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Introduction

This outline is intended to provide basic information to current and future holders of an FAA Remote Pilot Certificate with UAS rating. The information contained in this outline covers all knowledge elements listed in the FAA Airman Certification Standards publication.

This outline is not intended to replace a formal course of training or as a substitute to full-length publications, but rather as a supplement. Rote knowledge is not sufficient to pass the FAA exam. The actual FAA exam tests an applicant’s ability to correlate multiple knowledge areas and apply them to a specific scenario.

In addition to this outline, it is suggested that the following publications be used to prepare for the FAA knowledge test.

- Airman Certification Standards for Remote Pilot, FAA-S-ACS-10
- Aeronautical Chart User’s Guide
- Aeronautical Information Manual
- Aviation Weather Services, FAA AC00-45G
- Crew Resource Management Training, AC120-51e
- Pilot’s Handbook of Aeronautical Knowledge, FAA-H-8083-25B
- Small Unmanned Aircraft Systems, FAA AC107-2
- Risks in Transporting Lithium Batteries in Cargo by Aircraft, FAA SAFO 10007
- Standard Operating Procedures for Flight Deck Crewmembers, AC120-71a
- Weight & Balance Handbook, FAA-H-8083-1B

These publications may be downloaded at uas.flightreadytestprep.com

Please report errors and omissions to support@flightreadytestprep.com
Definitions

Remote pilots must be familiar with the following basic terms and units:

Distances

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nautical Mile (NM)</td>
<td>Standard length unit used in aeronautical charts and communications.</td>
</tr>
<tr>
<td></td>
<td>1 nautical mile = 6,076 feet or 1.15 statute miles.</td>
</tr>
<tr>
<td>Statute Mile (SM)</td>
<td>The mile most people are familiar with. Generally used on weather reports</td>
</tr>
<tr>
<td></td>
<td>to indicate visibility.</td>
</tr>
<tr>
<td></td>
<td>1 statute mile = 5,280 feet or .87 nautical miles</td>
</tr>
<tr>
<td>Knots</td>
<td>The unit of speed used to communicate aircraft speed between pilots and</td>
</tr>
<tr>
<td></td>
<td>controllers.</td>
</tr>
<tr>
<td></td>
<td>1 knot = 1 nautical mile traveled per hour</td>
</tr>
</tbody>
</table>

FAR 107.3 Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control station</td>
<td>interface used by the remote pilot to control the flight path of the small unmanned aircraft</td>
</tr>
<tr>
<td>Corrective lenses</td>
<td>spectacles or contact lenses</td>
</tr>
<tr>
<td>Small unmanned aircraft (small UA)</td>
<td>small unmanned aircraft and its associated elements (including communication links and the components that control the small unmanned aircraft) that are required for the safe and efficient operation of the small unmanned aircraft in the national airspace system</td>
</tr>
<tr>
<td>Small unmanned aircraft system (UAS)</td>
<td>an unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft</td>
</tr>
<tr>
<td>Unmanned aircraft (UA)</td>
<td>an aircraft operated without the possibility of direct human intervention from within or on the aircraft</td>
</tr>
<tr>
<td>Visual observer (VO)</td>
<td>a person who is designated by the remote pilot in command to assist the remote pilot in command and the person manipulating the flight controls of the small UAS to see and avoid other air traffic or objects aloft or on the ground</td>
</tr>
</tbody>
</table>
### Other Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Traffic Control (ATC)</td>
<td>Controls air traffic within a specific area, such as a tower, airport taxiways, or a block of airspace.</td>
</tr>
<tr>
<td>Clearance</td>
<td>A verbal instruction issued by ATC to aircraft, which authorizes the aircraft to proceed within the airspace as stated in the clearance</td>
</tr>
<tr>
<td>Visual Flight Rules (VFR)</td>
<td>Regulations that require aircraft to maintain a minimum separation from clouds and flight visibility</td>
</tr>
<tr>
<td>Instrument Flight Rules (IFR)</td>
<td>Regulations that permit operating below VFR weather minimums.</td>
</tr>
</tbody>
</table>
Airspace

Airspace Classes

The National Airspace System (NAS) consists of airspace classes, categorized into:

- Controlled Airspace
- Uncontrolled Airspace
- Special Use Airspace
- Other Airspace

Controlled Airspace

Controlled airspace is designated as Class A, B, C, D, or E.

The airspace class designated for an airport may change depending on the time of day. Refer to the airport listing in the U.S. Chart Supplement for operating hours.

Class A

- Class A is not charted as it extends over all domestic airspace from 18,000’ MSL.
- Flight by small UA in Class A is always prohibited. FAR §91.135; §107.51.

Class B, C, D, and E

- Class B, C, D, and E airspace are identified on aeronautical charts, and have defined lateral and vertical dimensions.
- Flight by small UA in Class B, Class C, or Class D airspace or within the lateral boundaries of the surface area of Class E airspace requires prior authorization from ATC. FAR §107.41.
**Uncontrolled Airspace**

Airspace that is not designated as Class A, B, C, D, or E is Class G uncontrolled airspace. Small UA may operate in Class G without prior authorization.

**Airspace Identification**

**Special Use Airspace**

The purpose of special use airspace is to confine certain kinds of activities or to impose limitations on non-participating aircraft.

