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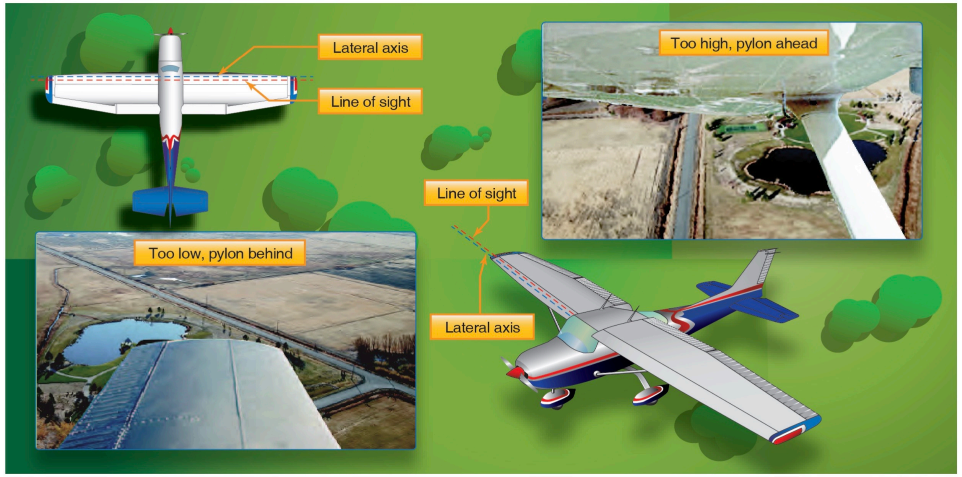
Eights on Pylons

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



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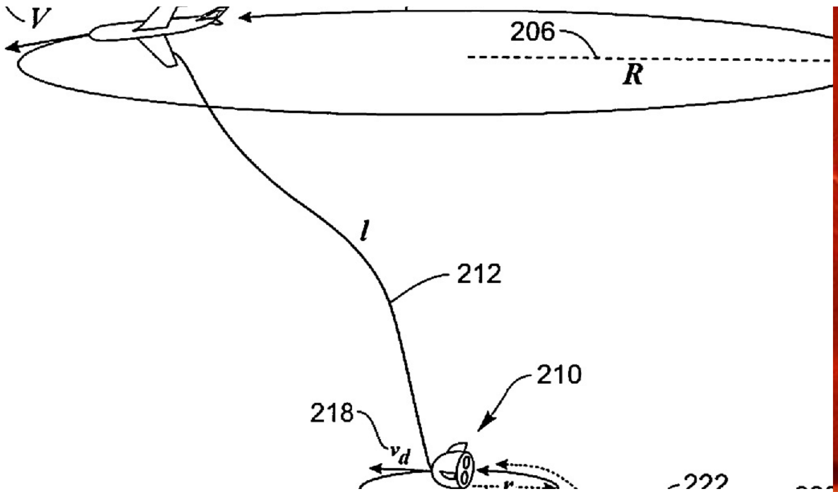
Origin

- 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

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Objectives

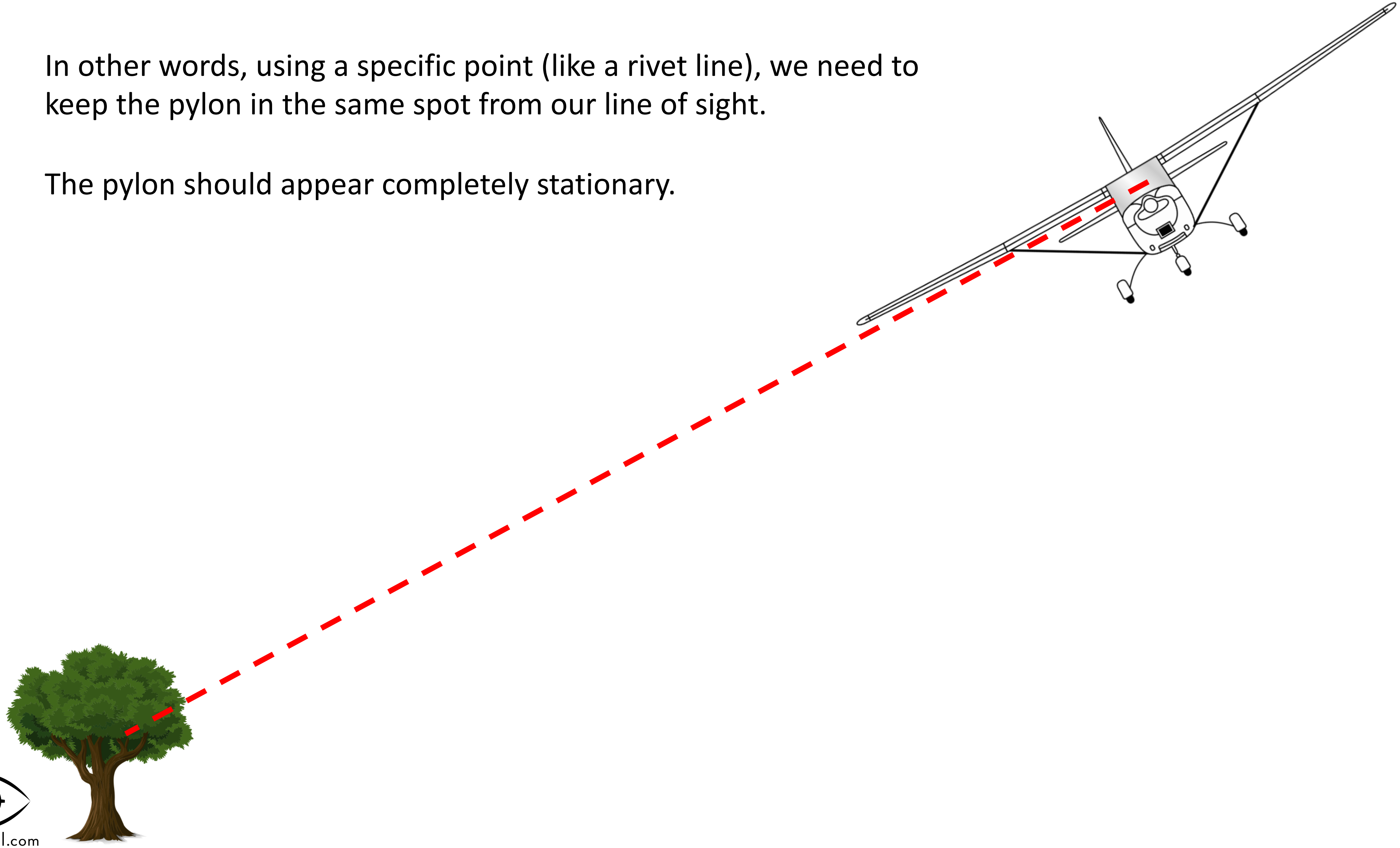
- Purpose: “developing intuitive control of the airplane” (AFH 7-10)
- Develop the ability to maneuver the airplane accurately while dividing attention between the flight path and selected references
- Demonstrate how wind affects the path and speed of the airplane over the ground
- Gain experience in 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)
- Determined by the airplane's groundspeed
- Goal is to maintain *lateral orientation* to a specific spot on the ground

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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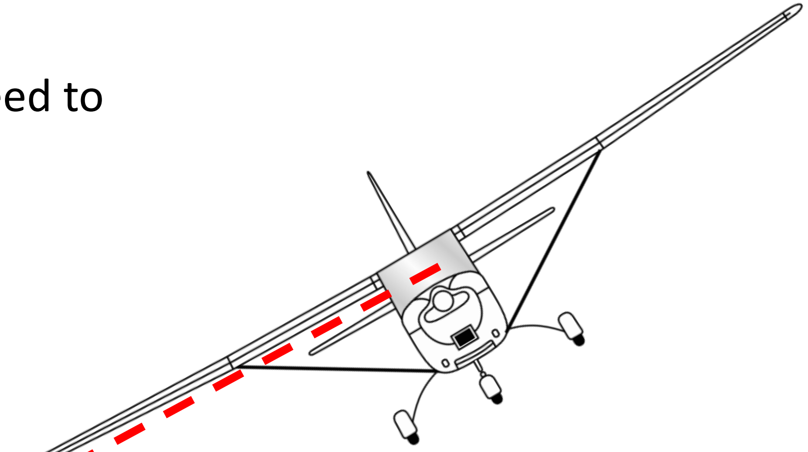

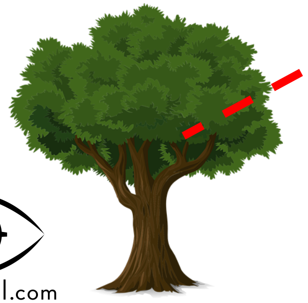

Pick a very specific reference on the wing.

