# Communications

**Session Time:** Four, 50-minute sessions

## DESIRED RESULTS

### ESSENTIAL UNDERSTANDINGS

Communicating a pilot's intentions is a key element of aviation safety.

Standardized terminology and phraseology helps to maintain the brevity and clarity of communications.

### ESSENTIAL QUESTIONS

How do pilots effectively communicate with other aircraft, air traffic control, and ground stations?

### LEARNING GOALS

**Students Will Know**

- Licenses and equipment required for radio operation
- Specialized communication aspects of aviation: phonetic alphabet and light gun signals
- Basic communication procedures at towered and nontowered airports

**Students Will Be Able To**

- *Recall* the phonetic alphabet and light gun signals. [DOK-L1]
- *Formulate* a plan for aircraft movement as a pilot and as an air traffic controller. [DOK-L3]
- *Critique* recorded pilot and air traffic controller communications. [DOK-L3]

## ASSESSMENT EVIDENCE

**Warm-up**
Students will begin by considering communication on a daily basis, including what they say and how they say it. They will then learn about the four W's of communication. The teacher will then ask questions and facilitate a discussion about communications.

**Formative Assessment**
In this activity, students will demonstrate their knowledge of what they learned regarding communications, including the four W's and loss-of-communication procedures (ATC tower light gun signals).

**Summative Assessment**
In this activity, students will demonstrate their knowledge of what they learned throughout the lesson. Students will analyze specific aviation situations including loss of communications, troubleshooting, light gun signals, and proper actions and verbiage both on the ground and in the air.

## LESSON PREPARATION

## MATERIALS/RESOURCES

- Communications Presentation
- Communications Student Activity 1
- Communications Student Activity 2
- Communications Student Activity 3
- Communications Student Activity 4
- Communications Student Activity 5
- Communications Teacher Notes 1
- Communications Teacher Notes 2
- Communications Teacher Notes 3
- Communications Teacher Notes 4
- Communications Teacher Notes 5
- Communications Teaching Aid 1
- Communications Teaching Aid 2
- Communications Teaching Aid 3

**Student Controllers and Student Pilots: Student Activity 4 (per class)**

- Large, flat area (parking lot, football field, gymnasium, wide hallway)
- Sidewalk chalk, masking tape, or spray paint
- Measuring tape

## LESSON SUMMARY

Lesson 1: Introduction to Airports and Airport Data
Lesson 2: Airport Markings and Signs
Lesson 3: Airport Lighting
Lesson 4: Traffic Patterns
**Lesson 5: Communications**
Lesson 6: Air Traffic Control (ATC)
Lesson 7: Pilot Communications and the Airport Environment
Lesson 8: Airport Safety and Pilot Considerations

The lesson begins with a warm-up: students take notes on a video, then discuss what they may already know or assume about communications. Students then complete an activity in which they sketch an airport, visual pattern, and timeline based on provided radio calls. They then learn about the basics of radio use and the equipment involved, as well as strategies for what to do when such equipment fails. Next, they complete a **Formative Assessment** that quizzes them on what they have learned.

Following the **Formative Assessment**, students dig deeper into situational communication, and how practices vary based on type of airport and/or airspace. Students complete activities that challenge them to determine what actions they would take in different scenarios, match terms to their explanations/definitions, and practice simulated calls.

Finally, students complete the **Summative Assessment** to demonstrate knowledge of what they learned throughout the lesson. Students analyze specific aviation situations, including loss of communications, troubleshooting, light gun signals, and proper actions and verbiage both on the ground and in the air. If time allows, the **Going Further** section lets students (individually or as a class) analyze video of a mishap caused by a communications breakdown, gather and share their insights/observations, and draw their own conclusions about lessons learned.

## BACKGROUND

Whether conversing with friends, family, coworkers, or controllers, clear communication is key to achieving understanding. Furthermore, understanding directions, intentions, and expectations is critical to safety in aviation. When air traffic control (ATC) transmits a directive, aircraft call sign, altitude, or other communication, misunderstanding that call could have potentially deadly consequences. That's why reading back calls and, in aircraft with multiple crew members, having more than one person monitor radio calls is a safeguard against potential errors.

In order to understand the basics of communication, we must first understand the speakers and the means by which they communicate. Pilots communicate via radio with other pilots, airports, ground stations, fixed-base operators, and ATC. The primary means of communication used by most pilots and controllers is very high frequency (VHF) radio. Military aircraft utilize ultra-high frequency (UHF), which tends to enable a clearer communication but with a shorter range.

## MISCONCEPTIONS

Air traffic controllers do not control aircraft; this is always the pilot's responsibility.

Pilots are not always in communication with air traffic controllers. At nontowered airports, pilots self-announce their intentions on the radio.

