HOW A PLANE FLIES

#3477

OPEN-CAPTIONED
LANDMARK MEDIA
1995
Grade Levels: 6-12
15 minutes
1 Instructional Graphic Enclosed

DESCRIPTION

How does a plane fly? What keeps it airborne? Presents the principles of flight and explains lift, thrust, gravity, and drag, the four forces that keep a plane aloft. Illustrates the four moveable parts of the wing and tail and how they function. Briefly describes different airplane engines and provides basic information on helicopters.

ACADEMIC STANDARDS

Subject Area: Science

- Standard: Knows the kinds of forces that exist between objects and within atoms
  - Benchmark: Understands general concepts related to gravitational force (e.g., every object exerts gravitational force on every other object; this force depends on the mass of the objects and their distance from one another; gravitational force is hard to detect unless at least one of the objects, such as the Earth, has a lot of mass) (See Instructional Goal #1)
- Standard: Understands motion and the principles that explain it
  - Benchmark: Understands effects of balanced and unbalanced forces on an object's motion (e.g., if more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude; unbalanced forces such as friction will cause changes in the speed or direction on an object's motion) (See Instructional Goals #1, #2, and #4)
- Standard: Understands energy types, sources, and conversions, and their relationship to heat and temperature
  - Benchmark: Knows that energy is a property of many substances (e.g., heat energy is in the disorderly motion of molecules and in radiation; chemical energy is in the arrangement of atoms; mechanical energy is in moving bodies or in elastically distorted shapes; electrical energy is in the attraction or repulsion between charges) (See Instructional Goal #3)

INSTRUCTIONAL GOALS

1. To explain the four forces acting on planes.
2. To illustrate the various control surfaces of a plane and explain how each is used.
3. To illustrate propellers and jet engines.
4. To explain how the movement of helicopters is controlled.

VOCABULARY

1. air resistance
2. leading edge
3. aerofoil
4. axis
5. trailing edge
6. starboard
7. port (left)
8. banked
9. pitch/pitching
10. fuselage

11. yawing
12. propeller
13. crankshaft
14. kerosene
15. hover
16. ascend
17. descend

BEFORE SHOWING

1. Preview the video to identify the large number of technical terms related to airplanes and flight, in addition to those listed above.
2. Discuss flight. Hypothesize how planes and helicopters fly. Create a list of ideas about flight. Keep the list and refer to it after viewing the video.
3. Introduce the concept of force. Discuss different forces the viewers are familiar with already. Hypothesize what forces may act on airplanes or be important for flight.
4. Copy and distribute the airplane control surfaces diagram for use during the showing of the video. (See INSTRUCTIONAL GRAPHICS.)

DURING SHOWING

Discussion Items and Questions

1. View the video more than once, with one showing uninterrupted.
2. Stop after the explanation of each of the control surfaces. Label each part on the diagram. Write an explanation of how each part works on the back. (See INSTRUCTIONAL GRAPHICS.)
3. Pause the video on the various labeled graphics and diagrams. Clarify the vocabulary words and review the explanations.

AFTER SHOWING

Discussion Items and Questions

1. Explain the four forces acting on a plane.
2. How does the wing shape generate lift?
3. Why does a racing car have aerofoils?
4. In the early days of flying, how did planes get enough lift?
5. Describe the location of the longitudinal axis.
   a. What is it called when the plane turns around this axis?
   b. How is rolling controlled?
   c. What happens when the plane is banked?
6. Describe the location of the lateral axis.
   a. What is it called when the plane turns around this axis?
   b. How is pitching controlled?
7. Describe the location of the vertical axis.
   a. What is it called when the plane turns around this axis?
   b. How is yawing controlled?
   c. How is the rudder used in the air?
   d. How is the rudder used on the ground?

8. How do the flaps move? For what are the flaps used? Why do flaps go down further just after landing?
9. What propels the plane through the air? Why is a propeller called an *airscrew*?
10. Explain how a jet engine works.
11. Identify things a helicopter can do that an airplane cannot.
12. What do a helicopter's rotor blades look like? Why is their shape important?
13. How does the collective pitch stick control the rotor blades so the helicopter can ascend, descend, and hover?
14. Explain how the direction of flying is controlled in a helicopter.
15. Why is the small rotor at the tail of the helicopter important?

