Preflight and Maintenance

Session Time: Three, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

A remote PIC is responsible for ensuring that—prior to every flight—a UAS is in a condition that will allow it to be flown safely in the National Airspace System (NAS).

Protocols for UAS preflight inspection and maintenance should be developed and followed to ensure safe and efficient operations.

ESSENTIAL QUESTIONS

1. What must a remote PIC do to meet their responsibility to determine that a UAS is in safe condition for operation in the NAS?
2. What maintenance protocols should be adopted to ensure that a UAS can be operated safely and efficiently?

LEARNING GOALS

Students Will Know

- Essential elements of a UAS preflight inspection.
- How, in lieu of manufacturer recommendations, remote PICs can develop maintenance protocols and preflight checklists for UAS.
- The importance of record keeping in developing and enhancing UAS maintenance practices.

Students Will Be Able To

- *Identify* important components of a UAS that should be inspected prior to every flight. [DOK-L1]
- *Construct* a preflight checklist using manufacturer recommendations and online research. [DOK-L3]
- *Assess* the readiness of a UAS for safe operation through careful examination of its components. [DOK-L3]

ASSESSMENT EVIDENCE

Warm-up
Students will examine the classroom drone and engage in a general discussion about safe UAS operations and preflight PIC responsibilities regarding inspection and maintenance prior to launching a UAS.

Formative Assessment
Students will answer questions to demonstrate their knowledge of topics from the lesson, including how to properly maintain and inspect a UAS.

Summative Assessment
Students will answer questions and apply their knowledge of topics from the lesson, including proper record keeping and inspection and maintenance procedures necessary for continual and safe UAS operations.

LESSON PREPARATION

MATERIALS/RESOURCES

- Preflight and Maintenance Presentation
- Preflight and Maintenance Student Activity 1
- Preflight and Maintenance Student Activity 2
- Preflight and Maintenance Student Activity 3
- Preflight and Maintenance Student Activity 4
- Preflight and Maintenance Teacher Notes 1
- Preflight and Maintenance Teacher Notes 2
- Preflight and Maintenance Teacher Notes 3
- Preflight and Maintenance Teacher Notes 4

Preflight Checklist Research: Student Activity 1

- 1 Internet-connected computer or mobile device (per group)
- 2–3 pieces of paper (per student)
- 1 pen or pencil (per student)

Preflight Checklist for the Classroom UAS: Student Activity 3

- 1 Internet-connected computer, tablet, or mobile device per group
- 2–3 pieces of graph paper per student
- 1 pen or pencil per student
- 1 red ballpoint pen per student
- printed classroom UAS quickstart guides, instructions, and safety tips (if available)
- URL to the classroom UAS website (if available)

LESSON SUMMARY

Lesson 1: Preflight and Maintenance
Lesson 2: UAS Crew Resource Management and Communication
Lesson 3: Handling Emergencies
Lesson 4: Human Factors and ADM

The lesson will begin with a warm-up in which students examine the classroom UAS while being asked to recall how FAA Part 107 regulations stress the ultimate responsibility of the PIC for the condition of a UAS and its continued safe operation. Students will then divide into groups, conduct internet research to find different preflight checklists, and compare and contrast their results. The class will then review Part 107 information regarding maintenance and preflight inspections of a UAS, as well as the tasks likely to be included on preflight checklists.

During the next part of the lesson students will be introduced to common manufacturer and industry UAS maintenance and inspection procedures as well as the importance of keeping maintenance records. The importance of conducting different levels of inspection at different intervals (e.g., prior to each flight, weekly, and long term) will be discussed. Students will learn how different UAS manufacturers have different instructions and checklists for maintenance and repairs. The importance of battery maintenance, as well as software and firmware installations will also be covered.

Finally, students will learn about the importance of comprehensive UAS record keeping. Preflight checklists, flight logs, maintenance records, custom modification records, and software upgrades will be discussed. Students will then divide into groups to collaborate and brainstorm on the development of a preflight checklist for the classroom UAS.

BACKGROUND

While contemporary UAS may seem commonplace today, they are still a relatively recent integration of many different technologies, aviation knowledge, and computer-controlled mechanical parts and systems all working together. Global Positioning System (GPS) satellites and various radio and Wi-Fi signals also aid UAS to make flying as easy as possible for the pilot. But even with sophisticated technology, pilots need to use preflight checklists and conduct regular maintenance of their UAS.

