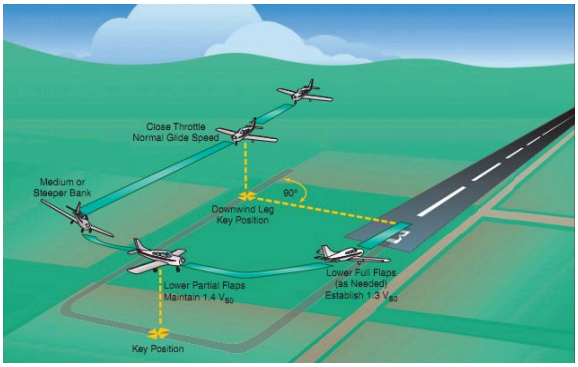
Power-Off 180 Accuracy Approach and Landing

Objective

To ensure the applicant learns the purpose of and can exhibit a clear understanding of the Power-Off 180 maneuver and how to perform the maneuver properly.

Purpose

The Power-Off 180 maneuver simulates an engine failure in the traffic pattern. Learning to perform this maneuver to touch down from a glide at a specified point will teach the pilot to effectively manage energy to maintain the desired glide path, and develops skills which can be used to safely execute emergency landings in a variety of confined areas.



Schedule

- **Ground Lesson**: 15 minutes
- Initial
  - **Flight 1**: 40 minutes - *Introduction to Maneuver*
  - **Flight 2**: 50 minutes - *Improve Proficiency (Dual)*
- Solo
  - **Flight 3**: 30 minutes - *Improve Proficiency*
- Pre-Checkride
  - **Flight 4**: 20 minutes - *Demonstrate Proficiency*
- **Debrief**: 10 minutes (*per flight*)

Equipment

- Airplane POH and Checklist
- Whiteboard / Markers (optional)
- Model Airplane (optional)

Student Actions

- Ask any questions, receive study material for the next lesson.
- Watch linked video.
- Review listed references.

Instructor Actions

- Deliver the ground lesson (below).
- Demonstrate the maneuver in flight.
- Debrief after each flight.

Completion Standards

- **Ground**: Student can explain the purpose of the maneuver and how to execute it properly.
  - Can explain the key positions, how best glide speed is affected by wind, how to manage a gliding approach, and the relationship to the steep spiral.
- **Flight**: Student can perform the maneuver to the applicable ACS standards.
  - Begin from downwind abeam position airspeed < Va.
  - Make an approach to land without engine power.
  - Touchdown -0/+200 ft from specified point.
  - See expanded Completion Standards below.

References

- The Finer Points - “Can You Glide To The Runway? - 3 Tips to be SURE you can”
  - YouTube - https://www.youtube.com/watch?v=x42c21M-z_o
- FAA-H-8083-3C (Airplane Flying Handbook) - Chapter 3, Page 21-24 [Glides/Gliding Turns], Chapter 9, Page 12-13 [Intentional Slips], Chapter 9, Page 24-27 [Power Off Accuracy Approaches], Chapter 9, Page 30-37 [Faulty Approaches and Landings]
- FAA-H-8083-25C (Pilot’s Handbook of Aeronautical Knowledge) - Chapter 5, Page 5 [Lift/Drag Ratio], Chapter 5, Page 7 [Induced Drag], Chapter 5, Page 11-12 [Ground Effect]
- FAA-S-ACS-7B (Commercial Pilot ACS) - Area IV Task M
- FAA-S-ACS-25 (CFI ACS) - Area VII Task O

