Commercial
Study Guide

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COMMERCIAL STUDY GUIDE

How to use this document:

This study guide follows the structure of the ACS and is a supplement to the FAA resources listed in the "References" section at the top of each ACS Task. It is not a replacement for ground training with a qualified instructor. Use this guide in conjunction with the FAA-approved resources to develop a deeper level of knowledge.

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Area of Operation I. Preflight Preparation

Task A. Pilot Qualifications

References: 14 CFR parts 61, 68, 91, 119.1(e); AC 68-1; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with airman and medical certificates including privileges, limitations, currency, and operating as pilot-in-command as a commercial pilot.

Knowledge:	The applicant demonstrates understanding of:
CA.I.A.K1	Certification requirements, recent flight experience, and recordkeeping.
CA.I.A.K2	Privileges and limitations.
CA.I.A.K3	Medical certificates: class, expiration, privileges, temporary disqualifications.
CA.I.A.K4	Documents required to exercise commercial pilot privileges.
CA.I.A.K5	Part 68 BasicMed privileges and limitations.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.I.A.R1	Proficiency versus currency.
CA.I.A.R2	Flying unfamiliar aircraft or operating with unfamiliar flight display systems and avionics.
Skills:	The applicant exhibits the skill to:
CA.I.A.S1	Apply requirements to act as pilot-in-command (PIC) under Visual Flight Rules (VFR) in a scenario given by the evaluator.

- ❏ Where are the training requirements listed for Part 61 commercial pilot certification? 61.123 (eligibility), 61.125 (aeronautical knowledge), 61.127 (flight proficiency, i.e., required maneuvers), and 61.129 (aeronautical experience, i.e., flight time requirements).
  - ❏ Where are the commercial pilot certification requirements located for students training under Part 141? 14 CFR Part 141 Appendix D.
  - ❏ As a Part 141 student, how can you determine that you meet the eligibility requirements for your EOC? Follow the 141 syllabus and satisfactorily completed all prior events.

- ❏ What document contains the *testing* standards for commercial pilot certification? The Commercial ACS.
  - ❏ How can you determine your ACS version is current? The latest version - currently, FAA-S-ACS-7B - is posted on FAA.gov: https://www.faa.gov/training_testing/testing/acs. Ensure your ACS version matches.
- ❏ For a commercial pilot add-on checkride, show me in the ACS how you would determine which tasks an examiner is required to include on the practical test? The "Additional Rating Task Table" for the rating sought is located in Appendix 5 of the Commercial ACS.
- ❏ What is the age requirement to receive a commercial pilot certificate? 18 years old.
- ❏ List the privileges of a commercial pilot ? Act as PIC of an aircraft 1) for compensation or hire, and 2) carry persons or property for compensation or hire.
  - ❏ Can you buy an aircraft and offer to fly people around for a fee? No, not unless an Air Operator Certificate (AOC) per Part 119 is obtained and operated under the rules of Part 135 or 121.
  - ❏ Without receiving an AOC from the FSDO and setting up your own Part 121/135 operation, what are ways to be compensated as a commercial pilot? You can fly FOR a commercial operator (or air carrier), but you cannot BE the commercial operator - not unless the operation is one of the 119.1(e) exceptions. Additionally, you can get paid to fly Part 91 (corporate), provided it is clear that you do not have operational control of the airplane. (In the case of Part 91 corporate, the flying is merely incidental to the business and not the business itself, so the aircraft owner/operator would not need an AOC).
  - ❏ What is the meaning of "operational control"? It means to have "authority over initiating, conducting, or terminating a flight." In layman's terms, the person or entity with operational control is liable for the flight's regulatory compliance and safety.
  - ❏ If a friend owned an airplane and offered to pay you to fly it, could you accept? Yes, provided the friend takes on operational control - this should be made clear in the employment contract..

Scenario: After passing your commercial checkride, you stop flying - the training becomes too expensive. 10 years pass before you see a job listing online for a pilot position where, in exchange for a salary, you would be on call to fly the owner of a CE-182 (230hp) to business meetings around the country, day and night. You would be the owner's employee, and most of the flying would be IFR.

- ❏ The listing describes this job as a Part 91 corporate position that does not require an Air Operator Certificate (AOC). Based on the information provided so far, is this operation legal? Why or why not? Yes, it's legal. It's a standard Part 91 corporate operation where no AOC is necessary because 1) it is not a commercial operation - the flying is incidental to the business, not the business itself. Put differently, the flights won't be generating revenue for the operator (the person or entity with operational control), so it's not a Part 121 or 135 operation. And 2) the plane is not large enough to trigger the Part 125 requirement for an AOC.

- ❏ As a commercial pilot, are you allowed to reach out to the owner and ask for employment? Yes, you can apply for the job. Flying or acting as PIC cannot occur until currency is established and endorsements are received for the CE-182 (high performance aircraft).
  - ❏ By reaching out to the owner, are you '*holding out'* your services? Wouldn't that entail common carriage and require an AOC? Applying for a job is not 'holding out' in terms of common carriage. Instead, if the aircraft's *owner/operator* (the person or entity with operational control) were to hold out the commercial use of their CE-182 to the public, that would involve common carriage and require an AOC.
  - ❏ When is "holding out" indicative of common carriage? This occurs when an aviation *business* holds out its services to the public. This is distinct from a commercial pilot holding out his or her potential piloting services to a prospective employer (applying for a job).
  - ❏ If you owned and operated the CE-182, provided you were current and proficient, could you post on Facebook that you would be willing to fly your friends to certain destinations for compensation? No, that's a commercial operation involving holding out - without an AOC you would be operating illegally as a common carrier. Depending on scheduling, this aviation business would have to operate under Part 135 or Part 121 after obtaining an AOC.
  - ❏ Why can airlines and charter operations hold out their business to the public but you can't? They have AOCs (akin to business licenses) and operate under the rules of Part 121 or Part 135.
  - ❏ What exactly is meant by "holding out"? Advertising. Holding out can also mean, simply, that the aviation business has developed a reputation for being open to the public.
- ❏ Given the CE-182 scenario described above, what must you do before flying legally as PIC? Become current and receive the proper endorsements. This would include the completion of a flight review, an instrument proficiency check, and if carrying passengers, accomplishing 3 takeoffs and landings within the previous 90 days (to carry passengers at night these landings must occur at night to a full stop). Additional requirements include the issuance of a 1st or 2nd class medical certificate with, at a minimum, active 2nd class privileges. A high performance endorsement is required, as well.
  - ❏ In order to carry passengers at night, 3 night takeoffs and full-stop landings are required. When exactly do these takeoffs and landings have to occur? The period from one hour after sunset to one hour before sunrise.
    - ❏ Once you've completed those night takeoffs and landings, you become current to carry passengers during what time frame? The period from one hour after sunset to one hour before sunrise, as well as during the day.
    - ❏ Can the night landings be stop-and-go's, or must they be full-stop-taxi-backs? Stop-and-go's are permitted.
    - ❏ Is it required to log these currency flights and takeoffs/landings, or is it sufficient that you've completed them? It is required to log currency flights.
    - ❏ Are you required to log any other type of flight time? Yes, in addition to currency flights, pilots must log flight time used to meet checkride certification requirements.
  - ❏ Why is a high performance endorsement required in this scenario? Because the engine produces more than 200 horsepower.

- ❏ Could you accept the position described in the scenario if you do not have an instrument rating? If no, why not? No. Without an instrument rating you could only fly passengers 1) during the day, and 2) within 50 NM. This job requires flying passenger(s) farther than 50 NM and at night.
  - ❏ What if the flights involved carrying cargo only, no passengers? Would an instrument rating still be necessary? No, an instrument rating would not be necessary because the 50 NM restriction and night restriction apply only to passenger-carrying operations.

**Refer to the "Instrument Study Guide" for instrument recency questions/information.*

- ❏ What is a "common carrier"? A commercial flight operation that involves "holding out."
  - ❏ Specifically, what are the four elements that define "common carriage"? 1) A holding out or a willingness to 2) transport persons or property 3) from place to place 4) for compensation.
- ❏ What is a for-hire "private carrier" (contract carrier)? A commercial flight operation that does not involve holding out.
  - ❏ Do private for-hire carriers need AOCs? Yes. All commercial flight operations, whether they involve holding out or not, must operate under Parts 121 or 135, and therefore must have an AOC.
  - ❏ Does "private" mean the flight is Part 91 and therefore not a commercial operation, thus not requiring an AOC? No, "private" simply means that no holding out was involved, i.e., not open to the public. There are plenty of private carriers that don't hold out - they still conduct commercial operations, but they contract with only a few select long-term customers.
    - ❏ Why only a few customers? Multiple contracts implies a willingness to contract with anybody.
    - ❏ What number of contracts triggers common carriage? 18-24 contracts have been found to be common carriage; 3 contracts have been found to be private carriage. Anything in between is a legal gray zone.
- ❏ If you took the job as the Part 91 CE-182 corporate pilot, what are some things you would want to keep an eye out for to ensure you weren't part of an illegal, uncertificated commercial flight operation? The flying should be incidental to the business, not the business itself (i.e., not a commercial operation) - so the flights should not be generating revenue. On the contrary, the flights should be costing the operator money. So make sure that the owner/operator isn't selling seats or cargo space. Also, passengers should be traveling only for related purposes.
- ❏ If you were a flight instructor, could you buy a plane and advertise on social media that you are willing to provide flight instruction for a certain hourly fee? Yes, flight instruction is one of the 119.1(e) exceptions.
  - ❏ What do you mean by "119.1(e) exceptions"? This regulation lists types of commercial operations that are excluded from the 119.1 Air Operator Certificate (AOC) requirements. In other words, these operations may be conducted under the operating rules of Part 91 and therefore do not require the operator to first obtain an AOC.
  - ❏ Does that mean a private pilot can engage in these activities for compensation? No, you must be a commercial pilot to be compensated for these activities.

- ❏ What are some examples of 119.1(e) exceptions? 1) flight instruction, 2) non-stop air tours (conducted within a 25 SM radius from the departure airport after first obtaining an Letter of Authorization from the FAA and complying with other provisions surrounding air tours), 3) ferry or training flights, 4) aerial work operations including: crop dusting, seeding, spraying, bird chasing, banner towing, aerial photography, and firefighting, and 5) nonstop parachute jump flight conducted within 25 SM of the departure airport.
- ❏ Is holding out permitted when conducting one of the 119.1(e) exceptions? Yes.

❏ You show up to your first day of work as your friend's corporate pilot, and instead of a CE-182, he has a B737. Just as the previous scenario, you're flying him to a business meeting. Is the flight still permitted without an AOC? Why or why not? No, an AOC is required because the flight now falls under Part 125.

- ❏ What is Part 125? It governs the operations of large aircraft not engaged in common carriage. Specifically, the rules of this Part are triggered when the plane's max payload exceeds 6000 pounds or has a passenger seating capacity of 20 or more, and the holding out of commercial services is not involved.
- ❏ You are a current commercial pilot with a multi engine rating. You have complex and high performance endorsements. Can you act as PIC while flying the B737? No, you need a B737 type rating and a high altitude endorsement.
- ❏ When is a type rating required? When acting as PIC and one of the following applies to the aircraft: 1) Max takeoff weight of more than 12,500 lbs, 2) turbojet powered, 3) the Administrator requires a type rating for an aircraft.
- ❏ When is a high altitude endorsement required? When acting as PIC of a *pressurized aircraft*, defined as an aircraft having a service ceiling or maximum operating altitude, whichever is lower, above 25,000 feet MSL.

❏ You have a commercial pilot certificate with a multi engine land and single engine land rating. Would you be current to carry passengers in the CE-182 (ASEL) after doing 3 takeoffs and landings in the previous 90 days in a PA-44 (AMEL)? No, passenger currency is class/type-specific. You would only be current in multi engine land airplanes, in this scenario.

- ❏ After the 3 PA-44 takeoffs and landings, would you be current to carry passengers in a Citation (i.e., an AMEL requiring a type)? No. Because a type rating is required, the takeoffs and landings would have to be conducted in the same type. However, if the takeoffs/landings were conducted in the Citation, you would be current in a PA-44.

❏ How often must a pilot complete a flight review? Every 24 calendar months.

- ❏ What starts the 24 month clock? Either the last flight review or the last checkride.
  - ❏ Last *pilot* checkride, or do flight instructor checkrides start the clock as well? Any checkride, CFI checkrides count.
  - ❏ Does an IPC count? No.
  - ❏ Do airline pilots have to do flight reviews as well? Generally no. Their routine 121 and 135 proficiency checks count for this requirement.
- ❏ You passed your previous checkride on 1/22/20. To stay current, by what date will you need to complete your flight review (or take another checkride)? 1/31/22.

- ❏ If you go beyond that date without completing a flight review, what happens? You won't be able to exercise the privileges of your pilot certificate. You won't be able to act as PIC.
- ❏ Now that you've gone more than 24 calendar months without a flight review or a checkride, how do you regain your currency so that you can act as PIC again? Complete a flight review or pass a checkride.
- ❏ Can you still *log* PIC time if you've exceeded 24 months without a flight review or checkride? Yes, provided I'm the sole manipulator of the controls and rated in that class of airplane; however, I cannot *act* as PIC because I'm not current, so there must be another pilot onboard who is appropriately rated/endorsed/current, acting as PIC.

❏ What happens if you don't pass a flight review? You don't get the endorsement, and the flight is logged like any other training flight.
- ❏ Does this failure go on your record? No, it's not even considered a failure. You simply didn't earn the endorsement. Instead, it's considered a training flight.

❏ Is IACRA required for flight reviews? No. IACRA is optional, but encouraged by the FAA, for flight reviews and IPCs.

❏ If you pass a flight review, are you required to log it? Yes, for currency.
- ❏ What exactly must be logged? The ground (if required), the flight, and an endorsement.

❏ What does a flight review consist of, at a minimum? 1 hour of ground and 1 hour of flight training. The ground must cover the current general operating and flight rules of Part 91. The flight must include a review of the maneuvers and procedures that, at the discretion of the person giving the review, are necessary for the pilot to demonstrate safe exercise of their pilot certificate.
- ❏ Are there any exceptions to these requirements? Yes, a person who has completed one or more phases of the FAA WINGS program within the previous 24 months need not accomplish a flight review. Also, a CFI who has renewed their CFI within the previous 24 months need not accomplish the 1 hour ground portion of the flight review.

❏ Who is permitted to conduct a flight review? A CFI or other person designated by the FAA. The CFI must have their instructor rating in the class of airplane (e.g., SE or ME) appropriate to the class of airplane being used for the flight review.

❏ You are a private pilot with airplane single engine land and multi engine land ratings. If you complete a flight review in a single engine aircraft, are you also current in a multi engine aircraft? Yes. Once a flight review is completed in any aircraft that you are rated to fly, you are now current in all the other aircraft in which you are rated.

❏ If you have a helicopter rating, as well as airplane single engine and multi engine land ratings, and you accomplish a flight review in a helicopter, are you current in single engine and multi engine land airplanes, as well? Yes.

❏ Is a current medical certificate required in order to receive a flight review? No. However, in this case the person conducting the flight review needs to be able to act as PIC for the flight portion.

- ❏ For obscure questions regarding flight reviews, where can one look to get answers? AOPA's flight review guide.

- ❏ When must a pilot have a current medical certificate? When exercising the privileges of their pilot certificate (when acting as PIC).
- ❏ What class of medical certificate are you required to have to take a commercial check ride? 3rd class medical certificate for the flight, provided it is in an airplane and not in a simulator (in which case no medical is required).
- ❏ You obtained a first class medical certificate on 1/5/2020. What is the last day that the medical certificate itself is valid? 1/31/2025.
  - ❏ What if you were 40 or older when you took the exam? 1/31/2022.
  - ❏ Describe the expiration dates of your first, second, and third class *privileges*, assuming you are under age 40. 1st class privileges expire 1/31/2021. 2nd class privileges expire 1/31/2021. 3rd class privileges expire 1/31/2025.
  - ❏ What if you took your exam when you were 40 or older? What are the expiration dates for each of your privileges? 1st class privileges expire 7/31/2020. 2nd class privileges expire 1/31/2021. 3rd class privileges expire 1/31/2022.
  - ❏ You took your 1st class medical exam one day before turning 40. Are you still entitled to 12 calendar months of 1st class privileges even after your 40th birthday? Or, when you turn 40, do the privileges revert down to 6 months? Privileges correspond to (are locked in at) one's age at the date of the exam, so the privileges would still be valid for 12 calendar months.
  - ❏ You are 41 years old and passed your 1st class medical exam 8 months ago. What class privileges do you have now? 2nd class privileges.
    - ❏ For how much longer? 4 more calendar months.
    - ❏ What occurs after? 12 more calendar months of 3rd class privileges.
- ❏ If the day after passing your medical exam you come down with an illness that would have been disqualifying had you had the condition prior to receiving your medical, are you still allowed to act as PIC? No. Medical certificates are self regulating per 61.53.
- ❏ Where can pilots find the standards necessary to qualify for each class of medical? FAR Part 67.
- ❏ If an aspiring pilot has a disqualifying condition in their past like, say, epilepsy, or a history of substance abuse, does that mean they cannot qualify for a medical certificate and therefore can never become a pilot? No, they can apply for a Special Issuance or a Statement of Demonstrated Ability (SODA).
- ❏ How would you go about applying for a special issuance or a SODA? The PHAK says to contact the local FSDO, which would provide guidance on how to apply to the FAA Federal Air Surgeon.
- ❏ What is the difference between a Special Issuance and a SODA? The former is for potentially progressive conditions and comes with a valid period, so it must be renewed periodically; the latter is for static conditions (poor vision in one eye, loss of a limb, color blindness) and only expires if the underlying condition worsens. SODAs are granted once the applicant demonstrates proficiency despite the condition.
- ❏ What class or classes of medical are permitted after receiving a special issuance or SODA? Any. The SI or SODA will specify which class of medical the pilot is eligible for.

- ❏ If you just want to fly small planes recreationally, is there a cheaper, more efficient, better option than going to an AME to get a medical certificate? Yes, BasicMed.
- ❏ What is BasicMed, and how does it work? BasicMed allows pilots who fly recreationally and who qualify for a driver's license to bypass the medical certificate/AME process, and instead see their normal physician to legally fly.
- ❏ What is required of the pilot to fly under BasicMed? The pilot needs to have held a medical certificate at some point AFTER July 14, 2006 (cannot have been denied or revoked), hold a current U.S. driver's license, print out the Comprehensive Medical Exam Checklist (CMEC) and take it to any physician to fill out every 48 months, take an online BasicMed self examination course every 24 calendar months, then store the CMEC and the BasicMed Online Course Certificate of Completion in their logbook.
- ❏ Must a pilot flying under BasicMed carry their logbook with the CMEC and Online Course Certificate records when they act as PIC? No.
- ❏ Must a pilot flying under BasicMed carry their driver's license when acting as PIC? Yes, along with their pilot certificate.
- ❏ Does anything need to be submitted to the FAA to operate under BasicMed? No.
- ❏ Can a commercial pilot fly under BasicMed? No, not when flying for hire.
- ❏ What are some of the limitations that apply to operations conducted under BasicMed? You can't fly for hire. You can't conduct a flight above 18,000 feet or fly faster than 250 knots. You can't fly an aircraft with a max takeoff weight greater than 6,000 pounds or certified for more than 6 occupants, and no more than 5 passengers on any flight.
- ❏ As a commercial pilot flying for-hire, what personal documents must you carry while acting as PIC? A commercial pilot certificate, government issued photo ID, and medical with current commercial pilot privileges.
- ❏ For the government ID requirement, could you use a birth certificate or a social security card? No.
  - ❏ Why not? There is no photo.
  - ❏ How about a passport? Yes, it has a photo.
- ❏ When flying a high performance airplane, do you need to carry your logbook containing the high performance endorsement? No.
- ❏ When can you log PIC time? When I am 1) rated in the aircraft, and 2) the sole manipulator of the controls. Additionally, solo students, flight instructors providing instruction, and safety pilots acting as PIC during instrument currency flights can also log PIC.
- ❏ When can you log night time? End of evening civil twilight to the beginning of morning civil twilight, as published in the American Air Almanac. (Avcams.faa.gov has a good civil twilight calculator, located under the "More" drop down menu.)
- ❏ When must the navigation/position lights be illuminated? Sunset to sunrise.
- ❏ Back to the original scenario where you've been hired to fly your friend on business trips in their CE-182. You are current and legal to act as PIC on the flight; however, other than 1 VFR flight in the CE-182 a few days ago to get the high performance endorsement, all your prior training has been in a CE-172 and a PA-44. The day of your first corporate flight the briefer informs you of IMC throughout your route and recommends you fly IFR. In this scenario, would you be willing to proceed with the IFR flight? Why or why not? No, despite

being current, you should not feel proficient flying IFR into IMC in a model of airplane you have only flown once.

- ❏ What would you do? Postpone the flight until you are able to fly some practice approaches in the CE-182 airplane or simulator.
- ❏ How would you distinguish proficiency from currency? Proficiency concerns safety, whereas currency deals with legality.
- ❏ Why is it important for pilots to recognize this proficiency/currency distinction? It's important to recognize that just because a pilot can fly legally doesn't mean they can fly safely. Pilots should always ensure they're *proficient*, not just current.
- ❏ What should you keep and abide by to ensure you're always proficient before piloting an airplane, not merely current? Personal minimums.

Additional scenario:

- ❏ To celebrate passing your commercial check ride, your mother offers to cover all flight expenses and buy you lunch if you'd be willing to rent a plane and take her flying? Could you accept? Why or why not?
  - ❏ No, you cannot secure the aircraft and receive compensation - you would have operational control in this scenario.
  - ❏ What if the two of you agree to split the flight-related expenses? Not if lunch is bought for you. This could be seen as compensation. If you pay for your own meal, however, then you could go ahead with the flight.

Task B. Airworthiness Requirements

References: 14 CFR parts 39, 43, 91; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with airworthiness requirements, including airplane certificates.

Knowledge:	The applicant demonstrates understanding of:
CA.I.B.K1	General airworthiness requirements and compliance for airplanes, including:
CA.I.B.K1a	a. Location and expiration dates of required aircraft certificates
CA.I.B.K1b	b. Required inspections and airplane logbook documentation
CA.I.B.K1c	c. Airworthiness Directives and Special Airworthiness Information Bulletins
CA.I.B.K1d	d. Purpose and procedure for obtaining a special flight permit
CA.I.B.K2	Pilot-performed preventive maintenance.
CA.I.B.K3	Equipment requirements for day and night VFR flight, including:
CA.I.B.K3a	a. Flying with inoperative equipment
CA.I.B.K3b	b. Using an approved Minimum Equipment List (MEL)

CA.I.B.K3c	c. Kinds of Operation Equipment List (KOEL)
CA.I.B.K3d	d. Required discrepancy records or placards
CA.I.B.K4	Special airworthiness certificate aircraft operating limitations, if applicable.

Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.I.B.R1	Inoperative equipment discovered prior to flight.

Skills:	The applicant exhibits the skill to:
CA.I.B.S1	Locate and describe airplane airworthiness and registration information.
CA.I.B.S2	Determine the airplane is airworthy in the scenario given by the evaluator.
CA.I.B.S3	Apply appropriate procedures for operating with inoperative equipment in the scenario given by the evaluator.

- ❏ Define “airworthy.” An aircraft is airworthy if it conforms to its original type design or properly altered state, and is in a condition for safe flight.
- ❏ Specifically, what goes into keeping an airplane airworthy? Proper *documents* onboard, *inspections* complied with, instruments and *equipment* either operating or properly deactivated and placarded inoperative. (The acronym is D.I.E.: Documents, Inspections, Equipment.)
- ❏ Who is primarily responsible for maintaining an aircraft in an airworthy condition? The owner/operator.
- ❏ Who is responsible for maintaining proper maintenance records of the airplane? The owner or operator.
- ❏ An FAA Inspector is conducting a ramp check following a flight during which you were the acting PIC. The FAA Inspector discovers that a required inspection was not accomplished. Who is primarily liable and why? The PIC is responsible. In this scenario, the PIC operated an unairworthy airplane. Per 91.7(a), “No person may operate a civil aircraft unless it is in an airworthy condition.”
- ❏ What aircraft documents must be onboard when the plane is being operated? The traditional acronym here is ARROW; however, this acronym omits a few potentially-required documents. The full list of required documents is: airworthiness certificate; registration certificate; radio station license (if flying outside the U.S.); POH/AFM and the operating limitations it contains such as the placards; the official, current weight and balance and equipment list; compass deviation card (if required by the POH/AFM); avionics cockpit reference guide (the specific required avionics document varies a bit for each aircraft, depending on the type of avionics installed); minimum equipment list (if the plane has one); special flight permit (when required). Some pilots add “external data plate” when listing required documents - certainly required, but not really a document.
- ❏ Is the maintenance binder required to be onboard? No, not per regulation. Per ATP policy, yes.
- ❏ Do the FARs require the airworthiness certificate, the registration certificate, or both, to be visible to occupants? Only the airworthiness certificate must be visible.

- ❏ Where are these certificates displayed in the aircraft? They are found in the front pocket by the pilot seat in the C172 and in the baggage compartment in the PA44/PA28.
- ❏ For how long is an airworthiness certificate valid? For as long as the aircraft is in an airworthy condition and remains registered in the U.S.
- ❏ Is an airworthiness certificate valid for only a specific tail number? Or can the certificate be used for any tail number of the same make and model of airplane? Just the one tail number.
- ❏ What is required before an airplane receives its airworthiness certificate? A representative of the FAA will inspect the airplane to ensure that it meets the regulatory requirements and is in a condition for safe operation.
- ❏ Do registration certificates expire? If so, how often? Yes, every 7 years after the last day of the month in which the registration was previously issued.
- ❏ The aircraft's registration certificate displays an issuance date of 1/8/2013 and expires on 1/31/2027. How is this possible? The registration doesn't list every renewal date, only the original issuance date and the next expiration date.
- ❏ Is the registration certificate the FAA's statement of who owns title to the plane? No. This is written on the certificate.
- ❏ Other than expiring, what else would cause the registration to no longer be valid? 1) Registered in a foreign country, 2) registration canceled upon written request of the certificate holder, 3) aircraft is destroyed or scrapped, 4) ownership transferred, 5) certificate holder loses U.S. citizenship, 5) 30 days have elapsed since the death of the holder of the certificate.
- ❏ For how long can a newly purchased aircraft operate with their Aircraft Registration Application forms - i.e., without being fully registered? 12 months.
- ❏ Are there any limitations associated with flying aircraft that have not yet been fully registered? Because the aircraft isn't fully registered, it is only valid for domestic flights.
- ❏ How can you register your aircraft? Online application on FAA.gov or get a paper application from the FSDO.
- ❏ What aircraft document is required only when flying outside the U.S.? Radio Station License.
  - ❏ Is this document for the aircraft, the pilot, or both? The Radio Station License is required for the plane, the Radio Operators Permit is required for the pilot.
  - ❏ How would a pilot intending to fly internationally acquire this? FCC.gov.
  - ❏ Do you have to pass a test first? No, just fill in some basic information and pay a fee.
- ❏ Where do you find the list of placards required to be on the airplane? Back of the Limitations section of the POH/AFM, section 2.
- ❏ If your aircraft doesn't have a POH/AFM inside, can you use one from another airplane of the same make and model? No.
- ❏ How do you know that you are using the correct POH/AFM for your airplane? Either match the tail number in the POH/AFM with your airplane's tail number, or match the serial number on the external data plate with the serial number in the POH/AFM.
- ❏ Does every section of the POH/AFM need to be in the airplane when it's being operated, or just the 'Limitations' section? The full POH/AFM.

- ❏ During your preflight, you see the POH/AFM in the baggage compartment. Why is this a problem? POH/AFM must be accessible to the pilot in flight.
- ❏ Which weight and balance is required to be onboard, the weight and balance form we fill out prior to each flight, or the weight and balance in the POH/AFM? The weight and balance in the POH/AFM.
- ❏ What section of the POH/AFM typically contains the official weight and balance? Section 6.
- ❏ What section of the AFM/POH contains the equipment list? Section 6.
- ❏ What source requires the weight and balance and equipment list to be onboard? Section 8 of the POH/AFM.
- ❏ It is an ATP requirement to calculate weight and balance prior to every flight. Is it a regulatory requirement as well? There is no regulation that explicitly states this requirement; however, we are required to abide by the limitations in the POH per 91.9, and therefore we must operate the aircraft within the CG envelope. Confirming this necessitates calculating the weight and balance. Also, 91.103 requires us to calculate takeoff and landing data at our departure/destination airports. Calculating accurate information with the performance charts requires us to first calculate the weight and balance. So yes, calculating weight and balance is essentially required.
- ❏ Under what circumstances must the airplane's official weight and balance be amended? For instance, if new, heavier avionics are installed, does the official weight and balance need to be updated? Yes. Any weight change not considered to be "negligible" must be accounted for on the weight and balance.
  - ❏ What is a "negligible" weight change? 1 pound or less if the airplane's empty weight is less than 5,000 pounds.
- ❏ If an aircraft has an MEL, does the MEL need to be carried onboard every time the plane is operated? Yes.
- ❏ Is each MEL only valid for one airplane? Yes, just like the POH/AFM.
- ❏ If an instrument or other piece of equipment becomes inoperative during the flight, should you consult the MEL? No, MELs (as well as 91.213(d)(2) procedures) are not intended to be used in-flight. For in-flight issues, use the checklist and POH/AFM.
- ❏ Where do you look to determine which avionics guide needs to be in the airplane? Section 8 and/or Section 9 of the POH/AFM. It could also be on the KOEL or specified in the avionics guide itself.
- ❏ Where must the avionics guide be stowed in the aircraft? Like the POH/AFM, it must be accessible to the crew.
- ❏ What are the required maintenance inspections and how often must each be completed? Traditional acronym is AAVIATES: Annual (12 calendar months), ADs (as specified), VOR (30 days), 100-Hour (within 100 hours of the last 100-Hour or Annual inspection), Transponder (24 calendar months), ELT (12 calendar months, battery recharged or replaced every 1 hour of cumulative use or when half of its useful life has expired), Static System/Altimeter/Mode-C reporting system* (24 calendar months).
- ❏ Which inspections are only required for IFR flights? VOR (provided the VOR is used for IFR navigation) and the Static/Altimeter/Mode-C inspections.

- ❏ What about the Transponder inspection. In the maintenance binder it's usually listed on the same page as the other IFR inspections? It's usually completed at the same time as the IFR inspections, but it's required for VFR operations as well.

❏ Would the VOR check need to be current for a local instrument training flight practicing instrument approaches under VFR? Not legally required, but ensuring the VORs are current and operating properly would show good ADM. Any time you're using them it's good practice to ensure they're working properly and that they've been checked within the previous 30 days.

❏ What is an Airworthiness Directive? An Airworthiness Directive (AD) is a legally enforceable regulation issued by the FAA to correct an unsafe condition in a product (Part 39 defines a product as an aircraft, engine, propeller, or appliance). It is similar to a vehicle recall.

❏ What FAR Part establishes the FAA's authority to release and enforce ADs? Part 39.

❏ What are the categories of ADs? Describe them. 1) Emergency, and 2) Less-Than-Urgent. The former requires compliance prior to flight, whereas the latter must be complied with within specified time frames. You can subdivide those two basic types of ADs into one-time, recurring, and conditional ADs.

❏ What is a conditional AD? An AD that becomes active only under certain conditions - e.g., an AD that is only required after a prop strike.

❏ Who is responsible for complying with an AD? The owner/operator.

❏ Are AD compliance records required to be kept? Yes.

- ❏ What records, specifically? Refer to 91.417. This regulation requires a compliance record to be maintained that shows the current status of applicable ADs, including the following: the method of compliance; AD number and revision date, if recurring; next due date and time; signature; type of certificate; certificate number of the repair station or mechanic who performed the work. For easy reference, ATP has a sheet with a chronological listing of the pertinent ADs, usually placed toward the front of the maintenance binder.

❏ Show how you verified that all of your aircraft's ADs have been complied with. Verify the relevant ADs listed on the AD Compliance Forms - in particular, the recurring ADs that state "SEE LOGBOOK FOR CONTINUED COMPLIANCE" - have been complied with and recorded properly in their corresponding Maintenance Logbook Entries.

❏ Not every flight school has such easily accessible maintenance logs. If you rented a plane from an FBO, say, how would you verify AD compliance? Use the FAA's Dynamic Regulator System (DRS) website, drs.faa.gov. Select the "Airworthiness Directives" link, and from the drop down menu select either "AD Final Rules" or "Emergency ADs." Using the filter, click "Model" and select the aircraft being flown to bring up the relevant ADs. Then, ask the owner/operator if you could review the maintenance records and confirm that those ADs had been properly complied with.

❏ What is a Special Airworthiness Information Bulletin (SAIB), and how is it different from an AD? The FAA issues a SAIB as an information tool to alert, educate, and make recommendations to the aviation community about ways to improve the safety of a product. It is different from an AD in that it contains non-regulatory, non-mandatory information and guidance for safety issues that do not meet the criteria for airworthiness directive action under Part 39. Sometimes SAIBs eventually become ADs, though.

- ❏ Is compliance with a SAIB mandatory? No, they're advisory.
- ❏ What is a Service Bulletin (SB), and how is it different from an AD? A SB is a notice from a manufacturer informing the owner/operator of a product improvement. *Alert* service bulletins are issued when safety is affected. SBs, unlike ADs, are not regulatory - they are issued by the product or aircraft manufacturer, not by the FAA - and therefore they are not mandatory in a legal or regulatory sense. However, if an alert SB is accompanied by an AD, it becomes mandatory.
- ❏ Is compliance with an SB mandatory? Only if accompanied by an AD.
- ❏ Other than the time frames, is there a difference between the Annual and 100-Hour inspections? In terms of what must be inspected, no, there's no difference. The only difference concerns who can conduct an Annual and approve the aircraft for return to service afterward: an A&P *with an Inspection Authorization*, aka an IA. A&Ps without their IAs can conduct 100-Hour inspections.
- ❏ Is there a difference between how the 100-Hour and Annual inspections are logged in ATP's maintenance binders? Most of our Annual inspections (located in the Airframe sections) are signed off with the verbiage, "I certify this airCRAFT has been inspected . . ." whereas the 100-Hour inspections state, "I certify this airFRAME has been inspected . . ." This means that when verifying Annual inspection compliance, it suffices to verify compliance in the airframe section alone. However, in order to verify 100-Hour compliance, you must verify that the 100-Hour inspection was complied with in all three sections of the binder (airframe, engine, prop).
- ❏ If an Annual inspection was completed on January 1, 2020, when is it next due? 1/31/2021
  - ❏ On 1/31/2021, you fly the plane to an airport and end up getting stuck there overnight due to weather. How do you get the plane back to its base for maintenance, seeing as more than 12 calendar months have now passed since the last Annual? Get a special flight permit.
    - ❏ How? Through the local FSDO or from a Designated Airworthiness Representative (DAR).
  - ❏ If you had been carrying passengers, could they fly back with you? No.
  - ❏ What about the rest of your crew? If they are *required* crew, then yes.
- ❏ Other than overflying an Annual, what are some scenarios that would require a special flight permit? Flying aircraft to a point for repairs, alterations, maintenance (such as to conduct an overdue Annual inspection), or storage; delivering new aircraft to the base of a purchaser or to a storage point; conducting production flight tests; evacuating an aircraft from impending danger; conducting customer demonstration flights in new production aircraft that have passed or completed production flight tests; excess weight operations.
- ❏ Other than "required crew only," what are some typical limitations on special flight permits? Day VMC conditions only; flight must be direct; valid for only the one flight; no overflight of congested areas; a mechanic must first inspect the aircraft and certify that it's safe for the flight; ADs must be in compliance.
- ❏ If you buy a plane and fly it only recreationally, are 100-Hour inspections required? No.
- ❏ What type of flight operations require 100-Hour inspections? When flying non-crew passengers for hire, as well as when giving flight instruction in an aircraft provided by the instructor.

- ❏ You rent an aircraft from a nearby local FBO. You and a friend plan to fly around and practice some landings and maneuvers. You examine the maintenance logs and find that the plane did not have a 100-Hour or Annual inspection completed within the previous 100 hours. Can you fly it? Yes, you have not been hired for this flight - i.e., this particular flight is not a for-hire operation; nor are you providing flight instruction in an aircraft.
- ❏ Here at ATP, is a 100-Hour inspection required? After all, your IP isn't really providing the plane, the flight school is. Yes. The FAA has ruled that if the flight school provides the plane and the instructor, a 100-Hour is required.
- ❏ What if your friend is a photographer, and he's going to pay you to fly him around the city so that he can take some aerial photos? Can you fly without the 100-Hour? No, now you are 'for-hire' and carrying a passenger.
- ❏ Locate the aircraft's 100-Hour inspection compliance in the maintenance binder. *Unlike the procedure for verifying Annual inspections, because the entries for 100-Hour inspections generally read "I certify this airFRAME has been inspected . . ." you must also verify in the prop and engine sections that those systems were inspected within the previous 100 hours.*
- ❏ Your aircraft needs a 100-Hour inspection, but it is currently at 98 hours and the repair station is a 5 hour flight away. fly the plane to the station for maintenance? Yes, you can overfly a 100-Hour by up to 10 hours as long as you're repositioning the aircraft to receive its 100-Hour inspection.
  - ❏ It's an early model CE-172 with small tanks. You'll need to make a fuel stop. Is that permitted? Yes.
  - ❏ If this is a brand new aircraft, and this is the very first inspection, and the inspection ends up being performed at 103 hours, when will the next 100-Hour be due? At 200 hours.
- ❏ What should you verify before overflying a 100-Hour inspection for maintenance? Verify that you won't be overflying an AD - those cannot be overflown and are sometimes required every 100 hours.
- ❏ If an Annual inspection was completed within the previous 100 hours, would that substitute for the 100-Hour? Yes.
  - ❏ Conversely, does the 100-Hour count in place of an Annual? No.
- ❏ What information must be included in inspection maintenance log entries - i.e., what specifically are you verifying when you review the maintenance binder entries? 43.11: 1) The type of inspection and a brief description of the extent of the inspection. 2) The date of the inspection and aircraft total time in service. 3) The signature, certificate number, and kind of certificate held by the person approving or disapproving for return to service the aircraft, airframe, aircraft engine, propeller, appliance, component part, or portions thereof. 4) [. . .] if the aircraft is found to be airworthy and approved for return to service, the following or a similarly worded statement: "I certify that this aircraft has been inspected in accordance with (insert type) inspection and was determined to be in an airworthy condition."
- ❏ How often must the ELT be inspected? Every 12 calendar months.
- ❏ How often must the ELT battery be replaced or recharged? Every 1 hour of cumulative use or when its half-life has been reached.
  - ❏ Who establishes the half-life date? The manufacturer.

- ❏ Where is this listed? On the ELT itself and in the maintenance log.

- Note: In some of the maintenance binders, the ELT inspection and confirmation of battery life are listed under their respective FAR regulations only: 91.207(d) for the inspection (aka the “functional”), 91.207(c) for the battery.

❏ Under what circumstances can the plane be operated without an ELT? These exceptions are listed under 91.207(f). Two common examples: 1) training operations conducted within 50 NM of the departure airport, and 2) when the ELT has been removed for maintenance, provided no more than 90 days has passed since its removal.

❏ Do our aircraft have 121.5 ELTs or 406 ELTs? 406, although they broadcast on 121.5 as well.

- ❏ What’s the difference? 121.5 are analog beacons that send a signal to other aircraft and ATC that can be heard when monitoring 121.5. 406 transmitters send digital signals with more precise aircraft identification information.

❏ When should 121.5 ELT tests be conducted so as not to confuse ATC and/or other aircraft? First 5 minutes of the hour, and no more than 3 sweeps.

❏ Where is the ELT located in the aircraft, and why? Toward the back of the tail cone. The regulations require this, as the tail cone generally receives the least damage in the event of a crash.

❏ What causes the ELT to sound, and how do you know it’s been activated? Rapid deceleration, such as a crash or an extremely hard landing. Also, the pilot can manually activate it with the switch. Once activated, you’ll hear a loud aural tone in the cabin, and the red light on the ELT switch will blink.

❏ Are non-mechanics allowed to conduct any kind of maintenance on the plane? Yes, but only preventative maintenance, and the maintenance must be performed by a pilot with at least a private pilot certificate (there is also an obscure exception for sport pilots, with added caveats).

❏ As a private pilot, could you perform preventative maintenance on someone else’s plane that you don’t operate? No, preventative maintenance must be performed by the owner or operator of the aircraft.

❏ What is the definition of preventative maintenance? Simple or minor preservation operations and the replacement of small standard parts not involving complex assembly operations.

- ❏ If you feel that the maintenance fits that definition, and as long as you’re at least a private pilot and it’s an aircraft that you operate, can you do the maintenance? No, the maintenance needs to be on the list of preventive maintenance in Part 43 Appendix A, paragraph “c.” Anything not on the list is not preventative maintenance.

❏ Can you add oil or add air to the tires of your aircraft, even though it is not listed? Yes, adding oil and adding air to tires is considered general/basic upkeep, like washing the windshield.

❏ Just because a particular preventative maintenance task is listed in Appendix A, and therefore as a private or commercial pilot you are legally permitted to do it yourself, should you? No, not unless you’ve received proper training and feel qualified to competently perform the maintenance task.

❏ Is a maintenance log entry required after performing preventative maintenance? Yes.

- ❏ What information must be included? Per 43.9: 1) Description of the work, 2) date of completion, 3) name of the person performing the work, 4) signature, certificate number, and kind of certificate held by the person approving the work.

❏ What do the following common maintenance log abbreviations stand for? N/A: Not applicable. S/N: Serial number. P/N: Part number. P/C/W: Previously complied with. O/H: Overhaul. A/C: Aircraft. I/A/W: In accordance with.

❏ During your preflight you discover that the (insert any instrument or equipment item here) is inoperative. Your aircraft does not have an MEL. Take me through your process for determining whether and how you can continue with the flight.

Follow 91.213(d)(2): Confirm that the inoperative item is not 1) part of the regulations listed on the TCDS under which the plane was type certificated, 2) indicated as required on the Equipment List, 3) indicated as required on the Kinds of Operations Equipment List, 4) required by 91.205 or any rule of Part 91, or 5) required by an AD. If not required, the item must then be deactivated or removed. This step is almost always accomplished by a mechanic, as pilots are limited to conducting the preventative maintenance tasks listed in Part 43 Appendix A. Once deactivated, placard the item "inoperative." Finally, make a PIC determination about whether the deactivated equipment/instrument constitutes a hazard. If not, proceed with the flight.

❏ You're going to be flying VFR in a G1000 CE-172 in weather that is marginal. You may have to pick up an IFR clearance at some point. During your run-up you pull the alternate static knob to test it, but you don't get the typical bump on the static instruments. You figure the alternate static source is probably blocked. What are you going to do?

1) Confirm that the alternate air source isn't part of the Part 23 regulations listed on the TCDS; however, the CE-172 has an Equipment List that specifies exactly which equipment was required by Part 23 and 91 for certification, so go to the Equipment List in section 6 of the POH/AFM instead.
2) Check the Equipment List. The line about the alternate static reads *34-04-S ALTERNATE STATIC AIR SOURCE 0501017-1 0.2 15.5.* The "S" in "34-04-S" stands for STANDARD, so the equipment is not "indicated as required." If it were required there would be an "R" there instead.
3) Check the KOEL:

KINDS OF OPERATIONS EQUIPMENT LIST (Continued)

System, Instrument, Equipment and/or Function	KIND OF OPERATION				COMMENTS
	VFR DAY	VFR NIGHT	IFR DAY	IFR NIGHT	
EQUIPMENT AND FURNISHINGS					
1 - Seat Belt Assembly	1	1	1	1	Each Seat Occupant
2 - Shoulder Harness	1	1	1	1	Front Seat Occupants
FLIGHT CONTROLS					
1 - Flap Position Indicator	1	1	1	1	
2 - Flap Motor	1	1	1	1	
3 - Elevator Trim System	1	1	1	1	
4 - Elevator Trim Indicator	1	1	1	1	
FUEL SYSTEM					
1 - Electric Fuel Pump	1	1	1	1	
2 - Fuel Quantity Indicator - L Tank	1	1	1	1	
3 - Fuel Quantity Indicator - R Tank	1	1	1	1	
ICE AND RAIN PROTECTION					
1 - Alternate Static Air Source	0	0	1	1	
2 - Alternate Induction Air System	0	0	1	1	
INDICATING/RECORDING SYSTEM					
1 - Stall Warning System	1	1	1	1	
2 - System Annunciator and Warning Displays	1	1	1	1	
LANDING GEAR					
1 - Wheel Fairings	0	0	0	0	Removable

The “Alternate Static Air Source” is not required for VFR operations.

4) There is no Part 91 regulation that requires alternate static.
5) Check ATP’s compliance record to see if there is a relevant AD, and/or do an AD search on drs.faa.gov. No alternate static-related ADs are listed.

Nothing about alternate static appears on the Part 43 Preventative maintenance list, so at this point, have a mechanic inspect the alternate static system and ensure that it’s properly deactivated. Then, make sure that the maintenance log is updated to reflect the maintenance performed. Then, put a placard by the alternate static knob that says “INOPERATIVE.” At this point you’d have to make a PIC decision about whether to continue with the flight. Usually an inoperative alternate static wouldn’t be a big deal when flying VFR. But in our case, due to the marginal weather, you might have to pick up an IFR clearance. And because the alternate static is required for IFR operations per the KOEL, your PIC decision should be to make a no-go decision.

❏ Can the inoperative alternate static remain inoperative indefinitely? 91.405(c) describes that the owner/operator “shall have any inoperative instrument or item of equipment, permitted to be inoperative by §91.213(d)(2) of this part, repaired, replaced, removed, or inspected at the next required inspection.” So at a minimum, the inoperative item must be *inspected* at the next inspection (and the maintenance logs should reflect this), and re-evaluated for

safety at every inspection thereafter (per both 91.405(c) as well as the Peri-Aircraft Electronics Legal Interpretation - 2018).