As the UAS industry grows, the FAA continues to keep pace by updating regulations and using technology to prioritize safety as the nature of UAS operations and aircraft evolve. FAA regulations continue to stress that the onus lies directly with the PIC to properly check and maintain their UAS.

Because of the many technologies all working together on a UAS, the PIC must regularly check and maintain all the various parts and components of any UAS they fly or plan to fly. The importance of preflight checklists and proper maintenance is understood throughout the UAS industry. However, because there are so many different manufacturers and types of UAS, there is not a clear consensus on exactly what to include in preflight checklists and UAS maintenance. In the end, the PIC must work to combine industry suggestions and their own know-how to create custom preflight checklists and take the best steps to properly maintain their UAS.

MISCONCEPTIONS

Some students may recall the discussion in previous lessons (e.g., Grade 10, lesson 10.A.3: Inspections) of preflight inspections in relation to manned aircraft. These students may incorrectly assume that, like manned aircraft, UAS come with inspection checklists for PICs to follow. This is not always the case, however, and as a result the PIC must create their own preflight checklist and maintenance procedures.

Students may also assume there is not much for a PIC to do regarding their UAS beyond learning to properly fly and land it. Many manufacturers make UAS that are intended to be hands-off beyond updating software, changing batteries, and swapping old propellers for new ones. As a result, students may conclude that just following manufacturer instructions is sufficient. Even when manufacturers include checklists or maintenance instructions, the PIC should be aware that these can be updated and customized.

Although Part 107 of the Federal Aviation Regulations (FARs) does not specify that PICs must maintain records or logbooks, the FAA strongly recommends it. The FAA Small Unmanned Aircraft Systems Advisory Circular AC107-2 stresses the “Benefits of Record Keeping” in section 7.3.5: “sUAS owners and operators may find record keeping to be beneficial.... Methodical maintenance and inspection data collection can prove to be very helpful in the tracking of sUAS component service life, as well as systemic component, equipage, and structural failure events.”

UAS operators should also conduct preflight checks and keep maintenance records to properly track and maintain their equipment, not just for the benefit of their UAS but for safety when flying. Proper record keeping is also important if a UAS malfunctions and it is unclear if it was a result of PIC error or an equipment malfunction. Keeping comprehensive maintenance records would be beneficial to produce to the FAA or manufacturers, should such a need ever arise.

DIFFERENTIATION

To promote collaboration and engagement during the **ENGAGE** part of the lesson plan, have students perform Think-Pair-Share instead of just a class discussion. You might also want to encourage students to write down their ideas so that they can confirm their thinking is correct as they work through the lesson.

To support struggling learners during the **EXPLAIN** section of the lesson plan, you may choose to provide students with a list of resources to check as they complete the **Formative Assessment**. Or, you may choose to let students work in pairs to collaborate with each other, instead of having them work individually.

LEARNING PLAN

ENGAGE

Teacher Material: Preflight and Maintenance Presentation

Session 1

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

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

Teaching Tips

Remind students that every UAS manufacturer provides different sets of specifications, documentation, and instructions for proper care and operation of the UAS. Updates and additional information can be found online. If possible, provide students with all included documentation and instructions to accompany the inspection of the classroom UAS, or look online for downloadable documentation.

Warm-Up

Display or pass around the classroom UAS, and ask students to study and consider its various parts and components, such as the propellers, motors, arms, and landing gear, as well as any additional accessories and controls. Ask students to consider how all the various complex mechanical and computer-controlled components function together and give the UAS its flight capabilities.

Ask students to recall the FAA Part 107 regulations; in particular, remind them of 14 CFR Part 107.19, which states, "The remote pilot-in-command is directly responsible for and is the final authority as to the operation of the small unmanned aircraft system." In addition, 14 CFR Part 107.15 states, "the remote pilot-in-command must check the small unmanned aircraft system to determine whether it is in a condition for safe operation."

Stress to students that safe PIC UAS operations are not limited to simply flying; they also include the continued inspection, maintenance, record keeping, and care of all the systems, parts, and functions of the UAS.

Ask: What precautionary steps should be taken with the classroom UAS before launching it?

