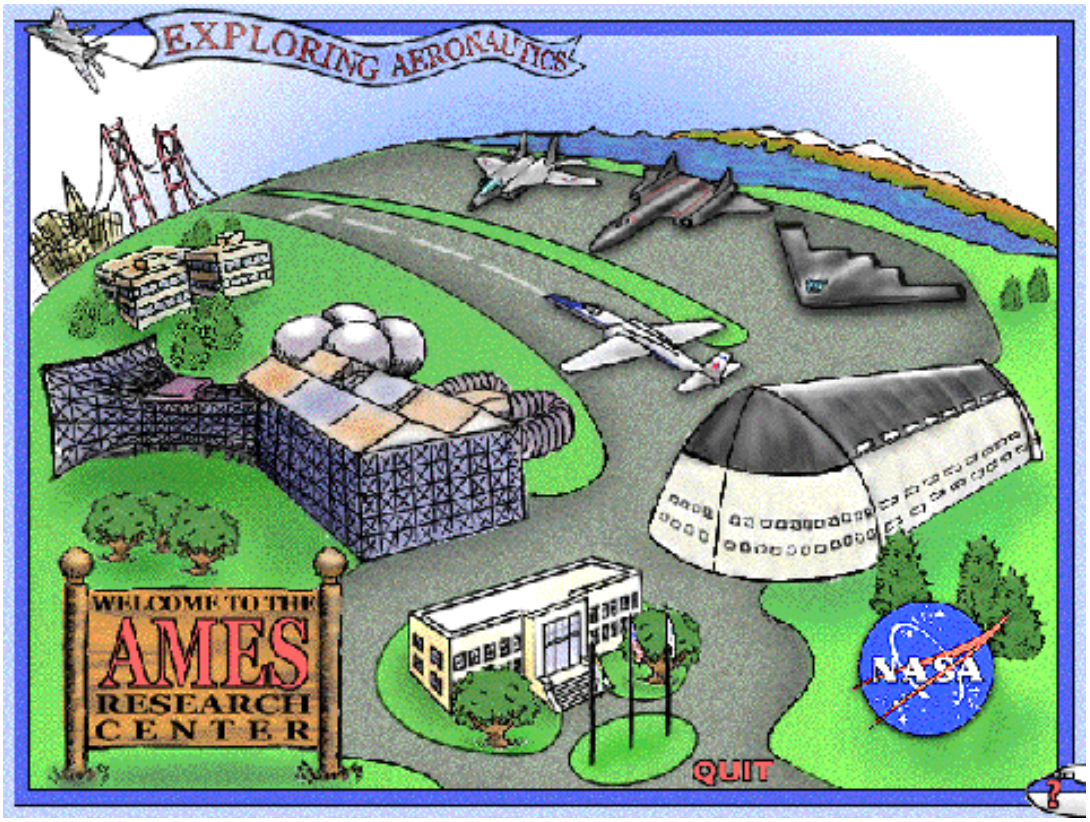
Exploring Aeronautics



Part III
Multimedia CD-ROM
and
Student Logbook

Multimedia CD-ROM and Student Logbook

Part III
of the Three-Part Series
Exploring Aeronautics

Produced by the
External Affairs Office
Ames Research Center
National Aeronautics and Space Administration
Moffett Field, CA

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EXPLORING AERONAUTICS

Part III

Section 1

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Section I Multimedia CD-ROM

Introduction

Welcome to **Multimedia CD-ROM and Student Logbook**, the third part of the NASA series **EXPLORING AERONAUTICS**. **Multimedia CD-ROM and Student Logbook** is meant to provide instructions on how to use the CD-ROM **EXPLORING AERONAUTICS** and to provide a student workbook for use in conjunction with the CD-ROM.

We hope that **Multimedia CD-ROM** will provide you with enough information to use the CD-ROM effectively. If not, please do not hesitate to contact the offices listed under Assistance.

Each section of the CD-ROM has accompanying worksheets and exercises in the **Student Logbook**. Teachers can pick and choose the worksheets that are most appropriate for their students' grade level, aeronautics background and interests. Keys for all exercises are also included.

We hope that you enjoy using these instructional materials!

Overview

Upon entering **EXPLORING AERONAUTICS**, students will view a brief introductory montage. To bypass this introduction, simply click the mouse.

After the introductory montage, a brief overview of each section is presented. The main screen then appears and audio directions are given. These directions indicate where each section of aeronautical information is located as well as how to access the information found therein. The sections include the following: The Resource Center, The Hangar, How an Airplane Flies, The Tools of Aeronautics and The Activity Center. See Navigation Map to note their locations. To return to the main screen at anytime, click on the NASA logo found in the lower left-hand corner of each menu bar or screen.

By clicking on the building nearest the three flagpoles students will be able to access The Resource Center that contains the "Glossary", the "History", and the "Web Sites and Books" subsections. The "Glossary" contains aeronautical terms, definitions and illustrations. "History" includes a timeline of aviation and aeronautical events. "Web Sites" is a listing of URL's for aeronautical sites, as well as a brief description of the type of information contained in that particular URL, suggested grade level usage, and correlation to the CD-ROM and its accompanying print material. The "Book List" contains a listing of aeronautical or aviation trade books appropriate for the fourth through sixth grade reading level.

A click on the The Hangar leads students to a listing of six unique aircraft. Click on each aircraft in the menu bar to view photos and QuickTime (c) movies of each airplane, as well as to examine each airplane's specifications.

To learn about the principles of flight, click on the airplane located on the runway. This takes students to the section How an Airplane Flies. Here they can learn more about the concept of "Lift"; how the "Four Forces" interact on an airplane; the importance of "Wing Shape" to different types of flight; the different "Parts" of an airplane; and an airplane's "Movement". The "Movement" subsection includes the motions of an airplane, the airplane's control surfaces and the movements these control surfaces affect.

Clicking on the wind tunnel will direct students to The Tools of Aeronautics. Here they will be introduced to four researchers who answer questions about their work. Each tool of aeronautics is demonstrated through video footage.

Perhaps the final subsection to visit should be the The Activity Center. Using the scientific method, students work as researchers to determine which airfoil shape will give the greatest amount of lift and the least amount of drag.

The **Student Logbook** contains student activity sheets for each section of the CD-ROM which can be used to demonstrate the student's acquisition and application of the skills, concepts and processes embedded in **EXPLORING AERONAUTICS**.

Navigation Map

Click on the NASA logo to return to the homepage.
Click on the nose of the airplane in lower right-hand corner to activate the Help Bar.

The Activity Center

Main Menu Homepage

How an Airplane Flies

The Tools of Aeronautics

The Resource Center

The Hangar

Technical Directions

System Requirements

Mac
- Macintosh with minimum of 8 MB memory and 5 MB of available RAM
- Operating System: OS 7.1 or greater
- Colors: Minimum 256 color monitor
- CD-ROM Drive: minimum double speed

PC
- PC compatible with minimum 8 MB memory and 5 MB of available RAM
- Operating System: Windows 3.1, Windows '95 or Windows NT
- Colors: Minimum 256 color monitor
- CD-ROM Drive: minimum double speed

Getting Started

Insert the **EXPLORING AERONAUTICS** CD-ROM into your CD-ROM player. The automatic start-up function will activate, and the CD-ROM will begin by displaying the introductory montage.

If the automatic start-up function is not activated, double-click on the **EXPLORING AERONAUTICS** icon to open the file folder. Choose the file that describes the computer system you are using by double-clicking on it. This will launch the program.

Key Features

The Homepage contains five sections which students can explore by clicking on the various locations specified in the Overview. Each subsequent screen contains a menu bar located along the left-hand side. Clicking on any of the icons will activate a subsection. To return to the Homepage, click on the NASA logo.

To quit the program from one of the subsections, click on the NASA logo to get to the Homepage, then click "QUIT."

Help

To activate the help bar, click on the nose of the airplane located in the lower right-hand corner of each screen. The airplane will extend and give you the following three choices: sound adjustment (speaker), navigation review (?) and the index (i). To adjust the sound, click on the speaker and then click on a number. The greater the number, the louder the sound. To review the navigation process, click on the question mark (?). To go to the index, click on the "i". The index is a textual breakdown of the information contained on the CD-ROM. Click on a topic and you will go directly to the subsection of the CD-ROM where that information is found.

Usage Suggestions

Although there are a variety of ways to integrate multimedia into an educational setting, below you will find a few suggestions for implementing **EXPLORING AERONAUTICS** in the classroom.

1. Use the CD-ROM in conjunction with a projection system (LCD panel, LCD projector or a large screen television monitor) to introduce the new aeronautical concepts before the students perform the student reading and note taking.

2. Use the CD-ROM in conjunction with a projection system (LCD panel, LCD projector or a large screen television monitor) to illustrate or reinforce the aeronautical concepts during the course of student reading and note taking.

3. If you have access to computers in a networked lab setting, load the CD-ROM onto the network server's hard drive and run the CD-ROM program throughout the lab. Have the students in a group setting engage in each section of the CD-ROM (using the **Student Logbook**) after each aeronautical topic is introduced. Save the Activity Center for one of the final sections because the students should be well versed in the concepts from the section How an Airplane Flies, as well as the scientific method before performing this activity.

4. If you have classroom access to computers, the computers can be used as learning center stations. Other stations can include a science lab, an activity from "Additional Student Activities and Projects," an informational reading and note taking station, an art activity, etc. All of these types of activities can be found in Part I **The Science of Flight** Instructional Unit, Part II **Integrating with Aeronautics** and Part III **Student Logbook.**

5. The CD-ROM can also be used as an independent learning station for enrichment. The student, using the **Student Logbook**, can navigate through the CD-ROM and record his/her responses and experiences in the **Student Logbook**.

Troubleshooting

Sound not playing

Make sure the volume on your computer is turned up (See your Windows or Macintosh operating system user's guide for information). Go to the Help Bar in the lower right-hand corner of the screen and click on the airplane's nose. "0" is no sound and "6" is the greatest volume. Remember to return the airplane to its original position by clicking on the nose before attempting to proceed.

Movies not playing smoothly

The speed of your computer, as well as the speed of your CD-ROM player, determines the quality of the movies and the accompanying sound. High-end computers will play the movies more smoothly. The slower the computer, the choppier the performance. Unfortunately, there is not much that can be done to improve this performance aspect of the CD-ROM.

Cannot find files

If the program won't start and an error message indicates that the CD-ROM cannot be found, make sure the CD-ROM is in your player, label side up, and that your CD-ROM player is properly installed.

Not enough memory to play movies

If you see this message on the screen, that means that you do not have enough free memory to run QuickTime (c) movies. You could have other software running that is using memory that this CD-ROM application needs. Try quitting all other applications and running only the CD-ROM. If this does not get a positive result, then check your system versus the system requirements of this CD-ROM.

Not enough memory to run the program

If you get this message when starting the program, you do not have enough free memory to run this CD-ROM. Shut down any other applications you are running and try again.

Inability to access certain sections of the CD-ROM

This could be a bug on the CD-ROM or a failed disk. If this should happen see Assistance and give us a call.

Assistance

If you are still having technical problems after reviewing Troubleshooting, give us a call at NASA Ames Research Center's Educator Resource Center 1-650-604-3574 or fax us at 1-650-604-3445 between 9:00 a.m. and 4:00 p.m. PST from Tuesday through Saturday.

EXPLORING AERONAUTICS

Part III

Section 2

Student Logbook

Table of Contents

Section 2 Student Logbook

Introduction

The **Student Logbook** provides exercises and worksheets to accompany the **EXPLORING AERONAUTICS** CD-ROM**.** Each section of the CD-ROM,

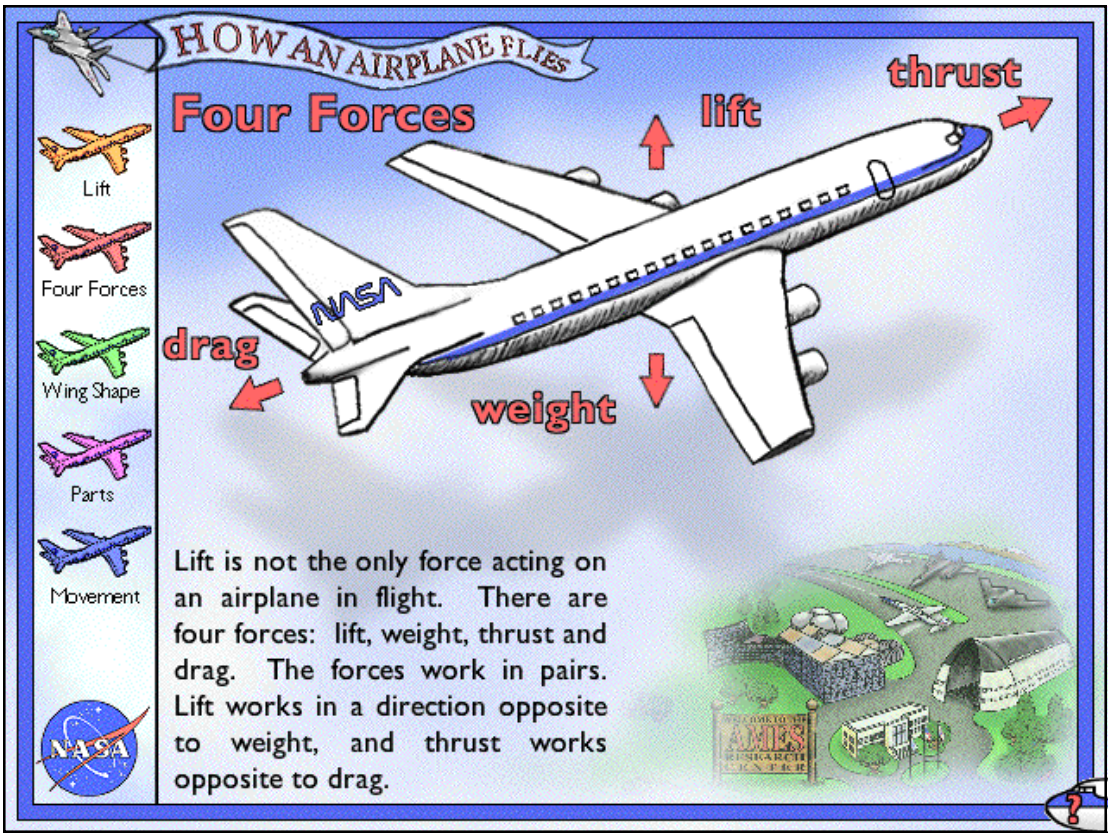
1. How an Airplane Flies
2. The Hangar
3. The Tools of Aeronautics
4. The Activity Center
5. The Resource Center

has a corresponding section in this **Student Logbook**. The worksheets can be used as follow-on or enhancement tools to reinforce the lessons learned on the CD-ROM. Alternatively, they can be used as assessment tools. All information needed to complete the worksheets can be found (with a little educational searching!) on the CD-ROM.