Applications and Activities

Study the forces that act on planes. Perform the following experiments:

1. Make a variety of simple kites. Fly the kites. Analyze and compare the kites' performance related to their construction.
2. Make a variety of paper airplanes with different designs. Test the planes and record results. Then design and make a model airplane with balsa wood or Styrofoam. When testing, consider:
   a. How far does it fly?
   b. How long does it stay in the air?
   c. How fast does it fly?
   d. How high does it fly?
   e. How well is the flight controlled?
   f. How well does it reach a target or follow a course?
3. Research and report on different types of aircraft. Include information about history, wing design, size, and use.
4. Create a timeline of the history of flight.
5. Make a model helicopter. Investigate different-shaped strips. Investigate spinning it both directions.
   a. Cut a strip of plastic from an empty plastic bottle, about 2 cm by 10 cm.
   b. Give the strip of plastic a shape by holding the two ends and twisting in opposite directions.
   c. Make a small hole at the midpoint of the strip. Poke a pencil or piece of thin doweling through the hole.
   d. Hold the pencil or doweling between two hands and spin it around. Release it when it is spinning quickly.
6. Research and report on famous pilots and famous flights.
7. Make a balloon jet. Inflate a balloon and hold on tightly to its neck while taping a straw to the top of the neck. Thread a string through the straw and stretch the string across the room. Let the balloon go.

EXPERIMENTS

1. Experiment with lift.
   a. Cut a 2-inch wide strip of paper that is 10 inches long. Hold one end against the chin, just below your mouth. Let the strip hang freely. Blow hard over the top of the paper.
   b. Hold a small rectangular piece of paper at two corners of the long sides. Blow hard on the underside of the paper. Blow hard across the top of the paper. Watch the paper move.
   c. Make an aerofoil.
      (1) Cut a paper strip about 10 inches by 2 inches. Fold it in half. Tape the top of the aerofoil to the bottom about ½inch from the end.

(2) Slide a ruler through the wing. Hold the ruler so one's mouth is opposite the folded edge of the aerofoil.
(3) Blow hard and steadily at the fold.

2. Experiment with drag.
   a. Drop a stone and a sheet of paper from the same height. Experiment to make the paper fall as quickly as possible. Investigate ways to make the stone fall as slowly as possible.
   b. Notice that some seeds float or spin through the air. Design and make a model seed that takes a long time to reach the ground.
   c. Investigate drag in the water.
      (1) Move a hand through the water slowly, then quickly. Slide the hand sideways through the water, then with the palm flat on the surface.
      (2) Place a gently sloping ramp in a sink full of water. Release two ball bearings of different sizes so they roll down the slope. Time them. Add modeling clay to alter the drag.
3. Experiment with moving air and air pressure differential.
   a. Hold two pieces of paper about 4 inches apart in front of one's mouth. Blow hard between the papers. Watch which way the papers move.
   b. Tape two apples on strings. Hang them from a doorframe so they hang about 1 inch apart. Blow hard between the apples. Watch which way the apples move.
   c. Make a whistling water spray.
      (1) Cut a 1-inch long and a 2-inch long piece of plastic drinking straw.
      (2) Tape the two straw pieces together on one side so they form a 90-degree angle.
      (3) Stand the short straw in a saucer of water. Blow hard and steadily through the long straw.

INSTRUCTIONAL GRAPHICS

- AIRPLANE CONTROL SURFACES

RELATED RESOURCES

Captioned Media Program

- Principles of Flying #1547
- Forces: Gases and Water #2474
- Lighter Than Air #2197
- Development of Transportation, The: (Third Edition) #2373
- Lindbergh's Great Race #3374
- Exploring Gravity #3121

World Wide Web

The following Web sites complement the contents of this guide; they were selected by professionals who have experience in teaching deaf and hard of hearing students. Every effort was made to select accurate, educationally relevant, and "kid-safe" sites. However, teachers should preview them before use. The U.S. Department of Education, the National Association of the Deaf, and the Captioned Media Program do not endorse the sites and are not responsible for their content.

- FLIGHTS OF INSPIRATION http://www.fi.edu/flights/index.html

  The Franklin Institute presents this excellent site for children ages 10-14. The section "Your Own Flight" covers the forces and control surfaces with experiments. Teachers' section is also excellent.

- NASA OBSERVATORIUM AERONAUTICS http://observe.ivv.nasa.gov/nasa/aero/aero_index.shtml

  "See How It Flies" explains, with activities, the forces involved in flight. Other sections cover astronomy from planes, high altitude and fast planes, and wind tunnels ; for upper elementary.

- PAPER AIRPLANES http://www.geocities.com/CapeCanaveral/1817/

  Ken Blackburn, who holds the world's record for paper airplane flight, presents directions for making paper airplanes, history, aerodynamics information, links, and teaching resources.