At this point, questions are only meant to stimulate class discussion. It is not necessary for students to provide correct answers. Common preflight checklist tasks will be examined throughout the lesson.

EXPLORE

Teacher Materials: Preflight and Maintenance Presentation, Preflight and Maintenance Teacher Notes 1
Student Material: Preflight and Maintenance Student Activity 1

Slide 7: Distribute **Preflight and Maintenance Student Activity 1**. In this activity, small groups (2–3 students per group) will work together to conduct online research to find a variety of preflight checklists, safety guidelines, and instruction manuals for UAS; these resources may have been created by UAS manufacturers, distributors, or individual operators. Students will compare similarities and differences in their groups, and then the entire class will discuss the results. Do not restrict this research to sUAS.

Questions to initiate a classroom discussion, along with sample responses and other notes for the instructor, are available in **Preflight and Maintenance Teacher Notes 1**.

Teaching Tips

Instruct students to search the internet to find various preflight checklists, safety guidelines, and instruction manuals for UAS. Remind students not to sign up for anything or give out personal information to obtain any resources. Thorough searches will yield many free results.

Explain that while some UAS manufacturers will include preflight checklists, many do not. Typically, manufacturers include some form of instructions and safety documentation with a UAS. Many manufacturers also provide comprehensive user manuals, specifications, and safety guidelines as downloadable PDFs for specific drone models. For example, popular UAS manufacturer DJI has a *Flying Tips* webpage (https://www.dji.com/flyingtips) with links to different world locations. DJI also has a webpage called *Fly Safe* (https://www.dji.com/flysafe), which contains general and in-depth information for remote pilots. Webpages such as these can be found on many UAS manufacturer websites and should be consulted depending on the make and model of the UAS being flown.

Creating a custom preflight checklist is an important step for any PIC to ensure the safety and reliability of their equipment. In addition, if a PIC has multiple drones or has customized a UAS, it's important to create a custom-tailored preflight checklist that goes beyond the safety guidelines or checklists provided by the manufacturer. A custom preflight checklist will also suit the PIC's needs relevant to their equipment and circumstances.

EXPLAIN

Teacher Materials: Preflight and Maintenance Presentation, Preflight and Maintenance Teacher Notes 2
Student Material: Preflight and Maintenance Student Activity 2

Slide 8: Remind students that consumer drones and more advanced UAS are a relatively recent introduction into the National Airspace System (NAS). The FAA created Part 107 regulations to ensure that UAS could operate safely along with manned aircraft in the NAS. The FAA continues to introduce new safety technology such as the Low Altitude Authorization and Notification Capability or LAANC, which allows remote pilots to access controlled airspace at or below 400 feet.

Because manned and unmanned aircraft now share NAS, including controlled airspace, remote pilots must care for and maintain a UAS so it is safe to fly.

Slide 9: Explain to students that just as flying a manned aircraft requires instruction and training, flying a UAS should be treated similarly. The PIC should always read any available instructions and familiarize themselves with a UAS before flying it. Pilots can go online to the website of a particular UAS manufacturer to find more information about that UAS. Although acquiring a new UAS can be exciting, taking the time to learn how to fly and properly care for that UAS will keep it functioning properly and you flying safely.

Remind students that becoming familiar with and properly maintaining a UAS is not just a suggestion. Part 107.15 states, "the remote pilot in command must check the small unmanned aircraft system to determine whether it is in a condition for safe operation." Furthermore, a remote PIC should immediately cease operating a UAS if its condition becomes—or seems to be—compromised at any time during flight.

Slide 10: Remind students that, while many UAS manufacturers do not provide information such as weight and balance, many manufacturers do include preflight checklists with their products. Remote pilots should take the initiative and create their own preflight checklists. Inform students that many UAS have preflight checklists that have been created by other drone pilots and distributed online.

Many UAS manufacturers include recommended safety guidelines and instructions. UAS instruction manuals or quickstart guides can be used as a starting point for remote pilots to gather useful information to create a custom preflight checklist. Remote pilots should feel free to add any additional steps or procedures to a preflight checklist that they deem important.

