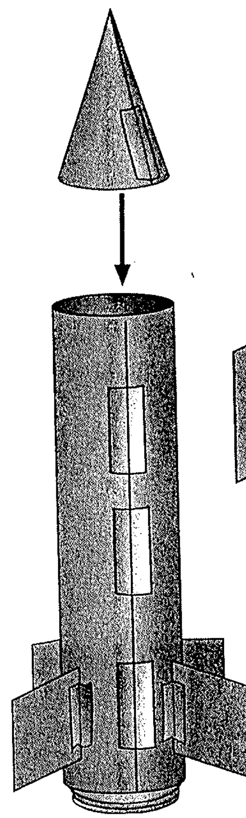


3



Tape fins to your rocket.

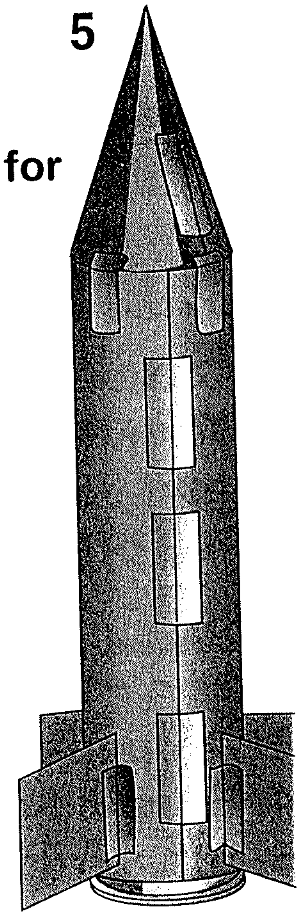
4

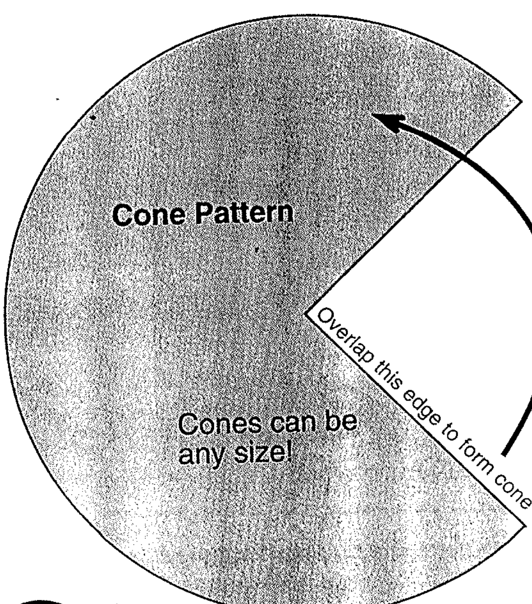


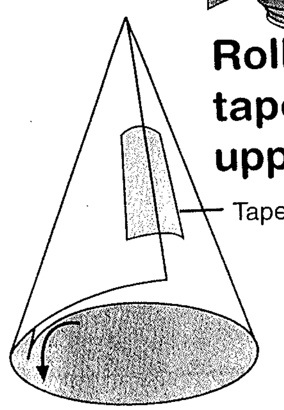
Roll a cone of paper anc tape it to the rocket's upper end.

5

Ready for flight







ROCKETEER NAMES

____

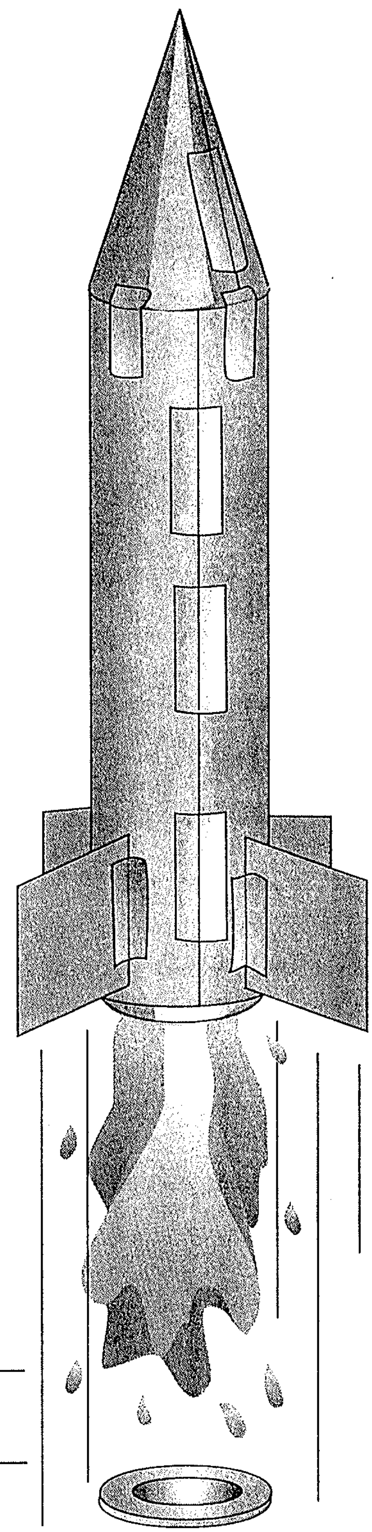
____

COUNTDOWN:

1. Put on your eye protection.
2. Turn the rocket upside down and fill the canister one-third full of water.

Work quickly on the next steps!

3. Drop in 1/2 tablet.
4. Snap lid on tight.
5. Stand rocket on launch platform.
6. Stand back.



LIFTOFF!

What three ways can you improve your rocket?

1. ______________________________

2. ______________________________

3. ______________________________

3 - 2 - 1 Pop Rocket Test Report

Names:____________________
____
____

Use your altitude tracker to measure how high it flew?

Make one design change & retest. Describe change & results.

Rocket 1: ____________ ____

Rocket 1: ____________ ____

Rocket 2: ____________ ____

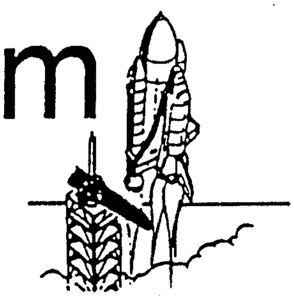
Rocket 2: ____________ ____

Rocket 3: ____________ ____

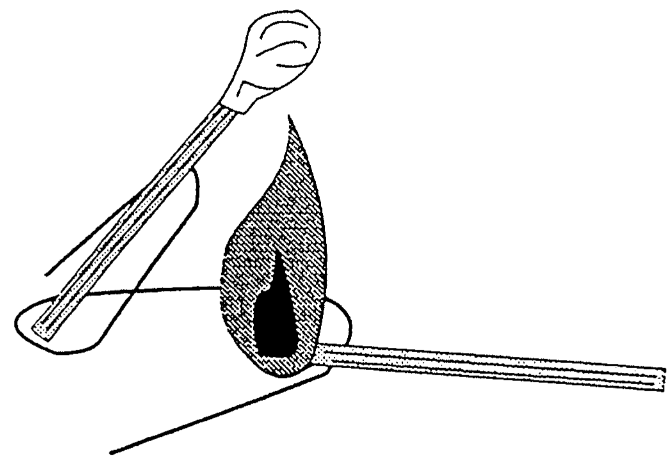
Rocket 3: ____________ ____

Discuss with your group and write below:
What do you conclude from your design changes?
What design change would you make next? Why?
Do you think the canister has an effect on the altitude? If so, what effect and why?
Do you think the "fuel" has an effect on the altitude? If so, what effect and why?
On the back of this paper, draw your best rocket design and point out any special details you think are the reasons it flew the best.

Classroom Activities



Match Stick Rocket



Subject: Rocketry
Topic: Propulsion
Contributed by: Steve Culivan, KSC
Description: A small solid propellant rocket is made from a match and a piece of aluminum foil.

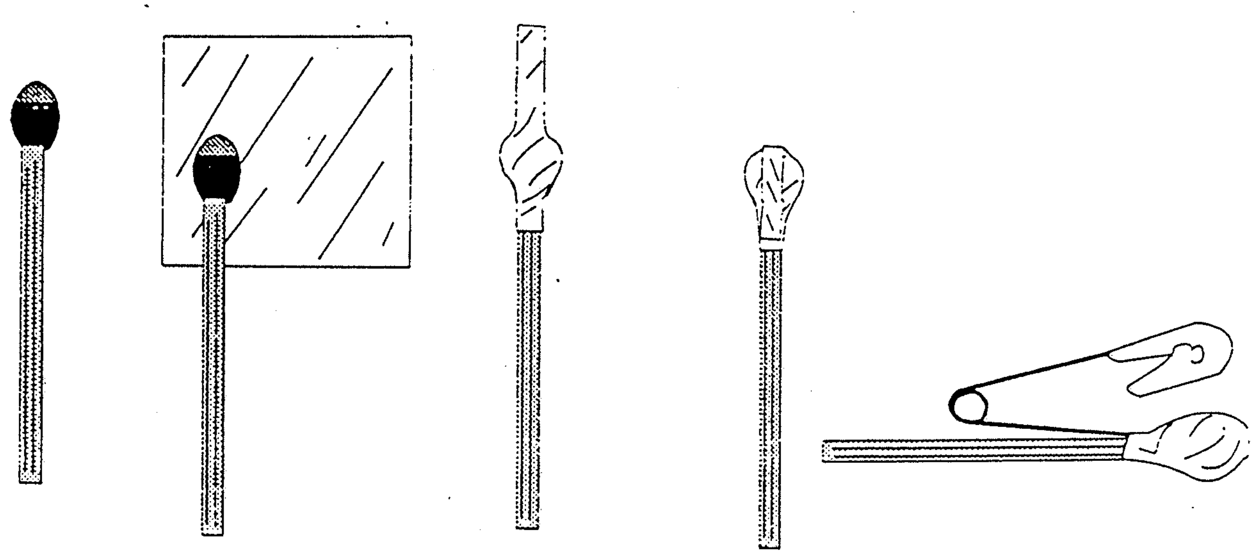
Materials:

2 match book matches or wooden stick matches
Small square of aluminum foil
Paper clip
Safety pin

Procedure:

1. Take one match and wrap a small piece of aluminum foil around the match-head. Wrap the foil tightly.
2. Make a small opening in the foil wrapped around the match head by inserting the point of a safety pin and bending upward slightly.
3. Bend the paper clip to form a launch pad as shown in the diagrams. Erect the match stick rocket on the pad. Make sure the pad is set up on a surface that will not be damaged by the rocket's exhaust such as a lab table.
4. Ignite the match by holding a second lighted match under the foil until its combustion temperature is reached.

Caution: Be sure the match rocket is pointed away from people or flammable materials. It is recommended to have water or some other fire extinguishant available. The foil head of the rocket will be very hot!



National Aeronautics and Space Administration

Educational Product	
Educators	Grades 5–12

Educational Brief

Connecting in Space: Docking With the International Space Station

Objectives
Students will demonstrate and identify procedures, selecting the best method to complete the docking activity.

Students will identify Newton's Laws of Motion.

Science Standards
Science as Inquiry
Physical Science
  Motions and forces
  Position and motion of objects

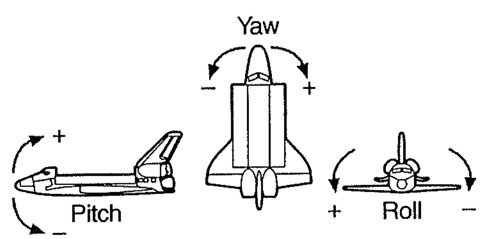
Math Standards
Problem Solving
Communication

Materials *(for each group of two)*
String, 4.6 meters
Pencil, sharpened
Tape
Space Shuttle template
Stand-off cross and docking ring template
2 small plastic cups
Straw
Clay

Background Information
The International Space Station will provide a long-term orbital laboratory in which research in biology, chemistry, physics, and other sciences will be conducted. With an approximate mass of 456,620 kilograms when it is complete, the International Space Station will be the largest object humans have built in orbit. Forty-five space flights are required to assemble this orbiting laboratory. These flights will occur over a 5-year period.

