Hercules STEAM Unit

The Hercules STEAM Unit provides students with an understanding of life in the early 1900s. Students will begin by becoming a historian and observing primary sources of information to answer the question: What is Hercules? Then, they will get to deeply understand how Hercules' engine works. They will be able to observe a series of experiments and simulations to comprehend how steam engines function at a molecular level and identify the energy transfers. Finally, students will have the opportunity to become engineers themselves. They will build a towboat and present their learnings to a National Parks Ranger.

Essential Question: How is energy transferred so that the Hercules can travel? How do communities face change? When opportunities shrink, who is left out? What would you do differently today?
Main Learning Goal: Students will learn about how energy is transferred from one part of Hercules' engine to another.
Estimated Length of Unit: 14 lessons/3 weeks
Year Long Placement: At the beginning of the year (replaces 1st unit in Amplify)

Unit Overview

Lesson Title	**Learning Objective**	**Activity**
1 - What is Hercules?	SWBAT analyze primary sources to explain Hercules' role as a towboat.	Students will look at pictures and text and write observations.
1.5 - What is Hercules' role in the water?	SWBAT explain Hercules' importance as a tugboat.	Students will engage in an interactive read aloud and then compare and contrast the historical Hercules with the realistic fiction Hercules.
2 - Diving Deeper Into Hercules	SWBAT understand the layout of Hercules and predict how it was powered.	Students will use the San Francisco Maritime Time Looper Xplore App to go on a virtual field trip.
3 - Boiler Room	SWBAT explain how water transfers to steam at a molecular level.	Students will observe an experiment and molecular simulation, then link their observations to the boiler room in Hercules.
4 - Fuel	SWBAT infer how energy is transferred in the boiler room.	Students will read a feature article on the different types of energy as they relate to

		Hercules and explain the energy transfer in the boiler room.
5 - Boiler Room: Personal Experience	SWBAT analyze primary sources and synthesize the information to explain the experience of a fireman in the boiler room.	Students will look at pictures and text and write observations for what it was like to work in the boiler room.
6 - Engine Room	SWBAT infer how energy is transferred in the engine room.	Students will observe an experiment and molecular simulation, then link their observations to the engine room in Hercules.
7 - Engine Room: Personal Experience	SWBAT analyze primary sources and synthesize the information to explain the experience of an oiler in the engine room.	Students will look at pictures and text and write observations for what it was like to work in the engine room.
8 - Putting It All Together	SWBAT develop a diagram explaining the energy transfer of Hercules and describe how Hercules is powered.	Students will play a matching game to demonstrate their understandings.
9 - Who Was Left Out?	SWBAT analyze Hercules' crew and explain who held the power and who was left out in marine work.	Students will look at pictures of the crew and share observations. They will engage in a classwide discussion.
10 - 12 - What Would You Do Differently?	SWBAT engineer a towboat that transfers energy; explain how energy is transferred in their model.	Students will engage in the engineering cycle to creating a towboat that transfers energy.
13 - 14 -Presentation	SWBAT present their understandings by describing how energy is transferred in the model and in Hercules.	Students will write their own presentation. They will present it to their classmates and a National Parks Ranger.

Lesson 1: Intro: What is Hercules?

Learning Goal: SWBAT analyze primary sources to explain Hercules' role as a towboat.

Prep Needed: Print photos for gallery walk & place around the classroom. Provide students with post it notes. Print worksheets.

Instructional Time/Lesson Sequence: 45 min.

- Introduce the idea that students will be historians by looking at artifacts from the past--primary sources--to learn about an object called the Hercules. As they explore these primary sources, they will be taking close observations and making inferences as to what the Hercules is, and when it was in use.
- Example/We Do: Provide a narrative/picture of the time period & practice
- Gallery walk--provide post-it notes for students to write observations & stick to primary sources; allow students to review/re-read each other's writing
- Independent Jot: What did you observe? What questions do you have?
- Classroom share. What did you observe? What questions do you have? Add: What's in a name?

Teacher's Pre-knowledge: None.