Slide 11: If included with a UAS, always follow manufacturer preflight inspection guidelines. These will differ depending on the company and type of UAS. Many UAS companies have tips and tutorial sections on their websites where valuable safety tips can be found. Sometimes there are online forums where a remote pilot can consult other users as well as the manufacturer themselves. Be sure to use all the resources available to create a thorough preflight inspection routine.

Slide 12: Because a UAS is a combination of many mechanical parts and complex computer systems with software and hardware, it is important to keep up on all aspects of maintenance. Visual inspections should be conducted before every flight to look carefully for physical damage of UAS components.

System inspections should check that the software is properly functioning and up to date. Inspections should always be relevant to the specific UAS that a remote pilot is using. Different UAS will likely require different preflight inspection procedures. When manufacturer data and preflight procedures are not provided, the PIC should seek information online and work to incorporate any relevant information into a custom preflight inspection procedure. As the PIC becomes more familiar with a UAS, updates can be made to the procedure.

Slide 13:

Questions

What should a PIC look for as they visually inspect a UAS?

Students should answer aloud. It is not important to correct student answers at this point, as these concepts will be explored during the lesson.

Slide 14: There are common things that all remote pilots should look for when visually inspecting a UAS. For example, propellers should be checked individually for wear and to confirm that they are installed properly. A damaged or worn propeller could have small fractures or hairline splits that may be hard to see. If overlooked, the damage could worsen with use and fail in flight, possibly causing loss of UAS control or catastrophic midair failure. Proper propeller inspection and scheduled replacement should always be conducted based on a manufacturer's usage guidelines.

Slides 15-16: Because UAS often have very similar parts and components, a general preflight checklist will overlap for different UAS makes and models. A good general preflight checklist will cover many basic operations that UAS pilots should be aware of. Some general preflight checklist items to consider are:

- Inspect that propellers are freely spinning and have no damage.
- Inspect that all moving arms are secure.
- Inspect all necessary wires and cables for damage.
- Check that the UAS has no visible damage.
- Check that the gimbal lock is removed.
- Check that the landing gear is extended.

The following additional items should also be considered for a general preflight checklist:

- Inspect that all modifications, additions, payloads, and attachments are secure.
- Check that the battery is charged and properly installed and secured. An improperly attached battery could result in loss of control and even cause the UAS to crash.
    - Inspect the size and shape of the battery.
    - If the battery is misshapen or warm, it should not be used.
- Inspect the controller, control sticks, mobile device, and ground control station.
- Confirm that the crew is ready.

Slide 17: Remind students how manned aircraft pilots perform preflight inspections and then conduct an engine run-up before takeoff to establish that the aircraft and engine are functioning properly and no irregularities are detected. The remote pilot should conduct similar system and performance checks to ensure flight safety and verify that the UAS is generating adequate power and that all its systems are working correctly. A remote pilot can perform a preflight system check by turning on the controller and UAS to establish that everything is functioning and connecting properly. Since many UAS need time to establish connections to several GPS satellites, this is a good time to look over the UAS and control system before launching. A short, low-altitude test flight and landing should be performed to see that the UAS is responding properly and operating normally.

Slide 18: Inform students that they will be watching a video discussing a preflight checklist that has been created for a DJI Phantom 4 Pro sUAS. Instruct students to take notes during the video, and to refer to these notes when creating their own preflight checklist later in the lesson.

Teaching Tips

The remote pilot in the video discusses everything quickly. Pausing the video once or twice may be helpful for students to take careful notes.

- "Drone Flight School Episode 2: Pre-Flight Checklist & Set-Up" (Length 8:16) https://video.link/w/8jPz

For teachers unable to access Safe YouTube links, the video is also available here: https://youtu.be/d6gPzpM0qnw

Briefly discuss the video, then ask students how the remote pilot determined the specific preflight checklist steps that were taken. Student answers should mention the remote pilot's level of experience, as well as the model of UAS being discussed.

Slide 19: After every flight it is also a good practice for remote pilots to conduct a postflight inspection. A postflight inspection of a UAS will help determine if anything has changed after a flight. A postflight inspection could include many of the steps taken before a preflight inspection. This is also a good opportunity to attach a protective gimbal lock, rotate batteries, remove and properly store cables and propellers, and take out the memory card. Any issues discovered during the postflight inspection should be addressed prior to the next flight.

