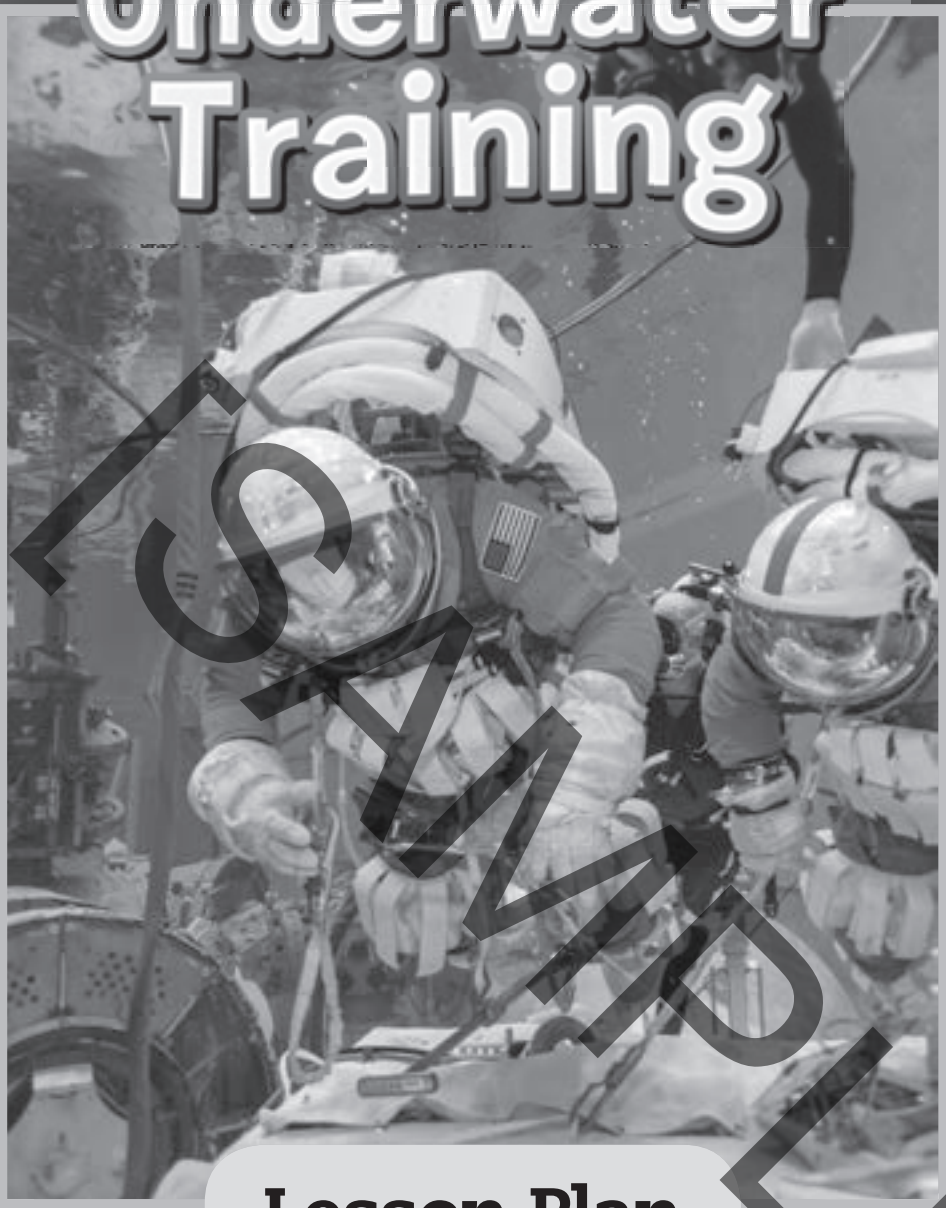
Underwater Training



Unit 3
Pushing the Limits

Lesson Plan

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Answer Key: *Underwater Training*

page 10—Preview and Question

Responses will vary. Check that questions are reasonable, answers are given, and a page number is provided. Example:

Text Feature: Cover

Question: Where is the person on the cover?

