#SeaworthySTEM

Splashdown Showdown

Grades 9-12

Teacher Guide

Seaworthy STEM™ in a Box Series

Splashdown Showdown

Teacher Guide for 9-12

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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).

Photo on the Cover: An Atlas V rocket carrying two satellite payloads for the USSF-12 mission launches from Space Launch Complex (SLC-41) at Cape Canaveral Space Force Station, Fla. July 1, 2022. The Atlas V will deliver the payload directly to the geosynchronous orbit approximately 22,000 miles above the equator. (U.S. Space Force photo by Joshua Conti)

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Introduction

Welcome to an innovative curriculum designed to engage students in the world of engineering, problem-solving, and creative thinking. This curriculum is structured around three fundamental components, each carefully crafted to provide students with a comprehensive learning experience. In this curriculum, each lesson is divided into three parts: Journal Entry, Part 1, and Part 2.

Parts of Each Lesson

Journal Entry

The first part of every lesson serves as a bridge between what students already know and what they are about to learn. The Journal Entry is an opportunity for students to reflect on their prior knowledge and experiences related to the topic. These questions will stimulate critical thinking and prime students for the exploration of new concepts. The teacher can mold these questions into a format that best fits their class. This entries can be done in the student workbook, a separate journal notebook or another location determined by the educator.

Part 1: Introduction & Research

Following the Journal Entry, Part 1 of each lesson is dedicated to research and in-depth exploration. The students will delve into the subject matter, investigate key concepts, and gather valuable information. This phase is essential in providing the foundation for the Engineering Design Challenge, ensuring that students have the necessary background knowledge and skills to approach real-world problems effectively. Do not feel as though you have to strictly follow these instructions. Use the tools that are necessary for your students. This could include adding teaching strategies, word banks or other differentiation techniques to the lessons.

Part 2: Engineering Design Challenge

The culmination of each lesson is the Engineering Design Challenge. This is where students put their newfound knowledge and research skills to the test. They will work through the engineering design process, applying their problem-solving abilities to develop practical solutions. The challenges are crafted to mimic real-world scenarios, allowing students to experience the fulfillment of creatively designing their own products. Engineering education can be enriched by infusing elements of business-style competitions into your lessons. This approach not only deepens students' technical understanding but also hones their teamwork, critical thinking, and real-world problem-solving skills. This can be done by using the team dynamics page as a "business" team page. Remember, as the teacher you create your materials pricing list from what you have. This will allow you to have more control over the outcome of the lesson. The educator becomes the customer while the students incorporate regular pitch sessions as part of the final presentation. Play with the style of the lesson and build students up to feel the business dynamic that unfolds through the engineering process.

Here We Go!

By the end of this curriculum, students will have the tools and confidence to address real-world challenges in a systematic way. This curriculum is designed to provide the basics and help organize a young engineers thought patterns. Teaching students how to map out their thinking is essential in the development of world changing solutions. We are excited to embark on this educational journey with you! Let's get ready to journal, research, and create as we embark on a #SeaWorthySTEM learning adventure!

Table of Contents

Lesson Title:

Splashdown Showdown

Time:

Average learning time is 4-5, 50 minute class periods

Student Objectives:

1. Understand the principles of water-based physics and engineering.
2. Apply the engineering design process to create a water rocket.
3. Collaborate effectively with peers to solve real-world problems.
4. Explore and analyze the impact of variables on rocket performance.

Lesson Overview:

Students will explore the science behind rockets and its significance in the #SeaworthySTEM industry. They will engage in a hands-on design challenge to create water rockets. The will work in teams to construct and test their water rockets while considering various factors that affect the rocket's performance. The goal is to launch the rocket to reach the highest altitude while ensuring a safe and controlled splashdown.

Next Gen Science Standards (NGSS):

HS-PS2-3 (Motion and Stability: Forces and Interactions)
Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

HS-ETS1-2 (Engineering Design)
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 (Engineering Design)
Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics.

