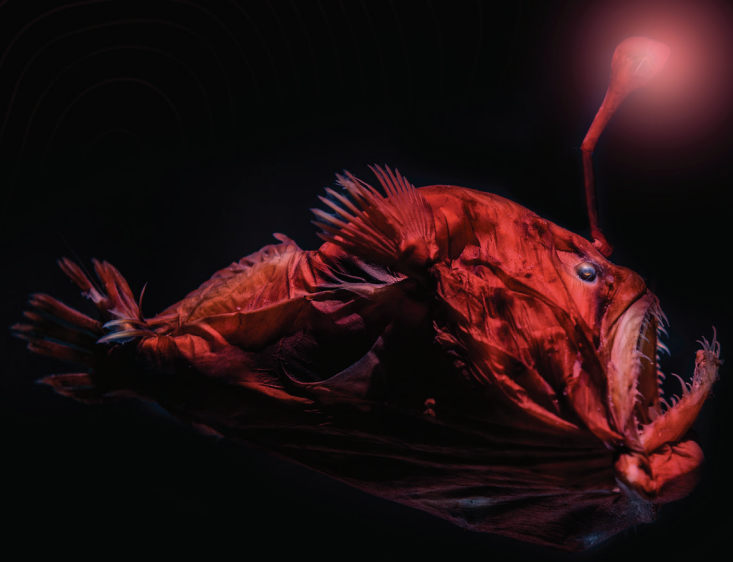
EXPLORERS OF THE DEEP

4-H STEM CHALLENGE

YOUTH GUIDE



Welcome Explorers of the Deep!

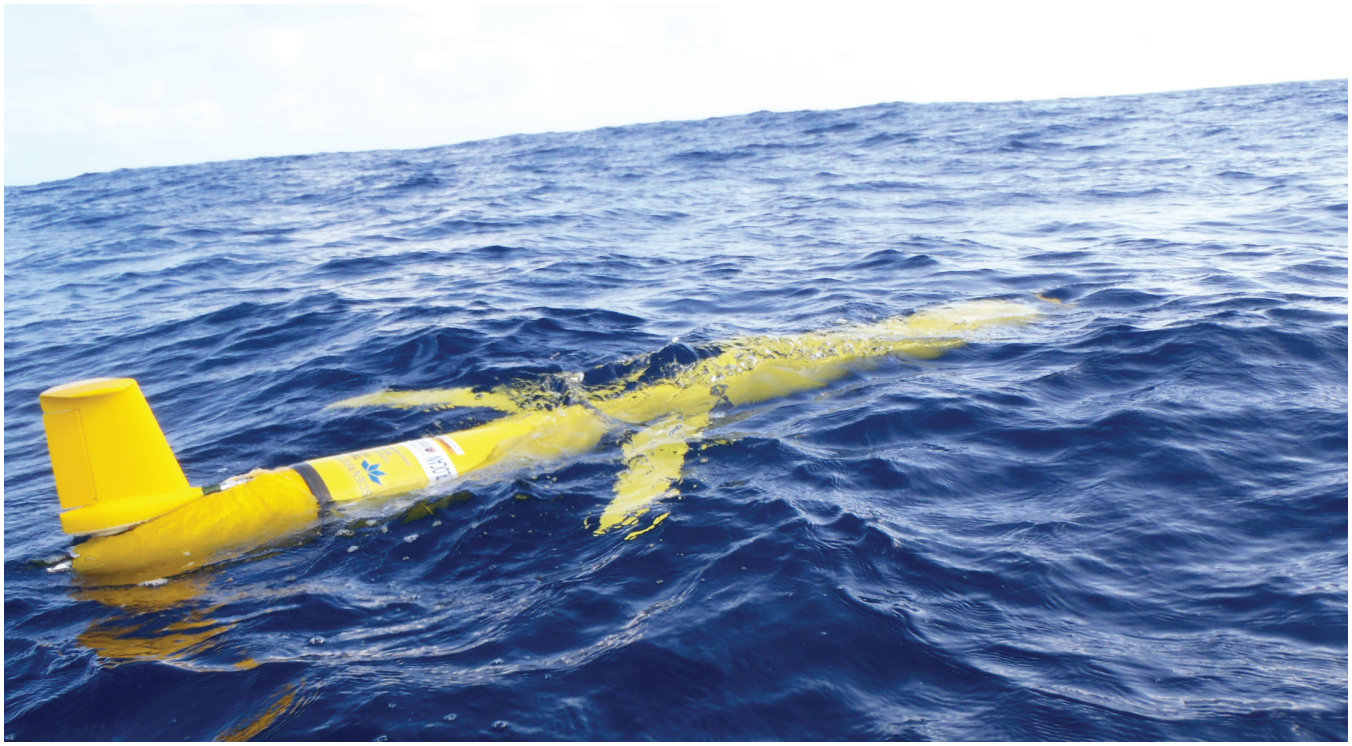
Everyone recognizes the word "ocean." What does it make you think of? Maybe you envision images of waves, beaches, ships or undersea creatures.

