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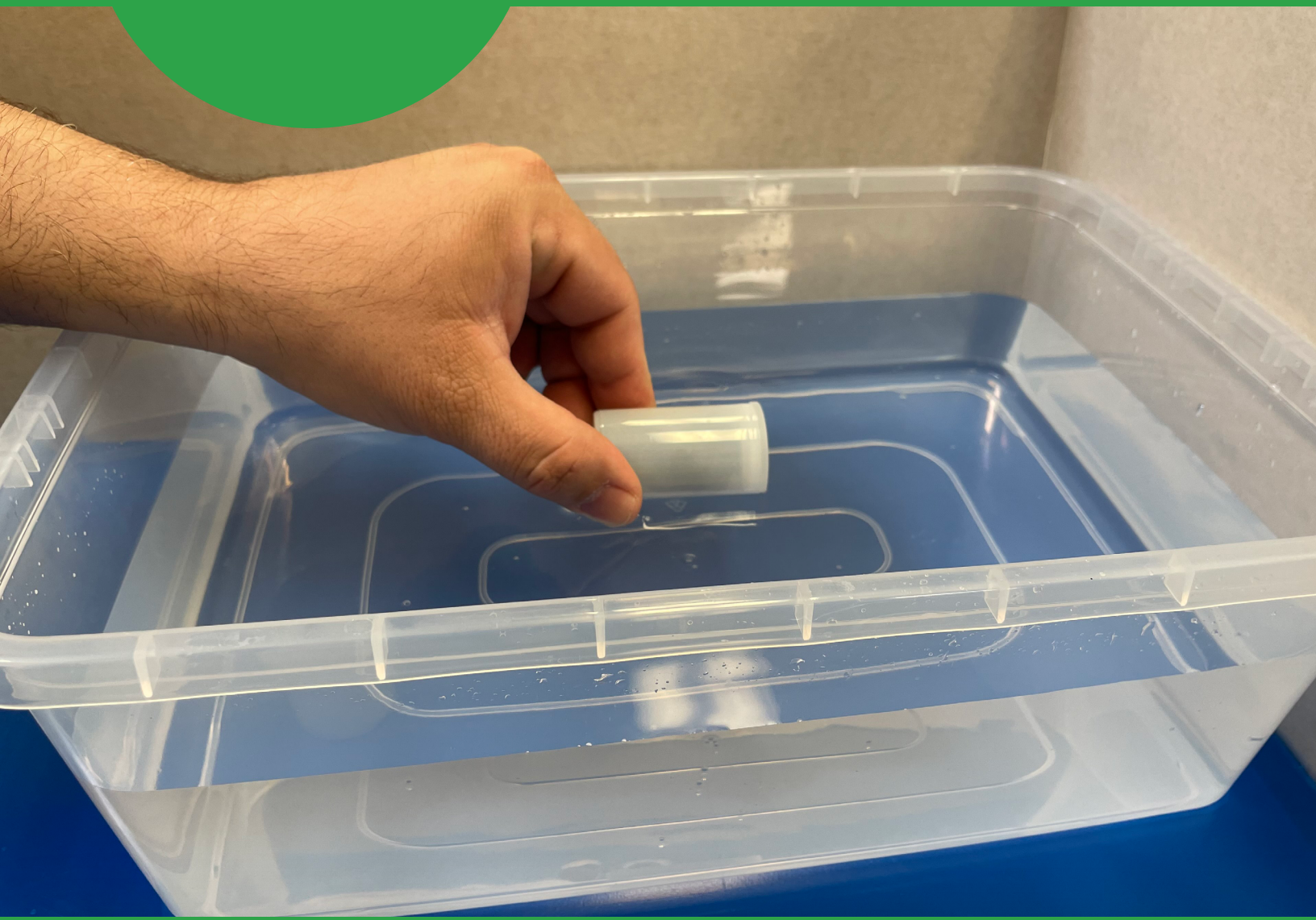
SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS

#SeaworthySTEM

Film Canister Boat Float

Grades 6-8

Teacher Guide



Seaworthy STEM™ in a Box Series

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Office of Naval Research
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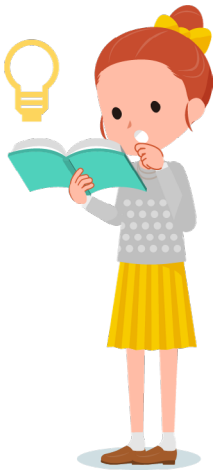
Film Canister Boat Float

Teacher Guide for 6-8



Seaworthy STEM™ in a Box Educator Kit description:

Seaworthy STEM™ in a Box activities are a Navy initiative to provide enhanced Naval-relevant, standards aligned, hands-on activities to K-12 teachers and students. Components of this program include, curated sets of classroom activities that aim to build deep conceptual understanding in Naval-relevant content areas. The kits also includes comprehensive lesson plans, material lists, scientific background information, STEM related literacy books, and student activity sheets. The Seaworthy STEM™ in a Box program is designed to support teachers as they select content, acquire materials, and implement more hands-on STEM activities in their classrooms. Increasing student access to hands-on STEM activities, also increases awareness of STEM career paths, engage students in STEM, and support development of student's abilities in STEM content.