Pilots departing from or arriving at airports with control towers will speak with the air traffic controllers in the tower, but some segments of en route flight do not require a pilot to communicate with air traffic controllers.

Some aircraft do not have radios, so pilots must remain vigilant and look outside the aircraft to safely operate at airports where they are permitted to fly without radio communication.

## DIFFERENTIATION

Provide students with a walkthrough tour of www.skyvector.com as preparation for Student Activity 3. Some students may be unsure of how to navigate through the site, and demonstrating how to access information for an example airport will help them build confidence in performing this task.

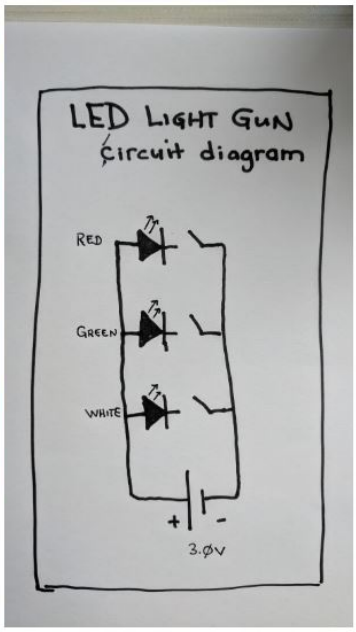
Provide students with a vocabulary list to create a Quizlet deck of flashcards

Provide students with a variety of conversations between pilot and controller that range from straightforward to complex or nonstandard. This will demonstrate how to construct a conversation, allowing students to learn by example.

As an optional activity, have students build their own ATC Light Gun. This activity uses LEDs, wires, switches, and batteries to construct a simple light gun signal simulator and uses skills from Grade 10, Semester 2, Unit 8, Lesson 2: Aircraft Electrical Systems. Students can quiz each other using the scratch-built light gun and use it in the hands-on traffic pattern activity in Student Activity 4.

The sample below was constructed with: 2AA batteries, battery holder, red LED, green LED, white LED, alligator clip jumper wires (9 wires), three momentary pushbutton switches, and a sushi container (optional).




## LEARNING PLAN

### ENGAGE

**Session 1**

**Slides 1-3:** Introduce the topic and learning objectives of the lesson.

**Slides 4-6:** Conduct the **Warm-Up**.

**Warm-Up**

Communications between aircraft and air traffic controllers, or between pilots of different aircraft may initially appear complex, but over time they become second nature, like becoming fluent in another language. Have students think of the last time they called someone on the phone. Consider asking students the following questions and recording their answers on a white board.

- What information did you send when you spoke?

*Student answers will vary. Possible answers may include: my name, their name, my location, subject /reason for the phone call, requests for information to be repeated, closing comments, goodbye.*

As the discussion comes to an end, advance to the next slide.

As students continue to ponder their recent phone conversations, have them take notes as they compare their conversations with the one in this video, writing down both similarities and differences. Students should also write down the four W's.

The following is a brief video about the four W's of communication:

- "ASI Safety Tip: Four W's of Communication" (Length 1:30) https://video.link/w/6BRq

For teachers who are unable to access Safe YouTube links, the video can also be found here: https://www.youtube.com/watch?v=IhI8Rpd2syY

Then discuss the following questions as a class:

- What are the four W's of communication?

***Who** you're calling, **who** you are, **where** you are, and **what** you want.*

- What conversations in your daily life involve the four W's?

*Student answers will vary.*

- What is the key to proper aviation communication?

*"Say only what you need to in a concise way."*

Direct the students' attention to the comments written on the whiteboard before the video. Have the students look reflect on their conversations, and state which information falls in line with the four W's. Strike through the information that does not, and ask the class as a whole if they agree with the final results on the board.

## EXPLORE

**Teacher Materials:** Communications Presentation, Communications Teacher Notes 1
**Student Material:** Communications Student Activity 1

**Slide 7:** Provide each student with a copy of **Communications Student Activity 1**. Ask students to follow the directions and pay attention to details as they sketch their airport environment and aircraft. Have them complete the worksheet and answer the questions. Suggested responses and other tips are in **Communications Teacher Notes 1**.

## EXPLAIN

**Teacher Materials:** Communications Presentation, Communications Teacher Notes 2, Communications Teacher Notes 3, Communications Teaching Aid 3
**Student Material:** Communications Student Activity 2, Communications Student Activity 3

**Session 2**

**Slide 8:** In order to understand the basics of communication, we must first understand the speakers and the means by which they communicate. Pilots communicate via radio with other pilots, ground stations (dispatchers, fixed-base operators, universal communications [UNICOM] operators providing advisory services to pilots), Flight Service Stations (FSS), and air traffic controllers (ATC). The communication equipment used by most pilots and controllers is very high frequency (VHF) radio. Military aircraft also utilize the ultra-high frequency (UHF), which tends to enable a clearer communication but with a shorter range. During transoceanic flight, many aircraft utilize high frequency (HF) radio due to its longer range beyond the horizon. There is a tradeoff, however, as HF radio is often static-filled and less clear. As a private pilot, you will transmit and receive over VHF frequencies.