<table>
<thead>
<tr>
<th>Special Use Airspace</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prohibited Area</td>
<td>All aircraft flight is prohibited. Indicated on chart by a “P” followed by a number (e.g., P-40).</td>
</tr>
<tr>
<td>Restricted Area</td>
<td>Aircraft flight is restricted due to hazardous activity. Indicated on a chart by an “R” followed by a number (e.g., R-2305)</td>
</tr>
<tr>
<td>Warning Area</td>
<td>Purpose is to warn non-participating aircraft of potential danger. Extend 3 NM from U.S. coastline. Indicated on a chart by an “W” followed by a number (e.g., R-2305)</td>
</tr>
<tr>
<td>Alert Area</td>
<td>Alert Areas contain a high volume of civil aircraft activity, generally relating to pilot training. Indicated on a chart by an “A” followed by a number (e.g., A-211)</td>
</tr>
<tr>
<td>Military Operations Area (MOA)</td>
<td>MOAs contain a high volume of military aircraft activity, sometimes involving abrupt maneuvering and high speeds. Indicated on the chart by a unique name followed by “MOA” (e.g., Camden Ridge MOA).</td>
</tr>
<tr>
<td>Controlled Firing Area (CFA)</td>
<td>CFAs are used for controlled military firing areas. They are not charted, and firing operations cease when military spotters observe aircraft in the vicinity.</td>
</tr>
</tbody>
</table>
Other Airspace

The following other types of airspace are relevant to the operation of a small UA because they indicated a potential for traffic conflicts with manned aircraft:

<table>
<thead>
<tr>
<th>Military Training Routes (MTR)</th>
<th>Used for military tactical flying, sometimes at low level and speeds exceeding 250 knots. Identified as IR (IFR) or VR (VFR) followed by 3 or 4 numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- MTRs with segments above 1,500’ AGL are indicated with 3 numbers (e.g., VR304)</td>
</tr>
<tr>
<td></td>
<td>- MTRs with no segments above 1,500’ AGL are indicated with 4 numbers (e.g., IR2007)</td>
</tr>
<tr>
<td>Parachute Operations</td>
<td>Indicated on charts by a parachute symbol Refer to the U.S. Chart Supplement for operating hours and additional information</td>
</tr>
<tr>
<td>Published VFR Routes</td>
<td>These routes are used by manned aircraft for transitioning through complex airspace, such as Class B areas.</td>
</tr>
</tbody>
</table>

Airspace Restrictions

Small UA are prohibited from flying in restricted and prohibited areas unless prior permission is obtained from the using or controlling agency. FAR §107.51.

Refer to the information panel of the Sectional Chart for controlling agency’s contact information.

Temporary Flight Restrictions

A Temporary Flight Restriction (TFR) may be imposed in any airspace to wholly prohibit flight operations.

TFRs are generally established to protect public figures and sporting events, or to provide a safe area for disaster relief, firefighting aircraft, or spaceflight operations.

A Notice to Airmen (NOTAM) notifies the public of a TFR, which will include the following information:

- Location (may be a radius from a navigational facility such as a VOR)
- Effective dates and times
- Altitudes
- FAA facility responsible for coordinating the TFR
- Reason(s) for the TFR
• Agency participating in the TFR (e.g., NASA)

To obtain NOTAMs for a location, contact the local Flight Service Station (FSS):
• 1-800-WXBRIEF
• www.1800wxbrief.com

Flight planning services such as ForeFlight and DUATS provide NOTAMs, but are not official sources
**Emergency Procedures**

**Carriage of Lithium Batteries**

Lithium batteries pose a significant fire risk for the following reasons:

- Made from highly flammable material
- Propensity for thermal runaways
  - A thermal runaway is a chain reaction where self-heating of a defective battery cell causes adjacent cells to ignite
- Capable of self-ignition when overheated, overcharged, or short circuited

Lithium batteries should be stored to minimize fire risk:

- Do not allow batteries to come in contact with metal objects
- Store multiple batteries separately

Lithium batteries should be monitored during charging for bubbling and deformation

- Do not attempt flight if a battery has bulges, nicks, or other visible defects

**Loss of Control Link**

The Federal Communications Commission (FCC) regulates the frequency spectrum used by small UA.

The radio link between a small UA and its control station operates on either 2.4 GHz or 5.8 GHz, and is dependent on line of sight with the small UA.

A “lost link” is defined as interruption or loss of the control link between the control station and the small UA.

The risk of a lost link increases when operating:

- near tall buildings or obstructions
- near high voltage power lines
- near other transmitters utilizing the same frequencies, such as Wi-Fi antennas
- outside the remote PIC’s line of sight
- at higher altitudes and longer distances from the control station

A lost link by itself is not an emergency

- Most small UA are programmed to automatically respond to a lost link by landing immediately or flying to a predetermined location

If a lost link occurs:

- Maintain visual line of sight
- Verify that control station is on
- Move closer to the UA
- If operating in controlled airspace, and unable to regain link, notify ATC
**Flyaways**

In a flyaway, a small UA lacks or does not follow preprogrammed lost link procedures

A flyaway is always an emergency

If in controlled airspace, notify ATC immediately

The occurrence of an emergency alone does not trigger notification of the FAA, however, the circumstances may trigger a report:

- An accident *may* require a report. See FAR §107.9.
- A deviation from a regulation requires a report if requested by the FAA. See FAR §107.21.