The Seaworthy STEM™ in a Box kits were designed to guide students through the scientific inquiry-based theory and the engineering design process. The content and Naval-relevant activities are aligned with the Next Generation Science Standards. The topics and content covered within the lessons are connected and scaffolded based on distinct grade bands (K-2nd, 3rd-5th, 6th-8th, and 9th-12th).

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Table of Contents

Lesson Title: Film Canister Boat Float

Time:

1 class period

Student Objectives:

The students will take accurate measurements (both mass and volume) and use the appropriate mathematical formulas to attempt to solve an engineering design challenge.

Notes

Lesson Overview:

The students will use math to design a "boat" that will hold mass without sinking. The end goal is to create the heaviest possible film canister (using sand) and still have it float on the surface of the water. An extension activity is provided whereas students will go through the iterative design process to get their boat to become submerged in the water without touching the bottom.

Next Gen Science Standards (NGSS):

MS-PS2-2

MS-ETS1-1

MS-ETS1-2

"A cross-disciplinary approach can accommodate diverse learning styles!"

Materials and Equipment List

For each pair of students:

- ☑ Film canister
- ☑ Ruler

One per approximately 4 students:

- ☑ Sand container with scoop
- ☑ Electronic balance

For entire class:

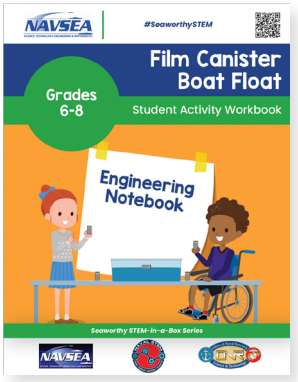
- ☑ Large container of water for floating boats

Optional:

- ☑ Materials to make film canisters look like boats

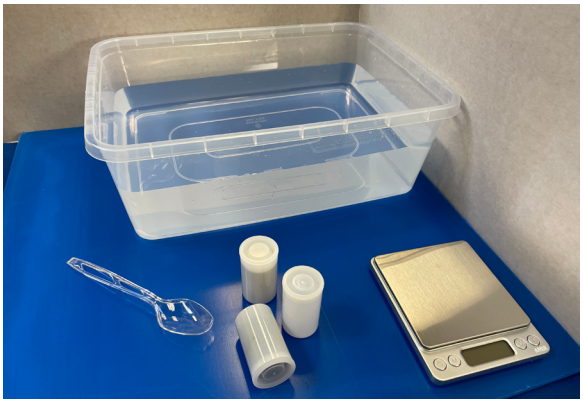
Student Activity Sheets/Handouts:

Student Activity Workbook:
Film Canister Boat Float



Procedure:

1. **Set up.** Each pair of students needs a ruler and a film canister. Set up several stations around the room with containers of sand, scoops, and electronic balances. Set up a water container and balance in the front of the room where students will test their boats.



2. Introduce challenge to students. The goal is to use a film canister boat hull and add enough sand to it to produce the heaviest boat that still floats. Boats will be built then tested individually with whole class data collection.

3. Provide background information (or let students use the internet to find background). Brainstorm problem solving strategies and information that will be needed to complete this challenge. Allow students to ask questions, but do not give direct procedures. Key ideas to emphasize:

   A. For a floating boat, the upward buoyant force acting on the boat equals the weight of the water that the boat displaces. In other words, a floating boat will displace its weight in water. Since mass and weight are proportional, this means that a 500 g floating boat will displace 500 g of water.

   B. Since the density of water is 1 g / cm3, the volume of water displaced (in cm3) equals the mass of the water displaced (in grams).

   C. Putting a) and b) together… a 500 g floating boat displaces 500 g of water which is equal to 500 cm3 of water.

4 Pairs of student will work together to measure their canister:

- **Calculate the Volume**
  - Formula for volume of a cylinder:
    $V = \pi \times r^2 \times h$

EXAMPLE:
What is the volume of a cylinder that has a radius of 5 cm and a height of 10 cm?

