

The Ninety-Nines, Inc.,® International Organization of Women Pilots®

Aviation Adventure Guide

Module 7 - Basics of Flights



Module 7

Basics of Flight



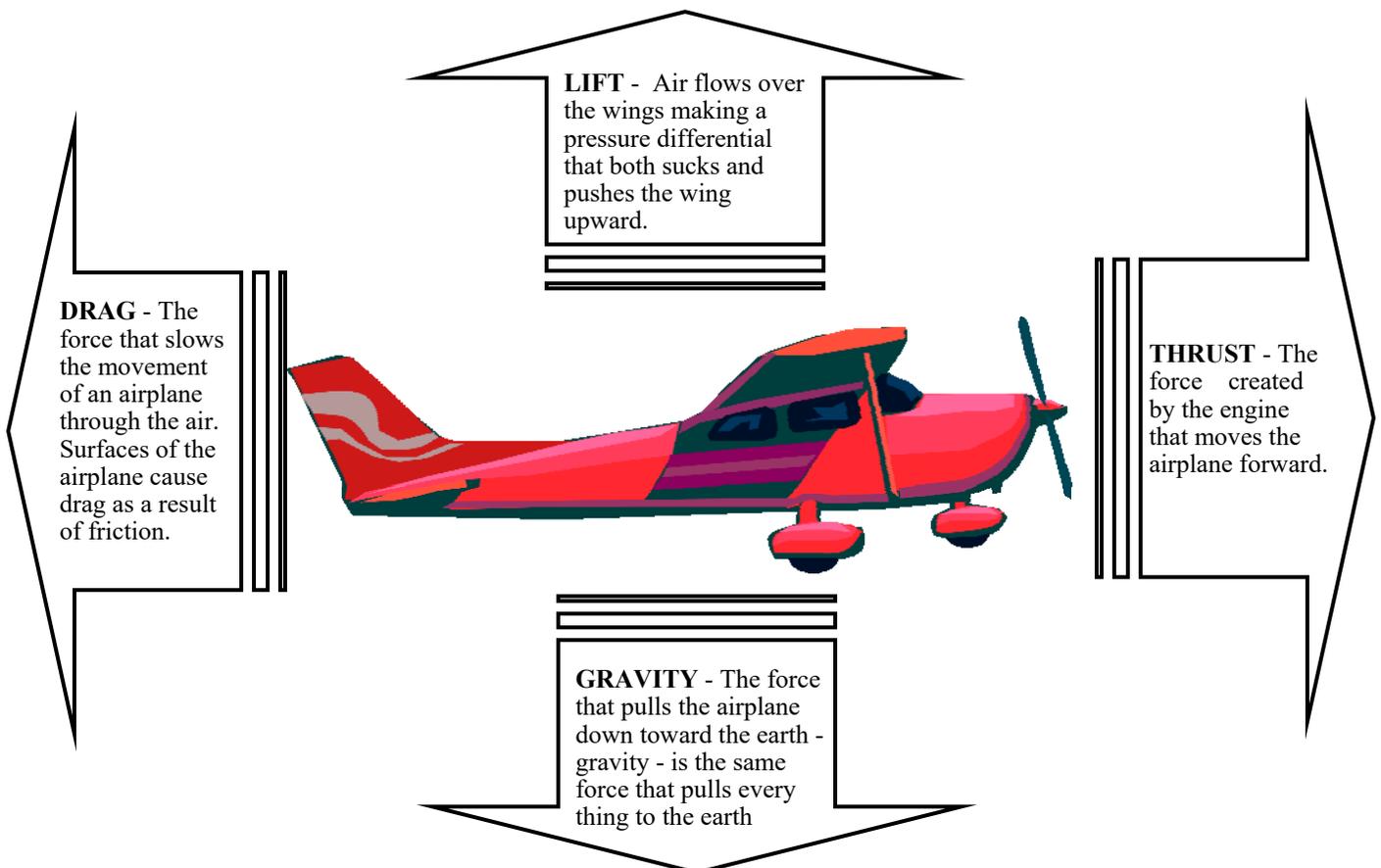
What makes an airplane fly? There is no short answer to why an airplane flies but there are a number of forces at work to make a plane become airborne.