Ground Lesson Outline

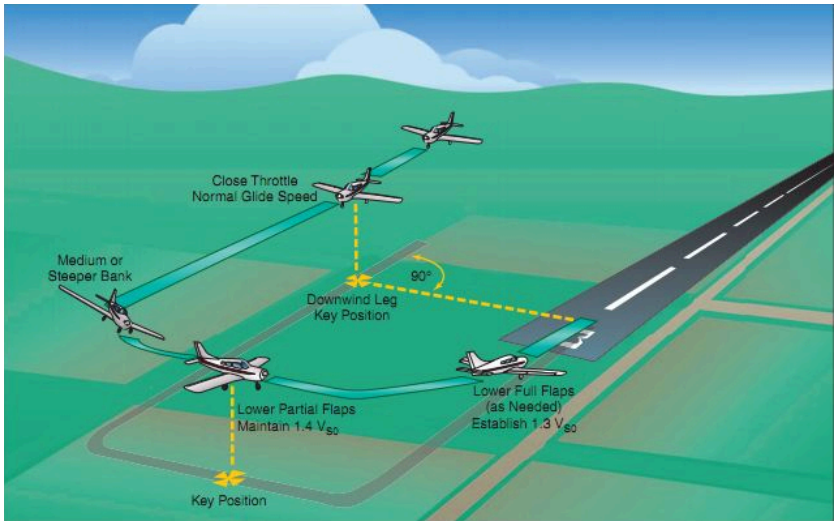
- What is a Power-Off 180?
  - No power - different than a normal landing - Steeper/Tighter/etc
- ‘Key’ Positions
- Estimating Glide Path - Think Energy Management
- Best Glide Speed
  - L/Dmax
- Tools for managing Glide Path
  - Approach geometry
  - Airspeed
  - Airplane Configuration - flaps, gear, etc.
  - Forward slips
- Glide speed vs. headwinds
- Choosing a touchdown point
  - Aim point vs. touchdown point
- Importance of a stabilized approach
- Relationship to the steep spiral maneuver
- Safety considerations
  - Use of checklists, Visual traffic scanning
  - Runway incursion avoidance
  - Windshear, Tailwinds, Wake Turbulence
  - Be prepared to go around
- Maneuver Description - step-by-step
  - Entry position, airspeed, etc.
- Expanded Completion Standards
- Further Reading - *Best Glide vs. Wind (expanded)*

Common Errors

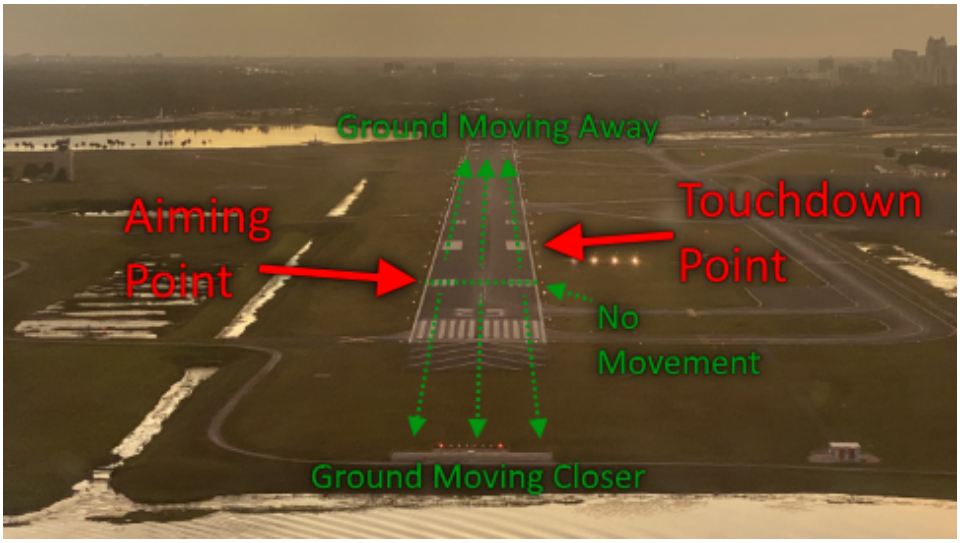
- Failure to establish approach and landing configuration at proper time or in proper sequence.
- **Failure to identify the key points in the pattern.**
- Failure to establish and maintain a stabilized approach.
- ***Executing a skid instead of a forward slip.***
- **Failure to consider the effect of wind and landing surface.**
- **Improper use of power, wing flaps, or trim.**
- Improper procedure during roundout and touchdown.
- Failure to hold back elevator pressure after touchdown.
- Poor directional control after touchdown.
- Improper use of brakes.