**Loss of GPS**

Small UA use GPS for position awareness, navigation, and automated functions such as contingency procedures after a lost link

NOTAMs should checked for potential GPS outages

- If GPS signal is lost, the UA may fly erratically or fly away

If a loss of GPS signal occurs:

- Disable GPS if possible
- Maneuver the UA to a safe landing area

**Deviations from Regulations**

The remote PIC is ultimately responsible and is the final authority for the operation of a small UA. FAR §107.19.

A remote PIC may deviate from any regulation to the extent necessary to meet an emergency. FAR §107.21.

- If a deviation occurs, it is not necessary to report the deviation unless requested by the FAA
- If requested by the FAA, the report of the deviation must be in writing
Aeronautical decision making (ADM) is a systematic approach to consistently determine the best course of action in response to a given set of circumstances.

A hazard is a present condition, event, object, or circumstance that could lead to or contribute to an unplanned or undesired event such as an accident. It is a source of danger.

Risk is the future impact of a hazard that is not controlled or eliminated.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulging battery case</td>
<td>Aircraft fire</td>
</tr>
<tr>
<td>Nicked propeller blade</td>
<td>Loss of aircraft control</td>
</tr>
<tr>
<td>Pilot fatigue</td>
<td>Inadvertent flight into a building</td>
</tr>
</tbody>
</table>

Use the PAVE model to detect risks:
- Pilot: health, mental and emotional state, fatigue
- Aircraft: mechanical condition
- enVironment: weather, ATC, terrain
- External pressures: negative influences on decision making

Attitude is a predisposition to act in a certain manner, based on a person’s foundation of beliefs.
- A hazardous attitude is one that interferes with sound decision-making.
- There are five common hazardous attitudes (see chart next page)
- A hazardous attitude can be countered by:
  - Recognizing the attitude
  - Labeling it as hazardous
  - Applying the appropriate antidote
<table>
<thead>
<tr>
<th>Hazardous Attitude</th>
<th>Description</th>
<th>Antidote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-Authority</td>
<td>This attitude is found in people who do not like anyone telling them what to do. In a sense, they are saying, “No one can tell me what to do.” They may be resentful of having someone tell them what to do, or may regard rules, regulations, and procedures as silly or unnecessary. However, it is always your prerogative to question authority if you feel it is in error.</td>
<td>“Follow the rules, they are usually right.”</td>
</tr>
<tr>
<td>Impulsivity</td>
<td>This is the attitude of people who frequently feel the need to do something, anything, immediately. They do not stop to think about what they are about to do; they do not select the best alternative, and they do the first thing that comes to mind.</td>
<td>“Not so fast, think first.”</td>
</tr>
<tr>
<td>Invulnerability</td>
<td>Many people falsely believe that accidents happen to others, but never to them. They know accidents can happen, and they know that anyone can be affected. However, they never really feel or believe that they will be personally involved. Pilots who think this way are more likely to take chances and increase risk.</td>
<td>“It could happen to me.”</td>
</tr>
<tr>
<td>Macho</td>
<td>Pilots who are always trying to prove that they are better than anyone else think, “I can do it—I'll show them.” Pilots with this type of attitude will try to prove themselves by taking risks in order to impress others. While this pattern is thought to be a male characteristic, women are equally susceptible.</td>
<td>“Taking chances is foolish.”</td>
</tr>
<tr>
<td>Resignation</td>
<td>Pilots who think, “What's the use?” do not see themselves as being able to make a great deal of difference in what happens to them. When things go well, the pilot is apt to think that it is good luck. When things go badly, the pilot may feel that someone is out to get me, or attribute it to bad luck. The pilot will leave the action to others, for better or worse. Sometimes, such pilots will even go along with unreasonable requests just to be a &quot;nice guy.&quot;</td>
<td>“I’m not helpless. I can make a difference.”</td>
</tr>
</tbody>
</table>
**Crew Resource Management (CRM)**

CRM is a component of ADM, where the pilot of a small UA makes effective use of all available resources: human resources, hardware, and information.

CRM is the last line of defense in preventing accidents (i.e., the final “link” in the chain)

- Actively monitoring and cross-checking the actions of other crewmembers makes it more likely that a potentially unsafe situation will be identified

Good CRM consists of:

- Maintaining situational awareness
- Delegating appropriate tasks to others individuals
- Adding more crewmembers as the complexity of the operation increases
- Effectively communicating with other members of the crew
  - Effective communication is only possible where open communication is encouraged and effected
- Applying CRM to all phases of the operation beginning with the preflight planning

**Fitness for Flight**

A person with a physical or mental condition that interferes with the operation of a small UA may not act as remote PIC, visual observer, or other required crewmember. FAR §107.9.

**Hyperventilation**

Hyperventilation is an excessive rate of respiration, which leads to a loss of carbon dioxide from the blood.

Can lead to unconsciousness.

Breathing normally is both the best prevention and the best cure for hyperventilation. In addition to slowing the breathing rate, breathing into a paper bag or talking aloud helps to overcome hyperventilation.

