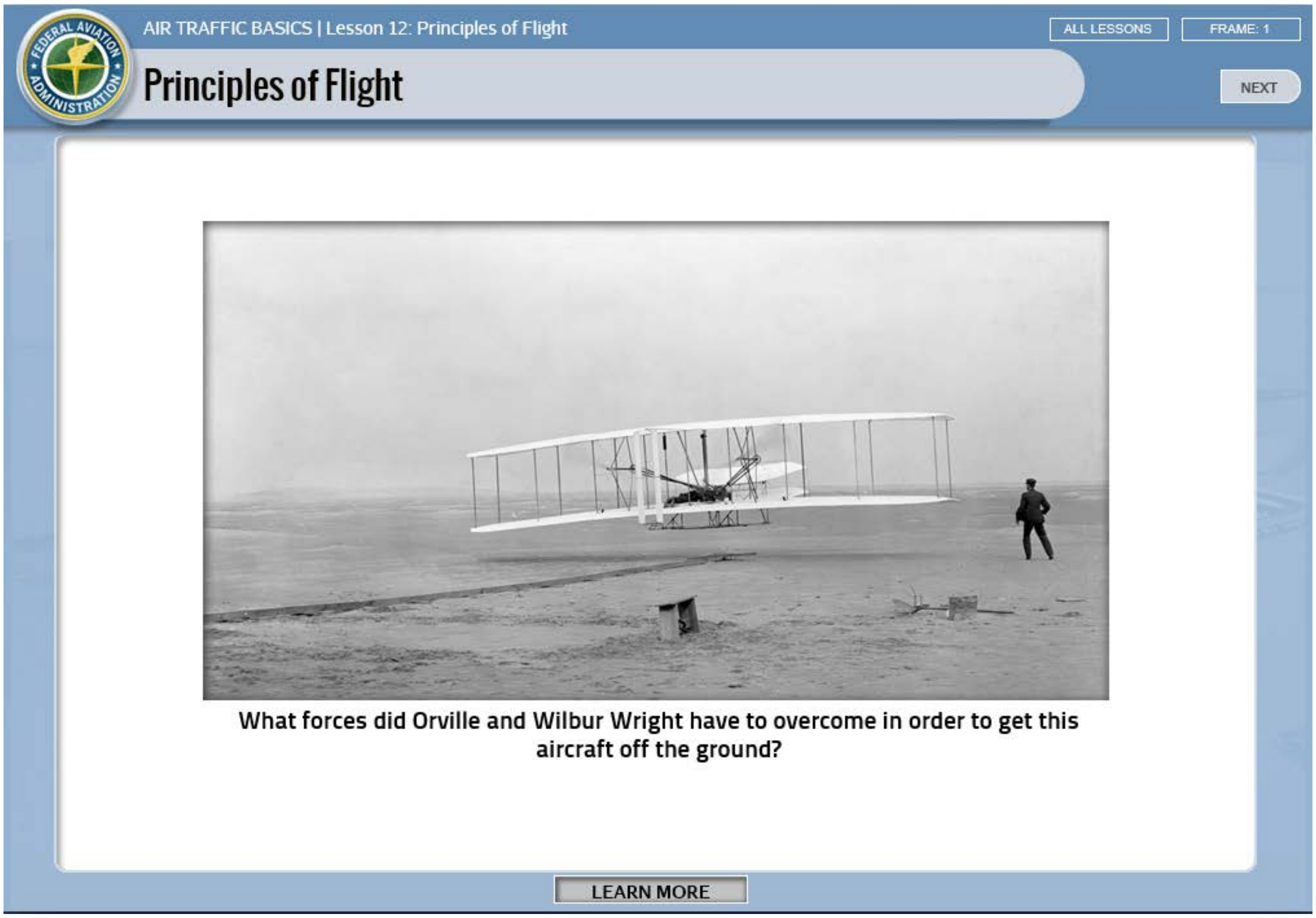
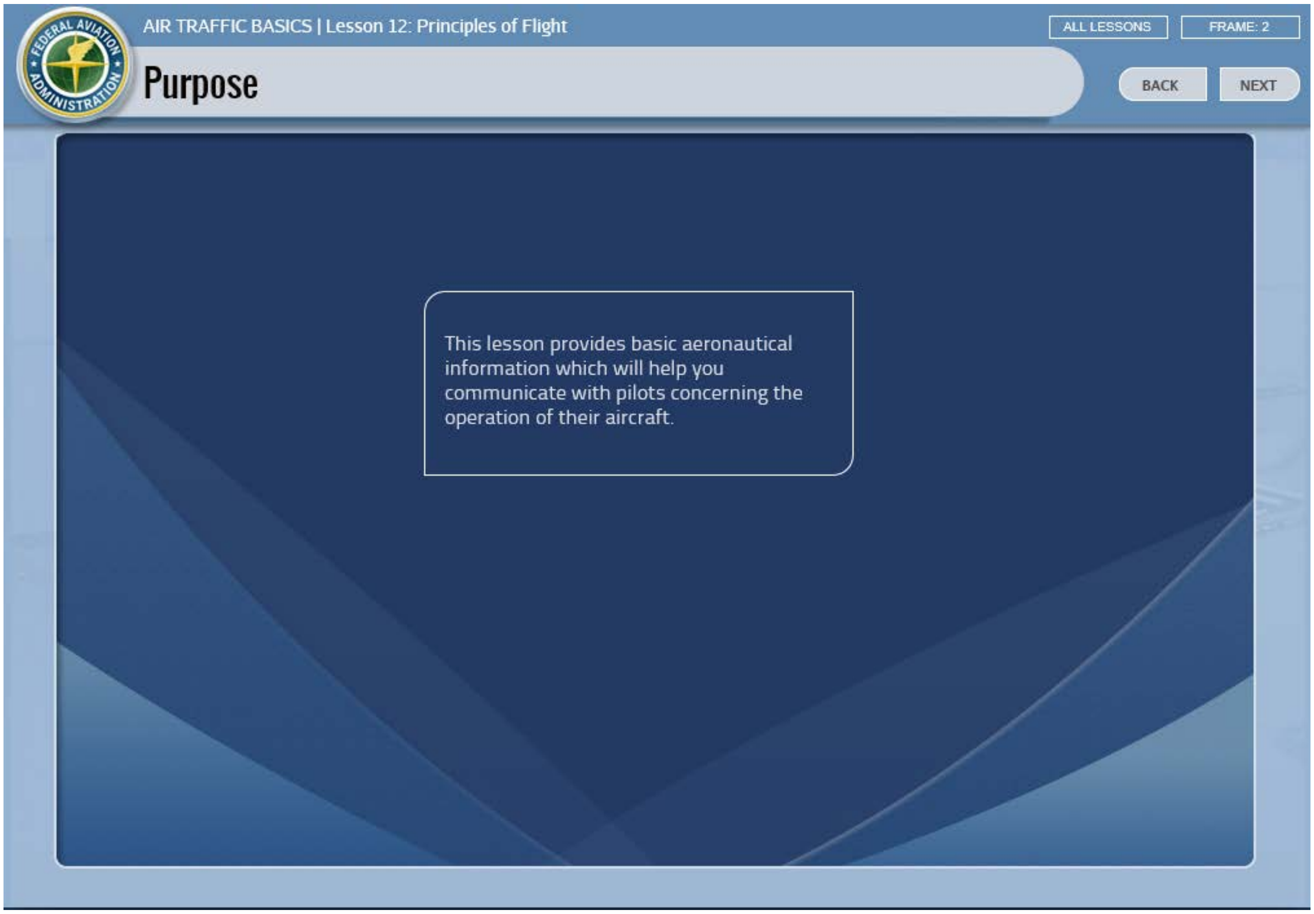


Knowledge of basic aerodynamics will help you communicate accurately and professionally with pilots concerning their aircraft. This knowledge will be used daily on a routine basis. Occasionally, during an aircraft emergency, an understanding of basic aerodynamics may be invaluable to you as an Air Traffic Control Specialist.


AIR TRAFFIC BASICS | Lesson 12: Principles of Flight
ALL LESSONS
FRAME: 2
Purpose
BACK
NEXT
This lesson provides basic aeronautical information which will help you communicate with pilots concerning the operation of their aircraft.

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 3

Objectives

BACK NEXT

In this lesson, you will identify:

1. Primary and secondary sources of lift
2. Relative wind
3. Types and parts of airfoils
4. Four forces that affect aircraft in flight, their interrelationships, and the effects on aircraft performance
5. Effects of altitude, temperature, and pressure on aircraft performance
6. Functions of primary and secondary flight controls and the movement around the aircraft axes.
7. Helicopter aerodynamics
8. Helicopter controls
9. Hazards affecting flight

You will meet the objectives in accordance with the following references:

- FAA-H-8083-21, Rotorcraft Flying Handbook
- FAA-H-8083-25, Pilot's Handbook of Aeronautical Knowledge
- Aeronautical Information Manual (AIM)
- AC 00-6, Aviation Weather

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 4

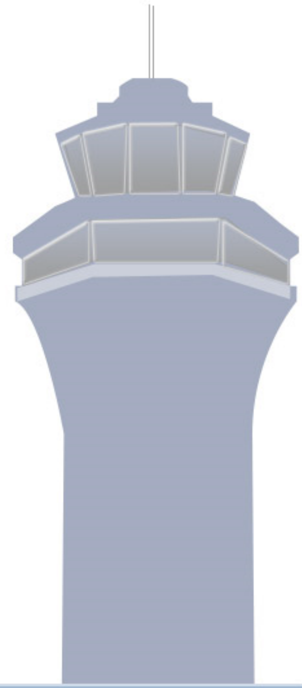
Theories of Flight

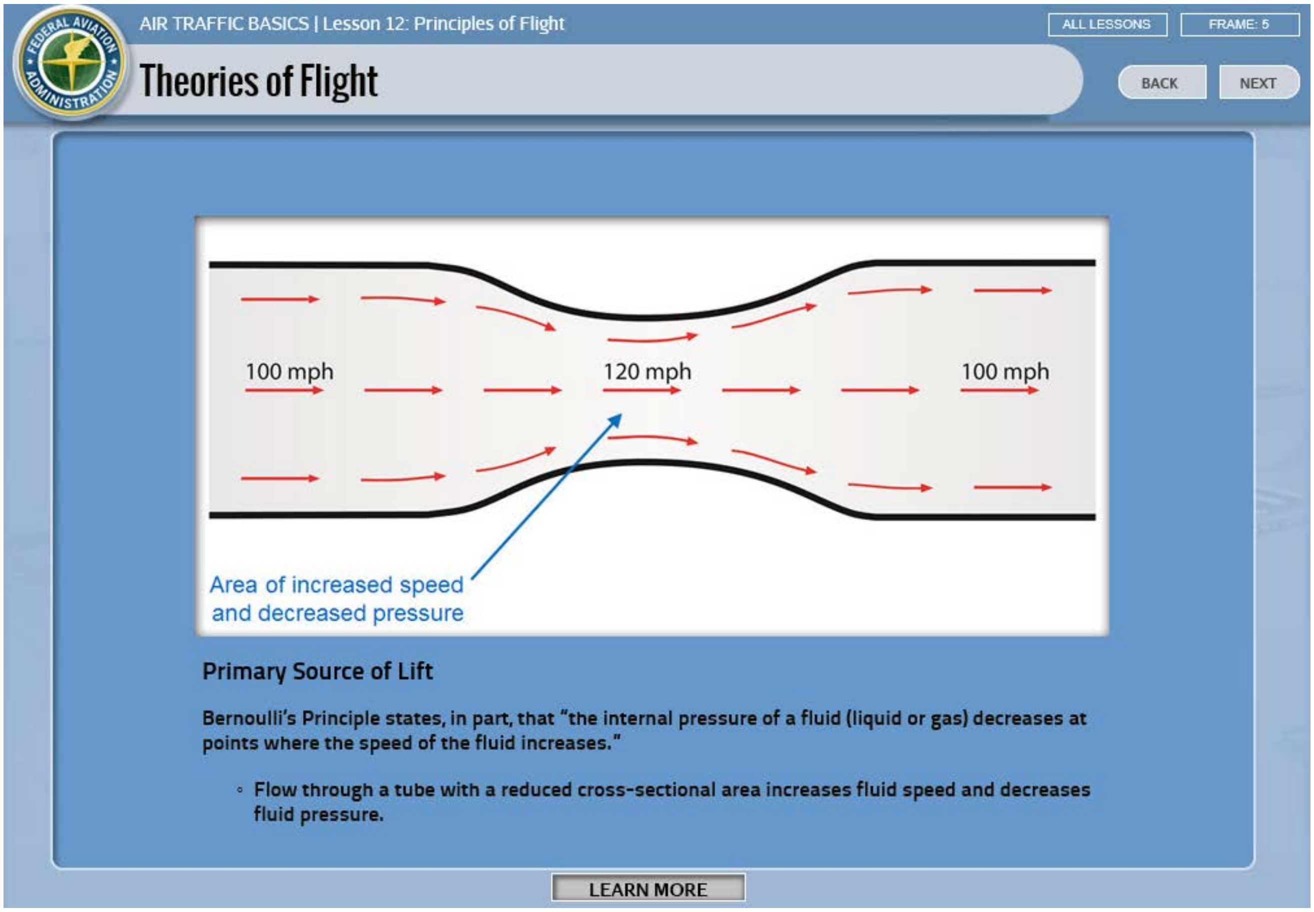
BACK NEXT

Physics of Flight

To understand what allows an aircraft to fly (how an airplane produces lift), basic knowledge of Bernoulli's Principle and one of Newton's Laws is necessary.

