

# PRIVATE PILOT COURSE STUDY GUIDE

## WITH ANSWERS



# Course Study Guide

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This guide is intended to help students prepare for the Flight Apprentice end-of-course practice exams, which mimic the real FAA Private Pilot Written Exam. It contains a summary of the information presented in the Private Pilot Online Ground School, including all of the 'Flashcard Questions'. We have also included questions designed to help you apply concepts so that you are prepared, not only for the written exam, but for the real world.

We recommend that you take your time while reviewing this material. In particular, if you don't understand a concept, be honest with yourself and take extra time to learn that material. It will pay dividends in the end: applicants with higher written exam scores often have an easier time on the oral portion of the checkride. Plus, if you put in the work now, you'll know that much more, and have that much more confidence when it's game time.

This guide contains not only the review questions, but the answers as well. If you are looking for only the questions, check your 'Flight Bag' for the Course Study Guide without the answers.

We are dedicated to providing the very best material that we can. If you find any errors, confusing phrasing, or have any recommendations for changes to this guide, please don't hesitate to reach out to us at [support@flightapprentice.com](mailto:support@flightapprentice.com), on social media or at [FlightApprentice.com](http://FlightApprentice.com)

Thanks for your continued support,

The Flight Apprentice Team

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## PILOT QUALIFICATIONS

### LEGAL

Do you need to have your pilot's license with you when you fly?

**Yes.**

What three documents must you carry with you when you fly?

**Pilot Certificate, Medical and Government Issued Photo ID**

Does a private pilot need to carry a logbook? What about a student pilot?

**Private Pilot does not, but a student pilot likely will. When a student pilot flies solo he/she receives written endorsements that give them legal permission to operate under certain conditions. Without these endorsements, the student cannot fly solo and these endorsements are almost always in the logbook.**

When does your medical certificate expire?

**Make sure you know when your medical will expire. For 3rd class medicals, you will need to renew after the 60th calendar month if you are under 40 years of age, and after the 24th calendar month if you are 40 and older. You can consult our "All About Medicals" handout in the Flight Bag for more information.**

*You arrive to the airport only to realize that you've left your logbook at home. As a private pilot, can you still fly?*

**Absolutely. In fact, it is recommended that you don't carry your logbook when you fly. Keep it somewhere safe.**

*You recently lost your wallet, but you have a student ID in your backpack. Can you use that to fulfill the photo ID requirement?*

**No, the ID must be government issued.**

*Your friend has a 3rd class medical issued July 17th, 2018 and is 41 years old. What is the last day she may use her medical certificate?*

**July 31, 2020.**

*Your friend has a 1st class medical issued Aug 15th, 2018 and is 34 years old. What is the last day he may use his medical certificate for an operating requiring 3rd class privileges?*

**August 31st, 2023.**

## FITNESS FOR FLIGHT

Why would you personally not want to fly sick?

**Being sick lowers your ability to focus, make decisions and slows your reaction time.**

What are the rules regarding alcohol consumption and flying?

**Pilots cannot fly within 8 hours of acting as a pilot, nor may you have a blood alcohol content BAC of .04% or higher.**

*Your dog just died a few hours before you were scheduled to go fly with a friend. Are you safe to fly?*

**Maybe, and maybe not. The challenging part about psychological factor is that they vary from person to person. Generally speaking, most new pilots should avoid flying immediately after something like that.**

*You wake up for a 5am flight, have a quick cup of coffee while you review the weather and head out. Your return by noon, only to find a friend waiting at the airport clubhouse. He seems eager to fly and asks you if you can take him flying. What might you consider in your IMSAFE assessment?*

**You have been flying all morning and have not had anything to eat that day. You should consider eating before you go on another flight.**

*Is the IMSAFE assessment a legal requirement or just good practice?*

**The IMSAFE assessment is mostly good practice, but certain components like the rules regarding medications with adverse affects and alcohol are regulatory as well.**

## ADM

What does ADM stand for?

### **Aeronautical Decision Making**

What are some examples where pilots are often called upon to exercise good ADM?

**Deciding whether to continue into marginal weather or divert**

**Deciding whether to stretch remaining fuel or stop and fill up**

**Deciding whether they are flying methodically and paying attention to the decisions they make, or simple reacting to situations as they arise.**

*These next questions are more to get you thinking about applying ADM in the real world...*

Can experienced pilots neglect ADM?

**They can, but should not. If anything, as pilots gain experience ADM should become a more ingrained model as they use it more and more.**

You're flying to a wedding, and are running late. Headwinds were slightly higher than expected, but you're fairly confident you'll have enough fuel. What will you do?

**We don't fly "fairly confident" that we'll have enough fuel. We either do or don't and in this case it sounds like we don't. Take the delay, add fuel.**

Now you're in flight and surprisingly receiving good tailwinds. But your right fuel gauge is decreasing alarmingly fast. What do you do?

**Something is not right. Check outside to see if you can see any fuel leaking. If you are in a high wing airplane, the fuel cap may be off and you may not realize it. Safer to make a quick stop and check.**

*Can someone be a good pilot and still exercise poor ADM?*

**That depends entirely on what we think of when we say a "good pilot". Can someone have great stick and rudder skills and lack good ADM? Absolutely. But truly good pilots are both skilled in stick and rudder flying and exercise good decision making.**

*You are returning to land at your home airport which is relatively remote. The airport does not have a weather station, and you fly over the airport to check the windsock only to realize that the only open runway has a crosswind that exceeds your skill level. The only other possible landing surface is a taxiway that faces into the wind. Alternatively, you can proceed to a neighboring town which has more favorable weather, but is about 30 minutes away. You have 40 minutes of gas. What will you do?*

**Land on the taxiway. It is undoubtedly the safest option. You should not attempt to land in winds that exceed your skill level, nor should you try to push to the next town, and risk running out of gas.**

CRM

When could a general aviation pilot use CRM?

**Any time you fly with another pilot is an opportunity to use CRM.**

*You're flying with a friend who is also a pilot. He wants to fly into an area of marginal weather and neither of you have an instrument rating. He assures you that his GPS has an amazing terrain feature and it's so simple that anybody could figure it out. How do you approach this situation?*

**Try to explain to your friend the risks involved in doing that. Accidents involving spatial disorientation don't usually result from pilots getting lost in the clouds. They get disoriented as to their pitch and bank, not being used to relying entirely on the instruments for spatial awareness. They then either exceed airframe limitations, causing an in-flight break up or hit the ground.**

SRM

What resources do you specifically have to use?

**Here are just a few of the resources you may have available..**

- **ATC**
- **Navigation Radios**
- **GPS**
- **Other Pilots**
- **Passengers (have them grab something you need, hold a chart, etc)**
- **Autopilot**
- **iPad/Cell Phone (i.e. in a lost communications emergency you can call ATC on your phone)**

What is the problem with relying on GPS during all of your flights?

**Over-reliance on GPS can make you complacent at remembering how to navigate other ways, such as using navigation stations or, more importantly for VFR pilots, looking outside.**

Why should pilots know how to use all systems available to them?

**Pilots can reduce their workload and increase their ability to accomplish tasks when they know how to use their resources wisely.**

*You're flying into a very busy airspace environment and you know that you are task saturated between navigating and coordinating with ATC. You have autopilot available, but you know that pilots who use autopilot often become reliant upon it, so you elect to leave it off. Is this good SRM?*

**No, this would be a great time to turn the autopilot on so that you can focus on other tasks.**

*You are flying at approximately 6,000 feet AGL when you experience an engine failure. You are halfway through a 100nm flight, near an area you aren't particularly familiar with. What resources do you have available to you?*

**The big resource available to you here is ATC. If you don't know where the nearest airport is, ask for vector to the nearest airport and declare your emergency.**

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## AIRWORTHINESS

### DOCUMENTS

What are the ARROW Documents?

- **Airworthiness Certificate**
- **Registration Certificate**
- **Radio Operators Permit (Int'l Only)**
- **Operations and Limitations Handbook**
- **Weight and Balance Paperwork**

When is a Radio Operator's permit required?

**Only during international operations.**

What **must** be on the weight and balance data?

**The weight and balance information and a *signature* from an authorized A&P mechanic.**

*Your local flight club recently bought a new, cheap Cessna 172. The club owners casually mention that the previous owner lost the Operations and Limitations Handbook for the aircraft, but they were able to find one for the same make and model online. They downloaded and printed it and left it in the airplane. Does this fulfill the legal requirement for the Operations and Limitations Handbook?*

**No! The handbook must be the one assigned to that particular serial number airframe. The club will need to contact the manufacturer to get a replacement.**

*You remove the rear passenger seats in your Beechcraft in order to use it for baggage. Do you need a new weight and balance data sheet?*

**Yes. The weight and balance of the airplane has been appreciably changed.**

## INSPECTIONS

What is a calendar month?

**A calendar month is the time period from the current day to the last day of the next month. For example, if today's date is October 17th, one calendar month from now is November 30th.**

What inspections are due every 24 calendar months?

**Transponder Inspection**

**Pitot-Static Inspection**

Is the pitot-static inspection required for VFR only aircraft?

**No. The pitot-static inspection is an IFR requirement.**

What are the inspection time-frames for the ELT?

- **12 calendar months**
- **1 hour of cumulative use**
- **When 1/2 of the battery life has been exceeded (based on expiration date on the battery)**

What kind of mechanic is needed to complete an annual inspection?

**A&P with Inspection Authority (normally referred to as an "IA")**

If your transponder test was last completed in February 2018, when will it expire?

**February 28th 2020.**

Memorize the acronym for either A1TAPE or AV1ATE.

- **Airworthiness**
- **100 Hour**
- **Transponder**
- **ADs**
- **Pitot-Static**
- **ELT**



Or

- Annual
- VOR
- 100 Hour
- Altimeter/Pitot-Static
- Transponder
- ELT

*Your last annual inspection was completed on June 15th, 2018. What is the last day your airplane may be flown before a new annual inspection is required?*

**June 30th, 2019**

*Your friend just became an A&P mechanic, and you'd like him to perform and sign you off on your next annual inspection. Do you foresee any issues with accomplishing this?*

**Your friend almost certainly does not have IA after just completing A&P certification.**

*You arrive to fly your flight school airplane on a day VFR flight only to realize that the Pitot-Static inspection is overdue. Are you legal to fly?*

**Yes, the pitot-static inspection is required for IFR flight only.**

*In the previous scenario you fly, and then come back to give the airplane to the next pilot who is panning to take it on an IFR flight to an airport with marginal weather. Is there anything you might mention to him?*

**Yes, he cannot legally fly IFR without complying with the pitot-static inspection.**

*Can you fly with an expired transponder inspection if you are only flying in airspace not requiring a transponder?*

**Yes, but in that case the transponder should not be used.**

## DAY AND NIGHT VFR REQUIREMENTS

Memorize ATOMATOFLAMES and FLAPS

- Anti-Collision Light

- Tachometer
  - Oil Pressure Gauge
  - Manifold Pressure Gauge
  - Altimeter
  - Temperature Gauge
  - Oil Temperature Gauge
  - Fuel Quantity Indicators
  - Landing Gear Position Indicator
  - Airspeed Indicator
  - Magnetic Compass
  - ELT
  - Safety Equip
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- Fuses
  - Landing Light
  - Anti-Collision Light
  - Position Light
  - Source of Electrical Power

When is a manifold pressure gauge required? Do you have a manifold pressure gauge in your airplane?

**A manifold pressure gauge is only required in airplanes with “altitude engines” which generally means an airplane with a constant speed propeller.**

What is the difference between a temperature gauge and an oil temperature gauge?

**A temperature gauge is required for liquid cooled engines, and an oil temperature gauge is required for air cooled engines. Both gauges are intended to tell you whether your engine is being cooled properly. An overheated engine can seize and stop running. Most training airplanes have air cooled engines and therefore require the oil temperature gauge.**

When is the night-VFR equipment required? Is it sunset, end of evening civil twilight, etc?