Many of us don't have direct experience with the ocean beyond an occasional seafood meal or a view from the coast while on vacation, however, you are directly connected to the ocean in your daily life! Did you know that the air you breathe, the food you eat and the rain that falls around you are all connected to the ocean's role in the life of the planet?

The ocean is an important part of the Earth system, including the atmosphere, land and a vast food web of creatures from microbes to whales. It even includes humans, who have a significant impact on the entire ecosystem.

Scientists and engineers are working together to learn more about the ocean every day. This information helps us make good environmental decisions. We need to learn as much as we can about the ocean to help combat climate change and improve the health of the Earth.

Each activity in **Explorers of the Deep 4-H STEM Challenge** is a way to celebrate and explore all that we have learned and still want to learn about the ocean planet–Earth! In this kit you will have an opportunity to investigate your interest in STEM through the ocean. **You will focus on how the ocean impacts you and how you impact the ocean!**



In this guide we will explore the following 4-H STEM Challenge activities:

Ocean Robot Test Tank

Mobilize the Mission: Choose a part of the ocean to explore with an ocean robot.

Driving School & Test Tank: Learn how to prepare and ballast your ocean robot for a research mission. You will add weights as ballast to create the sinking and floating behavior of a real ocean robot.

Diving into Data: Explore how to pilot an ocean robot and interpret the scientific data it collects.

Ocean Expedition

Play a board game to explore the mysteries of the ocean and test your ocean knowledge. Be the first to successfully navigate your robot to the end of its global ocean mission to win.

Ocean Communicator

Learn about ocean-related challenges and issues while playing a matching game, then create a communications art project to encourage other people to learn more.

Here is what's included in your Youth Guide:

- **Ocean Science Reference Guide**
- **Quick Instruction Guide and Activity Sheet for each of the three activities**
- **Certificate to celebrate your exploration**
- **Career Connections**

Ocean Science Reference Guide

Every explorer needs some information before their adventure! Let's start with seven good reasons to explore the ocean:

a. There is only ONE ocean. We have to protect it!

The Ocean...

b. sets the thermostat for the planet, regulating weather and climate;

c. provides 50% of the oxygen you breathe;

d. feeds the world! Three billion people rely on the ocean for protein;

e. is a major part of the water cycle and is connected to your water supply;

