FLIGHT INSTRUCTOR LESSON PLANS

Fourth Edition

CFI Bootcamp
Flight Instructor Training

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Mike Shiflett

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Fourth Edition
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Mike Shiflett's Aviation credentials and experience are as follows:

FAA Certificates
Airline Transport Pilot Certificate – Airplane Muli-Engine Land. CE-525 Type rating
Commercial Pilot Privileges: Airplane Single Engine Land and Sea
Flight Instructor Certificate – Airplane Single and Multi-Engine Land, Instrument Airplane
Former FAA Designated Pilot Examiner – Recreational – ATP including Initial CFI, CFII, MEI

UK Certificates
Commercial Pilot – Airplane Single Engine Land
Former UK Flight Examiner for Private Pilot and IMC ratings

Mike has amassed over 16,000 hours of which most was in general aviation aircraft. He also administered around 3,000 practical tests (Checkrides) for the FAA.

Mike has authored numerous courses used by top flight schools and Universities in his previous company. At CFI Bootcamp he authored all the course content including 42 hours of video, 10 books used by students at CFI Bootcamp and has been featured in many aviation media organizations. He has also presented at EAA Airventure – Oshkosh, WI, Sun-n-Fun and Aviation conferences as a speaker. He also produced a Podcast "Flight Training the way I see it", and has a weekly webinar called "The Power Hour". The CFI Bootcamp website has links to the webinar and previous Podcasts.

He continues to innovate in the aviation industry and is particularly focused on creating courses and training materials to produce better flight instructors.

Mike currently lives in both San Jose, CA and more often in Miami Beach, FL. He flies from the Opa-Locka airport just north of Miami International.

Introduction

Thanks for purchasing our Lesson Plans. This is the fourth edition. The content was reviewed for errors and updated. The maneuvers guide in these lesson plans are for a Cessna172S model. This complete set of lesson plans can be used for teaching flight maneuvers for Sport, Recreational, Private, Commercial Pilots, and Flight Instructors. There are also lesson plans for the technical subject areas such as Aerodynamics, Runway Incursion Avoidance, etc., for Private, Recreational and Commercial students.. Most of the technical subject areas for Flight Instructor students are also included.

These lesson plans are the same ones used by CFI Bootcamp students who go through our program in Miami, FL and Palo Alto, CA. They are time tested with hundreds of students that have used them for their checkrides and for teaching students once they got their Flight Instructor Certificate.

As always, if you find any errors, please send them to info@cfibootcamp.com..

Mike Shiflett – November 9th, 2021 - Miami Beach, FL

V

LESSON PLANS

The lesson plans can fit into most any training syllabus. If you don't have a training syllabus you can use ASAs or King Schools as a starting place. Both are very good.

Each flight maneuver lesson plan has an Objective, Motivation, Presentation (Elements), time for how long it should take, Key Points, 172 Maneuvers Guide, Common Errors, Questions to ask the students, Completion Standards and Risk Management. The ground lessons have an Objective, Motivation, Presentation with how long it should take, Instructor's actions, Student's Actions and references. There is also additional content behind the lesson plan that includes things like images, graphs, etc.

Note: Where a maneuver is common to both Private and Commercial pilots such as Steep Turns, the Private Pilot Knowledge Area, Risk Management and Skills (Completion Standards) are from the Private Pilot ACS. Refer to the Commercial Pilot ACS for Completion Standards for those maneuvers.

IMPORTANT: You need to teach each lesson plan out loud with a whiteboard and/or monitor. You will never know if you can teach the material in the plan until you do this. Simply reading over the lesson plans is NOT good enough. I realize this is a lot of work, but you will catch problems in your own understanding, flow issues and much more if you will take this on.

When teaching an actual student, you should teach from the lesson plan and at the end of your lesson you should ask the student to tell you how they will perform the maneuver. Demonstrating with a model airplane is very helpful. The idea is you don't want to get into the airplane until you are sure the student understands what they are going to do on that flight.

There are also lesson plans for ground instruction: All of the Technical subject areas in the Flight Instructor PTS are included. They contain the full lesson and include a lot of artwork and explanations.
I hope you find this book useful. Our instructors at CFI Boot Camp teach every day from these lesson plans, so they are field tested.

If you are working on your CFI now, consider purchasing our CFI Workbook. This book is intended to cement your knowledge by providing you with scenarios, assessment and study questions.

Thanks again for purchasing the Lesson Plans. Let us know how they work out for you.

Mike Shiflett - CFI Boot Camp Web: www.cfibootcamp.com

FLIGHT MANEUVERS LESSON PLANS FOR SPORT, RECREATIONAL, PRIVATE, COMMERCIAL PILOTS AND FLIGHT INSTRUCTORS

The following lesson plans are for teaching students pursuing the Private, Recreational, Sport and Commercial Pilot certificates.

They can be used in any order. They fit into the syllabus in the next chapter to form a complete course of training for the Private Pilot.

The lesson plans can also be used for the Flight Instructor Practical test if the flight instructor applicant personalizes them in such a way as to be able to teach from them.

Note: The Instructors Actions and Students actions are the same for all the maneuvers lessons, so they are not included on the Lesson Plans.

Instructors actions are always: Present the lesson, demonstrate the maneuver with the model airplane, and ask the student questions to assess their knowledge.

Student actions are always: Take notes on the presentation, demonstrate the maneuver to the instructor describing the key points of how to do it, and state any completion standards for

Maneuvers Lesson Plans Include:

1 **Objective and motivation** for each maneuver. The objective describes what will be accomplished and the motivation describes why it needs to be done.

2 **Presentation -** The Elements that should be taught in the order presented in the lesson plan. The step by step order of the lesson. Also includes the lesson

3 **Key Points -** These are areas to place extra emphasis after the presentation has been delivered. Not every lesson has key points.

4 **Risk Management -** In most lesson plans. These can be brought out at any point in the lesson. You may want to integrate them into the Presentation at the appropriate points, or you can teach them as separate topics at the end.

5 **Common errors -** Included for most lesson plans. They are from the Airplane Flying Handbook and Instructor Certification Standards.

6 **Completion Standards** and are reproductions from the Airman Certification Standards (ACS). Note: References to complex airplane standards have been removed from these lesson plans.

Sport, Recreational & Private Flight Maneuvers Lesson Plans

Objective

To make a level turn at bank angles between 20 – 45 degrees while maintaining constant altitude, airspeed and coordination.

Motivation

Mastering this skill is part of a pilot's basic skills to control the airplane.

Presentation

1. Aerodynamics of turning - VCL vs HCL, Load Factor, Need for additional lift.
2. Aileron controls bank angle. Relationship of horizon to cowling.
3. Elevator controls altitude - Needed to restore VCL. Measured with the ALT.
4. Throttle controls airspeed - Added elevator slows speed due to induced drag.
5. Rudder for coordination - Explain adverse yaw and rudder use in the turn.
6. If Yaw starts before bank established - SKID, Yaw opposite the turn - SLIP.
7. Pilot's outside view will be different between a right turn and a left turn.

Key Points:

- Adverse yaw will be present during roll in and roll out. Stop it with rudder.
- Use Elevator to control altitude and power to control airspeed.
- The site picture from a left and right turn are different.

Questions for the Student:

1. How can a pilot compensate for adverse yaw?
2. Why is increased elevator back-pressure necessary to maintain altitude during a turn?
3. What is the primary flight control that controls the bank angle?

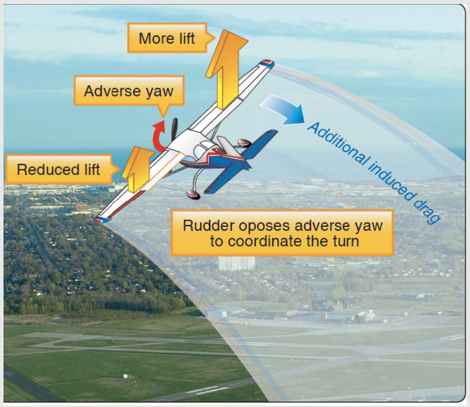
Common Errors

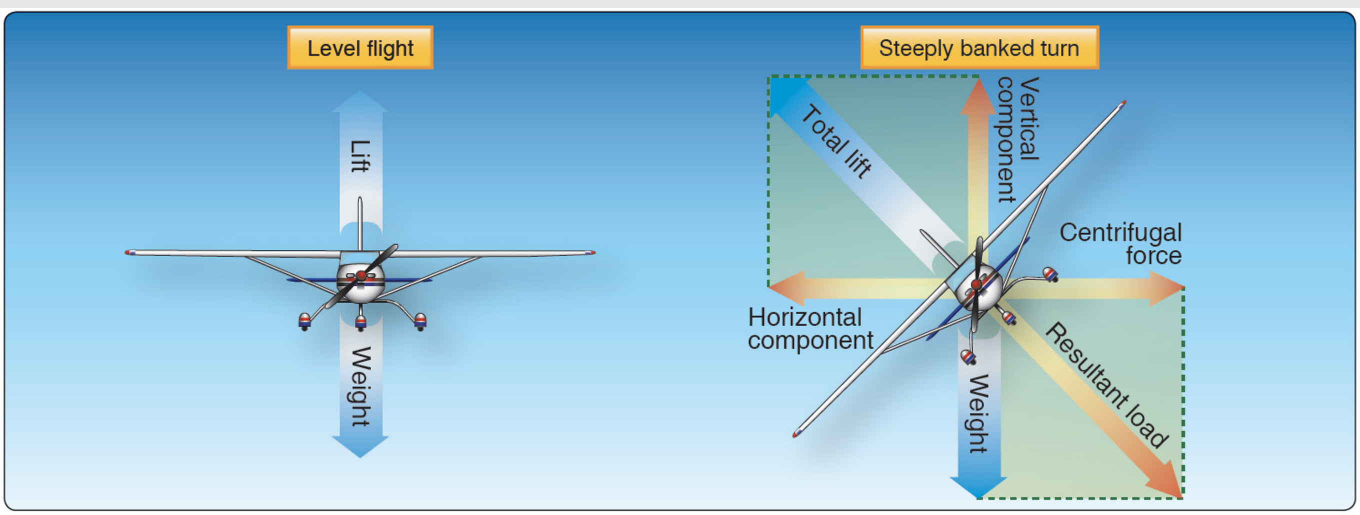
- Failure to adequately clear the area before beginning the turn.
- Attempting to execute the turn solely by instrument reference.
- Attempting to lean, in relation to the turn, while turning, rather than sitting upright.
- Insufficient feel for the airplane as evidenced by the inability to detect slips/skids without reference to flight instruments.
- Fixating on the nose reference while excluding wingtip reference.
- Holding un-necessary rudder in the turn.
- Gaining proficiency in turns in only one direction. (usually the left)
- Failure to coordinate the use of throttle with other controls.
- Altitude gain/loss during the turn.

Completion Standards

At the end of this lesson the student should understand the basic concepts of medium bank turns. The student should be able to perform this maneuver with the assistance of a flight instructor. There are no required Airman Certification Standards identified for medium bank turns. A proficient student pilot should be able to maintain altitude at +/- 100 feet, bank angle +/- 5 degrees, and roll out on the desired heading within +/- 10 degrees. Coordinated flight should be maintained throughout.

Lesson Additional Images





Objective

To perform a 360-degree level turn using between 45 - 50 degrees bank while maintaining altitude, airspeed and coordination.

Motivation

Develops smoothness, coordination, orientation, division of attention and control techniques to control the increase in load factor and stall speed. This maneuver can be used to avoid an encounter with clouds, terrain or other aircraft.

Presentation: 20 Minutes

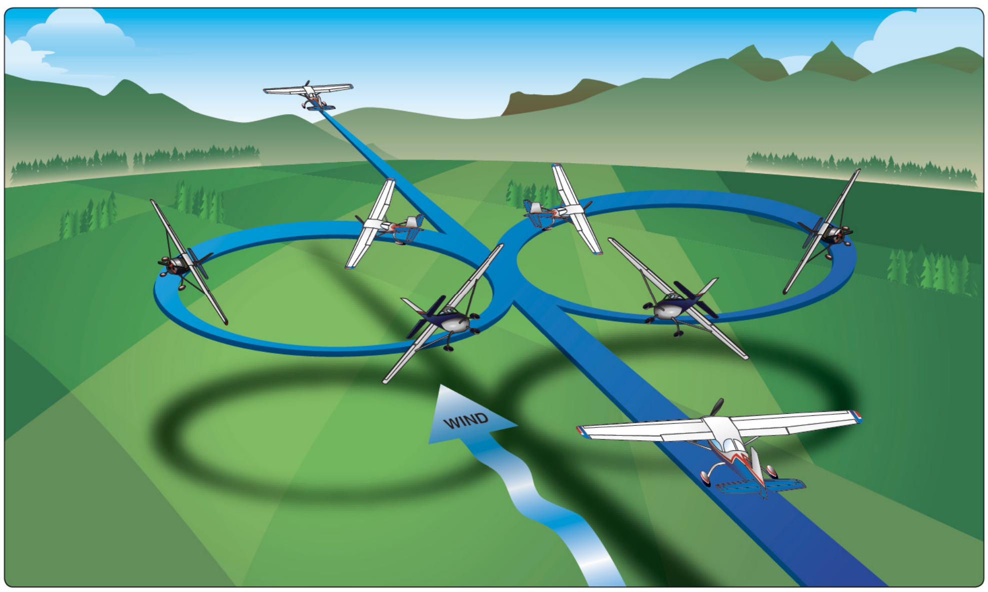
1. Aerodynamics review of turning flight including increases in load factor and stall speed and accelerated stalls.
2. How load factor increases with bank angle - Note how after bank angles of greater than 45 degrees load factor increases substantially with even small increases in bank angle.
3. Determining maneuvering speed, including changes in weight.
4. Identification of reference points and heading.
5. Adverse yaw and using rudder to stop it.
6. Use of horizon to determine bank and the different sight pictures in left / right turns.
7. Maintaining altitude with elevator and airspeed with power.
8. Use of trim in a turn.
9. Overbanking tendency.
10. Left turning tendencies and the use of rudder in the turn.
11. Anticipating rolling out. (1/2 bank angle in degrees)

Key Points:

- Load factor and stall speed increases quickly over banks angles of 50 degrees.
- Adverse yaw happens anytime the ailerons are deflected.
- Elevator controls altitude and power controls airspeed.
- During the turn right rudder will be needed to stop the left turning tendencies.

Risk Management - Teach how to identify, assess and mitigate risks enocmpassing the following:

1. Failure to divide the attention between airplane control and orientation.
2. Task management.
3. Energy management.
4. Accelerated stalls.
5. Spins.
6. Failure to maintain situational awareness.
7. Collision avoidance, scanning, and obstacle avoidance.
8. Failure to maintain coordinated flight.



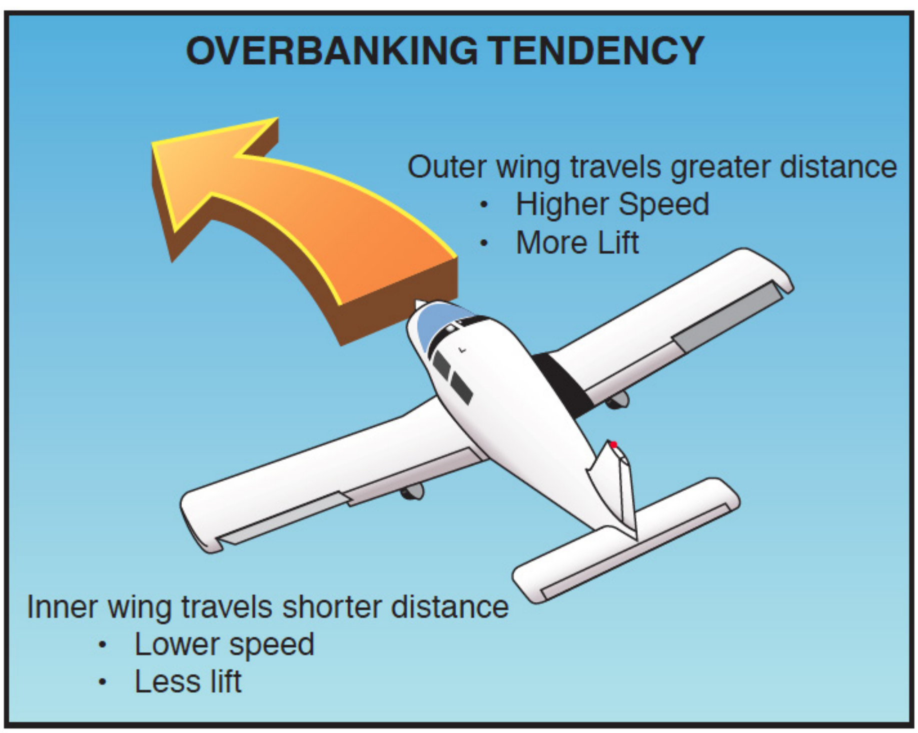
Questions for the Student:

1. What elevator, aileron and rudder control inputs will be necessary to maintain altitude during a steep turn?
2. What is the minimum bank angle required for a steep turn for a commercial pilot? Private pilot?
3. When should the roll out begin to be wings level at the 360-degree point of the maneuver?
4. What kinds of elevator control pressures will be required when entering and maintaining the steep turn?
5. What visual references should the pilot use during the turns to maintain altitude?

Common Errors

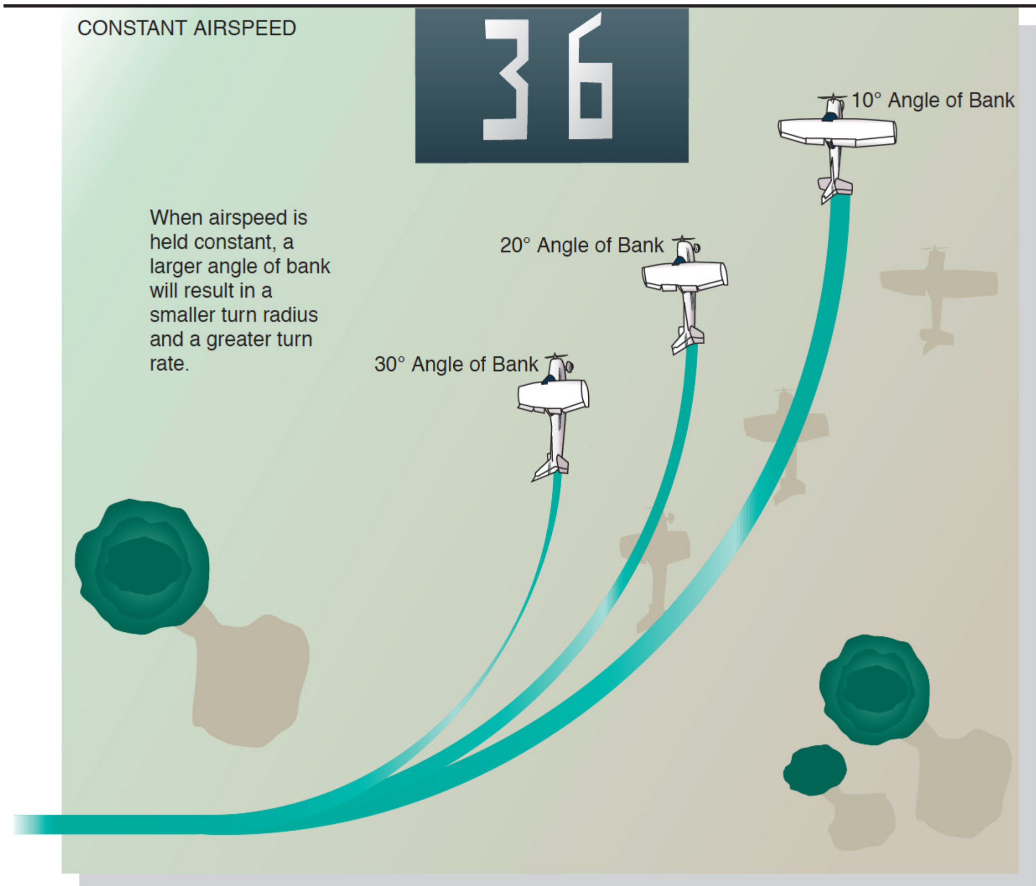
- Failure to adequately clear area.
- Excessive pitch changes during entry or recovery.
- Attempts to start recovery prematurely.
- Failure to stop the turn on a precise heading.
- Excessive rudder during recovery, resulting in skidding.
- Inadequate power management.
- Inadequate airspeed control.
- Poor coordination.
- Gaining altitude in right turns and losing altitude in left turns.
- Failure to maintain a constant bank angle.
- Disorientation.
- Attempting to perform the maneuver by instrument reference rather than visual reference.
- Failure to scan for other traffic during the maneuver.

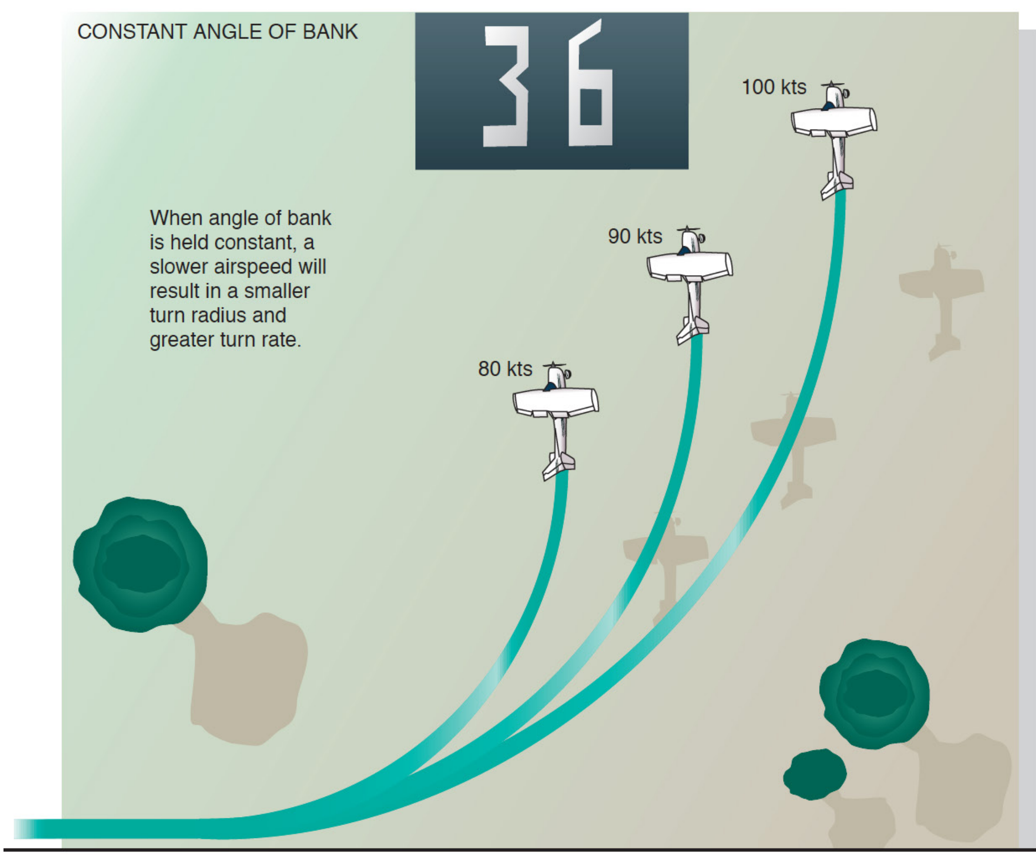
Steep Turns - Overbanking Tendency



Completion Standards

1. Establish the manufacturer's recommended airspeed or if one is not stated, a safe airspeed not to exceed V_A.
2. Roll into a coordinated 360° steep turn with a 45° bank.
3. Perform the Task in the opposite direction, as specified by the evaluator.
4. Maintain the entry altitude ±100 feet, airspeed ±10 knots, bank ±5°; and roll out on the entry heading, ±10° or as recommended by aircraft manufacturer to a safe maneuvering altitude.


CONSTANT AIRSPEED
36
10° Angle of Bank
20° Angle of Bank
30° Angle of Bank
When airspeed is held constant, a larger angle of bank will result in a smaller turn radius and a greater turn rate.


CONSTANT ANGLE OF BANK
36
100 kts
90 kts
80 kts
When angle of bank is held constant, a slower airspeed will result in a smaller turn radius and greater turn rate.

Commercial Pilot Flight Maneuvers Lesson Plans

Objective

To perform a 180-degree coordinated climbing turn, where the first 90 degrees is constant bank changing pitch and the second 90 degrees is fixed pitch changing bank so that at the end of the maneuver the airplane is just above stall speed.

Motivation

To develop the pilot's coordination, orientation, planning and accuracy of control of the airplane during a high-performance turn.