FAA-H-8083-25, Chap. 2





Lift is the upward force created by an airfoil when it is moved through the air.

An **airfoil** is any surface designed to obtain reaction such as lift from the air through which it moves.

Example: The wings of an airplane and the rotor blades of a helicopter are airfoils.

Reference: FAA-H-8083-25, Chap. 2

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 6

Theories of Flight

BACK NEXT

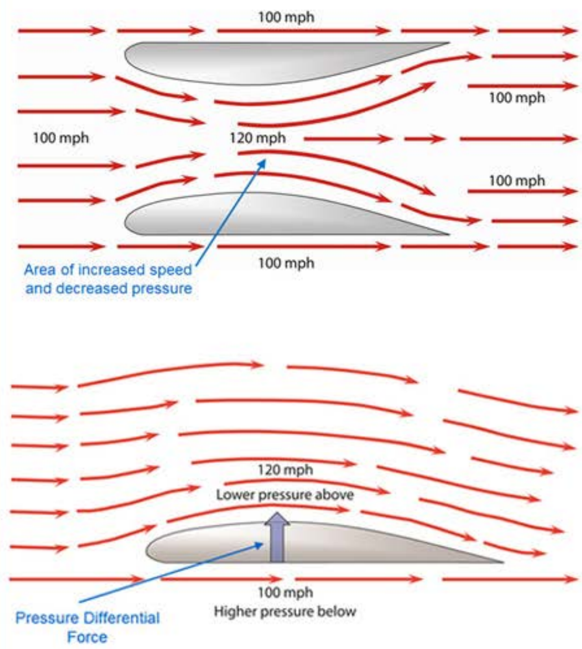
Primary Source of Lift

The tube can be replaced by two airfoils and cause the same effects.

The pressure differential around an airfoil is the primary source of lift.

- **A pressure differential occurs when there is a pressure difference between opposing sides of a surface.**
- **A pressure differential causes the higher pressure area below the airfoil to try to equalize pressure by pushing (lifting) the airfoil toward the lower pressure area above.**
- **This lift is the result of Bernoulli's Principle.**

FAA-H-8083-25, Chap. 2



AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

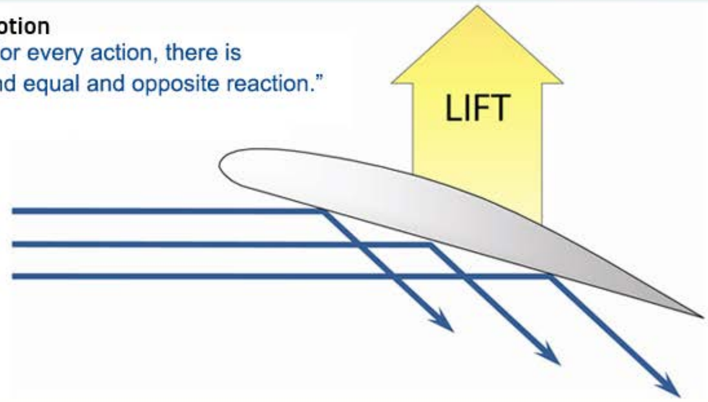
ALL LESSONS | FRAME: 7

Theories of Flight

BACK | NEXT

Newton's Third Law of Motion

"For every action, there is
and equal and opposite reaction."



Secondary Source of Lift

A secondary source of lift is an upward force generated by air striking the underside of an airfoil and being deflected downward.

- In this graphic:
  - Air is striking the underside of an airfoil (action)
  - The wing is being pushed up (reaction)

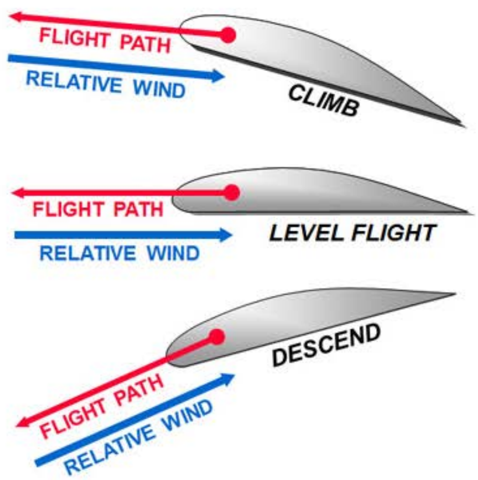
FAA-H-8083-25, Chap. 2

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS | FRAME: 8

Relative Wind

BACK | NEXT



Relative Wind

Relative wind is the direction of the airflow produced by an object moving through the air.

The relative wind for an aircraft in flight flows in a direction parallel with and opposite to the direction of flight.

The actual flight path of the aircraft determines the direction of the relative wind.

FAA-H-8083-25, Chap. 2, 3, Glossary

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 9

BACK NEXT

Airfoils

Types of Airfoils

Types of airfoils on aircraft are:

- **Wing**
- **Propeller**
- **Helicopter rotor**
- **Horizontal stabilizer**
- **Vertical tail surfaces**
- **Fuselage**

The three principle airfoils that produce lift on an aircraft are:

- **Wing**
- **Horizontal tail surfaces**
- **Propeller (lift produced in a forward direction)**

FAA-H-8083-25, Chap. 2

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 10

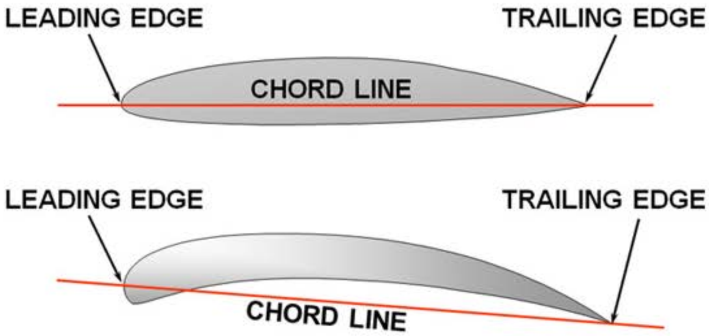
Airfoils

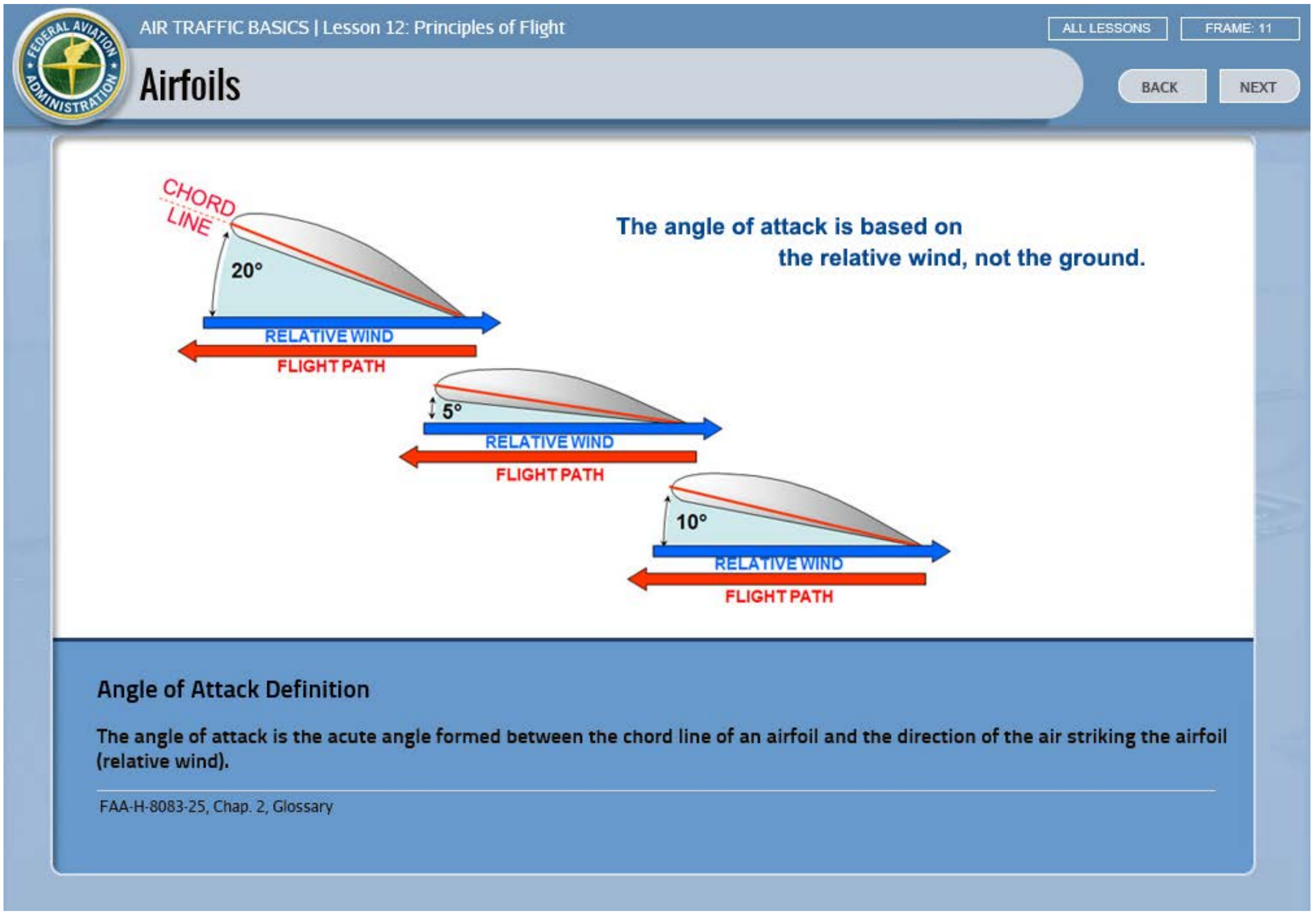
BACK NEXT

Parts of an Airfoil

- Leading edge
- Trailing edge
- Chord line
  - An imaginary straight line drawn from the leading edge to the trailing edge of a cross section of an airfoil.

FAA-H-8083-25, Chap. 2



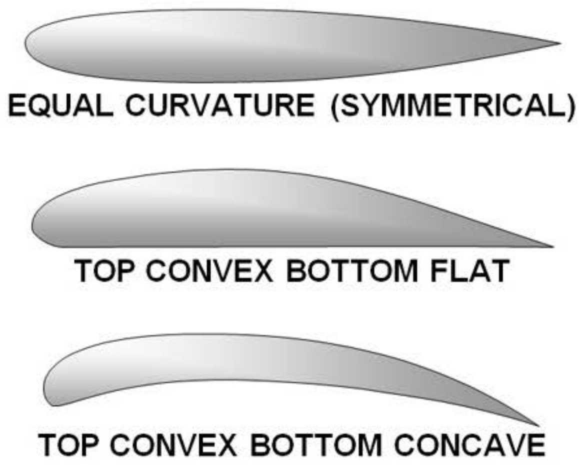

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight
ALL LESSONS
FRAME: 11
Airfoils
BACK
NEXT
CHORD LINE
20°
RELATIVE WIND
FLIGHT PATH
5°
RELATIVE WIND
FLIGHT PATH
10°
RELATIVE WIND
FLIGHT PATH
The angle of attack is based on the relative wind, not the ground.
Angle of Attack Definition
The angle of attack is the acute angle formed between the chord line of an airfoil and the direction of the air striking the airfoil (relative wind).
FAA-H-8083-25, Chap. 2, Glossary

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS | FRAME: 12

BACK | NEXT

Airfoils



Camber

The camber is the curvature of the airfoil from the leading edge to the trailing edge.