**Slide 9:** Aviation communications may be broken down into three elements: licenses (required for some pilots), radio equipment, and procedures.

**Slide 10:** 3 Elements of Communications

- Licenses
  - Pilots must hold a pilot certificate to fly, but no radio license is required when communicating within the United

States.
- Pilots operating outside the United States need to obtain a restricted radiotelephone permit from the Federal Communications Commission (FCC), and aircraft operated outside the United States need to have a radio station license.
- Pilots traveling between the United States and other countries, such as Canada, Mexico, or the Bahamas, must have a radio station operator's license in the aircraft.

- Equipment
  - Two-way radio communication in airplanes is most often accomplished via very high frequency (VHF) radios.
  - Radios consist of a transmitter (sends the aircrew's voice out) and a receiver (allows the aircrew to hear incoming transmissions).
  - These two components are combined into one radio like a walkie-talkie. The VHF frequencies most often used for aviation communication range from 118.0 megahertz (MHz) to 136.975 MHz.
  - By comparison, FM radio frequencies range from 88.0 MHz to 108 MHz, and 3G cell phone radio signals operate from 800 MHz to 1900 MHz.

- Procedures
  - Proper phraseology (aviation vocabulary) and procedures enhance everyone's understanding.
  - The FAA and the International Civil Aviation Organization (ICAO) has established certain guidelines for communications, such as use of the phonetic alphabet (A = alpha, B = bravo, etc.).

**Questions**

What is some proper phraseology that you may already know? (Consider writing student responses on a whiteboard.)

*Answers will vary based on student knowledge. Answers may include:*

*Roger – I understand.*
*Wilco – I will comply.*
*Copy – receipt verified.*
*Say again – please repeat.*
*Negative – No.*
*Affirmative (or A-firm) – Yes.*
*Squawk – transponder code.*
*In the blind – transmitting but not able to hear responses.*
*Nordo – no radio.*
*Mayday – extreme emergency (high potential for crash imminent).Guard – reserved emergency frequency.*
*Clear/cleared – Approval received.*
*Runways, headings, courses, wind bearings stated as separate numbers (i.e., runway 17 stated as "runway one-seven", winds 210/12 kts stated as "winds two-one-zero at 12 knots")*

**Slide 11:** Some VHF radio frequencies are reserved for specific purposes. For example:

- 121.5 MHz (or 243 MHz for UHF), also known as "Guard" frequency, is used for emergency communications.
- FSS may be contacted on 122.2 MHz.
- Pilots chatting aircraft-to-aircraft use the "air-to-air" frequency 122.75 MHz.

- 122.9 MHz is the MULTICOM (no acronym) is used as a common traffic advisory frequency (CTAF) at nontowered airports without a UNICOM. A UNICOM is a non-government communication facility present at most FBOs at airports.
- A common traffic advisory frequency (CTAF) is a frequency that anyone approaching, operating at, or departing from an airport can use to communicate. This is a frequency a pilot would generally use at a small, nontowered airport, or at a towered airport when the tower is closed.

**Slides 12-13:** Radio signals transmitted by aircraft eventually fade over long distances, and can be hindered or blocked by obstructions. Lower frequency transmissions can penetrate obstructions, and some ultra-low frequencies can even penetrate the earth. However, the most common communications band for aircraft, VHF, has its radio waves blocked by buildings, hills, mountains, and even trees.

Note the images on the slides. If a dense object intersects a straight line drawn between two antennas (typically an airplane and an ATC receiver), the signal may become garbled or blocked entirely. And based on this line-of-sight principle, the higher an aircraft is, the greater distance it can transmit and receive VHF radio signals.

**Slide 14:** Interrupting is rude at the dinner table, and it is both bad form and unsafe in aviation communications. Proper phraseology (aviation vocabulary) and procedures enhance everyone's understanding, so the FAA and ICAO have established guidelines for communications.

- Listen to a frequency before transmitting. You can often obtain important or useful information (runway in use for example) just by listening for a moment. Listening for a break between others who are speaking is also important so you do not "step on" (block or interrupt) a conversation that was in progress when you tuned to the frequency.
- Know what you are going to say before you say it. This is like ordering at McDonald's: while you're standing in line, plan what you want to order so that you aren't saying, "Um…uh …," when it's your turn to order. Wasting transmission time is poor radio etiquette. If it's very long, specific, or detailed, writing down what you plan to say can also help.
- Speak clearly and confidently at a normal volume into a microphone that is close to your mouth.
- Listen for a reply. Other pilots may be busy flying, a UNICOM operator may be helping a customer, or ATC may be speaking to another aircraft on another frequency. Give the person you are contacting a few moments to respond.