The keys for all worksheets can be found in the Answer Keys section.

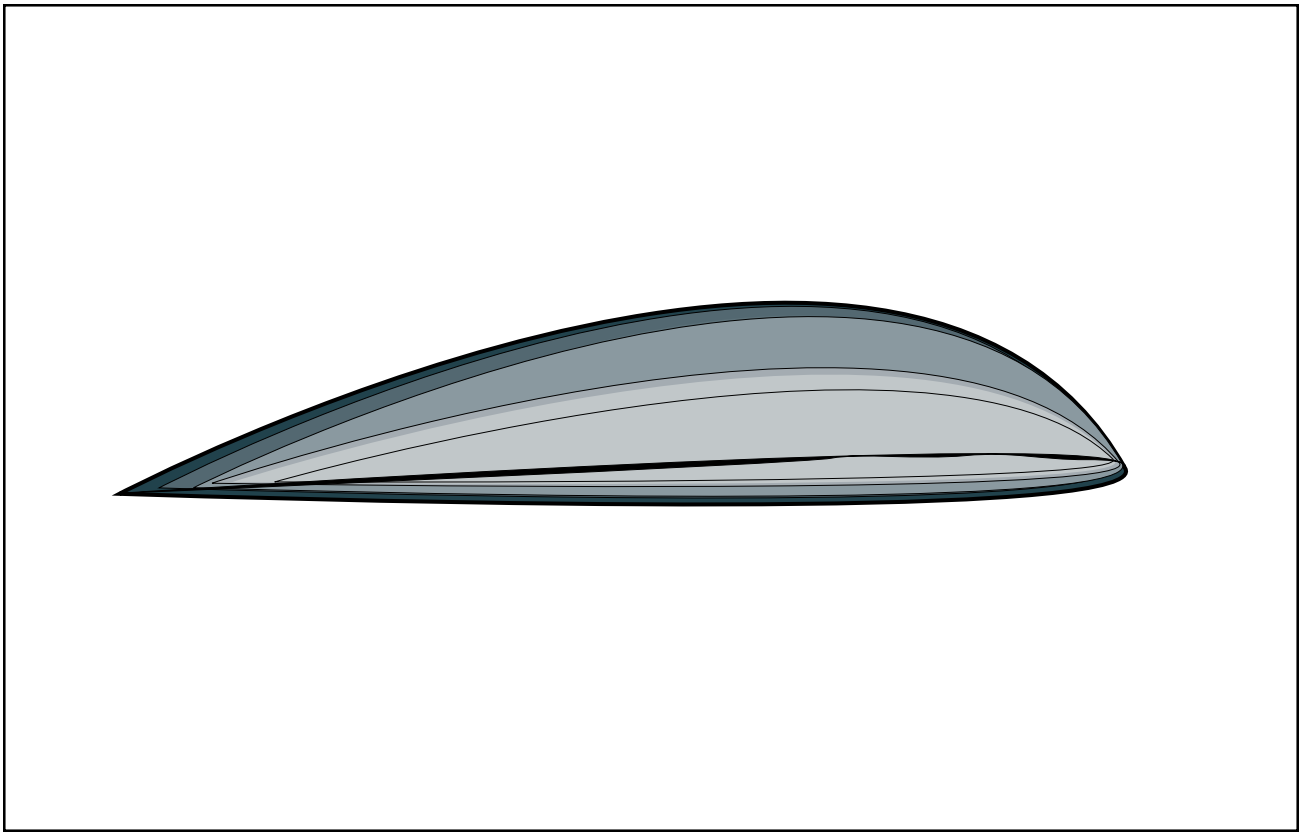
We hope that you and your students enjoy using the **Student Logbook**!

How an Airplane Flies



Directions: After you take off with the **EXPLORING AERONAUTICS** CD-ROM and reach your cruising altitude, set your course to How an Airplane Flies. As you fly through each subsection be sure to complete the questions at the end.

Lift



Directions: On the cross section of the wing above, label the following:

1. Show the airflow over and below and the wing;
2. Indicate which airflow is moving faster;
3. Label the low pressure area with an "L";
4. Label the high pressure area with an "H";
5. Draw an arrow showing the direction of lift.

Four Forces

Directions: Write the names of the four forces below and tell how they act on an airplane.

NAME OF THE FORCE	HOW IT ACTS ON AN AIRPLANE

Directions: The four forces that act on an airplane work in pairs. Below are the names of two of these forces. Give the names of the forces that work in the opposite direction.

Lift ⟷ _____

Thrust ⟷ _____

Wing Shape

Directions: After viewing "Wing Shape" on the CD-ROM, complete the chart below by drawing a picture of each wing shape and listing one important fact about each.

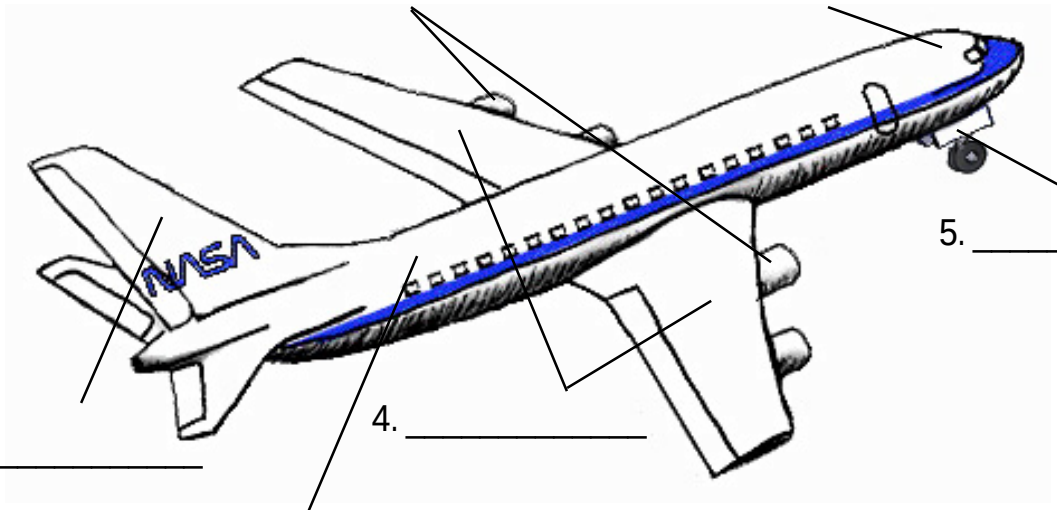
WING SHAPE	DRAWING	ONE FACT
STRAIGHT		
SWEEP-BACK		
FORWARD-SWEEP		

Wing Shape – *continued*

WING SHAPE	DRAWING	ONE FACT
OBLIQUE		
VARIABLE SWEEP		
DELTA		

Parts

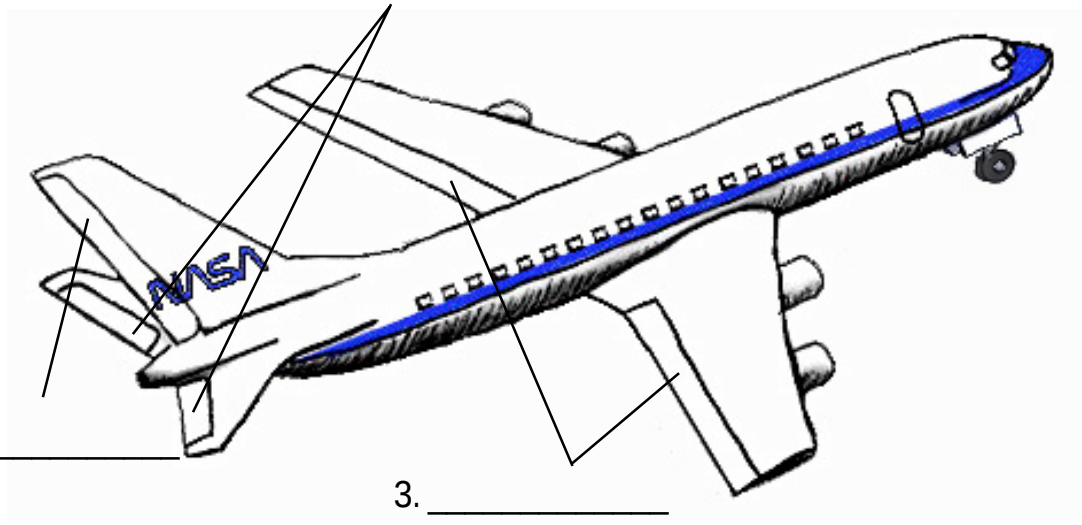
Directions: Label each part on the airplane below.



Control Surfaces

Directions: Label the control surfaces on the airplane below.

1. _____



2. _____

3. _____

Control Surfaces - *continued*

Directions: Complete the chart below by describing the motion that each control surface enables.

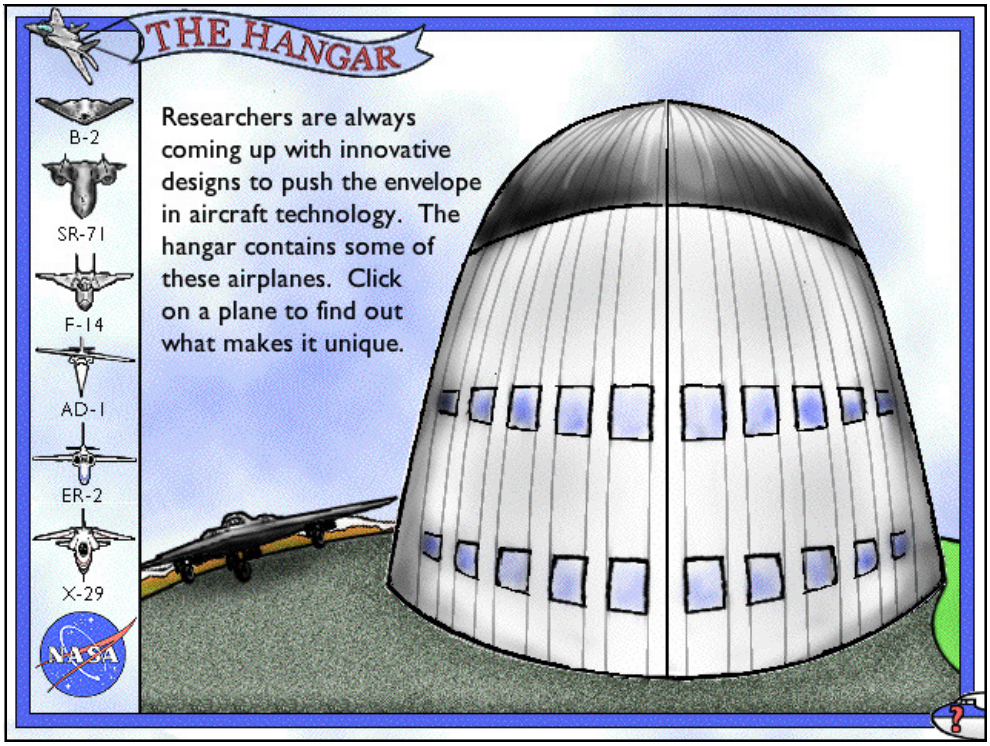
CONTROL SURFACE	DESCRIBE THE MOTION IT ENABLES
ELEVATORS	
AILERONS	
RUDDER	

Movement

Directions: Name three motions and describe the effect they have on the airplane.

NAME THE MOTION	DESCRIBE THE EFFECT IT HAS ON THE AIRPLANE

The Hangar



Directions: As you explore The Hangar make sure you read the specifications carefully. Be ready to help the pilots get their correct flight assignment. Also, be prepared to compare one airplane with another.

Pilot Clues

Directions: A group of pilots has been given flight assignments. Instead of being given the name of the airplane they have been assigned to fly, the pilots have been given a clue that describes their mission. The pilots must use the clues to determine which aircraft they must fly. Go to The Hangar section of the **EXPLORING AERONAUTICS** CD-ROM. Use the information you find in The Hangar to help the pilots select their airplane.

Clue 1: This flight assignment will have the pilot take off from an aircraft carrier and fly at different altitudes and speeds.

Airplane 1:

Clue 2: This flight assignment calls for the pilot to wear a pressurized suit. The pilot will be taking high-altitude photographs of a large area of land.

Airplane 2:

Clue 3: This flight assignment will take the pilot on a cross-country flight at high speed. The pilot will need to adjust the wings to save on fuel.