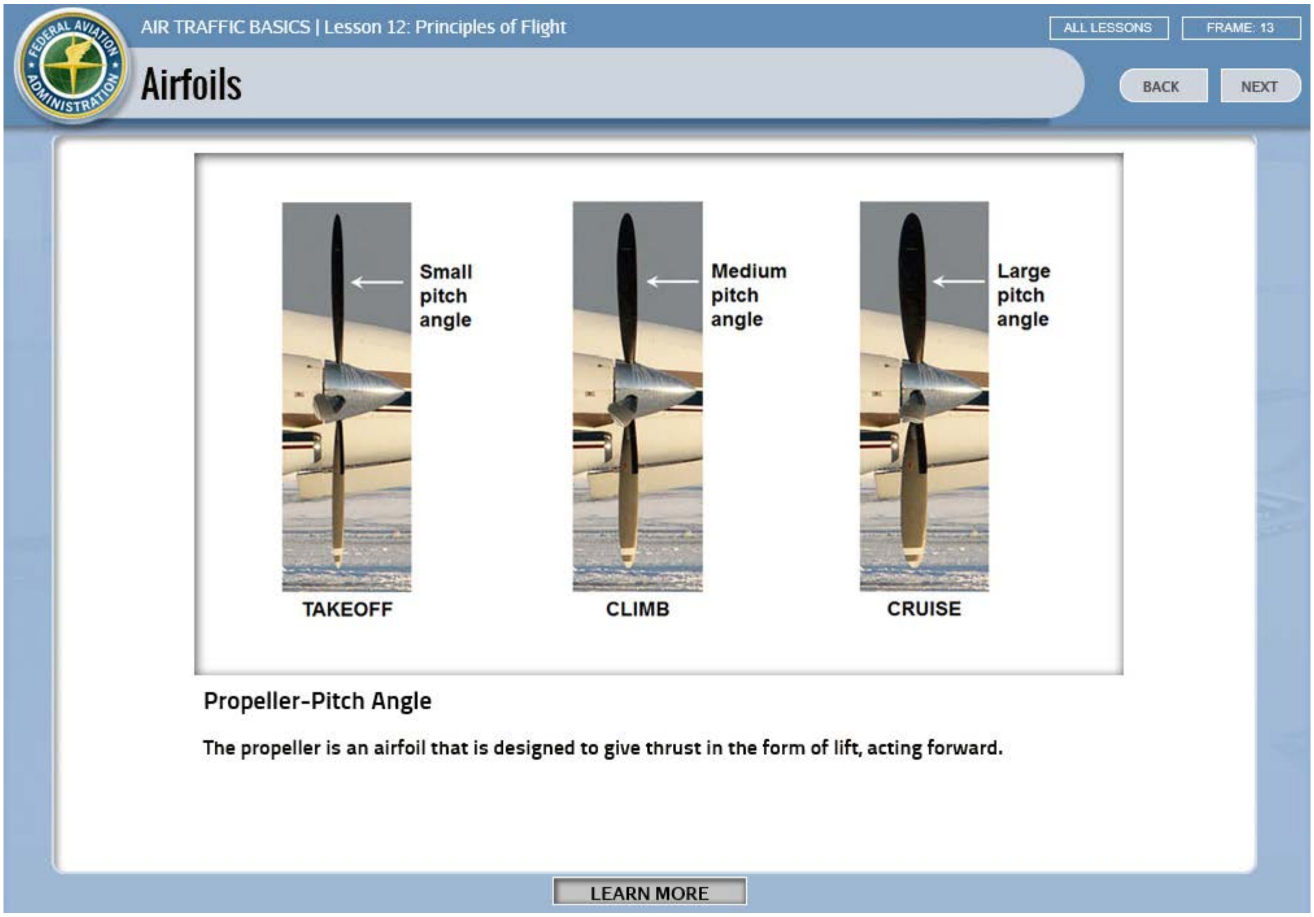
Lower camber refers to the curvature of the lower surface.

Upper camber refers to the curvature of the upper surface.

The camber or curvature of a wing is designed according to the:

- Type of aircraft
- Planned speed of the aircraft
- Weight of the aircraft
- Planned use of the aircraft

FAA-H-8083-25, Chap. 2, Glossary



There are generally two different types:

- Fixed pitch
  - The blade angle is set and cannot be adjusted
  - Used on small, less expensive, lower performance aircraft

- Variable pitch or constant speed
  - Blade angle is adjustable by pilot
  - More efficient performance

Reference: FAA-H-8083-25, Chaps. 3 and 5

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 14

BACK NEXT

Airfoils

Wing Planform

The wing planform is the shape or form of a wing as viewed from above. It may be long and tapered, short and rectangular, or various other shapes.

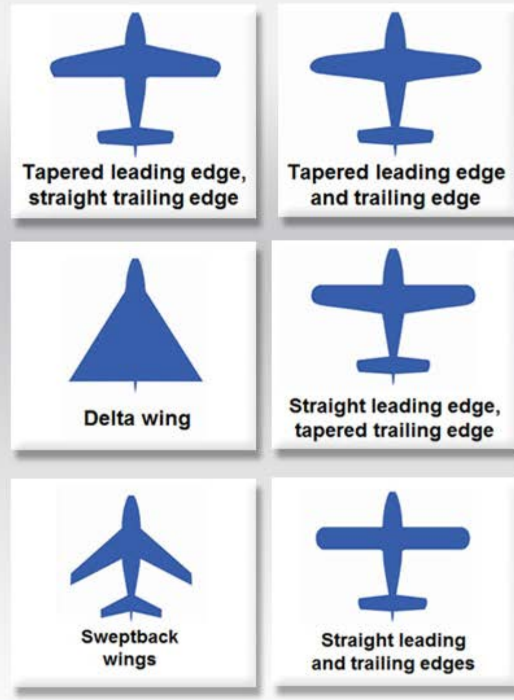
The planform design is dependent on the use of the aircraft.

- Examples: The faster the aircraft, the thinner the airfoil to reduce drag. The thinner the airfoil, the more surface area needed to produce lift.

The amount of lift generated by the wing depends upon several factors:

- Speed of the wing through the air
- Angle of attack
- Planform of the wing
- Wing area
- Density of the air
- Camber

FAA-H-8083-25, Chap. 3



AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 15

BACK NEXT

Forces Affecting Flight

Four Forces Affecting Flight

- **Lift - Upward force created by an airfoil when it is moved through the air**
- **Weight - Downward force which tends to draw all bodies vertically toward the center of the Earth**
- **Thrust - Manmade force that pulls or pushes the aircraft through the air**
- **Drag - Rearward acting force which resists the forward movement of the airplane through the air**

FAA-H-8083-25, Chap. 3

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 16

Forces Affecting Flight

BACK NEXT

Interrelationship of Lift and Weight

In straight and level flight (constant altitude), lift counterbalances the aircraft's weight, or

- When lift and weight are in equilibrium, the aircraft neither gains nor loses altitude.

If lift is greater than weight, the aircraft will climb.

If weight is greater than lift, the aircraft will descend.

FAA-H-8083-25, Chap. 3

Forces Affecting Flight

Interrelationship of Thrust and Drag

In straight and level flight, thrust and drag are equal in magnitude if a constant airspeed is being maintained.

Thrust is controlled by the throttle.

- As more throttle is applied, more thrust is produced.

When the thrust of the propeller is increased, thrust momentarily exceeds drag and the airspeed will increase, provided straight and level flight is maintained.

- With an increase in airspeed, drag increases rapidly.
- As soon as thrust and drag become equalized, the airspeed will again become constant.

FAA-H-8083-25, Chap. 3

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 18

Effects of Atmosphere on Aircraft Performance

BACK NEXT

Nature of the Atmosphere

Life exists at the bottom of an ocean of air called the atmosphere.

The atmosphere extends upward from the Earth's surface for many miles, gradually thinning as it nears the top.

Four key properties of the atmosphere that affect air density and aircraft performance are:

- Temperature
- Pressure
- Altitude
- Water Vapor (humidity)

NOTE: References to aircraft performance in this lesson include length of takeoff roll, initial rate of climb, and length of landing roll.

FAA-H-8083-25, Chap. 10

Four Atmospheric Properties

Temperature Altitude Pressure Water Vapor

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 19

BACK NEXT

Effects of Atmosphere on Aircraft Performance

Temperature

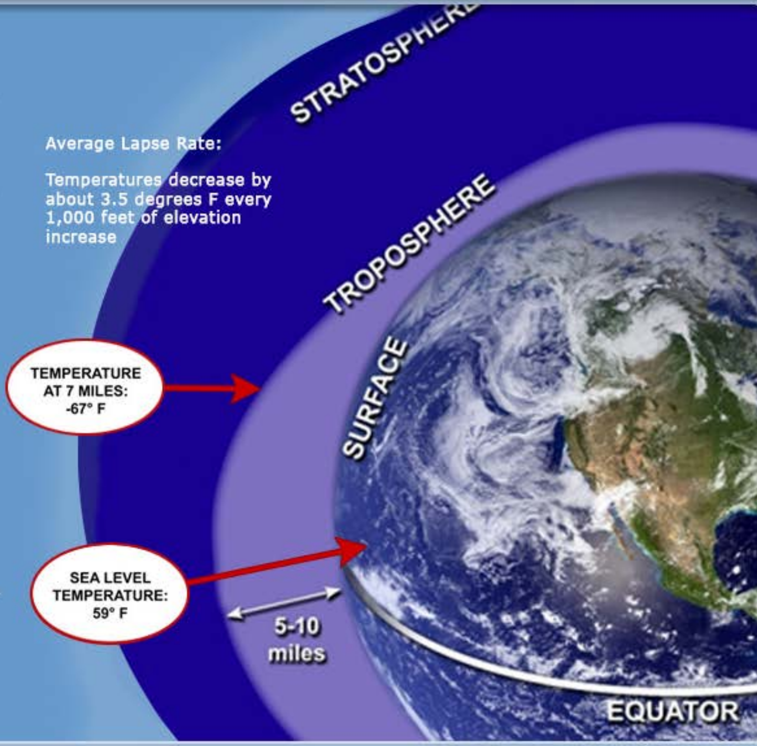
Near the surface, the air is relatively warm from contact with the Earth.

- Surface temperatures change frequently and are relatively warmer during the day and summer, and cooler during night and winter.
- The surface temperature in the U.S. averages about 59 degrees Fahrenheit.

As altitude increases, the temperature decreases on average by 3.5 degrees Fahrenheit (2° C) every 1,000 feet until air temperature reaches about minus 67 degrees at 7 miles above the Earth.

- A decrease of temperature with height is called a lapse rate.
- Cold air is denser than warm air.

FAA-H-8083-25, Chap. 10

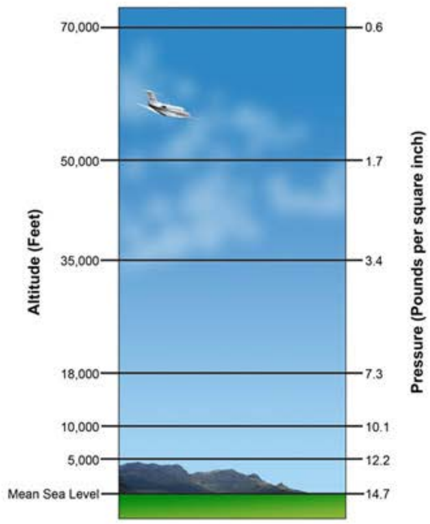


AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 20

Effects of Atmosphere on Aircraft Performance

BACK NEXT



Pressure

A body of air as deep as the atmosphere has tremendous weight.

- The weight of the atmosphere on an average person is about 20 tons!

Pressure is the result of the weight of the air above the measurement position.

- The average pressure at sea level is 14.7 pounds per square inch (psi) which corresponds with 29.92 inches of mercury.

Pressure decreases with height.

- At higher altitudes, there is less air above the measurement position and less weight.
- For example, pressure decreases from 14.7 psi at sea level to 12.2 psi at 5,000 feet above sea level, and to 3.4 psi at 35,000 feet (FL350).
- Lower pressure results in less dense air.

FAA-H-8083-25, Chap. 10

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 21

Effects of Atmosphere on Aircraft Performance

BACK NEXT

Water Vapor/Humidity

Moisture in the atmosphere is the invisible gas called water vapor.

The higher the temperature, the greater amount of water vapor the air can hold.

An increase in water vapor (higher humidity) results in a decrease in air density.

FAA-H-8083-25, Chap. 10

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 22

Effects of Atmosphere on Aircraft Performance

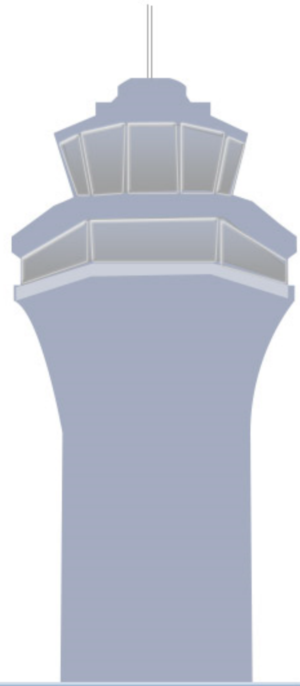
BACK NEXT

Density and Density Altitude

Density is the mass of air per unit volume and is often described by the term density altitude.