Standards Addressed:

- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

- CCSS.ELA-LITERACY.SL.4.2: Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

SPED/ELD Differentiation:

- Review vocabulary beforehand (included in powerpoint).
- Strategically partner students so that they are provided with additional supports.
- Sentence frames (included in powerpoint).

Extension Activities: None.

Resources:

- ☐ Day 1 Intro-What is Hercules? Materials (gallery walk)
- ☐ Day 1 Intro-What is Hercules? Slides (teaching)
- ☐ Individual Reflection Page

Lesson 1.5: What is Hercules' role in the water?

Learning Goal: SWBAT explain Hercules' importance as a tugboat.

Prep Needed: None.

Instructional Time/Lesson Sequence: 25 min.

- Review students' knowledge from the previous lesson. Ask: What is Hercules? What do we know about it and what is the proof?
- Introduce "Hercules The Harbor Tug" by Michael O'Hearn. Tell students that this book is a realistic fiction story, while yesterday's information was non-fiction writing. Ask: What is the difference between the two? Ask: What are some similarities from the Hercules we learned about yesterday and the Hercules in this story?
- Begin interactive Read Aloud.
- P. 7/8- What are some differences between the Hercules that we learned from yesterday and the Hercules in this story?
- P. 15/16-Why are tugboats important? How can they help other boats? Give proof from the story. What are some similarities from the Hercules we learned about yesterday and the Hercules in this story?
- P. 23/24-What do you think life on the Hercules (from the book or the primary sources) would have been like?
- P 32-What are some differences between the Hercules we learned about yesterday and the Hercules in the story? What are some similarities? Give proof. Record students' ideas on graphic organizer.

Teacher's Pre-knowledge: Tugboats are used in a variety of ways. They play a key role in helping boats dock when they come to the bay. They also help carry materials from one place to another. While the historic Hercules was also a tugboat, it wasn't functional during the time period of the realistic fiction story. It is also likely that it didn't take children on board when it was working.

Standards Addressed:

- CCSS.ELA-LITERACY.RI.4.7: Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
- CCSS.ELA-LITERACY.RI.4.3: Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

- CCSS.ELA-LITERACY.RI.4.5: Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.
- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.SL.4.2: Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

SPED/ELD Differentiation:

- Use pictures from the story to support student understanding and further provide context clues.

Extension Activities: None.

Resources:

- ☐ Hercules The Harbor Tug by Michael O'Hearn
- ☐ Interactive R.A. Graphic Organizer

Lesson 2: Diving Deeper Into Hercules

Learning Goal: SWBAT understand the layout of Hercules and predict how it was powered.

Prep Needed: Print worksheets. Obtain class set of laptops.

Instructional Time/Lesson Sequence: 40 min.

- Review information learned about the Hercules. Introduce the San Francisco Maritime Time Looper Xplore App and set expectations for student use.
- San Francisco Maritime Time Looper Xplore App: Allow students to explore the app
- Independent Jot: What did you observe? What questions do you have?
- Classroom share.
- Choose a student-created question to explore; should be along the lines of: How do you think Hercules is powered?
- Have students fill out Science Probe. Share thinking and reasoning.

Teacher's Pre-knowledge: None.

Standards Addressed:

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.SL.4.2: Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

SPED/ELD Differentiation:

- Work with students in a small group to explore the San Francisco Maritime Time Looper Xplore App. Have students each watch the videos/explore independently and then reflect on their discoveries as a group. Define vocabulary/paraphrase as needed.

Extension Activities: None.

Resources:

- ☐ Individual Reflection Page
- ☐ Science Probe

Lesson 3: Boiler Room

Learning Goal: SWBAT explain how water transfers to steam at a molecular level.

Prep Needed: Print worksheets. Obtain class set of laptops. Set up experiment.

Instructional Time/Lesson Sequence: 45 min.

- Revisit Boiler Room in San Francisco Maritime Time Looper Xplore App: replay video.
- Classroom share. What did you observe? What questions do you still have?
- Show picture of boiler system & link to fire and water experiment. (See next step!)