**Dehydration**

Dehydration is a critical loss of water from the body.

The first symptom is usually fatigue, but dehydration may also manifest itself as a headache, cramps, sleepiness, and dizziness.

**Stress**

Stress is the body’s negative response to environmental conditions.

Common stressors:

- Working with an inexperienced crewmember
- Lack of standard crewmember training
• Understanding new regulatory requirements
Proper planning and organizing can reduce stress.

Fatigue

Fatigue maybe physical or mental
• Physical fatigue is caused by sleep loss, exercise, or physical work
• Mental fatigue is caused by stress and prolonged cognitive work

Fatigue manifests itself as being in an impaired state, with lack of coordination and inability to communicate effectively

Alcohol

Alcohol impairs reaction time, judgment, and coordination.

No person may act as a crewmember of a small UA:
• within 8 hours after the time alcohol is consumed, or
• with a blood alcohol content above .04. FAR §91.17; 107.9.

Visual Illusions

Haze makes objects appear further than they really are.
**Load Factor**

“Load factor” is the ratio of lift to the weight of the aircraft

- In straight and level flight, lift is equal to weight, the load factor is therefore 1
- During turns, the load factor increases in proportion to the angle of bank
  - Turning is the result of redirecting lift in the horizontal direction
  - To maintain altitude, the vertical component of lift must remain the same
  - The total lift is therefore the sum of the vertical and horizontal components

To determine the total load on an aircraft during a turn:

- Determine the load factor for the angle of bank
- Multiply the load factor by the aircraft weight

<table>
<thead>
<tr>
<th>Angle of bank $\phi$</th>
<th>Load factor $n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>1.0</td>
</tr>
<tr>
<td>10°</td>
<td>1.015</td>
</tr>
<tr>
<td>30°</td>
<td>1.154</td>
</tr>
<tr>
<td>45°</td>
<td>1.414</td>
</tr>
<tr>
<td>60°</td>
<td>2.000</td>
</tr>
<tr>
<td>70°</td>
<td>2.923</td>
</tr>
<tr>
<td>80°</td>
<td>5.747</td>
</tr>
<tr>
<td>85°</td>
<td>11.473</td>
</tr>
<tr>
<td>90°</td>
<td>$\infty$</td>
</tr>
</tbody>
</table>

Lift is a function of angle of attack and airspeed

- Angle of attack is the angle between the airfoil and relative wind
- As angle of attack increases, lift increases (up to a certain point)
• Drag is a by-product of lift
  o As angle of attack increases, both lift and drag increase, but drag increases at a faster rate
  o The ratio of lift to drag reaches a peak at the critical angle of attack
  o Beyond the critical angle of attack, the ratio of lift to drag decreases
    ▪ This is known as a “stall”
    ▪ A stall always occurs at the critical angle of attack, regardless of weight, speed, aircraft attitude, or configuration

An aircraft structure can withstand a limited load before failing
• A slow airspeed provides a safety margin because the aircraft will stall before structural failure occurs
  o At a speed close to a stall, an aircraft will be flying close to its critical angle of attack, and an abrupt maneuver will result in a stall at approximately 1g.
  o As airspeed increases, the required angle of attack decreases. An abrupt maneuver will result in an increased load factor before the critical angle of attack is reached and stall occurs.
An aircraft operating at a high load factor (e.g., during a level turn) will stall at a higher airspeed

Load Factor = \frac{1}{\cos (AOB)}

\text{Stall Speed}_{AOB} = \sqrt{\text{Load Factor}} \times \text{Stall Speed}_{AOB \ 0^\circ}

<table>
<thead>
<tr>
<th>AOB</th>
<th>Load factor</th>
<th>Total load</th>
<th>Stall speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0^\circ</td>
<td>1.0 G</td>
<td>2,000 Lbs</td>
<td>55 KIAS</td>
</tr>
<tr>
<td>20^\circ</td>
<td>1.1 G</td>
<td>2,200 Lbs</td>
<td>57 KIAS</td>
</tr>
<tr>
<td>40^\circ</td>
<td>1.3 G</td>
<td>2,600 Lbs</td>
<td>63 KIAS</td>
</tr>
<tr>
<td>60^\circ</td>
<td>2.0 G</td>
<td>4,000 Lbs</td>
<td>78 KIAS</td>
</tr>
<tr>
<td>80^\circ</td>
<td>5.8 G</td>
<td>11,600 Lbs</td>
<td>132 KIAS</td>
</tr>
</tbody>
</table>
Weight and Balance

Always comply with loading instructions in the manufacturer’s Pilot’s Operating Handbook or Flight Manual

Loading an aircraft outside the manufacturer’s recommended weight and balance limits may result in an aircraft that is:

- Difficult or impossible to control
- Lacks sufficient performance to climb and clear obstacles

Stability and Control

<table>
<thead>
<tr>
<th>Lower Weight</th>
<th>Higher Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower stall speed</td>
<td>Higher stall speed</td>
</tr>
<tr>
<td>More maneuverable</td>
<td>Less maneuverable</td>
</tr>
<tr>
<td>Higher rate of climb</td>
<td>Lower rate of climb</td>
</tr>
<tr>
<td>Higher cruise speed</td>
<td>Lower cruise speed</td>
</tr>
<tr>
<td>Longer endurance</td>
<td>Shorter endurance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aft Center of Gravity</th>
<th>Forward Center of Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower stall speed</td>
<td>Higher stall speed</td>
</tr>
<tr>
<td>More maneuverable</td>
<td>Less maneuverable</td>
</tr>
<tr>
<td>Less stable</td>
<td>More stable</td>
</tr>
<tr>
<td>Higher cruise speed</td>
<td>Lower cruise speed</td>
</tr>
</tbody>
</table>
Maintenance

May not operate a small UA unless it is in a condition for safe operation. FAR §107.15.

