



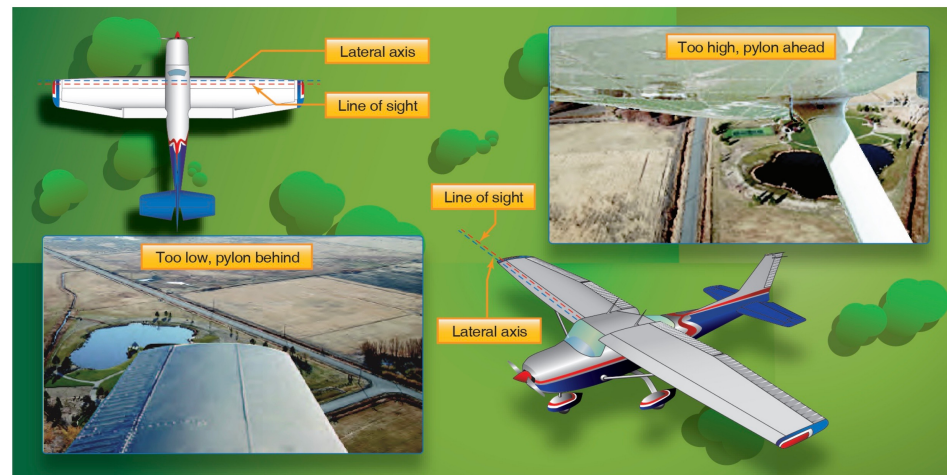
EyeFlyMD.com

Eights on Pylons

Commercial Flight Maneuver

Background

- The most advanced ground reference maneuver
- This is a figure 8 flown between two ground reference points
- The goal is to keep the two reference points at a constant line of sight
- It will appear as though the world is revolving around the pylons
- Unlike S-turns or turns around a point, the *elevator* is the primary control for maintaining a constant line of sight to the pylons

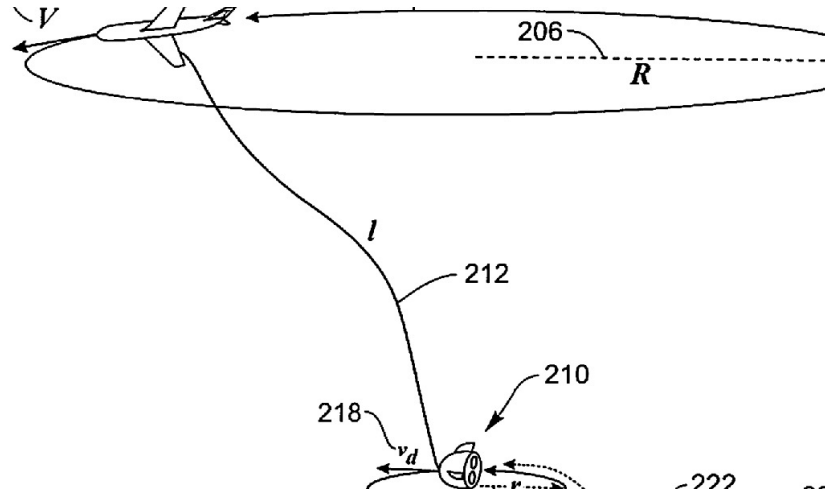


Origin

- Started as Pylon turns in racing, maintaining a constant sight picture
- “Long Line Loitering” for delivering mail with no airstrip
- Combat maneuver, constant line of sight to target



Pylon Racing



Long Line Loiter



Tracer Fire

Objectives

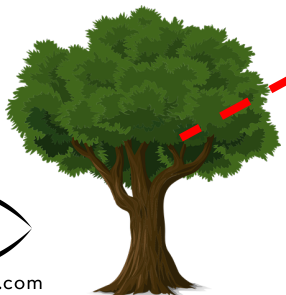
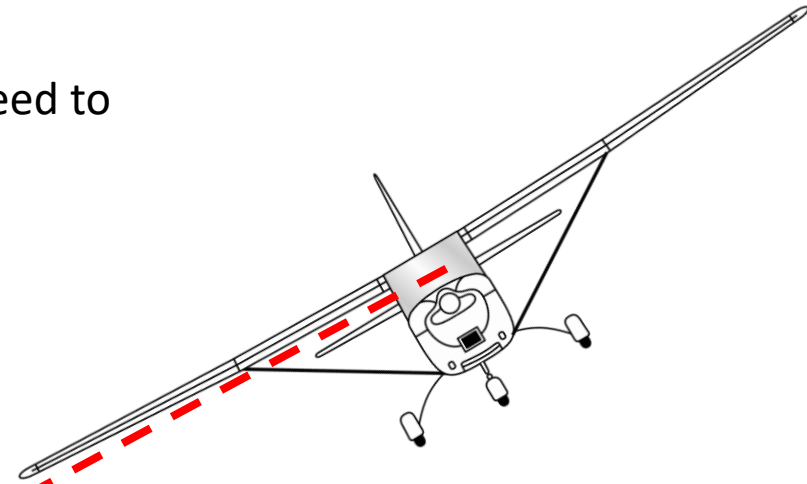
- Purpose: “developing intuitive control of the airplane” (AFH 7-10)
- Develop the ability to maneuver the airplane accurately while dividing attention between the flight path and selected references
- Demonstrate how wind affects the path and speed of the airplane over the ground
- Gain experience in the visualization of the results of planning before the execution of the maneuver
- Continue developing the skills of energy management and flight by visual references
- Maintain coordination and orientation

Pivotal Altitude

- Definition: “altitude at which, for a given groundspeed, the projection of the visual reference line to the pylon appears to pivot” (AFH)
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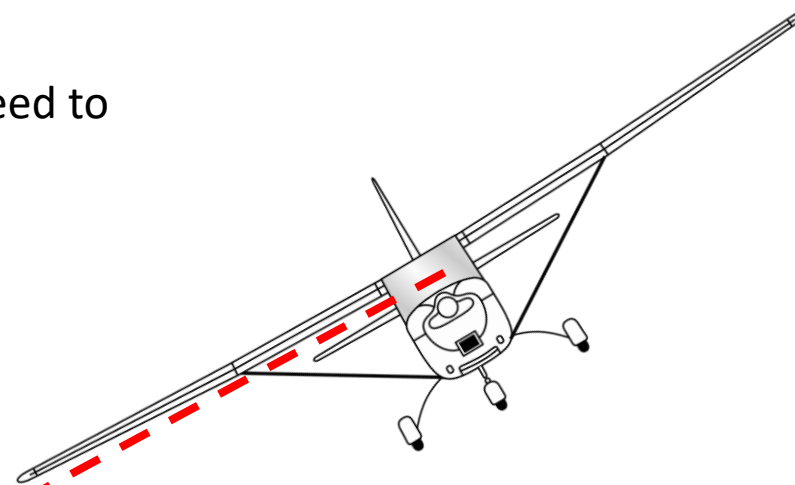
In other words, using a specific point (like a rivet line), we need to keep the pylon in the same spot from our line of sight.

The pylon should appear completely stationary.

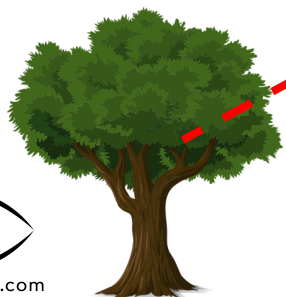


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Pick a very specific reference on the wing.