Solution
We have the following values:

Radius= 5
Height = 10
Using the volume formula with these values, we have:

$V = \pi \times r^2 \times h$
$V = \pi \times 5^2 \times 10$
$V = \pi \times (25) \times 10$
$V = 785.4\ cm^3$

The volume is equal to $785.4\ cm^3$

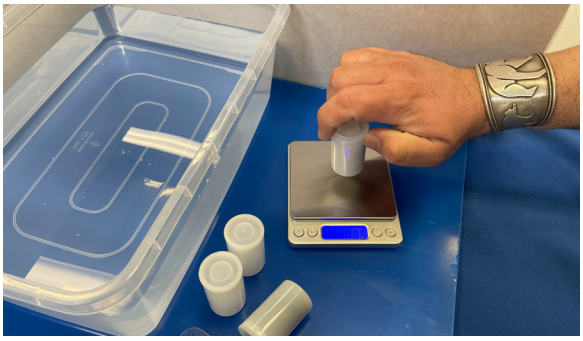
- **Calculate the Mass**
  - Use the balance to record the mass in grams.

    **Make sure they put the lid on the container, so they can find the correct mass.*

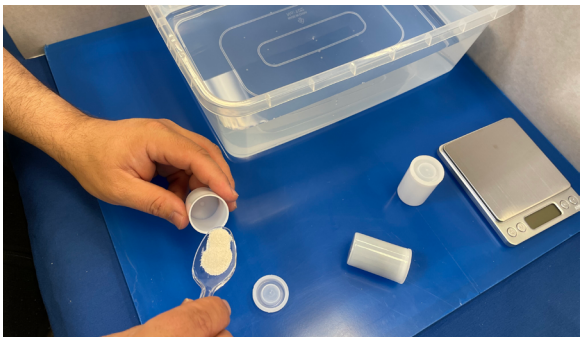
EXAMPLE:
For this example we will use 1000g

Solve using Density= Mass/Volume
$D = 1000g/785.4cm^3$
$D = 1.27g/cm^3$

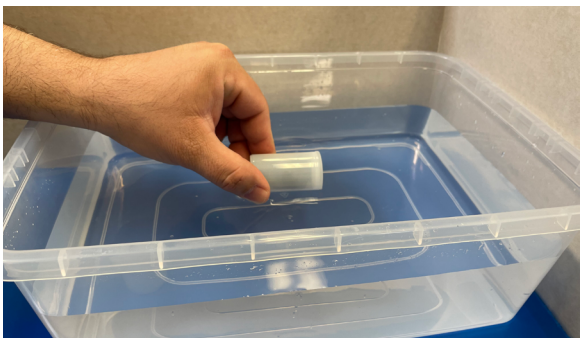
5. Once they have calculated their mass, they should go to a sand/balance station and load sand to get to their mass. Students who finish early may be given supplies to decorate their canister to look more like a boat (optional).



6. Once all students are ready, bring groups to the front 1 at a time to test their boat in front of the class. Place their boat on a balance and record its official mass on the board.



7. Allow students to place their boat in the container of water to determine if it floats or sinks. Record results.



8. The "winner" is the group that has the heaviest boat that still floats.

Teacher Background Information / Notes:

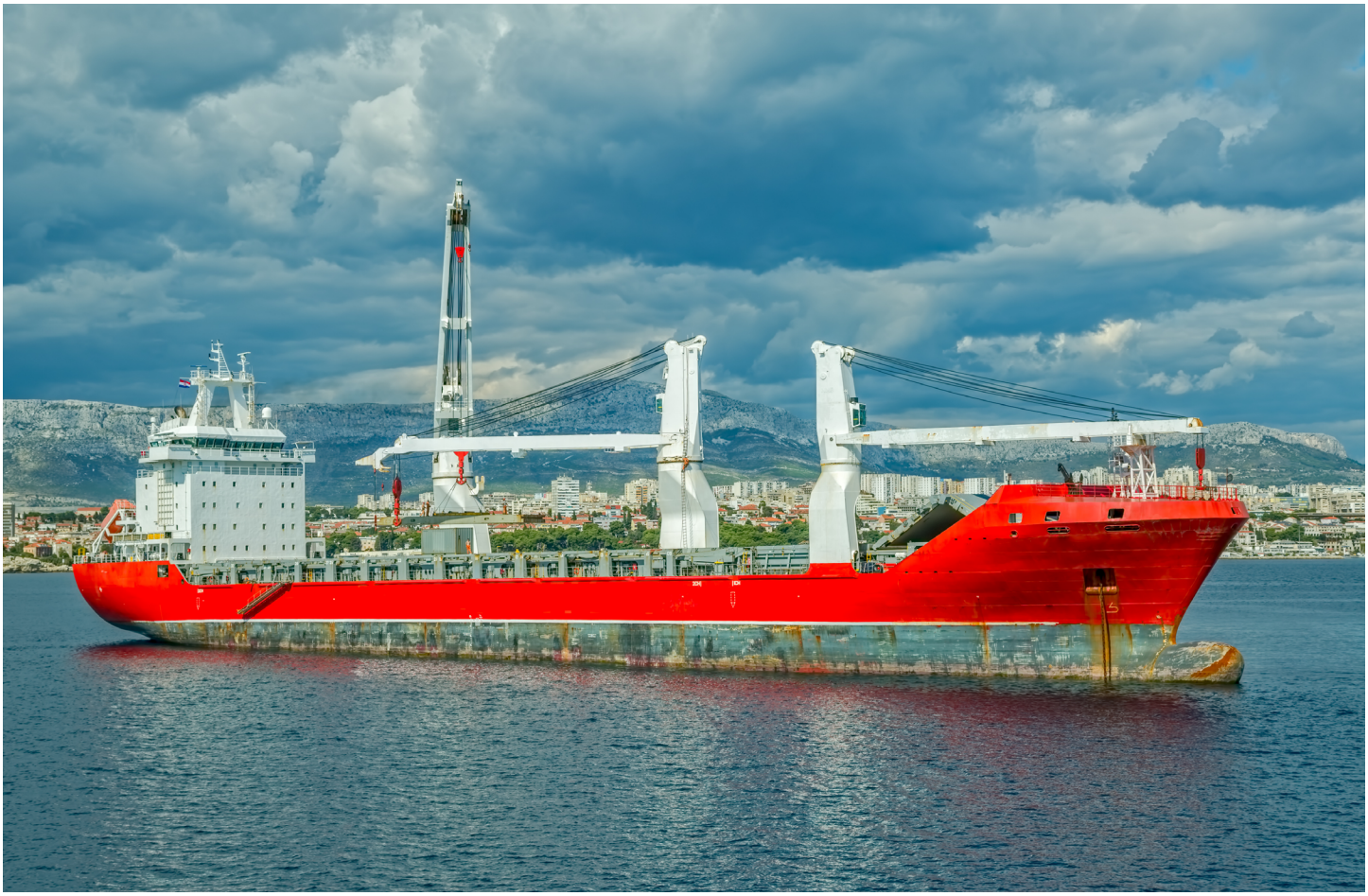
- This is a great "self-checking" activity that emphasizes mass and volume and the relationship of density to floating.
- Some boats may actually appear to float a bit below the water's surface due to the surface tension of the water causing a bead of water to build up higher than the rim of the canister.
- Containers of other shapes can be used to alter the difficulty level of the challenge or to allow students a 2nd trial with the procedures. Cubic prisms, plastic spheres, test tubes, plastic eggs, and different sized cylinders could be used.

Vocabulary Terms and Mathematical Formulas:

- Buoyant Force: The upward force exerted by any fluid upon a body placed in it
- Density: The amount of space an object or substance takes up (its volume) in relation to the amount of matter in that object or substance (its mass) Density = M/V
- Displacement: The volume of water displaced by an object is also equal to its immersed volume, which, in the case of a floating boat, will be its underwater hull volume.
- Liquid: A state of matter where particles are free to flow. It has a definite volume, it does not have a definite shape
- Mass: The amount of matter in an object
- Volume: The amount of space occupied by an object
- Formula for volume of a cylinder: $V = \pi \times r^2 \times h$

STEM Related Careers:

- Marine Biologist
- Meteorologists
- Naval Architect
- Ocean Engineering
- Mechanical Engineering



Need a lift?

This heavy lift ship is used to carry large loads that goes beyond the size and weight of regular traveled cargo. These ships can even carry another ship!

Notes

The Seaworthy STEM™ in a Box curricula was developed through collaborative efforts of a team of individuals at the Naval Surface Warfare Center Carderock Division and Albert Einstein Distinguished Educator Fellows via an inter-agency agreement with the U.S. Department of Energy for the Albert Einstein Distinguished Educator Fellowship (AEF) Program. We are grateful to the following Content Specialists who contributed their knowledge and expertise by researching and writing on selected topics: Suzanne Otto, Stephanie Klixbull, and Thomas Jenkins. We'd also like to acknowledge the contributions of AEF participant Ms. Deborah Reynolds, the inaugural AEF Educator at Carderock that helped inspire the design of Seaworthy STEM™ in a Box content. With the help of Albert Einstein Fellow, Melissa Thompson, and Carderock Outreach Specialist, Ashlee Floyd, special additions to the curriculum such as career portfolios, workforce trading cards, and in-house short story publications are included that reflect the diversity of NAVSEA Sites.

It is the goal of the SeaWorthy Curriculum to embrace NAVSEA technologies from sites nationwide to empower the youth of our nation to purse STEM-centric career pathways. The views and opinions of the Content Specialists expressed herein do not necessarily state or reflect those of the AEF Program, the U.S. Department of Energy, or the U.S. Government. Reference herein to any specific commercial product, process, or service by trade name, trademark, service mark, manufacturer, or otherwise does not constitute or imply endorsement, recommendation, or favoring by the AEF Program, the U.S. Department of Energy, or the U.S. Government.

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