Airplane 3:

Pilot Clues - *continued*

Clue 4:	This flight assignment calls for the pilot to survey a large area in a short amount of time. The pilot will be flying at supersonic speeds at high altitudes. The delta wing design of the pilot's aircraft will help to cut down on the amount of drag.
Airplane 4:	

Clue 5:	This flight assignment calls for the pilot to carry a large payload and fly without being detected by radar.
Airplane 5:	

Clue 6:	This flight assignment will require the pilot to fly at Mach 1. The special wing design of the airplane will ensure that there is a smooth airflow over the wings as it increases speed from subsonic to supersonic.
Airplane 6:	

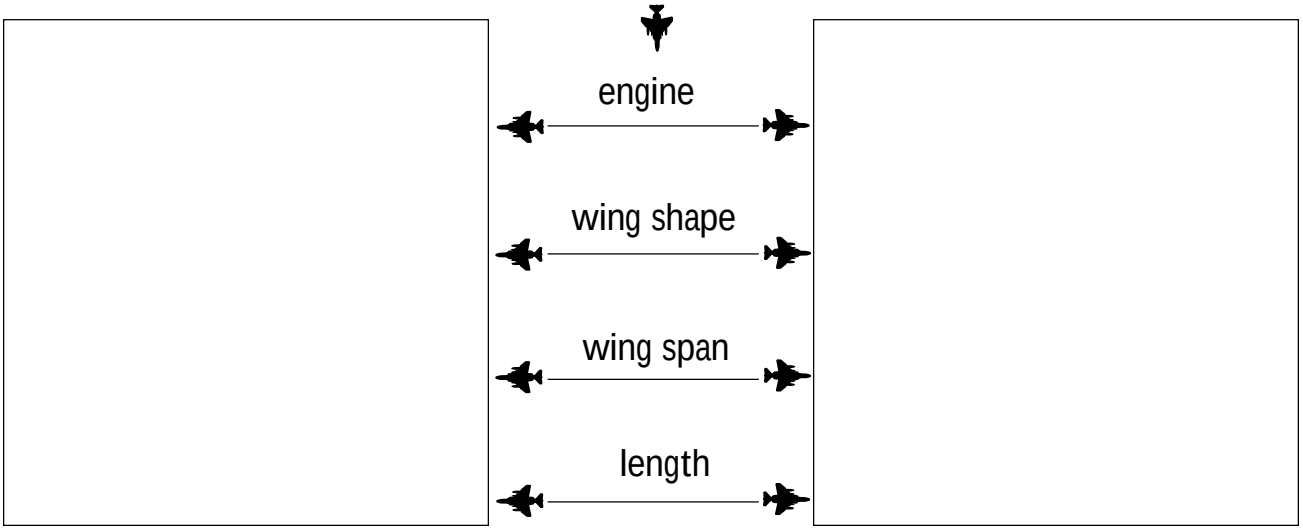
Make Your Own Comparison

How Are They Alike?

SR-71

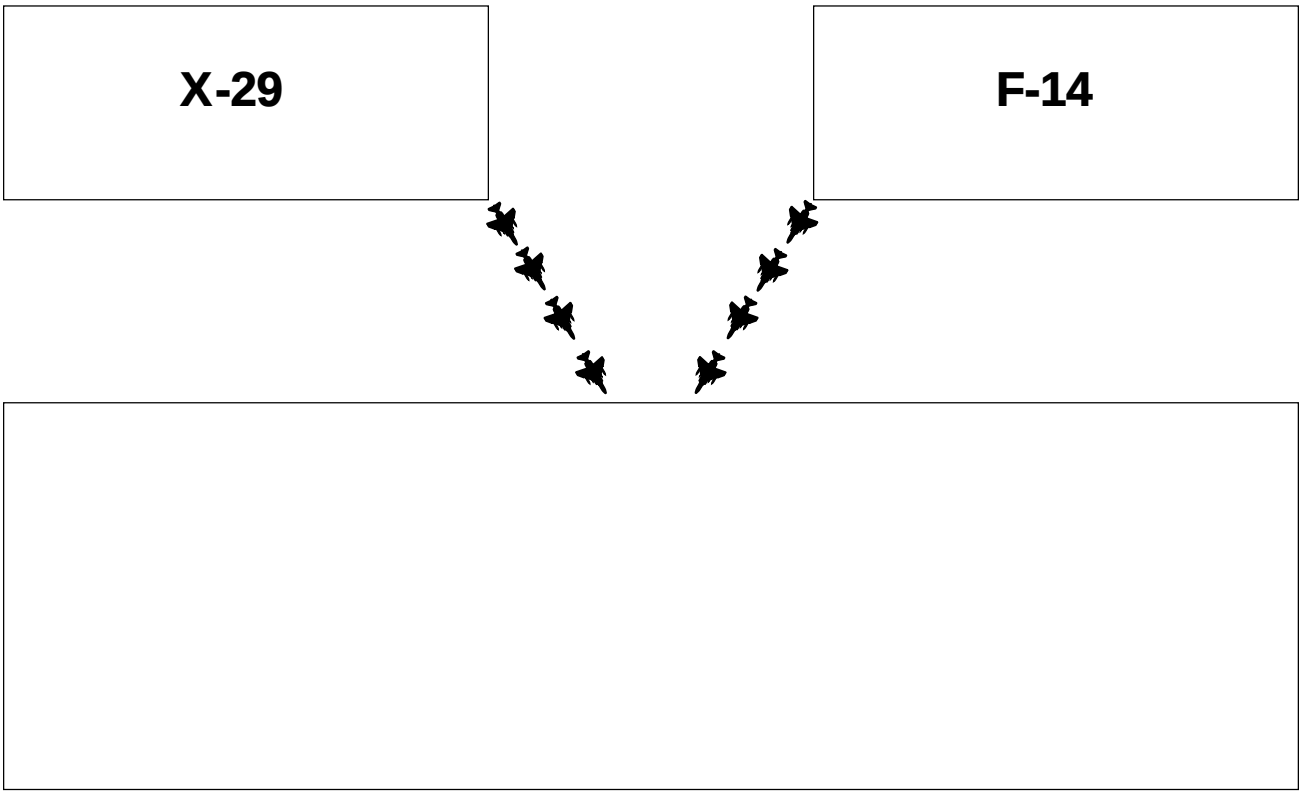
AD-1

In What Ways Are They Different?

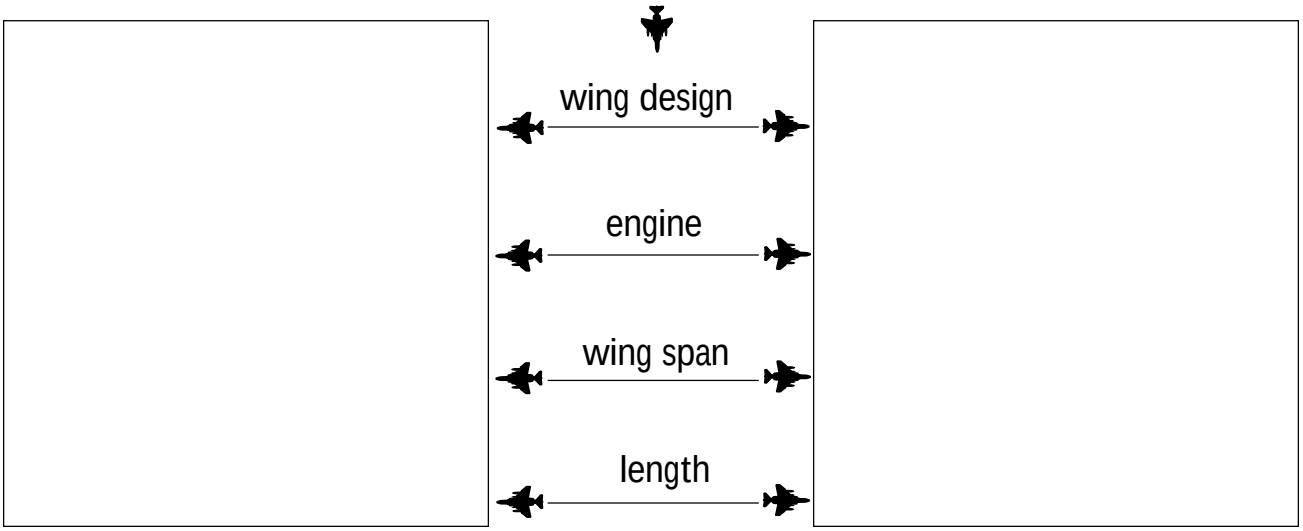


Make Your Own Comparison

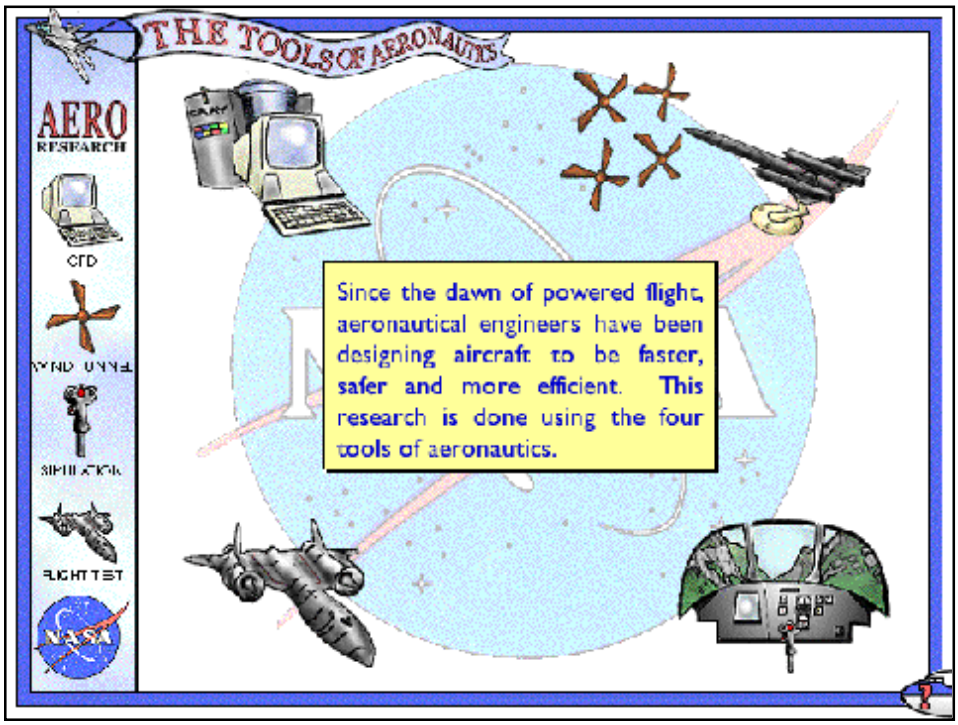
How Are They Alike?



In What Ways Are They Different?



The Tools of Aeronautics



Directions: Listen to each expert talk about his/her research work. Then, answer the questions.

Computational Fluid Dynamics
Listen to the Experts

Directions: View The Tools of Aeronautics section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about her work, answer the questions below using complete sentences.

1. Give the expert's job title and tell what she does in her job.

2. In your own words, explain what Computational Fluid Dynamics (CFD) is.

3. Explain why supercomputers are needed for this type of research.

4. How do the supercomputers display the results of the mathematical equations they solve?

Wind Tunnel
Listen to the Experts

Directions: View The Tools of Aeronautics section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about his work, answer the questions below using complete sentences.

1. Give the expert's job title and tell what he does in his job.

2. In your own words, explain how a wind tunnel works.

3. Name two measurements that are made in a wind tunnel.

4. Explain how computers are used with wind tunnels to do research.

Flight Simulation
Listen to the Experts

Directions: View The Tools of Aeronautics section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about her work, answer the questions below using complete sentences.

1. Give the expert's job title.

2. Tell what the simulator on the CD-ROM simulates.

3. In your own words, explain how flight simulators work.

4. Explain how computers are used with flight simulators to do research.

5. List three things an engineer can investigate in a flight simulator.

Flight Test
Listen to the Experts

Directions: View The Tools of Aeronautics section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about his work, answer the questions below using complete sentences.

1. Give the expert's job title and tell what he does in his job.

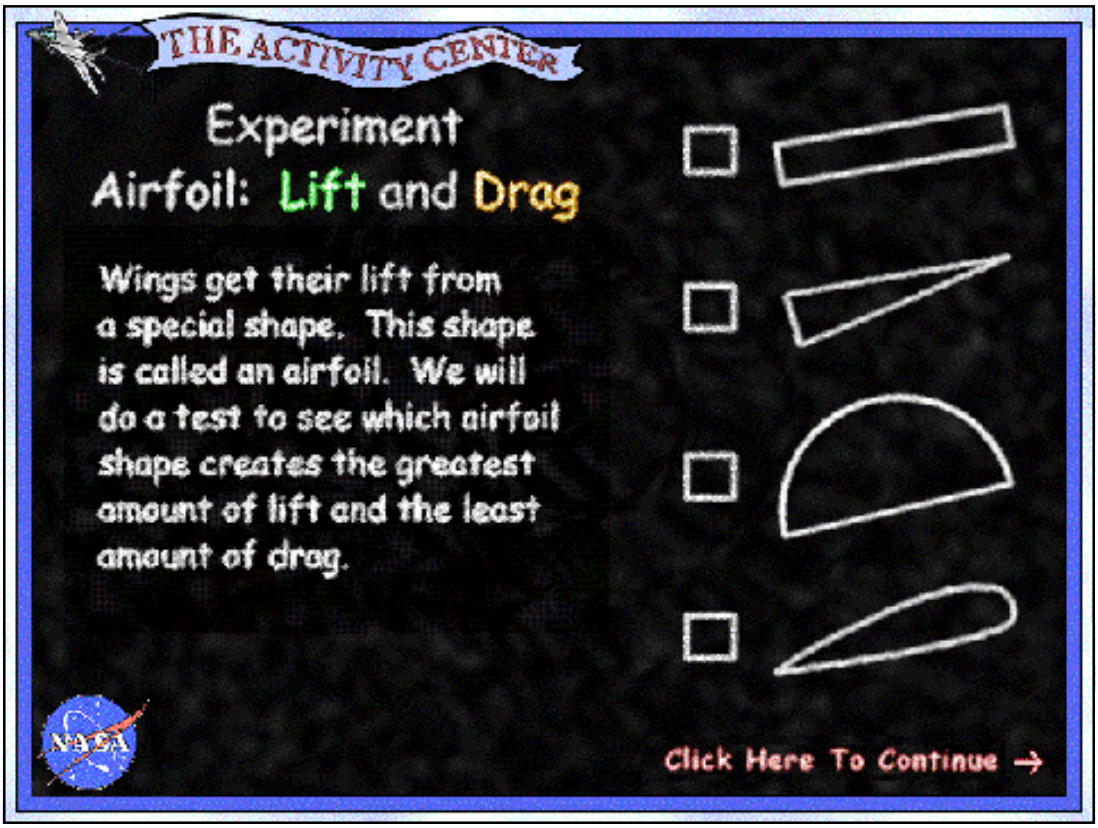
2. Name the two types of aircraft that can be tested during flight test.

3. In your own words, explain the role of a pilot in flight test. Tell what he does to test the airplane.

4. Explain how data is collected for flight test.

5. What is the purpose of flight test?

The Activity Center



Directions: Use the scientific method to help you determine which airfoil shape creates the greatest amount of lift and the least amount of drag.