- **Density altitude—the altitude in the standard atmosphere corresponding to a particular value of air density**
- **Density altitude calculations are used by pilots to determine aircraft performance characteristics given the existing atmospheric conditions.**
- **Higher density altitude indicates lower density (thinner air).**

AIM, par. 7-5-5;FAA-H-8083-25, Chap. 10



AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 23

Effects of Atmosphere on Aircraft Performance

BACK NEXT

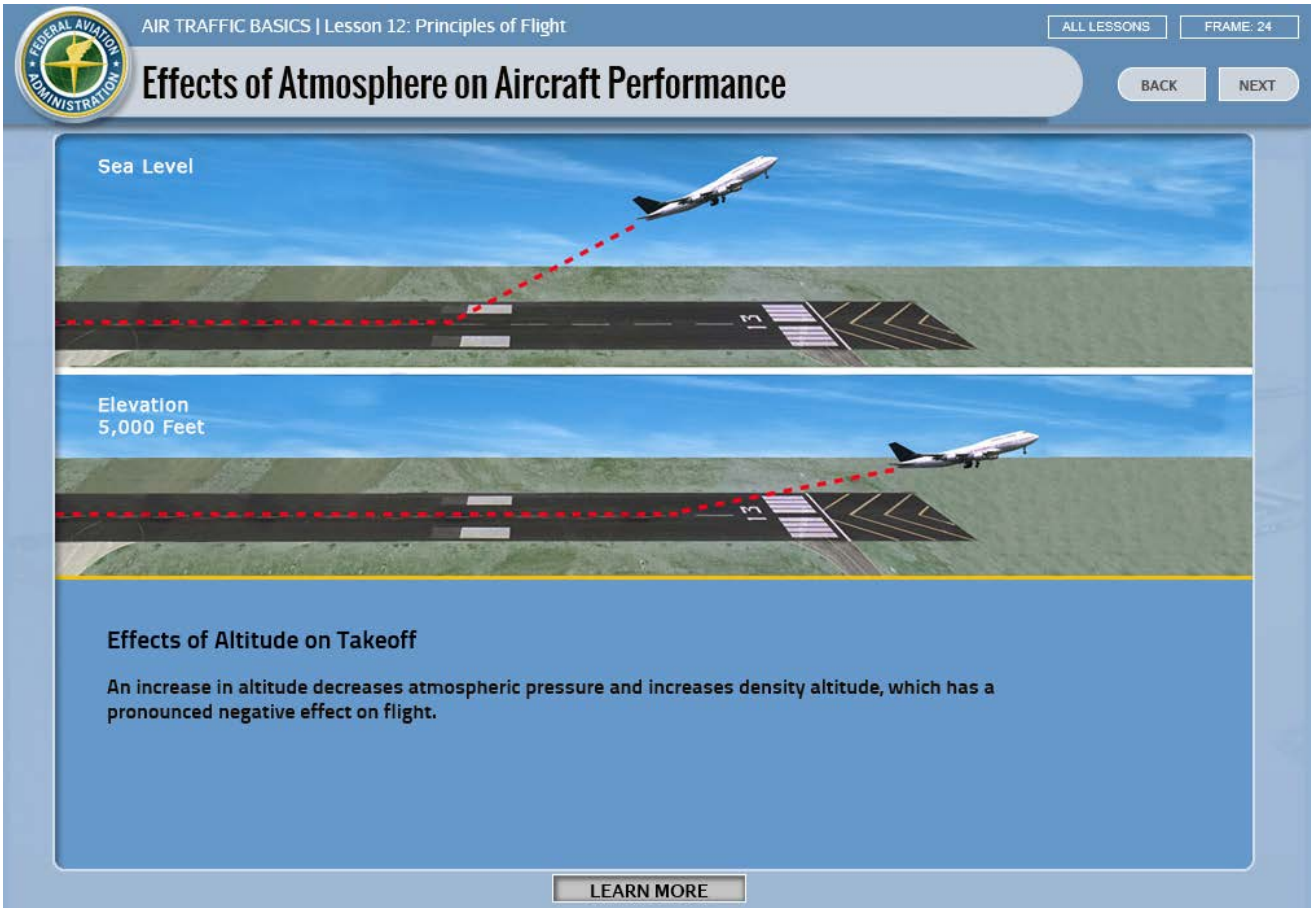
Density and Density Altitude

Increased density altitude, such as in mountainous and high terrain areas with warm humid air, can greatly reduce aircraft performance, including:

- **Longer takeoff roll**
- **Longer landing roll**
- **Slower climb rate**
- **Reduced engine power output**

NOTE: As you can see from the above information, the effects of high-density altitude on aircraft performance is going to greatly impact controller workload, e.g. more spacing required, slower climbs, more time to clear the runway, etc.

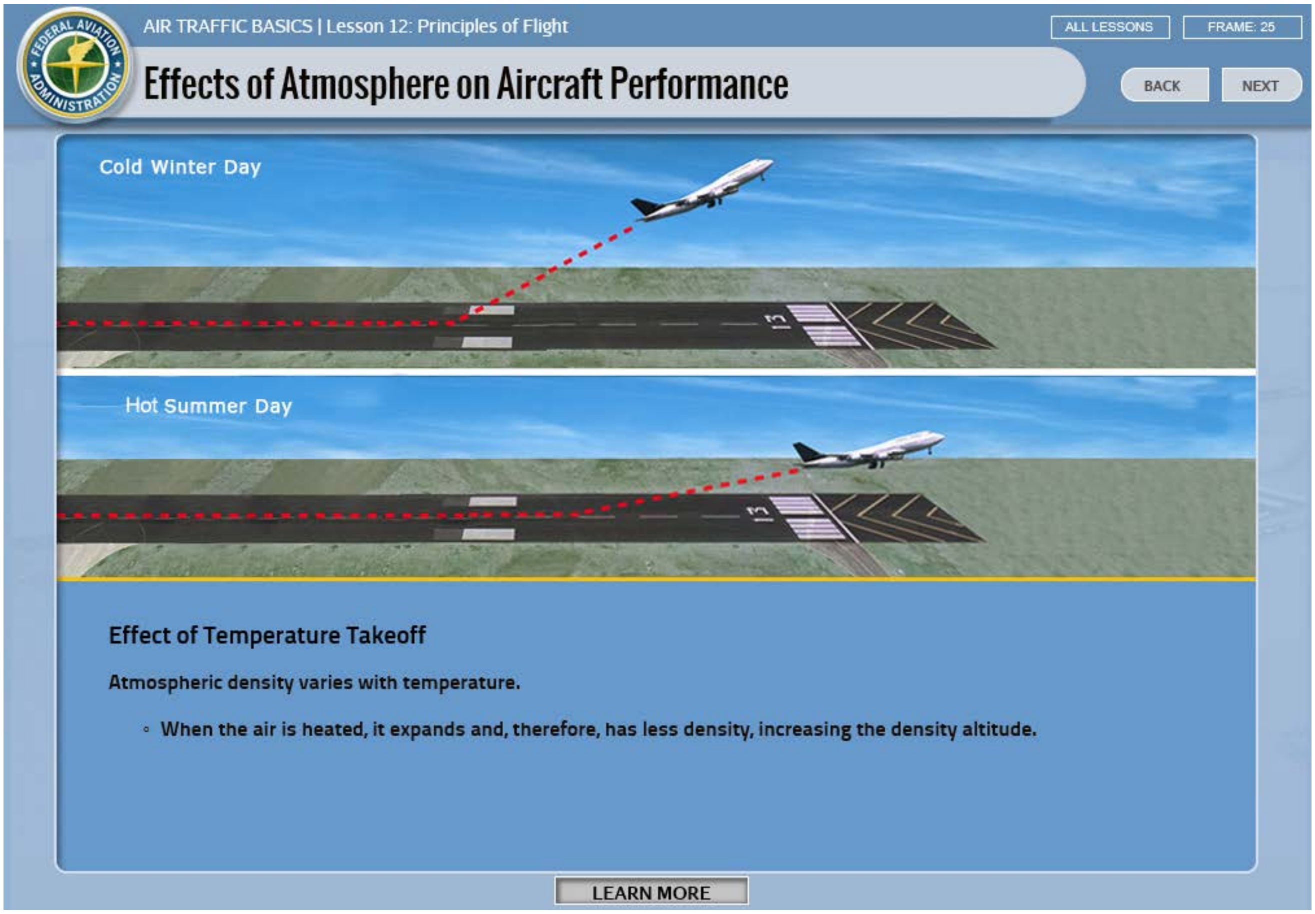
AIM, par. 7-5-5;FAA-H-8083-25, Chap. 10



At higher elevation airfields:

- The length of the runway needed for takeoff roll will be increased
- The climb performance of an aircraft will be diminished
- The length of the runway needed for the landing roll will be increased
- The amount of power an engine can produce will be decreased

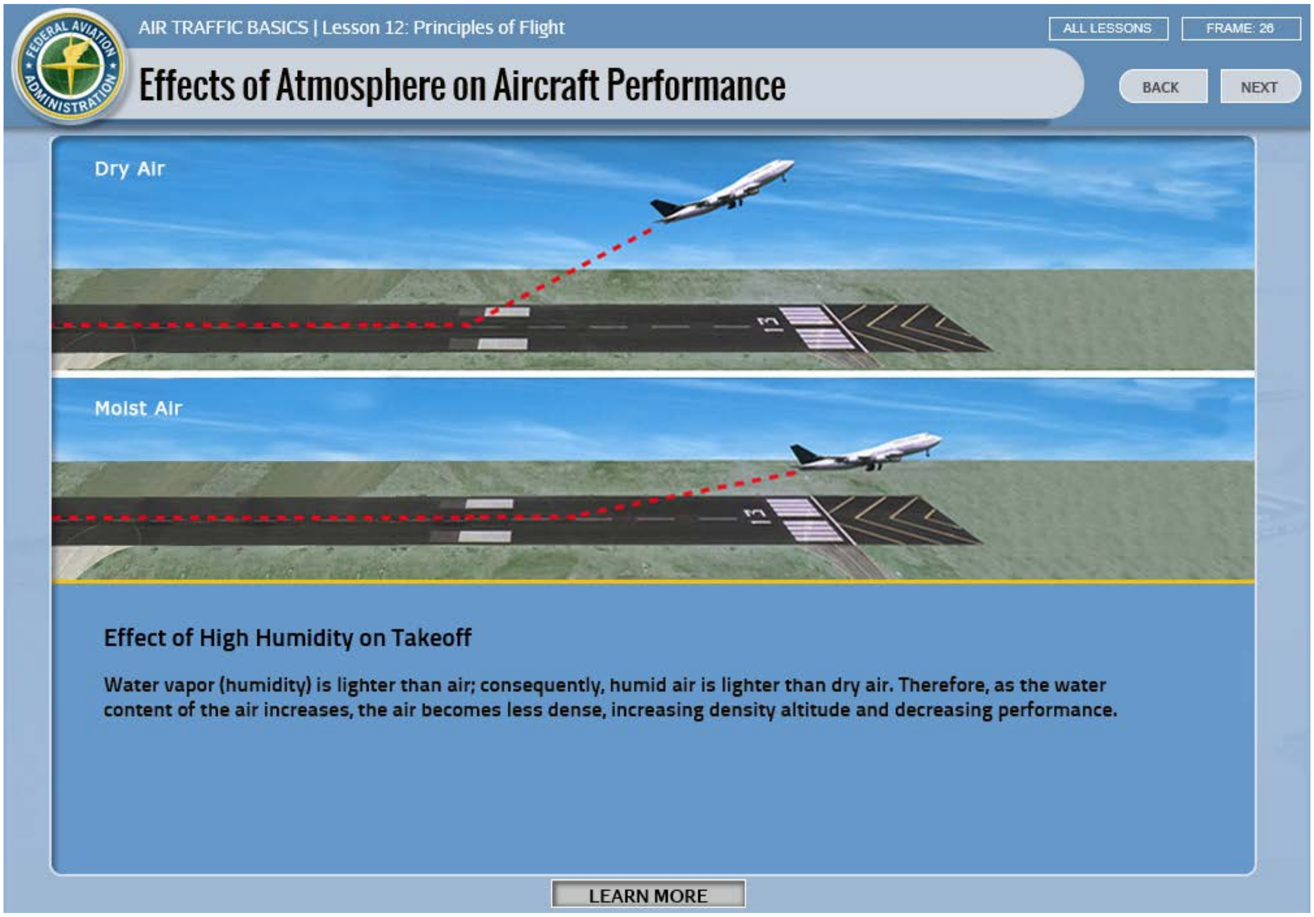
Reference: FAA-H-8083-25, Chap. 10



On a hot day, as compared to a cold day:

- Takeoff run will be longer
- Rate of climb will be slower
- Landing speed will be faster
- Engine power output will be decreased

Reference: FAA-H-8083-25, Chap. 10



Increased humidity (decreased air density) has a less pronounced effect on density altitude than altitude and temperature, but can still have a pronounced effect on flight.

