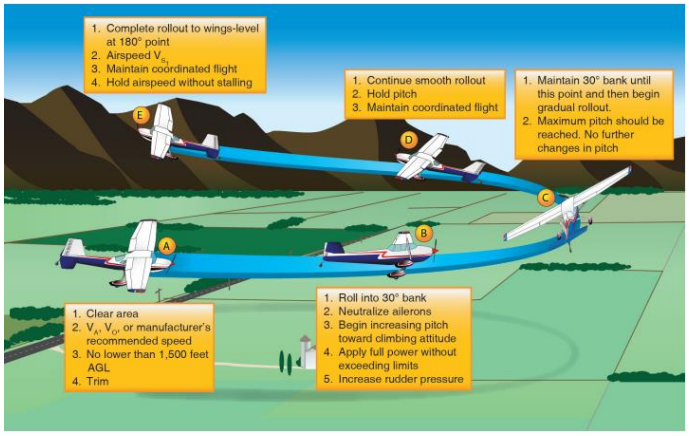
V.C. CHANDELLES

References: Airplane Flying Handbook (FAA-H-8083-3), Risk Management Handbook (FAA-H-8083-2), POH/AFM

KNOWLEDGE

The applicant demonstrates understanding of:

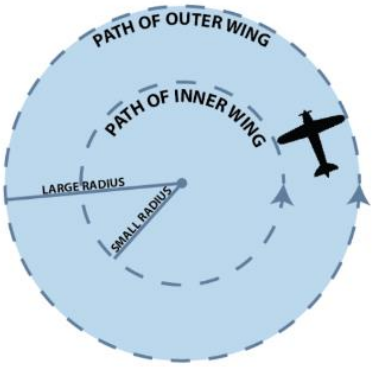


1. **How to Conduct Proper Chandelles**
   - A. Before Starting
     - i. Select an altitude – no lower than 1,500' AGL
     - ii. Pre-maneuver checklist; clear the area of traffic
     - iii. Straight-and-level flight at V_A, with flaps and gear (if retractable) in the UP position
     - iv. Note / bug the heading (rollout will be on the reciprocal heading)
     - v. Choose a visual reference point 90° off the wing in the direction of the turn
   - B. First 90° – Constant bank, Changing pitch
     - i. Smoothly enter a coordinated 30° turn
       - a. Maintain bank until 90° point
       - b. Correct for any variations/overbanking tendency
     - ii. With bank established, apply max power, and initiate a climbing turn
       - a. No other power adjustments are made during the maneuver
       - b. Smoothly apply back pressure to reach the highest pitch attitude as 90° of the turn is completed
         - Intent is to be halfway between entry speed and min controllable airspeed at 90° point
         - Divide attention between visual references, the 90° reference point, and instruments
         - If pitch is increased too quickly the aircraft will stall before reaching 180°
         - If pitch is increased too slowly, the aircraft will not come close to the stall speed
     - iii. Maintain Coordination
       - a. As speed decreases, torque becomes more pronounced & controls become less effective
         - Right rudder should be gradually increased to control yaw and keep coordinated
       - b. In a left turn, less right rudder will be necessary than in a right turn
     - iv. 90° Point: Airspeed should be about midway between entry speed and minimum controllable speed
       - a. Bank is at 30°, pitch is at the highest pitch attitude
   - C. 2nd 90° – Constant pitch, Changing bank
     - i. Begin rolling out of the bank at a constant rate while maintaining a constant-pitch attitude
       - a. Roll out approximately 10° of bank for every 30° of heading change
     - ii. As airspeed decreases, increased back pressure is required to maintain a constant pitch attitude
       - a. Left turning tendencies become more prevalent; right rudder is necessary to remain coordinated
     - iii. 180° Point: Airspeed is just reaching minimum controllable airspeed
       - a. Bank has been reduced to wings level, pitch is at the highest pitch attitude
   - D. The Rollout
     - i. Time the rollout so that wings are level at the 180° point
     - ii. Pitch attitude should be held momentarily while at the minimum controllable airspeed
   - E. Finishing the maneuver
     - i. Gradually reduce pitch to level flight, and accelerate while maintaining altitude

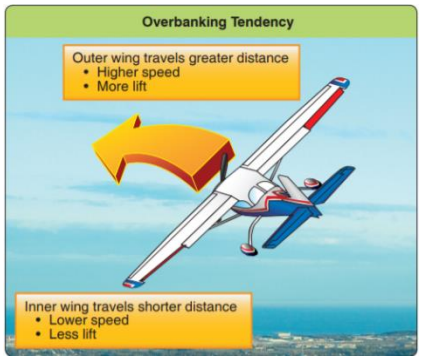
a. Increase right rudder as pitch decreases
b. Adjust pitch, power, and trim for cruise flight