- Airworthiness must be determined by conducting a preflight. FAR §107.15.
- Must discontinue flight if longer in a condition for safe operation. FAR §107.15.
- The remote PIC is the final authority and ultimately responsible for ensuring that the small UA is airworthy. FAR §107.19.

The UA must be made available for test or inspection by the FAA upon request. FAR §107.7.

Maintenance may be scheduled or unscheduled

- Scheduled maintenance is determined by time in service and the goal is to service or replace critical components before failure
- Unscheduled maintenance is the servicing or replacement of components that fail during normal operations

Part 107 does not require specific maintenance or recordkeeping, however:

- The manufacturer’s suggested scheduled maintenance should be followed to mitigate the risk of in-flight failures
- If the manufacturer does not provide a scheduled maintenance protocol, the remote PIC should establish a protocol that
  - Documents repairs, modifications, overhaul, or replacement of components
  - Records time in service for a component when a maintenance procedure is performed
  - Assesses maintenance records over time to establish a reliable and effective maintenance schedule for the UA
    - Records of past maintenance can help identify life-limited components and predict failure rates of such components

If the manufacturer does not provide specific repair instructions, consult maintenance personnel familiar with the UA
**ATIS Broadcasts**

Automated Terminal Information Service (ATIS) is a broadcast of non-control information such as wind, visibility, sky condition, and runways in use

- Available at select airports in high-activity areas
- Updated upon the receipt of any official weather even if no change
- If ATIS is missing sky condition, the ceiling is at least 5,000 feet and visibility at least 5 miles

Alternatives to ATIS for obtaining weather information at non-towered and less congested airports:

- ASOS: Airport Surface Observation System
- AWOS: Airport Weather Observation System

**Airport Signs and Markings**

**Airport lighting**

Taxiways edge lights are blue

Runway lights are white

Airports have rotating beacons that identify the type of airport at night:

- Land
- Water
- Helicopter
- Military

An airport beacon on during the day indicates that the weather is below basic VFR weather minimums
**Runway Markings**

Runways are identified with numbers, which correspond with the runway orientation with reference to magnetic north.

Parallel runways are further designated with L, C, or R after the number.
Airport Signs

The Aeronautical Information Manual contains a description of airport signs and markings.

Communication Procedures

It is important to understand manned-aircraft communication procedures in order to safely share airspace, especially in the vicinity of airports or high-traffic areas.

Phonetic Alphabet

<table>
<thead>
<tr>
<th>A</th>
<th>Alpha</th>
<th>B</th>
<th>Bravo</th>
<th>C</th>
<th>Charlie</th>
<th>D</th>
<th>Delta</th>
<th>E</th>
<th>Echo</th>
<th>F</th>
<th>Foxtrot</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Golf</td>
<td>H</td>
<td>Hotel</td>
<td>I</td>
<td>India</td>
<td>J</td>
<td>Juliet</td>
<td>K</td>
<td>Kilo</td>
<td>L</td>
<td>Lima</td>
</tr>
<tr>
<td>M</td>
<td>Mike</td>
<td>N</td>
<td>November</td>
<td>O</td>
<td>Oscar</td>
<td>P</td>
<td>Papa</td>
<td>Q</td>
<td>Quebec</td>
<td>R</td>
<td>Romeo</td>
</tr>
<tr>
<td>S</td>
<td>Sierra</td>
<td>T</td>
<td>Tango</td>
<td>U</td>
<td>Uniform</td>
<td>V</td>
<td>Victor</td>
<td>W</td>
<td>Whiskey</td>
<td>X</td>
<td>Xray</td>
</tr>
<tr>
<td>Y</td>
<td>Yankee</td>
<td>Z</td>
<td>Zulu</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Altitudes

State the separate digits of the thousands plus the hundreds if appropriate.

12,000  "One Two Thousand"
12,500  "One Two Thousand Five Hundred"

Speeds

State the separate digits of the speed followed by the word “KNOTS.”

250   “Two Five Zero Knots”
190   “One Niner Zero Knots”

Headings

The three digits of bearing, course, heading, or wind direction should always be magnetic.

(Magnetic heading) 100   “Heading One Zero Zero”
(Wind direction) 220     “Wind Two Two Zero”

Radio Frequencies

Numbers must be transmitted by pronouncing each digit.

When a radio frequency contains a decimal point, the decimal point is spoken as “POINT.”
Time

The FAA uses Coordinated Universal Time (UTC) for all operations. The word “local” or the time zone equivalent must be used to denote local when local time is given during radio and telephone communications.

0920 UTC "Zero Niner Two Zero"
1045 local "One Zero Four Five Local"

Operational Hazards

Unmanned Balloons

Unmanned balloons have trailing wires or suspension cables beneath them. Flight beneath unmanned balloons should be avoided.