**Night VFR equipment is required from sunset to sunrise. The issue of evening civil twilight to morning civil twilight has to do with logging of night time, not required night equipment.**

*You rent a 1960s Cessna 170, which you notice does not have a working anti-collision light. You inquire to the flight school about this, and they say that it's not legally required. Are they correct?*

**Yes, they are correct. Anti-collision lights are only required during daylight operations for airplanes certified after June 1996.**

*You are out for a late afternoon flight, and expect to land just before sundown. You don't have any of the required night VFR equipment on board. As you return to the airport, you are told that the only runway is closed because an airplane landed gear up. You have 5 minutes until sunset, 30 minutes of fuel and there are several other airports within a 10 minutes flight. What do you do?*

**You should immediately divert to one of the other nearby airports and land. It will put you slightly past sunset, which is technically illegal, but it is far safer than continuing to wait for the first airport's runway to reopen as you burn into the last remaining fuel and while it gets dark.**

**The other option you have is to land on a taxiway at the first airport. If that can be done safely, that is a possibility as well. But, because the issue is not a flight emergency requiring you to land immediately, but rather an issue of landing a few minutes after sunset, it is safer to just land at another airport than try to land on a taxiway at an airport with an active emergency situation (there are probably fire crews, other airplanes trying to move out of the way, etc).**

*You have invited a friend to go for a short night flight. It is a cloudless night with a full moon. When you preflight the airplane you find that the landing light is inoperative. Is it required for your flight?*

**No, it is not required, because the night is not for hire.**

## **INOPERATIVE EQUIPMENT**

What four steps are required to determine if one can legally fly with inoperative equipment? (without an MEL)

- 1. Is it required by 91.205? (TOMATOFLAMES, FLAPS)**
- 2. Is it required by AD?**
- 3. Is it required by the TCDS?**

#### **4. Is it required by the KOEL?**

Why would we want to disable/remove inoperative equipment?

- 1. Inoperative equipment could pose a fire risk, depending on the nature of the failure. Flying around with a powered system with a broken wire, for example, is not desirable.**
- 2. If an airplane is flown by multiple pilots, it is possible the other pilots will fly the airplane not realize equipment is broken and either anticipate using it only to realize it is broken or use it not realizing it is broken, possibly creating a safety issue.**

What is the TCDS?

**Type Certificate Data Sheet - This is paperwork that was furnished when the airplane was certified and often contains information about required equipment.**

What are ADs?

**Airworthiness Directives - These are changes that must be complied with in order to maintain an aircraft's airworthiness status. They come in two forms: One-time and Recurring ADs. ADs are issued when a manufacturing defect or design error is discovered.**

Know how to access (and ideally have a copy of) your aircraft's ADs, TCDS and, if you have one, KOEL.

**The ADs and TCDS are available from the FAA website at [faa.gov](http://faa.gov)**

**The KOEL will be located within your operations and limitations handbook.**

*You are the proud owner of a small airplane. You find out that the manufacturer has issued an AD to reinforce the tail structure. Compliance is required effective immediately. How long do you have until you cannot fly before complying with the AD?*

**Compliance is effective immediately, so you cannot fly until the AD is complied with.**

*You discover upon preflight that your airplane has an inoperative taxi light. It is daylight, and you'll only be out for about 30 minutes, so you decide to take the airplane and have the local mechanic fix it after you land. Is this legal? More importantly, is there any safety issue associated with this? How does the safety situation change if this is a club airplane that will be flown by other pilots later in the day?*

**No, it isn't legal. The safety issue is that the broken equipment has not been deactivated. This isn't a huge risk if you don't use it, knowing that it is broken, but the next pilot may not realize it is broken.**

MEL.CDL

What equipment is listed on the MEL? Is it broken equipment or working equipment?

**MELs list equipment that *can* be broken, and provide details as to how to properly deactivate and placard the broken equipment so that the airplane may still be flown.**

What does MEL stand for?

### **Minimum Equipment List**

*Your flight club airplane has an MEL. You preflight the airplane and find that the parking brake is inoperative. You look in the MEL and discover that there is no MEL for the parking brake. The flight club says that because it is not required equipment per 91.205 that you can legally fly it. Are they correct?*

**No. MELs must comply with 91.205, but once an MEL is being used, it must be complied with. If the MEL doesn't include the parking brake, there is no way to legally operate the airplane.**

### **AIRWORTHINESS REVIEW**

No review questions for this topic

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## **AERODYNAMICS**

### **FOUR FORCES OF FLIGHT**

If speed doubles, what happens to drag?

**Answering this question depends on your airspeed at the beginning: Parasite drag will increase by 4x, and induced drag will decrease by 4x. But, the total drag this results in is dependent upon what your speed was initially. If you were very slow, doubling your speed could result in less overall drag. If you were already moderately fast, then it will certainly increase your overall drag.**

What is un-accelerated flight?

**Flight when lift is equal to weight and thrust is equal to drag.**

*You are flying at 70 knots, with a parasite drag force of 400lbs. How does parasite drag force change when you increase your speed to 140 knots?*

**Parasite drag will increase by the square, so it will increase by 4x.**

*To establish an unaccelerated climb, what is required?*

**Excess thrust.**

*A 60 degree level turn results in a 2G loadfactor, meaning your airplane is effectively twice as heavy as it would be in unaccelerated flight. How much does lift increase?*

**In order to maintain level flight, lift will have to double as well.**

## AIRFOILS

What is the purpose of an airfoil?

**An airfoil is a surface that generates lift as a fluid flows across it.**

How does an airfoil produce lift?

**An airfoil produces lift by causing air to accelerate differently over each side of the surface, creating a pressure differential.**

What other components of the airplane are airfoils besides the wings?

- **Propeller**
- **Horizontal Stabilizer**
- **Elevator**
- **Stabilator**
- **Rudder**
- **Vertical Stabilizer**
- **Aileron**
- **Flaps**

What is the boundary layer?

**The boundary layer is a thin layer of air along the surface of an airfoil that is mostly static.**

What happens to pressure as the speed of a fluid increases?

**Pressure decreases as the speed of a fluid increases.**

What happens to the temperature of a fluid as speed increases?

**Temperature of a fluid decreases with speed.**

*You notice at an airshow that as a jet pulls tightly in a turn, vapor forms over the wings. Why is this?*

**As the jet pulls tightly it is increasing loadfactor and increasing lift. This increased lift causes air to flow faster over the wings, creating a low pressure and a lower temperature. The vapor forms when the temperature of the air reaches the point where it condenses.**

**This effect is not limited to jets. On very humid days it can be observed in smaller airplanes as well.**

*In what way does an airfoil act like a Venturi?*

**A Venturi causes a fluid to accelerate by constricting the area in which it flows. An airfoil moving through the air constricts the direct that air may flow, causing it to accelerate.**

*Your airplane can takeoff at 50 knots. You are taxiing at 10 knots into the wind when you experience a 45 knot gust. Could your airplane accidentally become airborne?*

**Absolutely. Wheel speed has nothing to do with lift.**

*You put your Cessna 152 on the world's largest conveyor belt which moves backward at 50 knots. You apply full power. Will the airplane, which requires 50 knots in order to takeoff, be able to takeoff?*

**Yes. It will take us a while to accelerate to the required speed (and we'll be traveling backwards initially), since we are effectively taking off with a 50 knot tailwind, but the airplane will still accelerate.**

AOA

What is AOA?

**The angle of attack is the angle between the chordline of the wing and the relative wind.**

How does lift change as AOA increases?

**Lift increases as AOA increases, assuming configuration and airspeed are equal.**

What is a stall?

**A stall is a loss of airflow over an airfoil as it reaches the critical AOA.**

What is critical AOA and why is it important?

**The critical AOA is the AOA that causes a stall. It is fixed for a given airfoil, meaning the airfoil will always stall when that particular AOA is reached.**

Does an airfoil's critical AOA change depending on airspeed?

**No.**

*A propeller is an airfoil. How do we change the propeller AOA?*

**We change the propeller AOA the same way we change the wing AOA: The changing our flight path using the elevators. When our wing has a greater AOA our propeller does as well.**

*In a level turn your airplane is closer to critical AOA that it is in straight and level flight, assuming the same airspeed. Why is this?*

**In a level turn, load factor increases. In other words, the airplane is heavier than it is in level flight and extra lift is required to maintain level flight. This extra lift usually comes in the form of an increased AOA.**

**In a very basic sense, the steps required to turn are to bank the airplane in the direction of the turn and then pull back to increase the AOA to maintain level flight. In other words, “roll and pull”.**

*How could an airplane be stalled at a high speed, in a nose down attitude?*

**If enough elevator deflection was used, the wings would still stall despite the nose down attitude and high speed. However, this would also cause a lot of undue airframe stress, and possibly exceed airframe limits.**

**Interestingly, AOA and yoke/stick position are tightly related. An airplane will reach critical AOA when the stick position reaches a certain limit, regardless of airspeed. But, the change to the flight path and load factor *leading up to* reaching that stick position could be drastically different depending upon speed. For example, at a high speed, pulling back abruptly would probably lead to a very high load factor, and possible stress the wings to the point of failure. At a slow airspeed, that same stick position would simply cause a slight rise of the nose followed promptly be the stall.**

*Do all airfoils have an angle of attack or just the wings?*

**All airfoils have an AOA.**

*Some airplanes have horizontal stabilizers in front of the wings (normally called a canard). Often these designs have are designed so that the canard reaches critical AOA before the wings. What is an advantage of such a design?*

**Canard designs often intend to have the canards stall before the wing, which results in a nose-down movement, reducing the wing AOA and preventing a stall.**



*You transition from a 80 knot climb to a 115 knot cruise. How has the AOA change as you level off?*

**The AOA decreases during level off.**

*During a turn from downwind to final, and airplane maintains the same descent rate, airspeed and airplane configuration. What happens to AOA through the turn?*

**AOA increases through the turn and decreases again upon rollout. This is why many low altitude stall/spin accidents occur during low speed turns in the traffic pattern.**

**DRAG**

*If you increase your speed at L/D Max, what happens to your drag?*

**Drag will increase.**

*If you are below L/D Max and speed up, what happens to your drag?*

**Drag will decrease.**

*Is the drag created by landing gear sticking out into the air flow considered parasite drag or induced drag?*

**Parasite drag.**

*What determines an airplane's best glide airspeed?*

**Vg is determined by finding the airspeed that has the lowest *combined* parasite and induced drag profile.**

*Down low near the ground, wingtip vortices are often broken up by the ground before they can fully induce drag on the wings. What effect might this have for airplanes landing or taking off?*

**Induced drag is reduced near the ground (usually at a height of 1/2 the wingspan), causing an airplane with excess speed to float down the runway on landing. One takeoff, it can cause airplanes to become airborne but unable to climb higher until they accelerate. This is known as ground effect.**

*Slow flight is a maneuver in which the pilot flies the airplane with flaps (and gear if, retractable) in the down position and sustains level flight at a slow airspeed. Often, slow flight requires a large amount of power to maintain level flight and sufficient airspeed. Why is this?*

**High power may be required during slow flight because the airplane has a lot of induced drag as a result of the low airspeed.**

## CHANGING LIFT

What 3 ways can a pilot change lift?

**Increase speed, increase AOA, change airplane configuration.**

How does a pilot change the AOA?

**By using the elevator/stabilator in conjunction with power.**

What wing shape generally generates more lift for a given airspeed/AOA? What generates less?

**A thick cambered wing will generate more lift for a given airspeed and AOA than a thin, symmetrical wing.**

Why does a higher airspeed create more lift?

**A higher airspeed increases the airflow across the wings. If any lift is being generated, more will be created as airspeed increases.**

*What flight control most directly is used to change the AOA?*

**The elevator.**

*There is a limit to how much lift can be increased by changing the AOA. What is this limit called?*

**Critical AOA.**

*If an airplane with a symmetrical airfoil has a  $0^\circ$  AOA, what will be its flight path? Will this change with an increase in airspeed?*

**The airplane will descend because a symmetrical airfoil at  $0^\circ$  AOA does not produce lift. An increase in airspeed will not cause lift to be generated. A positive AOA must be established.**

*Are elevator position and AOA directly linked? Are elevator force and AOA directly linked?*

**Elevator position and AOA are directly linked, but elevator pressure and AOA are not. Maintaining a given AOA will require different levels of force depending on airspeed.**

## FLIGHT CONTROLS

Which flight controls help us pitch? To roll? To yaw?

- **Pitch: Elevator**
- **Roll: Aileron**
- **Yaw: Rudder**

If an airplane rolls left, what do the ailerons do?

**The left aileron comes up and the right aileron goes down.**

How do the elevators move to pitch down?

**The trailing edge of the elevator moves down.**

What moves the flight controls? How does movement of the flight controls happen from the pilot moving the stick/yoke?

**In light training airplanes, flight controls are usually connected to the yoke/stick through cables and pulleys.**

*A fellow pilot tells you that an airplane cannot be turned without an elevator or equivalent pitch flight control. In what way are they correct?*

**In order to turn an airplane, it must be rolled and then loaded. Roll and pull. If an airplane is simply rolled and not pulled it will lose vertical lift, gradually descent but won't change heading in any effective manner.**

*Theoretically speaking, if a flight control was moved too far or too abruptly, could it cause the flight surface to stall? Why do you think this is generally not a concern in light training airplanes?*

**Yes, it could. Usually this is not a major concern in light training airplanes because such adverse tendencies have mostly been avoided through the design process.**

## ADVERSE YAW

What is adverse yaw?