**Slide 15:** The ability to troubleshoot is an important element in proper communications. If the frequency that is tuned in is strangely quiet, there are some techniques to try.

- Volume – Ensure the volume both of the radio and of the headset (if applicable) are turned up to an audible level.
- Microphone button – Sometimes the transmit button gets stuck and is continuously transmitting. This is often referred to by others on frequency as "hot mic" or "stuck mic." Note that "mic" in this case is pronounced "mike." An open microphone often prevents pilots from receiving calls on that frequency. Sometimes a quick fix is to double-tap the mic and listen for a "fuzz" or click that can be heard when transmitting. Pilots may also look to see if the button is physically stuck or to look at the radio display, because some radios have a light or the letters 'TX' on screen to indicate that the radio is transmitting.
- Squelch – Many radios have a knob or setting that squelches or reduces the sound of background radio static. If it is on too strong a setting, it may actually squelch some radio calls. This especially comes into play when listening to an HF radio (often during transoceanic travel) when there is especially high static.
- Altitude– Because of the line-of-sight property of radio signals, it may be necessary to be at a higher altitude to reach or receive a ground station. It may also be possible that the strength of the transmitter is insufficient to reach the other receiver. This is why ATC controllers will continuously redirect pilots to switch to new frequencies as they travel.

**Slide 16:** While some aircraft do not have radios installed at all, it is possible that an aircraft with a radio may lose its ability to transmit and/or receive radio calls. This is known as NORDO (No Radio), which may be caused by several factors.

- Overheating of the radio equipment
  - Preflight inspections may include listening for the avionics cooling fan or inspecting the small air scoops on the sides of the aircraft which allow air to flow over avionics for cooling.

- Electrical failure
  - A fault may cause a circuit breaker to pop, cutting electricity to the radios.
  - An alternator, generator, and/or battery may have failed.
  - Battery power is usually available for some time, but it can run out quickly if too many electrical items are left on.

- Equipment problem
  - Broken cables or connectors may prevent the pilot from transmitting or receiving.
  - Headset earphones or microphone may have failed.
  - Buttons or knobs may be stuck.
  - Frequency display/screen may have failed.
  - For these and other reasons, keeping a backup headset, microphone, and/or radio in the plane is a good practice.

Squawking 7600 on the transponder is another way that pilots can let ATC know that they have a radio failure, also known as "lost comm." Even if the radio has failed, the transponder should still operate unless a debilitating electrical failure has occurred. In addition to squawking 7600, pilots might try to contact the control tower by using a cell phone to call or text. Flying in uncontrolled airspace or at a nontowered airport does not require a radio, so using the 7600 code on a transponder is not necessary in those cases.

**Slides 17-18:** So, if all troubleshooting fails and a pilot can't speak to (or hear back from) the tower at the airport of intended landing, what should the pilot do? Tower controllers have a light gun available to signal pilots with a combination of steady or flashing red, green, and white lights.

Pictured on the first slide is an example of a light gun and a diagram indicating the meaning of each light signal. Students should take a few moments to study each signal's meaning because they will be quizzed afterwards.

Once the students have had a few moments to study the diagram, go to the next slide. Open the link to access a multiple-choice quiz to be taken as a group:

- "Quiz: Do You Know These 6 Light Gun Signals?" https://www.boldmethod.com/blog/quizzes/2019/08/do-you-know-the-answer-to-these-six-light-gun-signal-questions/

**Teaching Tips**

This group quiz will help prepare students for the **Formative Assessment** that follows, so students should be told to pay close attention to the answers here in order to do well on the **Formative Assessment**.

**Slides 19-20:** Complete the **Formative Assessment**.

**Formative Assessment**

Provide students with **Communications Student Activity 2**. Students will use what they have learned thus far in the lesson to complete the activity. The first part of the assessment will require students to analyze the light signals on slide 20. Correct answers are provided in **Communications Teacher Notes 2**.

[DOK-L1; *recall*]

**Session 3**

**Slide 21:** Are there times when an aircraft must be radio equipped and pilots are required to communicate? Whenever there is an operating control tower at the airport the pilot is departing from or arriving at, pilots must communicate with ATC. Federal Aviation Regulations (FARs) give clear directions about contacting ATC when flying to, from, or through a towered airport's airspace. Pilots must also communicate when taxiing on the surface of an airport with an operating control tower.

**Slide 22:** If an aircraft is departing from an airport with an operating control tower, the pilot must also receive approval before entering the movement area (as explained in Grade 11, 3.A.2, Airport Markings and Signs). To receive this approval, a pilot would contact ground control on a designated frequency. A typical call to ground control would go like this:

"Lancaster Ground, Cherokee 8121K, west ramp, VFR, 4,500 to Frederick Regional with information Sierra, request taxi runway one four."