Smoke Stacks

Smoke stacks emit high temperature air that creates rising currents of air. These thermal currents (plumes) can result in updrafts that make it difficult or impossible to control a UA.

Powerlines

Most skeletal structures are supported by guy wires, which are very difficult to see. All skeletal structures should be avoided horizontally by at least 2,000 feet.

Airborne Aircraft Inspections

The pilot in the best position to assess the situation should take the responsibility of coordinating the airborne intercept and inspection. Considerations

- Area, direction and speed of the intercept
- Aerodynamic effects (e.g., rotorcraft downwash)
- Minimum safe separation distances
- Communications requirements, lost comm procedures, coordination with ATC

Rain

When flying in rain there is an increased risk of loss of control link due to precipitation static.
**Preflight Procedures FAR §107.49.**

Must assess:
- Local weather
- Airspace and flight restrictions
- Location of persons and property on the surface
- Other ground hazards

Must ensure all crewmembers are briefed on the operation, emergency and contingency procedures, roles and responsibilities, and potential hazards.

Must inspect small UA to ensure:
- Control link working correctly
- Sufficient power for anticipated flight time
- Ensure objects are secured and do not adversely affect flight characteristics or controllability

**Traffic Pattern Procedures**

May not interfere with operations and traffic patterns at any airport. FAR §107.43.

Aircraft follow a standard traffic pattern where all turns are made to the left; some airports utilize a non-standard right-hand traffic pattern

- An airport utilizing a right-hand pattern will have an “RP” notation in the Sectional Chart
- Pilots operating at non-towered airports self-announce their position on a Common Traffic Advisory Frequency (CTAF), which is noted on the Sectional Chart and the U.S. Chart Supplement entry for that airport
Use of Charts

U.S Chart Supplement

Contains the most comprehensive information about an airport

- Frequencies
- Hours of operation
- Airspace type
- Runways
- Traffic pattern altitudes and direction

Sectional Chart

Limited information about an airport, but better for visualizing airspace and locations

Sectional charts contain lines every 30 minutes of latitude and every 30 minutes of longitude

- 60 minutes = 1 degree
- Tick marks = 1 minute
- Latitude increases in the North direction, while longitude increases in the West direction

You will be provided with a chart legend during the exam.
### Sectional Chart Symbology

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
</table>
| ![Symbol](image1) | Public Use Airport  
A – Airport beacon  
B – Automated weather frequency  
C – UNICOM frequency  
D – Control tower frequency  
E – Traffic pattern for runways 23 and 34 is right hand |
<p>| <img src="image2" alt="Symbol" /> | Heliport |
| <img src="image3" alt="Symbol" /> | Private airport |
| <img src="image4" alt="Symbol" /> | Public use airport, lighted |
| <img src="image5" alt="Symbol" /> | Gliders operating in the vicinity |
| <img src="image6" alt="Symbol" /> | Class D controlled airspace from surface to 2,500 feet AGL |</p>
<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="29" alt="SFC" /></td>
<td>Floor of the airspace is the surface, and ceiling is the floor of the airspace above it</td>
</tr>
<tr>
<td><img src="30" alt="2144" /></td>
<td>Lighted tower with top 2,144 feet MSL (389 feet AGL)</td>
</tr>
<tr>
<td><img src="31" alt="1473" /></td>
<td>Unlit obstruction (building), with top 1,473 feet MSL (394 feet AGL)</td>
</tr>
<tr>
<td><img src="32" alt="122.9" /></td>
<td>Parachuting area, monitor activity on 122.9</td>
</tr>
<tr>
<td><img src="33" alt="NAME" /></td>
<td>Visual checkpoint used by manned aircraft (implies heavy traffic)</td>
</tr>
<tr>
<td><img src="34" alt="R-6401" /></td>
<td>Restricted Area – consult chart information panel for hours and controlling agency</td>
</tr>
<tr>
<td><img src="35" alt="A-631" /></td>
<td>Alert Area – implies heavy manned aircraft traffic</td>
</tr>
<tr>
<td><img src="36" alt="VR32" /></td>
<td>Military Training Route</td>
</tr>
</tbody>
</table>
Performance

Altitude

The air pressure at sea level is 29.92” on a standard day (59° F)

- As altitude increases, pressure decreases approximately 1” per 1,000 feet

An altimeter measures air pressure and translates it into an altitude

- Can be corrected for non-standard pressure, but not temperature
- The altitude read directly off the altimeter is “indicated altitude”
  - Pressure altitude is the indicated altitude when the altimeter is set to 29.92”
  - True altitude is indicated altitude corrected for temperature, and is the actual height above sea level
  - Density altitude is pressure altitude corrected for non-standard temperature

Atmospheric Effects

Uneven surface heating can affect UA performance because different surfaces radiate heat in varying amounts

- Barren land, pavement, and rocks radiate large amounts of heat, which may result in an unexpected increase in performance (climb)
- Bodies of water, trees, and vegetation radiate less heat, which may result in an unexpected decrease in performance (descent)

Gusty winds can cause rapid changes in direction and speed, which make it difficult to control a small UA