Ground Lesson Content

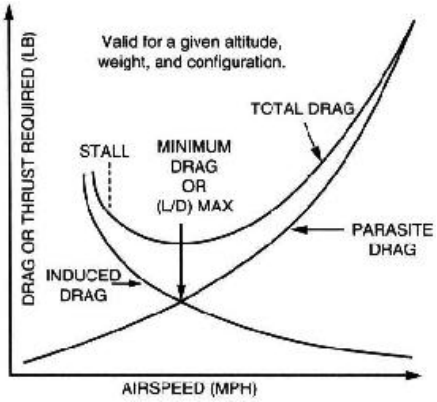
- **What is a Power-Off 180?** The Power-Off 180 maneuver is meant to simulate an engine failure in the traffic pattern. Unlike a normal landing, there is no power available to manage the glide path, and so the approach to land is somewhat different than a normal landing:
    - *It will be steeper.* A normal 3 degree glide path is not possible in most aircraft.
    - *It will be tighter.* It is usually necessary to fly a closer, 'tighter', base leg than usual.
    - *It may require maneuvering.* S-turns or slips may be required to lose altitude.
- **Key Positions** - The Power-Off 180 maneuver is normally begun from the downwind leg, at a point abeam the touchdown point. This point is called the ***downwind key position***. It is the position from which the pilot will initially estimate the distance to the runway, and plan the approach path. At the ***key position***, the pilot is at a close-in base leg position. At the key position, the pilot again estimates the distance to the runway, and modifies the approach path as necessary.



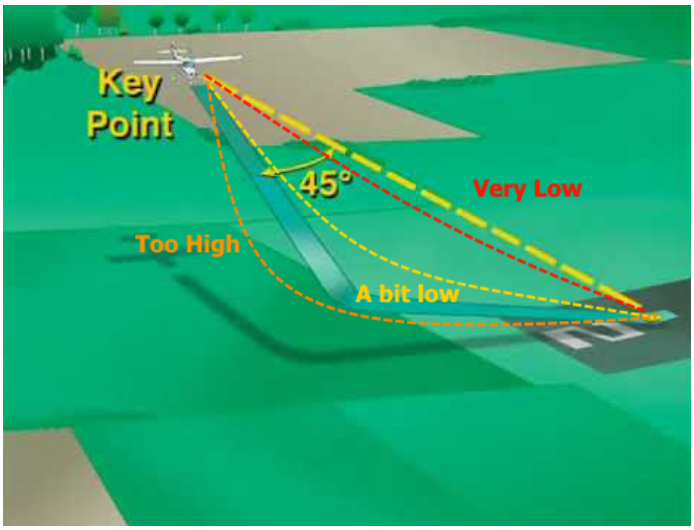
- **Estimating Glide Path** - In order to perform this maneuver successfully, pilots must develop their skills in visually estimating the airplane's glide path. This begins with finding an aiming point which is just before the desired touchdown point, to account for the roundout and flare. When in a stable descent, if the aim point is *moving away*, the landing will be short. When the aim point is *moving closer*, the landing will be too long. It is crucial to pay close attention to the movement of the aiming point and make the appropriate corrections.
    - It is useful to think about gliding approaches in terms of **Energy Management**. Since we have no engine during a gliding approach, we must necessarily fly a higher-than-usual energy approach. We want to have enough energy to take us to the intended landing spot, as well as a bit of reserve energy that we bleed off with our drag devices.
        - See the lesson on *Area 10 (X) - Task B - Demonstration of Flight Characteristics at Various Configurations and Airspeeds* for more details on energy management.



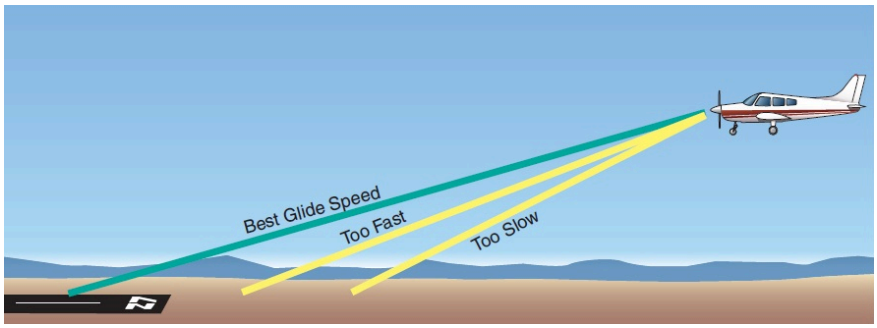
- **Best Glide Speed** - When gliding to land, the most important airspeed to remember is the *best glide speed*. Best glide speed is the airspeed that will, in the absence of wind, result in the airplane traveling the **furthest distance**. Generally the Power-Off 180 should be flown at approximately best glide speed, and in the clean (lowest drag) configuration, until a safe landing is assured. It is best to trim to best glide speed immediately at the start of the maneuver.
    - The best glide speed is the airspeed at which the ratio of lift to drag is at maximum (sometimes called *L/D max*), and is often published only for the clean configuration.