Answer: He is in one of the neutral buoyancy pools around the world.

page: 8

page 11—A Day at Aquarius

Responses will vary. Example:

Describe the setting: Aquarius is a lab off the coast of Florida where astronauts go to train. It is about the size of a school bus.

Describe the other experts you train with: I am training with six other astronauts and engineers for six weeks. Astronauts practice living and working in space, and engineers study the coral reef.

Describe your gear: I wear a special suit with weights that make me neutrally buoyant in the water.

Describe what you did: We researched at the lab and went outside the lab to practice working in space.

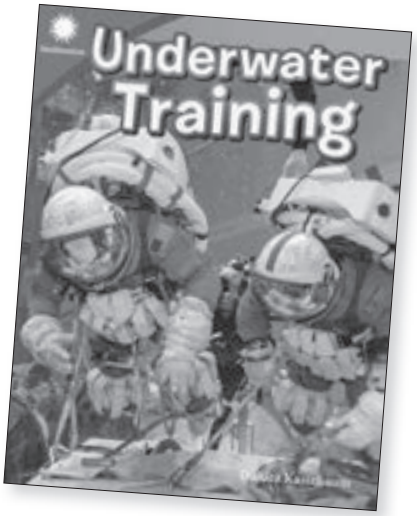
Describe what it feels like to train underwater: The special suit, equipment, and living area make me feel like I'm in space. I feel weightless underwater.

page 17—*Underwater Training* Quiz

1. C
2. D
3. C
4. B.
5. Neutral buoyancy is when something does not sink or float.

Underwater Training

Materials



- cup of water, marble, and packing peanut
- sticky notes
- *Underwater Training* books
- copies of student activity sheets (pages 9–19)
- drawing paper
- chart paper
- **STEAM Challenge materials include but are not limited to the following:**
  - ✓ bendy straws
  - ✓ binder clips
  - ✓ craft sticks
  - ✓ foam balls
  - ✓ large clear bins with water, approximately 6 inches deep (per team)
  - ✓ marbles
  - ✓ metal washers
  - ✓ packing peanuts
  - ✓ paperclips
  - ✓ pennies
  - ✓ plastic eggs
  - ✓ scissors
  - ✓ small balloons
  - ✓ small plastic cups
  - ✓ sponges
  - ✓ string

Learning Objectives

- **Reading:** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- **Writing:** Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.
- **Speaking and Listening:** Engage effectively in a range of collaborative discussions with diverse partners on grade-appropriate topics and texts, building on and expressing ideas clearly.
- **Engineering:** Define an engineering problem, design and evaluate solutions, and optimize a design based on test results.

Phenomena

Objects placed in water will sink, float, or remain neutrally buoyant.

Lesson Timeline

Day 1	Day 2	Day 3	Day 4	Day 5–10
Introductory and **Before Reading Activities** (page 4)	**During Reading Activities** (page 5)		**After Reading Activities** (page 5)	**STEAM Challenge** and **Assessments** (pages 6–8)
Define the STEAM Challenge, and practice previewing a text to ask questions before reading.	Research underwater training, ask and answer questions about the text, and brainstorm design solutions.		Write a journal entry as an astronaut training at Aquarius.	Design, build, test, improve, reflect on, and share a neutrally buoyant object. Complete the assessments.

Underwater Training (cont.)

STEAM Vocabulary

astronauts buoyant engineers
gravity lab

Introductory Activity

Define the Problem

1. Display a plastic cup with water, a marble, and a packing peanut to students. Invite them to share their observations about the marble and packing peanut, including details about size, shape, and weight. Discuss the concepts of *sink* and *float* and have them predict how each item will behave in water. Perform the demonstration. Ask students to state the results.
2. Distribute the *Underwater Training* books to students. Reveal the STEAM Challenge by reading aloud pages 28 and 29 of the book. Ask students to write one question they have about the STEAM Challenge on a sticky note. Have students place their sticky notes onto a sheet of chart paper to revisit later.
   - Display the Interactiv-eBook for a more digitally enhanced introduction to the challenge.
3. Distribute *Make a Plan* (page 9) to students. Have them summarize the challenge. Summaries should include constraints and criteria. Provide the following sentence frame to help students summarize: *Make a* _____ *object using* _____.