There are three phases to the development of the International Space Station. Phase One encompasses U.S. participation in the Russian *Mir* space station project. Having astronauts live aboard *Mir* with the Russian cosmonauts enables the United States to study the long-term effects of space on the human body and to practice procedures that will be used on the International Space Station. Phase Two of production for the International Space Station consists of the first portion of assembly, while Phase Three is the second portion of assembly.

In order for the components, crews, and supplies to be delivered to the International Space Station, a system needs to be in place that allows the Space Shuttle to dock, or attach, to the structure. One procedure practiced on *Mir* includes the docking techniques. After the Space Shuttle is launched and once inserted into an initial orbit, the Commander uses the Orbital Maneuvering System to thrust the Space Shuttle from one orbit to another. Using the Orbital Maneuvering System and Reaction Control System, the Space Shuttle is positioned approximately 110 meters below *Mir*. The Reaction Control System is used to complete the approach of the Space Shuttle toward *Mir*. The Reaction Control System is used to change speed, orbit, and attitude (pitch, roll, and yaw.) The pitch is an angular rotation about an axis parallel to the widthwise axis of a vehicle. The roll is the angular rotation movement about the lengthwise axis of the vehicle. The yaw is the angular rotation movement about the heightwise axis of the vehicle. The Reaction Control Systems are located in the nose and tail sections of the Space Shuttle. When the systems are activated, they are fired in a direction opposite to that which the Commander wishes to move. If the Commander wants to move to the left, he or she fires the Reaction Control System on the right, and if the desired movement is to the right, the system is fired on the left. The Space Shuttle travels toward *Mir* with a force that is equal and opposite to the Reaction Control System firings (Newton's Third Law).



The Space Shuttle stops within 50 meters of *Mir*, which is approximately one-half the length of a football field. From that position the Space Shuttle waits for clearance from Mission Control to continue. When the command is given to continue, the Reaction Control System is activated again and the Space Shuttle closes in on *Mir* at a speed of about 0.05 meters per second until it reaches a distance of about 9 meters. There, the Space Shuttle stops again and waits for approximately 5 minutes. The Commander and Pilot make sure they can see the docking target clearly and fine-tune the alignment of the Space Shuttle with the docking target. A large black cross called the Stand-off-Cross is mounted 30 centimeters (cm) above the back plate in the center of the target. When the Commander has the Stand-off Cross squarely in line with the docking target, he or she maneuvers the Space Shuttle and makes contact with the docking ring. Once a series of hooks is engaged, the Space Shuttle is then successfully docked with *Mir*. It takes about 2 hours for the passage between the Space Shuttle and *Mir* to pressurize. After the passage is pressurized, the hatch is opened and the crews exchange greetings and supplies.

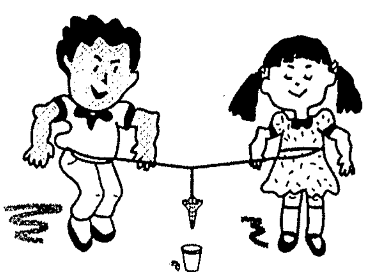
These procedures, which have been learned during Phase One of the International Space Station, have been invaluable to astronauts and supporting ground crews. With the knowledge gained through cooperation, these procedures will secure the future success of the International Space Station for years to come.

Astronauts must understand the three important scientific principles that govern the motion of all objects whether on Earth or in space. These were described by English scientist Sir Isaac Newton in 1687 and are now called Newton's Laws of Motion. In simple form, they are:

1. Objects at rest will stay at rest and objects in motion will stay in motion in a straight line unless acted upon by an unbalanced force.
Newton's First Law of Motion is demonstrated by the Space Shuttle using the Reaction Control System to align itself with *Mir*. If the system were not used, the Space Shuttle would continue to move in its orbit instead of changing position to encounter *Mir*.

2. Force is equal to mass times acceleration.
This equation is used to determine how much force is needed to move the Space Shuttle from one position to another.

3. For every action there is always an opposite and equal reaction.
A good example of this law is the use of the Reaction Control System. When the Commander wants to move the Space Shuttle to the left, he or she fires the system on the right, and if the movement needs to be to the right, the system fires on the left.



Docking Activity
Invite two students to demonstrate the activity for the class. Introduce the Space Shuttle on a string apparatus. Help the students tie the loose end of the string around their waists as illustrated in the drawing. Place an empty, small plastic cup on the floor between the two students. Tell the students the cup represents the docking ring on the *Mir* space station. Explain that their task or mission is to get the orbiter inside the cup without tipping the cup over. The students may not use their hands. Allow them to demonstrate for the class. They will find teamwork is very important as they decide how to maneuver. Different techniques are to move back and forth, move closer together, and bend at the knees. Students should experiment to find the best and quickest way to dock the orbiter.

After demonstrating the activity, show the illustration and have the students estimate how long a string they will need to tie between them. Make sure each team has a copy of the Shuttle template and instruct them to tape the cut-out Space Shuttle orbiter onto a sharpened pencil. The sharpened end of the pencil needs to be at the nose or front of the orbiter. Have the students estimate the length of string that will be needed to tie the orbiter to the string that connects the students. Allow students time to practice the docking maneuver. When the students have practiced docking, bring the class together and discuss what problems may have occurred and how those problems were solved. Discuss Newton's Laws of Motion, and have the students give examples of those laws in their docking procedure.

For older students:
Copy the docking target, and enlarge the Stand-off Cross to 150 percent on heavy paper. Have the students cut out the docking target. Construct a docking apparatus by placing a piece of clay at one end of a straw. Affix this to the bottom of a small cup. Put a small hole through the docking target, and slide it over the straw. The straw should be tall enough to protrude 2–3 cm above the docking target (i.e., above the bottom of the cup). Identify the center of the Stand-off Cross. Mount the center of the cross on top of the straw over the center of the docking target. The cross should be 2–3 cm above the target. It needs to be below the top of the cup. The top of the cup simulates the actual docking ring, which is the surface that is contacted by the Space Shuttle docking system capture ring.

Have the students dock the orbiter using the same techniques as stated for younger students. When dockings have been practiced with two students, a third student might be added. This student would stand directly over the docking target and Stand-off Cross and control the string with the orbiter attached. This student would communicate to the other students what they need to do in order to line up to dock. This student would communicate to the two students attached to the string which way to move to line up with the Stand-off Cross. The center student would use his or her hands on the string to control the orbiter movement in an up-and-down motion and thus control the docking. These three students simulate the x, y, and z axes (roll, pitch, and yaw) used in docking the Space Shuttle in orbit.

Assessment:
Each group will prepare a demonstration to show which techniques they found to be the best procedure. In this demonstration, they should state the reasons they chose this procedure. The students should discuss which of Newton's Laws of Motion pertain to the activity.

Extensions:
1. Restrict students' view of the docking ring by using glasses or a headband that has blinders affixed to the sides, such as those used for horses. Then they should practice the activity with their vision impaired.

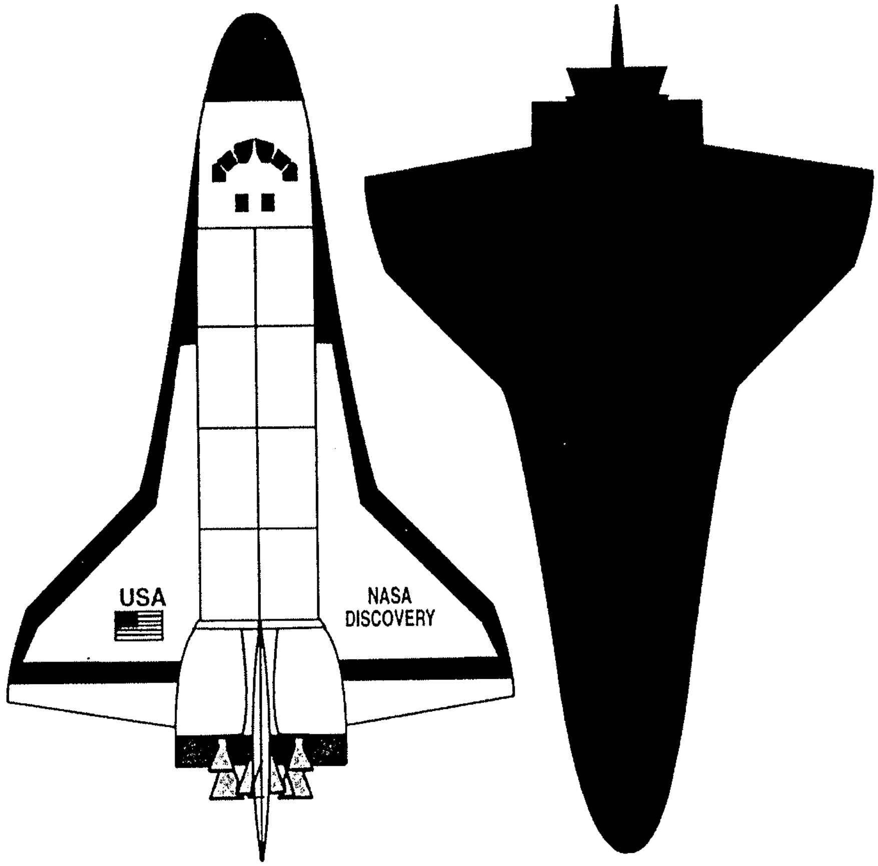
2. Use a shorter string for the docking string.

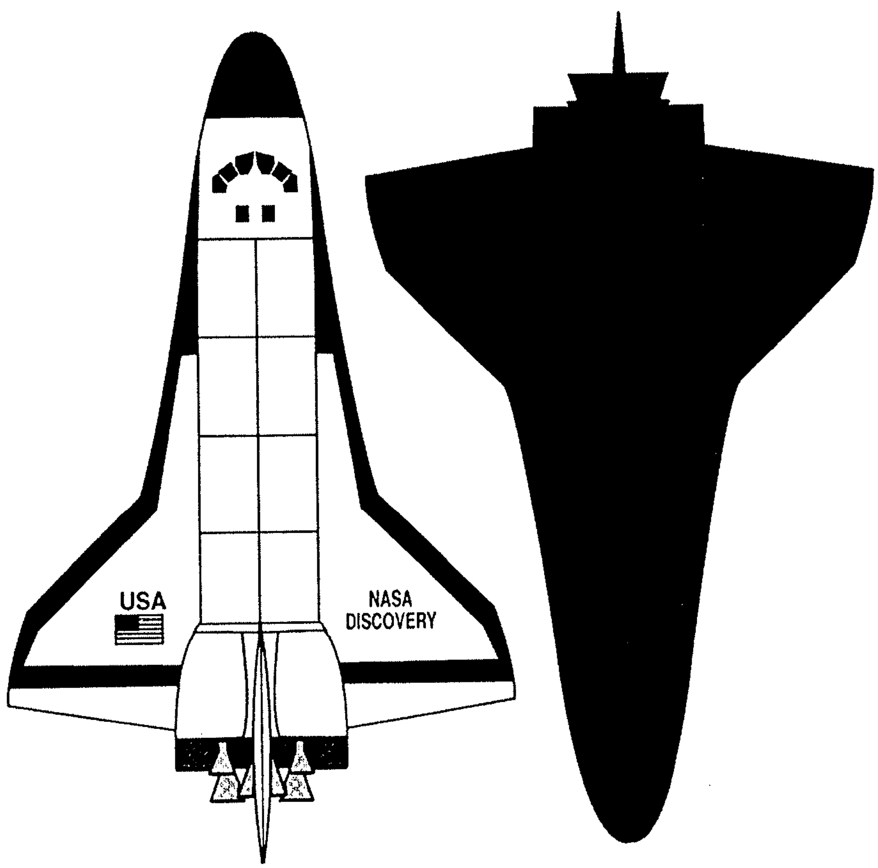
3. Use a different size cup: taller, smaller, larger, different shape.

