GRADES 6-8

Revised 06.04.2024

USS CLEVELAND LEGACY FOUNDATION

STEAM STARS

MODULE 2 LESSON GUIDE // U.S. NAVY AVIATION

USS CLEVELAND LEGACY FOUNDATION STEAM STARS PROGRAM

LESSON OVERVIEW

This lesson introduces aircraft used by the U.S. Navy and explains how the Navy uses STEAM skills and technology in everyday operations. Throughout the presentation, students will learn STEAM terms and concepts through guided discussion questions and entertaining video clips. Finally, students will use the engineering design process to design, build, and test a paper airplane launcher, and see a catapult-assisted takeoff just like how Navy fighter jets takeoff from aircraft carriers.

TABLE OF CONTENTS

LESSON TITLE

U.S. Navy Aviation

TIME

90 min 1 class for Presentation and start of Activity *(see page 7)*
1 class to finish Activity and Wrap-Up

LEARNING OBJECTIVES

Students will:

- Learn about advanced technology systems used in and by military aircraft.
- Learn about interesting career opportunities in STEAM fields.
- Use the engineering design process to design, build, and test a paper airplane launcher.
- Understand how potential energy is converted to kinetic energy when using the launcher.

NEXT GEN SCIENCE STANDARDS (NGSS)

This lesson helps students prepare for these Next Generation Science Standards Performance Expectations:

> MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
>
> MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

MATERIALS AND EQUIPMENT LIST

1. Module 2 Presentation (U.S. Navy Aviation)
2. Build a Paper Airplane Launcher Activity
   Divide class into teams of 4-6 students. Materials needed for each team:
   - ☐ Paper (several sheets of letter size paper)
   - ☐ Rubber bands
   - ☐ Pen or pencil
   - ☐ Paper clips
   - ☐ Tape or stapler
   - ☐ Construction materials to build a paper airplane launcher (**WATCH VIDEO** for ideas), such as:
     - Corrugated cardboard and duct tape
     - Wooden craft sticks and a hot glue gun

- Building toys like LEGO® or K'NEX®
- Wooden boards and nails or screws

☐ Open area to launch paper airplanes (without wind or strong drafts).

STUDENT ACTIVITY SHEETS/HANDOUTS

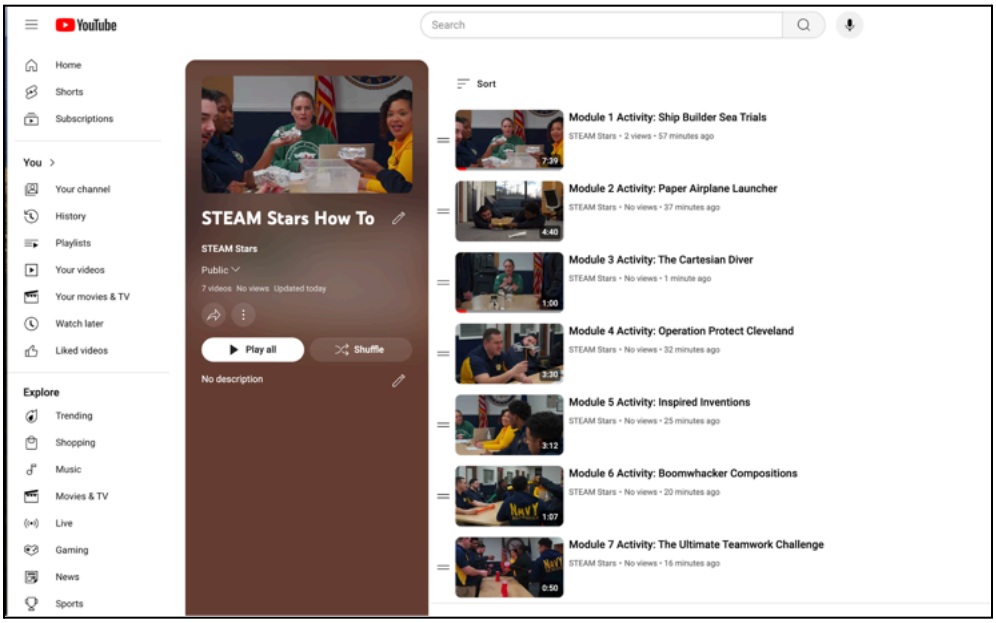
☐ M2 Paper Airplane Instructions (print out copies for each group or project on screen)

TECHNOLOGY TOOLS

☐ Digital display projector with internet access
☐ Ability to project and play Google Slides and YouTube videos with sound
☐ Printer/Copier

PREP WORK

☐ Test slide deck, embedded videos.
☐ Print the student worksheets. Print the paper airplane instructions and optional lab worksheet if needed.
☐ Reserve open area to safely launch paper airplanes (aimed away from other students). A hallway or large room like a cafeteria or gymnasium will work best. Set up one or more tape measures on the ground so students can easily measure flight distance.
☐ Go to the @USSCLF-STEAMStars YouTube to watch helpful How-To videos!