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- Equations:

$$\bullet \text{ Pivotal Altitude} = \frac{\text{Groundspeed}^2}{15 \text{ (MPH) or } 11.3 \text{ (kts)}} + \text{MSL of ground reference}$$

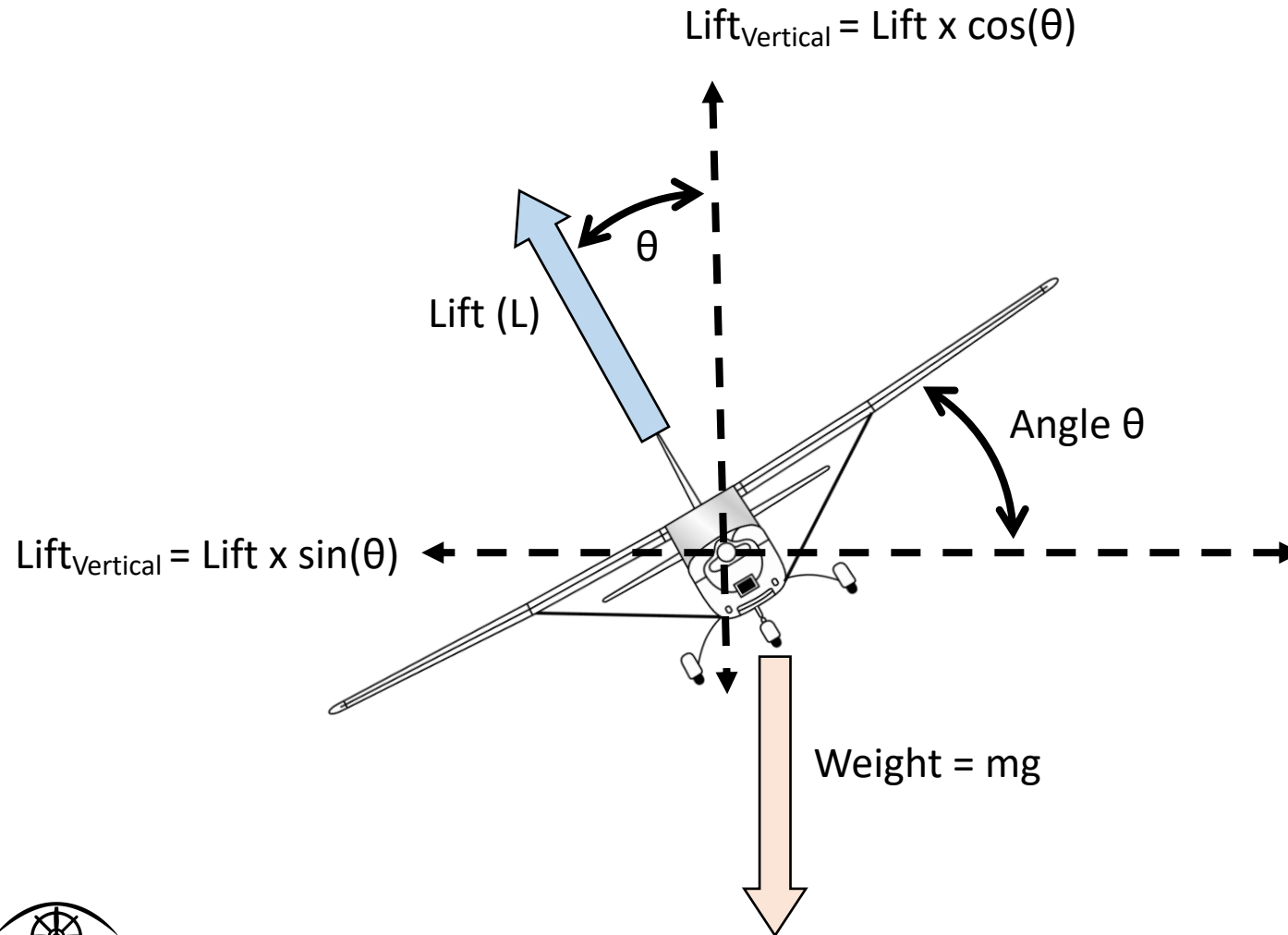
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Where does this come from?

Origin of the Equation (for those interested)



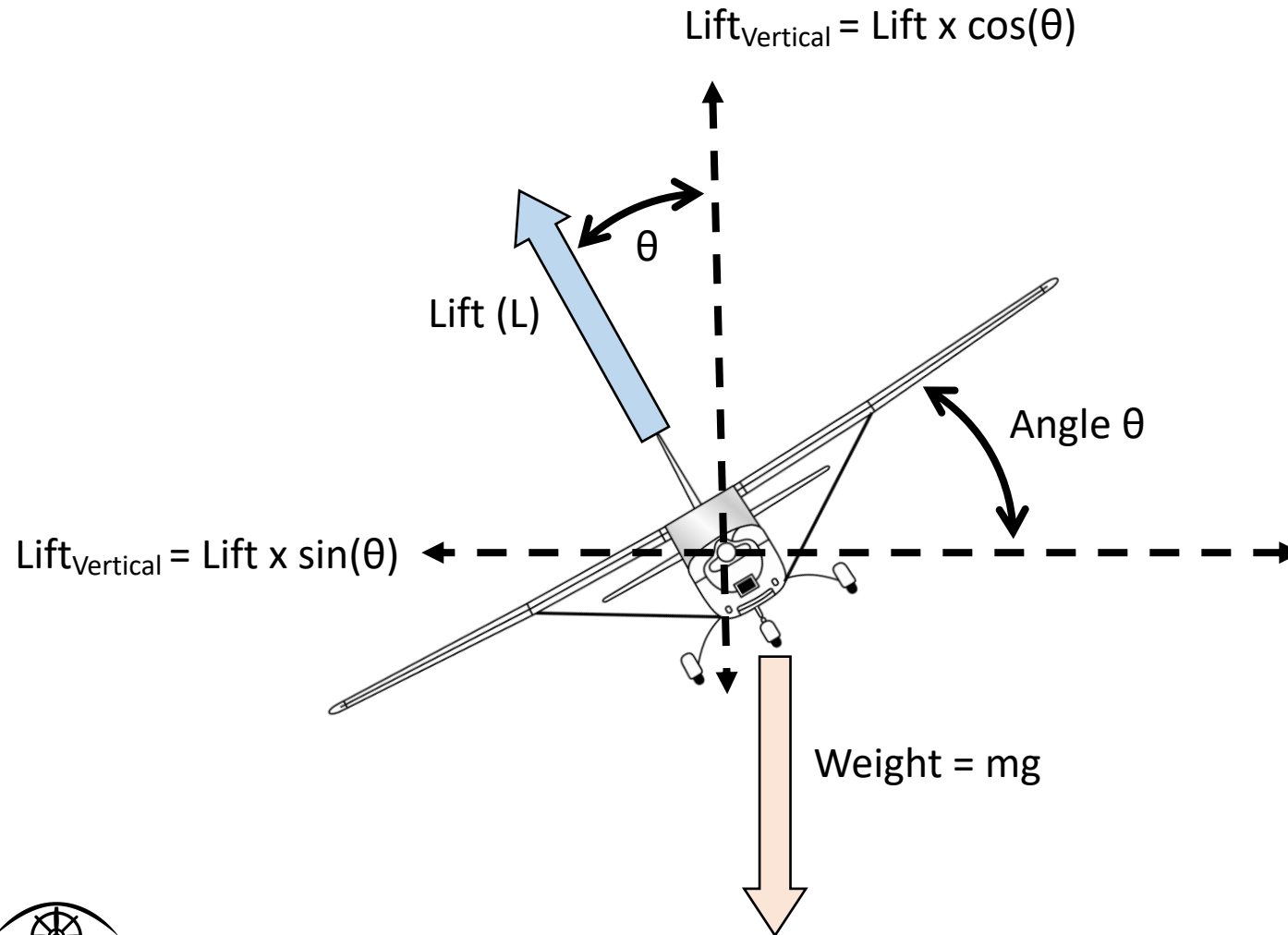
Vertical Force = 0

$$L \cos \theta = mg$$

Horizontal Force = $m \times a_{centripetal}$

$$L \sin \theta = m \frac{v^2}{r}$$

Origin of the Equation (for those interested)