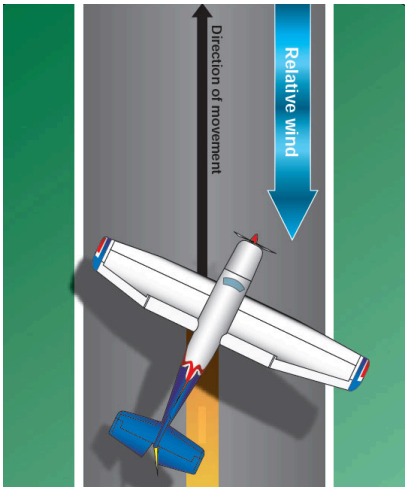
- **Tools for Managing Glide Path** - Because there is no power available, pilots have fewer tools to correct their glide path than in a normal powered approach, however, they do have a few important tools:
    - **Approach geometry** - Flying a longer or shorter path to the runway can vary the amount of altitude dissipated in the glide. It is usually possible to 'cut off the corners' of the normal pattern turns if the glide appears too short, or if the glide appears too long, to fly past the approach path and turn back towards it, or perform S-turns.



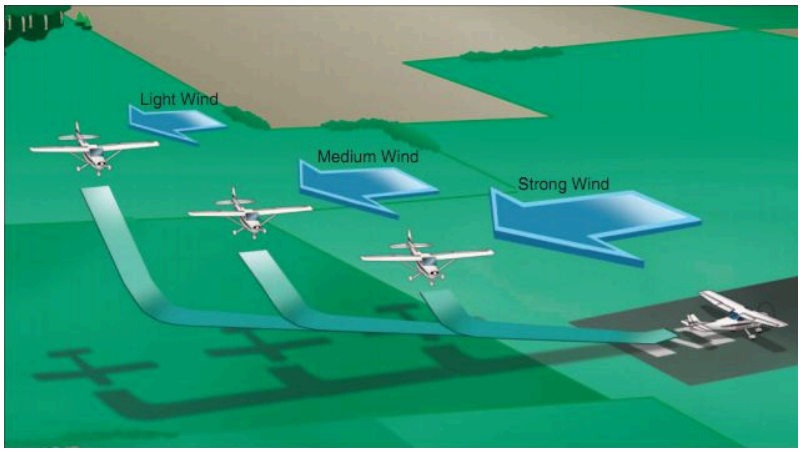
- **Airspeed** - Flying at an airspeed faster than, or slower than, best glide speed will result in a shorter glide.



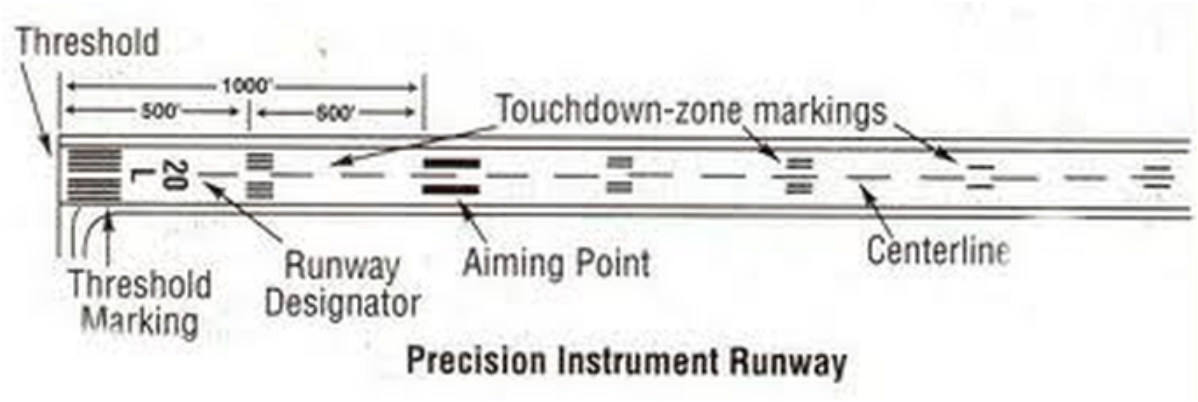
- **Aircraft configuration** - Flaps can be used to slow the airplane, and shorten the glide, if it appears the glide will be too long.
- **Forward slips** - Forward slips are another tool which increases drag and can dramatically shorten a glide.