2. Aerodynamics Associated with Chandelles, to Include:

A. Maintaining Coordinated Flight
   i. 1st 90-degrees of the Turn
      a. As the airspeed decreases through the turn, the torque effect becomes more pronounced
         - Right rudder pressure is gradually increased to control yaw and keep coordinated
      b. In a left turn, less right rudder will be necessary
      c. In a right turn, more right rudder will be necessary as the right turn adds to the engine torque
   ii. 2nd 90-degrees of the Turn
      a. The left turning tendencies caused by P-factor and the slip stream become more prevalent, and right rudder pressure will be necessary to coordinate turns in either direction
   iii. Rollout
      a. Left Chandelle Rollout
         - The left wing must be raised by lowering the left aileron
            a This creates more drag, resulting in a tendency for the airplane to yaw to the left
         - With the low air airspeed, torque effect also tries to make the airplane yaw to the left
         - Thus, there are two forces pulling the nose left
            a To maintain coordination, considerable right rudder pressure is required
      b. Right Chandelle Rollout
         - The right wing must be raised by lowering the right aileron
            a Creates more drag on the right wing and tends to make the airplane yaw right
         - At the same time, the effect of torque at the lower speed is causing the nose to yaw left
         - Thus, aileron drag pulling the nose right, and torque pulling the nose left, work against each other
            a Less right rudder correction is needed
         - This rollout is accomplished mainly by applying aileron pressure
      c. In either case, when the wings are level, aileron drag is neutralized, and torque is acting alone again
   iv. Returning to Normal Flight
      a. During the decrease in pitch, right rudder pressure must be increased to counter the additional torque caused by gyroscopic precession of the propeller



B. Overbanking Tendencies
   i. As turn radius becomes smaller, a difference develops between the speed of the inside wing & outside wing
      a. Outside wing travels a longer path, but in the same amount of time as the inside wing
         - Outside wing generates more lift
         - Difference in lift can increase bank
      b. Shallow bank: the difference in lift is overcome by lateral stability
      c. Medium bank: the lift differential matches lateral stability
      d. High bank: the difference in lift outweighs lateral stability
         - Aircraft continues to bank even with neutral flight controls
         - Aileron pressure is required in the direction opposite the turn to maintain bank angle
   ii. Overbanking Tendency and the Chandelle
      a. Opposite aileron is necessary in the slow, nose high turn near the



top of the Chandelle to prevent overbanking

iii. Overbanking Tendency and the Chandelle
   a. When in a nose high turning attitude, bank tends to increase
      - As speed decreases, the airplane flies in a smaller and smaller arc (lower groundspeed = smaller turn radius)
      - Since the outer wing travels a larger radius, and travels faster than the inner wing, it generates more lift, causing the outside wing to rise (overbanking tendency)
   b. Use opposite aileron to maintain the desired bank angle and prevent the overbanking tendency

C. Maneuvering Speed, Including Impact of Weight Changes
   i. The maneuvering speed is the maximum speed at which the aircraft will stall prior to exceeding airframe limitations and potentially damaging the airframe (basically, you'll stall before you break)
      a. Above this airspeed full control deflection (or less than full depending on how fast you are going), can result in airframe stresses greater than what the aircraft is designed to handle
   ii. Weight Changes (Bold Method Video)
      a. V_A increases with increased weight and V_A decreases as weight is decreased
         - This means the aircraft can maneuver at higher airspeeds when heavy
      b. Example:
         - Imagine flying straight-and-level at V_A and at max gross weight (V_A is certified at max gross weight)
            a If the pilot were to pitch up excessively the aircraft's angle of attack increases, but right when you reach the limit load factor (3.8 G's for a Normal rated aircraft) the aircraft will reach the critical angle of attack, stall, and return to 1G flight. The aircraft doesn't exceed its structural limitation of 3.8 G's and therefore doesn't break
         - Now consider the same aircraft (still straight-and-level, still at V_A), but at a lighter weight
            a To maintain level flight, the aircraft now flies at a lower angle of attack. Because of this there is now a greater distance between the aircraft's angle of attack and the critical angle of attack. When the pilot pitches up excessively the aircraft will reach the limit load factor (3.8 G's) prior to reaching the critical angle of attack, and the aircraft will break before it stalls.
               1. For this reason, decreases in weight result in lower maneuvering speed. The Bold Method video linked above does a great job explaining this
   iii. Perform all maneuvers at or below V_A

