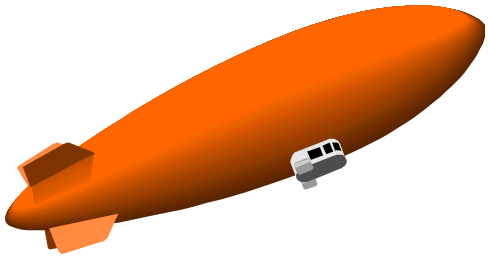
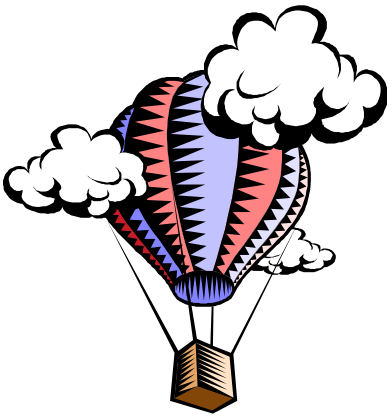
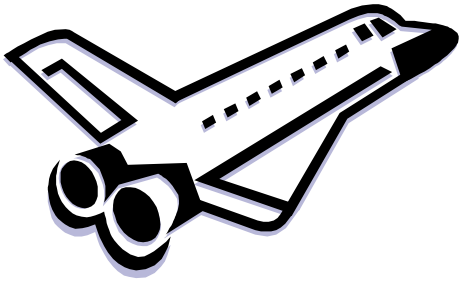
Mysterious Flight





Ever since man first saw birds flying free in the skies, he has tried to make flying possible for humans. Almost everyone has dreams of being able to fly sometime in his life. This thematic unit deals with the history and physics of flying from the time of kites and hot-air balloons to the new age of commercial jet liners and stealth bombers. Although there is enough information and activities for a complete unit, there are still plenty topics out there that you may want to research further and add to this unit.



A Thematic Unit

Social Studies: History

1000 B.C.

Kites are flown in China. They even designed kites that carried people.

1000 A.D.

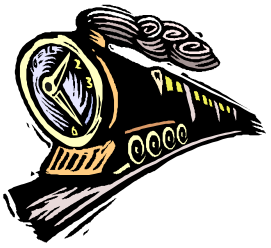
Between 500 and 1400, there were people in England called "tower jumpers" who would strap man-made wings to their arms and jump from buildings in hopes of flying.

1480

Leonardo Da Vinci was very interested in bird flight and he drew designs for ornithopters (flapping-wing aircraft). Later on it was realized that his creations wouldn't really work but they were a source of inspiration for future innovators.

1765

James Watt , a Scottish engineer, developed a practical steam engine which later revolutionized flight.



1766

An English scientist, Henry Cavendish, discovered hydrogen. This was used in lighter-than-air flight experiments such as the balloon and blimp. The explosion of the Hindenburg stopped the use of hydrogen (as it is a highly explosive gas).

1782

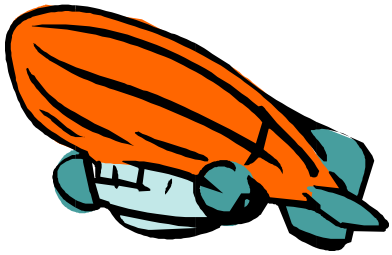
The Montgolfier brothers of France began experimenting with hot-air balloons. The idea came to them when they saw smoke rising from a fire. They tried to find a way to harness the lifting ability of the smoke. Hot-air balloon flights became more common after their experiments.

1783

Another Frenchman Jacques Alexandre Cesar Charles was the first to use hydrogen to lift balloons.

1852

Henry Giffard from Paris created the first powered and controlled flight in a dirigible (balloon that can be steered); it was steam powered. Giffard is known as the "father of the airship."



1853

George Cayley, from Britain, was considered the "father of aerial navigation." He was the first person known to consider the modern-day heavier-than-air flight. He laid the basic foundations and principles of flight. In 1853, he made the first gliding flight in history.

1885

Gottlieb Daimler, of Germany, invented the gasoline powered internal combustion engine. This made heavier-than-air flight practical because it provided the machines with more power and less weight. The steam engine was not practical because of the weight: water and coal were heavy and there was very little power generated

1888

Karl Wolfert from Germany made the first gasoline powered flight in a dirigible.

1891

Otto Lilienthal, from Germany, made the first successful glider after studying bird flight for many years. He realized that the wings had to be curved, that birds took off into the wind, and that the lift was directly dependent upon the speed of the bird. He was one of the first flight scientists to use the Scientific Method to record his findings and apply his discoveries to future creations.

1896

Samuel Pierpont Langley, from Massachusetts, made many small, working model airplanes. He was invited by the military during the Spanish-American War to build a full-size airplane for war use. Although his model airplanes worked well, he was unable to successfully make the airplane. After his Aerodrome failed, the New York Times declared that a millions years would pass before airplanes would carry humans across the sky.

1903

Orville and Wilbur Wright, from Ohio, made the first powered, sustained and controlled heavier-than-air flight at Kitty Hawk, North Carolina. They had been bicycle builders in Ohio and decided to take on the challenge of flight. They reviewed what had been done previously and applied their new-found knowledge to the creation of gliders. After they mastered the glider, they added an engine and propellers, and two sets of wings to construct *Flyer*.

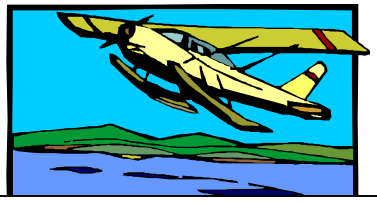
1906

Alberto Santos-Dumant made the first powered and sustained airplane flight in Europe. Before this, he successfully built a powered, controlled dirigible which he would fly from café to café as his father owned a Brazilian coffee plantation.

Early 1900s

Count Ferdinand von Zeppelin, from Germany built huge dirigibles that eventually became to be known as 'Zeppelins.' During World War I (1914-1918) Zeppelins were used to drop bombs on England and soon after it was used for passenger travel.

1907



Glenn Curtiss, now known as the "father of naval aviation," started his career by building bicycles and motorcycles in New York. He was the fastest man in the world with his Curtiss engines that he used in car races. He became interested in seaplanes and eventually built planes for the U.S. Navy and taught Navy personnel how to fly his planes. His seaplanes were used in WWI and were very important as runways were not perfected at the time.

1909

Louis Bleriot, a Frenchman, became the first person to English Channel in an airplane. During 1909 the U.S. Army bought it first military airplane, a Wright biplane.

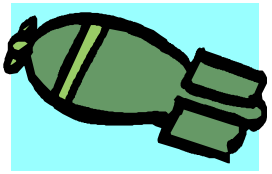
1912

America's first licensed woman pilot, Harriet Quimby, successfully crossed the English Channel.

1913

This year became known as the "Glorious Year of Flying." People were performing aerobatics (acrobatic flying), making long-distance flights, stunt flying was popular, and flight scientists worldwide adopted many new sound design principles.

1915



Germany's Zeppelin airships began making raids on Britain, which initiated air combat roles during wartime.

1919

The NC-4 flying boat, made by Curtiss, became the first aircraft to cross the Atlantic Ocean.

1923

The first helium-filled airship makes a flight in the United States. Helium was much safer than hydrogen because it is unreactive.

1927

Charles Lindbergh completes the first non-stop, solo flight across the Atlantic Ocean.

1929 — The Graf Zeppelin makes the first around-the-world flight.

1932 — Amelia Earhart is the first woman to fly solo across the Atlantic Ocean. In 1935, she became the first person to fly solo across the Pacific Ocean. Her goal was to be the first to fly around the world along the equator. She began the flight in 1937 and was about 4000 miles short of her goal when she mysteriously disappeared.

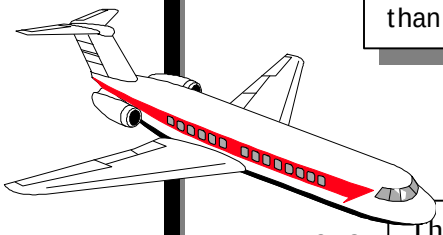
1933 — Wiley Post became the first person to fly solo around the world

1937 — The German zeppelin Hindenburg crashes at Lake Hurst, New Jersey after it explodes in mid-air, killing 35 people and essentially ending lighter-than-air passenger travel.

1939 — The German Heinkel He becomes the first jet-powered airplane to fly.

1941 — Igor Sikorsky develops the first truly practical helicopter. He had been making innovations in airplane flight since 1910, but his real desire was to make a practical helicopter. Up to this point, helicopters were not stable. He realized that the torque of the main rotor could be counterbalanced with a small tail propeller.

1947 — Air Force test pilot Chuck Yeager becomes the first human to fly faster than the speed of sound.

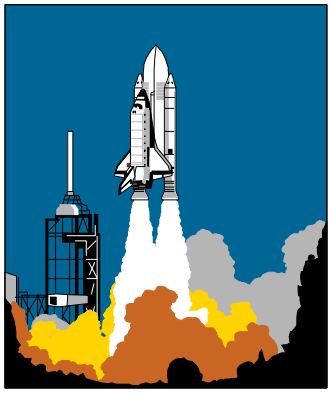


1952 — The first jet-powered aircraft to offer regular passenger service takes off, the *De Havilland Comet*.

1953 — Jacqueline Cochran became the first woman to break the sound barrier. This same year Yeager flew more than twice the speed of sound.

1976 — The Concorde begins service as the first supersonic passenger airliner.

1981 — Columbia launches from Florida, the first space shuttle made by NASA.



Traveling Through Time

This activity will help your students be able to put the history of flight into perspective. The chart below gives several events, inventions, and discoveries that have happened throughout history. Use several of these events as well the key events leading to modern flight.