   Note: You may wish to distribute all student activity sheets as one packet. They will be used throughout the STEAM Challenge.

Before Reading

1. Write the vocabulary words on the board and explain their meanings. Sort students into five groups and assign each group a vocabulary word. Have groups create a motion for each word. Then, have groups show their motions to the class. Have the rest of the class guess the word the motion represents.
2. Tell students that skillful readers preview texts and ask questions before reading. Explain that to preview a text, they can look at text features, such as the cover, table of contents, headings, images, and captions.
   - To help **below-level learners** understand the previewing strategy, discuss the purpose of a movie preview.
3. Distribute *Preview and Question* (page 10) to students. Have students look at the cover of the book and record at least one question. Invite students to share their questions. Then, have students view other text features to preview the book. Ask them to write questions on the activity sheets after they preview each text feature. Tell students they will read later to find answers to their questions.

Underwater Training (cont.)

During Reading

Research and Brainstorm

1. Distribute the *Underwater Training* books and the completed *Preview and Question* activity sheets to students. Ask students to review the questions they wrote on their activity sheets. Read pages 4–9 together. Pause periodically to model asking and answering questions about the text. Invite students to share their questions and answers aloud.
   - Display the Interactiv-eBook for a more digitally enhanced reading experience. You may wish to have students annotate the PDFs as you read.
   - Play the audio recording as students follow along to serve as a model of fluent reading. This may be done in small groups or at a listening station. The recording will help **English language learners** practice fluency and aid in comprehension.
   - Challenge **above-level learners** to fact check answers with another source.
2. Have students read the books in pairs. Ask them to stop after each page to discuss any new questions they have. Ask them to answer their questions with information from the text on their *Preview and Question* activity sheets.
3. Have students record ideas for their designs on their *Make a Plan* activity sheets.

After Reading

1. Write the vocabulary words on the board and review their meanings with the class. Distribute drawing paper to students. Organize students into five groups and assign each group a word.
2. Ask students to use the letters of the words to create symbols that represent the words' meanings. For example, students might create arrows pointing downward with the letters of the word *gravity*. Have students share their creations.
3. Distribute the *Underwater Training* books to students. Tell them that scientists often write to record observations about experiments and journeys. Explain that naturalist Charles Darwin kept a journal of his experiences throughout a five-year voyage (1831–1836) aboard the *H.M.S. Beagle*, which he later used to publish an important piece of scientific writing.
4. Distribute *A Day at Aquarius* (page 11) to students. Explain that they will use details from the text to write journal entries about a day spent training at the Aquarius underwater lab from the perspective of an astronaut. Have them use the activity sheets to plan their journal entries.
5. Have students write journal entries on separate sheets of paper. Remind students to introduce the setting and characters, describe actions and feelings, use transition words and phrases (e.g., *at first*, *after*, *as soon as*, *finally*, *next*, *now*), and provide closure.
   - Challenge **above-level learners** to show, not tell, an emotion in their journal entries, such as excitement or fear.

Underwater Training (cont.)

Prep

- Review all designs prior to building.
- Prepare all materials for the STEAM Challenge.