On a humid day, as compared to a dry day:

- Takeoff run will be longer
- Rate of climb will be slower
- Landing speed will be faster
- Engine power output will be decreased

Reference: FAA-H-8083-25, Chap. 10

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

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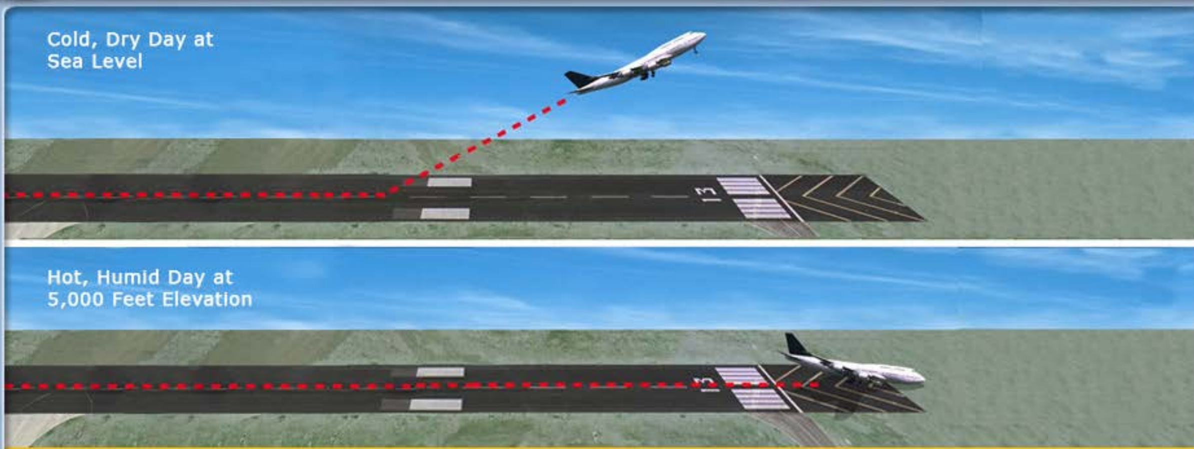
Effects of Atmosphere on Aircraft Performance

BACK | NEXT

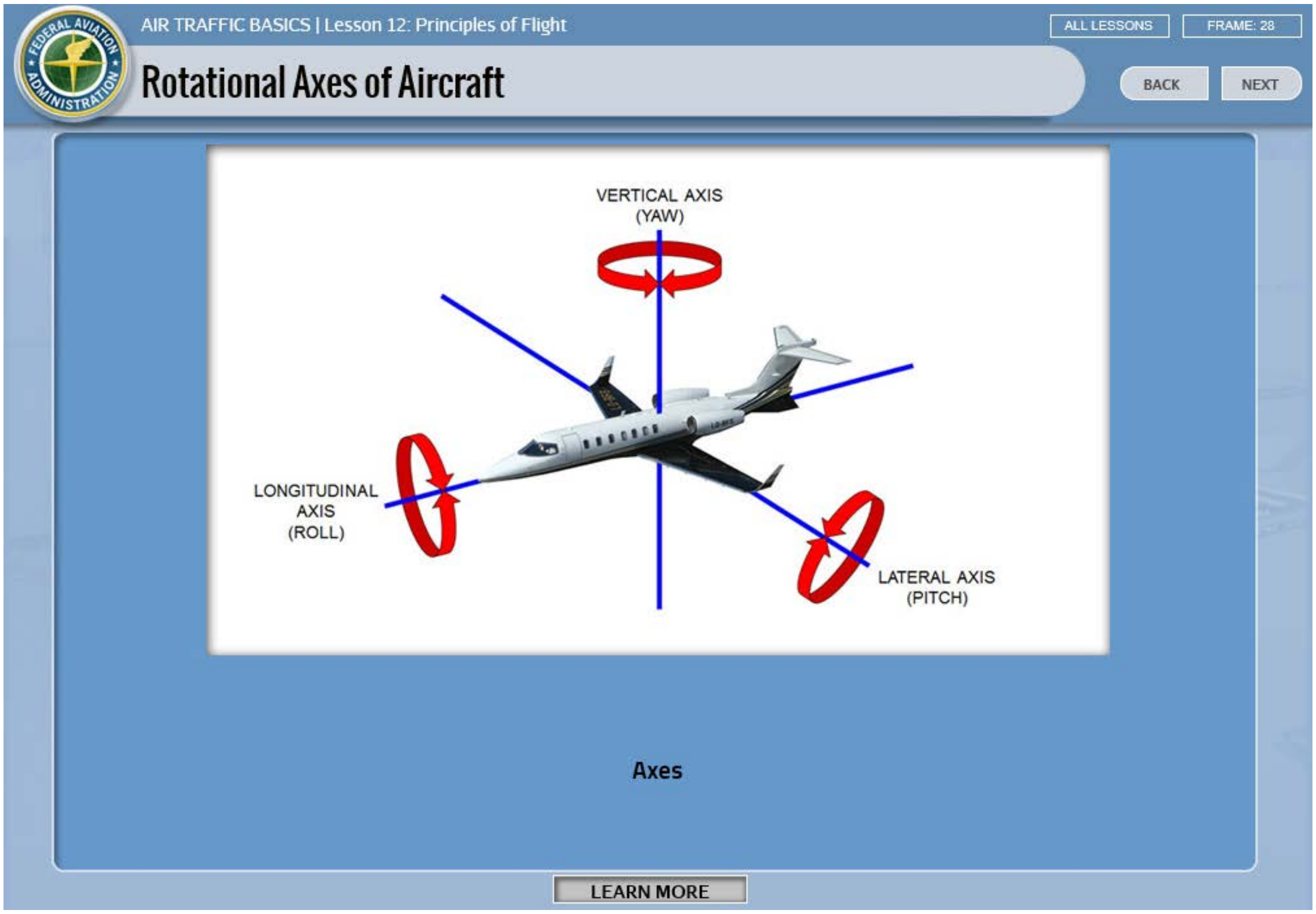


Combined Effects on Takeoff

High elevation airfields with hot and humid conditions will have very poor aircraft performance.

- Length of runway needed for takeoff roll will be increased
- Initial climb performance of an aircraft will be diminished
- Length of runway needed for landing roll will be increased
- Engine power output will be decreased

FAA-H-8083-25, Chap. 10



An axis is a straight line about which a body rotates.

- An aircraft has three axes of rotation.
  - Longitudinal Axis (Roll)
  - Lateral Axis (Pitch)
  - Vertical Axis (Yaw)
- The directions of rotation are always relative to the pilot view.

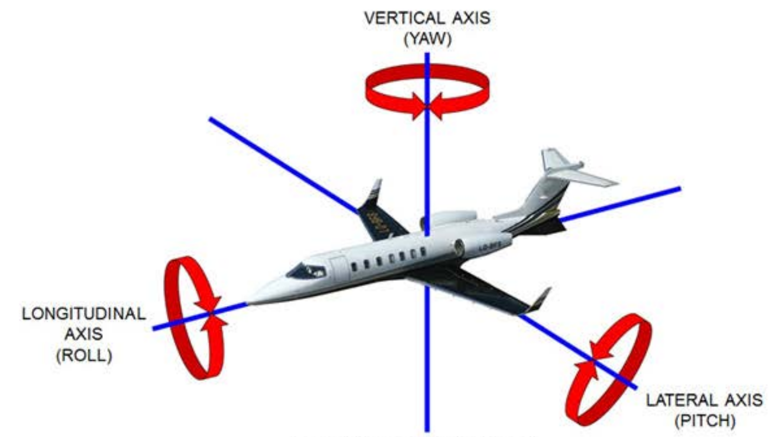
Reference: FAA-H-8083-25, Chap. 3

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 29

Rotational Axes of Aircraft

BACK NEXT



Longitudinal Axis (Roll)

The longitudinal axis is an imaginary straight line through the fuselage, nose to tail.

- **Movement around the longitudinal axis is called the roll movement.**
- **Controls angle of bank**
- **Controls aircraft heading**

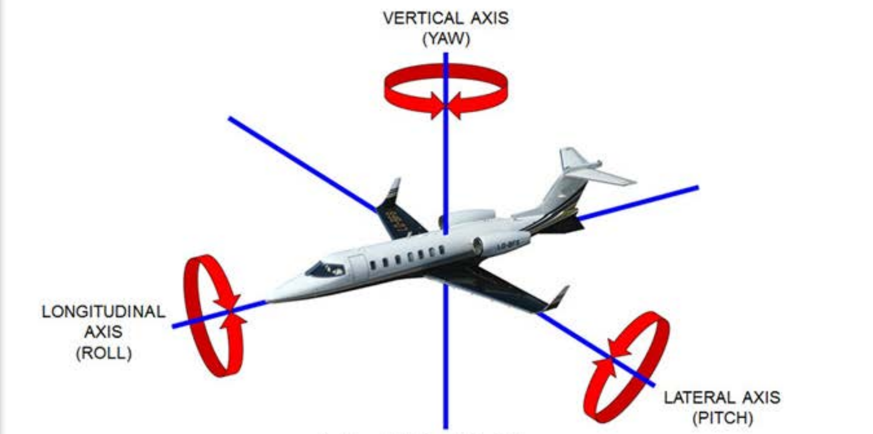
FAA-H-8083-25, Chap. 3

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS | FRAME: 30

Rotational Axes of Aircraft

BACK | NEXT



Lateral Axis (Pitch)

The lateral axis is a line through the wing from wing tip to wing tip.

- **Movement around the lateral axis is called the pitch movement (nose up, nose down).**
- **Controls angle of attack and aircraft pitch attitude**
- **Controls altitude**

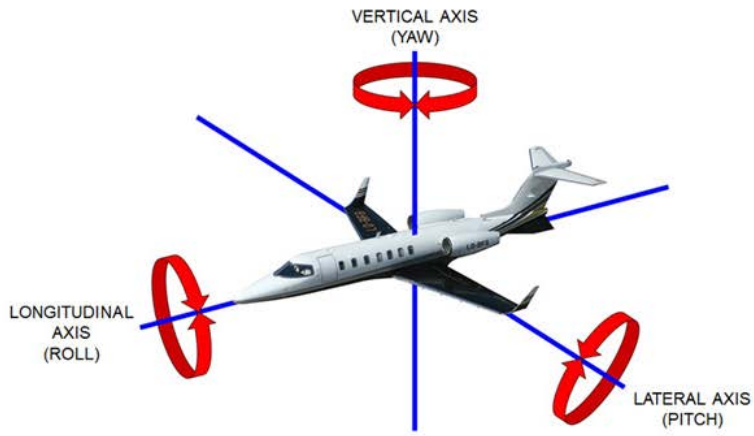
FAA-H-8083-25, Chap. 3

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 31

Rotational Axes of Aircraft

BACK NEXT



Vertical Axis (Yaw)

The vertical axis is a line through the center of gravity from top to bottom.

- **Movement around the vertical axis is called yaw movement.**
- **Controls left-to-right alignment of the longitudinal axis with respect to the relative wind**
- **Controls the streamlined motion of the aircraft**