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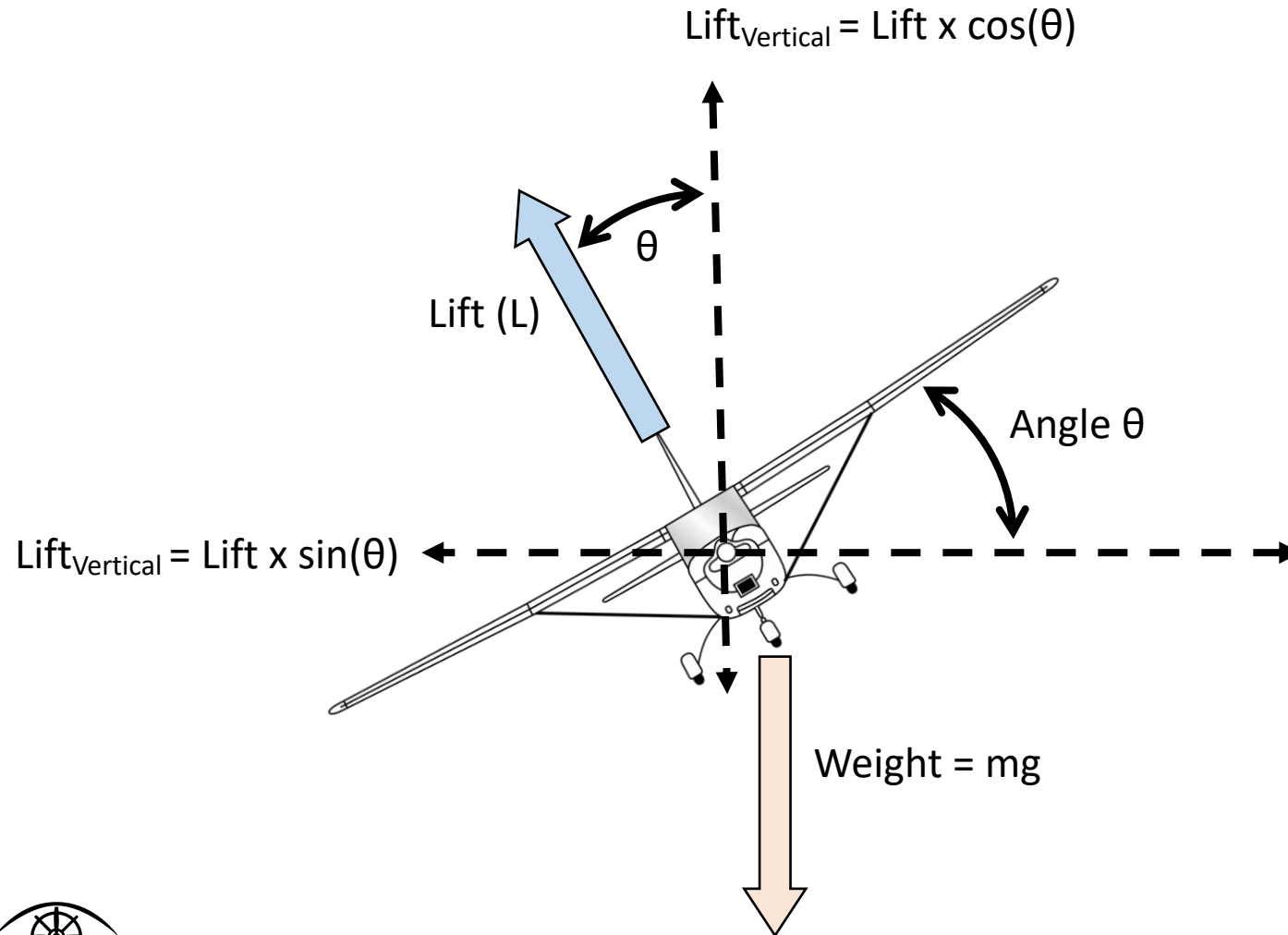
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$$\frac{L \sin \theta}{L \cos \theta} = \tan \theta = \text{constant} = \frac{m \frac{v^2}{r}}{mg}$$

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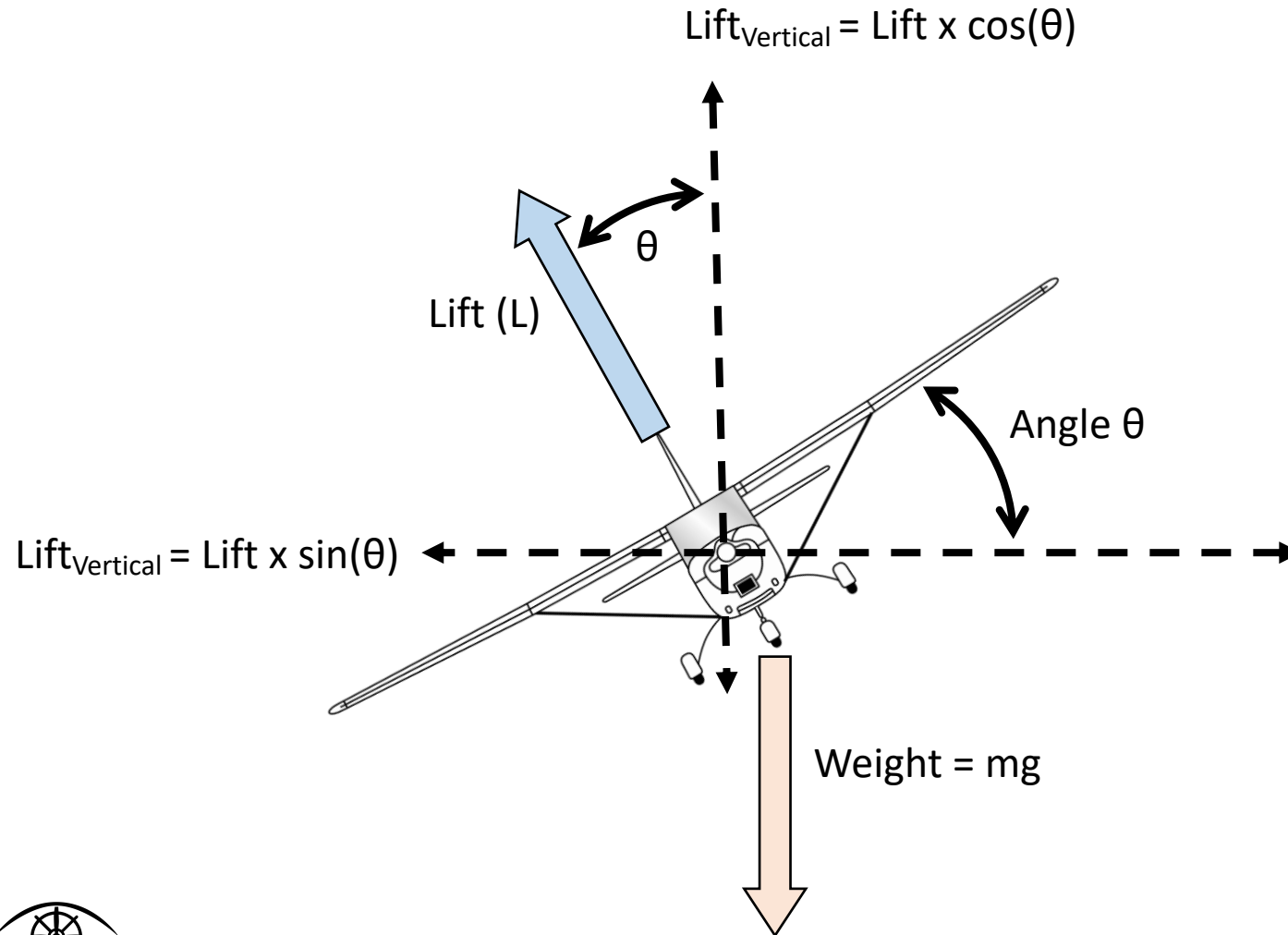
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Mass cancels, same physics for a 152 and 747