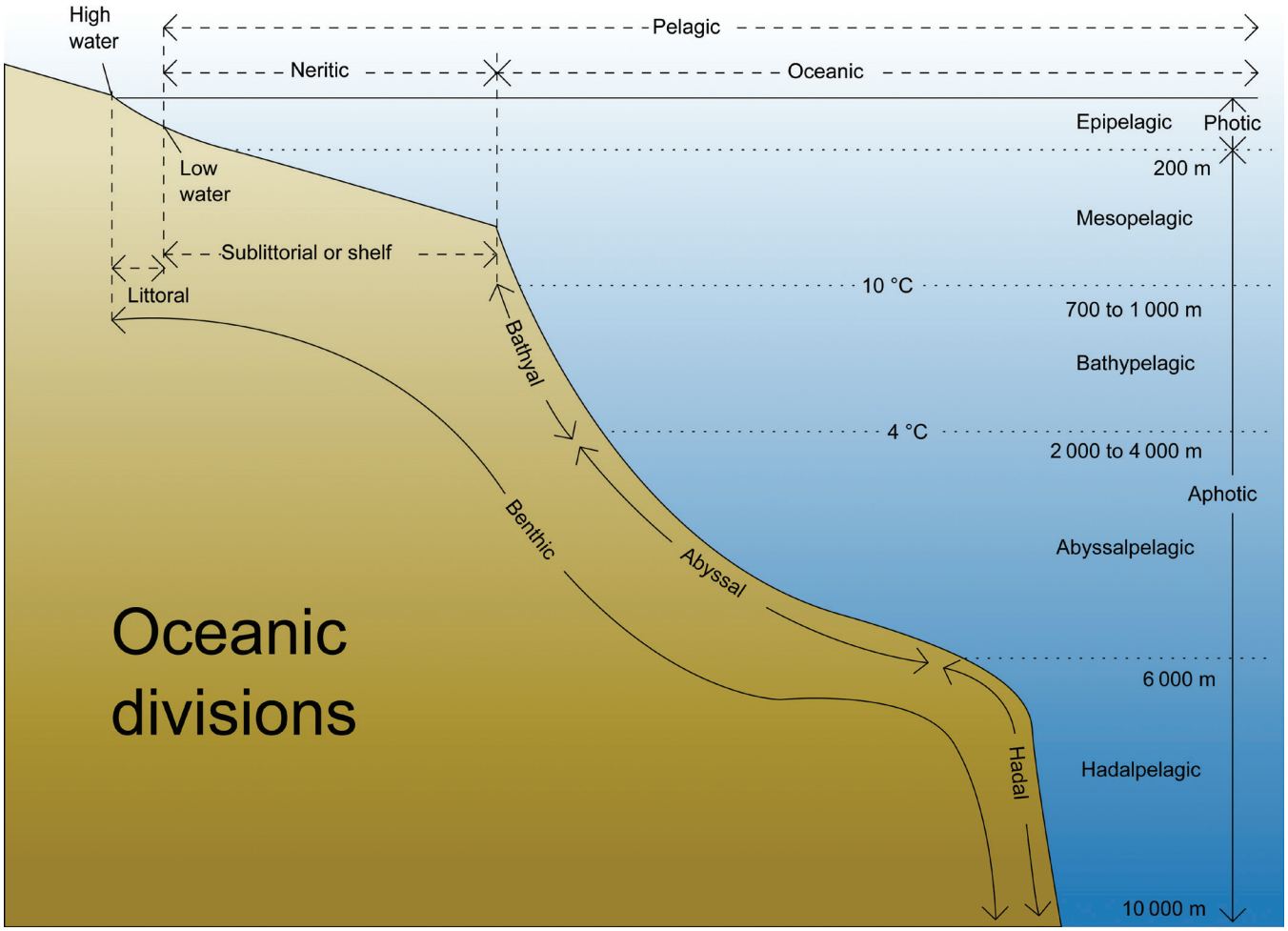
f. is a transportation hub for world commerce - over 85% of products travel across the ocean; and

g. provides recreation and fun for millions of people around the world!

The ocean covers over 70% of our planet yet is largely unexplored.

Some things to consider before exploring the ocean

The ocean is a beautiful and challenging place to explore. It has five major zones, from the surface of the water at 0 meters [m], all the way down to 11,000 m. At this great depth, there is no longer any light and the pressure of the water can crush a car! Much of the ocean is very cold and dark and the pressure is often too high for humans to explore safely. In many ways, exploring the ocean is even more challenging than exploring space!



en.wikipedia.org/wiki/Oceanic_zone

How do scientist explorers collect information about the ocean?