FAA-H-8083-25, Chap. 3

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 32

Primary Control Surfaces

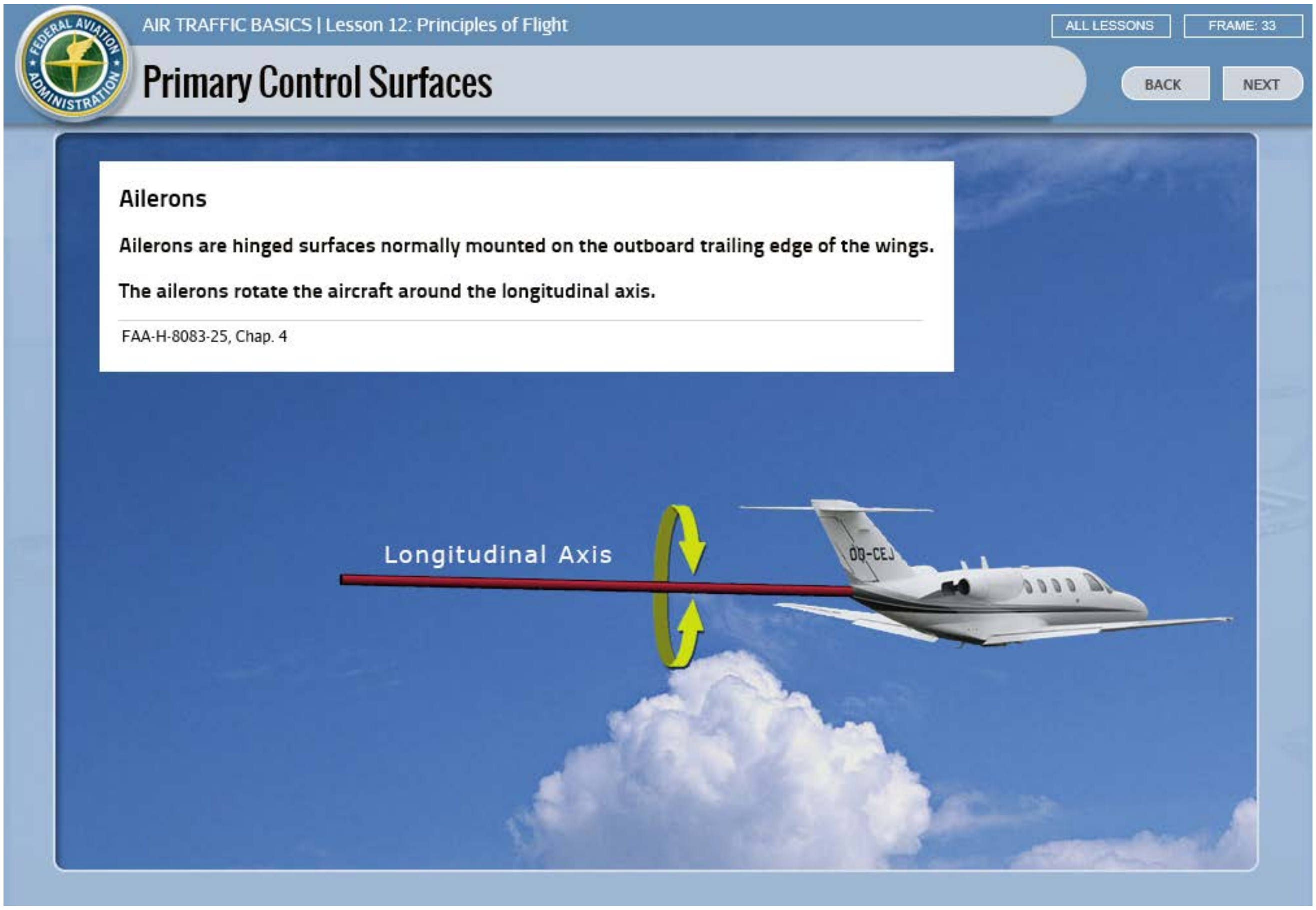
BACK NEXT

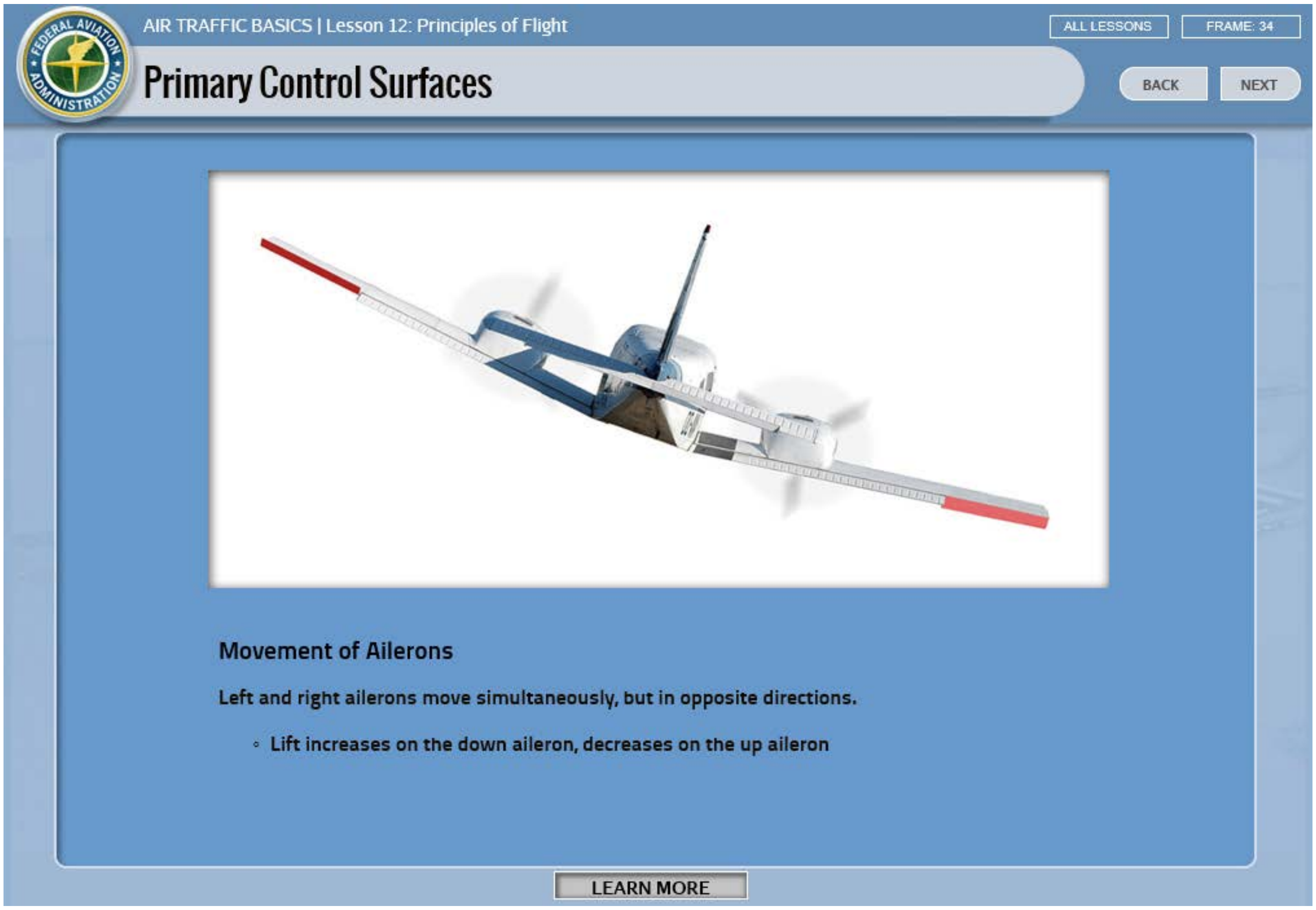
Aircraft Control

Control of the aircraft movement about its three axes of rotation is affected by the primary control surfaces.

- **Ailerons (controls roll)**
- **Elevator (moves as a unit; controls pitch)**
- **Rudder (controls yaw)**

FAA-H-8083-25, Chap. 4


AIR TRAFFIC BASICS | Lesson 12: Principles of Flight
ALL LESSONS
FRAME: 33
Primary Control Surfaces
BACK
NEXT
Ailerons
Ailerons are hinged surfaces normally mounted on the outboard trailing edge of the wings.
The ailerons rotate the aircraft around the longitudinal axis.
FAA-H-8083-25, Chap. 4
Longitudinal Axis



Moving ailerons induces adverse yaw.

- Adverse yaw is the tendency of the nose of the aircraft to yaw in the opposite direction of the turn.
- Adverse yaw is caused by the drag of the "down" aileron.

Reference: FAA-H-8083-25, Chap. 4

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 35

Primary Control Surfaces

BACK NEXT

Yoke Position When Wings are Level or Banking

The control yoke controls the ailerons. The control yoke turns left or right.

FAA-H-8083-25, Chap. 4

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 36

Primary Control Surfaces

BACK NEXT

Elevator

The elevator is a hinged surface normally located on the rear of the horizontal stabilizer.

The elevator rotates the aircraft around the lateral axis.

- The elevator controls the pitch and angle of attack of the aircraft.
- On some aircraft, the entire horizontal tail surface moves. This is also known as a stabilator.

NOTE: The stabilator is a single-piece horizontal tail surface on an airplane that pivots around a central hinge point. A stabilator serves the purposes of both the horizontal stabilizer and the elevators.

FAA-H-8083-25, Chap. 4

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 37

Primary Control Surfaces

BACK NEXT

YOKE PULLED BACK
AIRCRAFT CLIMBS

YOKE PUSHED FORWARD
AIRCRAFT DESCENDS

Movement of Yoke

The control yoke controls the elevator.

- Yoke moves forward and backward to control the elevator.
  - Pulled back, nose goes up
  - Pushed forward, nose goes down

FAA-H-8083-25, Chap. 4

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 38

Primary Control Surfaces

BACK NEXT

Rudder

The rudder is in the aft of the vertical stabilizer.

FAA-H-8083-25, Chap. 4

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 39

Primary Control Surfaces

BACK NEXT

Rudder

The rudder rotates the aircraft around the vertical axis.

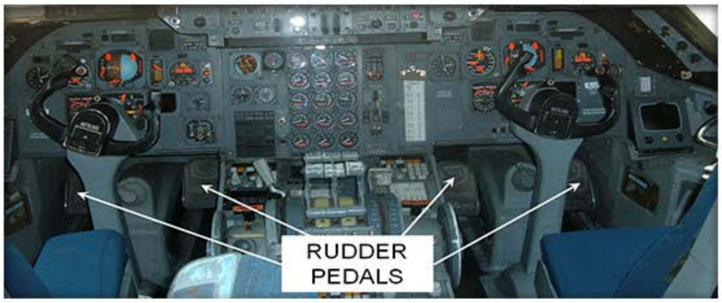
The rudder controls the yaw of the aircraft.

Rudder Pedals

The rudder is controlled by rudder pedals.

- Depress right pedal, aircraft will yaw right
- Depress left pedal, aircraft will yaw left

FAA-H-8083-25, Chap. 4



AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

ALL LESSONS FRAME: 40

Secondary Control Surfaces

BACK NEXT

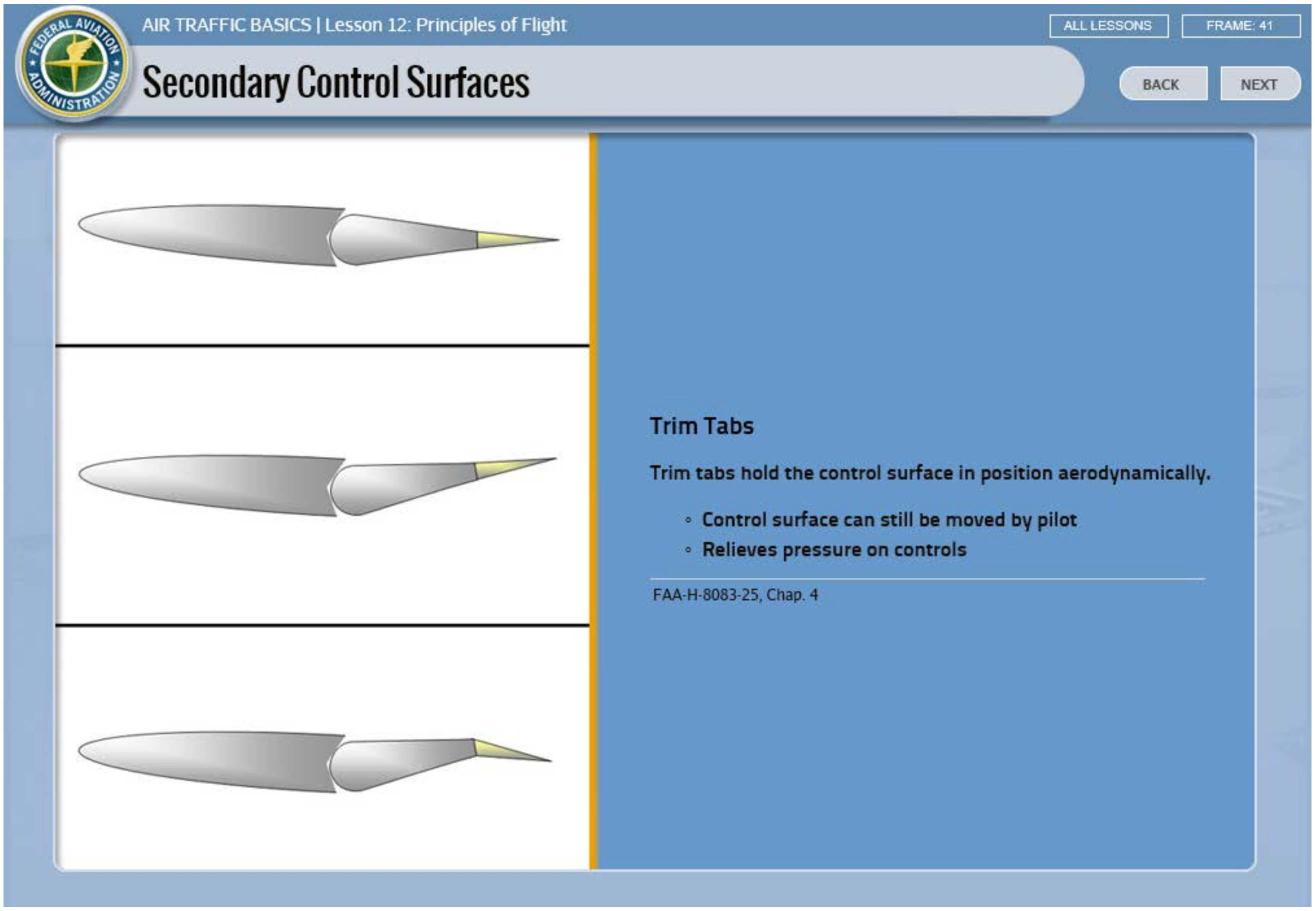
Trim tabs are small, adjustable, hinged surfaces on the trailing edge of the primary control surfaces.

The purpose of trim tabs is to lessen the manual pressure the pilot must apply to the control surfaces.

Aileron trim tabs are generally used on large aircraft.

Elevator and rudder trim tabs are common on all aircraft.

FAA-H-8083-25, Chap. 4


AIR TRAFFIC BASICS | Lesson 12: Principles of Flight
ALL LESSONS
FRAME: 41
Secondary Control Surfaces
BACK
NEXT
Trim Tabs
Trim tabs hold the control surface in position aerodynamically.
◦ Control surface can still be moved by pilot
◦ Relieves pressure on controls
FAA-H-8083-25, Chap. 4

AIR TRAFFIC BASICS | Lesson 12: Principles of Flight

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Secondary Control Surfaces

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Trim Tabs

Trim tab controls are either manual or electric.

NOTE: Some light airplanes have trim tabs that are ground-adjustable.