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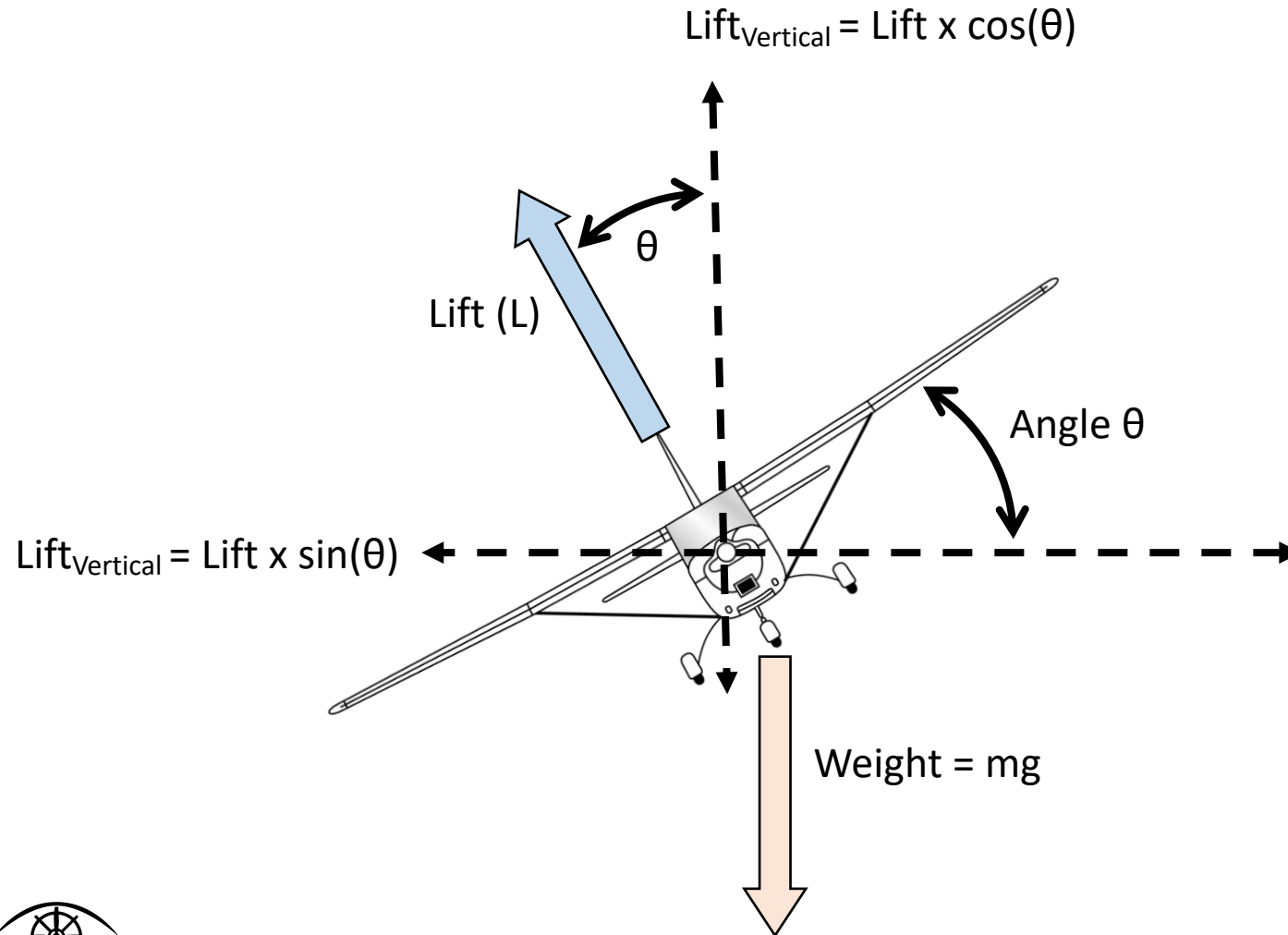
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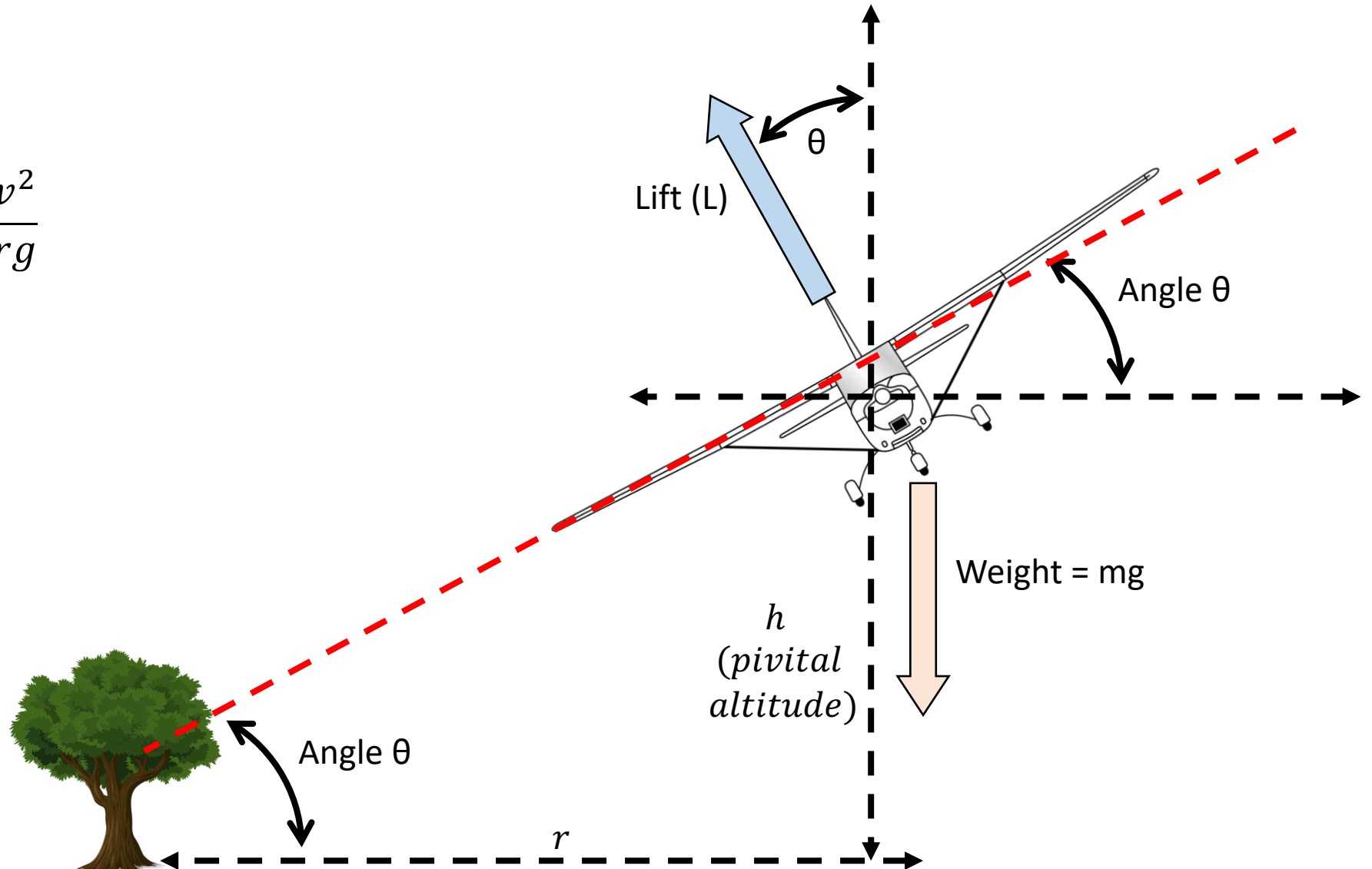
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$$\frac{L \sin \theta}{L \cos \theta} = \tan \theta = \text{constant} = \frac{v^2}{rg}$$

The relationship here between V and r is why slower airspeeds result in smaller radius turns.