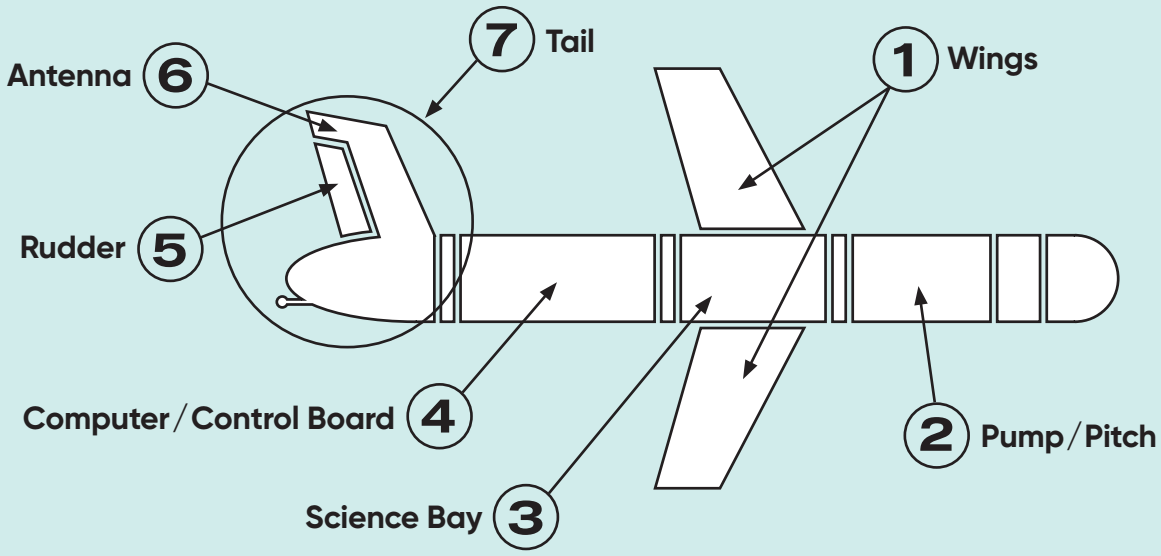
Many scientists use technological innovations such as underwater robots to do some of the most difficult and dangerous work in this challenging environment. These ocean robots (which include gliders, remotely operated vehicles (ROVs), autonomous vehicles, profilers and others), help people better understand the ocean, the organisms that live there and the interconnectedness between humans and the ocean. Robots provide safer and innovative ways to get to remote and dangerous parts of the ocean. Many also have a smaller carbon footprint than a traditional research ship. Ocean robots are increasingly important tools for collecting ocean data.

Some ocean robots are autonomous, which means they operate with little human interaction, while others are remotely controlled by humans using a long cable attached to a ship.

We're focusing our 4-H STEM Challenge on ocean robots, called gliders. These autonomous robots look like torpedoes. They don't have propellers or an internal engine, but rather use a pump like a submarine to adjust their buoyancy. Buoyancy refers to an object's ability to float.

For example, when the glider receives an email message from the glider pilot to sink, it pumps water into its nose cone and fills its water chamber. When it is told to rise, it pumps the water out. The mass of the glider stays constant, but the volume changes as the amount of water in the chamber changes. These robots are controlled remotely from land using a cell phone and computer to communicate.

Color the parts of the ocean robot below. Ocean robots are bright yellow to help researchers find them on the surface of the ocean.



ACTIVITY:

Ocean Robot Test Tank

Prepare and test a robot designed to navigate the ocean!

Join your fellow ocean robot pilots, Dave and Nicole, in the Center for Ocean Observing Leadership (COOL) Laboratory at Rutgers University.

Let's get the ocean robot ready for its mission!

Instructions

Part I: Mobilize the Mission

Decide what part of the ocean you want to explore with an ocean robot. Spread out the six location cards in your kit and select a mission card to start your expedition!

1. Every science mission has a name. In 2016, the Rutgers Center for Ocean Observing Leadership (COOL) sent gliders on a mission called Challenger where they navigated ocean robots throughout the global ocean. What are you going to call your mission?