STEAM Challenge

Design and Build

1. Discuss the following questions as a class to connect the reading to the STEAM Challenge:
   - *Why do astronauts use neutral buoyancy pools?* Discuss with students how astronauts train to live and work in space in neutral buoyancy pools because it helps them get used to the feeling of being weightless.
   - *What do astronauts add to their suits to make them neutrally buoyant underwater?* Lead students to the answer that weights are added to their suits. Tell students that they may need to add or take away items to make their objects neutrally buoyant.
2. Distribute previously completed activity sheets to students. Review the STEAM Challenge on pages 28 and 29. Revisit the questions students wrote during the Introductory Activity and discuss the answers. List available materials on the board and show students the water tank they will use to test their objects.
3. Ask students to independently sketch and label two designs on their *Make a Plan* activity sheets. Allow students the opportunity to handle materials to assess the relative weight, size, and features of each material.
4. Organize students into teams. Distribute one copy of *Collaborative Design* (page 12) to each team. Ask teams to have each member share their designs. Then, have groups choose, sketch, and label a team design. (Team designs must be submitted for approval before building.)
5. Ask teams to include plans for how they will adjust an object if it sinks or if it floats. Explain that they will place their objects in the water tank and will have five minutes to make adjustments to their designs before the 30-second test.
   - Challenge **above-level learners** by adding constraints or criteria (e.g., the object must have certain dimensions).
6. Explain to students that when they build their objects, they must follow their design plans. Reassure them that they will have an opportunity to change and improve their designs after the test. Review classroom expectations for working with materials. Give teams time to build their objects.
   - You may choose to digitally record students' processes to share at a later date with students and parents.
7. Distribute *Think about It* (page 13) to students. Explain that reflection is an important part of the engineering design process. Read aloud questions 1 and 2 on the activity sheets and have students write their responses. Ask volunteers to share.

Underwater Training (cont.)

Prep

- Review all designs prior to building.
- Prepare all materials for the STEAM Challenge.
- Prepare water tank for students to test their objects.

STEAM Challenge

Test and Improve

1. Discuss the following questions as a class to connect the reading to the STEAM Challenge:
   - *What challenges might astronauts face while training in neutral buoyancy pools?* Discuss with students that astronauts must practice all aspects of working in space and this may present new and unfamiliar challenges. Explain that students might also face challenges while building, testing, and improving their objects.
   - *Why is it important for astronauts to work together on Earth and in space?* Guide students to the idea that collaboration and perseverance are essential for success when astronauts are in space or underwater, just as it will be in their STEAM Challenge.
2. Have teams place their objects in the water tank. Then, give students five minutes to make any of the planned adjustments included on their *Collaborative Design* activity sheets. After five minutes, have them take their objects out of the water.
3. Gather teams for testing. Explain that they will offer feedback after each test. Use *Friendly Feedback* (page 14) to review best practices for giving feedback.
4. Distribute *Neutral Buoyancy Test Results* (page 15) to students. Ask them to record each team's results. Allow time for students to test their objects, one team at a time. Have teams place their objects in the water tank. If an object remains neutrally buoyant for 30 seconds, the design is successful. Ask volunteers to give friendly feedback.
5. Allow time for teams to brainstorm ways to improve designs based on feedback and test results. Refer students back to their *Collaborative Design* activity sheets. Ask them to sketch their improved designs and explain any changes. Have students submit improved designs for approval before building.
   - Challenge **above-level learners** and successful teams with additional constraints or criteria for the second design (e.g., include a way to change the buoyancy of the object to sink or float).
6. Have teams gather materials to improve their designs. Then, have them retest their objects.
7. Have students answer questions 3 and 4 on their *Think about It* activity sheets.

Underwater Training (cont.)

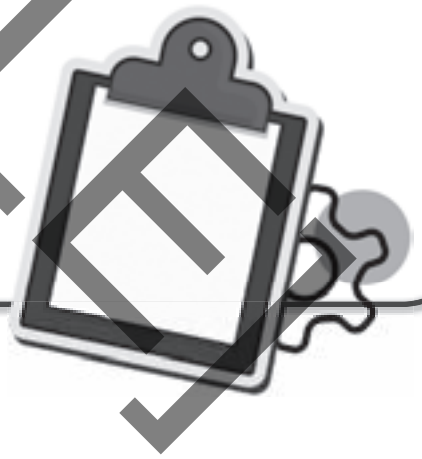
STEAM Challenge

Reflect and Share

1. For each team, divide a sheet of chart paper into four sections: *Design*, *Build*, *Test*, and *Improve*. Have students reflect by asking them to include words, phrases, and pictures that represent their experiences during each phase of the STEAM Challenge. Invite teams to share a word, phrase, or picture that best represents their overall experience.
2. Have students answer question 5 on their *Think about It* activity sheets.
3. Distribute *Engineering Design Process* (page 16) and review how students used each step to complete the challenge. Have them annotate the infographics with details specific to this challenge.
4. Read "Career Advice" on page 32 of the book. Ask students to brainstorm other tips for a career as an astronaut.