Date	*Event/Invention*	*Person*	*Country*
725	First clock	I-Hsing & Liang-Tsan	China
1455	Printing	Johann Gutenburg	Germany
1462	Watch	Bartholomew Manfredi	Italy
1492	Sailed to Caribbean	Christopher Columbus	Italy
1589	Flush Toilet	Sir John Harrington	England
1776	Submarine	David Bushnell	USA
1789	First US President	George Washington	USA
1800	Battery	Alessandro Volta	France
1804	Train (steam)	Richard Trevithick	England
1839	Bicycle	Kirkpatrick MacMillan	Scotland
1850	Refrigerator	Harrison/Twining	England/USA
1851	Sewing machine	Isaac M Singer	USA
1852	Elevator	Elisha G Otis	USA
1876	Microphone	Alexander G Bell	USA
1876	Telephone	Alexander G Bell	USA
1879	Lamp	Thomas Edison	USA
1879	Gramophone	Thomas Edison	USA
1885	Petrol-powered car	Karl Benz	Germany
1885	Motorcycle	Gottlieb Daimler	Germany
1894	Escalator	Jesse W Reno	USA
1895	First moving picture	For Institute for Deaf	USA
1901	Vaccuum Clearner	Hubert Booth	USA
1907	Typewriter	Pellegrine Tarri	Italy
1912	Sinking of Titanic	-	England
1926	Television	John Logie Baird	England
1938	First writing pen	Lazlo & George Biro	Hungary
1938	Computer	Atanasoff, Berry	USA
1940	Microwave	Randall & Boot	England
1948	Record	Peter Goldmark	USA
1978	First Compact Disc	Philips & Sony	Netherland/Japan

- Choose 40 or so events, including flight inventions and events, and write the names of these on the plain side of 5x7 index cards. Write in large black letters on the top of the card.
- Illustrate several of these cards yourself. Draw the pictures or use magazine clippings. Choose events along the timeline randomly or at intervals so as to help provide perspective for your students.
- Have students illustrate the remaining cards with crayon or using magazines.
- Make a timeline on the chalkboard, butcher paper, or bulletin board with the dates of all of the events you are using for the activity and the cards that you previously prepared.
- Have students place their card where they THINK it goes. The same date can be used more than once.
- With the class, adjust the timeline as they think appropriate.
- Provide several books for research at each table for students to confirm or deny the choices they made. Have them adjust the timeline as necessary.
- Discuss the final timeline and have students share their misconceptions and new found knowledge.
- Emphasize some of the inventions for planes and flight in general as an introduction to the unit.

Who am I?

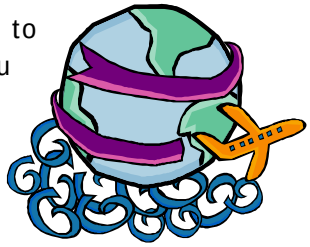
- Toward the end of the unit (when students have a basic knowledge of the main events and people contributing to the invention of human flight) have a project assigned to students concerning the characters that played roles in putting humans in the skies.
- Have students either choose or draw out of a hat one of the historical figures in the history of flight—MAKE SURE that they do not show or tell any of their classmates which one they have chosen.
- Their assignment will be to dress up as the person they chose and play the part of that person. This will require some research and reading that you may help them with; or, you may direct them to the school's library or public library. If it is possible, have time allotted for research during the week.
- They will act out the part of their character in a presentation to the class that should include a thorough biographical account of the person as well as interesting details. Their goal is to be good enough to convince their classmates of which character they are playing.
- As this is a public speaking activity, try to have students talk about "themselves" casually, rather than reading a report. They may also bring in props to help them feel more comfortable and to add authenticity to what they say so that the class can have some extra clues to guess who they are.

Social Studies: Geography

Interactive Bulletin Board

- Obtain a world map (get one that you are prepared to use push-pins with) and attach it to a bulletin board in your classroom.
- As you study the different innovations of flying, use push-pins to designate where these took place. Attach a piece of string to the pushpin. Have it strung across the bulletin board where you will attach an index card. Information about the event or invention should be written on these cards.
- You can create the cards with the class as you study the events, getting information from the students. You may also want to have each student fill out a card, including an illustration of the event or invention.
- When you have introduced all of the events/inventions and the cards have all been prepared and placed on the board, leave it up as a reference for the rest of the unit.
- In order to make the bulletin board interactive, create two pockets on the board, one for string and one for the cards. As a center or independent activity, the students will match the geographic location to the event or invention.

A Mural of Journeys



- Group students in pairs and have them pick an aviator or aviation event to research. You should have a list available for them to choose from; you should include aviators who traveled a recordable distance. For example: Louis Bleriot traveled across the English Channel, the Hindenburg traveled from Germany to New Jersey, etc. You may be able to find enough for the pairs to research more than one.
- Provide simple copies of maps for students to record the voyage of their chosen aviator(s). These will be a rough draft for you to look over and make any necessary corrections.
- With students help create a large mural of a world map. You can do this by projecting a transparency of a simple world map outline onto the wall where the mural is posted.
- Have students paint the mural and come up with a title.
- They will then, as a pair, show the path that their aviator traveled using painted lines of different colors. They will need to add the necessary information on the map to form a key. You may want the class to come up with a way of doing this to keep it consistent.
- You can have your students add other details as you feel necessary, such as a mileage scale, country names, oceans, etc.
- This will be a great tool to use throughout the unit, and other classes would probably enjoy seeing your Class Journey Mural as well. Students will really feel important after putting so much work into a project, and they will also be getting a feel for the complexity of mapmaking.

Mathematics

Timeline Math

For this activity students will have to refer to a timeline to answer a variety of math problems. The timeline worksheet is included in the unit. Here is some of the math that this activity will cover:

- Subtraction/addition of dates
- Figuring out what century events took place
- Conversion from years to months, weeks, days, hours, and seconds.
- Use of millennium, century, and decade terminology.

Airline Safety

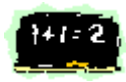
You will need an almanac to do this activity.

- Using an almanac, find the airline crash data in the transportation section. There is usually a comparison among commercial airlines.
- Have your students compare and graph this data (or a selection of the data).
- To expand this activity further, find out how many flights the airlines actually made during the selected year and find out which airlines had the highest percentage of crashes from that data.
- After your students have found the results, have them decide which airline is the "safest" and discuss what factors would contribute to this conclusion. [number of flights, number of planes, national/international, size of planes, etc.]

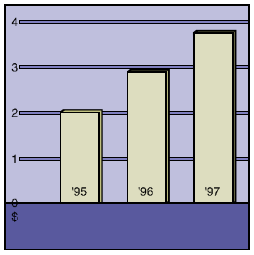
Airplane Crashes vs. Automobile Crashes

You will an almanac to do this activity.

- In the transportation of the almanac, locate the crash statistics for automobiles and those for airplanes.
- Have your students find which mode of transportation is safer in general.
- To do this, they will need to compare the number of cars vs. car accidents and the number of airplanes vs. airplane accidents.
- Your students should discover that statistically, airplane flight is much safer than driving your car.

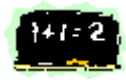


Airline Rate Comparisons



This is a great authentic homework / family activity that your students can do.

- Have your class pretend they are going on a flight to their favorite vacation spot.
- It will be necessary for them to find out which airline will give them the best price for their airline ticket, or rate. This is something adults do often (price comparisons) so it will be a good real-life activity for your class.
- The assignment will be for them to compare the rates of 5 different airlines and visually present the data. In order to do this, they will need to call the different airlines to get the rate information.
- The ultimate question is "Which airline would you choose and why?" the students should discuss the ticket prices and the savings on the particular airline they have chosen.



Weight vs. Horsepower: Acceleration

Using the chart below, have your students compute the hp to weight ratio and decide which machine can accelerate the fastest. The weight/horsepower part of the table below shows how many pounds per horsepower each vehicle has to pull. For example, for the lawnmower, each horsepower has to pull approximately 15 pounds.

Vehicle	Horsepower (hp)	Weight (lbs)	Weight/Horsepower
Cessna	**300**	**3350**	**11.2**
Lockheed Electra (Earhart's plane)	**550**	**10500**	**19.1**
Push Lawnmower	**6**	**90**	**15.0**
First steam-powered dirigible	**3**	**480**	**160.0**
Mazda RX-7	**250**	**2100**	**8.4**
Family Van	**194**	**3800**	**19.6**
Wright Flyer	**13**	**746**	**57.4**
Yamaha V-max Motorcycle	**150**	**580**	**3.8**
Military Helicopter	**1775**	**14750**	**8.3**

- Provide the first three columns of this chart for your class. The fourth column is what your students will need to figure out.
- The assignment is for them to calculate the weight per horsepower for each vehicle.
- They will need to decide which vehicle can accelerate the fastest. This will be the one that has to pull the smallest amount of weight per each horsepower. The vehicle that can accelerate the fastest will not necessarily be the vehicle that can attain the highest speed. There are many other factors involved in speed calculation such as drag (air vs. road), actual engine size, torque produced, etc.

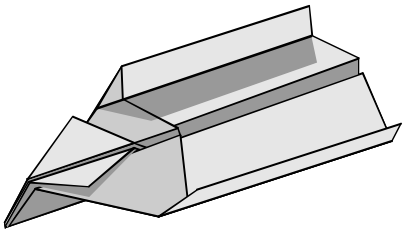
Amelia Earhart

- Discuss with your class Amelia Earhart's trip "around the world." She never quite made it all the way around – she mysteriously disappeared near Howland Island in the Pacific Ocean. There is an excellent National Geographic article about Amelia's flight in the January 1998 issue you may want to share with your class. There are also a plethora of children's biographies to select from as well.
- The total trip would be approximately 29,000 miles. Amelia only had to go another 4,000 miles when she disappeared.
- Have your students figure out the percentage of the trip that she completed/had left to complete.
- You can also do this with other aviators flights across the Atlantic Ocean, English Channel, the United States, etc. with respect to the radius of the Earth.

Trip Comparison Graph

- This activity is to be used in conjunction with the Mural Activity in the Social Studies section of this thematic unit.
- In this Mural Activity, students will have researched different aviators and created the paths that they flew.
- Have students compare several of the paths by mileage and create a graph from the data.
- Then students will come up with several questions about their data that can be found by looking at their graph.
- Have students exchange their graphs and questions with each other in order to practice reading graphs.

Paper Plane Activities



Here is a list of several math activities you can do with your students dealing with paper airplanes. Refer to the Paper Airplanes activity in the Science section of this thematic unit.