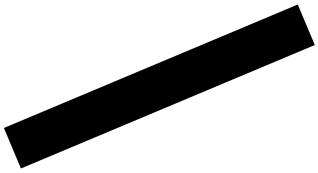
Experiment
Airfoil Lift and Drag

For many years, researchers at NASA have studied the way air moves around aircraft. They have stored much of this research data on supercomputers. Using this data and a computer we will conduct an experiment. Our experiment will show which airfoil shape will give the greatest amount of lift and the least amount of drag.

Follow each step of the scientific method below as you use the computer as a tool to help you do your experiment.

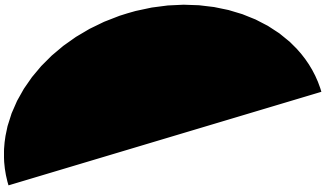
Step 1: Using what you have learned from the How an Airplane Flies section, circle the airfoil shape below that you think will give the greatest amount of lift and the least amount of drag.

A.

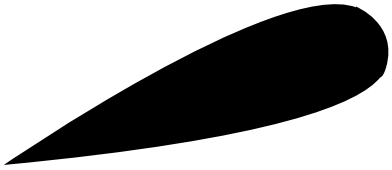


B.

C.



D.



Experiment - *continued*

Step 2: When using the scientific method, first write the question you want to have answered by the experiment.

Complete the question below:

Which _____shape will give the _____

amount of _____ and the _____

amount of drag?

Step 3: Write your hypothesis (the answer to the question) below.

I think that airfoil shape _____ will give the greatest

amount of lift and the least amount of drag because _____

_____

_____

_____

_____

Experiment - *continued*

Step 4: Design the Experiment

The experiment you will run with the help of data gathered by NASA's computers will be a simulation. The computer will simulate the air flowing around each airfoil shape. The computer will then calculate how much lift and drag the airfoil shape has.

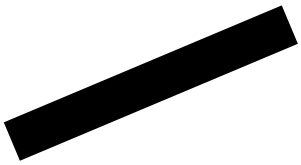
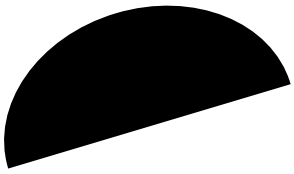
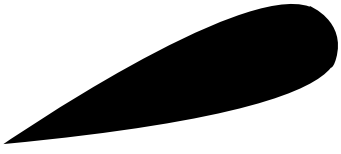
Step 5: Do the Experiment

Choose each airfoil shape by clicking on it. The computer will simulate the airflow. The data will be displayed for you to record.

Step 6: Organize and Analyze Your Results

Use the chart on the next page to record the results for each airfoil shape. On the lines next to each airfoil shape give your analysis of the results.

Experiment - *continued*
Data Chart

AIRFOIL SHAPE WITH AIRFLOW, LIFT AND DRAG	ANALYSIS
A. 	
B. 	
C. 	
D. 	

Experiment - *continued*

Step 7: Conclusion

Compare the results and write your conclusion on the lines below.

_____

_____

_____

_____

_____

_____

_____

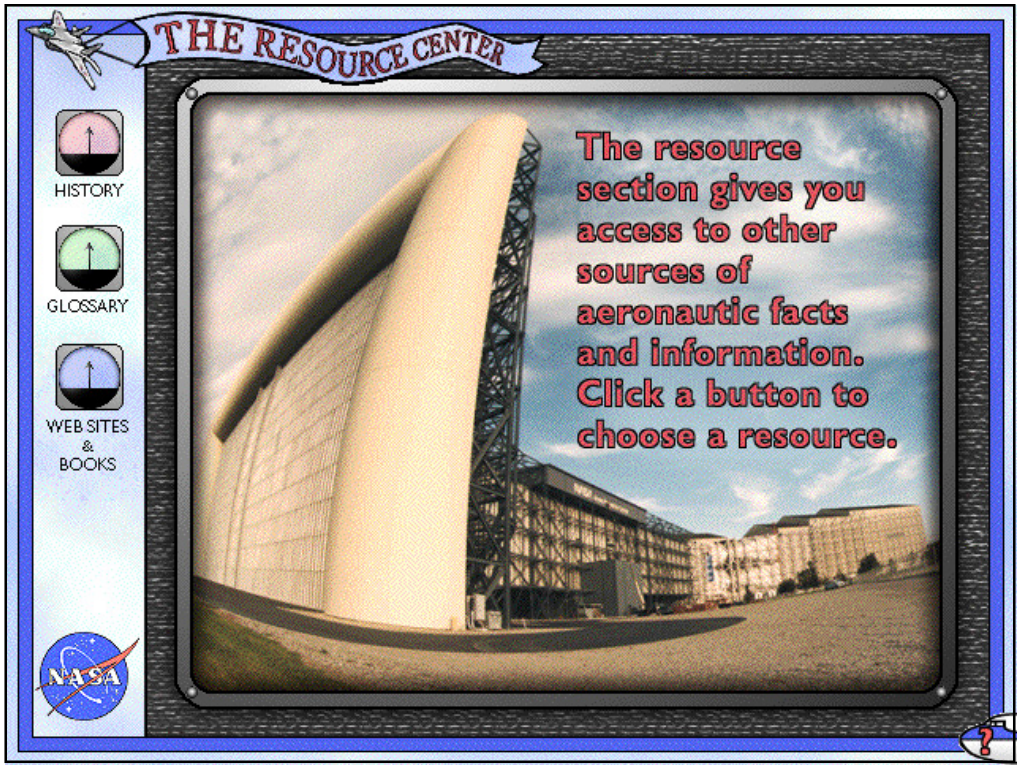
_____

_____

Step 8: Meet with your fellow researchers to discuss your findings and your conclusion.

Step 9: When you are ready to check your conclusion with the computer, click to continue.

The Resource Center



Directions: Explore the history of aeronautics in the "History" subsection of **The Resource Center** by using a history research activity sheet. Become more familiar with aeronautical vocabulary by doing some "Glossary" searches.

History Research

The following student worksheets can be utilized as individual, partner or small group fact searches using the **EXPLORING AERONAUTICS** CD-ROM:

The Firsts in Flight

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to answer the following questions about first-time events in the history of flight. Answer each question by writing the information in the blank.

_____ 1. The first engine-powered flight was performed by whom?

_____ 2. The first manned balloon was flown by the Montgolfiers in what year?

_____ 3. Who was the first African-American to pilot an airplane?

_____ 4. In 1881 Lilienthal piloted the first successful flights of what type of aircraft?

_____ 5. Name the man who made the first powered flight in Europe.

_____ 6. The first ornithopter was developed by Hargrave in what year?

_____ 7. Who was the first aviator to fly solo around the world in 1933?

_____ 8. Quimby was the first female pilot to cross what channel in 1912?

_____ 9. The first parachute descent was done by Garnerin in what year?

_____ 10. This aviator became the first female commercial airline captain in 1968.

The People of Flight

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to answer the following questions about the people who made tremendous contributions to the field of aeronautics. Write the name of the individual described in the blank.

_____ 1. This person invented the four stroke engine.

_____ 2. This German developed the great airships which flew in the early 1900s.

_____ 3. This Italian created early drawings of helicopters, but never built or flew them.

_____ 4. This scientist developed the blunt nose principle.

_____ 5. This scientist made many contributions to the development of aeronautical principles in the late 1800s.

_____ 6. This man is credited with being the "Father of Naval Aviation."

_____ 7. This woman was a female glider test pilot for the Germans during WWII.

_____ 8. This researcher at NASA Ames Research Center developed the sweepback, forward-sweep and oblique wing designs.

_____ 9. This pioneer researcher invented the airfoil.

_____ 10. This aviation pioneer experimented in rocketry.

Dates in the History of Flight

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to find the year in which the events described below happened. Write the year in the blank.

_____ 1. The Supersonic Airliner, *Concorde*, flew its maiden flight.

_____ 2. Charles Lindbergh made his historic solo flight across the Atlantic Ocean.

_____ 3. Louis Bleriot made his flight across the English Channel.

_____ 4. Sikorsky built the first practical, single-rotor helicopter.

_____ 5. The Russian satellite, *Sputnik*, was launched.

_____ 6. The space shuttle was first launched.

_____ 7. Whittle invented the jet engine.

_____ 8. Airplane cabins were pressurized.

_____ 9. The first human-powered aircraft was flown.

_____ 10. Yeager broke the sound barrier.

The Aircraft

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to answer the following questions. Determine the vehicle that is described and write its name in the blank.

_____ 1. The British and French governments built and continue to fly this supersonic airliner.

_____ 2. The explosion of this dirigible ended the Age of Great Airships.

_____ 3. This satellite was launched by the U.S.S.R. in 1957 and began the "Space Race."

_____ 4. This airplane featured the first fully pressurized cabin in 1940.

_____ 5. This airplane was the first jumbo jet and was flown in 1970.

_____ 6. This airplane was designed to land and take off from the water and featured a Curtiss water-cooled engine.

_____ 7. This airplane was designed for long-range reconnaissance. It flew for the first time in 1966.

_____ 8. This airplane is considered by aviation experts to be one of the most important commercial transport planes of its time.

_____ 9. This airplane was used to fly across the English Channel in 1909 by its pilot and designer.

_____ 10. This experimental airplane design will be the next generation space plane.

Technology and Aeronautics

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to find the year when the specified technology was developed in the field of Aeronautics. Write the year in the blank next to the description.

_____ 1. The supercomputer, Cray-2, is developed to compute large numbers of mathematical equations for new aircraft designs.

_____ 2. The sweepback wing design is perfected by Jones.

_____ 3. The jet engine is invented by Whittle.

_____ 4. Whitcomb designs the "wasp shape" fuselage.

_____ 5. The German dirigible, *Hindenburg*, is destroyed.

_____ 6. The blunt nose principle is developed which helps in the design of the Mercury capsule.

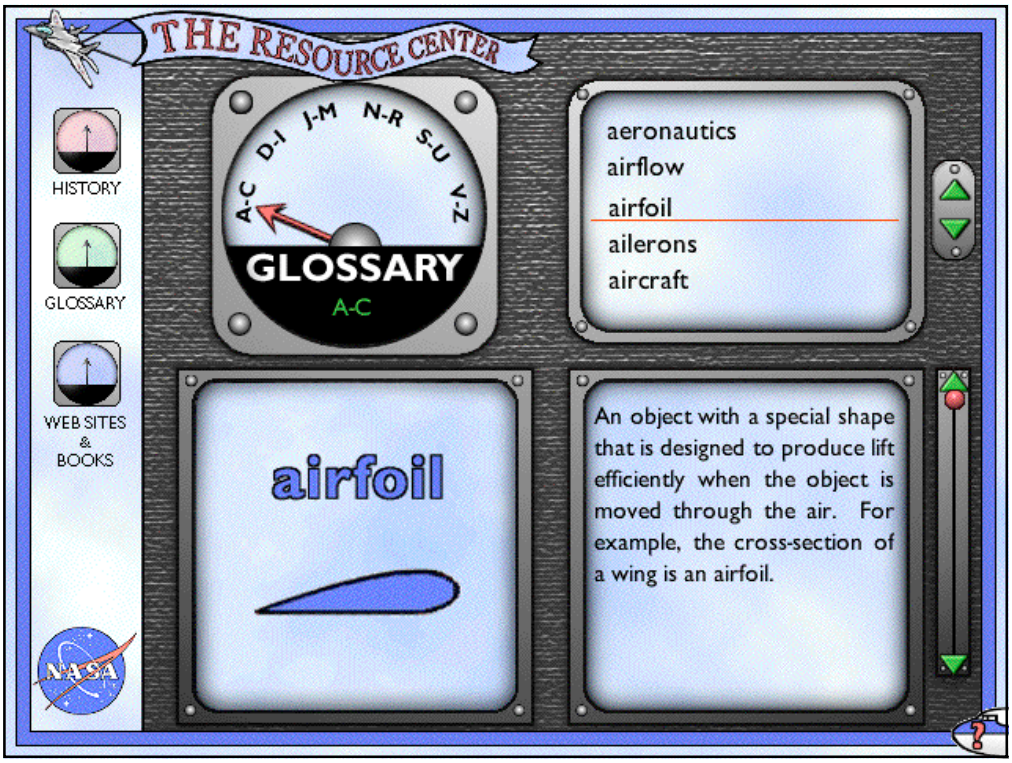
_____ 7. Rodert solves the deicing problem.

_____ 8. The "stressed skin" concept is developed by Rohrbach to decrease drag.

_____ 9. The boundary layer concept is developed which leads to improved aircraft design for supersonic flight.

_____ 10. Phillips' early research on the airfoil forms the basis for understanding how wings work.

Glossary Activities



Glossary Search: Compound Words

A compound word is a combination of two or more words. Some compound words can be formed by putting the two smaller words together like *airline.* We connect the two smaller words *air* and *line* to form a new word: airline. Some compound words actually appear as two separate words, yet when these two separate words are placed next to each other they form a new meaning. Consider the two words *trailing* and *edge.* One meaning of the word *trailing* is *to follow along behind.* One meaning of the word *edge* is *a line where an object or area begins or ends.* When these two words are used next to each other they take on a whole new meaning: *the thin, rear edge of a wing.*

Directions: Use the "Glossary" subsection of **EXPLORING AERONAUTICS** CD-ROM, your Aeronautics Glossary and a dictionary to match the aeronautical compound word below with its correct definition.

streamline airfoil forward-sweep leading edge undercarriage

_____ 1. a wing or propeller designed to give lift

_____ 2. the landing gear located underneath the fuselage

_____ 3. the front part of a wing

_____ 4. to shape an object to allow air to flow smoothly around it

_____ 5. a wing which is slanted toward the front of the aircraft

Word Hunt

Directions: View the **EXPLORING AERONAUTICS** CD-ROM. Use the "Glossary" subsection to help find the word or words described by each clue.

1. There are three abbreviations in the "Glossary" subsection. Find all three abbreviations and tell what each letter stands for.