**Adverse yaw is the yawing force generated from unequal lift and drag produced from using ailerons. It causes a rolled airplane to yaw towards the outside (opposite direction) of a turn.**

Once we are established in the turn, do we still experience adverse yaw?

**No, once the ailerons are neutral as they are in an established turn, we will no longer experience adverse yaw.**

How does the amount of aileron deflection change the magnitude of adverse yaw?

**An increased aileron deflection produces an increased adverse yaw effect.**

How does airspeed change the magnitude of adverse yaw?

**A decreased airspeed requires more aileron deflection to roll, thus increasing the adverse yaw effect. Adverse yaw is often unnoticeable in cruise, but very apparent at slower speeds.**

*At very slow airspeeds, some airplanes are able to slowly turn right by deflecting the ailerons in a slight left turn, and vice versa. Why is this?*

**This maneuver is accomplished by deflecting the ailerons *just enough* to create an adverse yaw effect, but never long enough to roll the airplane much. So the wings remain mostly level, but the airplane slowly yaws to the outside of the “turn” as a result of adverse yaw.**

## TURNING TENDENCIES

What is P-factor?

**P-factor is the unequal thrust generated by a propeller when the airplane is not aligned with its flight path and is most noticeable during operations with relatively high AOA. The angle between the descending and ascending blades and the oncoming wind produce more thrust on the descending blade (on the right side of the airplane, from the pilot's perspective). This causes the airplane to yaw left.**

What is slipstream?

**Spiraling slipstream is airflow that is pushed back by the propeller, which then spirals around the fuselage and strikes the vertical stabilizer and rudder, pushing the empennage (tail section) right and therefore yawing the nose left.**

What is torque?

**Torque is the left turning tendency that is the equal-and-opposite reaction of the propeller and crankshaft rotating right.**

What factors (airspeed, power, etc) affect each turning tendency?

**P-factor increases with power and AOA**

**Spiraling Slipstream increases with power and decreases with airspeed**

**Torque increases with power**

What flight regimes have the highest left turning tendencies?

**Takeoff roll, rotation, initial climb out and go around.**

How does a pilot counteract left turning tendencies?

**By adding right rudder.**

*Which is likely to require more rudder input, a turn to the left or a turn to the right? Assume starting from a neutral rudder position and all other variables being equal.*

**A turn to the right, because left turning tendencies help coordinate turns to the left.**

*What flight condition is likely to have the least amount of left turning tendency?*

**Low power descent.**

*A pilot is practicing slow flight, flying just above stall speed (just below stall AOA). Lacking sufficient rudder correction, the airplane begins a gradual left turn. The pilot corrects by adding right aileron and gently pulling back. The airplane promptly flips over to the left and nose dives. Why?*

**The pilot was not using sufficient rudder pressure to counteract left turning tendencies, which resulting in the gradual left turn. The correct response should have been to add right rudder. Instead, they applied right aileron, and adverse yaw increased the left yawing force. When they pulled back they stalled the wings and the airplane entered the first stage of a spin.**

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## SYSTEMS

### PARTS OF AN AIRPLANE

What is a semi-monocoque design? What about monocoque?

**A monocoque design is a design where the skin of the structure supports the load. A semi-monocoque design is similar, but includes extra reinforcing structures to help avoid structure failure during high loads.**

**Most light training airplanes, and many larger airplanes, use a semi-monocoque design.**

What is the advantage to using a frame and thin metal to build an airplane, instead of solid metal?

**Weight reduction.**

*Why is weight such a critical design factor in airplanes?*

**Airplanes cannot fly unless they can produce at least as much lift as they have weight (and in reality, need to be able to produce significantly more). Each additional pound of weight is a pound of lift that must be generated to sustain flight.**

**Furthermore, in a turn with load factor, each pound of weight is in fact much more than a pound of a lift that must be generated.**

*You are preflighting your airplane when you notice a wrinkle in the skin. Your friend, who is the owner, says not to worry about it because it doesn't change aerodynamics very much. Is there still a reason you might be concerned?*

**It may not change the aerodynamics, but a wrinkle in the skin could indicate a failure of an underlying structure. You should have the airplane checked out by a mechanic before flying.**

## PRIMARY AND SECONDARY FLIGHT CONTROLS

What are the primary flight controls?

**Elevators, Ailerons, Rudder.**

What are the secondary flight controls?

**Flaps and Trim**

In your airplane, how are the primary flight controls actuated? Cables? Hydraulics?

**This will obviously vary, but the vast majority of light training airplanes use a cable and pulley system.**

In your airplane, how are the flaps actuated?

**This will vary from airplane to airplane. Some systems are purely mechanical, using a large handle on the floor between the front seats, while other systems use an electric motor and smaller flap switch to control moving the flaps.**

In your airplane, how is trim actuated?

**Some airplanes have an electric trim, but almost all light training airplanes have a manual trim crank or trim wheel that uses a cable pulley system to trim the airplane.**

*Just before takeoff, you perform a flight control check. As you move the yoke to the left, the left aileron goes down and the right aileron goes up. Is this correct?*

**No! Your flight controls are reversed, which is obviously dangerous. Mechanics will need to remount the ailerons correctly.**

*While performing a flight control check you notice that there is a lot of resistance and a kind of jerky motion as you check the elevator. Is this normal?*

**No. Flight controls definitely shouldn't bind or have excessive resistance during control checks. Something could be interfering with the cable movement. Don't fly until a mechanic thoroughly inspects.**

*On your downwind to base turn you add the first flap selection and feel the airplane quickly steepen the turn. What may have happened?*

**Flaps have likely descended asymmetrically. In this case the up wing flaps came down more than the down wing flaps.**

**In this scenario it's best to avoid adding any more flaps, and land as is. Of course, a go around and second approach would likely be in order. No need to rush dealing with a flight control issue like that. Give yourself a nice long final to get stabilized.**

## PISTON POWERPLANT

What provides electrical power to the spark plugs?

**Magnetos**

What functions can exhaust heat serve?

**Exhaust air is often passed through a shroud which heats clean, cool air to be used for cabin heat, windshield heat and carburetor heat.**

How many magnetos are present in a 6 cylinder engine?

**Usually 2.**

How many spark plugs are present in a 6 cylinder engine? 4 cylinder engine?

**Usually 2 spark plugs per cylinder, so 12 spark plugs with 6 cylinders and 8 spark plugs with 4 cylinders.**

*You go flying with a long-time friend who is a car mechanic. Halfway through the flight, your alternator quits. Your friend is worried, thinking that the spark plugs will soon lose power and the engine will quit. What do you tell your friend?*

**Tell him that the spark plugs are powered by magnetos, unlike in most cars, and that the loss of the alternator has no bearing whatsoever on the continued operation of the engine.**

*In your airplane, fresh air passes through an exhaust shroud to provide cabin heating. One day, you turn on the cabin heat as you climb into cooler air, and immediately smell exhaust. What may be happening? What is the major risk? What will you do to mitigate that risk?*

**We likely have a leak in the exhaust shroud, causing exhaust air to mix with clean air. The major risk here is carbon monoxide poisoning, which can cause victims to experience decreasing performance and lose consciousness. We should immediately turn off the cabin heat and open vents to clear the exhaust smell. Tell a mechanic after landing.**

## CARBURETED ENGINES

What is the major disadvantage to a carbureted system?

**Carbureted systems are susceptible to carburetor ice, which can decrease engine performance or even cause an engine failure in extreme situations.**

What brings fuel from the float chamber to the venturi?

**The low pressure in the Venturi creates a suction force.**

What distributes fuel-air mixture to each cylinder after it passes through the venturi?

**The intake manifold.**

Describe how the throttle plate operates.

**The throttle plate is a butterfly valve which rotates to allow more or less air/fuel mixture to pass through.**

Mechanically speaking, how does the mixture control operate?

**The mixture control causes a valve to open and close in the bottom of the float bowl. When the valve is fully closed, fuel cannot flow into the venturi.**

What happens to air temperature inside the venturi? Why?

**Air temperature drops, because pressure drops as the fluid velocity increases.**

*You are flying on a humid day and notice the engine starting to run rough and see a drop in RPM. Suspecting carburetor icing, you turn carburetor heat on. You notice a drop in RPM. Is this normal?*



**Yes. Initial use of carburetor heat will cause a drop in RPM as warmer, less-dense air is introduced. However, this should be followed by a gradual rise in RPM as the ice is melted.**

*When you suspect an engine problem is related to carburetor ice it is imperative that you turn on the carburetor heat as quickly as possible. Why?*

**Usually carburetor heat is provided by passing cool air through the exhaust shroud. Should the engine fail entirely, the exhaust shroud will lose heat and eventually be unable to provide the heat needed to provide carburetor heat. In this situation, it is very unlikely you'll be able to restart the engine.**

## FUEL INJECTED ENGINES

Describe how a fuel-injection system differs from a carbureted system.

**A fuel injected system delivers fuel directly to each cylinder through a spider valve which meters fuel to each cylinder.**

What is the role of the spider valve?

**To meter fuel.**

What are the advantages and disadvantages of a fuel injected system?

**Advantages: Fuel injected system are not susceptible to carburetor ice, which is the major advantage. They can also allow for more accurate fuel metering, which can decrease fuel burn and provide for more efficient engine operation.**

**Disadvantages: Fuel injected systems can experience vapor lock in warm conditions which can make starting the engine hard.**

*A pilot goes out to their fuel-injected airplane for a return trip back home after a quick lunch at the airport restaurant. It is a hot summer day. They crank the engine, but cannot get it to start. What is likely the problem? What is the solution?*

**The airplane is likely vapor locked. In order to fix the situation, the pilot should flood the engine just a little bit to push fuel through the lines. Then he/she should start the engine using the corresponding flooded start procedure.**

**In simple terms, the pilot will push fuel through the lines until the vapor is removed. Then perform a flooded start, which basically means starting the engine without introducing fuel right away (as there is already enough fuel in the cylinders).**

## FIXED PITCH PROPELLER

Does your airplane have a fixed-pitch or a constant speed propeller?

**Find out! Most light trainers are fixed pitch, but there are plenty of constant speed trainers as well.**

What instrument do we use to measure power in an airplane with a fixed-pitch propeller?

**The tachometer.**

What are the advantages of a fixed-pitch propeller?

**Fixed pitch propellers are cheaper, simple and have low maintenance costs as a result.**

*Fixed pitch propellers are set at a specific pitch to yield a corresponding performance profile. If you wanted a propeller pitched for maximum takeoff performance, would that be a propeller with a low or high pitch?*

**A propeller pitched for maximum takeoff performance would be pitched for low pitch, high RPM.**

**A propeller pitched for maximum cruise efficiency would be pitched for high pitch, low RPM.**

## CONSTANT SPEED PROPELLER

Describe the steps that occur as you move the propeller lever forward.

**The prop lever is set further forward, which creates a momentary underspeed condition. Spring tension and flyweight movement open the valve permitting oil to flow out of the hub, decreasing blade angle until the underspeed condition is eliminated.**

If you began a dive, would this create a temporary overspeed or underspeed condition on the propeller?

**This could create a temporary overspeed condition. The system would adjust accordingly to allow more oil to flow into the hub and increase blade angle.**

What are the advantages of a constant speed propeller?

**Constant speed propellers can be adjusted to favor performance or efficiency depending on requirements. During takeoff a low pitch, high RPM setting can be used, but in cruise a higher pitch, lower RPM setting can be used for better cruise speed and efficiency.**

*In the event of a loss of oil pressure in a single-engine airplane, it is desirable that the propeller moves to a low pitch, high RPM position. Why is this?*

**In a single engine airplane we want the propeller to windmill (keep turning) so that we can try to restart it. A low pitch, high RPM setting is most conducive to windmilling.**

*Why is it desirable that, in a multi-engine airplane, a loss of oil pressure causes the propeller to move to high pitch, low RPM position? How might the design of the system be changed to reflect this?*

**In a multi-engine airplane (2 engine in this scenario), we want to reduce drag as much as possible on a failed engine so that we can get the most performance from our airplane with the single engine we have left. A high pitch blade angle creates less drag. Most multi-engine airplanes have a system in place to then allow the pilot to move the blades fully sideways to the oncoming wind (called “feathered”) to reduce the drag even further.**

## LANDING GEAR OVERVIEW

Does your airplane have fixed or retractable gear?