Presentation: 15 Minutes

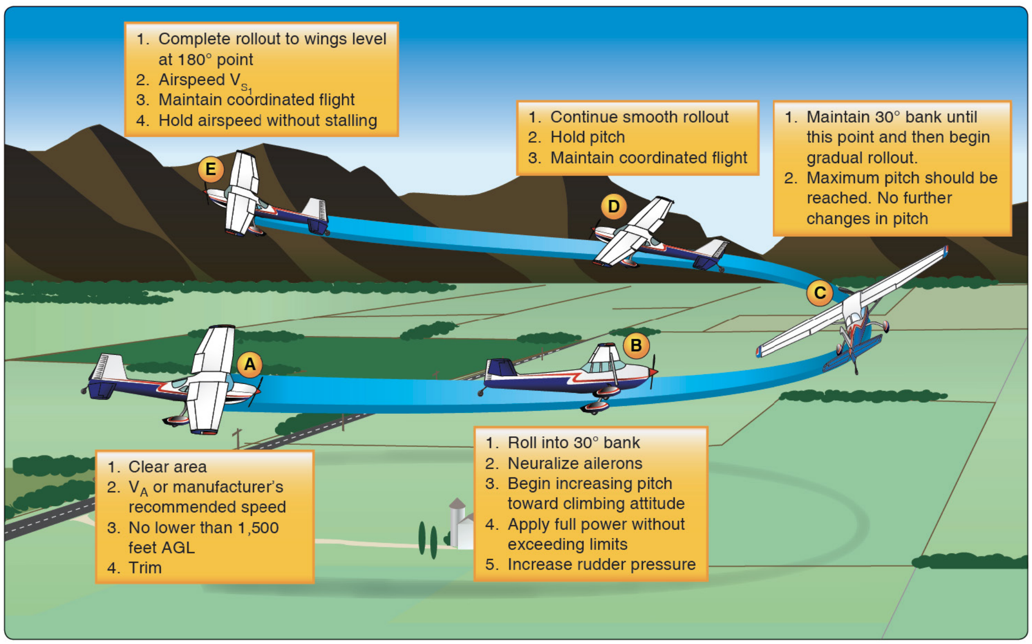
1. Purpose and practical applications of Chandelle maneuver. 180 degree climbing turn - Demonstrate with a model and diagram.
2. Aerodynamics of Chandelles - Left turning tendencies.
3. Identification of outside references - 90 degrees left or right. Minimum altitude 1500 ft. AGL, aircraft clean configuration below V_a.
4. Phases of Chandelle - First 90 degrees are constant bank (30 degrees) and changing pitch, last 90 degrees is fixed pitch reducing bank. Airspeed is constantly decreasing - never fixed or stalled.
5. Maximum pitch attitude occurs at the end of the first 90 degrees of turn and is that attitude that will cause the airplane to be at the approximate stalling speed and the completion of the maneuver. Altitude should be maintained momentarily at the end of the 180-degree turn.
6. Rudder use - constantly increasing during the maneuver.
7. Use of rudder when performing Chandelles to both the left and right - More required to the right due to the left turning tendencies.
8. Potential for an accelerated stall.

Key Points:

- Entry speed below V_a or as recommended by the manufacturer.
- Identifying reference points.
- First half of turn involves fixed bank and increasing pitch.
- Second half of turn involves fixed pitch and decreasing bank.
- Use of rudder during the maneuver.
- No more than 30 degrees of bank.

Risk Management - Teach how to identify, assess and mitigate risks enocmpassing the following:

1. Dividing attention between airplane control and orientation.
2. Task management.
3. Energy management.
4. Stall/spin awareness.
5. Situational awareness.
6. Rate and radius of turn with confined area operations.
7. CFIT avoidance.
8. Visual scanning and collision avoidance.



Questions for the Student:

1. At what point should the airplane reach its highest pitch up attitude?
2. How quickly should the bank be made at the beginning of the maneuver?
3. How long should the pilot hold the pitch angle at the end of the maneuver?
4. During the second half of the Chandelle, which direction of turn (left or right) requires the most right rudder?
5. Which altitude and speed should be used to initiate a Chandelle?

Common Errors

- Failure to adequately clear area.
- Initial bank too shallow, resulting in a stall before the turn is complete.
- Initial bank too steep, resulting in failure to gain maximum altitude before turn is complete.
- Allowing the bank to increase after establishing initial bank angle.
- Failure to start the roll out at the 90-degree point.
- Allowing the pitch attitude to increase as the bank is rolled out during the second 90 degrees of turn.
- Rolling out to quickly so that wings are level prior to reaching the 180-degree point.
- Nose low on completion of the turn, resulting in too much airspeed.
- Control roughness.
- Poor coordination. (slipping or skidding)
- Stalling at any point during the maneuver.
- Execution of a level steep turn instead of a climbing maneuver.
- Failure to scan for other aircraft.
- Attempting to perform the maneuver by instrument reference rather than visual reference.

Completion Standards

1. Select an altitude that will allow the maneuver to be performed no lower than 1,500 feet AGL.
2. Establish the appropriate entry configuration, power, and airspeed.
3. Establish the angle of bank at approximately 30°.
4. Simultaneously apply power and pitch to maintain a smooth, coordinated climbing turn, in either direction, to the 90° point, with a constant bank and continually decreasing airspeed.
5. Begin a coordinated constant rate rollout from the 90° point to the 180° point maintaining power and a constant pitch attitude.
6. Complete rollout at the 180° point, ±10° just above a stall airspeed, and maintaining that airspeed momentarily avoiding a stall.
7. Resume straight-and-level flight with minimum loss of altitude.

Objective

To perform two 180 degree climbing and descending symmetrical turns in opposite directions during which none of the flight controls are ever stationary.

Motivation

To develop precise control of pitch, bank and yaw in all combinations, and a feel for steady, constant application of the flight controls.

Presentation: 15 Minutes

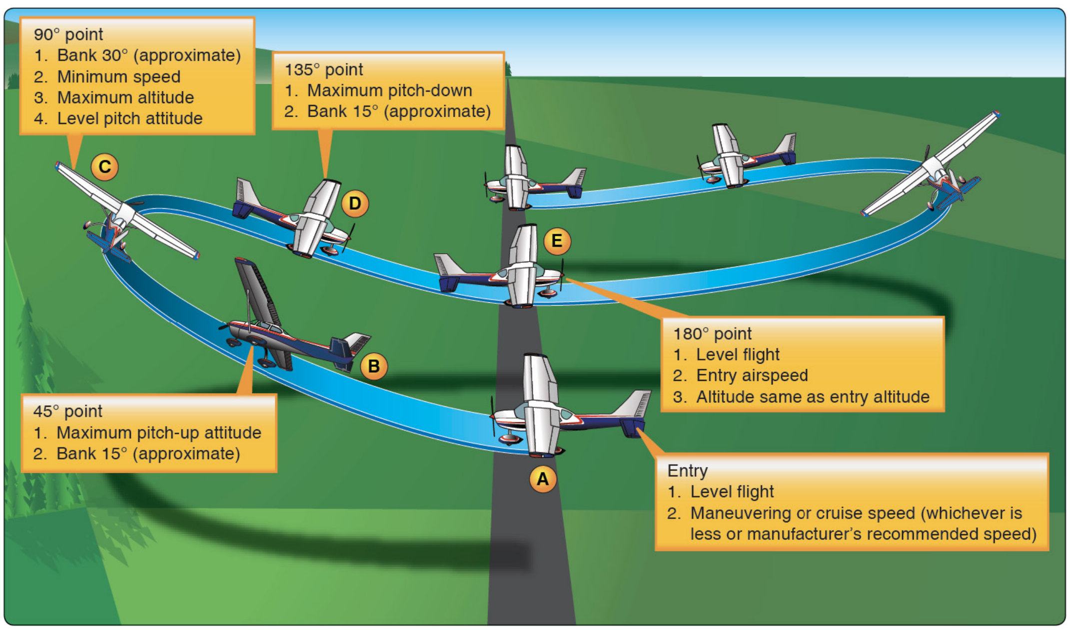
1. Demonstrate Lazy Eight with a model and diagram - Entry altitude, airspeed.
2. 45-degree point should result in 15 degrees of bank and maximum pitch.
3. 90-degree point, bank 30 degrees and pitch level with the minimum airspeed. 5 to 10 knots above stall. Most rudder is required here.
4. 135-degree bank 15 degrees and pitch attitude lowest.
5. 180 degree point the bank 0 degrees, the pitch attitude level, heading 180 degrees from entry, altitude and airspeed the same as entry.
6. Controls never stationary - Explain rudder required at each point and differences in each direction. (Left vs Right)

Key Points:

- Identify reference points at 45, 90, and 135 degrees in both turning directions.
- Control pressures always changing throughout the maneuver, never stationary.
- Be aware that more rate of pitch is required than rate of bank throughout.
- Significant difference in the rudder pressures between the right and left turns.
- The maneuver is performed with a fixed power setting.

Risk Management - Teach how to identify, assess and mitigate risks enocmpassing the following:

1. Dividing attention between airplane control and orientation.
2. Task management.
3. Energy management.
4. Stall/spin awareness.
5. Situational awareness.
6. Rate and radius of turn with confined area operations.
7. CFIT avoidance.
8. Visual scanning and collision avoidance.



Questions for the Student:

1. Where should the airspeed be the lowest?
2. At what point in the maneuver will the most rudder pressure be needed?
3. At what point will the flight controls be stationary?
4. What minimum entry altitude and airspeed is used for the lazy eight?
5. At what point should the pitch attitude be at the maximum?
6. At what point should the pitch attitude be level?
7. At what point should the bank angle be the greatest?

Common Errors

- Failure to adequately clear the area.
- Using the nose or top of engine cowl instead of the true longitudinal axis, resulting in unsymmetrical loops.
- Watching the airplane instead of the reference points.
- Inadequate planning, resulting in the peaks of the loops both above and below the horizon not coming in the proper place.
- Control roughness, usually caused by attempts to counteract poor planning.
- Persistent gain or loss of altitude with the completion of each eight.
- Attempting to perform the maneuver rhythmically, resulting in poor pattern symmetry.
- Allowing the airplane to “fall” out of the tops of the loops rather than flying the airplane through the maneuver.
- Slipping and/or skidding.

Completion Standards

1. Select an altitude that will allow the task to be performed no lower than 1,500 feet AGL.
2. Establish the recommended entry configuration, power, and airspeed.
3. Maintain coordinated flight throughout the maneuver.
4. Achieve the following throughout the maneuver:
    a. approximately 30° bank at the steepest point.
    b. constant change of pitch and roll rate and airspeed.
    c. altitude tolerance at 180° point, ±100 feet from entry altitude.
    d. airspeed tolerance at the 180° point, plus ±10 knots from entry airspeed.
    e. heading tolerance at the 180° point, ±10°.

6. Continue the maneuver through the number of symmetrical loops specified and resume straight-and-level flight.

Objective

To recognize situations that lead to an accelerated stall, and how to recover from this condition.

Motivation

A developed awareness of stalls in any attitude, configuration, or airspeed will prevent errors in handling the airplane, particularly at low altitudes.

Presentation: 15 Minutes

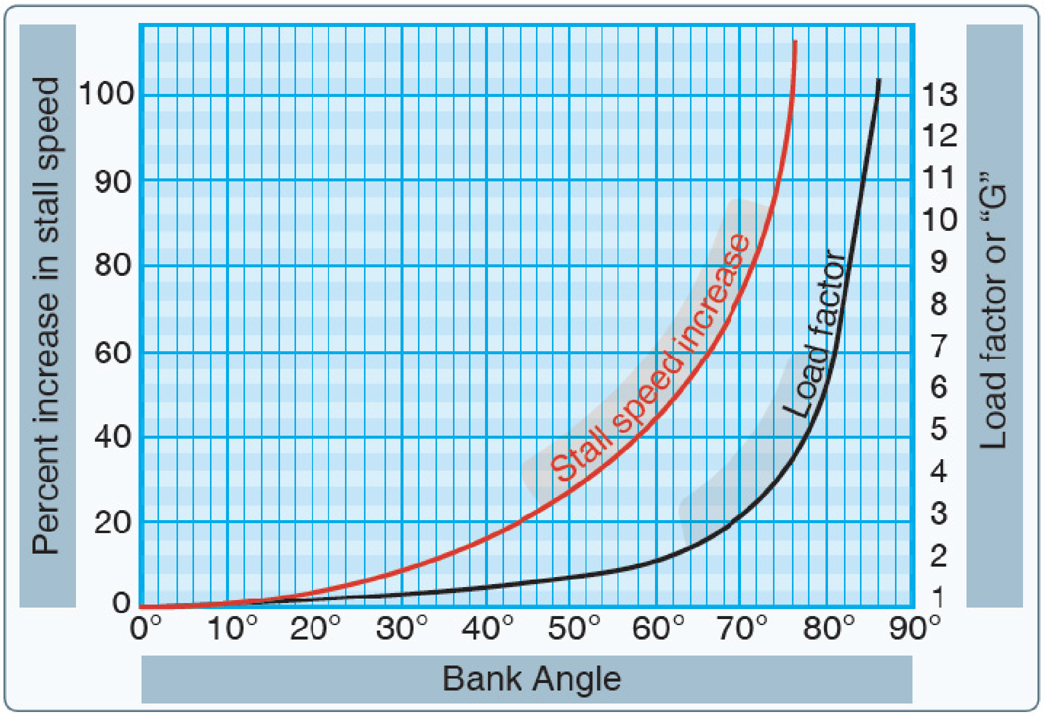
1. Relating the maneuver to a realistic flight conditions that could cause this stall.
2. Aerodynamics associated with accelerated stalls and spins in various attitudes including load factor and the increase in stall speed.
3. Minimum 3000 - ft AGL throughout maneuver.
4. Procedure to induce an accelerated stall - Below V_a, bank 45 degrees, maintain level flight momentarily, power idle, smoothly firmly and progressively increase the AOA elevator until a stall occurs.
5. Approach to stall indications - Accelerated indications happen quickly
6. Full stall indications - Uncommanded pitch down - potential spin entry
7. Efficient stall recovery procedure so that a minimum loss of altitude occurs. Reduce angle of attack until no buffeting or stall warning apparent, apply full power and level the wings

Key Points:

- Pitching/rolling actions tend to be more sudden than in other stalls.
- A stall will occur at a higher airspeed if the load factor is increased.
- Perform this maneuver with no flaps.

Risk Management - Teach how to identify, assess and mitigate risks enocmpassing the following:

1. Dynamic aerodynamic relationship between angle of attack, airspeed, load factor, aircraft configuration, aircraft weight, and aircraft attitude.
2. Reliance on aircraft performance indications such as aircraft buffet instead of artificial warning systems such as stall horn.
3. Required actions for aircraft maximum performance and the consequences of failing to do so.
4. Scenarios during which an accelerated stall can occur.
5. Inadvertent stall/spin entry.



Questions for the Student:

1. Why is there no accelerated stall speed marking on the airspeed indicator?
2. What happens to stall speed with an increase in load factor?
3. Why is it recommended to be in a turn to demonstrate an accelerated stall?

Common Errors

- Failure to clear area.
- Inability to recognize an approaching stall condition through feel for the airplane.
- Premature recovery.
- Over-reliance on the airspeed indicator while excluding other cues.
- Inadequate elevator back-pressure resulting in not stalling the airplane.
- Inadequate rudder control.
- Inadvertent secondary stall during recovery.
- Failure to maintain a constant bank angle.
- Excessive forward elevator pressure during recovery resulting in negative load on the wings and a potential secondary stall.
- Failure to take timely action to prevent a full stall during the conduct on.

Completion Standards

1. Clear the area.
2. Select an entry altitude that will allow the Task to be completed no lower than 3,000 feet AGL.
3. Establish the configuration as specified by the evaluator.
4. Set power appropriate for the configuration, such that the airspeed does not exceed the maneuvering speed (VA) or any other applicable POH/AFM limitation.
5. Establish and maintain a coordinated turn in a 45° bank, increasing elevator back pressure smoothly and firmly until an impending stall is reached.
6. Acknowledge the cue(s) and recover promptly at the first indication of an impending stall (e.g., aircraft buffet, stall horn, etc.).
7. Execute a stall recovery in accordance with procedures set forth in the POH/AFM.
8. Configure the airplane as recommended by the manufacturer and accelerate to V_X or V_Y.
9. Return to the altitude, heading, and airspeed specified by the evaluator.

Airman Certification Standards Differences for Maneuvers Common to both Private Pilot and Commercial Pilot

The following table shows the completion standards differences for the Commercial Pilot ACS stated in the lesson plans. Refer to the latest ACS for the details.

Steep Turns	50 degrees of bank
Slow Flight	+/- 50 Feet Altitude, +5/-0 kts airspeed
Power Off Stalls	Recover at stall onset (Buffeting) or a full stall as specified by the evaluator.
Power On Stalls	Recover at stall onset (Buffeting) or a full stall as specified by the evaluator.
Normal Landing	+200/-0 feet
Short Field Landing	+100/-0 feet

Instructions

The syllabus that follows can be used by a flight instructor as a guide to what ground lessons and what flight lessons should go in what order.

The video lessons are assignments given to students prior to completing that GL (Ground Lesson) and before the next flight lesson. The video lessons can be from any company that creates Private Pilot Flight Maneuvers videos.

The flight times indicated are the minimum amount of time that should be spent on the lesson. Some lessons may take considerably more time, such as normal landings.

The ground lessons (GL) are for you to quiz the student on the video homework and to assess their knowledge of the subject(s).

The Flight Lessons (FL) can be taught using the lesson plans in this workbook. All of the maneuvers-based lesson plans are included; however, there are no lesson plans for cross-country, flight planning, weather and so on. These are best taught using real weather integrated into a real flight plan for a flight you are taking or proposing to take in the future.

Private Pilot Airplane Syllabus

	Lesson	Description	Min Hour	Accom-plished
Phase I - Presentation	GL1	VIDEO LESSONS: Introduction to Aviation and Regulations for Student Pilots	1	☐
	GL2	VIDEO LESSONS: Airplanes, Power plant, Safety of flight	1	☐
	FL2	Pre-flight procedures, Taxiing, Straight and Level flights, Climbs and Descents	1	☐
	GL3	VIDEO LESSONS: Forces of flight, Aerodynamic stability	1	☐
	FL3	Normal takeoffs, medium bank turns, introduction to slow flight, YR and IR m.2 IR)	1	☐
	GL4	VIDEO LESSONS: Maneuvering flight, Fuel oil and and engine cooling systems	1.5	☐
	FL4	Slow flights, introduction to power-off stalls VR and IR (0.2 IR)	1	☐
	GL5	VIDEO LESSONS: Propellers, Electrical systems basics	1.5	☐
	FL5	Power-off and Power-on stalls (IR 0.2)	1	☐
	GL6	VIDEO LESSONS: Aircraft electrical systems, Flights Instruments, pilot operating handbook	1.5	☐
	FL6	Review of fundamental flight skills VR and IR (0.2 IR)	1	☐
	GL7	VIDEO LESSONS: Instruments indications and errors, Aeromedical factors	1	☐
	GL7	Rectangular courses, S-turns across a road, Turns around a point, (IR enroute 0.5)	2	☐
	GL8	VIDEO LESSONS: Airports, Radio communications and ATC services	1	☐
	FL8	Normal landings and go-arounds	1.5	☐
	FL?	Crosswind takeoffs and landings	1	☐
	FL8	Forward slips to a landing, fight maneuvers review	1.5	☐
	GL9	VIDEO LESSONS: Airspace, ADM	2	☐
	FL9	Emergency procedures in the traffic pattern and at altitude	2	☐
	GL10	Administer, grade and review incorrect answers of the Pre-solo knowledge test	1	☐
	FL10	Pre-solo evaluation (current or another instructor) Review FL2 - FL9	2	☐
	FL11	Dual I readiness for solo flight	1	☐
	FL12	Solo Flight	1	☐

Phase	Lesson	Description	Hours	Done
Phase - 2 Cross Country	GL11	VIDEO LESSONS: Aeronautical chart basics, FAR Part 91	1	☐
	FL13	Flight by sole reference to the flight instruments, unusual attitude recovery (IR 0.8)	1	☐
	GL12	VIDEO LESSONS: Reading aeronautical charts, sources of flight information	1.5	☐
	FL14	Solo practice flight, turns at medium bank, slow flight, power-off stalls	2	☐
	GL13	VIDEO LESSONS: Performance basics, performance charts	1.5	☐
	FL15	Dual flight: Steep turns, Short-Field Takeoffs and landings	1	☐
	FL16	Dual flight: Short-field takeoffs and landing review, Soft field takeoffs and landings	1	☐
	GL14	VIDEO LESSONS: Basic weather theory, flight computers, pilotage and dead reckoning	2	☐
	FL17	Dual flight: Pilotage cross country, emergency procedures, lost procedures	1	☐
	GL15	VIDEO LESSONS: Weather theory - Winds, Radio navigation, Printed weather reports	2	☐
	GL16	VIDEO LESSONS: Flight Computers, Graphic Weather Reports	2	☐
	FL18	Solo Flight - Steep turns, slow flight, power-off and power-on stalls	2	☐
	GL17	VIDEO LESSONS: Weather theory - Stability, VFR flight planning	3	☐
	FL19	Dual I cross country flight >100nm, three airports, lost procedures, diversions (IR 0.3)	2	☐
	GL18	VIDEO LESSONS: Weather theory - Visibility, Weather patterns,	1	☐
	FL20	Dual flight: Night operations - Local flight - 8 takeoffs and landings sole manipulator	1	☐
	GL19	VIDEO LESSONS: Weather Hazards, NTSB 830, Regulations for Private Pilots	1.5	☐
	FL21	Dual flight: Night cross country - 2 takeoffs and landings sole manipulator (IR 0.3)	2	☐
	GL20	Practical Test Standards Review, Review of knowledge test results	2	☐
	FL 21	Solo cross country to an airport with an operating control tower (3X takeoffs and landings)	1.5	☐
	FL22	Solo cross country >1S0nm , landings at three points, 1 leq >50nm	3.5	☐
Phase - 3 Test Prep	FL23	Dual flight: Review of all PTS flight operations (IR 0.3)	1.5	☐
	GL21	Practice oral evaluation using the PTS	2	☐
	FL24	Dual flight: Evaluation using PTS	1.5	☐
	GL22	Review as necessary for preparation for the practical test	1	☐
	FL25	Dual flight: Review as necessary for the practical test	1	☐

Instructions:

1. Lesson plans exist for each maneuvers-based lesson
2. There are no lesson plans for XC flights. These should be planned in real time
3. The times in the syllabus are minimums to complete the lesson. It may take longer to complete the lesson than shown and multiple lessons may be required
4. VIDEO LESSONS are to be assigned prior to the lesson being taught. AGL in the syllabus (Ground Lesson) may be combined with a flight lesson or may be taught separately.
5. VIDEO LESSONS use any vendors Private Pilot Ground School video lessons as assignments prior to the next flight lesson in the syllabus

Flight Hours	40
Dual Hours	30
Instrument	3
Nighttime	3
Solo Hours	10
Solo XC Hours	5
Prep for Test	4
Pre-fight brief	13
hrs. Post-flt brief	13

Ground Lesson Plans

Objective

To become familiar with Aeromedical factors.

Motivation

It's almost a sure thing that you will have a passenger who exhibits a medical symptom from being in the air. Knowing how to identify what they are having trouble with and then taking the corrective action is why you need to understand Aeromedical factors.

Presentation: 45 Minutes

What it is	Causes	Symptoms	Corrective actions
Hypoxia	Lack of oxygen	Headache, Dizziness, Numbness in extremities, Cyanosis	Lower altitude or supplemental oxygen
Hyperventilation	Not enough CO2, Nervousness, Anxiety, Fright	Clammy sweaty skin, rapid breathing	Breath More Slowly
Middle ear and sinus problems	Inflammation, Disease, Cold / Flu	Pain due to pressure difference	Valsalva method, Clear ears, descend more slowly
Spatial Disorien-tation	Loss of horizon or visual reference	Loss of control, Confusion of airplane attitude	Use the flight instruments
Motion Sickness	Motion not matching visual cues	Clammy skin, Pale color, hot, Nausea	Look out to the horizon, climb to avoid turbulence, Open ventilation, Sick sack
Carbon monoxide poisoning	Hypoxia caused by CO.	Same as hypoxia except red extremities in the later stages	Turn off heater, land, ventilate cabin
Stress and fatigue	Chronic or Acute	Delayed reaction, not thinking well, Fatigued, Loss of Muscle control	Acute - Rest and eliminate stress Chronic – Under care of physician
Dehydration	Loss of water or electrolytes	Loss of balance or muscle control, Confu-sion, Disorientation	Restore electrolytes and hydrate

Alcohol	Produces hypoxia like symptoms and dehydration	8 hrs. before last drink, 0.04% BAC, Not under the influence	Wait
Drugs	Prescription vs. Non prescription	Varies	Use AOPA guide to drugs

Completion Standards

This lesson is complete when the student demonstrates a basic understanding of aeromedical factors during oral quizzing and completion of homework exercises.