- Demonstrate for students by turning on the bunsen burner. When the fire is started, add a beaker with water to the top. Allow students to observe water converting to steam. Students take notes & draw observations.
- Classroom share: What did you observe? What do you think is happening?
- Link boiler on hot plate experiment to pHet model. Explain that molecules are the smallest unit of matter. Everything is made up of molecules, but they are so small that our eyes can't see them. We use simulations to think about what happens to water molecules when they transfer from liquid to steam. Use Amplify Scale Tool (from Student Apps Page--5th Grade Unit: Ecosystem Restoration) to give students reference of the size of molecules.
- Allow students to experiment with the pHet model. Students take notes & draw observations. Introduce vocabulary: speed, space. Introduce sentence frames: I notice that the speed of water/steam molecules...I notice that the space between the water/steam molecules...
- Classroom share. What did you observe? What do you think is happening? How does this relate back to the boiler room?
- Introduce the idea of energy transfer. Energy is never lost or gained--it is converted from one form to another. For example, when we eat food so we can move around, we convert the energy from the food into movement/mechanical energy. When we plug in a hair dryer, we convert electrical energy to heat energy. What are the two kinds of energies involved in this conversion process? How do we know?

Teacher's Pre-knowledge: When water is heated up, the molecules move faster and there is more space between the molecules. In this process, heat energy is transferred to mechanical energy.

Standards Addressed:

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

SPED/ELD Differentiation:

- Review vocabulary beforehand (included in powerpoint).
- Strategically partner students so that they are provided with additional supports.
- Sentence frames (included in powerpoint).

Extension Activities: Challenge students to draw experiment at a molecular level.

Resources:

- ☐ Water**
- ☐ Beaker**
- ☐ Portable Bunsen Burner/Camping Stove**
- ☐ Tongs**

**Fire & Water Experiment: Demonstrate for students by turning on the bunsen burner. When the fire is started, add a beaker with water to the top. Allow students to observe water converting to steam.

- ☐ pHet Model (Note: Make sure to change the molecules to water using the bar on the right.)
- ☐ Amplify Scale Tool (found in Student Apps Page--5th Grade Unit: Ecosystem Restoration)
- ☐ Day 3: Boiler Room Slides
- ☐ Day 3: Boiler Room Materials (observational drawings)

Lesson 4: Fuel

Learning Goal: SWBAT infer how energy is transferred in the boiler room.

Prep Needed: Print worksheets.

Instructional Time/Lesson Sequence: 45 min.

Day 4: Fuel

- Review students' knowledge from the previous lesson. Ask: What do we know about the purpose of the boiler room? What is the transfer of energy?
- Introduce the idea of cause and effect. Explain that "cause" is the reason why something happened, while the "effect" is what happened. For example, it was raining (the cause), so I wore a rain jacket (the effect). Another example is that water was heated with fire (the cause), so the water converted to steam (the effect). Ask students to think of more causes and effects they noticed in the boiler room or in their everyday life. Demonstrate how to take "cause and effect" notes using the graphic organizer.
- Introduce the idea of different types of fuel.
- Explain to students that their task will be to read a feature article and take notes on the cause and effect of fuel on Hercules.

- Classroom share. What are some main takeaways from the feature article?
- Link fire in the boiler room to creating fire on the bunsen burner/camping stove. Demonstrate experiment for students. Turn on camper stove/bunsen burner and emphasize all the elements needed to start the fire. Students take notes & draw observations.
- Classroom share. How do you think this experiment connects back to what is happening in the boiler room?
- Exit Ticket: What is the transfer of energy in the boiler room?

Teacher's Pre-knowledge: When heat, oxygen, and fuel are combined, a fire starts. This is a transfer from chemical energy (from the fuel) to heat energy (from the fire). This is important because the boiler room relies on fire to heat up water. With the help of the fire, water is transferred to steam.

Standards Addressed:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- CCSS.ELA-LITERACY.RI.4.5: Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.
- CCSS.ELA-LITERACY.RI.4.7: Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

SPED/ELD Differentiation:

- Review vocabulary beforehand (included in powerpoint).
- Strategically partner students so that they are provided with additional supports or work with students in small group.

