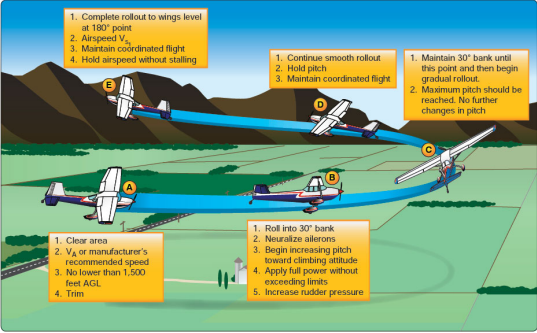


Chandelles

Objective	 <p>The diagram illustrates the five stages of a chandelle maneuver:</p> <ul style="list-style-type: none"> Stage A: Clear area, V₄ or manufacturer's recommended speed, No lower than 1,500 feet AGL, Trim. Stage B: Roll into 30° bank, Neutralize ailerons, Begin increasing pitch toward climbing attitude, Apply full power without exceeding limits, Increase rudder pressure. Stage C: Maintain 30° bank until this point and then begin gradual rollout, Maximum pitch should be reached. No further changes in pitch. Stage D: Continue smooth rollout, Hold pitch, Maintain coordinated flight. Stage E: Complete rollout to wings level at 180° pose, Airspeed V₄, Maintain coordinated flight, Hold airspeed without stalling.
<p>To ensure the applicant understands the elements of the chandelle maneuver and how to perform it properly.</p>	
Purpose	
<p>The purpose of the chandelle maneuver is to execute a 180 degree climbing turn with minimum turn radius. The chandelle demonstrates the relationship between speed and rate of turn, and the left-turning tendencies. Correctly performing the chandelle maneuver demonstrates pilot proficiency with accurately managing aircraft attitude, maneuvering in slow flight near the stall, and compensating for the left-turning tendencies.</p>	
Schedule	Equipment
<ul style="list-style-type: none"> ● Ground Lesson: 15 minutes ● Initial <ul style="list-style-type: none"> ■ Flight 1: 30 minutes - <i>Introduction to Maneuver</i> ■ Flight 2: 30 minutes - <i>Improve Proficiency (Dual)</i> ● Solo <ul style="list-style-type: none"> ■ Flight 3: 20 minutes - <i>Improve Proficiency</i> ● Pre-Checkride <ul style="list-style-type: none"> ■ Flight 4: 20 minutes - <i>Demonstrate Proficiency</i> ● Debrief: 10 minutes (<i>per flight</i>) 	<ul style="list-style-type: none"> ● n/a
Student Actions	Instructor Actions
<ul style="list-style-type: none"> ● Ask any questions, receive study material for the next lesson. ● Watch linked video. ● Review listed references. 	<ul style="list-style-type: none"> ● Deliver the ground lesson (below). ● Demonstrate the maneuver in flight. ● Debrief after each flight.
Completion Standards	
<ul style="list-style-type: none"> ● Ground: Student can explain the purpose of the maneuver and how to execute it properly. ● Flight: Student can perform the maneuver to the applicable ACS standards. <ul style="list-style-type: none"> ● See expanded Completion Standards below. 	

References

- The UND AeroCast - Commercial Chandelles
 - YouTube - <https://www.youtube.com/watch?v=Ml8Y17oj2Q8>
- FAA-H-8083-3B (Airplane Flying Handbook) - Chapter 9, Page 6 [Maneuver Description], Chapter 3, Page 12-14 [Turn Radius, Overbanking Tendency]
- FAA-H-8083-25B (Pilot's Handbook of Aeronautical Knowledge) - Chapter 5, Page 30-33 [Left Turning Tendencies], Chapter 5, Page 41 [Turn Radius]
- FAA-S-ACS-7A (Commercial Pilot ACS) - Area V Task C
- FAA-S-8081-6D (CFI PTS) - Area IX Task C