References

Airplane Flying Handbook (FAA-H-8083-3a)
FAR / AIM (FAA-H-8083-25B)
NTSB reports
Personal stories
FAA-S-ACS-6B

As a pilot, it is important to stay aware of the mental and physical standards required for the type of flying done. This page provides information on medical certification and on aeromedical factors related to flying activities

Obtaining Medical Certificate

Pilots must have held a medical certificate in the previous 10 years to use the new system. If this is the case the pilot needs to have his regular Doctor sign a checklist and the pilot keeps it to prove his fitness for flight. This must be done every 4 years. Also, an online course about aero-medical factors must be taken every two years. No submission of anything is required to FAA. If the pilot has not held a medical certificate in the previous 10 years, then they must get at least a Third-Class Medical certificate.

Environmental and health factors affecting pilot performance

A number of health factors and physiological effects can be linked to flying. Some are minor, while others are important enough to require special attention to ensure safety of flight. In some cases, physiological factors can lead to in-flight emergencies. Some important medical factors that a pilot should be aware of include hypoxia, hyperventilation, middle ear and sinus problems, spatial disorientation, motion sickness, carbon monoxide poisoning, stress and fatigue, dehydration, and heatstroke.

Other subjects include the effects of alcohol and drugs, anxiety, and excess nitrogen in the blood after scuba diving.

Hypoxia

Hypoxia means “reduced oxygen” or “not enough oxygen.” Although any tissue will die if deprived of oxygen long enough, usually the most concern is with getting enough oxygen to the brain, since it is particularly vulnerable to oxygen deprivation. Any reduction in mental function while flying can result in life-threatening errors. Hypoxia can be caused by several factors including an insufficient supply of oxygen, inadequate transportation of oxygen, or the inability of the body tissues to use oxygen. The forms of hypoxia are divided into four major groups based on their causes: hypoxic hypoxia, hypemic hypoxia, stagnant hypoxia, and histotoxic hypoxia.

Hypoxic Hypoxia

This occurs when the blood is not able to take up and transport a sufficient amount of oxygen to the cells in the body. Hypemic means “not enough blood.”

Stagnant Hypoxia

Stagnant means “not flowing,” and stagnant hypoxia results when the oxygen-rich blood in the lungs isn’t moving, for one reason or another, to the tissues that need it.

Histotoxic Hypoxia

The inability of the cells to effectively use oxygen is defined as histotoxic hypoxia. “Histo” refers to tissues or cells, and “toxic” means poison.

Symptoms of Hypoxia

Common symptoms include:

- Cyanosis (blue fingernails and lips)
- Headache
- Decreased reaction time
- Impaired judgment
- Euphoria
- Visual impairment
- Drowsiness
- Lightheaded or dizzy sensation
- Tingling in fingers and toes
- Numbness

Altitude	Time of useful consciousness
45,000 feet MSL	9 to 15 seconds
40,000 feet MSL	15 to 20 seconds
35,000 feet MSL	30 to 60 seconds
30,000 feet MSL	1 to 2 minutes
28,000 feet MSL	2½ to 3 minutes
25,000 feet MSL	3 to 5 minutes
22,000 feet MSL	5 to 10 minutes
20,000 feet MSL	30 minutes or more

Hyperventilation

Hyperventilation occurs when an individual is experiencing emotional stress, fright, or pain, and the breathing rate and depth increase, although the carbon dioxide level in the blood is already at a reduced level.

The result is an excessive loss of carbon dioxide from the body, which can lead to unconsciousness due to the respiratory system's overriding mechanism to regain control of breathing.

Common symptoms of hyperventilation include:

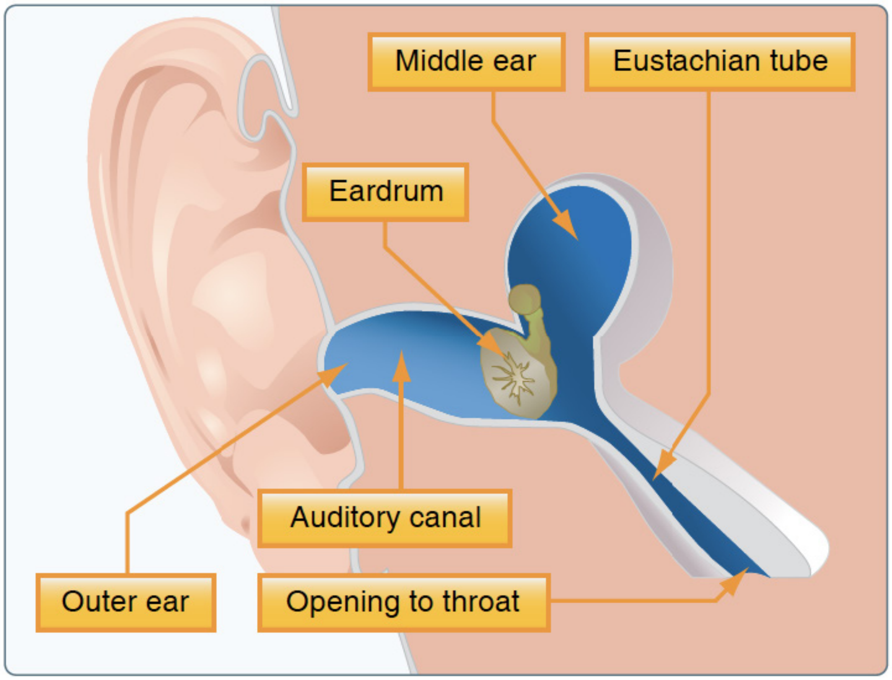
- Headache
- Decreased reaction time
- Impaired judgment
- Euphoria
- Visual impairment
- Drowsiness
- Lightheaded or dizzy sensation
- Tingling in fingers and toes
- Numbness
- Pale, clammy appearance
- Muscle spasms

Hyperventilation may produce a pale, clammy appearance and muscle spasms compared to the cyanosis and limp muscles associated with hypoxia.

The treatment for hyperventilation involves restoring the proper carbon dioxide level in the body. Breathing normally is both the best prevention and the best cure for hyperventilation. In addition to slowing the breathing rate, breathing into a paper bag or talking aloud helps to overcome hyperventilation. Recovery is usually rapid once the breathing rate is returned to normal.

Hypoxic Hypoxia

This occurs when the blood is not able to take up and transport a sufficient amount of oxygen to the cells in the body. Hypemic means “not enough blood.”

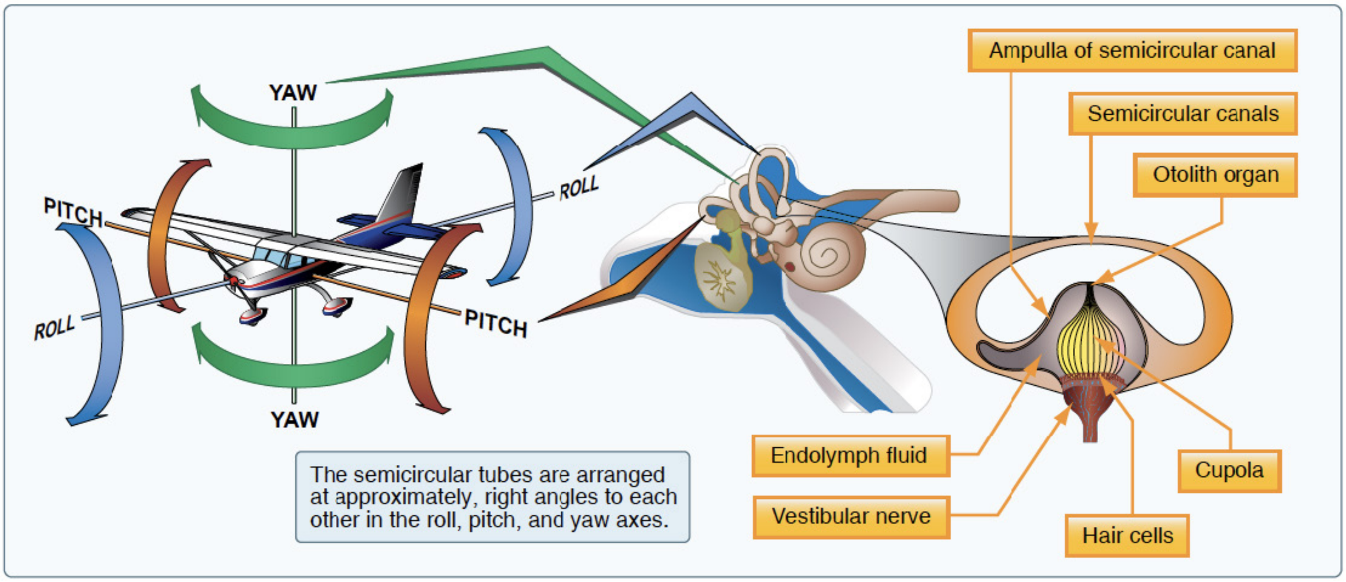


The eustachian tube allows air pressure to equalize in the middle ear

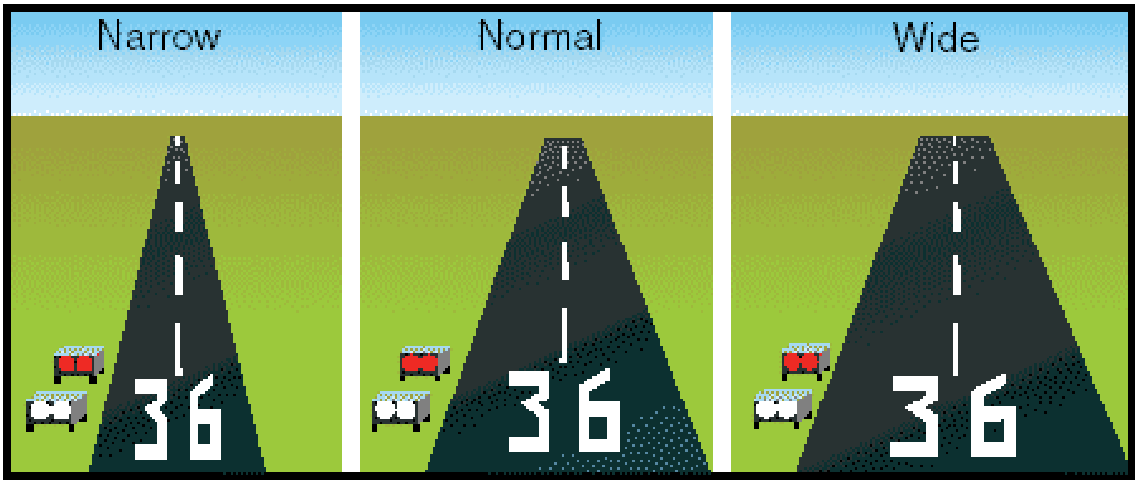
Blocked or swollen Eustachian tube causes a difference in pressure on the ear drum causing pain. In a similar way, air pressure in the sinuses equalizes with the pressure in the cockpit through small openings that connect the sinuses to the nasal passages. An upper respiratory infection, such as a cold or sinusitis, or a nasal allergic condition can produce enough congestion around an opening to slow equalization. As the difference in pressure between the sinus and the cockpit increases, congestion may plug the opening. This “sinus block” occurs most frequently during descent. Slow descent rates can reduce the associated pain. A sinus block can occur in the frontal sinuses, located above each eyebrow, or in the maxillary sinuses, located in each upper cheek. It will usually produce excruciating pain over the sinus area. A maxillary sinus block can also make the upper teeth ache. Bloody mucus may discharge from the nasal passages.

Spatial Disorientation and Illusions

Spatial disorientation specifically refers to the lack of orientation with regard to the position, attitude, or movement of the airplane in space.



The semicircular canals lie in three planes, and sense motions of roll, pitch, and yaw.



Runway Illusions

BICEFLAGS

Black Hole	**False**
Inversion	**The Leans**
Coriolis	**Autokinesis**
Elevator	**Somotographic Illusion**

Motion Sickness

Motion sickness, or airsickness, is caused by the brain receiving conflicting messages about the state of the body.

Carbon Monoxide Poisoning

Carbon monoxide (CO) is a colorless and odorless gas produced by all internal combustion engines. Since it attaches itself to the hemoglobin in the blood about 200 times more easily than oxygen, carbon monoxide prevents the hemoglobin from carrying oxygen to the cells, resulting in hypemic hypoxia. It can take up to 48 hours for the body to dispose of carbon monoxide.

Anytime a pilot smells exhaust odor, or any time that these symptoms are experienced, immediate corrective actions should be taken. These include turning off the heater, opening fresh air vents and windows, and using supplemental oxygen, if available.

Stress

Stress is defined as the body's response to physical and psychological demands placed upon it.
Acute stress involves an immediate threat that is perceived as danger.
Chronic stress can be defined as a level of stress that presents an intolerable burden, exceeds the ability of an individual to cope, and causes individual performance to fall sharply.

Fatigue

Fatigue is frequently associated with pilot error.
Acute and chronic. Acute fatigue is short term and is a normal occurrence in everyday living.
A special type of acute fatigue is skill fatigue. This type of fatigue has two main effects on performance:

- **Timing disruption** Appearing to perform a task as usual, but the timing of each component is slightly off.
- **Disruption of the perceptual field** Concentrating attention upon movements or objects in the center of vision and neglecting those in the periphery. This may be accompanied by loss of accuracy and smoothness in control movements.

Chronic fatigue, extending over a long period of time, usually has psychological roots, although an underlying disease is sometimes responsible.

Dehydration and heatstroke

Dehydration is the term given to a critical loss of water from the body. The first noticeable effect of dehydration is fatigue. If this fluid is not replaced, fatigue progresses to dizziness, weakness, nausea, tingling of hands and feet, abdominal cramps, and extreme thirst. Heatstroke is a condition caused by any inability of the body to control its temperature. Onset of this condition may be recognized by the symptoms of dehydration, but also has been known to be recognized only by complete collapse.

Alcohol

Alcohol impairs the efficiency of the human mechanism.

Alcohol interferes with the brain's ability to utilize oxygen, producing a form of histotoxic hypoxia.

14 CFR part 91 requires that blood alcohol level be less than .04 percent and that 8 hours pass between drinking alcohol and piloting an airplane. A pilot with a blood alcohol level of .04 percent or greater after 8 hours cannot fly until the blood alcohol falls below that amount. Even though blood alcohol may be well below .04 percent, a pilot cannot fly sooner than 8 hours after drinking alcohol. Although the regulations are quite specific, it is a good idea to be more conservative than the regulations.

Drugs

Pilot performance can be seriously degraded by both prescribed and over-the-counter medications, as well as by the medical conditions for which they are taken. The Code of Federal Regulations prohibits pilots from performing crewmember duties while using any medication that affects the faculties in any way contrary to safety. The safest rule is not to fly as a crewmember while taking any medication, unless approved to do so by the FAA. If there is any doubt regarding the effects of any medication, consult an aviation medical examiner before flying.

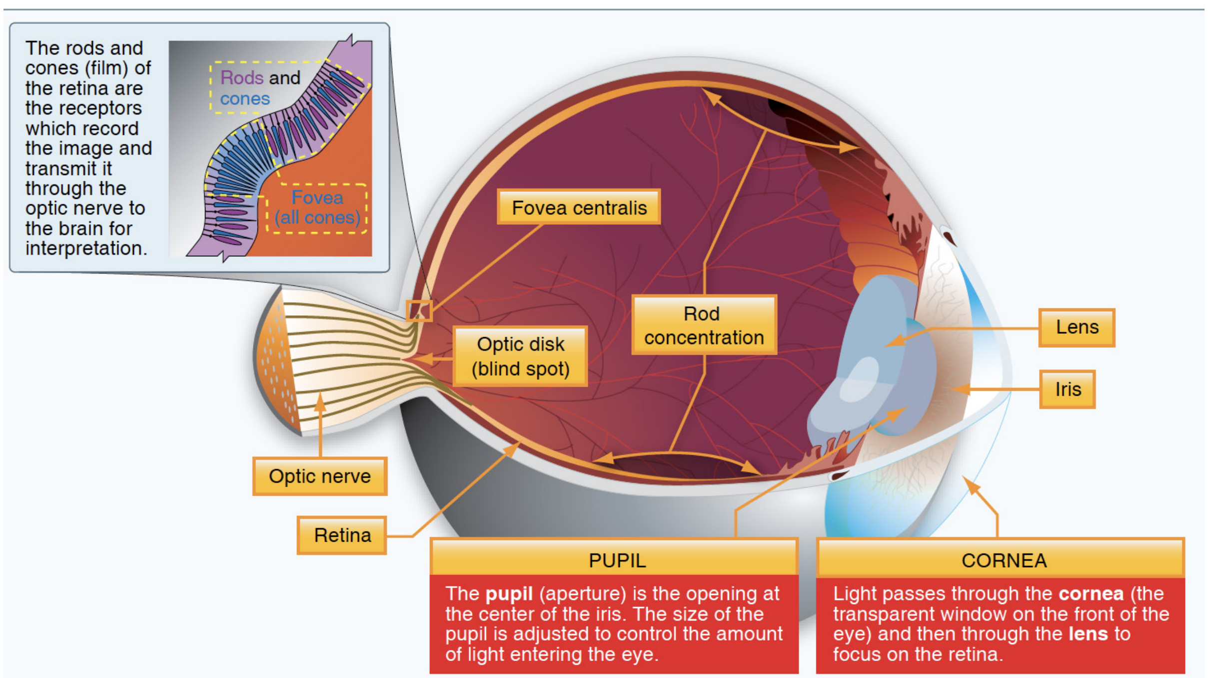
Scuba diving

The bends can be experienced from as low as 8,000 feet MSL, with increasing severity as altitude increases. As noted in the Aeronautical Information Manual (AIM), the minimum recommended time between scuba diving on non-decompression stop dives and flying is 12 hours, while the minimum time recommended between decompression stop diving and flying is 24 hours.

Scuba divers must not fly for specific time periods following dives to avoid the bends.

Empty-field Myopia

There are two kinds of light sensitive cells in the eyes: rods and cones.



There are two kinds of light sensitive cells in the eyes: rods and cones.

The eye's blind spot.

The area where the optic nerve enters the eyeball has no rods or cones, leaving a blind spot in the field of vision. Normally, each eye compensates for the other's blind spot. Figure 7 provides a dramatic example of the eye's blind spot. Cover the right eye and hold this page at arm's length. Focus the left eye on the X in the right side of the windshield and notice what happens to the airplane while slowly bringing the page closer to the eye.

Empty-field Myopia

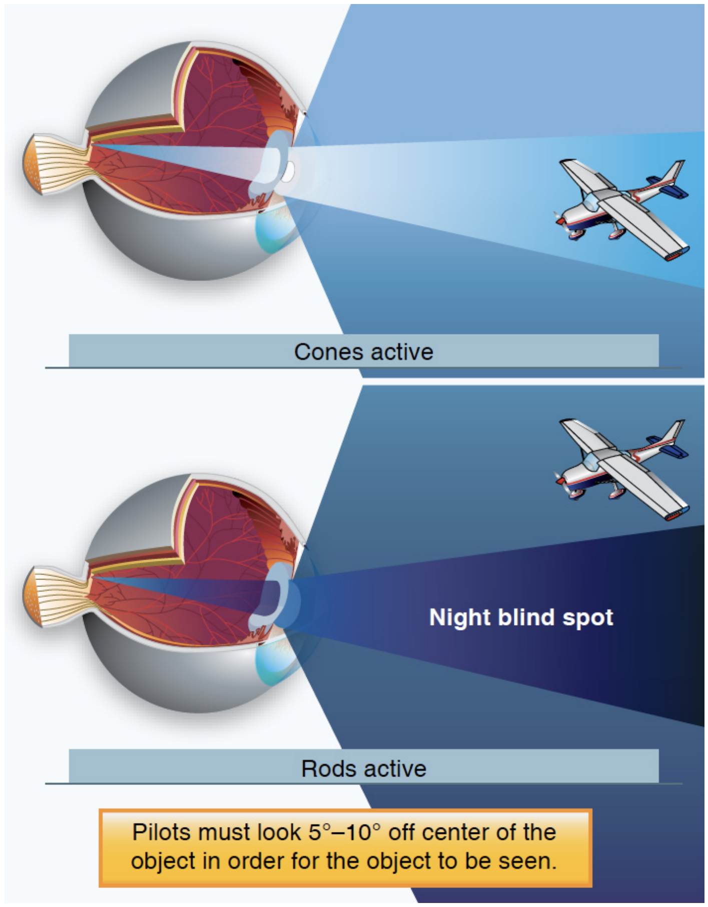
Another problem associated with flying at night, in instrument meteorological conditions and/or reduced visibility is empty-field myopia, or induced nearsightedness.

With nothing to focus on, the eyes automatically focus on a point just slightly ahead of the airplane.

Searching out and focusing on distant light sources, no matter how dim, helps prevent the onset of empty-field myopia.

Night Vision

The concentration of cones in the fovea can make a night-blind spot in the center of the field of vision. To see an object clearly at night, the pilot must expose the rods to the image. This can be done by looking 5° to 10° off center of the object to be seen.



Apparent Horizon

When looking directly at an object, the image is focused mainly on the fovea, where detail is best seen. At night, the ability to see an object in the center of the visual field is reduced as the cones lose much of their visual acuity and the rods become more sensitive. Looking off center can help compensate for this night-blind spot. Along with the loss of sharpness and color at night, depth perception and judgment of size may be lost.

Night Visual Illusions

There are many different types of visual illusions that commonly occur at night. Anticipating and staying aware of them is usually the best way to avoid them.

Auto kinesis is caused by staring at a single point of light against a dark background for more than a few seconds. After a few moments, the light appears to move on its own. To prevent this illusion, focus the eyes on objects at varying distances and avoid fixating on one target. Be sure to maintain a normal scan pattern.

False Horizon

A false horizon can occur when the natural horizon is obscured or not readily apparent.

Night Landing Illusions

Above featureless terrain at night, there is a natural tendency to fly a lower-than-normal approach. Elements that cause any type of visual obscuration, such as rain, haze, or a dark runway environment also can cause low approaches.

Bright lights, steep surrounding terrain, and a wide runway can produce the illusion of being too low, with a tendency to fly a higher-than-normal approach.

Often a set of regularly spaced lights along a road or highway can appear to be runway lights. Pilots have even mistaken the lights on moving trains as runway or approach lights.
Bright runway or approach lighting systems can create the illusion that the airplane is closer to the runway, especially where few lights illuminate the surrounding terrain.

Objective

To develop a methodical approach to visual scanning & collision avoidance.

Motivation

Avoiding a collision with another airplane when VFR is always the responsibility of the pilot even if radar services are used. The See and avoid concept applies to all pilots.

Presentation: 45 Minutes

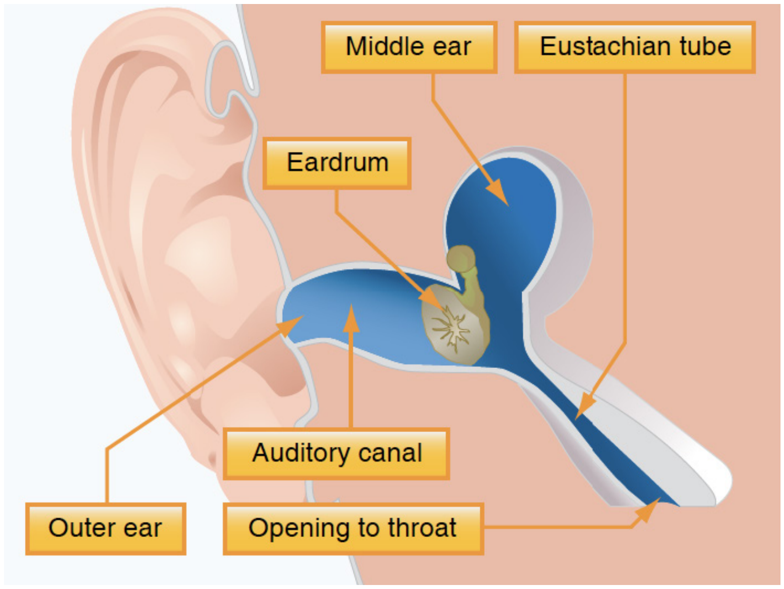
1. Relationship between a pilot's physical condition and vision.
2. Environmental conditions that degrade vision.
3. Vestibular and visual illusions.
4. "See and avoid" concept.
5. Proper visual scanning procedure.
6. Relationship between poor visual scanning habits and increased collision risk.
7. Proper clearing procedures.
8. Importance of knowing aircraft blind spots.
9. Relationship between aircraft speed differential and collision risk.
10. Situations that involve the greatest collision risk.
11. Using TIS and ADS-B.

