#SeaworthySTEM

Laser Maze Challenge

Grades 9-12

Teacher Guide

Seaworthy STEM™ in a Box Series

Laser Maze Challenge

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).

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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:

Laser Maze Challenge

Time:

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

Student Objectives:

1. Understand the basics of optics and light reflection.
2. Apply knowledge of angles and reflection to manipulate a laser beam through a maze.
3. Work collaboratively in a team to design and build a functional laser maze.

Lesson Overview:

In this lesson, students will explore the principles of optics and light reflection. They will construct a laser maze using mirrors and other inexpensive materials, with the goal of guiding a laser beam through a maze to a target. Through this lesson, students will gain a practical understanding of how light behaves and how it can be manipulated using simple tools. This #SeaWorthySTEM lesson focuses on the optics that many may not typically tie to a Naval Career.

Next Gen Science Standards (NGSS):

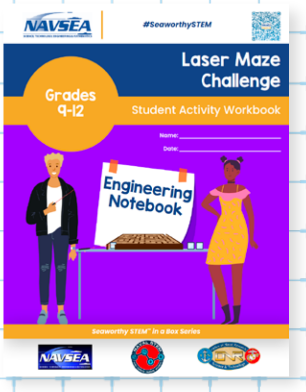
HS-PS4-3
Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS4-5
Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Notes

Materials and Equipment List

- ☑ Laser pointers
- ☑ Cardboard
- ☑ Mirrors
- ☑ Tape
- ☑ Scissors
- ☑ Rulers
- ☑ Markers
- ☑ Targets
- ☑ Protractors
- ☑ Various Inexpensive items for building obstacles (e.g., plastic cups, straws, popsicle sticks)



Student Activity Sheets/Handouts:

Student Activity Worksheet:
Laser Maze Challenge

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. Describe key features and technologies you would use in your laser design and why?
2. What do you know about structure and function of a laser?
3. Explain the scientific principles, from your perspective, that lasers require.

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 of a laser" then answer the following questions:

1. What is a laser, and how does it differ from other sources of light?
2. Can you name at least three common applications of lasers in everyday life or various industries?
3. What are the key components required for the operation of a basic laser system?
4. Can you describe the differences between the three main types of lasers: gas, solid-state, and semiconductor, and provide an example of each type's application?

3 Hook:

Show this video and have students reference questions from the journal and pre-activity section. (Note: Video is lengthy but goes through five different levels of perspective on lasers.)
https://www.youtube.com/watch?v=3eTogq7rknQ

YouTube:

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 Lasers 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 laser design and share Navy examples and explain the upcoming design engineering challenge.

1. **Weapon Systems:** The Navy has been exploring the use of laser weapons for defense and offense.
2. **Dazzler Systems:** The Navy has been interested in developing laser dazzler systems, which use non-lethal lasers to temporarily disorient or distract the sensors and targeting systems of hostile vessels or aircraft.
3. **Communication and Sensing Systems:** Lasers have the potential to be used in advanced communication systems and sensors.

Part 2: Engineering Design Challenge

Background Information:

The word 'LASER' stands for Light Amplification by Stimulated Emission of Radiation. Unlike regular light, lasers are focused and powerful, making them useful in many fields. The concept of lasers was first theorized in the early

20th century, and their development began in the 1960s. They have been used in many fields since then including entertainment, medicine, and technology. Understanding how lasers work and their basic properties can help us appreciate their widespread use and their impact on the world around us.

Check out more information on lasers here: https://lasers.llnl.gov/education/how-lasers-work

The Engineering Design Challenge:

The Navy has tasked your design team to create a laser maze. You will use mirrors to send a laser beam through a maze to reach a designated target. Your maze must have all the specifications designated by your teacher. The goal of your design is to hit your target as closely as possible. Your team must be creative in determining what type of design and features should be included for success. Your team must be creative in determining what type of boat and features should be included for success.