**Most, but not all, initial trainers are fixed.**

What is the difference between a convention and tricycle configuration?

**A tricycle configuration has a nose wheel and two main wheels under the wings. A conventional system has two main wheels and a tailwheel.**

**The main difference is the stability characteristics on the ground. Tailwheel airplanes are naturally unstable because the center of gravity is aft of the wheel base, whereas tricycle gear airplanes are inherently stable because the CG is located forward of the wheel base.**

**Airplanes rotate around the center of gravity and braking is accomplished using brakes on the main gear. In a conventional system, the CG wants to swing left or right and get in front of the wheel base. Of course, this issue is not present in tricycle gear airplanes.**

Does your airplane have bungees, springs, oleo struts or a combination of those?

**Check out your airplane or look in the Operation/Limitations Handbook or Airplane Flight Manual.**

*You are interested in buying an airplane to fly in the back-country, which you are going to base at a dirt strip near your house. You talk to a friend involved in sales and he recommends you look for a tailwheel airplane. Why does he make that recommendation?*

**Tailwheel airplanes are often more suited to landing off airport because they have improved propeller clearance and no nose wheel which can get caught in potholes.**

## OLEO STRUT

What is the advantage of an oleo strut compared to a spring or bungee system?

**Oleo struts are often capable of absorbing more force.**

You go out to pre-flight the airplane and find dark red/black fluid pooled around the nose gear. What does this probably mean?

**You have a hydraulic fluid leak in the strut. Usually when this happens, it's caused by a broken seal in the strut.**

Does your airplane have oleo struts? If so, which wheel assemblies use oleo struts?

**Know your airplane!**

*You preflight a Piper Archer and find that the right oleo strut sits several inches higher than the left. You rock the wings a bit and the struts mostly even out. What might cause this issue?*

**Often older airplanes just have oleo struts that get a little sticky. They still do their job well, and are safe, but can stick a bit. If an oleo strut is clearly deflated, however, that's a different story and you should check with a mechanic to make sure you don't do damage.**

*You fly formation with a friend in your Piper Warrior which has three oleo struts. Your friend takes photos of your airplane in flight. You later look at the photos and see that your oleo struts are much lower in the photos than they normally are when you preflight. Why is this?*

**Oleo struts work by exerting a constant base line of pressure on the system. When the airplane takes off, the strut expands because there is no weight compressing the strut. In fact, if it weren't for the joint holding the bottom of the strut on, it would simply slide off.**

## RETRACTABLE LANDING GEAR

What are the advantages to a retractable gear system?

**Retractable gear decreases drag, which reduces fuel burn rate and increases cruise speed and performance.**

What are the disadvantages of a retractable gear system?

**Retractable gear systems are often expensive, require far more maintenance (and therefore maintenance cost) and are more subject to malfunctions than fixed gear systems.**

What are some ways that retractable gear can be actuated?

- **Hydraulic-Electric: Electric pump powers hydraulic systems which raise the gear**
- **Electrical-Mechanical: Electric motor raises the gear mechanically.**
- **Pure Mechanical: Often used as a backup for emergency extension, but was once the primary method on older airplanes. In a purely mechanical system, the pilot cranks the gear up or down with a hand crank.**

In a retractable gear system, what typically holds the gear down?

**Springs and over center locks.**

What mechanisms can hold the gear up in a retractable system?

**Usually mechanical up locks. However, some systems do require constant hydraulic pressure to hold the gear up.**

Would hydraulic pressure ever be used to hold the gear down? Why would this be a bad idea?

**A system requiring hydraulic pressure to keep the gear down would require a gear up landing in the event of hydraulic pressure loss. Most systems either fail into the down position or don't fail into either position or the other.**

Does your airplane have a retractable gear system? If so, how is it actuated?

*You're at the club house talking to friends about gear failures. Your friend asserts that if they experienced a landing gear failure that they would make a normal approach and then kill the engine right before touchdown to avoid denting the propeller on landing. Do you think there is merit in doing so?*

**This is a very common discussion in general aviation circles. The bottom line, however, is that pilots do not die from intelligent gear up landings. Plenty have died, however, trying to secure their engine on final, only to realize that they weren't in gliding distance from the runway. You are better off destroying the prop and landing safely than risking your life, and your passengers lives, for a hunk of metal.**

*Another friend says that if they had a gear failure that they would land in the grass alongside the runway instead of landing on the pavement, in an effort to avoid damaging the airplane more than necessary. Why is this a bad idea?*

**This is another common gear-up discussion. Generally speaking pavement is great for gear up landings because it does not cause rapid deceleration. Grass can get bunched together and cause you to flip over. This is one scenario where you're more likely to keep yourself and your airplane in better shape if you just land it on concrete.**

## FUEL

How many fuel pumps does your airplane have?  
What type of fuel does your airplane use?  
Is your airplane certified to use any other fuel octanes?  
Does your airplane have wet wings or bladders?

*How would you recognize a fuel leak during preflight?*

**A fuel leak is often visible by blue staining along the area around the fuel tank or fuel lines. Often a fuel leak can be smelled as well.**

*Your airplane is certified for 100LL. You land at an airport and refill it with 80/87 octane. Will the airplane run safely on 80/87?*

**No. Doing so could be potentially harmful to your engine.**

## OIL

What function does oil serve?

**Oil cools the engine, removes contaminants and lubricates moving parts.**

What are the advantages of a wet sump system?

**Wet sump systems are simple and cheap.**

What main factor dictates the type of oil used in your airplane?

**Other than the type of engine, the temperature of the air in normal operating conditions is the major consideration. Oil is more viscous in cold temperatures, so in a colder environment, a thinner oil may be desired.**

How does oil circulate through the engine?

**Oil is pumped from the bottom of the oil pan through the oil system and then flows back to the oil pan.**

*In cruise, you notice your oil pressure gauge indicating zero. Oil temperature remains at normal levels. What does this likely indicate?*

**Likely this is a gauge malfunction. Low oil pressure situations are usually accompanied by a rise in oil temperature.**

*In cruise, you notice your oil pressure gauge decreasing rapidly. Oil temperature, meanwhile, is increasing rapidly. What is this likely indicating?*

**This is indicating a loss of oil pressure, probably due to an oil leak. It is likely the engine will fail shortly and you should quickly find a suitable airport to land at, or if not possible, a safe off-airport landing location.**

*Why might a mechanic recommend that you change oil types between summer and winter?*

**To use an oil more suitable to different temperature ranges.**

*You depart a mountain airstrip and climb at your best-angle climb speed, which is relatively slow, to avoid terrain. You notice that your oil temperature is getting rather high. Why is this, and how could you improve the situation while still avoiding terrain?*

**Oil is usually cooled by airflow through the front of the engine cowl. Steep climbs limit airflow across the oil cooler, which can lead to warm oil temperatures. Shallow your climb. If shallowing your climb will cause issues with terrain clearance, consider circling in place in a shallower climb until you've climbed over the terrain.**

## HYDRAULIC

What are your airplane's hydraulic systems?

The incompressible characteristic of fluids allows us to use hydraulics to:

**Transmit force through the fluid.**

*Aeration is the condition where air/gas enters a fluid line. Why might this be a major issue in a hydraulic system like brakes?*

**Fluid is generally not very compressible, but air is. Air introduced in a hydraulic line will compress, potentially causing the hydraulic system to fail.**

*What is the advantage mechanical actuation as opposed to hydraulic actuation in a system like flight controls? What is the disadvantage?*

**Advantage: Mechanical systems do not require electric motors, hydraulic pumps, in order to operate, and are therefore less likely to fail.**

**Disadvantage: Mechanical systems are not as suitable to larger airplanes because the flight forces are so much higher. On larger airplanes, a mechanical system results in slower movements and very heavy control forces which can make it harder to fly.**

## ELECTRICAL

A master switch usually has two sides. What is each one for?

**One side connects the battery to the electrical system, and the other side connects the alternator to the electrical system.**

The battery discharges while supplying electrical power to systems. What re-charges the battery?

**The alternator**

If your engine stopped, would the battery discharge?

**Yes.**

If your alternator failed, would the battery discharge?

**Yes.**

What is a bus?

**A bus is a component that provides electricity to multiple components.**

Many airplanes have an avionics master switch. What does this switch do?

**The avionics master switch isolates the navigation and communication radios. It is usually used to quickly turn off all navigation and communication radios before shutting down the airplane, to prevent damage to systems.**

*What advantage do circuit breakers have over fuses? What extra risk do they create for uneducated/careless pilots?*

**Unlike fuses, which burn, circuit breakers pop and can therefore be reset. However, circuit breakers can create a dangerous situation if pilots force a popped circuit breaker to stay in. This can create an over temperature situation and even potentially lead to an in flight fire.**



*Before takeoff, many pilots turn on a light or electric pump and while watching the ammeter. What are they testing in doing this?*

**Turning on an electrical component will show a slight draw on the ammeter. Pilots can watch for this slight draw to detect that the ammeter is in fact operating and not just stuck at a certain value.**

**This can be especially evident on airplanes with strobe lights. Each flash of the strobes will cause a little jump on the ammeter.**

*In an electrical emergency in busy airspace, how could you limit battery discharge while also maintaining communication with ATC?*

**Transmitting requires far more power than receiving. Although you should not continue into busy airspace with an electrical emergency unless absolutely necessary, you can tell ATC that you have a battery that is draining and that you are going to limit transmissions, but will still be listening on frequency. You should also shed all unnecessary electrical equipment, which may include items like:**

- **Electric boost pump**
- **Lights**
- **Second communication radio**
- **Navigation radio**
- **Transponder**

## **INSTRUMENTS**

What instrument shows airspeed?

**Airspeed indicator**

What instrument shows the airplane's altitude?

**Altimeter**

What instrument shows the airplane's heading?

**Heading indicator, aka Directional Gyro**

Does the DG have a compass inside it?

**No**

Which instruments are gyroscopic?

**Attitude Indicator, Directional Gyro, Turn Coordinator**

Which instruments are pitot-static?

**Airspeed Indicator, Altimeter, VSI**

If your static port becomes clogged, how would instruments will be affected?

**Airspeed Indicator: Erroneous airspeed readings.**

**Altimeter: Needle will stop moving**

**VSI: Needle will stop moving.**

*The directional gyro and compass essentially provide the pilot with the same information. Why have two different instruments instead of one?*

**The magnetic compass is difficult to use because of various compass errors. The directional gyro is a simple gyro that does not contain a compass and is therefore not subject to these errors. In straight and level flight the compass is more accurate, but the directional gyro is easier to use for most operations.**

*On an easterly heading, you transition from a climb to level flight. You notice that the compass momentarily indicates a turn to the left. Is this normal? Why or why not?*

**This is normal. On East/West headings, acceleration may initially cause the compass to indicate a turn North. Similarly a deceleration can cause the compass to indicate a turn South.**

*Under which condition will your airspeed indicator function as an altimeter? That's to say that as your altitude increases your indicated airspeed increases.*

*How will your instruments indicate if the pitot-tube is blocked, but the drain hole and static ports are open?*

**Airspeed will indicate zero, but the Altimeter and VSI will be accurate.**

*How will your instruments indicate if the pitot-tube and drain hole clog but the static ports are open?*

**Airspeed will be fixed initially, but will indicate an increase with a climb and a decrease with a descent. This is because the air in the pitot side is now fixed, but the static pressure will change with altitude. Altimeter and VSI will continue to operate normally.**

*How will your instruments indicate if the pitot-tube and drain hole are open but the static ports clog?*

**Airspeed will be unreliable. Altimeter will freeze at the altitude where the blockage occurred. The VSI will indicate zero.**

*In flight, you notice something wrong with your instruments: The turn coordinator indicates a turn to the left, while the attitude indicator shows a descending turn to the right. The altimeter and VSI indicate level flight, and the airspeed indicator indicates cruise speed. What has likely occurred?*

**All instruments are in agreement except the attitude indicator. Therefore, the attitude indicator has most likely failed. Ignore it, or cover it up (or, if you're VFR, just keep looking outside, you don't need it).**

## AVIONICS

What is the purpose of a standby frequency in a radio?

**Standby frequencies allow you to tune the next frequency without leaving the current frequency. This is particularly nice if you go to the next frequency only to find that there is nobody there. You can easily switch to your last frequency.**

Do communication and navigation radios operate on the same frequency band?

