This book was written in 1995. A lot has changed since then. But the basic principles of flying haven't. With GPS there are fewer if any paper charts, VOR flights, DME arcs, non-electronic E6C's, and NDBs. There is less of a need for manual flight planning. But I have left these topics in because you may have to fall back on less sophisticated technogies when the circuits or batteries fail.

I. KEY PRINCIPLES

Early in my training my flight instructor often told me, "The airplane knows how to fly. *You* don't know how to fly." I thought that he was criticizing my undeveloped stick and rudder skills. I inferred that he meant that I do not know how to fly *yet*. I assumed that soon during my training I would learn how to fly. It wasn't until a few years later that I realized what he was talking about. What he was saying was, "The airplane knows how to fly, but you will *never* know how to fly." He did not mean that I was a terrible candidate for flight training. What he was saying was that I could flap my arms until I'm exhausted. I could jump off of retaining walls - or high buildings if I dared. *But I would never know how to fly!* A pilot does not fly! The airplane flies.

First key principle of being a pilot

The airplane knows how to fly.
The pilot merely ***guides*** *the airplane.*

This is the first key principle in learning how to "fly." The airplane "knows" how to level its wings, keep its nose from going too high or too low, how to recover from a stall, and even how to take off. This is all due to the inherent stability of the airplane. The airplane design engineers and the FAA assure that this is so. You — the pilot — merely guide the airplane along by making small, gentle corrections when it deviates from your desired plan.

What about landing, you might ask. Surely an airplane doesn't "know" how to land. But landing is merely approaching the runway at the correct airspeed and flying an inch off the ground at the proper pitch attitude. If you guide the airplane to the desired airspeed and pitch attitude, the airplane will land itself. It takes training and practice to learn how to guide the airplane to the desired configuration an inch off the ground. But once there, the airplane *will* land itself.

How to guide the airplane leads us to the second key principle in being a good, smooth pilot.

The second key principle

Apply control ***pressures*** *not control* ***movements****.*

If you can see the yoke move forward or backwards, or see it turn, then you are overcontrolling. All control inputs should be so subtle and gentle that the control yoke does not appear to move. To achieve this, always maneuver the airplane as if your passengers have a full cup of hot coffee in their hands — *don't spill the coffee!*

When you are a beginning student pilot you are exhausted after an hour flying lesson. You have a death-grip on the controls. Your muscles are tense. During your one hour lesson you try to teach the airplane what to do. This is fruitless for one reason: the airplane already knows how to fly, and it is impossible to teach it anything more. When I first learned how to fly, I thought I was having a heart attack because after every lesson my left arm suffered a dull ache. Then I realized that I was grabbing the yoke with my left hand much too tightly. When I learned to relax my grip, the "heart attacks" disappeared and my flying improved, too.

When you learn to relax your grip on the controls, even let go most of the time, only then will you get the feel of the airplane. This should be taught and emphasized on the ground.

In this book, I will still refer to it as "learning to fly" with the understanding that it should be called "learning to guide" or "learning to be a pilot."

2. FLIGHT INSTRUCTION

WHERE TO TEACH FLYING

Flight instruction should not be done in an airplane! What? Where else could you possibly do flight instruction other than an airplane? The answer is simple: flight *instruction* is done on the ground. What is done in the airplane is *practice*.

flight instruction should only be done on the ground

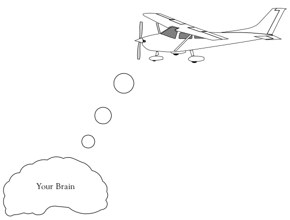
A training airplane is the worst possible place to teach anything. It is noisy, cramped, too hot or too cold, and uncomfortable. You are so tense and preoccupied with "flying" that you hear very little of what your instructor is saying. Because the instructor is constantly distracted looking for traffic, he cannot devote 100 percent of his time to you.

The best place to teach anything about learning to be a pilot is on the ground, in a quiet, comfortable environment such as classroom or cockpit of an airplane parked on the ramp. Both the instructor and you can focus on the tasks at hand — teaching and learning. You can best hear everything your instructor has to say, and the instructor can focus on your needs, questions, and body language. Once your instructor has given you a preflight lesson on the ground, then you are prepared to get into the airplane to practice what was taught in the classroom. In the classroom you have been taught the material, you just don't yet know how to apply it. You now need practice — in the airplane.

Some flight schools pressure their instructors to get the student into the airplane and keep the airplanes flying. This produces revenue. But the better schools realize the importance of teaching on the ground, and practicing in the air.

THE MENTAL AIRPLANE

Another concept that you and your instructor should understand is the power of the mind to process and learn while doing unrelated tasks. Your flight instructor may recognize the phenomenon without understanding what is going on. During a particular lesson you can't do anything right. You're a complete klutz. But at the very next the lesson you perform almost flawlessly. Your instructor accuses you of getting some extra flight instruction on the side, which you vehemently and truthfully deny.



What happened? As you learn, your brain makes new chemical and electrical connections. But this does not happen instantly. It happens over a period of days. While you eat, sleep, and maybe even watch television, your brain is processing what has recently occurred. And if you merely think about a physical task, you can learn that task without repetitively performing it.

Instructors can take advantage of this phenomenon. Perhaps you are becoming frustrated during the practice of a new maneuver. On the ground after the flight, your instructor tells you to think about the maneuver, to do it perfectly in your head, to think about what it feels like to do it correctly. Fly the "mental" airplane. As an incentive, realize that it is much less costly than dual—it's free!

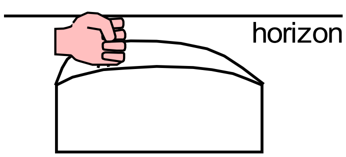
Wait a few days before the next lesson to let the neurological connections form inside your brain. You will be amazed at how much better you will perform during the next practice flight. Don't laugh. This works.

FIST ON THE GLARESHIELD

Before you can run, you have to learn to crawl and then walk. Flying is no different. Before you can takeoff, fly to another airport, and land you must learn the basics. You must learn the correct pitch attitude for level flight, for climbs and for descents.

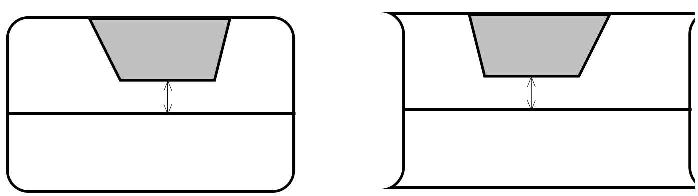
How do you recognize the correct pitch? By learning the sight pictures. What does the world look like out of the window. This is crucial to learning to be a pilot. Where is the horizon and where should it be? For most light trainers you can use the fist on the glareshield method. Trim the airplane for level flight and place your closed fist on top of the glareshield directly in front of you. The horizon will be on top of your fist. This will be about four inches up from the top of the glareshield. Depending on your particular height and seat adjustment, the location of the horizon may be up to one finger-width above or below your fist, but it should be consistent once you establish the correct view for yourself. Make sure you visualize and memorize this "sight" picture. Don't hesitate to use a pillow on your seat to raise your upper torso. Even some tall people have long legs but a short upper body.

place a closed fist on top of the glareshield



After a while you will not have to place your fist on the glareshield, but will be able to imagine your fist on the glareshield. But use your fist as often as you need to until you're comfortable.

Then look out the left and right windows at the wings and the horizon. In the example shown here for a high wing airplane notice that the distance from the wingtip to the horizon is the same for both wings.



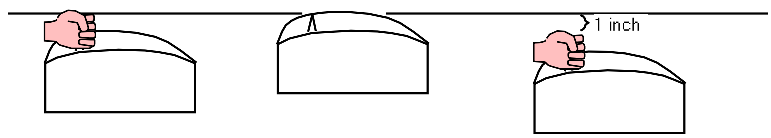
left window   right window

If both wings are the same height above the horizon, the airplane is not banked and will not turn. And as a cross check to the fist on the glareshield method, check that the flat, bottom surface of each wing is parallel to the horizon. This is another sight picture, confirming level pitch attitude. If there is an angle between the wing and horizon, the pitch is not correct for level flight.

For practice, the instructor should place the airplane in various attitudes and have you return to straight and level by these sight pictures.

CLIMBS AND DESCENTS

Once you master straight and level flight by these simple sight pictures, you are ready to learn climbs and descents using the same techniques. For a climb, the sight picture should place the glareshield about even with the horizon. And for a descent, there should be about an inch gap between the fist and the horizon.



straight and level climb descent

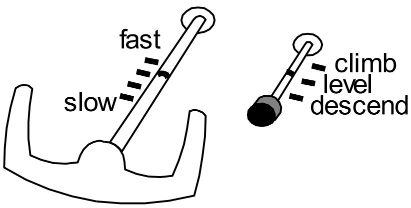
PITCH AND POWER ➔ PERFORMANCE

Pitch and power control airspeed and rate of climb/descent. But which controls which? There are differing opinions on this. However, in the long run, when pitch or power is changed, and airspeed and climb rate have reached steady values, we find

Pitch controls airspeed. Power controls climb

- *pitch controls airspeed and*
- *power controls rate of climb/descent.*

It would be possible to mark the shafts of the yoke and throttle to indicate the settings for various speeds on the yoke and for climb, level and descent on the throttle.



Any configuration change requires both a pitch and a power change. And any change of either pitch or power will result in both an airspeed and an altitude change. It is tempting to treat the control input that exhibits the most immediate effect, or least side effect, as the primary control for that performance factor. But you should consider what the final effect will be, not what the "quick results" suggest.

If you are a student pilot you might want to skip this next section, but if you are a flight instructor or experienced pilot, you should read it.

EXPLANATION

Here are observations and justifications for the statement "pitch controls airspeed and power controls rate of climb/descent.."

1. Rate of climb is proportional to excess horsepower (HP).

In fact, Rate of Climb (FPM) = $\frac{33,000 \cdot \text{excess HP}}{\text{weight}}$. The airplane needs excess horsepower to climb. Without it, the airplane cannot climb.

Rate of climb is proportional to excess horsepower. Pitch controls angle of attack, which controls airspeed.

2. Pitch controls angle of attack, which controls airspeed.

Pitch is the angle of attack control. The airplane wants to maintain a constant angle of attack for any given elevator setting. If something disturbs this angle of attack such as an abrupt change in airspeed, the airplane will respond to the change to return to the original angle of attack and original airspeed.

The lift equation can be simplified to $L \approx AofA \cdot V^2$. Lift is proportional to angle of attack ($AofA$) and airspeed (V) squared. In level flight, or steady climb or descent, lift must equal weight, which is, of course, constant. Therefore $AofA \cdot V^2$ is constant. An increase in V must result in a decrease in $AofA$, and vice versa.

Hence pitch controls angle of attack, and angle of attack controls airspeed, therefore pitch controls airspeed.

3. *Consider an airplane in a glide due to engine failure. It has no throttle control and therefore has no up/down control. It is only going down.*

A glider (or airplane gliding) has no horsepower and cannot climb in calm air. You can get a transient climb by ballooning, but the steady-state condition will be a descent.

4. *Consider an airplane in a 60 knot approach to landing. The tower says, "32 Bravo, go around." What do you do? Apply* throttle!

The throttle will convert the 60 knot glide to a 60 knot climb. You would not even consider doing the go around with the elevator alone. You may have to adjust the elevator trim to maintain 60 knots, but elevator alone would not convert a 60 knot glide to a 60 knot climb.

5. *You are on final approach, but are too slow - 50 knots. To speed up to 60 knots, lower the nose. Results: increased airspeed. Pitch controls airspeed.*

Okay, if you are too fast - 80 knots - up elevator will cause a balloon as well as a speed reduction, but that is because you are converting excess kinetic energy into potential energy. To reduce the *side-effect* of ballooning, you must reduce the power to avoid the transient climb.

6. *You are in level cruise. If you reduce the power, you will descend and maintain about the same airspeed.*

Let's say that you are overtaking traffic in the pattern. You can slow down much quicker by hauling back on the elevator than by reducing the throttle. Sure, you will gain altitude, but that is a side effect. What slowed you down - quickly - was the increased induced drag caused by the increased angle of attack. You control the transient ballooning by a temporary power reduction.

Let's try slowing down by reducing the power alone (and ignore downwash on the tail, which complicates things). Decreased thrust will result in a slight deceleration - *initially*! (There's that word again!) The slightly reduced airspeed will result in a loss of lift and the airplane will begin to sink. The relative wind is now coming from below and the airplane will nose down a bit into the relative wind. There will now be a component of weight along the longitudinal axis, compensating for the decreased thrust. The airplane will adjust its attitude to restore the original angle of attack (remember, we didn't touch the elevator or trim, so it wants to weathervane into the relative wind as before and restore the original angle of attack). If the component of weight along the longitudinal axis is the same as the initial thrust reduction, the original airspeed will be restored because the final lift and drag will be the same. And the airplane will descend.

7. *During the initial climb after takeoff, your airspeed is too high. You will raise the nose, not reduce the power.*

You would never consider using power reduction during the initial climb to control airspeed.

There is no such thing as "reverse command."

8. *There is no such thing as "reverse command."*

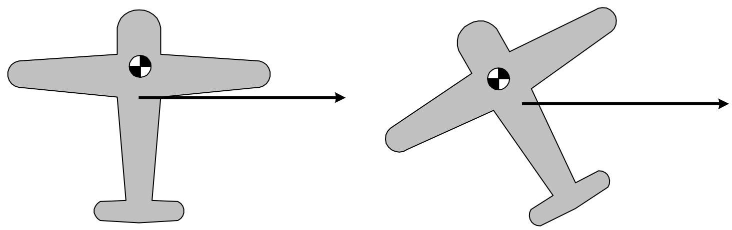
The pitch and power controls do not reverse their roles on the "backside" of the power curve. Hence you have to learn only one rule for any flight condition, namely, in the *steady state*,

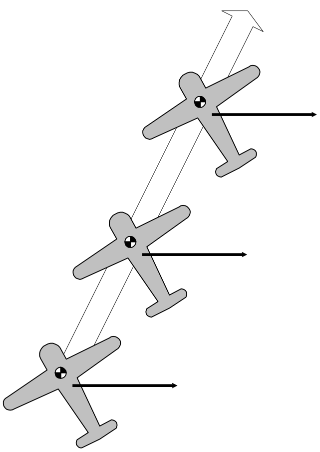
- pitch (more accurately, elevator) controls airspeed
- power controls altitude.