- ❏ What is a Master Minimum Equipment List (MMEL)? An MMEL is the generic basis (think, starting point) from which the owner/operator develops the MEL for his or her specific tail number. The MMEL is initially created by the manufacturer in conjunction with the FAA for a specific type of aircraft. It contains a list of items of instruments and equipment that may be inoperative (under certain conditions, after following specific procedures) on a type of aircraft.
- ❏ What is a Minimum Equipment List (MEL)? An MEL is a tail number-specific document (derived from the MMEL) listing instruments, equipment, and procedures that allow the aircraft to be operated under specific conditions with inoperative equipment. (It does not include obviously required items such as wings, flaps, rudders, etc.)
- ❏ If you were the owner/operator, how would you go about obtaining an MEL for your aircraft? Schedule an appointment with the FSDO. During the appointment an FAA inspector will provide you with the MMEL and ensure that you understand MEL operations and procedures. Once it is determined that you have an appropriate understanding of this information, you and the inspectorI will both sign the LOA, which goes in the MEL, and then you are on my own to create the tail-number specific Procedures Document and operate the aircraft in accordance with the MEL. The MEL is now considered a supplemental type certificate.
- ❏ Can you create an MEL that is more restrictive than the MMEL (as in, one that requires more equipment to be operating than what's listed on the MMEL)? Yes.
  - ❏ How about less restrictive? No.
- ❏ What 4 parts comprise an MEL? The MMEL, Preamble, Letter of Authorization, and Procedures Document (the O and M procedures).
- ❏ What do the "O" and "M" signify? The "O" indicates that a specific *Operations* procedure must be accomplished before continuing the flight with the listed item of equipment inoperative. Normally the flight crew accomplishes these "O" procedures. An "M" indicates that a specific *Maintenance* procedure (conducted by maintenance personnel, clearly) must be accomplished before beginning operation with the listed equipment item inoperative.
- ❏ A position light is inoperative. How would you use the MEL in this case? Look up "Position Light" in the O+M procedures section of the MEL. It will likely state something to the effect of "the item may be inoperative provided the aircraft is not operated at night." If there is an "O" next to the "Position Light" item (which there would be in this case), then follow the specified operations procedure in order to deactivate the inoperative item. Then, placard the Position Light switch inoperative and fill out a discrepancy/deferral form. These forms are kept in the MEL so that maintenance can reference them at the next inspection.
- ❏ What if the inoperative instrument or equipment is not listed on the MEL? Then the flight cannot be continued until the inoperative item is repaired.
- ❏ What is meant by "repair interval categories"? Each letter, A through D, represents a period of time within which the inoperative item must be repaired. These categories do not apply to Part 91 aircraft.
- ❏ Does the MEL need to be onboard when the plane is being operated? Yes.
- ❏ Is an MEL tail number-specific or type-specific? Tail number-specific.

- ❏ What if the inoperative equipment is required by 91.205, would you still refer to your plane's MEL? Yes.
- ❏ If the plane is sold, does the MEL transfer with the plane? No.
- ❏ Other than the legal requirement, why is it important to always placard deactivated instruments and equipment "inoperative"? It's a reminder not to rely on the inoperative item. Also, it serves as a warning to other flight crews using the aircraft that might otherwise not be aware that the equipment is inoperative.
- ❏ What is a Supplemental Type Certificate (STC)? It is a change in type design not great enough to require a new application for a type certificate. An example would be the installation of a powerplant different from what was included in the original type certificate.
- ❏ Specifically, when is an STC required? For major alterations to the airframe or systems, provided the alteration is not covered by AC43.13-2.

Task C. Weather Information

References: 14 CFR part 91; AC 91-92; AIM; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25, FAA-H-8083-28

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with weather information for a flight under VFR.

Note: *If K2 is selected, the evaluator must assess the applicant's knowledge of at least three sub-elements.*

Note: *If K3 is selected, the evaluator must assess the applicant's knowledge of at least three sub-elements.*

Knowledge:	The applicant demonstrates understanding of:
CA.I.C.K1	Sources of weather data (e.g., National Weather Service, Flight Service) for flight planning purposes.
CA.I.C.K2	Acceptable weather products and resources required for preflight planning, current and forecast weather for departure, en route, and arrival phases of flight such as:
CA.I.C.K2a	a. Airport Observations (METAR and SPECI) and Pilot Observations (PIREP)
CA.I.C.K2b	b. Surface Analysis Chart, Ceiling and Visibility Chart (CVA)
CA.I.C.K2c	c. Terminal Aerodrome Forecasts (TAF)
CA.I.C.K2d	d. Graphical Forecasts for Aviation (GFA)
CA.I.C.K2e	e. Wind and Temperature Aloft Forecast (FB)
CA.I.C.K2f	f. Convective Outlook (AC)
CA.I.C.K2g	g. Inflight Aviation Weather Advisories including Airmen's Meteorological Information (AIRMET), Significant Meteorological Information (SIGMET), and Convective SIGMET
CA.I.C.K3	Meteorology applicable to the departure, en route, alternate, and destination under visual flight rules (VFR) in Visual Meteorological Conditions (VMC), including expected climate and hazardous conditions such as:
CA.I.C.K3a	a. Atmospheric composition and stability
CA.I.C.K3b	b. Wind (e.g., windshear, mountain wave, factors affecting wind, etc.)
CA.I.C.K3c	c. Temperature and heat exchange

CA.I.C.K3d	d. Moisture/precipitation
CA.I.C.K3e	e. Weather system formation, including air masses and fronts
CA.I.C.K3f	f. Clouds
CA.I.C.K3g	g. Turbulence
CA.I.C.K3h	h. Thunderstorms and microbursts
CA.I.C.K3i	i. Icing and freezing level information
CA.I.C.K3j	j. Fog/mist
CA.I.C.K3k	k. Frost
CA.I.C.K3l	l. Obstructions to visibility (e.g., smoke, haze, volcanic ash, etc.)
CA.I.C.K4	Flight deck instrument displays of digital weather and aeronautical information.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.I.C.R1	Making the go/no-go and continue/divert decisions, including:
CA.I.C.R1a	a. Circumstances that would make diversion prudent
CA.I.C.R1b	b. Personal weather minimums
CA.I.C.R1c	c. Hazardous weather conditions, including known or forecast icing or turbulence aloft
CA.I.C.R2	Use and limitations of:
CA.I.C.R2a	a. Installed onboard weather equipment
CA.I.C.R2b	b. Aviation weather reports and forecasts
CA.I.C.R2c	c. Inflight weather resources
Skills:	The applicant exhibits the skill to:
CA.I.C.S1	Use available aviation weather resources to obtain an adequate weather briefing.
CA.I.C.S2	Analyze the implications of at least three of the conditions listed in K3a through K3l, using actual weather or weather conditions provided by the evaluator.
CA.I.C.S3	Correlate weather information to make a go/no-go decision.

Weather Sources, Products, and Interpretation

** Note: per CA.I.C.K1-3, as well as the Skills elements, applicants should show up to their checkrides and EOCs ready to prove that they verified weather using acceptable sources for the full route and duration of the planned flight. Tip: The Graphical Area Forecast (GFA) is an indispensable tool for doing this - it allows pilots to plot their courses, then select for virtually any type of weather while adjusting for the various times and altitudes corresponding to the flight. Be sure to use the "flight path/cross-section" tool (located on the right of the GFA map) in order to show your intended route on the map - this way, you can determine weather in relation to your flight path.*

- ❏ Justify your go/no-go decision. In other words, list all the weather charts that you used to plan this VFR cross-country flight and prove that you won't encounter any adverse weather. If there *is* adverse weather and you're making a go decision, how have you competently

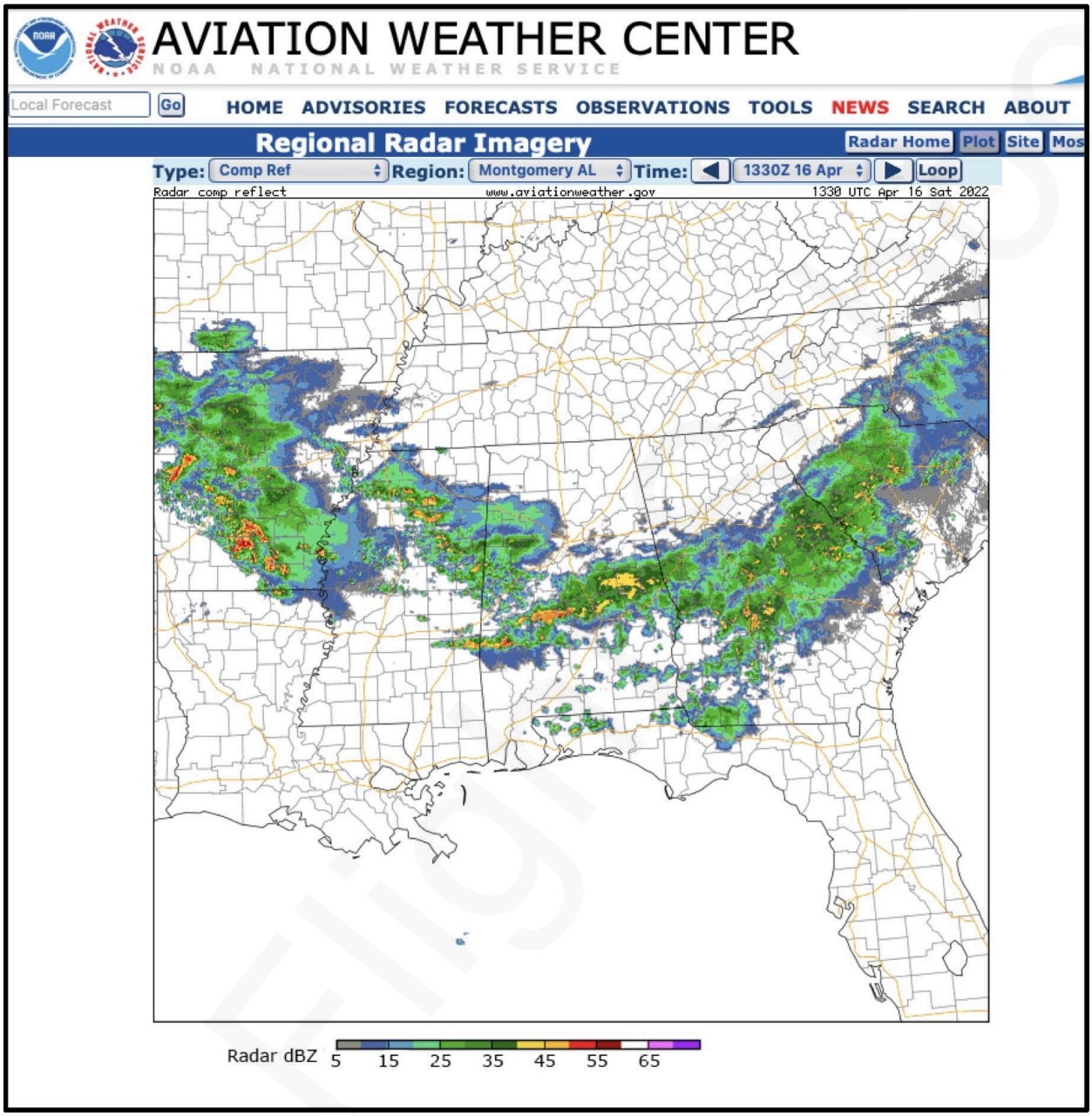
planned around it? Typical charts that applicants use: Radar Imagery, Surface Analysis, Convective Outlook, Low Level Significant Weather Prognostic, Winds Aloft, METARs and TAFs for all stations along the flight route, Graphical Area Forecast (GFA) charts for the full flight duration and range of altitudes, PIREPs, various icing and freezing level charts.

- ❏ What sorts of enroute weather would lead you to make a no-go decision for this VFR flight? Thunderstorms or any other convective activity, excessive winds (including windshear), excessive turbulence, low cloud ceilings/visibility, icing conditions, heavy precipitation.
  - ❏ List and describe the weather charts and sources you used to verify that you won't encounter any such weather. * *Note: there are many options/answers to this question. Here are some:*
    - Thunderstorms/convection: Radar Imagery, Graphical Area Forecast, METAR/TAF, PIREP, Convective Outlook, Convective SIGMET.
    - High winds: Winds Aloft, Surface Analysis, METAR/TAF, Graphical Area Forecast, AIRMET/SIGMET/Convective SIGMET.
    - Turbulence: AIRMET/SIGMET/Convective SIGMET, Graphical Area Forecast, Low Level Prog.
    - IMC/low cloud ceiling/low visibility: Graphical Area Forecast, METAR/TAF, Low Level Prog, AIRMET Sierra.
    - Icing: Graphical Area Forecast, Icing Forecast, PIREP. Applicants can also determine icing conditions through the use of Winds Aloft and/or Freezing Level charts to determine freezing level(s), and the Graphical Area Forecast/METARs/TAFs to determine the location of visible moisture.
    - Heavy precipitation: Radar Imagery, METAR/TAF, Graphical Area Forecast.
- ❏ How can pilots determine cloud coverage and visibility beyond the 5 SM range of a TAF? Use the GFA tool. Select the "Weather" tab at the top of the page, then select "Clouds" from the drop-down menu, and adjust the time at the bottom accordingly.
- ❏ What are the three types of weather products? Observation, forecast, and analysis.
- ❏ What government agency or agencies are the sources of weather data and products that pilots should use for preflight planning? The National Weather Service (NWS), which is a sub-agency of the National Oceanic and Atmospheric Administration (NOAA). One component of the NWS is the Aviation Weather Center (AWC), which issues a range of weather products tailored to the aviation community. These products are found on aviationweather.gov.
- ❏ What does the FAA consider to be "approved sources of aviation weather information" for pilots? Per AIM 7-1-3: 1) FAA/NWS sources, 2) Enhanced Weather Information System (EWINS - essentially an FAA authorized, proprietary weather tracking system used by certain commercial flight operations), and 3) commercial weather information providers (although for 121 and 135 operators, commercial products can only be used if they do not substantially alter the government-produced weather information).
- ❏ Can pilots receive a regulatory compliant weather briefing without contacting Flight Service? Yes.
- ❏ Why is it generally best practice (and ATP policy) to contact a weather briefer (FSS) prior to flights? Briefers are the experts - they are qualified and certificated by the FAA to translate pertinent weather and route/NOTAM information and convey it effectively to pilots.

Furthermore, using FSS leaves a record that the pilot verified weather and NOTAMs per 91.103.

- ❏ What is meant by the phrase “legal weather briefing”? This is not an official FAA term. Under Part 91, for any IFR flight or flight not in the vicinity of an airport, pilots must become familiar with all available information concerning that flight, including weather reports and forecasts. This can be accomplished legally with a thorough review of pertinent government or commercial weather products. Often pilots use the phrase “legal weather briefing” colloquially to indicate that they used an NWS/FAA source that leaves a record.
- ❏ Is it legal to use non-FAA/NWS-sourced, commercial weather products to verify weather per 91.103? If so, what guidance does the FAA offer for using such weather products/sources? AIM 7-1-3 states: *Pilots and operators should be aware that weather services provided by entities other than FAA, NWS, or their contractors may not meet FAA/NWS quality control standards. Hence, operators and pilots contemplating using such services should request and/or review an appropriate description of services and provider disclosure. This should include, but is not limited to, the type of weather product (for example, current weather or forecast weather), the currency of the product (that is, product issue and valid times), and the relevance of the product. Pilots and operators should be cautious when using unfamiliar products, or products not supported by FAA/NWS technical specifications. Many new weather products now have a Precautionary Use Statement that details the proper use or application of the specific product.* In multiple places, the AIM reminds pilots: *When in doubt, consult with an FAA Flight Service Station Specialist.*

** Note: Extremely basic chart symbology questions have been left off this COMMERCIAL guide. This should not suggest that examiners will not ask such questions. The focus here is generally on common problem areas.*



- ❏ Are radar images considered to be forecasts, observations, or analyses? Observations.
- ❏ How frequently is a radar image/observation generated, and what is its valid time? Generated every 4 to 11 minutes upon completion of the radar scan. The valid time is the end of the last radar scan, which is listed on the observation.
- ❏ What type of equipment generates radar observations in the U.S.? Doppler radars. They make up the NEXRAD (Next Generation Weather Radar) system used by the National Weather Service (NWS) and the FAA.
- ❏ How does a Doppler radar work? It sends out a signal that reflects (or echoes) off of precipitation. The radar then measures the reflective power (i.e., the backscattered energy) in terms of decibels (dBZ). The higher the reflectivity, the more intense the precipitation.

- ❏ What is a radar “echo”? It’s the appearance (colors), on a radar display, of the backscattered energy (i.e., reflectivity).
- ❏ Would you expect to encounter the strongest precipitation in the green or pink regions? Pink, those represent the highest decibels.
- ❏ What precipitation intensity classifications correspond to each color region? Gray and dark blue regions are likely clouds. Light blue through light green is considered LIGHT precipitation. Dark green is MODERATE. Yellow and orange are HEAVY. And red through purple is EXTREME.
- ❏ What information does a radar image provide? Directly, it displays the location and intensity of precipitation. Storm cells, as well as their directions and speed of movement, can also be determined.
- ❏ Are radar echo tops the same as cloud tops? No, echo tops represent the highest altitude containing precipitation. Cloud tops are generally slightly above this.
- ❏ In the image above, Kentucky is all white - does this mean there are no clouds in Kentucky? No, this chart does not show cloud coverage, it shows precipitation. The colored areas will certainly have clouds, as precipitation needs to fall from something; but the absence of precipitation does not necessarily mean no clouds are present.
- ❏ Name some limitations associated with radar-generated weather products?
  - Precipitation Attenuation: distant precipitation targets may not be displayed accurately on a radar image because closer targets absorb or scatter the radar beam’s energy.
  - Range Attenuation: beyond 50 to 75 NM from the radar, the intensity of the radar’s beam decreases - therefore, a target will appear less intense than an identical target closer to the radar.
  - Resolution: when multiple precipitation targets are discovered within the same radar beam, they are combined into one echo.
  - Beam Overshoot/Undershoot:
    - Overshoot: some of the Doppler radars that generate radar images are on mountain tops, and the radars don’t look down. So any precipitation occurring below the elevation of the radar equipment won’t be detected.
    - Undershoot: occurs when the precipitation occurs above the radar beam, usually with high-cloud-based precipitation near the radar site. This often occurs in the western US in the summer.
  - Beam Blockage: terrain can block the radar beam.
  - Ground Clutter: echo returns from trees, buildings, or other objects on the ground are *usually* automatically removed from the image.
  - Wave Propagation (aka sub-refraction or super-refraction): the radar beam is bent and its speed is affected by differences in atmospheric density caused by variations in temperature, moisture, and pressure. This occurs in the vertical and horizontal directions.
  - Anomalous Propagation (AP): this occurs when the radar beam is bent downward enough to hit the ground (aka “ducting”), causing false echoes known as anomalous propagation. Animating the radar image can help differentiate between AP and a thunderstorm - AP blooms up and dissipates, whereas thunderstorms move with a smooth continuation motion.

- Ghosts: echoes in apparently clear air caused by a “cloud” of point targets, or by refraction returns of the radar beam in truly clear air.
- Angels: echoes caused by a physical phenomenon not discernible by the eye at the radar site, such as bats, birds, or insects.
- Other Non-Meteorological Phenomena: wind farms and smoke from forest fires can result in beam blockage, false echoes, or high reflectivity values.

❏ What are some additional limitations associated specifically with radar charts? The Aviation Weather Handbook says tops above 50,000 ft can be disregarded, that they are likely a mistake. Also, this chart is merely a snapshot of the weather at a specific time - weather changes rapidly, so this chart should be considered highly supplemental to any preflight weather briefing.

❏ What’s a major concern about flying through a region showing high echo tops? Stronger updrafts, possibly leading to more severe convective activity.

```
 (Extracted from FBUS35 KWNO 121354)
FD5US5
DATA BASED ON 121200Z
VALID 131200Z   FOR USE 0600-1800Z. TEMPS NEG ABV 24000

FT  3000    6000    9000   12000   18000   24000  30000  34000  39000
BIH      9900    2814+05 2820+01 2440-12 2349-25 235741 235951 235952
BLH 3413 2117+19 2124+13 2131+07 2237-08 2339-22 225938 227647 227853
FAT 9900 3105+07 2814+03 2925-01 2535-13 2538-25 244541 244350 254652
FOT 9900 2909+00 2818-04 2930-04 2840-17 2948-27 319040 820547 328353
ONT 9900 2613+12 2519+11 2520+06 2338-08 2345-22 234840 235349 226554
RBL 1709 2013+03 2513-02 2822-06 2835-15 2838-28 294843 306048 304749
SAC 2008 2409+06 2716+02 2824-03 2832-14 2736-27 294642 315648 294451
SAN 3112 2616+14 2324+11 2326+07 2435-07 2340-22 234939 235748 226753
SBA 0207 3318+10 3121+08 2824+04 2533-10 2638-24 244440 244350 244553
SFO 3021 3017+06 2922+02 3028-02 2833-13 2941-26 326140 328348 316254
SIY      2606+02 2315-04 2518-09 2829-16 2829-29 262244 283648 293947
WJF      2813+11 2820+09 2623+05 2339-10 2346-23 235140 235150 235854
AST 2310 2410-01 2511-06 2513-11 2329-20 1949-30 185644 204548 253145
IMB              2705-01 2509-05 2223-16 1438-27 162845 182950 193748
LKV              2517-02 2218-07 2226-17 1523-28 180845 261147 232246
OTH 2211 2311-01 2613-06 2722-08 2524-19 2622-29 272443 294046 294348
PDX 2610 2516-01 2512-04 2211-09 2323-18 1942-28 186145 204350 232545
RDM      2717+00 2411-03 2316-06 2229-16 1742-27 183746 202549 212346
GEG      2908+08 0206+02 1415-02 1756-14 1846-27 185344 185851 195651
SEA 2510 2411-01 2410-05 1913-09 2025-18 1953-28 187945 195751 213046
YKM 3019 2409+03 2114+00 1821-06 2139-17 1657-27 185745 194752 194248
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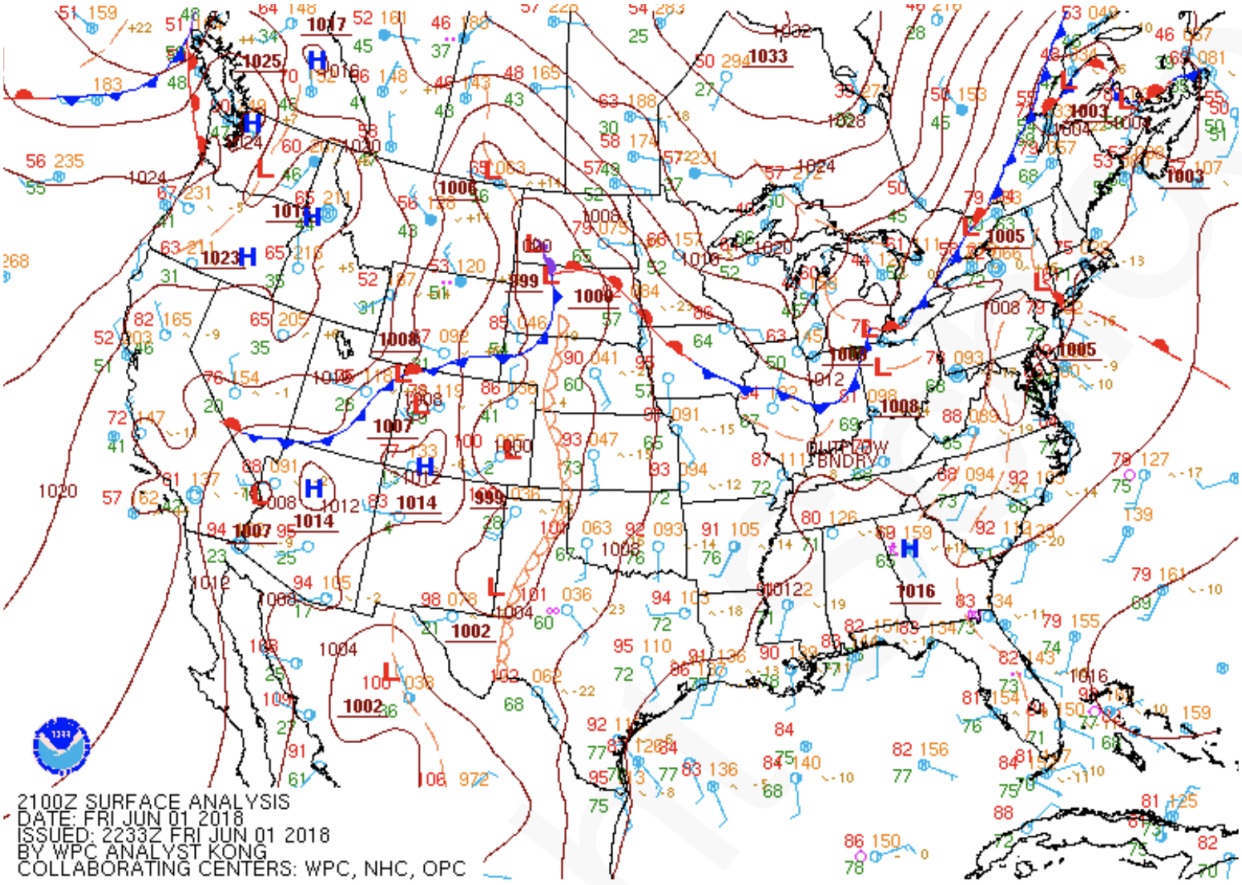
❏ How often is the Wind and Temperature Aloft Forecast (FB) issued, and when is it valid? The forecast is now produced 4 times a day (PHAK wrongly still says twice daily). The wind and temperature information depicted in the forecast are predicted to occur at the valid time specified in the header; however, the information CAN BE USED for flights occurring within the specified “for use” time window.

- ❏ Are the wind directions true or magnetic? True.
- ❏ What does 9900 mean? Light and variable.
- ❏ Why are wind and temperature not listed for SIY at 3000 feet? Wind is not listed within 1,500 feet of a location's elevation. Temperatures are only provided for the 6,000 foot level and above. Use the METAR/TAF to interpolate winds and temps at altitudes near field elevation. Surface friction makes the wind predictions difficult.
  - ❏ Why is no temperature listed for BIH at 6,000 feet? Temperatures are not listed within 2,500 feet of a location's elevation (and again, never for the 3,000 foot elevation).
- ❏ What wind and temperature would you expect in the vicinity of the FOT station at 34,000 feet? Wind from 320 at 105 knots, temperature -47 degrees Celsius.
  - ❏ What tells you that the temperature is negative? The header states that all temps above FL240 are negative.
- ❏ Would you expect stable or unstable air flying in SEA below 12,000 feet? Why? Stable. A temperature drop of approximately 3 degrees or fewer for every 1,000 feet of increased altitude is generally indicative of stable air. In the case of SEA, the temperature drops only 8 degrees between 6,000 and 12,000 feet. Additionally, the change in wind direction and velocity among these altitudes is not significant, lending additional support to stable air conditions.
- ❏ What is the freezing level along your route of flight? Find/interpolate the altitude with a 0 degree temperature.
- ❏ Are the altitudes depicted on this forecast shown in MSL, AGL, or pressure altitudes? MSL below 18,000 feet; pressure altitudes (flight levels) starting at 18,000 feet and above.



- ❏ What are the issuance and valid times for the Surface Analysis Chart? This chart is issued every 3 hours, once analysis of the observed weather is complete. The valid times are either 00, 03, 06, 09, 12, 15, 18, or 21 UTC. In the case of the chart above, the weather shown on the chart is valid for 2100Z.
- ❏ What type of chart is this? Analysis.
- ❏ What do the maroon solid lines represent? Isobars. These connect areas of equal sea level pressure.
  - ❏ So if the pressure reads “1014”, say, that does *not* indicate station pressure? Correct. It shows station pressure *adjusted down to sea level.*
- ❏ What kind of weather would you expect to encounter in areas where the isobars are close together? Why? High winds. Isobars close together indicate a steep pressure gradient. This causes the air to be more inclined to move.
- ❏ What does the orange scalloped line extending up from Mexico continuing through the middle of the U.S. represent? Dry line.
  - ❏ What is a dry line? During parts of the year, moist air comes up from the Gulf of Mexico. The result is that moist air blankets the eastern U.S., whereas dry air remains dominant in the southwest. The dividing line is known as the dry line.
- ❏ What does the dashed orange line extending up from Florida along the east coast represent? A trough.

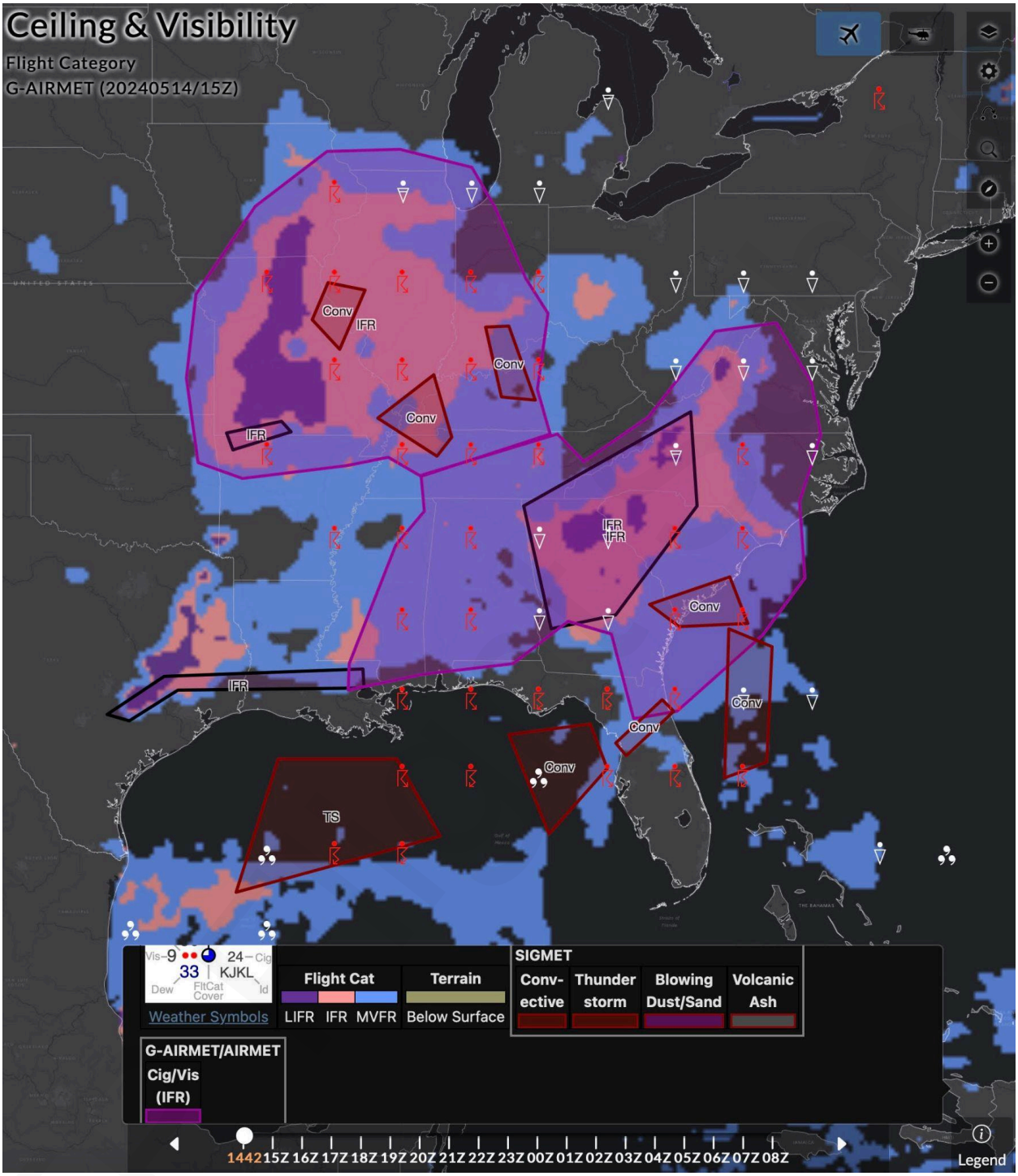
- ❏ What's a trough, and what kind of weather would you expect to encounter flying along one? It's an elongated area of relatively low pressure. Expect generally poor weather, as low pressure systems involve updrafts which are conducive to convective activity.

❏ The station plot in south western California is a blue circle surrounded by another blue circle. What does this symbol indicate? Winds calm.

- ❏ Surrounding that symbol, what do the red "81," green "42," orange "137," and orange "\" with a "-7" to the right of it, all represent? Temperature 81 degrees F, dewpoint 42 degrees F, pressure 1013.7 mb, pressure continuously fell over the previous 3 hours by 0.7 mb.

❏ What does an "M" inside a station plot circle indicate? Missing cloud observation.

❏ In northern Georgia there is a pink "R" just to the left of the high pressure system. What does this symbol indicate? Thunderstorm.



- ❏ Looking at eastern Texas, what do the colors on this Ceiling and Visibility Chart (CVA) indicate? Blue: Marginal VFR. Pink: IFR. Purple: Low IFR.
  - ❏ Specifically, what type of weather qualifies as MVFR, IFR, and LIFR?
    - MVFR: Ceilings 1,000 to 3,000 ft. and/or visibility 3-5 SM.
    - IFR: Ceilings 500 to less than 1,000 feet and/or visibility 1 to less than 3 SM.
    - LIFR: Ceilings less than 500 ft. and/or visibility less than 1 SM.

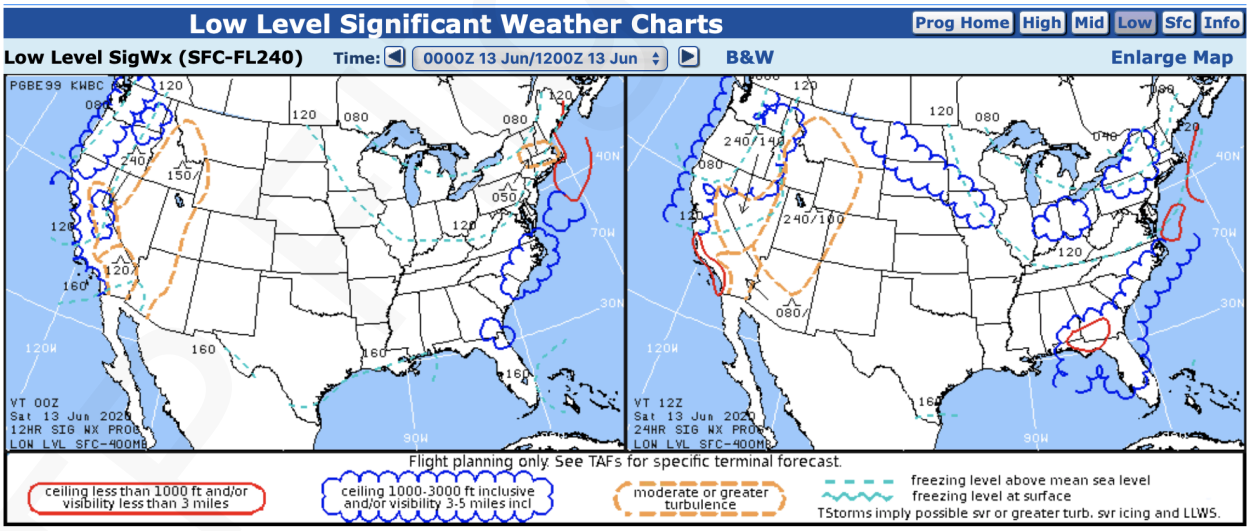
- ❏ Are MVFR conditions considered to be a sub-type of VFR weather conditions, or are they non-VFR conditions? Same question for LIFR - do LIFR conditions still fall within the category of IFR conditions? Yes, MVFR and LIFR still fall within the VFR and IFR weather categories, respectively (so weather less than 3 SM and/or 1,000 ft. ceiling is always considered IFR). “MVFR” and “LIFR” are simply nomenclature the FAA use on some charts to designate more intense subcategories of VFR or IFR weather conditions.

❏ Would it be wise to use this chart to determine cloud position along your route? Why or why not? No, this chart merely shows IFR/VFR conditions, not cloud position. If the visibility in Texas were ½ SM due to mist with no cloud ceiling, the region would be colored purple - same color as if the ceiling were 004OVC and the visibility were 20 SM. Also, ceilings beginning above 3,000 ft., as well as FEW and SCT clouds, are not depicted on this chart. Also, the chart does not specify cloud bottoms and tops.

- ❏ So what chart should be used to determine cloud location, along with their top and bottom altitudes? Select “Clouds” from the “Weather” tab on the GFA tool. Zoom in on your flight route area - the ceilings will populate.

❏ What are represented by the purple, red, and black borderlines surrounding various regions on the chart? Per the legend at the bottom of the image: Purple: AIRMET for IFR conditions. Red: SIGMETS (or CONVECTIVE SIGMETS if “Conv” is shown). Black: Center Weather Advisory (meaning either an update to an existing AIRMET or SIGMET, or an unscheduled advisory when there is not already an existing AIRMET or SIGMET).

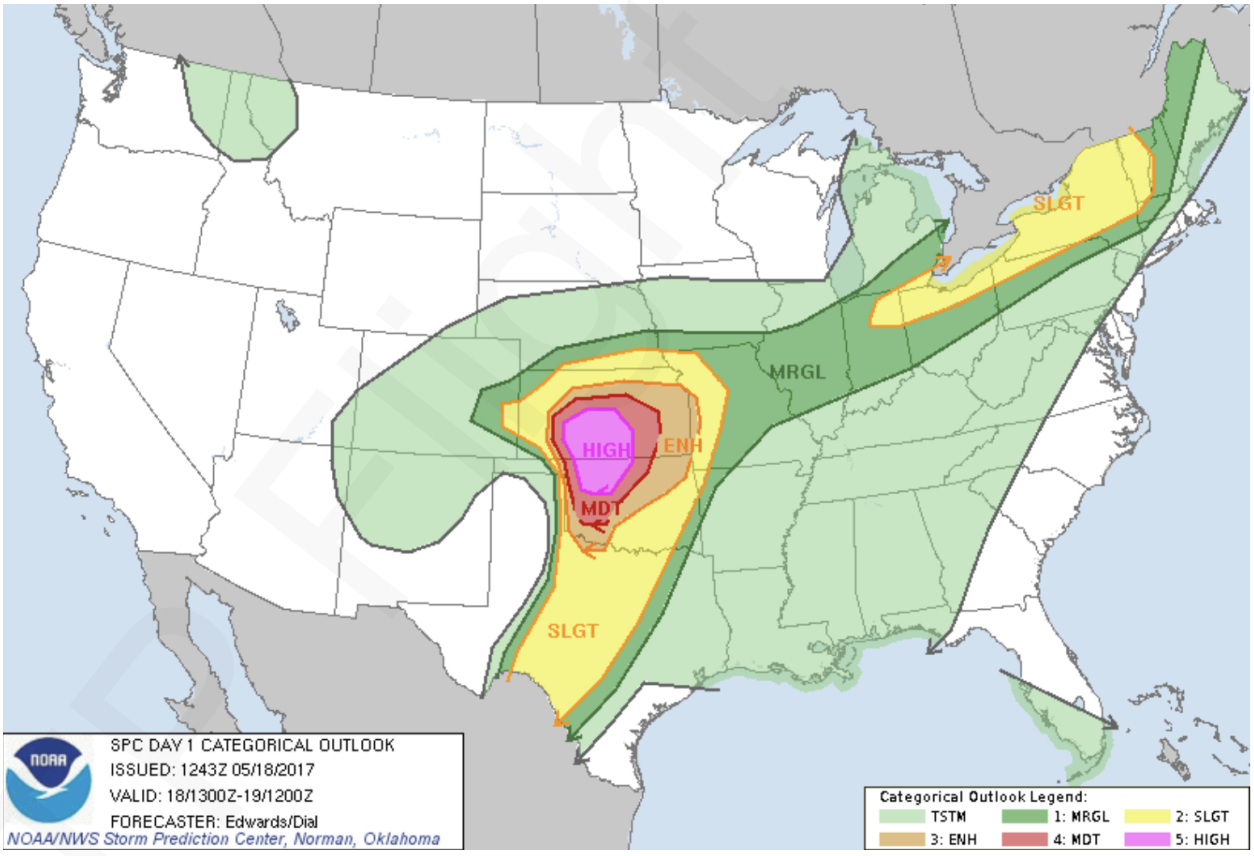
❏ How often are Center Weather Advisories (CWAs) issued, and for how long are they valid? Issued as necessary for weather forecast to occur within 2 hours. Valid for 2 hours.



❏ What type of chart is a Low Level Significant Weather Prognostic Chart? Forecast, observation, or analysis? Forecast.

❏ What kind of weather is depicted on this chart? (Just read from the legend on the bottom of the chart.) IFR, MVFR, moderate or greater turbulence, freezing levels.

- ❏ What are the issuance and valid times for this chart? Issued 4 times per day, valid at the specific times listed on the charts. The left and right panels will always be 12 hours apart.
- ❏ On the left panel, what does the "/" after the "150" in Idaho mean? The symbol means *down to the surface*. So the moderate turbulence descends from 15,000 ft MSL down to the surface.
- ❏ Provided your ETD matches the valid time on the chart, can you take off without being on an IFR flight plan out of a controlled airport surrounded by one of the blue scalloped lines? Yes, marginal VFR is still 3 SM & 1,000 foot ceiling or greater.
  - ❏ What if your airport is surrounded by a red line? No, must be on an IFR flight plan.
- ❏ Let's say you're flying from Nevada to Colorado. You think it would be better to get your freezing level off of this chart or the Winds Aloft? Winds Aloft, as it will indicate the precise freezing level for your location.
- ❏ The dashed orange line represents areas with "moderate or greater turbulence." What symbol does this chart use to differentiate severe and extreme turbulence from moderate? Same dashed orange line, except the listed altitude would be accompanied by more of the little turbulence symbols stacked up above it in order to indicate more intensity.



- ❏ What type of chart is a Convective Outlook? Forecast.
- ❏ What are its issuance and valid times? The Day 1 Outlook is issued 5 times per day, with the valid time frame specified on the chart. (Other Convective Outlooks show forecasts that extend up to 8 days, and those are issued less frequently.)

- ❏ What weather information does this chart provide? It shows 2 things: 1) the probability of *severe* convection (meaning: tornados, wind gusts 50 kt or greater, or hail 1 inch in diameter or greater), and 2) *non-severe* (general) convection.
- ❏ What do the colors represent? The light green TSTM areas represent *non-severe* (general) convection. The rest of the colors indicate areas of marginal, slight, enhanced, moderate, and high probabilities of *severe* thunderstorms occurring.

METAR

- ❏ What type of weather product is a METAR? Observation.
- ❏ When is it issued and what is its valid time? Issued hourly, usually toward the end of the hour, valid at the time of observation specified on the METAR.
- ❏ What does METAR stand for? Aviation Routine Weather Report (the acronym comes from the French translation of Aviation Routine Weather Report).
- ❏ What kind of weather product will be released in place of a METAR in the event of a significant weather change? A Special Weather Report (SPECI).

KSFO 121756Z 26020G27KT 200V290 R17L/2600 ft VV002 FEW005 SCT015 SCT100 BKN200 18/-12 A3009 RMK AO2 RAB46 PK WND 27029/1729 WS010/18040KT LTG DSNT S OCNL LTGICCC SE CB DSNT S TS SE MOV S SLP191 T01781117 $

- ❏ Does this SFO METAR show VFR or IFR conditions? Why? IFR, due to visibility (2,600 feet) being less than 3 SM, as well as the ceiling (200 feet) being less than 1,000 feet.
- ❏ What is the ceiling? 200 feet.
- ❏ Are the reported winds true or magnetic? True.
- ❏ Is “BKN200” in MSL or AGL? AGL. Clouds are always AGL on METARs and TAFs.
- ❏ What is the gust factor? 7 knots (difference between sustained and gusting winds).
- ❏ What does “A02” indicate? The station is automated with a precipitation discriminator.
  - ❏ Is this more or less advanced than an A01? More.
- ❏ Does wind reported as 270 at 20 knots mean that the wind is blowing westbound or eastbound? Eastbound - the wind is coming FROM 270.
- ❏ What kind of weather would you expect to accompany a small temperature/dewpoint spread? Clouds, possibly fog and mist.
- ❏ What do the following abbreviations taken from the METAR above mean?
  - 200V290: wind variable between 200 and 290 degrees.
  - R17L/2600 feet: runway visual range for Runway 17L is 2,600 feet.
  - VV002: vertical visibility is 200 feet (ceiling is indefinite, so vertical visibility becomes the ceiling).
  - RAB46: rain began 46 minutes past the hour.
  - PK WND 27029/1729: peak wind was 270@29 knots occurring at 17:29Z.
  - WS010/18040KT: wind shear at 1,000 ft: 180@40 knots. Put differently, the surface wind of 260@20 gusting 27 shears to 180@40 at 1,000 feet.

- LTG DSNT S OCNL LTGICCC SE CB DSNT S TS SE MOV S: lightning distant south, occasional lightning in-cloud and cloud-to-cloud to the southeast, cumulonimbus clouds in the distant south, thunderstorm to the southeast moving south.
- SLP191: sea level pressure is 1019.1
- T01781117: more precise temperature and dewpoint: temperature is 17.8, dewpoint -11.7.
- $: maintenance needed.

TAF

- ❏ What kind of weather product is a TAF? A forecast, it's in the name.
- ❏ When is a TAF issued and what is its valid time? Issued 4 times per day (000Z, 0600Z, 1200Z, and 1800Z), valid for either 24 hours or 30 hours, as depicted on the TAF.
- ❏ What does TAF stand for? Terminal Aerodrome Forecast.
- ❏ What is the range of a TAF? In other words, the weather reported on a TAF applies to the region extending how far out from the station? 5 SM from the center of the runway complex.

```
KACV 121740Z 1218/1318 33010KT 4SM -SHRA BR SCT002 SCT016 OVC035
 TEMPO 1218/1219 BKN002 OVC016
  FM122200 33010KT 6SM -TSRA SCT015 BKN020
  TEMPO 1222/1302 SCT020 OVC050
 FM130600 35003KT P6SM -SHRA BKN015 OVC025
 FM131600 24009KT P6SM VCSH SCT025 OVC050 PROB30 1317/1318 3SM
 TSRA BKN030CB
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- ❏ What does TEMPO mean? Means that the indicated weather is expected to last for less than 1 hour, and in total, less than half the time indicated.
- ❏ Are the conditions forecast to be VFR or IFR on the 12th at 19:30? VFR.
- ❏ At what time, or times, are conditions forecast to become IFR? Then when do they become VFR again? IFR is forecast between 18:00 - 19:00 on the 12th. After 19:00 the weather returns to VFR.
- ❏ Decode -TSRA, BR, and VCSH: Respectively: thunderstorm with light rain, mist, showers in the vicinity.
- ❏ Would you expect lower visibility if FG or BR were reported? FG. Fog is for < 5/8 SM; mist (BR) is used for > 5/8 SM.
- ❏ Decode "PROB030 1317/1318 3SM TSRA BKN030CB": 30% probability that the weather between 17:00Z and 18:00Z on the 13th will drop to 3 SM vis, thunderstorms with moderate rain, and broken cumulonimbus clouds at 3,000 feet AGL.

AIRMET (WA), SIGMET (WS), Convective SIGMET (WST)

- ❏ What is another weather product(s) that provides pilots with weather information beyond the 5 SM scope of a TAF? AIRMETs, SIGMETs, and Convective SIGMETs.

- ❏ What are the 4 types of inflight aviation weather advisories: SIGMET, Convective SIGMET, AIRMET, and Center Weather Advisory (CWA).
  - ❏ What is a Severe Weather Watch Bulletin (WW)? WWs supplement those 4 inflight aviation weather advisories.
- ❏ How are inflight aviation weather advisories disseminated? They are issued by the Aviation Weather Center (AWC) and are periodically announced by ATC to pilots in flight. Pilots can also get these while enroute from an FSS. They are obtainable on the ground through virtually all approved aviation weather sources.
- ❏ Are these products intended for preflight planning, enroute weather advisories, or both? Both.
- ❏ Are altitudes MSL or AGL? MSL unless stated otherwise.