**No. Communication radios operate from 118.000-136.975 MHz and navigation radios operate from 108.000-117.950 MHz**

*After starting the airplane you turn on the avionics and immediately hear a lot of static. What could be the cause?*

**You may need to adjust the volume or squelch or change frequencies.**

*While on the ground you attempt to use Com Radio #2 to pick up the weather, while you monitor ground using Com Radio #1. The signal on Radio #2 comes in broken. What could be the reason for this?*

**Sometimes, the com #2 radio antenna is on the underside of airplanes. This can cause a weaker signal than the Com #1 antenna which is usually on the top. When a weak signal makes it hard to pick up a transmission on #2, it can sometimes help to just switch to #1.**

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## AIRPORT OPERATIONS

### TRAFFIC PATTERN

What is the standard traffic pattern direction?

**Left**

What is the purpose of the segmented circle?

**The segmented circle tells pilots about traffic patterns that are non-standard (i.e. right traffic).**

When would a pilot use a teardrop entry? What about a forty-five entry?

**A tear drop entry would be used to enter the downwind if you are on the side of the airport that doesn't have the traffic pattern. In other words, when you have to cross over the airport in order to reach the side of the airport with the traffic pattern.**

**A forty-five entry would be used when you are already on the side of the airport with the traffic pattern.**

*You're at traffic pattern altitude on an 8 mile 45° to the downwind. You make your first position report. Immediately after, another airplane calls in on a 7 mile 45°. Is there an issue here? How will you react?*

**There is an issue. A report of one mile is a pretty small distance. You should assume that you and the other airplane are practically on top of each until you can get visual contact. Call again on CTAF and tell them your altitude, and ask them what their altitude is. If you are separate vertically, there is little cause for alarm over lateral proximity.**

*At a towered airport, you call in and are told to make a left base for runway 32. How will you do this?*

**Proceed directly to the point where you would normally turn from downwind to base (instead of entering the downwind first) and continue the approach from that point.**

*You are in cruise when you notice the local weather deteriorating rapidly. You decide to divert to a small non towered airport, which has left traffic for both runways. As you near the airport, you see that there are clouds at traffic pattern altitude along the 45 to the favorable runway. How do you proceed?*

**Although a normal entry would be left traffic, that is not the safest option at the moment. Your priorities are getting on the ground before the weather gets worse, and landing safely. Enter right traffic for the favorable runway (or a base entry or straight-in if that makes more sense) and land.**

*On short final, another airplanes taxis on to the runway to begin their takeoff roll. They are totally unaware of your presence, and without a radio. You initiate a go around. Why is it critical that you also side step away from the downwind leg?*

**When you side-step you are able to maintain visual contact on the conflicting traffic. You are going around at the same time they are taking off. Therefore, it's important to keep track of each other to mitigate a collision risk.**

## **AIRPORT SIGNS AND MARKINGS**

A fully horizontal wind sock indicates winds of approximately what speed?

**15 knots or greater.**

Does the pointy side of a wind triangle point into or away from the wind?

**Into the wind.**

What color indications should a pilot receive on a PAPI/VASI if they are on glidepath?

**Two red, two white.**

When may a pilot need to hold short of a critical ILS area?

**During instrument conditions.**

When must pilots hold short of runways?

**At a towered airport, they must always hold short unless explicitly cleared to cross. At non-towered airports they can enter a runway at an time, but are responsible for making sure there are not conflicts with other traffic.**

Runway 15 has a segmented circle, that indicates right traffic for runway 15. What is the traffic pattern direction for runway 33?

**Left.**

Can you use a displaced threshold to begin a takeoff roll? What about to land?

**You can use a displaced threshold for takeoff, but not for landing.**

*You listen to a non-towered airport's automated weather and learn that the winds are favoring runway 9. As you proceed over the airport to make a teardown entry, you look down at the windsock at notice it slightly favoring runway 27. What is likely happening, and how will you proceed? What wind conditions might you expect as you continue approaching the airport.*

**Winds are either very gusty or light and variable. Either way, you can expect shifting winds on approach. Be aware of this, and proceed to one of the runways (whichever you think the winds are most predominantly favoring). Remember that a go around is always an option.**

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# FARS

## FAR OVERVIEW

What is 14 CFR Part 1?

### **Definitions and Abbreviations**

What is 14 CFR Part 21?

### **Certification Procedures for Products and Articles**

What is 14 CFR Part 39?

### **Airworthiness Directives**

What is 14 CFR Part 43?

### **Maintenance, Preventative Maintenance, Rebuilding and Alteration**

What is 14 CFR Part 61?

### **Certification for Pilots and Flight Instructors**

What is 14 CFR Part 71?

### **Airspace, Traffic Service Routes and Reporting Points**

What is 14 CFR Part 73?

### **Special Use Airspace**

What is 14 CFR Part 91?

### **General Operating and Flight Rules**

What is NTSB830?

### **Notification and Reporting of Aircraft Accidents or Incidents**

*You and a friend are discussing the maximum speed within a class B airspace. What section of the FARs would that information be found?*

### **Part 91**

*Your friend is a student pilot, seeking his private pilot's license. She wants your help to make sure she is meeting all the hour requirements to obtain her license. What section of the FARs would this information be found?*

## **Part 61**

### **PART 61 SUMMARY**

***If you haven't already, please refer to the Part 61 summary document in the Flight Bag. That outlines every single regulation you need to know from Part 61. The questions below are to help you apply your knowledge of those regulations, but to commit the regulations to memory, you need to first go through the Part 61 summary and memorize the regulations using flashcards, or whatever method works best for you.***

*Your friend says that, because he is never going to seek another flight certificate or rating, he doesn't need to log his time. Is he correct?*

**No. Your friend still needs to log enough flight time to satisfy the requirements of the flight review and 90 day currency requirements if he wants to carry passengers.**

*You have been flying a tailwheel Piper Cub for the last 4 months, and have been practicing full stop landings often. Your friend asks to go on a night flight. You know that you are tailwheel current, because you have completed far more than 3 full stop landing in 90 days. Because the landings are to a full stop, are you also night current? If not, what must be accomplished before you can take your friend flying?*

**No, you must make three landings to a full stop at night.**

*If a pilot never takes passengers flying, what is the bare minimum of flight time they must log?*

**Those hours required to meet flight review requirements (1 hr every 24 calendar months).**

**Of course, insurance costs decrease as you fly more, so it's almost always in your best interest to log all your flight time.**

*Your friend offers to pay the cost of fuel if you take him flying to a business meeting in a town 100 miles away. You are close friends, and have been looking for a reason to fly together anyway. She is a business executive that makes far more money than you and is more than willing to cover the costs of the flight. Is this legal?*

**No. This counts as compensation even though you are not taking a profit.**

## PART 91 SUMMARY

***If you haven't already, please refer to the Part 91 summary document in the Flight Bag. That outlines every single regulation you need to know from Part 91. The questions below are to help you apply your knowledge of those regulations, but to commit the regulations to memory, you need to first go through the Part 91 summary and memorize the regulations using flashcards, or whatever method works best for you.***

*You overfly a friend's house and drop a tennis ball on his front lawn. You are the star of the high school baseball team and have perfect aim. You are 100% confident that you will not endanger people or property in doing this. Is this legal? How could the FAA deem your action to be illegal?*

**It is technically legal, per the regulations about dropping objects from airplanes, however it can still be deemed as reckless behavior from the perspective of the FAA, in which case you could still get in trouble.**

*You are going on a night flight. The airport is empty, so as you start your engine you don't bother yelling clear out of the window to alert those nearby that you are about to start your engine. Have you broken any rules? Could this be considered reckless?*

**You have not broken any specific rules, but it could be considered reckless behavior.**

*You go to your friend's bachelor party where you stay out partying and drinking heavily until 2:00am. You know you will fly the next day at 10:00 so you make sure to stop your drinking promptly at 2:00. Are you legal to fly at 10:00?*

**You are technically legal to fly at 10:00 as long as your BAC is less than .04%. Obviously this is a terrible idea, and very poor ADM.**

*Your friend lives in the suburbs and has a little brother that is very ill and loves airplanes. Your friend asks you if you could fly over his house this afternoon to cheer up his brother. You agree. What is the lowest you can fly? Can you fly lower than the standard MSA because you have your friend's permission?*

**In theory you can go lower and even land on someone's property with their permission, but your friend lives in the suburbs: you cannot go any lower than the standard MSA without violating the MSA limits of his neighbors and their property. At the lowest, you are limited to 500 feet above persons or property, but realistically speaking you should consider the suburbs to be a congested area, which required 1,000 foot clearance.**



*Your flight school training airplane comes out of the maintenance hangar just as you pull up. They say it's ready to fly, that is was just having a 100-hour inspection performed but is now good to go. They mention that although the inspection is complete, they've been having printing issues and have not printed out the logbook entry yet. They say not to worry and that they'll take care of it when you get back. Is this legal?*

**No. There is no evidence of a completed inspection without the appropriate logbook entry. If needed, they can hand write it or you can wait to fly until the printer issue is resolved.**

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## ATC AND RADIO PROCEDURES

### COMMUNICATIONS OVERVIEW

What are the 5Ws?

- 1. Who you're talking to**
- 2. Who you are**
- 3. Where you are**
- 4. What you want**
- 5. Who you're talking to (non-towered)**

### NON-TOWERED RADIO PROCEDURES

Is a radio required at a non-towered airport?

**No, but it is a great idea to have and use one.**

If you call in 10 miles out and another airplane calls in from a similar location, what will you do?

**Coordinate with them on altitude, landmarks, etc to ensure that you mitigate a collision risk.**

*Exercise: What radio calls should you make at your local non-towered airport? Practice these radio calls so that you can say them without thinking too hard about it.*

***Some examples:***

***“\_\_\_\_\_ Traffic, Cessna 123FA, 10 miles south, 45 for left downwind, runway 25 \_\_\_\_\_ Traffic”***

***“\_\_\_\_\_Traffic, Cessna 123FA, 8 miles west, 45 for left downwind, runway 33 \_\_\_\_\_ Traffic”***

***“\_\_\_\_\_ Traffic, Cessna 123FA, left downwind runway 15, \_\_\_\_\_ Traffic”***

*“\_\_\_\_\_ Traffic, Cessna 123FA, left base runway 15, \_\_\_\_\_ Traffic”*

*“\_\_\_\_\_ Traffic, Cessna 123FA, final runway 15, \_\_\_\_\_ Traffic”*

*“\_\_\_\_\_ Traffic, Cessna 123FA, departing runway 10, left closed traffic \_\_\_\_\_ Traffic”*

*Approaching an airport you call “Jackson Traffic, Cessna 123FA, 10 miles south, Jackson”.  
What information have you left out?*

**You haven’t stated your intentions. Other pilots now know where you are, but they don’t know what you’re planning to do.**

## TOWERED RADIO PROCEDURES

What is ATIS?

**Automatic Terminal Information Service. It’s a broadcast of weather and NOTAMs for a specific timeframe, usually an hour. ATIS is usually broadcast 53 past the hour, every hour. A SPECI may be issued if weather changes quickly enough to warrant an update ahead of schedule.**

What is the purpose of ground frequency?

**Ground frequency is used to direct traffic from parking spaces to the runway. It may also issue IFR clearances at some airports.**

What is the purpose of tower frequency?

**Tower frequency is used to clear traffic for takeoff and landing and direct them into and to of the airspace immediately surrounding the airport.**

What must ATC say in order for an airplane to cross a runway while taxiing?

**ATC must tell you to cross the runway. They cannot simply give you a taxi clearance that takes you across the runway and expect you to cross it.**

*You call ground control with the following: “Executive ground, Cessna 123FA, ready taxi”. They respond: “Cessna 123FA, verify you have Tango.” What information did you leave out, and what is ground control asking from you?*

**You did not tell ATC that you had the latest ATIS broadcast. They need to know that you have the current weather before they will allow you to taxi out.**

*You receive a clearance to taxi to runway 20 via M and B. That taxi route will cause you to cross runway 31. Are you cleared to cross the runway, or do you need to clarify with ATC?*

**No, you must explicitly receive instruction from ATC to cross that runway.**

## FLIGHT FOLLOWING / EN-ROUTE

What is flight following?

**Flight following is a voluntary service provided by ATC in which controllers will assign your aircraft a squawk code and provide traffic advisories en-route.**

Is flight following a mandatory service?

**No.**

Is ATC required to provide pilots with flight following?

**No. It is voluntary on the part of pilots and controllers.**

What is the advantage of using flight following?