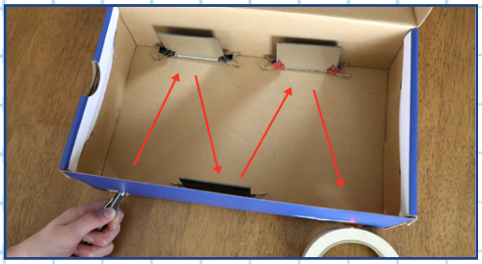
Procedure:

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

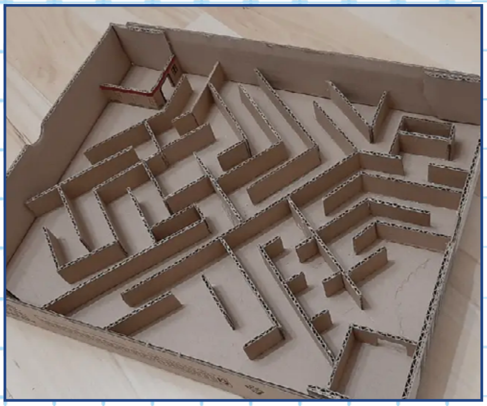
I **What is the Problem?**

- Have the students discuss the basic scientific principles associated with the lab: optics, refraction, and reflection.
- Introduce the engineering challenge:
    - ***Design and build mirror maze that can direct a laser light to a specific target.***
- 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.

Examples



Source: https://frugalfun4boys.com/laser-puzzle-boxes/



Source: https://www.littleladoo.com/cardboard-maze-kids-adults/

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
- Number of mirrors used
- Number of turns the laser must take
- Accuracy of the laser on the target
- Budget Constraints

3 How can we Brainstorm and construct the Prototype?

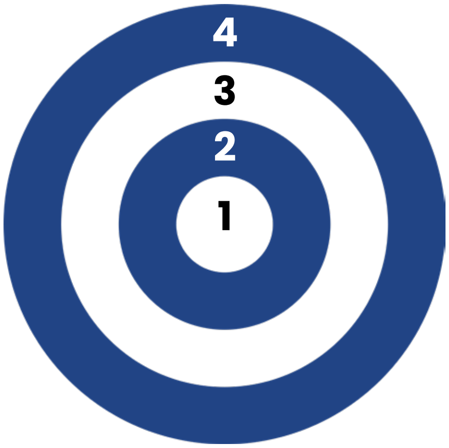
- Have the student brainstorm multiple designs for their prototype.
- Students will choose one design, justify their choice in the writing section and build their models according to their designs.
- Emphasize teamwork, creativity, and adherence to budget.

4 How can we Test and Data Collection?

- Each team tests their prototype by:
  - A. Students will design the layout of their maze.
  - B. Students will have to produce different "pathways" for the laser to hit the target.

C. Students will adhere to the specifications provided by the teacher for the number of mirrors used, turns, and design elements that will influence maze structures.

D. Students will complete trials and record the accuracy of the laser on the targets. The example below can be used as a target. The numbers indicate scores for locations where the laser hits the target. See image below for example:



Note teachers are encouraged to have students create their own step-wise procedures as well. Students may develop different models then the ones listed above, allow for experimentation and flexibility in data collection.

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.

Teacher Background Information / Notes:

Lasers represent advancements in the field of optics and technology. LASER means "Light Amplification by Stimulated Emission of Radiation." Lasers use the principles of quantum mechanics and the electromagnetic spectrum to produce a beam of light. The concept of the laser was proposed by Albert Einstein in 1917, who developed the theories for the emission of concentrated light. The first working laser was developed by Theodore Maiman in 1960. Lasers are now used in a variety of fields, ranging from industrial manufacturing and telecommunications to healthcare, defense, and scientific research.

Misconceptions:
Student misconceptions about lasers can often come from their portrayal in media and a lack of understanding of the physics behind light. One common misconception is that lasers are destructive beams capable of causing harm. This oversimplification can hinder student understanding of principles behind the science of lasers. The portrayal of lasers as futuristic and magical devices in fictional narratives can contribute to the misconception that lasers possess limitless capabilities.

Vocabulary Terms:

- **Optics**
- **Light reflection**
- **Laser beam**
- **Mirrors**
- **Refraction**
- **Diffraction**

STEM Related Careers:

- Optics engineer
- Laser scientist
- Photonics researcher
- Electrical engineer
- Physics researcher

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.

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