Origin of the Equation (for those interested)

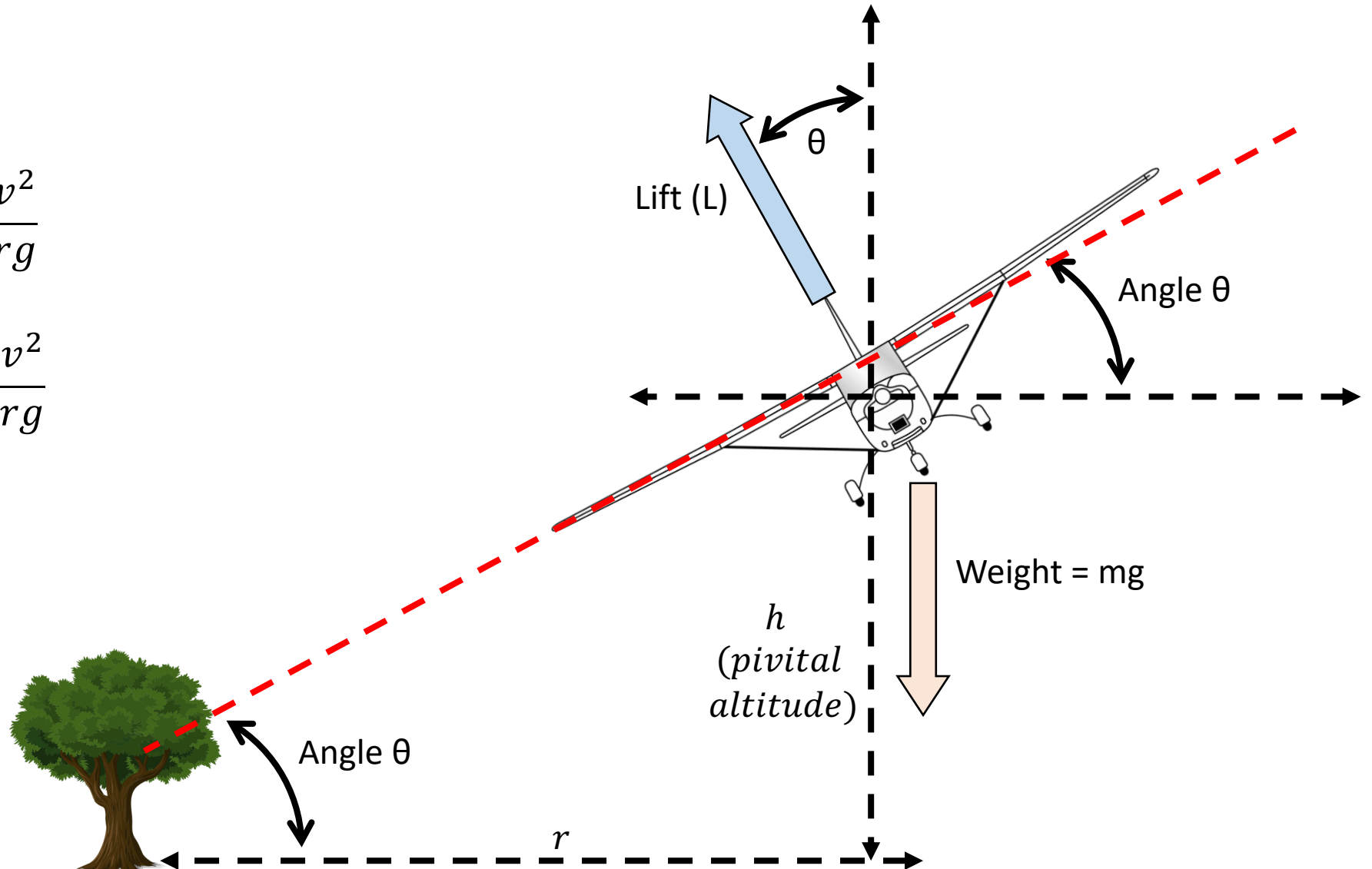
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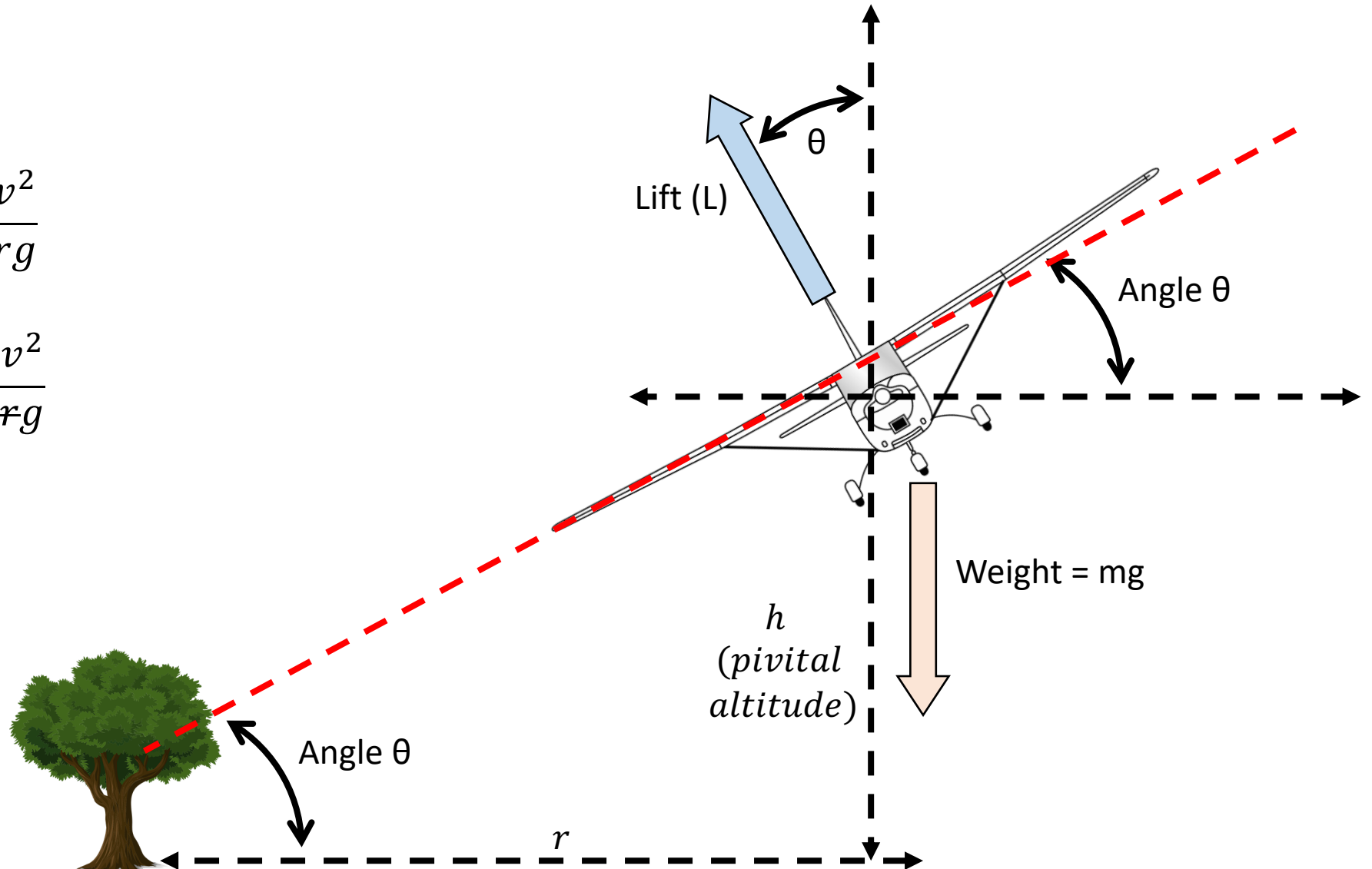
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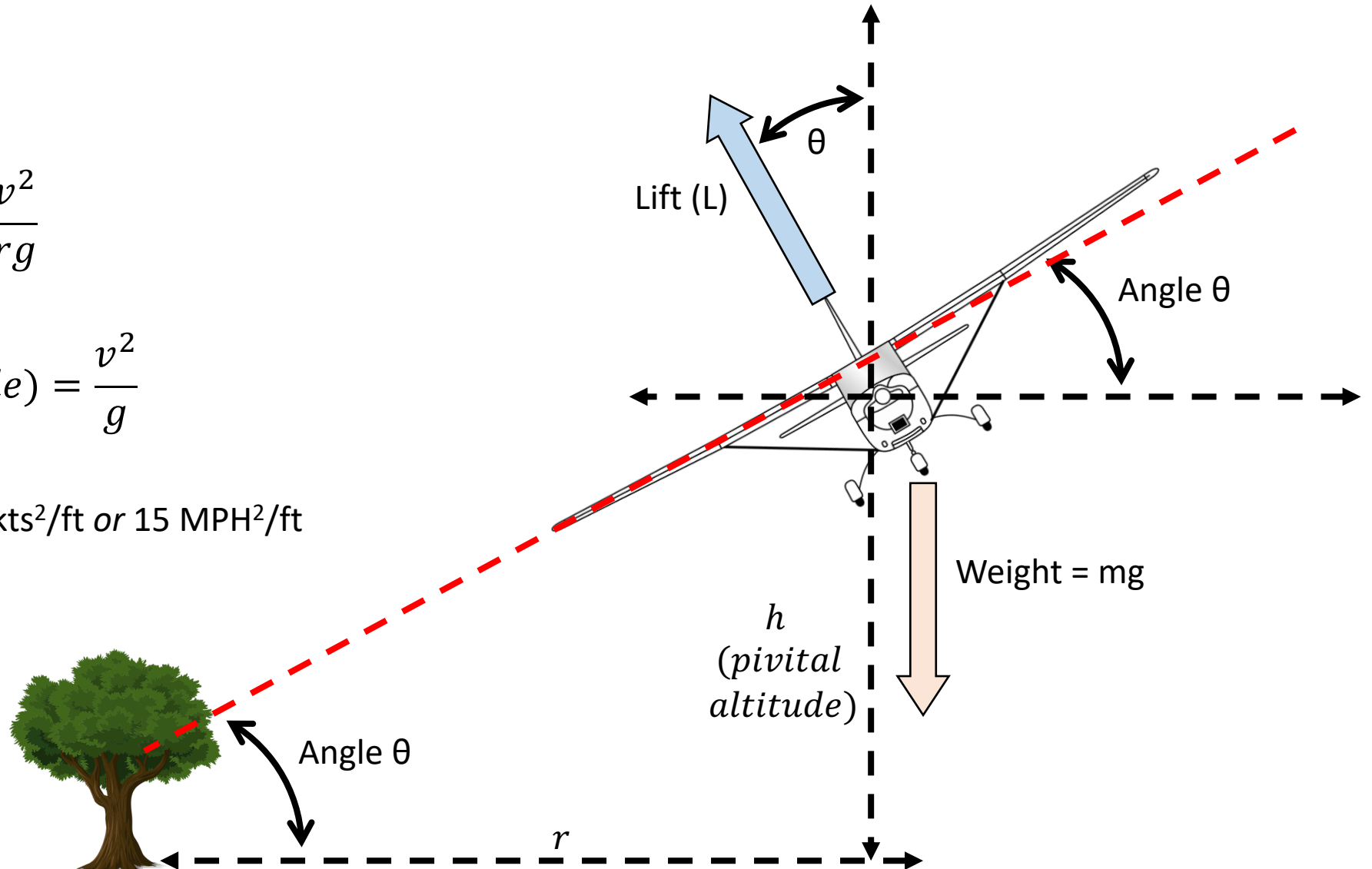