- ❏ Are AIRMETs intended for pilots of small, large, or all aircraft? All, although they're certainly more pertinent for smaller aircraft and pilots without instrument ratings. Put differently, an AIRMET details significant enroute weather phenomena that could be of interest to all aircraft, but potentially hazardous to small aircraft.
- ❏ What is an AIRMET, and how is it different from a SIGMET? An AIRMET is a forecast that describes significant weather occurring at intensities lower than weather requiring the issuance of a SIGMET. Generally, an AIRMET is issued for *moderate* weather, whereas a SIGMET is issued for *severe or greater* weather.
- ❏ What does AIRMET stand for? Airmen's Meteorological Information.
- ❏ Define "moderate turbulence." Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. Usually variations in indicated airspeed will occur. Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.
- ❏ What are the issuance and valid times for AIRMETs? Issued every 6 hours, valid for 6 hours. Includes an outlook describing weather over the next 6 hours. Unscheduled amendments and updates are issued as required.
- ❏ What are the three types of AIRMETs, and what type of weather is included in each? For all of the following, when the weather phenomena are occurring or are expected to occur over an area of at least 3,000 square miles:
  - Tango: moderate turbulence, sustained surface wind greater than 30 knots, and/or non-convective low-level windshear potential below 2,000 feet AGL.
  - Sierra: extensive IFR conditions (less than 3 SM visibility or less than 1,000 foot ceiling) and/or mountain obscuration.
  - Zulu: moderate icing with freezing level heights.
- ❏ Would the existence of an AIRMET Tango enroute for moderate turbulence affect your go/no-go decision? In what way? Possibly, although probably not. Investigate further to see if the turbulence exceeded my personal minimums. If able, plan around the affected area.
- ❏ Are SIGMETs intended for pilots of small, large, or all aircraft? All aircraft, but unlike AIRMETs, SIGMETs indicate weather that is potentially hazardous to all aircraft.
- ❏ What does SIGMET stand for? Significant Meteorological Information.

- ❏ What are the issuance and valid times for SIGMETs? Issued as necessary, valid for up to 4 hours, except that SIGMETs involving tropical cyclones and volcanic ash are valid for 6 hours. Updates and corrections issued as necessary.
- ❏ What type of weather is included in a SIGMET? When the following *non-convective* weather phenomena occur or are expected to occur over an area of at least 3,000 square miles:
  - Severe or extreme turbulence or clear air turbulence not associated with thunderstorms.
  - Severe icing not associated with thunderstorms.
  - Widespread dust storm or sandstorm lowering surface visibilities to below 3 miles.
  - Volcanic ash.
- ❏ Define “severe turbulence.” Severe turbulence causes large, abrupt changes in altitude and/or attitude usually accompanied by large variations in indicated airspeed. Aircraft may be momentarily out of control.
- ❏ How would the existence of a SIGMET along your flight path affect your go/no-go decision? Plan around it. If unable, make a no-go decision.

- ❏ What is a Convective SIGMET, and how is it different from a SIGMET? The key word/differentiator is “convective” - so unlike SIGMETs, Convective SIGMETs sound the alarm on more extreme weather *associated with thunderstorms*. To quote the AIM directly: a Convective SIGMET may be issued for any convective situation that the forecaster feels is hazardous to all categories of aircraft.
- ❏ What are the issuance and valid times for a Convective SIGMET? Issued hourly 55 minutes past the hour, updated as required. Valid for up to 2 hours.
- ❏ What type of weather is included in a Convective SIGMET?
  - Severe thunderstorms due to:
    - Surface winds greater than or equal to 50 knots.
    - Hail at the surface greater than or equal to ¾ inches in diameter.
    - Tornadoes.
  - Embedded thunderstorms.
  - A line of thunderstorms.
  - Thunderstorms producing precipitation greater than or equal to heavy precipitation affecting 40 percent or more of an area of at least 3,000 square miles.
- ❏ If a Convective SIGMET does not mention turbulence, icing, or wind shear, does that mean you can expect smooth air and no icing? No, any Convective SIGMET implies severe or greater turbulence, severe icing, and low-level wind shear.

- ❏ What is a Center Weather Advisory (CWA)? This is an unscheduled inflight weather advisory issued for hazardous weather when there is either no existing advisory - i.e., AIRMET/SIGMET/Convective SIGMET) - or to supplement an existing advisory. The FAA describes a CWA as a “nowcast” for conditions developing in the next 2 hours.
- ❏ For how long are CWAs valid? Up to 2 hours.

<u>Graphical Area Forecast (GFA)</u>

- ❏ What is the GFA tool, and what is it used for? The GFA provides aviation weather information to give users a complete visual picture of the weather that may impact their flights. Users can select for virtually any type of weather, time, altitude, and flight path.
- ❏ How often is GFA information updated, and what are its valid times? Updated continuously, valid for the selected times. Users can select FORECAST for a range of valid times that extend 15 hours into the future, or select OBSERVATION for valid times in the previous 14 hours.

PIREP

- ❏ Interpret this PIREP: **KCMH UA /OV APE 230010/TM 1516/FL085/TP BE20/SK BKN065/WX FV03SM HZ FU/TA 20/TB LGT/IC MDT MXD 040-050/RM LLWS –15 KT SFC-030 DURGC RY 22 CMH** Nearest station: KCMH; message type: routine (non-urgent) report. / Location: weather occurred 10DME out on the APE 230 degree radial. / Time: reported weather occurred at 15:16Z. / Altitude: altitude where the weather was encountered was 8,500 feet MSL. / Aircraft type: type of aircraft reporting the PIREP was a BE20. / Sky condition: broken at 6,500 feet MSL. / Flight visibility and weather: 3 SM due to haze and smoke. / Air temperature: 20 degrees. / Turbulence: light. / Icing: moderate mixed iced between 4,000 - 5,000 feet MSL. / Remarks: low-level wind shear, pilot reported minus (a loss of) 15 knots between the surface and 3,000 feet during climb out from runway 22 at CMH airport.
- ❏ Who do you contact to file a PIREP? ATC or FSS.
- ❏ What would “UUA” (instead of UA) signify on a PIREP? Urgent.
- ❏ What are some ways to check for PIREPs on the ground as part of your preflight planning? How about in-flight? On the ground you can use Foreflight, aviationweather.gov, 1800wxbrief.com, or call a briefer. In the air you can talk to ATC or an FSS.
- ❏ What is the procedure for filing a PIREP? PIREPs can be filed in-flight with either ATC or FSS. The AIM advises against being overly concerned with strict format or phraseology: “The important thing is that the information is relayed so that other pilots may benefit from your observation.” Pilots should simply give position, time, altitude, type aircraft, and a description of the weather (sky cover, flight vis, precip, restriction to vis, temp, wind direction and strength, turbulence, icing, additional remarks).
- ❏ Are altitudes in a PIREP reported in MSL or AGL? MSL, unless noted otherwise.

FSS Weather Briefings

- ❏ Describe the 3 types of weather briefings pilots can request from an FSS briefer. When should each be used?
  - Standard briefing: a standard weather briefing provides a complete picture of the weather and is the most detailed of all briefings. It includes adverse conditions, VFR flight not recommended (if applicable), a synopsis, current conditions, en route forecast, destination forecast, winds and temps aloft, NOTAMs, prohibited areas and SFRAs, ATC delays, and other information specifically requested by the pilot. This type of briefing should be obtained prior to the departure of any flight.

- Abbreviated briefing: this is a shortened version of the standard briefing that should be requested when a departure has been delayed or when specific weather information is needed to update a previous standard briefing.
- Outlook briefing: this briefing should be requested when a planned departure is 6 or more hours away. It provides initial forecast information that is limited in scope, but that can influence decisions regarding route of flight, altitude, and ultimately the go/no-go decision. A follow-up standard briefing prior to departure is advisable.

<u>Atmospheric Composition and Stability</u>

- ❏ Describe the composition of the Earth's atmosphere. 78% nitrogen, 21% oxygen, and then the last 1% is made up of argon, carbon dioxide, and other gasses.
- ❏ What is the atmosphere? What is its purpose? It's a cloud of gas and suspended solids extending from the surface out many thousands of miles, held in place by the Earth's gravitational pull. It's a protective bubble that holds oxygen, moisture, gasses, and tiny particles, and that essentially protects you from outer space.
- ❏ The Earth's atmosphere is divided into 5 concentric layers. In what layer do you fly, and up to what altitude does it extend? Troposphere. It extends up to approximately 36,000 feet. Jets can fly above this in the stratosphere.
- ❏ What is the standard composition of the troposphere in terms of temperature and pressure? For every 1,000 feet of altitude gained, the temperature decreases by 2°C, and the pressure decreases by 1 inch Hg.
- ❏ What does it mean to say that an atmosphere is "stable"? "Stability" refers to the atmosphere's ability to resist vertical movement of the air. For example, if a parcel of air gets pushed upward in a *stable* atmosphere, it will quickly cease rising or even get pushed back down; whereas a parcel of air pushed upward in an *unstable* atmosphere will continue rising.
  - ❏ What kind of weather would you expect to form in an *unstable* atmosphere? Turbulent airflow, clouds with extensive vertical development, and just generally convective activity.
- ❏ What two things determine the stability of the air? Temperature and moisture.
- ❏ If the air is cool and dry, would this be indicative of a stable or unstable atmosphere? Stable.
  - ❏ How about warm and wet air? Unstable.
    - ❏ Why? Warm air is more inclined to rise, and air that is wet has more water vapor (which is lighter than air molecules) so it's less dense and even more inclined to rise.
- ❏ What does "adiabatic lapse rate" refer to? How does it relate to stability? As air rises into an area of lower pressure, the molecules of air expand, giving off heat, causing the air temperature to drop at an average rate of 2 degrees C per 1,000 feet of altitude gain. Completely dry air tends to decrease in temperature by about 3 degrees per 1,000 feet as it rises (aka "*dry* adiabatic lapse rate") whereas moist air decreases anywhere from 1.1 - 2.8 degrees C (aka "*moist* adiabatic lapse rate").

Wind (e.g. crosswind, windshear, mountain wave, etc.)

- ❏ What causes wind to form? Uneven heating of the Earth's surface causes density and pressure changes in the atmosphere - air then flows from high to low pressure. Additionally, the Coriolis force contributes to air movement.
- ❏ What's the difference between "wind" and "convective currents"? Wind moves horizontally. Convective currents move up and down.
- ❏ Why can it be dangerous to take off with a tailwind? A higher ground speed is required, meaning more stress on the tires and gear while on the ground, a longer takeoff roll, and a shallower climb angle.
- ❏ You're flying from California to Florida. There is a high pressure system along your route. Would you get more favorable winds flying along the north or south side of the high pressure system, and why? North - wind flows clockwise around a high pressure system.
- ❏ Flying over pavement on short final, would you expect up or downdrafts? Updrafts.
  - ❏ How about over water or areas of vegetation like a group of trees? Downdrafts.
- ❏ Describe how land breezes and sea breezes form. During the day, land heats faster than water, so the air over the land becomes warmer and less dense. It rises and is replaced by cooler, denser air flowing in from over the water. This causes an onshore wind called a sea breeze. Conversely, at night land cools faster than water, as does the corresponding air. In this case, the relatively warmer air over the water rises and is replaced by the cooler, denser air from the land, creating an offshore wind called a land breeze.
- ❏ What are mountain waves? They are turbulent waves that form when stable air flows over a mountain or mountain ridge.
  - ❏ Where do they form? They form above and downwind of mountains, extending up to 600 miles downwind from the mountain range, and up to (and even above) the top of the troposphere.
  - ❏ What type of cloud indicates the presence of mountain waves? Lenticular.
  - ❏ In windy conditions, would you expect more favorable conditions approaching a mountain from the windward or leeward side? Why? Windward. As the air flows down the *leeward* side of the mountain, the air follows the contour of the terrain and is increasingly turbulent. This tends to push an aircraft into the side of the mountain. The stronger the wind, the greater the downward pressure and turbulence become. Downdrafts can be severe.
  - ❏ What technique should pilots use if flying low-level over a mountain range? Cross the range at an angle, making it easier to turn around if necessary.

Moisture/Temperature

- ❏ Does hot air hold more or less moisture than cold air? More.
- ❏ Define "dew point." Then put it in layman's terms. Dew point is the temperature to which the air must be cooled to become fully saturated. In layman's terms, this means that the dew point is the temperature at which the air can hold no more moisture/water vapor - if the temperature drops further, then the water vapor becomes a visible liquid, i.e., it condenses.

- ❏ What does a high dew point indicate? This indicates that there is more moisture in the air.
- ❏ Explain relative humidity. Relative humidity is the amount of moisture in the air compared to the total amount of moisture the air could hold at that temperature. So a relative humidity of 65 percent means that the air is holding 65 percent of the total amount of moisture that it is capable of holding.
- ❏ What would feel muggier, an atmosphere with a temperature of 80 degrees F and a dew point of 70 degrees F; or a temperature of 50 F and a dew point of 50 F (so 100% relative humidity)? The former - the dew point is higher, meaning there'd be more moisture in the air.

❏ What effect does the formation of water vapor (evaporation) have on the temperature? A cooling effect.

❏ Define the following:

- Evaporation: liquid to gas/vapor. (E.g. sweat evaporating, or a lake drying up.)
- Sublimation: solid to gas/vapor. (E.g. dry ice.)
- Condensation: gas/vapor to liquid. (E.g. cloud/dew formation.)
- Deposition: gas/vapor to solid. (E.g. frost.)

<u>Precipitation</u>

❏ What dangers can precipitation pose to pilots? It can reduce visibility, create icing situations through freezing rain or runway icing, negatively affect landing and takeoff performance, and contaminate fuel tanks and engines.

❏ How does precipitation form? :Precipitation forms when water or ice particles in clouds grow (through collision and coalescence) to a sufficient size such that the atmosphere can no longer support them.

❏ What three ingredients are necessary for the formation of precipitation? Water vapor, sufficient lift to condense the water vapor into clouds, and a growth process that allows cloud droplets to grow large and heavy enough to fall as precipitation.

❏ What are the various types of precipitation? Rain, drizzle, snow, ice pellets/crystals, and hail.

❏ What do ice pellets and freezing rain indicate in terms of the temperature makeup of the atmosphere? They indicate a temperature inversion above. The formation of both types of precipitation requires the precipitation to pass through a cold/freezing temperature layer, then a warm/above-freezing layer, then back through a cold layer where the precipitation either refreezes as ice pellets, or becomes supercooled/freezing rain.

❏ What is virga? Precipitation that evaporates before hitting the ground.

<u>Weather System Formation Including Air Masses and Fronts</u>

❏ What is a front, and how does one form? A front is the boundary layer between two types of air masses. An air mass is a large body of air that takes on the characteristics of the surrounding area or source region, generally classified as tropical or polar. As an air mass

moves across a body of water or land, it eventually comes in contact with another air mass, resulting in the formation of a front.

- ❏ When does a cold front occur? When a mass of cold, dense, and stable air advances and replaces a body of warmer air.
  - ❏ Describe the typical dimensions/shape and speed of a cold front? Cold fronts move rapidly, progressing at a rate of 25-30 mph. They are shaped like a snow plow, sliding under the warmer, less dense air ahead of it and forcing it aloft.
  - ❏ What is a sign of imminent cold front passage? A high dew point and a falling barometric pressure.
  - ❏ What kind of weather would you expect to accompany a passing cold front? The weather changes suddenly as the steep slope of the fast-moving cold front hits, often with little or no warning; towering cumulus or cumulonimbus clouds dominate the sky, accompanied by heavy showery precipitation, unstable air, lightning, thunder, hail, poor visibility, winds variable and gusty, temperature and dew point drop rapidly, pressure bottoms out then begins a gradual increase. After passage the weather clears rapidly. Good visibility and drier air prevails, along with colder temperatures and rising pressure.
- ❏ When does a warm front occur? When a warm mass of air advances and replaces a body of colder air.
  - ❏ What kind of weather would you expect to accompany a passing warm front? The front gives plenty of warning, then passes slowly, causing the weather to change gradually: warm, humid air gradually slides over the top of a relatively colder air mass, pushing the cold air away, leading to warmer temperatures, low ceilings and low visibilities with fog, stratiform clouds, steady continuous precipitation, drizzle, sleet, rain, and snow. When the warm front's air is unstable (common in the summer), thunderstorms and convection can occur. Warm fronts take days to pass through a region, so steady precipitation, low visibility and stratiform clouds tend to linger after the front passes.
- ❏ What is a stationary front? A stationary front occurs when the forces of two air masses are relatively equal, and the boundary (or front) that separates them remains stationary and influences the local weather for days.
  - ❏ What kind of weather would you expect to accompany a stationary front? A mixture of weather found in warm and cold fronts.
- ❏ What is an occluded front? This is when a fast-moving cold front catches up to a slow-moving warm front, forcing the warm air aloft.
  - ❏ What kind of weather would you expect to accompany the passage of an occluded front? A mixture of weather found in warm and cold fronts: usually as the occluded front approaches, expect warm front weather; this is immediately followed by cold front weather.
  - ❏ Describe a warm vs cold front occlusion. A cold front occlusion occurs when the fast moving cold front is colder than the air ahead of the slow moving warm front. A warm front occlusion occurs when the cold front's air is warmer than the air ahead of the warm front.
  - ❏ Which generally produces worse weather, a warm or cold occluded front? The weather is more likely to be severe and convective during a warm front occlusion provided that the warm air being forced aloft is unstable.

- ❏ What kind of weather is generally associated with a low pressure system? Inclement.
  - ❏ What direction does the wind flow around a low pressure system? Counter clockwise, inward, and upward.
- ❏ What kind of weather is associated with a high pressure system? Generally more favorable conditions, with light winds.
  - ❏ Describe the airflow around a high pressure system. Clockwise, outward, and downward.

Clouds

- ❏ What qualifies as a *ceiling*? FAA's definition: the lowest cloud layer or obscuring phenomena reported as "broken," "overcast," or "obscuration," and not classified as "thin" or "partial." ICAO's definition (different language, but in practice, virtually the same meaning): the height above the ground or water of the base of the lowest layer of cloud covering more than half the sky.
- ❏ What causes clouds to form? The water vapor in rising air currents cools to its dew point and condenses onto miniscule particles of matter (like dust/salt/smoke) into visible moisture.
- ❏ Clouds are classified using the following nomenclature - describe each:
  - Cumulus: look like fluffy cotton balls - heaped or piled clouds. Bases are usually low-middle clouds, but tops can extend up to 60,000 ft.
  - Stratus: layered clouds, usually low-level.
  - Cirrus: thin, wispy, high-level clouds usually composed of ice crystals.
  - Castellanus: cloud with a common base but with separate vertical development, castle-like.
  - Lenticular: lens-shaped cloud that forms over mountains in strong winds.
  - Nimbus: rain-bearing clouds.
  - Fracto: ragged or broken clouds.
  - Alto: middle level clouds existing between 5,000 to 20,000 ft.
- ❏ What is the most dangerous cloud type to pilots? Cumulonimbus.
- ❏ What are the approximate altitude cutoffs that define *low*, *middle*, and *high* clouds? Low: surface - 6,500 AGL; middle - 6,500 AGL - 20,000 AGL; high - above 20,000 AGL.
- ❏ What would you do if approaching a cloud shaped like a lens (or like a flying saucer) positioned directly above some mountains. Why? Avoid it by a wide margin. Lenticular clouds form from mountain waves - they indicate excessive turbulence/winds.

Turbulence

- ❏ What are the 3 causes (or types) of turbulence? Describe each.
  - ❏ Convective: Uneven heating of the Earth's surface on summer afternoons with little wind causes bubbles of warm air to rise, leading to rising and sinking air currents. Billowy cumuliform clouds on sunny afternoons are an indication of such turbulence.
  - ❏ Mechanical: Caused by obstructions that disrupt smooth wind flow, instead creating eddies that get carried downstream. Mountain waves are one form of mechanical

turbulence, as is turbulent air around airports caused by the wind flow colliding with hangars and buildings and other obstructions.
    - ❏ Wind shear: This turbulence is generated between two wind currents of different direction and/or speeds. Temperature inversion boundary layers and Clear Air Turbulence (usually occurring between the jet stream and surrounding air) are two forms of this.
- ❏ What are the 4 levels of turbulence intensity, and what defines each?
    - ❏ Light: Causes slight changes in altitude and/or attitude. Occupants may feel slight strain against their seat belts. Unsecured objects may be displaced.
    - ❏ Moderate: Causes changes in altitude and/or attitude and indicated airspeed, but positive control is maintained. Occupants feel definite strains against seat belts. Unsecured objects are dislodged.
    - ❏ Severe: Causes large changes in altitude/attitude and large variations in indicated airspeed. Aircraft may be momentarily out of control. Occupants are forced violently against their seat belts.
    - ❏ Extreme: Causes aircraft to be violently tossed about, rendering it practically impossible to control. May cause structural damage.
- ❏ In windy conditions, why should pilots be on high alert for turbulence when overflying mountains? Due to mountain waves.
    - ❏ What causes these? Wind flowing perpendicular to the mountains gets pushed aloft causing up/downdrafts and waves.
- ❏ At what altitudes is clear air turbulence (CAT) a very serious operational factor to flight operations?" All. Especially above 15,000 MSL, though.
    - ❏ What is the best way to determine the location of clear air turbulence before a flight? PIREPs.
- ❏ Would you expect to encounter less turbulence flying through a small thunderstorm than through a large one? No, there's no useful correlation between the external visual appearance of thunderstorms and the severity or amount of turbulence or hail within them.

<u>Thunderstorms/Microbursts</u>

- ❏ What ingredients are necessary for a thunderstorm to form? Sufficient water vapor, an unstable lapse rate, and an initial lifting action.
    - ❏ Are all three always required? Yes.
- ❏ In terms of thunderstorm formation, must the moisture in the air be visible? No, water vapor is sufficient.
- ❏ What charts can you use to determine the presence of each ingredient? Plenty of options here. One viable answer: for moisture look at the dewpoint - a higher dew point means more water vapor; for instability look at the temperature lapse rate on the winds aloft chart; for a lifting action look at the surface analysis and/or prog chart for low pressure systems, frontal activity, etc.
- ❏ What is "unstable" air? Air that, when pushed upward, continues rising. Conversely, stable air resists upward movement.

- ❏ What are some examples of weather phenomena that can cause a lifting action? Orographic effects (wind moving upward across mountains and valleys), frictional effects (low pressure systems), frontal lifting, buoyancy (uneven heating of surface), converging winds around surface lows and troughs, drylines, outflow boundaries generated by prior storms, and local winds, such as sea breeze, lake breeze, land breeze, and valley breeze circulations.
- ❏ Explain each stage of a thunderstorm.
  - Cumulus: Strong updrafts push warm, moist air upward until all the moisture becomes too heavy for the clouds to support.
  - Mature: The moisture, too heavy now for the updrafts and clouds to support, falls in the form of precipitation. When the precipitation reaches the surface, the mature stage begins. Precipitation descends through the cloud and drags the adjacent air downward, creating strong, cool downdrafts alongside the warm updrafts.
  - Dissipating: Characterized mostly by downdrafts, which replace the updrafts, effectively cutting off the supply of moisture provided by the updraft. Precipitation tapers off and ends.
- ❏ What are the three principle thunderstorm types? Explain each.
  - Single-cell (aka air mass): Like it sounds, a one-cell thunderstorm. Usually lasts 30 minutes. Easily circumnavigated by pilots. These are rare.
  - Multi-cell (aka steady-state): A multicell thunderstorm consists of a cluster of cells at various stages of their life cycles. With an organized multicell cluster, as the first cell matures, it is carried downwind, and a new cell forms upwind to take its place. A multicell cluster may have a lifetime of several hours or more. New cells will continue to form as long as the three necessary ingredients exist.
  - Super-cell: This is an especially dangerous convective storm cell that consists primarily of a single, quasi-steady updraft that persists for an extended period of time. Updraft speeds may reach 9,000 feet per minute. Nearly all supercells produce severe weather (large hail, damaging wind), and about 25 percent produce a tornado. These persist for many hours, and can be part of multicell storms as well.
- ❏ Generally, what causes air mass vs steady-state thunderstorms to form? Air mass thunderstorms usually form on hot afternoons due to surface heating. Steady-state thunderstorms are associated with weather systems, like fronts or converging winds or troughs.
- ❏ What is it called when thunderstorms form in a line, continually re-forming at the leading edge of the system, extending laterally for hundreds of miles? Squall line.
- ❏ During what stage do weather hazards generally reach peak intensity? At the end of the mature stage.
- ❏ What marks the end of the mature stage? Anvil cloud top.
- ❏ How long is the typical life cycle of a single thunderstorm cell? Around 30 minutes.
- ❏ What clouds produce thunderstorms? Cumulonimbus.
- ❏ Should you *always* expect thunder and lightning in a thunderstorm? Yes, always.
  - ❏ What other kinds of weather would you expect? Every type of extreme weather, to include strong winds and turbulence, icing (including freezing rain), hail, heavy rain, and sometimes tornadoes.

- ❏ You're flying at night and find that you've flown into a thunderstorm. What procedures do the AIM recommend pilots follow here? Verify pitot-heat and defroster are on; set a power setting (and generally don't adjust it, unless necessary) to maintain an airspeed below Va; keep your eyes on your instruments, not outside; maintain a constant attitude while allowing the altitude and airspeed to fluctuate; don't turn back once you are in the thunderstorm as turning maneuvers increase stress on the aircraft; turn up cockpit lights to their highest intensity to lessen temporary blindness from lightning; disengage auto-pilot, if equipped.
  - ❏ Why is it important to disengage the auto-pilot, if equipped? The autopilot will mask the effects of icing/an impending stall. The autopilot will also try to maintain altitude, heading, and airspeed, despite the fact that proper technique for flying in a thunderstorm involves simply maintaining a pitch attitude and riding the waves, so to speak.
  - ❏ If you accidentally fly into a thunderstorm what airspeed will you fly? Maintain an airspeed below Va for the current weight of the aircraft.
  - ❏ If you're stuck in a thunderstorm would you try to maintain a level altitude or level attitude? Attitude. Doing otherwise could overstress the aircraft.
- ❏ By how many miles are you supposed to circumvent a thunderstorm? Why? 20 miles, to avoid hail and strong winds.
- ❏ Up ahead along your victor airway you see a thunderstorm - it appears to be moving to the right. The area to the left of the airway is clear. What are you going to do/say to ATC? "Center, Career Track ____, request to deviate approximately _____ degrees left of course for weather avoidance."
- ❏ What does the METAR symbol -TSRA mean? It means LIGHT RAIN associated with a thunderstorm.
- ❏ Is flying *under* a thunderstorm safe? No.
- ❏ As you turn final at your destination airport, you notice virga just above the runway. Your indicated airspeed starts increasing despite that fact that you're not adding power or increasing your descent rate. What do you think is going on here? You're approaching a microburst.
  - ❏ Is this a dry or a wet microburst? Dry.
  - ❏ What additional sign might you see at the surface of a dry-type microburst? A blowing ring of dust.
  - ❏ What are you going to do? Add full power and start climbing - go around. If you're already in the microburst climb straight ahead; if you're approaching the microburst but not yet in it, immediately turn around while climbing.
  - ❏ How strong can the downdrafts get? 6000 ft/min.
    - ❏ How about the horizontal winds? 45 kt (90 kt shear).
  - ❏ How long would you expect this microburst to last? 15 minutes maximum.
  - ❏ What sort of weather activity needs to exist for a microburst to form? Convective.

<u>Icing and Freezing Level Information</u>

- ❏ Pretend the weather at your destination airport at your ETA is this: *071653Z 03004KT 10SM OVC040 07/02 A3029 RMK AO2 SLP260 T00670017.* You intend to file an IFR flight

plan and this airport has multiple approaches. Would you make a go or no-go decision? Why or why not? No-go due to icing. With a normal lapse rate the temp at 4000 ft would be -1 degrees, and the ceiling is overcast at that altitude.

- ❏ Show me with your charts and weather information how exactly you determined that we won't be at risk of flying into icing conditions. This will involve using the charts to both show where the clouds/visible moisture will be during every phase of the flight, as well as determining the freezing level throughout the route. There are many ways to effectively do this. Some options: Because the TAF range extends only 5 SM from the airport, and seeing as only larger airports have TAFs, determining cloud coverage beyond the range of these airports involves using the Graphical Area Forecast (GFA). The GFA tool on aviationweather.gov allows you to plot your flight path and show the cloud coverage along the entire route at various selected times. Determining precise freezing levels along your route involves using the winds aloft chart - be sure to use the stations along the entire route, not just departure and destination airport stations. More options include using graphical icing forecasts, PIREPs, freezing level charts, etc. Using the "show flight path" feature is always extremely helpful, as it allows you to see the location of this weather relative to your exact route.
- ❏ What kind of weather conditions need to exist for structural icing to form? Temperatures around freezing (close enough for the surface of the plane to be at or below 0℃) and visible moisture.
  - ❏ Must this moisture be visible? Yes.
- ❏ What are the different types of icing and what characterizes each?
  - Clear (or glazed): Transparent, smooth ice that forms when the temperature is just below freezing, allowing supercooled drops (either rain or cloud droplets) to spread out along the surface before slowly freezing. Clear ice is denser, harder, heavier, and more transparent than rime ice, and can form ice horns protruding from the leading edge surfaces.
  - Rime: Rough, milky, opaque, beady ice formed by the rapid freezing of supercooled drops after they strike the aircraft. Due to the lower temperatures required for rime ice to form, it usually acreets right as it strikes the aircraft, at the stagnation point. This type of ice is porous and brittle due to trapped air pockets.
  - Mixed: Combination of clear and rime icing features. This type of icing usually forms in the temperature range toward the middle of temperatures conducive to forming clear and rime ice.
  - ❏ What temperature ranges typically correspond to the formation of each of these types of structural ice? Clear: +2 to -10 degrees C. Mixed: -10 to -15 degrees C. Rime: -15 to -20 degrees C.
- ❏ How can you use the weather charts to determine whether there's a possibility of freezing rain along the route? Other than checking for thunderstorms and PIREPs, look for temperature inversions on the winds aloft coupled with precipitation on the radar summary, GFA, and/or METARs/TAFs.
- ❏ What are the different intensity levels of structural icing that pilots can report to ATC? Trace, Light, Moderate, and Severe.
  - ❏ What defines each?

- Trace: Ice is perceptible.
- Light: Ice may create a problem if flight is prolonged. Occasional use of de/anti-icing removes/prevents accumulation. Icing does not present a problem if the de/anti-icing is used.
- Moderate: Ice accumulation is such that even short encounters become potentially hazardous. Use of de/anti-icing equipment or flight diversion is necessary.
- Severe: Immediate flight diversion necessary. De/anti-icing equipment fails to control the hazard.

<u>Fog/Mist</u>

❏ Tell me about every type of fog, and in particular, what causes each type to form.
- Radiation fog: Forms on clear nights with little to no wind when the ground cools rapidly due to terrestrial radiation causing the surrounding air temperature to cool to its dew point.
- Advection fog: Common in coastal areas with sea breezes (winds up to 15 knots are usually required), advection fog occurs when the wind pushes the layer of warm, moist ocean air over a cold terrestrial surface which cools the moist air to the dew point.
- Upslope fog: Occurs when wind forces moist, stable air up sloping land features like a mountain range until the moist air cools to the dew point.
- Steam fog/sea smoke: Forms when cold, dry air moves over warm water - as the water evaporates it rises and resembles smoke.
- Ice fog: Similar to radiation fog, except involving extremely cold, arctic temperatures that cause the water vapor in the air to form directly into ice crystals.

❏ Transcribe this METAR: *KYYQ 301300Z 35011KT 1/8SM FG VV001 02/02 A2991 RMK SLP131*
  ❏ What is the ceiling? 100 ft. Any time there is completely obscuring phenomena (in this case fog), the Vertical Visibility (VV) is listed, and that becomes the ceiling.

❏ What kind of illusion would you expect when you're approaching to land and you enter fog? Entering fog gives the sudden feeling of pitching up, possibly leading the pilot to dangerously pitch the nose down.
  ❏ What can you do to mitigate this illusion? Rely on your instruments, and use visual aids like PAPI's/VASI's.

❏ What's the difference between fog and a cloud? Fog is just a cloud that is on the surface.

❏ If the METAR shows a temperature of 5 and a dew point of 4, what sort of weather would you expect? Visible moisture: mist, fog, clouds.

<u>Frost</u>

❏ What causes dew to form? Dew collects when a surface - like a blade of grass, or the skin of the aircraft - cools below the dewpoint, causing the water vapor (i.e. the gas form of water) to condense (become a visible liquid).

❏ What causes frost to form on an aircraft? Frost occurs when the temperature of the surface of the aircraft cools below the dewpoint *and* below freezing (O degrees C).

- ❏ On what type of nights is frost most likely to form? Cool, clear, calm nights with a low dew point.
- ❏ Why is it a bad idea to take off with frost on the wings? Because frost increases drag, adds to the plane's weight, changes the shape of the airfoil, and thus decreases lift. Also, it's illegal.
- ❏ What kind of drag does frost cause? Parasite - skin friction.

<u>Obstructions To Visibility (e.g. smoke, haze, volcanic ash, etc.)</u>

- ❏ What is smoke, and what causes it? Smoke is a suspension in the air of small particles produced by combustion due to fires, industrial burning, or other sources.
  - ❏ What makes it dangerous to pilots? It can reduce visibility, its compounds can be highly toxic or irritating, and it can contain carbon monoxide.
  - ❏ Why does smoke take longer to dissipate than fog or mist? Fog and mist can dissipate through evaporation or through the movement of air (wind); smoke doesn't dissipate - it requires the movement of air.
- ❏ What is haze? Haze is the suspension in the air of extremely small particles invisible to the naked eye and sufficiently numerous to give the air an opalescent (multi-colored, shimmering) appearance.
  - ❏ How does haze reduce visibility? By scattering light. Visibility in haze varies greatly, depending on whether the pilot is facing into or away from the sun. Above the definite ceiling of the haze layer the visibility is unrestricted, whereas at or below the ceiling the slant range visibility (air-to-ground) is poor.
  - ❏ How is haze different from mist and fog? In terms of density, haze is the least dense (increasing in density to mist, then fog). Also, haze appears blue or yellow, depending on the position of the sun, whereas mist and fog generally appear gray.
- ❏ Why is it dangerous to fly through volcanic ash? Volcanic ash is made up of fine particles of rock powder called "silica" (glass) that, if ingested by the engine, can melt and produce a soft sticky molten product that adheres to internal parts of the engine. Ash also causes abrasive damage to aircraft flying through it at hundreds of miles per hour - particles impacting the windshield can sandblast the surface into a frosted finish that obscures the pilot's view.
  - ❏ Can ATC radar detect the presence of volcanic ash? No - *weather* radar can, though.

<u>Miscellaneous</u>

- ❏ What kind of weather would legally require us to be on an IFR flight plan in order to take off from a controlled airport (assuming no SVFR clearance)? Anything below VFR takeoff minimums - i.e., below either 3 SM *OR* 1000 ft ceiling when departing from a controlled airport.
  - ❏ What about from an uncontrolled airport? Visibility below 1 SM *OR* if you can't maintain clear of clouds.

Task E. National Airspace System

References: 14 CFR parts 71, 91, 93; AIM; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; VFR Navigation Charts

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with National Airspace System (NAS) operations under VFR as a commercial pilot.

Knowledge:	The applicant demonstrates understanding of:
CA.I.E.K1	Airspace classes and associated requirements and limitations.
CA.I.E.K2	Chart symbols.
CA.I.E.K3	Special use airspace (SUA), special flight rules areas (SFRA), temporary flight restrictions (TFR), and other airspace areas.
CA.I.E.K4	Special visual flight rules (VFR) requirements.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.I.E.R1	Various classes and types of airspace.
Skills:	The applicant exhibits the skill to:
CA.I.E.S1	Identify and comply with the requirements for basic VFR weather minimums and flying in particular classes of airspace.
CA.I.E.S2	Correctly identify airspace and operate in accordance with associated communication and equipment requirements.
CA.I.E.S3	Identify the requirements for operating in SUA or within a TFR. Identify and comply with special air traffic rules (SATR) and SFRA operations, if applicable.

- ❏ What are the two *categories* of airspace? Regulatory and Non-regulatory.
- ❏ What kinds of airspace qualify as “regulatory”? A, B, C, D, E, Restricted Areas, Prohibited Areas.
- ❏ What kinds of airspace qualify as “non-regulatory”? Military Operations Areas, Warning Areas, Alert Areas, Controlled Firing Areas, National Security Areas.
- ❏ What are the 4 *types* of airspace? Controlled, Uncontrolled, Special Use, Other.
- ❏ What is “controlled airspace”? Airspace under the jurisdiction of ATC. It’s where ATC services are available.
- ❏ How is Class A airspace charted on a sectional? It’s not.
  - ❏ What are the dimensions of Class A airspace? 18,000 feet MSL up to FL600, extending 12 NM off the coast.
  - ❏ When flying above 18,000 ft, what should you do to the altimeter? Set 29.92.
    - ❏ Why? Flight levels/pressure altitudes are used above 18,000 feet MSL.
  - ❏ What are the operating rules and equipment requirements for operating in Class A airspace? Must be a current, instrument-rated pilot flying an instrument-equipped aircraft on an IFR flight plan. A Mode-C capable transponder with ADS-B Out is required (Mode-S transponders have Mode-C altitude reporting capability, so any time there is a Mode-C requirement, Mode-S transponders will also satisfy the requirement).
  - ❏ Are there any Class A speed restrictions? Less than Mach 1 because Class A airspace is above 10,000 feet MSL.
  - ❏ What are the basic VFR weather minimums associated with Class A airspace? None, flying IFR is required.

- ❏ How is Class B airspace charted on the sectional? Bold blue line with the associated MSL altitudes listed in each shelf section.
  - ❏ What are its dimensions? Generally looks like an upside down wedding cake, extending up to around 10,000 feet MSL. Each B airport has individually tailored airspace to accommodate its approach and departure operations.
  - ❏ What equipment is required to operate in Class B? 2-way radios and a Mode-C capable transponder with ADS-B Out when operating in or above the airspace. In addition to being required within the Class B airspace, the Mode-C transponder with ADS-B Out is required when operating within the Mode-C veil, so anywhere within 30 NM of the Class B airport.
  - ❏ So if there's a Class B shelf that extends beyond the 30-mile Mode-C veil, and you're flying in or above that B airspace, a Mode-C transponder and ADS-B Out are required? Yes.
  - ❏ What are the pilot certification requirements to fly in Class B? Must be either a private pilot, or a student pilot with an endorsement to fly in that particular B airspace; if a landing is involved, you would also need an endorsement to land at that particular Class B airport.
  - ❏ Do any Class B airports completely prohibit student pilot solo operations? Yes, they are listed under Appendix D to Part 91 of the FAR/AIM.
  - ❏ PHX Approach responds to your request to transition the Class B airspace with, "Cessna 976SP, standby." Can you enter? No.
  - ❏ What do you need to hear in order to enter? Tail number, and ". . . cleared into the Class B."
  - ❏ Say you're inbound to land VFR at a Class B airport. How do you determine which approach frequency to use to initiate contact? The edge of the sectional has a section called "Class B, Class C, Terminal Radar Service Areas, and Selected Approach Control Frequencies." that you can use. You could also get the frequencies off of the Terminal Area Chart (zoom in a bit on the sectional on Foreflight to bring up the TAC); they are listed in blue boxes in each approach sector.
  - ❏ What are the basic VFR weather minimums associated with Class B? 3 SM and clear-of-clouds.
    - ❏ What if you're operating below 1,200 ft AGL? Same.
    - ❏ And at night? Same.
  - ❏ Why does Class B have less restrictive cloud clearance requirements than Class C, D, and E? Because in Class B, all aircraft (VFR and IFR) receive separation and sequencing services.
  - ❏ Are VFR aircraft separated from other VFR aircraft while receiving Class B service? Yes.
  - ❏ Is traffic avoidance ATC's responsibility when operating in Class B airspace? No, not while in VMC. In VMC, whether flying VFR or IFR, this responsibility falls on the PIC.
  - ❏ What is the maximum airspeed permitted in Class B airspace? There are no speed restrictions inside Class B; however, most B airspace exists below 10,000 feet MSL, which entails a 250 knots indicated speed limitation. So while flying in Class B airspace below 10,000 feet MSL, the max indicated speed is 250 kt.

- ❏ Are there any other speed restrictions associated with Class B airspace? You can not fly faster than 200 knots beneath a B shelf or in a B corridor.
- ❏ Are there any exceptions to the speed restrictions (this applies to Class C and D speed restrictions as well)? If the plane's minimum safe speed is faster than what the regulations permit, then the plane can operate at its minimum safe speed.
- ❏ Would you feel comfortable flying 100 ft below a B shelf? Why or why not? No. The AIM specifically advises pilots not to fly close to B shelves. There are large, fast, passenger-carrying aircraft at those altitudes.
- ❏ So what's a good distance to fly below a B shelf? At least 500 feet.
- ❏ Say I wanted to fly from an airport located on one side of the Class B, to an airport on the direct opposite side. What are my most efficient options to do this? Check if there is a VFR transition or corridor available. If neither of those exist, then reference the flyway chart.
- ❏ What is a Class B VFR transition route, and where do you find the instructions for these? A Class B transition route is a recommended flight path for VFR traffic to use when traversing Class B airspace. The instructions are on TAC charts. In Foreflight you can download the document - it's in the "Visual Chart Supplemental" folder.
- ❏ Is a clearance required to fly a VFR transition route? Yes. You're flying through Class B airspace, so typical Class B clearance procedures apply.
- ❏ Are there altitude restrictions on these routes? Yes, whatever is stated on the Visual Chart Supplemental.
- ❏ What is a VFR corridor? These are holes in the B airspace through which VFR aircraft can fly.
  - ❏ Is a clearance necessary? No, you are not technically flying through B airspace. But each corridor has its own unique procedures that must be followed.
  - ❏ Where are these listed? What are some examples of airports that have corridors? They are in the Visual Chart Supplemental folder as well. KSAN has a corridor. KLAX has an SFRA that is effectively a corridor.
- ❏ What is a VFR flyway? These are efficient flight paths that pilots can use to navigate around complex terminal environment airspace.
  - ❏ Is a clearance required to fly these? No, the recommended altitudes and paths on the flyway charts keep you out of B/C/D airspace.
  - ❏ Where are these listed? On the back of the TAC. Or in Foreflight, in the "Fly Charts" folder.

- ❏ How is Class C airspace charted, and what are its dimensions? Charted with solid magenta lines with the associated MSL altitudes listed in each shelf section. Dimension-wise, Class C airspace, like with B airspace, is individually tailored to the traffic needs of the primary airport. Typical dimensions are as follows: a 5 NM radius core surface area that extends from the surface up to 4,000 feet above the airport elevation, and a 10 NM radius shelf area that extends no lower than 1,200 ft up to 4,000 ft above the airport elevation. There is also an uncharted procedural "Outer Area" that extends approximately 20 NM from the airport.
  - ❏ What are the equipment requirements for operating in C airspace? 2-way radios and a Mode-C transponder with ADS-B Out in and above (BUT NOT BELOW) the C airspace.

- ❏ What did you mean by “outer area”? It’s an area that extends 20 NM out from the primary Class C airport within which VFR aircraft can receive “Class C service.”
- ❏ What is “Class C service”? Think flight following plus separation and sequencing. Specifically, this service provides, in addition to basic radar service, approved separation between IFR and VFR aircraft, and sequencing of VFR arrivals to the primary airport.
- ❏ What does “basic radar service” cover? Flight following information: safety alerts, traffic advisories, and limited radar vectoring (workload permitting).
- ❏ As a VFR aircraft receiving Class C service, what kind of separation services can you expect? You can expect separation from IFR traffic. It is always the PIC’s responsibility to see and avoid in VMC, though.
- ❏ What minimum pilot certification is required to operate in Class C airspace? No specific certification required (i.e., a solo student could fly in Class C without a Class C-specific solo endorsement).
- ❏ Communications-wise, what is required to enter Class C airspace? You must establish communications.
- ❏ Define “establish communications.” ATC must say your tail number.
- ❏ What if ATC says, “Cessna 976SP, standby.” Can you enter? Yes.
- ❏ How about, “Cessna 976SP, remain outside the Class C airspace”? Then no - you have to follow instructions.
- ❏ Say ATC is distracted and says, “Traffic calling SE of Tucson, continue inbound, maintain present altitude and say call sign.” You respond, “Continue inbound, maintain altitude, Cessna 976SP.” Can you enter the Class C? No, not until ATC responds with your tail number.
- ❏ How far out are you expected to contact ATC when landing at a Class C airport? 20 NM, it’s on the sectional.
  - ❏ Is this required or advisory? Advisory.
  - ❏ Do you contact Approach or Tower? Approach.
  - ❏ Why so far out? Class C airports get a lot of IFR/passenger-carrying operations. Because of this they are serviced by approach radars, and this allows for sequencing among the IFR aircraft.
- ❏ What speed limitations are associated with Class C airspace? Within 4 NM of the airport, up to 2,500 feet AGL, the max indicated airspeed is 200 knots.
  - ❏ So if I’m in the Class C, but more than 4 NM out from the airport, can you go faster than 200 kts indicated? Yes.
- ❏ What are the basic VFR weather minimums in Class C airspace? 3 SM visibility, 1000 feet above clouds, 500 feet below clouds, 2000 feet horizontal from clouds (also known as 3152).
  - ❏ How about at night? 3152.
- ❏ What is the procedure for taking off from an untowered satellite airport located within the Class C (or D) airspace surface area? Is a takeoff clearance from ATC required? No, however two-way radio communications must be established as soon as practicable after departing with the ATC facility having jurisdiction over Class C (or D) airspace.

- ❏ KIWA has a lot more traffic than KTUS, and yet KTUS is Class C and KIWA is Class D. Why is that? The airspace classes are not designated by the overall amount of traffic, but instead by the amount of IFR, passenger-carrying, and commercial traffic. KTUS has a lot more of that sort of traffic, which necessitates an approach radar and additional ATC services.
- ❏ What are some of the ways that operating out of a Class C airport differs from operating out of a Class D airport? Departing VFR out of a Class C airport feels similar to departing IFR out of a D airport: usually when departing VFR out of a C airport, the pilot calls up Clearance first and specifies the intended direction of departure and climb altitude, after which Clearance provides a route/altitude clearance and a beacon code. Then the pilot calls up ground for taxi instructions. After departure the pilot can expect a hand-off to Departure, and then VFR Flight Following is automatically provided. When arriving, the main difference between C and D airspace is that, for Class C, the pilot contacts Approach Control 20 NM out, whereas in Class D, the pilot usually contacts Tower approximately 10 NM out.