**There are several:**

- **ATC can provide traffic advisories, which can decrease your risk of a close encounter with another aircraft.**
- **In an emergency, you are already on frequency with someone who knows the details of your flight and can assist you.**
- **You can pass through airspace that would otherwise require separate ATC communications. Examples where it is valuable could include passing through TFRs, passing through the top portion of a Class C airspace, Or navigation between closely spaced Class D airspace without worrying out accidentally skimming the side of one.**

What is a squawk code?

**A squawk code is a four number code that identifies your aircraft to ATC. Squawk codes range from 0000 to 7777. Know the emergency squawk codes:**

- **7500: Hijacking “Seven five, I’m alive”**
- **7600: Lost Communications “Seven six, can’t hear shit”**
- **7700: Emergency “Seven seven, going to heaven”**

*You call ATC requesting flight following and they tell you to ident. What does that mean?*

**Press the “Ident” button on your transponder. This sends a signal that momentarily highlights your aircraft on the controller’s radar screen which makes it easier for them to find and positively identify you.**

*You depart a non-towered airport and, once in range, call center requesting flight following. Your first call to center is the following: "Center, Cessna 123FA, 10 miles north Georgetown, 3 thousand climbing niner thousand request flight following to Lincoln." What mistake did you make?*

**You cold-called ATC with a full request. It is much better practice to make an initial call stating "Center, Cessna 123FA, VFR request". Then, when they have time they will tell you to go ahead with their request.**

**Often, such a cold call catches ATC off guard and they'll end up having to ask for your information again anyway.**

## SCENARIOS

*These aren't necessarily questions for Flashcards... more like thinking questions. You need to have an idea of how to act when things get weird in the airport environment.*

You're on a one-mile final, cleared to land, when tower clears another aircraft to takeoff on the same runway. You know there won't be enough spacing for them to takeoff and you to land. What do you do?

**Tell tower that you are going around for spacing. Be sure to side step on the go around.**

You're on a 5 mile final and ATC clears another aircraft to make a 2 mile base and land, ahead of you. You're not sure if it'll be enough spacing. What do you do?

**You can slow in advance (within reason, of course, DO NOT slow so much that you stall) to give the aircraft more time and increase spacing. If spacing is very close or the other aircraft is still on the runway, ATC will tell you to go around, or you will tell them you are going around.**

As you're in left downwind to land on runway 25, another airplane calls in, for the first time, saying they're on left downwind to land on runway 07. What do you do?

**Try to get the other airplane in sight to verify they are in fact on the left downwind for Runway 7. If they are, it is usually best practice to tell them you will wait for them to land and then follow. If winds do favor runway 25 and there are no other airplanes landing runway 7, you can depart the pattern and re-enter, or simply fly a closed pattern at traffic pattern altitude.**

**Do not try to race them to the ground, berate them on the radio for landing opposite direction to you, etc. You make the decision for what you will do to maintain safety. You have no control over others' actions in the air.**

On short final for runway 23, you notice another airplane on the runway, departing runway 5, directly at you. They've made no calls on the radio. What do you do?

**Go around. Side step and re-enter the pattern.**

Immediately after takeoff, in a Cessna 172, a pilot calls in saying they are on the crosswind leg for the runway you just departed. Is there a potential traffic conflict? What do you do?

**There is a potential conflict. If they are truly in the crosswind leg, they are probably slightly in front of you or directly on top of you. Do not climb too quickly, for risk of climbing into them. Look over your shoulder to try to get a visual on them.**

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## NATIONAL AIRSPACE SYSTEM

### AIRSPACE OVERVIEW

What are the six types of airspace?

**Alpha, Bravo, Charlie, Delta, Echo, Golf**

What three types of airspace make up most of the National Airspace System (NAS)?

**Alpha, Echo, Golf**

Which types of airspace are established specifically around certain airports?

**Bravo, Charlie, Delta**

*What is the fundamental difference between controlled and uncontrolled airspace?*

**In controlled airspace, ATC is responsible for traffic separation of IFR traffic. In uncontrolled airspace, they are not.**

*What types of airspace require a mode C transponder?*

- **Anytime above 10,000' MSL (if above 2500' AGL)**
- **In Bravo**
- **Above Bravo**
- **In the mode C veil of Bravo**
- **In Charlie**

- **Above Charlie**
- **Crossing the ADIZ, in either direction**

## **ALPHA**

Where does class A start?

**Flight Level 180 (FL180), otherwise known as 18,000 feet pressure altitude.**

What requirements must be met to enter class A airspace?

**Aircraft and pilot must be IFR certified, on an IFR flight plan and clearance.**

When is DME required in class A?

**Above FL240.**

What do pilots do as they enter class A?

**They set their altimeters to “standard” 29.92” Hg.**

*You are on an instrument flight plan and instructed to “climb and maintain FL260”. Do you need to hear ATC say “cleared into class A”?*

**No, that is sufficient clearance.**

## **ECHO**

What are the weather requirements in class E below 10,000’ MSL?

**3152**

- **3sm visibility**
- **1000’ above clouds**
- **500’ below clouds**
- **2000’ horizontally from clouds**

What are the weather requirements in class E above 10,000’ MSL?

**5111**

- **5sm visibility**
- **1000' above clouds**
- **1000' below clouds**
- **1sm horizontally from clouds**

When is a transponder required in class E?

**Above 10,000 feet MSL.**

What does it mean that class E is “controlled airspace”?

**ATC is responsible for separating IFR traffic from other IFR traffic.**

*If an airport is uncontrolled, does that mean that it is in uncontrolled airspace?*

**No, not necessarily. There are non-towered airports with Class E to the surface.**

## GOLF

What is meant when we say that class G is “uncontrolled?”

**ATC is not responsible for separating IFR traffic from other IFR traffic.**

Where is class G typically found?

**Down low, near the ground. Usually between the surface and 700 to 1,200 feet. Places where it extends higher are usually fairly remote.**

What are the weather requirements in class G below 10,000' MSL, but above 1200' AGL?

## 1152

- **1sm visibility**
- **1000' above clouds**
- **500' below clouds**
- **2000' horizontally from clouds**

What are the weather requirements in class G below 1200' AGL?

**1sm visibility and remain clear of clouds.**

What are the weather requirements in class G above 10,000' MSL?

**5111**

- **5sm visibility**
- **1000' above clouds**
- **100' below clouds**
- **2sm horizontally from clouds**

Your airport is class G until 700' AGL and then becomes class E. The traffic pattern altitude is 1,000 AGL. In a closed traffic pattern, are you operating in both class G and class E?

**Yes.**

*Weather is 3/4sm visibility at night in class G. Can you operate legally as long as you stay in the traffic pattern?*

**No. You must have a minimum of 1sm visibility and operate within 1/2 mile of the runway.**

*Weather is now 1 1/4sm visibility at night at an airport in class G. Can you operate legally long as you stay within the traffic pattern?*

**Yes\*, but you must stay within 1/2 mile of the runway.**

**Obviously, this is a pretty bad idea. 1 mile of visibility is not much, even during the day, but especially at night. But, we want you to understand exactly what the regulations permit, even if they allow you to sometimes do things that are highly dangerous.**

**BRAVO**

What are the weather requirements in class B?

**3sm visibility, remain clear of clouds.**

What is the mode C veil?

**This is an area that usually extends 30nm in all directions from the center of the primary airport of a Class B airspace. Within this ring you are required to have and use a mode C transponder.**

What is the speed limit under a class B?

**200 KIAS**

Is there a speed limit in the class B?



**No. There is a speed limit under Class B and there is a speed limit below 10,000 feet MSL. There is not a specific limit within Class B, although there are only a few instances where class B extends above 10,000 feet MSL.**

Typically aircraft in a class B are restricted to 250 knots. What rule causes this restriction?

**The speed limit of 250 KIAS below 10,000 feet MSL.**

To enter a class B airspace, what must a VFR pilot hear from the controlling facility?

**“Cleared” into the Class Bravo.**

CHARLIE

What are the weather requirements in class C?

**3152**

- **3sm visibility**
- **1000’ above clouds**
- **500’ below clouds**
- **2000’ horizontally from clouds**

What kind of ATC communication is required to enter class C?

**Positive, two way radio communication. Essentially, you must call with your tail number and they must read back your tail number.**

Is a transponder required in class C? What about above the airspace within the lateral bounds?

**Required in class C and above.**

What are the normal dimensions of class C?

**10nm radius, extending up to 4000 feet AGL. Usually the outer ring extends from miles 5 to 10 and from 1,500 feet AGL to 4,000 feet AGL.**

*You launch a rocket from within class C airspace, with permission of the relevant controlling facilities. Assuming there is not overlaying B airspace, what airspace types will your rocket pass through on its way to space?*

**Charlie, Echo, Alpha, Echo.**

## DELTA

What are the weather requirements in class D?

**3152**

- **3sm visibility**
- **1000' above clouds**
- **500' below clouds**
- **2000' horizontally from clouds**

What radio communications are required to enter class D?

**Positive two way radio communication.**

What are the typical dimensions of class D?

**4nm radius, extending from the surface to 2,500 feet AGL.**

*Can you operate in class Delta with less than the basic weather requirements for the airspace?  
How?*

**Yes, you can operate under Special VFR, which allows you to operate within the lateral bounds of controlled airspace to the surface as long as weather is reported 1sm visibility and you can remain clear of clouds.**

*You call: "Tower, Cessna 123FA, 10 miles south with Juliet". Tower says "last aircraft proceed inbound". Is that sufficient for you to proceed inbound?*

**No, you should wait until ATC has positive read back your tail number before proceeding inbound. It is unlikely ATC would say this in the first place, but be aware of how to protect yourself in such a situation.**

*You call again, and this time tower says "Cessna 123FA, roger." Is that sufficient?*

**Yes.**

## SPECIAL USE AIRSPACE

How can a pilot identify a type of special use airspace on a sectional chart?

**The airspace will have an identification which has a letter and number (e.g. R-1234). The letter identifies the type of airspace:**

- **R: Restricted**
- **P: Prohibited**
- **W: Warning Area**
- **A: Alert Area**
- **M: MOA**

Where can a pilot find the frequency for the controlling facility of a special use airspace?

**The hours of operation, vertical extend and contact information for each special use airspace is shown on the side or top of the sectional chart.**

*Another pilot asks you if there is any Prohibited Airspace on your local sectional chart. What is the quickest way you could find out?*

**Look at the side or top of the sectional chart to see if there is any Prohibited Airspace listed.**

MOA, RESTRICTED, PROHIBITED

What is the purpose of MOAs?

**MOA's separate IFR traffic from military traffic.**

Can VFR pilots enter MOAs?

**Yes.**

What is the purpose of Prohibited Airspace?

**To prevent aircraft from getting close to areas which could compromise national security.**

Can VFR pilots enter Prohibited Airspace? If so, how?

**Yes, but it requires a clearance. Receiving such a clearance would be fairly abnormal.**

What is the purpose of Restricted Airspace?

**To prevent aircraft from getting close to an area which could pose a risk to the aircraft.**

Can VFR pilots enter Restricted Airspace? If so, how?

**Yes, but it requires a clearance.**

What is the functional difference between Restricted and Prohibited Airspace?

**Restricted airspace protects the pilot from something, while Prohibited airspace protects something from the pilot.**

CFA, WARNING AREA, ALERT AREA

Where are Warning Areas found?

**Warning areas can begin 3sm off the coast.**

Why might a Warning Area be established?

**Warning areas can contain hazardous activities like live firing, fast moving aircraft and electronic weaponry.**

Why might an Alert Area be established?

**An Alert area is usually established to alert pilots to an area of high traffic volume.**

Can VFR pilots enter a Warning Area?

**Yes. Obviously it can be very dangerous so it is advised against.**

Can VFR pilots enter an Alert Area?

**Yes.**

*Where could aircraft flying in excess of 250 knots be found, other than in special use airspace?*

**Along Military Training Routes (MTRs)**

TEMPORARY FLIGHT RESTRICTION

Can VFR pilots enter TFRs? If so, how?

**Yes, but they must be in contact with the controlling ATC facility.**

Why may TFRs be established?

- **For Presidential or other VIP movements**
- **During wildfires or natural disaster areas**

- **Over large public gatherings (e.g. Disneyland, sporting events)**
- **For certain military operations**

## NOTAM

What are NOTAMs?

**Notices to Airmen are textual reports that identify conditions that pilots should be aware of including taxiway, runway or airport closures, changes to airspace, instrument approaches, nav aids, etc.**

When should a pilot check for NOTAMs?

**Every time before flying.**

What kind of information might be displayed in NOTAMs?

- **Taxiway, runway or airport closures**
- **Changes to airport markings**
- **Changes to instrument approach procedures**
- **Obstacles, including inoperative lighting on nearby obstacles.**
- **Airspace changes including TFRs.**

## CHARTS

How often are sectional charts published?