Abbreviation	Word each letter stands for
A. _____	
B. _____	
C. _____	

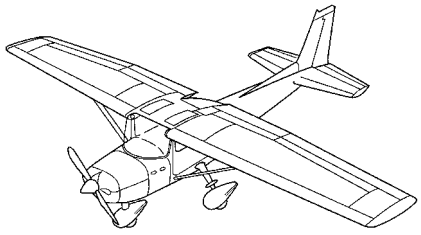
Word Hunt - *continued*

2. The "Glossary" subsection has three aeronautical terms that use the word "axis" with one other word. List them below. Then, on the airplane diagram draw in each axis and label it.

A. _____ axis

B. _____ axis

C. _____ axis



3. The "Glossary" subsection has four aeronautical terms that use the word "of". List them below.

A. _____

B. _____

C. _____

D. _____

4. The "Glossary" subsection has two aeronautical terms that use the word "motion". List them below.

A. _____ motion

B. _____ motion

Word Hunt - *continued*

5. There are four aeronautical terms in the "Glossary" subsection that have the suffix "-sonic". List them below in their proper order from slowest to fastest.

A. _____sonic

B. _____sonic

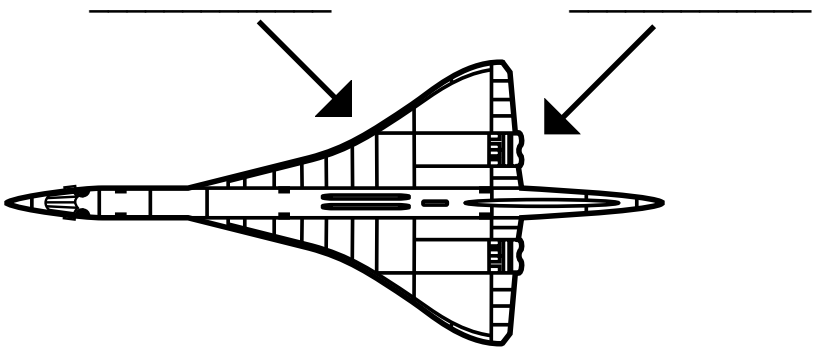
C. _____sonic

D. _____sonic

6. There are two aeronautical terms in the "Glossary" subsection that use the word "edge" as their second word. List the two terms. On the airplane below, label the edges.

A. _____ edge

B. _____ edge



7. List the five aeronautical terms in the "Glossary" subsection that have the word "air" in them.

A. _____

B. _____

C. _____

D. _____

E. _____

Word Hunt - *continued*

8. List ten aeronautical terms from the "Glossary" subsection that name parts found on an aircraft.

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

J. _____

Prefixes

A prefix is added to the front of a root word or base word. The meaning of a root word is changed by the prefix that is added. Review the meanings of the prefixes below.

aero	=	air	trans	=	across, beyond
bi	=	two	di	=	twice
sub	=	under, below	ac	=	to, toward
de	=	from, down, away	mono	=	one

Directions: Find one example of an aeronautical vocabulary word from the "Glossary" subsection that uses each prefix.

aero-

_____

bi-

_____

sub-

_____

trans-

_____

de-

_____

di-

_____

ac-

_____

mono-

_____

Where in the World Did *THIS* Word Come From?

Many of the words that we use today came from other languages used a long time ago. These old words hold the key to the modern meaning of a word. Many of the aeronautical vocabulary words found in the "Glossary" subsection come from the French language. This is explained by the fact that many early aeronauts were French (F). Other aeronautical words come from Latin (L), Greek (G), Italian (I) and Middle English (ME).

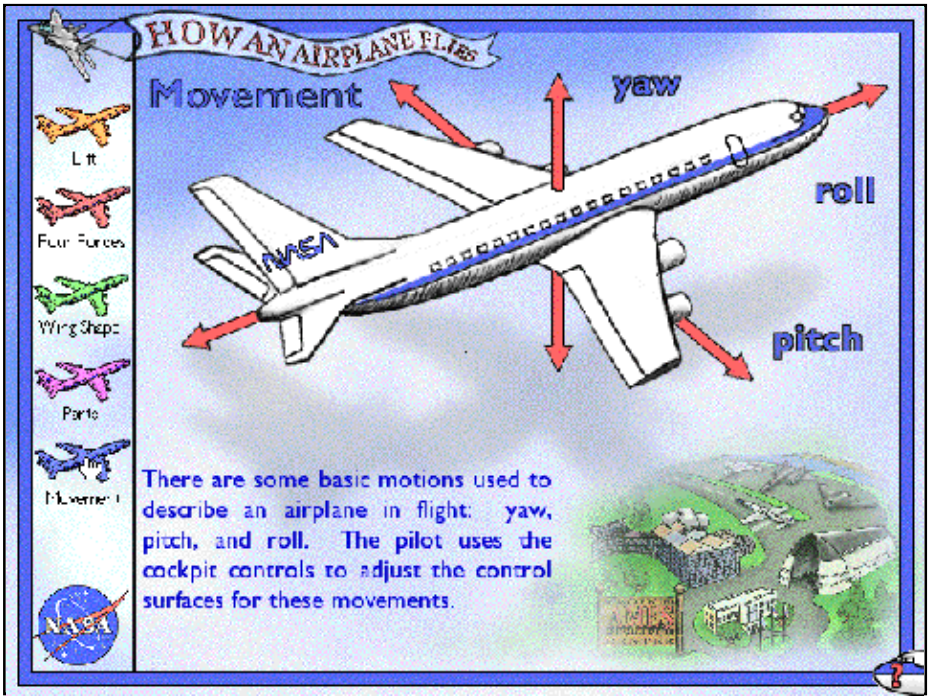
Directions: Complete the chart on the next page by taking a look at each word on the left and its meaning. In the blank on the right fill in the modern aeronautical word we use today that has nearly the same meaning. Use the spelling as well as the meaning of the word to find clues. Use your dictionary or the "Glossary" subsection of the **EXPLORING AERONAUTICS** CD-ROM to help you.

Where in the World Did *THIS* Word Come From? - *continued*

Foreign Word	Meaning	Modern Word
EMPENNER	TO FEATHER AN ARROW (F)	
REGIMIN	CHARACTERISTIC BEHAVIOR (L)	
SUPER SONUS	ABOVE SOUND (L)	
RECONOISSANCE	TO RECOGNIZE (F)	
VELOX	QUICK (L)	
AERODYNAMIQUE	AER(F) = AIR DYNAMIKOS(G) = POWERFUL	
ROTHER	TO PADDLE (ME)	
AEROPLANE	AER(F) = AIR PLANE(F) = FLAT, LEVEL	
TURBULENTUS	CONFUSION (L)	
AILE	WINGS (F)	
CAMBRE	CURVED (F)	
PILOTA	TO STEER (I)	

Answer Keys

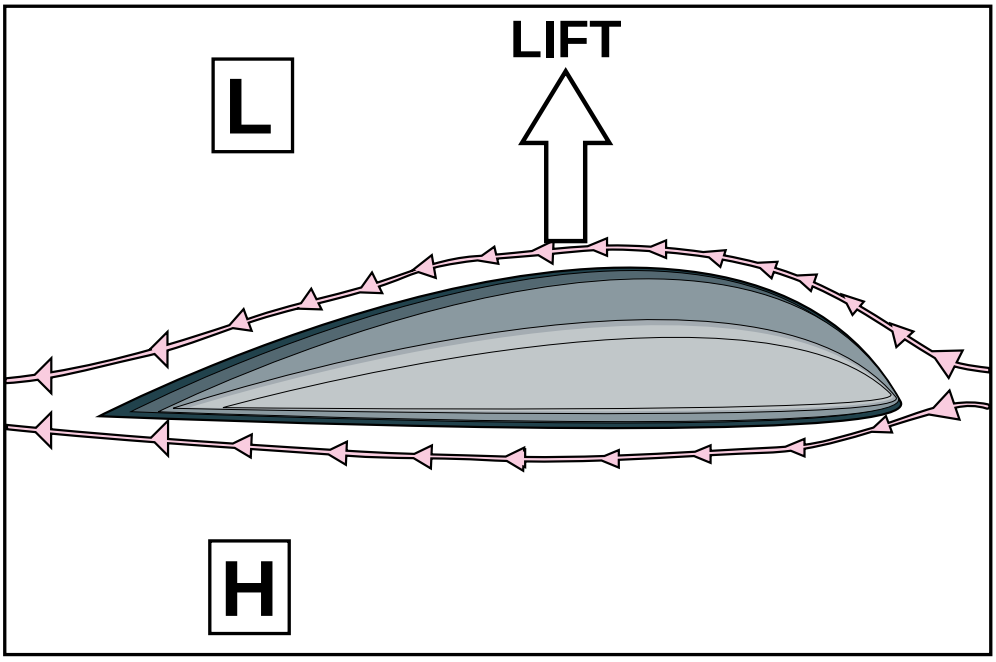
Answer Keys for How an Airplane Flies



Directions: After you take off with the **EXPLORING AERONAUTICS** CD-ROM and reach your cruising altitude, set your course to How an Airplane Flies. As you fly through each subsection be sure to complete the questions at the end.

Answer Key for "Lift"

AIRFLOW IS FASTER OVER THE TOP OF THE WING
THUS THE **LOWER** AIR PRESSURE



AIRFLOW IS SLOWER UNDERNEATH THE WING THEREFORE
THE AIR PRESSURE IS GREATER/**HIGHER**

Directions: On the cross section of the wing above, label the following:

1. Show the airflow over and below and the wing;
2. Indicate which airflow is moving faster;
3. Label the low pressure area with an "L";
4. Label the high pressure area with an "H";
5. Draw an arrow showing the direction of lift.

Answer Key for "Four Forces"

Directions: Write the names of the four forces below and tell how they act on an airplane.

NAME OF THE FORCE	HOW IT ACTS ON AN AIRPLANE
LIFT	PUSHES AIRPLANE AWAY FROM EARTH
WEIGHT	PULLS AIRPLANE TOWARDS EARTH
THRUST	PROPELS AIRPLANE FORWARD
DRAG	RESISTANCE THAT SLOWS AIRPLANE MOTION

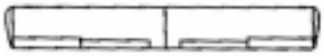
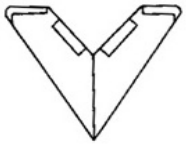
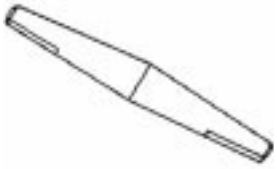
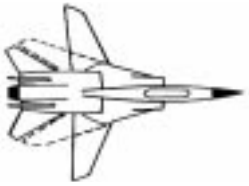
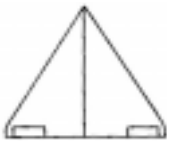
The four forces that act on an airplane work in pairs. Below are the names of two of these forces. Give the name of the forces that work in the opposite direction.

Lift ⟷ **Weight**

Thrust ⟷ **Drag**

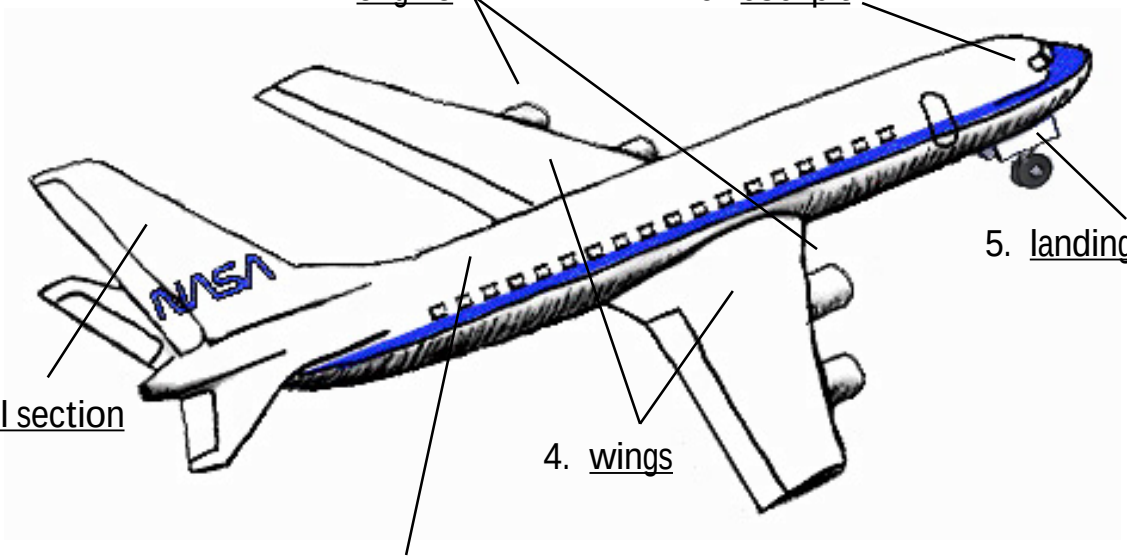
Answer Key for "Wing Shape"

Directions: After viewing "Wing Shape" on the CD-ROM, complete the chart below by drawing a picture of each wing shape and listing one important fact about each.

WING SHAPE	DRAWING	ONE FACT
STRAIGHT		Used on low-speed airplanes such as small private airplanes and gliders. Gives good lift at low speed, lots of drag at fast speed.
SWEEP-BACK		Used to delay formation of shock waves on airplanes at high subsonic speeds. Usually found on airliners and jets.
FORWARD-SWEEP		Design was tested on X-29. Reduces drag at transonic speed. Gives pilot better control at a high angle of attack.
OBLIQUE		Used on the AD-1 research aircraft. Wing pivots from perpendicular to fuselage at slow speed to a 60-degree angle at fast speed. Oblique angle of wing reduces drag. Gives increased speed and longer range which saves on fuel.
VARIABLE SWEEP		Wing moves from sweepback to delta position during flight. Sweepback position gives more lift and control during takeoff and landing. Delta flies more efficiently at fast speeds. Used on F-14.
DELTA		Sweepback leading edge with straight trailing edge. Good for smooth supersonic flight. Needs long runway because it has a fast landing speed. SR-71 uses this wing design.

