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25 Questions

Answers That Every Pilot Should Know

By Budd Davisson

There are about a million pieces of information that are woven together to become the fabric we call aviation. Some of that information falls under the category of regulations. Other facts deal with specific aircraft operations. Still more information is of such a general nature that we often assume we know it because it is so basic, when in fact maybe we don't. We've made a random selection from this last category of information, knowing full well that we haven't made a dent in the total. In our estimation, these are facts and concepts every pilot should know and understand. There are many others we could have selected, and we invite readers to submit items that they think should be added to this list.

1. Why do higher temperatures decrease performance?

Airfoils and engines share one characteristic in that their performance hinges on the density of the air. When the air expands because of the heat, the molecules are driven apart, and there is a lower weight of air per cubic foot than there is when the air is cool. As a result, the wing can't extract as much energy from the same airflow and requires higher speeds to get the same effects. The engine, which essentially is an air compressor, can't find enough air to gulp down, so the fuel/air ratio is too rich for efficient combustion and you have to lean it out. The result is that the engine is turning out less horsepower - and it is trying to put that energy into the slipstream through a propeller whose efficiency also is compromised by the higher temperatures. These further compound the degraded performance potential of the wings.

2. What is the actual purpose of the rudder?

It is instinctive to think that the rudder is there to guide the airplane right and left. Except it's not. In most flight conditions the rudder is there to counteract adverse yaw. Adverse yaw is the unwanted byproduct of the imbalance of lift from one wing to the other and the associated drag that occurs while making an airplane bank. Far too few pilots have this fact at the core of their aerodynamic understanding. It's pretty basic that dropping an aileron gives one wing more lift than the other, so it goes up, causing the bank. However, nothing is free in aviation, especially lift. More lift causes more drag, so the wing that is going up - the outside one in a turn - has more drag, but only while it is in the process of being lifted into the bank, not while it's in the stabilized turn. Also, the inside aileron is reducing lift, which reduces drag on the inside wing (differential aileron deflection was designed to combat this effect). This causes the outside wing to be momentarily dragged back, and the rudder is used to keep it from pulling the nose sideways. So, every single time an aileron is deflected for any reason, rudder must go with it or it will produce a little waggle of the tail/nose and, for that instant in time, the airplane is operating at reduced efficiency. The rudder is also there to counteract forces like torque, p-factor, and slipstream that cause the airplane to yaw.

3. What effect does moving back the center of gravity (CG) have on an airplane's handling? Moving it forward?

As the CG moves aft, it takes away some of the airplane's stability in pitch until, as it goes far enough out of the back of the envelope, the airplane hits neutral stability. Here the nose stays anywhere you put it, and it doesn't want to return to neutral. Move the CG further aft from that point and the nose wants to move away from level flight rather than toward it, because you're into an area of divergent stability. This situation most often leads to an accident because it's nearly impossible to damp out the oscillations by hand. When loaded toward the rear of the allowable envelope airplanes are generally slightly faster, but they are more sensitive in pitch. Moving the CG forward has the opposite effect. The airplane gets increasingly stable in pitch. The CG envelope dictated by the pilot's operating handbook (POH) keeps the CG away from either extremes of behavior by a sizable margin.

4. If your static port gets plugged, how do you get your instruments to work, and which instruments are affected?

Some instruments depend on the differential between two calibrated air pressures to generate a reading. One of those pressures is always a static pressure, as measured by a static port somewhere on the airframe or the pitot tube. If the static source is lost for some reason, and your aircraft is old enough that you don't have an alternate static spigot in the cockpit, you only have to break the glass on one instrument face to let air into the system and create an in-cockpit static source. The vertical speed indicator is a good one to smack, as it's not critical to most flight operations. The instruments that need the static port include the altimeter and airspeed indicator. Be advised, however, that using the cockpit as a static source will make the instruments work, but they won't be as accurate as they were before.

5. What color are the lights on each wing tip and why?

Just remember R stands for red, right, and (w)rong. So, if you see a set of nav lights ahead of you and the Red is Right, it's Wrong and the airplane is coming at you, not going away, and this might be a good time to immediately be somewhere else. The left light is red, and the right light is green. Anything else is wrong. Also, the tail light is white and, if you can see it, it verifies that you're behind the airplane.

6. What is the effect of weight on takeoff roll?

This rule of thumb along with those that follow came from an old Cessna POH. A 10-percent increase in weight increases the takeoff roll by 20 percent.