The pilot would then receive instructions for taxiing. If the taxi instructions are to taxi to a particular runway, the pilot must stop prior to crossing any runway. As explained in Grade 11, Lesson 3.A.2, clearance must be obtained prior to crossing any runway.

Pilots landing at an airport when a control tower is in operation are typically required to speak to ground control after landing and taxiing clear of the active runway. A pilot must remain on the tower frequency until the tower controller directs them to contact ground.

**Teaching Tips**

Ground control frequencies are special because they usually begin with 121. The tenths place is almost always an odd integer, so after an aircraft lands, a tower controller may say something like this: "Cirrus 301MD, right on Bravo, ground point seven." This means the pilot is expected to turn right onto taxiway Bravo, stop after the hold lines, and contact ground control on 121.7 MHz.

**Slide 23:** Flight through certain types of airspace means that the pilot must establish communication with ATC as well.

- Flight in Class A and B airspace requires ATC clearance prior to entry, and requires pilots to maintain communications (to monitor the radio and be ready to respond) while established within the airspace.
- Class C and D airspace require that pilots establish communication prior to entering and that they maintain two-way communication with ATC while in the airspace. The difference between this and Class A and B is that you don't have to be "cleared" in. If a controller refers to an aircraft by its call sign, two-way radio communication is established and that aircraft may enter the airspace. If, however, a controller only identifies an aircraft generally (e.g. "aircraft calling, please stand by"), the pilot may not enter the airspace until the aircraft's specific call sign is used.

- An important point to remember is that a clearance requires the pilot to hear the words “cleared into,” but establishing two-way radio communication can be as simple as ATC repeating the calling pilot’s aircraft call sign.

**Slide 24:** Provide each student with a copy of **Communications Student Activity 3**. Students will navigate to www.skyvector.com to look at the following airports and the airspace around them: KPIT, KCAK, and KLBE. Students may utilize either the Low IFR or VFR charts. They will then identify each type of airspace (B, C, and D respectively) and recall the communication requirements for entry and flight within each. Answers can be found in **Communications Teacher Notes 3**.

**Slide 25:** Pilots have communication requirements based on regulations; however, there are also times when it’s simply smart or good etiquette to make certain calls. For instance, at nontowered airports, radio use is not regulated as it is for towered airports. However, good radio protocol promotes safe and efficient operations at nontowered airports. While some aircraft may not have radios, and some pilots may make only intermittent radio calls, pilots should work to develop positive habits.

- Communicate your position and intentions. For example:
  - Who you are calling: Mt. Hawley Traffic
  - Who you are: Cirrus Five Papa Romeo
  - What you are doing: Departing Runway 36
  - Where you are (again): Mt. Hawley

- Good practice means making calls similar to this when:
  - Approaching the airport
  - Entering the traffic pattern
  - Turning to each leg of the traffic pattern
  - Clearing the runway

**Slide 26:** Sometimes, radio communications are difficult to hear or understand. Frequency congestion (many pilots and controllers talking on the same frequency), background noise or static, unfamiliarity, and nerves can all make understanding certain words or names difficult.

Did you ever try spelling your name to someone on the phone? Did they get some letters confused like B’s and D’s or M’s and N’s? You might clarify which letter to use by saying something like “M as in mother.”

In aviation, standardization is important for understanding, so pilots use the phonetic alphabet that has been adopted as an ICAO standard. This way, no matter what country a pilot is flying through, other pilots and controllers will have an excellent chance of understanding the message.

The ICAO phonetic alphabet uses specific words to identify each letter of the alphabet. For example, to spell the word RADIO using the phonetic alphabet, one would say, “Romeo Alpha Delta India Oscar.” This becomes especially important when identifying certain navigational spots called fixes or navigational aids. For example, if an ATC controller needs to tell a pilot to fly direct to fix BUBKE, saying that word over the radio could easily be misunderstood. Therefore, the pilot may request that the controller “say again” or “please spell” the fix name. The controller would then spell BUBKE phonetically as “Bravo Uniform Bravo Kilo Echo.” The complete list is shown on this slide.

**Teaching Tips**

A phonetic alphabet handout is included as part of this lesson. **Communications Teaching Aid 3** is available for the teacher to pass out to students or post online.

For practice, call upon students to spell their own names using the phonetic alphabet. For example, a student named John would look at the slide and say “Juliett Oscar Hotel November”. If anyone

feels that they already know it and are comfortable, they can turn away from the slide and spell their name. Explain that, over time, pilots and controllers become so proficient that it's almost like a second language.