   _____

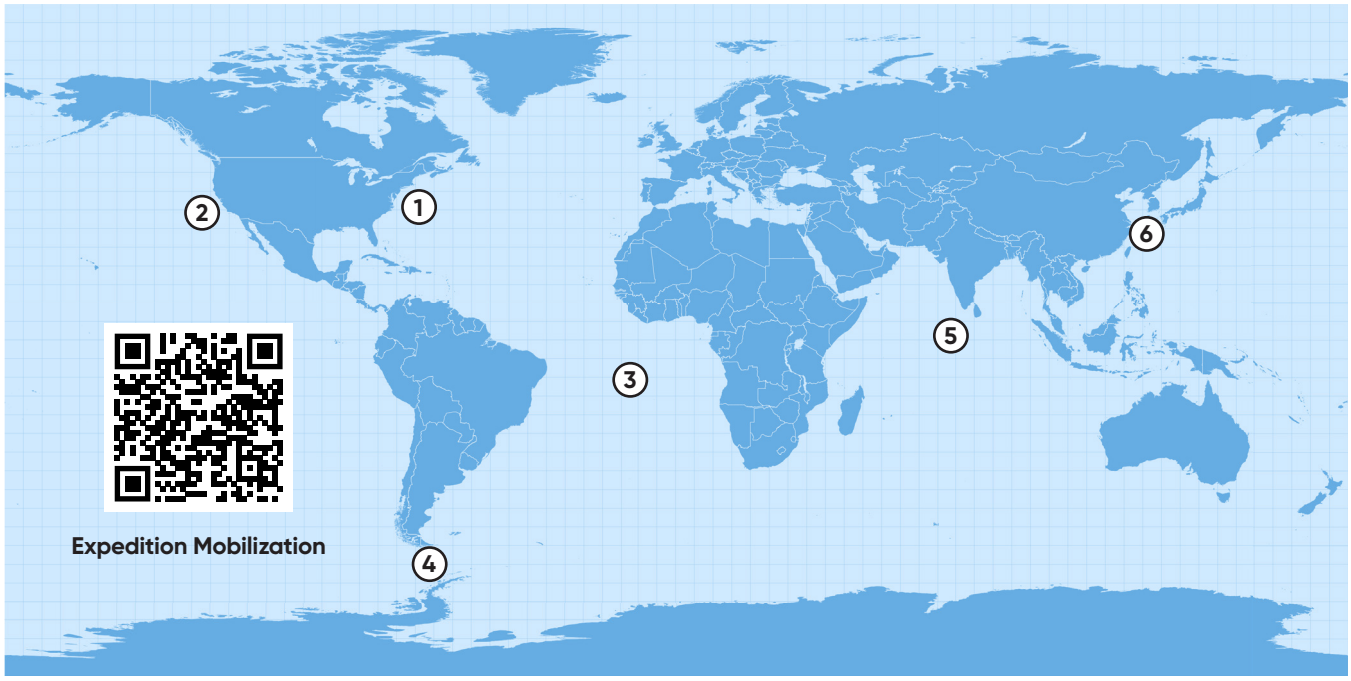
2. Which location did you choose?

   _____

3. After reading your mission card, use this space to draw or write something you learned or noticed about the geographic location of your ocean robot mission:

4. Think about how you will mobilize or start your scientific mission. How will you get there?

a. Starting Point: Where do you live? Draw a dot on the map, then draw a line representing your journey from where you live to where you will launch the robot mission.



b. Will you need to fly on an airplane to get to your study location? **Yes** or **No** (Circle your answer)

c. What airports or port cities could you use to get to your study location?

d. Do you need to put the robot on a research vessel to get to the study location? **Yes** or **No** (Circle your answer)

5. What questions do you have about ocean robots and your mission?

6. What problems do you think you might encounter in your mission? What ideas do you have to overcome them? What else do you think you will need to account for in planning the mission?

7. Once you have reviewed your mission and taken notes, move on to the "Expedition Mobilization" part of the map and use your phone (if you have one) to scan the QR code. Here you can watch a short video to meet the scientists joining you on this mission.

Now you're ready to prepare your ocean robot for its mission!

Part II: Driving School & Test Tank

In this part of the activity, you will assemble your ocean robot, practice your ballasting skills and create the sinking and floating behavior of a glider.

Ocean robot pilots, Dave and Nicole, welcome you to the COOL lab. Help us get ready for the research mission!

1. Take the ocean robot out of the Explorers of the Deep 4-H STEM Challenge kit and lay out the following parts: the **main body**, **wings**, **stickers** and a **rudder**.

2. Affix the wings to the side of the ocean robot. This helps it move or "glide" through the water. Scientists often call these robots "ocean gliders" because the wings are essential to it operating properly in the water. Now attach the rudder. Finally, use the rubber bands to hold the glider together.

3. Scan the QR code to get a description of how the robot works. Glider pilots pay attention to the density (mass of the glider in a certain volume), buoyancy (ability to float in a liquid) and the salinity (saltiness) of the water where the robot will be completing its mission. Finally, affix your favorite sticker to the ocean robot. You're ready to go!

Pilot Checklist

Wings attached: ☐

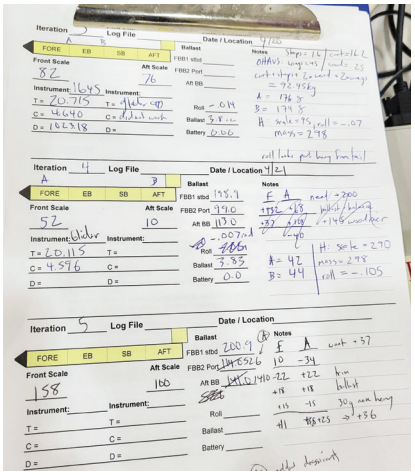
Rudder attached: ☐

Sticker attached: ☐

Ocean robot pilots put on the wings to make it glide through the ocean.