Transients must be kept in check by the other control until steady state conditions return.

WHY DOES AN AIRPLANE TURN?

Many authors, and the FAA, have the answer to this all wrong. The literature says that the *horizontal component of lift* causes an airplane to turn. This is not true. It cannot be true. Here is why: the center of gravity is in front of the center of lift. When you bank the airplane to the right, for example, the horizontal component of lift, behind the center of gravity, will "tug" on the airplane and try to yaw the airplane to the *left*, not the right.

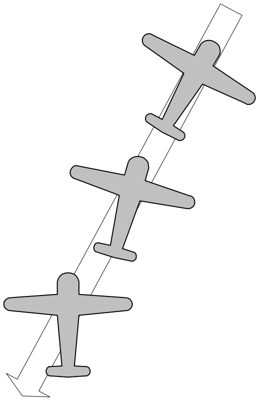




The horizontal component of lift would then slide the airplane to the right while yawing it to the left Clearly, the horizontal component of lift cannot be what turns an airplane.

(Do not confuse the yawing to the left in this example with adverse aileron yaw, which also causes a left yawing tendency, but only while the ailerons are deployed to bank the airplane. Once the airplane is in a bank and the ailerons are neutralized, there is no longer any adverse aileron yaw. We will discuss this in the next section on the rudder.)

So what does turn the airplane?



The vertical stabilizer weathervanes the airplane into the relative wind.

In the diagram on the left once the airplane is banked it starts moving towards the northeast. The relative wind is now coming from that direction, from the direction of the white arrow. The relative wind hits the vertical stabilizer on the right side, and will yaw the airplane into the relative wind. The relative wind turned the airplane.

WHAT'S THE RUDDER FOR?

The rudder is a temporary trim device to overcome the imperfections in the airplane design.

Most people unfamiliar with airplanes think the rudder steers the airplane. Pilot know this isn't true. But some pilots don't seem to know what it's used for, either. At least they fail to use it during turns or climbs. There are pilots that will tell you to use the rudder to center the ball on the skid-slip indicator, without understanding why.

The rudder is a temporary trim device to overcome the imperfections in the airplane design.

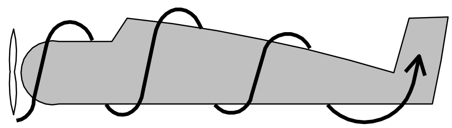
A perfect airplane does not need a rudder. The Airecoupe was close to perfect in certain aspects and had no rudder. But it wasn't a very fast or efficient airplane. As the designers improved airplane performance, compromises from "perfection" had to made, and the rudder is just one compromise component.

Torque

Torque is the name given to the left-turning tendency of an airplane during climb or minimum controllable airspeed (MCA). Torque is caused primarily by three phenomena that are not a factor during straight and level cruise. They are:

- Spiraling slipstream,
- Engine torque, and
- P-factor.

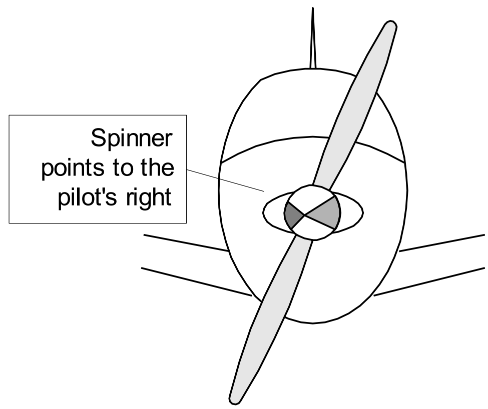
Spiraling slipstream: The clockwise-turning propeller (as seen by the pilot in an American built airplane) engulfs the airplane in a spiraling horizontal tornado, called the slipstream. This slipstream tends to impact the left side of the vertical stabilizer more than the right, thereby pushing the nose to the left.



During climb and MCA, this slipstream is tighter and more concentrated and impinges on the vertical stabilizer even more. This is why we have to apply right rudder during climbs and slow flight.

The entire engine is mounted on the airplane at an angle to compensate for torque

So why don't we have to apply right rudder all the time, since the spiraling slipstream is always occurring? The airplane designers felt it was poor design to force the pilot to apply right rudder all the time, so they made "corrections" to the design to compensate for the constant left-turning tendency. Look straight into the propeller spinner of a Beechcraft Bonanza parked on the ramp. The spinner is not pointing straight ahead! It is aimed somewhat to the right side of the airplane. The entire engine is mounted on the airplane at an angle to compensate for torque. In some other airplanes the vertical stabilizer is mounted at an angle to provide the compensation.



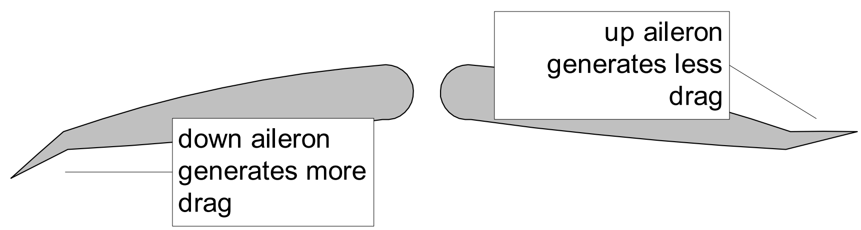
Engine torque: Propeller torque is the tendency of the airplane to want to roll to the left because the propeller is turning to the right. The air is offering some resistance to the turning propeller. Imagine an extreme case of Superman grabbing and stopping the spinning propeller. The airplane would simply begin rolling counterclockwise (as seen by the pilot) about the propeller's spin axis. The air resistance offers a milder case of "propeller grabbing," but the effect is similar, though less dramatic. Again, the design compensations described earlier for the spiraling slipstream are also effective here.

P-factor: (don't confuse this with the physiological result of drinking too much coffee before a flight!) P-factor occurs during climb or nose up attitude where the relative wind is coming from below rather than from straight ahead. P-factor is caused by the down-going propeller blade on the right side of the airplane having a larger angle of attack than the up-going blade on the left. There is more thrust from the right side of the propeller "disk" than the left side, and the airplane tends to be pulled to the left. During straight and level cruise, the P-factor disappears, unlike spiraling slipstream and torque, which are always present, just less so during cruise.

Adverse Aileron Yaw

Every time you apply aileron, you must apply rudder on the same side. I am talking about coordinated turns and banks. I am not referring to intentional slips for losing altitude, sight-seeing, or compensating for a crosswind.

When an airplane banks, the aileron on the rising wing is down, causing more drag than the opposite wing's up aileron. This drag yaws the airplane toward the lifting wing, causing the nose to move in the opposite direction of the roll.



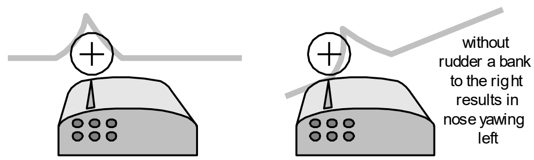
Every time you apply aileron to bank or unbank the airplane you must apply rudder in the same direction..

The result is a coordinated turn. So what if it is not coordinated? A coordinated turn means the relative wind is coming from straight ahead. Both wings are being subjected to the same, symmetrical airflow. The airplane is not skidding nor slipping, you don't feel you are being thrown to one side of the airplane, and your coffee won't spill from the cup!

"DUTCH" ROLLS

The best way to practice aileron-rudder coordination is by doing coordination maneuvers, or sometimes erroneously called "Dutch rolls." (A Dutch roll is an inherent instability of an airplane, where it spontaneously and constantly oscillates in roll and yaw.)

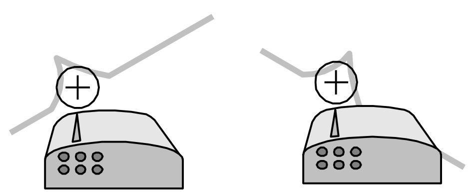
Begin by picking a target on the horizon. Imagine a gun sight on your windshield aimed at this target. Now quickly roll the airplane into a 30° right bank and watch what the nose of the airplane does. It yaws to the left — in the opposite direction of the bank!



Rolling back to wings level, the airplane will yaw to the right.

Next apply aggressive rudder in the direction of the bank. Pretend you are a gunner and must keep the gunsight on the target at all times. With a little practice, you will keep the nose locked onto the target.

Alternate right and left banks, keeping the nose glued to the target. You can practice this for a minute or two during every flight. In climbs or MCA (minimum controllable airspeed), the adverse yaw is magnified and you will



discover that almost full rudder may be required to keep the nose on the target. Caution - don’t do this with passengers - it tends to make them sick, especially if you aren’t very good at it.

3. LANDING

When you're a student pilot you are in a hurry to solo. You want to get in the pattern and do touch and go's. This is a big mistake because landing requires a number of skills that must be mastered before trying to maneuver close to the ground. If these skills are not learned, you will become frustrated. It will take longer to learn to land by staying in the hectic traffic pattern than by acquiring the prerequisite skills in the practice area, far removed from the pattern.

Before trying to land you must have mastered the following skills:

- basic attitude flying, trimming
- airspeed control, MCA
- stalls
- dealing with torque
- managing adverse yaw
- ground reference maneuvers
- wind drift correction.

If you try to learn to land without mastering these fundamentals you will likely fail. Look at the list above and try to imagine landing an airplane without knowing just one item.

Let's examine each of these fundamental skills.

BASIC ATTITUDE FLYING, TRIMMING

The four basics are straight and level, climbs, descents, and turns. These skills are best learned using sight pictures as described in chapter 2. Once you memorize these sight pictures you will learn how to put the airplane in the correct attitude and then trim.

The word "trim" means to cut away, as in trim away fat from a piece of meat. The trimming process is to trim away control pressures. This can only be learned by relaxing the grip on the control wheel or stick — for this discussion, we'll call it the stick. Using only the thumb and index finger on the stick, you can then feel the control pressures. With a tight, fist grip, you will have no pressure sensitivity at all. Remember, you are guiding the airplane, not flying it. Guiding requires only finger-tip pressures. The procedure is:

1. Using the thumb and index finger on the stick, put the airplane in the proper attitude
2. Trim away any pressures on the thumb and index finger
3. Repeat steps 1 and 2 as necessary.

Any change in attitude will result in a change in airspeed, which will change the airflow over the control surfaces, which will require retrimming.

Trimming is a process**, not an** event

*Trimming is a **process**, not an **event***

You may not realize that trimming is a process, not an event. You may think you are doing something wrong when you can't trim the airplane in one try. The process of trimming must be repeated three, four or even five times to reach a hands-off, perfectly trimmed condition.

Every time you make a configuration change such as from level to climb, climb to level, or level to descent recite the four point check list: **power, pitch, rudder, trim.**

- **power** - set the power for the configuration
- **pitch** - put the airplane in the proper pitch attitude using the elevator control
- **rudder** - apply right rudder in climbs, perhaps left rudder in descents, and
- **trim** - trim away any control pressures on the elevator control.

Repeat this check list as necessary until the airspeed and attitude remain constant.

For example, to transition to a climb -

- **power** - set full power
- **pitch** - put the nose on the horizon
- **rudder** - apply right rudder to prevent yawing
- **trim** - trim away any control pressures on the elevator control.

Repeat this as necessary until you can climb “hands-off.”

Another example, to level off from a climb -

- **power** - leave full power until cruise airspeed
- **pitch** - put the nose a fist below the horizon
- **rudder** - relax right rudder
- **trim** - trim away any control pressures on the elevator control.

Repeat this as necessary. When you reach cruise airspeed, reduce the power to cruise and repeat as necessary until you can remain level “hands-off.”

For a descent from level flight -

- **power** - reduce to descent power
- **pitch** - put the nose slightly lower than a fist below the horizon — you may need up elevator to do this
- **rudder** - slight left rudder
- **trim** - trim away any control pressures on the elevator control.

After a while, this procedure will come as second nature to you and you will not have to verbalize the checklist - **“power, pitch, rudder, trim.”** Just do it.

AIRSPEED CONTROL, MCA

Performance is the result of pitch and power. Performance is airspeed, and vertical movement (climbs, level flight, descent). In chapter 2 I discussed which causes which. For level flight, a specific power setting and pitch attitude will result in a singular airspeed. You should be able to fly at any airspeed the instructor requests from cruise down to MCA, and any in between.

STALLS

There are only two conditions under which you desire a light airplane to stall

There are only two conditions under which you desire a light airplane to stall during a non-training flight: during landing and in severe turbulence. In a light airplane the least stress is placed on the airplane if it is stalled a few inches off the runway. Mitigating the deleterious effects of turbulence is the reason for establishing V_a: below V_a the airplane will stall rather than overstress the airframe. You are taught stalls for a different, much more important reason: stall avoidance. Other than landing, you do not intentionally stall an airplane. But you should recognize the conditions that could lead to a fatal stall, namely on approach or departure, close to the ground. And in the event of an inadvertent stall above a hundred feet AGL, quick stall recovery procedure could save yourself.

Since landings should be full stall, or close to stall, stalls should be mastered before learning to land. Refer to a later chapter on learning about stalls.

DEALING WITH TORQUE

You should be able to recognize the need to apply right rudder during climbout without referring to the ball in the slip indicator. If the wings are level and no right rudder is applied, the airplane will slowly turn to the left. If you are not accustomed to applying right rudder, you will, incorrectly, stop the left turning tendency by lowering the right wing. This only aggravates the slip. The best way to learn to recognize the need for right rudder in the climbout is to cover the turn and slip indicator and stop the left turning tendency by application of rudder, while keeping the wings level with the ailerons.

Managing Adverse Yaw

Adverse aileron yaw was discussed in the previous chapter. You must be able to cope with adverse yaw, because in the pattern and during approach and landing, airspeed is lower and hence adverse yaw is much more prevalent. Any application of aileron at low speed causes the nose of the airplane to yaw significantly in the opposite direction of the bank.

Ground Reference Maneuvers

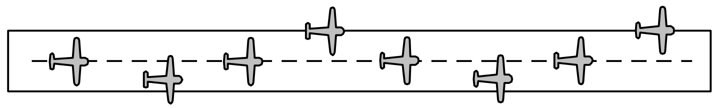
Flying the traffic pattern certainly qualifies as a ground reference maneuver: it is maneuvering close to the ground using only visual references. Ground reference maneuvers teach wind drift correction, altitude control, speed control, and track control. These are essential skills that must be mastered before you can be taught to land.