PROCEDURE PART 1: PRESENTATION

Module 2 - U.S. Navy Aviation

Slide 1. 	
Slide 2. 	When we think of the Navy, we typically think of battleships right? Maybe aircraft carriers? But did you know the U.S. Navy has a fleet of more than 3,700 aircraft? It's the second largest air force in the world, second only to the U.S. Air Force itself. In this lesson, we're going to be looking at a few of the aircraft that make up the Navy's air fleet, from fighter jets to choppers.
Slide 3. 	This is the F-35 Lightning 11, the U.S. Navy's most advanced fighter jet. The F-35 is the most technologically advanced fighter jet in history - with the most advanced and comprehensive sensor technology. It's what we call a Force Multiplier. **Force Multiplier is a term we use in Physics... who knows what a Force Multiplier is?** In physics, a force multiplier reduces the amount of force necessary to move an object. In military science, a force multiplier refers to a factor or a combination of factors that gives us the ability to accomplish greater feats than without it. In this case, the F-35 Lightning's systems are so advanced, that they are considered to be a force multiplier because they significantly enhance the capabilities and range of its missile detection systems, greater than any other fighter jet, and even have systems to find, track, and stop missile launches before an attack. Some more facts about the F-35 Lightning II... • It is one of the few fighters that can travel at supersonic speeds, meaning, faster than the speed of sound (also known as mach speed). • It conducts vertical take-offs and landings. • And to operate it, the pilot wears a 360 degree helmet-mounted display system that is custom-fit and costs more than a ferrari!

Slide 4. 	This is the F/A-18 E/F Super Hornet. **"F/A" - Can you guess what this acronym stands for?** **If you guessed fighter attack jet, you are correct!** The "F" or fighter indicates air-to-air fighting capabilities and the "A" or attack indicates air-to-ground attacks (or strikes). The F/A mission capabilities also include: reconnaissance, air defense and in-flight refueling. One of the other cool features about this jet is it is controlled by an LCD touchscreen. **How many of you have seen an F-18 Super Hornet before?** None? Maybe a few? I bet some of you have and may not even know it...
Slide 5. 	**Have you been to the Cleveland air show before?** The F/A-18 jets are what the Blue Angels fly, and they come to our area every two years to give us a show! Another thing about these Super Hornets is they are incredibly fast. At 50,000 ft in the air, they can reach speeds of Mach 1.8... **do you know how fast that is in MPH (miles per hour)? Who has a guess?** I'll give you a clue... the speed of sound on a calm day is 761 MPH. And Mach 1.8 would mean 1.8 x the speed of sound. So the answer is.... 1370 MPH. (761 x 1.8 = 1370) Now that is fast!
Slide 6. 	Now the next aircraft isn't as fast as the F-35 or F-18, but it is groundbreaking for another reason. It is the Navy's UAS drone, which stands for Unmanned Aircraft System: the MQ-4C Triton. Triton pilots operate fully remotely, and these systems can stay airborne for more than 24 hours at a time, and fly up to 8,200 miles. A fun fact about Triton pilots is that they are licensed pilots that have hours of training on in-person aircraft before they learn to fly the UAS.
Slide 7. 	This next aircraft is another cool one for the Navy... **can you tell from the photo what makes it unique?** It's a cross between a helicopter and a fixed wing plane. This is called tilt-rotator technology, and you can probably see why they call it that. It allows the aircraft to be able to handle vertical takeoff and landings like a helicopter, which they often need to do during operations and missions, or even landing on ships.
Slide 8.	For this same reason, Helicopters play a vital role in helping the Navy achieve its mission. They are used for: • Search and rescue • Attack, defense and logistic support • Anti-submarine and mine countermeasures