LIFT: A force that is created by the shape of the wing which makes the pressure on the top side of the wing lower than the pressure on the bottom side of the wing. The high pressure created underneath the wing “pushes” upward toward the lower pressure above the wing. Since the wing is between those two pressure centers, it goes up with the high pressure, making the airplane go upward.

GRAVITY: Working opposite of lift, gravity is at work all over the Earth pulling everything, including an airplane, down toward the Earth. Gravity is the force that makes us not float off the ground and the force that pulls us back to the ground when we jump up in the air.

THRUST: The power that moves the plane forward is called thrust. The power can come from the engine driven propeller or a jet engine. Think about sitting in a car when the driver accelerates quickly; the car is moved forward by the thrust of the car engine.

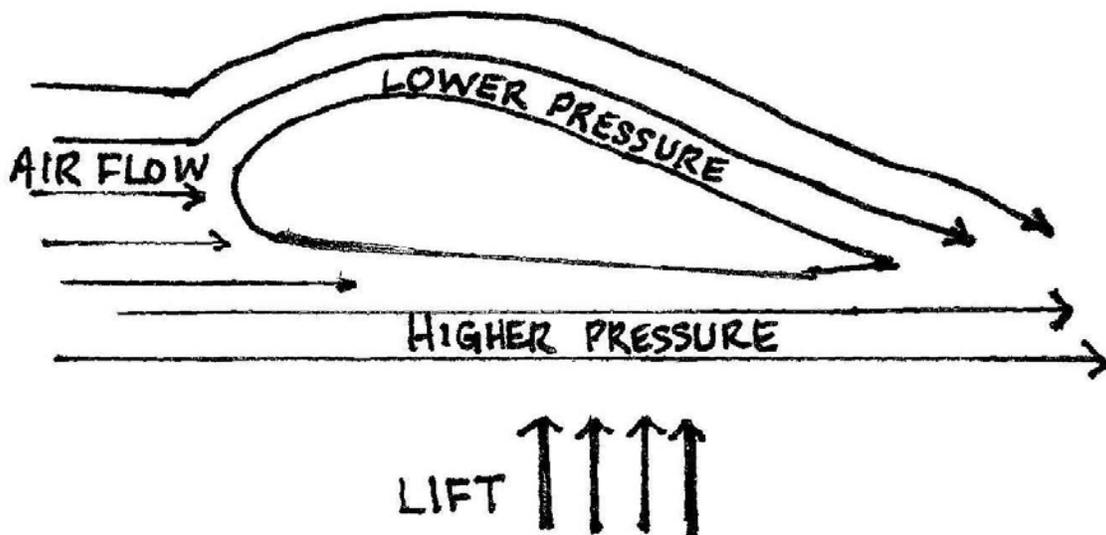
DRAG: A force that will slow things down is called drag. Drag can be caused by some sort of friction. Think about how much easier it is to ride your bicycle over a smooth road than it is to ride over rough gravel. If drag is less than thrust, a plane moves forward.



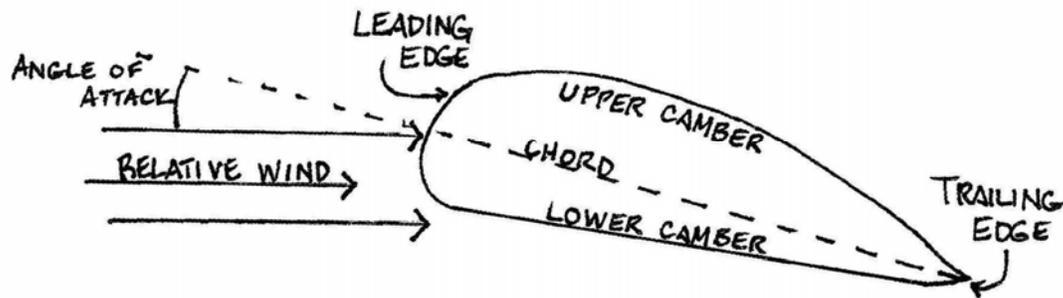
SHAPE OF THE WING: Notice the shape of the wing in the drawing below: the top of the wing has a larger curve than the nearly flat bottom of the wing. As the airplane moves through the air, either on the ground before take-off or as the airplane flies, the air that hits the wing has to go around the wing. Some of the air flows over the top of the wing and some of the air flows over the bottom of the wing. Think about being in the water; the water cannot go *through* you: it has to go *around* you. Air works the same way.