Ground Lesson Outline

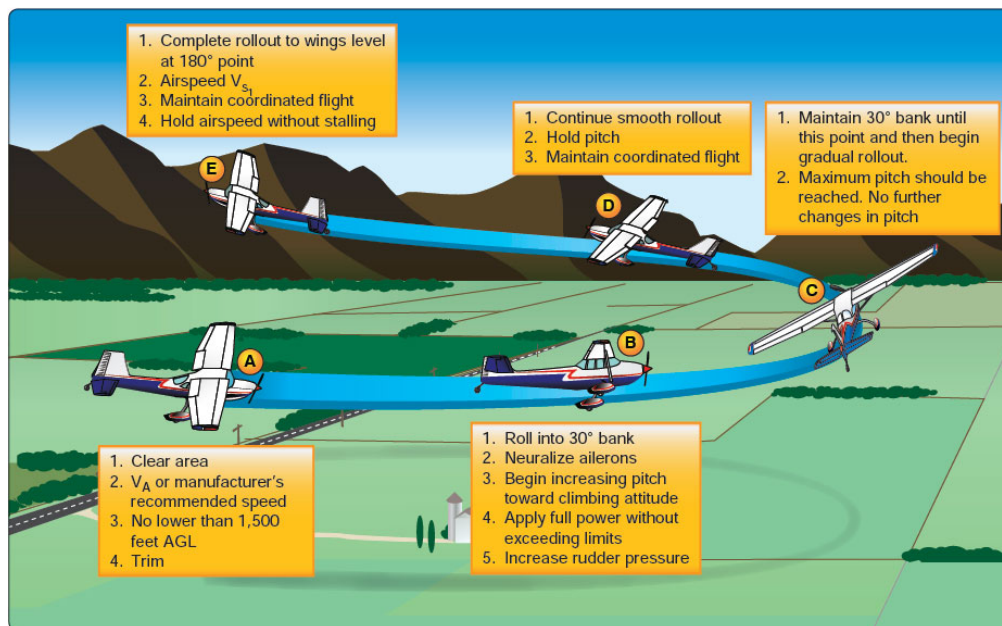
- What is a Chandelle?
 - Two phases
 - Constant Bank, Increasing Pitch
 - Constant Pitch, Decreasing Bank
- Rate of Turn vs. Airspeed
 - Less speed = Higher rate of turn for a given bank angle
- Left Turning Tendencies
 - Especially P-factor due to high Angle of Attack
- Safety considerations
 - Use of checklists
 - Visual traffic scanning
- Maneuver Description - step-by-step
 - Entry position, airspeed, etc.
- Expanded Completion Standards

Common Errors

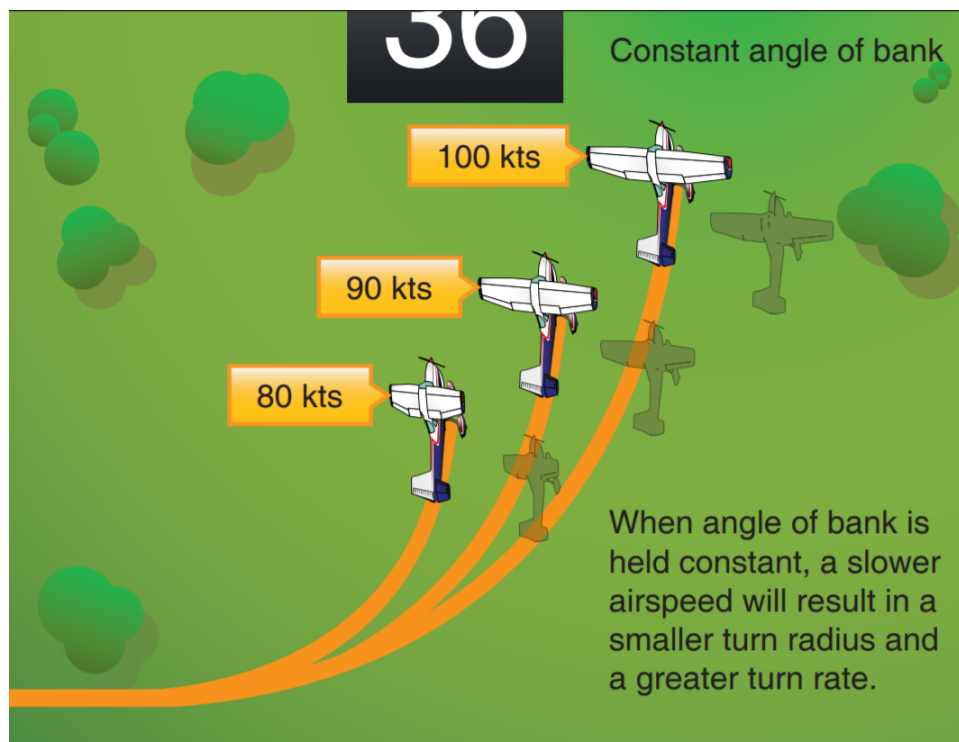
- Not clearing the area
- **Initial bank is too shallow resulting in a stall**
- Initial bank is too steep resulting in failure to gain maximum performance
- Allowing the bank angle to increase after initial establishment
- Not starting the recovery at the 90° point in the turn
- Allowing the pitch attitude to increase as the bank is rolled out during the second 90° of turn
- **Leveling the wings prior to the 180° point being reached**
- **Pitch attitude is low on recovery resulting in airspeed well above stall speed**
- Application of flight control pressures is not smooth
- **Poor flight control coordination**
- Stalling at any point during the maneuver
- Execution of a steep turn instead of a climbing maneuver
- Not scanning for other traffic during the maneuver
- **Performing by reference to the flight instruments rather than visual references**

Ground Lesson Content

- **What is a Chandelle?** - The chandelle is a maximum performance 180 degree climbing turn that can be broken down into two phases:
 - **Phase 1 - Constant Bank, Increasing Pitch** - Aircraft begins in normal cruise, below V_A , banks to 30 degrees, sets maximum available power, and increases pitch smoothly until the 90 degree point of the turn.
 - **Phase 2 - Constant Pitch, Decreasing Bank** - Aircraft maintains a constant pitch angle while smoothly reducing bank angle until the 180 degree point of the turn is reached, ending in slow flight, just above stall speed. The aircraft then recovers to normal cruise.