Notes

Materials and Equipment List

- ☑ Empty plastic 2-Liter soda bottles (3-4 per group) or smaller bottles
- ☑ Water
- ☑ Packing Tape or Duct Tape
- ☑ Box Cutter
- ☑ Scissors
- ☑ Hot Glue Gun
- ☑ Rocket Decor
- ☑ Air pump with pressure gauge
- ☑ Cardboard or foam fins
- ☑ Duct tape
- ☑ Nose cones (e.g., foam or plastic)
- ☑ Sticks or straws
- ☑ Antacid Tablets
- ☑ Stopwatch or timer
- ☑ Launch pad or stand
- ☑ Measuring tools (ruler or measuring tape)
- ☑ Safety goggles

Student Activity Sheets/Handouts:

Student Activity Worksheet:

Splashdown Showdown

Technology Tools:

Computer

Internet access

Part I: Background Research

1 Pre-Assessment Activity:

The student journal response can be used as a pre-assessment for this unit. Have the students answer these questions in the "Journal Entry" section of their engineering notebook.

Sample Journal Prompts:

1. Imagine you are an astronaut traveling in a rocket to explore outer space. Describe the sights, sounds, and feelings you experience during the liftoff and as you journey through the Earth's atmosphere. What do you think would be the most exhilarating part of the rocket launch, and why?
2. If you were to design your own rocket, what features would you include to ensure a successful launch and safe travel into space?
3. Research and choose one significant space mission that utilized a rocket. Describe the purpose of the mission, the type of rocket used, and the challenges the scientists and engineers faced during the launch and journey.

2 Pre-Activity:

Have the students answer these questions in the "Think about..." section of their engineering notebook. The teacher can post the questions below for the class to reference when answering.

Tell the students to "Think about what you know about rockets..." then answer the following questions:

1. What are the primary components of a rocket, and how does each component contribute to the overall function and performance of the rocket during launch and flight?
2. How does Newton's third law of motion apply to the operation of a rocket, and what specific forces are involved in propelling a rocket into space?

YouTube:

3. What are the key differences between solid-fuel and liquid-fuel rockets, and what are the advantages and disadvantages of each type in terms of efficiency, control, and safety?

3 Hook:

Show this video and have students reference questions from the journal and pre-activity section: https://www.youtube.com/watch?v=1yBwWLunlOM

4 Background Research- Primary Sources:

Research Artifacts:

- Have students complete the: "**Let's Explore Primary Sources & Research**"

5 Background Research- Information:

Research Sheets:

- Have the students complete the: "**Type of Rockets Research Sheets**"

6 Student Discussion:

After the students complete their research, use the information within both research sections to review with the students. Class discussions, share outs, partner shares or gallery walks are effective methods of communicating findings.

7 Engineering Design Challenge:

Discuss rockets and share Navy examples and explain the upcoming design engineering challenge. Some examples are included below:

1. Launching Missiles: The Navy uses rockets to launch missiles from ships and submarines to protect the country from potential threats.
2. Providing Supplies: Rockets help the Navy send important supplies, like food and equipment, to sailors on ships and submarines stationed far away.
3. Conducting Research: The Navy uses rockets to send special instruments and tools into space to learn more about the Earth and the oceans.

4. Exploring Space: Rockets help the Navy send satellites and spacecraft into space to explore and learn about planets, stars, and galaxies beyond Earth.
5. Sending Signals: Rockets are used to launch communication satellites that help the Navy send messages and signals to other ships and bases around the world, even in places where regular communication might be tricky.

Part 2: Engineering Design Challenge

Background Information:

Rockets are vehicles designed to propel themselves through space using the principle as described by Newton's third law of motion. They work by expelling a high-speed jet of gas in one direction, causing the rocket to move in the opposite direction. Rockets come in various forms, such as solid-fuel and liquid-fuel rockets, each with their unique advantages and applications. These devices have played a pivotal role in space exploration, satellite deployment, and defense systems. From launching satellites that enable global communication to powering spacecraft that journey to distant planets, rockets have revolutionized our understanding of the universe and have become an essential tool for scientific research and technological advancement.