**Slide 27:** While letters are spoken phonetically, individual numbers are spoken as you are used to in English, with some exceptions. Technically, in the ICAO/North Atlantic Treaty Organisation (NATO) phonetic alphabet, the number 3 should be spoken as "tree," 4 should be spoken as "fow-er," and 5 should be spoken as "fife." This ICAO/NATO-correct pronunciation is not commonly followed in the United States. However, the number 9 should always be spoken as "niner." This is done for the sake of clarity and to reduce errors, since over an especially static-filled radio frequency, the numbers 5 and 9 may sound somewhat similar.

It is important to remember that there is a difference between the letter O and the number 0. While in day-to-day language, a phone number starting with 605 may be read as "six oh five," the proper verbiage over the radio would be "six zero five."

When speaking large numbers like altitudes, thousands and hundreds are spoken separately. Here are some examples:

- 600 - "six hundred"
- 7500 - "seven thousand five hundred"
- 10,000 - "one zero thousand"
- 12,500 - "one two thousand five hundred"

Additionally, in the United States, flight levels begin at 18,000 ft mean sea level (MSL), and therefore any altitude 18,000 ft or above will be a flight level (FL). For example, 23,000 ft would be FL230. Flight levels are always pronounced as separate numbers. Therefore, if ATC wanted an aircraft to continue climbing and then remain at FL230, they would state "climb and maintain flight level two three zero."

**Slide 28:** Students will practice making radio calls, as described below.

**Questions**

Call upon students at random to speak an appropriate response to a question in the four W's format. The teacher will play the role of an ATC controller and the student will play the role of the pilot. The student will say the teacher's name as the controller (for example, instead of "Houston Center", the student will say "Mrs. Johnson"), then spell their name using the phonetic alphabet as their callsign. As a refresher, first ask "what are the four W's of aviation communication?"

***Who** you're calling, **who** you are, **where** you are, and **what** you want.*

Sample questions and responses are below. Feel free to create more; students may need to write them down to create a proper response. Student responses do not need to give the sample answers verbatim, because there are several ways to properly respond to ATC. However, their responses should be similar, and if they are specifically cleared for something, they should read that back nearly verbatim.

"John, radar contact, climb and maintain flight level one niner zero."

*"Mrs. Johnson, Juliett Oscar Hotel November, roger (or wilco), climb and maintain flight level one niner zero."*

"Julie, winds two four zero at one three, clear for takeoff runway two three, runway heading to three thousand."

*"Mrs. Johnson, Juliett Uniform Lima India Echo, roger clear for takeoff runway two three, runway heading to three thousand."*

"Bob, hold short runway one two, say intentions."

*"Mrs. Johnson, Bravo Oscar Bravo, roger (or wilco) hold short runway one two, request VFR pattern runway one two for the option, closed traffic."*

To practice number pronunciation, write a variety of numbers on the board and select students to read them as a pilot or controller would. Suggestions include, but are not limited to:

*9,000: "niner thousand"*

*13,400: "one tree thousand fow-er hundred"*

*10,500: "one zero thousand fife hundred"*

As students get the hang of this, they may pair up and make their own aviation communications to one another. One student will play the role of the ATC controller and the other will play the role of the pilot (switching halfway through).

**Slide 29:** Students may use the rest of the time available in Session 3 to explore and use the PlaneEnglish smartphone application, if school policy permits this. The PlaneEnglish app allows users to listen to and practice speaking aviation radio calls. The app is available through Apple's App Store and Google Play, and the first week of use is a free trial.

The following is a video demonstration of PlaneEnglish:

- "ARSim 3 MINUTE OVERVIEW AND TUTORIAL" (Length 3:30)
  https://video.link/w/3dmKb

For teachers who are unable to access Safe YouTube links, the video can also be found here: https://www.youtube.com/watch?v=VqsLpuNDxLw&feature=youtu.be

Practicing with this app is an excellent homework assignment prior to **Communications Student Activity 4** in Session 4.

## EXTEND

**Teacher Materials:** Communications Presentation, Communications Teacher Notes 4, Communications Teaching Aid 1
**Student Material:** Communications Student Activity 4

**Session 4**

**Slides 30-33:** Students will begin Session 4 by completing **Communications Student Activity 4,** an Air Traffic Control simulation adapted from an activity in the Grade 9 course (Grade 9, Semester 2, 7.C.1, Becoming an Air Traffic Controller). This is an excellent refresher that will enable students to practice what they have learned thus far in this lesson. It can be completed outdoors (in a parking lot or sports field) or indoors (in a gymnasium or wide hallway).

Provide students with **Communications Student Activity 4** for a description of the ATC simulation, along with roles, rules, and instructions. Students should also watch the following video, which illustrates the basic shape of the simulation.