7. What is approximate effect of a 10-degree Celsius (18-degree Fahrenheit) temperature increase?

This increases takeoff roll by 10 percent.

8. What is effect of an upward-sloping runway?

You've got gravity working against you, and a 2-percent slope (60 feet on a 3,000-foot runway), which isn't drastic, increases takeoff distance by 10 percent.

9. What is the effect of a tailwind on takeoff?

A wind that is 10 percent of your stall speed increases the ground speed required for takeoff by 20 percent.

10. What is effect of grass, both damp and dry?

Dry grass increases the takeoff run by 20 percent to 25 percent. Wet grass increases the takeoff run by 25 percent to 30 percent. A soft surface adds 25 percent to the above.

11. The performance charts in the POH are based on what weight and conditions?

This is a trick question because not all POHs are the same, and that's the point we're trying to make. All of the major manufactures quote their performance specifications at "standard conditions," which is universally accepted to be approximately 15 degrees C at sea level and gross weight. The major POHs may also include charts at different weights and temperatures/altitudes. A few manufacturers show their performance at nonstandard weights and conditions. Most will state those conditions somewhere on the chart, but you may have to look closely to find them. One of our favorites is the POH for a noted STOL airplane that includes a notation in tiny mouse-type that says, "Performance shown with two people and half fuel." So, read the fine print.

12. What does the skid ball indicate?

The skid ball is simply reading sideways force - centrifugal force, really - that indicates the airplane is sliding one way or the other. It is a direct indication that the pilot didn't really believe the answer to Question 2 and is driving his airplane around using insufficient rudder.

13. What is the effect of the ball's being off-center?

If the ball is off-center the airplane isn't aligned with its direction of travel and is going through the air slightly sideways. This not only causes excess drag, which slows the airplane, but if it is climbing or gliding, the plane is not performing as it should be. If the ball is on the inside of a turn, as during a gliding turn, the airplane is making a wider, slower turn. Lowered aerodynamic efficiency could also be viewed as wasted gasoline, as a lot of horsepower is burned up trying to overcome the unnecessary drag.

14. At what point do most flaps begin generating more drag than lift?

There are four basic types of flaps: split, plain, and Fowler; the last two can be slotted. On modern general aviation aircraft the plain hinged (Piper, Mooney) and Fowler (Cessna) flaps predominate. Although it's not cast in concrete, it is generally accepted that the first 15 degrees of flaps generate almost pure lift, and as you go past that number, the ratio of lift to drag decreases until the last 15 degrees generates almost nothing but drag. Fowlers are more efficient in the lift category because they also track back as they extend, so they increase the effective wing area. Since most of their breed are also slotted flaps, they generate more lift than simple hinged flaps.

15. Can you slip an airplane with the flaps down?

This depends on the airplane and type of flaps. However, never assume a full-flap slip is kosher until checking it in the POH - then make sure you read exactly what it says. Some Cessnas, for instance, say that full-flap slips "aren't recommended." It doesn't say they are prohibited. What is likely to happen, if an airplane is marginal in this area, is that the elevator effectiveness will be adversely affected by the airflow over the flaps. Usually, the airplane pitches up and down, causing a weird sensation that's not necessarily dangerous as long as the pilot doesn't fight it too vigorously. This generally only happens at high angles of slip and full flaps. Slight slips almost never cause a problem, but check the POH for restrictions. There are a lot of old wives' tales that say slipping with flaps will always cause an airplane to pitch down uncontrollably, and that's just not the case.

16. What is necessary for an airplane to spin?

An airplane requires both yaw and a critical angle of attack (stall) to spin. If it doesn't have both, it may spiral, but it will not spin. Excessive angle of attack causes the airplane to stall, which is bad enough, but if the ball is off center and enough yaw is generated, the wings enter their respective stalls at different times, causing an imbalance of both drag and lift which causes the airplane to autorotate about a vertical axis. If you stall on the base-to-final turn and the ball is centered, the airplane will roll to the outside of the turn and you'll just have to recover from the stall. It will not spin. If the ball is off-center, however, the airplane will want to snap opposite to the direction that the ball is out. So, if you are dragging the nose around the turn with inside rudder, but trying to hold the bank angle with outside aileron, the ball will be forced to the outside of the turn, and the airplane will snap over the top to the inside of the turn. You must rectify both the yaw and the angle of attack to recover - but at such a low altitude, even an immediate response will not guarantee recovery.