4. Use two-way radio and/or video camera to simulate actual communication with Mission Control.

For more information about the International Space Station, please visit: **http://station.nasa.gov**

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





Note: Two copies of the Shuttle orbiter are provided for ease in duplication.

Construct A Parafoil

Objectives:

To construct a parafoil similar to the one that will be used for the X-38.
Test the parafoil's performance capabilities.

Science Standards

Grades 5-8

Physical Science: Motions and forces
Science and Technology: Abilities of technological design

Mathematical Standards

Grades 5-8

Measurement
Geometry
Computation and estimation

Materials:

Paper pattern*
Sewing thread
Cellophane tape
Glue stick
Weights (different sized metal washers and nuts)
Metric ruler
Scissors
Sharp knife
Cutting surface

Procedure:

1. Cut out the paper pattern for the parafoil.
2. Use the sharp knife to cut small slots for the tabs. It may be necessary to assist younger students with this step.
3. Prefold the parafoil on the dashed lines.
4. Insert the tabs marked "port" and "starboard" into their corresponding slots.
5. Hold the tab securely by taping them on the inside of the parafoil.
6. Fold the left and right sides of the parafoil together so that the flaps come together. Spread glue on the inside of the flaps and press them together.
7. Fold over the flap and glue it to the lower side of the center airfoil to hold it together.
8. Bend the port and starboard airfoils slightly downwards so that they join the center airfoil along the edges. Make sure the tabs are slipped inside the model for strength. Hold the airfoils together with a small amount of cellophane tape.
9. Attach two pieces of thread to the front and back of each side with a small piece of tape. Each thread should be 30 centimeters long.
10. Tie the ends of the threads together and then tie a weight to the ends.

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

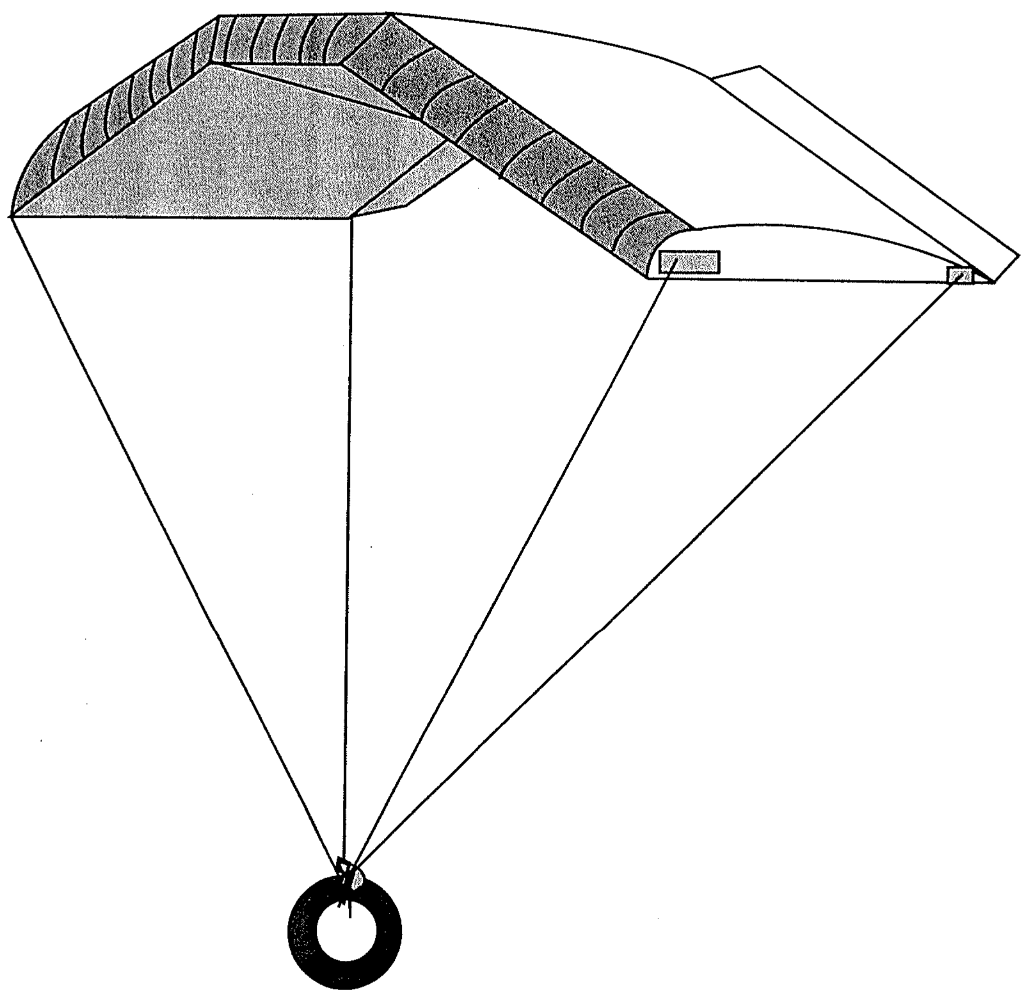
Flight Testing:

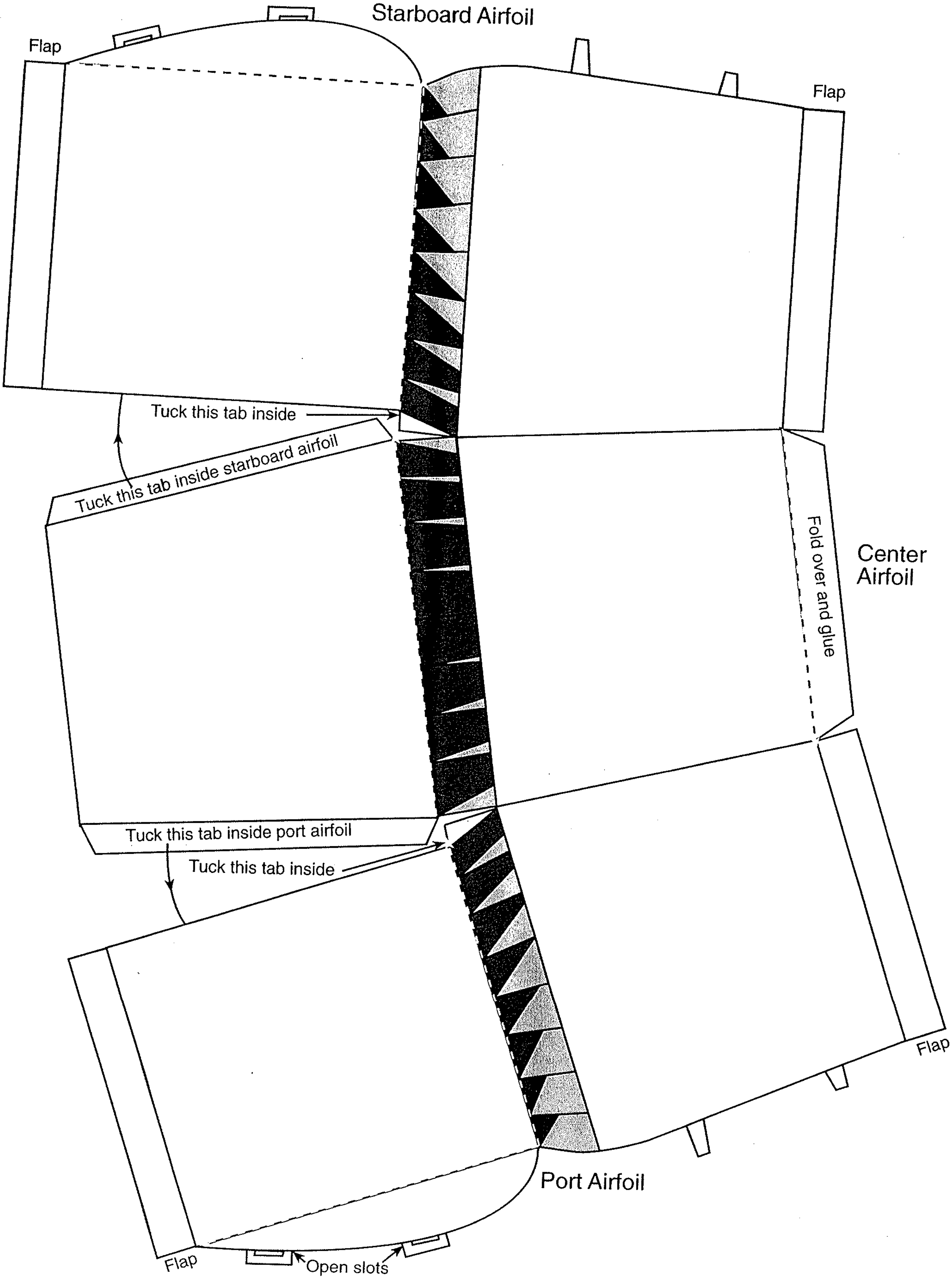
1. Hold the parafoil off the floor and drop it. Observe how it flies.
2. Make adjustments to improve the parafoil's flight. Possible adjustments include:
   - Tying the weight higher up on the threads
   - Adjusting the flaps up or down
   - Using a heavier or lighter weight
   - Shortening or lengthening the front or back threads to change the angle of the parafoil to the vertical

Assessment:
Measure how far the parafoil glides when dropped from a given altitude. Graph the glide distance of the parafoil with different weights.

Extensions:
Compare and contrast the operation of a parafoil with a traditional parachute. Small parachutes can be made from circles cut from plastic grocery bags. Attach threads with tape and hang a weight from the ends.

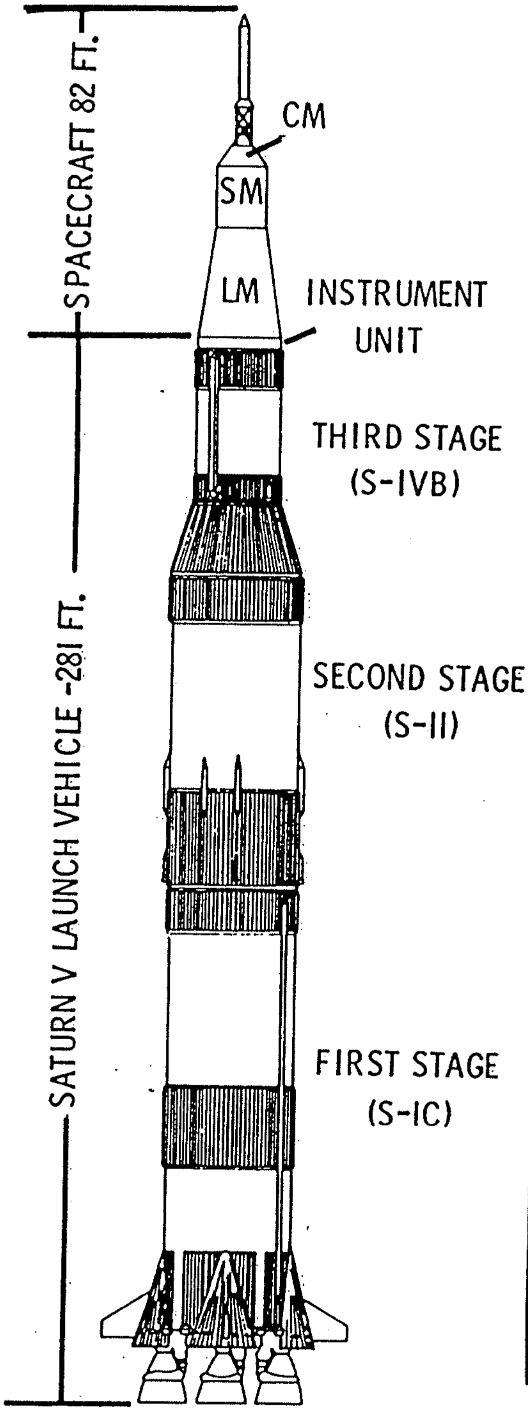
* *The shaded small rectangles on the leading edge of the parafoil represent the open cells in the real parafoil that take in air so that the parafoil becomes rigid.*





Note: Pattern may be enlarged.