Wind Drift Correction

You must understand and master wind drift correction before learning to touch down. All landings involve some crosswind correction. It is a rare airport that does not have some crosswind at some time during the day. And even if the wind is completely calm or straight down the runway near the surface, it is likely to be different a few hundred feet above the runway.

The best way to teach wind drift correction is to perfect ground reference maneuvers away from the pattern in the practice area, and then do low approaches to the runway. First perfect altitude control by flying at a constant altitude above the runway, starting at fifty feet above the runway for early passes, gradually decreasing the altitude of each pass until you can skim the runway at one or two feet.

Next, control only the rudder pedals, while your instructor banks the airplane right and left. You should be able to keep the airplane's longitudinal axis parallel to the runway centerline, while the airplane drifts right and left across the centerline.



Then control both drift (ailerons) and straight (rudders). Finally skim down the centerline of the runway at one foot off the surface. You must control altitude (elevators), speed (power), drift (distance from the runway center line) and straightness (parallel to the runway). When, and only when, you can accomplish these are you ready to actually land.

CENTERED, STRAIGHT, SLOW, SMOOTH.

The four S's for a good landing. Okay, one S is really a C, but it sounds like an S.

Centered means two things - the airplane is on the centerline of the runway, and it is not drifting right or left. In other words, it is centered with no drift.

Straight means the longitudinal axis is parallel with the centerline of the runway.

Slow means $1.3 \cdot V_s$ during approach. Too much airspeed results in excessive float, and too little causes control difficulties and is too close to a stall and dangerous.

The three most important things in landing are airspeed, airspeed and airspeed.

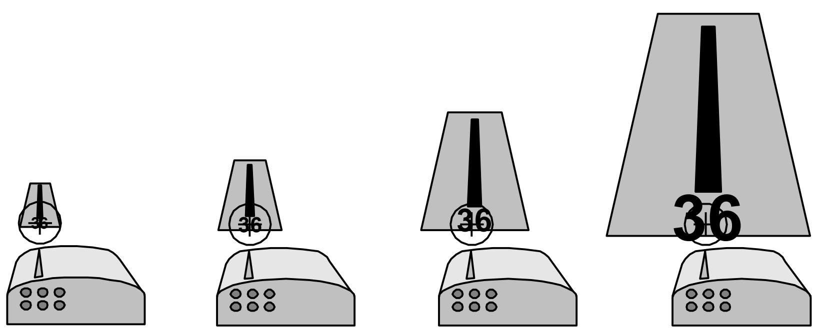
The three most important things in landing are
***airspeed**, **airspeed** and **airspeed**.*

Smooth is the least important of the four S's. Not every landing will be a greaser. What is important is being centered, straight and slow.

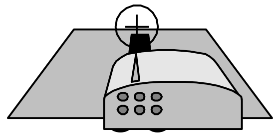
KAMIKAZE LANDINGS

Japanese kamikaze pilots were suicide bombers - the airplane was the bomb. All they had to do was keep the target centered in the windshield in front of them. This technique works for normal landings too, as long as you remember to forego the suicide finish.

If you had a gunsight on your windshield, or maybe just a smashed bug, directly in front of your eyes at horizon level during cruise, you could use this as a gunsight to make a kamikaze approach to the runway numbers. The goal is to keep the numbers on the same place on the windshield, where the gunsight is. The runway will grow in size as your approach it, but it will stay the same shape, and the numbers will be centered on your gun sight. Keep this sight picture until you begin your round out to level flight.

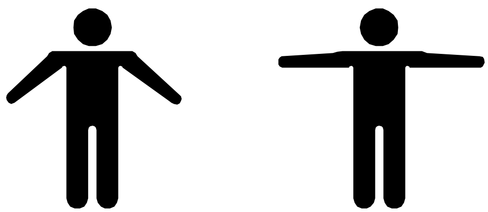


The round out should begin about ten feet above the runway surface. Pitch up to bring the gunsight up to the far end of the runway.



Slowly bring your arms up to horizontal, but keep looking straight ahead.

During the landing flare, when the nose is on the horizon, the runway cannot be seen straight ahead. You must judge the *rate* of descent, the rate that the ground comes ups to meet you, using peripheral vision. To practice what you are looking for, stand up and look straight ahead but hold your arms out to your sides at about 45° down from horizontal. Slowly bring your arms up to horizontal, but keep looking straight ahead.



As you raise your arms up from 45° to horizontal, slow down the rate of rise. Notice that you can see your arms coming up even though you are looking straight ahead. This simulates your view of the descent to the runway with your peripheral vision. You will use the elevator to control this rate descent. This so-called "round-out" is the part that makes landing somewhat tricky.

The round-out is simply holding the airplane one inch off the ground. As the airplane slows down the elevator becomes less effective, and you must continuously increase back pressure just to maintain the same nose-high attitude. Keep the gunsight on the horizon at the far end of the runway.

When you are initially learning to land you may tend to pull back on the stick too quickly and the airplane will "balloon" or start going up. So the next time you try rounding-out, not wanting to make the same mistake, you fail to apply any back pressure at all. This causes the nose to fall and results in a flat landing or wheelbarrowing on the nose gear.

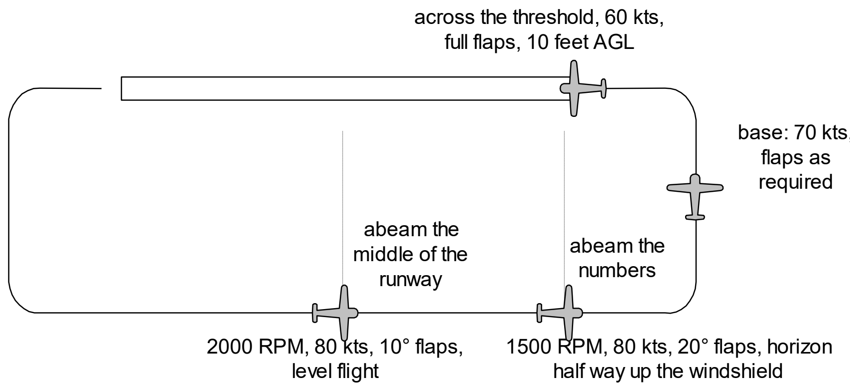
Landing is merely holding the airplane one inch off the runway with the power at idle. Keep the nose on the horizon by continually applying more and more back pressure, until the airplane stalls on the runway.

FOLLOW THAT AIRPLANE

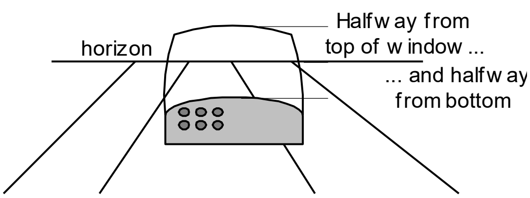
How many times have you heard ATC tell you to follow that airplane ahead on downwind, and you turn to follow the other airplane's ground track, as if playing follow the leader. You must understand that the job of the tower controller is to *sequence* aircraft — to establish your place in line — and not to tell you how to fly your airplane. When the controller tells you to follow another airplane, he is establishing your order in sequence to land. Where you fly and how fast is *up to you*. If the pilot ahead of you in the pattern is extending the downwind too far for your comfort and safety, don't be suckered in to extending your downwind too. Slow down instead. Or request a 360 to the downwind or a 270 to the base. Avoid getting yourself far from the runway at the low pattern altitude.

APPROACH TO LANDING

Constantly in the pattern, you should be asking yourself **SPA:** "How's my **S**peed, **P**itch, and **A**ltitude?" There is a correct speed, pitch and altitude for every place in the pattern. Using a light trainer such as Cessna 152 as an example, establish the following rough settings:



Abeam the middle of the runway — reduce power to 2000 RPM, 10° of flaps, trim for level flight, speed should become about 80 kts, fly at pattern altitude.



Abeam the approach end of the runway — 1500 RPM, 20° flaps, begin descent, sight picture should be horizon halfway up the windshield.

Maintain this sight picture for the remainder of the approach.

Base leg — reduce airspeed to about 70 kts. Make small power adjustments as necessary to establish correct speed. The sight picture remains the same: horizon halfway up the windshield.

Consider full flaps as your "get out of jail free" card. You can only use it only once: use it early if you are too high or too fast, or delay using it if you are low or slow.

Over the threshold — 65 kts., full flaps, 10 feet AGL. Begin flare.

COUNT YOUR LANDINGS

It is easy for your instructor or you, when practicing touch and go's, to count how many landings you have done during a lession or session. Use the VOR frequency selector on the NAV radio. Set it initially to 110.0 (zero landings so far). Every time you land, increment the last digit by one. After the first landing, set it to 110.1; after the second, 110.2. When you get to the tenth landing set it to 111.0. If you ignore the first two digits and the decimal point, the last two digits will be a count of the number of landings that have been made. You will usually underestimate the number of landing you have made. This way, you can keep and accurate count.

TAKEOFF

When you are number one for takeoff use the “lights, camera, action” checklist.

- Lights - turn on landing lights and strobes and nav lights if necessary
- Camera - turn on your transponder — the “camera” that ATC uses to “take your picture.”
- Action - check wind sock, correct for crosswind, apply full throttle and check for full power (tach and MP), oil pressure.

CLIMBOUT

During climbout repeat the four point checklist - **“power, pitch, rudder, trim.”**

- **pitch** - put the nose on the horizon
- **power** - maintain full power
- **rudder** - apply right rudder to prevent yawing
- **trim** - trim away any control pressures on the elevator control.

4. ENROUTE

COURSE, HEADING AND TRACK AND BEARING

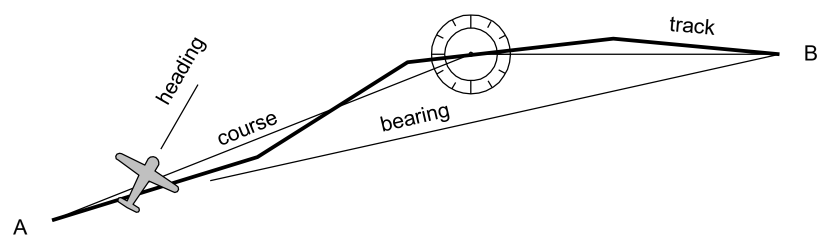
These three terms, course, heading, and track, are often used interchangeably by many pilots. They each describe something different and you should clearly understand the differences.

Course - the path you want to take from place A to place B (not necessarily a straight line).

Heading - the direction the nose of the airplane is pointing relative to magnetic north.

Track - the path the airplane is actually making.

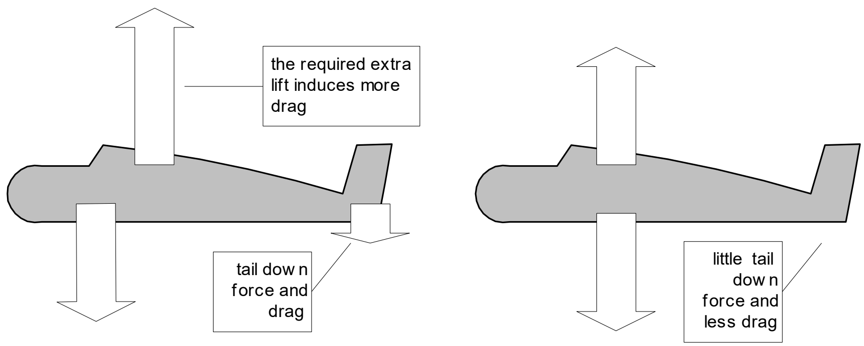
Bearing - Angle relative to a reference direction, usually magnetic north.



You desire the *track* to be the same as the *course*, but wind, inattention to heading, and other factors such as ATC vectors around traffic, will cause differences between the two. *Heading* will be different from course when there is any crosswind, which there usually is. The *bearing* to the destination is its angle relative to magnetic north from the airplane.

BEST CG FOR FASTEST AIRSPEED

To get the most speed out of your airplane, load the airplane to the most rearward center of gravity (CG) location. Of course, you must remain inside the legal CG limits. The most rearward CG gives the least drag. Why? Because with the CG to the rear, the CG and the center of lift will be closest together, and the required tail down force will be the least. The results in the lowest drag and hence the fastest airspeed.



TIME IN YOUR TANKS

Think of your airplane not as having gallons of fuel in the tanks, nor miles worth of fuel, but simply *time*. You have time in your tanks. Thinking in terms of gallons (or miles) is just one more calculation to perform during flight. And distance is not the proper measure because of the wind. The extreme case is a headwind the same as the airspeed. The aircraft would hover over the same point until fuel exhaustion. But a time calculation would be valid.

For example your airplane holds 40 useable gallons and burns 10 gallons per hour in cruise. You have 4 hours of fuel on board. If you want to land with an hour reserve, plan no more than a three hour leg without refueling.

SIMPLIFIED FLIGHT PLANNING

During climb the airplane flies slower. You could use the climb ground speed for the climb portion of the flight, but here is an easier way. Use *cruise* ground speed for all calculations

Add one minute of fuel burn for every 1,000 feet of climb.

If you are climbing from sea level to 5,500 you will burn an extra 5.5 minutes of fuel (round up to 6 minutes). Here is an example of a flight planning chart.

Check Points	ID / freq	± Var -14 Magnetic Course	±WCA Magnetic Heading	Altitude	Time off TAS GS	Dist	ETE	ETA ATA
Airport A								
		338		↑6.5	100	19	: 11 : 07	
Refinery								
		298		6.5	100	25	: 15	
Intersection								
		305		1.0	100	32	: 19 : 10	
Airport B								
							1:02	

For the first leg of 19 miles, you will climb to 6,500 feet. Using cruise ground speed of 100 kts, the time will be about 11 minutes. Adding 7 minutes to climb to 6,500 feet, you will burn 18 minutes in the first leg. Assuming level flight the next leg of 25 miles, you will burn 15 minutes of fuel. The final leg of 32 miles will burn 19 minutes, and you add 10 minutes for normal circling, approach and landing. The total trip fuel burn is 62 minutes.

