GRADES 6-8

Revised 06.04.2024

USS CLEVELAND LEGACY FOUNDATION

STEAM STARS

MODULE 1 LESSON GUIDE // U.S. NAVY WATER VESSELS

USS CLEVELAND LEGACY FOUNDATION STEAM STARS PROGRAM

LESSON OVERVIEW

This lesson introduces ships used by the U.S. Navy, featuring a short history on the USS Cleveland ships, and explains how Navy ship builders use STEAM skills to design ships and carriers that can handle extreme conditions. Throughout the presentation, students will learn STEAM concepts in a fun way, and verify their understanding in using the provided activity worksheet. Finally, students will use the engineering design process to design, build, and test their own foil boat design and conduct a Navy Builder Sea Trial activity, simulating the trials real ship builders use to test ships and get them ready for deployment.

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LESSON TITLE

U.S. Navy Water Vessels

TIME

90 min. 1 class for Presentation and start of Activity *(see page 6)*
1 class to finish Activity and Wrap-Up

LEARNING OBJECTIVES

Students will:

- Learn about Cleveland's history of Navy ships.
- Learn how design can keep even the largest ships afloat.
- Learn about current Navy ships and their capabilities.
- Use the engineering design process to design, build, and test a foil boat that can withstand harsh trials.
- Understand scientific principles such as buoyancy and displacement and how the same principles work for tin foil as it does for aircraft carriers.
- Understand how a real-world problem can be solved through engineering.
- Apply the engineering design process to iteratively improve a design.

NEXT GEN SCIENCE STANDARDS (NGSS)

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

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

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.

MODULE 1 LESSON GUIDE // U.S. NAVY WATER VESSELS

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MATERIALS AND EQUIPMENT LIST

1. Module 1 Presentation (U.S. Navy Water Vessels)
2. Ship Builder Sea Trials Activity
   Divide class into teams of 4-6 students. Materials needed for each team:
   - ☐ 1 Large Plastic Tub filled with water (½ - ⅔ full)
   - ☐ Towel (to dry with)
   - ☐ Foil (several sheets)
   - ☐ 50 Pennies
   - ☐ Tennis ball, Bouncy ball, and/or Rock
   - ☐ 1 Plastic Straw
   - ☐ 1 Yard Stick (Optional)

U.S. Navy Water Vessels

Name/Group: _____

USSCLF STEAM Stars Student Worksheet

Date: _____

Ship Builder Sea Trials Activity: Lab Worksheet

A fun mini engineering challenge! Use what you've learned about ships to design one that can stand up to the Navy's Sea Trials!

Materials List

1 Large Plastic Tub filled with water (½ - ⅔ full)
Towel (to dry with)
Foil (several sheets)
50 Pennies
1 Each - Tennis ball, Bouncy ball, and a Rock
1 Plastic Straw
1 Yard Stick (Optional)

Boat Requirements:

- Draft, Design, Test, and Build ships made of foil. You may make several test prototypes, but only one can go to Builder Sea Trials!
- Each boat must be made of foil only (any size)
- No other materials (i.e., tape, cardboard) are allowed to be used in the construction

Procedure:

- Fill the plastic tub ⅔ full with water. Let the water settle.
- Draft or test your boat design. Think about ways Naval ship engineers design ships to handle difficult conditions!
- When you're ready with your final design, place the boat in the water. Proceed with trials. Place a check mark (✓) if completed successfully. Place an x (✗) if failed.

TRIAL #1: STANDARD CARGO HOLD TEST

☐ Add 10 Pennies to boat

TRIAL #2: HIGH SPEED TURN TEST

☐ Using the straw, blow to force your boat to turn sharply across the water

TRIAL #3: PRECISION AIRCRAFT LANDING

☐ Drop a single penny from 8 inches above, into the middle of the boat

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STUDENT ACTIVITY SHEETS/HANDOUTS

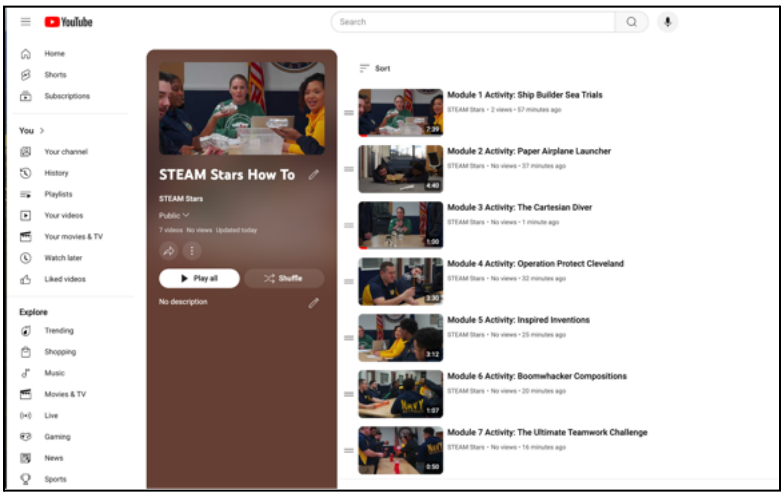
- ☐ M1 Worksheet: Ship Builder Sea Trials Activity