D. Accelerated Stalls
   i. The airplane will stall at a higher indicated airspeed when excessive maneuvering loads are imposed
   ii. Smoothly and positively apply the control pressures to execute the chandelle
      a. Abrupt, aggressive control inputs could lead to an accelerated stall

3. Appropriate Configuration for Maximum Performance Climb

A. Prior to starting a chandelle, the flaps and gear (if retractable) most likely will be in the up position
B. Configure the aircraft for maximum performance as specified by the manufacturer

4. Proper Pitch Control Required for Continually Decreasing Airspeed

A. As airspeed decreases increased back pressure will be required to maintain a constant pitch attitude
   i. Airspeed is approaching the stall speed; maintain back pressure to obtain maximum performance without stalling the aircraft

RISK MANAGEMENT

The applicant demonstrates the ability to identify, assess, and mitigate risks, encompassing:

1. Division of Attention Between Airplane Control and Orientation

A. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
   i. Over concentration inside or outside will result in the other being neglected and a poor maneuver
   ii. Crosscheck should be based on outside references and supplemented with instrument indications
      a. Allows the pilot to divide attention between aircraft control and the orientation
      b. Orientation does not just include the bank angle/pitch attitude, but also where you are (airspace, terrain, etc.) and what or who is around you (aircraft, airports, etc.)

B. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety first

2. Collision Hazards

A. Collision Avoidance
   i. Scanning
      a. Series of short, regularly spaced eye movements bringing successive areas into the central visual field
         - Each movement should not exceed 10°, each area should be observed for at least one second
      b. Divide attention between flying and scanning for aircraft
   ii. Clearing Procedures
      a. Climb/Descent: Execute gentle banks to scan above/below the wings as well as other blind spots
      b. Prior to any turn: Clear in the direction of the turn
      c. Pre-Maneuver: Clearing turns – clear above/below, in front/behind
   iii. Operation Lights On
      a. Voluntary FAA safety program
      b. Turn on landing lights during takeoff and when operating below 10,000', day or night
   iv. Right-of-Way Rules (FAR 91.113)
      a. An aircraft in distress has the right-of-way over all other traffic
      b. Converging Aircraft
         - When aircraft of the same category are converging, the aircraft to the right has the right-of-way
         - If the aircraft are different categories:
            a Basically, the less maneuverable aircraft has the right-of-way
               1. Balloons, gliders, and airships have the right of way over airplanes
            b An aircraft towing or refueling an aircraft has the right-of-way over all engine driven aircraft
      c. Approaching Head-on: Each pilot shall alter course to the right
      d. Overtaking: Aircraft being overtaken has the right-of-way; when overtaking, pass on the right
      e. Landing
         - Aircraft landing/on final approach to land have the right-of-way over those in flight or on the surface
            a Do not take advantage of this rule to force an aircraft off the runway which has already landed
         - When two or more aircraft are approaching for landing, the lower aircraft has the right-of-way
            a Don't take advantage of this rule to cut in front of another aircraft

B. Terrain
   i. Study terminal charts and IFR/VFR chart altitudes, use Max Elevation Figures (MEFs)
   ii. Day vs Night flying over terrain
      a. Be extra vigilant at night, when terrain may be impossible to see until it is too late

C. Obstacles and Wire Strike
   i. Antenna Towers
      a. Numerous antennas extend over 1,000'-2,000' AGL
         - Most are supported by guy wires which can extend 1,500' horizontally from the structure
   ii. Overhead Wires (may not be lighted)
      a. Overhead transmission wires and lines span runway departures and landmarks pilots frequently follow
         - Lakes, highways, railroad tracks, etc.

D. Minimum Safe Altitudes (FAR 91.119)

i. Anywhere: At an altitude allowing an emergency landing without undue hazard to persons or property
ii. Over Congested Areas: 1,000' above the highest obstacle within 2,000'
iii. Over other than Congested Areas: 500' above the surface, except when over open water/sparsely populated areas, then no closer than 500' to any person, vessel, vehicle, or structure