SATURN V LAUNCH VEHICLE



FIRST STAGE (S-IC)	
DIAMETER	33 FEET
HEIGHT	138 FEET
WEIGHT	5,022,674 LBS. FUELED 288,750 LBS. DRY
ENGINES	FIVE F-1
PROPELLANTS	LIQUID OXYGEN (3,307,855 LBS., 346,372 GALS.) RP-1 (KEROSENE) - (1,426,069 LBS., 212,846 GALS.)
THRUST	7,653,854 LBS AT LIFTOFF

SECOND STAGE (S-II)	
DIAMETER	33 FEET
HEIGHT	81.5 FEET
WEIGHT	1,059,171 LBS. FUELED 79,918 LBS. DRY
ENGINES	FIVE J-2
PROPELLANTS	LIQUID OXYGEN (821,022 LBS., 85,973 GALS.) LIQUID HYDROGEN (158,221 LBS., 282,555 GALS.)
THRUST	1,120,216 TO 1,157,707 LBS.
INTERSTAGE	1,353 (SMALL) 8,750 (LARGE)

THIRD STAGE (S-IVB)	
DIAMETER	21.7 FEET
HEIGHT	58.3 FEET
WEIGHT	260,523 LBS. FUELED 25,000 LBS. DRY
ENGINES	ONE J-2
PROPELLANTS	LIQUID OXYGEN (192,023 LBS., 20,107 GALS.) LIQUID HYDROGEN (43,500 LBS., 77,680 GALS.)
THRUST	178,161 TO 203,779 LBS.
INTERSTAGE	8,081 LBS.

INSTRUMENT UNIT	
DIAMETER	21.7 FEET
HEIGHT	3 FEET
WEIGHT	4,306 LBS.

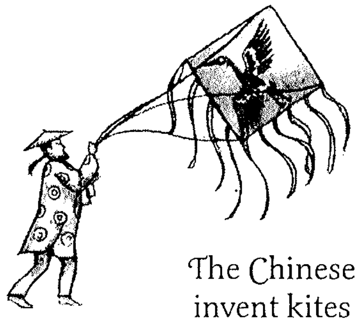
NOTE: WEIGHTS AND MEASURES GIVEN ABOVE ARE FOR THE NOMINAL VEHICLE CONFIGURATION FOR APOLLO 11. THE FIGURES MAY VARY SLIGHTLY DUE TO CHANGES BEFORE LAUNCH TO MEET CHANGING CONDITIONS. WEIGHTS NOT INCLUDED IN ABOVE ARE FROST AND MISCELLANEOUS SMALLER ITEMS.

Oklahoma Celebrates Flight

Details & Extras

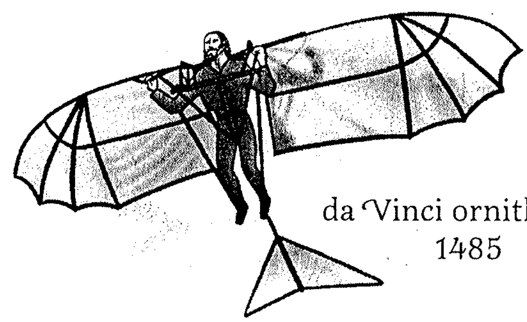
Time Line

400-350 BC



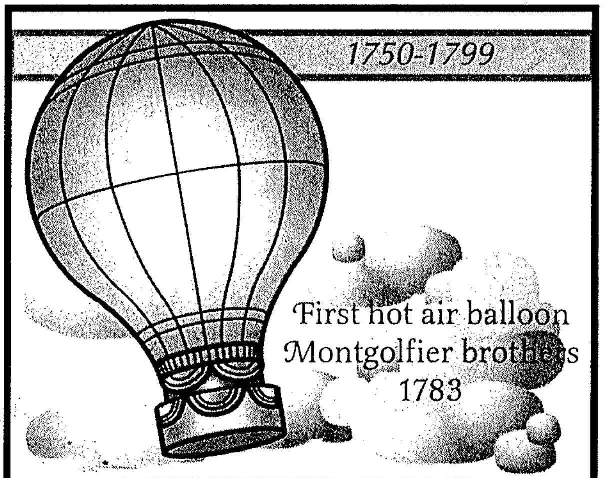
The Chinese
invent kites
400 BC

1450-1499



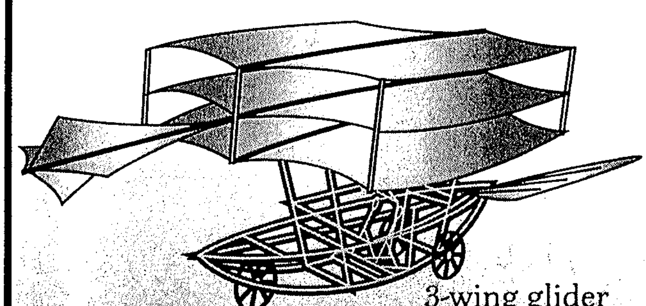
da Vinci ornithopter
1485

1750-1799



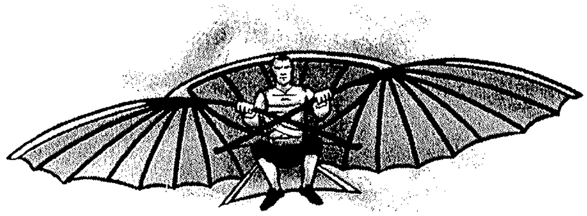
First hot air balloon
Montgolfier brothers
1783

1800-1850



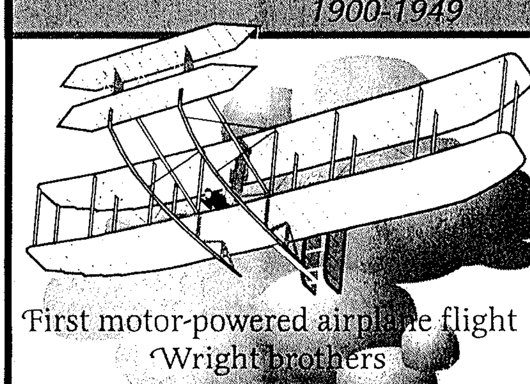
3-wing glider
Sir George Cayley
1849

1850-1899



Lilienthal glider
1891

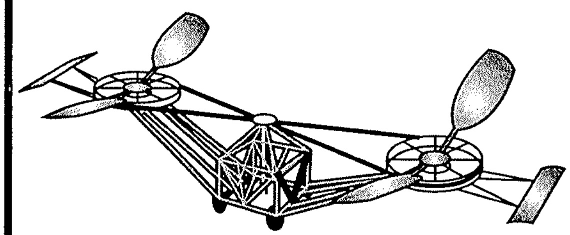
1900-1949



First motor-powered airplane flight
Wright brothers
1903

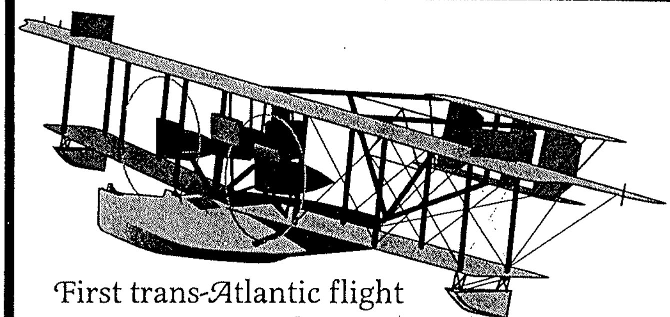
Time Line

1900-1949



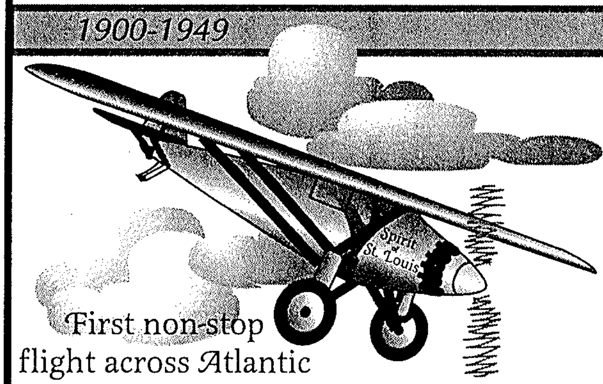
First helicopter
Paul Cornu
1907

1900-1949



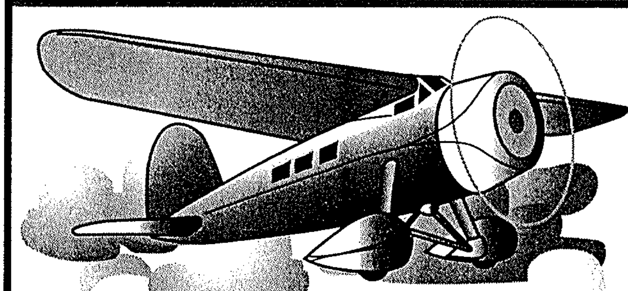
First trans-Atlantic flight
A. C. Reed
1919

1900-1949



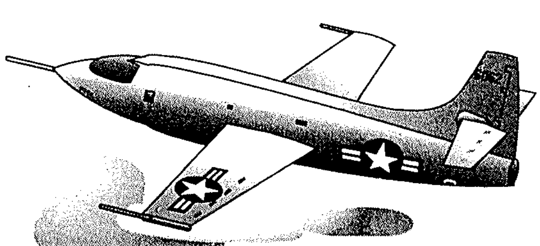
First non-stop
flight across Atlantic
Charles Lindbergh
1927

1900-1949



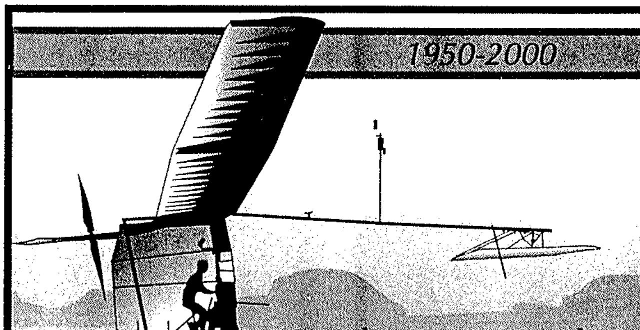
First solo flight Hawaii-California
Amelia Earhart
1935

1900-1949



First human flight faster than sound
Chuck Yeager
1947

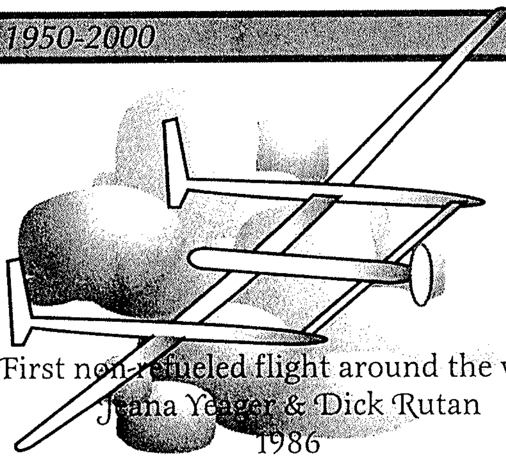
1950-2000



First human-powered
flight across English Channel
Bryan Allen
1979

Time Line

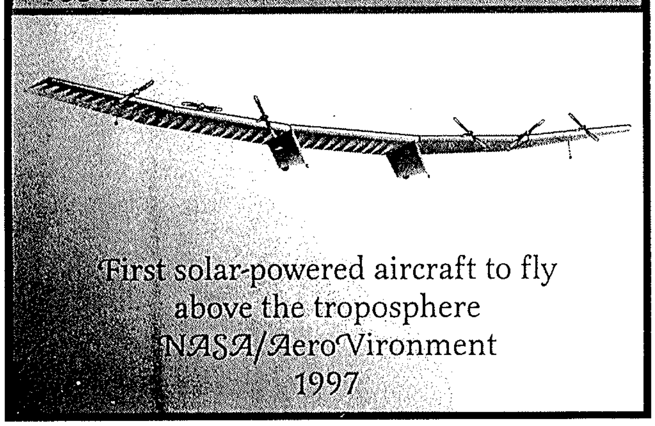
1950-2000



First non-refueled flight around the world
Jeana Yeager & Dick Rutan
1986

Add to the time line by researching other aeronautical events, or design events of the future.