- "Traffic Pattern Exercise" (Length 4:57)
  http://video.link/w/36Ke

For teachers who are unable to access Safe YouTube links, the video can also be found here: https://www.youtube.com/watch?v=mYvHu9Dkvy4&feature=youtu.be

The slideshow also provides a diagram with a "graphic" that may be reproduced on the ground using chalk or masking tape. Refer to **Communications Teacher Notes 4** for additional information on setting up the activity, including the airport graphic and dimensions that should be used. **Communications Teaching Aid 1** provides a score sheet that students may use to evaluate each other and their performance.

**Teaching Tips**

This ATC simulation is designed to give students the experience of being a controller at a busy airport. Student "pilots" will simulate taxiing and flying aircraft by walking around an "airport" in a traffic pattern while being directed by student "controllers." The purpose of the activity is to help students realize the communication and planning skills necessary to be an effective controller.

A simple point system to evaluate the controllers is included to encourage efficient and safe aviation operations. Scoring will be completed by either the teacher or a selected student "FAA scorekeeper." A simple score sheet is provided in **Communications Teaching Aid 1**.Depending on class size, teachers may want to draw more than one airport in order to give all students several opportunities to act as "controllers."

[DOK-L3; *formulate*]

**Teaching Tips**

Alternatively, or in addition, students may perform their own air traffic control simulations online (one option is https://www.openscope.co/). Review the tutorial with students, then provide them with the opportunity to perform their own simulations.

## EVALUATE

**Teacher Materials:** Communications Presentation, Communications Teacher Notes 5
**Student Material:** Communications Student Activity 5

**Slides 34-43:** Quiz students on the Private Pilot Knowledge Test questions.

**Slide 44:** Conduct the **Summative Assessment**.

**Summative Assessment**

Provide each student with a copy of **Communications Student Activity 5**. Students will use the knowledge of what they've learned throughout the lesson to complete the handout. Sample responses are provided in **Communications Teacher Notes 5**.

[DOK-L3; *formulate*]

**Summative Assessment Scoring Rubric**

- Follows assignment instructions
- Answers show evidence of one or more of the following:
    - Knowledge of various communication rules and procedures.
    - Details about communication rules and procedures.
- Contributions show understanding of course of the concepts covered in the lesson
- Contributions show in-depth thinking including analysis or synthesis of lesson objectives

**Points Performance Levels**
9-10 Answers 11-12 of the questions with full understanding of the lesson objectives demonstrated.
7-8 Answers 9-10 of the questions with sufficient understanding of the lesson objectives demonstrated.
5-6 Answers 6-8 of the questions with partial understanding of the lesson objectives demonstrated.
0-4 Answers 0-5 of the questions with little or no understanding of the lesson objectives demonstrated.

## GOING FURTHER

**Teacher Materials:** Communications Presentation, Communications Teaching Aid 2

### GOING FURTHER VIDEO 1

**Slide 45:** Now that students have learned a significant amount about aviation communications, they should be able to analyze a situation and see both errors and the potential for mishaps.

The following video reveals a conversation between a Cirrus SR22 and a controller in Melbourne, Florida. Students should take notes regarding pilot communications and actions and controller communications and actions.

- "Accident Case Study: Communication Breakdown" (Length 13:10)
  https://video.link/w/QETq

For teachers who are unable to access Safe YouTube links, the video can also be found here: https://www.youtube.com/watch?v=pAWy9mjnrYM

As the video and chain of events plays out, pause from time to time and have the students respond to these questions:

- What errors do you notice from the pilot?
- What errors do you notice from the controller?
- What could have been done differently?

Challenge the students to draw conclusions and create their own list of "lessons learned" to incorporate if they were in a similar situation.

## GOING FURTHER VIDEO 2

**Slide 46:** Whether talking to friends, family, coworkers, or controllers, clear communication is important to understand and interact properly with others. Understanding directions, intentions, and expectations is critical to safety in aviation. When ATC states a directive, aircraft call sign, altitude, or other communication, misunderstanding that call could have dangerous or even deadly consequences.

The following video reveals a conversation between a light aircraft and the tower controller at Houston Hobby airport. Students should take notes regarding pilot communications and actions and controller communications and actions.

- "Accident Case Study: Traffic Pattern Tragedy" (Length: 20:57)
  https://video.link/w/LETq

For teachers who are unable to access Safe YouTube links, the video can also be found here: https://www.youtube.com/watch?v=mf3xhjXl454

As the video and chain of events plays out, pause from time to time and have the students respond to these questions:

- What errors do you notice from the pilot?
- What errors do you notice from the controller?
- What could have been done differently?

Challenge the students to draw conclusions and create their own list of "lessons learned" to incorporate if they were in a similar situation.

## GOING FURTHER ACTIVITY

**Slide 47:** The official guide for the correct verbiage in aviation communications is known as the Pilot/Controller Glossary (PCG) and can be found here: https://www.faa.gov/air_traffic/publications/media/pcg_8-15-19.pdf.