1. style of plane vs. flight time
2. average flight time from several flights
3. distance competition for straight flyers (fly in line rather than looping)
4. weight vs. flight time (use heavy paper, add paper clip, etc.)
5. speed of the plane (distance÷time)
6. prediction of flight vs. actual outcome
7. size of wing vs. flight time
8. tail or no-tail vs. length flown

Balloon Lift: Weight vs. Height

In order to do this activity, you will need the following materials to create a makeshift blimp:

- one of these: lid of a shoebox, cardboard lid to a box of paper, small gift box, any lightweight open box
- several helium balloons
- a straight, long straw (not the type that bends)
- string
- tape

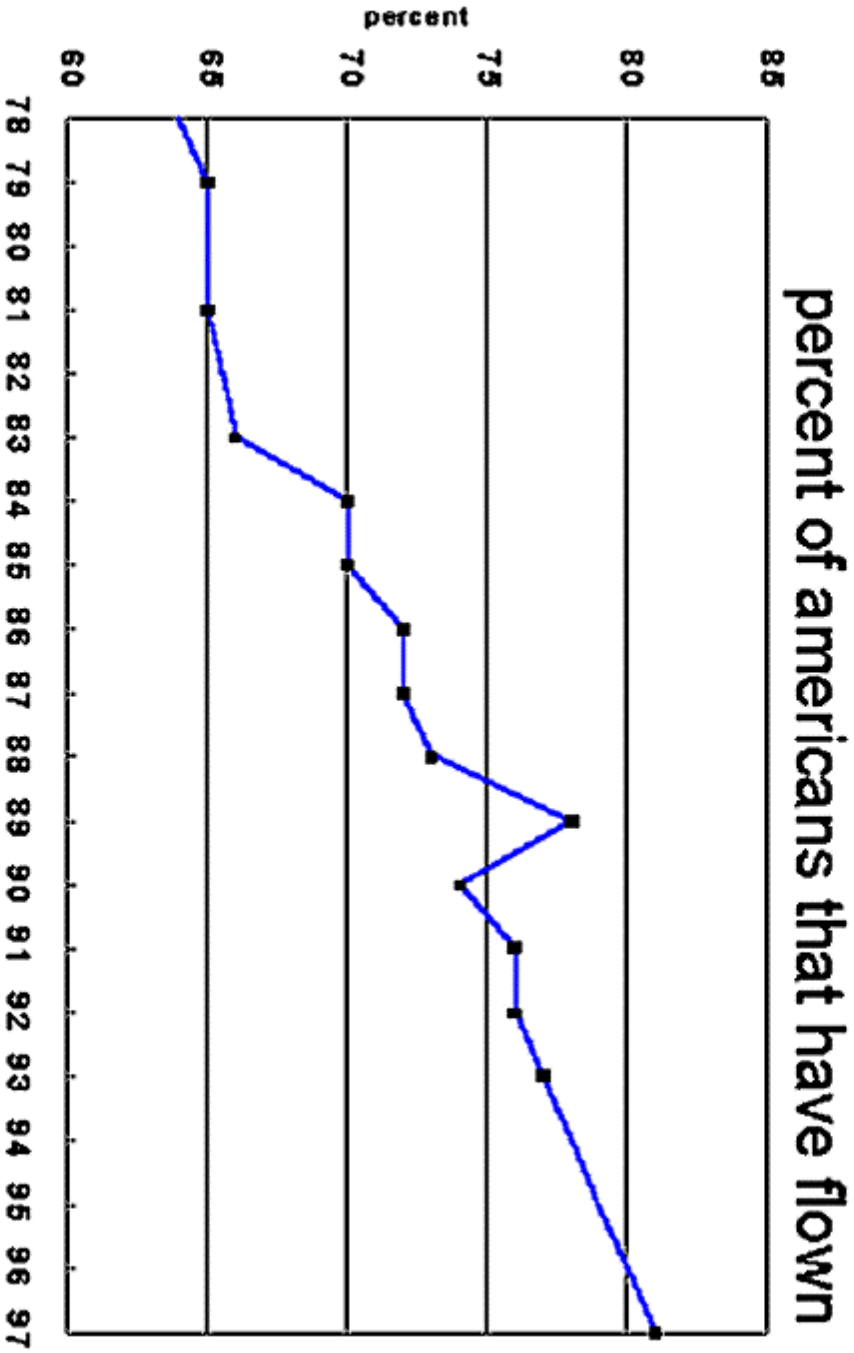
Have your students assemble the blimp by attaching the balloons to the straw using the tape or string. Use the picture to the right as a reference. Attach string from the straw to the corners of the box using tape. Use extra balloons as needed.

After the blimp is ready to float, have your class do the activity below.

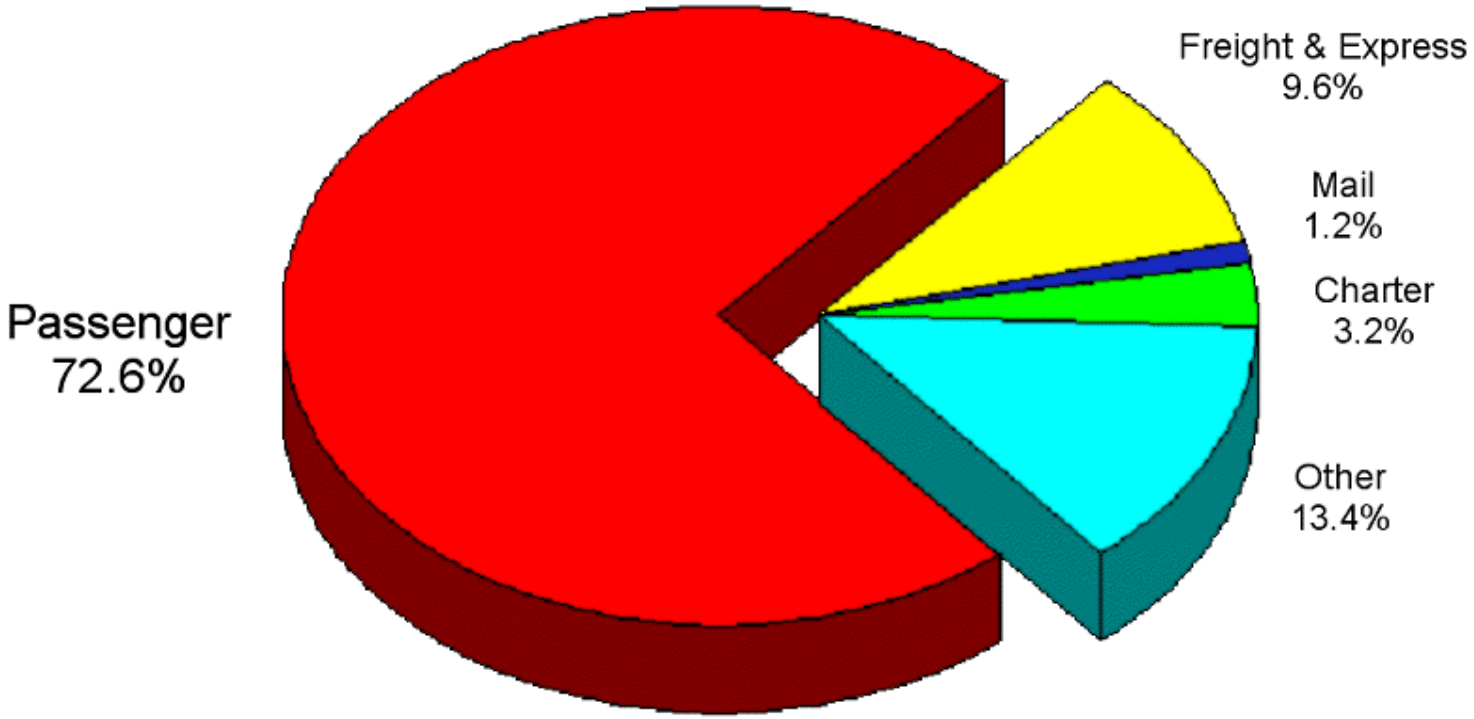
1. Select an object from the classroom that there is a set of: Unifix cubes, pencils, two-sided counters, lima beans, etc.
2. Have your students experiment in groups with the blimp by placing the objects into the gondola part of the blimp.
3. Have your students create a chart comparing the effects of the number of objects placed in the gondola section vs. the height of the blimp.
4. They will need meter sticks or rulers in order to measure the height of the blimp.
5. Have them analyze the data and see if there is a relationship between some of the properties that they were testing. A good way to do this is to have them create a line graph of weight vs. height and to then analyze the line: a straight line indicates that the relationship is proportional - a line increasing upward indicates that it is exponential, etc.
6. Have the groups compare their results and discuss what differences could be attributed to.