3. Low Altitude Maneuvering

A. A small problem at high altitude can quickly become a big problem at a low altitude
B. Be aware of, and avoid, obstructions, towers, etc.
   i. Quick, panicked maneuvers, especially when slow, can result in a stall or loss of control close to the ground
C. Low Altitude Stall/Spin
   i. A low altitude stall or spin can leave little to no recovery time
      a. ALWAYS maintain coordination, and airspeed at low altitudes
      b. If you get any indication of a stall at low level, recover, and climb to a safe altitude
   ii. Spin
      a. A spin is a result of a stall + yaw
      b. Prevention
         - Maintain coordination
         - Do not use abrupt, excessive pressure inputs (especially back elevator pressure)
         - Stop whatever you're doing and recover at the first sign of a stall
      c. Recovery (PARE)
         - Power - Idle
         - Ailerons - Neutral
         - Rudder - Full rudder opposite the spin direction
         - Elevator - Brisk, positive forward pressure (nose down)
         - Once the spin has stopped, neutralize the rudders and raise the nose, being careful not to stall again
      d. Different aircraft respond differently to spins and spin recoveries, follow the POH procedures
D. CFIT (Controlled Flight into Terrain)
   i. AC 61-134: General Aviation CFIT Awareness
   ii. The solution to combating CFIT accidents starts on the ground
      a. Common themes include proper planning, good decision making, and being able to safely operate the aircraft throughout its entire operating range
   iii. Recommendations:
      a. Non-instrument rated VFR pilots should not attempt to fly in IMC
      b. Know and fly above minimum published safe altitudes
      c. If IFR, fly published procedures
      d. Verify proper altitude, especially at night or over water, through use of a correctly set altimeter
      e. Verify all ATC clearances. Question potentially hazardous clearances
      f. Maintain situational awareness both vertically and horizontally
      g. Comply with appropriate regulations for your specific operation
      h. Don't operate below minimum safe altitudes if uncertain of position or ATC clearance
      i. Be extra careful when operating in an area which you are not familiar
      j. Use current charts and all available information
      k. Use appropriate checklists
      l. Know your aircraft and its equipment

4. Distractions, Task Prioritization, SA & Disorientation

A. Distractions
   i. Distractions should be avoided

   ii. Attention needs to be divided between the reference points, ground track, performance (pitch, bank, airspeed, etc.), instruments, and scanning
B. Failure to Maintain Situational Awareness
   i. With the myriad of factors associated with chandelles, a loss of situational awareness is possible
      a. Note your entry heading/direction and remember or bug your planned exit heading
      b. Divide attention between the instruments and visual references
      c. Always know where you are and what's next
   ii. In the case of a loss of situational awareness, stop the maneuver, admit the problem, and take action to regain situational awareness
C. Task management
   i. Divide attention between the aircraft and outside references
      a. The pilot should only be managing the maneuver and clearing for traffic
   ii. Find a crosscheck and be very familiar with visual references to safely manage the multiple tasks at hand

5. Uncoordinated Flight

A. A failure to maintain coordination results in increased drag and a less than maximum performance turn
B. Maintain coordination as discussed in 2.A. Maintaining Coordinated Flight

6. Energy Management

A. A failure to manage energy results in a less than maximum performance turn
B. Maximum performance is degraded if pitch (and therefore airspeed) is not established correctly
   i. Too high of pitch and the plane stalls prior to reaching max performance, too low and the climb is degraded
C. Maximum performance is degraded if bank is not established correctly
   i. A constant 30° bank is essential; too much bank results in an early completion of the turn and less altitude gained; too little bank results in the aircraft slowing excessively, or stalling, prior to completing the turn
D. Maximum performance is degraded if power is not set to max
   i. Less power results in less altitude, ensure maximum power is used

7. Rate and Radius of Turn with Confined Area Operations

A. As the aircraft slows, the rate of turn increases and radius of turn decreases
   i. As the maneuver progresses through the first half of the turn (constant bank, decreasing airspeed) the rate of turn increases and radius decreases
   ii. During the second half of the turn (decreasing airspeed and decreasing bank), rate and radius may stay the same, it may decrease some, or it may increase. Airspeed continues to decrease, but bank also decreases. How this affects rate and radius is unknown.
B. Be certain in confined area operations that the aircraft can make the turn and/or climb in the space available
   i. There are no charts in the POH to determine this information
   ii. With practice, the pilot can use experience to judge the aircraft's ability to perform within a confined area, but because numerous atmospheric variables beyond control of the pilot will affect the aircraft's performance on any given day this is merely an estimate

SKILLS

The applicant demonstrates the ability to:

1. Clear the area.
2. Select an altitude that will allow the maneuver to be performed no lower than 1,500' AGL.
3. Establish the appropriate entry configuration, power, and airspeed.
4. Establish the angle of bank at approximately 30°.
5. 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.

6. Begin a coordinated constant rate rollout from the 90° point to the 180° point maintaining power and a constant pitch attitude.
7. Complete rollout at the 180° point, ±10° just above a stall airspeed, and maintaining that airspeed momentarily avoiding a stall.
8. Resume straight-and-level flight with minimum loss of altitude.