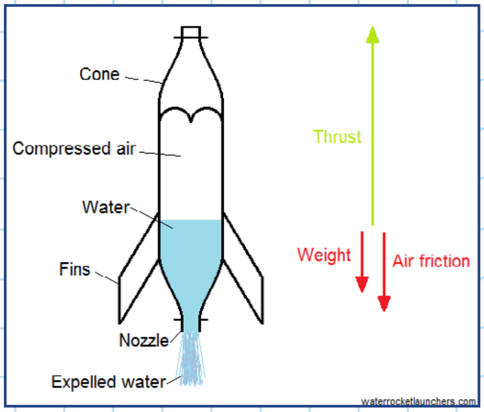
The Engineering Design Challenge:

The Navy has tasked your design team with creating a rocket that can launch the highest. Your rocket must be able to maintain a trajectory and structure. The goal of your design is to use materials that maintain the integrity of the rocket while achieving the best results. Your team must be creative in determining what type of materials and features should be included for success.

Procedure:

Pre-Activity: Students will fill out a Team Dynamics page to review expectations and goals of the challenge.

Examples



Source: http://waterbottlerockets.weebly.com/design---rocket-variables.html

Source: https://www.teachengineering.org/activities/view/ucd_bottlerockets_activity1

1 What is the Problem?

- Have the students discuss the basic scientific principles associated with the lab: stability, aerodynamics and propulsion.
- Introduce the engineering challenge:
  - ***Design and build a rocket that can fly the highest.***
- Form small teams and distribute the materials. Note: If allowing students to choose materials at random, create a materials home-base (a large box or storage container) designated for hand-selected materials.
- Have the students formulate a problem (in question form) from the scenario provided.

2 What are the Criteria and Constraints?

- Have the students list out the criteria and constraints for the lab.
- Constraints: Provide your students with a list of constraints for the engineering design challenge.
- Discuss budget constraints (a limited number of materials per team).
- Have the students fill out the budget form for their design.

  Possible ideas are listed below:

  - You will have (pre-determined number) of class periods to design, build and test your project.
  - Material Constraints
  - Budget Constraints
  - Power source (Airpump or Antacid Tablet)

3 How can we Brainstorm and construct the Prototype?

- Have the student brainstorm multiple designs for their prototype.

- Students will choose one design, justify their choice in the writing section and build their models according to their designs.
- Emphasize teamwork, creativity, and adherence to budget.

4 How can we Test and Data Collection?

- Each team tests their prototype by:
    - A. Shooting the rocket and measuring the distance traveled.
    - B. Vertical or horizontal goals can be considered.

5 What are our Findings? Data Analysis and Reflection

- Team present their findings by creating a data chart, graph and reflection statement to discuss the findings of their prototype.
- Teams discuss what worked and what did not in their design.
- Reflect on the engineering design process by answering the following questions:
    - A. Does my prototype meet the requirements of the design challenge?
    - B. Can I improve the design from its original specifications?
    - C. How can I reduce the cost of my final prototype without sacrificing quality?

6 Let’s Improve it! Class Discussion, Team Redesign Conclusion

- Discuss the most successful designs and strategies.
- Relate the activity to real-world applications in naval engineering and design.

7 Peer Evaluation of Teamwork

- Students will be providing feedback of teammates and collaboration.

Vocabulary Terms:

- **Thrust**
- **Drag**
- **Lift**
- **Aerodynamics**
- **Altitude**
- **Pressure**
- **Iteration**
- **Design variables**

STEM Related Careers:

- Aerospace Engineer
- Mechanical Engineer
- Civil Engineer
- Data Analyst
- Meteorologist
- Physicist

Notes

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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, Thomas Jenkins and Melissa Thompson. 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. Special thanks to Albert Einstein Fellow Melissa Thompson, for the creation of a collaborative high school engineering curriculum and supplemental additions to the early grade bands; career portfolios, workforce trading cards, and in-house short story publications. Gratitude to Carderock Outreach Specialist Ashlee Floyd, STEM Program Manager, Charlotte George, and Media Specialist Kristin Behrle for the creation and support of this naval endeavor that showcases the diversity of NAVSEA Sites.

It is the goal of the Seaworthy STEM™ 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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