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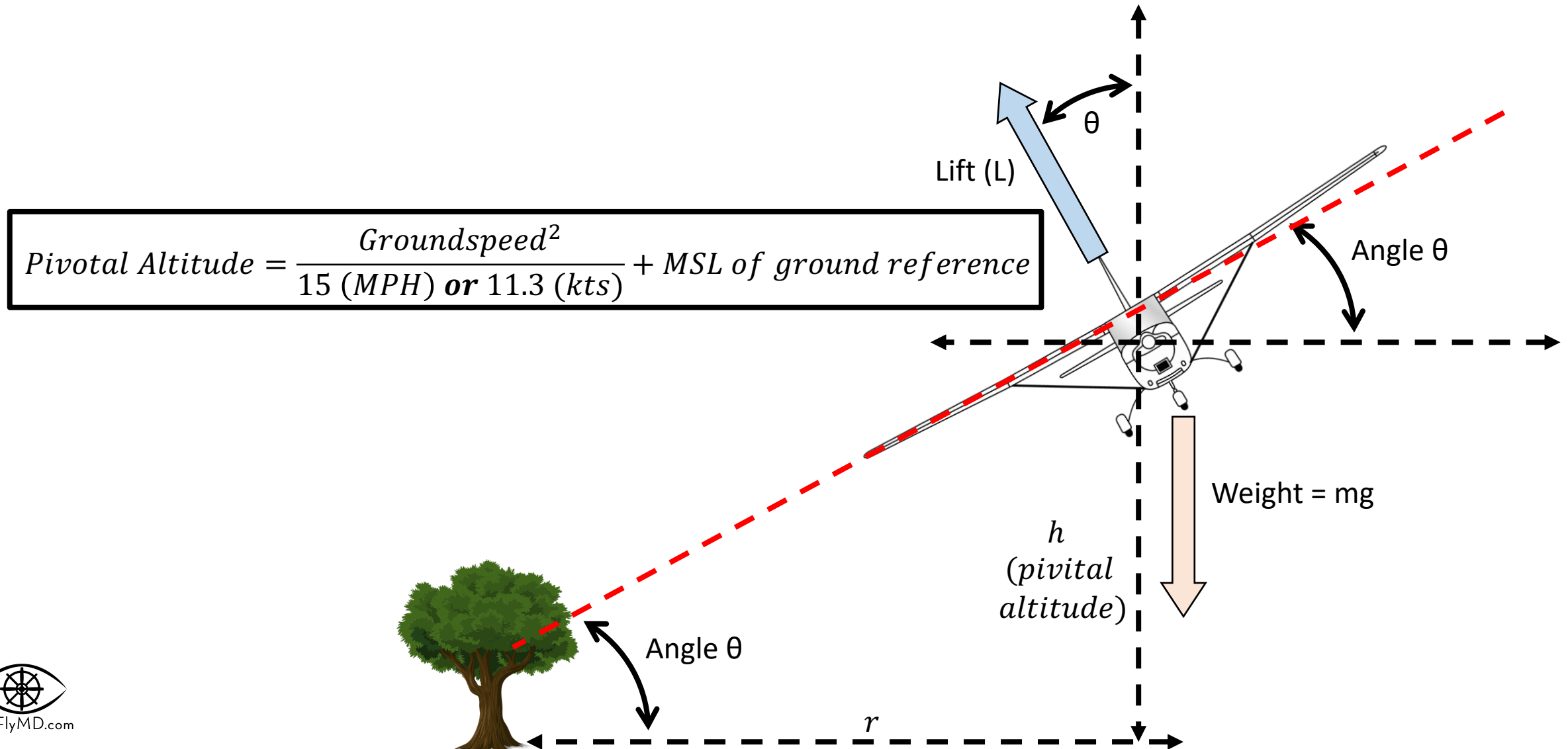
$$\text{constant} = \frac{v^2}{rg}$$

$$h(\text{pivotal altitude}) = \frac{v^2}{g}$$

Recall $g = 9.8 \text{ m/s}^2$ or $11.3 \text{ kts}^2/\text{ft}$ or $15 \text{ MPH}^2/\text{ft}$



Origin of the Equation (for those interested)



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What should our pivotal altitude be today?

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
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At a normal power setting, we can expect ~ 105-110 MPH groundspeed.