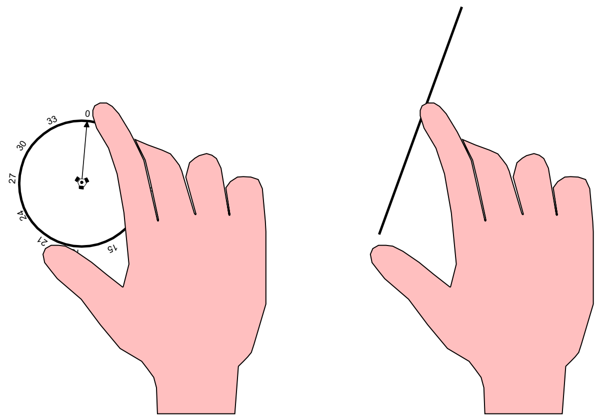
Here is a summary of this simple method of calculating fuel burn.

- use cruise ground speed in all calculations
- add 1 minute for each 1,000 feet of climb
- add 10 minutes at the end of the flight.

For high performance single engine airplanes, you should add 2 minutes for each 1,000 feet of climb.

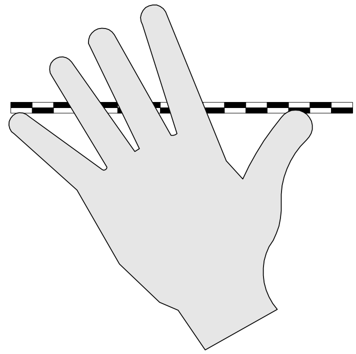
ESTIMATE DISTANCES - USE FINGERS

It is easy to make quick estimate of distances on your sectional charts. The VOR compass rose is 20 nm. in diameter on a sectional chart (10 nm. on a terminal chart). Use this fact to scale a distance on your chart. Spread your thumb and forefinger to span a VOR compass rose on your sectional. Then, without changing the spacing between your thumb and forefinger, move your hand to a course line that you want to estimate. In the example above the course line is approximately 40 nm., because it is about half your thumb-finger span.



For terminal charts the diameter of the compass rose is 10 nm.

Another technique is to roughly calibrate the span of your left hand. Use a plotter or scale on the edge of your sectional chart. Memorize the span from the outside of your pinkie to the outside of your thumb. This will give you a scale with which to approximate distances. Let's say the span of your hand is 60 nm on a sectional chart. You can quickly estimate distances on the section



by counting how spans of your hand there are between point A and point B.

On a terminal chart, the span would be 30 nm.

ESTIMATE TIME - USE APPROXIMATIONS

It is very easy to fill out a flight log for a Cessna 172. It goes about two miles a minute. So 10 miles takes about 5 minutes. 20 miles about 10 minutes, and so on. If your airplane flies at 150 kts., it goes about 2.5 miles per minute. This is 1 mile in 0.4 minutes, so to convert miles to minutes multiply miles by 4 and move the decimal point. 35 miles times 4 = 140 or 14 minutes.

You don't have to learn the calculations for every speed, just for your airplane Once you figure out the shortcut for *your* airplane, it is easy to make quick calculations in the air.

Here is a chart to help you with the shortcut for your favorite airplane:

GS kts	*How to calculate the time for a particular distance*
90	use 2/3 of the distance
100	use 0.6 times the distance
110	close to 2 miles per minute; use half the distance
120	use half the distance
150	use 0.4 times the distance
180	3 miles per minute; use 1/3 the distance
200	use 0.3 times the distance
240	4 miles per minute; use 1/4 the distance

CROSSWIND COMPONENT

Crosswind and headwind component charts are handy, but you can use a rule-of-thumb without the chart. Remember that a wind of 45° off the nose has both a crosswind and headwind component of about 0.7. If the wind is 45° off the nose at 10 knots, the crosswind component is 7 knots and the head component is also 7 knots.

Every 15° shift from the 45°, add or subtract 0.2 from the 0.7 multiplier. Here is the whole rule summarized in a chart:

wind angle	Crosswind multiplier	Headwind multiplier
0°	0	1.0
15°	0.3	1.0
30°	0.5	0.9
45°	0.7	0.7
60°	0.9	0.5
75°	1.0	0.3
90°	1.0	0

Take, for example, a wind of 20 knots from 20° off the nose. This is closer to 15°, so the crosswind multiplier is 0.3. Take 0.3 times 20 knots and get a 6° crosswind component. The exact value is 6.8°, but 6° is close enough.

The chart is easy to memorize and reproduce if you remember how to create it.

WIND CORRECTION ANGLE

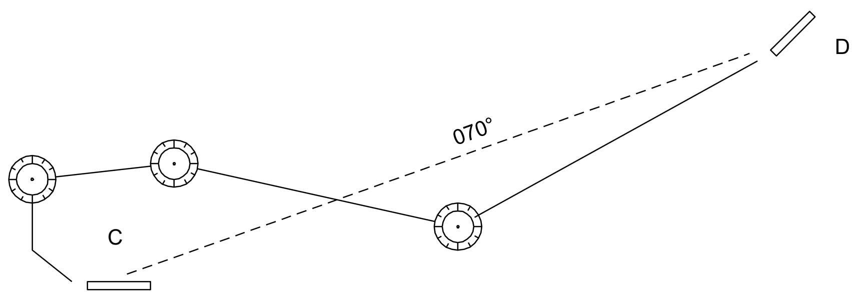
Estimating the wind correction angle is easy. First find the crosswind component using the technique described above. Then divide your wind speed by your airspeed in miles per minute. You should have this memorized for the airplane that you normally fly.

See the section called Estimate Time - Use Approximations, above, on how to do this.

For example, if your crosswind component is 15 knots and your airspeed is 2 nautical miles per minute, divide 15 by 2 to get 7.5° wind correction angle. This method is based on the Rule of 60's Triangle, described later in this book.

WIND CORRECTION FOR YOUR TRIP

Don't waste your time calculating the wind correction angle (WCA) and ground speed for every leg of the flight. First of all, the estimated winds aloft are just that: *estimated*. They are not exact, and they are only calculated for specific places, not necessarily where you will be flying. Second, since you are going generally in the same direction for most of the flight, figure out what that general direction is and make one wind calculation based on that direction. Here is an example of a course from airport C to airport D. Notice that the general direction is 070°. Calculate the WCA and ground speed for that direction — 070° — and use it as a planning guide for the entire trip.



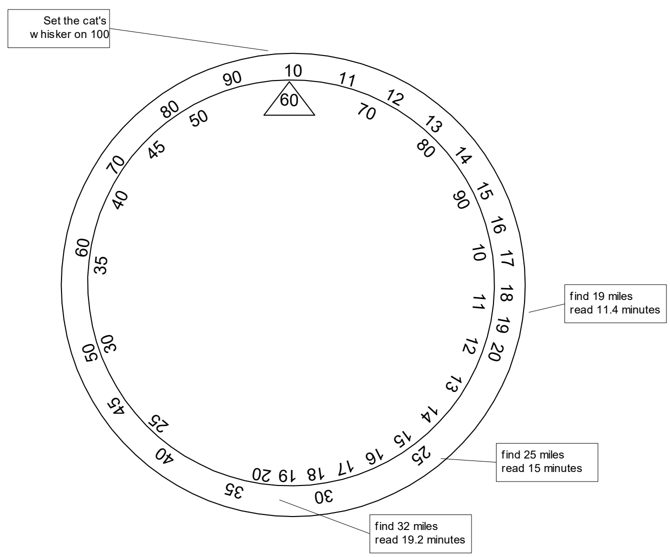
This is a lot easier than trying to calculate the winds for each zig and zag and will be about the same accuracy.

E6B - SET AND SEE ALL

An E6B "whiz-wheel" is so easy to use and so quick and reliable, that I can see no good reason for buying a fancy electronic flight computer. An E6B will never fail due to battery failure or circuit malfunction. And it has the advantage that once the ground speed is dialed in, you can read the time for any distance by merely looking at it. You don't have to turn anything!

Once you set the "cat's whisker" (the pointy black triangle) to GS you can leave it alone.

To remember how to set up the E6B, think *per* (miles *per* hour, gallons *per* hour). "per" sounds like "purr" which should remind you of the "cat's whisker." Rotate the dial to point the cat's whisker to the ground speed (in miles "purr" hour) and you're done. *No more rotating is required*. To determine the time enroute, find the distance on the outside wheel and read the time on the inside wheel.



In this example taken from the flight plan from A to B, above, the cat's whisker is set to 100 kts (the 10; you supply the extra zero). Then merely find distance on the outside wheel and read the time from the inside. Opposite 19 miles on the outside wheel read 11.4 minutes on the inside; opposite 25 miles read 15 minutes, and opposite 32 miles read 19.2 minutes.

In one glance you can see all times and distances corresponding to 100 kts. This can be a lot faster than pushing buttons on an electronic calculator.

WRITE ON YOUR CHARTS

Ever since you were a kid, you were told not to write in books and maps. But when it comes to aeronautical charts, it's okay to mark up your charts - they are not the national archives. You will replace them within six months regardless. Use a bright felt marker such as a day-glo® orange or pink to mark your routes. Avoid thin pencil lines. You can't see them very well in flight. Use a different color for each flight to keep track of which course you are on.

TIMID VIRGINS MAKE DULL COMPANIONS. ADD WHISKEY.

If you have a hard time remembering how to convert true compass readings to magnetic and vice-versa, just remember this:

Timid Virgins Make Dull Companions. Add Whiskey.

Use this mnemonic to remember the following expressions:

True ± Variance = Magnetic ± Deviation = Compass, Add Westerly (variation)

What it means is this:

- to find a **M**agnetic direction, begin with the **T**rue direction and **A**dd a **W**estern variation, or subtract a eastern variation.
- To establish the **C**ompass reading, take the **M**agnetic and add or subtract the **D**eviation, found on the compass correction card

You'll never forget the rules again.

HOW TO GET ATC TO TREAT YOU LIKE A PRO

It's easy to get ATC to treat you like a professional. Act like a professional. Talk on the radio like a pro and they will treat you like one. Otherwise you will hear all too often, "Standby, remain clear of the class D airspace."

First, think about what you are going to say *before* you key the mike, not during. Write it down first if you must. Use the **who, where, what** checklist. *Who* you are (and who you're calling on the first call only), *where* you are (position and altitude), and finally, *what* do you want.

"Coast approach, Skyhawk N12345, over the breakwater, 2,500, landing Long Beach with information Charlie."

With such a professional call, how can you possibly be refused service? If you force the controller to play twenty-questions to get all the information out of you, you wasting the controller's time and tying up the frequency.

And avoid the slang and sloppy verbiage.

Wrong way	Right way
"... at two point five ..."	"... at two thousand, five hundred ..."
" Ah, Coast approach, this is, ah, Cessna N12345 ..."	Coast approach, Skyhawk N12345
"... turn right to thirty ..."	"... turn right zero three zero ..."
"Roger"	Use "Wilco" if you mean *you will comply*. Use "affirmative" if you mean *yes*. Only use "Roger" to mean "I heard you."

Some pilots misuse the word *roger* all the time. Roger does not mean "yes." Yet you hear pilots answering yes-no questions with roger. Roger means "I heard you." It does not mean "yes", and it does not mean "I will do what you told me." It would be appropriate to use roger when a controller reads you the ATIS.

Here, roger simply means that you heard what he said. It doesn't require an answer or for you to do anything.

Use "wilco" to mean "I **wil**l **co**mply." Normally, it is better to skip the wilco and merely repeat the clearance. But if the frequency is very busy and there is no doubt in your mind what the controller wants you to do, then a simple "wilco" will suffice.

Affirmative means "yes." Don't use roger to say yes. ATC: "Can you accept the left runway?" pilot: "affirmative." Use "negative" for "no."

When responding to a traffic call, use either "traffic in sight" or "negative traffic." These two phrases sound very different and cannot be misinterpreted. What if you said "Negative traffic in sight" but the word "negative" where cut off due to a late mike button or a blocked transmission. ATC only heard the "... traffic in sight" portion without the "negative." The controller would erroneously assume you see the traffic, a dangerous situation.

Read the AIM about correct radio usage. It's a fine reference proper radio phraseology. Professional sounding pilots get better service.

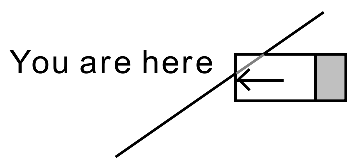
THE MOST IMPORTANT THING IN AVIATION

The most important thing in aviation is the next thing. Always be thinking ahead. Ask yourself what's next. Try to anticipate what the next call from ATC will be. If you are not using flight following, ask yourself what is the next thing you should do. What VOR radial or frequency will I use next? What VOR cross radial could I be tuning in? Where would I go if I just lost my engine? Where would I go if the weather turns nasty ahead? When should I descend? Climb? Slow down?

I had one student take this to the absurd extreme. He set up the VOR to the destination airport before we even took off!

TOM - THUMB ON MAP: POST-IT™ TAPE FLAGS.

I teach the TOM method of flying: Thumb On Map. Keep your thumb or finger on the chart where you currently are. Move it as the airplane moves. Use visual references, dead reckoning, VOR cross radials, DME fixes, or even your trusty GPS. But keep track of where you are. If you don't want to use your thumb, there is a better way. Use a Post-it™ tape flags to keep track of your position. Draw an arrow to edge of the Post-it and keep the arrow head pointing to your current position. You can lift it off the chart and move it to another location because the adhesive on the Post-it is designed not to permanently stick to the paper.



WHEN TO BEGIN DESCENT

How many miles before a fix should you begin your descent? If you use a comfortable 500 feet per minute descent rate, then determine from the chart below how many miles before the target destination to begin your descent:

Descent GS	*Miles per 1,000 feet of descent*
90 kts	3
120 kts	4
150 kts	5
180 kts	6

As an example you are cruising at 8,500 feet and need to descend to 1,500 feet. This is a descent of 7,000 feet. Your ground speed for your airplane in descent is 150 kts. Use 5 miles per 1,000 feet which gives 35 miles. Begin your 500 feet per minute descent 35 miles before the airport.

If you want to use a different ground speed or different rate of descent, you can calculate the miles per 1,000 feet of descent using the following formula.

$$\text{Miles per 1,000 feet of descent} = \frac{\text{Groundspeed} \bullet 16.6}{\text{Rate of Descent}}$$

For example if your descent ground speed is 160 and your chosen rate of descent is 700 feet per minute then the formula gives 3.79. Round this up and use 4 miles per 1,000 feet.