The air that goes over the top of the curved part of the wing has a longer path to travel than does the air going across the flat bottom part of the wing. In order for all of the air to join back together at the back side (or trailing edge) of the wing, the air on the top must go faster than the air on the bottom. This faster moving air on top creates the lower pressure on top of the wing that acts as a suction. The higher pressure on the bottom of the wing “pushes” the wing upward toward the low pressure area on top. The two forces working together create LIFT.

Look at the diagram below to see how the lines representing air flow are longer along the top than they are along the bottom.



Bernoulli’s Principle: In 1783, Daniel Bernoulli, a physicist, developed the laws that explain lift. He discovered the relationship between the pressure and the speed of a fluid (air is a fluid) in motion. As the speed of the air increases, the pressure decreases. As the air moves over the top and the bottom of the wing, the pressure on the top is less than the pressure on the bottom so the wing has no choice but to move upward. There is literally a “suction” on the top and a “push” from the bottom to make the airplane go upward.



WING VOCABULARY

Air Foil - any surface such as a wing, propeller, rudder or even a trim tab which provides aerodynamic force when it interacts with a moving stream of air.

Angle of Attack - the acute angle between the chord line of the air foil and the direction of the relative wind.

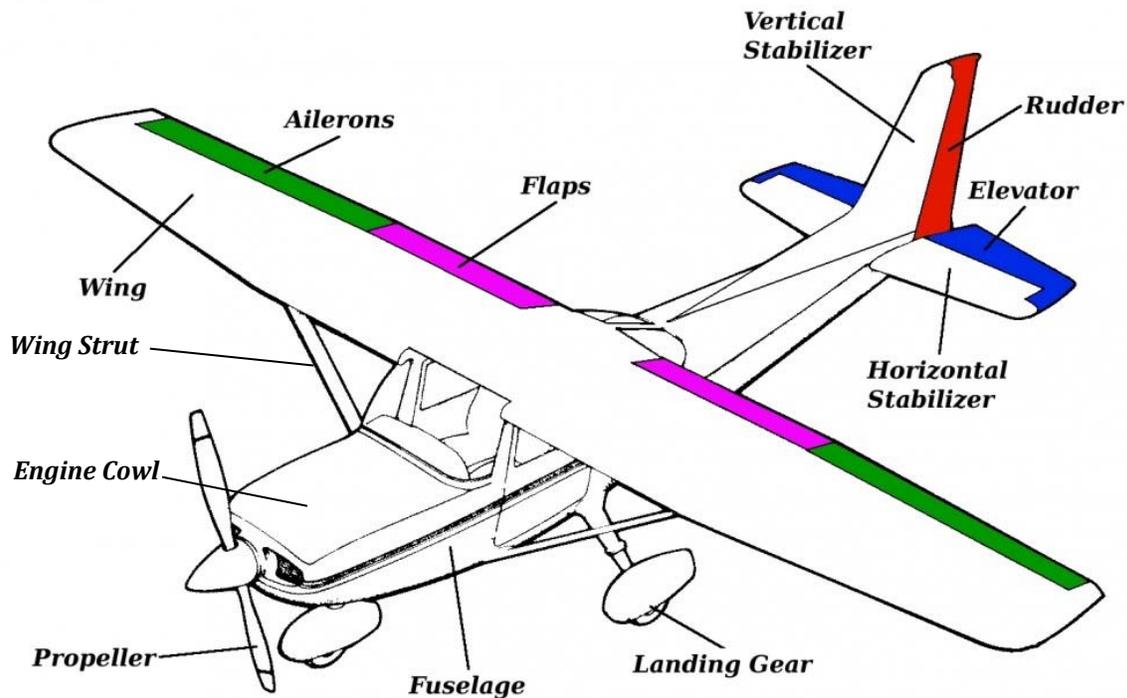
Relative Wind - the direction of the air flow with respect to the wing. If a wing moves forward horizontally, the relative wind moves backwards horizontally. Relative wind is parallel to and opposite the flight path of the airplane.

Leading Edge - the part of the air foil that meets the air flow first.