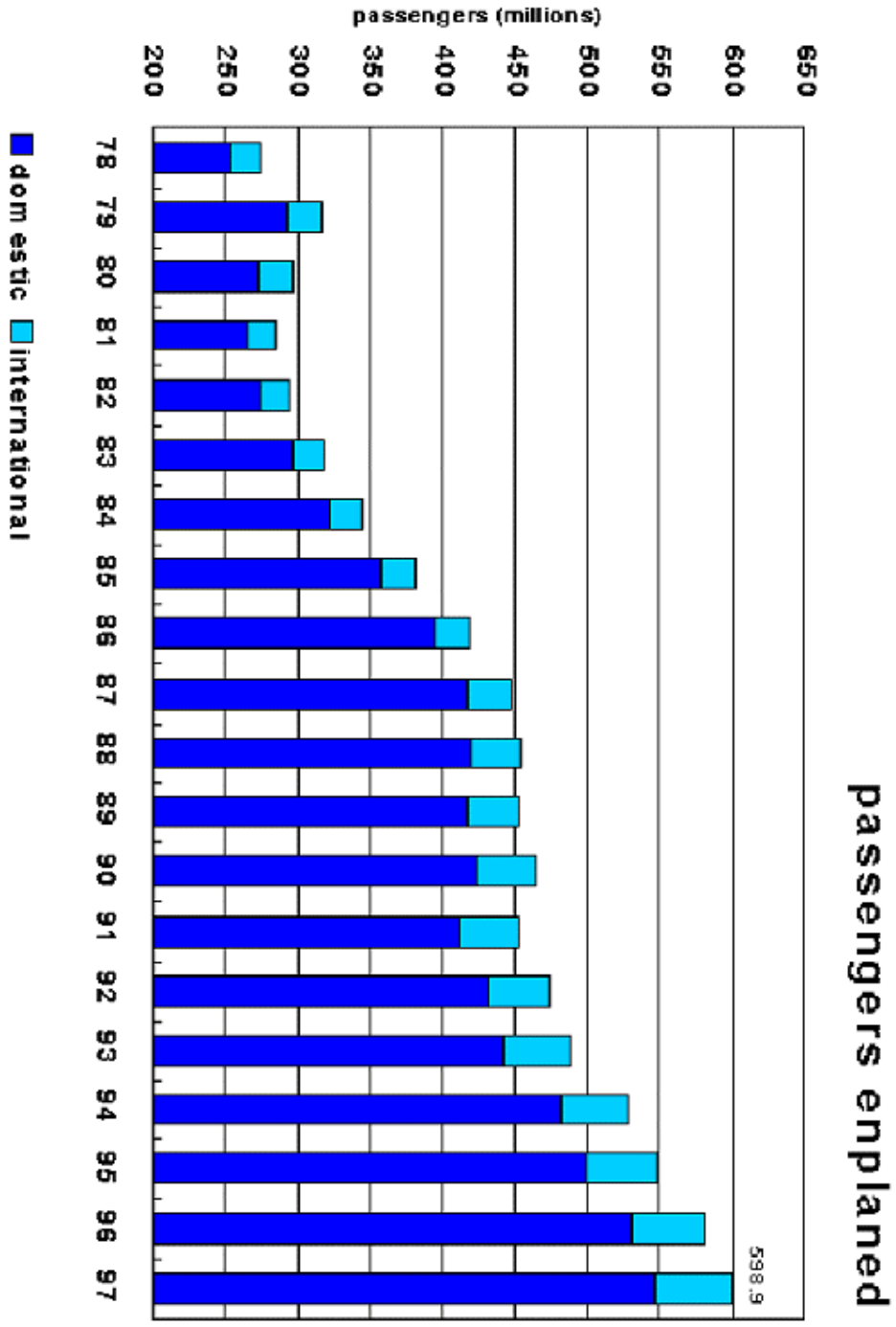
Graph Analysis

On the following 4 pages there are graphs depicting airline statistics. Have your class analyze the data in order to practice interpreting graphs as well as to learn more about the airline industry.

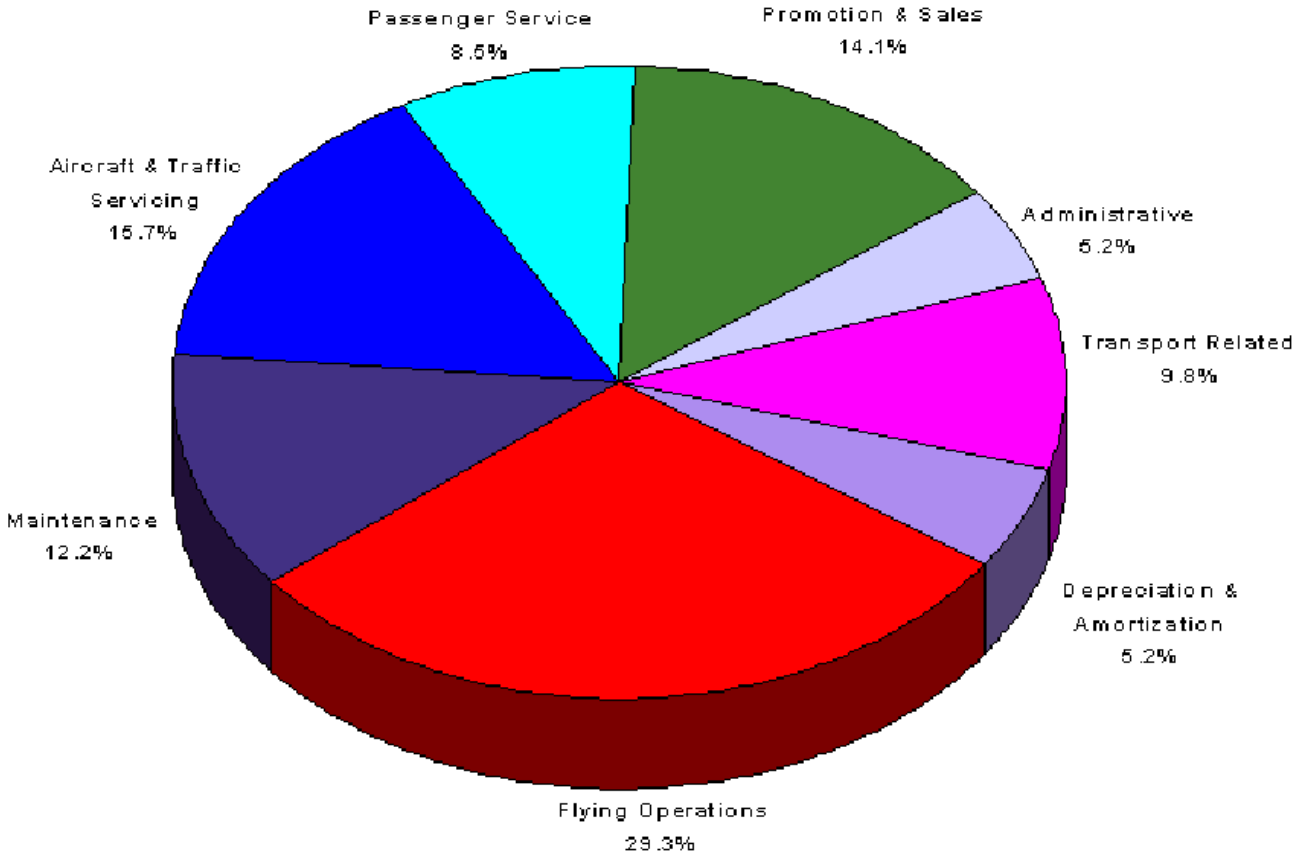


operating revenues




passengers enplaned
passengers (millions)
200
250
300
350
400
450
500
550
600
650
598.9
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97
domestic
international

operating expenses



Flight Time

1000 B.C. — Kites are flown.

1020 A.D. — Tower Jumpers try to fly using wings.

1782 — The Montgolfiers begin their hot air balloon experiments.

Sept. 24, 1852 — Henri Giffard makes the first powered and controlled flight in a dirigible.

1891 — Otto Lilienthal builds and flies the first successful glider.

Dec. 17, 1903 — The Wright brothers make the first powered and

July 25, 1909 — Louis Bleriot is the first to cross the

July 1, 1911 — The first flight of a U.S. Navy aircraft - a Curtiss seaplane.

Jan. 15, 1915 — The first air raid during war: on Britain by Germany's

May 21, 1927 — Charles Lindbergh completes the first solo flight across the Atlantic.

August 8,1929 — The Graf Zeppelin makes the first around-the-world flight.

May 20, 1932 — Amelia Earhart is the first woman to fly solo across the Atlantic.

May 6, 1937 — The Hindenburg crashes in New Jersey.

June 20, 1939 — The Heinkel He 176 is the first rocket-powered (or jet) airplane to fly.

March 13, 1940 — Sikorsky makes and flies the first practical helicopter.

May 2, 1952 — The De Havilland Comet becomes the first jet-powered aircraft to offer passenger service.

Jan 21, 1976 — The Concorde becomes the first supersonic commercial airliner.

April 12, 1981 — The first space shuttle, Columbia, takes off.

Using the timeline above, answer the questions about flight.

1. In what century did the tower jumpers try to fly?
2. When was the first around-the-world flight performed?
3. How many years has it been since kites were flown in China?
4. How many months passed between the flights of the first man and the first woman to fly across the Atlantic Ocean?
5. What was the first significant passenger flight accident?
6. How many days passed between the Wright brothers success and the use of the jet airplane for passenger flights?
7. How many years have NASA space shuttles been in service?
8. How long after the invention of the hot-air balloon did it take to actually make it controllable?
9. When did the first jet airplane fly? How many years later did jet flight reach supersonic levels?
10. For how many decades have airplanes been used in the US Navy?
11. How many weeks ago was the first practical helicopter flown?
12. How many years after the invention of the dirigible was the first around-the-world zeppelin flight accomplished?
13. How many centuries passed between the use of kites and gliders?
14. When was the first air raid for war?
15. Approximately how many seconds passed between the first airplane flight and Louis Bleriot's flight across the English Channel?

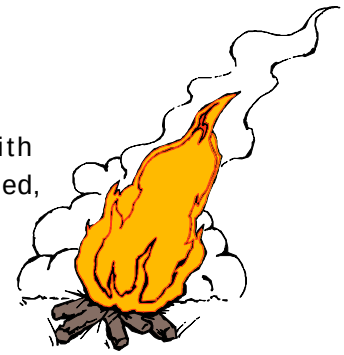
Science

What Goes Up?

- Begin this lesson by dropping a pen on the floor and asking the class to explain what happened.
- Then, hold out a book and ask what will happen when you let go of it. Do the same for a few other objects.
- Ask students if anything that you hold out (regardless of size or weight) will fall when you let go of it.
- Briefly discuss the concept of gravity with the class, seeing what they already know.
- Have students brainstorm the following question in groups: What goes up?
- Have a chart prepared with three columns: 1. What goes up? 2. Why we think it goes up. 3. Why it actually goes up.
- Gather students' responses from their group activity and record on the chart. Here are some probable responses: birds, planes, helicopters, balloons, smoke, etc.
- Have them guess why each of these goes up. By the end of the unit they will understand that some of these things can actually fly, some simply glide, and some float in the air.

Lighter-than-Air Flight: Floating

The Montgolfier Gas



1782 was the year the Montgolfier brothers started experimenting with lighter-than-air flight. Up until this time, no "flying" had been documented, other than that of kites. It all started when they noticed the smoke from a campfire going up into the sky. They used small silk bags to try to harness the smoke—and it worked! The bags floated up. The hot-air balloon was born.

- Before you discuss the Montgolfier brothers with your class, have your students complete the Where did it all start? Writing activity to guess how flight started.
- After sharing the above information with your class, look at some of the responses and compare your students' ideas to those of the Montgolfier brothers.