❏ How is Class D airspace depicted on a sectional, and what are its dimensions? Class D is depicted with a dashed blue line, with the airspace's upper limits shown in MSL inside a dashed blue box. As is the case with B and C airspace, the dimensions of D airspace are individually tailored to the needs of the airport it surrounds; typical dimensions, however, are 2,500 AGL and a 4 NM radius.

- ❏ Is KIWA Class D full time? No.
- ❏ What airspace does it revert to, and when? Refer to the Chart Supplement, which in the case of KIWA states: *AIRSPACE: CLASS D svc 1200-0700Z; other times CLASS G.* This means that the surface airspace reverts to Class G (up to the overlying Class E at 700 ft) from 12pm - 5am local time, so after applying the -7 hour AZ Zulu conversion.
- ❏ What pilot certification is required to operate in Class D airspace? No specific certification required.
- ❏ Who do you contact when attempting to enter Class D airspace, and how far out should you initiate contact? Contact Tower about 10 NM out.
- ❏ Can you operate inside Class D airspace without a Mode-C transponder? Yes.
  - ❏ How about without ADS-B Out? Yes.
- ❏ Can you fly at KIWA without a Mode-C, ADS-B Out-equipped transponder? No, KIWA is inside the KPHX Mode-C veil.
- ❏ If a Mode-C transponder is not required, can you operate with your Mode-C transponder turned off? No, if you have a Mode-C transponder it needs to be operating.
- ❏ What other equipment is required to operate in Class D airspace? 2-way radio.
- ❏ What are the communication requirements for entry into Class D airspace? Same as Class C: must establish communications - i.e., must hear your tail number.
- ❏ What are the basic VFR weather minimums in Class D airspace? 3152.
- ❏ How about at night? Same, 3152.
- ❏ What speed limitations are associated with Class D airspace? Same as Class C: within 4 NM of the airport, up to 2,500 ft AGL, the max indicated airspeed is 200 kt.
- ❏ What if the Class D airspace extends 6 NM out from the airport? Can you operate within the D for the first 2 NM going faster than 200 kt? Yes.

- ❏ What kind of separation services can VFR aircraft expect in Class D airspace? None. Only IFR aircraft receive separation services in Class D.
- ❏ Does Tower look out for you at all in Class D? Workload permitting, you'll receive basic radar service such as traffic advisories, safety alerts, and limited vectoring. Safety alerts are always mandatory.

❏ What are the various ways Class E airspace can be depicted on a sectional, and what are its various dimensions? Class E starting at the surface is shown with a dashed magenta line. Class E starting at 700 ft AGL is shown with a thicker magenta line that fades into the Class E airspace it surrounds. Class E starting at 1,200 ft AGL that abuts Class E starting at 14,500 ft MSL is shown with a blue line (the soft side of the blue line surrounds the Class E starting at 1,200 ft AGL; the hard side designates Class G with Class E starting at 14,500 ft MSL). Class E exists at 1,200 ft AGL unless depicted otherwise. All Class E airspace extends upward until it reaches more restrictive airspace (A, B, C, or D), which at some point will be Class A at 18,000 ft MSL. Class E then starts again above FL600 and extends upward into space.

- ❏ What are the pilot certification, equipment, and arrival communication requirements for Class E airspace? None. However, if operating above 10,000 ft MSL (but not below 2,500 ft AGL) in Class E, a Mode-C, ADS-B Out-equipped transponder is required.
- ❏ What are the basic VFR weather minimums in Class E airspace? Below 10,000 ft MSL: 3152. Above 10,000 ft MSL: 5 SM visibility, 1,000 ft above clouds, 1,000 ft below clouds, 1 SM horizontal from clouds (5111).
- ❏ How about at night? Same.
- ❏ What does the last "1" in 5111 represent? 1 *statute mile* horizontal from clouds.
- ❏ Why are the visibility and cloud clearance requirements increased above 10,000 MSL? Aircraft move faster at these higher altitudes. More restrictive weather minimums provide more time to see and avoid.
- ❏ What is the purpose of Class E airspace? It has many functions, but essentially Class E exists to provide controlled airspace so that aircraft can receive ATC services.
- ❏ What kind of airspace surrounds victor airways, and what are its dimensions? Class E. Unless otherwise designated, this Class E starts at 1,200 ft AGL and extends up to 18,000 ft MSL, 4 NM on either side of the airway.

❏ Define Class G airspace. Uncontrolled airspace that has not been designated as Class A, B, C, D, or E airspace.

- ❏ What are its dimensions and how is it depicted on a sectional? Class G airspace is not marked on the sectional. It exists wherever ABCDE airspace doesn't - i.e., it underlies controlled airspace.
- ❏ What are the Class G airspace basic VFR weather minimums? Below 1,200 ft AGL: 1 SM and clear-of-clouds during the day; 3152 at night (unless you're operating within ½ NM of the runway and you're in a traffic pattern per the 91.155 exception - then it's 1 SM clear-of-clouds). Above 1,200 ft AGL but below 10,000 ft MSL: 1152 during the day, 3152 at night. Above 10,000 ft MSL and above 1,200 ft AGL: 5111 always (day or night).
- ❏ Is IFR flight permitted in Class G airspace? ATC has no jurisdiction over Class G airspace, so while in the Class G airspace, no IFR services are available. An instrument

rated pilot flying an IFR-equipped plane may fly when the weather conditions are less than basic VFR; having an IFR clearance when operating in such weather is only required when in *controlled* airspace (91.173) - so such a pilot may fly in IMC in uncontrolled airspace without a clearance. Still, the pilot here could open themself up to a 91.13 (dangerous and reckless) violation. In fact, the NTSB has ruled that *taking off* in uncontrolled airspace in IMC without an IFR clearance violates 91.13. Also the pilot should be aware that certain rules in 91.177 and 91.179 pertaining to minimum IFR altitudes and the hemispherical rule kick in when flying in IMC in uncontrolled airspace.

- ❏ Some airports are towered, but uncontrolled - they are shown on the sectional in blue, but with no controlled airspace surrounding them. Are there any communication requirements associated with these Class G towered airports? Yes, the pilot must be in contact with the tower within a 4 NM radius up to 2,500 feet AGL.

- ❏ What are the different types of Special Use Airspace (SUA)? Prohibited Area, Restricted Area, Warning Area, Military Operations Area (MOA), Alert Area, Controlled Firing Area (CFA), and National Security Area (NSA).
- ❏ What is a Prohibited Area, and how is it depicted on a sectional? A Prohibited Area contains airspace within which the flight of aircraft is completely prohibited (unless you're an approved aircraft like Air Force One). It is depicted with the same blue hash-marked line as Restricted and Warning Areas, and identified with a "P" followed by a number, e.g., P-40.
  - ❏ Where would you find a Prohibited Area? Camp David, National Mall, and other areas of heightened national security.
- ❏ What is a Restricted Area, and how is it depicted on a sectional? A Restricted Area contains airspace within which the flight of aircraft, while not always prohibited, is subject to restrictions due to operations being conducted that could be hazardous to nonparticipating aircraft. A Restricted Area is charted with the same blue hash-marked line as Warning and Prohibited Areas, except identified with an "R" followed by a number.
  - ❏ Give some examples of why an area would be designated as a Restricted Area? Various potentially hazardous (and often invisible) activities, such as artillery firing, aerial gunnery, and guided missiles.
  - ❏ Can IFR traffic fly through a Restricted Area? If the Restricted Area is not active, yes. If the restricted area IS active, then ATC will keep IFR traffic out of the restricted airspace.
  - ❏ Is a clearance necessary when flying IFR through an inactive Restricted Area? No.
  - ❏ Can VFR traffic fly through a Restricted Area? No, not when it is active.
    - ❏ And when it's not active? Yes it's permitted, but it's usually a good idea to call the controlling agency to confirm before flying through the area.
  - ❏ For the 2310-A Restricted Area north of the city of Florence (slightly north of P08 airport), how do you determine its controlling agency and frequency in order to ask about its active status? Look up 2310-A on the top of the sectional (use Settings > Map Touch Action > Bring Chart Legend To Front on Foreflight); or call a briefer; or tap the Restricted Area on your iPad, locate the frequency, and call the controlling agency from the plane.
- ❏ What is a Warning Area, and how is it depicted on the sectional? It's an area of defined dimensions off the U.S. coast that warns pilots of activity that may be hazardous to

nonparticipating aircraft. A Warning Area extends from 3 nautical miles outward, charted with the same blue, hash-marked line as Restricted and Prohibited Areas, except identified with a “W” followed by a number. Warning Areas can be over international and/or domestic waters.

- ❏ Is an ATC clearance necessary to enter a Warning Area? No, but use caution.

❏ What is the purpose of a MOA? Primarily to separate military traffic from IFR traffic. A MOA also serves as a warning to VFR traffic of possible high-speed military flight activity.

- ❏ Do military aircraft have to abide by the Part 91 aerobatic and speed restrictions in a MOA? No.
- ❏ How can you determine if a MOA is active? Same procedures as for Restricted and Warning Areas.
- ❏ Can VFR traffic fly into a MOA without an ATC clearance? Yes, but use caution.
- ❏ Can IFR traffic fly through a MOA? Absent the rare occasion where ATC is able to coordinate and provide separation, IFR traffic will not be cleared through a MOA.

❏ What is an Alert Area and how is it depicted on a sectional? This is an area used to alert nonparticipating pilots of either a heightened volume of training activity, or of an unusual type of aerial activity. They are charted with magenta, hash-marked lines.

- ❏ Do Alert Areas have active times and controlling agencies? They can.
- ❏ Where do you find this information? Sectional or Foreflight or briefer, same procedure as for Restricted/Warning Areas.
- ❏ How do you determine the reason for the Alert Area status? This will be charted along with the name of the Alert Area. E.g. “Alert Area A-231 Concentrated Student Jet Transition Training.” You could also contact the controlling agency.
- ❏ If an Alert Area surrounds a Class D or C airport, is that C/D airspace considered part of the Alert Area? No.

❏ What is a CFA, and how is it depicted on a sectional? A Controlled Firing Area, or CFA, contains activities that, if not conducted in a controlled environment, could be hazardous to nonparticipating aircraft. Unlike with Restricted Areas, though, CFAs utilize spotter aircraft, ground look-outs, and radar to detect any aircraft approaching the area, in which case the hazardous operations are suspended immediately. Because of this, CFAs are not charted.

❏ What is an NSA, and how is it depicted on the sectional? A National Security Area, or NSA, consists of airspace of defined vertical and lateral dimensions established at a location where there is a requirement for increased security and safety of ground facilities. An NSA is charted with a thicker broken magenta line.

- ❏ Can you fly through an NSA without an ATC clearance? Yes, generally.
- ❏ Would you? No, pilots are requested to voluntarily avoid them.
- ❏ Can you *always* fly through an NSA without a clearance? No, sometimes flight operations are temporarily prohibited.
- ❏ How can you determine this? NOTAM.

❏ What are the types of Other Airspace? Local Airport Advisory (LAA)/Information Services (RAIS), Military Training Route (MTR), Temporary Flight Restriction (TFR), Parachute Jump Operation, VFR Corridor, VFR Transition, VFR Flyway, Air Defense Identification Zone (ADIZ), Special Flight Rules Area (SFRA) and Special Air Traffic Rules (SATR), Terminal Radar Service Area (TRSA), Wildlife Area, National Oceanic and Atmospheric

Administration Marine Area (NOAA), Tethered Balloon, Weather Reconnaissance Area (WRA).

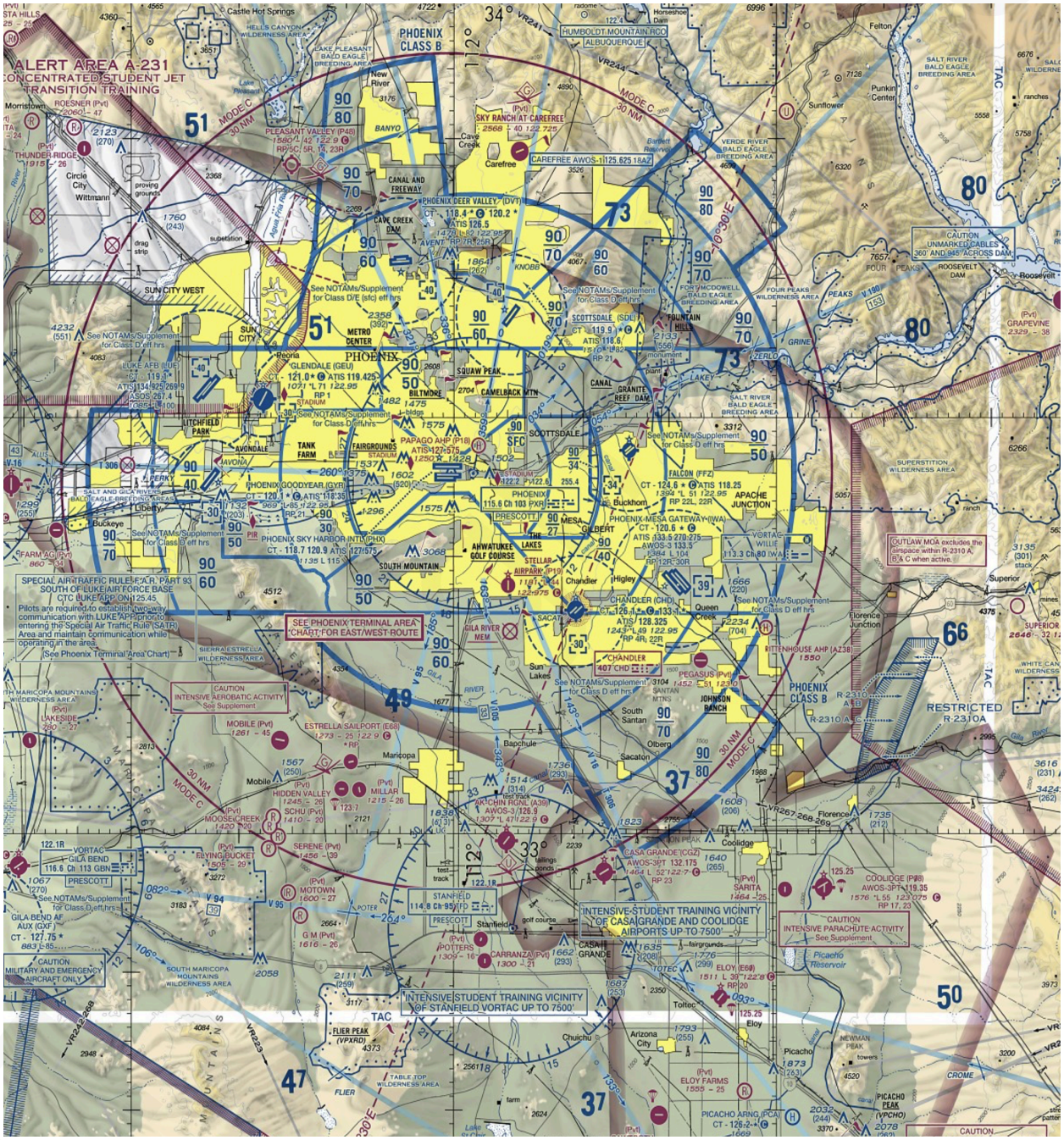
- ❏ What is an LAA? It's a service available only in Alaska where the Flight Service Station is located on-field at an uncontrolled airport and can provide local airport advisories to arriving and departing aircraft.
- ❏ What is a Remote Airport Information Service (RAIS)? This is when a FSS provides support for short term special events like small to medium-sized fly-ins. These are advertised by D-NOTAMs and do not include weather information.
- ❏ What are MTRs, and how are they charted? MTRs are routes used by the military for low altitude training. On sectionals they look like V-airways, except thinner and gray.
  - ❏ What differences would you expect between an MTR named "IR267" and an MTR named "VR2673"? The former is an IFR route and has segments above 1,500 feet AGL; the latter is a VFR route and has no segment above 1,500 feet AGL.
  - ❏ Can nonparticipating aircraft (non-military) fly on MTRs? No.
  - ❏ Can participating aircraft (military) fly faster than 250 knots while on MTRs? Yes.
  - ❏ How could you determine whether an MTR will be in use during your flight? Contact a FSS.
  - ❏ What is the route width of an MTR? Varies, 4 to 16 miles.
- ❏ What is a TFR? A TFR, or Temporary Flight Restriction, is a tool used by the FAA to restrict aircraft operations within designated areas.
  - ❏ What are some of the purposes for establishing a TFR? To protect persons and property in the air or on the surface from an existing or imminent hazard (e.g. hijackings, imminent volcano eruptions, toxic gas leaks, or nuclear incidents); provide a safe environment for the operation of disaster relief aircraft (e.g. forest fires, or aircraft relief activities after a natural disaster); prevent an unsafe congestion of sightseeing aircraft above an incident or event that may generate a high degree of public interest (e.g. sporting events); protect declared national disasters for humanitarian reasons in the State of Hawaii; protect the President, Vice President, or other public figures; provide a safe environment for space agency operations.
  - ❏ What kind of NOTAM is a TFR? FDC or Flight Data Center.
  - ❏ How do you check for TFRs along your flight route? Ask a FSS/briefer. On Foreflight, after selecting for TFRs, they will appear on the sectional in red when active, yellow when inactive. Tap on the TFR to bring up more information about it. Tfr.faa.gov is another available tool.
  - ❏ Is flying through a TFR ever permitted? Each TFR's restrictions are unique. The presidential TFRs, for instance, generally have an extremely restrictive inner ring and a slightly less restrictive outer ring. Occasionally VFR traffic with a beacon code in communication with ATC may transition through the outer ring, whereas the inner ring may allow, say, 121 IFR traffic only. The restrictions are specified in the NOTAMs.
  - ❏ If you're intercepted after accidentally busting a TFR, what basic intercept procedures would you be expected to follow? Squawk 7700; communicate on 121.5; rock your wings to acknowledge instructions; follow the interceptor aircraft.

- ❏ What tools do you use to avoid Parachute Jump Areas while planning your route? These areas are shown on sectionals with a parachute symbol. Also speak with a briefer about your route of flight - he or she should notify you of any active jump activity.
  - ❏ Does the placement of the parachute symbol give an indication of where the drop zone is located, or are the symbols just placed randomly around their associated airport? They don't give a *precise* location, but as long as there is space available they are placed as close as possible to where the jump ops generally occur.
  - ❏ So how can you determine the exact location of the drop zone? Check the Chart Supplement.
  - ❏ If there is no parachute symbol at an airport, does that mean that jump operations do not occur there? No, the parachute symbol is primarily for airports that have a high amount of jumps per year (over 1,000).
  - ❏ So how would you know if jump operations existed at a certain airport? Check the Chart Supplement.
  - ❏ Enroute, what is the best way to protect yourself against flying through an active Parachute Jump Area? Pick up flight following. The drop plane notifies the controlling agency prior to each drop, so ATC can give you warnings.
- ❏ What is an ADIZ and how is it depicted on a sectional? The Air Defense Identification Zone, or ADIZ, designates an area over land or water at which the ready identification, location, and control of all aircraft (except for the Department of Defense and law enforcement aircraft) is required in the interest of national security. These are charted with a dotted magenta line, like you can see at the U.S./Mexico border.
  - ❏ What kind of equipment is required to cross an ADIZ? 2-way radios and a Mode-C transponder.
  - ❏ Can VFR aircraft cross an ADIZ? Yes, provided certain requirements are met.
  - ❏ What are the requirements? Must file and pick up a D-VFR flight plan; must take off within 5 minutes of the scheduled departure time; must maintain 2-way radio communication with the appropriate ATC facility and squawk the assigned beacon code; and you must notify ATC within 15 minutes of crossing the border and give the position, altitude, and time at which you intend to cross the ADIZ.
  - ❏ Is there an ADIZ at the U.S./Canadian border? No.
- ❏ What is a SFRA/SATR, and how are these areas charted? A Special Flight Rules Area, or SFRA, or a Special Air Traffic Rules, or SATR, signifies an area within which the flight of aircraft is subject to the unique air traffic rules specified in Part 93. These rules and the nature of the operations vary among each SFRA and SATR. The way these areas are charted also varies. Usually SFRAs are designated with a blue castellated line and SATRs utilize a blue or magenta hash-marked line.
- ❏ Say your flight is going to take you through a SATR or an SFRA. How do you determine what the special procedures are that you will need to follow? Look up that specific SATR or SFRA in Part 93. Additional information and resources are available on faasafety.gov.
  - ❏ What are the requirements to fly within the Washington DC SFRA? (Refer to Part 93.)
  - ❏ What are the requirements to fly through the SATR just west of Luke Airforce Base? (Refer to Part 93, or read the Special Air Traffic Rule information box located nearby on the sectional.)

- ❏ What is a TRSA, and how is it charted? A Terminal Radar Service Area, or TRSA, is just like it sounds: it's an area in the terminal environment of an airport for radar services. Specifically, it is a charted area in the terminal environment of some Class D airports within which pilots are encouraged to contact the radar approach control to receive radar services. TRSAs are charted with a solid black line and associated altitudes for each region.
  - ❏ Are pilots required to use the TRSA services? No, participation is voluntary but encouraged.
  - ❏ Why is it a good idea to use TRSA services? Typically these airports have a lot of IFR and commercial traffic. Using the TRSA allows an approach controller to separate you from other inbound aircraft and sequence you in to land.
  - ❏ Let's say I am 20 NM out, approaching to land at KPSP, which has a TRSA. Take me step by step through that process. Contact SoCal Approach with your tail number, location, altitude, and intentions. Follow their instructions.
  - ❏ When SoCal Approach reads back your tail number, are you cleared into the KPSP Class D? Or does Tower separately need to say your tail number? Establishing communications with Tower is still required - they must say your tail number.
- ❏ At least how many feet are pilots supposed to fly above the surface of a Wilderness Area? 2,000 feet AGL.
  - ❏ Is this mandatory or a request? A strong request.
  - ❏ Is this true for *all* Wilderness Areas? No, some have special flight rules associated with them that outright prohibit overflight at certain altitudes.
  - ❏ What is the definition of the "surface" when in reference to a Wilderness Area? The highest terrain within 2,000 feet laterally of the route of flight, or the uppermost rim of a canyon or valley.
  - ❏ How is a Wilderness Area charted? Blue line with blue dots on the inside.
- ❏ What altitude restriction is associated with NOAA Marine Areas? Either 1,000 ft. AGL or 2,000 ft. AGL minimum, depending on what the Marine Area warning box says.
  - ❏ Is flight below 1,000/2,000 AGL prohibited or advised against? Prohibited by the National Oceanic and Atmospheric Administration (not by the FAA).
  - ❏ How are Marine Areas charted? With a magenta line with magenta dots on the inside.
- ❏ How are Tethered Balloons charted? Usually these are surrounded by a small circle of Restricted airspace with a caution box nearby containing language like, "CAUTION: UNMARKED BALLOON ON CABLE TO 15,000 MSL."
- ❏ What is a WRA, and how is it charted? A Weather Reconnaissance Area, or WRA, is an area established to support weather reconnaissance/research flights. These are not charted; they are published by NOTAM, so their dimensions, location, active times, and expected activities will be included in the NOTAM.
- ❏ Can non-participating aircraft fly through a WRA? VFR aircraft should avoid them; IFR aircraft will be rerouted to avoid them.

- ❏ How are sectionals scaled? 1:500,000.
  - ❏ What does that mean? It means the sectional is zoomed out so that for every 1 unit of measurement at the surface, on a sectional that unit is represented as 500,000 times smaller.

- ❏ How are TAC charts scaled? 1:250,000.
- ❏ How often are sectionals updated? Every 6 months.
- ❏ How are changes to sectionals that occur before the 6-month update disseminated to pilots? Refer to the Aeronautical Chart Bulletins section of the Chart Supplement. These are updated every 56 days as each new Chart Supplement is released.



- ❏ Tell me everything that you can glean from the sectional about KCHD (located SE of KPHX). It's blue so it's towered. The tick marks extending from the airport symbol mean

fuel is available (at least 10am - 4pm or self-serve). It's a circular, filled-in airport diagram symbol, meaning that the longest runway is less than 8,069 feet long and it's hard surface. The airspace surrounding the airport is Class D up to, but not including (due to the negative sign in the "[-39]"), 3,000 ft. MSL. The star means that the airport has a rotating beacon operating from sunset to sunrise. The airport information just to the right of the airport symbol tells us the following: the airport's name and identifier; "CT" indicates the control tower frequency: 126.1; the star next to this frequency means part-time; the "C" identifies the CTAF frequency (the "C" FOLLOWS the frequency it refers to, meaning that when the tower closes, 126.1 becomes the CTAF); 133.1 is a second tower frequency and it is also part time; the ATIS is 128.325; field elevation is 1243 ft.; the "*L" means that the runway has lights and the pilot should consult the Chart Supplement to determine limitations (more often than not, the "*" just indicates that the lighting is pilot-controlled); the longest runway is 4,900 ft.; the UNICOM is 122.95 (because it's italicized); and runways 4R and 22R have right traffic patterns. The pink dots surrounding the airport symbol mean that there's an NDB located there.

- ❏ Towered airports often have lights that are not pilot-controlled. At these airports, what is the procedure for turning on the lights and/or adjusting their brightness? Make a request to the Tower.
- ❏ Why is the CTAF at KCGZ (located just NE of the TFD VOR) italicized? That means that it is the UNICOM frequency.
  - ❏ What's a UNICOM? It's a frequency pilots can use to coordinate services such as fuel or parking. Sometimes you can get additional weather and airport information on this frequency as well.
- ❏ On top of the KCHD airport symbol, trace how you would takeoff and fly a right traffic pattern for runway 4R.
- ❏ Say you are inbound from the south and you call up KCHD Tower and request touch and go landings. Tower responds: "Cessna 976SP, Chandler Tower, make right traffic runway 4L." How would you enter this traffic pattern?
  - ❏ What if instead, Tower responds: "...overfly the runways midfield and make left traffic runway 4L." Trace how you would fly this. (DO NOT do a teardrop entry here. Teardrop entries are a non-towered airport procedure.)
- ❏ Is a Mode-C transponder required to operate in KCHD's airspace? Yes.
  - ❏ Why? Because KCHD's airspace is located inside the Mode-C veil. Otherwise, a Mode-C transponder would not be required in Class D airspace. Same goes for ADS-B Out.
- ❏ Along the bottom of the chart toward the right is a blue circle with an "H" inside it. What does this represent? Towered heliport.
  - ❏ What kind of airspace surrounds it? Class G.
  - ❏ So if you were a helicopter could you land without a clearance? No. As discussed previously, communications must be established with Tower within a 4 NM radius and 2,500 ft AGL of the heli/airport.
- ❏ At the VERY top of the image, in the middle, above the VR241/VR244 MTR, there is a small blue circle with a dot in it. What does this symbol indicate? A Remote Communications Outlet.

- ❏ What are these for? These are unmanned communications facilities remotely controlled by Flight Service Stations (FSS), used to extend communication range.

❏ How would you file a VFR flight plan? Same process as for IFR flight plans - i.e., call a briefer on the ground or contact an FSS in the air.

- ❏ If your route does not involve any detours or major turns, what would you file for your "route"? Direct.
- ❏ Say you filed a VFR flight plan before takeoff. You take off out of KCGZ (non-towered airport located just NE of the Stanfield VOR: TFD) and start flying westbound. Take me through how you would pick up your VFR flight plan. Be specific. The frequency for the relevant FSS is located on top of the TFD NAVAID box, it says 122.1R; the name of the FSS is at the bottom, Prescott Radio. The "R" means that THEY receive on 122.1, so I'll be receiving on the TFD VOR frequency, 114.8. After selecting 114.8 and activating "NAV1", I would call up Prescott Radio on 122.1R and tell them that I'm listening on 114.8, give them my time off the ground, and let them know that I would like to pick up my VFR flight plan to ____. They will likely give me some pertinent weather, request PIREPs, and tell me that my flight plan has been opened.
- ❏ How would you close this flight plan? Call a FSS, either in the air on the radio, or on the ground through 1-800-wx-brief.
- ❏ If landing at a towered airport, will Tower close your flight plan automatically when you touch down? No, pilots must always close VFR flight plans.
- ❏ How much time do you have after your filed ETA to close your flight plan before it is officially overdue? 30 minutes. After this, a communications search begins. This search becomes progressively more involved until search and rescue personnel are dispatched several hours later.
- ❏ Is there a universal FSS frequency pilots can try, even if it's not depicted on a NAVAID box or with an RCO? Yes, 122.2.

❏ Why does Gila River Memorial Airport (located just west of KCHD) have an "X" through it? That means that it is abandoned.

❏ Pretend you take off from Gila River Memorial Airport in a rocket and fly straight up into space. What are the different types of airspace you will pass through? Be specific about their associated altitudes. Class G up to but not including 700 ft. AGL > Class E starting at 700 ft. AGL up to but not including 6,000 ft. MSL > Class B starting at 6,000 ft MSL up to and including 9,000 ft MSL > Class E above 9,000 ft. MSL up to but not including 18,000 ft. MSL > Class A from 18,000 ft. MSL up to and including FL600 > Class E above FL600.

- ❏ Use the figure above. Same rocket scenario, except now you're taking off over Cedar Knoll (private airport located just east of KSFB). Class G up to but not including 700 ft. MSL > Class C from 700 ft. MSL up to but not including the overlying Class B at 3,000 ft. MSL > Class B from 3,000 ft MSL up to and including 10,000 ft. MSL > Class E above 10,000 ft. MSL up to Class A starting at 18,000 ft. MSL, etc.
- ❏ Same figure, same scenario, except now you're taking off over SOTHERLAND (private airport toward the bottom right of the image). Class G up to but not including 1,200 ft. AGL > Class E from 1,200 ft. AGL up to but not including 1,300 ft. MSL > Class C from 1,300 ft. MSL up to but not including the overlying Class B at 3,000 ft. MSL > Class B from 3,000 ft. MSL up to and including 10,000 ft. MSL > Class E above 10,000 ft. MSL up to Class A starting at 18,000 ft. MSL, etc.
- ❏ Every quadrant on a sectional contains one large 2-digit blue number. What are these numbers called, and how are they calculated? Maximum Elevation Figures (MEFs). If the highest point in the quadrant is terrain, then the MEF is calculated by adding 300 ft. to the highest terrain point, then rounding that number up to the next hundred-foot level. If the highest point is a man-made structure, then the MEF is calculated by adding 100 ft. to the elevation of the top of that obstacle, then rounding that number up to the next hundred-foot level.
  - ❏ Are MEFs safe altitudes? Absolutely not. Operating 300 ft. above terrain is not safe.
- ❏ Toward the upper-left of the Phoenix sectional image there are two white areas outlined with lines of blue hash marks. What is this? The Luke Airforce SATR.
  - ❏ What are the rules to operate in this SATR, and where do you find them? The specifics are listed in Part 93. You can also look on FAASafety.gov. Or there's a blue box next to the SATR that explains the basic rule: pilots must establish and maintain communications with Luke Approach while operating in the SATR area.
- ❏ Alert Area 231 is in the upper left section of the Phoenix (KPHX) sectional image. This region on the sectional is especially convoluted with symbology . . . what specific line(s) define the boundaries of this Alert Area? The line of magenta hash marks - same line style that is used for MOAs.

- ❏ Is the area just east of KCGZ an Alert Area? No, the "Intensive student training . . ." warning box does not make the area an Alert Area.

- Note: commercial students/applicants should know the meaning of all the symbols representing the different types of airports and miscellaneous activity areas, e.g. ultralight, military, military-civilian, heliport, public use soft surface, restricted use soft surface, unverified, abandoned, aerobatic, glider, hang glider, ultratight, unmanned, space launch.

❏ KTUS (not on the sectional image above) is referred to as an "AOE" on the sectional. What does this stand for and what does it mean? Airport of Entry. This means that the airport has Customs and therefore can be used as an initial port of entry for inbound international flights.

❏ Above KFLG (not on the sectional image above, use Foreflight) the number "12633" is highlighted in white. What does this indicate? This is the highest terrain elevation on the sectional.

❏ Is a Mode-C capable transponder required to operate in KFLG's airspace? No.

- ❏ How about if you were overflying KFLG's airspace at 10,500 ft MSL? Yes.
- ❏ How about if you were overflying the 12633ft peak (Humphrey's Peak) at 13,500 ft MSL? No, you'd be less than 2,500 ft AGL, so the >10,000 ft MSL Mode-C requirement wouldn't apply. The same applies for ADS-B Out.

❏ At KIWA (located just west of KCHD), there is a small open circle between the runways. What does this represent? An on-field VOR.

- ❏ Then why is there no compass rose depicted? The VOR has no airways associated with it.

❏ Effective basic VFR weather minimums exercise: "You are flying VFR right here (point to a spot on the sectional) at an altitude of (choose an altitude) feet MSL during the (day/night). What visibility and cloud clearance are required?

- ❏ E.g., you are flying VFR right here (say, directly over 13Q, Jewett Mesa Airstrip) at an altitude of 9,500 ft MSL during the day. What visibility and cloud clearance are required? The field elevation is 7,681 ft. So 9,500 ft MSL is more than 1,200 ft AGL and less than 10,000 ft MSL, and the airspace is Class G. So: 1152.
  - ❏ This airport is surrounded by the 1,200 ft AGL blue Class E line - how do you know that this line applies to the airspace *outside* the enclosed area, not inside? Both the 1,200 ft AGL and 700 AGL Class E lines fade IN to their applicable areas.

❏ What is the lowest ceiling/visibility that would still allow for a legal VFR takeoff out of KIWA (or any other Class D airport)? 3 SM and a 1000 ft. cloud ceiling.

❏ Say the METAR at KIWA lists the visibility and ceiling as *2SM BKN008*. You go outside to look at the weather and can see the Superstition Mountains, so the visibility is clearly MUCH greater than 2 SM. Plus, it looks to us like the ceiling has broken up and is more like FEW or SCT. So we get in the plane in order to listen to the ATIS, and it reports 2 SM visibility, clouds SCT at 2,000. Can we take off? No, reported visibility is less than 3 SM.

- ❏ What if the ATIS instead reports 4 SM visibility and a 2,000 ft SCT cloud layer, but the METAR on your iPad still shows 2 SM 008BKN. Can you take off now? Yes, you go by the airport's ATIS information.

❏ Would you take off VFR out of KIWA if the ATIS reported 3 SM visibility, 1000 ft OVC? Why or why not? No, because after takeoff we would have to maintain 500 feet below the

clouds. This would put us 500 feet AGL, so 500 feet above congested areas. There is also terrain in the vicinity of the airport that would require a higher climb. We also have an LOA, or letter of authorization, that requires us to maintain 3,000 feet MSL (1,500 feet AGL) enroute to the practice area.

- ❏ Under what specific circumstances does the 3 SM/1000 ft ceiling takeoff minimum apply? When departing VFR from an airport that is surrounded by controlled airspace down to the surface.
- ❏ What are your VFR takeoff minimums out of KCGZ during the day? 1 SM and clear-of-clouds.
  - ❏ How do your visibility and cloud clearance requirements change upon reaching 700 ft AGL on your climb-out? At 700 feet AGL I would hit Class E airspace, meaning vis and cloud clearance requirements become more restrictive: 3152.
- ❏ I'm an IR pilot flying an IFR-equipped aircraft. I've heard that I don't need to be on an IFR flight plan to takeoff from a Class G airport into hard IMC, as it's uncontrolled/unregulated airspace. Is this true? Here is the legal opinion addressing that scenario: https://www.ntsb.gov/legal/alj/OnODocuments/Aviation/3935.pdf. The NTSB found that 91.155 (the reg that covers basic VFR) does not prohibit an IR pilot from taking off in an IFR aircraft into IMC while not on an IFR flight plan and in uncontrolled airspace; however, the NTSB went on to rule that it was dangerous and reckless per 91.13 and the pilot had his license temporarily suspended. In this particular case, there were some aggravating circumstances involved - such as passengers being onboard - but regardless, the answer to whether it's legal to takeoff in IMC while not on an IFR flight plan is almost certainly no because it violates 91.13.
- ❏ KIWA's tower closes at midnight and the airport reverts to Class G until 5am. What are your takeoff minimums now? Basic VFR mins at night in Class G airspace below 1,200 feet AGL are 3152. The 1000 feet ceiling limitation for VFR takeoffs would no longer apply, because there is no longer controlled airspace descending to the surface; **so your visibility minimum would be 3 SM and I would have to remain 500 ft below clouds.** There is a caveat, however, when operating in a Class G traffic pattern at night: if remaining in the pattern and within ½ mile of the runway, only 1 SM visibility and staying clear-of-clouds is required. However, at TPA in KIWA's pattern (approximately 1,200 feet AGL), you would be within the Class E airspace that starts at 700 feet AGL, therefore the 1 SM/clear-of-clouds Class G night caveat would not apply.
- ❏ What are the weather minimums required to *land* under VFR? Same as the VFR takeoff minimums.
- ❏ If a Class D airport reported an 800 feet ceiling and ¼ SM visibility, but the sky was clear above the ceiling, could you transition through the Class D airspace over the clouds at 2000 feet AGL under VFR? Yes, this is more than 1,000 feet above the clouds. You just couldn't operate *below* the ceiling under VFR.
- ❏ You're in the practice area returning to KIWA, so you listen to the ATIS and the visibility is reported as 1 SM, ceiling 5,000 feet OVC. You are NOT instrument current. You have flown out of KIWA for years and know the area well. Is there a legal way that you can enter KIWA's Class D airspace and land? Yes, pick up a special VFR clearance.

- ❏ From whom do you pick up this clearance? From the controlling agency of the airspace in which I'm trying to operate special VFR. In this case, KIWA Tower.
- ❏ Same scenario where you're returning from the practice area, except now it's just after sunset. Can you still pick up a special VFR clearance? No.
  - ❏ Why not? A pilot must be instrument current in an instrument-equipped aircraft to operate under special VFR from sunset to sunrise.

❏ What are the weather minimums for a special VFR clearance? 1 SM visibility (*reported* visibility to takeoff or land; *flight* visibility to transit) and maintain clear-of-clouds.

❏ In what type of airspace is special VFR permitted? Within 1) controlled airspace that is 2) designated to the surface 3) for an airport.

❏ Other than weather being below minimums, when else is special VFR prohibited? When "NO SVFR" is listed above the airport name on the sectional (this NSVFR information is also stated in the chart supplement).

❏ Who can you call to pick up a clearance for special VFR in a Class E surface area surrounding a non-towered airport? Nearest tower, FSS, or Center.

❏ Are there any differences between the Mode-C and ADS-B Out airspace requirements? If so, what are they? The requirements are almost identical, with one exception: only ADS-B Out is required in Class E airspace at and above 3,000 ft. MSL over the Gulf of Mexico from the coastline of the U.S. out to 12 NM.

Task F. Performance and Limitations

References: FAA-H-8083-1, FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating an airplane safely within the parameters of its performance capabilities and limitations.

Knowledge:	The applicant demonstrates understanding of:
CA.I.F.K1	Elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance.
CA.I.F.K2	Factors affecting performance, including:
CA.I.F.K2a	a. Atmospheric conditions
CA.I.F.K2b	b. Pilot technique
CA.I.F.K2c	c. Airplane configuration
CA.I.F.K2d	d. Airport environment
CA.I.F.K2e	e. Loading and weight and balance
CA.I.F.K2f	f. [Archived]
CA.I.F.K3	Aerodynamics.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.I.F.R1	Use of performance charts, tables, and data.
CA.I.F.R2	Airplane limitations.
CA.I.F.R3	Possible differences between calculated performance and actual performance.
Skills:	The applicant exhibits the skill to:

CA.I.F.S1	Compute the weight and balance, correct out-of-CG loading errors and determine if the weight and balance remains within limits during all phases of flight.
CA.I.F.S2	Use the appropriate airplane performance charts, tables, and data.

Atmospheric Conditions

- ❏ Describe the composition of the atmosphere. 78 percent nitrogen, 21 percent oxygen, 1 percent other gasses, such as argon and helium.
- ❏ What do we mean when we talk about "atmospheric pressure"? It is the force exerted on a given area by the weight of the atmosphere. Essentially, the atoms and molecules in the air that comprise the atmosphere have mass, and therefore gravity pulls on them, meaning they have weight. Since air is a gas, this weight is applied in all directions, causing a force called air pressure when the molecules collide with something.
  - ❏ What happens to air pressure as altitude increases, and why? The weight of the atmosphere decreases, therefore the pressure decreases as well.
  - ❏ By approximately how much? -1 inch of mercury (Hg) per 1,000 ft. of altitude gain.
  - ❏ So if on a given day, sea level pressure is 30.00, what ambient air pressure would you expect to exist at 5,000 ft. MSL? 25.00, 5 inches fewer.
- ❏ Obviously the altimeter setting is the pressure in inches of mercury that gets entered into the Khollsman window. But what exactly does your current altimeter setting represent? It's the value to which the pressure scale in the Khollsman window is set so that the altimeter indicates true altitude at field elevation.
  - ❏ So does that mean that the altimeter setting represents the ambient air pressure at field elevation? In other words, does the altimeter setting equate with station pressure? No, the altimeter setting represents what the baseline, sea level pressure *would* be in that particular atmosphere at your location at that particular time. Put differently, the altimeter setting is station pressure (ambient air pressure at field elevation) corrected down to mean sea level.
  - ❏ If I stand outside with a barometer and it shows 29.72, is that the altimeter setting? No (although it would be if you're standing outside at sea level). From there you would have to adjust/ratio it down to sea level pressure, then it becomes your altimeter setting. So if you could drill a well below you down to sea level, then lower the barometer down to the bottom, whatever the barometer shows down there would be your altimeter setting.
  - ❏ Say you are flying out of an airport located at sea level. You set 29.92 in the Kollsman window on a standard day. What altitude would the altimeter read? 0 feet MSL.
    - ❏ If at that point you walk away from the plane, then return the next day when the ambient air pressure is 28.92 (instead of the 29.92 that it was the day before when you set the altimeter), what altitude would the altimeter show now? It would show approximately 1,000 ft. because a pressure of 28.92 is found at 1,000 ft. in the standard atmosphere; the altimeter is showing your pressure altitude.
    - ❏ What would happen to your indicated altitude if at this point you adjusted the altimeter setting to 28.92? It would show 0.

- ❏ If there were an airport a mile away that was built up on a 5,000 ft. MSL cliff, what would you expect that airport's altimeter setting to be? Close to the same: 28.92. The field elevation alone shouldn't influence your altimeter setting (if the airport is located in the same climate area). Airports have barometers that measure the ambient air pressure (station pressure), then that pressure gets ratioed down to what it would be at sea level, and that becomes the altimeter setting.

❏ Say you are flying at a true altitude of 5,000 ft. MSL with an altimeter setting of 30.00. You fly into an area of low pressure where the altimeter setting should be changed to 29.00, except you don't change it, it still shows 30.00. Will you be flying above or below the altitude shown on your altimeter? Explain why. Below. At first, when the altimeter setting is accurate (as in, when we are flying in an atmosphere where the sea level pressure is actually 30.00), the pressure outside the plane at 5,000 ft. MSL is approximately 25.00 (30.00 - 5 inches, i.e. -1 inch for every 1,000 ft. of altitude gain). At this point, the accurately-set altimeter senses 25.00 and indicates our true altitude: 5,000 feet. From here, as long as the altimeter setting doesn't change, the altitude will always read 5,000 feet when the altimeter senses a pressure of 25.00. Once the low pressure system moves in, the new atmosphere has a sea level pressure (the altimeter setting) of 29.00, meaning that the ambient air pressure of 25.00 that our altimeter is sensing (and we are tracking, because it corresponds to 5,000 feet) is now found at a true altitude of 4,000 feet (29.00 - 4 inches, i.e. -1 inch for each 1,000 feet of altitude). Because our altimeter is essentially just a barometer that tracks pressure levels, it will track the 25.00 pressure down to a true altitude of 4,000 feet. The altimeter is still using the old pressure scale where sea level pressure is 30.00, though, and on this scale the ambient air pressure of 25.00 will always correspond to 5,000 feet. So 5,000 feet MSL is still showing on the face of the instrument, and we are flying at a true altitude 1,000 feet below the altitude we think.

❏ So your altimeter is set for 30.00, your true altitude is 4,000 feet, and indicated altitude is 5,000 feet. Now let's say that you adjust your altimeter to what it should be: 29.00. What altitude will the altimeter read now, and why? 4,000 feet. By entering 29.00 into the Khollsman window, you recalibrate so that when the altimeter senses 29.00 it will indicate a 0 altitude, sensing 28.00 will indicate 1,000 feet, 27.00 will indicate 2,000 feet, 26.00 will indicate 3,000 feet, and our present ambient air pressure of 25.00 will indicate 4,000 feet.

❏ A cold front hits and the temperature drops severely. Are you now flying above or below the altitude indicated on the altimeter? Why? Below. Cold air is denser than warm air, so the pressure levels become more compact; they get scrunched together, pulled down toward the earth. The pressure altimeter does not compensate for nonstandard temperature (we adjust for non-standard pressure when changing the altimeter setting, but there is no temperature equivalent). As a pilot, you will continue flying your desired indicated altitude, even though this altitude is now closer to the earth because the air is denser causing your pressure level to be lower (refer to figure 8-3 in the PHAK for a visual).

❏ When flying over terrain, what is the most dangerous combination of pressure and temperature? Why? Low pressure, cold temperature. In this case, your true altitude will be

lower than what's indicated, so you'll think you have more terrain clearance than in actuality.

- ❏ What expression can pilots use to help them remember that when pressures/temps are high, they will be flying higher than indicated; when pressures/temps are low, they will be flying lower than indicated? "High to low, look out below; low to high, clear the sky."
- ❏ What is the definition of "pressure altitude"? The height above the standard datum plane (SDP).
  - ❏ What is a datum? A datum is just a reference point from which other things are measured. In this case, the SDP (just think datum) refers to an elevation and pressure used as a reference point. That elevation is sea level, and the pressure is 29.92. In the standard atmosphere, this pressure decreases 1 inch for every 1,000 feet of altitude gain above the datum. So your pressure altitude is just your altitude above sea level when the pressure at sea level is 29.92. In other words, it is the altitude that the altimeter shows when the altimeter setting - that is, the sea level pressure - is 29.92. Put differently again, it is the altitude in the standard atmosphere that corresponds to the pressure the aneroid wafers are sensing inside the altimeter.
  - ❏ What is pressure altitude used for? To calculate performance and to fly flight levels.
  - ❏ What are 3 methods a pilot can use to calculate pressure altitude? 1) Use the formula: (29.92 - altimeter setting)1,000 + field elevation; 2) set 29.92 into the Khollsman window and read the altitude shown on the altimeter; 3) use a pressure altitude table or graph, such as Figure 11-3 in the PHAK.
- ❏ What does air density (aka atmospheric density) mean? It means, the ratio of the mass (or weight) of the air to the volume it occupies. I.e., higher density means more air molecules in a given space.
- ❏ What affects the density of the air, and how? Pressure, temperature, and humidity. *Pressure* has a direct relationship with air density: since air is a gas, it can compress or expand; higher pressure naturally causes the air to compress, increasing density. *Temperature* has an indirect relationship with density: when air molecules are heated they become agitated and spread out, making them less dense. *Humidity* has an indirect relationship with density: water vapor molecules have a smaller mass (weigh less) than dry air molecules - i.e., wet air is less dense than dry air.
- ❏ In what 3 ways does less dense air (a higher density altitude) contribute to a reduction in performance? 1) Less power, because fewer air molecules are contributing to combustion in the engine(s); 2) less thrust, because the prop is throwing back fewer air molecules; 3) less lift, because fewer air molecules are striking the wings.
- ❏ What are the 3 definitions of "density altitude"? 1) Pressure altitude corrected for nonstandard temperature; 2) the altitude above sea level in the standard atmosphere at which a given atmospheric density is found; 3) the altitude at which the plane feels it is flying.
  - ❏ What are some ways to compute density altitude? Use the graph in the PHAK; use an E6B or a flight computer; or use the formula: 120(OAT - Standard Temp) + Pressure Altitude = Density Altitude.
  - ❏ What kind of air density exists at a high density altitude? Low.

