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The Parts of an Airplane

NASA T-34C Support Aircraft

NASA XB-70A Research Aircraft
Aeronautical Glossary

**aeronaut:** One who flies balloons.

**aeronautical chart:** A map designed for aerial navigation. Aeronautical charts include information about airports, ground elevations, landmarks, airspace designations, routes to fly, and other aids to navigation. Aeronautical charts are regularly revised to provide current information.

**airfoil:** An aerodynamic surface shaped to obtain a reaction from the air through which it moves; for example, wing, rudder, aileron or rotor blade.

**aerodynamics:** The branch of science that deals with the motion of air and the forces on bodies moving through the air.

**aileron:** Control surface, traditionally hinged to outer portion of the wing and forming part of the trailing edge, that provides control in roll as well as in banking the wings into a turn.

**angle of attack:** An engineering term that describes the angle of an aircraft’s body and wings relative to its actual flight path. It is also called alpha. High angles of attack (greater than about 10 degrees) are called high alpha.

**angle of incidence:** While angle of attack varies during flight, angle of incidence is fixed with the design of the aircraft. Airfoils are generally attached to the aircraft at a small angle in relation to its longitudinal axis.

**aspect ratio:** The ratio between the length of a wing and its width (chord). Short, stubby wings (as on most jets) have a low aspect ratio; long, narrow wings (as on gliders) have a high aspect ratio.

**ATC:** Air traffic control. A system that controls air traffic from airport locations. Air traffic personnel on the ground use two-way communication with aircraft crews to maintain the safe flow of aircraft in airport vicinities, and to direct aircraft on routes between airports.

**attitude:** The orientation of the three major axes of an aircraft (longitudinal, lateral, and vertical) with respect to a fixed reference such as the horizon, the relative wind, or direction of flight. Usually refers to the relationship between the nose of the airplane and the horizon, such as the nose is pointing “above” or “below” the horizon.

**canard:** Canard has a couple of meanings. It is an aircraft with the horizontal stabilizer placed ahead of the wing instead of behind it on the tail, and it also refers to a forward horizontal stabilizer. Some aircraft have canards in addition to a conventional horizontal stabilizer on the tail.

**composite:** Usually refers to a type of structure made with layers of fiberglass or fiberglass-like materials such as carbon fiber. The materials are called composites.

**digital-fly-by-wire:** A flight control system whereby instead of mechanical links (cables and pulleys) from the cockpit to the aircraft’s flight controls, wires carry electronic signals. These electric/electronic signals allow a pilot to “fly by wire.” Digital refers to digital computer inputs in the system; some fly-by-wire systems use analog computers. Virtually all modern, fly-by-wire flight control systems are digital. The acronym is DFBW.

**drag:** Resistance of a vehicle body to motion through the air. A smooth surface has less drag than a rough one.

**elevator:** A movable horizontal airfoil, usually attached to the horizontal stabilizer on the tail, that is used to control pitch. It usually changes the attitude of the nose, making it move up and down.

**elevon:** Elevons are moveable control surfaces located on the trailing edge of the wings to control pitch and roll. Working in unison (both up or both down), they function as elevators. Working differentially (one up and one down), they function as ailerons.

**fin:** Another term for the vertical stabilizer (see vertical stabilizer).
flaps: Hinged, pivoted, or sliding airfoils or plates (or a combination of them) normally located at the trailing edge of the wing. They are designed to increase the wing’s lift or otherwise improve an airplane’s slow-flight characteristics.

flight controls: Moveable surfaces on the aircraft that control its path through the air.

flight plan: Specific information about the intended flight of an aircraft that is delivered orally or in writing with air traffic control.

flight instruction: Instruction in airplanes, and on the ground, by a person who has been certified with the Federal Aviation Administration to teach flying.


fuselage: The main structural body of an aircraft to which the wings, tail unit, etc. are attached.