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

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Where does this come from?

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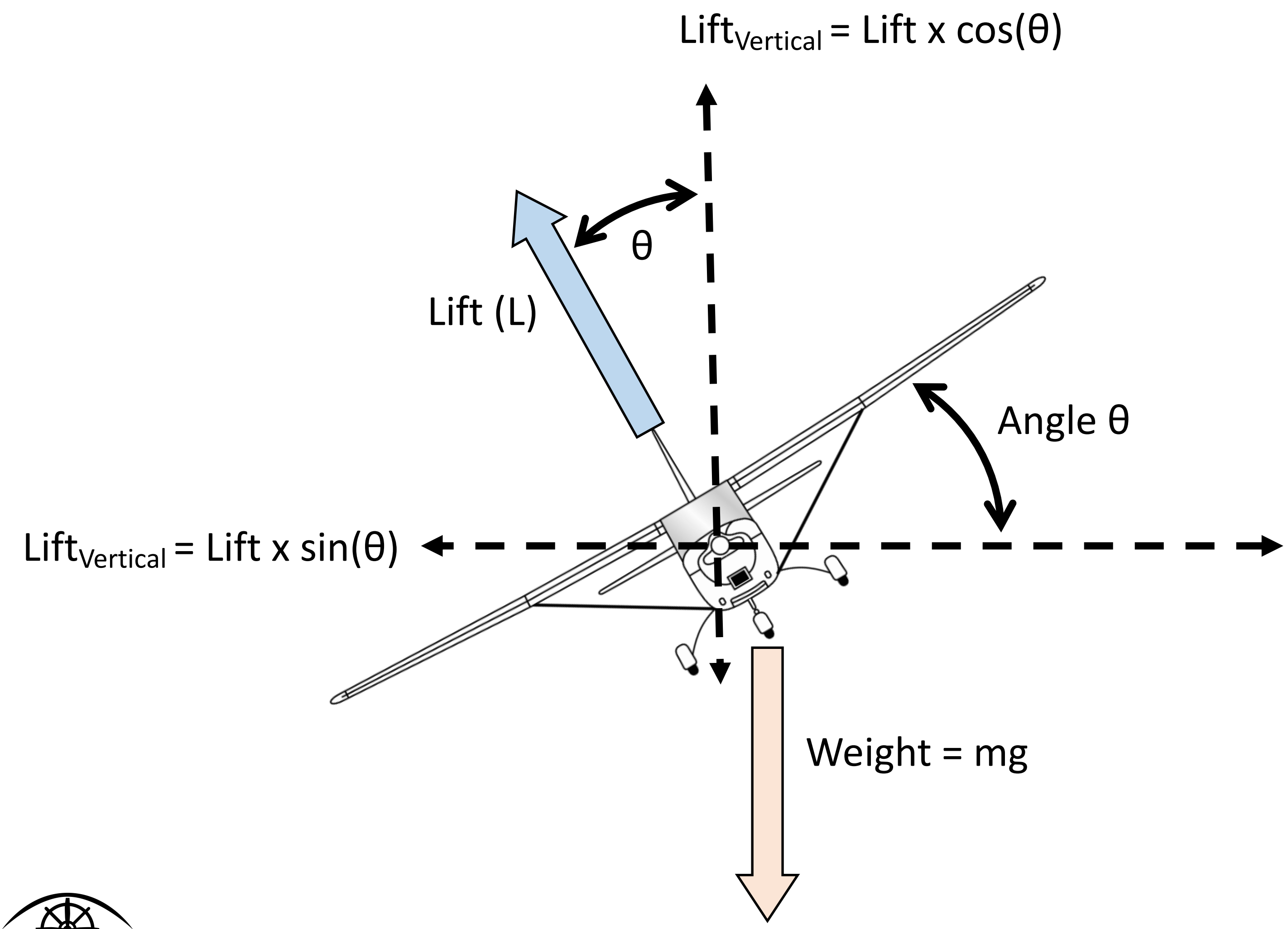
Origin of the Equation (for those interested)



Vertical Force = 0

$$L\cos\theta = mg$$

Horizontal Force = m x $a_{centripetal}$

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

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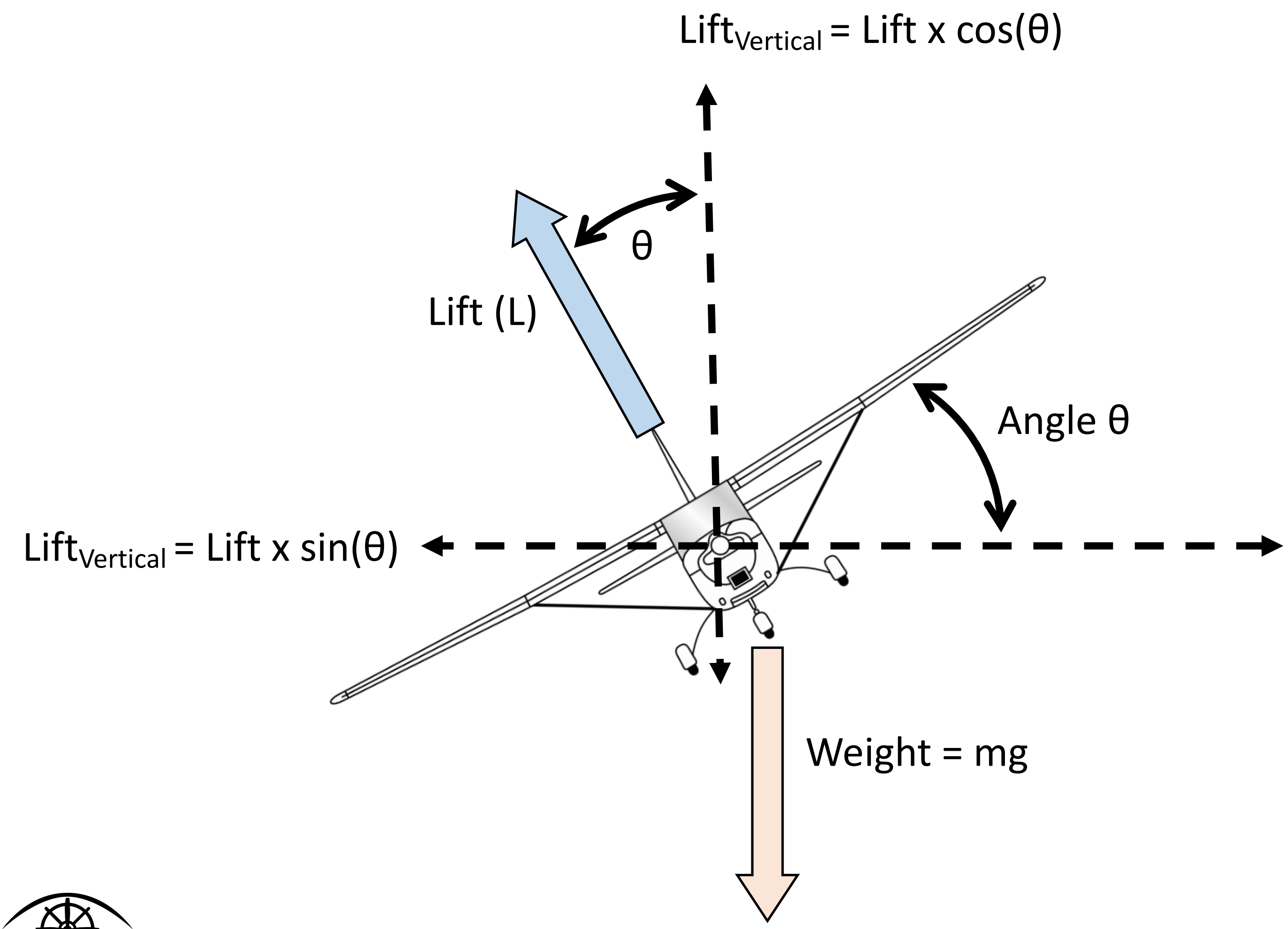