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. (1 per person or at least 1 per group)
- ☐ Pre-fill plastic tubs with water and have ready (1 per group)
- ☐ Tear off 12”x12” square sheets of foil – several for each group
- ☐ Pre-sort materials for each group
- ☐ Go to the @USSCLF-STEAMStars YouTube to watch helpful How-To videos!

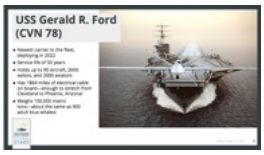


PROCEDURE PART 1: PRESENTATION

Module 1 - U.S. Navy Water Vessels

Slide 1. 	
Slide 2. 	Did you know the U.S. Navy is older than the United States? The U.S. Navy was founded in 1775 as the Continental Navy, has about 300 ships in its fleet today, and operates in nearly every major body of water around the globe: the Pacific, Atlantic and Indian Oceans, as well as the Mediterranean Sea, the Persian Gulf and the Horn of Africa. The Navy's surface fleet is made up of 16 different classes of vessels, and includes amphibious assault ships, aircraft carriers, command ships, minesweepers, destroyers, and more.
Slide 3. 	Here are some examples of different types of Navy ships. Every Navy ship has a name that includes an abbreviation for their class (like "CL" for Cleveland Light Cruiser or LCS for "Littoral Combat Ship") and a number, which is printed on the hull of the ship–their "Hull Number"--which is the sequential order of that type of ship when it was built. So, this first one, the C-19, was the 19th Denver class protected cruiser built. The next one would have been named C-20. Now all four of these ships have one cool thing in common. While their hull number may be unique (C-19, LPD-7, CL-55, LCS-31), they actually all share the same "first" name! These four ships are all named after our favorite city in Ohio. **Can you guess what their name is?** That's right, it's the USS Cleveland! The one pictured in the lower right is the USS Cleveland (LCS-31), and it is the newest one to bear our city's name, and it is actually still being built today! Hopefully, you will have the opportunity to see her in person in the fall of 2024 when she visits the Port of Cleveland. Five of her sister ships will be here for port visits over the next two years. Let's take a closer look at this ship class...
Slide 4.	The LCS is a fast craft, designed to operate in shallow waters, or hostile, near-shore environments to neutralize pirates, mines, terrorists, and subs, and launch special ops teams.

	If an aircraft carrier is a desktop computer, the LCS would be a "smartphone" –it's smaller, more versatile, but still powerful. 40% of the ship is reconfigurable space to allow for adaptability. And even though they typically hold a crew of 40-75 sailors on board, they only need 3 people on the bridge to steer the ship, and it's actually steered using two joysticks!
Slide 5. 	Another warship class is the Zumwalt-Class Destroyer, also called the "Stealth Destroyer." This class supports special operations like Navy SEALS. They are 600 feet long and weigh 15,000 tons. These ships produce enough power to each run a small city or 50,000 homes. They hold 147 sailors. And are outfitted with LRLAP (long range land attack projectile) with range of 83 nautical miles (95 miles or nearly the distance from Cleveland to Erie, PA)
Slide 6. 	This next ship is considered the centerpiece of the Navy fleet: the Aircraft Carrier, or class CVN.
Slide 7. 	The Ford-class aircraft carrier costs $13 billion dollars, took 8 years to build, is made of 60,000 tons of structural steel, and incorporated 23 new technologies.
Slide 8. 	**(CLICK TO ADVANCE ANIMATION)** It is over 250 ft wide, and is over 1106 feet long. **(CLICK TO ADVANCE ANIMATION)** To give a visual, that's the length of 3 football fields…
Slide 9. 	**(CLICK TO ADVANCE ANIMATION)** And if you could turn one up on its stern, or back end, it would be 159 feet taller than Cleveland's Key Tower!
Slide 10.	The CVN 78 is the newest class of aircraft carrier. Its service life is about 50 years, so a carrier which deploys this year would retire about the same time when each one of you will be getting ready to retire from your jobs, as well!