1950-2000



First solar-powered aircraft to fly above the troposphere
NASA/AeroVironment
1997

2000-2050

1900-1949

1950-2000

Oklahoma Celebrates Flight

The First 100 Years - 1903-2003

Oklahoma Time Line:

1903 – Dec. 17 Orville and Wilbur Wright make the first powered, controlled, manned flight by a heavier than air machine at Kill Devil Hills, NC.

1910 – March 18 Charles F. Willard flies the first airplane in Oklahoma.

1911 – The Nichols brothers build the first airplane in Oklahoma, the "Albatross".

1911 – Clyde Cessna test flies his first airplane over the Great Salt Plains and "ground loops" on the runway. Cessna had 12 of these crashes.

1915 – Hatbox Field in Muskogee is Oklahoma's first airport.
1915 – First military airlift squadron is flown from the airport at Fort Sill to Lawton to Fort Sam Houston in San Antonio.

1917 – First commercial aircraft production began at Dewey, including production of the Curtiss JN-4 "jenny" flight trainer. W. D. "Billy" Parker is involved in this manufacturing plant. He later invented the controllable pitch propeller.

1917 – Frank Champion from Oklahoma City flies the Moisand monoplane, copied after the French Bieriot. He becomes famous world over for his exhibition flying.

1917 – The first commercial airport is built in Oklahoma City by Bennett Griffin and Mark Adams. By 1928 there are 42 airfields in the state.

1918 – WWI produces many well-known Oklahoma pilots: B.S. "Cherokee" Graham, Bill Bleakley, Clarence Page, Burrell Tibbs, Jimmy Haizlip, and W.D. "Billy" Parker.

1918-1920 – Barnstorming allows everyone to fly WWI surplus trainers, purchased by former military pilots for $300 each. This enabled pilots to continue flying. The pilots landed in cow pastures and for a small fee took passengers for a short ride.

1927 – Frank Phillips donates the Woolaroc to Arthur Goebel, who won the Dole Pineapple, Pacific Air Race in 1927. Phillips sponsors Billy Parker's flying demonstrations.

June 20, 1928 – Tom Braniff creates the state's first commercial passenger flight between Oklahoma City and Tulsa. Braniff, who co-owned a Stinson Detroiter with E.E. Westervelt, creates one of the country's first major airlines with his brother Paul. Paul was a WWI pilot who served as the company's ticket seller and pilot.

1928 – Oil man Earl Halliburton establishes Southwest Air Fast Express, later known as American Airlines.

July 8, 1929- A Transcontintal Air Transport airplane lands at Waynoka, OK with Charles Lindbergh and Amelia Earhart onboard on a coast-to-coast trip that lasted just 48 hours and cost $350. The airline existed for 18 months.

1931 – In less than 8 days, Wiley Post and Harold Gatty complete the fastest around-the-world flight.

1932 – Thomas Cox Allen of Oklahoma City and J. Herman Banning of El Reno became the first black pilots to fly across the North American continent.

1933 – Wiley Post completes the first solo around-the-world flight.

1934, Dec. 7 – Wiley Post, sponsored by Frank Phillips of Phillips Petroleum Co., sets a new, world, altitude record of 55,000 feet. In order for him to accomplish this feat, Wiley had to invent the 1st pressurized flight suit.

Aug. 15,1935 - Wiley Post and Will Rogers die in a plane crash near Point Barrow, Alaska.

April 8, 1941 – Tinker Army Air Base is founded.
On July 30,1941, ground is broken on the Midwest Air Depot, located 9 miles southeast of downtown Oklahoma City.

Dec. 2,1942 – The first aircraft lands at brand new Altus Army Air Field.

1944 – The first International Flying Farmers fly-in is held in Stillwater.

Nov. 21, 1944 – The Air Corps Basic Flying School of Enid, OK, later Vance Air Force Base, is officially activated.

1960 – Jerrie Cobb from Ponca City, survived the 75 grueling tests performed by potential men astronauts for the Mercury program. She created records of her own.
Her success led to the following year's Mercury 13, a group of 13 women pilots who passed all the physical and psychological tests NASA deemed necessary for astronaut candidates. 2 other trainees had ties to Oklahoma: Gene Nora Stumbough Jessen (an OU alum) and "Wally" Funk, (an OSU graduate).

May 15-16, 1963 – Colonel Gordon Cooper, Jr., from Shawnee Oklahoma, piloted the "Faith 7" Mercury spacecraft on a 22-orbit mission. His flight lasted 34 hours and 20 minutes.
Colonel Cooper served as command pilot of Gemini 5 on Aug. 21, 1965, setting a new space endurance record by traveling 3,312,993 miles in 190 hours and 56 minutes.

Dec. 1965 – General Thomas P. Stafford, from Weatherford, OK, piloted Gemini VI, the first rendezvous in space. In **June 1966** he commanded Gemini IX, demonstrating the rendezvous maneuver that would be used in the Apollo project. In **May 1969 –** General Thomas P. Stafford was commander of Apollo 10, first flight of the lunar module to the moon. He performed the first rendezvous around the Moon and the entire lunar landing mission except the actual landing. On **July 15-24, 1975,** General Stafford's 4th flight was Apollo commander of the Apollo-Soyuz Test Project mission. Gen. Stafford was on the historic first meet in space between American Astronauts and Soviet Cosmonauts.

Nov. 16, 1973 – Colonel William Pogue logged 84 days, 1 hour, and 15 minutes, setting a record at that time for most time in space as pilot of Skylab 4. Col. Pogue and crew completed 56 experiments, 26 science demonstrations, and 13 student investigations during their 1,214 revolutions of the earth.

Jan. 31-Feb. 9, 1971 – Colonel Stuart Allen Roosa, from Claremore, Oklahoma, completed his first space flight as command module pilot on Apollo 14. He orbited the moon onboard "Kitty Hawk" while Edgar D. Mitchell and Alan B. Shepard used a "lunar rickshaw" pull-cart to carry their equipment.

1973 – Owen K Garriott (Ph.D.) was one of the first 6 Scientist-Astronauts select by NASA. His first space flight aboard Skylab in 1973 set a record at this time for duration in space of approximately 60 days.
His second flight was aboard Spacelab-1 in **1983**. Over 70 experiments were conducted on this multidisciplinary and international mission. He operated the world's first Amateur Radio Station from space.

June 17-24, 1985 – Shannon Lucid (Ph.D.), a Bethany native and America's first woman in space, served as mission specialist aboard STS-51G, **Oct. 18-23, 1989** STS-34, **Aug. 2-11, 1991** STS 43, and **Oct. 18-Nov. 1, 1993** STS 58.
Mar. 22, 1996 – Shannon Lucid traveled a record 45.2 million miles during 188 days aboard Russian Space Station Mir. She served as Board Engineer 2 arriving on STS-76 and departing on STS-79. She set a new record for non-Russian flight hours in orbit and for any woman in the world.

Nov. 23-Dec. 7, 2002 – Commander John Bennett Herrington, from Wetumka, Oklahoma, flew on STS-113 logging over 330 hours in space, including 3 EVA's totaling 19 hours and 55 minutes. It was the 16th shuttle mission to visit the ISS, delivering the Expedition-Six crew, installing and activating the P1 Truss, and the return of the Expedition-5 crew. John Herrington is the 1st Native American astronaut to fly in space.

First 100 Years Flight Timeline

Dec. 17, 1903 – Orville and Wilbur Wright make the first controlled, powered, manned flight by a heavier than air machine. at Kill Devil Hills, NC.

1907 – First helicopter flight is flown by Frenchman, Paul Cornu. The helicopter hovered 1 foot above the ground for 20 seconds.

1915 – First official military victory in a Fokker E.1 fighter plane.

1919 – First nonstop Atlantic crossing made by British aviators, Captain John W. Alcock and Lieutenant Arthur W. Brown in a Vickers Vimy bomber equipped with additional fuel tanks.

1921 – Bessie Coleman became the 1st black American woman to receive a Federal Aeronautic Internationale pilot's license.

1924 – First round-the-world flight crewed by U.S. Army Air Service personnel.

Mar. 16, 1926 – Dr. Robert Goddard launched the first liquid-propellant rocket. It reached a height of 41 feet.
In **December 1930**, Dr. Goddard blasted off another rocket that came to be known as "Nell", which reached an altitude of 2,000 feet plus another 1,000 feet of lateral flight before sinking to the ground. Dr. Goddard perfected the gimbaled engine flight control and each launch was more and more successful.
On **Aug. 9, 1938**, he launched a much larger rocket than "Nell" and it worked almost perfectly reaching a height of 5,000 feet.

May 20, 1926 – Charles Lindbergh took off from Roosevelt Field, long Island, NY in the "Spirit of St. Louis" and landed in Paris, France about 33 ½ hours later. He was the first person to make a nonstop solo flight across the Atlantic Ocean. He also won a prize of $25,000.

June 1928 – Amelia Earhart piloted the "Friendship" from Boston to Burry Port, Wales, making her the first woman to pilot across the Atlantic.

May 20, 1932 Amelia Earhart becomes the first woman to cross the Atlantic solo, in a Lockheed 5B Vega.

1935 Amelia Earhart was the first woman to fly from Hawaii to Oakland, CA over the Pacific Ocean.

July 2, 1937 Amelia Earhart and navigator, Fred Noonan, in a Lockhead 10-E, disappeared during an around-the-world flight attempt.

1931 – In less than 8 days, Wiley Post and Harold Gatty complete the fastest around-the-world flight.

1933 – Wiley Post completes the first solo around-the-world flight.

1934, Dec. 7 – Wiley Post sets a new, world, altitude record of 55,000 feet.

May 7, 1937 – First successful pressurized aircraft, the Lockheed XC-35, makes its maiden flight.

Dec. 7, 1941 – Japanese carrier planes attack the U.S. Pacific fleet at Pearl Harbor.

1942 – Five aviation cadets, the nation's first black military pilots, earn their wings at Tuskegee Army Air Field. Among them is Benjamin O. Davis Jr. who later became the first African-American Brigadier General in the United States Air Force.

Aug. 6, 1945 – "Enola Gay", a Boeing B-29, drops an atomic bomb on Hiroshima, Japan. Nagasaki is the target of a larger bomb on Aug. 9 dropped by "Bockscar, another B-29.