- ❏ When would density altitude be the same as indicated altitude? When temperature and pressure are standard - i.e., in the standard atmosphere.
- ❏ What happens to density altitude as temperature increases? Density altitude increases.
- ❏ If a low pressure system moves in, will this increase or decrease the density altitude? Increase.
- ❏ What kind of performance would you expect while flying at a high density altitude? Poor.
- ❏ The air is colder at higher altitudes . . . so shouldn't the air be more dense, and therefore shouldn't performance increase during climbs? No, because at the same time, air pressure drops rapidly, and the density-reducing effect of the rapidly diminishing air pressure is dominant.
- ❏ How would you expect your takeoff roll and climb-out to be affected if departing out of an airport with a high density altitude? Why? Increased takeoff roll distance and a reduced rate-of-climb. Before lift-off, the plane must reach a faster ground speed, requiring more runway; plus, the reduced power and thrust add a need for still more runway. As for rate-of-climb, the performance reduction caused by the thinner air will obviously translate to a lower climb rate (ft/min). Also, *angle* of climb will be reduced, because the higher density altitude translates to a faster true airspeed, and therefore the plane covers more distance horizontally over the ground for any vertical increase. In other words, the plane will climb at a shallower angle.
- ❏ When approaching to land at a high density altitude airport, what would you change about your approach speed and landing configuration, if anything? Nothing.
- ❏ How would you expect your landing roll to be affected by a high density altitude, and why? Landing roll would be longer, because the plane touches down at a faster ground speed, so overcoming that momentum with the brakes takes longer. Also, the effects of any mistakes during the landing (like sideloading) would be more serious, again, due to touching down at a faster groundspeed.
- ❏ Would you expect takeoff performance to be degraded more by a low pressure system, a warm front, or high humidity? Why? The warm front, because although pressure has the greatest effect on performance *vertically* in the atmosphere (because it drops so rapidly as altitude increases relative to the temperature drop), temperature has the greatest effect on density *horizontally* in the atmosphere (temperature often changes by as much as 40 degrees F over the course of even one day, whereas pressure generally stays within a window of about .1 or .2 inches). This is easily provable with the performance charts. As for humidity, although it does degrade performance, in general its effects are negligible in comparison with those of pressure and temperature.
- ❏ How does density altitude affect true airspeed (TAS) for any given indicated airspeed (IAS)? The higher the density altitude, the higher the TAS in relation to IAS.
- ❏ By approximately what percent of your IAS does your TAS increase for every 1,000 ft MSL of altitude gain? 2%.
- ❏ At 10,000 ft. MSL, approximately what would you expect your TAS to be if your IAS were 100 kts? 120.
- ❏ Say you're setting up for turns-around-a-point and you see that your groundspeed is 5 kts faster than your indicated airspeed. Does this mean you have a tail wind? No, because it doesn't factor in TAS. For instance, if you're at 5,000 ft. MSL with an IAS of

100 kts and your ground speed is 105 kts, that probably means you have about a 5 kt *headwind.* This is because the TAS would be about 110 kts at 5,000 ft. MSL, so if the GS is 5 kt.less, that would suggest a 5 kt headwind.

- ❏ As density altitude increases, what happens to the IAS at which the plane stalls? Stays the same.
  - ❏ How about the TAS at which the plane stalls? Increases.

<u>Loading Effects</u> **Answers are relative.*

- ❏ How and why does CG affect the following performance aspects of a properly trimmed aircraft:

  - Takeoff: A forward CG makes the aircraft nose-heavy, which can make raising the nose more difficult during rotation. Pilots can alleviate this by applying a bit of nose-up trim prior to departure. An aft CG can make rotation too easy, potentially leading to a tail-strike during rotation (especially during the takeoff-roll portion of a soft field takeoff), or even a power-on stall after lift-off.
  - Stall speed: A forward CG increases stall speed. This is because the plane is more nose-heavy, which requires the horizontal tail surface to produce more negative lift in order to level out the plane's pitch attitude. This added negative lift is a down force pushing down on the tail, making the plane heavier, increasing wing loading. To support this extra weight, the wings have to create more lift, and they do this by operating at higher angles-of-attack (AOA). This new, higher, AOA is closer to the critical AOA. So from here, as the plane slows and AOA slowly increases in order to maintain altitude, the plane will stall sooner, i.e. at a higher airspeed. An aft CG has the opposite effect.
  - Cruise speed: As explained in the previous answer, a forward CG results in the tail producing more negative lift - a down force on the plane that the wings have to support by increasing their AOAs in order to produce more lift. So, both the tail and the wings are now producing more lift, and therefore more induced drag. This causes a slower cruise speed. An aft CG has the opposite effect.
  - Fuel burn: The extra drag caused by a forward CG (as discussed in the previous answer) means that the engine has to work harder - i.e. requires more power/throttle/combustion - to maintain a given airspeed. So more fuel gets burned. An aft CG has the opposite effect.
  - Stability: A forward CG makes the plane more longitudinally stable. The plane's longitudinal stability comes from the way it is designed with the CG located in front of the wings/center of lift. To prevent the plane from naturally trying to nose down and descend all the time, the horizontal tail surface exists in order to produce negative lift, thereby raising the nose. Now, if there's a pitch disturbance that causes the properly-trimmed aircraft to nose down, the subsequent increase in airflow over the tail will cause an increase in negative lift, causing the nose to rise back up to its original, undisturbed position. Conversely, if the plane pitches up, less airflow over the tail (less negative lift) will cause the tail to rise and the nose to drop back down. The more forward the CG, the more nose-heavy the plane becomes, and therefore the more down

force the tail produces to counter it. In other words, as the CG moves forward, the aircraft becomes more nose heavy and tail heavy, and it becomes harder to displace both the nose and the tail. Thus the plane becomes more longitudinally stable.

- Controllability: Stability and controllability have an inverse relationship: as stability increases, the control forces required to overcome that stability become greater, meaning controllability decreases. An unstable aircraft - one with an aft CG - requires lighter control inputs to control the aircraft (i.e. is more responsive to pushing/pulling the yoke), and therefore is more controllable.
- Stall recovery: After stalling, an aircraft loaded with a forward CG will have a nose that naturally tends to drop, aiding in stall recovery. An aft CG will have the opposite effect. On a slightly different note, it is also easier to cause a stall when loaded with an aft CG, because an increased AOA (one that could potentially exceed the critical AOA) will be achieved with less elevator control force.
- Spin recovery: Recovering from a spin requires recovering from a stall, and a more forward CG helps to lower the nose of the aircraft below the critical AOA. A forward CG also results in a longer arm between the CG and the rudder, which translates to more rudder authority. This added rudder authority aids in stopping the spinning rotation. An aft CG, on the other hand, could lead to a flat spin, making recovery extremely difficult or even impossible.
- Landing: A forward CG makes raising the nose during the roundout and flare more difficult, possibly causing a 3-point/flat landing that could lead to porpoising. An aft CG can make the plane more prone to floating and ballooning in the flare, possibly leading to a tail strike.
- Vmc Speed (multiengine only): Vmc speed drops with a forward CG. A forward CG provides a longer leverage arm between the CG and the rudder. This translates to more authority with the rudder, which is the primary control surface we use to maintain directional control. Therefore we'll be able to stave off loss of directional control until a slower airspeed. Additionally, the forward CG results in a shorter leverage arm between the CG and the operating prop, meaning less asymmetrical thrust; it will be easier to resist that reduced asymmetrical thrust with the rudder until reaching lower airspeeds, further reducing Vmc. An aft CG has the opposite effect.

❏ How does a heavy weight affect the following:

- Takeoff: Takeoff distance increases as weight increases. A heavier plane has more inertia that needs to be overcome in order to accelerate the plane to its lift-off speed. Imagine putting your car's engine into a semi-truck; it's going to take a lot longer to accelerate that semi-truck to a certain speed than it would your car.
- Stall speed: Stall speed increases as weight increases. A heavier plane needs to produce more lift to counteract the extra weight, thus requiring a higher AOA (assuming a constant airspeed). To demonstrate this, imagine your plane cruising at 100 kt. If the plane is loaded within limits, it will never stall at this speed. Now imagine suddenly adding 1,000 lbs. You will have to increase AOA significantly in order to support this extra weight. Now add another 1,000 lbs. You'll have to increase AOA even more. At

some point (provided the wings don't snap . . .), if you keep adding weight and increasing AOA, the wings will exceed their critical AOAs and stall...at 100 kt. This is much higher than the normal stall speed, clearly showing that stall speed increases along with weight. A light weight has the opposite effect.

- Cruise speed: Cruise speed decreases as weight increases. Heavier planes operate at higher AOAs, meaning more induced drag (the byproduct of the extra lift), causing slower cruise speeds for any given power setting. A light weight has the opposite effect.
- Fuel burn: Fuel burn increases as weight increases. The extra drag caused by the higher AOAs (as discussed in the previous answer) means that the engine has to work harder - i.e. requires more power/throttle/combustion - to maintain a given airspeed. So more fuel gets burned. A light weight has the opposite effect.
- Stability: A heavy plane is more stable. This should be intuitive . . . just as you would have a harder time displacing a sumo wrestler than a small child, the air has a harder time displacing a heavy plane than a light plane. To explain this in more aerodynamic terms, a heavy plane has more inertia, and therefore requires more of a disturbance (be it an accidental control input or a gust of wind) to disrupt the plane from its undisturbed state. The opposite is true for light aircraft.
- Controllability: A relatively heavy plane is generally going to be less responsive to control inputs because it has more inertia to overcome before it can react fully to the deflection of its controls - i.e. when heavy, more air must be deflected by a control surface in order to cause the same course-change effect.
- Maneuverability: Maneuverability decreases as weight increases. This is because the wings on a heavier plane have to shoulder an increased load more rapidly as the plane gets maneuvered - exceeding the aircraft's design load limits is therefore easier.
- Maneuvering speed: Maneuvering speed increases as weight increases. For a given airspeed, a heavy plane sits closer to its critical AOA, as discussed previously. So when a sudden load is applied (such as a forceful control input, severe turbulence, etc.) that causes the plane to pitch up, the heavy aircraft will stall more readily; this stall unloads the aircraft and prevents exceeding its design load limits. A light aircraft, on the other hand, sits at more of a level pitch attitude, so that when a load is applied causing the plane to pitch up, it doesn't exceed its critical AOA and stall - instead, it continues pitching up, all the while taking on more and more load/stress.
- Spin recovery: A spin recovery often involves slowly pulling out of a dive with rapidly increasing airspeed and G loads. A heavier plane will experience increased loads during such a recovery.
- Landing: A heavier plane carries more inertia with it into the landing roll-out. This means that the brakes have to work harder to stop the plane's forward momentum, translating to a longer landing roll. A heavier plane also touches down with more force, which puts more stress on the gear, increasing the likelihood of impact-related gear and tire issues.
- Vmc speed (multiengine only): Vmc speed decreases as a particular aircraft's weight increases. This is because a relatively heavy plane produces more overall lift, and therefore each time it banks into the operating engine after an engine failure, it is able to create more horizontal lift for combatting the yaw/roll/pitch into the inoperative engine.

- ❏ In what ways should student pilots expect the plane to handle differently on their solo flights compared to their training flights? The plane will be lighter and the CG will be farther aft, as there will be less weight at the pilot/passenger station (which is located ahead of the CG). Because of this, some degree of the effects described above for light weight/aft CG should be expected.
- ❏ How would you expect *exceeding* the CG and/or weight limitations to affect performance? Put differently, what might the performance ramifications be of operating an aircraft outside of its loading envelope? First of all, you would be operating in uncharted territory (literally), so it would be impossible to know for sure what kind of performance to expect. If operating above max weight, safety margins are reduced, and over time the plane could experience excessive loads that degrade its structural integrity. If operating with an excessively forward CG, raising the nose during takeoff and landing could be difficult, or even impossible. An excessively aft CG could result in a critical degradation of longitudinal stability, producing very light control forces that make it easy to inadvertently overstress the aircraft. Recovery from stalls and spins might not be possible. When the CG is moved aft far enough to be aligned with the center-of-lift, the plane takes on neutral longitudinal stability. Moving the CG farther aft behind the center-of-lift causes a negative stability condition.

  Note: An effective technique for questioning students about the loading effects described above is to point at various locations inside and outside the plane's loading envelope and ask, "What kind of performance effects would you expect if you calculated your weight and balance and ended up with a CG/weight located here?"

<u>Weight and Balance</u>

- ❏ Define the following weight and balance terms:

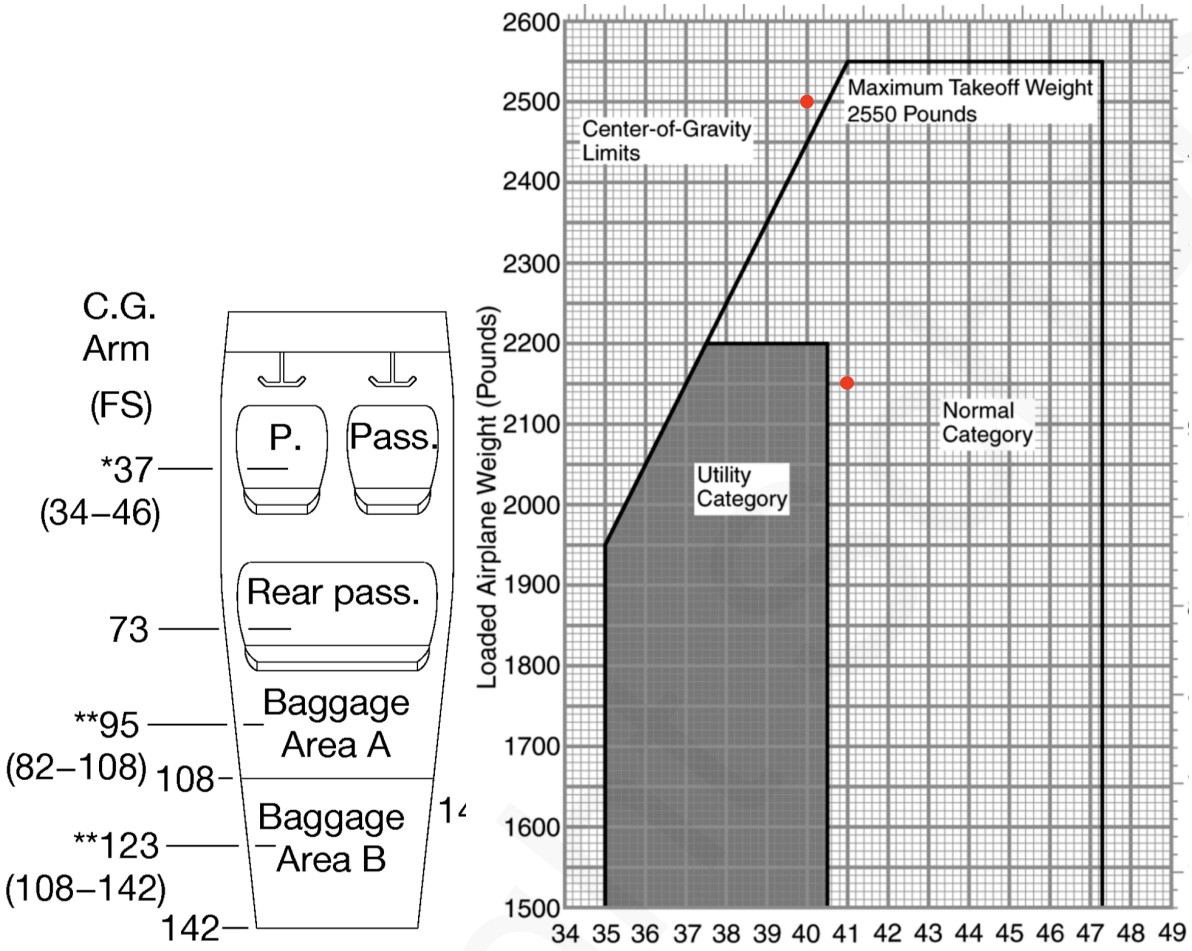
  - Arm: The horizontal distance in inches from the reference datum line to the CG of an item. The algebraic sign is plus (+) if measured aft of the datum and minus (–) if measured forward of the datum.
  - Basic empty weight (BEW): The standard empty weight plus the weight of optional and special equipment that have been installed. We get this off of the official weight and balance; it is our starting weight for calculating weight and balance. It includes full engine oil and hydraulic levels and unusable fuel. It's easier to think of BEW as the plane's weight on the ramp before we add baggage/cargo, fuel, and people.
  - Center of gravity (CG): The point about which an aircraft would balance if it were possible to suspend it at that point. It is the mass center of the aircraft, or the theoretical point at which the entire weight of the aircraft is assumed to be concentrated. The vertical, lateral, and longitudinal axes intersect through this point.
  - Datum (reference datum): An imaginary vertical plane or line established by the manufacturer from which all measurements of arm are taken.

- Maximum ramp weight: Self-defining. It is greater than the takeoff weight due to the fuel that will be burned during taxi and run-up operations. Ramp weight may also be referred to as taxi weight.
- Moment: The product of the weight of an item multiplied by its arm. Moments are expressed in pound-inches. Total moment is the weight of the aircraft multiplied by the arm of its CG. Think of moment as a force trying to rotate something around a point.
- Moment index: A moment divided by a constant such as 100, 1,000, or 10,000. The purpose of using a moment index is to simplify weight and balance computations for aircraft where heavy items and long arms result in large, unmanageable numbers.
- Standard empty weight: Aircraft weight that consists of the airframe, engines, and all items of operating equipment that have fixed locations and are permanently installed in the aircraft, including fixed ballast, hydraulic fluid, unusable fuel, and full engine oil. This is Basic Empty Weight minus optional equipment.
- Station: A location in the aircraft that is identified by a number designating its distance in inches from the datum. The datum is, therefore, identified as station zero. An item located at station +50 would have an arm of 50 inches. In layman's terms, a station is a commonly used arm where we often add/remove weight.
- Useful load: The weight of the pilot, copilot, passengers, baggage, usable fuel, and drainable oil. It is the basic empty weight subtracted from the maximum allowable gross weight. This term applies to general aviation (GA) aircraft only.

❏ What are the standard weights for AvGas, Jet A, Oil, and Water? Respectively: 6 lbs, 6.8 lbs, 7.5 lbs, 8.35 lbs.

❏ What are the three different methods for calculating weight and balance, and how can you determine which to use for your aircraft? Graph, table, and computational. Use the methods provided by the manufacturer in the POH/AFM.

** Use the loading arrangement arms and CG envelope provided below to answer the following weight shift and weight removal/addition scenarios.*



- ***Note: The usable fuel C.G. arm is located at FS 48.00.***

❏ What are the weight shift and weight addition/removal formulas?

$$Weight\ shifted\ /\ Total\ weight\ =\ Change\ of\ CG\ /\ Distance\ weight\ is\ shifted.$$

$$Weight\ added\ (or\ removed)\ /\ New\ total\ weight\ =\ Change\ of\ CG\ /\ Distance\ between\ location\ where\ weight\ is\ added\ (or\ removed)\ and\ old\ CG.$$

❏ Say you calculate weight and balance with topped-off tanks and end up out-of-envelope with a takeoff weight of 2,500 lbs and a CG of 40. The flight is anticipated to be only 2 hours, though, and you figure that taking off with 20 fewer gallons would still leave you with over 3 hours of fuel. So you opt to use the weight removal formula in order to determine whether loading the plane with 20 fewer gallons of fuel would get the CG/weight back inside the envelope. Will it? Show your work. 20 fewer gallons equates to a 120 lbs weight removal. So the new total weight is 2380 lbs. The distance between the location where weight was removed (48) and the old CG (40) is 8 inches. So our formula looks like this: 120 / 2380 = Change of CG / 8. Solve for “change of CG” and you get .4. To determine

which direction the CG will move - so whether to subtract or add this change of CG - just think, is the weight being removed from behind or ahead of the CG? In this case the weight (fuel) is being removed from behind the CG, meaning the new CG will move forward, closer to the datum. This means I will subtract .4 from the old CG and end up with a new CG of 39.6 to combine with the new weight of 2380 lbs. This new CG/weight combination falls barely within the envelope.

- ❏ Different scenario: This time you are doing the weight and balance in preparation for a spin training flight, for which the plane must be operated within the utility category. You plot your calculated weight and CG and end up just outside of the utility category with a weight of 2150 lbs and a CG of 41 inches. However, you remember that for spin flights there can't be any weight in baggage, and presently the box of oil and tow bar are in Baggage Area A, weighing a combined 25 lbs. You decide to secure them on the rear passenger seat instead. Use the weight shift formula to determine whether the spin flight is now legal. Weight shifted is 25 lbs. Total weight is 2150 lbs. The distance weight is shifted is 22 inches (from 95 for baggage to 73 for rear passengers). Change of CG is what we are solving for. Plug those numbers into the weight shift formula to get: 25 / 2150 = Change of CG / 22. Solve for change-of-CG to get: .26. Because the weight is being shifted toward the front of the plane (closer to the datum), subtract the .26 from the old CG of 41 to get: 40.74. Weight is unchanged at 2150 lbs. Plotting 40.74 inches and 2150 lbs shows that we remain outside the utility envelope. The flight is still not legal.
- ❏ What happens to the CG as fuel is burned, and why? The CG moves forward. This is due to the location of the fuel in relation to the CG. Because the fuel is stored slightly aft of the CG, as fuel burns there is less weight aft of the CG, causing the nose to tip forward, giving the plane a more forward CG.

Limitations **This section is extremely rote; the expectation is that a commercial pilot will know their aircraft's limitations well, as compliance is mandatory. Limitations related to specific systems will be covered in the Systems task.*

Note: the following limitations apply to the CE-172 Nav III 2008+ model. Refer to Section 2 of the POH/AFM for your specific aircraft's limitations.

- ❏ What are your aircraft's maximum ramp, takeoff, and landing weights? Respectively: 2558 lbs, 2550 lbs, 2550 lbs.
- ❏ Where exactly is the datum located on your aircraft? Lower portion of the front face of the firewall.
- ❏ What does the white arc, as well as its upper and lower limits, represent on the airspeed indicator? Full flap operating range. Upper limit is the maximum speed permissible with full flaps extended, 85 KIAS (Vfe is 110 KIAS, at and below which a flaps-10 extension is permitted). Lower limit of the white arc is the stall speed in the landing configuration (flaps 30), Vso, 40 KIAS.
  - ❏ Same question for the green arc. Normal operating range. Upper limit is the maximum structural cruising speed, Vno, 129 KIAS. Lower limit is Vs1, stall speed in the clean configuration (flaps 0).

- ❏ Now the yellow arc. Caution range: 129-163. Operations here must be conducted with caution and only in smooth air.
- ❏ Red line. Never exceed speed, Vne, 163.
- ❏ At what weight are these speeds calculated? Maximum takeoff weight.
- ❏ What are your maneuvering speeds at 2550 lbs, 2200 lbs, and 1900 lbs? 105, 98, 90.
- ❏ What is the max window-open speed? 163.
- ❏ How is maneuvering speed (Va) marked on the airspeed indicator? It isn't.
- ❏ What is the definition of Va? Defined two ways in the FAA sources: 1) The speed below which you can move a single flight control, one time, to its full deflection, for one axis of aircraft rotation only (pitch, roll or yaw), in smooth air, without risk of damage to the aircraft; 2) this is the maximum speed at which the limit load can be imposed (either by gusts or full deflection of the control surfaces) without causing structural damage. A simpler way to think of Va is that below this speed, the plane will be inclined to stall before it breaks.
- ❏ Does operating below Va provide structural protection against multiple full control inputs in one axis? No.
  - ❏ How about against full control inputs in more than one axis at the same time? No.
- ❏ What are some scenarios where you would slow below Va? Turbulence/gusty conditions, or setting up for high load maneuvers such as accelerated stalls.
- ❏ Your aircraft's current weight is 2400 lbs. Its max gross weight is 2550 lbs. Its max Va is 105 kt. What is its maneuvering speed? The formula is: $Va\ @\ Max\ Gross\ Weight\ *\ \sqrt{(Your\ Weight\ /\ Max\ Gross\ Weight)}$. Plug the numbers in and you end up with a Va of about 102 kts.

- ❏ What is the RPM limit for takeoff and continuous operation? 2700 RPM.
- ❏ What is the maximum allowable weight capacity for the baggage area (combination of areas A and B)? 120 lbs.
- ❏ What is the maximum number of occupants during a spin flight, and where must they be seated? Max 2, and the rear seat must not be occupied.
- ❏ Which maneuver(s) are permitted in the utility category that are not permitted in the normal category? Spins.
- ❏ Why do you think spins are permitted in the utility category but not in the normal? The aircraft takes on higher loads more rapidly in spins. Also, a forward CG aids in spin recovery. Operating in the utility category ensures both a lighter weight and a forward CG in order to prevent any such loading/recovery issues.
- ❏ Are aerobatic maneuvers permitted in the utility category? No, the POH does allow spins as long the plane is being operated in the utility category; however, the FAA has found that spins as part of either CFI training or upset recovery training do not qualify as aerobatic maneuvers: https://www.faa.gov/about/office_org/headquarters_offices/agc/practice_areas/regulations/interpretations/data/interps/2012/finagin-den-air%20-%20(2012)%20legal%20interpretation.pdf
- ❏ What is this aircraft's CG range (the difference between its forward and aft CG limits)? 12 inches.

- ❏ What are your aircraft's load limits in both the normal and utility categories? Normal category: +3.8 to -1.52. Utility category: +4.4 to -1.76.
  - ❏ How about with full flaps? +3.0.
- ❏ Explain the Vg Diagram (figure 5-55 in the PHAK). The Vg diagram shows the flight operating strength of the aircraft. This means that it shows how many Gs the aircraft can support for any given airspeed, as well as whether exceeding such Gs will cause a stall, structural damage, or structural failure. The green area represents the normal operating range on the airspeed indicator, the yellow represents the caution range, and the red represents never-exceed speed. The aircraft represented by figure 5-55 would have a Vs of approximately 64 kts because, at 1 G, the plane stalls at this speed. Its maneuvering speed would be approximately 136 kts because below this speed, if load factor is increased, the plane will stall, whereas above this speed, any increase in load factor could potentially lead to structural damage. This plane has a red line of 225 kts, meaning even when operating with extremely low or non-existent load factors, structural failure could occur.
- ❏ Say you have limited runway distance to takeoff. Usually you would use flaps 10 for a short field takeoff, but you want to give yourself plenty of clearance so you decide to extend flaps 20. Is this legal? No, flaps 10 is the max setting approved by the POH/AFM.
  - ❏ Why do you think flap 20 takeoffs are not permitted? The first 10 degrees of flap extension adds lift, as the flaps slide out on tracks and increase the overall size of the wing. The next 10 degrees of flap extension produces mostly drag as the flaps angle downward. This drag is helpful when approaching to land, not so much when trying to climb out and accelerate after takeoff.
- ❏ Under what circumstances may the plane be operated with the fuel selector valve handle on either the LEFT or RIGHT tank? Level flight only. Not during takeoffs and landings.
- ❏ You turn the master and avionics switches on during your preflight and see on the fuel gauge that the tanks are topped off. Fuel-wise, are you now legal for a 2 hour VFR flight? No, the POH states that "the fuel quantity, fuel used, and fuel remaining functions of the G1000 are supplemental information only and must be verified by the pilot." So I still need to visually verify the fuel level. If not topped off, I would verify with a fuel stick.
- ❏ Can the Terrain Awareness and Warning System (TAWS-B) be used to navigate around terrain and obstacles? No, TAWS-B is intended merely as an aid in helping the pilot see and avoid.
- ❏ In terms of day, night, VFR, and IFR, what operations are permitted in your aircraft? How do you know? The 172S Nav III is approved for day and night VFR, as well as day and night IFR. This is specified in section 2 of the POH/AFM.
- ❏ During your weather check you note that there are no icing PIREPs, and the briefer does not mention potential icing - but the temperature at field elevation is 1 degree Celsius and clouds are OVC004. Is an IFR takeoff permitted in your aircraft? No, this qualifies as known icing conditions, as a reasonable and prudent pilot would expect structural ice to form on the aircraft during the flight. Section 2 of the POH/AFM prohibits flight into known icing conditions.
  - ❏ What exactly constitutes "known icing conditions?" http://download.aopa.org/epilot/2009/090126icing.pdf

- ❏ What is the definition of *max demonstrated crosswind*? It is the velocity of the crosswind component for which adequate control of the aircraft during takeoff and landing was actually demonstrated (using average abilities) during certification tests.
  - ❏ What are your max demonstrated crosswind velocities for takeoffs and landings? For takeoffs and landings with up to 10 degrees of flaps: 20 kt. For landings with flaps full: 15 kt.
  - ❏ Is it legal to takeoff when the crosswind exceeds this speed? Yes, it's not a limitation.

<u>Performance Charts, Airport Environment, Pilot Technique, Airplane Configuration</u> ** Refer to the POH/AFM for sample problems that demonstrate how to use most of the charts and tables in Section 5. This section of the guide is generally limited to performance chart nuances commonly found to be weak knowledge areas among students.*

- ❏ With what information must the PIC become familiar prior to every flight? All available information. 91.103 specifies that this information must include (NWKRAFT): NOTAMs, weather, known traffic delays, runway lengths and takeoff/landing distances at all airports of intended use, alternatives to the flight, and fuel requirements.
- ❏ On a humid day with light rain at KIWA, you get cleared for an intersection departure on runway 30R at taxiway K. There is a 75 ft. crane about 500 ft. past the departure end of the runway. Your calculated short field takeoff distance over a 50 ft. obstacle is 2,000 ft. Would you takeoff? Why or why not? No, I would say, "Unable." Runway distance available for takeoff at this intersection is about 2,500 ft. The performance charts don't factor in humidity, which will decrease performance and increase takeoff roll, as will the potentially wet runway surface. Also, the performance numbers are calculated with the engine in good condition, which may not be the case here, as our engine was manufactured years ago. Also, adding a 50% buffer to my calculations to account for any weight/weather inaccuracies brings my required distance to 3,000 ft, which would be insufficient to clear the obstacle.
  - ❏ Should you also factor in that the plane is being flown by a test pilot, so by an advanced pilot flying the plane perfectly? The numbers were calculated "using average piloting
  - ❏ techniques," so not necessarily. I will add a buffer to my numbers for numerous other reasons, though.
  - ❏ Is there any feature to this runway that would *decrease* takeoff distance? Yes, it is downsloping.
- ❏ What procedure should you follow when using the alternate static air source? Windows and vents closed. Cabin heat, cabin air, and defroster on maximum. (Just follow the checklist.)
- ❏ The METAR says *18020KT*. What crosswind would you expect if taking off on runway 30L? Approximately 15 knots. To calculate this, be sure to first correct the METAR for magnetic variation (in the case of KIWA: -10 degrees), as winds on the METAR are oriented to true north, whereas runways use magnetic directions.
  - ❏ Describe the crosswind takeoff procedure that you would use for this takeoff. Begin with full left aileron, elevator in the neutral, perhaps slightly forward position. As the aircraft accelerates, keep the elevator in the neutral position and slowly roll out the left aileron so that as the nose rises off the ground, the ailerons are neutral.

- ❏ How should the rudders be utilized after lift off? Should you apply sufficient right rudder to maintain longitudinal alignment with the runway centerline during climb out? Why or why not? No, once off the ground use only sufficient right rudder to maintain coordination. Let the plane crab into the wind. Using additional right rudder to maintain longitudinal alignment creates excess drag, decreasing climb performance.
- ❏ Why is it critical that the ailerons are neutralized as the plane lifts off the ground during such a crosswind takeoff? Because otherwise the plane would enter a bank just as it lifts off the ground. Bank increases load factor, which increases drag and stall speed, decreasing performance. On the contrary, we are striving to maximize performance during this phase of flight.

❏ Now say that you are doing a short field takeoff at max weight on a grass runway with a 9 kt headwind at a field elevation pressure altitude of 4,000 ft. Temperature is 17 degrees. What distance is required to clear a 50 ft obstacle? At 10 degrees above standard at 4,000 ft, the takeoff distance required is 2295 ft. Per the notes below the table, decrease the distance by 10% for the headwind (-230), and increase the distance by 15% of the associated ground roll portion (200) to account for the grass runway. So the required distance is 2265 ft.

- ❏ What mixture setting would you use for this takeoff? Leaned for maximum RPM, because the pressure altitude is above 3,000 ft.
- ❏ Would your rotation speed change if your weight were 2400 lbs? Yes the new *lift-off* speed would be 48 kts, so rotation speed would be slightly below that.

❏ How would you expect your *rate*-of-climb to change if you were taking off into a sustained headwind? A sustained headwind does not affect rate-of-climb.

- ❏ How about your *angle*-of-climb? The angle-of-climb would steepen. This is because ground speed is slower, while rate-of-climb remains the same.

❏ If you had a strong headwind throughout your climb, how would you expect your time, fuel, and distance calculations to change? Time and fuel should stay about the same, but the distance would shorten.

❏ How would you set the mixture if cruising at 4,000 ft, standard day, 2600 RPM? Full rich, per the notes, as 2,600 RPM at 4,000 ft is greater than 75% power.

- ❏ What cruise TAS would you expect? 118 kts...after subtracting 2 kts for not using fairings.
- ❏ What *indicated* airspeed would this be? First use the E6B (or any applicable resource) to convert 118 kt TAS to 111 kts CAS. Then use the Airspeed Calibration chart to calculate a +3 kt conversion to KIAS, resulting in an IAS of 114 kts.

❏ For the performance numbers to be correct when operating at power settings less than 75%, how must the mixture be leaned? Lean for peak EGT, then enrich the mixture until the EGT drops 50 degrees - aka, 50 degrees rich of peak.

❏ The Range and Endurance graphs factor in a “45 Minutes Reserve.” What exactly does this mean? Means there will be 45 minutes of fuel remaining upon reaching the distance and time limits given by the graphs.

- ❏ Do you need to factor in an extra safety margin for fuel burned during start, taxi, takeoff and climb? No, it’s already factored in, per the notes.

❑ What exactly does your “total feet to clear 50 foot obstacle” calculation mean? In other words, where does this calculated distance start and end? Starts at the point where you clear the 50 ft. obstacle, ends where the plane comes to a stop.

Task G. Operation of Systems

References: FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-23, FAA-H-8083-25; POH/AFM

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with safe operation of systems on the airplane provided for the flight test.

Note: *If K1 is selected, the evaluator must assess the applicant's knowledge of at least three sub-elements.*

Knowledge:	The applicant demonstrates understanding of:
CA.I.G.K1	Airplane systems, including:
CA.I.G.K1a	a. Primary flight controls
CA.I.G.K1b	b. Secondary flight controls
CA.I.G.K1c	c. Powerplant and propeller
CA.I.G.K1d	d. Landing gear
CA.I.G.K1e	e. Fuel, oil, and hydraulic
CA.I.G.K1f	f. Electrical
CA.I.G.K1g	g. Avionics
CA.I.G.K1h	h. Pitot-static, vacuum/pressure, and associated flight instruments
CA.I.G.K1i	i. Environmental
CA.I.G.K1j	j. Deicing and anti-icing
CA.I.G.K1k	k. Water rudders (ASES, AMES)
CA.I.G.K1l	l. Oxygen system
CA.I.G.K2	Indications of and procedures for managing system abnormalities or failures.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.I.G.R1	Detection of system malfunctions or failures.
CA.I.G.R2	Management of a system failure.
CA.I.G.R3	Monitoring and management of automated systems.
Skills:	The applicant exhibits the skill to:
CA.I.G.S1	Operate at least three of the systems listed in K1a through K1l appropriately.
CA.I.G.S2	Complete the appropriate checklist(s).

* As stated in this Task’s objective statement, the knowledge being evaluated here is of *systems on the aircraft provided for the flight test*, which in the case of this study guide is the G1000 CE-172SP. So although the questions themselves apply to just about any aircraft, the answers are often specific to late model 172s with glass cockpits.

Note: failures and malfunctions are addressed separately in the "Systems and Equipment malfunctions" task.

- ❏ Why is having good systems knowledge essential for pilots? In order to troubleshoot effectively in the event of a system malfunction or failure. The stakes are high when things break in an aircraft. In a car you can just pull over to the side of the road - you can't pull over to the side of the sky, though.
- ❏ What are your aircraft's primary and secondary flight controls? Primary: ailerons, rudder, elevator. Secondary: flaps, trim.

<u>Primary Flight Controls</u>

- ❏ How are the yoke and rudder pedals linked to their associated flight control surfaces? Through cables, pulleys, bellcranks, and pushrods.
- ❏ When you turn the yoke to the left, which direction does each aileron move? Left aileron up, right down.
  - ❏ Aerodynamically, how does this cause the plane to roll left? The right aileron that drops has the effect of increasing its wing's camber, thus increasing the speed of the airflow over the top of its wing and increasing lift. Additionally, the chord line shifts slightly upward, resulting in an increased angle of attack. The left wing's aileron goes up, decreasing camber, decreasing lift.
  - ❏ Around what axis does the aircraft roll? Longitudinal.
  - ❏ What type of ailerons does your plane have? Differential, frise.
  - ❏ Describe the purpose and function of each of those features. *Differentia*l ailerons counteract adverse yaw. During a turn to the left, the right wing creates more lift and rises, but it also creates more induced drag, causing the nose of the aircraft to yaw away from the direction of the turn toward the raised wing. To negate this, the left wing's aileron sticks up high (higher than the right wing aileron's downward deflection) in order to create additional parasite drag and help the plane yaw properly in the direction of the turn. Further helping to counteract this adverse yaw is the *frise* feature of the ailerons. Sticking with the left-turn scenario, when the trailing edge of the left wing's aileron goes up, the leading edge of that aileron deflects downward below the wing in order to create additional drag and prevent the plane from yawing in the opposite direction. The frise feature also allows airflow beneath the wing to join and re-energize the airflow on the top surface of the aileron in order to increase its effectiveness (same idea behind slotted flaps).
- ❏ What type of horizontal tail surface does your plane have? Elevator (attached to the back of the fixed horizontal stabilizer).
  - ❏ How is this different from a stabilator? With a stabilator, the entire horizontal tail surface moves as one slab, pivoting from a central hinge point (like on the PA44).
  - ❏ When you pull the yoke back/pitch up, which direction does the trailing edge of the elevator deflect? Up.
  - ❏ Aerodynamically, how does this cause the plane to pitch up? When the trailing edge deflects upward, it sticks up into the relative wind, pushing the tail of the aircraft down,

raising the nose into a pitch-up attitude. Also, when the trailing edge deflects upward, more camber is created on the bottom of the horizontal tail surface, generating more negative lift to push the tail down and the nose up.

- ❏ Around what axis does the aircraft pitch? Lateral.

❏ When you step on the left rudder pedal, which direction does the trailing edge of the rudder surface deflect, and what effect does this have on the plane's orientation? Why? The rudder surface deflects to the left and the plane yaws to the left. The rudder is like a wing on its side - when it deflects to the left, the camber on the right side is increased, accelerating air faster over that side, increasing the rightward horizontal lift produced by the rudder, causing the tail to swing right and the nose left. In addition, when the rudder deflects to the left, the relative wind strikes it, pushing the tail to the right and the nose left.

- ❏ What function(s) does the rudder serve? Primarily the rudder exists to counteract adverse yaw (slips), as well as to counter any unwanted yaw tendencies, such as the left-turning tendencies. The rudder is also used to intentionally create more parasite drag during forward slips to land, to maintain longitudinal alignment during crosswind landings, and to help maintain directional control after engine failures in multiengine aircraft. Lastly, the rudder can be used to turn the aircraft in the event that the ailerons malfunction.
- ❏ Around what axis does the rudder cause the plane to yaw? Vertical.

❏ All the primary flight controls utilize balance weights (aka counterweights) located toward the front of the control surfaces. What is the purpose of these weights? Primarily to decrease control surface flutter at higher airspeeds. The weights also have the effect of reducing pilot control forces.

❏ At slow airspeeds, would you expect your flight controls to be more or less effective? Why? Less, due to the reduced airflow over the control surfaces.

<u>Secondary Flight Controls</u>

❏ Let's say I trim the plane nose down - i.e., roll the trim wheel from bottom to top. What effect will this have on the trim tab? The trailing edge of the trim tab will deflect upward.

- ❏ And how does this cause the aircraft to maintain its nose-down pitch attitude? With the trim tab up and into the airstream, the airflow over the horizontal tail surface tends to force the trailing edge of the elevator down. This causes the tail of the aircraft to move up and the nose to move down.
- ❏ What is the primary purpose of trim? To relieve control pressure.
- ❏ Does the 172 have a servo or anti-servo trim tab? What's the difference? Servo, which means the tab deflects in the opposite direction as the elevator's movement in order to increase control sensitivity, i.e., make the elevator more controllable. (The trim tab isn't labeled as "servo" in the POH/AFM; however its direction of movement relative to the elevator meets the definition of a servo trim tab.) Anti-servo tabs are typically found on planes with stabilators; because the whole control surface moves and therefore deflects a relatively large amount of air, stabilators are generally outfitted with anti-servo tabs in order to decrease control sensitivity, thereby preventing over-controlling the aircraft and overstressing the airframe.

- ❏ Does your rudder have trim? If so, what kind? Yes, it has a ground-adjustable trim tab - basically a piece of metal that can be bent manually on the ground.
- ❏ Can pilots adjust it, or just certified mechanics? Yes, pilots can adjust the rudder trim, although ATP wants maintenance to handle rudder trim adjustments.

❏ What kind of flaps does your aircraft have? Electrically operated, single-slot type flaps, with detents at 0, 10, 20, and 30 degree positions.

- ❏ Where is the flaps motor located? In the right wing, a couple of feet outboard of the cabin.
- ❏ What are some of the purposes of flaps? 1) Flaps produce more lift for any given angle of attack, permitting a lower landing speed, 2) flaps produce greater drag, permitting a steeper descent angle without airspeed increase, and 3) flaps reduce the length of the landing roll.
- ❏ Which flap settings increase lift, and which increase drag? The AFH says that, generally, the first 15 degrees of flaps primarily produces lift, whereas any flap deflection beyond 15 degrees generates large increases in drag.
- ❏ How does the slot in the slaps aid in producing lift? When the slotted flap is lowered, high energy air from the lower surface of the wing is ducted to the flap's upper surface. The high energy air from the slot 1) accelerates the upper surface boundary layer and 2) delays airflow separation.

❏ The metal skin of the aircraft's control surfaces - primary and secondary - is bent. What's this bent metal called, and why is it designed this way? It's called "corrugation." It increases the structural strength of the metal.

<u>Powerplant</u>

❏ What are the various functions of the engine? Provides the power to turn the prop, generates electrical power, provides a vacuum source, and provides a source of heat for the cabin.

❏ Reciprocating engines operate on what basic principle? They convert chemical energy (fuel) into mechanical energy.

❏ How is this done? How do we go from fuel inside the cylinders, to a spinning prop creating thrust? The sparks generated from the spark plugs ignite the fuel, causing controlled explosions that push the pistons inside the cylinders down. These pistons are connected to the crankshaft, causing the crankshaft to rotate. The rotating crankshaft is directly connected to the propeller, causing the prop to rotate at the same speed as the crankshaft. As the prop spins it throws back air, and the equal/opposite reaction to this air being thrown back is called thrust.

❏ Tell me about your aircraft's engine. It's a Lycoming, 4-cylinder, normally-aspirated, fuel-injected, 360 cubic inch, horizontally-opposed, air-cooled, direct-drive IO-360-L2A engine.

❏ What is its horsepower rating, and at what RPM? 180 horsepower at 2700 RPM.

❏ What do the "I," "O," "360," and "L2A" represent? "I" means that the engine is fuel injected (as opposed to carbureted). "O" stands for Opposed, as in the cylinders are positioned such that they horizontally oppose each other. "360" means 360 cubic inches of air displacement,

meaning that the total space inside the engine's 4 cylinders adds up to 360 cubic inches - the more space, the more fuel/air can be burned so the more power the engine can produce. The "L2A" is the engine model.

- ❏ What does *horizontally opposed* mean, and what makes horizontally-opposed engines so popular? This refers to the layout of the cylinders - they horizontally oppose one another with 2 cylinders on one side of the crankshaft, and 2 on the other. These engines are popular because they tend to be lighter as well as more compact/streamlined, minimizing drag.
- ❏ What does direct drive mean? This means that the propeller is directly connected to the crankshaft - if the engine (the crankshaft) is spinning at 1,000 RPM, the prop is spinning at 1,000 RPM. Some aircraft with more powerful engines and/or longer props use gear reduction boxes to keep their props spinning at lower RPM than the engine in order to prevent the prop tips from achieving supersonic speeds.
- ❏ Take me through what is going on internally during the ignition process for your aircraft, from battery master on to the engine running on its own. Feel free to reference your checklist. Turn on the battery to supply electricity to the starter and the auxiliary fuel pump. Crack open the throttle, turn the aux fuel pump on, and push the mixture in to allow fuel to flow into the cylinders - i.e. prime the engine. Then pull the mixture back to the cut-off position, and turn the aux pump off to avoid over-priming/flooding the engine. Press and hold the starter, which contains a spinning gear that now protrudes out a bit and links up with the flywheel's gear, causing the fly wheel to spin. The flywheel is attached to the crankshaft, which is geared to the magnetos. Now the magnetos are operating, providing electricity for the spark plugs to start firing off sparks inside the cylinders. There is already fuel inside the cylinders from the initial priming, so now there is combustion. At this point engine operation has become self-sustaining, so the starter can be released. The rapid opening and closing of the cylinders spins the crankshaft, which is directly connected to the propeller, causing it to spin.
- ❏ If at this point you were to turn the master switch off, what would happen? Why? Nothing, the engine would continue to run because the engine drives the *engine-driven* magnetos, which generate the electricity to produce sparks, causing the fuel in the cylinders to burn, causing the engine to keep running, causing the magnetos to keep running…it's a self-sustaining process.
- ❏ Explain how a magneto works. Inside a magneto there is a magnet, geared to the engine, spinning rapidly in close proximity to a coil of copper wires. This generates and harnesses electricity for the spark plugs.
- ❏ Where are the magnetos located? On the accessory case - the back of the engine.
- ❏ What's the function of the Impulse Coupler? When the starter is engaged, the engine RPM is too low for the magnetos to generate sufficient electrical current for the spark plugs. So to generate that high amount of initial electrical current despite low RPM, one of the magnetos has something called an impulse coupler attached to it. The impulse coupler is a coiled spring that winds up real tight at first, then snaps, causing the magnet inside to spin really fast and generate a lot of electricity for its spark plugs.
- ❏ How many magnetos does your plane have, and why? 2, for redundancy, as well as for more even burning of the fuel (better performance).