Once you know this figure for your airplane, you can forget the formula and just remember the number.

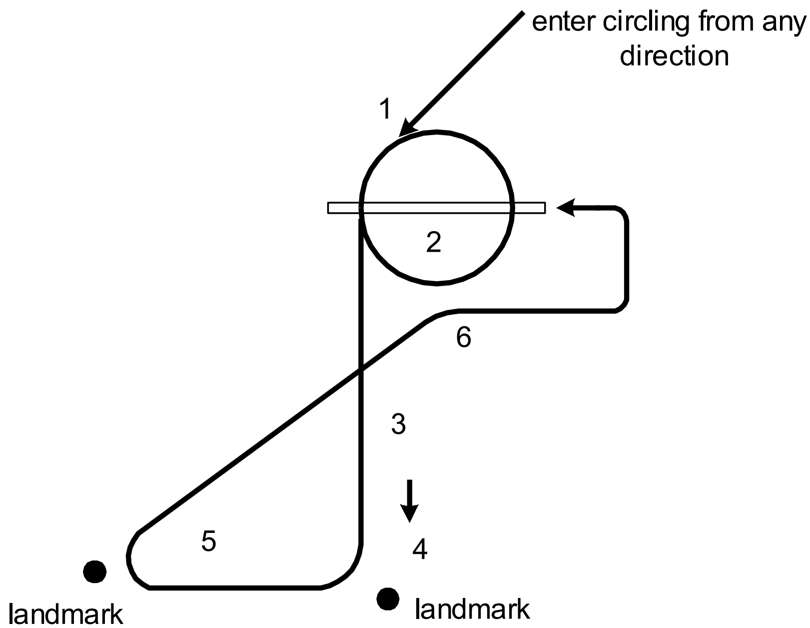
UNFAMILIAR AIRPORT ARRIVAL

Every new airport you fly into will be unfamiliar to you. How should you enter the pattern? How can you study the local situation before attempting to barge into the pattern? Here is a method that always works in both controlled and uncontrolled fields.

1. Approach the field 1,000 above traffic pattern altitude (TPA).
2. Circle over the field at this altitude, turning left (so that you, the pilot, can see the ground). Look at the segmented circle, the windsock(s), and the other traffic in the pattern. Use this opportunity to listen to ATIS if you haven't already done so, or listen on the unicom frequency. Look for landmarks where you will make your turns in steps 4 and 5, below.
3. Depart the airport perpendicular to the runway on the pattern side. Begin your descent to TPA.
4. About two miles from the runway, turn to the landing direction.

5. After about a mile, make a 135° turn to enter on the 45 to the downwind.
6. Enter the downwind from the 45 as usual.

This method will work at almost every airport in the world. At a controlled field, request to orbit over the field at 1,000 feet above the TPA. The safest place to be near an airport is directly over it. You many orbit for as long as you require to get your bearing



LOST

You are lost any time you don't know where you are. This is caused by a wrong assumption a some earlier point.

Here are some ways to get yourself lost:

- failure to monitor heading indicator and mag compass
- failure to hold heading

- failure to verify VFR pilotage checkpoints
- failure to monitor position
- failure to keep track of time

If you realize that you are lost, use the seven C's. Make a checklist and keep it handy.

Lost Checklist - the seven C's

Circle	• find easily identifiable landmark so as to have a frame of reference • circle over the reference • trim for level flight • use rudder for minor bank adjustments • locate yourself using large landmarks, then smaller landmarks
Climb	• get larger view of landmarks • better radio reception for COMM and VOR
Conserve fuel	• slow down to V_y
Communicate	• try any frequency for a radar facility you think you're near • try FSS for DF steer in remote areas • call on 121.5 if all else fails
Confess	• admit to *yourself* that you are lost
Calculate where you are	Methods of establishing position or getting help • Pilotage • VOR triangulation • Radar help • DF steer • 121.5
Comply	• comply with ATC - be prepared to: squawk assigned transponder code • tell what radial you're on • say when you last knew where you were • estimate how much fuel you have

	• reset heading indicator with magnetic compass if necessary • do what you are told

DIVERSION

You may have to divert to another airport due to weather, sick passenger or crew, equipment malfunction, airport closure, low fuel or any other reason.

To divert to another airport, use this checklist before diverting. Do not forget to use your fingers and the VOR rose to estimate distances, and to use approximations described earlier in this chapter to estimate time.

Circle over reference point, trim well, bank shallowly controlled with rudder so both hands are free

Choose destination ____________

Magnetic course ____________

Distance ____________

Time ____________

Altitude (restrictions) ____________

FSS (weather, change flight plan) ____________

Go (set heading indicator to mag compass)

To quickly estimate distances on your chart remember that on a sectional the VOR circles are 20 nm. in diameter and on a terminal chart they are 10 nm. in diameter The vertical ticks on the meridians (lines of longitude) are 1 nm. each. Do not use the horizontal ticks on the parallels; they are not 1 nm. Each except on the equator. Use shortcut techniques described earlier for calculating time.

TRIMMING FOR BEST GLIDE - QUICKLY

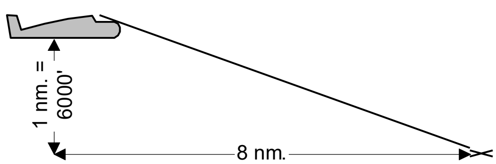
If you lose the engine in a single engine airplane, you must trim for best glide to give yourself maximum glide distance. To do this quickly, trim for maximum nose up on the trim wheel. On most general aviation airplanes, this will result in a final airspeed of very close to best glide. It might be a little slower, closer to best *endurance* airspeed - you'll stay aloft longer, but not glide as far. But the full nose up trim will get you *close* to best glide very quickly, and then you can fine-tune the trim for the exact best glide speed.

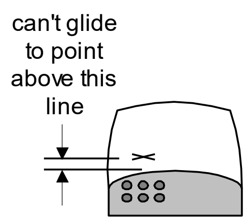
HOW FAR CAN I GLIDE?

A good rule of thumb for most general aviation airplanes for determining gliding distance is:

if you can see it out the front of the window,
you probably can't glide to it.

For some airplanes you might be able to see the longest glide point. It might be one inch from the bottom of the front window. Or two inches. This will vary from airplane to airplane.





You can determine the farthest glide point for the airplane you normally fly. Let us say that the glide ratio of your airplane is 8:1. That is, it will glide eight miles for every mile it is high. The next time you are flying on a clear day, maintain 6000 feet AGL (about one nautical mile). Using a chart, DME to a VOR that you can see, or your GPS, identify a point on the ground that is 8 miles in front of you. Notice where it appears on the front window. Anything above that point on the window you cannot glide to. Anything below it, you can. Memorize this point on the window. Don't even consider trying to glide to a point that is higher than this point.

5. OTHER TOPICS

TEACHING STALLS

Many students and even experienced pilots are frightened of stalls. This may be due to a bad experience during early training, or to the fear that the airplane is out of control, especially when a wing drops during the stall break.

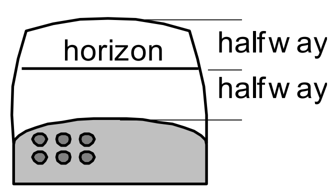
Learning stalls and stall recovery needn't be traumatic. The trick is to start with the gentlest stall and work up to the most dramatic. Here is the "pucker factor" sequence, from gentlest to most dramatic:

- power off, no flaps, stick forward recovery
- power off, some flaps, stick forward recovery
- power off, full flaps, stick forward recovery
- power off, full flaps, full power recovery
- power on, no flaps, stick forward recovery
- power on, no flaps, full power recovery
- power on, full flaps, full power recovery
- power on, full flaps, 10-20° bank, full power recovery.

There are other configurations in between these, but you get the idea.

The recovery sight picture for *all* stalls is the same: put the horizon half way up the windshield

The recovery sight picture for *all* stalls is the same: put the horizon half way up the windshield, just like the approach to landing sight picture. When the airspeed climbs to V_x, put the nose up to the V_x climb attitude.



The least scary stall is a power off, no flap configuration with a simple recovery of merely breaking the stall with slight forward stick pressure, with the power remaining at idle. Climb to a safe altitude that allows for multiple stalls without having to climb between each stall. First ask your instructor to demonstrate and then have you stall and recover, stall and recover. Say aloud, "It's stalled — it's flying," every time a stall and recovery is made.

Next, reinforce rudder control by doing the "falling leaf" stall. This is where your instructor holds the stick fully back with neutral ailerons while you keep the wings level with rudder alone. The airplane with stall and unstall repeatedly all by itself and your job is only the rudder.

Progress to more and more dramatic stalls only when you are very comfortable with the previous stall in the sequence.

DENSITY ALTITUDE AND STANDARD ATMOSPHERE.

Ask ten pilots what density altitude is and you'll most like get ten different answers, maybe more. Most likely you will hear, "It's pressure altitude corrected for temperature." Okay, what is pressure altitude? "It's the altitude shown on the altimeter when the Kollsman window is set to 29.92.

density of the air in the standard atmosphere is the same as where you are.

If the density altitude at your airport is 10,000 feet, what does that mean? It means that *the density of the air **at 10,000 feet in the standard atmosphere** is the same as where you are.*

Density is how many molecules of air there are in a cubic foot of it. In other words, how many air molecules (per cubic foot) does your airplane have to work with. Air density effects performance of the engine, propeller, wings, and control surfaces.

What is the standard atmosphere? It doesn't exist! It is fictitious. It is merely a non-existent standard that somebody made up. There is no place anywhere in the world where the standard atmosphere exists in nature, just like there is nothing on the earth that is exactly one foot or one metre long. But engineers can refer to the standard atmosphere when measuring and comparing airplane performance.

Let's say you are trying to measure the performance of your airplane. On a hot day the airplane will not perform as well as on a cool day. By converting the weather conditions on each day of your testing to the standard atmosphere, you can compare the performance on the hot day with that of a cool day. And you can compare your airplane to other airplanes that where tested on days that had different weather conditions than when you tested your airplane. Without this method of "leveling the playing field," it would be meaningless to specify airplane performance.

Just remember *high density altitude* doesn't mean high density. It means *high altitude*, and poorer airplane performance.

Pressure altitude is an intermediate measurement that is used to determine density altitude. By itself, pressure altitude is useless in comparing airplane performance.

CALCULATING DENSITY ALTITUDE

Use your E6B. But if you don't have it handy, use the following rules. First find standard temperature: take 15°C (standard temperature at sea level) and subtract 2°C for each 1,000 above sea level. Density altitude increases 1,000 for each 8°C above standard.

For example if the altitude is 6,000 feet, the standard temperature at 6,000 feet is 15° - (2° x 6) = 3°C. If the temperature today at 8,000 feet is 19°C, this is 16° higher than standard. 16/8=2 or 2,000 feet higher. 6,000+2,000=8,000 feet density altitude.

LIFT EQUATION

The lift equation, $L=C_L S(\rho/2)V^2$, looks complicated, but it is fairly simple. It is merely multiplying some numbers together. If any number is bigger, lift will be bigger, and if any number is smaller, (surprise!) lift will be smaller. Let's look at each number in the lift equation:

C_L is the coefficient of lift, but it is simply related to the design of the wing and the *angle of attack*. More angle of attack — AofA — more coefficient of lift and more lift.

S is the surface area of the wing. Bigger area wing, more lift.

(ρ/2) is the air density. Less air density, less lift.

V^2 is velocity or airspeed, squared. Don't let the "squared" scare you. It just means that a little more airspeed generates *much* more lift. For example a 10 percent increase in airspeed results in a 20 percent increase in lift (actually 21%, but who's counting that closely?).

Keeping the lift equation in mind can help us answer many questions about airplane configuration, environment and performance. For example, some wing flaps increase the total area of the wing. Increase S — surface area — increases lift. Airplanes with small wings (small S) have to make up for it with faster speeds (bigger V). At high altitudes where the air in less dense (lower ρ) the AofA must be larger, and a larger AofA means your are closer to a stall!

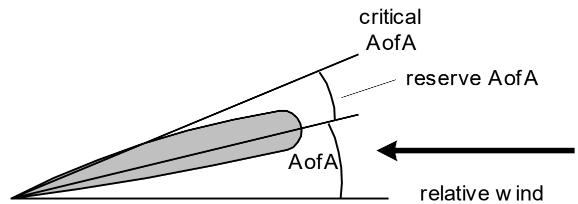
Where the altitude is constant and the wing size doesn't change, the lift equation can be simplified to $L \approx AofA \cdot V^2$. Lift is proportional to angle of attack — *AofA* — and airspeed squared — V^2.

RESERVE ANGLE OF ATTACK

An airplane wing will stall when the angle of attack - AofA - exceeds the critical AofA. The critical AofA of most single engine general aviation airplanes is about 18°. If the airplane cruises at an AofA of 5°, then it will require 13° more AofA before reaching the critical AofA. The reserve AofA, the AofA before reaching stall, is

13°. When flying slowly at a high AofA, say 12°, our reserve AofA is only 6°.

Reserve AofA is the margin of excess AofA remaining before stall.



Most general aviation airplanes do not have AofA indicators. But you can develop an awareness of high AofA and when our reserve AofA is dangerously low. Low airspeed, steep turns, sharp pull ups from steep dives are all situations with potentially low reserve AofA. Avoid the low reserve AofA situation and avoid a stall or stall/spin accident.

LIFT = WEIGHT, *ALWAYS*

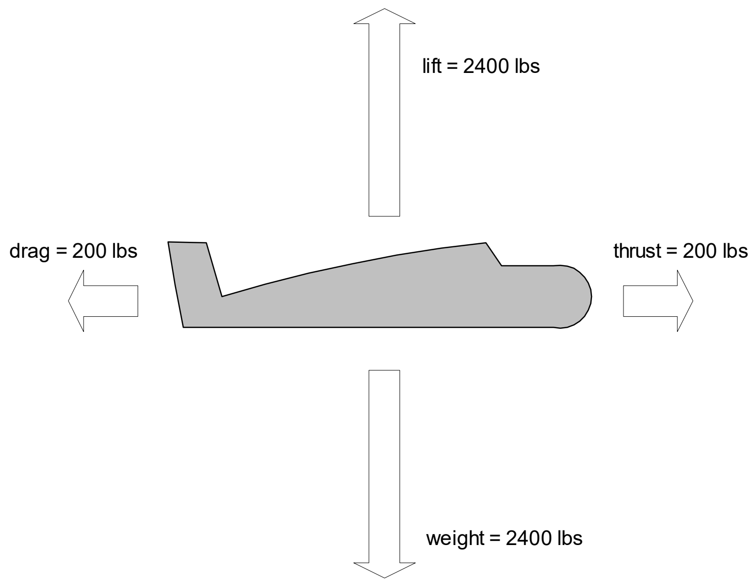
The total force on an object is zero when it is not changing velocity.