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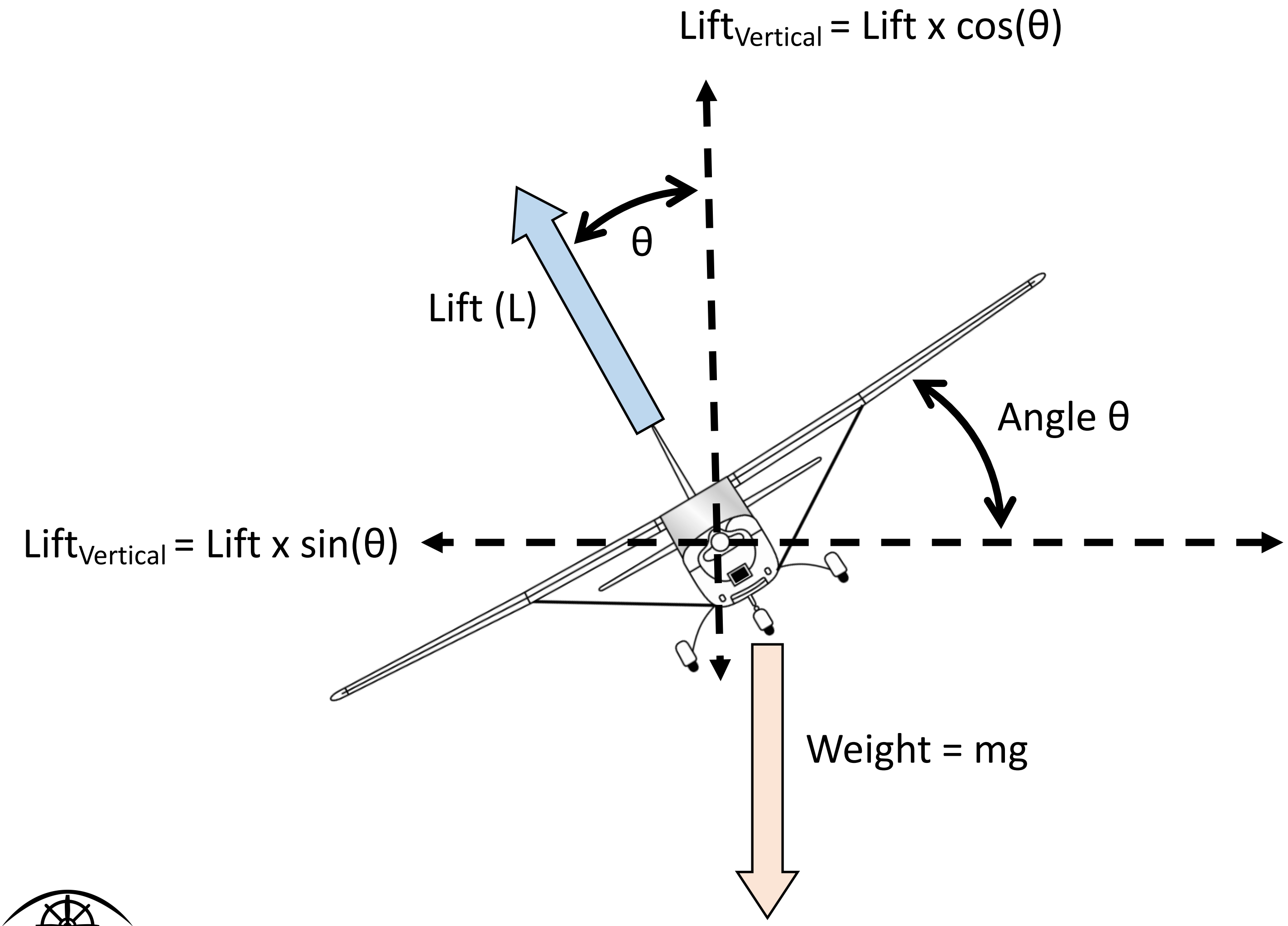

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Mass cancels, same physics for a 152 and 747

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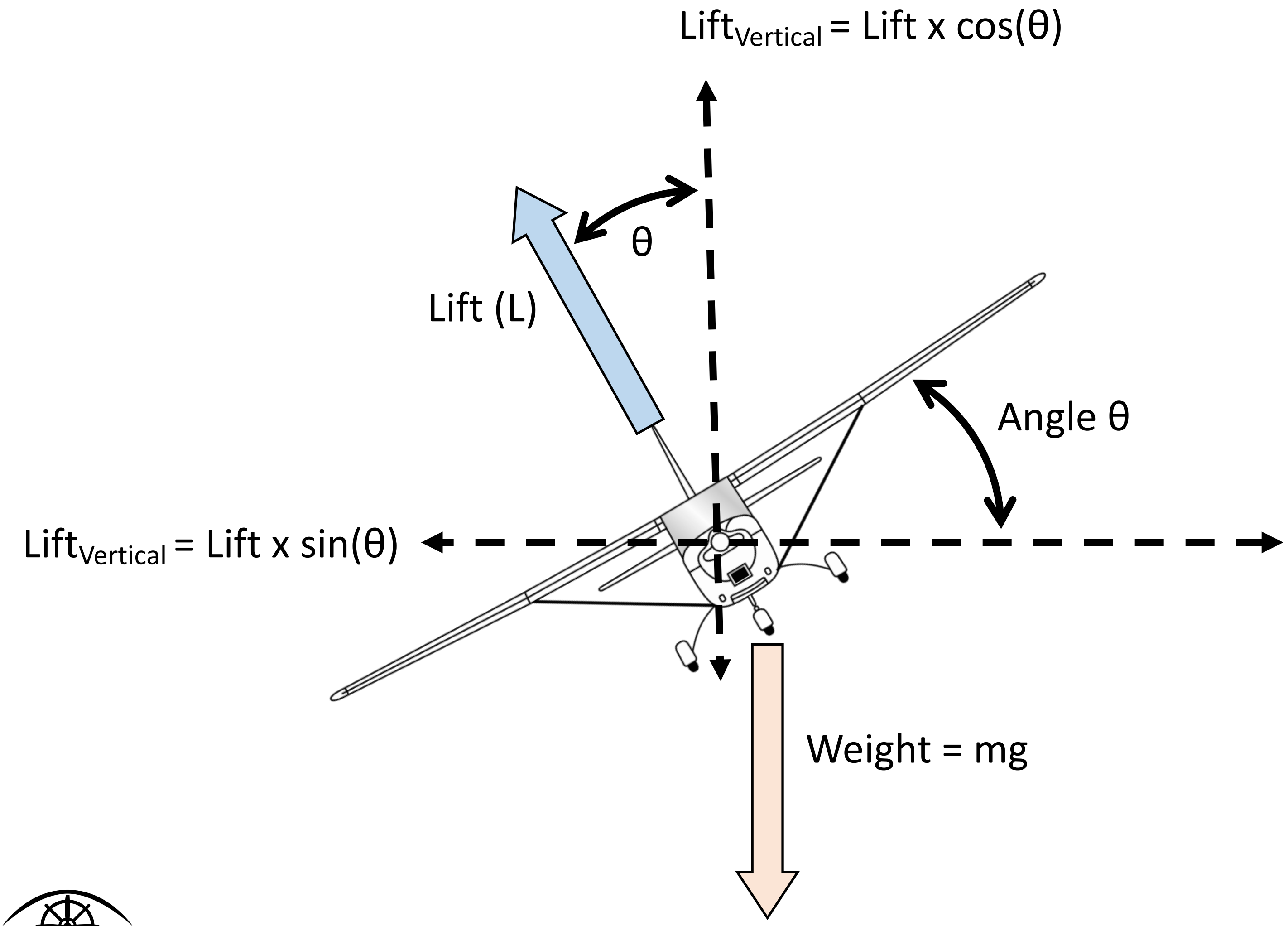