- **Rate of Turn vs Airspeed** - This maneuver illustrates the concept that as airspeed decays and bank angle remains the same, the rate of turn increases. As the bank angle is reduced in the second phase of the maneuver, the rate of turn remains high due to the decreasing speed.



- Left Turning Tendencies** - This maneuver also illustrates the increasing effects of left-turning tendencies as airspeed decreases and angle of attack increases. Towards the end of the maneuver, right rudder pressure will be significant. *The amount of rudder pressure required varies between a chandelle performed to the left and one performed to the right!*

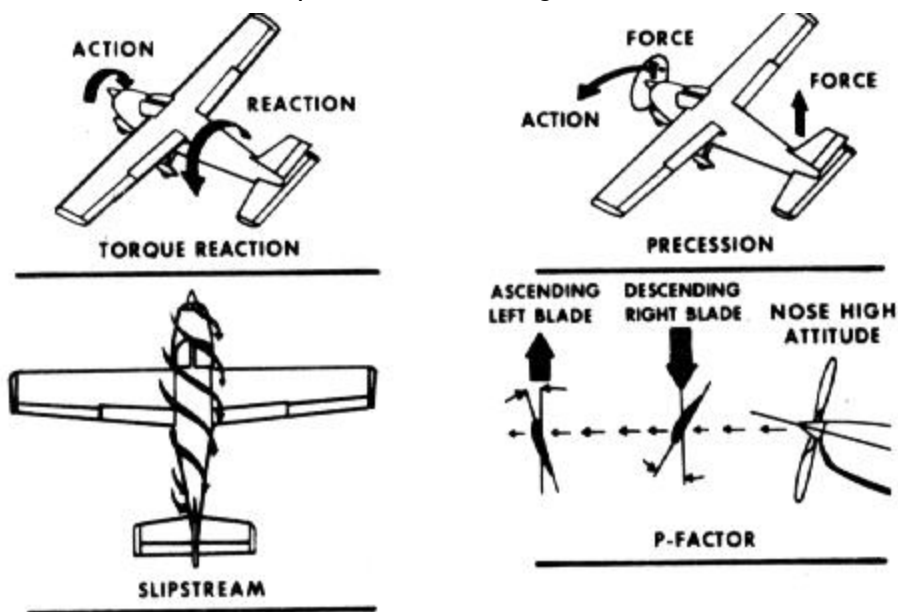


Figure 3-6 Left Turning Tendencies

- Safety Considerations**
 - Checklists** - Pilots should complete a pre-maneuver checklist before beginning the maneuver.
 - Visual Traffic Scanning** - Pilots must remember to keep up their traffic scan throughout the maneuver.

Maneuver Description

- **Entry Altitude** - A chandelle should be started *no lower than 1,500ft* AGL, however it is important to realize that a chandelle will result in a significant gain in altitude. An altitude should be selected such that the maneuver begins at least 1,500ft AGL, but that it can be safely completed *below any overlying airspace*. A chandelle typically results in the gain of approximately 500 feet of altitude, however planning for 1,000ft of altitude gain will allow for adequate safety margin.
- **Entry Speed** - Like all performance maneuvers, a chandelle must be started at less than **V_a** (maneuvering speed). Typically a chandelle is entered in level cruise flight, at least 5-10 knots below V_a.
- **Bank** - The steepest bank angle should be approximately *30 degrees of bank*.
- **Pitch and Exit Speed** - Sufficient pitch should be used such that at the end of the maneuver, the airplane is in slow flight, near the stall warning. Typically this is between *15 and 20 degrees of pitch*. Ideally, the stall warning sounds just as the 180 degree point of the turn is reached. Ending the turn at an airspeed too far above the stall results in failing to achieve maximum performance.
- **Recovery** - Maintain altitude (*do not lose altitude*) while slowly reducing back elevator pressure to regain airspeed. Recover to normal cruise flight.
- **Coordination** - Proper coordination is essential to the chandelle and should be maintained *at all times*. Right rudder pressure will be significant, especially in a right chandelle. Failure to apply adequate rudder pressure can result in an uncoordinated power-on stall, which can lead to entering a spin.
- **This is a visual maneuver!** Eyes should remain outside the cockpit as much as possible to scan for traffic and to help monitor the aircraft attitude and the progress of the turn.

Expanded Completion Standards

- The pilot can explain the purpose of the chandelle and how the various factors affect the performance of the maneuver.
- The pilot can perform the maneuver to the following standards:
 - Pilot clears the area, performs a pre-maneuver checklist, establishes a speed below V_a, and selects an altitude to perform the maneuver, beginning no lower than 1,500ft AGL
 - Pilot banks approximately 30 degrees and pitches up smoothly until reaching the 90 degree point of the turn
 - Pilot smoothly reduces bank while holding constant pitch and rolling out at the 180 degree point +/- 10 degrees just above stall speed, but *does not stall*
 - Pilot resumes straight and level flight with minimum loss of altitude