G or g: A symbol used to denote gravity or its effects. Also used as a unit of stress measurement for bodies undergoing acceleration, or the “loads” imposed on an aircraft and pilot. Loads may be centrifugal and aerodynamic due to maneuvering, usually expressed as g, i.e. 7 g is a load seven times the weight of the aircraft.

glider: An aircraft that does not use an engine for thrust. Gliders typically have relatively long, narrow wings (compared to powered aircraft) for maximum lift and minimum drag. A high lift-to-drag (glide) ratio allows the plane to fly a longer distance horizontally for every foot that it descends. High performance gliders, also known as sailplanes, can glide more than six-times the distance an average powered airplane can glide with its engine not operating.

hangar: A building used to house aircraft.

helicopter: A flying machine (heavier-than-air) that is uses motor-driven rotors for support in the air. These rotors also provide the main force to propel it horizontally. A rotorcraft.

horizontal stabilizer: Loosely, a fixed, horizontal tail surface, but on many supersonic aircraft the entire horizontal stabilizer moves to control pitch.

hypothesis: A hypothesis is a proposed answer to a problem, or an explanation that accounts for a set of facts and that can be tested by further experimentation and observation. The results of experimentation provide evidence that may or may not support the hypothesis.

inlet: Usually, openings that let air into a jet engine.

International Phonetic Alphabet: A system of words identifying the letters of the alphabet and numbers. The system was reached through international agreement, and uses words chosen for their ease of pronunciation by people of all language backgrounds.

lift: The sum of all the aerodynamic forces acting on an aircraft at right angles to the flight path. When the aircraft is in steady level flight the lift is equal and opposite to the weight of the aircraft. Wings create lift.

lifting body: An aircraft that uses the shape of its body to generate lift instead of using wings.

Mach number: The speed of the aircraft (true air speed) divided by the speed of sound at a given temperature. Loosely, it is the speed in terms of the speed of sound, i.e. Mach 1 is the speed of sound, Mach 2 is twice the speed of sound, etc.

meteorologist: A weather forecaster. A person knowledgeable in the field of meteorology, which is a branch of science that deals with the physical properties of the atmosphere. Meteorology deals with the way weather conditions develop and change.


ornithopter: A flying machine that is supposed to support itself in the air through the use of flapping wings.
**pitch, pitch attitude:** Loosely, the angle between the nose of an aircraft and the horizon. The nose pitches “up” or “down” in relation to level flight. It is different from angle of attack, which is the wing’s angle relative to the aircraft’s flightpath.

**ramjet:** A jet engine with no mechanical compressor, consisting of specially shaped tubes or ducts open at both ends. The air necessary for combustion is shoved into the duct and compressed by the forward motion of the engine.

**roll:** The rotation of an aircraft about its longitudinal axis. An aircraft is turned by controlling roll and yaw. A turn is initiated by “rolling” the wings into the direction of the turn. Once the turn is established, the rolling movement is stopped. A roll in the opposite direction of the turn is used to stop the turn.

**rotors:** The airfoils that are used by helicopters; they are rotated at high speeds to produce lift and thrust.

**rotor blades:** Also known as rotors.

**rotary wing aircraft:** Also known as rotorcraft. An aircraft (heavier-than-air) that uses rotating airfoils (rotary wings) to produce aerodynamic lift.

**rudder:** The primary control surface in yaw (sideways movement), it is usually hinged and attached to the trailing edge of the vertical stabilizer on an aircraft’s tail.

**runway:** A surface on the ground specifically used for aircraft takeoffs and landings.

**shock wave:** An aircraft generates a shock wave as it flies faster than the speed of sound, pushing air molecules aside like a boat creates a bow wave. The shock wave forms a cone of pressurized air molecules which moves outward and rearward in all directions and extend to the ground.

**solar-powered aircraft:** Solar-powered aircraft, such as the Pathfinder, use photovoltaic cells to convert energy from the sun into electricity to power electric motors that drive the aircraft.

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

**stall:** A flight condition wherein the airflow separates from the airfoil surface, or the airflow around the airfoil becomes turbulent, causing the airfoil to lose lift. It is usually a result of insufficient airspeed or excessive angle of attack.

**straight-wing:** A wing that is approximately perpendicular to the fuselage.

**supersonic:** Faster than the speed of sound (about 750 mph at sea level).

**swept-wing:** A wing that has a visibly obvious, backwards or forwards inclination relative to the fuselage. The adjective swept-wing describes an aircraft that has wings which sweep forward or sweep back. Some aircraft have the ability of sweeping the wings while in flight; these wings are called variable sweep wings.

**taxi way:** An airport road (used primarily for the movement of aircraft) connecting the runway to hangars, terminals and other airport locations.

**thrust:** A force that propels an aircraft forward. Rocket and jet engine “power” is referred to in “pounds of thrust.”