The Montgolfier buttoned pieces of linen together to make the first balloon. They mounted a container to the neck of the balloon that could hold a fire. They brought hay on board the balloon to keep the fire going—the flight lasted as long as the hay lasted.

- Have your students discuss the practicality of this method, of keeping the balloon aloft. Ask if they can come up with a better plan. Remind them that up to this point,

nothing else had been invented for the brothers to refer to. These innovators were on their own!

- The Montgolfier brothers thought that smoke was what lifted the balloon into the air. This smoke began known as Montgolfier Gas. See if your class knows what was actually making the balloon float upwards: the hot air from the fire weighed less than the surrounding air, causing the balloon to lift upward.
- Ask your class how this realization could open up the doors for more practical lighter-than-air flight. Once it was realized that smoke wasn't the lifting factor, other lighter-than-air experiments used different gases such as helium and hydrogen to provide lift for flight.
- Do some of the following experiments with your class to help them understand what was actually happening in lighter-than-air flight.

Sinkers vs. Floaters

Archimedes, a Greek mathematician from 250 B.C., discovered than object will float if it weighs less than the object it is floating in. This principle is known as buoyancy.

- Provide a tub of water for your students and the set of objects listed on the worksheet provided, Sinkers or Floaters?
- Have the students follow along on the worksheet, first making a prediction about what will sink and float and then observing.
- After testing all of the objects, the students will come to a conclusion about the properties that make things float or sink.
- Try to relate to your students the similarities between air and water. They are both substances that share the same physical characteristics. Objects can float in both air and water if they are lighter or less dense.

Warm Water Rises

For this experiment you will need a 10 gallon aquarium, a piece of cardboard that tightly fits in the tank, dividing in half, red and blue dye, hot and cold water.

- Place the cardboard divider in the aquarium.
- Pour cold water on one side of the divider and hot water on the other. (Works well using a tea kettle)
- Put a few drops of red dye in the hot water and blue dye in the cold water.
- Remove the cardboard divider QUICKLY and see what happens!
- The red water should be on top of the blue water since warm water rises. This occurs because warm water is less dense than cold water.
- Have students discuss why the water doesn't mix immediately when the cardboard is removed. Why does it separate into layers? Can they think of any examples in nature where this occurs? (atmosphere, ocean) Have them discuss the relationship between this water movement and that of warm air rising, etc.

Give Your Friends a Lift

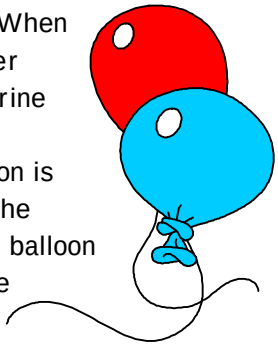
You will need a heavy-duty garbage bag, duct tape, and straws.

- Tape all edges of the garbage bag flat on the floor.
- Have a student lay or sit in the middle of the bag.
- Have a group of six or eight students insert their straws into the top layer of the garbage bag and blow air into the bag.
- Observe what happens!

Floating Eye Dropper

You will need a plastic soda bottle (small one works well), an eyedropper, and water.

- Fill the soda bottle with water completely.
- Squeeze the eyedropper and take up enough water so that it is half full.
- Place the eyedropper in the soda bottle and put the cap on.
- Let students experiment with the bottle. Ask them to notice what happens when they squeeze the bottle, when they let go, and how they can make the dropper stay in the middle.
- What happens to the water inside the eyedropper and when does this happen?
- This experiments illustrates some basic principles of pressure. When the eyedropper is placed in the soda bottle, it remains at the top because of the air inside the dropper. When the bottle is squeezed, the water pressure increases; the pressure inside the dropper must accordingly increase so water is taken in to increase the air pressure within the dropper. It sinks to the bottom. When released, pressure is decreased, causing the eyedropper to push water out, thus floating up again to the top. This is similar to what a submarine does with ballast and filling the tanks with water.
- Balloons work in a similar manner also. The medium in which the balloon is "floating" is air, rather than water in this case. When the air inside the balloon is heated, the pressure decreases, and it floats up. When the balloon wants to come down, it lets air out, increasing the pressure inside the balloon.



Some Simple Stuff

- Use straws to blow bubbles under water. Why do they go up?
- Helium balloon vs. air-filled balloon: Why does the helium balloon float up in air?
- Obtain some dry ice (sometimes grocery stores will give or sell it to you) and show your students that not *all* gases are lighter than air! For older students, you can

explain to them that air is a mixture of gases, and it is this mixture that gives air weight. Each element that makes up air is lighter than the mixture.

Lighter-than-Air Flight: Dirigible

The next step in lighter-than-air flight was to be able to actually maneuver the balloon and have some speed. Until the mid 1800's, balloon flight was limited to floating wherever the wind went. Henri Giffard was the first to create a steam-powered dirigible in 1852. The ship was shaped like a football and a gondola was suspended beneath it. A propeller was attached to the gondola in order to make it "steerable." The steam engine, coal, and water were placed in the gondola with the total weight being 500 pounds. The engine only provided 3 Hp(compare this to a standard push lawnmower averaging 6 Hp) and could travel at 5mph. This was not too practical to say the least. Experiments continued with use of the steam engine, and then with the electric engine, but until the invention of the gasoline-powered internal-combustion engine in 1885, not much happened with dirigibles.

Below are some activities you can do with your class in order to teach them the basics of the different engines used in history. There are many question-and-answer type books as well as many children's books specifically on engines that can also help young children understand these basics.

Steam-Powered Engine

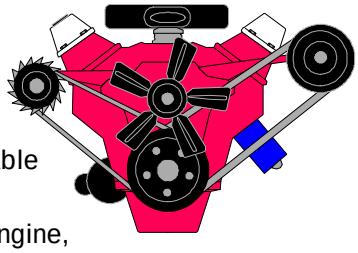
- Discuss with your class the basics of a steam-powered engine.
- In order to illustrate how captured steam can force pistons to move, in turn causing wheels or propellers to move, do this simple teakettle experiment with your class.
- You will need a teakettle that can be sealed easily with tape, a straw, a wad of paper, and some tape.
- Place the wad of paper in the straw and tape the straw onto the teakettle, making sure there is little room for air to escape.
- Boil the water in the teakettle and when it starts to steam it will push the paper out of the straw.
- Before actually doing the experiment, have your class predict what will happen.
- Using this simple experiment as a sample, discuss with your class the amount of steam needed to run a train, propel a vehicle forward, etc. Also discuss how steam used to be generated by using coal to keep a fire burning in order to heat water in order to get steam. Help your class to understand the impracticality of bringing these things aboard a balloon along with the difficulty of getting any power with all of the extra weight.

Electric Engine

Electric motors were experimented with in the early 1880's, but also proved to be impractical because of the weight of the batteries needed. Once again speed could not be achieved with the small amounts of energy being generated by the batteries.

- To help your class understand the concept of getting power from a battery, let them experiment with the following materials: a large battery, wire preferably with alligator clips attached for safety, a light bulb, and a switch. Most schools usually have electricity kits such as these designed specifically for use in the classroom. Or if not, they can be found in most toy stores.
- Though experimentation with these materials, your students will learn how to turn the bulb on and off by connecting the wire and switch to the battery.
- You may want to provide higher-powered bulbs and let your class determine the batteries' limitations. This will help them to understand the huge amounts of battery power that would be needed to propel an airship through the sky.

Internal-Combustion Engine

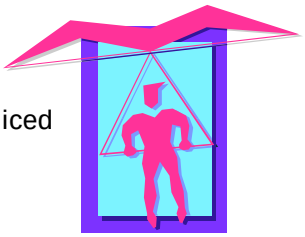


Finally, with Gottlieb Daimler's invention of the gasoline-powered internal-combustion engine, innovators of the time were able to provide enough energy to their dirigibles to get them moving at reasonable speeds.

- Discuss with your class the basics of the internal-combustion engine, basically the modern day car engine. Books with several pictures will really help your class to understand this engine better.
- Rather than using steam or electricity to gain power, this engine uses gasoline. It draws a gasoline and air mixture into a sealed cylinder, introduces a spark causing an explosion to take place, in turn pushing the piston connected to a rod which makes wheels, or propellers turn. This is a very basic explanation of a complicated engine.
- This is harder to illustrate for your class as you can't ignite gasoline too safely in the classroom! However, you can talk about things that your students have seen that indicate the explosiveness of gasoline such as: signs at gas stations saying "No Smoking," covering gas and oil spills with sand or litter, putting out an oil fire in a pan with flour rather than water, etc.
- You can also show your students your car engine and try to point things out. You also might check to see if any parents could help with this – there's bound to be a mechanic among all of the parents or relatives of the students. Taking apart a lawnmower engine or other small gas-powered motor would be an excellent learning experience for your class.
- Lastly, discuss the practicality of this engine style compared with the others. The weight is not nearly as much of a factor with gasoline and much more power is produced.

Heavier-than-Air Flight: Gliders

The next step toward modern day flight came with the invention of gliders. Although still dependent on the wind, gliders used the soaring features of birds, true fliers, to move in the sky. They also did not need to be lighter than air to get their lift. They got lift from the design of the wings and the force of the wind.



Otto Lilienthal created the first successful glider in 1891. He studied the flight of birds for many years before even attempting to build a glider. He noticed three very important things that enabled birds to fly:

1. bird wings are curved
2. birds took off into the wind
3. the faster the wind, the better the lift

He made his gliders with a light wooden frame and muslin to keep the glider light. He eventually added levers that could change the wing shape during flight in order to change direction, but the glider was still dependent on wind.