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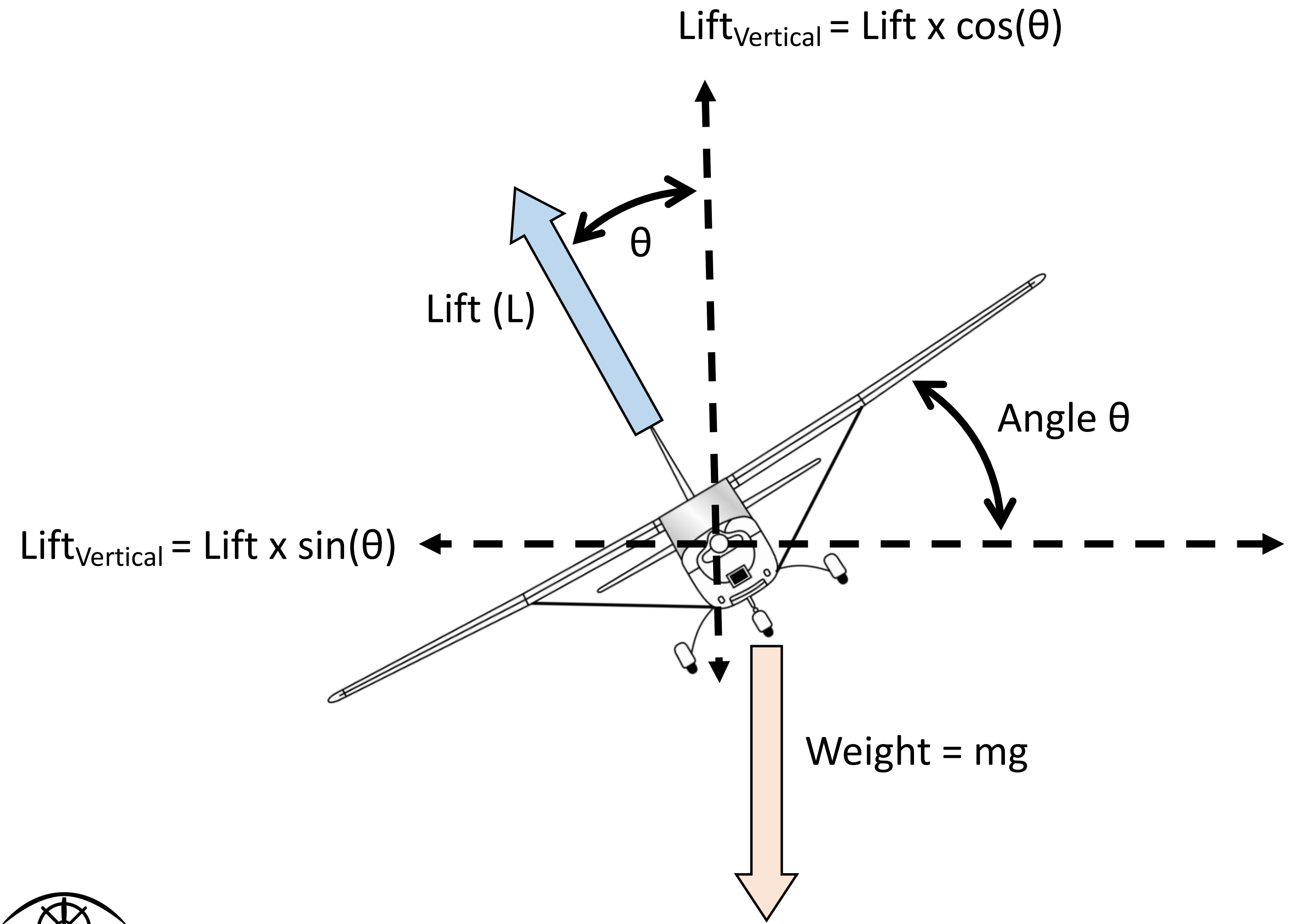

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The relationship here between V and r is why slower airspeeds result in smaller radius turns.

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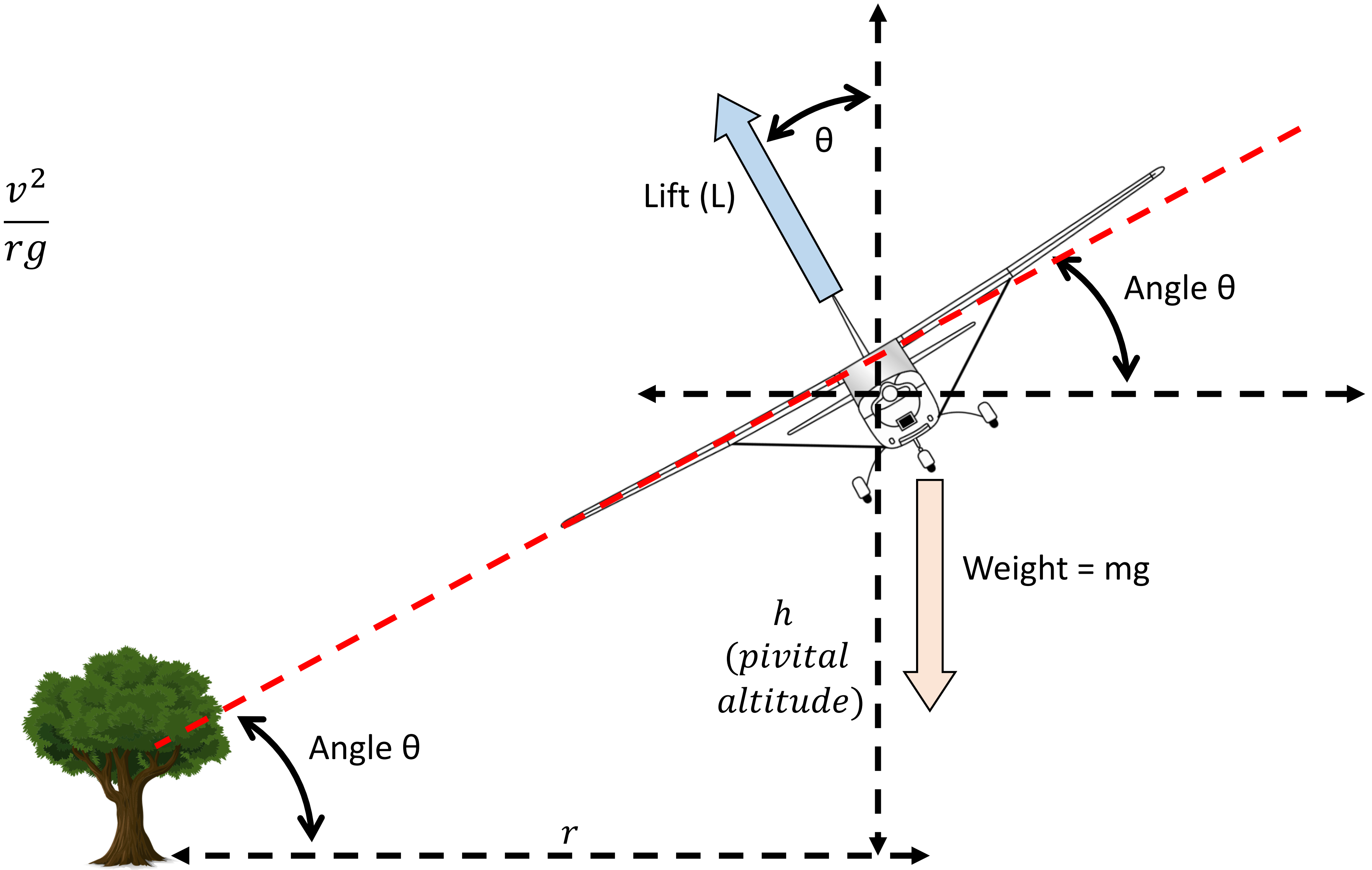
Origin of the Equation (for those interested)