**tiltrotor:** A rotor that is tilted from a horizontal alignment (as a helicopter) for takeoff and landing, to a vertical alignment (as an airplane) for level flight. Tiltrotor aircraft typically have the tiltrotors mounted on the tips of airplane-like wings, and achieve the flight characteristics of airplanes and helicopters.

**transonic:** Speeds slightly above and below the speed of sound.
**vertical stabilizer:** Sometimes referred to as a vertical fin, or fin, it is a vertical or inclined airfoil, usually at the tail or wing tip to increase directional stability. Sometimes the rudder is hinged to it.

**weight and balance:** A term referring to the distribution of weight in an aircraft and the location of its center of gravity. The center of gravity is the point where the weight is balanced. Proper weight and balance are essential for the safe operation of an aircraft.

**wind tunnel:** Tubular structures or passages, in which high-speed movements of air or other gases are produced. Objects such as engines or aircraft, airfoils, and rockets (or models of these objects) are placed inside of the wind tunnel so researchers can investigate the airflow around them and the aerodynamic forces acting upon them.

**wing loading:** Gross weight of an aircraft divided by the area of the wing. Aircraft that have proportionally large wings are said to be “wing-loaded,” while those with smaller wings, such as most jet fighters, are said to be “fuselage loaded.”

**winglet:** Small, nearly vertical, winglike surface mounted above the wing tip to reduce drag.

**wing warping:** A means to control aircraft roll by twisting (warping) the aircraft’s wing tips. The Wright brothers used wing warping on their early gliders, and on their first powered aircraft. Although wing warping was discontinued in favor of ailerons on most aircraft since 1910, the concept is still considered valid for special applications on advanced aircraft.

**yaw:** A flight condition of an aircraft in which the aircraft rotates about its vertical axis. Yawing is different from turning because an aircraft can be yawed while flying straight with the wind striking it from the side. An aircraft follows a curved flight path when turning, with the wind always flowing parallel to its longitudinal axis.
Suggested Reading

These books can be used by children and adults to learn more about aeronautics. The lists also include aviation-based fiction suitable for young readers.

**Teacher activity books:**

**Books for students and educators:**


**NASA Remotely-piloted Environmental Research Aircraft 1998**

NASA is developing several aircraft capable of flying for days at a time, at altitudes over 20,000 m, to conduct research of the earth’s environment. The Altus II and Perseus B aircraft are powered by a rear-mounted piston engine and propeller. The Pathfinder Plus uses front-mounted, solar-powered electric motors and propellers. (The depicted aircraft are scaled proportionally. The Pathfinder Plus wingspan is 36.57 m.)
APPENDIX

NASA Resources for Educators

NASA’s Central Operation of Resources for Educators (CORE) was established for the national and international distribution of NASA-produced educational materials in multimedia format. Educators can obtain a catalogue and an order form by one of the following methods:

NASA CORE
Lorain County Joint Vocational School
15181 Route 58 South
Oberlin, OH 44074-9799
Toll Free Ordering Line: 1-866-776-CORE
Toll Free FAX Line: 1-866-775-1460
E-mail nasaco@leeeca.org
Home Page: http://core.nasa.gov

Educator Resource Center Network (ERCN)
To make additional information available to the education community, NASA has created the NASA Educator Resource Center (ERC) network. Educators may preview, copy, or receive NASA materials at these sites. Phone calls are welcome if you are unable to visit the ERC that serves your geographic area. A list of the centers and the regions they serve includes:

AK, Northern CA, HI, ID, MT, NV, OR, UT, WA, WY
NASA Educator Resource Center
NASA Ames Research Center
Mail Stop 253-2
Moffett Field, CA 94035-1000
Phone: (650) 604-3574

IL, IN, MI, MN, OH, WI
NASA Educator Resource Center
NASA Glenn Research Center
Mail Stop 8-1
21000 Brookpark Road
Cleveland, OH 44135
Phone: (216) 433-2017

CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT
NASA Educator Resource Laboratory
NASA Goddard Space Flight Center
Mail Code 130.3
Greenbelt, MD 20771-0001
Phone: (301) 286-8570

CO, KS, NE, NM, ND, OK, SD, TX
NASA Educator Resource Center for
Space Center Houston

FL, GA, PR, VI
NASA Educator Resource Center
NASA Kennedy Space Center
Mail Code ERC
Kennedy Space Center, FL 32899
Phone: (321) 867-4090