Trailing Edge - the portion of the air foil where the air flow over the upper surface rejoins the lower surface airflow.

Chord Line - an imaginary straight line drawn through an airfoil from the leading edge to the trailing edge.

Camber - the characteristic curve of the upper and lower surfaces of the airfoil. The upper camber is more pronounced (bows outward from the chord line) while the lower camber is comparatively flat. This causes the velocity of the air flow immediately above the wing to be higher than that below the wing.



AIRPLANE VOCABULARY

Propeller - the air foil that the engine turns to provide thrust.

Landing Gear - wheels attached to a bar which provides cushion while taxiing or landing an airplane.

Wing Strut - a brace that supports the wing and goes from the fuselage to the wing.

Wing - an air foil attached to each side of the fuselage acting as the main lifting surface that supports the airplane in flight.

Aileron - primary flight control surfaces mounted on the trailing edge of an airplane wing, near the tip. Ailerons control roll about the longitudinal axis.

Flap - hinged portion of the trailing edge between the aileron and the fuselage. In some aircraft, ailerons and flaps are interconnected to produce a full-span “flaperon”. In all airplanes, flaps change the lift and drag of the wing.

Fuselage - the section of the airplane that consists of the cabin and cockpit, containing seats for the occupants and controls for the airplane.

Horizontal Stabilizer - the horizontal air foil that is a fixed part of the tail assembly and to which the elevators are affixed.

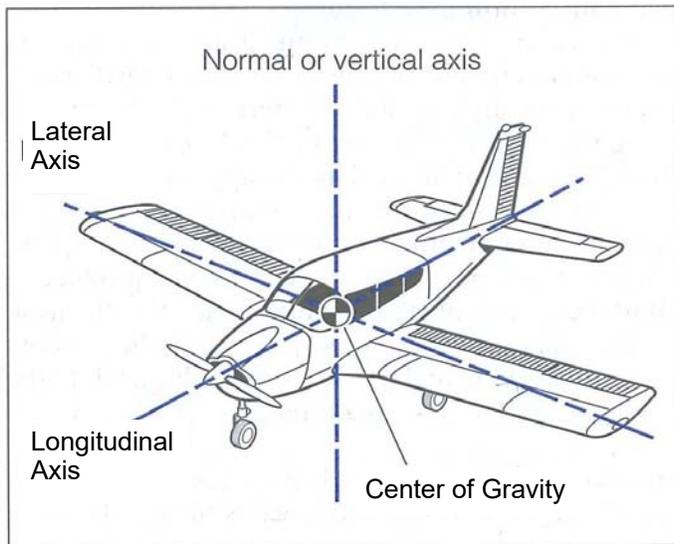
Vertical Stabilizer - the vertical structure or “fin” that extends upward and is part of the tail assembly.

Rudder - the movable primary control surface mounted on the trailing edge of the vertical fin of an airplane. Movement of the rudder rotates the airplane about its vertical axis.

Elevator - the horizontal, movable primary control surface in the tail section, or empennage, of an airplane. The elevator is hinged to the trailing edge of the fixed horizontal stabilizer.

Empennage - the tail section of the airplane consisting of the vertical stabilizer, the horizontal stabilizer and the associated control surfaces (elevators and rudder).

Engine cowl - the hood covering the airplane engine.



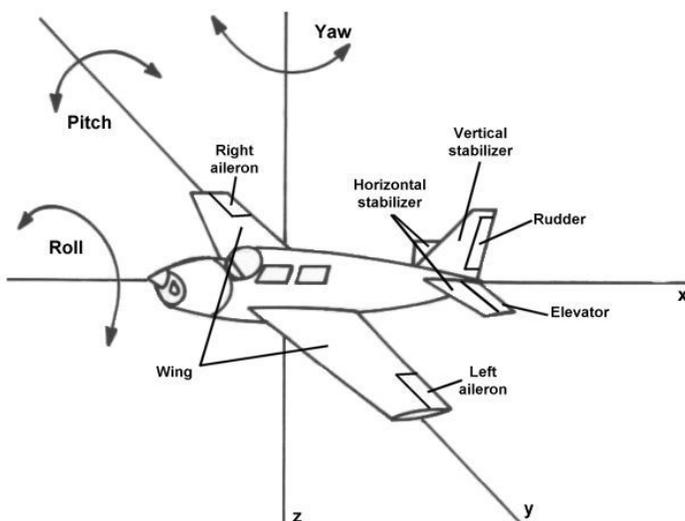
AVIATION VOCABULARY

Lateral Axis - an imaginary line passing through the center of gravity and extending across the airplane from wingtip to wingtip. Movement of the elevators rotates the airplane about the lateral axis. This is pitch or the Y axis.