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



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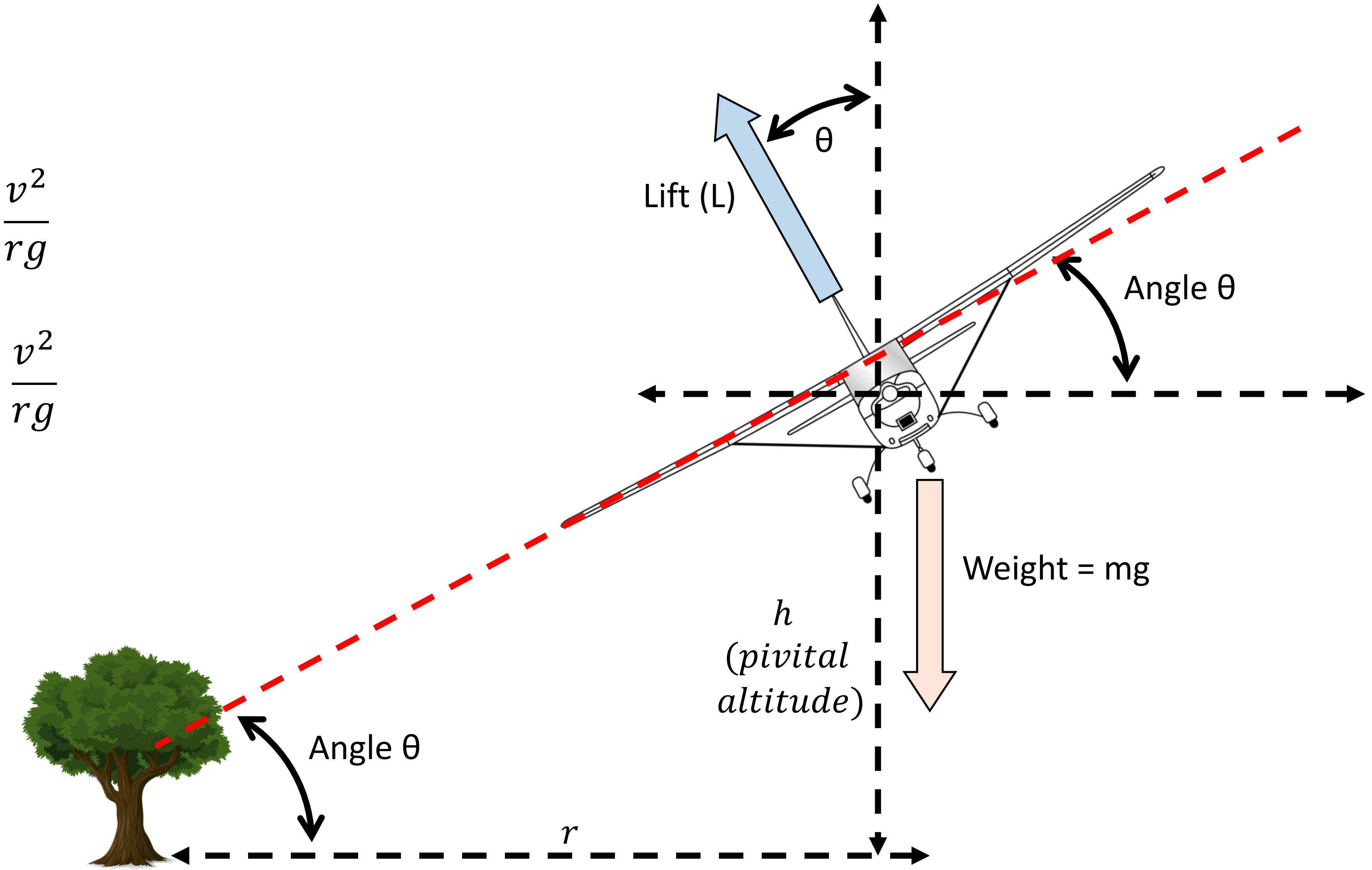
Origin of the Equation (for those interested)

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

$$\tan\theta = \frac{h}{r} = \frac{v^2}{rg}$$



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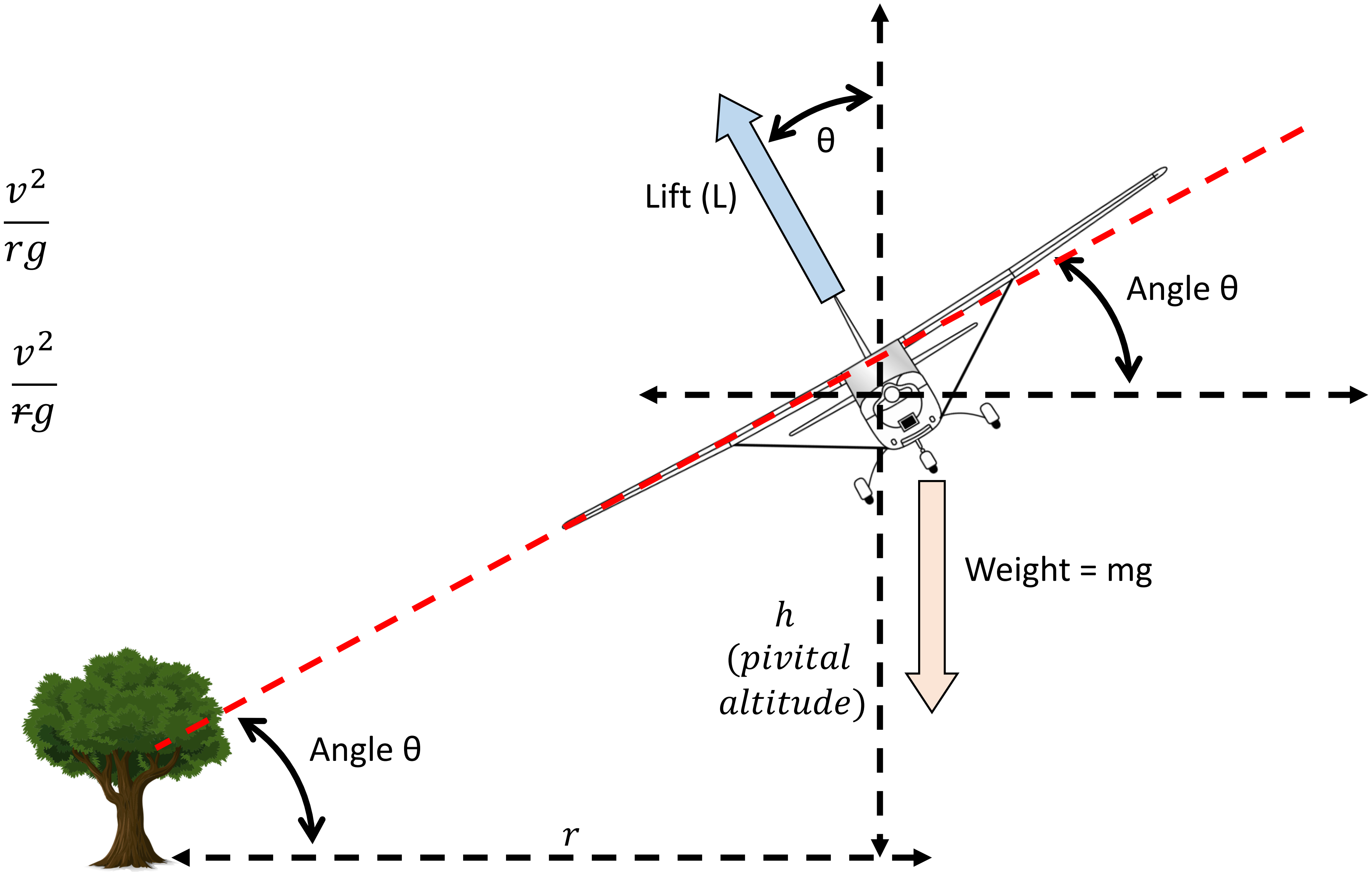
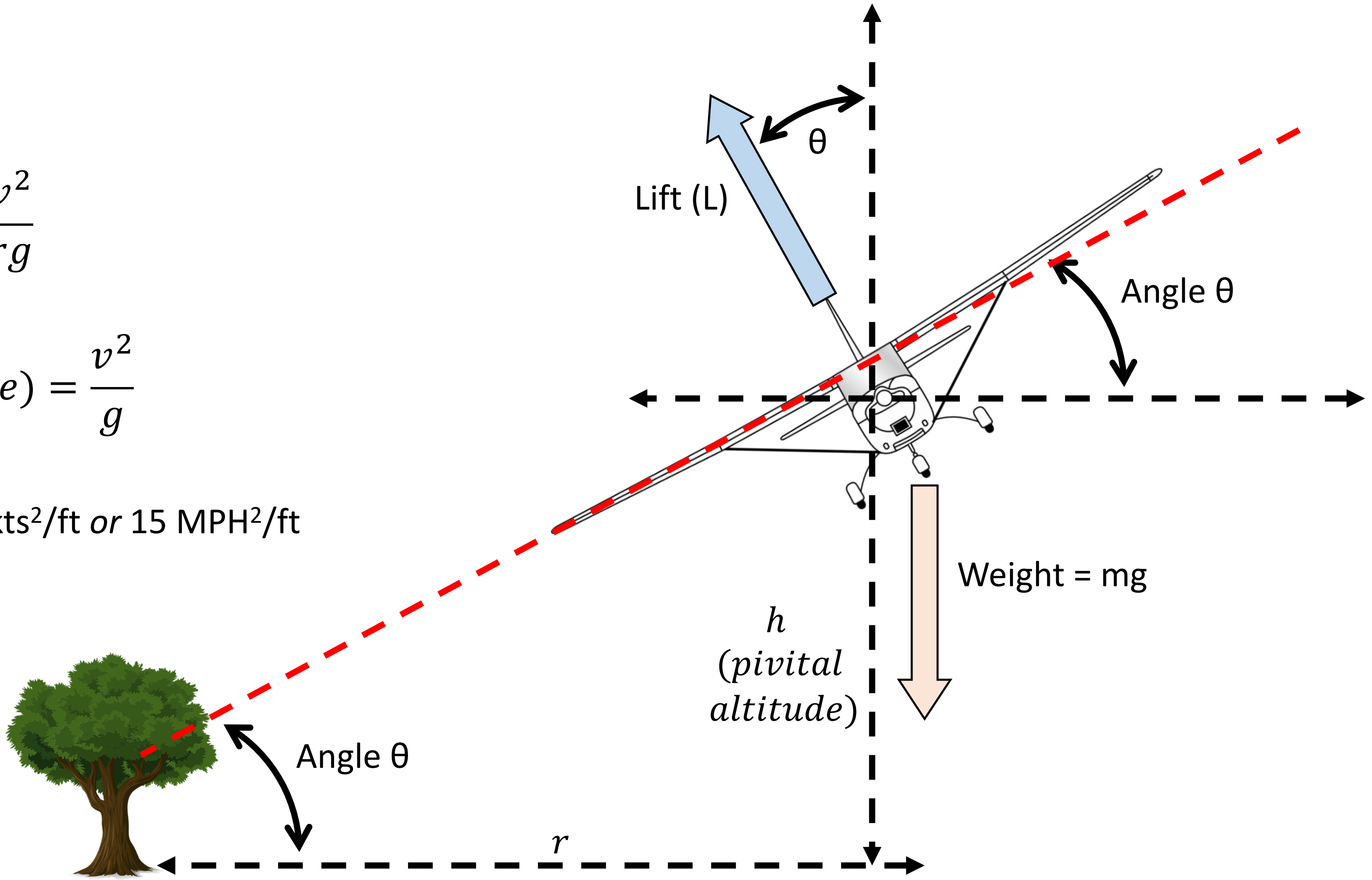