KY, NC, SC, VA, WV
Virginia Air & Space Center
Educator Resource Center for
NASA Langley Research Center
600 Settlers Landing Road
Hampton, VA 23669-4033
Phone: (757) 727-0900 x 757

AL, AR, IA, LA, MO, TN
U.S. Space and Rocket Center
NASA Educator Resource Center for
NASA Marshall Space Flight Center
One Tranquility Base
Huntsville, AL 35807
Phone: (256) 544-5812

MS
NASA Educator Resource Center
NASA Stennis Space Center
Building 1200
Stennis Space Center, MS 39529-6000
Phone: (228) 688-3338

CA
NASA Educator Resource Center for
NASA Jet Propulsion Laboratory
Village at Indian Hill
1460 East Holt Avenue, Suite 20
Pomona, CA 91767
Phone: (909) 397-4420

AZ and Southern CA
NASA Educator Resource Center for
NASA Dryden Flight Research Center
PO Box 273, M/S 4839
Edwards, CA 93523-0273
Phone: (661) 276-5009 or (800) 521-3416 x 5009

VA and MD’s Eastern Shores
NASA Educator Resource Center
GSFC/Wallops Flight Facility
Visitor Center Building J-17
Wallops Island, VA 23337
Phone: (757) 824-2298
Regional Educator Resource Centers offer more educators access to NASA educational materials. NASA has formed partnerships with universities, museums, and other educational institutions to serve as regional ERCS in many states. A complete list of regional ERCS is available through CORE, or electronically via NASA Spacelink at http://spacelink.nasa.gov/ercn.

NASA’s Education Home Page serves as the education portal for information regarding educational programs and services offered by NASA for the American education community. This high-level directory of information provides specific details and points of contact for all of NASA’s educational efforts, Field Center offices, and points of presence within each state. Visit this resource at the following address: http://education.nasa.gov.

NASA Spacelink is one of NASA’s electronic resources specifically developed for the educational community. Spacelink serves as an electronic library to NASA’s educational and scientific resources, with hundreds of subject areas arranged in a manner familiar to educators. Using Spacelink Search, educators and students can easily find information among NASA’s thousands of Internet resources. Special events, missions, and intriguing NASA Web sites are featured in Spacelink’s “Hot Topics” and “Cool Picks” areas. Spacelink may be accessed at: http://spacelink.nasa.gov.

NASA Spacelink is the official home to electronic versions of NASA’s Educational Products. A complete listing of NASA Educational Products can be found at the following address: http://spacelink.nasa.gov/products.

NASA Television (NTV) features Space Station and Shuttle mission coverage, live special events, interactive educational live shows, electronic field trips, aviation and space news, and historical NASA footage. Programming has a 3-hour block—Video (News) File, NASA Gallery, and Education File—beginning at noon Eastern and repeated four more times throughout the day. Live feeds preempt regularly scheduled programming.

Check the Internet for programs listings at: http://www.nasa.gov/ntv
For more information on NTV, contact:
NASA TV
NASA Headquarters - Code P-2
Washington, DC 20546-0001
Phone (202) 358-3572

**Appendix**

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This brochure serves as a guide to accessing a variety of NASA materials and services for educators. Copies are available through the ERC network, or electronically via NASA Spacelink.

Please take a moment to evaluate this product at http://ehb2.gsfc.nasa.gov/edcats/educator_guide. Your evaluation and suggestions are vital to continually improving NASA educational materials. Thank You.
The following listing of Internet addresses will provide users with links to educational materials throughout the World Wide Web (WWW) related to aeronautics and aviation.

**NASA Aeronautics Centers**

**Education Home Pages:**
- NASA Ames Research Center
  
  [http://education.arc.nasa.gov](http://education.arc.nasa.gov)

- NASA Dryden Flight Research Center
  
  [http://trc.dfrc.nasa.gov](http://trc.dfrc.nasa.gov)

- NASA Langley Research Center
  
  [http://edu.larc.nasa.gov](http://edu.larc.nasa.gov)

- NASA Lewis Research Center
  

**NASA Aeronautics Photographs and Images**

Dryden Flight Research Center Photo Gallery.
Hundreds of photographs from the 1940's to the present depicting NACA and NASA flight research.


**NASA Image eXchange (NIX).**
A web-based tool for simultaneously searching several NASA image archives on the Internet. NIX searches databases of over 300,000 on-line NASA images.