Extension Activities: Analyze the impact of coal on global warming.

Resources:

- ☐ Portable heater/bunsen burner
- ☐ Day 4: Fuel Slides
- ☐ Day 4: Fuel Graphic Organizer
- ☐ Day 4: Fuel Feature Article
- ☐ Day 4: Fuel Materials (observational drawings)
- ☐ Day 4: Exit Ticket

Lesson 5: Boiler Room: Personal Experience

Learning Goal: SWBAT analyze primary sources and synthesize the information to explain the experience of a fireman in the boiler room.

Prep Needed: Print photos for gallery walk & place around the classroom. Provide students with post it notes. Print worksheets.

Instructional Time/Lesson Sequence: 40 min.

- Review exit ticket from the previous lesson. What is the transfer of energy in the boiler room?
- Classroom share. What do you think it was like to work in the boiler room?
- Introduce activity. Today, they will have the opportunity to be historians again. They will be reading and observing primary sources to learn about the experience of working in the boiler room.
- Gallery walk--provide post-it notes for students to write observations & stick to primary sources; allow students to review/re-read each other's writing
- Independent Jot: What did you observe? What do you wonder?
- Classroom share. What did you observe? What do you wonder?
- Shared Writing. As a class, work together to create a diary entry from the perspective of someone who worked in the boiler room.

Teacher's Pre-knowledge: Work in the boiler room was hot and dangerous. Since the boiler room was inside the ship, it was fairly dark. There was not a lot of room there. To be a fireman in the boiler room, you had to have constant vigilance and be very watchful. A fireman's job was to make sure that there was a perfect mixture of air, heat, and fuel to ensure that the fire continued. He also had to make sure there was enough water in the system to boil into steam. If the amounts were not correct, a fire or explosion could potentially erupt.

Standards Addressed:

- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

- CCSS.ELA-LITERACY.SL.4.2: Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

SPED/ELD Differentiation:

- Review vocabulary beforehand (included in powerpoint).
- Strategically partner students so that they are provided with additional supports.
- Sentence frames (included in powerpoint).

Extension Activities: Students write their own diary entry from the perspective of someone who worked in the boiler room.

Resources:

- ☐ Day 5: Boiler Room Slides
- ☐ Day 5: Boiler Room Materials (gallery walk)
- ☐ Day 5: Individual Reflection Page
- ☐ Day 5: Shared Writing Slides

Lesson 6: Engine Room

Learning Goal: SWBAT infer how energy is transferred in the engine room.

Prep Needed: Print worksheets. Set up experiment.

Instructional Time/Lesson Sequence: 60 min.

- Revisit Engine Room in San Francisco Maritime Time Looper Xplore App: replay video.
- Classroom share. What did you observe? What questions do you still have?
- Show picture of engine system & link to balloon experiment. Demonstrate for students. Set up by filling beaker with water and putting a balloon over the mouth of the beaker. Turn on bunsen burner/camping stove and place beaker on top. Allow water to convert to steam and fill the balloon. Trapping the steam in the balloon, transfer it to the mini-engine system. Release the balloon and allow students to watch the engine move. Students take notes & draw observations.
- Classroom share: What did you observe? What do you think is happening?
- Link balloon experiment to Hercules' engine. Introduce the concept of pressure and show students the pHet simulation. Have students take notes & draw observations. Use slides to closely observe and guide students to determine how the engine functions.
- Compare & contrast: Ask students to closely observe what happens in the engine and explain how air moves it. How is this similar to the balloon experiment? How is it different?

- Have students demonstrate the transfer of mechanical energy by drawing arrows to show the cause and effect relationships in the engine room. Allow them to fill out “cause and effect” graphic organizer. Review responses as class.
- Exit ticket: What is the transfer of energy in the engine room?

Teacher’s Pre-knowledge: Steam from the boiler room travels to the engine room. The valves move down, allowing steam into the cylinder. Inside the cylinder, there is high pressure and low volume. The high pressure of the steam pushes the pistons down. The volume increases when the pistons are pushed down. When pistons push down, the crankshaft rotates, thus spinning the propeller. The propeller powers the tugboat.