- ❏ How many spark plugs are connected to each magneto, and where do those plugs go? 4 plugs extend from each magneto, with each plug going into a cylinder.
- ❏ During the run-up, you check the left magneto and the engine quits. What's the problem? Magneto failure.
- ❏ How about, instead, the engine feels rough and there's a 200 RPM drop. What's the problem? Fouled spark plug(s).
  - ❏ What causes fouled spark plugs? Usually running the engine with the mixture full rich at low RPM, i.e. running the engine too cold. If the engine runs too cold, lead and carbon don't burn off completely and end up in the form of deposits of the plug heads.
  - ❏ What's the remedy? Follow the checklist to run the engine hot and burn off the lead and/or carbon deposits, then do the mag check again to verify smooth operation.
- ❏ Say during the right mag check the RPM drop is normal, but there is no drop when you check the left mag? What is likely the issue? The right mag isn't grounding.
  - ❏ How do you verify this? Turn the mags to OFF. If the engine continues to run then the right mag is clearly still operating, meaning it isn't grounding.
- ❏ Take me through each step of your aircraft's air induction system. The engine air induction system receives ram air through an intake on the lower front portion of the engine cowling. The intake is covered by an air filter which removes dust and other foreign matter from the induction air. Airflow passing through the filter enters an air box, which is equipped with a spring-loaded alternate air door. If the air induction filter should become blocked, suction created by the engine will open the door and draw unfiltered air from inside the lower cowl area. After passing through the air box, induction air enters a fuel/air control unit under the engine, and is then ducted to the engine cylinders through intake manifold tubes. Once burned, the exhaust gas is ducted out of the aircraft through the exhaust pipe.
- ❏ Approximately how much power loss should be expected when the engine operates off of unfiltered alternate air? 10%.
- ❏ What does "normally (or *naturally*) aspirated" mean? As opposed to what? It means that the engine's air intake does not utilize a forced induction system such as a turbo or supercharger - rather it depends solely on ambient atmospheric pressure.
- ❏ What does "air cooled" mean? As opposed to what? This means that the relative wind flowing over the engine is primarily what cools it - as opposed to using some other cooling system like a radiator or heat exchanger or water cooling system.
- ❏ How can the relative wind adequately cool the cylinders when they are largely confined within the cowling and therefore not exposed to the outside air? This is where the cooling fins and baffles come in. The heat from the cylinders transfers to the cooling fins, which are exposed to the relative airflow, allowing the heat to dissipate. The baffles are positioned to guide the airflow to where engine cooling is needed, namely over the cooling fins/cylinders.
- ❏ What else cools your engine besides air? Fuel and oil.
- ❏ What are the 4 ways to cool an engine in flight? Decrease throttle, increase airspeed, enrich the mixture, open the cowl flaps (if equipped).
- ❏ How many strokes does your plane's engine use? Describe each stroke. It's a 4-stroke engine. 1) The *intake* stroke begins as the piston starts its downward travel. When this happens, the intake valve opens and the fuel-air mixture is drawn into the cylinder. 2) The *compression* stroke begins when the intake valve closes, and the piston starts moving back

to the top of the cylinder. This phase of the cycle is used to obtain a much greater power output from the fuel-air mixture once it is ignited. 3) The *power* stroke begins when the fuel-air mixture is ignited. This causes a tremendous pressure increase in the cylinder and forces the piston downward away from the cylinder head, creating the power that turns the crankshaft. 4) The *exhaust* stroke is used to purge the cylinder of burned gasses. It begins when the exhaust valve opens, and the piston starts to move toward the cylinder head once again.

- ❏ What do the throttle and mixture lever control in a fuel injection system? Increasing throttle opens up a butterfly valve to allow more air through the induction system; the fuel/air control unit senses this air increase and allows more fuel to mix with the increased volume of air in order to keep the overall fuel-to-air ratio unchanged. So ultimately, opening the throttle has the effect of allowing more of the fuel/air mixture to enter the cylinders, i.e. more combustion/power. Enrichening the mixture lever, on the other hand, causes the fuel/air control unit to add more fuel to the fuel/air mixture (without adjusting the amount of air), resulting in a more fuel-rich mixture. This may or may not have a small effect on overall power, depending on whether the mixture was originally too lean (not enough fuel in the mixture) or too rich (too much fuel in the mixture).

* The fuel injection system and its components will be discussed in greater detail in the fuel section.

<u>Propeller</u>

- ❏ List off the specs for your plane's propeller. It's a two-bladed, fixed pitch, one-piece, 76-inch propeller made out of aluminum alloy, manufactured by McCauley.
- ❏ Say there's a half-inch knick at the top of the propeller blade. Would maintenance be able to shave that down? Yes, as long as the blade's diameter doesn't dip below 75 inches, which is the minimum permitted by section 2 of the POH/AFM.
- ❏ Explain how the blade is twisted, and why? The outside of the blade spins significantly faster than the inside due to the fact that the tip is traveling a longer distance in the same amount of time as the hub. If the blade had the same angle of incidence (aka pitch) throughout its length, the blade tip would produce more thrust than the blade hub. To prevent this, the blade is designed such that the tip takes a relatively small bite of air (has a low pitch), whereas the hub takes a large bite (high pitch). This allows the blade to produce uniform lift - or rather, thrust, because it's directed forward - throughout its length.
- ❏ What does "fixed-pitch" mean? This means that the blade angle (or pitch) is set by the manufacturer and cannot be changed.
- ❏ What are the two types of fixed-pitch propellers? Describe each. *Climb* and *cruise*. A *climb* prop utilizes a low pitch, meaning that the blade spins through the air like a knife (from the perspective of the blade's plane of rotation), rotating rapidly but taking small bites of air. A cruise prop uses a high pitch, meaning the blade spins through the air more like a paddle, rotating slowly but taking large bites of air.
- ❏ What are the benefits and drawbacks to each? The climb prop's low, knife-like pitch translates to less drag as the blade slices easily through the air, allowing it to spin at higher

RPM and produce more horsepower. This increases performance during takeoffs and climbs, but decreases efficiency during cruising flight because the high RPM means more fuel burn. The cruise prop's higher pitch/low RPM prop configuration doesn't provide good climb performance, but it is more efficient for cruise flight due to the reduced RPM and therefore lower fuel burn.

- ❏ Which type does your aircraft use? The 172 uses a compromise of the two, a middle pitch.

Landing Gear

- ❏ What kind of landing gear does your plane have? Tricycle type, with a steerable nose wheel and two main wheels. Shock absorption is provided by the tubular spring steel main landing gear struts and the air/oil nose gear shock (oleo) strut.
- ❏ How do the tubular spring main gear struts work to absorb shock? They ration the shock of the touchdown throughout the plane's airframe.
- ❏ How does the oleo strut work? The exposed portion of the strut that we check for proper extension during preflight is a piston that has oil or some sort of hydraulic fluid inside it. During landing, when the tire hits the ground, the piston gets pushed up into the cylinder (upper chamber) above it, which contains compressed air or nitrogen. When the hydraulic fluid pushes against the air, it cushions the blow on the nose gear.
- ❏ What is the purpose of the torque link, aka scissor? The bottom section of the torque link is attached to the piston, while the upper torque link is attached to the cylinder (aka upper chamber). By locking firmly onto both the piston and the cylinder, the torque link prevents the piston from rotating inside the cylinder.
- ❏ What landing gear feature prevents the nose wheel from vibrating excessively during higher speed ground operations? Shimmy damper.
  - ❏ How does it work? There is hydraulic fluid inside the tiny horizontal cylinder. When you turn the nose wheel wheel at slower speeds, the fluid can easily get pushed around from side to side, so the turning is easy. At faster speeds, though, like on takeoff or landing roll-out, if the nose wheel starts turning too rapidly, the fluid can't get through as fast, causing the damper to resist movement/vibration.
- ❏ How is the nose wheel linked to the rudder pedals? Through a spring-loaded steering bungee.
- ❏ While on the ground, up to how many degrees each side of center does your plane turn, with the rudder pedals as well as with differential braking? 10 degrees with the rudder pedals alone, 30 degrees with differential braking.

Brakes (Hydraulic)

- ❏ Describe your aircraft's brake system. The aircraft has a single-disc, hydraulically-actuated brake on each main landing gear wheel. Each brake is connected by a hydraulic line (looks like a hose) to a master cylinder attached to each of the pilot's brake pedals.
- ❏ So how many master cylinders for the brakes are there in total on the plane? 2.

- ❏ How is the co-pilot able to brake if there are no cylinders behind the right-seat pedals? The right seat's brake pedals are mechanically linked to the left seat's pedals, which press down on the master cylinders.

❏ Take me through what happens internally in the brake system after the pilot presses on the brake pedals. Pressing on a brake pedal has the effect of pushing down on the piston in the master cylinder located just behind the brake pedal. The piston pushes the hydraulic fluid in the master cylinder through the hydraulic line into the brake assembly. Here, the fluid pushes against another piston which causes the brake pads to clamp down against the steel wheel disc that spins with the wheel. This creates friction and slows the plane.

❏ What color is hydraulic fluid, and why is this important to know? It's a light reddish color. Knowing the color of the plane's operating fluids makes troubleshooting leaks easier.

❏ Where is the hydraulic fluid reservoir for the brake system located? As mentioned earlier, the hydraulic fluid for the brake system is located in the master cylinders themselves, the ones behind the pilot-side rudder pedals.

❏ What are some of the symptoms of an impending brake failure? Gradual decrease in braking action after brake application, noisy or dragging brakes, soft or spongy pedals, and excessive travel and weak braking action.

❏ If the brakes feel spongy and unresponsive on your landing roll-out, what are you going to do to get the plane stopped? Pump the pedals in order to build up pressure in the brake lines.

❏ What is the procedure for applying the parking brake (reminder: parking brake use is not permitted at ATP)? Hold the brakes firmly, then pull the parking brake lever out and rotate the handle 90 degrees down in order to lock in the hydraulic pressure.

<u>Oil</u>

❏ Why do engines have oil systems? 1) Lubrication of the engine's moving parts, 2) cooling of the engine by reducing friction, 3) removing heat from the cylinders, 4) providing a seal between the cylinder walls and pistons, and 5) carrying away contaminants.

❏ What type of oil is approved for your aircraft? Aviation Grade with Ashless Dispersant.

❏ What type of oil are we permitted to use at ATP? 15W-50 Aeroshell.

❏ Say you need to add oil to an unfamiliar aircraft, how would you go about verifying the required oil type and quantity? Check the POH/AFM.

❏ What are your aircraft's oil quantity limitations? 5-8 quarts.

❏ What type of oil sump does your engine use? Wet.

❏ How is a wet sump different from a dry sump oil system? A wet sump system has a pan attached to the bottom of the engine that collects oil as gravity pulls it down through the system. A dry sump oil system, on the other hand, instead of having a pan that is an integral part of the engine, uses an oil tank that is separate from the engine and uses a series of pumps to keep the oil circulating throughout the engine. Dry sump systems are more complex and costly, but are necessary in aerobatic aircraft to prevent oil starvation during extremely high/low g-loads.

❏ Describe the path that oil takes through your engine's oil system. Oil collects in the wet sump/the big pan located at the bottom of the engine. From there oil is routed through a

strainer screen (collects hardened contaminants), through the engine driven oil pump, through the oil cooler and oil filter (this stage has a bypass system which allows the oil to bypass the cooler and filter if the oil is already cold enough, or if the filter is blocked), through a pressure relief valve (if the pressure is too high, the relief valve will open and send some of the oil directly back to the sump), then through the engine for lubrication while gravity pulls the oil back down to the sump which catches the oil, starting the process over.

- ❏ What is *ashless dispersant* oil? This type of oil contains an additive that helps to scavenge contaminants and carry them to the oil filter.
- ❏ Adding oil isn't listed under Part 43 Appendix A Preventative maintenance. Why are pilots allowed to do this? Adding oil is just basic upkeep, like washing the windscreen or adding air to the tires.
- ❏ For longer flights, what oil level does Cessna recommend? 8 quarts.

<u>Fuel</u>

- ❏ Describe your aircraft's fuel system. Fuel is housed inside the wings in integral-type tanks, aka wet wings. Total fuel capacity is 56 gallons, 53 gallons of which is usable. There are 13 fuel sumps: 5 under each wing and 3 under the engine cowling. There are 3 fuel vents: 1 under the left wing and 1 in each fuel cap. 100LL Grade Aviation Fuel (Blue) or 100 Grade Aviation Fuel (Green, although ATP does not allow this type) are the approved types of fuel.
- ❏ What are "integral" fuel tanks? These are tanks that are just part of the aircraft structure - in our case, the wing - that have been sealed to allow fuel storage.
- ❏ Is the fuel stored throughout the length of the entire wing? Where along the wings do the tanks end? Fuel is stored within the inboard portion of the wing, out to approximately where the flaps end.
- ❏ Looking at the plane, there doesn't seem to be a viable path for fuel to take from the wings to the engine . . . Where are the fuel lines located that transport the fuel from the wings to the engine? The fuel lines connecting the tanks in the wings to the engine descend through the slivers of airframe that separate the pilot/copilot windows from the windscreen.
- ❏ Why design the plane so that 3 gallons are unusable? Three gallons remain unusable because fuel is drawn from slightly above the bottom of the tanks, to avoid drawing contaminants into the engine.
- ❏ How many fuel vents does your plane have? 3.
  - ❏ Where are they located, and what is their purpose? Each of the fuel tank caps has an orange umbrella valve with 4 small holes acting as vents. Also, there is an outboard fuel vent located under the left wing behind the strut. This vent is connected to the right wing internally through a vent line between the fuel tanks. All together, the vents allow air to enter the tanks as fuel gets burned, replacing the space previously occupied by fuel, in order to prevent vacuums from forming that disrupt fuel flow.
  - ❏ Does the outboard vent serve any other purpose? Yes, it also acts as a fuel drain when heat causes the fuel inside the tanks to expand.

- ❏ Why is the outboard vent positioned directly behind the strut? This prevents ice from forming on the vent. Also, it prevents ram air from pressurizing the tank, which could cause variations in fuel flow.

❏ Walk me step-by-step through the path that fuel takes as it travels from the tanks into the cylinders. Tanks > fuel selector > fuel reservoir tank > electrically driven auxiliary fuel pump > fuel shutoff valve > fuel strainer > engine driven fuel pump > fuel/air control unit > fuel distribution valve (aka fuel manifold, aka flow divider) > fuel injector nozzles > cylinder (to be more precise, just prior to the cylinder's intake valve).

❏ What is the purpose of the fuel reservoir? The fuel reservoir stores about 1 gallon of fuel to provide the engine with a constant fuel supply in the event that fuel flow gets interrupted due to slips/skids/odd pitch attitudes.

❏ Explain your aircraft's recommended cruise leaning procedure. Lean until peak EGT, then enrich the mixture until 50 degrees rich of (colder than) peak.

❏ How must the plane be operated when using either the LEFT or RIGHT fuel selector? Level flight only. Takeoff and landing with the fuel selector valve handle not in the BOTH position is strictly prohibited. (Note: ATP conducts all normal flight operations with the fuel selector in the BOTH position.)

❏ When you sump the fuel, what are you checking for? Water and contaminants. Also verifying that the fuel is the correct color/type of fuel.

❏ What colors do you NOT want to see? Red or clear. Green/100 octane is permitted per Cessna, but it is no longer produced and is not permitted to be used by ATP.

❏ How can you tell that your fuel has water in it? Water is heavier than fuel, so it will sink to the bottom of the drain jar. Smaller amounts of water will show up as bubbles at the bottom of the jar.

❏ Other than water, what else might be indicated by a clear fluid at the bottom of your drain jar? Possibly Jet-A.

❏ Why is 100LL blue? A blue dye is added in order to make it easily identifiable.

❏ What does the "100" represent? This is the octane rating. The higher the number, the more energy it takes for the fuel to combust.

❏ What annunciator indication(s) is associated with the fuel system? What sets it off? When a tank has fewer than 5 gallons for more than 1 minute, a LOW FUEL L or LOW FUEL R annunciator will appear on the PFD.

❏ How much usable fuel exists when the fuel level sits at the bottom of the filler indicator tab? 17.5 (for that tank).

❏ Why are hot starts so difficult in fuel injected aircraft? Due to vapor lock.

- ❏ What is vapor lock? This is when the fuel becomes so hot it vaporizes in the fuel lines, not allowing fuel to reach the cylinders.
- ❏ Why are fuel injected systems prone to this? Because the fuel lines that extend from the fuel distributor to the cylinders sit on top of the engine; heat rises off of the engine, causing the lines to absorb much of the engine's heat, turning the fuel inside into vapor.

❏ How is a fuel injected system different from a carbureted system? In a carbureted system, the fuel and air mix inside the carburetor. In a fuel injected system, the fuel/air control unit measures the air going through the induction system, then nozzles spray the appropriately ratioed amount of fuel directly into the intake ports of each cylinder.

- ❏ What are the advantages of fuel injection over a carbureted system? Minimal-to-no chance of engine icing; better fuel flow; faster throttle response; precise control of the mixture; better fuel distribution to the cylinders; easier cold weather starts.
- ❏ What are the disadvantages to fuel injection? Difficult hot engine starts; vapor lock during ground operations on hot days; problems associated with restarting an engine that quits because of fuel starvation.
- ❏ What are the 6 basic components of a fuel injection system? Engine-driven fuel pump; fuel-air control unit; fuel manifold (fuel distributor); discharge nozzles; auxiliary fuel pump; fuel pressure/flow indicators.
- ❏ Where does the fuel first mix with air in a fuel injected system? The discharge nozzles spray fuel into the induction airstream just prior to the cylinders' intake valves.
- ❏ What causes the RPM reduction when alternate induction air is used? Lower intake pressure and/or a partially blocked filter. Also, the air is unfiltered.
- ❏ What measures fuel flow? A transducer located in the fuel injection system between the fuel/air control unit and the fuel distribution manifold.
- ❏ Why is our fuel system considered to be gravity-fed? Because gravity plays a major part in moving the fuel from the tanks into the engine (along with engine and electric pumps). High wing aircraft often use gravity fed systems, whereas low wing aircraft have to rely on pumps.
- ❏ Why does your plane have an electric fuel pump? Primarily as a backup in case the engine-driven fuel pump fails. It also allows us to prime the engine, and it can be used to combat vapor lock.
- ❏ When draining from the 3 drains located under the nose, from where in the fuel system is that fuel being sampled? The fuel selector, fuel reservoir, and fuel strainer.

<u>Electrical</u>

- ❏ Where are the alternator and battery located? The alternator is located just behind the nose cone on the right side; it is connected to the belt and is visible during preflight. The battery is in the back of the nose compartment, attached to the left side of the firewall.
- ❏ How many amp-hours and volts does your aircraft's battery produce? 8 amp hours (this changes significantly depending on the year of the CE-172 - check your plane's Comprehensive Equipment List for accurate information), 24 volts.
- ❏ How many amps and volts does your aircraft's alternator produce? 60 amps, 28 volts.
- ❏ Why does the alternator produce more volts than the battery? The extra 4 volts are directed toward recharging the battery.
- ❏ What does 8 *amp hours* mean? This means that the battery, when it's new, can support an 8 amp system for an hour before it's drained. In other words, it can produce 8 amps constantly for one hour.
    - ❏ If the alternator fails and you're running 16 amps on your flight, how long until the battery dies? What if you were running 4 amps instead? 30 min and 2 hours, respectively. Usually it's a good idea to cut those times in half, though, because the battery loses power with age and as it sits out on the ramp in the cold.

- ❏ What is the difference between amps and volts? Volts represent the pressure applied to the electrical current (also known as amps). Amps represent the amount of electrical current.
- ❏ What type of battery does your plane have? Lead acid (the same type of battery cars use).
- ❏ How is it possible that your plane has a DC system, yet still uses an alternator which produces alternating (AC) current? The system uses a rectifier to convert the AC current produced by the alternator into DC.
- ❏ How does an alternator work? In simple terms, the engine spins the alternator belt which spins a magnet inside the alternator. This magnet spins inside a circular winding of wires, generating electricity through the concept of electromagnetic induction.
- ❏ If the engine drives the alternator, what prevents system voltage from varying rapidly with RPM changes? The voltage regulator.
- ❏ What does the voltage regulator do? The regulator minimizes voltage fluctuations in the electrical system, that way close to 28 volts is always being produced despite low or high RPM.
- ❏ Our aircraft has an ACU, what is that? An Alternator Control Unit combines a voltage regulator with overvoltage protection.
- ❏ Does your electrical system have any protection against voltage spikes? Yes, the ACU contains an overvoltage sensor circuit - when voltage exceeds 32 volts, the ACU automatically opens the ALT FIELD circuit breaker, stopping alternator output.
- ❏ What does a voltmeter measure? It measures a system's voltage. Main bus voltage - i.e. the voltage output of the alternator when it's functional, or the battery when it's not - is displayed numerically below the M; essential bus voltage - i.e. the standby battery's voltage output - is displayed numerically below the E.
- ❏ What does the ammeter measure? It measures current going to/from the battery. In other words, the ammeter measures the battery's rate of charge (positive indication) or discharge (negative indication, meaning the alternator has either failed or isn't doing its job properly).
- ❏ What sets off a LOW VOLTS annunciation? Practically speaking, what does this mean? LOW VOLTS signifies that system voltage is below 24.5 volts. Practically, this means the alternator is not supplying the electrical power that it should - the battery has taken over and is being drained.
- ❏ What triggers a STBY BATT annunciation? What does this mean practically? STBY BATT means the standby battery has been discharging by more than .5 amps for more than 10 seconds. Practically speaking, this means the alternator and main battery are not functioning, and the standby battery is now powering the equipment hooked up to the essential bus.
- ❏ What sets off a HIGH VOLTS annunciation? HIGH VOLTS indicates that system voltage exceeds 32 volts and the ACU failed at automatically taking the alternator off line. Manual, immediate action is required by the pilot - turn the alternator switch off and refer to the appropriate checklist.
- ❏ What is a bus bar, and what is its purpose? A bus bar is like a power strip. It is used as a terminal in the electrical system to connect the electrical system to the equipment using electricity as a source of power. This simplifies the electrical system by reducing wiring, and also makes it easier for the pilot to take electrical equipment off-line by pulling a circuit breaker.

- ❏ What buses exist on our plane? Electrical bus #1, electrical bus #2, cross feed bus, avionics bus #1, avionics bus #2, essential bus.
- ❏ Say the alternator and battery both fail, and you're now operating off of the standby battery. What equipment will still operate? Refer to the electrical schematic in section 7 of my POH/AFM and see what is hooked up to the essential bus. All essential equipment like the AHRS/ADC and communications will still operate. The transponder and flaps will be inoperative, though.
- ❏ What are circuit breakers, and how do they work? Circuit breakers protect automatically against excess current, which could create fire hazards. When an electrical overload or a short circuit exists, the excess current/heat causes the small metal conductor inside the circuit breaker to expand and ultimately pop, breaking the circuit.
- ❏ What do the numbers on the faces of the circuit breakers represent? They are the amp ratings for the circuit breakers - they tell you how many amps cause the breaker to pop.
- ❏ What is the general policy for resetting circuit breakers? If the failed equipment is essential, the breaker can be reset once after allowing it to cool off.

<u>Avionics</u>

Note: all G1000 flight instrument systems are included in this Avionics section. The subsequent sections - "Pitot Static Flight Instruments" and "Vacuum/Pressure Flight Instruments" - will address conventional (6-pack) flight instrument systems.

- ❏ The individual components of the G1000 system are referred to by Garmin as . . . what? LRUs.
- ❏ List and describe all the Garmin LRUs.
  - PFD Display Unit (GDU). One of the GDUs is configured as the Primary Flight Display (PFD), which displays the flight and navigation instruments, among other primary flight information for the pilot.
  - MFD Display Unit (GDU). The other GDU is configured as the Multifunction Flight Display, which displays supplementary flight information, e.g. a moving map, TIS/ADS-B information, weather radar, Terrain Avoidance Warning System (TAWS), and airport information.
  - 2 Integrated Avionics Units (GIAs). The GIA is the main communication hub, linking all the LRUs with the PFD and MFD. Each GIA contains a GPS receiver and com/nav/GS receivers.
  - Engine/Airframe Unit (GEA). The GEA receives and processes engine and airframe information.
  - Air Data Computer (GDC). The GDC processes information from the pitot/static system as well as the outside air temperature sensor to give us our airspeed, altitude, vertical speed, OAT, and altitude reporting/pressure altitude information for the transponder.
  - Attitude and Heading Reference System (GRS). The GRS (AHRS) processes and displays yaw, roll, and pitch information compiled from its rate sensors, accelerometers, and tilt sensors.

- Magnetometer (GMU). The GMU measures local magnetic field information, then sends that information to the AHRS for processing to determine aircraft magnetic heading.
- Audio System with Integrated Marker Beacon Receiver (GMA). The GMA contains the nav/com/marker beacon controls - this is the audio panel.
- Mode-S Transponder (GTX). The GTX is the Mode-S transponder that provides Modes A, C, and S operation.
- Data Link (GDL). The GDL is an XM satellite radio receiver that provides real-time weather information to the G1000MFD. An XM satellite radio subscription is required for this to be used.

❏ Draw out the block diagram for the basic G1000 system. Draw figure 1-1 in the G1000 Pilot's Guide for Cessna Nav III.

❏ What flight instruments does the AHRS control? Attitude indicator, heading indicator (processes information from the magnetometer), slip/skid indicator, and the rate-of-turn indicator.

❏ Does the AHRS utilize gyroscopes or have any spinning parts? No, just sensors and accelerometers that don't spin and therefore won't tumble.

❏ How is rate-of-turn information provided in the G1000? A magenta trend vector extends directly above the heading indicator. The end of the vector gives the heading predicted in 6 seconds, based on the present turn rate.

❏ How is a standard rate turn depicted? When the vector extends to the first tick mark the turn is half-standard rate, the second tick mark is standard rate.

❏ Where in the plane is the AHRS equipment located? In the tail cone, behind baggage.

❏ Which LRU(s) provide heading information? Magnetometer and AHRS.

❏ Which flight instruments does the ADC control? Airspeed, altimeter, and VSI. The ADC also processes and displays OAT and pressure altitude information.

❏ Where is the ADC equipment located? In the tailcone, behind baggage.

❏ How does the ADC work? Dynamic air pressure from the pitot tube and static air pressure from the static port go into the ADC, which compiles and interprets that information, then digitizes/displays it on the screen in the form of airspeed, vertical speed, altitude, and true airspeed.

❏ Does the airspeed indicator still utilize a diaphragm? Does the altimeter use aneroid wafers? No to both. The ADC replaces the internal components of a conventional pitot/static system.

❏ Which instrument(s) does the magnetometer control? Heading indicator.

❏ Our heading indicator is referred to as an HSI. What does "HSI" stand for, and what is it? Stands for Horizontal Situation Indicator. This is a heading indicator coupled with a navigation/CDI overlay.

❏ Where is the magnetometer located, and why? Inside the left wing. The magnetometer senses magnetic fields - being out in the wing keeps it free from the magnetic fields created by the avionics in the cockpit.

❏ Which system would have to fail for us to lose our navigation equipment? How about coms? How about GPS? Both of the Integrated Avionics Units would have to fail.

❏ List the G1000's limitations.

- The screens can overheat, especially if one of the cooling fans breaks (note: the fans will not operate when the standby battery is in use).
- In-flight initialization can be difficult - the plane must be in a near-level flight attitude (+-20 degrees bank, +-5 degrees pitch).
- The G1000 provides such accurate flight information - especially the 20 foot altitude increments displayed on the altimeter - that it can cause pilots to over-control the aircraft.
- The myriad *supplemental* features on the G1000 that are designed to enhance situational awareness can, ironically, end up having the opposite effect - they can lead to over-reliance. Pilots must remain vigilant about flying the aircraft and focusing their attention outside the aircraft.
- Expired databases.
- Smudges on the screen can throw off the auto-dim feature, leading to excessive dimming. The pilot needs to override this by manually turning up the screen's brightness.

❏ Where are the com, nav, and GPS antennas located on the aircraft? The com/GPS antennas are mounted on the top of the cabin. The #1 antenna is on the right, #2 on the left. The blade-type navigation antenna (for the localizer, glideslope, and VOR) is mounted on either side of the vertical stabilizer.

❏ Do the G1000-equipped 172s have vacuum systems? Yes.

- ❏ Which instrument(s) are vacuum-powered? Just the standby attitude indicator.
- ❏ What drives the vacuum pump? The engine - the pump is geared to the engine.
- ❏ From where is the air that goes through the vacuum system originally drawn? The air gets sucked in from the cabin.
- ❏ And where is that air ultimately discharged? After passing through the vacuum pump, the vacuumed air gets discharged into the engine compartment.
- ❏ Where is the vacuum pump located? On the back of the engine - on the accessory case.
- ❏ What indicates that the standby AI is inoperative? A low-vacuum warning flag comes into view on the face of the instrument. Also, a LOW VACUUM annunciator will display in amber on the PFD.

<u>Magnetic Compass</u>

❏ How does the compass work? Inside the compass there are two small magnets that align with Earth's magnetic field. These magnets are attached to a metal float, allowing the magnets to float freely in a fluid similar to kerosene. A compass card marked with letters and numbers representing magnetic headings is wrapped around the magnet-float assembly. When we turn, we are just turning around this stationary compass card that remains aligned with the magnetic field.

- ❏ What mounting mechanism allows the magnet-float assembly the freedom to rotate and tilt when the aircraft is banked? Jewel-and-pivot type mounting.
- ❏ What is the name of the vertical line on the face of the compass that shows your present heading? Lubber line.

- ❏ What is the purpose of having kerosene inside the compass? 1) It dampens oscillations of the float and card, and 2) it takes the weight of the float/magnets off of its pivot so that magnets are free to align with the magnetic field.
- ❏ What errors are associated with the compass? VDMONA: variation, deviation, magnetic dip, oscillation, northerly/southerly turning errors (UNOS), acceleration errors (ANDS).
  - ❏ Describe each.
    - *Variation* refers to the difference between true north and magnetic north. True north/south are the geographical top/bottom of the globe, i.e. the north and south poles. Magnetic north/south are located over 1,000 miles away. These are the north/south to which compasses are oriented.
    - *Deviation.* The aircraft's avionics and various magnetized parts produce their own magnetic fields that can cause the compass to misalign with the Earth's magnetic field. This misalignment is referred to as magnetic *deviation*. The compass correction card provides the appropriate corrections.
    - *Magnetic Dip* is what leads to the northerly/southerly-turning and acceleration errors. Lines of magnetic flux emerge vertically from the magnetic north pole, then bend over the earth such that they are parallel to the Earth at the equator, then descend vertically downward into the magnetic south pole. When flying anywhere other than over the equator, the magnets in the compass will try to dip in order to align with the slightly vertical nature of the lines of magnetic flux. To prevent this, compasses are designed to resist this dip by lowering the CG below the pivot point and by increasing the weight of the float assembly. This works great during straight-and-level unaccelerated flight, but otherwise this extra weight and low CG can lead to inertial issues.
    - *Oscillation* refers to the way that the float assembly bounces around in turbulence causing the compass readings to be erratic.
    - *Northerly Turning Errors.* Magnetic dip leads to errors when turning to north and south headings. When turning to a north heading, stop the turn prior to arrival at the desired heading on the compass card. When turning to a south heading, allow the compass card to pass the desired heading prior to stopping the turn. The mnemonic here is UNOS: Undershoot North, Overshoot South. (Specific examples of this are provided below.)
    - *Acceleration Errors* refer to the way that the compass points northbound while accelerating on an east or west heading. Accelerating on a south or north heading has no effect. The mnemonic here is ANDS: Accelerate North, Decelerate South.
- ❏ While heading 360 you accelerate. What will the compass heading indicate? It will continue indicating north. The acceleration/deceleration errors only apply to east and west headings.
- ❏ You're southbound and you make a left turn with the goal of rolling out on a compass heading of 360. What heading will the compass indicate when you should roll wings level in order to roll out on the 360 heading? 030. Undershoot north by 30 degrees.
- ❏ What if you want to roll out on a heading of 060 instead? Undershoot by 10 degrees. (Ultimately goes down to 0 degrees under/overshoot when rolling out due east or west.)

- ❏ Where does the 30 degree under/overshoot correction for rolling out on 360/180 headings come from? Is it always 30 degrees? The formula is 15 degrees plus half the latitude. So no, this number can vary depending on latitude.
- ❏ Is the wet compass required equipment per 91.205? No, provided the plane is equipped with some other type of "magnetic direction indicator," such as an HSI.

Pitot-Static Flight Instruments

**This section addresses conventional (6-pack) flight instrumentation in the CE-172S. G1000-specific systems are detailed above in the "Avionics" section, as well as in the Systems and Equipment Malfunctions task.*

- ❏ Which instrument(s) is powered by both the pitot and static systems? Airspeed indicator.
- ❏ How does the airspeed indicator (ASI) work? Air goes through the ram air hole on the pitot tube and presses against the diaphragm inside the ASI (this is called dynamic air pressure), causing the diaphragm to expand like a balloon. Surrounding the diaphragm is the static air resting inside the instrument casing (this is called static air pressure), air that came in through the static port on the side of the nose. The diaphragm is attached to the needle on the face of the ASI through a series of gears and mechanical linkages. The faster you fly, the more air there is going into the diaphragm, causing it to expand more, causing the needle to indicate faster.
  - ❏ What does the ASI measure? Differential air pressure.
  - ❏ What limitations are associated with the ASI? There are inherent installation and instrument errors, hence the calibrated airspeed conversion chart. There are also pitot/static blockages that can cause a range of errors. *(Note: these blockages are covered in a more scenario-based context in the "Systems and Equipment Malfunctions" task.)*
    - ❏ If just the ram air hole on the pitot tube is blocked, but the drain and the static port are both unobstructed, what indication(s) can you expect on your flight instruments during the flight? The air inside the pitot lines and diaphragm will bleed out through the drain hole, causing the indicated airspeed to drop to zero knots. No other instruments will be affected.
    - ❏ How about if the pitot tube's ram air hole and drain are both blocked, but the static port is unobstructed? The ASI will act like an altimeter: as the plane climbs the indicated airspeed will read faster (despite airspeed not actually increasing), whereas descents will translate to a decreasing airspeed. In addition, acceleration and deceleration will no longer affect indicated airspeed. No other instruments will be affected.
    - ❏ What if the static port is blocked, but the holes on the pitot tube are unobstructed? In this case, the ASI will indicate erratically, generally like a reverse altimeter: climbs will indicate slower airspeeds, descents will indicate faster. That said, because the ram air hole remains open, the ASI will still show acceleration and deceleration. A static blockage will also affect the altimeter and VSI: the altimeter will indicate the altitude at which the blockage occurs (the air pressure at the blockage altitude is

now stuck inside the static casing), whereas the VSI's needle will gradually return to 0 rate-of-climb (once all the pressure leaks out of the calibrated leak, there is no longer a pressure difference between the air in the diaphragm and the air inside the casing).

- ❏ What makes a static blockage especially dangerous? As airspeed continues to climb (falsely) during a descent, the pilot could be inclined to keep reducing power in a misguided attempt at slowing the already slow aircraft. This could lead to a stall.

❏ Which instruments run solely off of the static system? Altimeter and Vertical Speed Indicator (VSI).

**Note: altimeter operation is discussed in detail toward the beginning of the "Performance and Limitations" task. Static blockages are addressed in "Systems and Equipment Malfunctions," as well as in the "Avionics" task.*

❏ How does the altimeter work? Within the altimeter there is a stack of aneroid wafers sealed with 29.92 Hg of air pressure inside of them. These wafers are free to expand and contract with changes to the static air pressure surrounding them inside the instrument casing. Static pressure higher than 29.92 presses down on the wafers and causes them to contract; static pressure less than 29.92 allows the wafers to expand. A mechanical linkage connects the wafer movement to the needles on the instrument's face. When the wafers expand due to low pressure surrounding them, the needle rises indicating a higher altitude; when the wafers contract due to high pressure surrounding them, the needle indicates a lower altitude.

- ❏ When you adjust the altimeter setting in the Kohllsman window, are you adjusting the pressure inside the aneroid wafers? If not, what exactly is being adjusted? Adjusting the altimeter setting merely changes the position of the needles, i.e. it recalibrates what altitudes correspond to the various pressures the instrument senses.
- ❏ How can you tell whether the altimeter is indicating below or above 10,000 ft MSL? The presence of the crosshatch flag signals that the indicated altitude is *below* 10,000 ft.
- ❏ Describe the limitations/errors associated with the altimeter?
  - *Mechanical errors:* these are what we check for after start-up when we verify that the altimeter reads within 75 ft of elevation with the current altimeter setting.
  - *Inherent errors*: these refer to altitude errors caused by non-standard temperature variations, which the altimeter cannot account for. For instance, on a standard day, when flying at a true altitude of 2,000 ft MSL with the altimeter set to 29.92, the wafers inside the altimeter sense 27.72 HG pressure and the instrument correctly indicates 2,000 ft. On an especially cold day, however, the air is more dense, causing the 27.72 pressure level to drop down closer to the Earth's surface. When the altimeter senses air at the pressure 27.72 HG it still indicates 2,000 ft, but the TRUE altitude is actually lower.
  - Altimeter settings are not always perfectly accurate/current - they must be adjusted regularly. Even if the altimeter setting is current, terrain can disturb the pressure of the air in the vicinity, thereby throwing off the altimeter's accuracy (which is why

2,000 ft of obstacle clearance is provided for the various IFR altitudes in mountainous regions, as opposed to 1,000 ft in non-mountainous).
    - Static port blockages.
- ❏ During your after-start instrument check, within how many feet of your elevation should the altimeter read? 75 ft.
    - ❏ According to what? This comes from the 91.411/Part 43 Appendix E altimeter inspection. Also, the PHAK and IFH recommend that if the altimeter reads more than 75 ft off, to have maintenance recalibrate.

❏ How does the VSI work? Inside the casing of the VSI there is a diaphragm. Both the diaphragm and the casing receive air from the static port at atmospheric pressure. The diaphragm receives unrestricted air, while the case receives the static pressure via a calibrated/metered leak. When the aircraft is on the ground or in level flight, the pressures inside the diaphragm and the case are equal, so the pointer indicates 0 ft/min. When the aircraft climbs or descends, the pressure inside the diaphragm changes immediately, but due to the metering action of the calibrated leak, the case pressure remains higher or lower for a short time, resulting in a pressure differential, causing the diaphragm to contract or expand. This pressure differential is indicated on the instrument needle as a climb or descent. When the pressure differential is increasing or decreasing, the needle shows the *trend* of the climb/descent; when the pressure differential stabilizes, the needle indicates the actual rate of altitude change in feet per minute.

- ❏ What is the VSI's principle of operation? Differential pressure.
- ❏ What 2 types of information does the VSI provide? At first it shows TREND information, i.e. an immediate indication of an increase or decrease in the aircraft's rate of climb or descent. After 6-9 seconds of holding a constant climb rate, the VSI will indicate the actual rate of climb/descent.
- ❏ Does the VSI have a diaphragm or an aneroid wafer? Diaphragm.
    - ❏ What's the difference? Aneroid wafers are sealed at a fixed pressure - the pressure inside doesn't change. A diaphragm has air constantly being fed into it.
- ❏ Is the calibrated leak connected to the diaphragm or to the static casing that surrounds the diaphragm? Static casing.
- ❏ Take me through the limitations associated with the VSI?
    - The major limitation is that it has a 6-9 second lag before showing an accurate climb rate.
    - It is susceptible to static blockages.
    - Sometimes the needle doesn't indicate 0 while on the ground and requires adjustment.
- ❏ What do you do if the needle shows +100 ft while on the ground? +100 becomes the new 0 ft/min - continue with the flight.

<u>Vacuum/Pressure Flight Instruments</u>

**Note: this section addresses conventional (6-pack) flight instrumentation in the CE-172S. G1000-specific systems are detailed above in the "Avionics" section, as well as in the "Systems and Equipment Malfunctions" task.*

- ❏ How many vacuum pumps are on your aircraft? 2.
- ❏ What drives the vacuum pumps? The engine (the pumps are geared to the crankshaft).
- ❏ From where is the air that gets sucked through the vacuum system originally drawn? The air gets sucked in from the cabin.
- ❏ And where is that air ultimately discharged? After passing through the vacuum pumps, the vacuumed air discharges into the engine compartment.
- ❏ Where are the vacuum pumps located? On the back of the engine - on the accessory case.
- ❏ What is the normal operating range of the vacuum system? 4.5 - 5.5 inches of mercury (Hg).
- ❏ When vacuum pressure falls below limits, what indication will you get? Depending on whether it is the left or right vacuum pump providing insufficient vacuum, an annunciator light will illuminate reading L VAC or VAC R.
- ❏ How many inches of mercury must the vacuum pressure fall below to trigger an annunciator? 3.0.
- ❏ Which instrument(s) are vacuum-powered? The Attitude Indicator (AI) and Heading Indicator (HI)
- ❏ What are the two fundamental properties of gyroscopic action? Explain them. “Rigidity in space” and “precession.” Rigidity in space refers to the principle that a gyroscope remains in a fixed position in the plane in which it is spinning. Precession refers to the principle that when a force is applied to a spinning object, that force is felt 90 degrees later in the direction of the object’s rotation.
- ❏ How does the AI work? Inside the AI there is a gyro that spins rapidly as the vacuum pump sucks air over it. Because the gyro is spinning, it stays rigid in space. Attached to this stationary gyro is the artificial horizon, i.e. the ground sky card on the face of the instrument. As our aircraft banks and pitches, the artificial horizon/ground-sky card remains fixed in space, again, because it is attached directly to the spinning gyro. The miniature aircraft on the face of the instrument, on the other hand, is not attached to the gyro - instead it is attached to the outer casing of the instrument, and therefore it banks and pitches along with the aircraft.
  - ❏ The AI’s gyro spins on a _____ plane around a _____ axis. Horizontal plane, vertical axis.
  - ❏ What is the AI’s principle of operation? Rigidity in space.
  - ❏ Name all the limitations/errors associated with the AI?
    - The gyro can tumble when the bank angle exceeds 100 degrees or the pitch attitude exceeds 60 degrees.
    - Acceleration can cause a slight pitch-up, whereas deceleration can cause a slight pitch-down.
    - Rolling out of a 180 degree turn can cause the AI to indicate a slight climbing turn in the opposite direction.
    - Vacuum failure or malfunction.
  - ❏ On the AI, is the gyro attached to the artificial horizon/ground-sky card or to the miniature airplane? The artificial horizon. Just like the actual horizon, the artificial horizon doesn’t move and the plane rotates around it.

- ❏ What design feature keeps the AI's gyro upright and prevents it from precessing? Pendulous veins.

❏ How does the heading indicator (HI) work? Inside the instrument's casing sits a gyro that spins rapidly around a horizontal axis on a vertical plane. This gyro is geared to the compass card that we see on the face of the instrument. Since the gyro remains rigid in space, the points on the card hold the same position in space relative to the vertical plane of the gyro. The aircraft rotates around the stationary, spinning gyro during turns, while gears spin the HI's compass card as appropriate.

- ❏ What is the HI's principle of operation? Rigidity in space.
- ❏ Describe all of the HI's limitations.
  - Precession: friction between internal parts of the instrument causes the gyro to precess over time.
  - Drift: the gyro remains rigid in space, but the Earth rotates at a rate of 15 degrees/hour. Thus, discounting precession caused by friction, the HI may indicate as much as 15 degrees of error per every hour of operation.
  - Extreme pitch and bank angles can cause the gyro to tumble.
  - Vacuum failure.

❏ What is the difference between a Turn Coordinator (TC) and a Turn and Slip Indicator (TSI)? TC shows rate-of-roll then rate-of-turn; TSI shows only rate-of-turn.

- ❏ What design feature enables the TC to show the rate-of-roll? 30 degree canted gyro.
- ❏ What is the TC's principle of operation? Precession.
- ❏ How do you know if your TC is inoperative? It will display a red OFF flag after engine start, meaning the instrument is not receiving electricity. Also, when the plane turns during taxi, the wing won't dip properly.
- ❏ If your vacuum pump(s) fail, will the TC continue to operate? Why or why not? Yes, electricity spins the gyro, not vacuum pressure.
- ❏ Will the TC tumble with excessive pitch or bank? Why or why not? No it won't tumble - the gyro has stoppers that prevent this.
- ❏ Let's say you've lost your AI. You're in a standard rate turn to the left per the aircraft on your TC. You start leveling the wings. What will your rate-of-turn indicator (the miniature airplane) show you when the aircraft is wings level, and why? The miniature airplane will show a standard rate turn to the right. This is because the rate-of-turn indicator initially shows rate-of-roll, and as I roll out of the left bank toward the right, this rightward roll trend will show up on the rate-of-turn indicator as a roll to the right, i.e. the right wing will drop. When approximately a standard rate turn to the right is shown, stop banking. The plane should be approximately wings level.
- ❏ While establishing a fwd slip to land on final, what will the needle and ball on a TSI show? The needle will continue to point straight up and down. The ball will show a slip, i.e. fall to the inside of the bank.
- ❏ You're turning to the left and the ball falls to the inside, is this a slip or a skid? Slip.
- ❏ What are the definitions and causes of a slip and a skid? A slip is when you have too much bank for your rate-of-turn, causing the ball on the inclinometer and the tail of the aircraft to slip inward (in the direction of the bank). A slip is generally caused by adverse yaw and insufficient rudder in the direction of the turn. A skid occurs when your

rate-of-turn is too great for the angle of bank, causing the ball (and the tail of the airplane) to swing to the outside. This is caused by too much rudder in the direction of the turn.

- ❏ Your engine fails, which flight instruments do you expect to lose (remember, conventional instrumentation)? The vacuum-powered instruments, so the AI and HI.
- ❏ Your electrical system fails, which flight instruments do you expect to lose (again, conventional)? The rate-of-turn indicator part of the TC.