[http://nix.nasa.gov/](http://nix.nasa.gov/)

**NASA Multimedia Gallery.**
A collection of links to most of NASA on-line video, audio, and photo imagery.


**Other Aeronautics Education Websites**

- The National Coalition for Aviation Education.
  Provides a list of over thirty member organizations and contacts, including: the Air Line Pilots Association, 4-H Aerospace Education Programs, the Soaring Society of America, and Women in Aviation, International.


- The K-8 Aeronautics Internet Textbook (K8AIT).
  Provides on-line lesson plans, student activities covering subjects that include the principles of aeronautics, and aerodynamics in sports technology. An aeronautics career guide, and tour of NASA projects relevant to K8AIT is also offered.

  [http://wings.avkids.com/](http://wings.avkids.com/)

- The Aeronautics Sign Language Dictionary.
  Provides 3-D animated aviators demonstrating aeronautical terms in sign language.


- The U.S. Centennial of Flight Commission provides a wide range of suggestions for how educators can engage their students in celebrating the 100th anniversary of powered flight.

  [http://www.centennialofflight.gov/education.htm](http://www.centennialofflight.gov/education.htm)

- Reliving the Wright Way is a rich resource of information on the Wright Brothers and their process of invention. Designed for use by educators and students, the Web site offers everything from online, interactive demonstrations of how the Wright Flyer worked to a regularly updated calendar of events related to the celebration of the Centennial of Flight.

  [http://wright.nasa.gov](http://wright.nasa.gov)
National Air and Space Museum (NASM) - Smithsonian Institution.
The NASM was established to memorialize the development of aviation and space flight, and provide educational materials for the study of aviation.

http://www.nasm.si.edu/

The United States Air Force Museum near Dayton, Ohio is the oldest and largest military aviation museum in the world.

http://www.wpafb.af.mil/museum/

Planes of Fame Museum.
In addition to information about its collection, this aviation museum in Chino, California is an excellent source of aviation links on-line.

http://www.planesoffame.org/links.htm

**APPENDIX**

NASA F-15B Aerodynamic Flight Facility (AFF) 1999

NASA F-15B Advanced Control Technology for Integrated Vehicles (ACTIVE) 1999
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
EDUCATION DIVISION
MAIL CODE FE
WASHINGTON DC 20546–0001

Fold along line and tape closed.
To achieve America's goals in Educational Excellence, it is NASA's mission to develop supplementary instructional materials and curricula in science, mathematics, geography, and technology. NASA seeks to involve the educational community in the development and improvement of these materials. Your evaluation and suggestions are vital to continually improving NASA educational materials.

1. With what grades did you use the educator's guide?
   Number of Teachers/Faculty:
   - K-4
   - 5-8
   - 9-12
   - Community College
   College/University - Undergraduate Graduate

   Number of Students:
   - K-4
   - 5-8
   - 9-12
   - Community College
   College/University - Undergraduate Graduate

   Number of Others:
   - Administrators/Staff
   - Parents
   - Professional Groups
   - General Public
   - Civic Groups
   - Other

2. What is your home 5- or 9-digit zip code?  __ __ __ __ __ — __ __ __ __

3. This is a valuable educator's guide?
   □ Strongly Agree  □ Agree  □ Neutral  □ Disagree  □ Strongly Disagree

4. I expect to apply what I learned in this educator's guide.
   □ Strongly Agree  □ Agree  □ Neutral  □ Disagree  □ Strongly Disagree

5. What kind of recommendation would you make to someone who asks about this educator's guide?
   □ Excellent  □ Good  □ Average  □ Poor  □ Very Poor

6. How did you use this educator's guide?
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   □ Demonstrate NASA Materials  □ Demonstration
   □ Group Discussions  □ Hands-On Activities
   □ Integration Into Existing Curricula  □ Interdisciplinary Activity
   □ Lecture  □ Science and Mathematics
   □ Team Activities  □ Standards Integration
   □ Other: Please specify: ____________________________

7. Where did you learn about this educator's guide?
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   □ NASA Central Operation of Resources for Educators (CORE)
   □ Institution/School System
   □ Fellow Educator
   □ Workshop/Conference
   □ Other: Please specify: ____________________________

8. What features of this educator's guide did you find particularly helpful?
   __________________________________________________________
   __________________________________________________________

9. How can we make this educator's guide more effective for you?
   __________________________________________________________
   __________________________________________________________

10. Additional comments:
    __________________________________________________________
    __________________________________________________________

Today's Date: ____________________________       EG-2002-06-105-HQ