Note that this resource is updated on a regular basis, and therefore the most recent version can be found by searching the FAA's website: https://www.faa.gov/search/?omni=MainSearch&q=pilot+controller+glossary.

This glossary is also located in the Aeronautical Information Manual (AIM). This resource is extremely useful; however, it is also quite extensive (over 120 pages).

**Slide 48:** Prior to completing this activity, you will need to cut out the cards that appear in the table in the **Communications Teaching Aid 2**. (Half the cards contain vocabulary terms, and the other half contain explanations or definitions.) This resource also contains the answers.

1. Students will stand up and be handed cards; each student will get one card with a term until everyone has one card, then the process will repeat until all cards are gone. Then, each student will get one card with an explanation or definition until every card has been handed out.
2. Students will then use either an open area of the floor or their desks to display their explanation/definition cards face-up. (Each student will keep their cards that have the terms.)
3. Students will then move around the room as necessary to locate the definitions that match their respective terms. This process should continue until everyone has their matches.

**Teaching Tips**
Students who are more knowledgeable in aviation phraseology may assist students who are less knowledgeable. Additionally, those who have already found their matches may want to assist those who are still searching.

## STANDARDS ALIGNMENT

### NGSS STANDARDS

**Three-Dimensional Learning**

- **HS-ETS1-2** - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - Science and Engineering Practices
        - Asking Questions and Defining Problems
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.A: Defining and Delimiting Engineering Problems
    - Crosscutting Concepts
        - None

### COMMON CORE STATE STANDARDS

- **RST.9-10.2** - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9-10.4** - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

### FAA AIRMAN CERTIFICATION STANDARDS

**PRIVATE PILOT**

**III. Airport and Seaplane Base Operations**
**Task A. Communications, Light Signals, and Runway Lighting Systems**

- Knowledge - The applicant demonstrates understanding of:

- **PA.III.A.K1** How to obtain proper radio frequencies.
- **PA.III.A.K2** Proper radio communication procedures and ATC phraseology.
- **PA.III.A.K3** ATC light signal recognition.
- **PA.III.A.K5** Lost communication procedures.
- **PA.III.A.K6** Equipment issues that could cause loss of communication.

- Risk Management - The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
  - **PA.III.A.R1** Poor communication.
- Skills - The applicant demonstrates the ability to:
  - **PA.III.A.S1** Select appropriate frequencies.
  - **PA.III.A.S2** Transmit using phraseology and procedures as specified in the AIM.
  - **PA.III.A.S3** Acknowledge radio communications and comply with instructions.

**REMOTE PILOT**
**V. Operations**
**Task A. Radio Communications Procedures**

- Knowledge - The applicant demonstrates understanding of:
  - **UA.V.A.K1** Airport operations with and without an operating control tower.
  - **UA.V.A.K2** The description and use of a Common Traffic Advisory Frequency (CTAF) to monitor manned aircraft communications.
  - **UA.V.A.K3** Recommended traffic advisory procedures used by manned aircraft pilots, such as self-announcing of position and intentions.
  - **UA.V.A.K4** Aeronautical advisory communications station (UNICOM) and associated communication procedures used by manned aircraft pilots.
  - **UA.V.A.K6** Aircraft call signs and registration numbers.
  - **UA.V.A.K7** The phonetic alphabet.
  - **UA.V.A.K8** Phraseology: altitudes, directions, speed, and time.

## REFERENCES

AOPA Air Safety Institute Document: Sample Radio Calls
https://www.aopa.org/-/media/files/aopa/home/pilot-resources/asi/sampleradiocalls.pdf

AOPA Air Safety Institute Document: Operations at Non-towered Airports
https://www.aopa.org/-/media/files/aopa/home/pilot-resources/asi/safety-advisors/sa08.pdf?la=en&hash=7CA16320FA364F6A9D0E693E150369962360D22F

AOPA Air Safety Institute Document: Operations at Towered Airports
https://www.aopa.org/-/media/files/aopa/home/pilot-resources/asi/safety-advisors/sa07.pdf?la=en&hash=9365204438CE33605C2765587838EA1705ABFE9E

AOPA Air Safety Institute Online Course: Say it Right: Mastering Radio Communication
https://www.aopa.org/lms/courses/say-it-right/#01-effective-radio-communication&01-introduction

FAA Pilot/Controller Glossary (PCG)
This is a 120-page comprehensive document.
https://www.faa.gov/air_traffic/publications/media/pcg_10-12-17.pdf

FAA Radio Communications Techniques
A MUST-READ with the four W's included.
https://www.faasafety.gov/gslac/ALC/libview_normal.aspx?id=17272

SkyVector: https://skyvector.com