Assessment Activities

1. Have students complete the short posttest, *Underwater Training Quiz* (page 17), to assess the lesson's objectives.
2. Students may complete the Interactiv-eBook activities in the Digital Resources for assessment purposes.
3. Have students complete *Teamwork Rubric* (page 18) and *Engineering Design Process Checklist* (page 19) to reflect on and evaluate their work and collaboration skills.
4. Have students complete the Read and Respond questions from the book. Possible answers to these questions can be found in the Digital Resources (underwater_reproducibles.pdf).



Name: _____ Date: _____

Make a Plan

Directions: Summarize the challenge. Brainstorm ideas and sketch two designs. Circle your favorite.

Challenge: _____

_____

Brainstorm

Design 1

Design 2

Name: _____ Date: _____

Preview and Question

Directions: Preview text features in the book. Write a question you have after looking at each text feature. Answer your questions as you read and record the page number.

Text Feature	Question	Answer (page)
cover		
headings		
images		
captions		

Challenge: Ask a new question after reading. Use a different resource to find the answer. Write your question and answer on the back of this sheet.

Name: _____ Date: _____

A Day at Aquarius

Directions: Imagine you are an astronaut training at Aquarius. Use information from the text to write a journal entry.

Describe the setting. _____

_____

_____

Describe the other experts you train with. _____

_____

_____

Describe your gear. _____

_____

_____

Describe what you did. _____

_____

Describe what it feels like to train underwater. _____

_____

_____

Team Members: _____

Date: _____

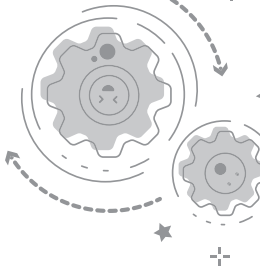
Collaborative Design

Directions: Sketch your team's design in the first box. Sketch your team's improved design in the second box. Label each design with materials needed and the purpose of each part.

Design 1

Design 2

Name: _____ Date: _____



Think about It

1. It was (hard/easy) to create one team design because _____

_____

_____

2. I helped my team by _____

_____

_____

3. Our design (failed/passed) the test because _____

_____

To improve our design, we _____

_____

4. Our improved design (worked/did not work). I know this because _____

_____

_____

5. During the challenge, I learned _____

_____

I liked _____

It was hard when _____

Name: _____ Date: _____

Friendly Feedback

Directions: Feedback can help people improve their work. Use these sentence stems to give feedback to your peers.

Clarify

Can you explain _____?

Why did you choose to _____?

How did you _____?

Warm Feedback

I like _____ because _____.

It is interesting that _____.

_____ is a good idea because _____.

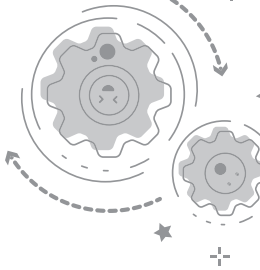
Cool Feedback

Have you thought about _____?

I wonder if _____.

You might want to try _____.

Name: _____ Date: _____



Neutral Buoyancy Test Results

Directions: Write the materials each team used. Mark the results of each team's test. Write suggestions for each team. Then, answer the questions.

Team	Materials	Object's Buoyancy after 30 seconds	Suggestions (Add mass, remove mass, use different materials, etc.)
		❑ positive ❑ neutral ❑ negative	
		❑ positive ❑ neutral ❑ negative	
		❑ positive ❑ neutral ❑ negative	
		❑ positive ❑ neutral ❑ negative	
		❑ positive ❑ neutral ❑ negative	
		❑ positive ❑ neutral ❑ negative	

Which design do you think was the most successful? Why?