Answer Key for "Parts"

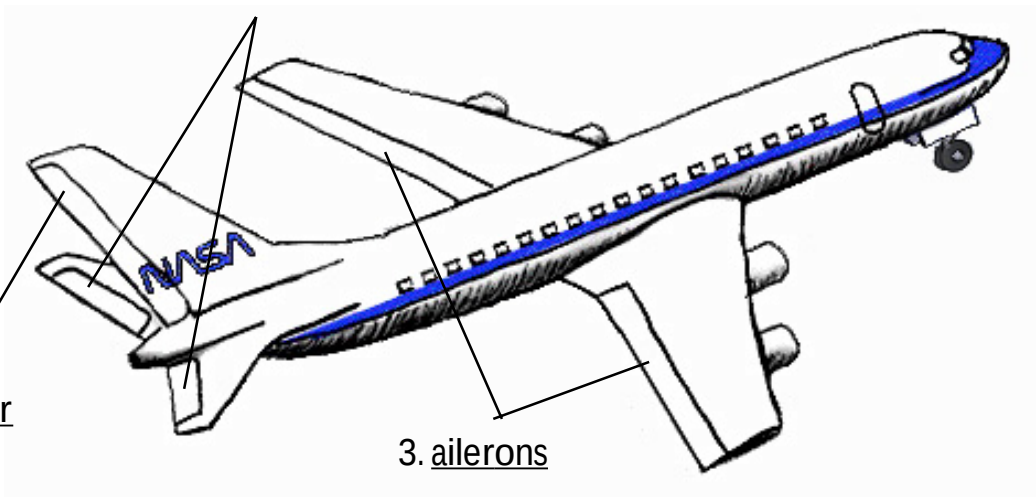
Directions: Label each part on the airplane below.



1. engine
2. tail section
3. fuselage
4. wings
5. landing gear
6. cockpit

Answer Key for "Control Surfaces"

Directions: Label the control surfaces on the airplane below.



Answer Key for "Control Surfaces"

continued

Directions: Complete the chart below by describing the motion that each surface enables.

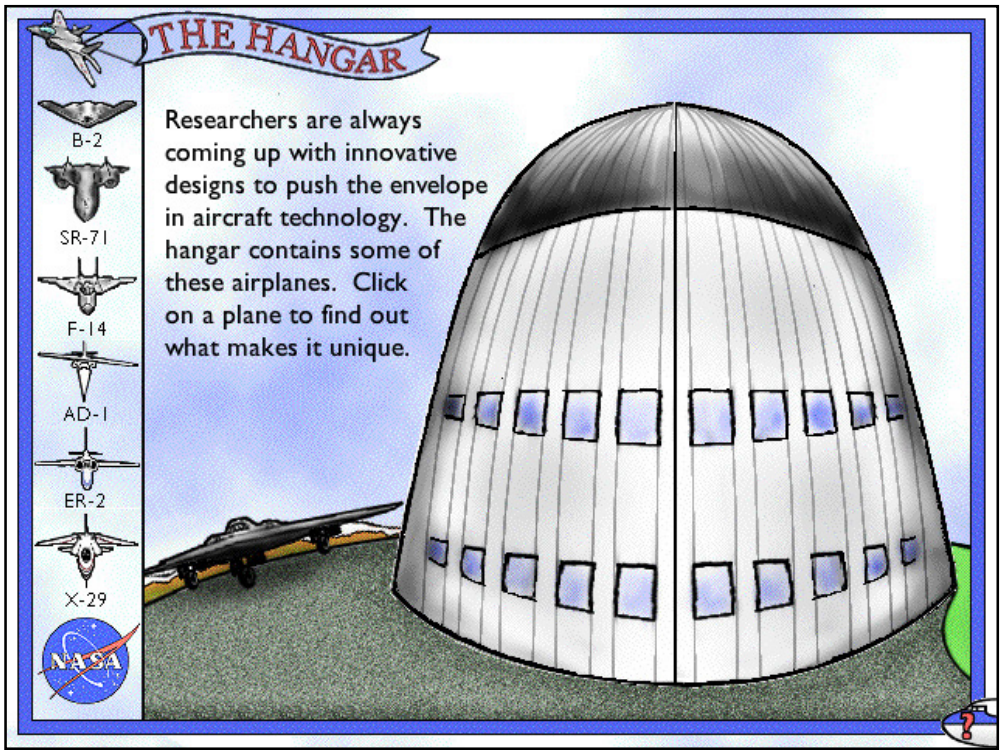
CONTROL SURFACE	DESCRIBE THE MOTION IT ENABLES
ELEVATORS	PITCH: NOSE MOVES UP OR DOWN
AILERONS	ROLL: ONE WING TIP MOVES UPWARD AS THE OTHER MOVES DOWNWARD
RUDDER	YAW: NOSE MOVES LEFT OR RIGHT

Answer Key for "Movement"

Directions: Name three motions and describe the effect they have on the airplane.

NAME THE MOTION	DESCRIBE THE EFFECT IT HAS ON THE AIRPLANE
YAW	NOSE OF THE AIRPLANE MOVES LEFT OR RIGHT (AROUND VERTICAL AXIS)
PITCH	NOSE MOVES UP OR DOWN (AROUND LATERAL AXIS)
ROLL	ONE WING TIP MOVES UPWARD AS THE OTHER WING TIP MOVES DOWNWARD (AROUND LONGITUDINAL AXIS)

Answer Keys for The Hangar



Directions: As you explore The Hangar make sure you read over the specifications carefully. Be ready to help the pilots get their correct flight assignment. Also, be prepared to compare one airplane with another.

Answer Key for "Pilot Clues"

Directions: A group of pilots has been given flight assignments. Instead of being given the name of the airplane they have been assigned to fly, the pilots have been given a clue that describes their mission. The pilots must use the clues to determine which aircraft they must fly. Go to The Hangar section of the **EXPLORING AERONAUTICS** CD-ROM. Use the information you find in The Hangar to help the pilots select their airplane.

Clue 1:	This flight assignment will have the pilot take off from an aircraft carrier and fly at different altitudes and speeds.
Airplane 1:	*F-14*

Clue 2:	This flight assignment calls for the pilot to wear a pressurized suit. The pilot will be taking high-altitude photographs of a large area of land.
Airplane 2:	*ER-2*

Clue 3:	This flight assignment will take the pilot on a cross-country flight at high speed. The pilot will need to adjust the wings to save on fuel.
Airplane 3:	*AD-1*

Answer Key for "Pilot Clues"
continued

Clue 4:	This flight assignment calls for the pilot to survey a large area in a short amount of time. The pilot will be flying at supersonic speeds at high altitudes. The delta wing design of the pilot's aircraft will help to cut down on the amount of drag.
Airplane 4:	*SR-71*

Clue 5:	This flight assignment calls for the pilot to carry a large payload and fly without being detected by radar.
Airplane 5:	*B-2*

Clue 6:	This flight assignment will require the pilot to fly at Mach 1. The special wing design of the airplane will ensure that there is a smooth airflow over the wings as it increases speed from subsonic to supersonic.
Airplane 6:	*X-29*

Answer Key for "Make Your Own Comparison"

How Are They Alike?

SR-71	AD-1

- Both use the same principles of flight
- Both are designed for long-range flight
- Both have wings

In What Ways Are They Different?

turbojets with afterburners	engine	turbojet
delta	wing shape	oblique
16.94 meters	wing span	9.7 meters
32.74 meters	length	12.12 meters

Answer Key for "Make Your Own Comparison"

continued

How Are They Alike?

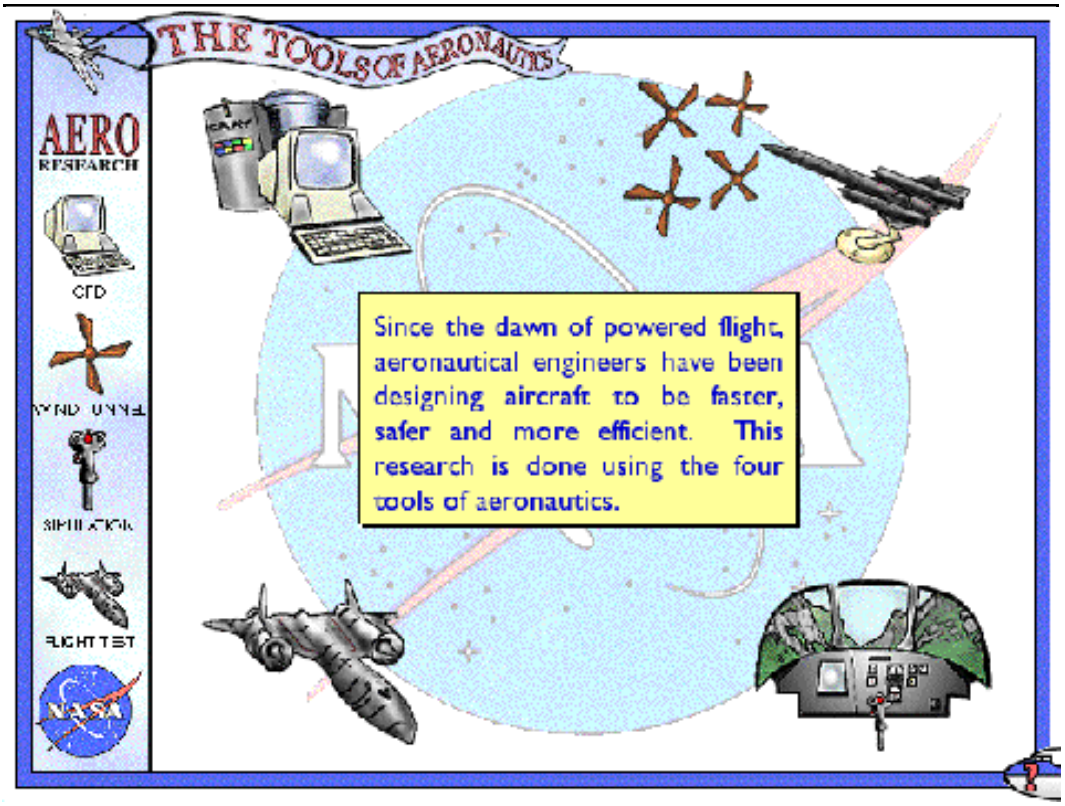
X-29	F-14

- Both are supersonic aircraft
- Both use turbojets
- Both have sweep wings

In What Ways Are They Different?

forward-sweep	wing design	variable sweep
turbojet	engine	turbojet with afterburners
8.24 meters	wing span	11.55 meters
14.58 meters	length	18.89 meters

Answer Key for The Tools of Aeronautics



Directions: Listen to each expert talk about his/her research work. Then, answer the questions.

Answer Key for "Computational Fluid Dynamics"

Directions: View **The Tools of Aeronautics** section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about her work, answer the questions below using complete sentences.

1. Give the expert's job title and tell what she does in her job.

   Research Scientist. She tests advanced supersonic aircraft and aircraft that fly at high angles of attack. She also develops new methods for CFD in the design and testing of wings.

2. In your own words, explain what Computational Fluid Dynamics (CFD) is.

   A study of aircraft dynamics using complex mathematical equations to describe and predict how an aircraft responds to the air flowing around it.

3. Explain why supercomputers are needed for this type of research.

   The mathematical equations are so difficult and complex that it would take too long for people to do.

4. How do the supercomputers display the results of the mathematical equations they solve?

   The supercomputers show the results of the mathematical equations by creating a graphic or picture with colored lines to show the airflow.

Answer Key for "Wind Tunnel"

Directions: View the **The Tools of Aeronautics** section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about his work, answer the questions below using complete sentences.

1. Give the expert's job title and tell what he does in his job.

   Research Engineer. He tests models in the wind tunnel.

2. In your own words, explain how a wind tunnel works.

   A wind tunnel is a tube or a tunnel in which a model of a plane or part of a plane is mounted. Air is blown around it and measurements are taken. Large fans blow the air through the tunnel.

3. Name two measurements that are made in a wind tunnel.

   Forces acting on the model, such as lift force and drag force, are measured. Air pressures along the model and airflow around the model are all measured.

4. Explain how computers are used with wind tunnels to do research.

   Special sensors are placed on the model which take measurements. The computer inputs those measurements as data. The computer then displays the data for researchers to analyze.

Answer Key for "Flight Simulation"

Directions: View **The Tools of Aeronautics** section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about her work, answer the questions below using complete sentences.

1. Give the expert's job title.

   Research and Operations Manager for flight simulators.

2. Tell what a flight simulator simulates.

   It acts just like an airplane in flight and reacts to the pilot's controls. The cockpit is a precise replica of the aircraft being tested.

3. In your own words, explain how simulators work.

   The pilot works the controls in the simulator cockpit.The computer controls the motion system that moves the cab according to the pilot's commands.Together with the motion, sound system and visuals, the computer creates the illusion of real flight.

4. Explain how computers are used with flight simulators to do research.

   Computers control the motion, sound and visuals that react to the pilot's commands.

5. List three things an engineer can investigate in a flight simulator.
   1. *How an aircraft handles in different conditions*
   2. *How a pilot would fly the aircraft*
   3. *Design of an aircraft*
   4. *What instruments can be put into the cockpit to help it fly*

Answer Key for "Flight Test"

Directions: View The **Tools of Aeronautics** section of the **EXPLORING AERONAUTICS** CD-ROM. After you listen to the expert talk about his work, answer the questions below using complete sentences.

1. Give the expert's job title and tell what he does in his job.

   Test Pilot. His work includes flight testing of advanced aircraft, including the new Tilt-Rotor. He also works with engineers to develop new flight control systems.

2. Name the two types of aircraft that can be tested during flight test.

   Modified aircraft or entirely new aircraft.