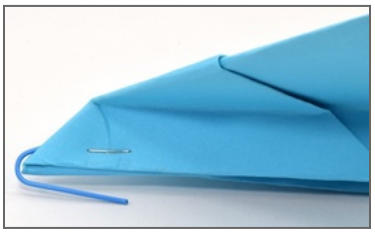
	• Replenishment missions And to: • Conduct enemy surveillance by collecting photographic intelligence
Slide 9. 	So what about the thousands of aircraft in the U.S. Navy fleet that ***don't*** have vertical takeoff abilities? How is the Navy able to use them in missions? Most aircraft use runways, as planes accelerate under their own power. Aircraft have to get going fast enough to generate enough lift to get off the ground. So especially for large, heavy planes, airport runways are typically very long (over a mile) to make sure the planes have enough room to get up to speed. This poses a problem for aircraft carriers. The largest aircraft carrier is just over 1,000 feet long, or just under a quarter of a mile. That's really big for a ship—but not that long for a runway! It takes a lot of coordination and teamwork to move all those people, planes, and equipment on and off such a short space. And to get planes off such a short runway, they need even more of a boost. They are assisted by a catapult system, which provides energy from an outside source (like compressed air or electromagnets) to slingshot them into the air. A very strong cable wire harness catches planes as they land. Our hands-on activity is going to be creating a catapult to test the science. But first, here are two videos to show what it's like for the U.S. Navy to take off and land jets on an aircraft carrier. As we watch together, try to catch where it shows the catapult system in action!
Slide 10. 	Clip Run Time: 4:40 **(Set to Play 15:58 - 20:38 Only)**
Slide 11. 	Run time: 2:44
Slide 12. 	So now we get to break into groups for a little activity. You'll be using your engineering skills to design and build a paper airplane launcher like the ones they use on aircraft carriers. Let's get started!

PROCEDURE PART 2: ACTIVITY

Build a Paper Airplane Launcher

Adapted from Science Buddies *Build a Paper Airplane Launcher*

To begin, divide class into even groups, or teams–approximately 4-6 per team. Each team will need their own set of materials. Instruct each team to build several paper airplanes to test. Because paper airplanes can get bent or destroyed easily, it's a good idea to build more than one. Give each team a copy of the Paper Airplane Instructions. Let them know that not everyone needs to make their own airplane, so each group has several to use for testing.



Demonstrate how to make the hook by taping or stapling a paper clip to the nose of each paper airplane. Point out the picture on Slide 12 in the presentation. The outer straight part of the paper clip should point backward parallel to the bottom of the plane, so it can serve as a hook to attach to the rubber band. There will be some pull on the hook, so make sure it's secure.

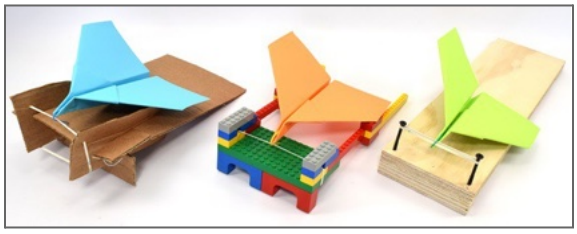
Instruct the class to use the engineering design process to build a launcher for their airplane. Think about the criteria for their designs. You will need to build a device to support the rubber band. It will need to be strong enough that it does not collapse when you pull back on the rubber band. You will also need to make sure the paper airplane does not get caught or snagged on the device when you launch it. Encourage them to work together as a team. Provide a time limit to keep teams moving forward.

**** OPTION TO BREAK THE LESSON UP INTO TWO PERIODS ****

To break up the lesson into two parts, in the first part, the teams should end with their planes assembled, and a prototype design drafted or started being assembled (60 min). In part two, they will finish their launchers, put their launchers to the test, then end with a brief closing discussion (60 min).

Once students have begun working on their designs, they might find that things don't fit together like they thought they would. That's okay! Encourage them to work together to figure out a solution in the time allowed.

Students will finish assembling, then begin testing their airplane launchers. It probably won't work perfectly on the first try. Encourage them to make changes to their designs to make it better.



PROCEDURE PART 3: DISCUSSION

Slide 13. 	**Closing Discussion** In order to take off, an airplane has to generate enough lift (upward force due to air pushing on the plane) to overcome its weight (downward force due to gravity). The faster an airplane goes, the more lift it generates. This is why airport runways are usually very long (generally longer than a mile): because planes need a lot of space to gain enough speed to take off. They also need a lot of space to land safely and slow down from such high speeds. Aircraft carriers are large ships with runways on them that allow aircraft to take off and land in the open ocean. Although aircraft carriers are huge compared with most other ships, they are very small compared with land-based airports and runways. The largest aircraft carrier is just longer than 1,000 feet, which is still less than a quarter of a mile. Airplanes can't gain enough speed to take off on their own over such a short distance, so they get an extra boost from a type of catapult (not the big wooden kind you might imagine flinging stones at castle walls). This catapult provides extra energy from a source such as compressed air or electromagnets to help the plane gain extra speed. The catapult hooks on to the plane and helps it accelerate over a much shorter distance so that it can get enough speed and lift to take off. You don't need any compressed air or electromagnets to build your own airplane catapult, however. In this project you built one using a rubber band. It stored potential energy, which gave extra kinetic energy (motion energy) to the paper airplane—in the same way the systems on carriers do.
	GO DEEPER **Discussion Questions For Further Exploration** How does the angle at which you launch the plane affect its flight distance? Did you try using different lengths and thicknesses of rubber bands? Did some work better than others? Why do you think that is?