References

FAA-H-8083-25b
AC 91-73B
Runway Safety
FAA Taxi Test

Faa.gov/go/runwaysafety

Https://livestream.com/FAASTeamTV/Events/2185859



- **Relationship between a pilot's physical condition and vision**
  - Vision is the most important sense in flight.
  - Good eyesight depends on good physical health.
    - Fatigue, illness, smoking, drugs, alcohol, oxygen deprivation, lack of vitamins.

- **Environmental conditions that degrade vision (AIM 8-1-6)**
  - Dark adaptation: Requires 30min.
    - Impaired by cabin Pressure Alt >5,000'MSL, CO (exhaust or smoking), Vitamin A deficiency.

- **Vestibular and visual illusions. (AIM 8-1-5)**
  - False perception of one's position and motion with respect to the earth.
  - Sensory illusions can lead to differences between instrument indications and what the pilot "feels".
  - Disoriented pilots are not aware of their orientation.
  - When an attitude is maintained for extended period, the vestibular system will cause the pilot to incorrectly determine attitude.
  - Abrupt change in attitude or head position can create spatial disorientation.
  - Correct orientation only by visual reference to reliable fixed position on ground or to flight instruments.
  - Examples of Illusions leading to Spatial Disorientation and Landing Errors.
    - See AIM 8-1-5.

“See and Avoid” Concept (AIM 5-5-8, FAR 91.113b)

- Regardless of type of flight plan or whether or not under control of a radar facility, the pilot is responsible to see and avoid other traffic, terrain, or obstacles.

Proper visual scanning procedure. (AIM 8-1-6c , AC 90-48)

- Scanning the sky for other aircraft is a key factor in collision avoidance.
- it should be used continuously by the pilot and copilot to cover all areas of the sky visible from the cockpit.
- Effective scanning is accomplished with a series of short, regular spaced eye movements that bring successive areas of the sky into the center visual field.
- Each movement should not exceed 10 degrees, and each should be observed for at least 1 second to enable detection.
- Eyes should be outside about 3/4 of the time. 4 to 5 secs on the instrument panel for every 19 seconds outside.
- Avoid “Empty-Field Myopia” - Condition such as above the clouds or haze layer with nothing specific to focus on outside the aircraft. This causes the eyes to relax and seek a comfortable focal distance which may range from 10 to 30 feet. This means looking without seeking, which is dangerous.

Relationship between poor visual scanning habits and increased collision risk

- Poor scanning habits will elevate the risk of collision.

Proper clearing procedures. (AC 90-48)

- Taxi onto Runway: scan for approaching traffic. (maneuver aircraft to get a clear view)
- Climb/Descent: Gentle banks left/right.
- Clearing turns before maneuvers.

Importance of knowing aircraft blind spots. (AC 90-48)

- Look around physical obstructions. (Doors / Window post)

Relationship between aircraft speed differential and collision risk Situation that involve the greatest collision risk. (AIM 8-1-8, AC 90-48)

- Places where aircraft tend to cluster:
- Airways, especially near VORs and IFR way-points.
- Near airports, especially on clear sky and good visibility days.

Objective

To understand the aerodynamic concepts of how an airplane can overcome its own weight and to understand how resistance to its movement is generated and managed.

Motivation

An airplane must overcome its weight to fly and must be able to move through the air in order to do it. An understanding of these aerodynamic concepts/forces allow the pilot to understand how to anticipate and manage these forces.

Presentation: 45 Minutes

Airplane Components to Introduce:

1. Fuselage – Airplane minus the wings and stabilizers – contains the cabin, engine etc.
2. Airfoil – Generates force to overcome weight.
3. Horizontal Stabilizer – Allows the airplane to be controlled to balance the effect of the airfoil.

The Four Forces:

1. Weight
2. Lift
3. Thrust
4. Drag

Lift and Weight

1. For an airplane to fly it must overcome its weight. Weight is always directed downward.
2. The force created to overcome weight is called lift.
3. Newtons Third Law – Reaction.
4. Bernoulli's Principle – Relationship of Pressure and Velocity.
5. Airfoil components.
6. Show restricted pipe and relate it to an airfoil.
7. Relative wind – Parallel and opposite the flight path.
8. Angle of attack of the airfoil – Larger AOA increases the path on the top of the airfoil = more velocity = increase in lift.
9. Lift equation – Lift = $PV^2SC_L/2$ – Lift increases at the square of the velocity.

10. Critical angle of attack – Air can no longer stay attached to the airfoil – Aerodynamic stall occurs – Lift decreases.
11. Lift equation – variables controlled by the pilot are velocity and C_L. (Angle of attack)
12. The slower the airplanes speed the more Angle of Attack is needed (C_L).
13. As speed or AOA increases lift increases and the Center of Lift (Cp) moves forward
14. Cp needs to always be behind the Center of gravity (CG).
15. Purpose of the horizontal stabilizer – Provides tail down force – keeps the wing from causing the airplane to rotate forward around it's CG.

Drag and Thrust

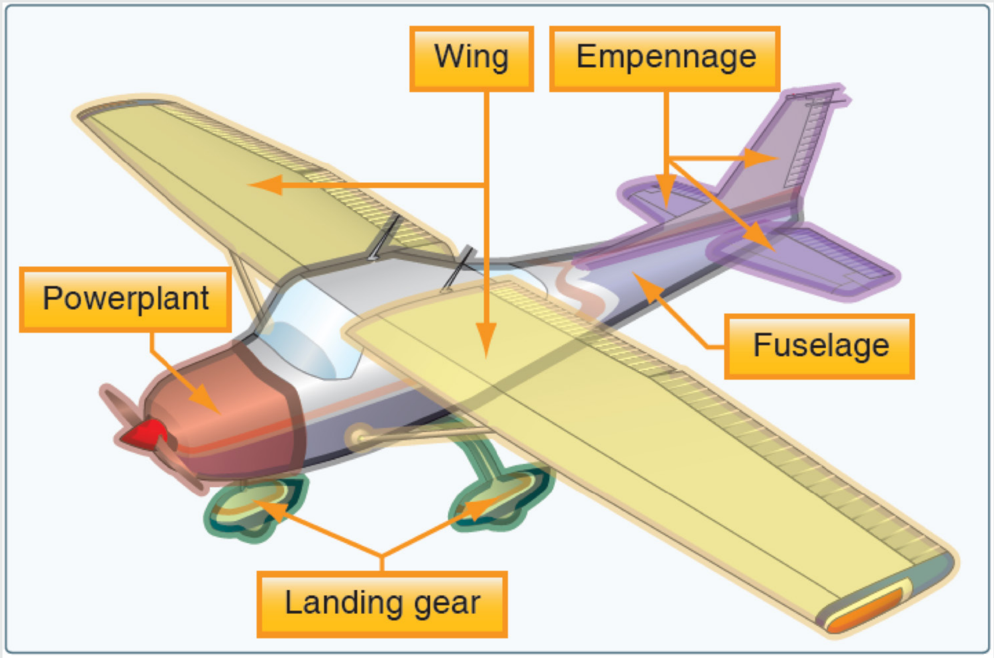
1. Thrust provides a means to create speed (Velocity)
2. Force that opposes motion that opposes thrust.
3. Parasite drag caused by the airplane parts – The larger the surface area the more the drag
4. Parasite drag – Increases at the square of the speed – Show graph Drag vs Speed
5. Induced drag – As speed is slowed more AOA is needed – Lift vector is tilted rearward - component of lift acting rearward has to be overcome by thrust or speed slows.
6. Induced drag – Wingtip vortices increase with higher AOAs. At the wingtips the High pressure below can corkscrew up toward the low-pressure area of the wing. It takes energy to create the vortices and this energy is lost the airflow causing lift which means more drag.
7. Induced drag – Show graph of Drag vs speed – Induced drag increases as speed is reduced. (AOA is generating lift instead of Velocity)
8. Total drag is the combination of Parasite and induced drag. (Show graph of Drag vs speed with total drag curve)
9. The lowest drag occurs at a particular speed.
10. Drag must be overcome by thrust in order to both speed up (Parasite drag) or to go slower (Due to induced drag) to maintain level flight.
11. Ground effect and how it relates to a decrease in drag.

Wing Design and Planform

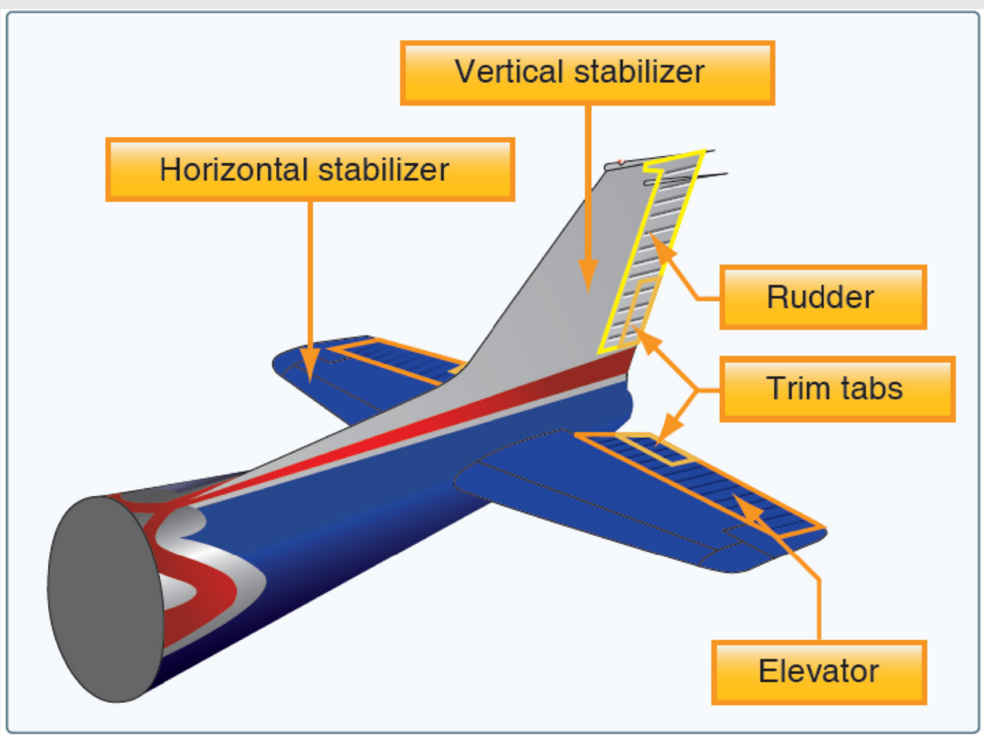
1. Aspect ratio as it relates to production of lift and drag.
2. Design choices of various wing planforms for speed and handling.

Lesson Additional Images

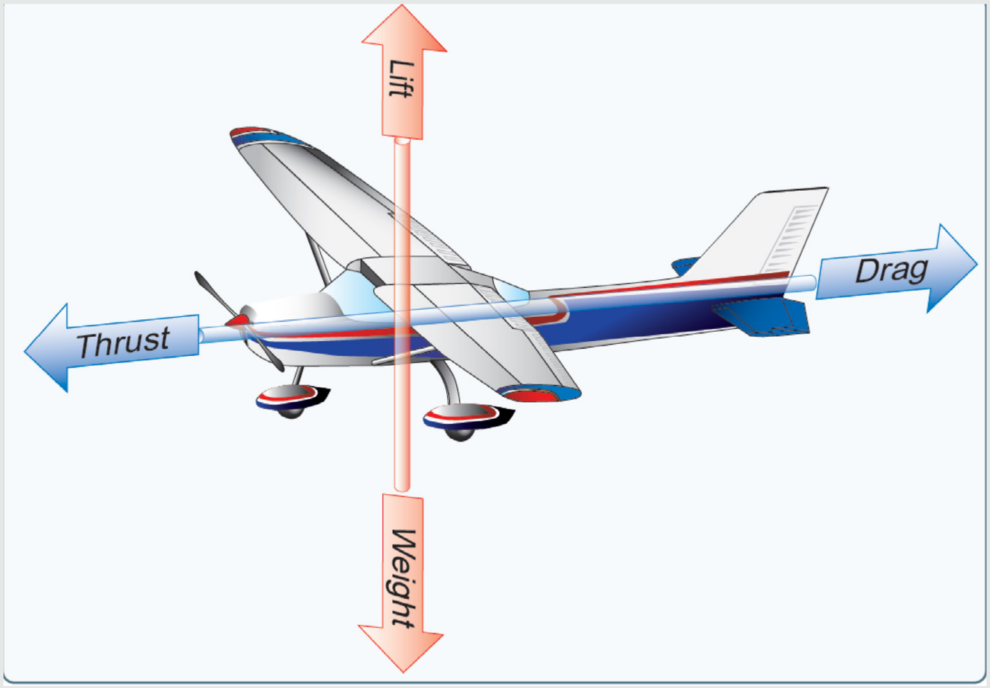
Components of an airplane



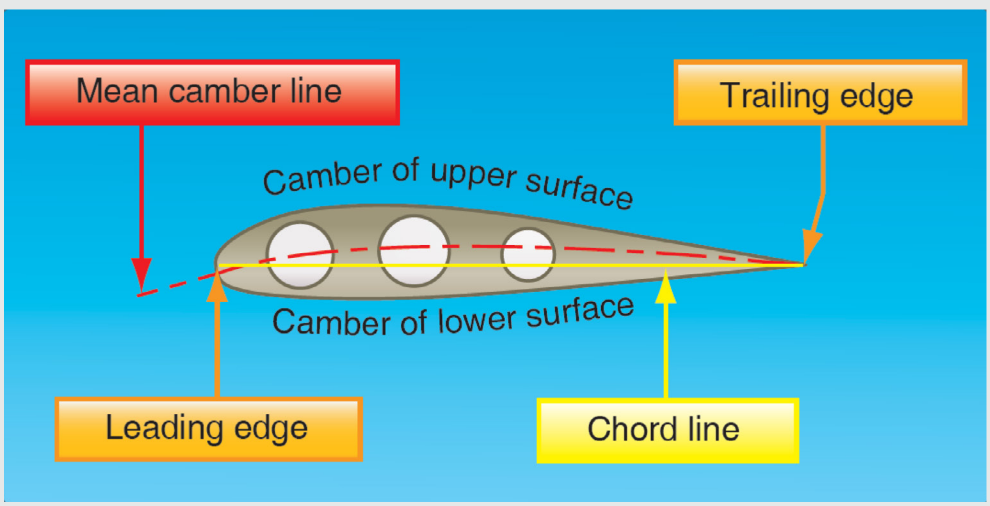
Horizontal Stabilizer



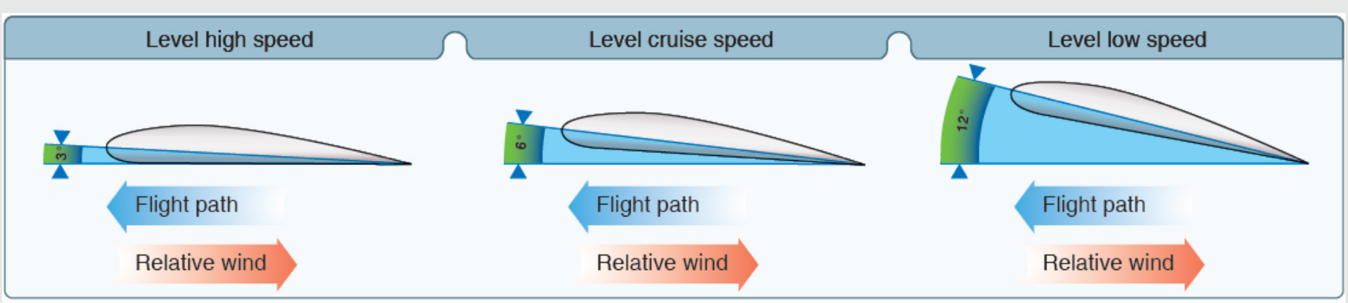
Components of an airplane



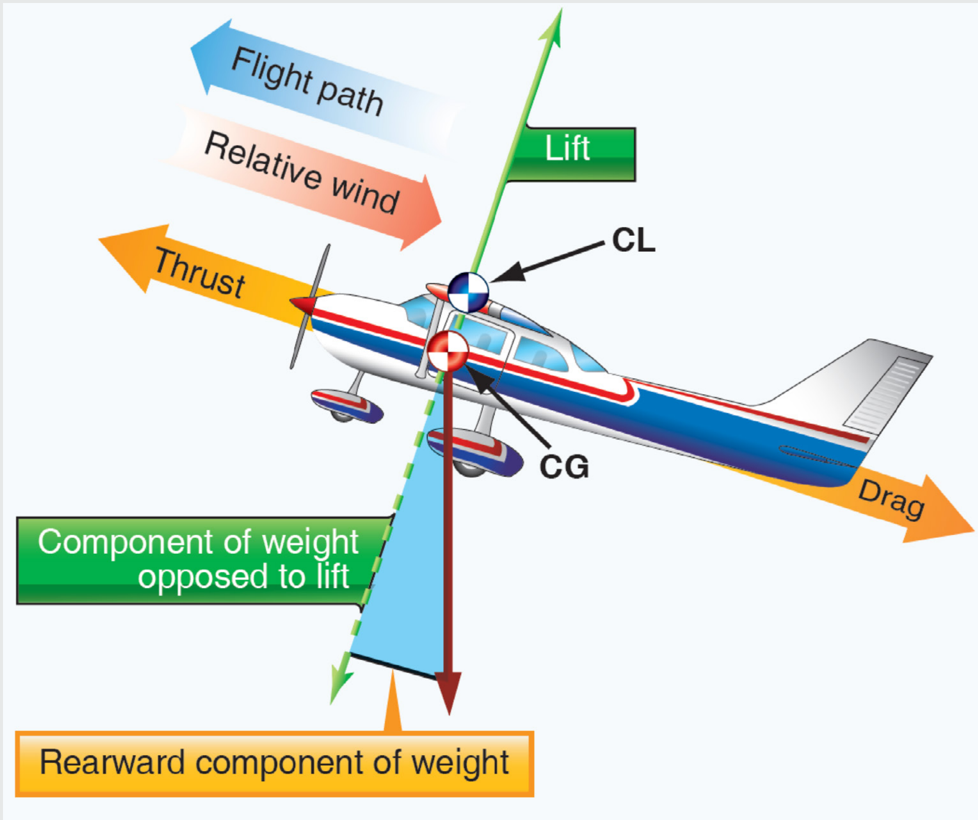
Horizontal Stabilizer



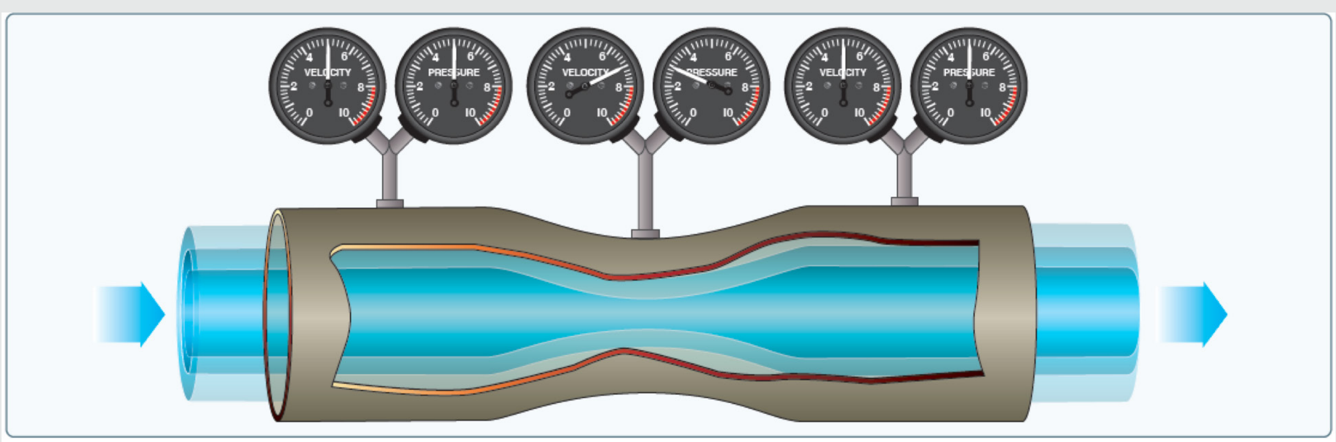
Relative wind as speed changes along the same flight path



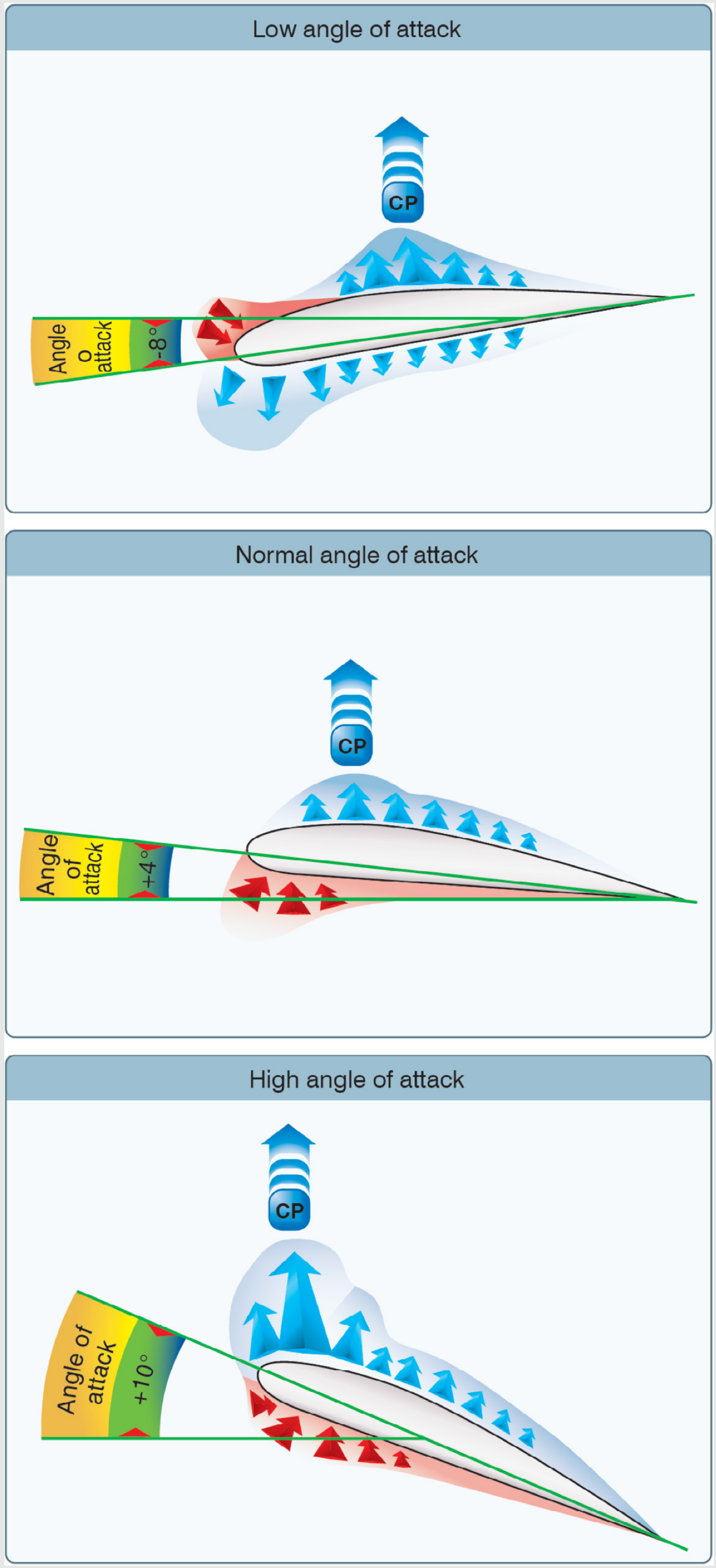
Relative wind in a climb



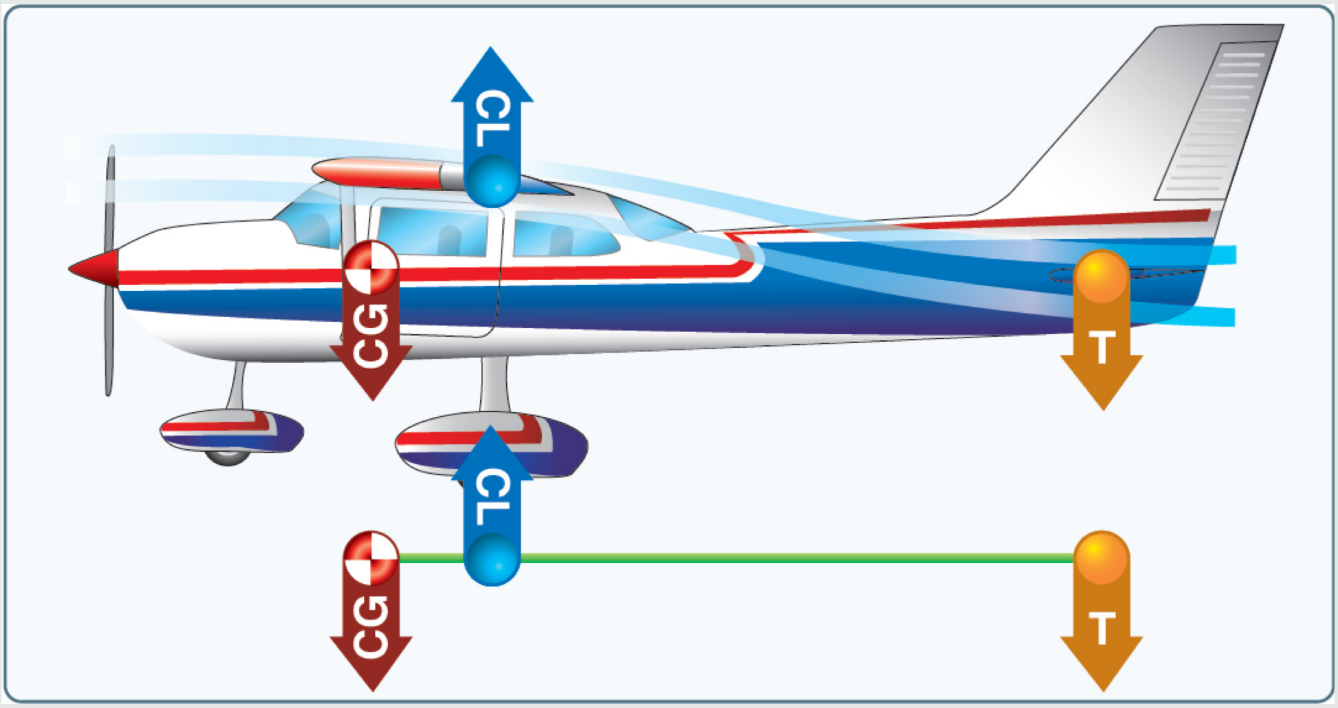
Pressure and Velocity Relationship - Bernoulli's Principle