3. In your own words, explain the role of a pilot in flight test. Tell what he does to test the airplane.
   - *Helps develop the questions to be answered by the test*
   - *Helps develop the flight test plan*
   - *Flies the test according to the plan*
   - *Tests how the aircraft handles or performs by following the plan*
   - *Is part of the Post Flight Debriefing to report on results*

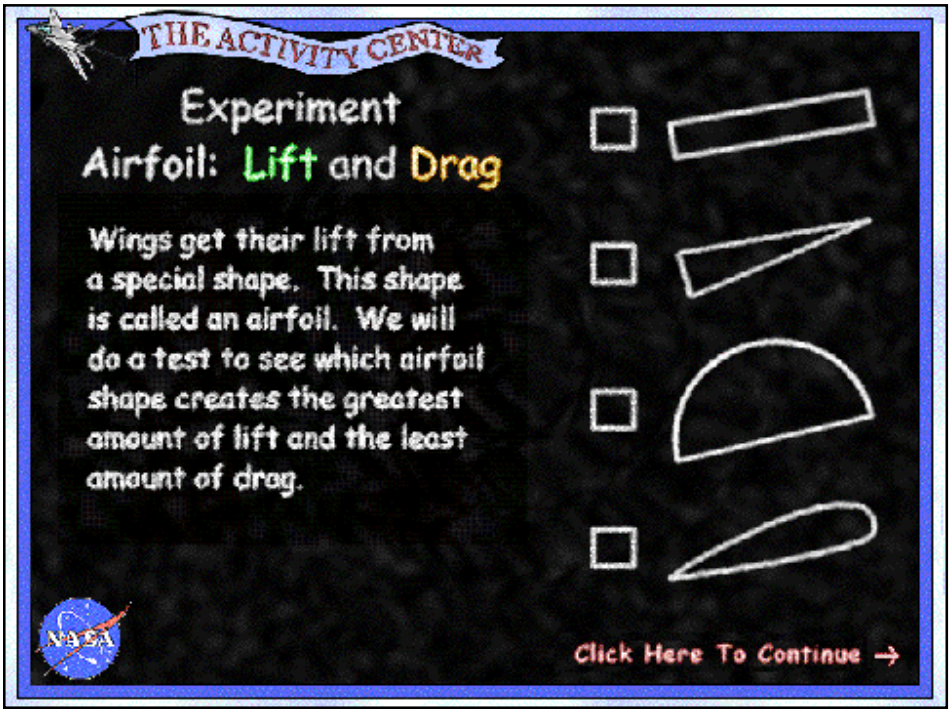
4. Explain how data is collected for flight test

   Instrumentation used to take measurements are mounted on the outside and inside of the aircraft and on the ground. Computers are also set up on the ground to collect data.

5. What is the purpose of flight test?

   To record data on how a new or modified aircraft handles or performs.

Answer Key for The Activity Center



Directions: Use the scientific method to help you determine which airfoil shape creates the greatest amount of lift and the least amount of drag.

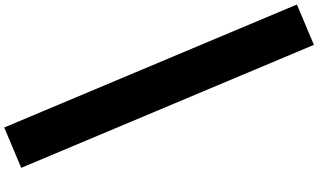
Answer Key for "Experiment: Airfoil Lift and Drag"

For many years, researchers at NASA have studied the way air moves around aircraft. They have stored much of this research data on supercomputers. Using this data and a computer we will conduct an experiment. Our experiment will show which airfoil shape will give the greatest amount of lift and the least amount of drag.

Follow each step of the scientific method below as you use the computer as a tool to help you do your experiment.

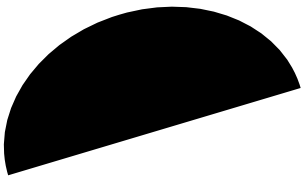
Step 1: Using what you have learned from the How an Airplane Flies section, circle the airfoil shape below that you think will give the greatest amount of lift and the least amount of drag.

A.

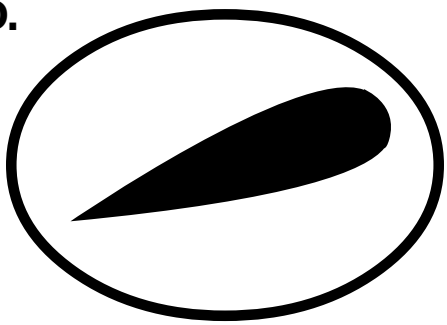


B.

C.



D.



Answer Key for "Experiment" - *continued*

Step 2: When using the scientific method, first write the question you want to have answered by the experiment.

Complete the question below:

Which ___airfoil___ shape will give the ___greatest___ amount

of ___lift___ and the ___least___ amount of drag?

Step 3: Write your hypothesis (the answer to your question) below.

I think that airfoil shape _____will give the greatest

amount of lift and the least amount of drag because _____

_____

(Answers will vary.)

_____

_____

_____

_____

Answer Key for "Experiment"- *continued*

Step 4: Design the Experiment

This experiment you will run with the help of data gathered by NASA's computers. It will be a simulation. The computer will simulate the air flowing around each airfoil shape. The computer will then calculate how much lift and drag the airfoil shape has.

Step 5: Do the Experiment

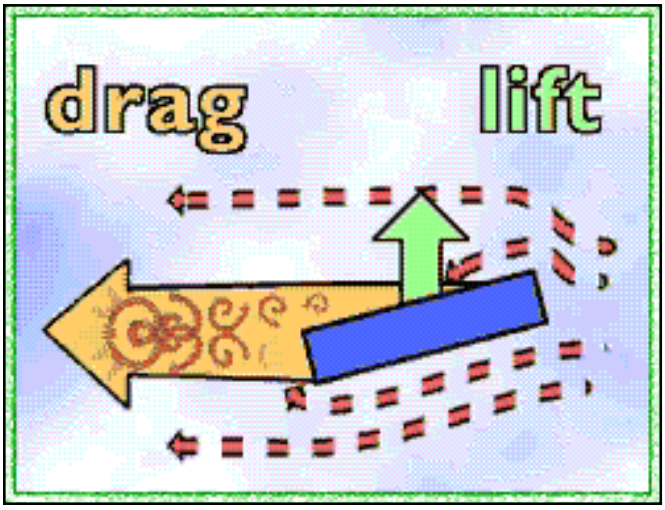
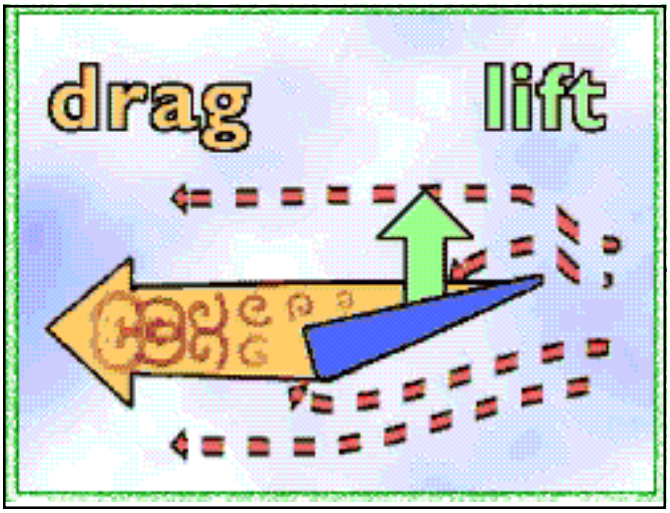
Choose each airfoil shape by clicking on it. The computer will simulate the airflow. The data will be displayed for you to record.

Step 6: Organize and Analyze Your Results

Use the chart on the next page to record the results for each airfoil shape. On the lines next to each airfoil shape give your analysis of the results.

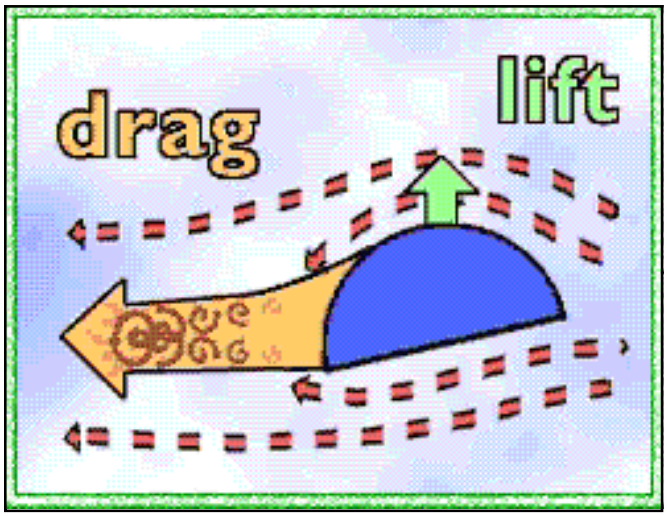
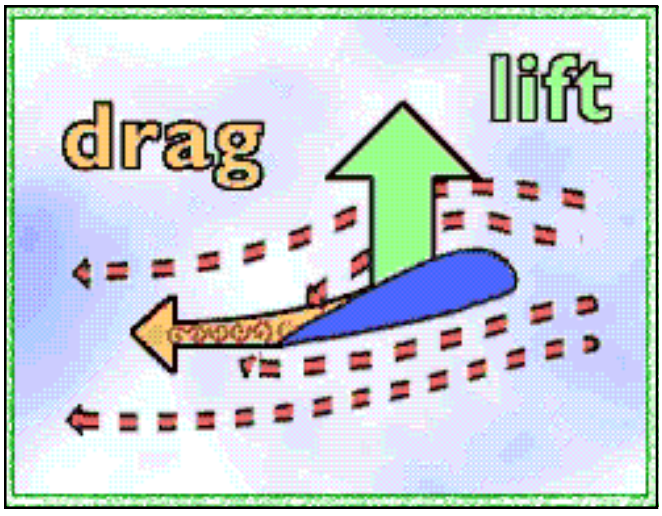
Answer Key for "Experiment"- *continued*

Data Chart

AIRFOIL SHAPE WITH AIRFLOW, LIFT AND DRAG	ANALYSIS
A. 	LIFT FACTOR = 5 DRAG FACTOR = 9 MORE DRAG THAN LIFT; WILL NOT FLY.
B. 	LIFT FACTOR = 4 DRAG FACTOR = 11 MORE DRAG THAN LIFT; WILL NOT FLY.

Answer Key for "Experiment"- *continued*

Data Chart

AIRFOIL SHAPE WITH AIRFLOW, LIFT AND DRAG	ANALYSIS
A. 	LIFT FACTOR = 2 DRAG FACTOR = 6 MORE DRAG THAN LIFT; WILL NOT FLY.
B. 	LIFT FACTOR = 12 DRAG FACTOR = 2 MORE LIFT THAN DRAG; THIS AIRFOIL WILL FLY.

Answer Key for "Experiment"- *continued*

Step 7: Conclusion

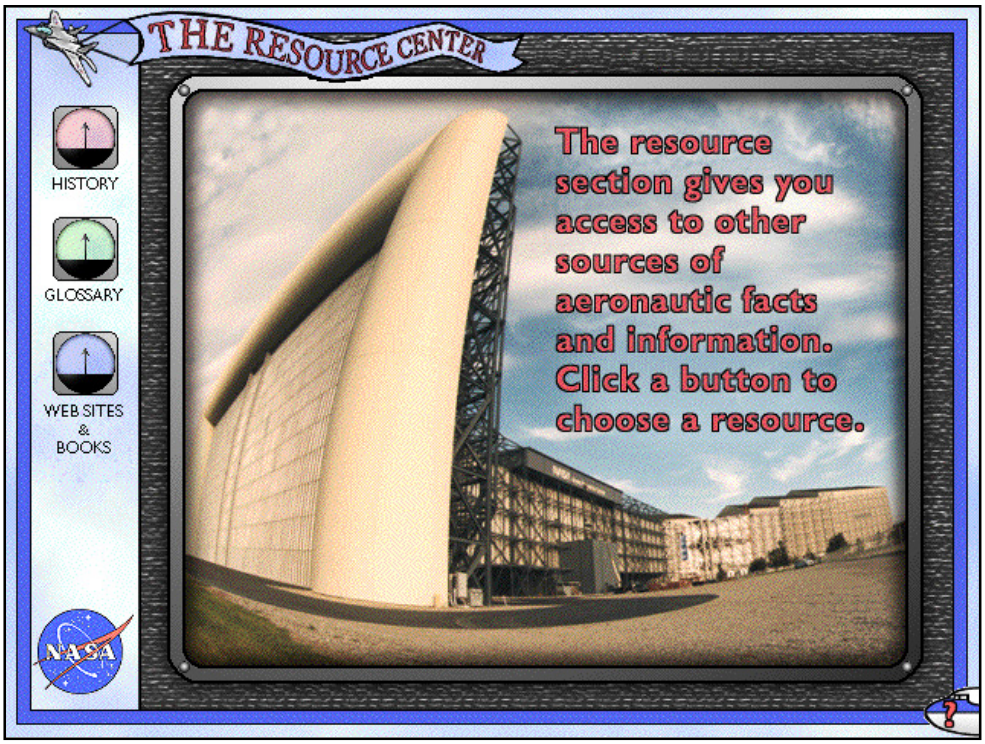
Compare the results and write your conclusion on the lines below.

- *The airflow needs to be faster over the top of the wing than underneath it in order to create lift.*
- *The top of the airfoil needs to have greater camber (or more of a curve or hump) than the bottom of the airfoil.*
- *The air needs to flow smoothly and closely along the airfoil's surface so that less drag is created. A square shape won't allow for that kind of smooth flow.*
- *The leading edge of the airfoil needs to be thicker than the trailing edge to cause the air flowing over the top of the wing to move faster than the air flowing underneath it.*

Step 8: Meet with your fellow researchers to discuss your findings and your conclusion.

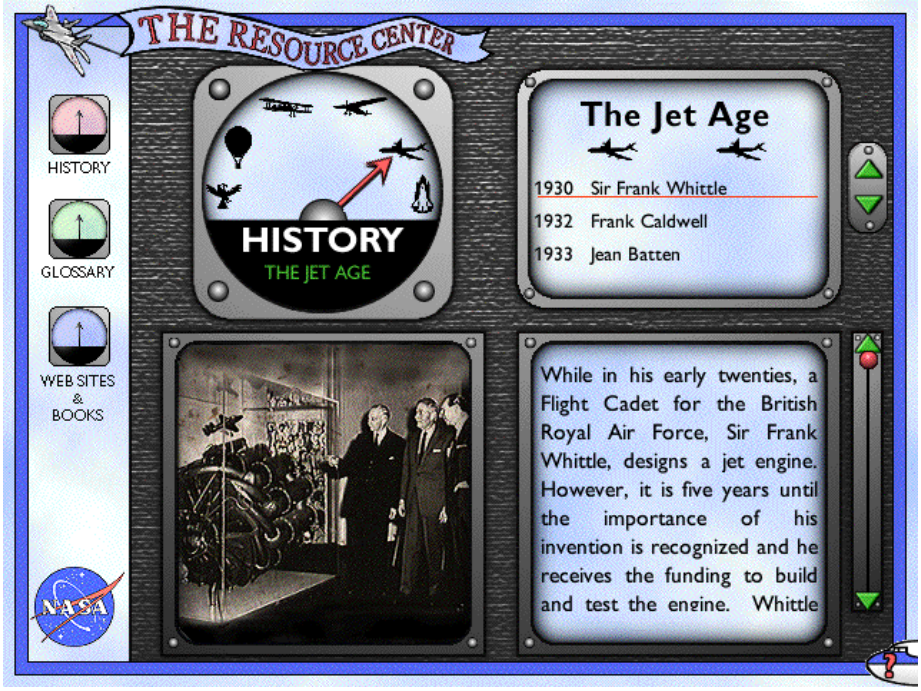
Step 9: When you are ready to check your conclusion with the computer, click to continue.