Longitudinal Axis - an imaginary line passing through an aircraft from nose to tail, passing through the center of gravity. The longitudinal axis is also called the X axis or roll axis of the aircraft. Movement of the ailerons rotates an airplane about the longitudinal axis.

Vertical Axis - an imaginary line passing vertically through the center of gravity of an aircraft. The vertical axis is called the Z axis or the yaw axis. Movement of the rudder rotates an airplane about the vertical axis.

Center of Gravity (CG) - the point at which the airplane would balance if it were possible to suspend it at that point. It is the mass center of the airplane, or the theoretical point at which the entire weight of the airplane is assumed to be concentrated. The CG location depends on the distribution of the weight of the aircraft.

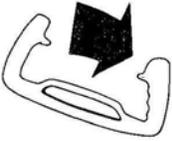


Pitch - the rotation of an airplane about the lateral axis. Movement of the elevators rotates the airplane about the lateral axis to change the pitch, causing the airplane to go up or down. Elevators control pitch. On a propeller, the blade angle as measured from the plane of rotation is known as pitch of the propeller blade.

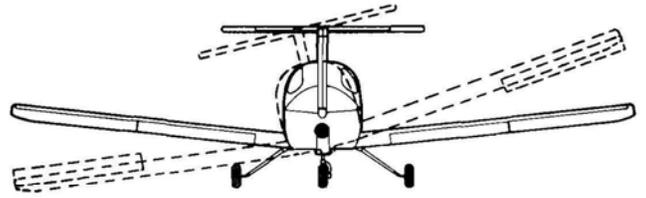
Roll - the motion of the aircraft about the longitudinal axis. Movement of the ailerons rotates an airplane about the longitudinal axis to roll the aircraft.

Yaw - Rotation about the vertical axis of the airplane. Movement of the rudder rotates an airplane about the vertical axis to produce yaw.

AILERONS

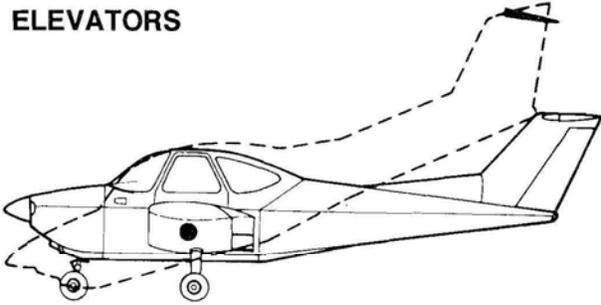


When the control wheel is turned to the right, the right aileron goes up and the left aileron goes down, rolling the airplane to the right.

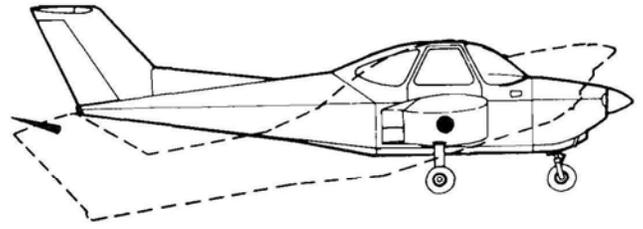


When the control wheel is turned to the left, the left aileron goes up and the right aileron goes down, rolling the airplane to the left.