- Wind gusts are likely in mountainous areas and near buildings

Headwinds and tailwinds affect landing performance

- A headwind will result in a shorter landing distance, and a tailwind will increase landing distance

Small UA performance is negatively affected by low air density

- A “high density altitude” corresponds to low air density and decreased performance due to reduced propeller efficiency, engine power output, and lift capability
  - The factors that contribute to high density altitude are high elevation, hot temperature, high humidity, and low pressure
  - Payload capacity, rate of climb, ceiling, and speed decrease
• Density and pressure altitudes can be calculated using the following chart:
Pilot Certification

**Obtaining A Remote Pilot Certificate**

Eligibility for a remote pilot certificate, FAR §107.61:
- Be at least 16 years of age
- Read, write, and speak English
- Demonstrate aeronautical knowledge by
  - Holding a private pilot certificate or higher and passing an initial training course administered by the FAA, or
  - Passing an initial knowledge test
    - A person who cheats on a knowledge test may be prohibited from applying for a remote pilot certificate for 1 year. FAR §107.69.
- Convictions for alcohol and drug offenses are disqualifying for one year following the date of conviction. FAR §107.57.

A remote pilot certificate may be issued by, FAR §107.63:
- FAA designated pilot examiner (DPE)
- Certified Flight Instructor
- Airman certification representative at a flight school
- Other person authorized by the FAA

A temporary remote pilot certificate is valid for 120 days. FAR §107.64.

**Recurrent Training Requirements**

The holder of a remote pilot certificate may not operate a small UA unless he or she has passed the knowledge test within the past 24 calendar months. FAR §107.65.
- A “calendar month” ends on the last day of the month.
  - If certificate was issued on September 3, 2016, the latest date to exercise privileges without passing a recurrent exam is September 30, 2018

**Loss of Privileges**

Must notify the FAA of a permanent address changes within 30 days. FAR §107.77.

A person who voluntarily surrenders their remote pilot certificate must complete the requirements for original issuance. FAR §107.79.

Certificate may be suspended or revoked for:
- A drug or alcohol conviction. FAR §107.57.
- Altering UA registration markings. FAR §107.5.
Applicability of Part 107

Part 107 does not apply to, FAR §107.1:

- Public aircraft (e.g., NASA)
- Air carrier operations
- Moored balloons and kites
- Amateur rockets
- Unmanned free balloons
- Model aircraft
  - Under 55 pounds
  - Recreational or hobby (no compensation)
    - Exchange of anything of value (football tickets) makes the operation commercial and within the purview of Part 107

Accident Reporting

An accident must be reported within 10 calendar days if it meets one of the following criteria, FAR §107.9:

- Serious injury to any person or any loss of consciousness; or
- Damage to any property, other than the small unmanned aircraft, unless one of the following conditions is satisfied:
  - The cost of repair (including materials and labor) does not exceed $500; or
  - The fair market value of the property does not exceed $500 if total loss.
Except in Alaska, civil twilight is the period:

- 30 minutes before official sunrise
- 30 minutes after official sunset

**Airport Security**

A Security Identification Display Area (SIDA) is a limited access area of an airport where displaying a badge issued by the operator is required to gain admission.

**Collision Avoidance**

The risk of midair collisions is higher:

- on clear days (complacency)
- near airports (high traffic)

Scanning for traffic is most effective when systematically focusing on different segments for short intervals

Must yield the right of way to all other aircraft. FAR §107.37.

- May not pass over, under, or ahead of the other aircraft unless well clear.
**Dropping of Objects**

May not drop objects if it creates an undue hazard to persons or property. FAR §107.23.

**Hazardous Materials**

May not carry hazmat. FAR §107.23.
- On board batteries used to power the UA are not considered hazmat

**Operating Limitations. FAR §107.5.**

Maximum groundspeed 87 knots (100 MPH)
Maximum altitude 400 feet AGL, except:
- Within 400-foot radius of a structure
- Not higher than 400 feet above top of structure

**PIC Authority FAR §107.19**

A pilot in command must be designated before each and every UA operation.
The remote pilot in command is directly responsible for and is the final authority as to the operation of the small unmanned aircraft system.
- This requires ensuring that all participants in the operation comply with Part 107

**Waivers**

The FAA may waive the following regulations, FAR §107.200:
- Operation from a moving vehicle or aircraft
- Operation at night
- Visual line of sight aircraft operation
- Use of visual observer
- Operation of multiple small unmanned aircraft systems.
- Yielding the right of way.
- Operation over people.
- Operation in certain airspace.
- Operating limitations (e.g., altitude, airspeed)
**UA Registration**

UAs that weigh more than .55 pounds at takeoff must be registered. FAR §48.15.

- Weight includes anything carried or attached to UA

UA registrants must be at least 13 years old. FAR §48.25.

Registration marking may be inside battery compartment provided it can be opened without tools. FAR §48.205

---

**Weather Minimums**

Visibility at least 3 statute miles
Current Weather (METAR)

METARs provide current conditions, and are generally issued 55 minutes past each hour at selected airports.

```
METAR KOKC 011955Z AUTO 22015G25KT 180V250
            Report Type          Station Identifier          Report Date and Time          Modifier          Wind Direction and Speed

            3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16
            Visibility          Runway Visual Range          Present Weather          Sky Condition          Temperature and Dewpoint

            A2992 RMK A02 TSB25 TS OHD MOV E SLP132
            Altimeter          Remarks
```

Wind direction is coded as the first three digits (220) in tens of degrees relative to true north using three figures. Directions less than 100° are preceded with a 0. For example, a wind direction of 90° is coded as 090.