Session 2

Slide 20: Regular maintenance is important in order to keep a UAS functioning properly. Maintenance can be either scheduled or unscheduled. Scheduled maintenance should be performed according to the manufacturer's recommendations. Unscheduled maintenance could occur at any time and for a variety of reasons. Any part of a UAS and related components and accessories may require the following maintenance throughout the life of the UAS:

- Service
- Overhaul
- Parts upgrade
- Repair
- Inspection
- Modification
- Replacement
- Software upgrades

Slide 21: Remind students that when they are performing preflight UAS inspections, it is important to refer to the manufacturer's instructions and safety tips. Any manufacturer-included documentation regarding maintenance should always be followed. Some of these recommendations will typically refer to when to replace parts based on usage, or how to have a UAS serviced if needed. If the manufacturer does not provide maintenance information, the remote pilot could reach out to the manufacturer online or create their own maintenance schedule (or both).

Slide 22: Because the UAS and circumstances for every remote pilot are different, maintenance schedules and protocols will differ too. Over time a remote pilot will acquire valuable knowledge and experience of their particular UAS and flight requirements. Keeping a maintenance record will be useful for scheduling a specific maintenance procedure that meets a remote pilot's needs. To accomplish this, a remote pilot should keep a record of the following:

- Any damage, repair, replacement, alteration, upgrade, service should be documented.
- The length of time that specific parts and components were used before they required service or replacement should also be documented.

Over time, documenting maintenance will help a remote pilot create a refined maintenance schedule that meets the needs of their specific equipment and circumstances.

Slide 23: Different types of inspection should be performed at different intervals. Before each flight, a basic visual inspection should be conducted. Over longer stretches of time, more in-depth inspections should be conducted. For example, once every five flights or seven days (whichever comes first), remote pilots should conduct UAS inspections looking for cracked parts, loose screws, or loose lens caps. Pilots should also clean out the battery and sensor contacts and perform any other manufacturer-recommended maintenance.

Once every 15 flights or 30 days, remote pilots should conduct a thorough, in-depth inspection of a UAS. If recommended by the manufacturer, panels can be opened for interior UAS inspection and dust or dirt cleaned out; be careful not to do anything that might void the warranty, however. Wires and internal parts and computer components can be visually inspected to look for any irregularities or loose screws. Camera parts and gimbal motors should be inspected, and software updates should be installed if needed.

Slide 24: Even with regularly scheduled maintenance, an unexpected maintenance issue can still arise. For example, a remote pilot may notice that a propeller motor requires maintenance, whether due to normal use or an accident. Unscheduled maintenance may also arise due to manufacturer software updates. Because of this, it's a good idea to periodically check UAS manufacturer websites to look for firmware updates, which can remove software bugs and introduce new system software features that may require new documentation. If any mechanical or software issues arise, a flight should be discontinued until all issues have been corrected.

Not all UAS models or parts are user-serviceable. Always follow the manufacturer's documented maintenance procedures; if none are available, contact the manufacturer for advice before attempting to service a UAS. If a remote pilot cannot service a UAS themselves, they should seek qualified maintenance professionals. If a UAS cannot be repaired or serviced, it's use should be discontinued.

Slide 25: Play the following video discussing drone maintenance. The video discusses helpful tips on preflight checklists, cleaning, flight practices, battery care, and protective case recommendations. Instruct students to take notes during the video to which they can refer when creating their own preflight checklist later in the lesson.

- “Give Your Drone The Longest Life – Drone Maintenance Tips” (Length 3:13) https://video.link/w/IFPz

For teachers unable to access Safe YouTube links, the video is also available here: https://youtu.be/H2JrtlbUnZo

Ask students which tips they found most useful and how they might apply the information to their own flying routines. Students may mention some of the helpful tips given in the video.

For example:

- using canned air to clean dirt out of a drone motor
- acquiring a nice case
- landing a UAS with the aft-end facing the remote pilot so as not to get directions confused

Slide 26: Batteries are sometimes overlooked by remote pilots as a simple swappable power source, but in fact battery care and maintenance are among the more complex and important aspects of UAS maintenance. For this reason, UAS batteries will be discussed independently and in-depth.

Teaching Tips

If available, display the classroom UAS battery for students, along with its charging components.