- THE JAVA VIRTUAL WIND TUNNEL http://ad-www.larc.nasa.gov/jvwt/index.html

  "The Java Virtual Wind Tunnel" is an applet which uses computational fluid dynamics methods to simulate the flow of air over a two-dimensional object. This is a sophisticated simulation.

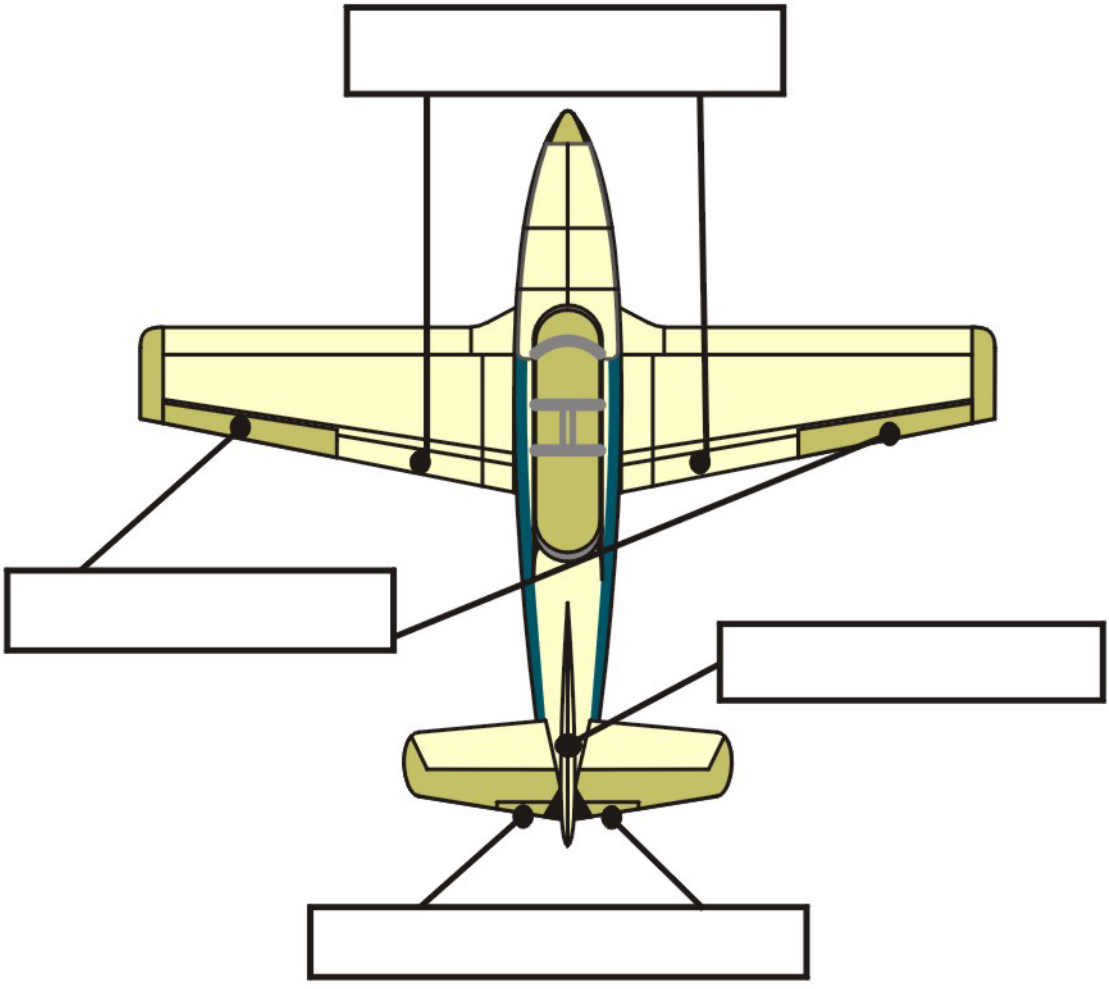
- PLANES, FLYING, AND K-12 EDUCATION
  http://observe.ivv.nasa.gov/nasa/exhibits/planes/planes_2a.html

  Here is a list of seven Web sites of districts, universities, and private corporations that are developing K-14 curriculum materials based on planes and flying. Funded by NASA.

Control Surfaces

Directions: Label the control surfaces on the diagram. On the back of this paper explain what each part controls.

ailerons	**elevators**
rudder	**flaps**



CAPTIONED MEDIA PROGRAM

PLEASE RETURN LESSON GUIDE WITH VIDEO

Lesson guide also available online at *www.cfv.org*

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