Origin of the Equation (for those interested)

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

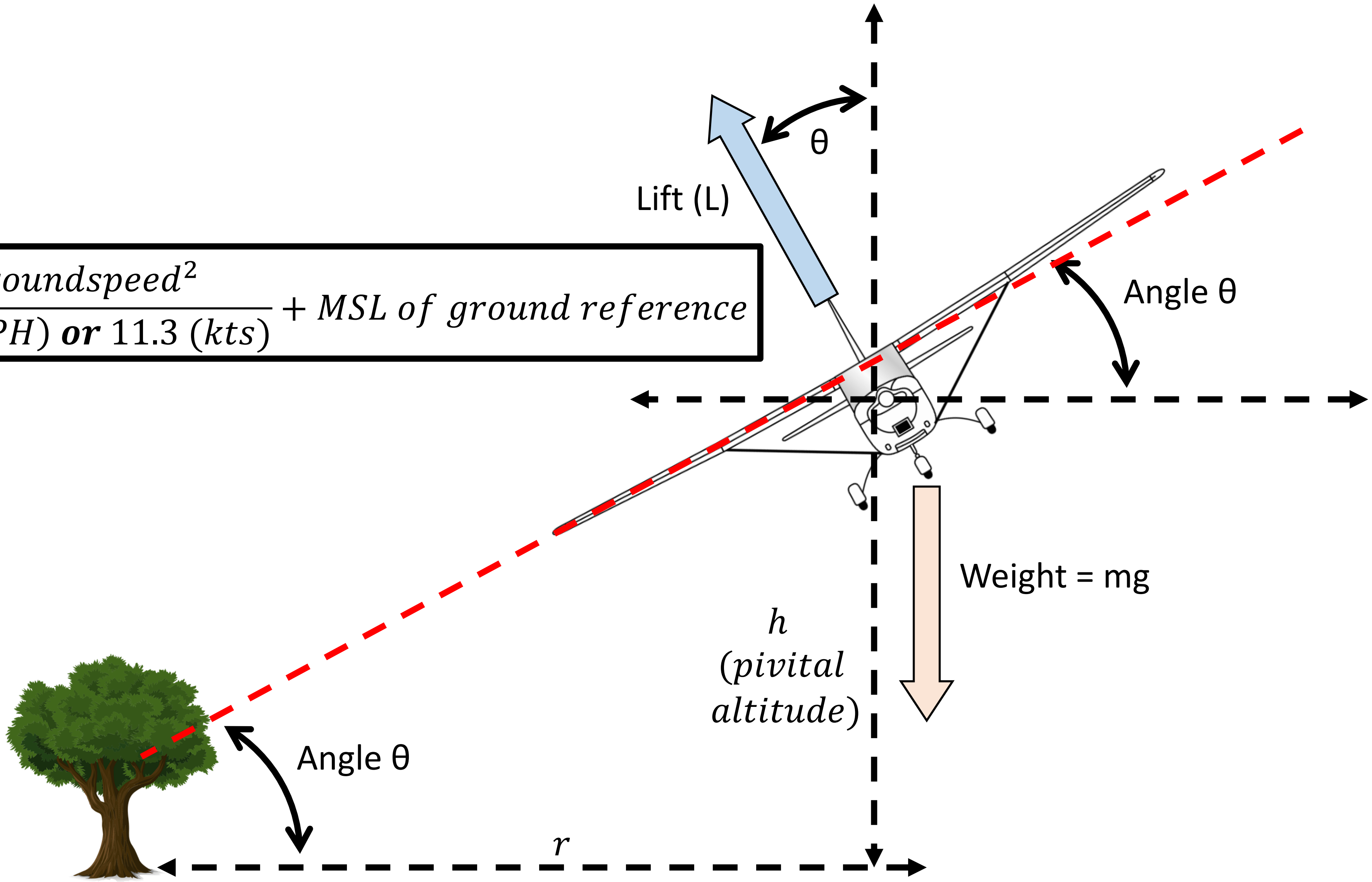
$$h(pivotal\ altitude) = \frac{v^2}{g}$$

Recall g = 9.8 m/s^2 *or* 11.3 kts^2/ft *or* 15 MPH^2/ft



Origin of the Equation (for those interested)

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



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

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.