**Every 6 calendar months.**

How often are Chart Supplements published?

**Every 56 days.**

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## WEATHER

### BIG PICTURE

What is ultimately responsible for earth's weather?

**Uneven heating of the earth's surface.**

How does warm air circulate?

**Upwards and (in the northern hemisphere), counter clockwise.**

How does cool air circulate?

**Downwards and (in the northern hemisphere), clockwise.**

Why does much of the weather in North America come from the west?

**Because surface winds tend to flow north from 30°N latitude. As they flow northwards, they bend to the right from the Coriolis effect. This produces westerlies.**

What is the Coriolis effect?

**The Coriolis effect is the shift in wind direction that occurs as a result of increased friction near the earth's surface and earth's rotation.**

*Weather on the west coast of the U.S. usually comes from the West, while weather in Hawaii often comes from the East. Why is this?*

**Weather on the west coast receives westerlies from air flowing away from 30°N latitude, while Hawaii receives easterlies from air flowing away from 30°N latitude (but in the opposite direction). The Coriolis effect**

*There is a small mass of air with a temperature of -25°C while the surrounding air is -45°C. Describe this situation referencing pressure instead of temperature.*

**The airmass that is -25°C is warmer and will rise, creating a low pressure.**

## ATMOSPHERIC PRESSURE

What happens to atmospheric pressure at altitude increases?

**Atmospheric pressure decreases a 1" Hg per 1,000 feet**

What is standard atmospheric pressure?

**29.92" Hg at sea level decreasing by 1" Hg per 1,000 feet.**

What is standard atmospheric temperature?

**15°C at sea level, decreasing by 2°C per 1,000 feet.**

*True or false: There is proportionally less oxygen the higher in the atmosphere you go.*

**False. There is proportionally the same level of oxygen, the air is simply less dense.**

*Using your knowledge of air density, why do airplanes have maximum altitudes?*

**Engines operate by combusting air. Engine performance decreases as altitude increases, because air density decreases. Airplanes are limited in altitude by the height where maximum engine power no longer provides sufficient excess thrust to climb.**

## **PRESSURE ALTITUDE**

What is pressure altitude?

**Pressure altitude is the height above standard pressure.**

What is standard pressure at 3,000' MSL?

**29.92" Hg.**

**The standard pressure at 3,000 MSL is 3" Hg less than 29.92" Hg, because the pressure lapse rate is 1" Hg per 1,000 feet.**

*If the current altimeter setting is 29.90, and you are at 1,000 feet MSL, what is your pressure altitude?*

**1,020 feet.**

**If the sea level pressure is 29.90" Hg, then the theoretical line of standard pressure is roughly 20 feet below sea level. You are 1,000 feet above sea level, so add 20 feet to find your pressure altitude.**

**Mathematically:**

$$29.92 - 29.90 = .02$$

$$.02 \times 1000 = 20 \text{ feet}$$

**Pressure is lower than standard, so we add the difference to our true/indicated altitude.**

$$20 \text{ feet} + 1,000 \text{ feet} = 1,020 \text{ feet.}$$

## **DENSITY ALTITUDE**

What is density altitude?

**Density altitude is pressure altitude corrected for non-standard temperature.**

What is the difference between pressure altitude and density altitude?

**Density altitude factors in air density, while pressure altitude does not. Density altitude, is therefore a far better metric for estimating aircraft performance.**

Which is a better measurement for performance: pressure altitude or density altitude?

**Density altitude.**

Does density altitude increase or decrease with temperature?

**Density altitude increases with temperature, which means that performance decreases.**

*True or false: An aircraft's performance is directly related to the density of the air.*

**True.**

## TEMPERATURE/DEWPOINT AND CLOUD TYPES

The shape of clouds is largely dependent on what?

**Atmospheric stability.**

What kind of clouds are formed from a stable atmosphere?

**Stratus**

What kind of clouds are formed from an unstable atmosphere?

**Cumulus**

What is dew point?

**The temperature at which air will become saturated.**

What often happens with a close temperature and dew point spread?

**Often, a close temperature and dew point spread results in saturated air and the formation of visible moisture (clouds, fog, rain, etc)**

What does the suffix “nimbus” mean in relation to clouds?

**Nimbus refers to clouds that are producing precipitation.**



*The local temperature lapse rate, normally 2°C/1000 feet, today is 5°C per 1,000 feet up to 4,000 feet. Is this a stable or unstable atmosphere?*

**Unstable atmosphere.**

*You are flying into a valley and notice a lot of smog and poor visibility down low. The weather clears around 2,000 feet. Is this indicative of a stable or unstable atmosphere?*

**Stable atmosphere, likely a temperature inversion.**

*As you approach your local airport, you see small puffy clouds. If you were to fly through one, what would you expect?*

**Light to moderate turbulence, as the clouds are formed by air that is rising faster than the air surrounding it.**

*Your friend remarks to you that to avoid turbulence on warm summer days, you should avoid flying directly under clouds. Is this reasonable advice? Why or why not?*

**Yes, this is reasonable advice. Flying directly underneath small puffy clouds, while not dangerous, does usually lead to encounters with turbulence.**

## CLOUD FORMATION AND FRONTAL SYSTEMS

What is an airmass?

**An airmass is a mass of air with similar temperature, stability and humidity.**

What is a front?

**A front is a boundary of two airmasses.**

What is a cold front?

**A cold front is a front where a cold air mass overtakes a warm airmass.**

What is a warm front?

**A warm front is a front where a warm airmass overtakes a cold airmass.**

Why do fronts often produce weather?

**Fronts often produce weather because they cause localized atmospheric instability, forcing some air to rise, which can lead to cloud and storm formation.**

What would likely create more intense weather? A fast moving cold front or a slow moving cold front? Why?

**A fast moving cold front, because it forces air to rise faster.**

## THUNDERSTORMS

What are the 3 stages of a thunderstorm?

**Cumulus, Mature and Dissipating.**

What marks the mature stage of a thunderstorm?

**Precipitation at the surface.**

What hazards do thunderstorms present to pilots?

- **Extreme turbulence**
- **Extreme icing**
- **Windshear**
- **IMC conditions**
- **Hail**

*Your friend returns from a flight with significant hail damage. There were thunderstorms in the area, but your friend swears he didn't go in one — that would be crazy after all! What likely happened?*

**Your friend flew close enough to the front of a thunderstorm that hail was blown forward out of the front of the thunderstorm and hit him, even though he was miles away from the storm. This is a major reason why thunderstorms should be given a large berth.**

*You are flying in the desert and notice a large ring of dust being kicked up underneath a dark cloud. What is this, most likely?*

**A microburst.**

## TURBULENCE

What are some ways turbulence can be generated?

**Turbulence can be generated from surface friction, convection, and shifting winds/windshear.**

What shape of cloud is likely to have the most turbulence? The least amount?

**Cumulus or lenticular clouds have the most turbulence. Stratus clouds have the least.**

*While crossing a mountain range you see thin, lens-shaped clouds near the mountain peaks. What weather conditions are indicated by these clouds?*

**That is a lenticular cloud, and you can expect very high winds and high turbulence in and around it.**

*On approach to an airport, you fly over a cold lake, then a very hot parking lot and then a large public park. Where are you likely to encounter updrafts?*

**You will probably encounter updrafts over the hot parking lot, as air is heated by the pavement and then rises.**

## ICE

Why is ice so dangerous?

**Ice decreases power, decreases lift and increases drag and weight.**

What other kind of ice are carbureted engines subject to?

**Carburetor icing.**

How can water stay liquid below a freezing temperature?

**If freezing water does not have a condensation nucleus it will not freeze.**

What are some methods pilots can use to escape from icing conditions?

- **Climb:** If better conditions are expected up higher (if, for example you know the clouds stop, or there is freezing rain at your altitude, which indicates warmer temperatures above you.)
- **Descend:** Temperature usually decreases with altitude, so descending may allow you to get into warmer air.
- **Turn:** If you have just started to pick up ice, that means there was no ice behind you. If you can, turn around and go back to the area without icing.

- **Fly Towards Coastal Areas:** Large bodies of water regulate temperature, and you may be able to find more favorable temperatures closer to the coast.

*Can ice still cause a fuel-injected engine to quit? If so, how?*

**Yes; Ice can still cause the front of the air-intake to be closed off, preventing airflow to the engine. Many fuel-injected engines have an alternate air source for this reason.**

*You are flying on a cold day with showery precipitation. Along your flight you encounter freezing rain at 2,000 feet, with cloud bases at 6,000 feet. What should you do?*

**Consider climbing to warmer air above you. You should also try to dodge areas of precipitation. Because the precipitation is showery, there are likely scattered areas with minimal precipitation.**

*You are flying on a cold day with stable atmospheric conditions. It begins to rain and you notice you are accruing ice very quickly. Cloud bases are only 500 feet above you. What do you do?*

**You need to turn back, if possible and find a place to land quickly. If there are no airports nearby, you may consider making an off airport landing, depending on your rate of ice accumulation.**

*What does freezing rain suggest?*

**Freezing rain suggests higher temperatures above your current altitude (temperature inversion).**

*While flying you notice a opaque white powder start forming on the leading edge of your wing. What kind of ice is this?*

**Rime (or mixed) ice.**

## BRIEFING TOOLS

*You are departing in the early morning and you'd like to get a quick weather brief before you go to bed. When you call Flight Service, what kind of brief will you request.*

**Request an outlook briefing because you will not depart for several hours still.**

*You have 10 minutes until departure, but have not received any type of weather brief at all. What kind of weather brief will you request when you talk to Flight Service?*

**Request a normal briefing. You should not request an abbreviated brief because you have not yet received a brief at all.**

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## WEATHER PRODUCTS

### METARS

What are METARs?

**METARs are Meteorological Aerodrome Reports: They are textual weather observations of weather at an airport at a particular time period.**

Are cloud heights in METARs measured in AGL or MSL?

**AGL.**

*A SPECI has been issued for your airport in the last 10 minutes. What does that suggest?*

**A SPECI indicates that the weather has changed quickly enough that it justifies publishing a new weather report ahead of the normally scheduled time.**

### TAFS

What is a TAF?

**Terminal Aerodrome Forecast. TAFs are forecasts for an airport area that usually cover a 24 hour period.**

How often are TAFs published?

**TAFs are published every 6 hours, or 4x daily.**

What does “FM” indicate on a TAF?

**FM indicates that from that time period following the FM the weather will be as stated. FM is used to indicate a usually short window of time when the weather will be different than the general weather trend.**

What does “BCMG” indicate on a TAF?

**BCMG indicates a longer term change to the weather than FM. Following the time period written after the BCMG, pilots can expect the weather to have changed.**

### PIREPS

What are PIREPs?

**Pilot Reports are textual reports of weather observed by pilots. It can include information like visibility, cloud ceilings, turbulence and icing.**

What is the difference between PIREPs coded with UA and PIREPs coded with UUA?

**PREPs coded with UA are normal, and PIREPs coded with UUA are urgent.**

What is the advantage of PIREPs over METARs and TAFs?

**METARs and TAFs only tell you what the weather is like at an airport, but PIREPs can tell you what the weather is like at places along your route of flight. Observations of turbulence, cloud tops, etc. are usually only found in PIREPs.**

## WINDS ALOFT FORECASTS

How are winds that are light and variable coded?

**9900**

How does a pilot decode winds above 100 knots?

**Subtract 50 from the direction and add 100 to the speed.**

## WEATHER DEPICTION AND PROG CHARTS

What information can be found on a prog chart?

What information can be found on a weather depiction chart?

What do shaded areas on a weather depiction chart indicate?

What do contoured areas without shading indicate?

*If you were concerned about determining freezing levels, would you consult a prog chart or a weather depiction chart?*

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## PERFORMANCE

### PERFORMANCE OVERVIEW

What factors can affect an airplane's performance?

- **Temperature**
- **Weight**
- **CG Location**
- **Air Pressure**
- **Wind**
- **Pilot Skill**
- **Terrain**
- **Weather**

Why should pilots not plan on getting the *exact* performance that's stated in the performance chart?

**Those numbers are from test flights using highly skilled pilots in brand new airplanes. Not everyone is an exceptional pilot, and certainly older airplanes do not perform quite as they do when they are brand new.**

What performance charts are common-use in your airplane?