ELEVATORS

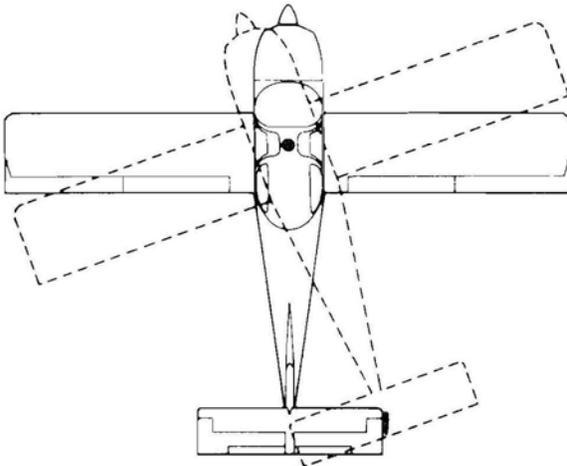


When the control column is pushed in, the elevators move down, pitching the tail of the airplane up and the nose down.

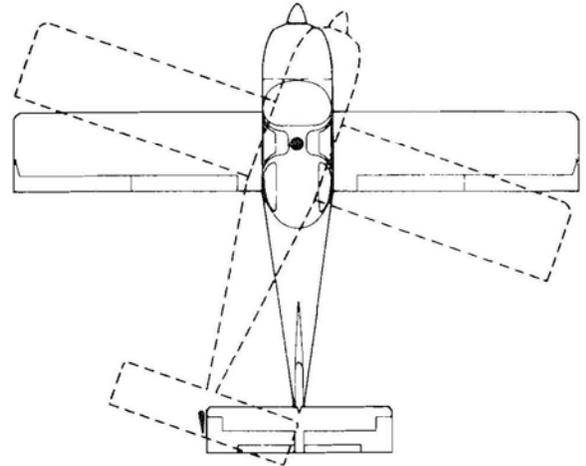


Pulling the control column back makes the elevators move up, pitching the tail of the airplane down and the nose up.

RUDDERS



Foot pressure on the left rudder pedal moves the rudder to the left, causing the nose of the airplane to move to the left.



When the right rudder pedal is pressed, the rudder moves to the right, causing the nose of the airplane to move to the right.

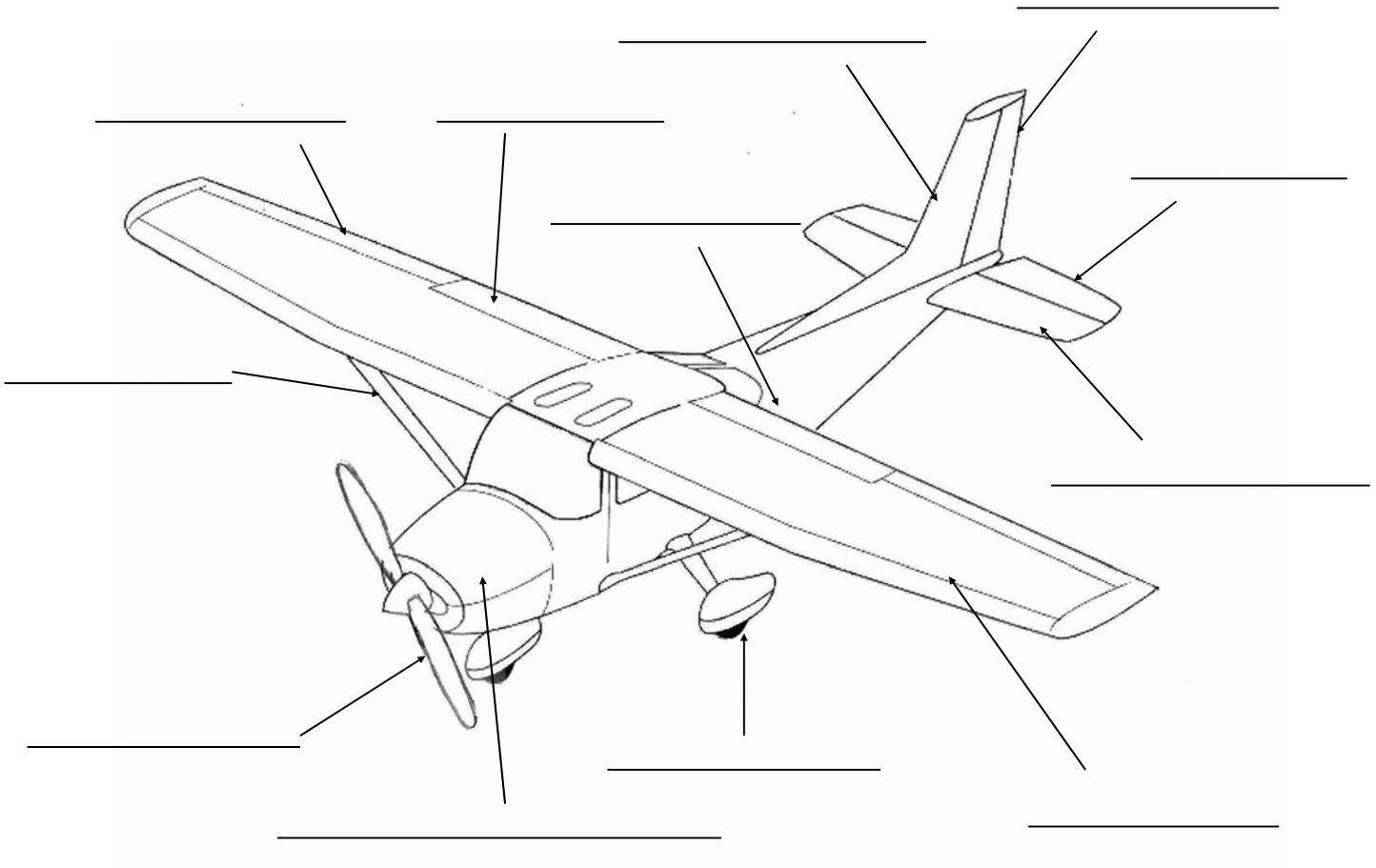
Activity - Airplane Vocabulary: Locate each word in the word bank and circle it in the word search puzzle. Words can run in any direction.