17. What weather characteristics separate a cold front from a warm front?

This is Weather 101, but with a couple of these facts, you can at least make generalized forecasts of conditions along a front. A cold front is characterized by a narrow, relatively sharp band of weather, almost like a vertical wall, caused by advancing cold air that displaces warmer air ahead of it. It'll be accompanied by more violent characteristics and possible storms in front of it, but it tends to be fast moving, may be fairly dry, and the weather behind it will clear up quickly. Plus, you'll clearly see the weather it contains coming. A warm front is harder to read and is preceded by advancing warm air riding up and over a colder air mass. The weather/clouds on top will spread out in front at high altitude, arriving as high, thin clouds that thicken and slowly work their way toward the ground as the front approaches, then go back up as it passes. So, the front arrives as a forward-leaning, inclined wall of clouds. Warm fronts tend to have more moisture associated with them and are generally slow-moving. These are all oversimplified rules of thumb, and they are not substitutes for checking weather carefully.

18. What are the basic cloud types, their appearance, and characteristics?

The four types are cirrus (long, streaky, and high), stratus (thicker, even layers), nimbus (darker, ominous), and cumulus (lumpy, high in the middle, more definite edges). Cirrus and stratus just lie there as relatively benign layers that hinder visibility. Nimbus can have almost anything in them and love to combine with other types to bring in moisture and other stuff we don't like. Cumulus (cu's) are vertical developments that, even when they are babies, are always full of - and floating on top of - turbulence. When Cu's grow to full size, they are 400-pound gorillas, and you let them go where they want and get out of their way. Cumulonimbus combinations are bad news no matter how you slice it. Again, generalized rules of thumb, but good enough to guess what kind of ride to expect around the clouds.

19. What are pros and cons of flying an approach faster than placarded glide speed?

The POH's best glide speed is where the airplane flies most efficiently with power off and lets you cover the most horizontal distance for the least vertical distance. Going slower or faster than that speed costs in distance flown. In other words, you are losing more altitude than is necessary. Also, the airplane will react differently during the flare. If the airplane is slow, it won't have as much energy when asked to flare, and it will tend to sink right through ground effect. If it is fast, it will float much farther than usual and leave lots of perfectly good runway behind it. Of course, you normally would use power to adjust your approach path's vertical profile to compensate for airspeed and/or altitude gains or losses.

20. Are runway headings magnetic or true, and how accurate are they?

They are magnetic and are rounded up or down to the nearest 10 degrees. So, by setting your directional gyro to the runway heading, you could be off by as much as 5 degrees.

21. What is the effect of best-rate versus best-angle climb speeds?

For once, an aviation term is self-descriptive. The best-rate airspeed will generate the fastest rate of climb, but, if you're worried about an obstacle at the end of the runway, it may not get you up quickly enough to clear it. The best angle of climb speed won't gain the altitude as quickly but will do it in less distance traveled horizontally, so you cover less ground and will clear the obstacle. Best-angle airspeed is always airspeed than best rate, but don't guess at the speed. Look it up in the POH, because trying to climb at too slow an airspeed will cause both a slower rate and a flatter angle - and put you in the trees.

22. When you're climbing, does the best rate of climb speed increase or decrease with altitude?

Check your POH. If it is a good one it will give you lower best-rate speeds for higher altitudes.

23. When climbing, what is the difference between a right and left turn?

You need no rudder input when initiating a climbing left turn; instead, it needs a decrease in the amount of right rudder being used to reduce what are usually called torque effects. In a high-powered airplane in a steep climbing left turn, you may have to hold right rudder to keep the ball centered. Turning right requires right rudder in addition to what is needed to keep the ball in the center during climb.

24. What direction does the ball go and which direction does the nose go when you reduce power and set up a glide?

The nose goes right and the ball goes left, indicating that you need left rudder to keep the nose in front of you. Depending on the airplane, you may have to carry a significant amount of left rudder throughout the entire approach to keep the ball centered. If you don't, you'll give up much more altitude than is necessary.

25. What kinds of changes do you make to your approach speed on hot days or at high altitudes?

This is another trick question. The answer is, none: You make no changes at all. The effects of temperature automatically show up in the indicated air speed (IAS) because the air is thinner, so the airplane has to be moving faster to cram more air than normal into the pitot tube to give the same IAS. Whether you want to or not, you'll be moving across the ground at a faster rate while still indicating the normal approach speed.

How'd you score? Pretty good, right? Now think about some areas in your knowledge that are still a little vague and send them along. Maybe we'll compile and publish a reader's list of facts we all should know - or a roster of things we don't understand.

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