Oct. 14.1947 – Captain Chuck Yeager breaks the sound barrier while piloting the rocket-powered Bell XS-1. It was launched out of the bomb bay of a Boeing B-29.

July 27, 1949 – The world's first jet airliner, the "De Havilland D.H.106 Comet makes its maiden flight.

1954 – Boeing introduces the first successful passenger jet, the Boeing 707.

1957 – Soviet Union launches Sputnik 1. It's the first Earth orbiting satellite and started the race to space.

April 12, 1961 – Soviet pilot, Yuri Gagarin, in Vostok 1 becomes the first man in space.

1961-1963 – Project Mercury, using the Redstone or Atlas launch vehicles, launched the first Americans into space.
May 5, 1961 Alan B. Shepard aboard Freedom 7 was the 1st U.S. astronaut. He flew a suborbital flight, lasting 15 minutes 28 seconds.

Feb. 20, 1962 John Glenn was the first American to orbit the Earth. He circled the Earth 3 times in 4 hours, 55 minutes aboard Friendship 7.

1964-1967 – Project Gemini, using the Titan 2 launch vehicle, launched 10 manned missions in 20 months, space flights became routine. The Manned Space Flight Center in Houston took over the role of Mission Control during this project.
Highlights: first orbital rendezvous and docking
first U.S. space-walk (EVA)
Virgil Grissom, Ed White and Roger Chaffee die during an Apollo launch pad test

1967-1972 – Project Apollo: used the Saturn V rocket for the launches into orbit and was best known for its flights to the moon.
Oct. 11-22, 1968, Apollo 7 was the first manned Apollo flight.
December 21-27, 1968 Apollo 8 launched the first lunar orbital flight.
Mar. 3-13, 1969 Apollo 9 tested the lunar lander, a critical piece of equipment for the moon mission.
Mar. 3-13, 1969, Apollo 10 sent the astronauts to within 8 miles of the lunar surface.
July 16-23, 1969 Apollo 11 achieved its goal of landing Neil A. Armstrong and Edwin "Buzz" Aldrin on the surface of the moon, while Charles "Pete" Conrad piloted the "Columbia" in a lunar orbit. Armstrong and Aldrin spent 21 hours on the moon.
Nov. 14-24, 1969 Apollo 12 returned to the moon with a precision perfect landing.
April 11-17, 1970 Apollo 13 proved the U.S. Space program could handle a major crisis, as a malfunction caused the flight to abort its lunar mission and return to Earth.

Jan. 31-Feb. 9, 1971, Apollo 14 astronauts on the way back from the moon conducted the first U.S. materials processing experiments in space.
July 26-Aug.7, 1971, Apollo 15 included the first lunar rover on its expedition. On the way back, Alfred Worden conducted the first space-walk between Earth and the Moon to retrieve film from the side of the spacecraft.
April 16-27, 1972, Apollo 16 nearly had to scrub its lunar landing due to a malfunction of the lunar module. The landing was successful and the astronauts collected a chunk of moon rock 11.34 kilograms, the largest brought back by any lunar astronauts.
Dec. 7-19, 1972, Apollo 17 was the last Moon mission. Astronauts, Eugene Cernan and Harrison "Jack" Schmitt, left behind a plaque which read: "Here Man completed his first exploration of the Moon, December 1972 A.D. May the spirit of peace in which we came be reflected in the lives of all mankind."

1973-1976 – Project Skylab, launched into orbit by the Saturn V rocket. It was the last time a Saturn V rocket vehicle was used. Three separate crews journeyed to the Skylab using modified Apollo command and service modules launched by the smaller Saturn 1B rockets.
May 14, 1973 on the unmanned Skylab 1 mission the space station was launched.
May 20, 1973 Charles "Pete" Conrad Jr., Paul J.Weitz, and Joseph P. Kerwin became the Skylab's first crew on mission Skylab 2. They began their mission with "home repairs", spending about a month fixing their new home. They returned to Earth with over 29,000 frames of film having spent 28 days in space which doubled the U.S. record.
July 28-Sept. 25, 1973 Skylab 3 included Alan L. Bean, Jack R. Lousma and Owen K. Garriet as crew. Highlights of their mission included: deploying a sun shield during a 6 ½ hour space-walk, many experiments, testing the jet=powered Astronaut Maneuvering Unit (AMU) and helped scientists develop the more sophisticated Manned Maneuvering Unit (MMU) later used on space shuttle missions.
Nov. 16, 1973-Feb. 8, 1974 Skylab 4's crew included Gerald P. Carr, William Pogue, and Edward G. Gibson. This crew was in space 84 days, 1 hour, and 15 minutes. Exercise was added to the routine of the crew to help with the return to Earth. Four space walks were executed and records were set on experiments in every discipline from medical investigations to materials science.

July 15-24, 1975 – Apollo-Soyuz Test Project
The final mission of the Apollo Project was a goodwill flight in which spacecraft from 2 nations rendezvoused and docked in orbit. An agreement was signed by U.S. President Nixon and Soviet President Kosygin. The crew for the flight included Thomas Stafford, Vance Brand, and Deke Slayton. The Apollo-Soyuz mission resulted in many technical advances including, a common docking system, a chance for both "sides" to view each other's space program, exchange flags and gifts, eat together, and converse in each other's language. The 2 spacecraft stayed docked for 44 hours.

1977-Present – Space Shuttle, Space Transportation System
1977 – Enterprise, a test vehicle not suited for space flight, was used for approach and landing tests.
April 12-14, 1981 – Columbia made the STS-1 debut flight with John Young and Robert Crippen aboard. After 36 orbits lasting 2 days, it made a smooth touchdown at Edward's Air Force Base in California.
After 9 flights, the STS numeration system changed to STS plus the number of the year the flight was intended to launch and the second number indicating the location of the launch. A 1 indicated Florida as the launch site and 2 for California. Therefore, the 10th STS flight was STS 41-B; the B indicates the second launch of the year. STS-41-B means Challenger was to launch in 1984, from Florida as the second launch of the year.
Jan. 28, 1986 – Flight STS-51-L, Challenger and all 7 astronauts: Commander Michael Smith (USN), Francis Scobee (USAF), Lt. Col. Ellison Onizuka (USAF), Dr. Ronald McNair, Dr. Judith A. Resnik, Mr. G.B. Jarvis, Mrs. Christa McAuliffe were lost 73 seconds into the flight.
September 20- October 3, 1988 – The space shuttle flights resumed with STS-26 with Discovery and its crew: Hauck, Covey, Lounge, Nelson and Hilmers returning America to space. NASA converted to a normal numeric system for the following missions beginning with this flight, number 26. Due to mechanical or weather difficulties, sometimes a shuttle mission is out of order numerically; however, it keeps its same number for whenever it launches. For example; STS-27 was launched Dec. 1988, STS-29 was launched Mar. 1989, STS-30 was launched May 1989, and STS-28 was launched Aug. 1989.
For further information on individual STS flights see www.nasa.gov.

International Space Station Program – 1998 to present
Nov. 11, 1998 – STS-88 launched the first element of the station, the control Module, Zayra. Zayra is the Russian word for sunrise.

Dec. 8, 1998 – Unity was added and Pressurized Mating Adapters (PMA) 1 and 2, the PMA connects the U.S. and Russian elements. The PMA-2 provides a shuttle docking location.
May 1999 – Flight STS-96 brought the first visitors aboard the ISS.
Nov. 2, 2000 – Mar. 21, 2000 – First Expedition crew onboard the ISS.
Mar. 8, 2001 – Aug. 12, 2001 – Second Expedition crew onboard the ISS.
Aug. 10, 2001 – Dec. 8, 2001 – Third Expedition crew onboard the ISS.
Dec. 5, 2001 – June 2002 – Fourth Expedition crew onboard the ISS.
June 7, 2002 – Dec. 7, 2002 – Fifth Expedition crew onboard the ISS.
Nov. 25, 2002 – May 3, 2003 – Sixth Expedition crew onboard the ISS.
April 25, 2003 – scheduled Oct. 2003 – Seventh Expedition crew onboard the ISS.
Oct. 2003 – Eighth Expedition crew scheduled to launch for the ISS.

July 2, 2002 – Steve Fossett becomes the first to circumnavigate the globe solo in a hot-air balloon.

Feb. 5, 2003 – STS-171, Columbia disintegrates upon reentry in the Earth's atmosphere killing all astronauts onboard: Commander William McCool (USN), Col. Rick Husband (USAF), Capt. David Brown (USN), Capt. Laurel Clark (USN), Lt. Col. Michael Anderson (USAF), Dr. Kalpana Chawla, and Col. Ilan Ramon (Israel AF)

Oklahoma Time Line for First 100 Years of Flight

- **1903, Dec. 17** Orville and Wilbur Wright make the 1st powered flight.
- **1910, Mar. 18** Charles F. Willard Flies the 1st airplane in OK.
- **1911** The Albatross is the 1st airplane built in Oklahoma.
- **1915** Hatbox Field becomes Oklahoma's 1st airport and the 1st military airlift squadron flies.
-
- **1917** First commercial aircraft and the first commercial airport is built.
- **1918-1920** Barnstorming allows everyone to fly!
- **1927** Frank Phillips donates the Woolaroc aircraft, which wins the Dole Pineapple, Pacific Air Race.
- **1928, June 20** The state's 1st commercial flight.
- **1929, July 8** Charles Lindbergh and Amelia Earhart land at Waynoka, OK.
- **1931** Wiley Post completes the fastest around-the-world flight.
- **1932** Thomas Cox Allen and J. Herman Banning (of OK) became the 1st black pilots to fly across the North American continent.
- **1933** Wiley Post completes the first solo, around-the-world flight.
- **1934, Dec. 7** Wiley Post sets a new, world, altitude record of 55,000 feet.
- **1935, Aug. 15** Wiley Post and Will Rogers die in a plane crash.
- **1941, April 9** Tinker Air Force Base is founded.
- **1942, Dec. 2** The 1st aircraft lands at the Altus Army Air Field.
- **1944** The 1st International Flying Farmers fly-in is held in Stillwater.
- **1960** Jerrie Cobb was the 1st woman to survive astronaut candidate tests.
- **1963, May 15-16** Col. Gordon Cooper, Jr. piloted the "Faith 7" Mercury space craft.
- **1965** General Thomas P. Stafford piloted Gemini VI.

- **1971** Col. Stuart Allen Roosa was the command module pilot on Apollo 14.
-
- **1973** Col. William Pogue logged 84 days, 1 hour and 15 minutes as pilot of Skylab.
- **1973** Owen K. Garriot spent 60 days onboard Skylab as a scientist.
- **1985, June 17-24** Shannon Lucid was America's 1st woman in space.
- **2002, Nov. 23-Dec. 7** Commander John Bennett Herrington flew on STS-113 delivering the Expedition-5 crew to the ISS.

First 100 Years World Flight Timeline

Dec. 17, 1903 – Orville and Wilbur Wright make the first powered flight

1907 – First helicopter flight is flown.

1915 – First official military victory in a Fokker E.1 fighter plane.

1919 – First nonstop Atlantic crossing.

1921 – Bessie Coleman became the 1st black American woman to receive a Federal Aeronautic Internationale pilot's license.

1924 – First round-the-world flight.

1926, Mar. 16, – Dr. Robert Goddard launched the first liquid-propellant rocket.

1926, May 20, – Charles Lindbergh, first person to make a nonstop solo flight across the Atlantic Ocean.

1928, June – Amelia Earhart, first woman to pilot across the Atlantic.

1932, May 20, Amelia Earhart, first woman to cross the Atlantic solo.

1935 Amelia Earhart, first woman to fly from Hawaii to CA over the Pacific Ocean.

1937, July 2, Amelia Earhart disappeared during an around the world flight attempt.