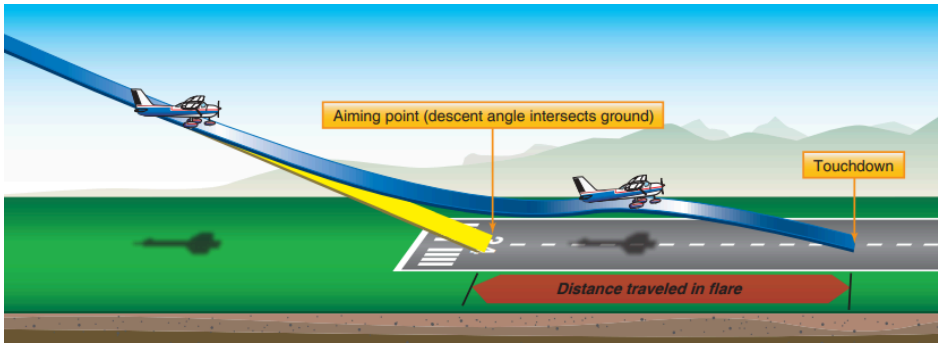
- **Glide Speed vs. Headwinds** - An important consideration for this maneuver is the wind speed. As with any landing, the Power-Off 180 should be made such that landing is into the wind, however it is important to understand that **a headwind causes glide performance to decrease and best glide speed to increase**! (See the *Further Reading* section below) Therefore, in situations where there is a strong wind, the base leg should be flown closer to the touchdown point.



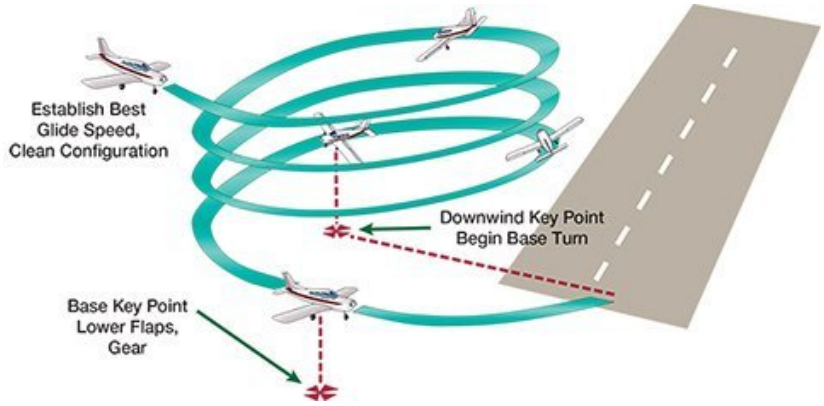
- **Choosing a touchdown point** - This maneuver also involves demonstrating precision control over the glide path such that the landing occurs with minimal floating. A touchdown point on the runway should be selected such that the airplane will land **at, but not before**, this point, or within 200 feet beyond it.
    - On a runway with precision markings, the 1,000 foot (aiming point) markers are a good choice, as on most runways they are 150 feet long. Other possible touchdown points can be a particular centerline stripe, or the numbers (for runways without other markings). *It is generally best to choose a marking that is not right at the start of the runway, to avoid the possibility of landing short of the runway.*



- **Importance of a stabilized approach** - As with all landings, it is important to maintain a stabilized approach if possible. If the glide path is planned well, it can be executed as a smooth, continuous 180 degree turn, while maintaining best glide speed and avoiding dramatic forward slips or other maneuvers the entire time. Except for during forward slips, the maneuver should be flown coordinated.
- As the airplane approaches the runway on final, the pilot should identify a point before the desired touchdown point and use it as an aiming point. As the airplane reaches the aiming point, a normal roundout and flare can be conducted, such that the airplane touches down at the touchdown point. Aiming at the touchdown point would result in landing long, because it does not account for the landing roundout and flare.