Standards Addressed:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

SPED/ELD Differentiation:

- Review vocabulary beforehand (included in powerpoint).
- Strategically partner students so that they are provided with additional supports.
- Sentence frames (included in powerpoint).

Extension Activities: Students independently do pHet simulation. Challenge students to draw experiment at a molecular level.

Resources:

- ☐ Balloon**
- ☐ Portable Bunsen Burner/Camping Stove**
- ☐ Water**
- ☐ Beaker**
- ☐ Tongs**
- ☐ Mini-Engine System**

**Balloon Experiment: Set up by filling beaker with water and putting a balloon over the mouth of the beaker. Turn on bunsen burner/camping stove and place beaker on top. Allow water to convert to steam and fill the balloon. Trapping the steam in the balloon, transfer it to the mini-engine system. Release the balloon and allow students to watch the engine move.

- ☐ Colored Writing Tools (crayons, colored pencils, markers. etc.)

- ☐ pHet Model
- ☐ Day 6: Engine Room Materials (observational drawings, map of engine room, & graphic organizer)
- ☐ Day 6: Engine Room Slides
- ☐ Day 6: Exit Ticket

Lesson 7: Engine Room: Personal Experience

Learning Goal: SWBAT analyze primary sources and synthesize the information to explain the experience of an oiler in the engine room.

Prep Needed: Print photos for gallery walk & place around the classroom. Provide students with post it notes. Print worksheets.

Instructional Time/Lesson Sequence: 40 min.

- Review exit ticket from the previous lesson. What is the transfer of energy in the engine room?
- Classroom share. What do you think it was like to work in the engine room?
- Introduce activity. Today, they will have the opportunity to be historians again. They will be reading and observing primary sources to learn about the experience of working in the engine room.
- Gallery walk--provide post-it notes for students to write observations & stick to primary sources; allow students to review/re-read each other's writing
- Independent Jot: What did you observe? What do you wonder?
- Classroom share. What did you observe? What do you wonder?
- Shared Writing. As a class, work together to create a diary entry from the perspective of someone who worked in the engine room.

Teacher's Pre-knowledge: Work in the engine room was dangerous. The shifts were long. OIlers in the engine room had to make sure that the engine was properly lubricated. They oiled the machines every hour and checked on them frequently by putting their fingers into the rotating parts. If their fingers were blue, then the system was fine. If their fingers were black, then there was a big problem. Being an oiler was very important; if their jobs were not done properly then the towboat could catch on fire or explode.

Standards Addressed:

- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

- CCSS.ELA-LITERACY.SL.4.2: Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

SPED/ELD Differentiation:

- Review vocabulary beforehand (included in powerpoint).
- Strategically partner students so that they are provided with additional supports.
- Sentence frames (included in powerpoint).

Extension Activities: Students write their own diary entry from the perspective of someone who worked in the engine room.

Resources:

- ☐ Day 7: Engine Room Slides
- ☐ Day 7: Engine Room Materials (gallery walk)
- ☐ Day 7: Individual Reflection Page
- ☐ Day 7: Shared Writing Slides

Lesson 8: Putting It All Together

Learning Goal: SWBAT develop a diagram explaining the energy transfer of Hercules and describe how Hercules is powered.

Prep Needed: Print cards (1 set per partner group). Print worksheets.

Instructional Time/Lesson Sequence: 30 min.

- Put students in partners. Give partners card deck and explain that they will be using the cards to show how energy is transferred so that Hercules can travel.
- When partners think they are done, prompt them to present their thinking to adults in the classroom.
- If students finish early, prompt them to check other students' cards.
- Review "What questions do you have?" from Day 1. Reflect on students' growth.
- Have students fill out Science Probe. Discuss thinking and proof.

Teacher's Pre-knowledge: See card deck answer key.

Standards Addressed:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

SPED/ELD Differentiation:

- Strategically partner students so that they are provided with additional supports or work with students in small group.

Extension Activities: Students reflect on their original answers and think about how they have grown over the unit.