1931 – Wiley Post completes the fastest around-the-world flight in less than 8 days.

1933 – Wiley Post completes the first solo around-the-world flight.

1937, May 7, – First successful pressurized aircraft flies.

1941, Dec. 7, – Japanese carrier planes attack the U.S. Pacific fleet at Pearl Harbor.

1942 – The nation's first black military pilots, earn their wings at Tuskegee Army Air Field.

1945, Aug. 6, – "Enola Gay" drops an atomic bomb on Hiroshima, Japan. Nagasaki is targeted on Aug. 9.

1947, Oct. 14. – Captain Chuck Yeager breaks the sound barrier.

1949, July 27, – The world's first jet airliner makes its maiden flight.

1954 – Boeing introduces the first successful passenger jet, the Boeing 707.

1957 – Soviet Union launches Sputnik 1, the first Earth orbiting satellite.

1961, April 12, – Soviet pilot, Yuri Gagarin in "Vostok 1" becomes the first man in space.

1961-1963 – Project Mercury: using Redstone or Atlas launch vehicles launched the first American, Alan Shepard, in space.

1964-1967 – Project Gemini: launched 10 manned missions in 20 months.

1967-1972 – Project Apollo: best known for its manned flights to the moon.

1973-1976 – Project Skylab: launched the 1st American manned orbiting spacecraft in space.

1977-Present – Space Shuttle, Space Transportation System: the first reusable American spacecraft..

1998 to present - International Space Station Program: is a permanent, international, orbiting spacecraft.

2002, July 2, – Steve Fossett becomes the first to circumnavigate the globe solo in a hot-air balloon.

2003, Feb. 5, – STS-171, Columbia disintegrates upon reentry in the Earth's atmosphere killing all astronauts onboard.:

Just for Fun Timeline:

Teddy Bears were invented - 1902

First affordable cars, the Ford Model T - 1903
Harley Davidson Motorcycles
Roller Coasters were invented
First Peanut Butter making machine
Crayola Crayons began to color a kid's world

Tinkertoys were invented - 1913

Snowmobile - 1922

Color TV - 1927

Bubble Gum - 1928

7-Up became a popular drink - 1929

Scotch Tape – 1930

Legos - 1934

Monopoly - 1936

Silly Putty - 1949

Velcro - 1955

Hula Hoop, Ball Point Pen - 1958

Pagers, Barbie Dolls - 1959

Email or Internet - 1971

Jet Ski - 1973

Walkman, Lap Top Computer - 1979

Cell Phone - 1981

Kitty Litter - 1985

Pokemon, trading card game - 1990

The Hummer - 1991

Skateboard - 1993

DVD Player - 1996

Website: www.inventors.about.com/library/inventors click on Famous Inventions, again Famous Inventions A-Z

Glossary of Aviation and Space Terms

Aileron: the control surfaces at the back edge of the wing, which by deflecting up or down helps to bank the airplane.

Air traffic control: the people who direct planes safely through the space they control, both in the air and on the ground.

Airfoil: a special shape that is designed to rise when air flows over and under it.

Altitude: the vertical distance from sea level to an aircraft in flight.

Ascend: climb upward.

Atmosphere: a blânket of air surrounding the earth.

Bank: a flight maneuver in which one wing points toward the ground and the other to the sky.

Bernoulli's principle: states that an increase in the velocity of any fluid is always accompanied by a decrease in pressure. Air is a fluid. If you can cause the air to move rapidly on one side of a surface, the pressure on that side of the surface is less than that on its other side.

Bernoulli's principle works with an airplane wing. In motion, air hits the leading edge of the wing. Some of the air moves under the wing and some of it goes over the top. The air moving over the top of the curved wing must travel farther to reach the back of the wing, so it must travel faster than the air moving under the wing to reach the trailing edge at the same time. Therefore, the air pressure on top of the wing is less than that on the bottom of the wing causing lift.

Black boxes: the airliner's flight recorder. They are actually orange in color to make them easier to locate.

Barometer: an instrument that measures changes in air pressure.

Cockpit or Flight deck: compartment where the pilot and crew use instruments to fly the aircraft.

Density: the heaviness of a substance for a particular volume.

Drag: air resistance caused by disturbances in the flow of air over an object; drag causes the object to slow down.

Elevators: control surfaces hinged to the horizontal stabilizer that control the pitch of the airplane.

Engine: the part of the airplane that provides power or propulsion to the aircraft.

Flaps: are located on the trailing edge of an aircraft's wing. They are moved up and down to increase lift during takeoff, climbing and descent to increase drag during landing approach.

Flight simulator: an exact copy of the inside of a real plane. Pilots practice hundreds of in-flight emergencies without leaving the ground.

Force: a push or pull that is used to start an object moving.

Friction: force that is created when 2 objects rub together, slowing down the movement of the objects.

Fuel: a substance used to make engines work.

Fuselage: the main body of the aircraft.

G suit: a partial pressure flight suit which stops the blood from draining out of the pilot's head. Without the G suit, the pilot would black out during extremely high altitude flights.

Glider: an aircraft that uses a large wingspan and currents of hot, rising air (called thermals) to stay aloft. It does not use an engine for thrust.

Gravity: the force that causes objects to fall toward the earth and the attractive force between objects.

Hanger: a building used to house aircraft.

Helicopter: aircraft capable of vertical takeoff and landing, using rotating blades for lift, propulsion and steering.

Jet engine: a turbofan jet engine has a propeller-like fan to suck air into the center of the engine. Here fuel is burned, hot exhaust gases shoot out of the back of the engine, and the aircraft pushes forward.

Knot: nautical mile per hour, most common measure of aircraft speed. 100 knots equals 115 miles per hour, for mph multiply knots by 1.15.

Lift: a force that acts upward against gravity.

Mach 1: the speed of sound, (Mach 2 is twice the speed of sound.)

NASA: abbreviation for the National Aeronautics and Space Administration.

Navigation: is the calculation of the aircraft's route from the departure location to the destination.

Pitch: the movement of an aircraft when the nose either rises or falls.

Pressure: the pushing force on a surface.

Propeller: an airfoil that the engine turns to provide thrust, pulling the aircraft through the air.

Roll: the movement of an aircraft when one wing rises and the other falls.

Rudder: control surface on the back of the vertical fin.

Satellite: an object that orbits or circles another object.

Slats: located on the leading edge of an aircraft wing, move forward to prevent the aircraft from stalling.

Sonic boom: the thunder-like noise heard on the ground when an aircraft flies overhead faster than the speed of sound. The boom is caused by the sudden change in air pressure with the passage of a shock wave.

Stabilizer: the horizontal area surface which stabilizes the airplane, also called a vertical stabilizer.

Streamlined: a shape that is long, narrow and smooth which allows an object to move more easily through the air.

Supersonic jetliners: aircraft that fly faster than the speed of sound, Mach 1.

Thrust: the force that pushes an airplane forward through the air.

Velocity: speed of the aircraft.

Wind: the movement of air in the atmosphere.

Wing warping: a means to control aircraft roll by twisting (warping) the aircraft's wing tips. The Wright brothers used wing warping on the first powered aircraft.

Wings: the part of the aircraft shaped like an airfoil, designed to provide lift when air flows over them.

Yaw: the movement of an aircraft when it turns either to the left or right.

Websites:

Aviation Organization Sites:

http://www.aopa.org - Aircraft Owners and Pilots Association
http://www.avkids.com - National Business Aviation Association, "AvKids" program
http://www.avdigest.com/99s/ProfHist.html - Ninety-nines, Women Pilots
http://www.cap.af.mil - Civil Air Patrol
http://education.dot.gov/ - U.S. Department of Transportation, careers in transportation
http://www.faa.gov/education - Federal Aviation Administration
http://www.nasm.edu/ - National Air & Space Museum
http://www.wiai.org/ - Women in Aviation

NASA Sites for Educators:

NASA CORE: - http://core.nasa.gov
NASA Educator Resource Center, materials and services available for OK teachers – http://www.okstate.edu/apdc
NASA Home Page - http://www.nasa.gov/
NASA Jet Propulsion Laboratory Mission Status Reports – http://www.jpl.nasa.gov
NASA QUEST "WEBCASTS", Interactive Events for Students – http://quest.arc.nasa.gov
NASA Shuttle Missions – http://www.ksc.nasa.gov/shuttle/missions/missions.html
NASA Space Flight information – http://spaceflight.nasa.gov
NASA Spacelink for news and images – http://spacelink.nasa.gov
NASA Student Involvement Program – http://education.nasa.gov/nsip
NASA Workshops for Teachers – http://education.nasa.gov/new

National Standards:

National Research Council Science Content – http://bob.nap/edu/readingroom/books/nses/html#content
NCTM Mathematics Content Standards – http://standardse.nctm.org.1.0/89ces/Table_of_Contents.html
National Geography – http://www.tapr.org/~ird/Nordick/Standards.html
National Standards for Arts Education – http://artsedge.kennedy-center.ort/cs/desigh/standards

Sites of interest:

The Boeing Company web site: www.boeing.com, click on gen/images, community & education link, then Boeing Kids Page, Wonder of Flight or A Century of Discovery
www.first-to-fly.com/History/ow121703.htm
www.first-to-fly.com/History/ow121706.htm
Hubble Space Telescope: http://oposite.stsci.edu/
Kids page: www.kids.net.au/profiles/2285.php
Omniplex/Kirkpatrick: www.omniplex.org/
Phillips Company: www.phillips66.com/photolibrary.html
Woolaroc: www.woolaroc.org
Women pilots: www.ninety-nines.org/
Young Astronauts Council: http://www.yac.org

Aviation Math & Logic

1. If a jet airplane is traveling at 300 miles per hour, how many feet per second will it travel?

2. If the distance from: Philadelphia to Memphis is 989 miles, Memphis to Dallas is 455 miles, Dallas to Phoenix is 2.045 miles, Phoenix to Los Angeles is 389 miles, Los Angeles to Denver is 1,009 miles, and returning to Philadelphia from Denver is 1,762 miles, how many miles would you have flown on this route?

   If the jet flies at 300 mph, how long would it take to fly from each of the above cities to the next destination?

   The jet plane averages 25 gallons of fuel per hour of flying time. How many gallons of fuel be needed for the round trip?

   If jet fuel costs $2.50 per gallon, how much will the round trip cost for fuel?

3. The Wright Flyer flew 120 feet in 12 seconds on its first flight. The Flyer was 21 feet, 1 inch long. It weighed 745 pounds. It had a wing span of 40 feet, 4 inches. The SR-71 Blackbird is a high-altitude, high-speed reconnaissance plane. It flew 2,193.7 miles per hour in a straight line. The SR-71 is 107 feet, 4 inches long. It weighs 67.550 pounds. It has a wing span of 55 feet, 6 inches. Compare the length and weight of the 2 planes. Compare the wing spans of the planes.

   If the SR-71 flew 15,000 miles in 10 & ½ hours, what is its average air speed?

   If the Wright Flyer flew 120 feet in 12 seconds, how many feet did it fly in 1 second?

   An SR-71 surveyed 723,042 square miles in one hour.
   That being true, what fraction of the United States did the plane cover in 1 hour?
   Hint: first find the number of square miles in the continental United States.

Aviation Math Answer Sheet

1. One mile equals 5,280 feet, multiply by the 300 miles. (1,584,000 feet)
   One hour equals 3,600 seconds.
   Divide 1,584,000 by 3,600 to get 44 feet per second.

2. Total miles: 6,649
   Total time: rounded to 21.2 hours
   Total fuel: 25 x 21.2 = 530 gallons
   Total fuel cost: 530 gallons x $2.50 = $1,325.00

3. Subtract the Wright Flyer measurements from the SR-71.
   The SR-71 is 86 feet, 3 inches longer, weights 66,704 more pounds and has a wing span 15 feet, 2 inches bigger than the Wright Flyer.