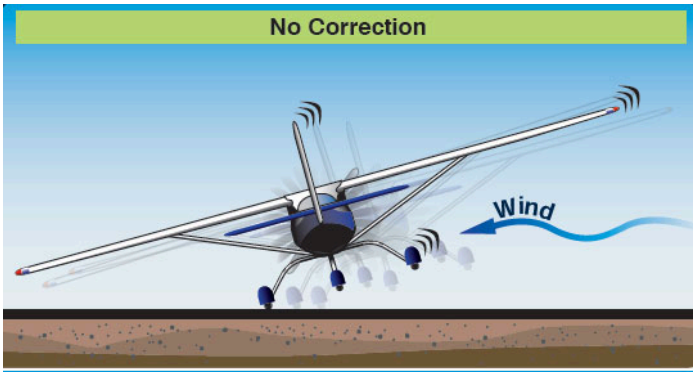
- Pilots should conduct all landings to hit a designated spot, whether or not they are performing a Power-Off 180. During the roundout and flare, the pilot should hold just enough back pressure to keep the airplane from touching down until the desired touchdown point is reached.
- **Relationship to the Steep Spiral maneuver** - The Power-Off 180 is an important tool outside of the traffic pattern environment also. In a power-off emergency, it may be possible to spiral down (see the *Steep Spiral* maneuver) such that the spiral ends on a downwind to a suitable emergency landing site, where a Power-Off 180 can be conducted.

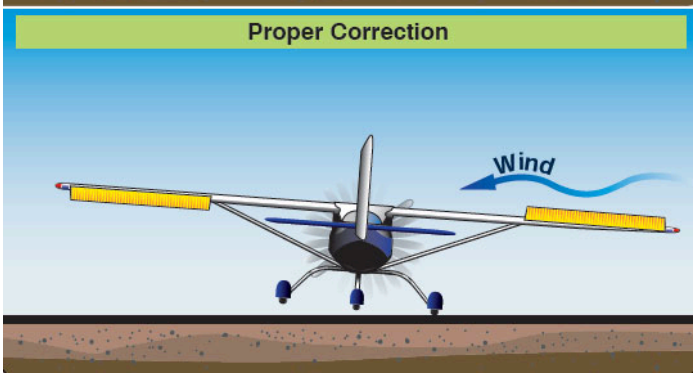


- **Safety Considerations**
  - As with any landing, the **use of checklists is important**. Before beginning the maneuver, the before landing checklist must be completed. After landing and rolling out to a safe point clear of the runway, the after landing checklist should be completed.
  - It is crucial to not become so focused on the maneuver that an unsafe situation is created. Maintain situational awareness, make appropriate radio calls, and ensure that landing clearance is obtained before landing. **Vigilance must be maintained after landing to avoid taxiing onto any intersecting runways beyond other hold short lines.** If there is a control tower, do not forget to contact ground control for taxi clearance after landing, and at uncontrolled fields, clearly communicate your taxi intentions on the radio.
  - Maneuvering at low airspeed, and performing forward slips or S-turns creates a risk of a stalling situation. If the stall warning sounds before the landing flare, go around! **Always be prepared to go around!**
  - **Windshear, Tailwinds, Wake Turbulence** - During takeoffs and landings, we are operating near the ground at low speed. Pilots should exercise caution if there are indications of windshear, pay attention to situations where wake turbulence will be a factor. Additionally, taking off or landing with a tailwind creates a much higher ground speed, lengthening the ground roll, and increasing the danger.