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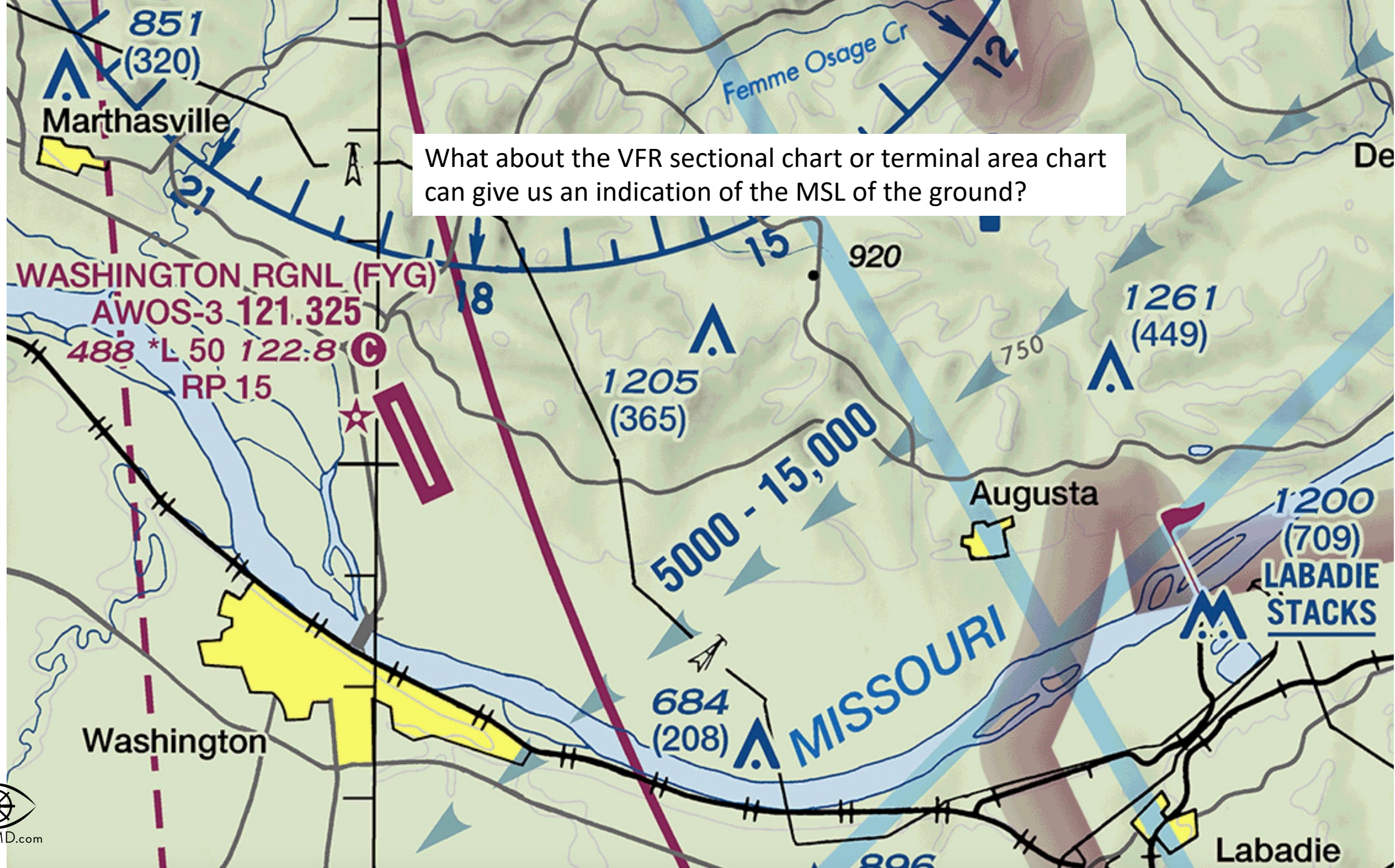
$$\bullet \text{ Pivotal Altitude} = \frac{\sim 110^2}{15 \text{ (MPH)}} + \text{MSL of ground reference}$$

105	735
110	810

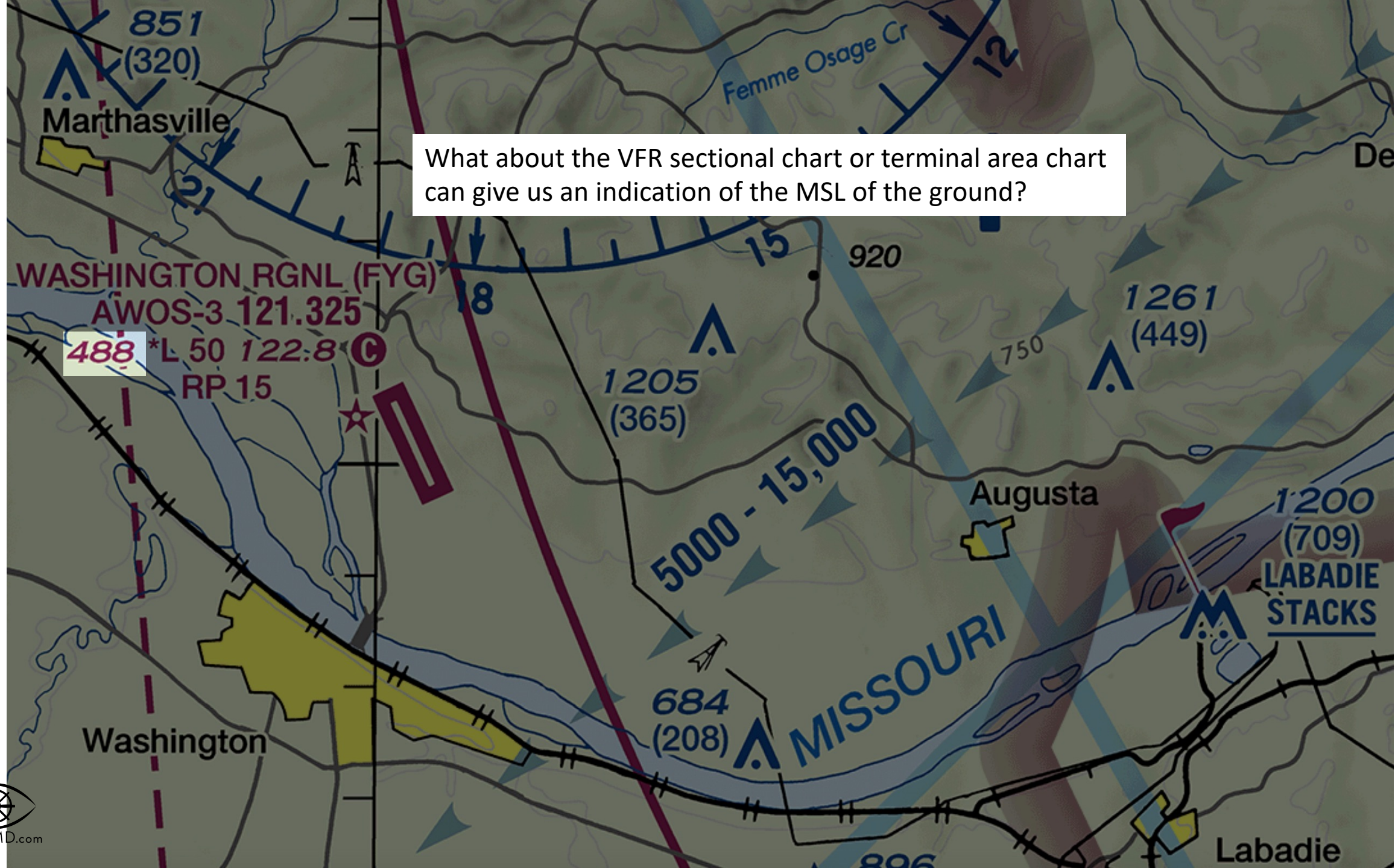
What should our pivotal altitude be today?

Now we need to know the MSL altitude of the ground in our practice area.

What about the VFR sectional chart or terminal area chart can give us an indication of the MSL of the ground?



What about the VFR sectional chart or terminal area chart can give us an indication of the MSL of the ground?



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- Equations:

$$\bullet \text{ Pivotal Altitude} = \frac{\sim 110^2}{15 \text{ (MPH)}} + \sim 500'$$

Let's do some math!

105	735
110	810

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- Equations:

- $$\text{Pivotal Altitude} = \frac{12,100}{15 \text{ (MPH)}} + \sim 500'$$

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105	735
110	810

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- Goal is to maintain *lateral orientation* to a specific spot on the ground
- Equations:
 - *Pivotal Altitude* = $\sim 800 + \sim 500'$

Let's do some *more* math!

105	735
110	810

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Let's do some *more* math!

NICE!

105	735
110	810

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- Equations:
 - *Pivotal Altitude* = ~**1,300**

Between 1,300' and 1,500' MSL is going to be a good starting point!

105	735
110	810

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- Goal is to maintain *lateral orientation* to a specific spot on the ground
- Equations:
 - *(our) Pivotal Altitude* = ~1,300
- **Most Importantly:**
 - The pivotal altitude changes with variations in groundspeed.
 - Groundspeed will *increase* during the downwind leg
 - Groundspeed will *decrease* during the upwind leg

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If this is our starting speed...

- **Most Importantly:**

- The pivotal altitude changes with variations in groundspeed
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- Goal is to maintain *lateral orientation* to a specific spot on the ground
- Equations:

- (our) Pivotal Altitude = **~1,500**

- **Most Importantly:**

- The pivotal altitude changes with variations in groundspeed
 - Groundspeed will *increase* during the downwind leg
 - Groundspeed will *decrease* during the upwind leg

The downwind leg will increase our groundspeed and thus increase our pivotal altitude. We need to **climb**.