Batteries are the power source for communication with and operation of a UAS. Like any fuel source, batteries only allow for a finite amount of flight time. Lithium polymer batteries (LiPo) are the most common battery used as a power source for UAS. Other types of batteries are sometimes used.

Slide 27: LiPo batteries are the standard power source used for UAS due to their high energy storage and discharge and recharge capabilities. LiPo batteries are also lightweight, which makes them ideal for UAS flight use. Students may not be aware that LiPo batteries require more attention and care than common alkaline batteries used in home flashlights, remote controls, and other everyday products. UAS LiPo batteries are often expensive; if not cared for properly, they could have a shorter rechargeable lifespan by as much as 50 to 75 percent. On rare occasions, LiPo batteries can catch fire. To reduce this risk, it is important to use and maintain them in accordance with manufacturer guidelines.

Slide 28: A new LiPo battery should not be fully drained during its first few flights; doing so will shorten the life of the battery and make it unreliable.

A new LiPo battery comes charged at around 40 percent capacity, which is the best way to store the battery when not in use. Before first using a new LiPo battery, be sure to fully charge it. Care should then be taken not to drain the battery below 50 percent capacity for the first few flights. This will help extend the life of the LiPo battery.

Teaching Tips

Explain to students that some UAS companies manufacture their own “smart” LiPo batteries and chargers that automatically balance battery cells and discharge them when not in use. However, many other batteries do not automatically do this. When buying LiPo batteries for smaller drones, custom-built drones, or racing drones, students should follow the instructions from the battery manufacturer. Additional equipment may be required to balance battery cells and discharge them when not in use.

Slide 29: Battery maintenance and care is important to consider when creating a preflight checklist and maintenance scheduled. Be sure to follow LiPo battery manufacturer care and usage instructions. In addition, make the following considerations when charging LiPo batteries:

- Only use manufacturer chargers designed for LiPo batteries.
- If possible, use chargers that will balance a LiPo battery's cells.
- Never overcharge a battery.
- Do not charge a battery too quickly, as this could lead to damage.
- Charge batteries at room temperature. Extreme heat or cold should be avoided.
- Stop charging if the battery temperature increases quickly.
- Swollen or damaged batteries should not be charged or used.
- Never leave charging batteries unattended.
- Do not over-discharge a battery (i.e., below 20 percent capacity).

Slide 30: LiPo batteries operate efficiently between a certain temperature range. Operations in extreme heat or cold should never be performed. Using a LiPo battery in freezing temperatures can result in abrupt power loss, which could require the UAS to land in an unplanned location—or, worse, to crash. Be sure to always store batteries at room temperature and within the recommended manufacturer guidelines.

Another condition that is bad for LiPo batteries is extreme heat. If a battery warms to 60 degrees Celsius, it will become damaged and could catch fire. The best temperature range to store LiPo batteries is between 5 and 25 degrees Celsius.

Slide 31: LiPo batteries do not last forever. When a LiPo battery has been charged and discharged multiple times over the course of its lifetime, it will no longer hold a sufficient charge, and it should be considered unreliable. After a battery will only charge to 80 percent of its original power, manufacturer's instructions should be followed. Tracking battery performance along with UAS performance will help a remote pilot track a battery's decline over time.

When a battery is no longer in good working condition, it must be retired. Always check local regulations and manufacturer instructions before disposing of a LiPo battery. Many electronic stores and local municipalities have facilities to recycle or dispose of used batteries. It's also a good idea to completely drain the battery before disposing of it.

Teaching Tips

A good place to direct students to for battery disposal and recycling is https://www.call2recycle.org. The website has useful information on battery disposal, as well as a zip code locator (https://www.call2recycle.org/locator/) that lists the closest battery drop-off locations. A mail-in service is also available.

Slide 32: Play the following video that gives helpful battery tips and recommendations for safe operation and maintenance that will help extend battery life.

Instruct students to take notes during the video and to refer to their notes when creating their own preflight checklist later in the lesson.

- "5 Things that can Kill your DJI Battery" (Length 3:29)
  https://video.link/w/6uSz

For teachers unable to access Safe YouTube links, the video is also available here: https://youtu.be/eENdcVhldj4

Engage students in a brief discussion about battery safety and maintenance.

Slide 33: Complete the **Formative Assessment**.