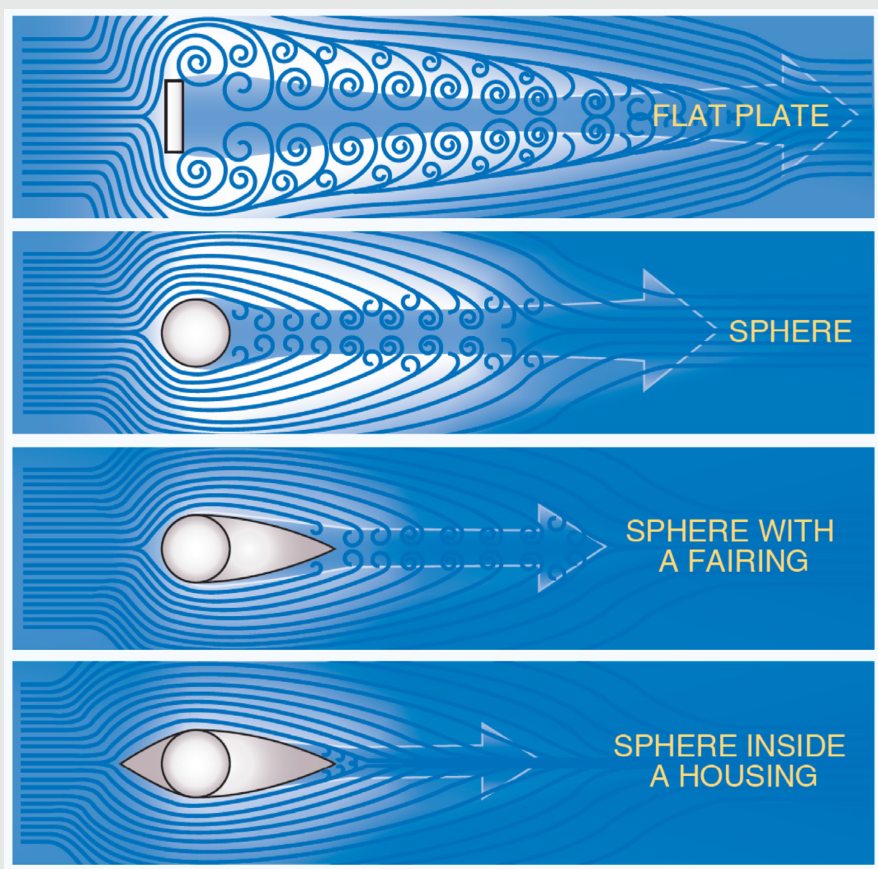
Center of pressure changes with angle of attack



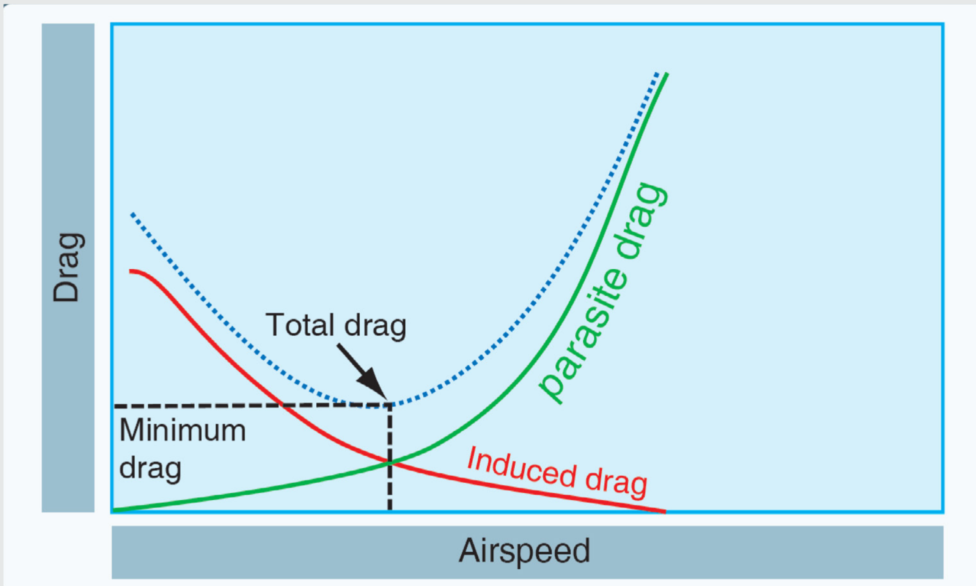
Relative wind in a climb



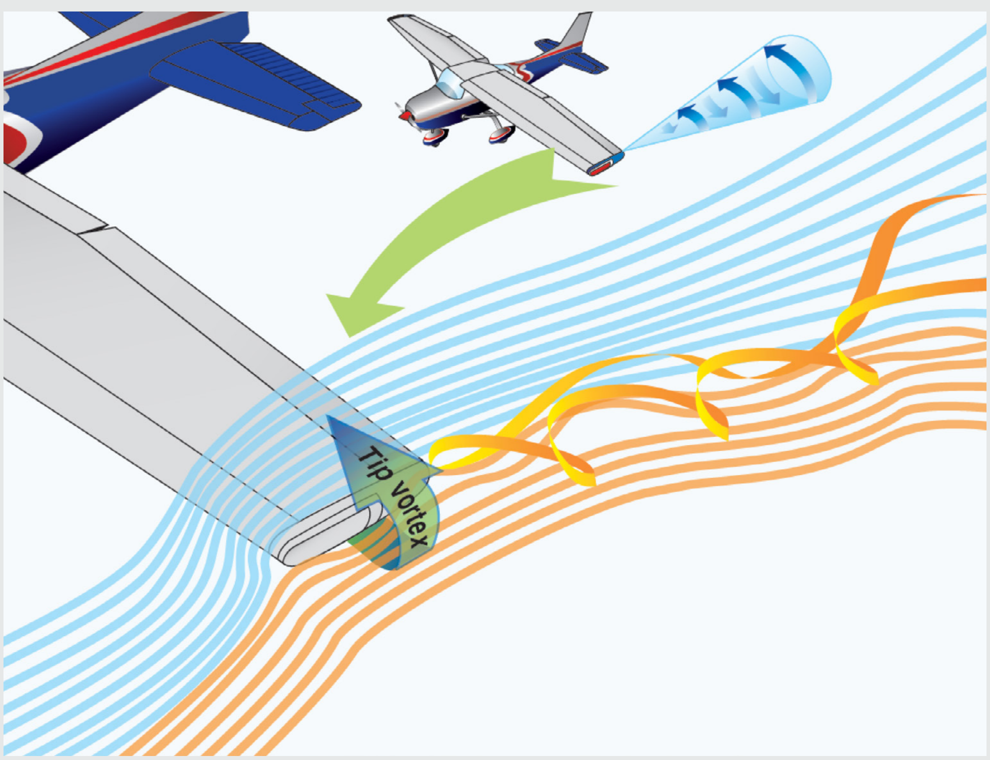
Pressure and Velocity Relationship - Bernoulli's Principle

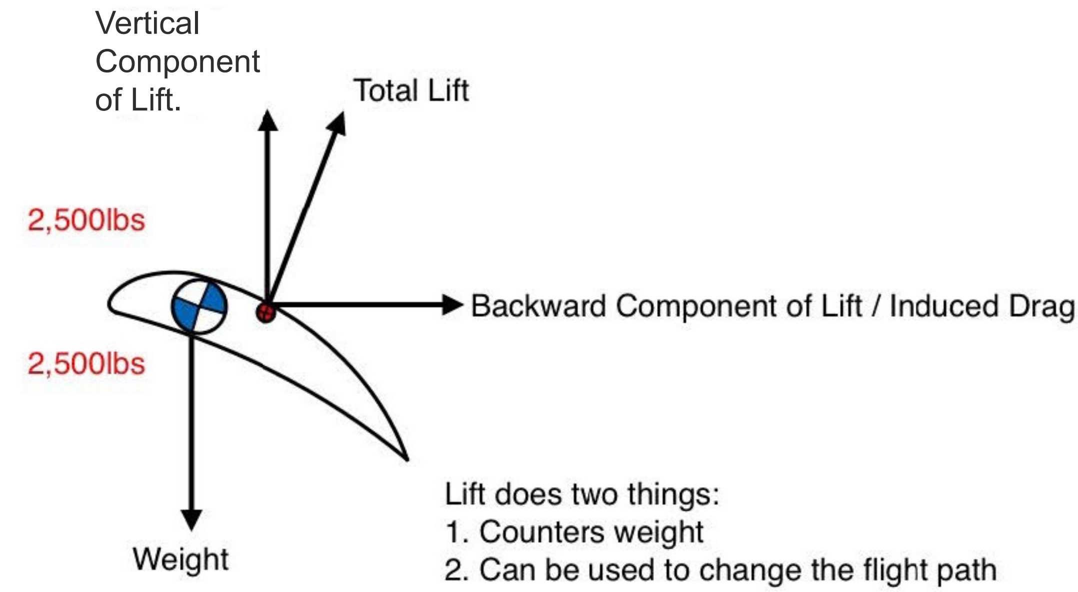


Components of an airplane



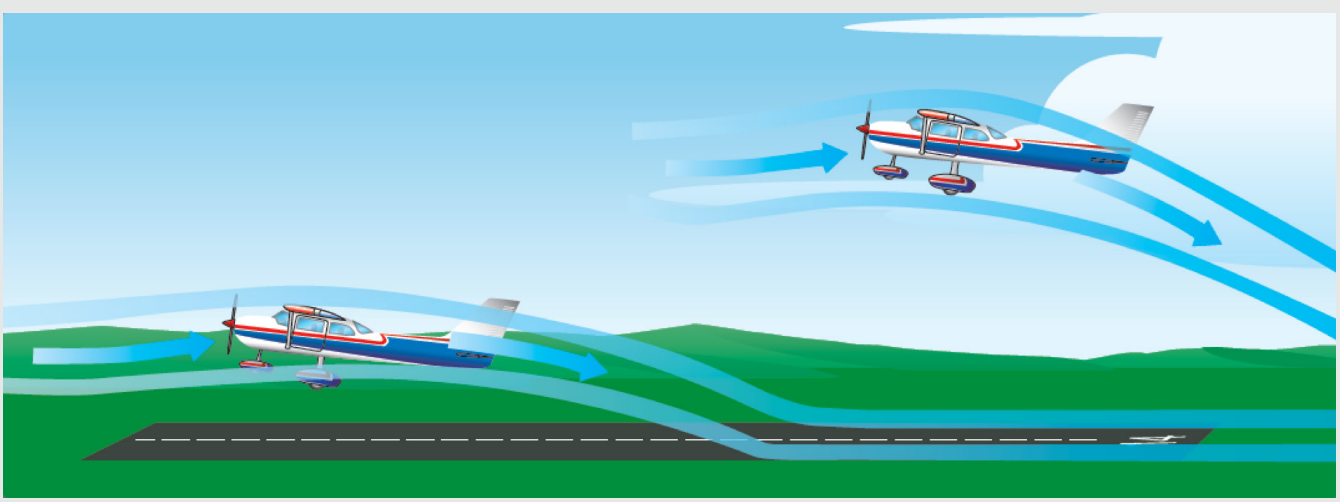
Horizontal Stabilizer



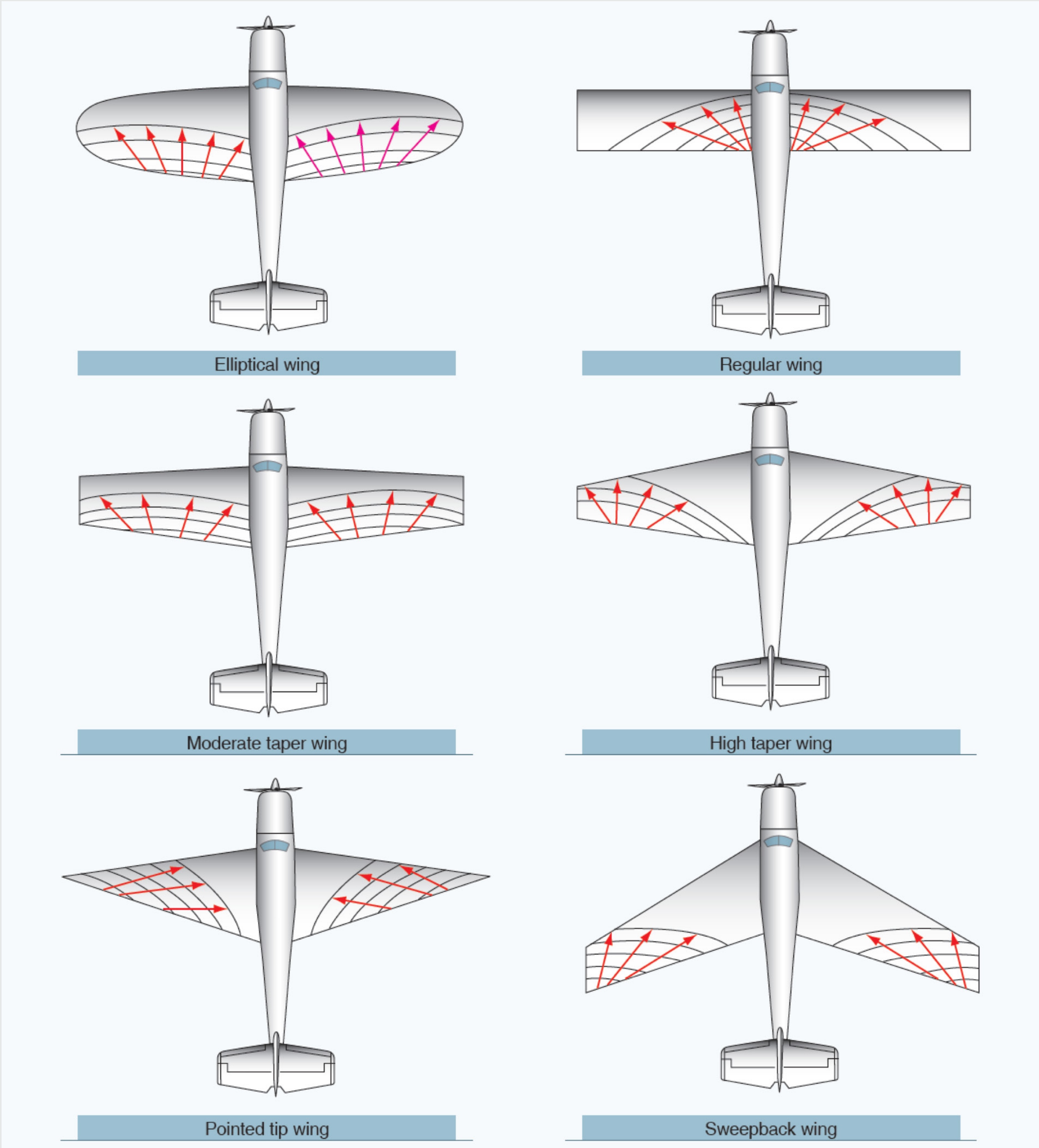


Thrust causes an airplane to climb, Lift causes flight path to be redirected.

Ground effect changes the airflow



Components of an airplane



Objective

The student will understand how a training or transport airplane achieves stability around it's three axes. The student will also understand how the center of gravity affects the control over the airplane the pilot has.

Motivation

Understanding stability will help the pilot understand when and to the extent a control input may be necessary after the airplane is disturbed by the environment such as turbulence. Understanding how the center of gravity determines how controllable the airplane is will also help the pilot load the airplane in a safe manner where controllability is assured.

Presentation: Aircraft stability and Controllability 30 Minutes

Stability

1. Airplane stability relates to how the airplane behaves if disturbed from its flight path.
2. Static stability – The initial tendency of the airplanes movement once disturbed.
3. Types of static stability – Positive, Neutral and Negative.
4. Dynamic stability – The tendency of the airplane's movement over time.
5. Types of dynamic stability – Positive, Neutral and Negative.
6. Longitudinal stability (Pitching) – Achieved by more or less tail-down force due to downwash. Also thrust-line will affect stability when power is changed.
7. Lateral stability (Rolling) – Achieved in a high wing airplane by pendulous effect and keel effect.
8. Lateral stability (Rolling) – Achieved in a low wing airplane by Dihedral.
9. Vertical stability (Yawing) – Achieved by the fuselage aft of the CG and the vertical stabilizer.
10. Free directional Oscillations (Dutch Roll) – Dihedral brings the wings level before the nose is aligned with the relative wind. This causes the airplane to form a figure eight along the horizon. Dampens down eventually.
11. Spiral instability – Caused by good directional stability – Strong directional stability on the airplane results in the nose aligning to the relative wind quickly compared to the weak dihedral causing the airplane to bank. The outside wing travels faster than the inside wing and the bank increases. Easy for a pilot to fix. Better control then Dutch roll so most airplanes are designed with spiral instability rather than Dutch roll.

Controllability

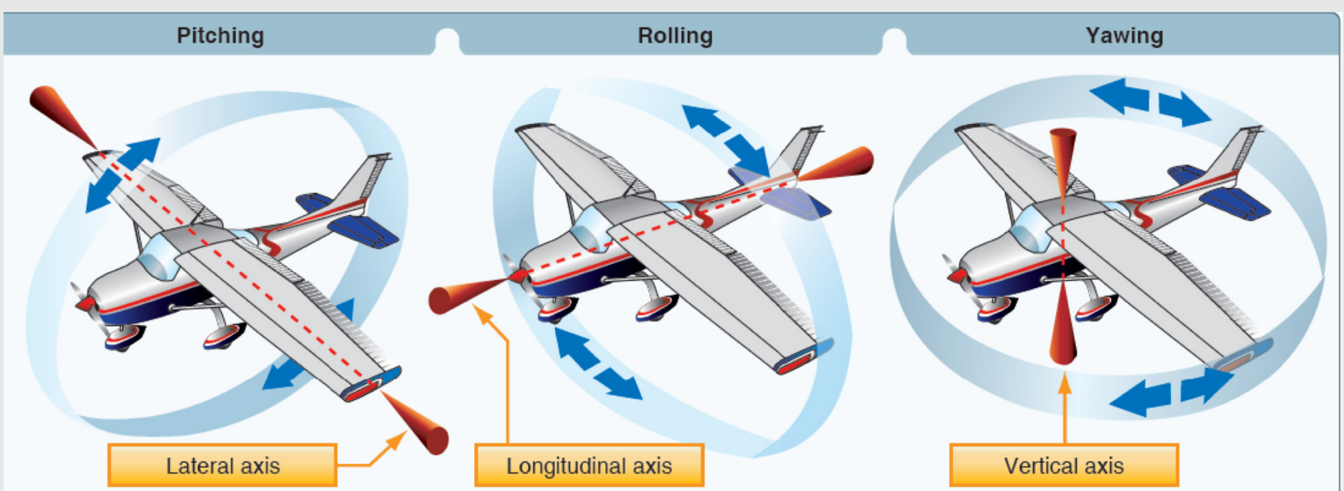
1. Controllability – The CG to the Cp is the determining factor. Design of the CG limits consider the amount of elevator control available to operate over all of the airplanes speed ranges.
2. CG location too far forward means less elevator travel upward – Not able to produce enough tail-down force (Impossible to flare). Very stable as a stall results in un-stalling quickly as the CG pulls the airplane down in the un-stalled direction.
3. CG location too far aft means too much tail-up force. Elevator may not be able to provide enough tail-up force to keep from stalling.

Completion Standards

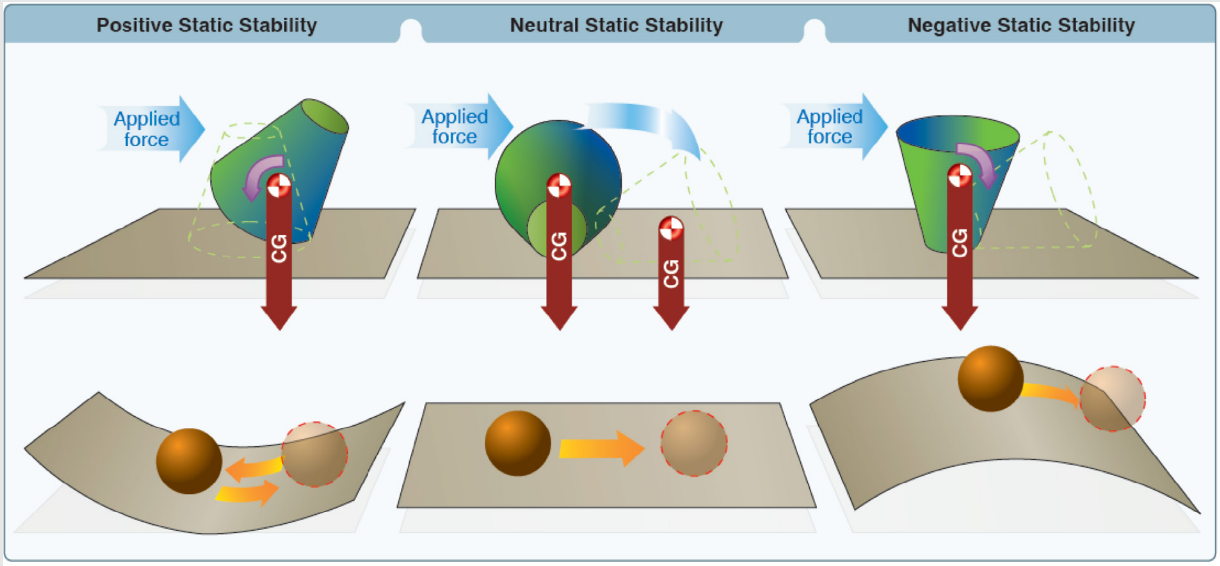
The student will be able to show how an airplane achieves stability around it's three axes using a model airplane or whiteboard. The student will also explain why an airplanes center of gravity is important for controllability.