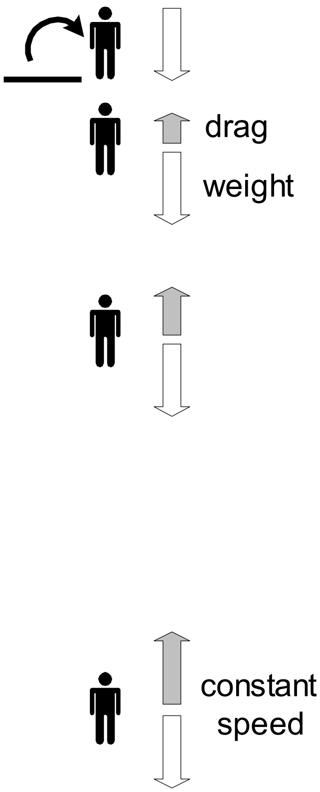
Lift = Weight and Thrust = Drag, *always*, even when climbing and descending. This may be hard to understand. How can lift equal weight during a climb. Isn't lift be greater than weight? No, in a steady climb or descent, lift = weight. Since for any phase of flight the weight is constant, lift must also be constant.

The total force on an object is zero
when it is not changing velocity.

The total force on an airplane traveling with an airspeed of 120 kts is zero. You have seen the diagram below. The total force on the airplane is zero. The up force of lift just cancels the down force of weight, and the forward force of thrust just cancels the backward force of drag. But what if you increase the thrust by advancing the throttle? For a short while, thrust will be greater than drag. But the airplane will accelerate. As is goes faster, the drag will increase (due to increased parasite drag) and soon the drag will equal the new thrust, and equilibrium will be restored.

What if you pitch up to climb. For a short while, the lift will be greater than the weight because of the increased angle of attack. The airplane will accelerate vertically. But the airplane will also slow down. As it does, the lift will be restored to the original value — remember the simplified lift equation $L \approx AofA \cdot V^2$ — and the airplane will climb at a constant vertical speed.





To understand this better, consider a sky diver jumping off a very tall bridge without his parachute opened. There is always a downward force acting on his body — his *weight*. At first there is no upward force acting on his body. But as he falls faster and faster, there is an increasing force called *drag* that acts upwards. When drag equals his weight, the sky diver has reached *terminal velocity*, and his speed will be constant from now on. The total forced on his body is now zero because drag equals weight. He is moving at constant speed, about 100 mph; he is not accelerating.

Constant speed ⇨ no net force

In level flight, steady climb or descent, lift must equal weight. And weight is, of course, constant during any portion of a flight. If weight is constant, then lift is constant, and $AofA \cdot V^2$ is constant. An increase in V must result in a decrease in $AofA$, and vice versa. As airspeed decreases, AofA must increase to maintain the same lift. That is why the nose is raised during level MCA, or slow flight. The AofA must be increased to compensate for the decrease in airspeed.

PILOTING IS MANAGING ENERGY

As a pilot you have to manage three kinds of energy:

- kinetic energy — airspeed
- potential energy — altitude
- chemical energy — fuel

Kinetic is the energy of motion. Something in motion has energy. Energy of motion is the mass of the object times velocity squared, V^2. A heavier moving object has more kinetic energy than a lighter object. And a faster moving object has more kinetic energy than a slow object. A 4,000 pound car going 100 mph has the same kinetic energy as a 64,000 pound bus going 25 mph. (4,000 • 100 • 100 = 64,000 • 25 • 25). The faster an airplane goes, the more kinetic energy it has.

Potential is the energy that is stored and can be released, such as a boulder on top of a hill or water in a dam. An airplane's altitude is potential energy. It can be converted into airspeed. Let's do a thought experiment. Say you held a small training airplane at 10,000 feet AGL with no airspeed on a string (how you do this I have no idea!). The airplane has potential energy, but no kinetic energy. Cut the string and let the airplane free-fall. It will nose down and begin to fly. You have converted some of its potential energy to motion — kinetic energy.

A pilot can convert potential energy to kinetic and kinetic energy to potential.

If you are low and fast on final approach, you can convert the excess speed to more altitude by raising the nose slightly. And when you descend from cruise, you convert the potential energy of altitude to a higher airspeed as you descend. The higher an airplane goes, the more potential energy it has.

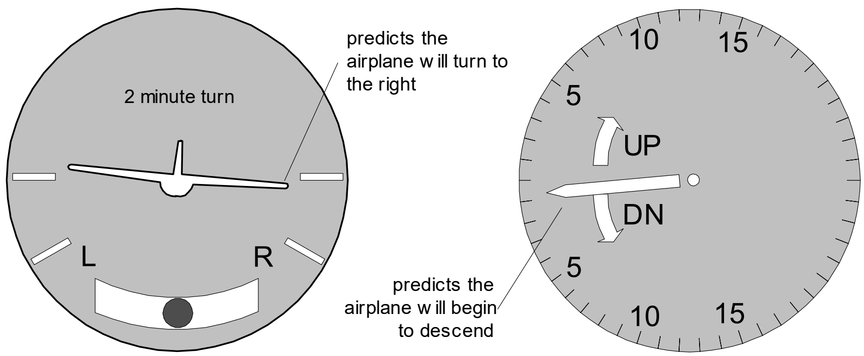
Chemical is the third type of energy pilots manage. It is the energy in the fuel and is converted to kinetic energy by the engine and propeller. The more fuel an airplane is carrying, the more chemical energy it contains.

Piloting an airplane requires that you manage these three energies. You always want to be sure you have enough of all three. If you are low and slow, you could be in trouble. Your only out is to have fuel and a working engine to convert it to kinetic energy. Being low and slow on final approach is dangerous. You cannot convert one to the other because you don't have very much of either one.

The worst situation is to be low or out of all three!

Instruments That Predict the Future: VSI and TC

The vertical speed indicator — VSI — and the turn coordinator — TC — are amazing predictors of the future! The VSI will indicate a climb or descent long before the altimeter will begin to budge. And similarly the TC will show a turn in advance the heading indicator turning.



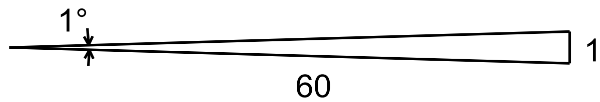
Some pilots are erroneously taught that the altimeter has inherent lag. The altimeter doesn't possess lag, the airplane does. The airplane has momentum and is not going to change altitude instantly. But the slighted change in altitude, imperceptible by the altimeter, will display clearly on the extremely sensitive VSI. The same is true of the TC and heading indicator.

The VSI and the TC can be considered leading indicators of attitude change. The alert pilot will include these two instruments in his scan — whether VFR or IFR — and will make small, early corrections and thereby avoid any deviations in altitude or heading.

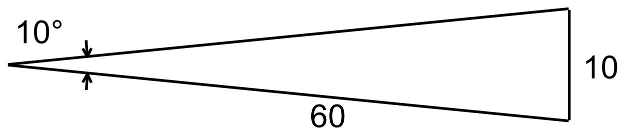
Wing leveler autopilots rely on the TC to keep the wings level. The old turn needle only responded to yaw, not roll rate. By the time the turn needle showed a turn, it was too late, the airplane was already turning. But the TC detects the slightest change in bank, so that the autopilot — or human pilot — can quickly correct the situation before the bank becomes a fully developed turn.

RULE OF 60'S TRIANGLE

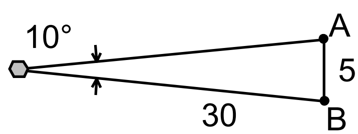
This is one of the most useful memory aids for working with small angles. It is called the rule of 60's and it works like this. Consider a triangle that is 60 units on the long sides and 1 unit on the short side. The acute angle will be 1° between the long sides. Memorize this triangle.



From this simple relationship, you can calculate many other triangles that are useful to a pilot. If the angle is made 10 times bigger, the short side of the triangle will be 10 times bigger, too.

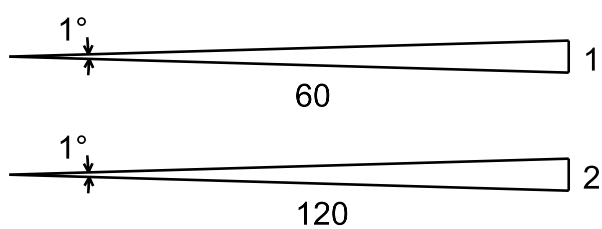


If you leave the angle alone and change the length of the long side, the short side will change proportionally. For example it takes you 5 minutes to fly from A to B for a 10° change in VOR radial, how far are you from the station?



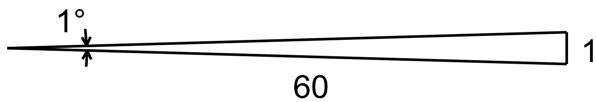
The answer is 30 miles. If the short side of the triangle is halved, the long side will be halved too.

Let's look at wind correction angle (WCA) calculations. For a 120 kt. cruise speed, double the triangle:

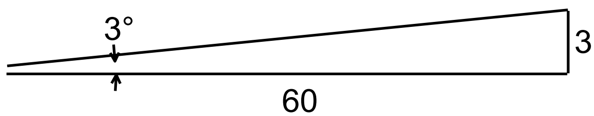


This suggests 1° of WCA for each two knots of crosswind component. So for a 10 kt. crosswind component, use about 5° of wind correction.

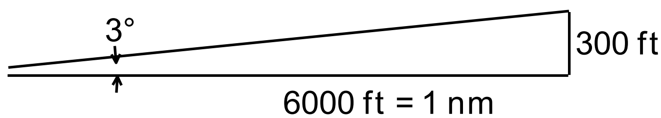
What about glideslope calculations. On a three degree glideslope, how high should you be 7 miles out? Begin with the original triangle.



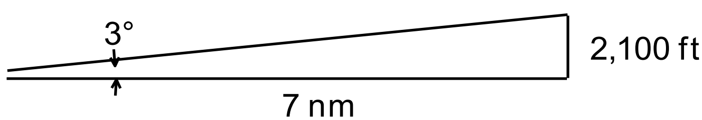
Change the angle to 3° and the short end of the triangle becomes 3.



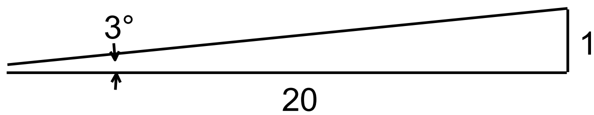
Now consider that 1 nautical mile is about 6,000 feet. So add two zeros to the dimensions of the triangle. Note that 6000 feet is about 1 nautical mile.



The final step is to change the 1 nm to 7 nm — multiply by 7 — and multiply the 300 feet by 7 to get the result: 2,100 feet.



Another way to look at this is to change the original triangle to a 3° glideslope and a 20:1 triangle. Now it is easy to see that for every 20 miles out, you are 1 mile high. If you are 10 miles out you are 1/2 mile high or 3,000 feet, and so on.



This is a lot easier than memorizing a lot of different formulas.

LIGHT SIGNALS THE EASY WAY

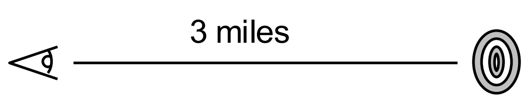
If you have trouble remembering the light signals from the control tower, realize that so do the controllers. They have the signals written out on a piece of paper taped to the light gun. You too should have the signals taped to your lap board in the rare case you should need them. But here is an easy way to remember them.

> *Flashing green* is **get ready**. On the ground, **get ready** to take off would be taxi to the runway (cleared for taxi). In the air, **get ready** means enter the pattern for landing (return for landing).
>
> *Green* is **go**. On the ground, **go** means takeoff (cleared for takeoff) In the air, **go** means land (cleared to land).
>
> *Red* is **stop**. On the ground, stops means **stop**! (**Stop** your taxi). In the air, stop means stop, but you can't stop an airplane, so do the next best thing, circle. (Give way to other aircraft and continue circling).
>
> *Flashing red* means **go away**. On the ground, **go away** means get off the active runway (taxi clear of the runway in use). In the air **go away** means just that, go away (airport unsafe, do not land).

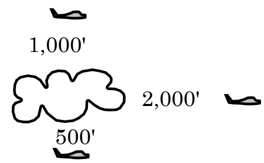
If you can remember that simple meanings of the colored lights, you will have no problem recalling their aviation definitions.

CONTROLLED VERSUS UNCONTROLLED AIRSPACE

One simple pair of weather rules will serve the VFR pilot well at the altitudes where nearly all general aviation pilots fly:



Visibility must be at least three miles, and



Cloud clearance must be at least 1,000 feet above, 500 feet below, and 2,000 feet horizontal.

If you remember a Cessna 152, think “**152 ABC**” and you can remember **1**000-**5**00-**2**000 **A**bove, **B**elow, **C**rosswise. If these are the only two rules you ever remember, you’ll function quite well in the system, and this section could end here and now. But there seems to be endless confusion about *controlled* and *uncontrolled* airspace, so let’s examine the airspace a little more closely.