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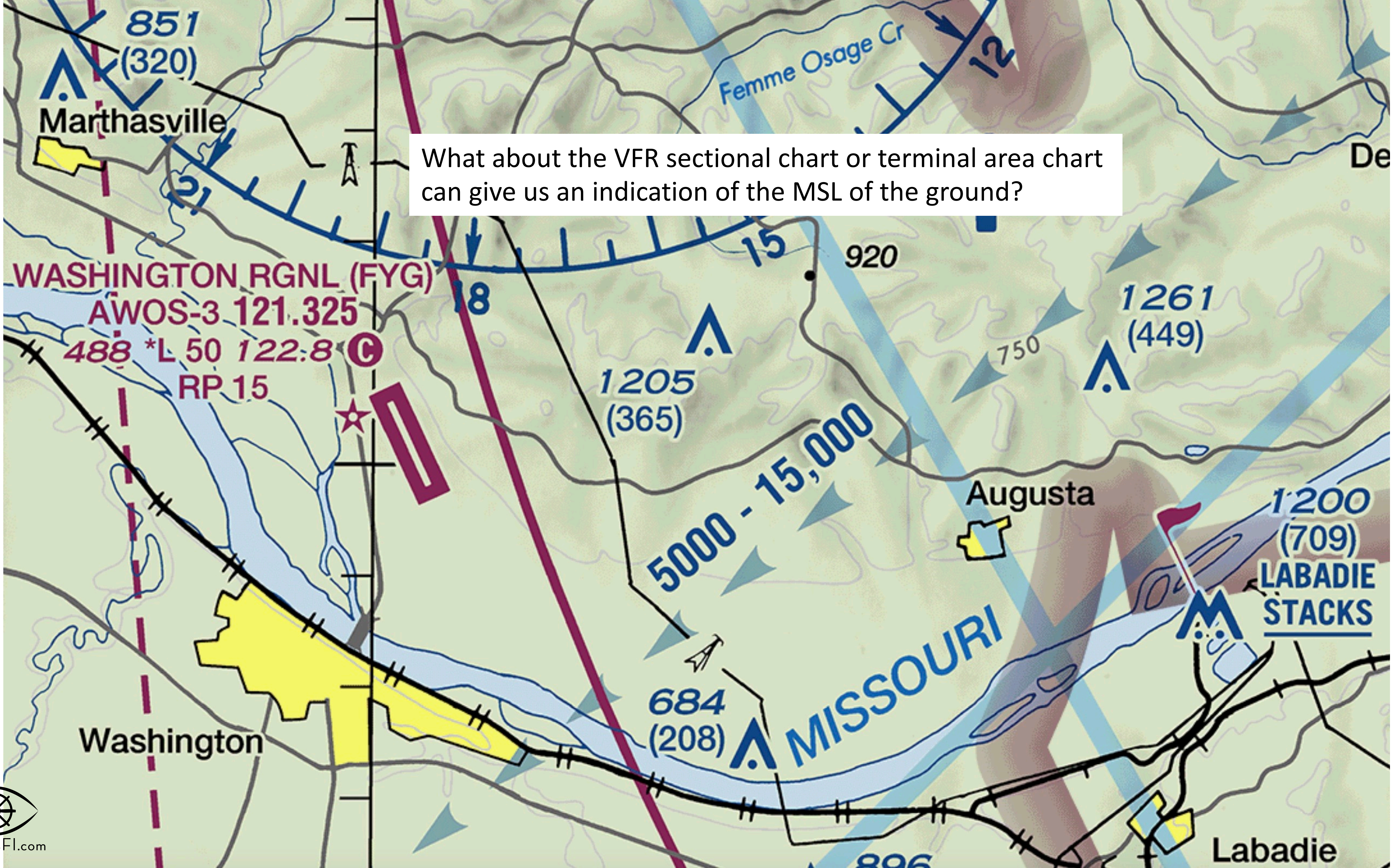
What about the VFR sectional chart or terminal area chart can give us an indication of the MSL of the ground?



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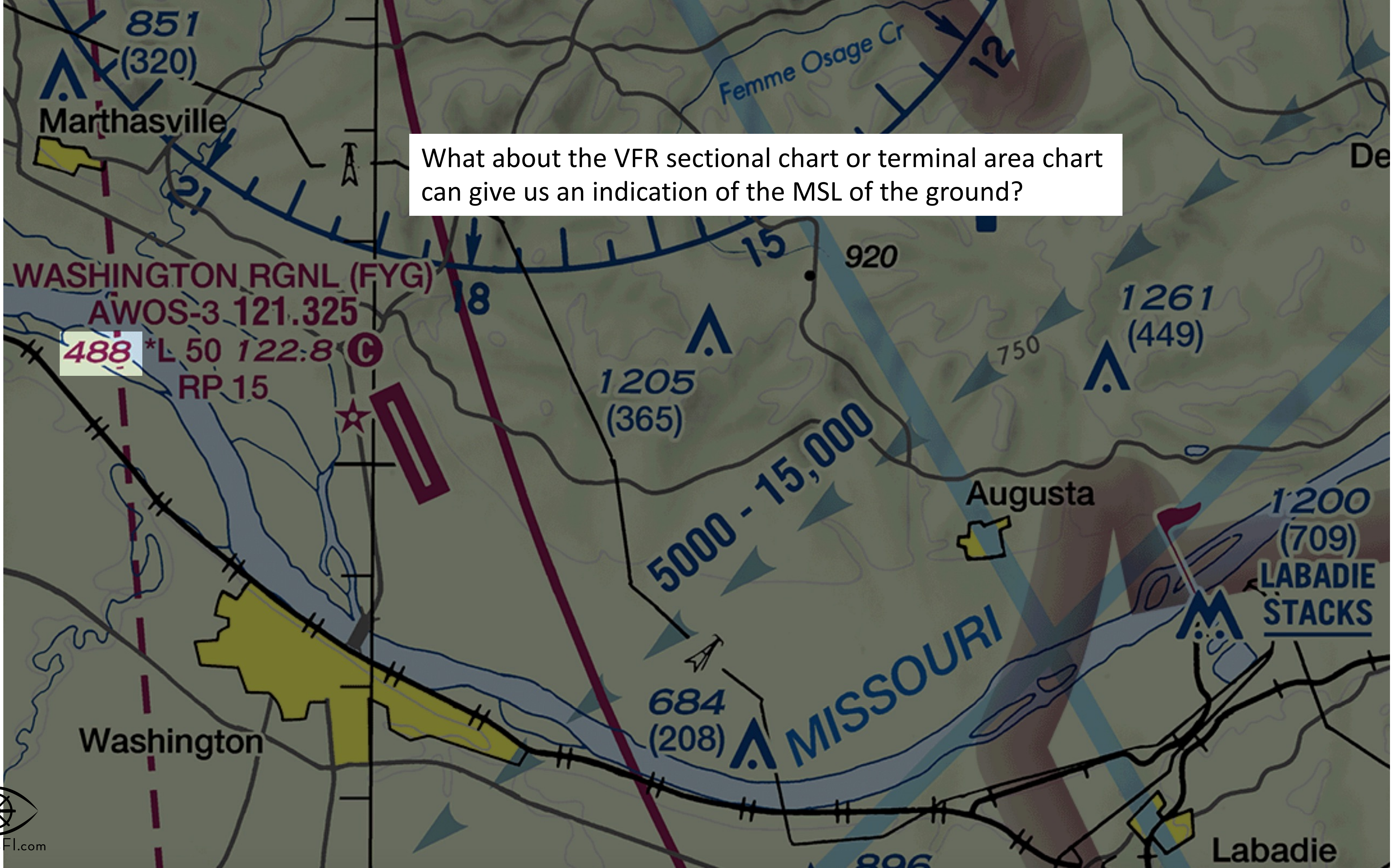

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- Equations:
  - $Pivotal\ Altitude = \frac{\sim 110^2}{15\ (MPH)} + \sim 500'$

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Let’s do some math!

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Let's do some *more* math!

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NICE!