Lesson Additional Images

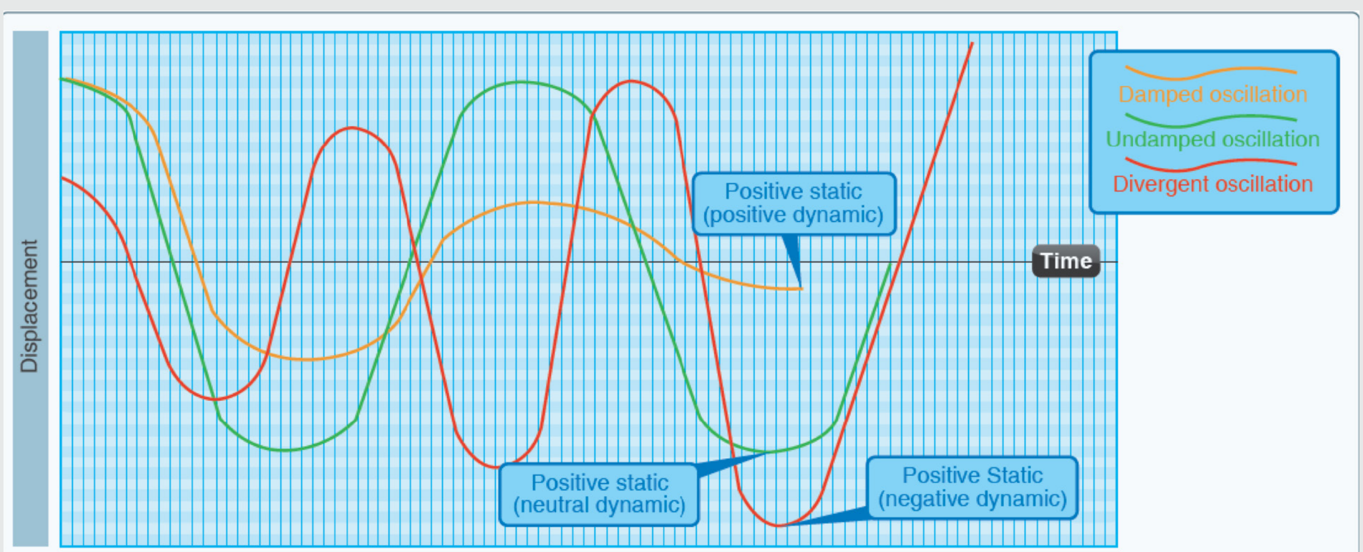
Axes of an airplane



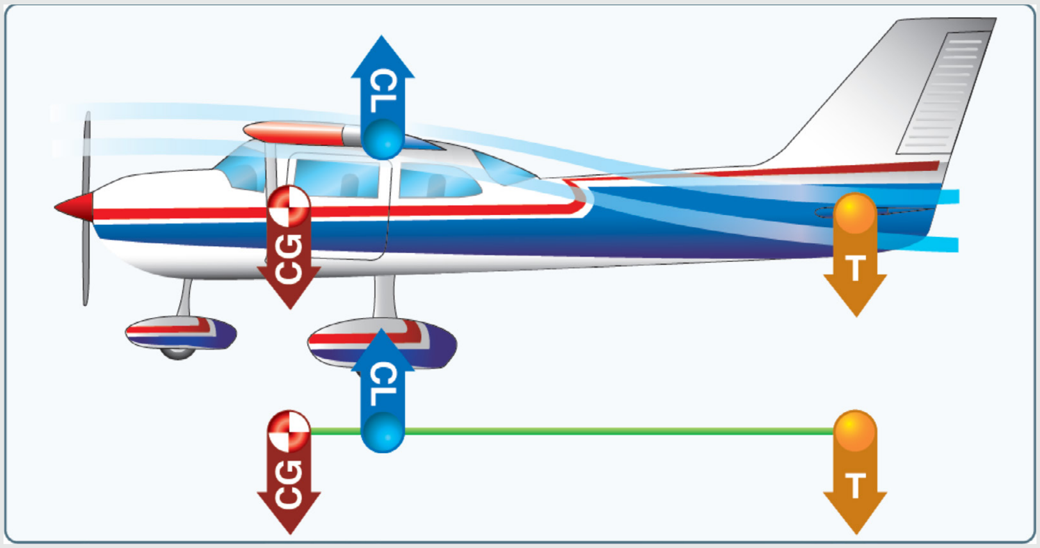
Types of static stability



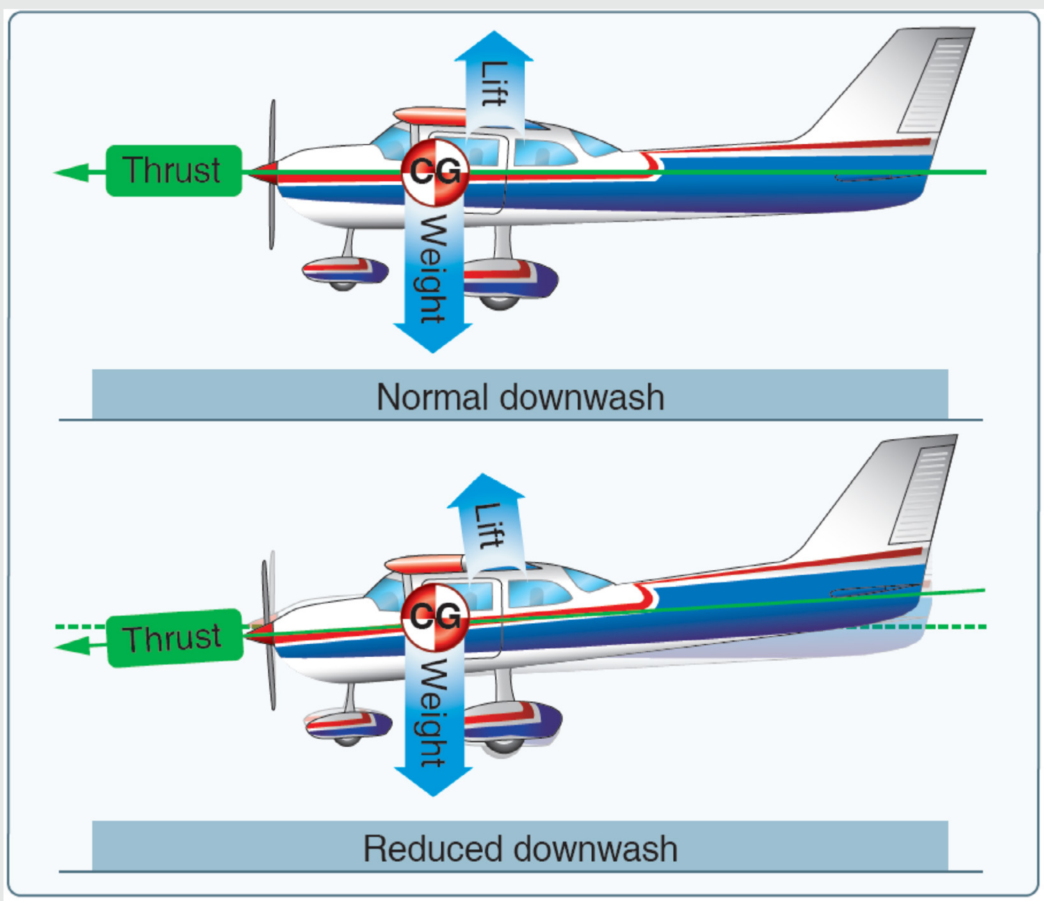
Dynamic stability and the effects of dampening



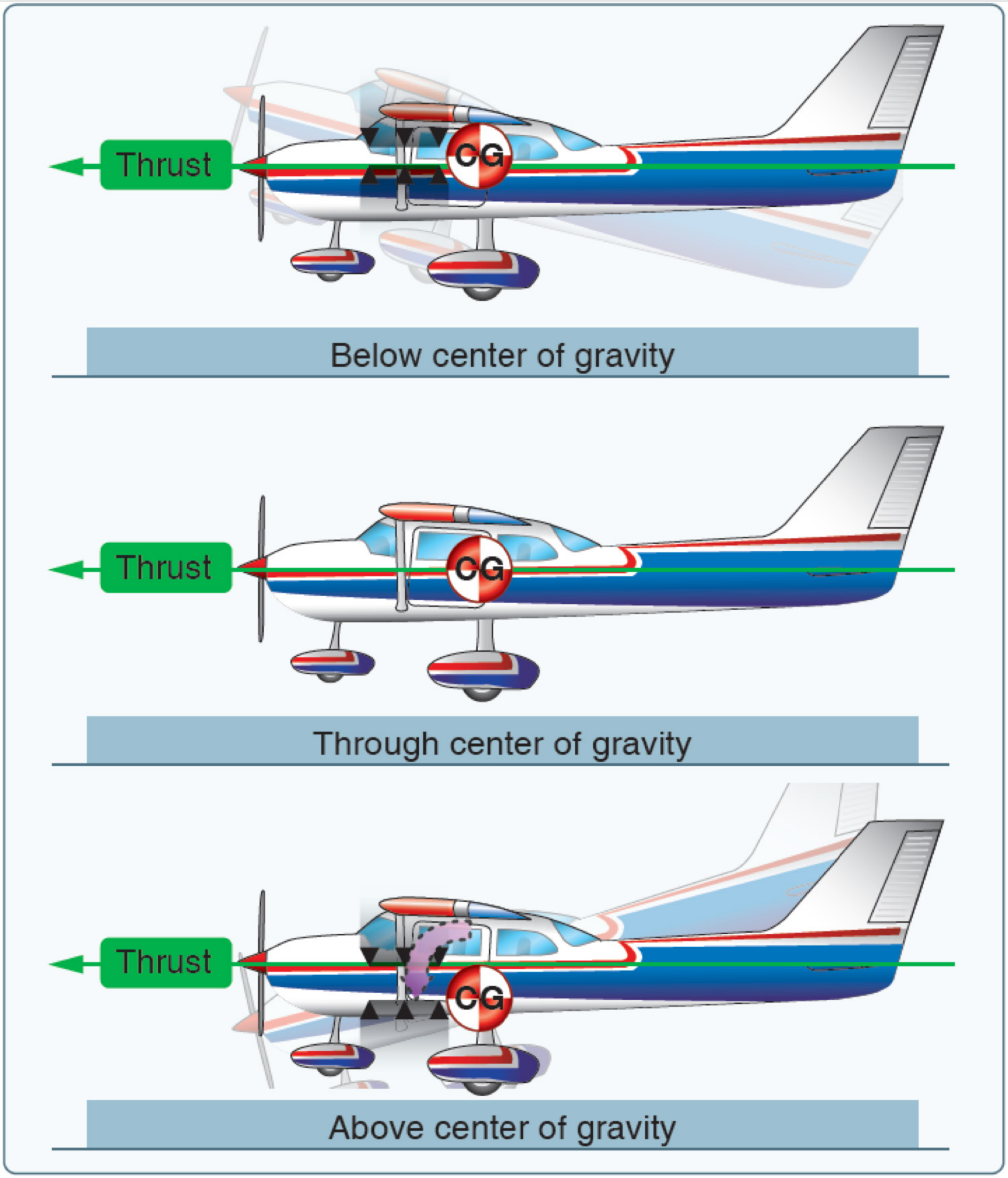
Longitudinal Stability



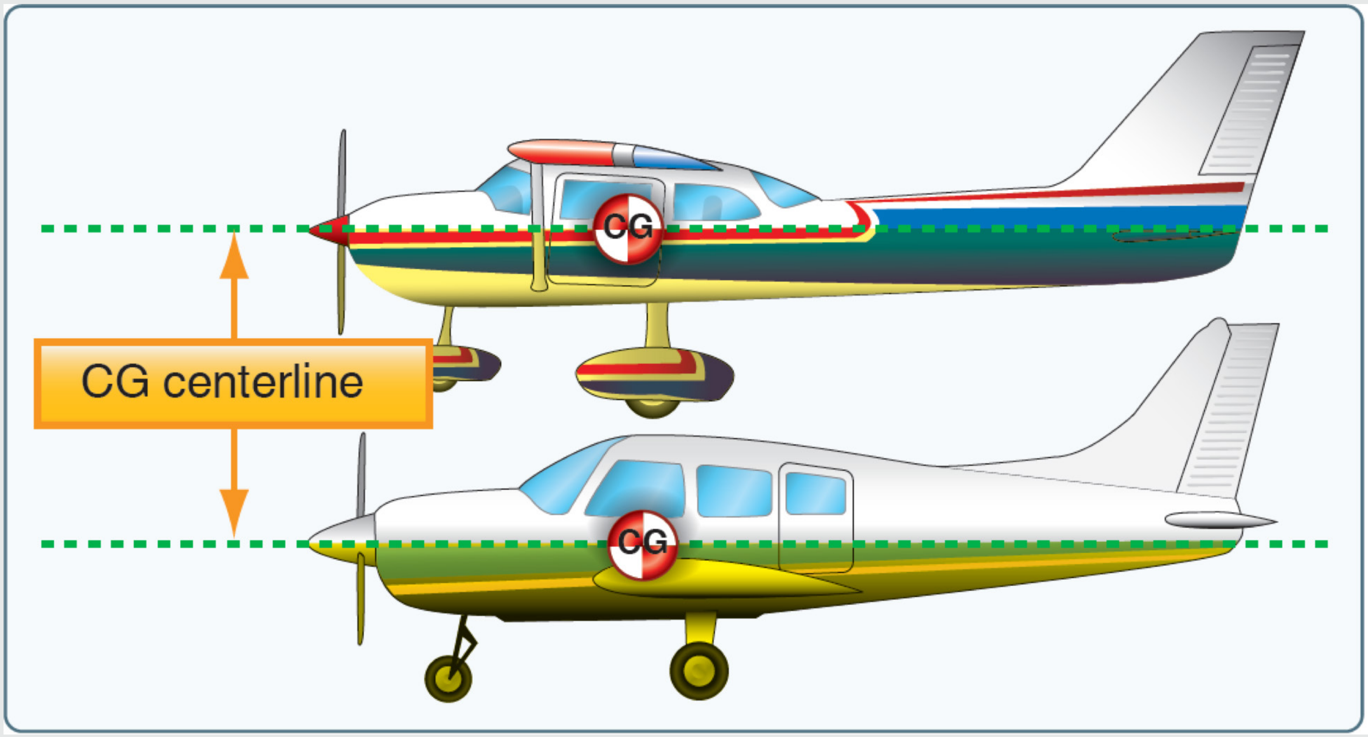
Downwash effect on longitudinal stability



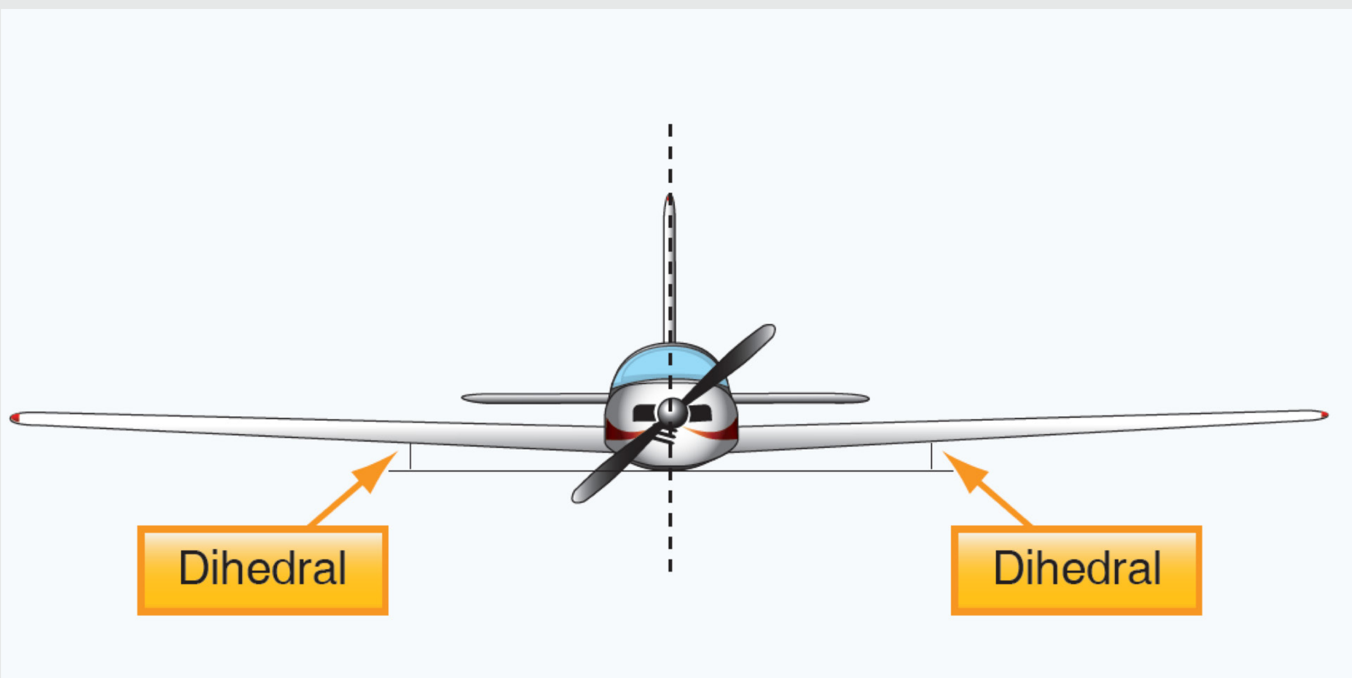
How the thrust line affects longitudinal stability



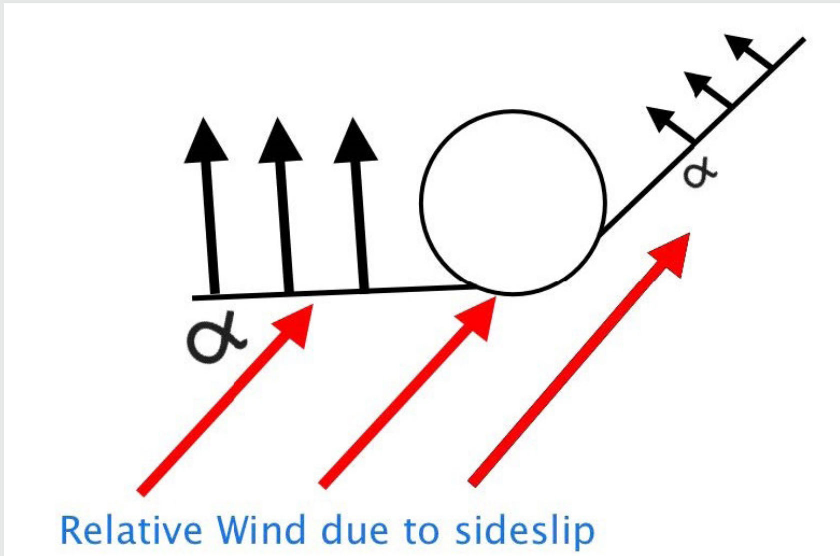
Keel effect



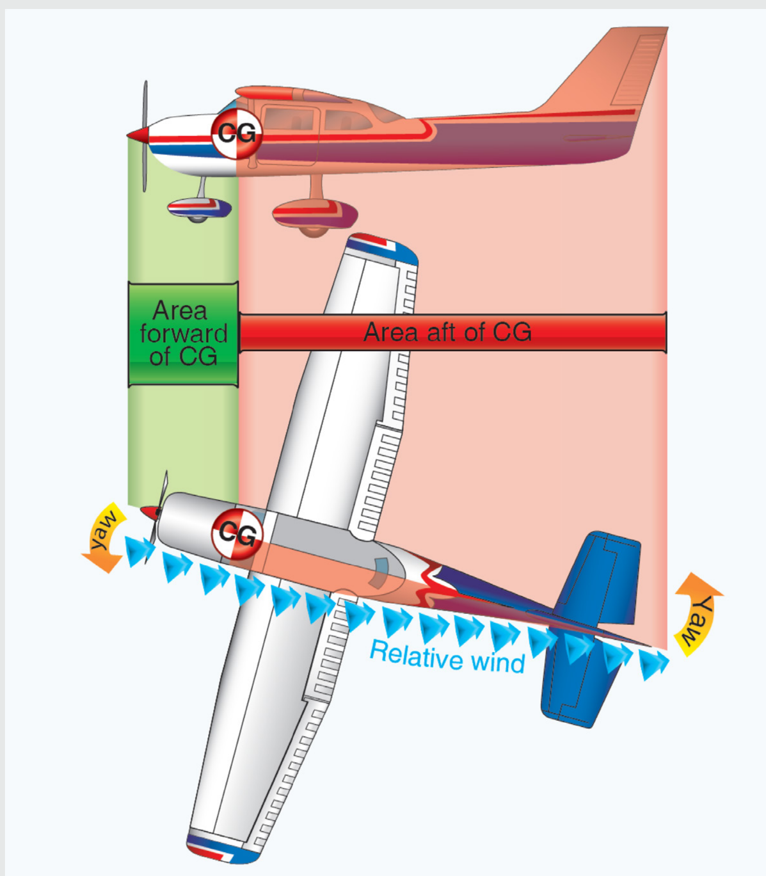
Dihedral



Increase of lift due to Slip



Fuselage and fin for directional stability



Objective

The student will understand the forces that tend to turn the airplane and how to prevent the airplane from turning or rolling. The student will also understand how the forces in a climb, descent and turn are different than in straight and level unaccelerated flight.

Motivation

Understanding the forces acting on an airplane allow the pilot to anticipate and control the forces that cause and airplane to takeoff, climb, descend and turn.

Presentation: 45 Minutes

Forces in unaccelerated straight and level flight

1. Lift is equal to weight.
2. Thrust is equal to drag.
3. The airplane is not accelerating so there is no change in the flight path.

Forces in a climb

1. Initially more lift is needed to change the flight path.
2. Once the new flight path is achieved lift returns to normal and the airplane climbs on excess thrust.
3. There is now a rearward component of lift and weight due to the climb – These forces cause the airplane to lose speed.

Forces in a descent

1. Initially the flight path is changed downward causing a reduction in lift.
2. Once the flight path is steady lift returns to normal.
3. There is now a forward component of lift and weight – These forces cause the airplane to increase in speed.

Forces in a descent

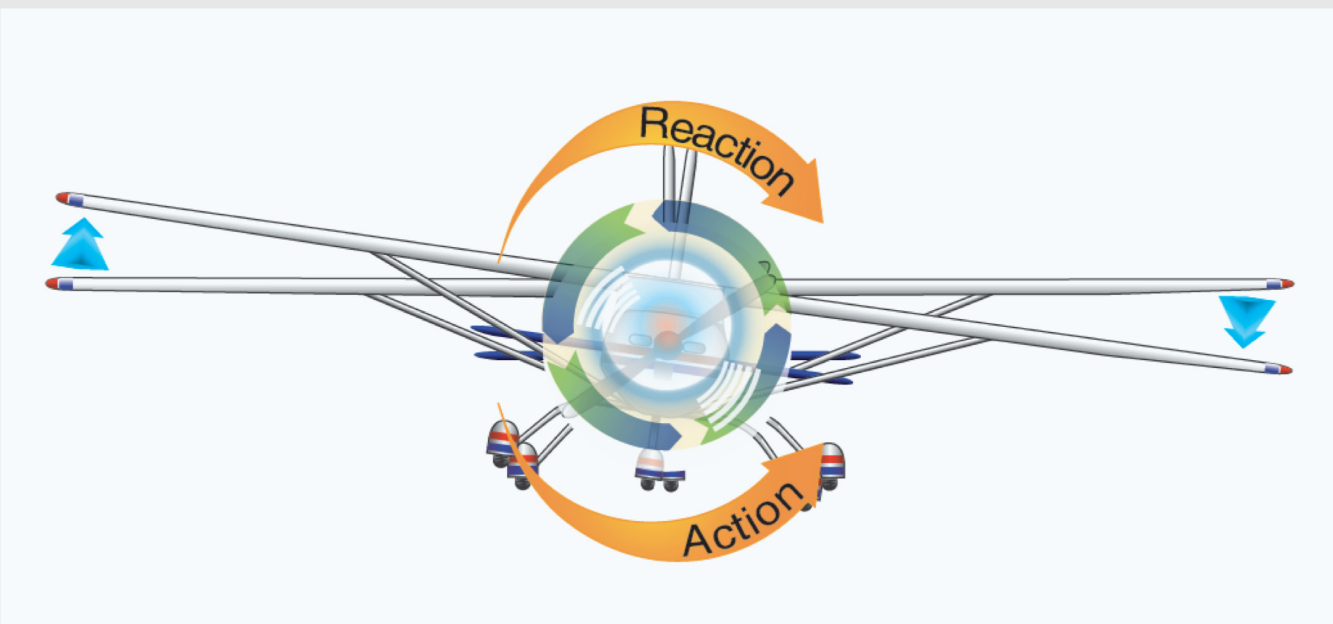
1. The airplane is banked to start a turn.
2. The lift vector is turned in the direction of the bank.
3. The lift vector has a horizontal and vertical component – The horizontal component turns the airplane and the vertical component causes it to climb or descend.
4. Because the lift vector is tilted more lift must be generated to both turn the airplane and stop it from descending – The amount of lift needed depends on the bank angle.
5. When the airplane turns weight remains acting downward – the force that opposes the total lift is the weight that opposes lift which is called load factor.
6. As the bank angle increases the amount of lift required increases as well as the load factor.
7. At 60 degrees of bank the lift required doubles and so does the load factor.
8. From 0 to 60 degrees of bank load factor increased 2 times – From 60 to 75 degrees load factor increases to approximately 4.5 which is beyond most non aerobatic airplane limits.
9. Small changes in bank angles over 60 degrees create load factor quickly.
10. The airplanes stall speed increases with increased bank angles – at 60 degrees of bank the stall speed is more than 40 percent higher than in level flight.
11. In a turn the airplane is constantly accelerating (changing its flight path) so load factor is always present as long as altitude is being maintained.
12. With higher bank angles the risk of an accelerated stall increases – most noticeable stall symptoms happen quickly with little to no warning.
13. When starting a turn adverse yaw will be present – caused by the downward aileron producing more lift to roll the plane, thus more drag slowing the wing which causes the nose to swing opposite of the bank - Rudder is used to prevent adverse yaw when starting and stopping turns .
14. When established in a turn the left turning tendencies are present and rudder is needed to prevent the airplane from skidding in a turn to the left and slipping in a turn to the right – In either turn right rudder is needed.
15. When there is no skidding or slipping the horizontal component of lift and centrifugal forces are equal.