There are different varieties of controlled airspace, named A through E. Uncontrolled airspace is named G. For the VFR pilot there are two very simple differences between *controlled* and *uncontrolled* airspace

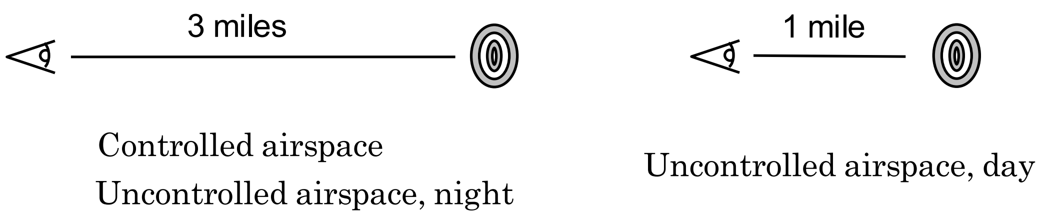
1. There is a weather difference (below 10,000 feet MSL):
   - In controlled airspace the visibility requirement is three miles, but
   - *In uncontrolled airspace during the day the visibility requirement drops to **one** mile.*

and

2. There is an ATC (air traffic control) difference:
   - In controlled airspace, ATC **may** exercise control under certain circumstances (depending on the weather or class of controlled airspace), but
   - *In uncontrolled airspace ATC will **never** exercise control*.

There are some exceptions.

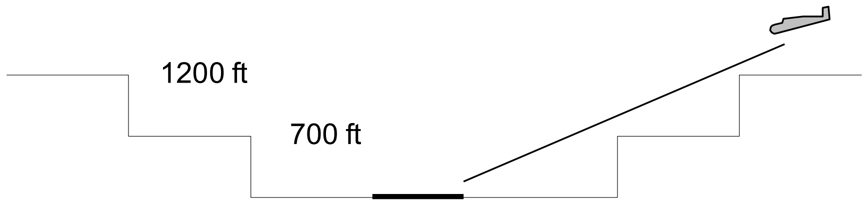
- In uncontrolled airspace at *night* the requirements are the same as in controlled airspace up to 10,000 feet MSL.



- Above 10,000 feet the visibility requirement becomes five miles *everywhere*, and cloud clearance becomes: 1,000 feet below, 1,000 feet above, and 1 mile horizontal. This is necessary because there are no speed limits above 10,000 feet and the larger clearance gives you more time to see other airplanes near clouds. Above 14,500 feet *all* airspace is controlled. For the VFR pilot 14,500 feet has no practical significance.
- Below 1,200 feet AGL, airspace is *uncontrolled*. During the day the cloud clearance becomes *clear of clouds*. But in some locations it is desirable to bring controlled airspace lower than 1,200 feet AGL.

Why bring controlled airspace below 1,200 AGL? The answer is quite easy to understand. To make approaches safe for instrument pilots, merely *clear of clouds* is too hazardous. Consider an instrument pilot breaking out of the clouds below 1,200, only to suddenly encounter a *legal* VFR aircraft just clear of the clouds.

There would be no room for either aircraft to maneuver. To avoid this occurrence, controlled airspace is brought closer to the ground so that VFR pilots are required to have three miles visibility and stay 1,000 feet above, 500 feet below, and 2,000 feet horizontally from clouds.



- When Class E controlled airspace is specified *down to 700 feet AGL* it is also called Class E airspace and denoted on VFR charts by a feathered magenta shading.
- When controlled airspace is specified *down to the surface*, it is denoted as either Class B or Class C surface area, as class D airspace (dashed blue line), or as Class E airspace by a dashed magenta line.

The varieties of controlled airspace, A through E, have other restrictions and distinctions such as communications requirements, equipment requirements, speed limits, and separation services provided.

But the essence of uncontrolled airspace is:

1. one mile visibility during the day, and
2. ATC will never exercise control.

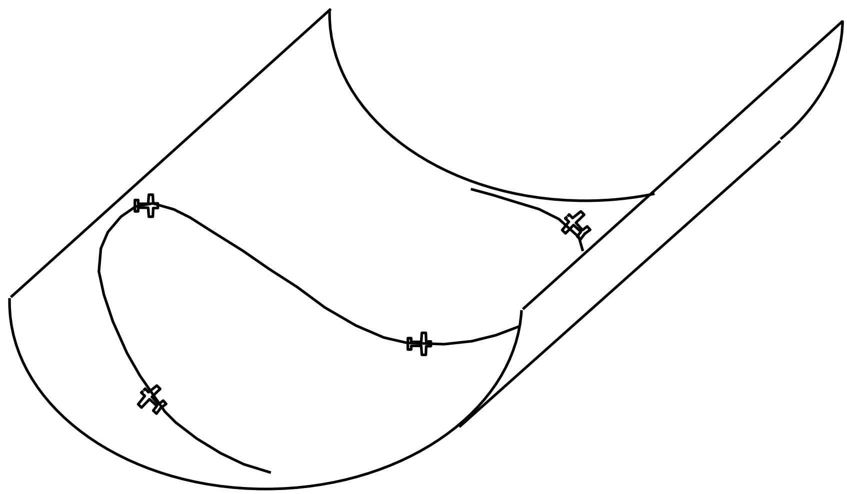
Let's keep it simple.

WHEN ARE YOU READY FOR THE CHECKRIDE?

How does a flight instructor know you are ready to take the checkride? You are ready for the checkride when your instructor can honestly say to himself, "I would trust this pilot with my *loved-ones — my wife, my dog, myself sleeping in the back seat?*" Anything less than that indicates that you need more practice.

USE CURVED PAPER TO VISUALIZE LAZY-8'S

If you are a commercial student, you may have a difficult problem visualizing the lazy eight. You may have a hard time understanding that even though the nose may be dropping, the airplane is still climbing. To more easily show what the airplane is doing during each phase of the lazy eight, use this learning tool. Draw a big S as big as the entire sheet of a piece of typing paper. Then fold the paper into an arc as shown below. The S is the path that the airplane flying during the lazy eight. This will help you visualize all phases of the maneuver.



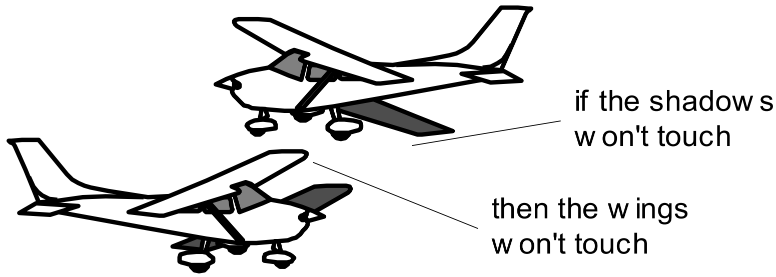
THE SHADOW KNOWS

When you are taxiing, how can you tell if your wing tips will touch another airplane's wings or tail? Look at the shadows.

If the shadows won't touch, the wings won't either.

(The converse is not true. If the shadows touch, the wings *may* touch. This is because one wing may overlap another, but at a different height, such as a high wing overlapping a low wing. The shadows will touch, but the wings will not.)

This only works when there is a shadow from a single light source such as the sun. On an overcast day, give extra wide berth to other parked or taxiing airplanes.



6. COCKPIT MANAGEMENT

MAKE YOUR OWN FLIGHT PLANNING SHEET

Once you decide what is important to you during flight planning, make your own customized flight planning sheet on your word processor.

wind 220@10	WCA +2			TAS 140	beg fuel	:	
Check Points	ID / freq	Course	Alt	Dist	GS	ETE	ETA / ATA
Departureville							ATD 02:45
		060	↑3.5	65	149	:30	03:15
ABC VOR	ABC						03:13
	115.5	065	3.5	82	149	:33	03:46
Destinationville							03:44
						:	:
							:
						:	:
							:
					total:	1 :03	:

Calculate your wind correction once for the entire trip, since you are going generally in the same direction. Calculate your true airspeed for the entire trip just once. Write these in the spaces provided. Enter your beginning fuel in *hours*. All fuel calculations will be done using *time*, not gallons or distance.

For each leg, use the staggered flight log. Consider the checkpoints as *fence posts* and your course, altitude, distance, speed and time calculations as *fences* connecting the *fence posts*. Fill out all the column *before* the flight except the last column. You will fill this out *during* the flight.

Because you are making your own flight log, you can include only those columns that you will use and exclude those that do not apply. You might choose to leave out any columns referring to true directions because you do all your calculations in magnetic. You could exclude any references to gallons of fuel used, since you like to use time.

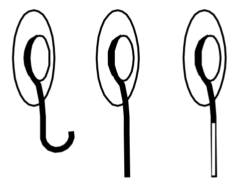
MAKE YOUR OWN CHECKLIST

Whether you rent or own your own airplane, making your own checklist has many advantages. First, you can add items that are applicable to the airplane you fly. For example the standard checklist that comes with the airplane may make no reference to the autopilot, or your GPS or graphic engine analyzer. You can also delete items that do not apply to your airplane such as reference to electric trim. You can add check items for IFR flight that might not be in the standard checklist, such as checking pitot heat, VOR log, instrument movement during taxi, alternate static source, and so on.

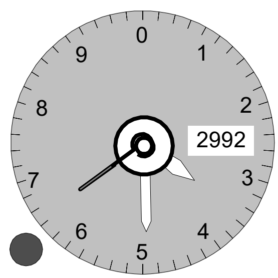
You can tape the checklist to the backside of your lapboard. If you maintain your checklist on your word processor, it is easy to make changes and print a new one.

MAKE AN ALTITUDE BUG USING A HOOK AND SUCTION CUP

You can make a altitude bug for your altimeter for about $2. Purchase a small wire kitchen hook with a half-inch diameter suction cup on it. This is usually available at a hardware store or hardware section of your grocery store. With a pliers, bend the hook straight. Paint the end of the straightened hook with yellow or orange paint.



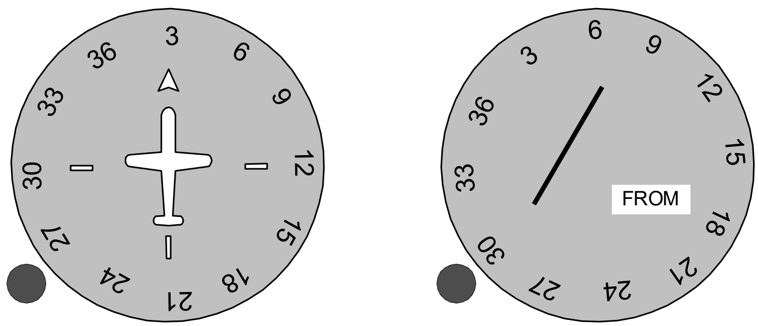
Put the suction cup on the center of the face on your altimeter. Now you can turn the colored pointer with your finger to point to your desired or assigned altitude.



7. NAVIGATION TRICKS

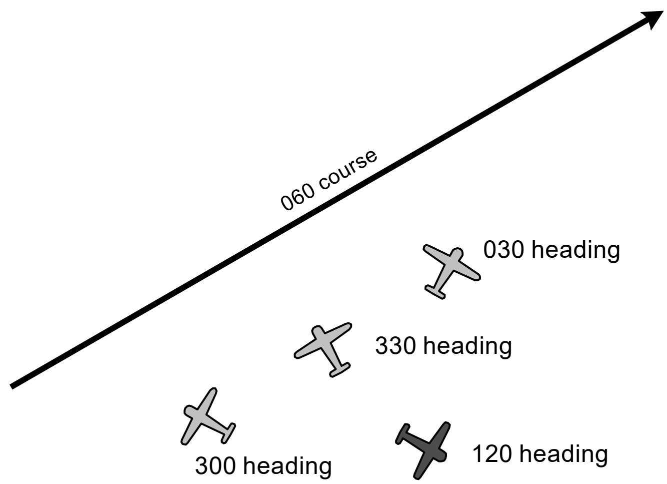
VOR TECHNIQUES — HEADINGS THAT WILL (AND WON'T) WORK

Using the VOR it is very easy to tell whether a vector or heading will result in a successful intercept or not, or whether you have yet to reach an intersection defined by a cross radial, or have not yet passed it. Take the case shown here



The airplane is on a 030 heading to intercept a 060 course line. Will this heading work? Looking at the VOR omni head, the needle to the left. The 030 heading is on the same side as the CDI, and therefore this heading will work. This will be a 30° intercept.

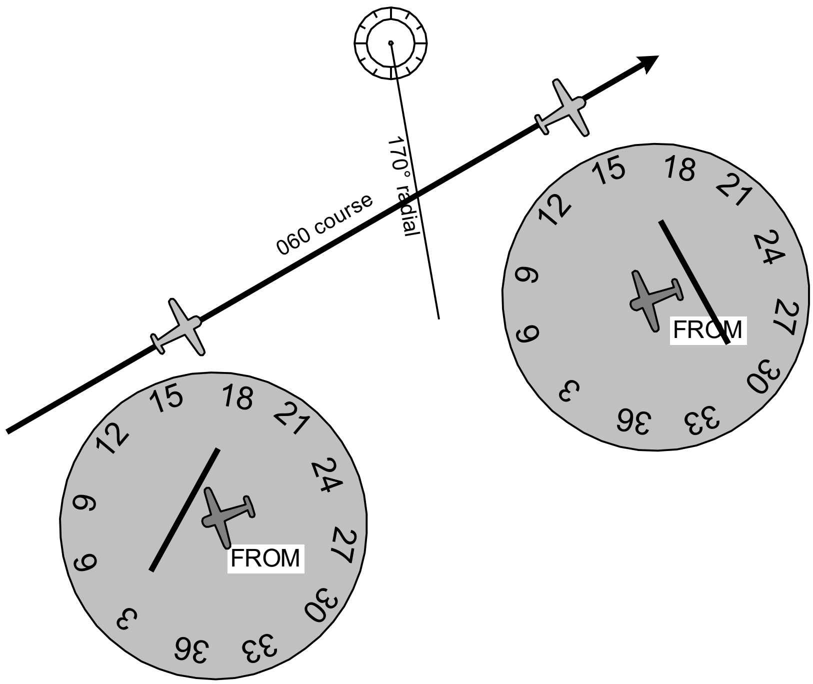
If you wanted a 90° intercept, by examining the CDI, you can see that a 330 heading will give us the desired intercept. A 120 heading will not intercept because 120 is on the opposite side of the CDI needle (the dark airplane in the diagram below).



- Any heading on the same side as the CDI will intercept the course.
- Any heading on the same side as the CDI and on the *top* half of the omni head will intercept the course most directly.
- And any heading on the same side as the CDI and on the *bottom* half of the omni head will intercept the course but would be a poor choice since you would be not be making forward progress (for example, the airplane on the 300 heading in the above diagram).