Maneuver Description

- **Selecting a Suitable Runway** - The purpose of this maneuver is to simulate an engine failure in the traffic pattern, and therefore it is important to select a runway that will allow landing into the wind, or with a manageable crosswind.
- **Selecting a Touchdown Point** - Select a prominent feature on the runway that is easy to identify from the downwind leg, and explicitly state it. Features like 1,000 foot markers, touchdown zone markers, or runway numbers are good choices. Until proficiency is developed, select a feature that is not directly at the start of the runway, in case the glide comes up short.
- **Entry Position and Altitude** - The maneuver should be entered on the downwind leg, abeam the touchdown point, at normal pattern altitude.
- **Entry Airspeed** - The maneuver must be started at less than **Va** (maneuvering speed). Choose a normal level cruise flight airspeed and power setting, at least 5-10 knots below Va. Ideally, begin this maneuver at a normal traffic pattern airspeed.
- **Checklists** - Pilots must perform a before-landing checklist before beginning the maneuver, and an after-landing checklist after taxiing safely clear of the runway, for full-stop landings.
- **Airspeed** - Airspeed should be kept at around best glide airspeed, although the approach can be flown slightly faster or slower, as necessary, to make the glide work out. *Take care to allow sufficient margin above the stall, and if the stall indication is heard at any point before the final landing flare, discontinue the maneuver and go around!*
- **Bank** - Since this maneuver takes place in an airport traffic pattern and involves maneuvering in gliding flight at low altitude, the bank angle should be *less than* **30 degrees**.
- **Approach Path** - Any approach geometry may be used to make the glide work out as necessary. This may require turning for the numbers early, or potentially flying past final and turning back towards it. S-turns and forward slips on final are also acceptable.
- **Coordination** - Except for during forward slips, the maneuver should be flown in coordinated flight. Attention should be given to proper rudder input during turns.
- **Slips** - Forward slips may be used as long as care is taken to ensure the nose remains below the horizon to maintain a margin above the stall. **Do not skid.**
- **Touchdown** - Choose an aiming point such that the airplane will land *at, but not before*, the selected touchdown point, or within 200 feet beyond. The landing should be at a proper pitch angle (*not on the nosewheel-- do not force it!*), safe, and under control. Positive aircraft control must be maintained at all times! **Apply *and hold* proper crosswind corrections to avoid sidewards drifting.**





- **After Touchdown** - Apply aerodynamic and wheel braking as necessary.
- **Be Prepared to Go Around!** The glide may not work out and a go-around is very possible. Be prepared to execute a go-around if needed.
- **This is a visual maneuver!** Eyes should remain outside the cockpit as much as possible to scan for traffic and ensure proper management of the glide path. *Monitoring for other traffic is especially critical when performing this maneuver at uncontrolled airfields.*

Expanded Completion Standards

- The pilot can explain the purpose of the Power-Off 180 maneuver and how wind and other factors affect the performance of the maneuver.
- The pilot can perform the maneuver to the following standards:
    - Pilot selects a runway suitable for the weather conditions, establishes the airplane on a downwind leg at pattern altitude, performs a pre-landing checklist, establishes a speed *below* **Va**, makes the appropriate radio calls, and designates a touchdown point.
    - At a point on the downwind no later than abeam the touchdown point (the downwind key position), the pilot closes the throttle, applies carb heat as necessary, and establishes a gliding descent.
    - Pilot uses a combination of approach geometry, slips, and flaps to manage the approach path, **avoiding skidding turns at all times**.
    - Pilot manages the descent and aims for a point so as to make a safe, controlled landing **at or within 200 feet beyond the designated touchdown point**. (The pilot may not touch down before the designated point)
        - For Private Pilot students, the landing need only be within the first ⅓ of the runway
    - Pilot applies appropriate wheel and aerodynamic braking techniques.

- Pilot divides attention between accurate, *coordinated airplane control* and outside visual references.