Completion Standards

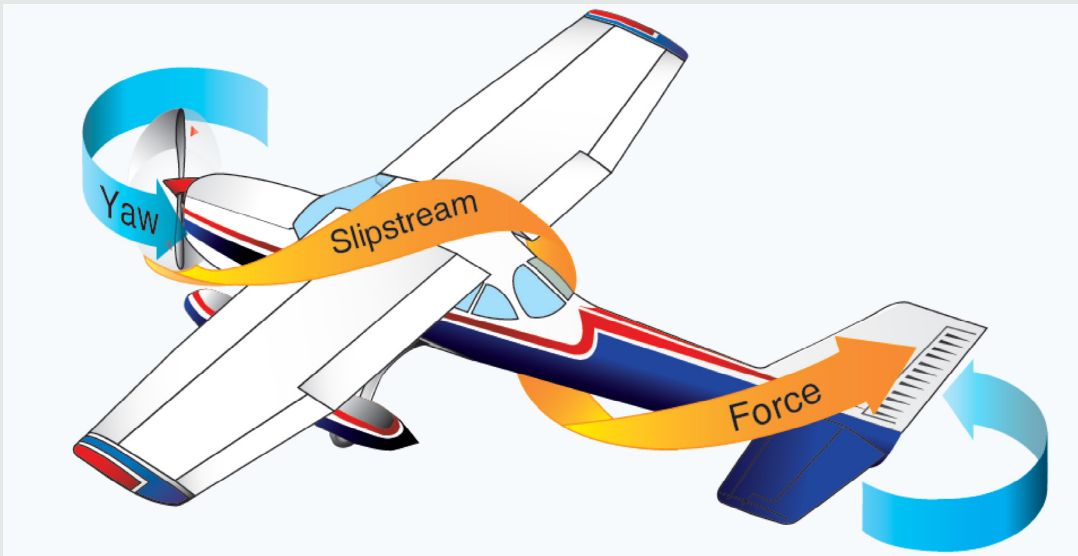
The student will be able to explain the turning tendencies from Torque, P-factor, Slipstream and Gyroscopic action and the forces in a climb, descent and turn using a model airplane or white-board.

Lesson Additional Images

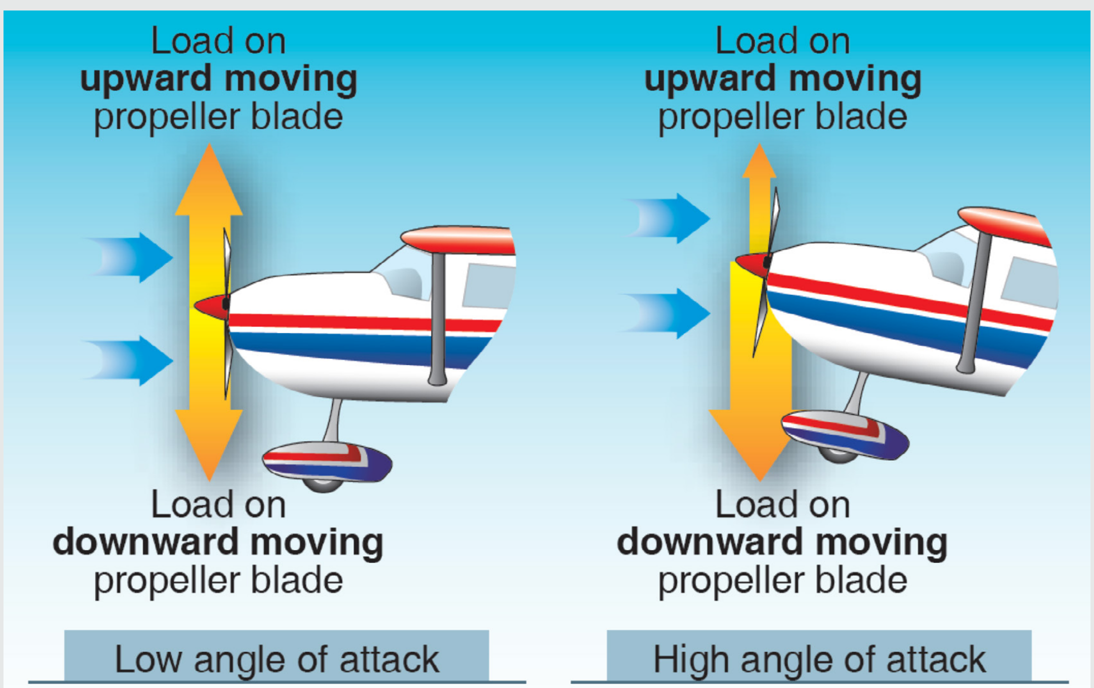
Axes of an airplane



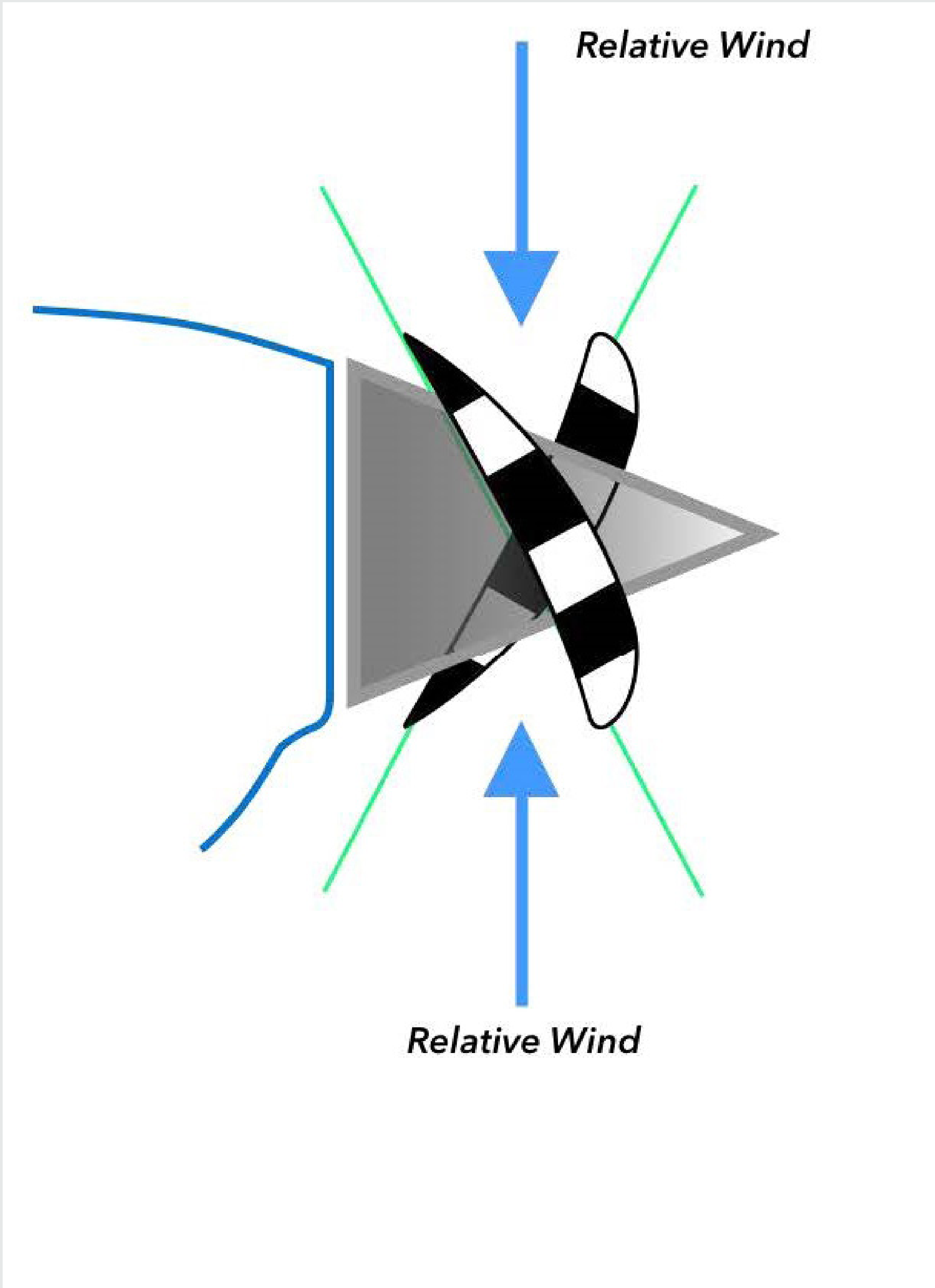
Components of an airplane



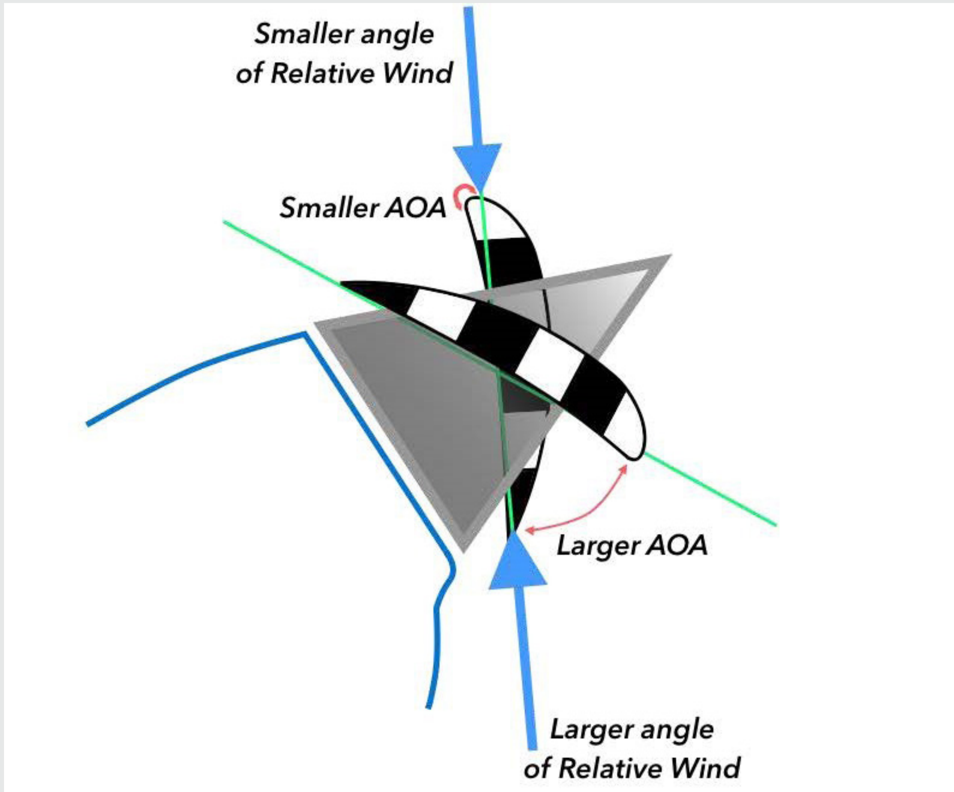
Asymmetric loading of propeller (P-factor)



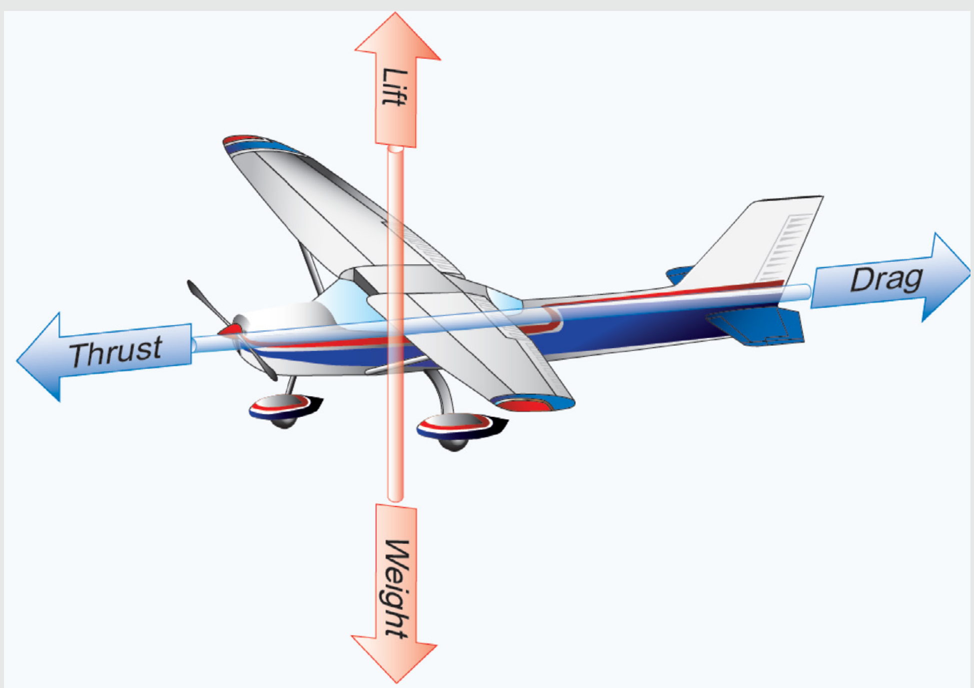
Low AOA - No P-Factor - Blade bites equally



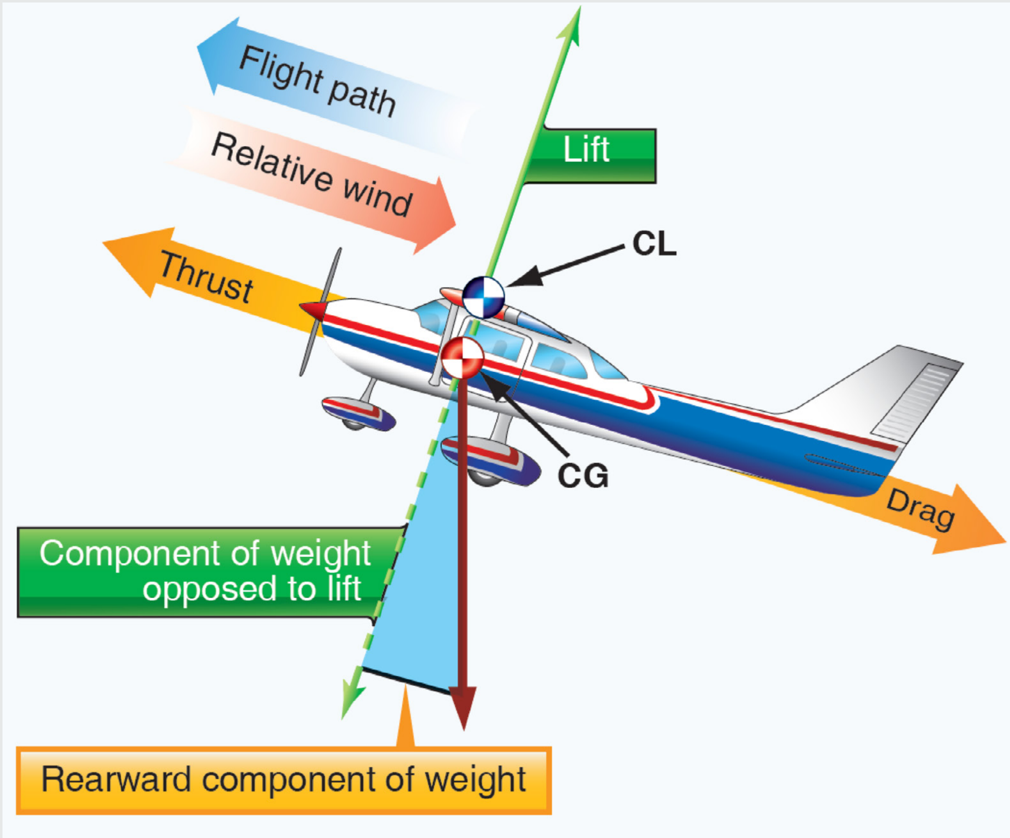
High - AOA - P-Factor - Blade bites not equal - More bite on descending



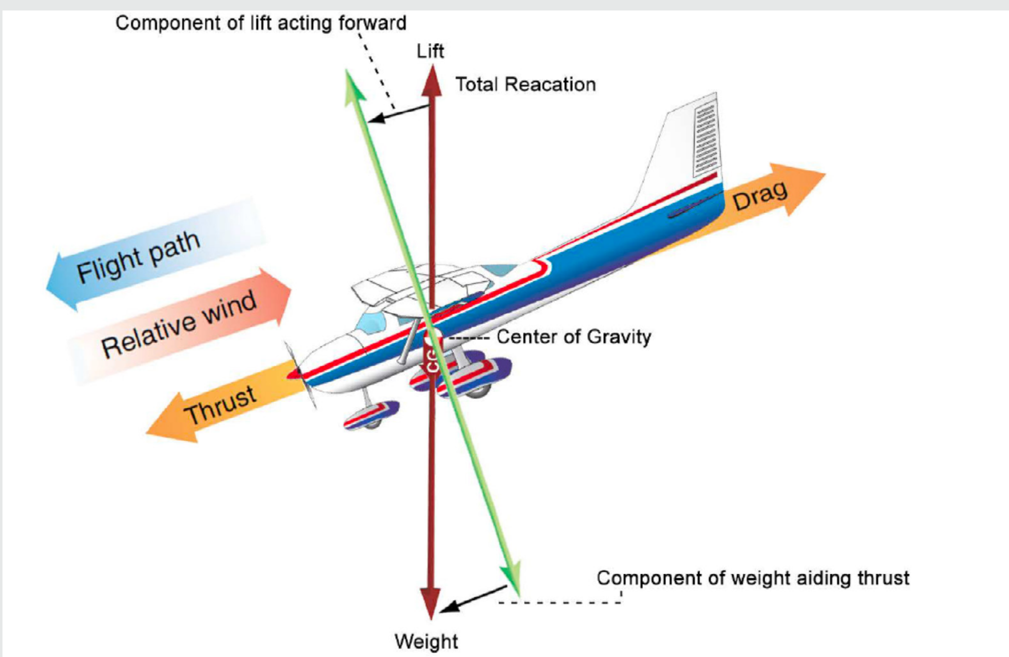
Four forces in straight and level unaccelerated flight



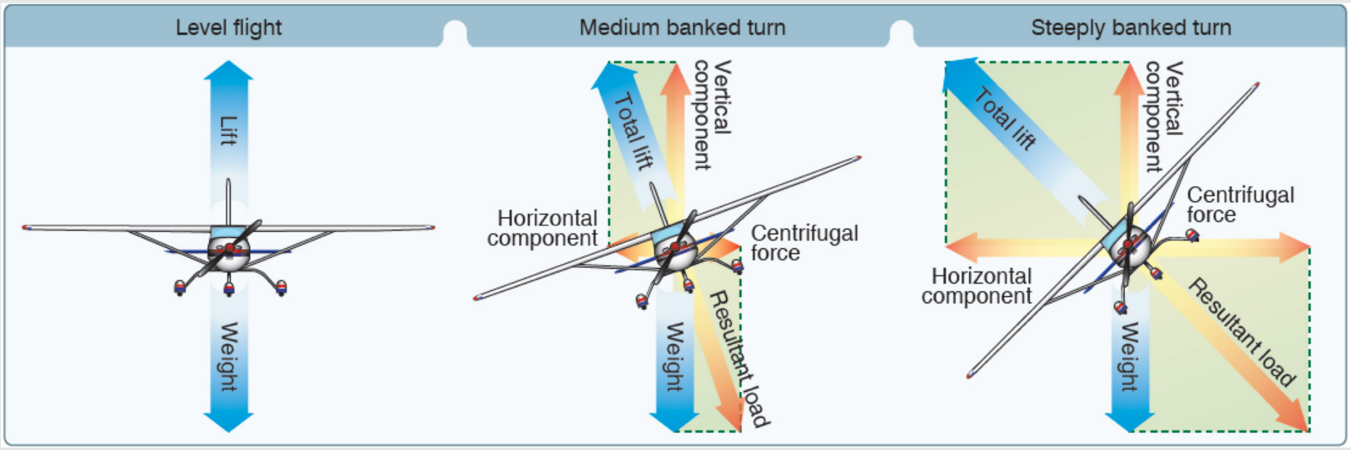
Low AOA - No P-Factor - Blade bites equally



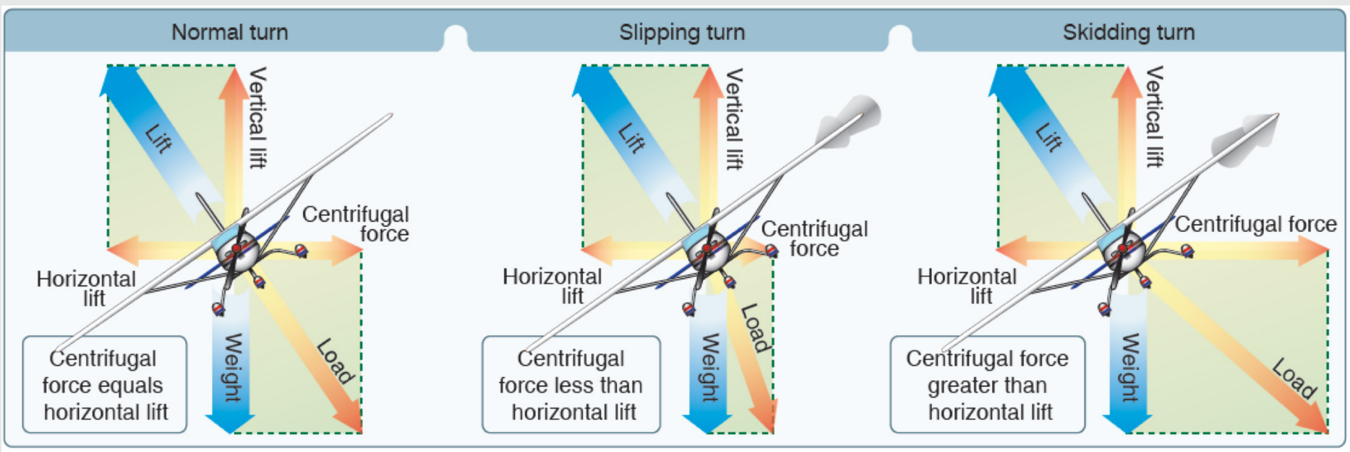
Low AOA - No P-Factor - Blade bites equally



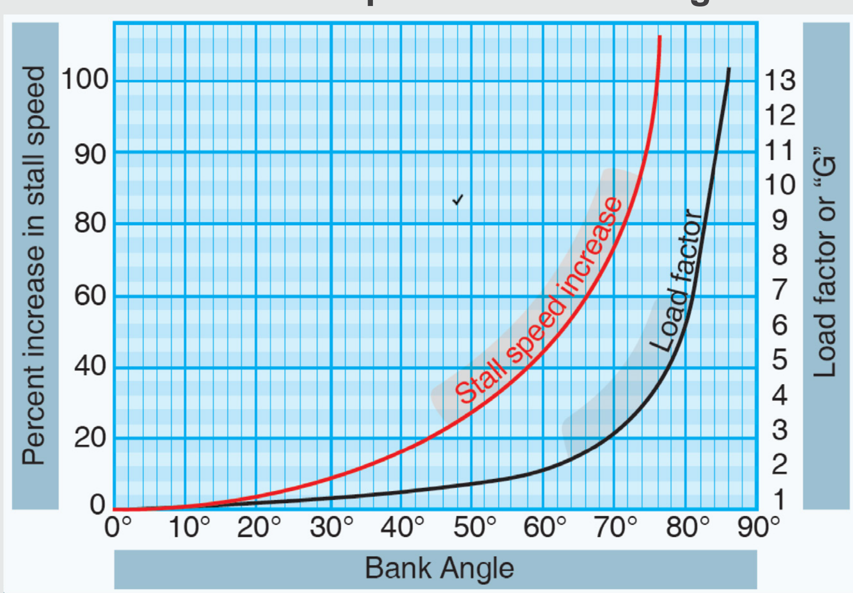
Forces in a stabilized turn at a constant altitude