Resources:

- ☐ Science Probe
- ☐ Card Deck

Lesson 9: Who Was Left Out?

Learning Goal: SWBAT analyze Hercules' crew and explain who held the power and who was left out in marine work.

Prep Needed: None.

Instructional Time/Lesson Sequence: 25 min.

- Classroom share. Who do you think worked on Hercules? What did they look like?
- Introduce the idea of diversity. Ask students: What is a place that you go where there is a lot of diversity? What is your proof? Introduce the idea that students will analyze the diversity of Hercules crew members. Ask students: What is the diversity of the Hercules crew? What is your proof?
- Scroll through slides 3-10. Have students silently place a thumb up when they observe a pattern.
- Classroom share. What did you observe? What patterns are you finding? Why do you think this is the case?
- Introduce the concept that there was a diversity problem on Hercules. Most crew members, and thus, most engineers, were white males. Ask students: Why is diversity important? Remind students that problems need to be identified in order for solutions to occur.
- Tell students that during the early 1900s, there was already work being done to change the diversity in boat crews. Read excerpts from Mrs. Westcott, the first woman

in the world to hold her chief engineer's license. Remind students that she was an exception, not a norm.
- Classroom share. What do you think it was like for people like Mrs. Westcott to create change? What barriers did they have to overcome? What character traits would they need to have?

Teacher's Pre-knowledge: Hercules' crew predominantly consisted of white men. This resulted in a lack of diversity on the boat. There were some women, such as Mrs. Westcott, who were trying to change the status quo and break barriers in marine engineering.

Standards Addressed:

- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.RI.4.7: Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
- CCSS.ELA-LITERACY.RI.4.7: Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

SPED/ELD Differentiation:

- Provide students with sentence frame "A pattern I notice is...My proof is…".
- Pre-read Mrs. Westcott quote with students in small group.

Extension Activities: Students reflect on their original answers and think about how they have grown over the unit.

Resources:

- ☐ Day 9: Who Was Left Out? Slides

Lesson 10: What Would You Do Differently?--Design

Learning Goal: SWBAT engineer a towboat that transfers energy; explain how energy is transferred in their model.

Prep Needed: Organize materials so that each partner group gets a set. Print worksheets.

Instructional Time/Lesson Sequence: 60 min.

- Review learnings from previous day. Ask: Who was left out?
- Classroom share: Imagine you are in charge of Hercules. What would you do differently to solve this problem? Why is it important?
- Link students' ideas to diversity in engineering today. Prompt students to analyze 2015 Graph. Ask: What do you notice? What are some similarities and differences between engineering diversity during Hercules' time and engineering diversity today?
- Emphasize importance of introducing engineering skills in elementary school to building a more diverse engineering workforce.
- Introduce engineering process and project. Problem: San Francisco is a growing city. Materials need to be towed into the bay so that it can continue to prosper. Towboats need to be built to keep up with the growth of demand. Constraints: The boat needs to be able to--travel the length of the "SF Bay" (plastic tub), use energy transfer as a mode of power, tow "logs" (matches)
- Allow students time to research. Research project 1: What floats? Research project 2: How can energy be transferred? Students take notes & draw observations.
- Classroom share: What were your findings?
- Students work in partners to brainstorm towboat design.

Teacher's Pre-knowledge: In the last lesson, students learned about a lack of diversity in engineers on Hercules. Similarly, there is a lack of diversity in engineering today.

Standards Addressed:

- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

SPED/ELD Differentiation:

- Strategically partner students so that they are provided with additional supports.

Extension Activities: None.

Resources:

- ☐ Day 10: Design Slides
- ☐ Day 10: Design Materials (observational drawings & design)
- ☐ Straws
- ☐ Plastic tubing
- ☐ Foam
- ☐ Sponge
- ☐ Legos
- ☐ Plastic bottles
- ☐ Soda cans
- ☐ Balloons
- ☐ Plastic Tub

Lesson 11: What Would You Do Differently?--Create & Test

Learning Goal: SWBAT engineer a towboat that transfers energy; explain how energy is transferred in their model.