   The average air speed of the SR-71 per hour: divide 15,000 miles by 10.5 hours. Average air speed is: 1,428.57 miles per hour.

   To find the distance per second of the Wright Flyer, divide the 120 feet distance by 12 seconds: 10 feet per second.

   The SR-71's flight covered an area measuring 723,942.6 miles, that is about 2 tenths of the total area of the continental U.S.
   The area of the continental U.S. is approximately 3,615.2 square miles.

High Flight by John Gillespie McGee Jr.

Oh, I have slipped the surly
bonds of earth
And danced the skies on
laughter-silvered wings;

Sunward I've climbed, and
joined the tumbling
mirth

Of sun-split clouds-and done
a hundred things

You have not dreamed of-
wheeled and soured
and swung
High in the sunlit silence.
Hov'ring there,
I've chased the shouting wind
along, and flung

My eager craft through
footless halls of air.

Up, up the long, delirious,
burning blue
I've topped the windswept
heights with easy grace

Where never lark, or even eagle
flew.

And, while with silent, lifting
mind I've trod
The high untrespassed sanctity
of space,
Put out my hand, and touched
the face of
God.

Pat's Oklahoma Aviation and Space Facts

The first recorded attempt at flying in Oklahoma took place in Vinita at the Indian Territory Fair. The year was 1888 and the event was a balloon ascension made by Professor Keil of Clinton, Missouri. Due to the strong Oklahoma winds it is not known if the balloon ever made it into the air.

Colonel Charles F. Willard flew the first airplane in Oklahoma. The year was 1910 and he flew a biplane named the Butterfly at Capitol Hill in Oklahoma City.

The first airplane manufactured in quantity in Oklahoma was a World War I Curtiss Jenny, it was built by the Dewey Airplane Company of Dewey.

Cherokee Indian and Oolagah native Will Rogers was a big supporter of aviation during his lifetime. However, after his first flight, that took place over Washington, D.C., pilot of the plane, Billy Mitchell asked how he enjoyed the flight he said "I don't know, I spent the entire flight in the floorboard of the airplane!"

Oklahoman Wiley Post, from Maysville, was the first person to fly clear around the world by himself. He also invented the first high altitude pressure suit, the same basic design that we use for today's astronauts.

When the President of Douglas Aircraft Company was approached about building a bomber manufacturing plant in Tulsa his response was said to be, "Why would I do that, Okies don't know anything about building airplanes, they're just farmers!" As it turned out, the bomber plant was built in Tulsa in 1941 and Oklahomans built thousands of aircraft during World War II

During the attack on America's naval base at Pearl Harbor, Hawaii on December 7th, 1941 only two American pilots managed to get their airplanes in the air to fight the Japanese. One of those pilots was Lt. Kenneth Taylor of Hominy. During the confusion of that early Sunday morning, Taylor managed to shoot down two Japanese aircraft with his Curtiss P-40.

In 1928, Charles Lindbergh was instrumental in creating the Transcontinental Air Transportation Corp or TAT. The idea of TAT was that passengers could travel across the United States within 48 hours by using a combination of railroads and air travel. Lindbergh chose Waynoka, Oklahoma as one of the stopping points on the TAT line. Passengers would fly a Ford Trimotor from St. Louis, Missouri to Waynoka where they would board the Santa Fe railroad for Clovis, New Mexico. Again, they would board the Trimotor that would take them to Winslow, Arizona and from there they again boarded the train for Los Angeles, California.

From the National Geography Standards

I. PHYSICAL SYSTEMS

a. physical processes
b. ecosystems

II. HUMAN SYSTEMS

a. populations
b. cultures
c. economic interdependence
d. human settlement
e. cooperation and conflict

III. PLACES & REGIONS

a. physical and human characteristics
b. regions
c. perceptions

IV. ENVIRONMENT & SOCIETY

a. modifications
b. adaptations
c. resources

V. THE WORLD IN SPATIAL TERMS

a. spatial perspective
b. mental maps
c. analyze spatial organizations

VI. THE USES OF GEOGRAPHY

a. interpret the past
b. interpret the present; plan for the future

THE FIVE THEMES OF GEOGRAPHY

Lisa Keys-Mathews
Department of Geography
University of North Alabama

To specifically serve the teacher population, a publication entitled Guidelines for Geographic Education was published in 1984 and its contents became known popularly as the "Five Themes of Geography." These themes are:

- Location
  - Relative Location
  - Absolute Location
- Place
  - Human Characteristics
  - Physical Characteristics
- Human-Environmental Interactions
  - Humans adapt to the environment
  - Humans modify the environment
  - Humans depend on the environment
- Movement
  - People
  - Goods
  - Ideas
- Regions
  - Formal
  - Functional
  - Vernacular (perceptual)

The five themes served as a framework upon which the content of geography can be taught and served the K-12 population until the national geography standards were published in 1994. Since the six elements of the national standards embrace the five themes, they remain a valuable tool for students to use in developing a "geographic perspective," while the standards strengthen instructional planning.

LOCATION

"Where are we?" is the question that the theme *Location* answers. Location may be absolute or it may be relative. These locations, whether relative or absolute, may be of people or places.

An absolute location is a latitude and longitude (a global location) or a street address (local location).

Florence, AL is 34°46' North latitude and 87.40' West longitude
Paris, France is 48°51' North latitude and 2.20' East longitude
Marshall Islands are 10°00' North latitude and 165°00' East longitude

Relative locations are described by landmarks, time, direction or distance from one place to another and may associate a particular place with another.

PLACE

What kind of place is it? What do you think of when you imagine China? Japan? Russia? Saudi Arabia?

Places have both human and physical characteristics, as well as images.

Physical characteristics include mountains, rivers, soil, beaches, wildlife, soil. Places have human characteristics also. These characteristics are derived from the ideas and actions of people that result in changes to the environment, such as buildings, roads, clothing, and food habits.

The image people have of a place is based on their experiences, both intellectual and emotional. People's descriptions of a place reveal their values, attitudes, and perceptions.

How is your hometown connected to other places? What are the human and physical characteristics of Florence? How do these shape our lives?

HUMAN/ENVIRONMENTAL INTERACTION

How do humans and the environment affect each other? We change the environment and then sometime Mother Nature changes it back. For example, floods in the mid-West, Hurricane Emily (Hatteras), and earthquakes and mudslides in California.

There are three key concepts to human/environmental interaction:

Humans adapt on the environment.
Humans modify the environment.
Humans depend to the environment.

People depend on the Tennessee River for our water and transportation. People modify our environment by heating and coolings buildings for comfort. People adapt to the environment by wearing clothing that is suitable for summer and winter; rain and shine.

All places on Earth have advantages and disadvantages for human settlement. One person's advantage may be another person's disadvantage. Some like the excitement of large cities whereas others prefer remoteness. Environment is not just trees, spotted owls, and rain forests. Environment is a feeling. What is the environment of a big city? Boston? Los Angeles? Dallas?

Given the choice, where would you live? Why? What is the environment? How do people interact with the environment? How do the physical features affect us?

How have we adapted to or changed our landscape? For example, in the Sudan even though everything is seemingly barren, the land sustains farmers and nomadic herders. People and animals have adapted to a hot, dry climate.

MOVEMENT

The movement of people, the import and export of goods, and mass communication have all played major roles in shaping our world. People everywhere interact. They travel from place to place and they communicate. We live in a global village and global economy.

People interact with each other through movement. Humans occupy places unevenly on Earth because of the environment but also because we are social beings. We interact with each other through travel, trade, information flows (E-Mail) and political events.

Not only do humans move but also ideas move; fashions move; fads move. What is an example of an idea that moves? Fashion? Fad? How do we depend on people in other places? How would our lives change if our movement options changed? What would happen if we traveled by camel or horse? How do we move from place to place? How do we actually get food?

REGION

A region is the basic unit of study in geography. A region is an area that displays a coherent unity in terms of the government, language, or possibly the landform or situation. Regions are human constructs that can be mapped and analyzed.

There are three basic types of regions.

Formal regions are those defined by governmental or administrative boundaries (i. e., United States, Birmingham, Brazil). These regional boundaries are not open to dispute, therefore physical regions fall under this category (i. e., The Rockies, the Great Lakes States).

Functional regions are those defined by a function (i. e., TVA, United Airlines Service area or a newspaper service area). If the function ceases to exists, the region no longer exists.

Vernacular regions are those loosely defined by people's perception (i. e., The South, The Middle East).

What region do we live in? What type of region is it? What are its characteristics? South, North Alabama, the Shoals, the University community? What states do you define as the South? The Northeast? The Bible Belt? What characteristics and perceptions go along with these regions?

Created by Lisa Keys Mathews. 9/10/98. Last revison. 10/3/98 lkm

Oklahoma Celebrates Flight

Special Credits & Thanks

Oklahoma's Aviation Story
Author: Kim Jones, Tulsa Air & Space Museum
Oklahoma Historical Society
Carl Gregory, Historian
Editor: Bill Moore

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http://www.ou.edu/okage/ocase

The Oklahoma Coalition for Aviation and Space Education

coordinates programs that promote Oklahoma aviation and space education, with the goal of fostering an environment of aerospace technology literacy for the citizens of Oklahoma, and to support the activities of the Oklahoma Space and Aviation Industries.

General membership meetings are held quarterly, to serve as a think tank for ideas to promote space education. OCASE officers meet each month.

OCASE Oklahoma Coalition for Aviation and Space Education

About OCASE | Members | Join OC

Organization	Mission / Goal	Web Site
Civil Air Patrol		
Kirkpatrick Science and Air Space Museum at OMNIPLEX		www.omniplex.org
NASA Aerospace Education Services Program		
Oklahoma Aerospace Educators Association		
Oklahoma Alliance for Geographic Education (OKAGE)	The Oklahoma Alliance for Geographic Education is an educational outreach initiative of the State Department of Education and the National Geographic Society, and provides curriculum development and outreach programs in Geography Education.	www.ou.edu/okage
Oklahoma NASA Space Grant Consortium	The Oklahoma Space Grant Consortium is Oklahoma representation of NASA's National Space Grant College and Fellowship Program. OSGC's activities focus the power of the states' higher education system in advancing Oklahoma's participation in the Aerospace Industry. OSGC promotes activities in science, mathematics, engineering, technology, geography, and other aeronautics and space related disciplines throughout Oklahoma's educational system.	http://www.okspacegrant.ou.edu/indexNet.
	The mission of the OU Sooner Flight Academy is to facilitate the growth of aviation using experiential	

education to empower learners of all ages in science, math, and technology through the exciting world of flight.

OU Sooner Flight Academy

The OU Sooner Flight Academy is an outreach arm of the OU Department of Aviation providing hands-on aviation education programs for learners of all ages from 6 to 80 years old. Located in Norman, OK , the Academy serves airports across Oklahoma and the four adjoining states. Airplanes are our classroom - Come Fly With Us!

http://flightcamp.ou.edu/

Oklahoma Space Industry Development Authority

It is the mission of the Oklahoma Space Industry Development Authority to create, in this decade, a commercial spaceport that will expand and economically develop the Oklahoma space frontier with advanced operating spaceport facilities

http://www.okspaceport.state.ok.us/

STARBASE Oklahoma

http://www.starbaseoklahoma.org/

With the vision of creating the future, impacting the present, learning from the past, the Tulsa Air and Space Museum strives to

Tulsa Air and Space Musuem

be nationally recognized as a premier learning center and tourist destination for aviation and space exploration. The museum immerses visitors in exhibits capturing real moments in aviation and space developments that demonstrate mankind's efforts to reach the stars.

www.tulsaairandspacemuseum.com

Young Astonauts Program