> **Formative Assessment**
>
> Distribute **Preflight and Maintenance Student Activity 2**. Students will work individually to answer the questions, in order to demonstrate their understanding of the information and concepts covered in the lesson so far. Sample answers are provided in **Preflight and Maintenance Teacher Notes 2**. If class time is short, this activity could be used as homework.
>
> [DOK-L1; *recall*]

EXTEND

Teacher Materials: Preflight and Maintenance Presentation, Preflight and Maintenance Teacher Notes 3
Student Material: Preflight and Maintenance Student Activity 3

Session 3

Slide 34: Detailed record keeping is an important part of any UAS maintenance schedule and maintenance procedure. It is particularly important for remote pilots who use multiple UAS with many hours of flight operations. Keeping detailed records is a good way to stay organized; more importantly, it is essential for operational safety. Keeping track of how long different parts and components have been in use before wear and tear appears will allow pilots to track their quality and determine whether particular parts will soon need to be serviced or replaced.

Slide 35: To ensure thorough, useful records, remote pilots should document (with either hard copies or electronic copies) all inspections, maintenance, repairs, replacements, upgrades, and alterations that are performed on a UAS. Records should include not only maintenance performed on the UAS itself, but also on all components of the system, including the remote control, cables, mobile devices, launch and landing equipment, payload attachments, storage cases, and any other hardware required for the safe operation of the UAS.

Comprehensive record keeping demonstrates a remote pilot's attention to equipment care and safe flight operations. These practices can be helpful should the need ever arise to produce records for the FAA.

Slide 36: Distribute **Preflight and Maintenance Student Activity 3**. In this activity, groups (4–5 students/group) will work to brainstorm and develop ideas for creating a preflight checklist for the classroom UAS. Student groups will then share their checklist ideas with the entire class. After a discussion, the class will agree on and create a final preflight checklist for the classroom UAS.

Suggestions to initiate student/group preflight checklist brainstorming for the instructor are available in **Preflight and Maintenance Teacher Notes 3**.

> **Teaching Tips**
>
> If printed instructions for the classroom UAS exist, make copies available for student groups. Otherwise, go online to see if downloadable PDFs or any relevant documentation—including quickstart guides, instructions, and safety tips—exist; if so, have the necessary URLs available for students.

EVALUATE

Teacher Materials: Preflight and Maintenance Presentation, Preflight and Maintenance Teacher Notes 4
Student Material: Preflight and Maintenance Student Activity 4

Slides 37-60: Quiz students on the FAA Remote Pilot Knowledge Test questions on slides.

Slide 61: Conduct the **Summative Assessment**.

Summative Assessment

Students will answer written questions. Provide students with **Preflight and Maintenance Activity 4**. Correct answers and guideline responses are provided in **Preflight and Maintenance Teacher Notes 4**.

[DOK-L3; *assess*]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Postings show evidence of one or more of the following:
    - Knowledge of flight paths and basic instruments
    - Provides details about the factors that affect flight path
    - Provides explanation of actions pilots can take to account for wind and other factors while flying
- Contributions show understanding of the concepts covered in the lesson
- Contributions show in-depth thinking including analysis or synthesis of lesson objectives

Points	Performance Levels
9-10	Shows a strong understanding of how to assess the readiness of an sUAS for safe operation through careful examination of its components and using a preflight checklist using manufacturer recommendations and online research.
7-8	Shows a sufficient understanding of how to assess the readiness of an sUAS for safe operation through examination of its components and using a preflight checklist using manufacturer recommendations and online research. Student work shows small gaps in understanding.
5-6	Shows an insufficient understanding of how to assess the readiness of an sUAS for safe operation. Student work shows many gaps in understanding.
0-4	Shows little or no understanding of how to assess the readiness of an sUAS for safe operation. The student does not demonstrate an understanding of lesson objectives.

STANDARDS ALIGNMENT

COMMON CORE STATE STANDARDS

- **RST.11-12.2** - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- **RST.11-12.4** - 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 11-12 texts and topics*.
- **RST.11-12.7** - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- **RST.11-12.9** - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- **WHST.11-12.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- **WHST.11-12.7** - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **WHST.11-12.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- **WHST.11-12.9** - Draw evidence from informational texts to support analysis, reflection, and research

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