The same technique works for cross radials. Imagine the airplane is in the center of the omni head, pointing in the direction matching the heading. For example you are on a 060 heading and wish to know where you are relative to a 170 cross radial from a VOR. The airplane on the left has not yet reached the cross radial. The small airplane that you have mentally placed on the omni head pointing at a 060 heading has not yet reached the CDI needle. The airplane on the right has passed the cross radial and the mental airplane has passed the CDI needle.

All techniques shown here will work correctly regardless of a TO or a FROM indication.



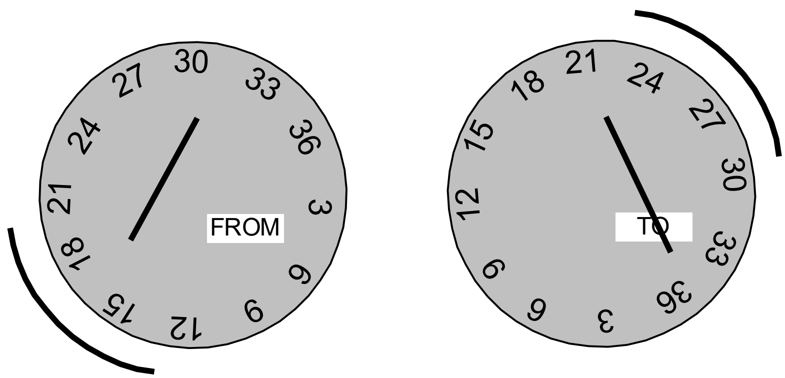
How to Proceed to a VOR Without Turning the OBS

If ATC tells you to "proceed direct ABC VOR", you can begin the turn without touching the OBS knob. How? Just by looking at the VOR omni head:

- If the needle is to the left, a heading on the left side of the omni head will work.
- If the needle is to the right, a heading on the right side of the omni head will work.

- If the TO-FROM flag is a TO, a heading on the top half of the omni head will work.
- If the TO-FROM flag is a FROM, a heading on the bottom half of the omni head will work.

By merely looking at the CDI needle and TO-FROM indicator, pick a course in the middle of the corresponding quadrant and turn to that heading. Here are some examples:



The omni head on the left shows that a heading from about 130 to 190 will get you to the VOR station; try 160. The omni head on the right indicates that a heading of about 230 to 290 will work; try 260.

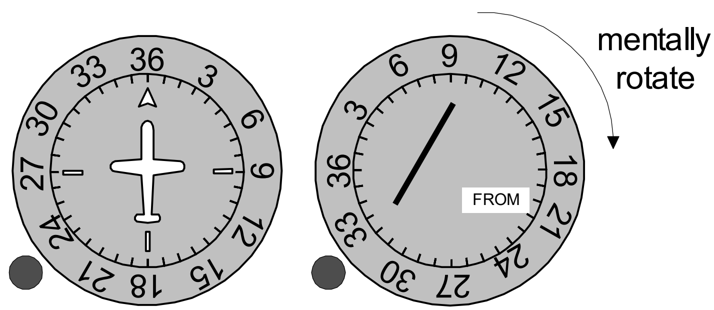
Of course if the CDI needle happens to be centered with a TO flag, turn to that heading. If centered with a FROM flag, then turn to the heading at the bottom of the instrument. If the TO-FROM is oscillating between TO and FROM, then the station is in the direction shown on the left or right side as indicated by the CDI needle. For example in the omni head on the left in the diagram above, if the TO-FROM flag was oscillating, a heading of 210 would get you to the station.

Once you know the direction to turn, then you can reach up at your leisure and center the needle with a TO indication to fine tune your heading.

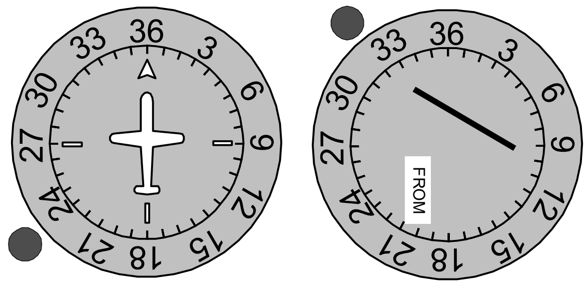
MENTAL HSI

An HSI - Horizontal Situation Indicator - combines a VOR head into a heading indicator. It shows you your situation relative to a course you have selected. With a little bit of imagination you can mentally lift the omni head out of the instrument panel, rotate it and lay it on top of your heading indicator. This will help you determine if you are approaching or have passed a cross radial The CDI tells you which side of a pair of radials you are on. That's all it tells you. For example, in the figure below if you are anywhere south of the 090/270 radials and have dialed the OBS to 090, the OBI will point to the left, regardless of the TO/FROM indication. (The TO/FROM will tell you if you are east or west of the VOR station, but for this discussion you don't care.)

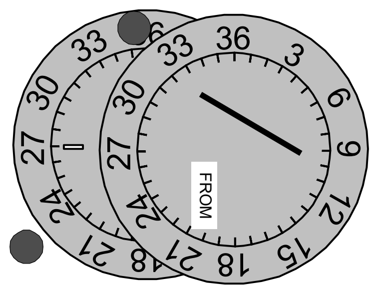
For example, you are heading north bound and will intersect the VOR 090° radial.



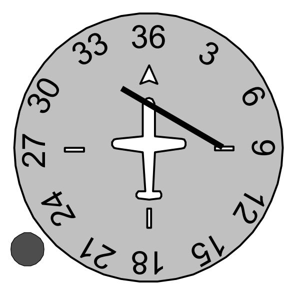
Or have you already passed it? How can you tell? It's easy! Mentally pick up the omni head - just lift it right out of the panel! Mentally rotate it so that the OBS heading - 090° - lines up with the 090° on your heading indicator.



Visualize placing the rotated omni head right on top of your heading indicator, as in the next figure.



When you mentally rotated the omni head, CDI needle rotated also - as if it were glued to the same relative position on the instrument. On the combined instrument notice that the CDI needle is in front of the little airplane in the center of the heading indicator.



This means that the airplane (you) have not yet reached the 090° radial. If you had passed the 090° radial, the needle would be behind the little airplane. This procedure works correctly regardless of the indication on the TO/FROM indicator. The TO/FROM indicator only tells you if you are east or west of the VOR, but not on which side of the 090° radial you are.

If you had dialed in the 270° radial instead of the 090° radial, the method still behaves properly! The CDI needle would be positioned on the other side of the instrument. Again, envision picking up the omni head and place it on the 270° position on your heading indicator. As before, the needle is in front of the little airplane on the heading indicator - you have not reached the radial yet, or in this case, the extension of the radial through the VOR station.

Caution: do not actually pull the omni head out of the panel especially if it is your own airplane! Do it only if it is someone else's airplane and you do not like him very much.

Why does this method work? If you think of a VOR as the hub of a bicycle wheel, and a radial as the direction of one "spoke" as it leaves the wheel, you can imagine the other end of the radial having its magnetic bearing imprinted on it. When you are flying towards the other end of the radial, the CDI will tell you whether the radial is to your left or to your right. But if you are flying in some other direction, "left" and "right" has no meaning. So "left" and "right" on the CDI only makes sense if the CDI is facing in the direction that its OBS is set to. And that is what you are doing when you visualize pulling the omni head out of the panel and rotating it to face in the direction that the OBS is set. You are (mentally) facing the CDI in the direction that its OBS is set to.

The next time you are flying on an airway and want to know if you have reached an intersection or crossover point, practice mentally picking up your omni head, rotating it and placing it over the heading indicator. You will never again have to remember any rules of thumb to determine radial passage.

8. IFR Topics

How to Legally Fly Enroute IFR Using a VFR-Only GPS

Most GPS receivers are not approved for enroute IFR. So how can you legally use your VFR-only GPS during enroute IFR? You cannot file /R for RNAV since your GPS is not a legal RNAV (area navigation) device. You cannot legally use a GPS route between two VORs = you must use the VORs - even though we all know that the GPS is more reliable and much more accurate.

The good news is that ATC personnel realize that more and more pilots are GPS equipped. In fact, they almost assume you are. Let's say you want to bypass a VOR or two and fly directly to the VOR near your destination. Your VOR receiver cannot even pick up the destination VOR, let alone track to it. But your GPS can.

Here is what you do. Use your GPS to determine a heading that will track you directly to the destination VOR. Call ATC and ask for a vector but you provide them the requested heading. For example:

> "Request heading 120 until able ABC VORTAC direct"

This gets you and ATC off the legal hook. They gave you a vector and you can "monitor" your progress with your GPS. (and if the wind changes appreciably, ask for a new, pilot supplied, vector). But who is going to know that you are really tracking a GPS course? ATC knows what you're doing, but it keeps everyone legal and happy.

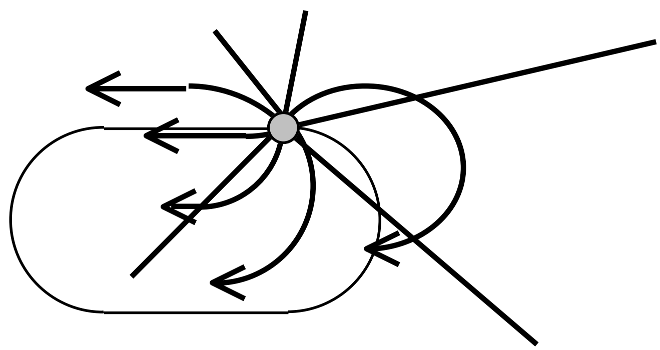
Holding Entries Made Easy

The purpose of a hold is to delay you. If ATC could, they would ask you to just stop. But airplanes will fall out of the sky if they stop, so they have to keep flying. Someone invented the holding pattern as a way to stop the progress of an airplane. If you are told to hold, remember, ATC is merely delaying you. The first thing to do is slow down, with ATC approval. Why rush to the holding fix if it is a delaying tactic? By slowing down, you may avoid having to hold as long, or hold at all.

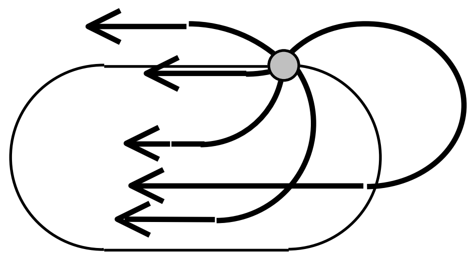
Holding consists of just hovering around holding fix at the correct altitude. ATC doesn't care at all what your holding pattern really looks like. Just stay close to the fix, on the holding side and maintain altitude. If you do this, you won't hit the terrain or another airplane. So just fly a reasonable racetrack holding pattern. If your timing and track isn't perfect, who cares?

Without using the fancy FAA recommended entry rules, just remember the following principals.

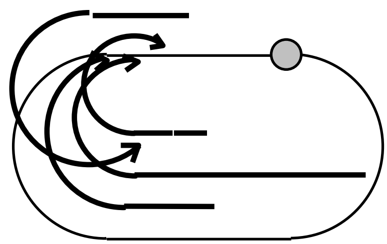
- Fly directly to the holding fix.
- Turn outbound, turning in a direction to stay tight on the protected side of the hold.



- Fly the outbound course for 1 minute.



- Turn towards the holding fix, staying in the holding side and taking wind drift into account

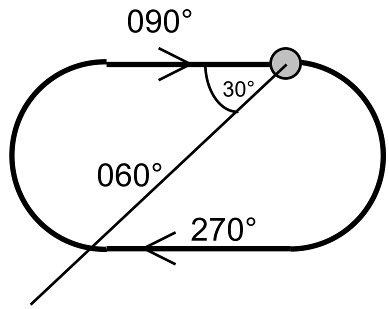


Relax. You shouldn't become tense when you are simply delaying. To make the holding easier, you can

- ask ATC for two minute legs.
- home back to the fix if you are holding at an NDB or locator beacon. It is easier to home than to try to track, and you will not drift very far on only a one or two minute leg.

HOLDING WITHOUT A TIMER

Rather than timing the outbound leg, use the navaid to determine when to turn inbound. Intercept a course 30° off the inbound course. Below, the inbound course is 090°. When on the outbound leg, twist the OBS to 060° and fly heading 270° until the CDI needle centers. Then set the OBS to 090° while turning inbound to intercept the 090° course.



This method is even easier with the NDB. On the outbound leg, turn inbound when the ADF needle 30° off your tail. And there is nothing to twist on each lap of the hold.

ANATOMY OF AN APPROACH CLEARANCE

If you understand the simple components of an approach clearance, you will easily be able to read back the important parts, skip the unimportant items, and know what to do next. Here is an example of a approach clearance that you would expect after being vectored around for awhile:

> Five miles from LEMON
> Turn right heading 165
> Maintain 2,600 until established
> Cleared for the ILS 19R approach
> Contact the tower at Lemon.

Once you are given this approach clearance, read back the important parts, and then say to yourself, *"headings and altitudes are now up to me."* The controller is finished with you. You're on your own!

Let's break this down to its individual components and see what it means.

Five miles from LEMON - How far you are from the final approach fix. This is to make sure that you and the controller agree on your position. If you have been keeping track of your position - as you should be doing - then you should know where you are and this part of the clearance should be no surprise to you. You need not repeat this part during your readback.

Turn right heading 165 - The final approach heading will be within 30° of the final approach course. It must be, by law! The controller is required to turn you within 30°. Because "headings and altitudes are up to you," don't become fixated on 165°. Use whatever heading will work to intercept the final approach course. Because this is just an approximate intercept heading within 30° of final, you need not repeat it back to the controller, either.

Maintain 2,600 until established - This is important. Read it back. You must maintain this altitude until you are established on the final approach course. What does "established" mean? On a VOR or ILS, when the CDI is "alive" - that is - not on the peg. For an NDB, when withing 10° of the final approach course.

Cleared for the ILS 19R approach - You must be told you are cleared for the approach - not merely told to intercept the final approach course and track inbound. Again, once you are given this approach clearance, read back the important parts, and then say to yourself, *"headings and altitudes are now up to me."*

Contact the tower at Lemon - This will sometimes be included at the time the approach clearance is issued, or it may be given later or not at all. In any case, after crossing the final approach fix and doing your 6T's, the last one is "Talk," Talk to the tower.

An appropriate readback for this clearance would be,

> "Maintain 2,600, cleared for the ILS runway 19R."

That is really all you have to say. The rest of the clearance needn't be read back.