	These ships are so large, they can hold 2600 sailors, 2000 aviators, and up to 90 aircraft at a time, including cargo planes, fighter jets, helicopters, and unmanned combat aerial vehicles like the drone you see in this photo. And there is 3 MILLION meters of electrical cable on board, or 1864 miles of cable. That's enough cable to stretch from Cleveland to Phoenix, Arizona. With all that on board, the Ford-class carriers weigh about 100,000 metric tons. That's the weight of 900 adult blue whales!
Slide 11. 	So with all that weight, how does that work? Have you ever thought about how these massive Navy ships are able to float? Let's watch a video to help the science needed to make ships float. And just a hint! You *may* want to remember some of this for the activity we're about to do next! **(PLAY VIDEO - RUN TIME 2:11)**

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

To break up the lesson into two parts, in the first part, you will have students prepare the foil boat prototypes after the first video. Let students know that in part two, they will be putting their prototypes to the test! For part two, open with the second video and finish the activity.

Slide 12. 	Now imagine being a ship builder for the U.S. Navy that not only has to take into account massive cargo loads, but also, the extreme conditions of being out in foreign seas, in hostile conditions, extreme weather, and other unknowns. The last video we're going to watch is about the Builder's Sea Trials for the USS Gerald R. Ford (CVN 78), the aircraft carrier we learned about earlier in the lesson that took 19,000 builders working 8 years to complete. After all those years to plan, design, engineer, and build the first ever ship of its kind; this is the first time the builders get to see their ship out at sea, and test if everything on this massive carrier they built works. Let's watch! **(PLAY EMBEDDED VIDEO - RUN TIME: 3:12)**
Slide 13. 	So now, it's your turn. You'll be thinking like a U.S. Navy Ship builder, engineering your ship out of the provided materials, and conducting your own Builder Sea Trials. Let's get started! **(Pass out materials bins and instruction/activity worksheets and separate into groups)**

PROCEDURE PART 2: ACTIVITY

Builder Sea Trials

To begin, divide class into even teams, approximately 4-6 students each. Each team will need their own set of materials and at least one worksheet (you may choose to have each student complete their own, or have one per team).

Encourage students to think like a Navy ship builder! How can you design the shape of the boat's hull to maximize strength without making it too dense?

OPTIONAL: While students test different boat designs, feel free to call out any interesting engineering discoveries! You may also wish to conduct some experiments from the front of the class to give students some ideas for how to go about their design. For example…

- Tear two squares of foil of roughly the same size, approximately 5" x 5". Lay one flat on top of the water, then push it slightly down. Show how it sinks once water gets on top of the foil. Now, pull the foil out of the water, crumple it up into a ball. Dry your hands with a towel, and take the second sheet of foil, and crumple it up into a ball. Now place both balls of foil into the water, about 1-2 inches deep, and let them go. Notice that the one that was wet now sinks to the bottom, but the dry one, floats to the top? Interesting!
- Test a flat bottom boat vs a v-shaped bottom boat. Add pennies to see which one carries more weight. Add side impact (drop rocks or balls to the side) to see if one or the other handles waves better.

Boat Requirements:

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- Fill the plastic tub ⅔ full with water. Let the water settle.
- Draft or test your boat design. Think about ways Naval ship engineers design ships to handle difficult conditions!
- When you're ready with your final design, place the boat in the water. Proceed with trials. Have students document their findings on their lab worksheet by placing a check mark (✓) when the trial is completed successfully and an x (X) if the trial failed.

TRIAL #1: STANDARD CARGO HOLD TEST

- ☐ Add 10 Pennies to boat

TRIAL #2: HIGH SPEED TURN TEST

- ☐ Using the straw, blow to force your boat to turn sharply across the water

TRIAL #3: PRECISION AIRCRAFT LANDING

- ☐ Drop a single penny from 8 inches above, into the middle of the boat

TRIAL #4: EXPLOSIVE SHOCK TRIALS

- ☐ Drop the tennis ball/bouncy ball/rock at the yardstick, from approximately 7 inches above the water line.
- ☐ Drop the tennis ball/bouncy ball/rock at the yardstick, from 12 inches above the water line.
- ☐ Drop the tennis ball/bouncy ball/rock at the yardstick, from 20 inches above the water line.

DISCUSS: Did your boat tip? What happened?

TRIAL #5: MISSION CAPACITY SURGE TEST

- Guess how many more pennies your ship will hold (in calm waters).
- Add more pennies, one at a time, until you run out of pennies, or your ship sinks. How many pennies total did your ship hold?

GO DEEPER
Discussion Questions For Further Exploration

If you had more time or materials, what changes would you make to your ship?