D L O N G I T U D I N A L A X I S X N M S E R I Y S G S E Z
 C C H A G I T E D R C T P O N F H E H A D G E A S E I A V B
 A A T O R N V B K A I L A N D I N G G E A R G P Z S B L R N
 B N H V X E O U N S D Y L W M F E A O B J T S P L Q X E E F
 N G Y I C Z D F W W M U F E Q G L S R N T I O D L J S A B A
 L L B M A F O D L E Y V T U D H E V X S L O G S P A I L M A
 R E C I N H Z I U P I C A E S N S G U W H W A T T H X E A Y
 E O E W F I T R O R A L G L E E P I R E H I O M D O A I C W
 Z F R R O D A N S L L N E N W I L F A B C R I C R V L N G V
 I A L C D K A L D N I O O I T A B A S T I X B B E L A A N C
 L T T J N M A U Y D D E S Y N D M K G A P Q Z U Z N C T I K
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 B A G O W O I E E T I A I L E R O N I H C W L E L T T G D P
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 T D E J R E R E A L G R A E N D T O M F L E Y Y T R S P U W
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 E Y I X V L U R D M Z C O A N T E W R D P I E R O A K N Y R
 V L O I J G O G O S O T D L O N H T I T R S A U Z M G L E E
 F C T C O T E M G P N O M A W I C H E L S L E M I W I L H X
 U Y A R A G N I G N E S T X M D A P I V D G A A R J F R C A
 S D D V R C E S E R N L A I P I P H E W K A N R O A V I R M
 T S E C A N M E R R I S L S H T H A M A L O R I H O F F U O
 L L S R U K I O X C F P S E Y A Y R E D F G L Q W C Y E L E
 E D R G T W J K O L M C Q A R I O E N I L D R O H C R R X I

WORD BANK: Aileron Airfoil Angle of Attack Camber
 Center of Gravity Chord Line Elevator Empennage Engine Cowl Flap
 Fuselage Horizontal Stabilizer Landing Gear Lateral Axis Leading Edge
 Longitudinal Axis Pitch Propeller Relative Wind Rudder Trailing Edge
 Vertical Axis Vertical Stabilizer Wing Wing Strut Yaw

Activity - Parts of an Airplane: Fill in the diagram with the parts of the airplane from the work bank below.

Aileron Rudder Elevator Propeller Fuselage Flaps Wing Strut
Engine Cowl Vertical Stabilizer Horizontal Stabilizer Landing Gear Wing



Activity - Paper Airplanes: Get some paper and create paper airplanes with your friends. See whose plane will fly the farthest. Try different shapes, wing configurations, adding or subtracting weights in various places. What design works the best? What characteristics do you think make it the best?