Wind speed is given as two digits. If there is a wind gust, the minimum speed is followed by a “G” then the maximum gust speed.

Visibility is given in statute miles. A visibility greater than six statute miles is encoded as P6SM.

Sky condition may be:
- SKC – sky clear
- SCT – scattered
- BKN – broken
- OVC - overcast

A ceiling is the lowest layer that is either broken or overcast. Ceilings are coded in three digits. The code OVC007 represents a 700-foot overcast ceiling.
Terminal Aerodrome Forecast (TAF)

TAFs are forecasts issued for a period of generally 24 hours in the future, for an area approximately 5 statute miles from the center of the airport.

TAFs use the same encoding as METARs

Issued 4 times per day

AIRMET

Weather advisories concerning weather phenomena potentially hazardous to aircraft having limited capability because of lack of equipment, instrumentation, or pilot qualifications.

- Sierra – IFR & mountain obscurations
- Tango – Turbulence (winds > 30 knots or low level wind shear)
- Zulu – Icing (freezing level height)

Issued every 5 hours

SIGMET

Weather advisories concerning weather phenomena potentially hazardous to all aircraft

- Severe icing and turbulence not associated with thunderstorms
- Sand storms reducing visibility to <3 miles
- Volcanic ash

Automated Weather Reports

Two types of automated reporting systems are installed at many non-towered airports:

- ASOS - Automated Surface Observation Systems
- AWOS - Automated Weather Observation System

The frequency to obtain ASOS / AWOS information is listed in the Sectional Chart next to the airport, and in the U.S. Chart Supplement listing for that airport

Some ASOS / AWOS systems may be accessed via a telephone number listed in the U.S. Chart Supplement

Official Weather Sources

Official weather, including METAR and TAF reports, may be obtained at

www.aviationweather.gov

www.1800wxbrief.com
Weather Theory

Causes of Weather

Weather is the result of unequal heating of the Earth’s surface, which results in differences in pressure.

An air mass is an area with similar characteristics (pressure, temperature, stability).

A front is the boundary between different air masses.

Stability of Air Masses

Stable air is resistant to lifting.

<table>
<thead>
<tr>
<th>Stable Air</th>
<th>Unstable Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratiform clouds</td>
<td>Cumuliform clouds</td>
</tr>
<tr>
<td>Smooth air</td>
<td>Turbulent air</td>
</tr>
<tr>
<td>Poor visibility</td>
<td>Good visibility</td>
</tr>
<tr>
<td>Continuous precipitation</td>
<td>Showery precipitation</td>
</tr>
</tbody>
</table>

Wind

Wind flows from areas of high pressure to areas of low pressure.

Coriolis force deflects winds to the right in the Northern Hemisphere.

Wind shear is an abrupt change in wind speed or direction:

- Can occur at any altitude, and in the vertical or horizontal direction.
- Wind shear occurs most often in frontal zones and areas of temperature inversions (temperature increases with altitude).

Temperature and Dewpoint

Temperature decreases approximately 5.4° F per thousand feet:

- A temperature inversion is when the temperatures increases with altitude.

Dewpoint is the temperature air needs to be cooled to have 100% humidity:

- Further cooling results in condensation.
- Dewpoint decreases approximately 1° F per thousand feet.
**Clouds**

Clouds form when air condenses in the presence of nuclei.

The base of the lowest cloud layer can be estimated by dividing the temperature-dewpoint spread into 4.4°F.

**Frost**

Frost will form on a surface with a temperature below dewpoint and below freezing.

The formation of frost on wings, rotor blades, and propellers results in a disruption of airflow that adversely affects lift.

**In-Flight Icing**

Icing will form on an aircraft surface when:

- there is visible moisture
- temperature of the surface is at or below freezing

Freezing rain will result in the highest accumulation of ice. To determine areas of probable icing, refer to AIRMET and SIGMET reports.

**Fog**

**Advection fog**

Forms when moist air flows over colder ground or water, typically near coastal areas. Requires wind to move the air mass.

**Radiation Fog**

Forms after sundown when surface heat radiates into cooler, moist air above it.

**Steam Fog**

Forms when cold, dry air moves from land to over warmer ocean waters.

**Hail**

Likely during severe thunderstorms with strong updrafts.
**Thunderstorms**

The formation of thunderstorms requires moist air, a lifting force, and unstable air.

Three stages:
- **Cumulus** – initial building stage with strong updrafts
- **Mature** – rain begins, greatest turbulence
- **Dissipating** – strong downdrafts

A “squall line” is a non-frontal narrow band of thunderstorms.

**Microbursts**

Microbursts are strong localized downdrafts that occur in strong thunderstorms:
- Generally last 15 minutes
  - Wind increase in first 5 minutes
  - Peak intensity last 2-4 minutes after initial increase
- Downdrafts may reach 6,000 feet per minute
- Wind shear of up to twice the wind speed may occur within a few hundred feet above ground level.