FAA-H-8083-25, Chap. 4

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Secondary Control Surfaces

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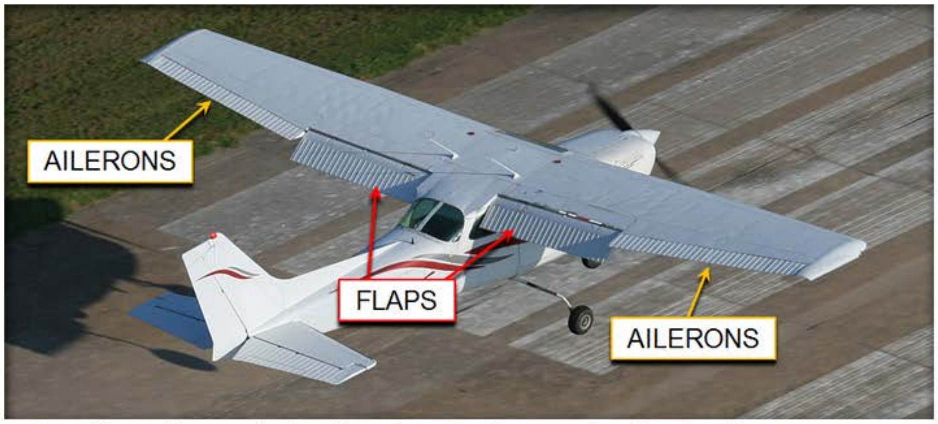
Flaps



Flaps are located inboard on the wing's trailing edge and are used to increase lift.

Flaps are extended in increments described as degrees from the full up position of 0 degrees.

- Usually, three or four positions can be selected
  - i.e., 10, 20, 30, 40 degrees
- Flaps extend on both wings at the same time.

FAA-H-8083-25, Chap.4

The extension of the flaps increases the camber and on some types increases the wing area.

- Lift increases
- Drag increases
- Lowers stall speed
- Allows steeper approach to runway without increased speed

Flaps are mostly used for takeoff and landing.

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Secondary Control Surfaces

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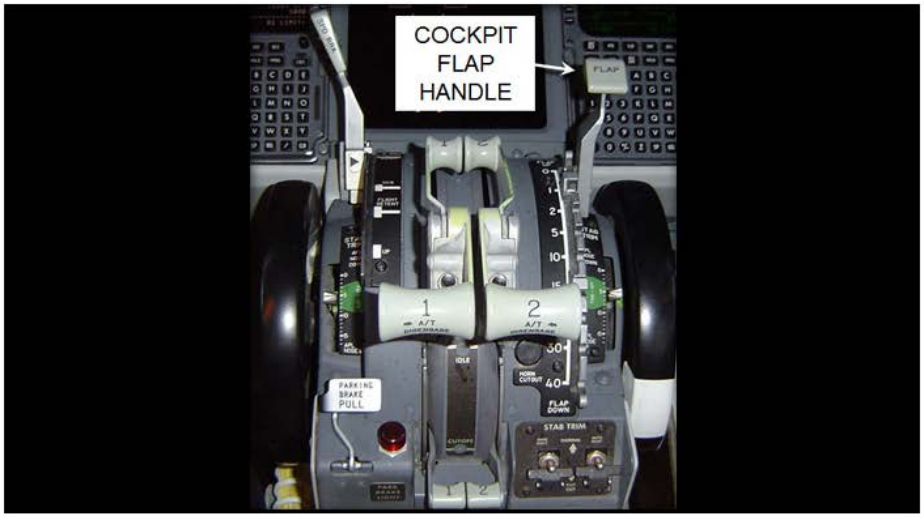
Flaps



Flaps are adjusted:

- **Manually**
- **Electrically**
- **Hydraulically**

FAA-H-8083-25, Chap. 4

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Helicopter Aerodynamics

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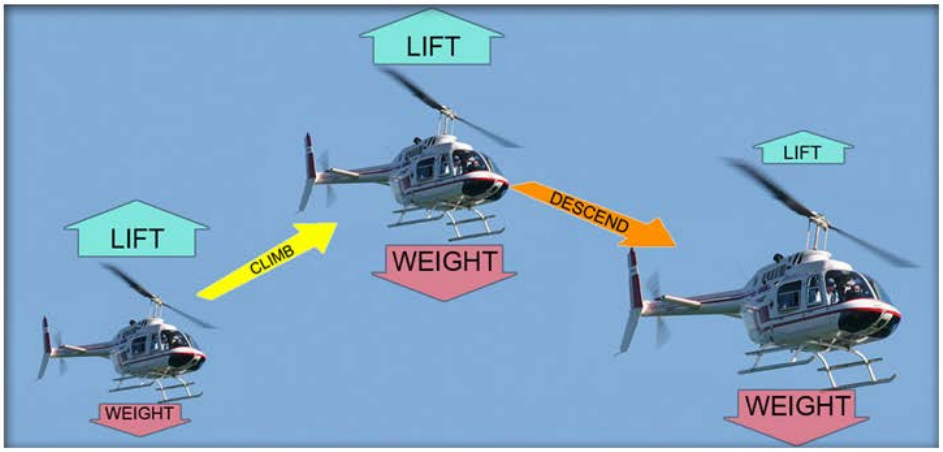

Basic Helicopter Aerodynamics

The forces acting on helicopters are the same as those acting on fixed-wing aircraft:

- Lift
- Thrust
- Weight
- Drag

Lift is provided by rotor blades.

- Each blade is shaped like an airfoil.
  - Bernoulli's Principle applies.
- The rotor blades are moved through the air by the engine. When the blades are in motion, they act as a wing.

FAA-H-8083-21, Chaps. 2 and 3

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Helicopter Controls

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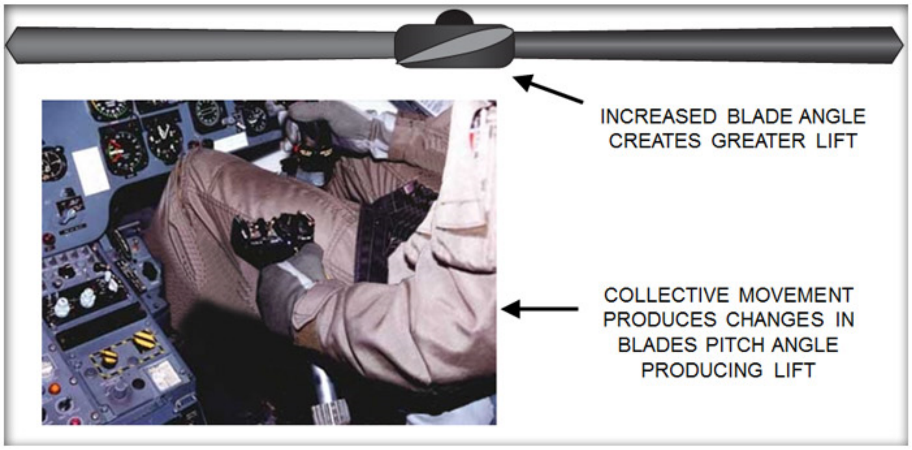


Collective

The collective controls the pitch of the rotor blade (angle of attack).

- The greater the blade angle the greater the lift produced.

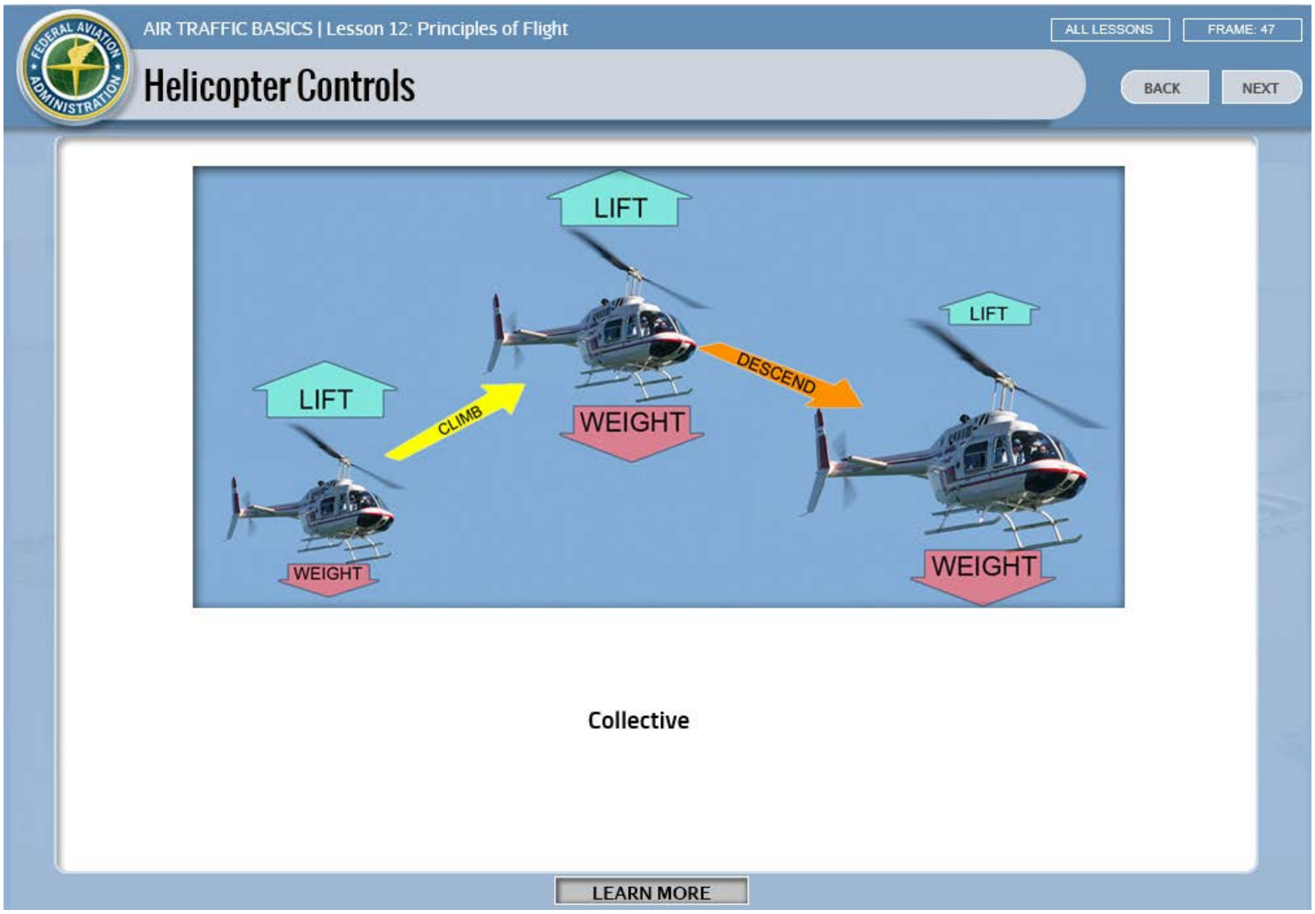
FAA-H-8083-21, Chap. 4

Throttle Control

The throttle is mounted on the forward end of the collective pitch lever in the form of a motorcycle type twist grip.

- The function of the throttle is to regulate the Revolutions Per Minute (RPMs).

FAA-H-8083-21, Chap. 4



A combination of RPMs and blade pitch controls:

- Vertical ascent
    - Lift is greater than weight
- Vertical descent
    - Weight is greater than lift
- Hovering
    - Motionless flight over a reference point
    - Constant heading and altitude
    - Thrust and lift equals weight and drag

Reference: FAA-H-8083-21, Chap. 4

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Helicopter Controls

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The cyclic controls the tilt of the rotor blade which controls the direction of flight.

The cyclic is pushed in the direction that the helicopter is to be moved.

- The tilt of the rotor blades creates thrust in the direction of movement.

Push cyclic forward, helicopter moves forward.

FAA-H-8083-21, Chap. 4

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Helicopter Controls

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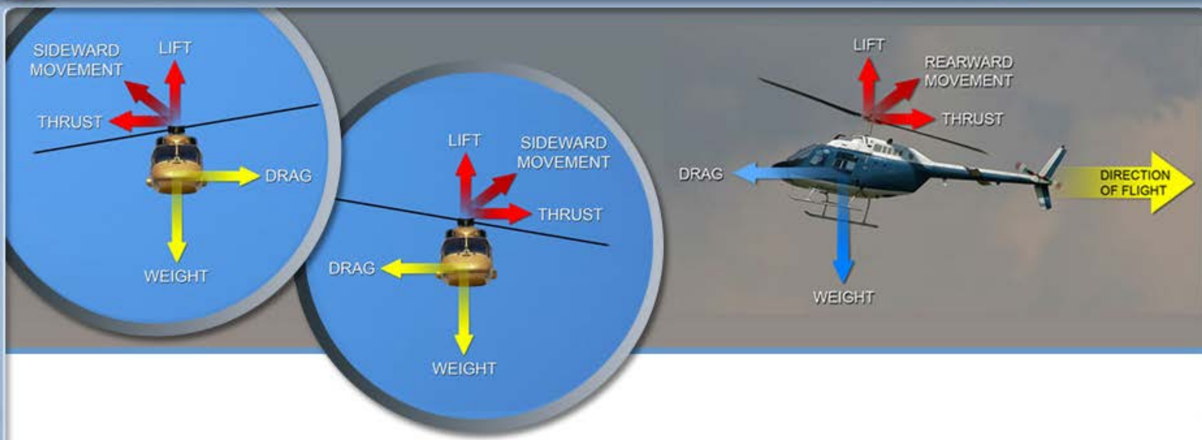

Cyclic

Pull cyclic back, helicopter moves back.