Answer Keys for The Resource Center



Directions: Explore the history of aeronautics in the "History" subsection of **The Resource Center** by using a history research activity sheet. Become more familiar with aeronautical vocabulary by doing some "Glossary" searches.

Answer Keys for "History Research"



Answer Key for "The Firsts in Flight"

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM "History" subsection to answer the following questions about first-time events in the history of flight. Answer each question by writing the information in the blank.

Wright Brothers 1. The first engine-powered flight was performed by whom?

1783 2. The first manned balloon was flown by the Montgolfiers in what year?

Bullard 3. Who was the first African-American to pilot an airplane?

Glider 4. In 1881 Lilienthal piloted the first successful flights of what type of aircraft?

Santos-Dumont 5. Name the man who made the first powered flight in Europe.

Sintes 6. This aviator became the first female commercial airline captain in 1968.

Post 7. Who was the first aviator to fly solo around the world in 1933?

English 8. Quimby was the first female pilot to cross what channel in 1912?

1797 9. The first parachute descent was done by Garnerin in what year?

1893 10. The first ornithopter was developed by Hargrave in what year?

Answer Key for "The People of Flight"

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to answer the following questions about the people who made tremendous contributions to the field of aeronautics. Write the name of the individual described in the blank.

Otto 1. This person invented the four stroke engine.

Hindenburg 2. This German developed the great airships which flew in the early 1900s.

da Vinci 3. This Italian created early drawings of helicopters, but never built or flew them.

Allen 4. This scientist developed the blunt nose principle.

Chanute 5. This scientist made many contributions to the development of aeronautical principles in the late 1800s.

Curtiss 6. This man is credited with being the "Father of Naval Aviation."

Reitsch 7. This woman was a female glider test pilot for the Germans during WWII.

Jones 8. This researcher at NASA Ames Research Center developed the sweepback, forward-sweep and oblique wing design.

Phillips 9. This pioneer researcher invented the airfoil.

Goddard 10. This aviation pioneer experimented in rocketry.

Answer Key for "Dates in the History of Flight"

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" section to find the year in which the events described below happened. Write the year in the blank.

1975 1. The Supersonic Airliner, *Concorde*, flew its maiden flight.

1927 2. Charles Lindbergh made his historic solo flight across the Atlantic Ocean.

1909 3. Louis Bleriot made his flight across the English Channel.

1939 4. Sikorsky built the first practical single-rotor helicopter.

1937 5. The Russian satellite, *Sputnik*, was launched.

1981 6. The space shuttle was first launched.

1930 7. Whittle invented the jet engine.

1940 8. Airplane cabins were pressurized.

1977 9. The first human-powered aircraft was flown.

1947 10. Yeager broke the sound barrier.

Answer Key for "The Aircraft"

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to answer the following questions. Determine the vehicle that is described and write its name in the blank.

Concorde 1. The British and French governments built and continue to fly this supersonic airliner.

Hindenburg 2. The explosion of this dirigible ended the Age of Great Airships.

Sputnik 3. This satellite was launched by the U.S.S.R. in 1957 and began the "Space Race."

Boeing 307-B Stratoliner 4. This airplane featured the first fully pressurized cabin in 1940.

Boeing 747 5. This airplane was the first jumbo jet and was flown in 1970.

Hydroplane 6. This airplane was designed to land and take off from the water and featured a Curtiss water-cooled engine.

SR-71 7. This airplane was designed for long-range reconnaissance. It flew for the first time in 1966.

Boeing 777 8. This airplane is considered by aviation experts to be one of the most important commercial transport planes of its time.

Bleriot IV 9. This airplane was used to fly across the English Channel in 1909 by its pilot and designer.

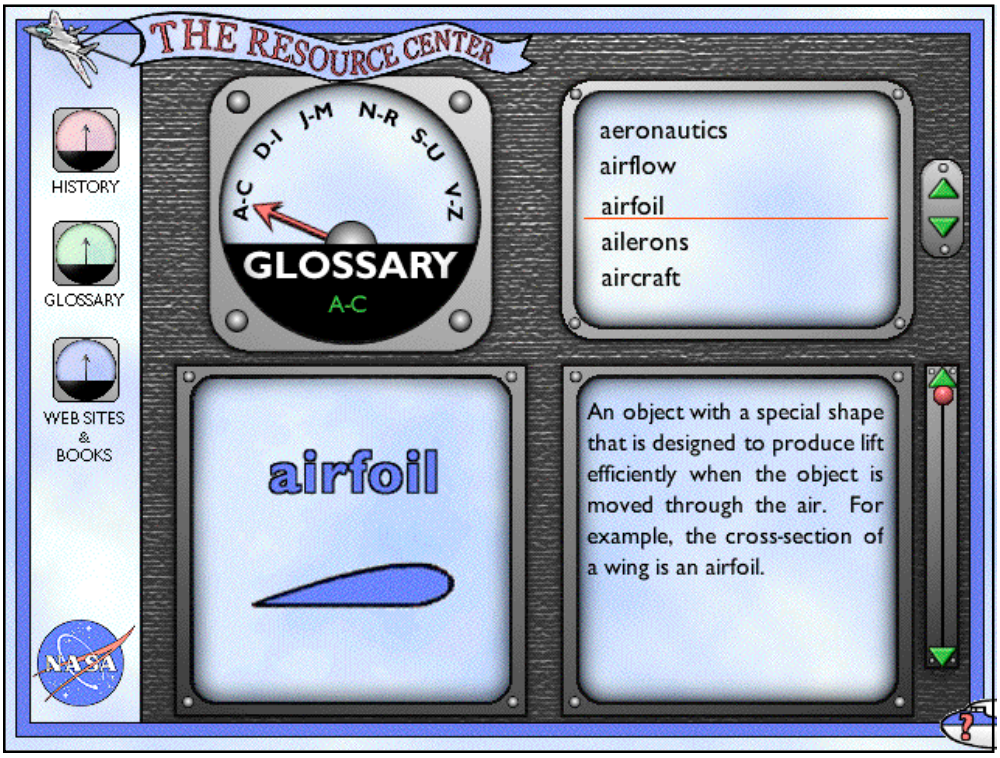
X-33 10. This experimental airplane design will be the next generation space plane.

Answer Key for "Technology and Aeronautics"

Directions: Use the **EXPLORING AERONAUTICS** CD-ROM, "History" subsection to find the year when the specified technology was developed in the field of Aeronautics. Write the year in the blank next to the description.

1. *1984* The supercomputer, Cray-2, is developed to compute large numbers of mathematical equations for new aircraft designs.
2. *1945* The sweepback wing design is perfected by Jones.
3. *1933* The jet engine is invented by Whittle.
4. *1944* Whitcomb designs the "wasp shape" fuselage.
5. *1937* The German dirigible, *Hindenburg*, is destroyed.
6. *1952* The blunt nose principle is developed which helps in the design of the Mercury capsule.
7. *1942* Rodert solves the deicing problem.
8. *1919* The "stressed skin" concept is developed by Rohrbach to decrease drag.
9. *1904* The boundary layer concept is developed which leads to improved aircraft design for supersonic flight.
10. *1893* Phillips' early research on the airfoil forms the basis for understanding how wings work.

Answer Keys for "Glossary Activities"



Answer Key for "Glossary Search: Compound Words"

A compound word is a combination of two or more words. Some compound words can be formed by putting the two smaller words together like *airline.* We connect the two smaller words *air* and *line* to form a new word: airline. Some compound words actually appear as two separate words, yet when these two separate words are placed next to each other they form a new meaning. Consider the two words *trailing* and *edge.* One meaning of the word *trailing* is *to follow along behind.* One meaning of the word *edge* is *a line where an object or area begins or ends.* When these two words are used next to each other they take on a whole new meaning: *the thin, rear edge of a wing.*

Directions: Use the "Glossary" subsection of the **EXPLORING AERONAUTICS** CD-ROM, your Aeronautics Glossary and a dictionary to match the aeronautical compound word below with its correct definition.

streamline airfoil forward-sweep leading edge undercarriage

airfoil	1.	a wing or propeller designed to give lift
undercarriage	2.	the landing gear located underneath the fuselage
leading edge	3.	the front part of a wing
streamline	4.	to shape an object to allow air to flow smoothly around it
forward-sweep	5.	a wing which is slanted toward the front of the aircraft

Answer Key for "Word Hunt"

Directions: View the **EXPLORING AERONAUTICS** CD-ROM. Use the "Glossary" subsection of **The Resource Center** to help find the word or words described by each clue.

1. There are three abbreviations in the "Glossary" subsection. Find all three abbreviations and tell what each letter stands for.

Abbreviation	Word each letter stands for
A. *FAA*	*F = Federal* *A = Aviation* *A = Administration*
B. *NACA*	*N = National* *A = Advisory* *C = Committee for* *A = Aeronautics*
C. *NASA*	*N = National* *A = Aeronautics and* *S = Space* *A = Administration*

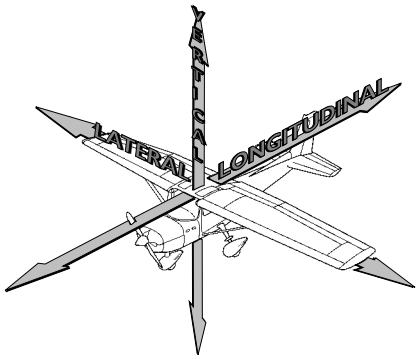
Answer Key for "Word Hunt"- *continued*

2. The "Glossary" subsection has three aeronautical terms that use the word "axis" with one other word. List them below. Then, on the airplane diagram below draw in each axis and label each one.

A. *longitudinal* axis

B. *vertical* axis

C. *lateral* axis



3. The "Glossary" subsection has four aeronautical terms that use the word "of". List them below.

A. *angle of attack*

B. *center of gravity*

C. *regimes of flight*

D. *speed of sound*

4. The "Glossary" subsection has two aeronautical terms that use the word "motion". List them below.

A. *translational* motion

B. *rotational* motion

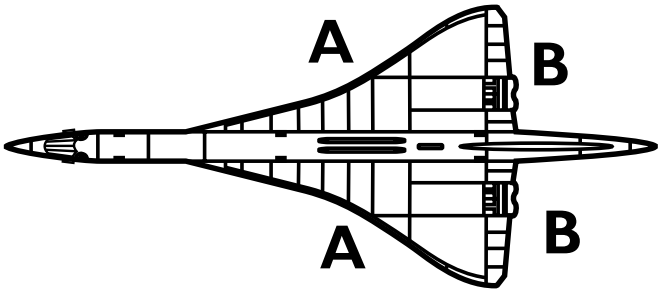
Answer Key for "Word Hunt"- *continued*

5. There are four aeronautical terms in the "Glossary" subsection that have the suffix "-sonic". List them below in their proper order from slowest to fastest.

   A. *sub*sonic (slowest)
   C. *super*sonic
   B. *trans*onic
   D. *hyper*sonic (fastest)

6. There are two aeronautical terms in the "Glossary" subsection that use the word "edge" as their second word. List the two terms. On the airplane below, label the edges.

   A. *leading* edge
   B. *trailing* edge



7. List the five aeronautical terms in the "Glossary" subsection that have the word "air" in them.

   A. *airflow*
   D. *aircraft*
   B. *airfoil*
   E. *air pressure*
   C. *airplane*

Answer Key for "Word Hunt"- *continued*

8. List ten aeronautical terms from the "Glossary" subsection that name parts found on an aircraft.

A. airfoil

B. aileron

C. cockpit

D. control surfaces

E. elevator

F. empennage

G. engine

H. fin

I. flaps

J. fuselage

K. horizontal stabilizer

L. landing gear

M. propeller

N. rudder

O. spoiler

P. stabilator

Q. stabilizer

R. tailplane

S. undercarriage

T. wing: delta wing
forward-sweep wing
straight wing
sweepback wing
variable sweep wing

Answer Key for "Prefixes"

A prefix is added to the front of a root word or base word. The meaning of the root word is changed by the prefix that is added. Review the meanings of the prefixes below.

aero	=	air	trans	=	across, beyond
bi	=	two	di	=	twice
sub	=	under, below	ac	=	to, toward
de	=	from, down, away	mono	=	one

Directions: Find one example of an aeronautical vocabulary word from the "Glossary" subsection that uses each prefix.

aero-
aerodynamic
aeronautics

bi-
biplane

sub-
subsonic

trans-
translational motion
transonic

de-
deceleration

di-
dihedral

ac-
acceleration

mono-
monoplane

Answer Key for "Where in the World Did *THIS* Word Come From?"

Foreign Word	Original Meaning	Aeronautical Word
EMPENNER	TO FEATHER AN ARROW (F)	EMPENNAGE
REGIMIN	CHARACTERISTIC BEHAVIOR(L)	REGIMES
SUPER SONUS	ABOVE SOUND (L)	SUPERSONIC
RECONOISSANCE	TO RECOGNIZE (F)	RECONNAISSANCE
VELOX	QUICK (L)	VELOCITY
AERODYNAMIQUE	AER(F) = AIR DYNAMIKOS(G) = POWERFUL	AERODYNAMIC
ROTHER	TO PADDLE (ME)	RUDDER
AEROPLANE	AER(F) = AIR PLANE(F) = FLAT, LEVEL	AIRPLANE
TURBULENTUS	CONFUSION (L)	TURBULENCE
AILE	WINGS (F)	AILERON
CAMBRE	CURVED (F)	CAMBER
PILOTA	TO STEER (I)	PILOT