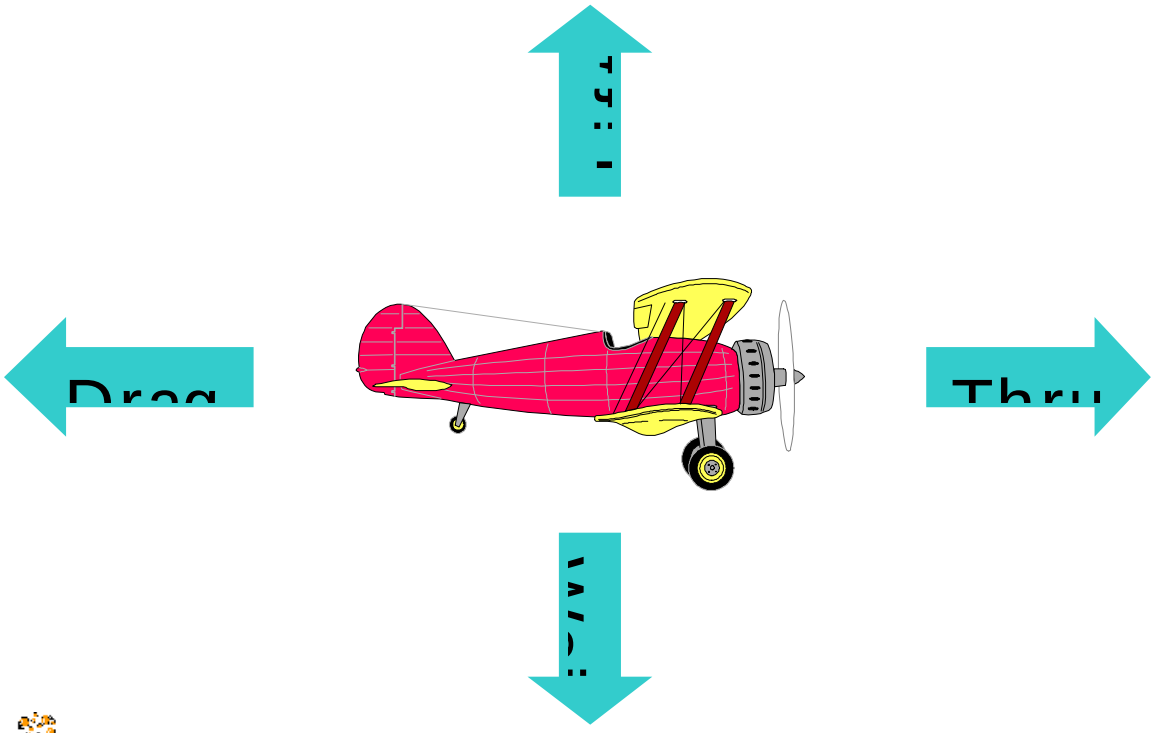
Paper Airplanes

- Have your class experiment with paper airplanes. Provide books and materials to help them make several different designs. If you have access to a computer, and are willing to invest a little money, there is a great educational paper airplane program called *The Greatest Paper Airplanes* that is made by Kitty Hawk Software and distributed by Mindscape. This program has a history of flight as well as an explanation of the physics that enable planes to fly. It provides about 50 different paper airplanes that can be made using their 3-dimensional folding instructions systems. They are very easy to create because the program gives step-by-step "video" in 3D as well as written instructions.
- Encourage your students to modify wings, wingtips, the tail, use paperclips to add weight, etc. in order to come up with a good design.
- Have your students keep track of the design vs. flight time to see which variables work best. There are several activities in the Math section which you may want to incorporate into this activity.
- When students have come up with their favorite design, have them name their plane, decorate it, and write about the special features which enable it to glide well. At this point you may also want to provide thicker paper in order for students to make their final model.

Model Gliders

- An ideal activity to help students understand the physics of gliding would be to have them create a model glider as a class. These can be found at most hobby shops and vary in price. You may want to check around to see if some of your students already have one or if one of the parents might be able to donate one to your class.

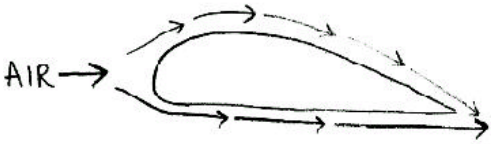
Heavier-than-Air Flight: Airplanes



How does a plane fly?

In order for a plane to take off, the lift of the plane must be greater than the weight and the thrust greater than the drag. There are many features of a plane that enable it to meet those requirements:

- Aerofoil: this is the cambered shape of the wing that causes air to create less pressure on the top of the wing, making it lift



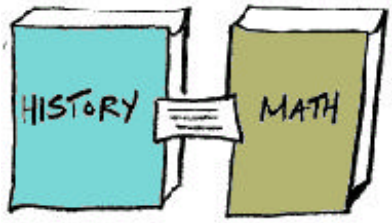
- Weight: the plane is made as light as possible by using aluminum alloys
- Speed: planes are able to gain the necessary speed using thrust in order to take off (slower planes need large cambered wings in order to lift whereas fast planes need small wings only slightly cambered)
- Drag: planes are smooth and slippery in order to keep drag minimal
- Tail: this keeps the plane level during take off

There is an excellent children's book called *Bernoulli's Book* written by B. K. Hixson filled with tons of neat experiments showing kids how the principle of the aerofoil works. I am including a few experiments based on this book below. There are also several patterns included for making airplanes, rockets, and helicopters along with experiments to be used with these.

The Card Bridge

You will need two books and an index card in order to do this experiment.

- Place the two books side by side on a table.
- Place an index card between the books the "long" way with only the edges of the card resting on the book.
- Have students predict what will happen when they blow under the card through the gap between the books.
- Have them do the experiment.
- The card will bend toward the table due to the difference in air pressure between the top and bottom of the card. The air on the bottom is moving more quickly than the air above and doesn't have as much time to put pressure on the card.



Kissing Balloons

You will need two balloons and two pieces of string to do this experiment.

- Blow up the balloons and tie the string around them.
- Hold the balloons by the end of the strings (balloons should be at face level) about a foot apart.
- Predict what will happen when you blow between the balloons.
- Do the experiment.
- The balloons will move toward each other and "kiss." This happens because the pressure on the outside of the balloons is greater than the pressure between them.

Thirsty Straw

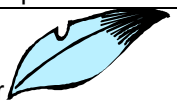
You will need a straw and a glass of water to do this experiment.

- Place the straw in the glass of water and observe the water level in the straw. It should be even with that of that of the water level in the glass.
- Predict what will happen when you blow across the top of the straw.
- Do the experiment.
- The level in the straw will rise when you blow across it because the pressure above the water in the straw is reduced because the air is moving faster. This causes the water to go up the straw.

After doing all of these experiments and the others in *Bernoulli's Book*, your students will be experts on the basic principles of air pressure.

Sinkers or Floaters?

1. Use the chart below to predict if the objects will sink or float in water.
2. Place the objects one at a time in the tub of water and observe what happens.
3. Record your findings.
4. In the box at the bottom of the page, make a conclusion about what properties an object has that makes it float or sink.

Object	Your Prediction	Your Observation
Rock 		
Pine cone 		
Bottle cap 		
Feather 		
Stick 		
Leaf 		
Tennis ball 		
Peanut (in shell) 		
Penny 		
Pencil 		

Conclusion: _____
_____
_____
_____
_____
_____

Language Arts: Vocabulary/Spelling

ornithopter: an aircraft whose flight is powered by flapping wings, rather than fixed wings and propellers or jets
buoyancy: principle that an object will float if it weighs less than the substance in which it is suspended
hydrogen: a highly flammable gas, having 1/14 the density of air; the most abundant element in the universe
ballast: sandbag or water bag that can be thrown overboard to increase altitude of a balloon
dirigible: a balloon that can be steered; also called an airship
gondola: a basket or area suspended beneath a balloon to hold cargo and/or passengers
fuselage: the body of an aircraft
monoplane: an airplane with one set of wings
biplane: an airplane with two sets of wings
zeppelin: a dirigible with an internal frame, which makes it rigid
blimp: a dirigible that is non-rigid

aerodynamics: the science of air in motion and the motion of objects in air
heavier-than-air flight: flight in which lift is derived from wings rather than hot air
lighter-than-air flight: flight in which lift is derived from hot air or lighter-than-air gases
horsepower: a unit for measuring power
Montgolfier gas: the name attributed to the "lifting power" of smoke
propeller: a device that consists of a central hub with radiating blades that is used to pull or lift a vehicle (as a ship or airplane)
Hindenburg: one of the largest and most luxurious zeppelins ever built; exploded when a spark from the engine ignited the hydrogen-filled balloon, ending zeppelin passenger travel
aileron: movable flap on wings of airplanes used to control rolling and banking
amphibian: an aircraft that can take of from and land on either land or water
resistance: opposition to
rudder: vertical flap on tailfin that directs left/right movement
elevator: horizontal flap on tail which is used to move the plane up and down
cambered: slightly convex; curved

Language Arts: Reading

There are a plethora of books discussing Flight, including general flight books, flight history, physics of flight, biographies, as well as activity-centered workbooks and instructional aides. Here are some of the more original and interesting books found on Flight.

1. Bernoulli's Book by B.K. Hixson: This book is a collection of 25 experiments that make the basic physics of flying easy to understand. There are also airplane and rocket patterns included.

2. Famous Flying Machines : A Quick History of Flight With 7 Authentic Models to Make and Fly by Leon Baxter: This book is both provides working aircraft models and informative text for the your students.
3. The Fantastic Cutaway Book of Flight by Jon Richards: This book contains cross-section and illustrations revealing the complex technology of 747s, helicopters, supersonic jets, and other vehicles of flight.
4. Flight (Make It Work! Science) by Jack Challoner and Andrew Haslam: An illustrated book of projects demonstrating the properties of flight.
5. Flight : Fliers and Flying Machines (Timelines) by David Jefferis: This work traces the evolution of the airplane from man's first flying machine to today's supersonic jets.
6. The Glorious Flight : Across the Channel With Louis Bleriot by Alice & Martin Provensen: A picture book biography of the Louis Bleriot whose fascination with flying machines produced the Bleriot XI, which in 1909 became the first heavier-than-air machine to fly the English Channel.
7. Magic School Bus Taking Flight : A Book About Flight
8. The Story of Flight : Early Flying Machines, Balloons, Blimps, Gliders, Warplanes, and Jets by Dan Hagedorn, et al: This fun book is a history of aviation highlights such topics as the Wright brother's workshop and wartime plane motors while profiling such important figures as Da Vinci, Lindberg, and Earhart, and provides reusable stickers of cockpit panels, warplanes, and blimps.

Language Arts: Writing

Airline Advertising

- Provide students with several brochures, pamphlets, and taped commercials advertising different commercial airlines.
- In groups, have students decide and list the different properties of the ad or commercial that help to promote the airline. For example: What kinds of names do they use for their airline? What colors do they paint their planes? What slogans do they have? What kind of music and people do they include in their ads?