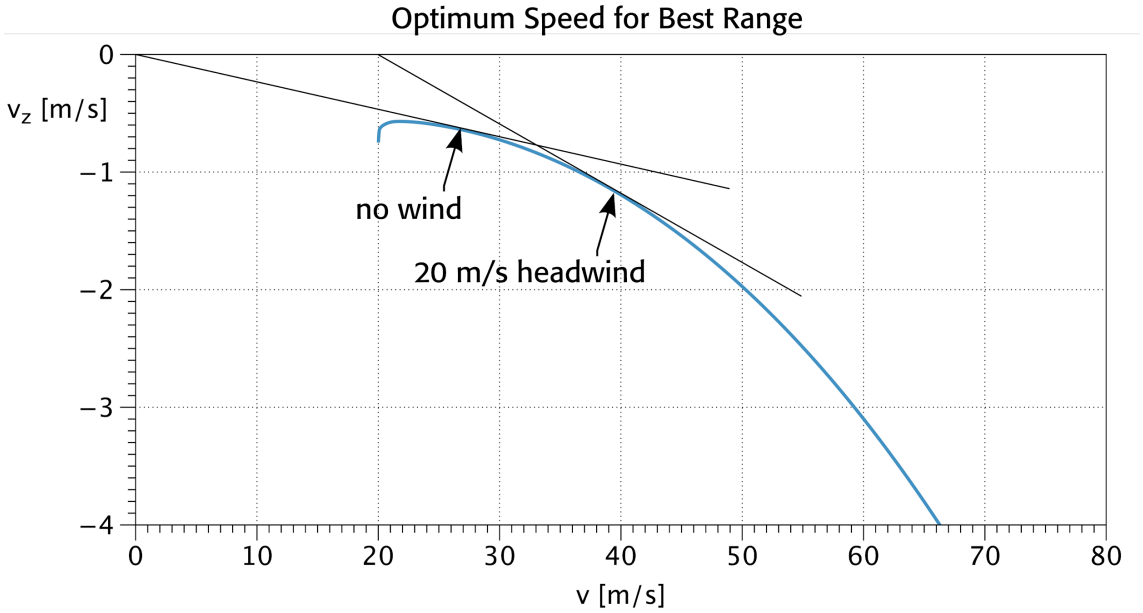
Further Reading

Best Glide vs Wind (expanded)

- The reason that glide performance depends on wind is that an airplane's best glide speed is calculated such that the airplane travels the furthest distance *into the relative wind* for a given amount of altitude lost. However, when an airplane glides into the wind, some of its forward motion *along the ground* is in effect 'lost' due to the headwind. This results in a situation where, in a strong headwind, the airspeed which results in the longest glide distance *across the ground* is higher than the airspeed that results in the most glide distance *into the wind*.
  - *Example*: Imagine a scenario with an airplane with a best glide speed of **50 kts** and a **8:1 glide ratio**. For every 1,000 feet of altitude lost, the airplane will travel 8,000 feet into the relative wind when flying at best glide speed. At 50 kts, the airplane will travel ~5,063 feet per minute (50 nm/hr x 6,076 ft/nm / 60 min/hr) *through the relative wind*. The airplane begins its glide at **1,000 feet**.
    - **No Wind** - The airplane would reach the ground in ~ 1 minute, 35 seconds, and cover 8,000 feet *through the relative wind*, and 8,000 feet over the ground.
    - **25 kt Headwind** - The airplane would reach the ground *at the same time*, 1 minute, 35 seconds, traveling 8,000 feet through the relative wind, but *only 4,000 feet over the ground*. (25 kt ground speed during the glide)
    - **50 kt Headwind** - The airplane would reach the ground again **at the same time**, 1 minute, 35 seconds, traveling 8,000 feet through the relative wind, but travel **0 feet over the ground**. (0 kt ground speed during the glide)
  - Consider further now that at a speed of **60 kts**, the same airplane has a slightly worse **7.5:1 glide ratio**. For every 1,000 feet of altitude lost, the airplane will travel 7,500 feet into the relative wind when flying at this speed. At 60 kts, the airplane will travel ~6,076 feet per minute *through the relative wind.* The airplane begins its glide again at 1,000 feet.
    - **No Wind** - The airplane would reach the ground in ~ 1 minute, 14 seconds, and cover 7,500 feet through the air, and 7,500 feet over the ground, which is 500 feet less glide performance.
    - **25 kts Headwind** - The airplane again glides in ~ 1 minute, 14 seconds, covering the same 7,500 feet through the air, but now covers 4,666 feet *over the ground*. (35 kt ground speed in the glide) **This is an improvement of over 600 feet in total glide over the ground!**
    - **50 kts Headwind** - The airplane again glides in ~ 1 minute, 14 seconds, covering the same 7,500 feet through the air, but now covers 1,333 feet *over the ground*. (10 kt ground speed in the glide) **This is an improvement of over 1,300 feet in total glide over the ground!**
  - Notice that, for a given speed and glide ratio, the amount of time that the airplane remains aloft remains the same. The airplane 'feels' only the relative wind.

- Also notice that, for a given speed and glide ratio, the amount of distance *into the relative wind* the airplane travels remains the same, regardless of wind, however the distance traveled *over the ground* varies greatly.

- This can be plotted using a 'polar curve'



- See: https://www.wikiwand.com/en/Polar_curve_(aerodynamics)