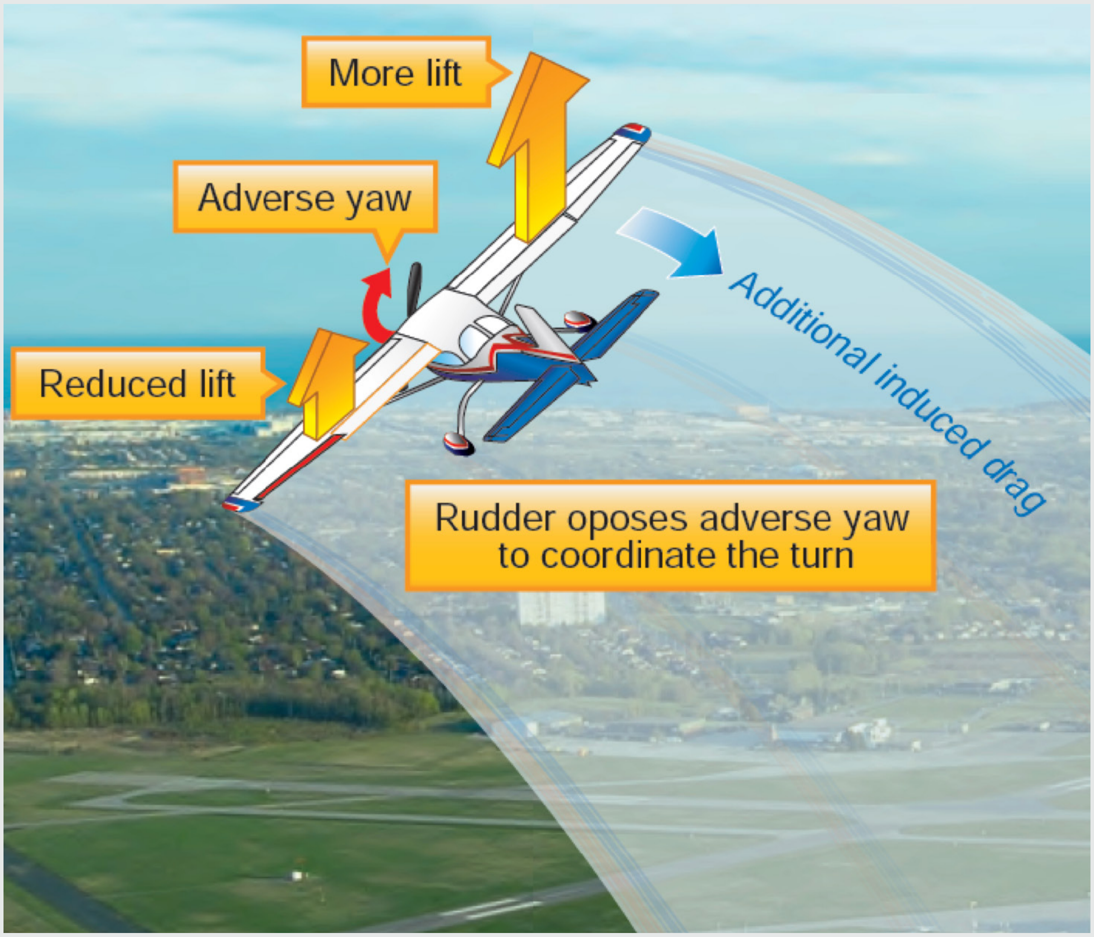
Normal, slipping and skidding turns at a constant altitude



Increases in load factor and stall speed with bank angle



Low AOA - No P-Factor - Blade bites equally



Objective

To understand how a pilot or the environment can generate unwanted forces called load factor on an airplane, measured in terms of G force. The pilot will recognize when load factor can be generated and what can be done about it. The pilot will also understand how an airplane generates wingtip vortices which can be dangerous when operating near other airplanes.

Motivation

Pilots need to understand how to avoid high G force that can damage the airplane. There are speeds that limit the amount of G force that can be generated. Pilots need to be aware and use these speeds and when to use them. Encounters with wake turbulence from wingtip vortices can result in an uncontrollable rolling force. Knowing how and where vortices are will avoid this situation.

Presentation: 45 Minutes

1. Load factor is the proportion between lift and weight.
2. Any force that causes the airplane to deviate from a straight line will cause load factor.
3. Load factor is expressed in G's. (Acceleration of Gravity)
4. It's possible for a pilot to impose dangerous loads on the airplane.
5. Increased load factors cause an increase in stall speed which can cause a stall at a seemingly safe airspeed.
6. Limit load factors – Set by the manufacturer – FARs mandate the airplane be able to withstand 1.5 times the Limit load factor.
7. Gusts can induce loads on the airplane as well as maneuvering by the pilot.
8. Categories are Normal, Utility and Aerobatic – Airplanes may be capable of only Normal or all.
9. Normal 3.8 to -1.52, Utility 4.4 to -1.76, Aerobatic 6.00 to -3.00.
10. Load factor categories are placarded in the airplane – Except older designed airplanes.
11. Load factors induced by turning are caused by the result of two forces: Weight and Centrifugal force.
12. Load factors are caused by the need to generate more lift to keep the airplane at the same altitude or climbing while turning.
13. For any given bank angle - The rate of turn varies with the airspeed. The higher the speed the lower the rate of turn – This compensates for centrifugal force which allows the load factor to remain the same as the airspeed varies .

14. Design maneuvering speed (V_a) is the speed at which the airplane would stall before exceeding its load limit – Good for a single axis, single direction, one time.
15. Turns – Bank angles of over 50 degrees increase load factor at a terrific rate with small increases past 50 degrees – The stall speed also increases rapidly above this bank angle as well.
16. Stalls – Pilots can induce high load factors in stall recovery if airspeed is allowed to build to high amounts during stall recovery – Because the pilot will want to return the airplane to a climb – Inducing load factor.
17. Spins – Low G maneuver at first – Airplane is stalled and pivoting – recovery attitude is more nose down than a regular stall which results in approximately 2.5Gs in the recovery from the dive.
18. High speed stalls – Stalls from high airspeed require a pilot to induce more load factor – results in a quick stall at high G force that is dangerous.
19. Chandelles and Lazy Eights – Chandelle requires load factor due to the climb and turn – Lazy eight requires load factor due to the climbing and descending turns from V_a to near the stalling speed at the 90-degree point – High loads can be avoided by making smooth control inputs.
20. Rough Air – Turbulence causes acceleration on the airplane which causes load factor – Pilots can choose V_a or slower speeds to reduce loads on the airplane and avoid structural damage.
21. Vg diagram shows loads vs airspeed for a given airplane at a given weight.

Wingtip vortices and precautions to be taken:

1. Caused by the production of lift – High pressure under the wing moves toward the low pressure on top of the wing – results in a swirling roll up of air called a vortex that moves behind the airplane.
2. Vortices on each end of the wing rotate in opposite directions to one another.
3. Vortex strength – Produced most when an airplane is Heavy, Clean and Slow.
4. Airplanes in the dirty configuration hasten vortex decay.
5. Wake turbulence is what the pilot experiences if the airplane if flown into the vortex.
6. Vortex descends at several hundred feet per minute and drift with the winds aloft – Tend to move laterally across the ground with the surface wind.
7. A light quartering tailwind causes the greatest threat on the ground.
8. Delay takeoff if a crosswind is present from a parallel runway where a large airplane is departing.
9. Wait at least 2 minutes prior to taking off after a large airplane has departed on the same runway.
10. An airplane on takeoff generates the vortex at the rotation point – If taking off behind, become airborne prior to that point and out climb or turn away from the flight path of the vortex.
11. An airplane that is landing generates the vortex until touchdown – plan to land after the point the airplane touched down.
12. When airborne avoid wake turbulence by maintaining at least 1000 feet from the airplane if below.

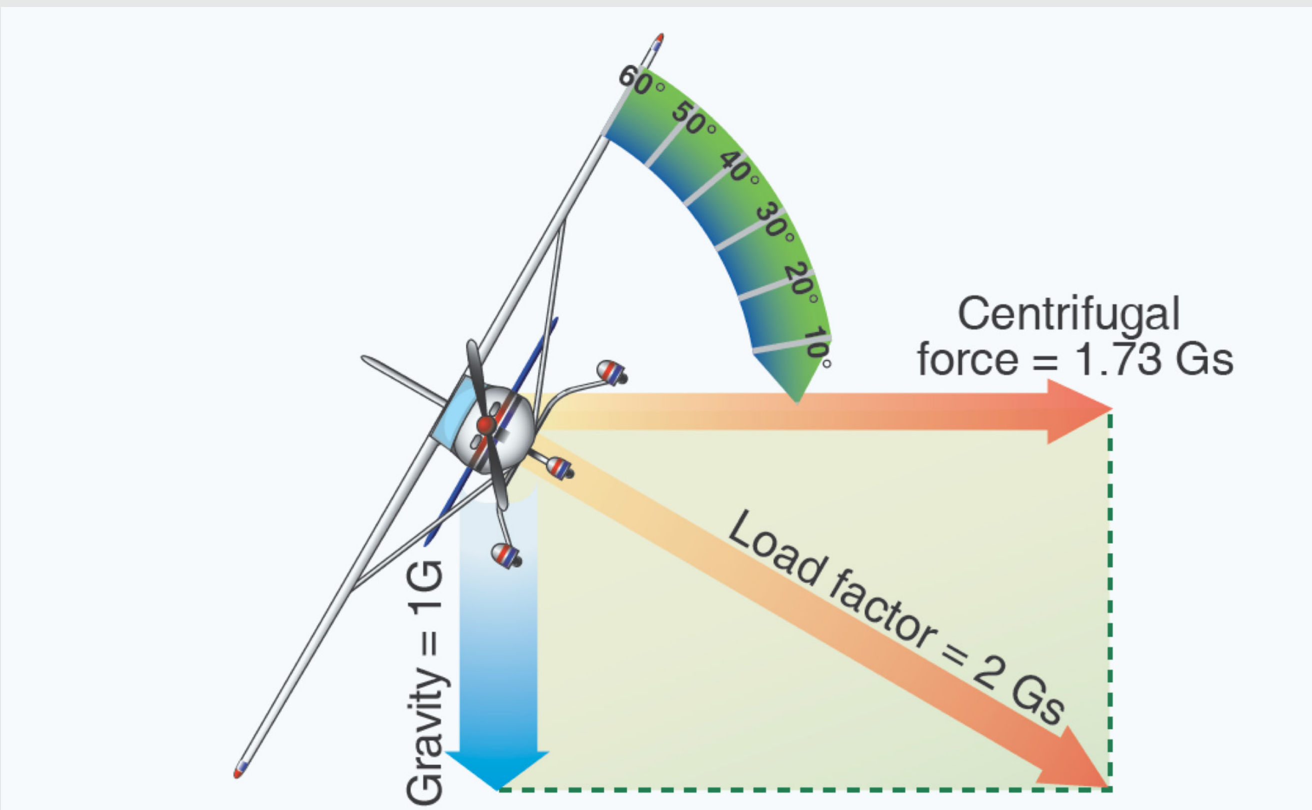
Completion Standards

The student will be able to describe how load factor affects the way a pilot controls the airplane and what the safety speeds are and how they change with weight. The student will also understand how to avoid wake turbulence in all phases of flight by explaining and using a model airplane.

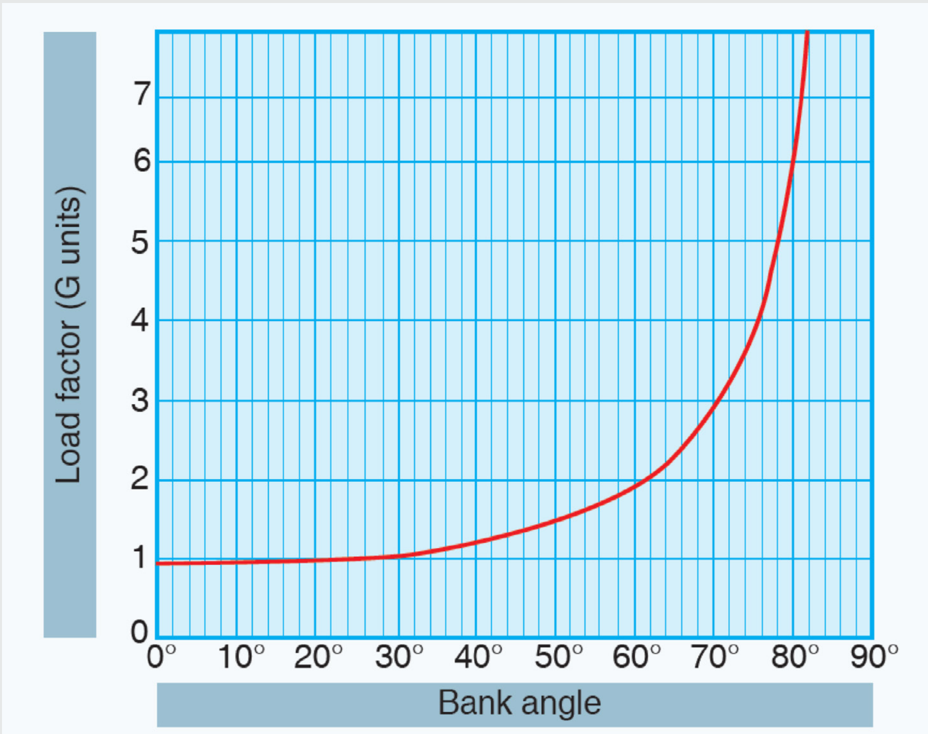
Lesson Additional Images

CATEGORY	Limit Load Factor
Normal	3.8 to - 1.52
Utility (mild acrobatics, Including spins)	4.4 to - 1.76
Acrobatic	6.0 to - 3.00

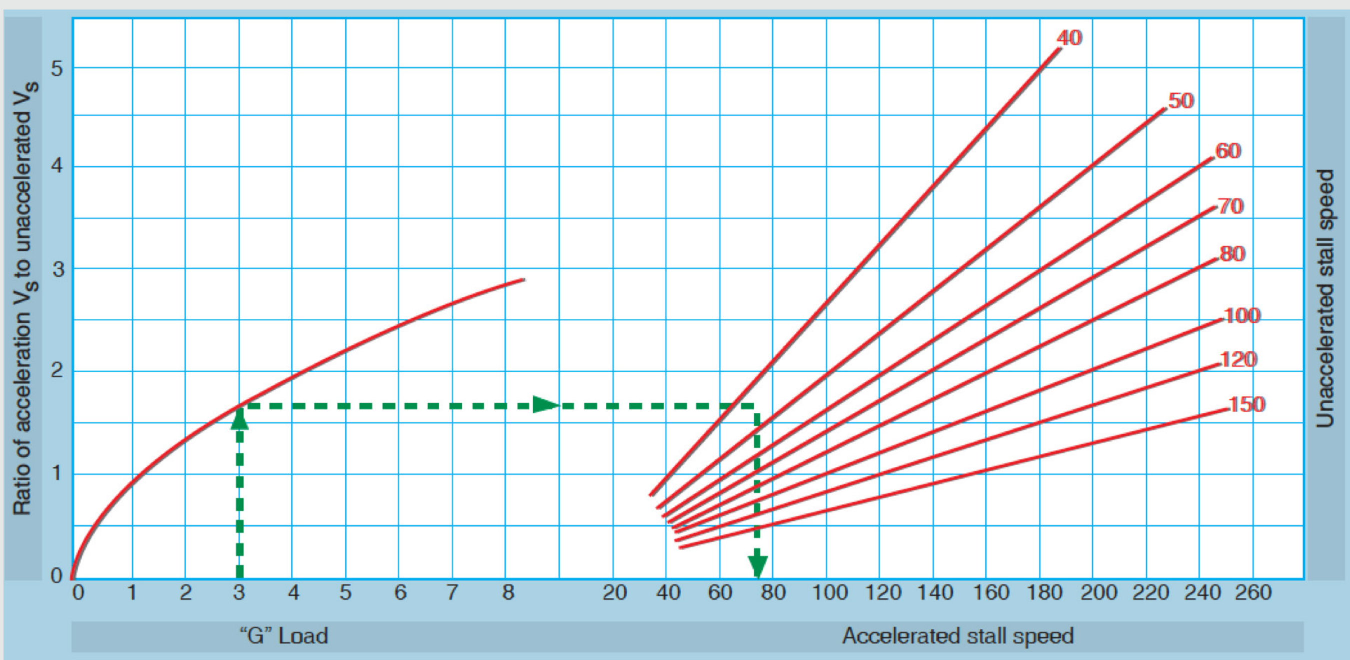
Components of an airplane



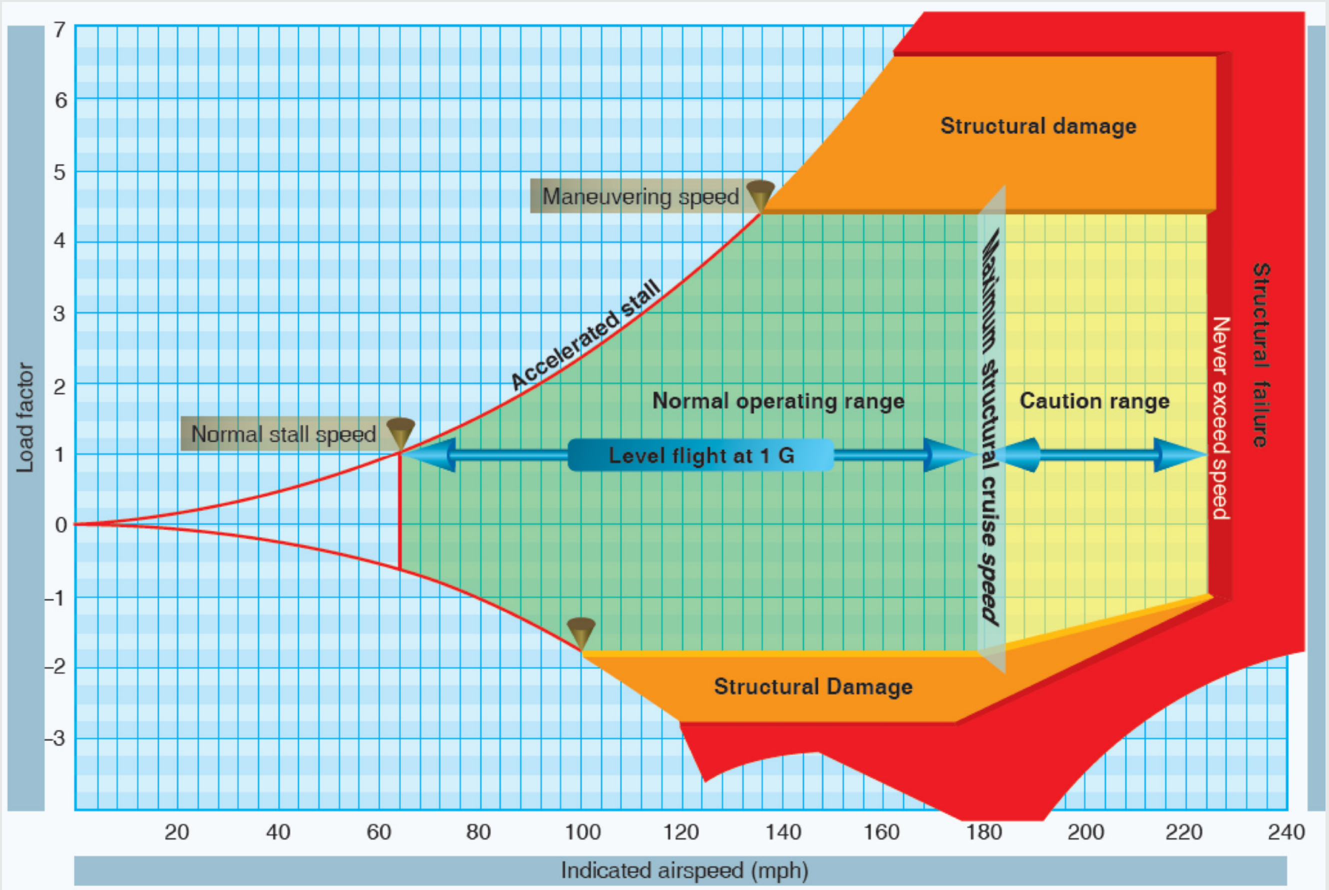
Load Factor vs Bank Angle



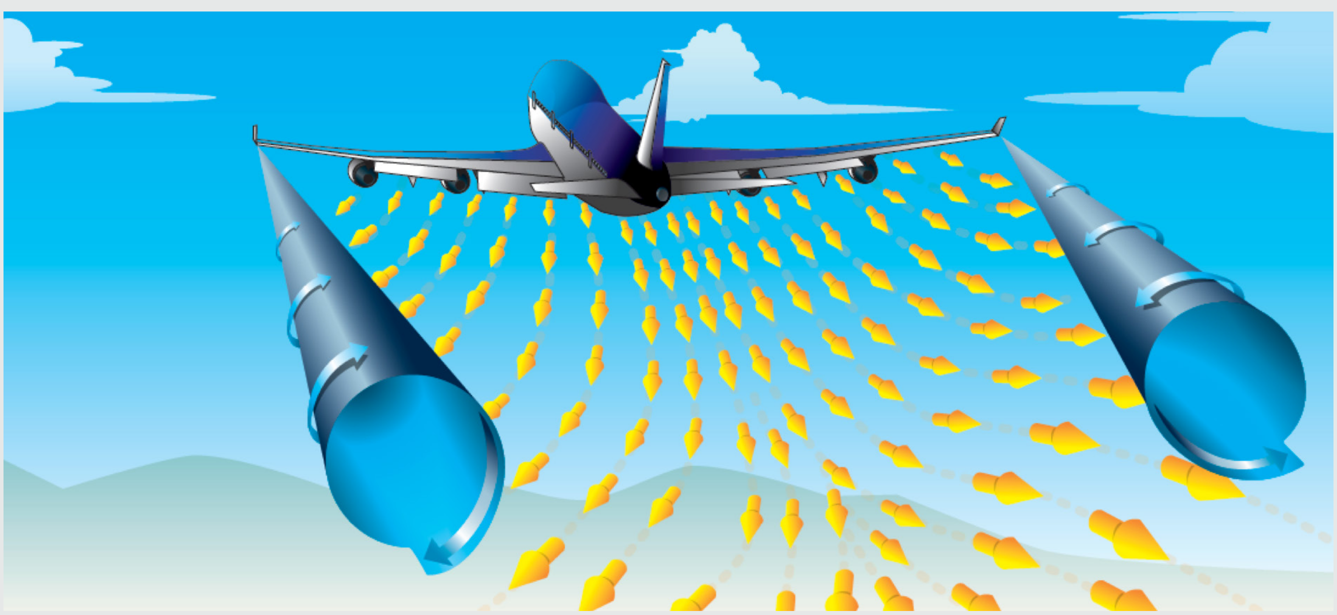
Components of an airplane



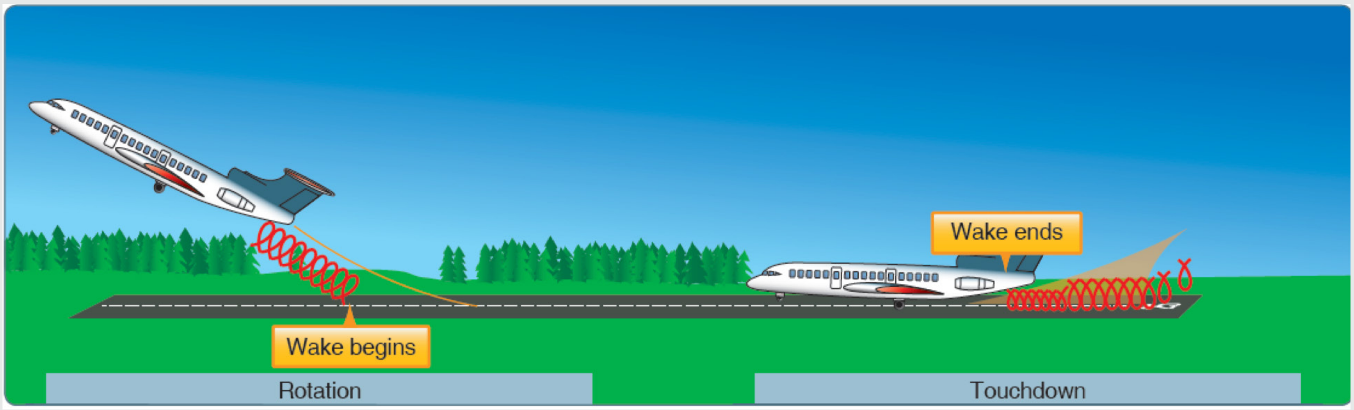
Vg Diagram



Vortex Generation



Load Factor vs Bank Angle



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