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- Equations:

- (our) Pivotal Altitude = **~1,200**

- **Most Importantly:**

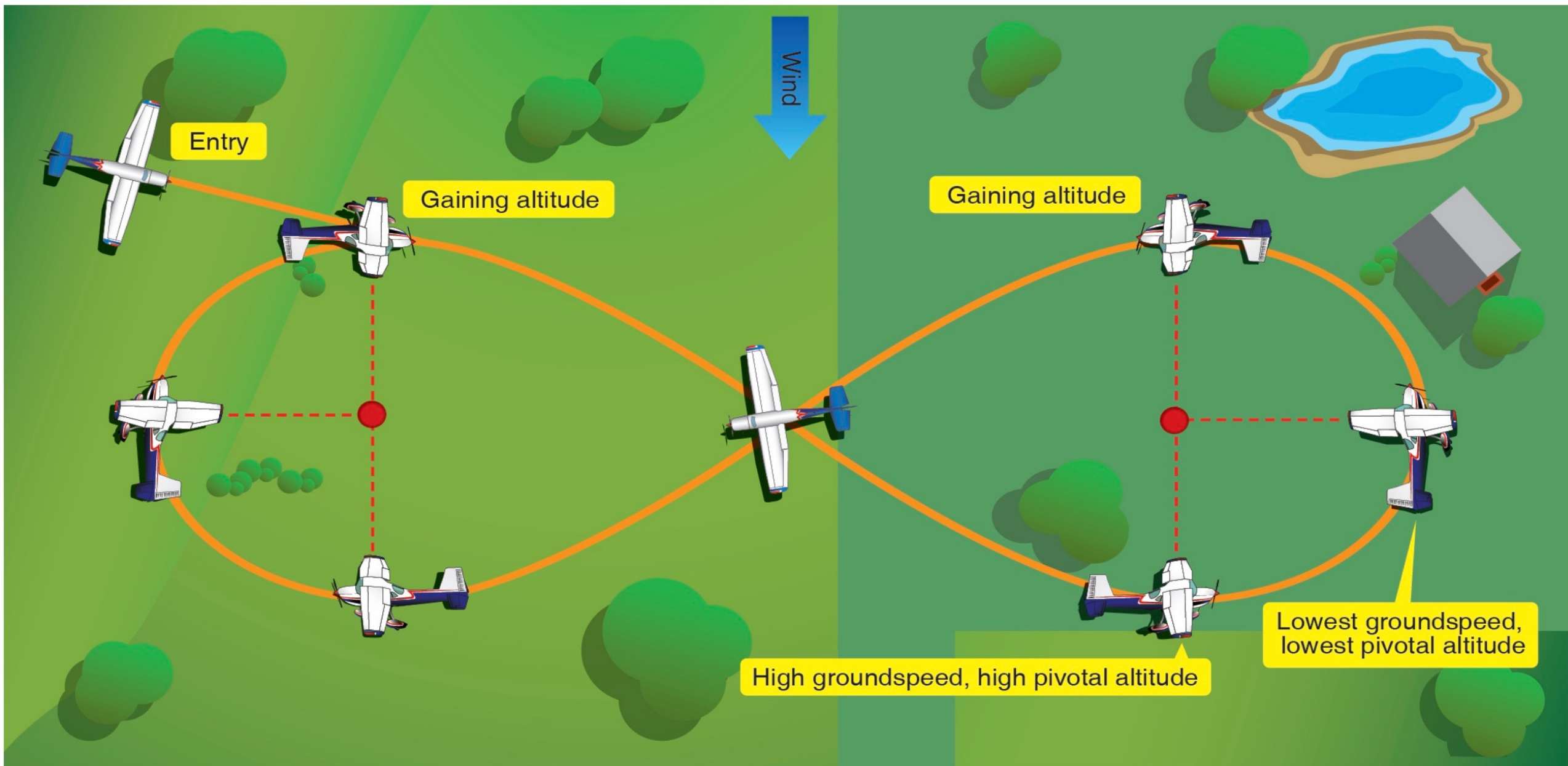
- The pivotal altitude changes with variations in groundspeed
- Groundspeed will *increase* during the downwind leg
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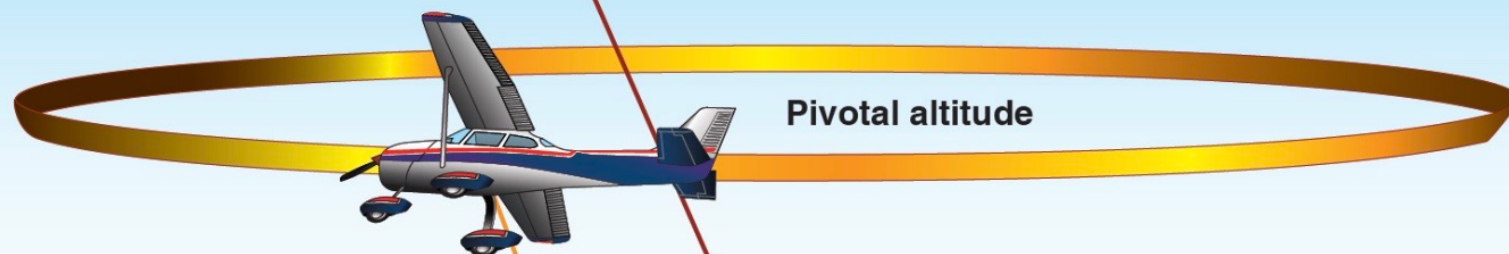
The upwind leg will decrease our groundspeed and thus decrease our pivotal altitude. We need to **descend**.

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Steps Overview

- Prepare for maneuvering (clearing turns, communication, etc.)
- Pick two pylons about “3-5 seconds” of straight and level flight apart and the same elevation (AFH)
- Establish and maintain 105-110 MPH (approx. 2200 RPM) and pivotal altitude
- Enter the maneuver on a 45° to the downwind between the two points
- Abeam the first point, roll into about 30° of bank placing the first pylon below the wingtip
- Keep the point under the wingtip, the reference line should appear to pivot on the pylon
 - If the point moves forward, push forward and descend
 - If the point moves backwards, pull up and climb
- The pylon should appear stationary throughout the turn
- After a complete turn, fly for 3-5 seconds in level flight
- Perform the second turn
- Depart the maneuver on the entry heading and complete the checklists







Tips

- If the pylon is getting ahead of you, “speed up” to it by losing altitude
- If the pylon is getting behind you, “slow down” by gaining altitude
- Remember the tale as old as time: PITCH FOR AIRSPEED
- Let the pylons determine the altitude, don’t be attached to your math
- Do NOT manipulate the pylon position with rudder
- Try to keep a constant angle of bank
- Avoid overcontrolling or overcorrecting
 - Review the math, a 20 MPH (~20 kt) difference in groundspeed only equates to a 300’ change in pivotal altitude; corrections are small

Common Errors (from AFH)

- Failure to adequately clear the surrounding area for safety hazards, initially and throughout the maneuver.
- Skidding or slipping in turns (whether trying to hold the pylon with rudder or not).
- Excessive gain or loss of altitude. (It's easy to lose the pylons this way)
- Poor choice of pylons.
- Not entering the pylon turns into the wind.
- Failure to assume a heading when flying between pylons that will compensate sufficiently for drift.
- Failure to time the bank so that the turn entry is completed with the pylon in position.
- Abrupt control usage. (we shouldn't feel any Gs)
- **The most common error in attempting to hold a pylon is incorrect use of the rudder**

Completion Standards (per ACS)

- Clear the area.
- Determine the approximate pivotal altitude
- Select suitable pylons that will permit straight-and-level flight between the pylons.
- Enter the maneuver in the correct direction and position using an appropriate altitude and airspeed.
- Establish the correct bank angle for the conditions, not to exceed 40°.
- Apply smooth and continuous corrections so that the line-of-sight reference line remains on the pylon.
- Divide attention between accurate, coordinated airplane control and outside visual references.
- Maintain pylon position using appropriate pivotal altitude, avoiding slips and skids.

Questions?