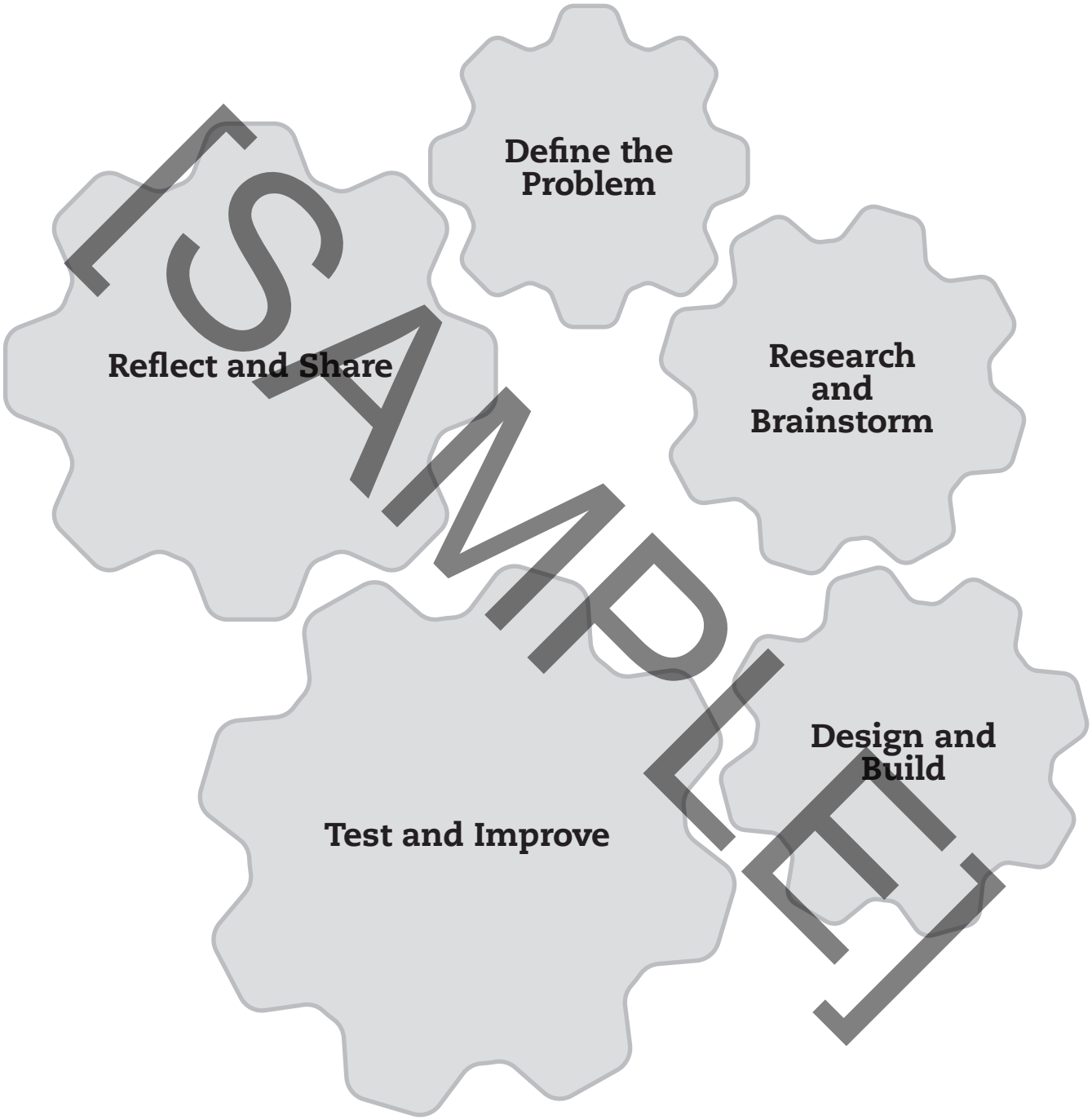
_____

_____

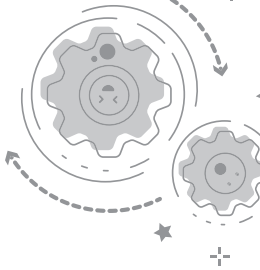
_____

Name: _____ Date: _____

Engineering Design Process



Name: _____ Date: _____



Underwater Training Quiz

Directions: Read each question. Choose the best answer. Fill in the bubble for the answer you have chosen. Answer the last question in complete sentences.

1. Why is the heading on page 14 "What to Wear"?

- (A) Astronauts wear whatever they want in space.
- (B) Athletes wear special swimwear when they train in water.
- (C) Astronauts wear special suits to train underwater.
- (D) Physical therapists design space suits.

2. What is one thing the author says astronauts practice underwater?

- (A) floating in water
- (B) building muscle
- (C) swimming in the ocean
- (D) fixing a telescope

3. Athletes recovering from an injury may train in water to:

- (A) add stress to their bodies.
- (B) practice working at a space station.
- (C) build muscle.
- (D) test equipment.

4. Astronauts train in underwater _____ before working in space.

- (A) electronics
- (B) labs
- (C) gravity
- (D) telescopes

5. What is neutral buoyancy?

_____

_____

_____

_____

Name: _____ Date: _____

Teamwork Rubric

Directions: Think about how you worked in your team. Score each item on a scale of 1 to 4.

4 = Always 3 = Often 2 = Sometimes 1 = Never

I listened to people on my team.	4	3	2	1
I helped people on my team.	4	3	2	1
I shared ideas with people on my team.	4	3	2	1
We made choices as a team.	4	3	2	1
Total				

Comments: _____

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

Engineering Design Process Checklist