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- Equations:
  - $Pivotal\ Altitude = \sim\mathbf{1,300}$

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

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- Goal is to maintain *lateral orientation* to a specific spot on the ground
- Equations:
  - $(our)\ Pivotal\ Altitude = {\sim}\mathbf{1,300}$
- **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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How does this affect things?

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If this is our starting speed…

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

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- **Most Importantly:**
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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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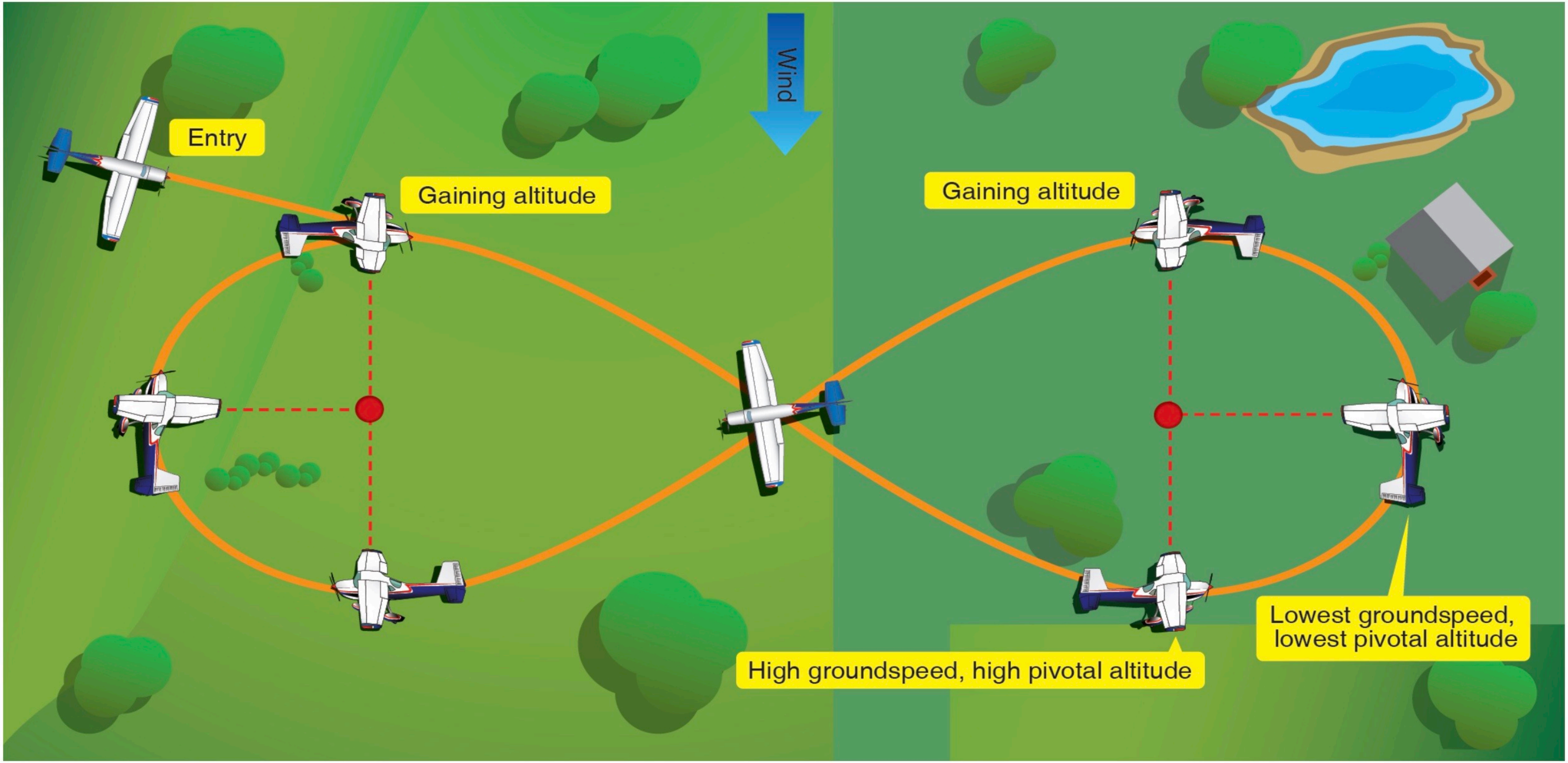
Steps Overview

- 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



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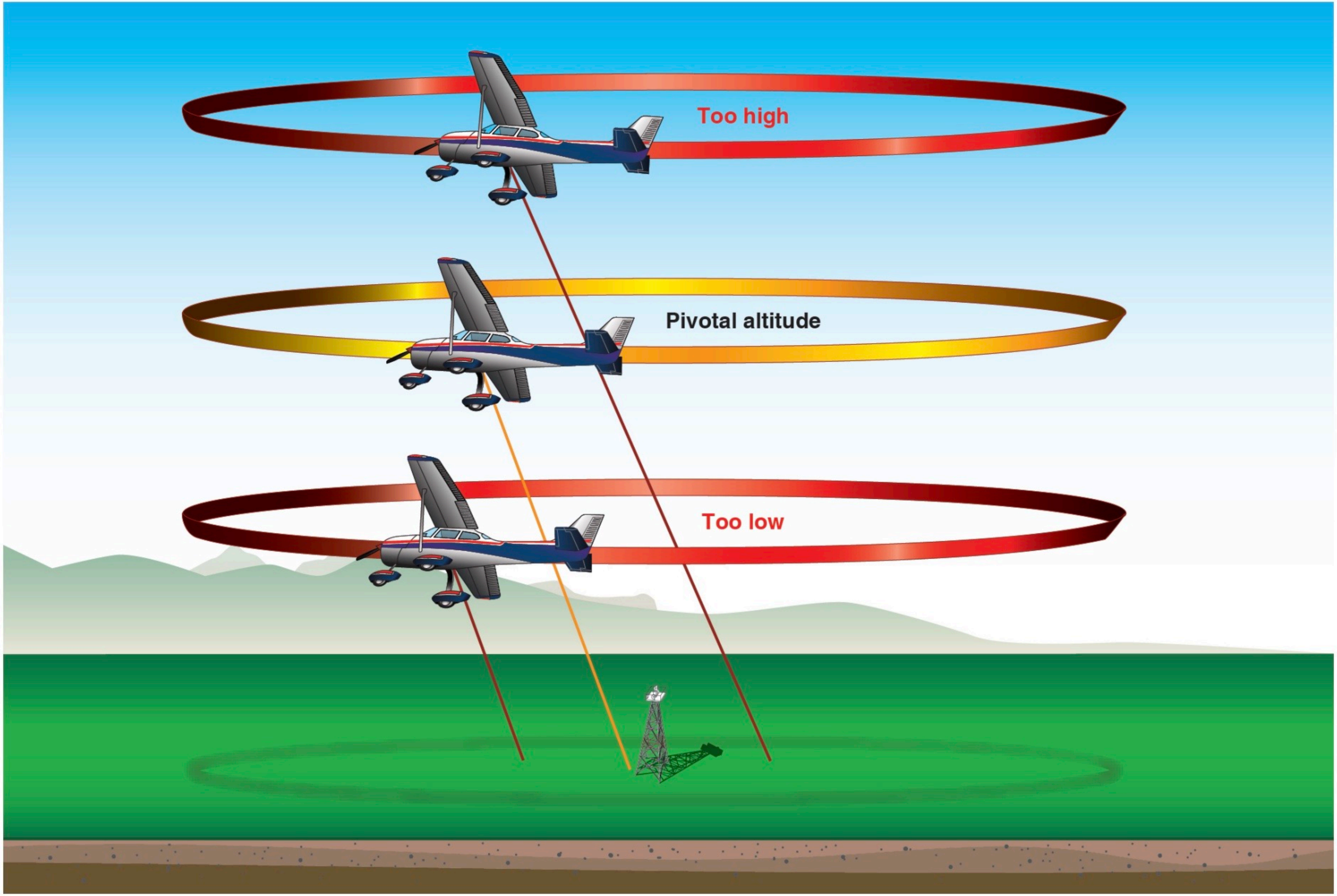
Too high
Pivotal altitude
Too low


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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?