Environmental

- ❏ What components comprise the environmental system on your aircraft. Cabin air, cabin heat, windshield defrost, and numerous overhead fresh air vents.
- ❏ How do you get fresh air into the cabin? Pull the cabin air knob and open up all the overhead vents. The windows can be opened as well, up to 163 kt.
  - ❏ Where does this air come from? Pulling the cabin air knob opens up the ventilating air door on the right side of the aircraft's nose, allowing it to scoop outside air and direct it through the cabin floor air outlets. Opening the overhead cabin air outlets allows ram air passing through the fresh air inlets on the leading edges of the wings to duct into the cabin.
- ❏ How does the cabin heat work? Hot exhaust gas gets expelled through the exhaust pipe, causing the pipe itself to become hot. Wrapped around the pipe is an exhaust muffler shroud that traps the heated air between the pipe and the shroud. This heated air gets ducted into the cabin through floor outlets when the cabin heat knob is pulled.
  - ❏ Say you apply the cabin heat, then a few minutes later you start feeling nauseous. What's your concern here? Carbon monoxide (CO) poisoning.
  - ❏ Where is the CO coming from? A crack in the exhaust pipe allows CO to leak into the exhaust muffler shroud. When cabin heat is applied, this CO gets ducted into the cabin.
  - ❏ Other than the physical symptoms, what else should alert the pilot to CO? Many aircraft are equipped with stick-on CO detectors that change color when CO is detected. These are usually stuck to the instrument panel. The G1000 will display an annunciator, CO LVL HIGH, when its CO detection system senses a CO level of 50 parts per million by volume or greater.
- ❏ How do you activate the windshield defroster? Apply the cabin heat, then use the sliding knobs on the dashboard to allow the hot air from the exhaust shroud to get ducted through the defroster outlets located near the lower edge of the windshield.

Deicing and Anti-Icing

- ❏ What de-icing and anti-icing features are on your aircraft? The 172 does not have de-icing equipment, just anti-icing. This equipment includes pitot heat and the defroster. The automatic alternate induction air door and the wing strut blocking the external fuel vent on the left wing also have anti-icing features.

- ❏ What is the difference between de-icing and anti-icing equipment? *De*-icing equipment is intended to remove ice that has already formed, whereas *anti*-icing equipment is intended to prevent ice from forming.
- ❏ How does the pitot heat work? There is an electrical heating element built into the body of the pitot head that heats the metal casing around it when the PITOT HEAT control switch is selected in the cabin.
- ❏ When should pitot heat be used? At least a few minutes prior to flying into IMC when the ambient air temperature is such that structural icing is even remotely possible (ATP requires pitot heat to be activated when operating in IMC within 10 degrees C of freezing).

Task H. Human Factors

References: AIM; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with personal health, flight physiology, and aeromedical and human factors related to safety of flight.

Knowledge:	The applicant demonstrates understanding of:
CA.I.H.K1	Symptoms, recognition, causes, effects, and corrective actions associated with aeromedical and physiological issues, including:
CA.I.H.K1a	a. Hypoxia
CA.I.H.K1b	b. Hyperventilation
CA.I.H.K1c	c. Middle ear and sinus problems
CA.I.H.K1d	d. Spatial disorientation
CA.I.H.K1e	e. Motion sickness
CA.I.H.K1f	f. Carbon monoxide poisoning
CA.I.H.K1g	g. Stress
CA.I.H.K1h	h. Fatigue
CA.I.H.K1i	i. Dehydration and nutrition
CA.I.H.K1j	j. Hypothermia
CA.I.H.K1k	k. Optical illusions
CA.I.H.K1l	l. Dissolved nitrogen in the bloodstream after scuba dives
CA.I.H.K2	Regulations regarding use of alcohol and drugs.
CA.I.H.K3	Effects of alcohol, drugs, and over-the-counter medications.
CA.I.H.K4	Aeronautical Decision-Making (ADM) to include using Crew Resource Management (CRM) or Single-Pilot Resource Management (SRM), as appropriate.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.I.H.R1	Aeromedical and physiological issues.
CA.I.H.R2	Hazardous attitudes.
CA.I.H.R3	Distractions, task prioritization, loss of situational awareness, or disorientation.
CA.I.H.R4	Confirmation and expectation bias.
Skills:	The applicant exhibits the skill to:
CA.I.H.S1	Associate the symptoms and effects for at least three of the conditions listed in K1a through K1l with the cause(s) and corrective action(s).
CA.I.H.S2	Perform self-assessment, including fitness for flight and personal minimums, for actual flight or a scenario given by the evaluator.

<u>Hypoxia</u>

- ❏ You notice your passenger's lips appear to be turning blue. What's the concern here? Hypoxia.
  - ❏ What is this symptom (blue lips and fingernails) called? Cyanosis.

- ❏ What is hypoxia? A state of oxygen deficiency in the body sufficient to impair functions of the brain and other organs.
- ❏ Why does flying at high altitudes without supplemental oxygen lead to hypoxia? There are fewer oxygen molecules available at a pressure necessary for them to be used by our respiratory systems.
  - ❏ Is the percentage of oxygen in the atmosphere the same at high altitudes? Yes but its pressure is greatly reduced - so much so that our bodies become unable to use the low-pressure oxygen.
- ❏ What effect does alcohol have on hypoxia, and why? Alcohol renders a pilot more susceptible to hypoxia by disrupting the body's absorption of oxygen - so at high altitudes, not only are there fewer oxygen molecules available for the body to access, but with alcohol involved the body struggles to use the oxygen it does manage to access.
  - ❏ Let's say that in your case drinking one beer has zero effect on you - you feel nothing, you experience no inebriation. Would you expect that beer to continue to have no effect on you if you were to hop in the aircraft and climb to 11,000 ft MSL? Why or why not? No, this could be extremely dangerous as alcohol makes the body more susceptible to hypoxia at lower altitudes.
  - ❏ One ounce of alcohol (i.e., the amount of alcohol commonly associated with 1-2 drinks) can equate to an additional _____ feet of physiological altitude. 2,000 ft.
- ❏ For some people, hypoxia can cause impairment when at altitudes as low as ____ feet MSL? 5,000 ft.
- ❏ At what altitude (MSL) does the average person begin to experience impairment from hypoxia? 10,000 ft.
- ❏ What makes hypoxia so insidious? It sneaks up on pilots by stealing the first line of sensory protection: the sense that something is wrong. In fact initial hypoxia symptoms - such as a carefree feeling - can even provide a false sense of security. Also, the human body does not give reliable signals at the onset of hypoxia, so a pilot needs special training on how to recognize their unique symptoms.
- ❏ How can pilots safely become familiar with their unique hypoxia symptoms? Do an altitude chamber "flight." The FAA provides this opportunity through aviation physiology training, which is conducted at the FAA Civil Aeromedical Institute and at many military facilities across the U.S.
- ❏ What is the first part of the body to reflect a diminished oxygen supply? The brain.
- ❏ What are some common types of medications that can make pilots more susceptible to hypoxia? Any medications that depress the nervous system, such as sedatives (sleep aids) or antihistamines (allergy/motion sickness drugs).
- ❏ Would you expect *your own* hypoxia symptoms to vary from case to case, or stay consistent? Symptoms do not vary in an individual, so I'd expect my symptoms to stay consistent.
- ❏ Do symptoms vary from pilot to pilot? Yes, hypoxia affects each person differently.
- ❏ During the day and night, above what altitude(s) does the FAA recommend using supplemental oxygen? 10,000 ft MSL during the day; 5,000 ft at night.
- ❏ Name the different types of hypoxia. Hypoxic, hypemic, stagnant, histotoxic.

❏ Describe the cause of each type of hypoxia on a physiological level. Also, provide some typical scenarios that lead to each type occurring.

- Hypoxic hypoxia: caused by insufficient oxygen available to the body as a whole. The classic scenario for pilots that leads to hypoxic hypoxia would be operating at high altitudes without supplemental oxygen. Other scenarios would be drowning, choking (blocked airway), or transporting dry ice which can sublimate into large quantities of CO2 and rapidly displace oxygen-containing air via carbon dioxide intoxication.
- Hypemic hypoxia: occurs when the blood - or specifically, the blood molecule *hemoglobin* - is not able to take up and transport a sufficient amount of oxygen to the cells in the body. The classic aviation-related example of this is carbon monoxide (CO) poisoning (explained in more detail later in this section of the study guide). Other scenarios would be reduced blood volume from severe bleeding, anemia, or blood donation. The effects of blood loss are much greater when at higher altitudes.
- Stagnant hypoxia: occurs when oxygen-rich blood in the lungs, for one reason or another, can't move sufficiently to the tissues that need it. The classic scenario is pulling excessive Gs. Other scenarios would be extreme cold temperatures, a limb going to sleep, shock, the heart failing to pump blood effectively (heart attack), or a constricted artery.
- Histotoxic hypoxia: this is the inability of cells/tissues to effectively use oxygen due to the cells/tissues being poisoned, usually by drugs or alcohol.

❏ Although symptoms vary, what are considered common FIRST symptoms of hypoxia? Euphoria and a carefree feeling.
  ❏ What are other hypoxia symptoms? Cyanosis, headache, decreased response to stimuli and increased reaction time, impaired judgment, visual impairment, drowsiness, lightheaded or dizzy sensation, tingling in fingers and toes, numbness, and tunnel vision.
  ❏ What symptom usually kicks in toward the end as hypoxia worsens? The field of vision begins to narrow (tunnel vision) - instrument interpretation becomes difficult.
❏ You suspect your passenger is suffering from hypoxic hypoxia. What are you going to do? Provide supplemental oxygen (if it's available), declare an emergency, and descend.

<u>Hyperventilation</u>

❏ After a near collision, you notice your passenger is breathing more and more rapidly - what's the concern here and what would you do? Hyperventilation. Talk to them and try to get them to deliberately slow their breathing rate. Additionally, have them breathe into a paper bag or talk out loud.
❏ What else can cause hyperventilation besides stressful situations? Flying at higher altitudes. At higher altitudes a pilot may have a tendency to breathe more rapidly than normal, which can lead to hyperventilation.

- ❏ What is hyperventilation? Heavy breathing that leads to an excessive loss of carbon dioxide from the blood - the more you breathe out, the more CO2 you exhale, leading to more breathing and more anxiety, leading to more loss of CO2.
- ❏ What is the primary symptom of hyperventilation? Rapid breathing.
- ❏ What are some other common hyperventilation symptoms? Visual impairment, unconsciousness, lightheaded or dizzy sensation, tingling sensations, hot and cold sensations, muscle spasms.
- ❏ What will eventually happen if hyperventilation goes untreated? Unconsciousness due to the respiratory system's overriding mechanism to regain control of breathing.
  - ❏ Is this dangerous? It is if you're supposed to be flying an aircraft! For passengers, it's not especially dangerous - passing out functions as a hard reset for the body to regain control of the breathing.
- ❏ If you're unsure whether a passenger is hypoxic or hyperventilating, which would you treat and why? I would treat hypoxia, as prolonged oxygen starvation can lead to death; untreated hyperventilation, on the other hand, would simply lead to passing out temporarily.

<u>Middle Ear and Sinus Problems</u>

- ❏ You wake up with a cold - you're congested. Would you continue with your flight as planned? Why or why not? No, flying could lead to middle ear and sinus problems.
  - ❏ How does congestion cause middle ear problems? Mucus blocks the pathways (such as the Eustachian tube) that allows pressure to equalize in and out of the ear and throat.
- ❏ Why do descents tend to inflict more discomfort on the ear drums than climbs? Equalizing lower pressure air inside the middle ear through the Eustachian tube becomes more difficult due to the fact that the partial vacuum tends to constrict the walls of the Eustachian tube. This vacuum effect on the Eustachian tube doesn't happen with climbs.
- ❏ What is the middle ear? A small cavity located in the bone of the skull, right on the inside of the eardrum.
- ❏ What is the inner ear? This portion of the ear is also located on the inside of the eardrum - it houses organs that make up our vestibular system, i.e,. the "semicircular canals."
- ❏ What can pilots do to remedy uncomfortable air pressure building up in the middle ear during climbs and descents? Valsalva maneuver, swallow, chew gum, and/or yawn.
  - ❏ What is the Valsalva maneuver? A combination of closing the mouth, pinching the nose closed, and attempting to blow through the nostrils - it forces air through the Eustachian tube in order to equalize pressure.
- ❏ What can happen if the Eustachian tube is blocked and unable to equalize pressure during climbs and descents? An ear block, which produces severe ear pain and loss of hearing that can last from several hours to several days. This can also lead to a rupture of the eardrum and/or an infection.
- ❏ Other than ear discomfort, what is another reason why pilots shouldn't fly when congested? The potential for sinus blocks.
  - ❏ How does a sinus block happen? Air pressure in the sinuses (small cavities above the eyebrows and in the upper cheeks) equalizes with the pressure in the flight deck

through small openings that connect the sinuses to the nasal passages. Enough congestion can prevent pressure equalization by plugging the openings, leading to a sinus block.

- ❏ What's bad about a sinus block? They can be excruciatingly painful, lead to bloody mucus discharging from the nasal passages, and cause teeth pain.
- ❏ Do sinus blocks occur most frequently during climbs or descents? Descents.
- ❏ What should you do to prevent sinus block issues in flight? Don't fly in the first place if you're sick. If you're in flight and you or a passenger experiences sinus block symptoms, descend SLOWLY.

❏ Say you're congested - should you feel protected from the potential for a sinus block by using decongestant sprays or drops that help relieve congestion? No, the AIM says these do not provide adequate protection.

Spacial Disorientation and Illusions

❏ What does "spatial disorientation" mean? A lack of orientation with regard to the position, attitude, or movement of the aircraft in space.

❏ On a physiological level, what causes spatial disorientation? When our three sensory systems provide conflicting information to the brain, this gives an unclear idea of where and how the body is moving.

❏ What three sensory systems does the body use to ascertain orientation and movement in space, i.e., to stay spatially oriented? Describe each.

- Visual: eyes, which sense position based on what is seen.
- Somatosensory (aka postural): nerves in the skin, muscles, and joints that, along with hearing, sense position based on gravity, feeling, and sound.
- Vestibular: organs found in the inner ear (semicircular canals) that sense position by the way we are balanced.

❏ Which system is the cornerstone of our sensory system, the major orientation source that prevails over false sensations from other sensory systems? Visual.

❏ What flight situation typically leads to spatial disorientation among pilots? Loss of visual cues during flight into IMC or at night.

❏ List and describe all the vestibular illusions.

- The Leans: An abrupt correction of a banked attitude, which has been entered too slowly to stimulate the motion sensing system in the inner ear, can create the illusion of banking in the opposite direction. The disoriented pilot will roll the aircraft back into its original dangerous attitude, or, if level flight is maintained, will feel compelled to lean in the perceived vertical plane until this illusion subsides.
- Coriolis Illusion: Occurs when a pilot has been in a turn long enough for the fluid in the ear canal to move at the same speed as the canal. A movement of the head in a different plane, such as looking at something in a different part of the flight deck, may set the fluid moving, creating the illusion of turning or accelerating on an entirely

different axis. This action causes the pilot to think the aircraft is performing a maneuver it is not. The disoriented pilot may maneuver the aircraft into a dangerous attitude in an attempt to correct the aircraft's perceived attitude.

- Graveyard Spin: A proper recovery from a spin that has ceased stimulating the motion sensing system can create the illusion of spinning in the opposite direction. The disoriented pilot will return the aircraft to its original spin.
- Graveyard Spiral: An observed loss of altitude during a coordinated constant-rate turn that has ceased stimulating the motion sensing system can create the illusion of being in a descent with the wings level. The disoriented pilot will pull back on the controls, tightening the spiral and increasing the loss of altitude.
- Somatogravic Illusion: A rapid acceleration during takeoff can create the illusion of being in a nose-up attitude. The disoriented pilot will push the aircraft into a nose-low, or dive attitude. A rapid deceleration by a quick reduction of the throttles can have the opposite effect, with the disoriented pilot pulling the aircraft into a nose-up, or stall attitude.
- Inversion Illusion: An abrupt change from climb to straight and level flight can create the illusion of tumbling backwards. The disoriented pilot will push the aircraft abruptly into a nose-low attitude, possibly intensifying this illusion.
- Elevator Illusion: An abrupt upward vertical acceleration, usually by an updraft, can create the illusion of being in a climb. The disoriented pilot will push the aircraft into a nose-low attitude. An abrupt downward vertical acceleration, usually by a downdraft, has the opposite effect, with the disoriented pilot pulling the aircraft into a nose-up attitude.

❏ Which of those vestibular illusions do pilots experience most commonly during flight?
The leans.

❏ List and describe the visual/optical illusions, along with the illusions that can lead to landing errors.

- Runway Width Illusion: A narrower-than-usual runway can create the illusion that the aircraft is at a higher altitude than it actually is. The pilot who does not recognize this illusion will fly a lower approach, with the risk of striking objects along the approach path or landing short. A wider-than-usual runway can have the opposite effect, with the risk of leveling out high and landing hard or overshooting the runway.
- Runway and Terrain Slopes Illusion: An upsloping runway, upsloping terrain, or both, can create the illusion that the aircraft is at a higher altitude than it actually is. The pilot who does not recognize this illusion will fly a lower approach. A downsloping runway, downsloping approach terrain, or both, can have the opposite effect.
- Featureless Terrain Illusion: An absence of ground features, as when landing over water, darkened areas, and terrain made featureless by snow, can create the illusion that the aircraft is at a higher altitude than it actually is. The pilot who does not recognize this illusion will fly a lower approach.

- Atmospheric Illusions: Rain on the windscreen can create the illusion of greater height, and atmospheric haze creates the illusion of being at a greater distance from the runway. The pilot who does not recognize these illusions will fly a lower approach. Penetration of fog can create the illusion of pitching up. The pilot who does not recognize this illusion will pitch the nose down and steepen the approach, often quite abruptly.
- Ground Lighting Illusions: Lights along a straight path, such as a road, and even lights on moving trains can be mistaken for runway and approach lights. Bright runway and approach lighting systems, especially where few lights illuminate the surrounding terrain, may create the illusion of less distance to the runway. The pilot who does not recognize this illusion will fly a higher approach. Conversely, the pilot overflying terrain which has few lights to provide height cues may make a lower than normal approach.

❏ When approaching to land, what type of runway - in terms of width, slope, terrain, and lighting - would you consider to be the most dangerous? Why? Narrow, upsloping, minimal ground features (such as over water or darkened areas), and few lights. All these runway features can lead to lower than normal approaches, as they contribute to the illusion of being higher or farther away from the runway.
❏ What are some things you can do to prevent these illusions and their potentially hazardous consequences? Use the VASI/PAPI or electronic glideslope when they're available; anticipate the illusions; use the chart supplement for information of runway slope, terrain, and lighting; make frequent references to the altimeter.

<u>Motion Sickness (Airsickness)</u>

❏ You notice that, despite only occasional light turbulence, your passenger is sweating and looks pale. What do you think the problem is and what would you do? Motion sickness. Open the fresh air vents (and possibly the window), and tell them to focus on an object outside the aircraft as well as to avoid unnecessary head movements. Provide them with a bag in case they vomit. Control the aircraft smoothly and try to find an altitude with smoother air.
  ❏ If you had to fly this passenger again, what would you do/recommend? Limit flights to smooth-air conditions and make sure they bring a bag. Provided the passenger won't be flying the plane, recommend Dramamine.
❏ What causes motion sickness? It's caused by the brain receiving conflicting messages about the state of the body. It can also be caused and/or aggravated by stress and anxiety about flying - this is common among flight students during their initial training flights.

<u>Carbon Monoxide (CO) Poisoning</u> **Addressed additionally in the SYSTEMS task.*

❏ You turn the heater on in flight and minutes later start feeling the onset of a headache and just generally feel weak. What is your concern? CO poisoning.
  ❏ What is going on here on a physiological level? Hemoglobin, the blood molecule that transports oxygen to your organs, can't sufficiently bind to oxygen molecules because

CO attaches itself to hemoglobin 200 times more easily than oxygen and thus boxes out the oxygen molecules.

- ❏ So you've established that it's CO poisoning - what corrective actions will you take as the PIC? Turn off the heater, open the cabin air and fresh air vents and windows, use supplemental oxygen if available, consider declaring an emergency, do an emergency descent, and land as soon as practical (or even as soon as *possible* depending on the circumstances). Refer to the checklist!
- ❏ Once using supplemental oxygen, would you expect your symptoms to clear up promptly? No, but the fresh oxygen should prevent the poisoning from getting worse.

- ❏ What kind of hypoxia is CO poisoning? Hypemic.
- ❏ What sort of symptoms would you expect to experience if suffering from CO poisoning? Headache, blurred vision, dizziness, drowsiness, and/or loss of muscle power.
- ❏ What makes CO especially insidious? CO itself is odorless, tasteless, and colorless (although it's often accompanied by exhaust fumes).
- ❏ Other than exhaust leaks, what is a common cause of CO poisoning among pilots? Smoking.
  - ❏ How so - what exactly makes smoking potentially hazardous to pilots? Smoking raises the CO concentration in the blood - smoking at sea level, say, can result in physiological effects similar to flying at 8,000 ft.
- ❏ Symptoms-wise, what distinguishes CO poisoning from hypoxic hypoxia? When suffering from CO poisoning, expect to feel all-around crummy, whereas usually (but not always), hypoxic hypoxia leads to more carefree, euphoric sensations.

<u>Stress and Fatigue</u>

- ❏ Your longtime significant other broke up with you a few hours before a flight. Would you feel comfortable "leaving it on the ground" and continuing with the flight? Why or why not? No, I would delay the flight due to the stress, which impairs pilot performance - stress can occupy thought processes enough to markedly decrease alertness.
- ❏ On a physiological level, how does the body react to stress? The body releases hormones (such as adrenaline) into the blood, and metabolism increases to provide more energy to the muscles. Also, blood sugar, heart rate, respiration, blood pressure, and perspiration all increase.
- ❏ What type of stress triggers the "fight or flight" response? Acute.
  - ❏ Define this type of stress. Acute stress is short term - it involves an immediate threat that is perceived as danger.
  - ❏ Is it recommended to see a professional when experiencing this level of stress? No, normally a healthy person can cope with acute stress and prevent stress overload.
  - ❏ Would you ever fly if experiencing this type of stress? Potentially - depends on many factors, but acute stress shouldn't be seen as automatically disqualifying. Dealing with this type of stress is often a part of everyday life.
- ❏ Into what type of stress can ongoing acute stress evolve? Chronic.

- ❏ Define this type of stress. Long-term stress that presents an intolerable burden, exceeds the ability of an individual to cope, and causes individual performance to fall sharply.
- ❏ What are some scenarios that might lead to this type of stress? Unrelenting psychological pressures such as loneliness, financial worries, and relationship or work problems that can produce a cumulative level of stress that exceeds a person's ability to cope with the situation.
- ❏ How should a healthy person cope with this type of stress? Regardless of how healthy one is, consult a professional.
- ❏ Would you ever fly if experiencing this type of stress? No.

❏ Other than being a distraction that impairs alertness, how else can stress impair pilot performance? By affecting sleep and contributing to fatigue.

❏ Other than a lack of sleep, what else can contribute to physical fatigue? Exercise or physical work.

❏ Is fatigue always physical? No, there's also *mental* fatigue - this results from stress and prolonged performance of cognitive work.

❏ What are the two broad categories of fatigue? Explain each. Acute and chronic. As with stress, acute fatigue is short term and normal, chronic is long term and should be addressed by a physician.

❏ In what ways does fatigue degrade pilot ability? Degradation of attention, concentration, coordination, ability to communicate, and decision making.

❏ Say you're stressed about your spin training flight the following day and end up getting only a couple hours of sleep the night before the flight. What type of fatigue would you expect to experience, and how would you handle it? Acute. I would explain the situation to the IP, and if I'm expected to act as PIC, I would cancel the flight.

- ❏ Would you be comfortable flying with this type of fatigue once you have more flight experience? No, the FAA resources recommend staying on the ground - no amount of training or experience can overcome fatigue's detrimental effects, even with acute fatigue.
- ❏ How should pilots prevent this type of fatigue? Proper diet and adequate rest and sleep.
- ❏ What are the causes of this type of fatigue? Mild hypoxia, physical stress, and psychological stress.
- ❏ What is the special sub-type of fatigue that is especially detrimental to pilot performance? Explain it. Skill fatigue. This type of acute fatigue has two main effects on performance: 1) timing disruption, where tasks seem to be performed as usual except that the timing of each component is slightly off, and 2) disruption of the perceptual field, where attention becomes concentrated upon movements or objects in the center of vision, neglecting those in the periphery.

❏ What would you expect to occur when there is not enough time for full recovery between episodes of acute fatigue? Chronic fatigue.

- ❏ What causes this type of fatigue? Usually the cause has psychological roots, although an underlying disease can also be responsible.

- ❏ List some of the symptoms of this type of fatigue. Weakness, tiredness, palpitations of the heart, breathlessness, headaches, irritability, stomach or intestinal problems, and generalized aches and pains throughout the body.
- ❏ How should a pilot expect to recover from this type of fatigue? Treatment by a physician.

Dehydration and Nutrition

- ❏ Say you're a flight instructor in Florida during the summer. On your second flight of the day, up at altitude, your head starts aching and you start feeling unusually fatigued - this despite having gotten a full night's sleep along with having drunk multiple cups of coffee earlier in the day. What's the issue? Dehydration.
  - ❏ What are some other signs of dehydration? Cramps, sleepiness, and dizziness.
  - ❏ What is usually dehydration's first noticeable effect? Fatigue.
- ❏ Why are pilots especially prone to dehydration? Hot flight decks and flight lines, wind and humidity, the prevalence of diuretic drinks such as coffee/tea/soft drinks, and alcohol.
- ❏ What makes dehydration especially insidious? The thirst mechanism is triggered too late (once dehydration has already occurred) and gets turned off too easily (before replacement of needed body fluid is complete).
- ❏ How much water consumption is recommended to prevent dehydration? 2-4 quarts every 24 hours. Plan to drink more for stressful situations.
- ❏ In quarts, what water deficit usually triggers the thirst mechanism? A 1.5 quart deficit.
- ❏ What steps should you take to prevent dehydration? Stay ahead, i.e., drink plenty of water consistently, not just when thirsty; limit daily intake of caffeine and alcohol; carry a container in order to measure daily water intake.
- ❏ What serious condition can severe dehydration left untreated in especially hot environments lead to? Heat stroke.

Hypothermia **None of the FAA resources listed for this task address hypothermia. The following information comes from a December 2014 FAA Safety Briefing.*

- ❏ If the heater were to break in flight on an especially cold day, what medical emergency should you be concerned about? Hypothermia.
  - ❏ What is hypothermia? A medical emergency that occurs when your body loses heat faster than it can produce it, causing a dangerously low body temperature.
  - ❏ Why exactly is this dangerous? Hypothermia can be incapacitating: once your body temperature drops too low, your body tries to jump-start some heat through shivering, teeth chattering, and muscles constricting. This discomfort can be extremely distracting for pilots. Eventually you'll feel pins and needles in the fingers and toes, permanent nerve damage, a slowed pulse, loss of consciousness, and eventually death.
  - ❏ What should pilots do to mitigate the risk of hypothermia? Plan ahead. Scope out the weather en route thoroughly; verify heater function beforehand; take extra warm clothing to bridge the gap until rescue; identify contingency routes.

Alcohol, Drugs, And Over-The-Counter Medications

- ❏ What are the primary Part 61 and Part 91 regulations pertaining to pilot use of alcohol and drugs? 91.17 and 61.53.
- ❏ Say you haven't had anything to drink since a party you attended during the afternoon the previous day. You're feeling a bit hungover so, before flying, you use a store-bought breathalyzer test and see that your BAC is .01. Are you legally allowed to fly? No, a hangover counts as being under the influence of alcohol.
  - ❏ What exactly are the alcohol regulations that apply to pilots? 1) 8 hours bottle to throttle, 2) can't be under the influence, and 3) can't fly with .04 alcohol concentration (in breath or blood) or higher.
  - ❏ Most adults feel nothing after having one 12 ounce light beer - driving a car is generally legal in this case (provided the driver isn't under the influence, of course). Why do you think pilots have to abide by more restrictive regulations - regulations that prohibit operating a plane within 8 hours of *any* alcohol consumption even when not under the influence? This is due to the aggravating effects of higher pressure altitudes - as little as one ounce of liquor, one bottle of beer, or four ounces of wine can impair flying skills by rendering a pilot more susceptible to hypoxia and disorientation (not only is there less oxygen available at altitude, but alcohol in the bloodstream means the brain has less capacity to use the oxygen the body is able to access). And finally, piloting an aircraft entails a heightened burden of decision making and coordination - more so than driving a car.
  - ❏ Say a passenger shows up to the plane visibly intoxicated. Can you continue with the flight with this person onboard? Why or why not? No, not unless they're a medical patient or it's an emergency, per 91.17.
  - ❏ Say a law enforcement officer approaches you on the ramp and informs you that someone at the FBO suspected you've been drinking. The officer tells you they're going to give you a breathalyzer test. Can you refuse the test? No, per 91.17.

- ❏ How long does the FAA recommend waiting between dosing intervals before flying after taking any medication that has potentially adverse side effects? Five maximal dosing intervals (a "dosing interval" is the time between recommended prescribed dosings). So for example, a dosing interval of 5 to 6 hours would require you to wait 30 hours.
- ❏ Say your allergies flare up, so you head to the nearest CVS and buy some over-the-counter allergy medication. Because it's over-the-counter, can you rest assured that you are legal and safe to act as PIC on a flight? No - the FAA forbids flying while on many types of over-the-counter medications.
  - ❏ How do you know which meds are off limits? Contact your AME. There are lists of approved and disapproved medications online, but regardless, contact your AME as they are trained to advise and interpret the FAA's guidance.
  - ❏ What if you've taken this particular drug before and you know that, on the ground, it doesn't affect you in any way other than to alleviate your allergy symptoms. Can you take it and fly legally? Not necessarily. Everyone reacts differently to medications, and it could be that this medication, despite not affecting me, is still prohibited by the FAA.

Also, the medicine might not cause adverse effects on the ground, whereas in a reduced-oxygen situation such as when flying at higher altitudes, the medicine could become inebriating.

- ❏ So you call your AME and she approves the medication. Are you going to take the initial dose right before flying? No, the FAA recommends taking the first dose at least 48 hours before flying in order to verify no adverse side effects.
- ❏ Say you get your AME's approval for the medication. A few days prior to your flight you sample the medication and find that it makes you drowsy. Are you still legally allowed to fly? No, 91.17 prohibits the use of any drug that affects a person's faculties in a way contrary to safety.
  - ❏ What if you're the SIC, not acting PIC? Can you take the medicine now? No, not as a required crew member.
- ❏ What rule-of-thumb does the FAA recommend following when it comes to medications and flying? Don't fly as a crewmember while taking any medication unless approved to do so by the FAA - contact your AME.

<u>Dissolved Nitrogen In The Bloodstream After Scuba Dives</u>

- ❏ Why is it unwise to fly immediately after scuba diving? The potential for altitude-induced decompression sickness (DCS).
  - ❏ Take me through, physiologically, how that works. Scuba diving subjects the body to increased pressures, causing more nitrogen to dissolve in body tissues and fluids. The lower pressures encountered up at altitude during flight causes the excess nitrogen to come out of the solution (tissues and fluids) in the form of bubbles that can get lodged in joints and other areas of the body, causing severe pain.
  - ❏ What type of DCS occurs when the nitrogen bubbles get stuck in your joints? The bends.
  - ❏ How about getting bubbles in the lungs, what is that called? The chokes.
  - ❏ How would you respond to a passenger suffering from DCS? Give them supplemental oxygen if available, begin an emergency descent and land ASAP; tell them to keep the affected area still (don't try to shake out the pain); upon landing, seek medical assistance from a medical professional or a hyperbaric medicine specialist - definitive medical treatment may involve the use of a hyperbaric chamber.
    - ❏ By the time you land, the passenger suffering from DCS has no more symptoms. Should you still seek medical evaluation for them? Yes, delayed signs and symptoms of DCS can occur after return to ground level regardless of the presence of symptoms (or lack thereof) during flight.
  - ❏ You did a deep dive 20 hours ago that involved a controlled ascent (i.e. with decompression stops). Your anticipated cruise altitude will be 3,000 ft MSL. Would you fly? No, the FAA recommends waiting at least 24 hours after dives involving controlled ascents.
    - ❏ How long should you wait after a dive that did *not* involve decompression stops? 24 hours still, unless the flight altitude is at or below 8,000 ft MSL - then 12 hours minimum.

- ❏ Say instead, you did a dive NOT involving a controlled ascent 8 hours ago. You're flying on an airliner that will be keeping its onboard pressure altitude at 6,000 ft; however, the actual flight altitude (MSL) will be at least FL300. Would you be willing to be a passenger on this flight - why or why not? No, the 24 hour minimum wait time applies to actual flight altitudes (MSL), not pressure altitudes.
- ❏ Why actual flight altitudes? To ensure safety even in the event of a decompression event.

Hazardous Attitudes

- ❏ What is the first step toward neutralizing a hazardous attitude? Recognize the hazardous thought.
  - ❏ Then what? Label it as hazardous and state the corresponding antidote.
- ❏ List and explain the hazardous attitudes - provide an aviation-related example of each, along with the antidote for the hazardous attitude:

  - Anti-authority: "Don't tell me what to do." E.g., a new instructor who transferred from a different flight school refuses to follow the new company's policies that he or she thinks are excessive. Antidote: follow the rules, they are usually right.
  - Impulsivity: "Do it quickly." E.g., a recently certified private pilot suddenly gets the urge to fly, so he heads right to the airport, rents a plane, jumps in and flies without doing any weather/flight planning. Antidote: not so fast, think first.
  - Invulnerability: "It won't happen to me." E.g., despite having not spun a 172 since CFI training years ago, and despite not verifying that the plane has a CG in the utility category, a pilot decides to attempt a spin. Antidote: taking chances is foolish.
  - Macho: "I can do it." E.g., a pilot doesn't want to look weak in front of her new employer, so she attempts to land in a 30 knot crosswind despite this exceeding her personal mins. Antidote: taking chances is foolish.
  - Resignation: "What's the use?" E.g. a student feels fully unprepared for a checkride but agrees to take the checkride anyway because he feels that his flight school would never allow the cancellation. Antidote: I'm not helpless, I can make a difference.

Perform Self-Assessment, Including Fitness For Flight And Personal Minimums, For Actual Flight Or A Scenario Given By The Evaluator.

- ❏ What checklist does the FAA recommend using for a self-assessment to determine your own physical and mental readiness for flying? IMSAFE
  - ❏ Take me through this. Illness - am I sick? Medication - am I taking any medicines that might affect my judgment or make me drowsy? Stress - am I under serious psychological or physical pressure? Alcohol - have I been drinking? Fatigue - am I tired and not adequately rested? Emotion/Eating - am I emotionally upset? Am I hungry?
  - ❏ Say you managed only one hour of sleep last night - are there any regulations that explicitly prohibit you from flying today? No.
    - ❏ Would you fly? No.

- ❏ So clearly there are times when, in the interest of safety and proficiency, we need to do more than merely meet the minimum standards in the regulations. What sort of minimums should pilots always keep and abide by in order to minimize risk? Personal minimums.
- ❏ Take me though yours. **As the student runs through their personal minimums, the evaluator should propose scenarios that place the student in situations below their minimums - verify proper no-go decisions whenever personal minimums are violated.* https://www.faa.gov/training_testing/training/fits/guidance/media/personal%20minimums%20checklist.pdf

Area of Operation III. Airport and Seaplane Base Operations

Task A. Communications, Light Signals, and Runway Lighting Systems

References: 14 CFR part 91; AIM; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal and emergency radio communications, air traffic control (ATC) light signals, and runway lighting systems.

Knowledge:	The applicant demonstrates understanding of:
CA.III.A.K1	How to obtain appropriate radio frequencies.
CA.III.A.K2	Proper radio communication procedures and air traffic control (ATC) phraseology.
CA.III.A.K3	ATC light signal recognition.
CA.III.A.K4	Appropriate use of transponder(s).
CA.III.A.K5	Lost communication procedures.
CA.III.A.K6	Equipment issues that could cause loss of communication.
CA.III.A.K7	Radar assistance.
CA.III.A.K8	National Transportation Safety Board (NTSB) accident/incident reporting.
CA.III.A.K9	Runway Status Lighting Systems.

Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.III.A.R1	Communication.
CA.III.A.R2	Deciding if and when to declare an emergency.
CA.III.A.R3	Use of non-standard phraseology.

Skills:	The applicant exhibits the skill to:
CA.III.A.S1	Select and activate appropriate frequencies.
CA.III.A.S2	Transmit using standard phraseology and procedures as specified in the Aeronautical Information Manual (AIM) and Pilot/Controller Glossary.
CA.III.A.S3	Acknowledge radio communications and comply with ATC instructions or as directed by the evaluator.

- ❏ You are 30 miles out from your home base, a Class C airport, when you notice that the radios have been dead quiet for some time. What are you going to do? Fly the aircraft and troubleshoot.
  - ❏ Troubleshoot how? Check the radio frequency volume and the intercom/pilot volume, check headset connections, try a different headset, check your headset volume, verify you're on the correct frequency, try the previous frequency (if you forgot it, contact a FSS in order to get the appropriate one), turn the avionics switch off and on again, check the circuit breakers, press the mic and see if a "TX" is displayed next to the active com frequency - this indicates that your radio calls are transmitting properly.
  - ❏ Show me specifically how you would check both the com radio volume and the intercom/pilot volume. The knob by the com frequency controls that frequency's volume (so the volume of ATC and other traffic). The VOL/SQ knob toward the bottom of the audio panel controls the intercom volume - i.e., the volume of aircraft occupants' voices.
  - ❏ How can you verify that the radio frequency's volume is appropriate even when ATC or other aircraft are not talking? Press the com volume knob so that the squelch sounds and adjust the volume from there - the volume of the squelch matches the radio volume.
  - ❏ How can you determine whether the problem is a stuck mic? A white "TX" appears permanently by the active COM frequency.
  - ❏ You see that the white "TX" remains on permanently. You're now 25 miles out from your original Class C destination. Let's say that there's another ATP location approximately the same distance away, this one a Class D airport that you are moderately familiar with. There are also numerous untowered Class G airports in the vicinity. What are you going to do? Continue to prioritize flying the aircraft. I'll announce that I have a stuck mic and state my intentions, switch off the frequency so that I'm not clogging up the radios, and squawk 7600. Due to all the IFR and large commercial traffic that fly into Class C airports, as well as because the FAR/AIM doesn't detail VFR lost com procedures for Class C and B airports, I'll divert to the other ATP location, the Class D airport. If I had been completely unfamiliar with the Class D airport I probably would have initially headed to one of the untowered G airports just to get the plane on the ground and regroup and devise a plan to get back to an ATP location.
  - ❏ Would you consider lost coms to be an emergency scenario? No, not barring some aggravating circumstance like, say, low fuel, a sick passenger, rough running engine, total electrical failure at night in an unfamiliar area, etc. That said, if a different pilot feels it's an emergency then it's that pilot's prerogative to act accordingly. In that case, squawk 7700 instead of 7600.
    - ❏ How might a complete electrical failure (instead of just a stuck mic) alter your destination choice? I would be more inclined to head to one of the non-towered airports. Without electricity I won't be able to squawk 7600, the ADS-B won't work so detecting traffic would be much more challenging, ATC won't be able to see my altitude because the Mode-C/S and ADS-B Out capabilities would be gone, and a total electrical failure would likely be a sign of a larger electrical issue, one that could even be a fire hazard. So I'd just want to get the plane on the ground at one of the nearby Class G airports, regroup and go from there.

- ❏ Is there still a way that you could communicate and coordinate your lost-coms arrival with the Class D tower in the plane, even with a completely failed electrical system? Yes I could use my cell phone (easy with some headsets) . . . as long as I could locate the tower's phone number.

❏ So you're approaching the Class D airport with a stuck mic (the rest of your electrical system is operating correctly) . . . take me through your procedures for getting the plane safely and legally on the ground. I will follow the procedures in AIM 4-2-13 and remain outside or above the Class D airspace until I can determine the direction and flow of traffic. All of our planes have ADS-B so this should be easy to determine. (Otherwise, I would fly above the airspace for a better vantage point and observe pattern direction and traffic flow from there.) Then I'll switch to the tower frequency and state my type of aircraft, position, altitude, intention to land, and request to be controlled with light signals - then switch back off of the frequency.

❏ You haven't received a light gun signal yet, can you enter the Class D airspace? Yes, per the 4-2-13 "Receiver Inoperative" procedures.

❏ So you're heading toward the traffic pattern, what's next? Approximately 3 to 5 miles from the airport, I'll advise the tower of my position and join the airport traffic pattern - if I'm not sure of the location of other aircraft in the pattern, good ADM would have me remain 500 ft above the highest traffic pattern until I know that TPA is clear. From this point on I'll watch the tower for light signals, transmitting my position during each leg of the pattern before switching back off frequency.

❏ As you approach the pattern you receive a solid red light gun signal. What are you going to do? This signal means "give way and continue circling," so I'll acknowledge receiving the signal by rocking my wings, then give way and circle outside of (or above) the pattern while awaiting further light signal guidance.

- ❏ What is the procedure for acknowledging light signals at night? Flash the landing light or nav lights.
- ❏ How do you acknowledge light gun signals on the ground during the day? Move the ailerons or rudder.

❏ What signal would indicate that you are cleared to re-enter the pattern? Flashing green.

❏ Once established downwind you receive a solid green light signal, what does this mean? Cleared to land.

- ❏ If you never receive a solid green signal, can you land? No, not unless you intend to play the 91.3 emergency card, which in the case of a mere receive-only, stuck mic, lost coms situation is a bit far-fetched.
- ❏ Let's say you expect to see a solid green light signal so you glance briefly at the tower, see what you are expecting to see, then continue and land, only to get a phone number/deviation because the signal was actually a *flashing* green light and you never actually received a landing clearance. What is this common source of pilot error called? Expectation bias (aka confirmation bias).

❏ What if on final you see a flashing red signal, what will you do? The signal means "airport unsafe, do not land," so I will go around; provided no other light signals are given, I will depart the area and proceed to one of the Class G airports.

- *Instructors should alter the above scenario as necessary in order to test students' knowledge of ALL the light gun signals, both in the air and on the ground.*

❏ So you head to one of the Class G airports. It's now dark outside, and along the way your entire electrical system fails. Fortunately someone else in the pattern has turned on the lights. You see blue lights and white lights on the ground. Which lights outline the runway and which outline the taxiway? Runway edge lights are white, taxiway edge lights are blue.
  ❏ If this runway had centerline lights, what color would those be? White.
  ❏ How about taxiway centerline lights? Green.
  ❏ Let's say that this runway has a displaced threshold. It's night . . . which lights demarcate the beginning of the landing threshold? A bar of green threshold lights. There will also be Runway End Identifier Lights (REILs). Those are the white strobe lights flashing on each side of the approach end of the runway.
  ❏ As you roll out, you see taxiway lead on/lead off lights at each taxiway intersection. What color are those? Alternating yellow and green.
  ❏ As you roll out to the end of the runway - provided this is a precision approach runway - the colors of the runway edge lights and centerline lights change. Take me through when and how the lights change color. The runway edge lights change to yellow for the last 2,000 ft. The runway centerline lights are white until the last 3,000 ft of the runway. The white lights begin to alternate with red for the next 2,000 ft, and for the last 1,000 ft of the runway, all centerline lights are red.

❏ You go off the end of the runway and hit a fence. Do you have to self-report this to the FAA? If it qualifies as an "accident" or "serious incident," then yes. Otherwise no.
  ❏ Let's say that the plane is fine, but the sudden stop causes you to tweak your neck. A few days later the pain gets much worse and you end up at the hospital. Would you consider this an accident? Yes. Because I require hospitalization within 7 days, the occurrence qualifies as a serious injury, and therefore it's an accident.
  ❏ What exactly constitutes an "accident" to the FAA? *Death or serious injury* to a person onboard, or *substantial damage* to the aircraft.
  ❏ How are "serious injury" and "substantial damage" defined by the regulations?

  - *Serious Injury* - any injury which: (1) Requires hospitalization for more than 48 hours, commencing within 7 days from the date of the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.
  - *Substantial Damage* - damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component. Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires,

flaps, engine accessories, brakes, or wingtips are not considered “substantial damage” for the purpose of this part.

- ❏ So we’ve established that this is an accident. By when are you required to report it, and to whom? Immediately, and by the most expeditious means available, I would notify the nearest NTSB office. Then within 10 days I would send in a report per 830.15.
- ❏ Say the plane is totally wrecked when it hits the fence. Will you clean up the mess or leave it be? Why? I’ll leave it, because “the operator of an aircraft involved in an accident or incident for which notification must be given is responsible for preserving to the extent possible any aircraft wreckage, cargo, and mail aboard the aircraft, and all records, including all recording mediums of flight, maintenance, and voice recorders [...]”
- ❏ What if the wreckage is a potential safety issue for arriving and departing aircraft? Will you still leave it? If not, what will you do first? Yes in that case I’ll move the wreckage, but first I’ll document the crash as best I can with pictures and notes. FAR 830.10 states that “where it is necessary to move aircraft wreckage, mail or cargo, sketches, descriptive notes, and photographs shall be made, if possible, of the original positions and condition of the wreckage and any significant impact marks.”

- ❏ On a different note, what is a Runway Status Light System? How does it work? It’s an automated lighting system that provides runway status information to pilots in order to more clearly indicate when the runway is clear. Essentially, the system uses sensors that can detect the presence of aircraft taking off, landing, and crossing the runway - when the aircraft are off the runway, the sensors turn off the red in-pavement hold-position lights.
  - ❏ So when the red lights turn off, that means you can enter the runway? No, a verbal ATC clearance is still required - these lights *verify* an ATC clearance, they do not *substitute* for an ATC clearance.
  - ❏ What if ATC clears you, but the red lights remain illuminated? Query ATC and stay put.
  - ❏ What does it mean if you are approaching to land and the PAPIs are blinking at you? This is a FAROS (Final Approach Runway Occupancy Signal), and the blinking PAPIs indicate that the runway is occupied and that it may be unsafe to land.

Task E. Spin Awareness

References: AC 61-67; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM

Objective: To determine the applicant exhibits satisfactory knowledge of the causes and procedures for recovery from unintentional spins and understands the risk associated with unintentional spins.

Knowledge:	The applicant demonstrates understanding of:
CA.VII.E.K1	Aerodynamics associated with spins in various airplane configurations, including the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
CA.VII.E.K2	What causes a spin and how to identify the entry, incipient, and developed phases of a spin.
CA.VII.E.K3	Spin recovery procedure.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.VII.E.R1	Factors and situations that could lead to inadvertent spin and loss of control.
CA.VII.E.R2	Range and limitations of stall warning indicators (e.g., aircraft buffet, stall horn, etc.).
CA.VII.E.R3	Spin recovery procedure.
CA.VII.E.R4	Effect of environmental elements on airplane performance related to spins (e.g., turbulence, microbursts, and high-density altitude).
CA.VII.E.R5	Collision hazards.
CA.VII.E.R6	Distractions, task prioritization, loss of situational awareness, or disorientation.
Skills:	The applicant exhibits the skill to: [Intentionally left blank].