FAA-H-8083-21, Chap. 4

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Helicopter Controls

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Antitorque Pedals

The antitorque pedals control the yaw of the helicopter by controlling the pitch of the tail rotor.

- **The antitorque pedals are similar to the rudder pedals on a fixed-wing aircraft.**

FAA-H-8083-21, Chap. 4

Helicopter Controls

Autorotation

An autorotation is a maneuver that is performed whenever the engine is no longer supplying power to the main rotor blades.

A helicopter transmission is designed to allow the main rotor to rotate freely in its original direction if the engine stops.

- At the instant of engine failure, the blades will be producing lift and thrust as a result of their angle of attack and velocity.
- As the helicopter descends, the upward flow of air provides sufficient thrust to maintain rotor RPMs and lift throughout the descent.

FAA-H-8083-21, Chap. 11

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Hazards Affecting Flight

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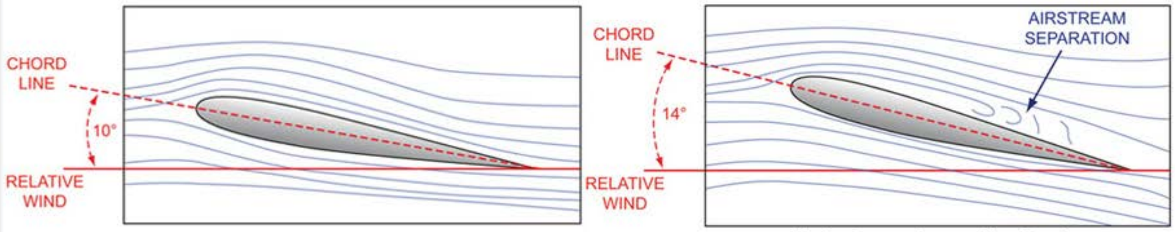

Attached Airstream   Mainstream Separation Begins

Stalls

Stalls are the most common cause of light aircraft accidents.

- A stall occurs when the airfoil (wing) reaches a "critical angle of attack," which is approximately 15 to 20 degrees on most airfoils.

During flight, the airstream remains attached to the wing surface and lift is produced when operating within the normal angle of attack range.

As the critical angle of attack is approached, the smooth flow of the airstream begins separating from the rear of the upper wing surface.

- The airstream can no longer follow the upper curvature of the wing because of the excessive change in the direction of the flow.
- The portion of the wing where the airflow has separated ceases to produce lift.

FAA-H-8083-25, Chap. 3

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Hazards Affecting Flight

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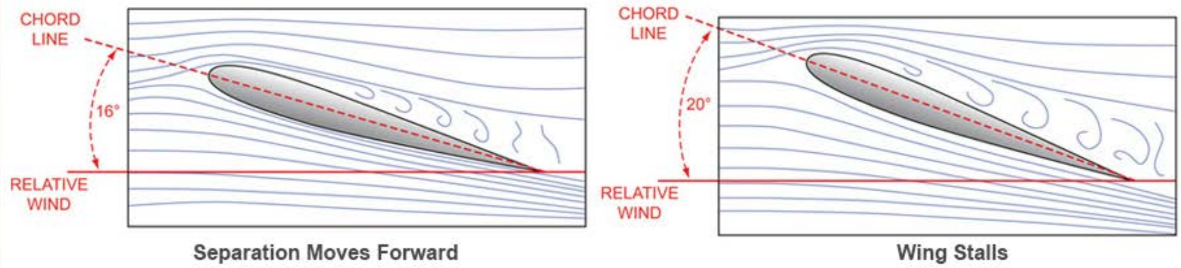

Stalls

As the angle of attack is further increased, the separation of the smooth flow of the airstream moves further forward on the upper surface of the wing.

As the critical angle of attack is reached, the separation of smooth flow moves forward to the area of the highest camber and creates a wing stall.

- The wing no longer produces enough lift to support the airplane.

FAA-H-8083-25, Chap. 3

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Hazards Affecting Flight

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Causes of Stalls

Three primary causes of stalls are:

- **Insufficient airspeed**
- **Excessively violent flight maneuvers**
- **Severe wind shear**

FAA-H-8083-25, Chap. 4

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Hazards Affecting Flight

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Types of Icing

The three primary types of icing are

- Structural icing
- Pitot-static system icing
- Carburetor icing.

Structural icing changes the shape of the airfoil.

- The greatest hazard of this type of icing is airfoil distortion which disrupts smooth airflow reducing lift and also adds weight.
- Many IFR-equipped aircraft have anti-icing and/or de-icing equipment.

AC 00-6, pp. 92 thru 98; FAA-H-8083-25, Chap. 5

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Types of Icing

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Pitot Tube Icing

Pitot-static system icing

- When pitot tube icing occurs, the airspeed indicator becomes unreliable.
  - Pitot heat is used on many aircraft to prevent icing.
- Although rare, when static vent icing occurs, all three instruments are affected (e.g., airspeed, vertical speed indicator, and altimeter).
  - An alternate static air vent, although not as accurate, is installed inside the cabin on some aircraft.

AC 00-6, pp. 92 thru 98; FAA-H-8083-25, Chap.5

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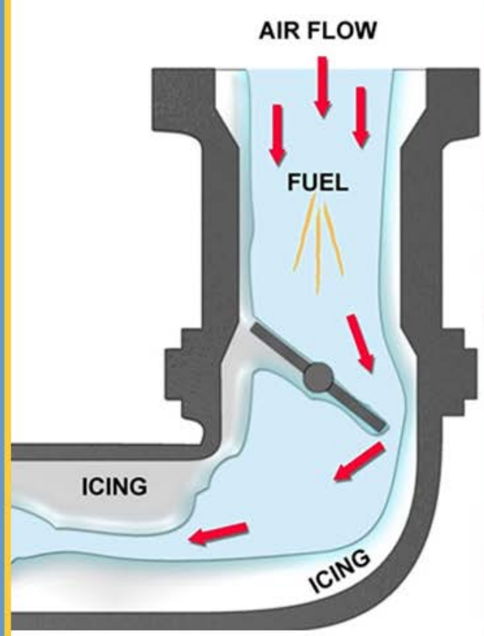
Types of Icing

Carburetor Icing

Carburetor icing reduces the fuel/air flow to the engine.

- This can cause complete engine failure by starving the engine of fuel and air.
- Occurs most often between 20-70° F under conditions of high humidity.
- Lowered pressure and vaporization in the carburetor lowers the temperature of the fuel/air mixture to the point where any water vapor or moisture present will freeze, forming ice or frost inside the carburetor.
- Carburetor ice can be cleared by adding carburetor heat which recirculates heated air from engine, but this is primarily for anti-icing not de-icing.

FAA-H-8083-25, Chap. 6.



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Hazards Affecting Flight

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Aircraft System Failures

Aircraft system failures may occur due to:

- **Electrical failures**
- **Mechanical failures**
- **Hydraulic failure**
- **Engine failure**
- **Engine fire**

When you become aware of an unusual situation, use all available resources to assist the aircraft and notify your supervisor.

AIM, par. 7-5-1 and 7-6-2

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Hazards Affecting Flight

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Electrical Failures

- During partial electrical failure, some instruments and systems are affected.
- When complete electrical failure occurs, there is a loss of:
  - Some instruments
  - Flaps on some aircraft
  - Radios, navigation and transponder equipment
  - Lights

Air traffic controllers should be aware of these losses and assist in any way possible (e.g., priority handling, clear conflicting traffic, alert emergency equipment).

AIM, par. 7-5-1 and 7-6-2

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Hazards Affecting Flight

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Mechanical Failures

Mechanical failures include:

- **Landing gear**
- **Blown tire**
- **Wheel off**
- **Panel off**
- **Flight controls**
- **Windshield**

AIM, par. 7-5-1 and 7-6-2

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Hazards Affecting Flight

Hydraulic Failure

Hydraulic failure affects landing gear, flaps, and brakes on some aircraft.

Handling a hydraulic failure may require long runways, emergency equipment, etc.

AIM, par. 7-5-1 and 7-6-2

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Hazards Affecting Flight

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Engine Failure

Engine failure may affect:

- Engine driven vacuum system for instruments (e.g., B52, C172)
- Hydraulic power
- Electrical power
- Pressurization

Engine failure may result in:

- Forced landing
- Loss of altitude

Air traffic controllers should assist pilots by advising them of the nearest airport suitable for landing.

AIM, par. 7-5-1 and 7-6-2

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Hazards Affecting Flight

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Engine Fire

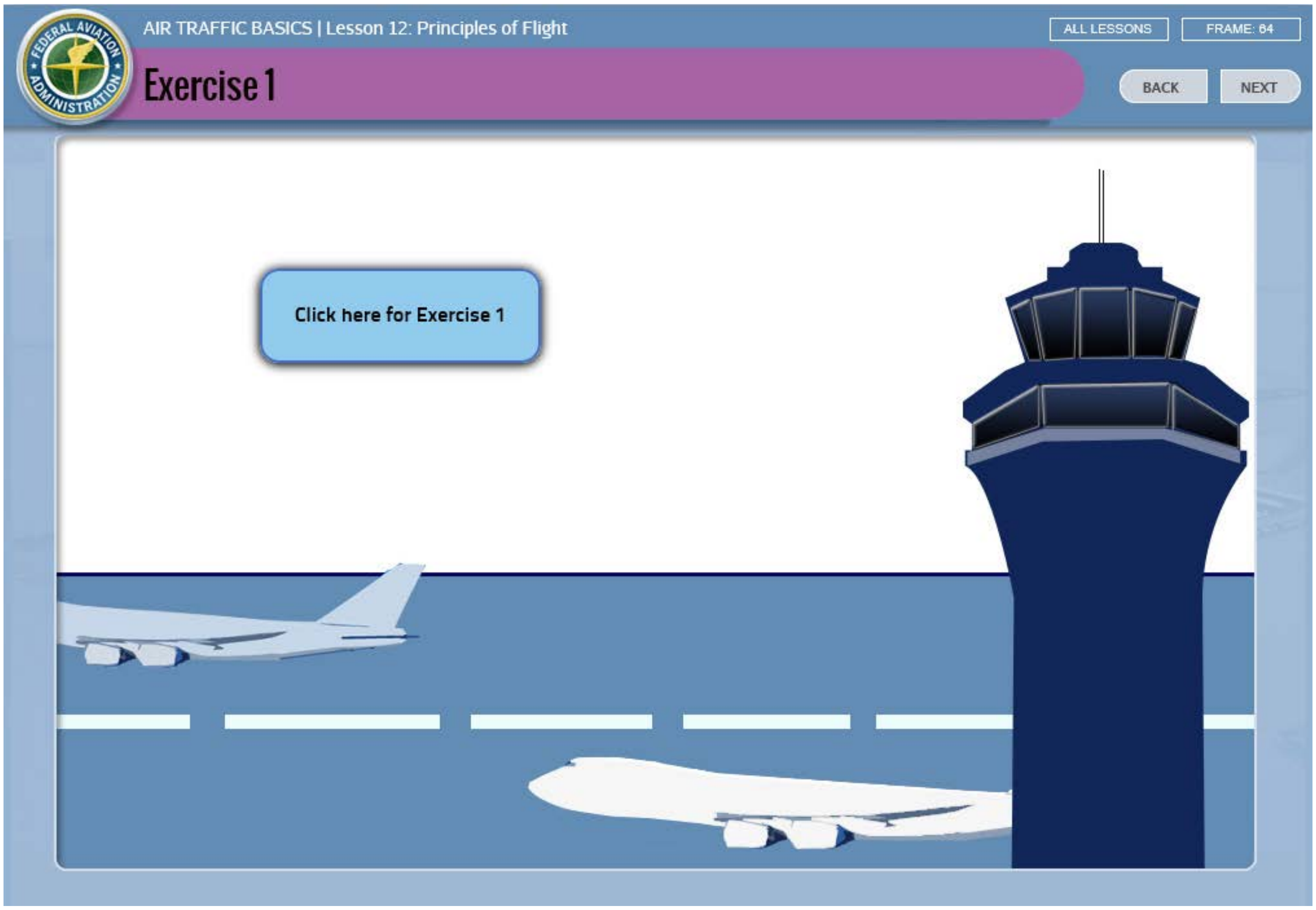
An engine fire is usually controllable.

- **The indication to the pilot of an engine fire is via the fire warning light.**

A cabin/cockpit fire is extremely serious.

Specialists who are advised by pilots of a fire warning light or a cockpit/cabin fire may expect either a bailout or a request for immediate landing.

AIM, par. 7-5-1 and 7-6-2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Lesson Summary
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◦ Relative Wind
◦ Airfoils
◦ Forces Affecting Flight
◦ Effects of Atmosphere on Aircraft Performance
◦ Rotational Axes of Aircraft
◦ Primary Control Surfaces
◦ Secondary Control Surfaces
◦ Helicopter Aerodynamics
◦ Helicopter Controls
◦ Hazards Affecting Flight
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