Directions: Check the boxes to show that you completed each step.

Define the Problem

- ❑ I understood and explained the problem in my own words.

Research and Brainstorm

- ❑ I used research to help me brainstorm solutions.

Design and Build

- ❑ I planned and made a model.
- ❑ I thought like a mathematician.

Test and Improve

- ❑ I used criteria to evaluate designs.
- ❑ I improved designs based on test results.
- ❑ I thought like a mathematician.

Reflect and Share

- ❑ I shared my results and reflected on my work.

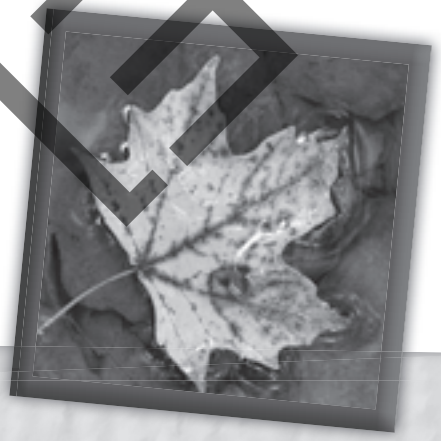
STEAM CHALLENGE

Define the Problem

An important part of astronaut training happens right here on Earth! Scientists have asked you to make a neutrally buoyant underwater lab. Can you change an object to make it neutrally buoyant?

Constraints: You can only use three types of materials to make the object.

Criteria: The object must stay neutrally buoyant in a water tank for 30 seconds.



1 Research and Brainstorm

How does training in water prepare astronauts for space? What does it mean to be neutrally buoyant? What could you add to an object that floats to make it sink?

2 Design and Build

Observe the materials. Then, sketch your design of the object. What purpose will each part serve? What materials will work best? Build the model.

3 Test and Improve

Test your object in the water tank. Did it work? How can you improve it? Modify your design by adding to it or removing from it. Try it again.

4 Reflect and Share

Do you think the object would be neutrally buoyant in other types of liquid? What about this challenge was most difficult? How did you overcome it?