**Look at your airplane's performance charts. Usually you'll see things like:**

- **Takeoff and landing distance (ground roll and over an obstacle)**
- **Time, fuel, and distance to climb**
- **Cruise power settings / endurance profiles**

*You are departing your local airport which has a 2,400 foot runway. You calculate your takeoff ground roll required to be 2,100 feet. Do we have enough information to know if this is a safe takeoff? If not, what are we missing?*

**No, first you need to consider if there are obstacles that you need to clear. Knowing your ground roll alone is not a sufficient performance consideration unless there are no obstacles to clear after takeoff.**

*Generally speaking low temperatures are good for performance. What is a performance metric for which low temperatures are not desirable?*

**Cruise performance. A lower temperature in cruise results in lower true airspeed and higher fuel burn.**

## WEIGHT AND BALANCE EQUATION

What is the equation for moment?

**Moment = Weight x Arm**

In general terms, how does a pilot solve a weight and balance problem?

**Find the weight and moment for each item that will be loaded (bags, passengers, fuel, etc) and add the weights to the aircraft's empty weight and the moment to the aircraft's empty moment. Then, divide total moment by total weight to find the CG.**

What is moment?

**Moment is a calculation of the effect that a weight will have, as a result of it's weight and location in the airplane.**

What is arm?

**Arm is the distance from a standard datum line that the weight is located.**

What is the common term for total moment divided by total weight?

**Center of Gravity (CG).**

## TAILDOWN FORCE AND BALANCE

Why does an aft CG increase performance?

**An aft CG requires less tail down force in flight to keep the airplane level. As a result, the airplane is effectively lighter, and thus capable of better performance than an airplane with a forward CG.**

What are the disadvantages to an aft CG?

**Aircraft loaded with an aft CG tend to be less stable, harder to control, and are easier to spin in a stall with poor rudder control.**

What are the advantages to a forward CG?



**An aircraft loaded with a forward CG will tend to be more stable, easier to control and less likely to spin in a stall with poor rudder control.**

What are the disadvantages to a forward CG?

**Aircraft with forward CGs have poorer performance than aircraft with aft CGs. They can also be nose heavy and therefore harder to rotate or flare.**

*Do pilots control the amount of tail down force, separately from the weight and balance of the aircraft?*

**Yes and no. Pilots use the elevator to add or reduce the forces acting on the tail, but they are limited by the aircraft requirements. Generally, airplanes must climb, cruise and descend at certain AOAs, and the elevator is used to set that AOA. Thus, the pilot can change the tail down force, but has almost no freedom in the amount of tail down force used in a particular flight regime. So technically yes, but practically, no.**

**VX AND VY**

If a pilot needs to gain the most altitude in a given time, which speed should they climb at?

**V<sub>y</sub>**

If a pilot needs to clear obstacles in a given distance, which speed should they climb at?

**V<sub>x</sub>**

Which speed is higher, V<sub>x</sub> or V<sub>y</sub>?

**V<sub>y</sub>**

*While out flying, you notice that when you start from cruise flight, you can climb much steeper at 55 knots than you can at 65 knots. 65 knots is your published V<sub>x</sub> climb speed. Why is this the case?*

**These speeds assume you are already in an unaccelerated climb. In other words, V<sub>x</sub> and V<sub>y</sub> are only truly the best angle or best rate of climb airspeed when you hold that speed. If you are faster to begin with you can obviously gain more altitude in a short distance by trading the extra airspeed for altitude.**

*Why might some pilots want to climb a little faster than V<sub>y</sub> under normal conditions?*

**Climbing at  $V_y$  can cause the engine to run hotter than is preferable since it can limited the airflow across the engine. Many pilots, and especially aircraft owners, prefer to fly a little faster than  $V_y$ .**

## CHARTS

What is interpolation?

**Interpolation is a system of averaging or estimating the value between two known number. In a very simple example, if you know that the climb speed at 1000lbs is 100 knots and at 2000lbs the climb speed is 120 knots, we could interpolate that at 1,500lbs the climb speed is 110 knots.**

**Interpolating is often required while using performance tables, because tables only have a finite number of known values. Sometimes you may even need to interpolate twice (e.g. between weights and then between temperatures).**

**Generally when interpolating it's a good idea to err on the side of being conservative. For example, if you have a takeoff distance chart with temperatures at 20 degrees and 30 degrees and the actual temperature is:**

- **21 degrees —> Use 25 (average 20 and 30)**
- **26 degrees —> Use 30**

**We know that hotter temperatures reduce performance, so it's safer to estimate performance with a slightly higher temperature than actual, instead of the other way around. When you get better performance than you estimated, that's a nice surprise. When you get worse performance than you estimated, that can kill you.**

When interpolating with temperature, is it better to round up or round down?

**Round up.**

When dealing with pressure altitudes, is it better to round up or round down?

**Round up.**

When it comes to headwind, is it better to round up or round down? What about with tailwind?

**With a headwind, round down. With a tailwind, round up.**

*Must a pilot reference a takeoff and landing distance chart every time they fly? Why not?*

A pilot must know their performance before they fly. If you fly under the same conditions, at the same airport, in the same airplane with similar weights, then you know how the airplane will perform and hence you do not need to do calculations each time. Of course, there is no harm in doing so, and any time there is doubt as to what performance can be achieved, the proper calculations must be made.

## PILOT TECHNIQUE

At a high density altitude airport, you rotate and try to climb and the airplane doesn't climb, even though your performance calculations said it should. Why is this, and what should you do?

**You have probably rotated early. Normally aircraft performance is sufficient that this goes unnoticed by the pilot. In this case, however, it provided sufficient lift to takeoff, but not sufficient to leave ground effect. At the same time, the high pitch has added enough drag that the airplane is now barely accelerating. You need to lower the nose first, accelerate and then climb.**

**This is a great reason why performance calculations are so important in high density altitude situations. If you have a short runway, you do not have time to debate whether you need to change technique, accelerate longer, etc. You either need to takeoff or you need to abort the takeoff.**

*You are approaching an airport with a 8,000 foot density altitude. On approach, although you are flying at the published final approach speed of 65 knots, you feel like you are very fast. Why is this? Do you need to make any correction?*

**You feel fast because you are fast in terms of groundspeed. In the higher density altitude, the same approach speed which you are (correctly) flying, is a higher groundspeed. This is the reason that takeoff and landing distance increases with density altitude.**

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## NAVIGATION SYSTEMS

### VOR

In simple terms, how does a VOR work?

**A VOR works by comparing the receiving time of two signals. One signal is directional, scanning in 360° over a set period of time. The other is omni-directional, so it goes in all directions at the same time. Our receiving equipment uses the difference in reception time of the first signal and the second to calculate our bearing from the station.**

What navigational information can a VOR provide?

**VOR alone just provides azimuth information.**

What does the TO/FROM arrow on a VOR instrument indicate?

**TO/FROM indicates whether the omni-bearing selector (OBS) course, if flown, would take you to the station or away from the station.**

What is the difference between a radial and a bearing? Can they ever be the same?

**A radial is a line extending away from a station. A bearing is the path to the station. If, for example, you are directly east of a station, you are on the 090° radial. If you fly 090° and track outbound, your bearing away from the station is also 090°. If you fly to the station, your bearing is °270.**

*What condition will create reverse sensing?*

**Reverse sensing will occur when there is a disagreement between your OBS course and your intended route. In other words, if you are trying to go TO the station but have a FROM indication, you will have reverse sensing. Similarly, if you are trying to go FROM the station, but a receiving a TO indication, you will have reverse sensing.**

*What is the primary danger in reverse sensing?*

**The danger in reverse sensing is that a pilot will turn the wrong direction to intercept a course and end up in a location they were not intending to be. Depending on where they are flying, there could be mountains, busy airspace, etc. that create a major hazard.**

## TUNING A VOR

What are the steps to tuning a VOR?

**Find the VOR frequency, tune it, listen to the ident and then tune the OBS selector.**

Why is it important to hear the morse code identifier on a VOR?

**This confirms that your VOR receiver is receiving the station you intended it to. Sometimes, stations will fail or go down for maintenance, in which case the morse code identifier will not play.**

## HOW TO FLY A RADIAL

What will happen if a pilot tries to fly a course with the wrong TO/FROM indication?

**They will experience reverse sensing and, as they turn towards a course, will find that the course seemingly moves further away from them.**

Why might the airplane's heading required to hold a radial not be equal to the bearing to or from the station?

**Wind correction. A radial is a magnetic course, not a magnetic heading. In order to fly a radial you may need to correct left or right for wind.**

## CROSSING OVER A VOR

What is the cone of confusion?

**The cone of confusion is the area nearly directly over a VOR where course adjustments become very sensitive. Pilots often make their lives harder than necessary in the cone of confusion because they "chase" the needles, when they are in fact on course, but simply experiencing the cone of confusion. As a general rule of thumb, do not make major course corrections directly over a VOR unless you are intentionally changing course.**

If a pilot crosses over a VOR from east to west, do they need to re-tune the omni-bearing selector to continue outbound from the station?

**No. They are continuing on the same bearing. The TO/FROM indication will simple reverse.**

When is station passage determined to have occurred?

**Station passage is defined by a full reversal of the TO/FROM indication.**

## DME

What is DME?

**DME is distance measuring equipment. It is a system that determines an airplane's straight-line distance from a station by timing the difference between sent and received signals.**

How does DME work?

**The aircraft's DME equipment sends a signal to the station, which sends a response signal. The time between sent and received signals is used to calculate the distance.**

Do all VORs have DME? How do we know if a VOR has DME equipment?

**No, only VOR/DME and VORTAC. VOR/DME and VORTAC have different symbols on sectional charts.**

Do VORTACs have DME capability?

**Yes.**

What is slant-range error?

**DME measures the straight line distance from the aircraft to the station. Some of this distance is vertical. The most obvious slant range error is seen when an airplane is directly over the station. In this case, the aircraft's altitude will be indicated in miles on the DME. For example, an aircraft directly over the station at 6,000 feet would indicate roughly 1nm from the station.**

**Slant range error decreases with distance from the station and with lower altitude.**

## NDB

What is an NDB?

**Non-directional beacons are a type of NavAid, whose signal is received by an automatic direction finder (ADF).**

What equipment in the airplane is used to track to an NDB?

**Automatic Direction Finder (ADF).**

What is the advantage of an NDB over a VOR? What are the disadvantages?

**And NDB is lower frequency than a VOR, (high frequency or HF, as opposed to very high frequency or VHF) and can therefore be used beyond line of sight. The disadvantage to NDB is that they are more subject to interference, especially from weather.**

## ADF

What is the difference between fixed-card and moveable card ADFs?

**Fixed card ADFs have no directional gyro component. They simply indicate 0° as the aircraft's current heading. In order to find the bearing to a station, the pilot must add the magnetic heading to the relative bearing shown on the fixed card ADF.**

**Moveable card ADFs have a directional gyro component, and therefore will point directly to the magnetic bearing to a station.**

Why might the best route to a station not be to follow the exact heading on the ADF needle?

**Pilots that fly the exact heading on the ADF needle don't compensate for wind and will end up flying an arcing path to the station, as the wind continuously blows them off course. Instead, they should notice the ADF needle drifting, and make a heading correction to adjust for wind, sufficient to prevent the needle from drifting.**

## GPS

How does GPS work?

**Global Positioning System (GPS) works by measuring the time it takes for signals to pass from a satellite to a receiver. The time it takes the signal to travel, multiplied by the speed of light, equals the distance from receiver to satellite. By combining four or more signals together, the receiver can calculate its exact position based purely on its distance from the satellites.**

How many GPS satellites are needed to establish a 3 dimensional position?

**4.**

What is the advantage of GPS compared to VORs or NDBs?

**GPS is more accurate, and allows aircraft to travel directly to any point on earth. Instead of needing to fly from navaid to navaid, the GPS can simply determine a direct course to an airport or waypoint or even random coordinates.**

*Why do many GPS systems require contact with 5 satellites in order to function properly?*

**The 5th satellite is used to back up the other 4. With a 4 satellite system, one of the satellites could be inaccurate and it would create an inaccurate position. A 5th satellite provides an additional data point which can detect a system failure if there is any disagreement among the satellites.**

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## CROSS COUNTRY PLANNING

### USING A PLOTTER

*Calculating true course requires lining up the plotter's black line along the \_\_\_\_\_ and then referencing the true course by moving directly \_\_\_\_\_.*

**True course. Horizontally.**

### TOP OF CLIMB AND TOP OF DESCENT

*Why is Top of Climb and Top of Descent calculated before we pick checkpoints in the middle?*

**We want to make sure that checkpoints along the route of flight are evenly spaced. We won't know where to make the first and last checkpoints until we figure out where the top of climb and top of descent are.**