Prep Needed: Organize materials so that each partner group gets a set. Print worksheets.

Instructional Time/Lesson Sequence: 45 min.

- Review problem and constraints. Set expectations for Create Day.
- Students work in partners to design.
- Class share: What was the design process like?
- Students work in groups of 4 to test design. Students take notes & draw observations.
- Class share: What happened? What were some glows and grows? What would you do differently next time and why?

Teacher's Pre-knowledge: None.

Standards Addressed:

- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

SPED/ELD Differentiation:

- Strategically partner students so that they are provided with additional supports.

Extension Activities: None.

Resources:

- ☐ Day 11: Create & Test Slides
- ☐ Day 11: Create & Test Materials (design, observational drawing & reflection)
- ☐ Straws
- ☐ Plastic tubing
- ☐ Foam
- ☐ Sponge
- ☐ Legos
- ☐ Plastic bottles
- ☐ Soda cans
- ☐ Balloons
- ☐ Plastic Tub
- ☐ Tape
- ☐ String
- ☐ Matches

Lesson 12: What Would You Do Differently?--Revise

Learning Goal: SWBAT engineer a towboat that transfers energy; explain how energy is transferred in their model.

Prep Needed: Organize materials so that each partner group gets a set. Print worksheets.

Instructional Time/Lesson Sequence: 45 min.

- Review problem and constraints.
- Students work in partners to design and create.
- Class share: What changes were made and why? How did the design day differ between today and Day 11 (yesterday)? Why do you think it was different?
- Students work in groups of 4 to test design.

- Class share: What happened? What were some glows and grows? What would you do differently next time and why?

Teacher's Pre-knowledge: None.

Standards Addressed:

- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

SPED/ELD Differentiation:

- Strategically partner students so that they are provided with additional supports.

Extension Activities: None.

Resources:

- ☐ Day 12: Review Slides
- ☐ Day 12: Revise Materials (observational drawing & reflection)
- ☐ Straws
- ☐ Plastic tubing
- ☐ Foam
- ☐ Sponge
- ☐ Legos
- ☐ Plastic bottles
- ☐ Soda cans
- ☐ Balloons
- ☐ Plastic Tub
- ☐ Tape
- ☐ String
- ☐ Matches

Lesson 13: Presentation Preparation

Learning Goal: SWBAT develop a presentation explaining how energy is transferred in the model and in Hercules.

Prep Needed: Print worksheets.

Instructional Time/Lesson Sequence: 45 min.

- Explain that as engineers, students will be presenting their projects to their customers, the San Francisco Maritime National Historical Park. Review rubric. Analyze sample speech and grade using rubric.
- Students work with partners to write and practice presentations. Adults give feedback as needed. Students reflect on presentations using Student Self Assessment.
- Class share: What are you proud of? Can you share some presentation tips? What questions do you still have?

Teacher's Pre-knowledge: None.

Standards Addressed:

- CCSS.ELA-LITERACY.W.4.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- CCSS.ELA-LITERACY.SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

SPED/ELD Differentiation:

- Strategically partner students so that they are provided with additional supports.
- Sentence frames (included in worksheet).

Extension Activities: None.

Resources:

- ☐ Student Self Assessment/Rubric
- ☐ Day 13: Presentation Preparation Slides
- ☐ Day 13: Presentation Graphic Organizer

Lesson 14: Presentation

Learning Goal: SWBAT develop a presentation explaining how energy is transferred in the model and in Hercules.

Prep Needed: Print worksheets.

Instructional Time/Lesson Sequence: 45 min.

- Review presentation expectations. Ask: What are the speaker's expectations? What are the audience's expectations?
- Students present to Rangers at San Francisco Maritime National Historical Park. Rangers provide glows & grows.
- Students "celebrate" with Junior Ranger badge.

Teacher's Pre-knowledge: None.

Standards Addressed:

- CCSS.ELA-LITERACY.SL.4.4 Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

SPED/ELD Differentiation:

- None.

Extension Activities: None.

Resources:

- ☐ Junior Ranger Badges
- ☐ Rubric