- After students have a grasp for airline advertising, have them form their own advertising agency and prepare to make a convincing ad for an airline that they create.
- Have them come up with a name for their airline, a picture of their airplane, a logo, a slogan, and a brochure or pamphlet. If the resources are available, you could have your students create their own TV or radio commercials.

- Have them share their "Advertising Campaign" with the class and with other classes to see what airline ad is most alluring.

Where would we be without flight?

- Have your students brainstorm the different kinds of transportation available.
- After coming up with a compiled (hopefully complete) list of ideas, sort through them with your class and select those that methods of transportation that relate to air travel.
- Pose the following question to your students: How would the world be different without air travel?
- Have your students write an informal essay answering the question, including a discussion of the essential reasons vs. non-essential reasons for air transport.

Flying Machine Directions

This Writing assignment deals with the Science activity where your students build their own Flying Machine.

- Have your class think of different uses for giving directions.
- Discuss the cases where directions need to be accurate and those where they are not as important.
- Provide samples of different kinds of directions including: cooking recipes, putting together furniture, driving directions, installing programs on your computer, etc.
- Have your class decide what kinds of things all of these directions have in common and notice where they differ.
- When your class has a clear understanding of how to give accurate directions, have them write directions on how they built their flying machine.
- After the instructions have been written, they will exchange these with fellow classmates and build each other's Machines based *solely* on the instructions given. This means that their directions need to be very thorough, not leaving out any steps, no matter how small.
- When building the machines based on the directions, your students should realize just how important and necessary good instructions are!

The Hindenburg Report

- Share several different news reports (TV, radio, newspaper, magazine) with your class. Acquaint the students with the reporting format: the way the reporters talk, the words used, the formatting and style of the text, tone of voice, etc.
- Next, have your class research the Hindenburg incident using the library and/or Internet. They will need to acquire as many specifics as they can about the tragedy.

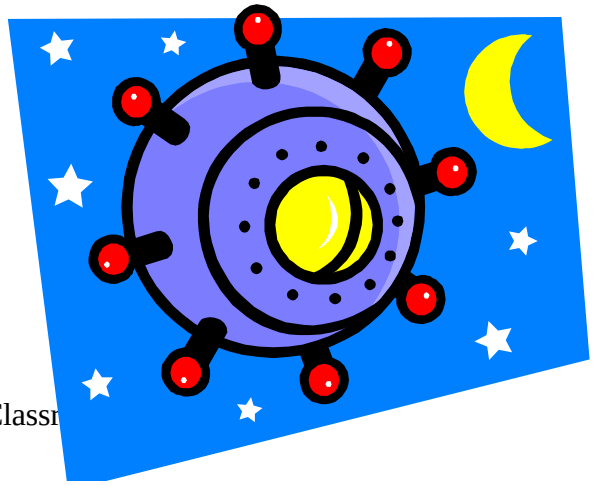
- The assignment is to report the explosion and crash of the Hindenburg zeppelin in an informative and dramatic way. Your students can do this in groups in order to act out the drama—have them interview some of the survivors, the relatives of the deceased, and any witnesses. Have them corroborate to create a provocative yet instructive factual account of what occurred that day.
- You can let your students take this activity as far as you would like. They could create backdrops for their drama, have commercials for their radio story, make a TV news report (Breaking News), or write a lengthy article of the specifics of the airship and a scientific explanation for what happened.
- If possible, after all of the reports have been presented share the headline article on the actual day of the explosion printed from microfiche from your local library or college library.
- Have your students compare their own articles/reports with the actual stories.

The Good and Bad

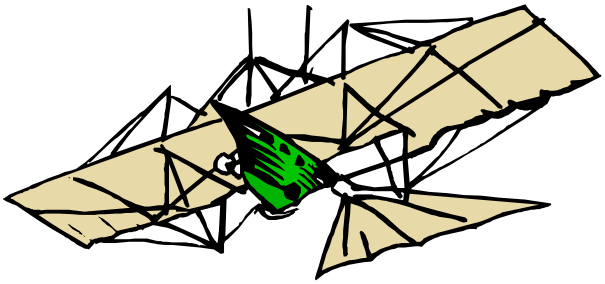
Toward the end of your study of Flight, have the class write a persuasive essay on the positive and negative aspects of flying and air travel. They should attempt to remain on one side of the issue and defend with facts and informed opinions on a variety of topics concerning flying. However they also need to address the other side and refute those ideas with their own arguments. Of course, before assigning this you will need to provide sample of persuasive essays to your class if you have not already studied them.

What's Next?

- As a fun assignment for your class, tell your students to draw and write about a futuristic aircraft that they think will be the next means of air transportation.
- Their drawings should be detailed and should complement their written description.
- Some of the aspects they will need to talk about include the basic shape of the vehicle, how it is powered, from where does it get its lift, unique characteristics for passengers and/or pilots, what is its main purpose, where does it fly (space, low-altitude), and average speeds.
- They also need to include reasons for the invention of this new vehicle. Why do they think that the vehicle they create will be needed in the future?



Art

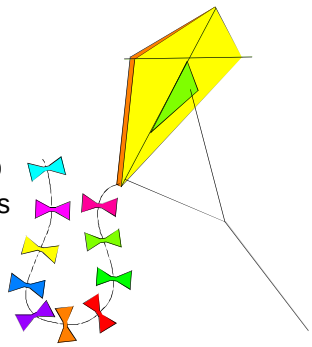


Create a flying Machine

There were many weird flying contraptions created during the formative years of flight. Almost all books about the history of flight contain many pictures of these early developments.

- Share some of these pictures with your class.
- Also share Leonardo da Vinci's early sketches of flying machines with your class. He created these in the 15th century, way before any actual machine was developed.
- Have your students create their own flying machines. Provide them with tons of materials: old cloth, safe wire, rubber bands, wood scraps, clay, toothpicks, pop sickle sticks, etc.
- They will love this assignment! This could also be a homework assignment in which they can use whatever materials they want. And parents will probably enjoy helping as well.
- Have them write about their creations. Where did their design come from? What special features does their flying machine have? Where can it fly? How does it achieve lift? From where does the power come? Is it a lighter-than-air flyer or heavier-than-air? Why did they decide on that particular kind of design?
- You don't really need to put any limitations on this other than the fact that it needs to be original and a flying machine. You will be amazed with some of the products your students will come up with!

Cool Kites

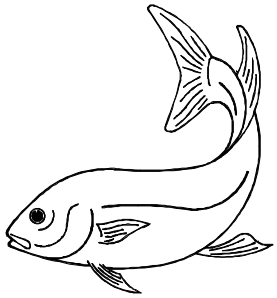


Bring in materials about kites and kite flying for your class to refer to during this activity. There are thousands of books on kite-making, kites in history, kite aerodynamics, etc. Try to obtain several books to share with your class as well as bringing in actual kites if possible. Books that provide simple instructions for making kites will be especially helpful. This will provide your students with a variety of possibilities when creating their own kites.

Here is one method of making a kite that is pretty basic, but there are many others out there.

- You will need strips of bamboo, close-knit materials such as nylon or heavy tissue paper, strong string, glue or staples, strips of cloth for the tail, and various other decorating materials.
- Dampen bamboo strips in water until they are very flexible. Shape the bamboo into the desired shape. Tie the strips into place.
- Add crosspieces for support wherever there is large open spaces.

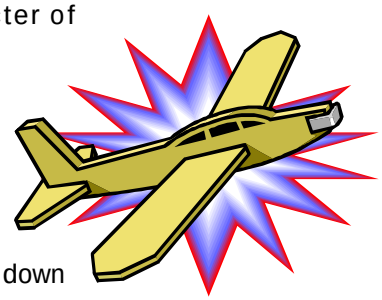
- Cut a cover for the kite out of the material, adding about 2 inches all the way around in order to attach fabric or tissue to frame.
- Decorate the material as desired. If students make a fish kite they may want to add sequins for scales, a plastic eyeball, or simply color in a fish.
- Attach the material to the frame with heavy glue or by stapling. The covering should be firm but not too tight.
- Make a tail for the kite by attaching string to the end of the kite (i.e.; on a fish kite you would probably choose the tail fin area). Tie strips of cloth at about 1 foot intervals along the tail. The tail should be around 15 feet for an average size kite.
- Attach the end of a ball of string/twine to the middle of the cross supports and you're ready to go!



You may want to teach students about Chinese Art when making kites. You could have them study art from many Chinese artists and design their kites in a similar fashion. May 5 in Japan is Children's Festival Day where Japanese children fly carp kites. You may want your class to make carp kites on this day in order to help them better understand other cultures. They can fly their kites in the school playground and partake in the Children's Festival.

Plane Pastels

- Obtain some model airplanes of differing varieties including both modern day and early innovations. Ask other teachers and students throughout the school. Your bound to find a few people who build and collect model planes.
- Display the models around the room, near or on tables in which students can do a "still-life" of the airplanes. Let students choose which model they want to illustrate.
- Encourage students to draw the model from different perspectives, not just from the side, but from the front view, bird's eye, etc.
- Have students draw the plane in pencil first adding all the details of the model.
- Then have students use oil pastels to complete their airplane "still-life."
- When they have finished with the plane, have students create a background for their plane – anything they feel will help add to the character of their artwork.



- Have students suggest different ways to portray the different models available. For example, if there is a Wright brother plane, how might you make the art look dated? How might the coloring be different? If drawing people in the background, how would the clothes change from those of modern day pilots? If the model has wheels down for landing how would the background change from one without landing gear down?
- Have children name their planes? Discuss the choices with them. Why did they choose that particular name? How does it represent their plane?

Hot-Airless Balloons

Although these balloons won't actually be able to float, your class will have fun making them and will learn some new skills. There are two parts to making this hot-air balloon: the balloon and the basket. You will need to set aside time during a few consecutive days when you can work on this activity with your class.