- ❏ What causes a spin? A full stall plus a yaw acting on the plane at, or beyond, the point of the stall - i.e., a stall plus a yaw.
- ❏ What can cause the plane to yaw? Being uncoordinated (too much rudder, or not enough - so a skid or a slip), turbulence/wind shear, torque, p-factor, slipstream, gyroscopic precession, improper aileron usage, wake turbulence, adverse yaw (a slip), asymmetrical thrust.
- ❏ You're in a climbing right turn and the plane stalls. You stomp on the left rudder at the point of the stall. Which direction will the plane spin? In the direction of the yaw, which in this case will be to the left because left rudder was applied.
- ❏ Do spins require both wings to be stalled or just one? At least one, per the AFH.
- ❏ Are the wings producing any lift in a stall and/or spin? Yes, in both a stall and a spin the wings are producing lift, just not nearly enough to maintain level flight.
- ❏ You're spinning to the left - which wing has the higher angle of attack? Which wing is producing more drag? The lower/inside wing is at the higher AOA and is creating more drag; it is more stalled, meaning it has exceeded the critical AOA greater than the higher wing.
    - ❏ What happens to this spin if you add left aileron, so aileron in the direction of the spin? Tightens/speeds up the spin and points the nose down - the plane tends to transition into a spiral, causing rapidly increasing loads.

- ❏ What happens to this spin if you use right aileron, so opposite the direction of the spin? The spin flattens, i.e., the nose rises and recovery becomes more difficult.

❏ To cause a spin to the right, would you step on the left or right rudder as the plane stalls? Right. The plane spins in the direction of the yaw, and right rudder causes a yaw to the right.

❏ During a spin, is the plane corkscrewing downward around its own vertical axis, or an outside independent spin axis? The plane follows a downward corkscrew path around an independent spin axis.

- ❏ What happens to the relationship between the plane's vertical axis and the spin axis during a flat spin? The axes move closer together.

❏ What does the ASI show once established in a spin? Stabilized at an airspeed around the stall speed, usually a little below.

❏ What's the difference between a spin and a spiral? In a spin the wings are stalled. In a spiral the wings are not stalled - the plane is just flying in a spiral dive toward the earth.

❏ Define a spin. A spin is an aggravated stall that typically occurs from a full stall occurring with the aircraft in a yawed state and results in the aircraft following a downward corkscrew path, i.e., "autorotation." The aircraft is basically descending due to gravity, rolling, yawing, and pitching in a spiral path.

❏ Aerodynamically, what causes the plane to enter the downward corkscrew formation of a spin? Both wings have exceeded their critical AOA's, but not equally. With gravity pulling the stalled plane downward, the lower wing is more stalled and therefore at a higher AOA, creating more drag; whereas the outboard/raised wing is less stalled, at a lower AOA, and therefore creating less drag and more lift.

❏ You're in a spin in IMC - how can you determine the direction of the spin? The miniature airplane/rate-of-turn indicator. It will be banked in the direction of the spin.

- ❏ What about the ball/inclinometer, could you use that? Why or why not? No, the FAA resources say the ball is unreliable. The location of the instrument in the airplane, rather than the direction of the spin, determines how the ball will move. For example, the ball mounted on the left side of the airplane will always move to the left, even in spin with rotation to the right.

❏ Why wouldn't you want to rely on the AI or the HI to determine spin direction? Their gyros tumble.

- ❏ Is that true for the G1000 as well? No, its instruments are solid state - no spinning gyros.
- ❏ Why doesn't the gyro in the Turn Coordinator tumble? It is secured with stoppers that prevent tumbling.

❏ You're in a spin in IMC, what tells you that you've transitioned from a spin into a spiral? ASI will start increasing, as you are no longer stalled.

❏ What are the stages of a spin? Entry, Incipient, Fully Developed, Recovery.

❏ What characterizes both the Incipient and Fully Developed stages? Incipient: first 2-4 turns where aerodynamic and inertial forces have not yet reached a balance. Fully Developed: plane is in equilibrium. Rate of rotation, rate of descent, and airspeed are all stabilized in a near-vertical downward flightpath.

- ❏ What is the generic spin recovery procedure for a single-engine aircraft? (Every 172 model POH/AFM details its own spin recovery nuances that should be followed; however, all closely resemble this generic recovery procedure listed in the AFH and AC 61-67c.) P.A.R.E. To be performed sequentially: Power (throttle) idle, ailerons neutral, rudder full opposite the direction of the spin, elevator briskly fwd (sufficiently to break the stall). Neutralize the rudder once the spinning stops and gradually apply back pressure in order to return to level flight.
- ❏ Explain the WHYS behind each spin recovery step.
  - Throttle idle: This reduces the left turning/yaw tendencies, slows the rate of rotation and rate of descent, and decreases airflow over the elevator in order to reduce negative lift (a down force on the tail) and help lower the nose to break the critical AOA, i.e., recover from the stall.
  - Ailerons neutral: Using aileron control opposite the spin direction flattens the spin by increasing the AOA on the lower wing, thus deepening that wing's stalled condition; because of the flatter (more nose-up) spin attitude, lowering the nose to break the critical AOA becomes more difficult. As for using same-direction aileron, this causes the plane to roll into a steeper (more nose-down) spin attitude, increasing the rate of rotation, increasing airspeed, potentially causing excess loads on the aircraft and delaying recovery.
  - Rudder full opposite (then held in that position): Considered by the AFH to be the most important control for spin recovery, this input resists the spin direction and yaws the plane out of the spin, i.e., stops the rotation.
  - Elevator briskly forward: this reduces the AOA below the critical AOA, thereby reattaching smooth airflow over the tops of the wings and breaking the stall. If the plane isn't stalled, it's not spinning.
- ❏ Per the AFH, approximately how many feet are lost in each 3 second turn in a spin? Once established in the spin: 500 ft (this translates to a 10,000 ft/min descent). The first spin rotation loses approximately 1,000 ft, however.
- ❏ What are the 3 types of spins listed in AC 61-67c, and which is the most dangerous? Incipient, fully developed, and flat. Flat spins are the most dangerous.
- ❏ What is a flat spin and why is it a particularly dangerous type of spin? A flat spin is a spin with a nose-high/pitched-up attitude. It is dangerous because it is harder to get the nose down in order to break the stall during the recovery.
- ❏ What is Piper's recommended PA-44-180 spin recovery procedure? (No spin tests have been conducted, and the PA-44-180 is not approved for spins, so this is a recommended procedure based on the best available information.) P.R.E.A. As soon as the spin is entered, and as near simultaneously and as forcefully as possible: power idle, rudder full opposite, elevator full forward, ailerons neutral. These controls should be held in this position until the rotation stops. Once the spinning has stopped, neutralize the rudder and slowly pull out of the dive.
- ❏ In ME aircraft, why is it imperative to input these controls as immediately as possible and as soon as spin development is recognized? The longer you wait, the less recoverable the spin becomes. Light twins are not required to undergo spin testing and thus are not designed to be spin recoverable.

- ❏ What effect does an aft CG have on spin recovery? Why? Makes it more difficult. The aft CG makes lowering the nose and breaking the critical AOA/stall more difficult. Conversely, with a fwd CG, not only does the nose naturally want to lower itself, there is also a longer arm between the CG and the control surfaces that are used to arrest the spin - i.e., the rudder and elevator - translating to more leverage.
- ❏ If you are in a spin with the flaps and/or landing gear extended, when should you retract them? As soon as practicable after spin entry, per the AFH.
- ❏ Approximately how many Gs does an aircraft experience in the fully developed phase of a spin? How about during the recovery phase? 1 G during the spin, 2.5 Gs during the recovery.
- ❏ Where and when are unintentional spins most likely to occur and why?
  - The takeoff and landing environment where airspeeds are slower, distractions are most prevalent, and task saturation is more likely. Base-to-final turns, go arounds, and short field takeoffs and approaches require particular vigilance when it comes to spin avoidance.
  - Delayed recoveries and bad technique while performing certain low-airspeed maneuvers such as stalls, slow flight, and especially one engine inoperative (OEI) maneuvers.
  - Disorientation leading to unusual attitudes and stalls during flight at night and/or in IMC.
- ❏ How can you determine whether your aircraft is certified for intentional spins? 1) TCDS, 2) limitations section of the POH/AFM, 3) placard in the cockpit.
- ❏ The 172 is certified for intentional spins only when the CG falls within what category? Utility.
  - ❏ What are this category's load limits? Utility. 4.4 to -1.76.
- ❏ Talk me through a left base-to-final turn resulting in a cross-control stall? In a misguided attempt at turning faster (say, after overshooting final), pilots may apply too much rudder (beyond the necessary rudder to maintain coordination) IN THE DIRECTION OF THE TURN, in this case to the left. Because the plane is already in a left bank, the nose will point downward (remember, you're only about 500 ft AGL at this point…) causing the pilot to pitch back and attempt to remove the bank by using right aileron. At this point the plane is at a low airspeed, and the pilot has applied left rudder, right aileron, and back pressure . . . all the ingredients necessary for a spin to occur, with minimal altitude available for a recovery.
  - ❏ Which direction will this plane spin? To the left.
- ❏ What are some other flight situations conducive to cross-control stalls?
  - Stalling during a fwd slip to land.
  - Losing track of airspeed and stalling during a crosswind landing while using the wing low sideslip technique.
  - Use of ailerons to counteract roll in a stalled condition.
- ❏ Is a spin an aerobatic maneuver? According to what? No, not according to the FAA's Finagin Legal Interpretation. It states: *"Spin training typically is conducted under three scenarios: (1) to meet the requirements for the issuance of an initial CFI certificate; (2) in conjunction with unusual upset instruction; and (3) in conjunction with aerobatic flight instruction. The first two scenarios typically are not considered aerobatic flight maneuvers because spin training maneuvers, in these circumstances, do not require use of a*

parachute and are required by regulation for particular certificates and ratings to simulate recovery procedures. 14 CFR § 91.307(d). The FAA distinguishes spin training in these scenarios from intentional spin aerobatic flight maneuvers."

- ❏ According to 91.303, aerobatic maneuvers are prohibited when, over any congested area of a city, town, or settlement; over an open air assembly of persons; within the lateral boundaries of the surface areas of Class B, Class C, Class D, or Class E airspace designated for an airport; within 4 nautical miles of the center line of any Federal airway; below an altitude of 1,500 feet above the surface; or when flight visibility is less than 3 statute miles. Do these prohibitions apply to spin training? No, the Finagin Legal Interpretation goes on to say, ". . . provided no additional aerobatic flight maneuvers are performed, spin training to meet the requirements of a CFI certificate or associated with upset recovery training are not considered aerobatic maneuvers, and the requirements of § 91.303 do not apply." Regardless, not abiding by 91.303 when performing intentional spins would show abysmal ADM.
- ❏ During spin training for the 61.183(i) endorsement, are the student and IP required to wear parachutes? Why or why not? No. According to 91.307(c), parachutes are not required when performing spins required by the regulations for a certificate or rating when the training is being conducted by a CFI.

Area of Operation VIII. High-Altitude Operations

Task A. Supplemental Oxygen

References: 14 CFR part 91; AC 61-107; AIM; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with flight at higher altitudes where supplemental oxygen is required or recommended.

Knowledge:	The applicant demonstrates understanding of:
CA.VIII.A.K1	Regulatory requirements for supplemental oxygen use by flight crew and passengers.
CA.VIII.A.K2	Physiological factors, including:
CA.VIII.A.K2a	a. Impairment
CA.VIII.A.K2b	b. Symptoms of hypoxia
CA.VIII.A.K2c	c. Time of useful consciousness (TUC)
CA.VIII.A.K3	Operational factors, including:
CA.VIII.A.K3a	a. Characteristics, limitations, and applicability of continuous flow, demand, and pressure-demand oxygen systems
CA.VIII.A.K3b	b. Differences between and identification of "aviator's breathing oxygen" and other types of oxygen
CA.VIII.A.K3c	c. Precautions when using supplemental oxygen systems
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.VIII.A.R1	High altitude flight.
CA.VIII.A.R2	Use of supplemental oxygen.
CA.VIII.A.R3	Management of compressed gas containers.
CA.VIII.A.R4	Combustion hazards in an oxygen-rich environment.
Skills:	The applicant exhibits the skill to:
CA.VIII.A.S1	Determine the quantity of supplemental oxygen required in a scenario given by the evaluator.
CA.VIII.A.S2	Operate or simulate operation of the installed or portable oxygen equipment in the airplane, if installed or available.
CA.VIII.A.S3	Brief passengers on use of supplemental oxygen equipment in a scenario given by the evaluator.
CA.VIII.A.S4	Use single-pilot resource management (SRM) or crew resource management (CRM), as appropriate.

* *Note: hypoxia is covered more thoroughly in the "Human Factors" task.*

- ❏ Why do you think it's important for pilots to have the concepts in FAR 91.211 - supplemental oxygen requirements - committed to memory? Because ATC generally has no idea whether my aircraft has supplemental oxygen or even what the 91.211 regulations require, meaning ATC often issues climb instructions that pilots must be prepared to reject when flying aircraft that are not equipped with supplemental oxygen.
- ❏ During a day flight, you are told to climb to 12,500 ft and that you can expect to be at that altitude for the next couple hours. Can you accept? Legally yes. The oxygen requirements are *above*-type requirements, meaning each additional restriction kicks in *above* the

associated cabin pressure altitude threshold. So for instance, the requirement for crew to use supplemental oxygen kicks in when flying *above* a cabin pressure altitude of 12,500 ft for more than 30 minutes. So 12,500 would be the highest VFR cabin pressure altitude permitted for operation without supplemental oxygen.

- ❏ During a day flight, you are told to climb to 13,500 ft and that you can expect to be there for 15 minutes. Can you accept? Legally yes, as long as the time spent above 12,500 ft does not exceed 30 minutes. Good ADM would likely require an "unable" reply, though, as it will take significant time to climb to 13,500 and descend back to 12,500, and the 15 minutes is just ATC's projection.
- ❏ How might your answers to the previous two questions change if you were flying at night? The legal answers to both would still be "yes"; however, the FAA recommends the use of supplemental oxygen at night when operating at altitudes above 10,000 ft during the day and 5,000 ft at night.
  - ❏ Why so low for night flying? Mostly because night vision tends to degrade rapidly above a 5,000 ft pressure altitude. Eyes use rods at night, and rods are much more sensitive to oxygen deprivation than cones, which we use to see during the day. Also, pilots are generally more fatigued when flying at night, and fatigue aggravates the effects of hypoxia.
- ❏ Specifically, what are the general supplemental oxygen requirements? Required to be used by the required flight crew above a 12,500 ft cabin pressure altitude up to 14,000 ft when at those altitudes for more than 30 min. Required to be used by the required flight crew at all times above a cabin pressure altitude of 14,000 ft. All occupants must be *provided* with oxygen above a cabin pressure altitude of 15,000 ft.
  - ❏ When you say "cabin pressure altitude," do you mean that if you are operating with an altimeter setting below standard, say 29.72, at a flight altitude of 12,500 ft MSL for more than 30 minutes, that you would be required to use supplemental oxygen? Because the pressure altitude in the cabin is above 12,500? Yes.
- ❏ Are these general supplemental oxygen requirements for all aircraft or only those without pressurized cabins? All. E.g. if the cabin pressure altitude on a pressurized aircraft were to exceed 12,500 ft for more than 30 min, the required crew would have to use supplemental oxygen, etc.
- ❏ Take me through the supplemental oxygen requirements that apply to aircraft with pressurized cabins. The general requirements still apply. In addition, at least a 10 minute supply of supplemental oxygen must be available for each occupant for flights above FL250. Above FL350, at least one pilot at the controls needs to be using supplemental oxygen; however, there is an exception to this rule if quick-donning masks are available: as long as there are two pilots at the controls, neither needs to be using supplemental oxygen. This exception goes away above FL410.
- ❏ What qualifies as a quick donning mask? Basically a mask that can be secured on the face with one hand and start supplying oxygen within 5 seconds.
- ❏ What is the major risk of flying at an altitude above 10,000 ft without using supplemental oxygen? Hypoxic hypoxia.

- ❏ What else might lead to hypoxic hypoxia, other than flying a non-pressurized aircraft above 10,000 ft without supplemental oxygen? A rapid or explosive decompression event, a pressurization system malfunction, or an oxygen system malfunction.
- ❏ On a physiological level, what causes hypoxic hypoxia when flying at high altitudes without supplemental oxygen? The partial pressure of oxygen is so reduced at higher altitudes that when this low-pressure oxygen gets delivered to the lungs, the lungs can't use it - i.e. the lungs can't transfer the oxygen from the ambient air to the blood to be carried throughout the body.
- ❏ What kind of symptoms would you expect from hypoxic hypoxia? Cyanosis (blue fingernails and lips), inflated sense of well being or euphoria, headache, decreased response to stimuli/increased reaction time, impaired judgment and alertness, visual impairment, drowsiness, lightheaded or dizzy sensation, tingling in fingers and toes, numbness, tunnel vision.
- ❏ Other than fatigue and night flying, what can aggravate the effects of hypoxia? Smoking, alcohol, drugs, poor physical fitness or an underlying medical condition like anemia, certain over-the-counter medications, as well as any situation that increases the body's demand for oxygen, such as extreme heat and cold, fever, and anxiety.
- ❏ What are the 3 components of most oxygen systems? Storage system (containers), delivery system, mask or nasal cannula.
- ❏ On a commercial airline flight, what type of oxygen delivery system would you expect the aircraft to provide for passengers? Continuous flow.
- ❏ What type of oxygen delivery system uses the dixie cup? Continuous flow.
- ❏ How does this system work? A continuous flow of oxygen is delivered into a rebreather bag. The passenger breathes in this oxygen through an oral/nasal cup or an airline drop-down unit (dixie cup). Exhaled air is released to the cabin.
- ❏ Continuous flow systems are considered effective up to approximately what altitude? 25,000 ft.
- ❏ You're cleared for a climb to FL350. What type of oxygen delivery system(s) would be necessary for the pilots? Diluter demand or pressure demand.
- ❏ Describe how a diluter demand system works. Oxygen is delivered only when the user inhales, thus the "demand" part of the name. At lower altitudes some of the supplemental oxygen that the user inhales is diluted with outside air. As the altitude increases, the oxygen becomes less and less diluted, eventually becoming 100% pure oxygen.
  - ❏ Up to what altitude is this system considered effective? 40,000 ft.
- ❏ You're cleared for a climb above FL400. What type of oxygen delivery system is necessary for the pilots? Pressure demand.
  - ❏ Describe how this oxygen system works. The only difference between pressure and diluter demand systems is that pressure demand supplies the oxygen to the mask and lungs under pressure. This makes pressure demand safe to use above 40,000 ft, where 100% oxygen without positive pressure will not suffice.
- ❏ What type of oxygen are pilots required to use, and why? Aviator's Breathing Oxygen, because it abides by the *Aviator's Breathing Oxygen Purity Standard,* which requires at least 99.5% pure oxygen (in practice the oxygen is virtually 100% pure, as are medical, welding, and research oxygen).

- ❏ During a preflight, how can pilots verify that the oxygen in the supplemental oxygen container(s) is Aviator's Breathing Oxygen? It'll be labeled as such.
- ❏ Why does the FAA advise against using medical grade oxygen? Because of the potential for water molecules that can freeze in low temperature environments and clog the oxygen delivery lines.
- ❏ What precautions should be taken when it comes to servicing, handling, and storing oxygen? Why? Not only is oxygen flammable, but it renders materials combustible that are normally nearly fireproof. Because of this, oils and greases should not be stored in the vicinity of the oxygen, nor should they be used to seal the valves and fittings of oxygen equipment. Also, smoking during the use or servicing of any kind of oxygen equipment is also strictly forbidden. When it comes to servicing the oxygen, the FAA advises marking the bottle with the recommended pressure (usually 1,800-2,200 psi) before filling the tank to that pressure level.
- ❏ What checklist can pilots use to ensure a proper preflight check of the oxygen system? Describe it. PRICE: Pressure (ensure that there is enough oxygen pressure and quantity to complete the flight), Regulator (inspect the oxygen regulator for proper function), Indicator (ensure that the flow indicator shows a steady flow of oxygen when in use), Connections (make sure all the connections are secured), Emergency (ensure sufficient oxygen for any emergency that might occur during the operation. This step should include briefing the passengers on the location of oxygen and its proper use).

Task B. Pressurization

References: AC 61-107; AIM; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with flight in pressurized aircraft at high altitudes.

Knowledge: The applicant demonstrates understanding of:

CA.VIII.B.K1	Fundamental concepts of aircraft pressurization system, including failure modes.
CA.VIII.B.K2	Physiological factors, including:
CA.VIII.B.K2a	a. Impairment
CA.VIII.B.K2b	b. Symptoms of hypoxia
CA.VIII.B.K2c	c. Time of useful consciousness (TUC)
CA.VIII.B.K2d	d. Effects of rapid decompression on crew and passengers

Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.VIII.B.R1	High altitude flight.
CA.VIII.B.R2	Malfunction of pressurization system, if equipment is installed.

Skills:	The applicant exhibits the skill to:
CA.VIII.B.S1	Operate the pressurization system, if equipment is installed.
CA.VIII.B.S2	Respond appropriately to simulated pressurization malfunctions, if equipment is installed.
CA.VIII.B.S3	Brief passengers on use of supplemental oxygen in the case of pressurization malfunction, if equipment is installed.
CA.VIII.B.S4	Use single-pilot resource management (SRM) or crew resource management (CRM), as appropriate.

** Note: the "Symptoms of Hypoxia" element is covered thoroughly in the Human Factors task.*

- ❏ What are some of the main reasons that aircraft fly at high altitudes? To avoid bad weather/turbulence, avoid terrain, fuel efficiency (an aircraft flown at high altitudes consumes less fuel for a given airspeed than it does for the same speed at a lower altitude), and to fly at faster groundspeeds.
- ❏ What prevents occupants from being hypoxic all the time when operating at high altitudes? Cabin pressurization or supplemental oxygen.
- ❏ Let's say you just passed your Private Airplane Multiengine Land practical test. Can you immediately jump in a multiengine pressurized aircraft and pilot it? More than likely I'll likely need a high-altitude endorsement. Plus, most pressurized aircraft require a type rating, so I'll probably need one of those as well.
  - ❏ Is this high-altitude endorsement always required to fly pressurized aircraft? No it's technically only required if the aircraft is pressurized AND has a max operating altitude or service ceiling above 25,000 ft MSL, whichever is lower.
  - ❏ Do you have to carry this endorsement on you (so carry your logbook) when you fly pressurized aircraft? No.
  - ❏ Where are the requirements to receive the high altitude endorsement listed? 61.31(g)
- ❏ How does a basic pressurization system work? Pressurized air from the compressor section of the engine is allowed to bleed into the aircraft. A heat exchanger cools the hot compressed air before it enters the cabin. Then valves onboard control the exit of this pressurized air through a controlled leak - the valves either close in order to trap the pressurized air inside the aircraft and lower the cabin pressure altitude, or they open to let

the pressurized air escape in order to increase the cabin pressure altitude. This process is all controlled automatically by a *cabin pressure regulator*.

- ❏ Name and describe the functions of these valves (each pressurized aircraft has its own unique system - just describe the generic valve system detailed in the PHAK). The *outflow valve(s)* is the primary pressure-regulating valve that opens and closes in order to regulate how much pressurized air exits the aircraft; this allows for a constant inflow of high-pressure air to the pressurized areas of the aircraft, followed by a controlled leak through the outflow valve(s) back out to the atmosphere. The *safety valve* is a combination pressure relief, vacuum relief, and dump valve (in practice these are often separate valves). The pressure relief component prevents cabin pressure from being too high in relation to that of the ambient air pressure (provides redundancy for the outflow valve). The vacuum relief component prevents ambient air pressure from exceeding cabin air pressure by allowing external air to enter the cabin in the rare event that ambient pressure exceeds cabin pressure. The dump valve aspect just dumps all the cabin air into the atmosphere.
  - ❏ What is a scenario where vacuum relief might be necessary - i.e. when would ambient air need to be let INTO the cabin to prevent a situation where the air pressure inside the cabin is lower than outside? Rapid or emergency descents.
  - ❏ What's so bad about the air pressure inside the cabin being lower than outside? The walls of the aircraft are built to expand and withstand low external pressure/high internal pressure situations, not the other way around.
  - ❏ When would it be necessary to use the dump valve? When there is a need to immediately depressurize an aircraft during an emergency such as a cracked window, contaminated bleed air, a cabin fire that can be controlled or extinguished by starving it of oxygen, or the need to clear the cabin of smoke.
- ❏ What prevents the compressed air from being excessively hot? The compressed air goes through some sort of heat exchanger before being ducted into the cabin.
- ❏ What other function(s) does a pressurization system serve? Removes odors in the cabin by keeping fresh air circulating; prevents excessive pressure differentials between the air inside and outside of the cabin (which can weaken or damage the structural integrity of the aircraft); prevents altitude sickness and other high-altitude related physiological conditions among occupants; moderates the rate of pressure change inside the cabin for occupants' comfort; keeps belongings/baggage from becoming damaged.
- ❏ What maximum cabin pressure altitude do most airline pressurization systems maintain? 8,000 ft.
- ❏ Are baggage compartments pressurized as well? Yes.
- ❏ The pressurization system fails during a flight at 40,000 ft. How long until your performance becomes impaired? Immediately. Although my Time of Useful Consciousness (TUC) would be a bit longer.
  - ❏ Does TUC refer to the *onset* of unconsciousness? No. Impaired performance may be immediate.
  - ❏ So how do you define TUC? This is the period of time from exposure to an oxygen-poor environment, to the time when an individual is no longer capable of taking proper corrective and protective action.
  - ❏ What TUC would you expect at 40,000 ft? Approximately 15-20 seconds.

- ❏ How about at 20,000 ft and 30,000 ft? 5-12 minutes or more for 20,000 ft (duration varies among the FAA sources); 1-2 minutes at 30,000 ft.
- ❏ How precise are these TUCs? Not very. They vary according to each person's sensitivity to oxygen deprivation, as well as according to how rapidly pressurization is lost. *Rapid* decompression, for instance, greatly reduces these TUCs.
- ❏ If a rapid decompression situation occurs, by how much would you reduce the expected TUC? 50% (per AC 61-107).

❏ A cabin window just blew out at FL350. What type of decompression would you expect? Depends on the size of the aircraft and the capabilities of the pressurization system. A very small jet would decompress explosively or rapidly, whereas a large jet might actually be able to maintain some degree of pressurization.

❏ If the pressurization system slowly fails, what kind of decompression would occur? Gradual (aka slow).

❏ A large chunk of the roof of the aircraft just blew off at FL350. What kind of decompression would occur? Explosive.

❏ What distinguishes explosive from rapid decompression? The primary difference is that during explosive decompression, the cabin pressure decompresses faster than the lungs; in rapid decompression, the lungs are able to decompress before the cabin.

❏ Time-wise, what is the cut-off between rapid and explosive decompression? Any decompression that occurs in less than .5 seconds is considered explosive.

❏ Besides the potential for getting sucked out of the aircraft, what makes explosive decompression so dangerous? When the air inside your lungs cannot decompress before the ambient air, the air inside your lungs gets pulled out with enough force to potentially cause lung damage. Dangerous flying debris will also be more likely.

❏ How would you expect the cabin environment to change after a rapid or explosive decompression event? There would likely be noise, fog, flying debris, dust, wind blast, cooler temperatures, and gas expansion in the body.

❏ Why fog? The ambient air rushing into the cabin causes a rapid temperature drop and thus a change to the relative humidity.

❏ Which type of decompression is the most dangerous, and why? The AC says that "slow decompression is as dangerous as or more dangerous than a rapid or explosive decompression." This is because "by its nature, a rapid decompression commands attention. In contrast, a slow decompression may go unnoticed and the resultant hypoxia may be unrecognized by the pilot."

❏ What is the best indication of gradual decompression? Automatic visual and aural warning systems generally provide an indication of slow decompression. In addition, having experience in an altitude chamber allows the occupant to more immediately recognize signs and symptoms of hypoxia.

❏ What are the dangers associated with decompression? Hypoxic hypoxia is the primary one. Another danger is evolved gas decompression sickness, wind blast, being struck by debris, and being tossed or blown out of the aircraft if located near the opening(s).

❏ What are some of the associated cabin instruments that you would expect to see on an aircraft with a pressurization system? What do they measure/indicate? Cabin rate-of-climb indicator, cabin altimeter, and a cabin differential pressure indicator. The cabin rate-of-climb

indicator shows the rate-of-climb and descent of cabin pressure; the cabin altimeter shows the pressure altitude of the cabin; the cabin differential pressure indicator shows the difference in air pressure between inside and outside of the aircraft.

Task C. Systems and Equipment Malfunctions

References: FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM

Objective: To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with system and equipment malfunctions appropriate to the airplane provided for the practical test.

Knowledge:	The applicant demonstrates understanding of:
CA.IX.C.K1	Causes of partial or complete power loss related to the specific type of powerplant(s).
CA.IX.C.K1a	a. [Archived]
CA.IX.C.K1b	b. [Archived]
CA.IX.C.K1c	c. [Archived]
CA.IX.C.K1d	d. [Archived]
CA.IX.C.K2	System and equipment malfunctions specific to the aircraft, including:
CA.IX.C.K2a	a. Electrical malfunction
CA.IX.C.K2b	b. Vacuum/pressure and associated flight instrument malfunctions
CA.IX.C.K2c	c. Pitot-static system malfunction
CA.IX.C.K2d	d. Electronic flight deck display malfunction
CA.IX.C.K2e	e. Landing gear or flap malfunction
CA.IX.C.K2f	f. Inoperative trim
CA.IX.C.K3	Causes and remedies for smoke or fire onboard the aircraft.
CA.IX.C.K4	Any other system specific to the aircraft (e.g., supplemental oxygen, deicing).
CA.IX.C.K5	Inadvertent door or window opening.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
CA.IX.C.R1	Checklist usage for a system or equipment malfunction.
CA.IX.C.R2	Distractions, task prioritization, loss of situational awareness, or disorientation.
CA.IX.C.R3	Undesired aircraft state.
CA.IX.C.R4	Startle response.
Skills:	The applicant exhibits the skill to:
CA.IX.C.S1	Determine appropriate action for simulated emergencies specified by the evaluator, from at least three of the elements or sub-elements listed in K1 through K5.
CA.IX.C.S2	Complete the appropriate checklist(s).

** The unique context of any emergency and all of its near-infinite nuances will dictate a pilot's appropriate course of action. As such, there is no single, perfectly correct answer to many of these questions - the answers provided are simply good answers (in the experience and opinion of the writer) among perhaps many. That said, WRONG answers certainly do exist. Ultimately, a good answer should involve making clear that you intend to first and foremost fly*

the aircraft, incorporate the checklist while efficiently and effectively addressing the malfunction/emergency, communicate effectively, and exercise good ADM in order to get the plane safely on the ground. ***Recommended procedures in the POH/AFM and per ATP must be followed at all times.***

Note - Unless specified otherwise, the following scenarios presume the pilot is flying a G1000-equipped CE-172S Nav III. Its electrical, vacuum, pitot/static, and, obviously, avionics systems can vary significantly from those in conventional CE-172 aircraft. Refer to sections 3 and 7 of your 172 model's POH/AFM for accurate information regarding emergencies and systems.

- ❏ During an emergency situation, what is the pilot's most important task? FLY THE AIRPLANE. To quote the POH directly: "In any emergency situation, the most important task is continued control of the airplane and maneuvering to execute a successful landing."
- ❏ You're in the practice area working on maneuvers when the engine starts running slightly rough. What are you going to do? Fly the airplane. Accomplish the appropriate memory items: carb heat on (if equipped), mixture adjust for max smoothness, fuel pump on, engine gauges check, magnetos check, adjust the throttle position. Refer to the checklist to verify compliance. If the roughness persists, or depending on the original cause of the roughness, I'll head toward an airport and land as soon as practical. I will also notify ATC of the issue in order to prevent any undue delays getting a landing clearance, and I'll be ready to declare an emergency and squawk 7700 as well, depending on whether the "slight" roughness worsens.
  - ❏ What are some possible causes of this rough-running engine? Carb ice (if carbureted), mixture too lean or too rich, throttle idle with mixture full rich (such as during certain low-engine-speed maneuvers like power off stalls, or when approaching to land at high density altitude airports), detonation or pre-ignition (if climbing on a hot day, generally with the mixture too lean), fouled spark plugs, a magneto malfunction, engine-driven fuel pump failure, fuel starvation, water/contaminants in the fuel, excessive fuel vapor (if fuel injected), low oil pressure/oil leak.
  - ❏ How would you determine that the issue is carb ice? After applying the carb heat, the ice will melt and dislodge from where it has accumulated, resulting in the ice draining through the system, causing additional engine roughness. This roughness will gradually smooth out, and eventually the RPM needle (or Manifold Pressure if flying a constant speed prop) will rise above where it was before when the ice was still present in the carburetor.
  - ❏ What should accompany any application of carb heat, and why? Lean the mixture. Carb heat reduces the density of the air going into the engine. Leaning the mixture keeps the fuel/air ratio appropriate.
  - ❏ Say you check the left mag and the engine roughness becomes more pronounced. You switch to the right mag and the engine runs smoothly. What could be causing the roughness, and what will you do? Fly the airplane. In this case, slight engine roughness is typically a sign of a fouled spark plug, so I'll lean the mixture while staying in the vicinity of (or heading to) an airport and wait for the problem to clear up, verifying

everything with the checklist. If the issue doesn't clear up, I'll operate on both mags if able, and if not, then on the good mag, and land as soon as practical. Sudden onset roughness or misfiring, on the other hand, would indicate a magneto problem. If that were the case I would try to operate on BOTH magnetos if possible; if not, I'd change to the good mag and continue to the nearest airport. I would be sure to utilize the checklist and communicate as appropriate with ATC.

- ❏ You notice a sudden reduction in the fuel flow indication (FFLOW GPH) immediately before a loss of power while operating from a fuel tank containing adequate fuel. What's the issue and what are you going to do? Engine driven fuel pump failure. Fly the airplane, turn on the aux fuel pump switch, run the appropriate checklist, and land as soon as practical. Be prepared to potentially declare an emergency and squawk 7700.
- ❏ What signals low oil pressure in your aircraft? Low oil annunciator. Also, the oil pressure gauge on the engine page or the oil psi on the system page should read low.
  - ❏ As oil pressure is lost, what would you expect the oil temperature to indicate, and why? Oil temperature will rise. One of the purposes of oil is to cool the engine, so if oil is lost, temp will rise.
  - ❏ You're enroute and the low OIL PRESSURE annunciator illuminates. You check your oil pressure gauge and it indicates low, slightly inside the red band; oil temperature is elevated and rising. What is the major concern here, and what are you going to do? The concern is that there is an oil leak that could lead to an engine failure. I'll fly the airplane, reduce power immediately in order to coddle the engine, run the appropriate checklist, and look to land immediately, possibly even doing a forced landing if there is no airport in the immediate vicinity and depending on how the engine feels. I will also declare an emergency and squawk 7700.
  - ❏ Say you're climbing out of an airport in the Phoenix area in the summer and your oil temperature gauge indicates high, but within the green range. What will you do? Fly the airplane while doing what I can to cool off the engine: pitch down to increase airspeed and airflow over the engine; richen the mixture; reduce throttle. If the engine doesn't cool off, I'll consider heading back to my departure airport.
- ❏ In a fuel injected 172, you fly into the clouds and rapidly begin picking up rime ice on the wing struts. If the induction air filter becomes blocked with ice as well, what will you expect to happen? How will you get alternate induction air to the engine? The blockage will cause suction generated from the engine to open a door inside the lower cowl area which will allow alternate induction air into the engine. The process is automatic - no pilot action required. A 10% approximate power loss can be expected.
- ❏ ATC sets you up for a slam dunk approach (i.e. brings you in high, requiring a steep descent angle) in a carbureted 172. You're in IMC and the temperature gauge shows 10 degrees celsius. What's the big concern here, and what will you do to negate it? This approach will likely require a rapid descent at low power settings, a configuration prone to accruing carb ice. To prevent this, preemptively apply carb heat and lean the mixture.
- ❏ You're enroute in a carburated 172. The OAT is 0 degrees celsius. Unwisely, you enter IMC and immediately start picking up structural ice. Suddenly, the engine struggles for a bit, then quits. What do you think happened? The air induction source is blocked with ice.
  - ❏ How do you get alternate air to the engine? Apply carb heat.

- ❏ You're practicing maneuvers about 30 miles away from your home airport (it's the nearest airport) when you hear a warning tone and notice a LOW FUEL L annunciator message. What does this annunciator tell you? Means that the fuel quantity in the left tank is less than 5 gallons and has remained that way for more than 60 seconds.
  - ❏ Your fuel indicator shows 7 gallons on the right tank. What are you going to do? Fly the airplane. Use the fuel selector to select the RIGHT tank, and head to the nearest airport. When close, I'll return the fuel selector to the BOTH position prior to descending to land, as the RIGHT and LEFT positions are for straight-and-level flight only.
  - ❏ Say that as you approach your destination, your low fuel levels are such that you cannot accept any undue delays. What would you declare? "Minimum fuel."
  - ❏ Does this imply a need for traffic priority? No, not per AIM 5-5-15.
  - ❏ What should you do if you feel the need for traffic priority to ensure a safe landing? Declare an emergency.
- ❏ 45 minutes away from your destination airport the LOW VOLTS annunciator appears. What does this indicate? System voltage is below 24.5 volts. This means that the alternator is not supplying sufficient power - the battery is being drained.
  - ❏ The battery is rated at 8 amps/hour. What does this mean? When brand new/fully charged, it can support an 8 amp system for an hour before being completely drained.
  - ❏ For how long would an 8 amp hour battery support an electrical system running at 16 amps before dying? If new and fully charged, 30 minutes.
    - ❏ And how much battery life could you count on? About half of that, so around 15 minutes.
  - ❏ So you're 45 minutes away from your destination, the LOW VOLTS annunciator is on, and the M BAT AMPS meter is showing a 6 amp discharge. What are you going to do? Fly the airplane. Run the "Low Volts Annunciator During Flight" checklist: ALT switch off > alternator CB (ALT field) check in > ALT switch back on. Continue to my destination.
  - ❏ After running the checklist, the LOW VOLTS annunciator remains illuminated. What now? Continue with the "If Low Volts Annunciator Remains On" and "Electrical Load Reduction" checklists - i.e. turn the alternator switch off and reduce the electrical load as much as possible. Let ATC know about the issue.
  - ❏ Will you still continue to your original destination, or land as soon as practical? Why? To add some context, say your destination is a Class D airport that is your home base. There are also numerous Class G airports in the vicinity. I will continue to my original destination. The 6 amp discharge means that the battery should support the entire system for a little over an hour (provided it's an 8 amp/hour battery), although I will only count on half of that, so 30 minutes. But once the main battery is drained, the standby battery/essential bus will kick in and provide at least 30 minutes of additional electrical power for all of the essential equipment.
  - ❏ What will you expect to change about your approach when operating on the standby battery? I won't be able to extend the flaps - flaps aren't on the essential bus, which is the bus powered by the standby battery.
  - ❏ If you really wanted access to the flaps (say if you are landing on a short field), what could you have done to ensure that main battery life would still be available when you arrive at your destination airport? Section 7 of the POH says that "if the alternator

system fails, the MASTER switch may be set in the OFF position to preserve main battery capacity for later in the flight." So in this case, you'll drain the standby battery first (while operating off only the essential equipment), then switch the fully-preserved main battery back on upon arrival at the destination.

- ❏ In the plane, what is an easy way to determine which equipment will work while operating off of the standby battery? Look at the circuit breakers - the equipment powered by the essential bus will be operable.

❏ In flight, the HIGH VOLTS annunciator illuminates. What does this mean, and what are you going to do? This means that there is an overvoltage situation (alternator is producing more than 32 volts) and the ACU automatic alternator shutdown process has failed. While flying the airplane, I will immediately turn off the alternator switch and reduce the electrical load. Follow the checklist and land as soon as practical.

❏ When the ALT FIELD circuit breaker pops, what problem does this indicate? An overvoltage situation occurred so the ACU automatically took the alternator offline.

- ❏ What will you do if you see this in flight? The popped CB will be accompanied by a LOW VOLTS annunciator because the electrical system is now running off of the battery. So I will follow the "Low Volts Annunciator During Flight" checklist and turn the Alternator switch off, push the Alternator circuit breaker back in, then turn the Alternator switch back on. Verify the M Bus Volts and M Bus Amps read appropriately, then make a PIC determination about whether to continue or land as soon as practically. Communicate with ATC as appropriate.

❏ If the vacuum pump fails, which instrument(s) will be affected and what indications would you expect to see? The standby attitude indicator will fail. A LOW VACUUM annunciator will display on the PFD and a low-vacuum warning flag will appear on the standby attitude indicator.

- ❏ Specifically, what sets off the LOW VACUUM annunciator? When suction from the engine-driven vacuum pump drops below 3.5 in. hg (or 3.0 in. hg for non-G1000 aircraft).
- ❏ Normal operating range is 4.5-5.5. If there's no annunciator but the vacuum pointer on the MFD's engine page reads below the green band, is the standby attitude indicator reliable? No, use the attitude indicator on the PFD.

❏ You're in the clouds on your final descent to land and the OAT is approx 0 degrees C. You notice your airspeed increasing as you descend despite the fact that you haven't increased either power or your rate-of-descent. What do you think the problem is? Blocked static port.

- ❏ What are you going to do? Apply Alternate Static. USE THE CHECKLIST: Alt static air valve ON > Cabin Vent CLOSED > Cabin Heat and Cabin Air Control Knobs ON > Airspeed - refer to POH Section 5 calibration chart.
- ❏ What is the alternate static's air source? Air inside the cabin.
- ❏ Is the pressure of the cabin air lower or higher than the ambient air pressure? Lower.
- ❏ What indications will you get on your pitot/static instruments when you use the alternate static? ASI and altimeter will show a small increase/climb. VSI will momentarily rise, then return to 0.
- ❏ With the static port blocked, what does the ASI read while flying at the altitude where the blockage occurred? Accurately.

- ❏ Same scenario where you are descending in IMC with temps around freezing. This time, however, as you descend, your airspeed also continues dropping. What's the problem and what will you do? The ram air and drain holes on the pitot tube are blocked, static open. I will turn on the pitot heat (*should've* been turned on well before entering the IMC…), turn on alternate static (in case the static port becomes blocked as well), get out of the clouds, and run the icing checklist.
- ❏ When maintaining altitude with blocked ram and drain holes, what does the airspeed indicator show when accelerating and decelerating? No change. When both holes on the pitot tube are blocked, the ASI will only respond to altitude changes (will act like an altimeter).
- ❏ What does your ASI indicate if the ram air hole is blocked, but the pitot tube drain and static port are both unobstructed? 0 kt.
- ❏ So blockages don't cause red Xs over the pitot/static instruments? No, the Xs are caused by malfunctions in the avionics systems.

❏ The ADC just failed. Which instruments are affected, and how? The airspeed indicator, altimeter, VSI, TAS, and OAT all display red Xs. Mode-C/ADS-B Out capability will also fail (pressure altitude data is no longer available to the transponder) so the transponder will revert to Mode A.

- ❏ You're at cruise altitude in IMC heading to a Class C airport when this happens. What are you going to do? Fly the airplane. Check the ADC/AHRS circuit breaker - if popped, I'll reset it once. I'll use the backup airspeed indicator and altimeter, and run the appropriate checklist. I'll also inform ATC about the failure and make sure that I have permission to enter the Class C without an altitude-reporting transmitter, as a Mode C or S transponder is required and ours is now Mode A.
- ❏ Can you still shoot approaches? Yes, all of them.

❏ Which instruments are affected by an AHRS failure? Attitude indicator, heading indicator, rate of turn coordinator, slip/skid indicator . . . they all display red Xs. The course needle points straight up but the CDI still deflects properly.

- ❏ Can you still shoot approaches? Where do you get your heading information? Yes I can still shoot approaches, the CDI will deflect appropriately. I'll get heading and course information from the DTK and TRK data fields at the top of the PFD, as well as from the GPS-derived compass rose on the MFD. I can also use the magnetic compass.

❏ What procedure will you use while landing with a flat tire? Follow the procedures in the POH: touch down initially with the good tire(s), with the flat tire in air, and hold the flat tire off as long as possible. Full flaps will allow you to touch down at the slowest possible airspeed. In the case of a flat nose tire, after the nose touches down, maintain full back elevator as the aircraft slows to a stop.

❏ After touchdown, you attempt to brake but the brakes feel mushy and you're having trouble slowing the plane down. What do you do? Pump the brakes in order to build up pressure in the hydraulic lines. If there's still insufficient room to stop before the end of the runway, cut off fuel, air, and spark, and avoid obstacles the best you can.

❏ On takeoff, as soon as you lift off the ground, the door cracks open. What are you going to do? An accidental door opening is not hazardous, but this is a critical phase of flight, so first and foremost I'll fly the airplane. Upon reaching a safe altitude, per the POH: slow the plane

down (approximately 75 kt), momentarily shove the door outward slightly, then forcefully close and lock the door. If this doesn't work, the AFH recommends doing a forward slip away from the open door in order to aid in closing it. If I still can't shut the door I'll return to land and shut it on the ground.

- ❏ While cranking the starter during engine start, smoke and flames start rising out of the engine compartment. What are you going to do? Continue cranking. If the engine starts, throttle up to 1800 RPM for a few minutes, then shut the engine down and inspect for damage. If the engine doesn't start, go full throttle, cut the mixture, and keep cranking. Then follow the rest of the checklist to cut off all fuel, air, and spark, make sure the engine is secured, grab the fire extinguisher, and evacuate.
- ❏ While in the practice area working on maneuvers, the engine catches fire. What are you going to do? Fly the airplane. Immediately cut off fuel, air, and spark: Mixture cutoff, fuel shutoff off, fuel pump off, master switch off, cabin heat and air (except overheat vents) off, airspeed increase as required to extinguish fire, and execute a forced landing. Somewhere in there, if there's time and if practical before turning the Master switch off, declare an emergency.
- ❏ Enroute you see a whitish color smoke in the cabin along with what smells like burning insulation. What are you going to do? Sounds like an electrical fire. Fly the airplane. Make an emergency call, if able. Turn off all the electricity by immediately switching off the Standby Battery and Master switches. CLOSE the vents and cabin heat and air intake and use the fire extinguisher as necessary. Refer to the checklist and get the plane on the ground, possibly - perhaps even probably - executing an emergency descent and forced landing, depending on the circumstances.
  - ❏ Intuitively, one would think that you should open the vents during an electrical fire in order to vent the airplane. Why do you think the checklist says to CLOSE the vents? Having the vents/windows/air intake open can produce drafts that can fuel the fire.
- ❏ How will you address a wing fire? Fly the airplane. Turn off all the lights/electricity on the wing: Landing, Taxi, Nav, Strobe lights...all off. Pitot heat off. Verify with the checklist. Land as soon as possible, performing an emergency descent away from the wing that's on fire, using sideslips as necessary to keep the flames away from the fuel tank and cabin. Declare an emergency and squawk 7700 when able.