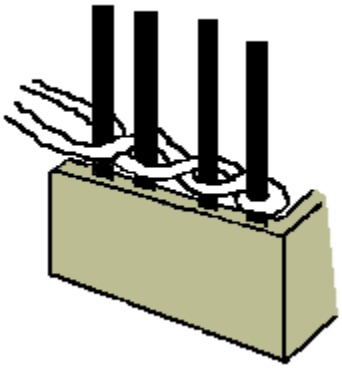
The Balloon

- You will need: balloons, newspaper; flour, water and glue for papier mache; paint, miscellaneous fabrics
- Have students rip up newspaper in one-inch strips.
- Meanwhile, you can make the papier mache. Add a quarter cup water to a cup of flour and mix, adding additional water as needed to make a paste the consistency of heavy cream. Then add a squirt of glue and mix. This works well in a pie pan.
- Students will need to each blow up a balloon and tie the end.
- In order to papier mache the balloons, you dip the strips of newspaper into the paste pulling off excess by sliding strip between two fingers. Then you attach the strips to the balloon.
- Students will need to add several layers to the balloon, completely covering it.
- Then the balloons will need to dry over night.
- When dry, the balloons can be decorated using paint, attaching fabric with glue, attaching tissue paper, etc.
- This will complete the balloon part of the activity.

The Twined Yarn Basket

This basket has many steps, but is really very simple to make. Your kids will thoroughly enjoy being able to make their own basket. You will need: corrugated cardboard, scissors, a ruler and pencil, masking tape, pipe cleaners, yarn of different colors

1. Make the base. Cut a 1 ½ by 10-inch strip of cardboard. Fold it into four equal sections. Using a ruler make a mark every ½ inch, continuously labeling it ½ , 1, 1 ½, and 2. Form the cardboard into a square, taping it into place. There will be four marks on each side.
2. Bend 8 pipe cleaners in half. Push one pipe cleaner into the top edge of the cardboard at a ½-inch mark. Pull it through the cardboard until you get to the bend in the pipe cleaner. Then push the end up through the cardboard at the 1 inch mark making a horse shoe. The ends at the top should be even. Do this all the way around the cardboard.
3. Start twining. You will need 8-10 pieces of yarn, each 6-feet long. Take one piece of yarn and fold it in half. Slip it over a pipe cleaner on any 2-inch mark. Moving from left to right, weave around the pipe cleaners with the 2 strands of yarn. you will rotate going over and under. Look at the diagram on the right.

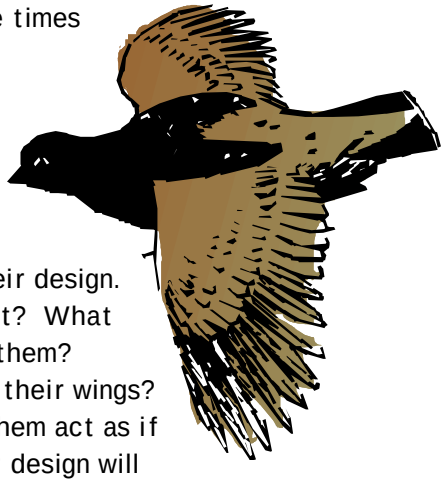


4. Continue to twine around the basket. When you get back to your starting point, just go over the previous row. Push down yarn as you go to make a tighter weave.
5. When you run out of yarn, start a new piece on the pipe cleaner where you left off. Just leave the ends of the yarn on the finished piece on the inside of the basket.
6. Weave until there is only 1 inch of pipe cleaner sticking up. Tuck the ends of the last piece of yarn into the weaving and trim off the excess.
7. Finish the top of the basket by folding the pipe cleaners into a loop tucking the end into the same hole that the pipe cleaner is in.
8. To finish the bottom of the basket, cut the cardboard at the corners and fold in, tucking flaps under each other like you do when you are closing a box.
9. That's it!

Then you make the hot-air balloon by attaching the basket to the balloon with several pieces of string and tape. Hang them up in the classroom to provide a great atmosphere to work in for the remainder of the unit.

Tower Jumper Wings

Before flying of any kind was invented, people used to try to fly like birds. They would make wings, attach them to their arms, and jump off of buildings flapping their wings in hopes of flying.

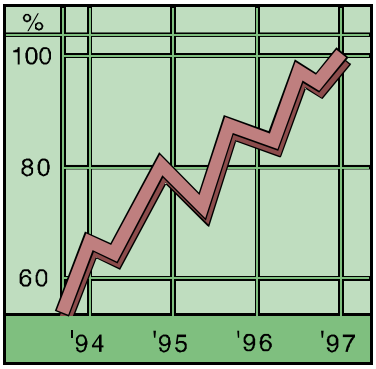


- Have your students pretend that they lived back in these times and were among the tower-jumping crowd.
- Have them make wings that will enable them to fly.
- This is a great activity that students can do with their parents. That way their parents can help them decide what materials to use and how to attach them together, etc.
- After making their wings, students should write about their design. Do they think that their wings will work? Why or why not? What materials did they choose to use? Why did they choose them? What are some aerodynamic features that they added to their wings?
- Have them give a presentation about their wings. Have them act as if they are trying to convince everyone why their particular design will work.
- These projects would be a great display for the whole school. Often the school library can display a classes' work, or the school may even have several display windows built in.
- You could also invite other classes to visit your wing exhibit. They can take a tour through the exhibitions with the different inventors discussing their own designs. You could even have the other classes vote on the design they think will work best.

Extras

Graphs For Flight

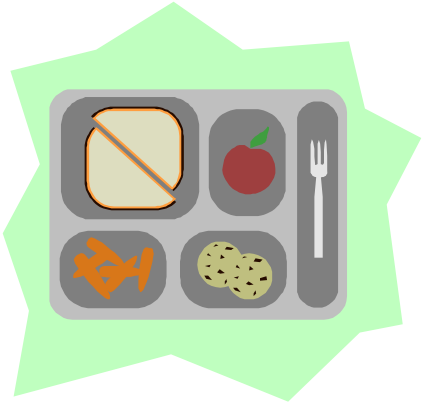
Use the graphs included in this section throughout your study of flight.



- What Airlines Have You Flown On?
- What machine was most important for the beginnings of modern day flight?
- When do you think flight was invented?
- Do you think it's safer to fly in a plane or drive in a car?

Lesson Ideas

- Size of airliner vs. Number of passengers
- Amount of fuel used during flight vs. Size of plane
- Amount of fuel in plane vs. Weight of plane
- Weight of plane vs. Power of engine
- Airplane collages (*Air and Space Magazine* and travel magazines are useful for this)
- Airline food (How do they keep food fresh? How is it packaged? Where is it kept?)



- What happens when you go to the bathroom (and flush!) in an airplane?
- Why do your ears pop when taking off/landing?
- Why do you get "butterflies" in your stomach?
- Where does turbulence come from?
- What part of the atmosphere do most commercial jet liners fly in?
- What would happen if a window broke during flight at high altitude?
- How do pilots know how high they are? (Altimeter)
- How do pilots maintain direction during flight?
- Figure out distance and/or time based on speed in miles per hour.

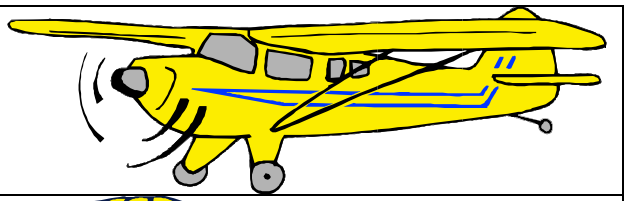
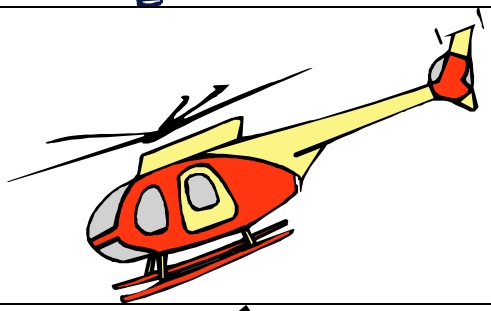
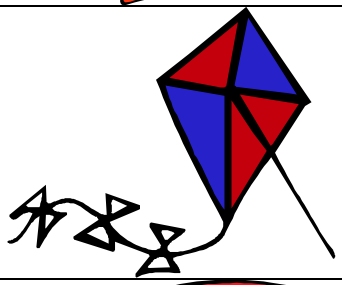
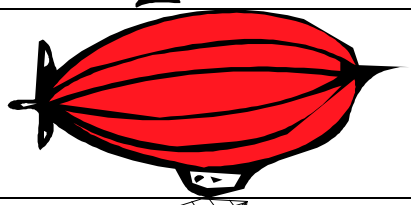
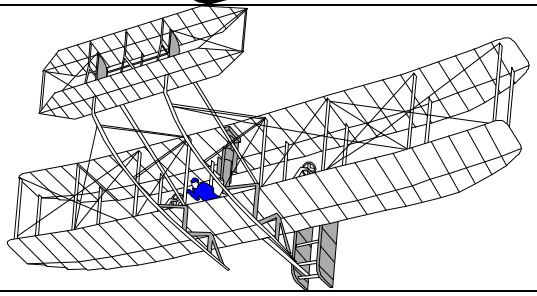
- Time differences: When would you get to Texas if you leave at 2:00 p.m. from Hawaii?
- How is a plane's weight found?

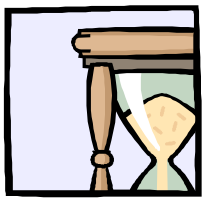
Miscellaneous Ideas

- Take a field trip to the closest airport/air traffic terminal
- Have a guest speaker such as pilot, air traffic control officer, rocket scientist, etc.
- Visit a small municipal airport where students can observe single engine planes with propellers, etc.
- Look around your area to see if there are any model airplane conventions or shows. Some areas have model airplane clubs that have meetings that your students may attend to get more hands-on knowledge of the physics of flight. Your local hobby store should be able to help.
- Visit any aeronautical museums in your area.
- Have flight relays with paper airplanes, parachutes, rockets, balloons, etc.
- Movies: Try to obtain news footage of different airplane crashes or experimental aircraft tests. There are also many movies on the history of flight and the physics of flight.

What airlines have you flown on?

What machine was most important for the beginnings of modern day flight?



When do you think flight was invented?

500 B.C.	
600 A.D.	
1000	
1300s	
1600s	
1700s	
1800s	
1900s	

Do you think it's safer to fly in a plane or drive in a car?