4. Next, test your ocean robot in a tank of water. Place your glider in the water and observe what happens.

Write your observations here or draw a picture:



Check out Dave and Nicole's checklist and ballasting notes.

What sensors will you need on your robot?

5. **Make your robot neutrally buoyant:** An object that has neutral buoyancy will neither sink nor rise. This is the first step in preparing an ocean glider for a scientific mission. When we "ballast" an ocean robot, it means that we add or subtract weight from it so that the robot's density matches the density of the water where it will be deployed. The density of seawater depends on its temperature and salinity: cold water is denser than warm water and salty water is denser than fresh water.

Engineering and Design Plan

Optional

Density (ρ) = Mass/Volume

a. First, we need to calculate the glider's density.

b. The glider weighs about 50 grams and has a volume of about 180 milliliters.

c. Density is found by dividing weight by volume (#grams/#milliliters)

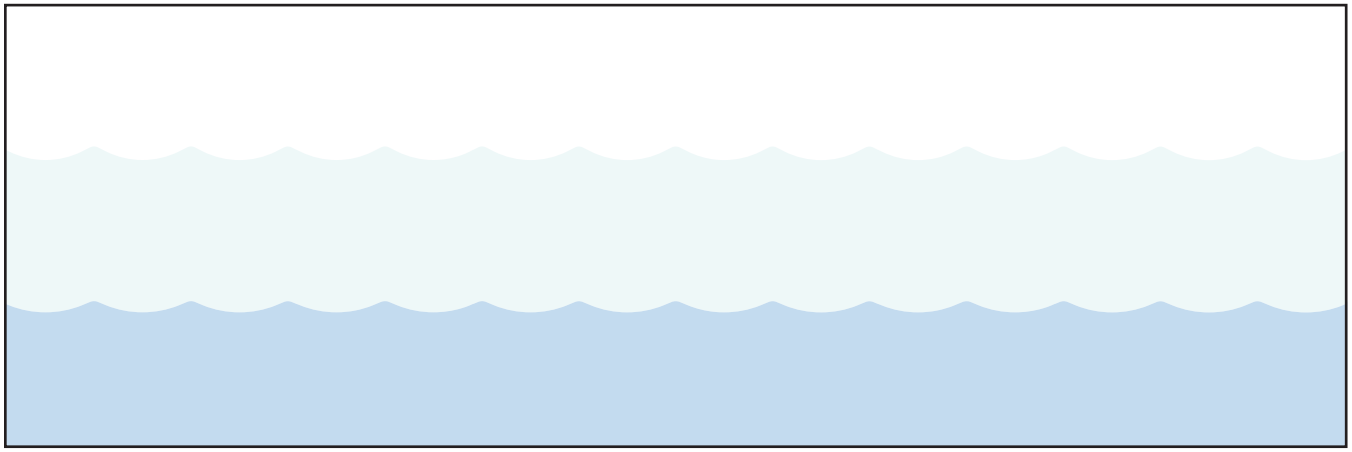
d. What is the density?

e. Let's compare that to the density of freshwater, which is 1 gram/milliliter. Is the density of the glider more or less than water? Write your ideas here:

f. Does that make sense with what you observed in the test tank? Write your notes here:

g. We need the density of the glider to be slightly less than the density of water to make it neutrally buoyant (about 0.97 grams/milliliter). Solve for how much weight we need to add to the glider.

6. Draw a picture of your robot being neutrally buoyant (just a little below the surface):



7. **Make your robot descend:** When a robot descends it gradually sinks into the ocean nose first. You will need to add weight to the nose of the robot to tilt its trajectory down into the water. This will take time and patience!

   How much weight did it take? What items and how many? Write your answer below:

8. **Make your robot ascend:** When a robot ascends it gradually floats to the surface of the ocean. You may need to add weight to the back of the robot to tilt its trajectory up into the water. You will need to hold your robot on the bottom of the container to test its ascent. This will take practice.

   How much weight did it take? What items and how many? Write your answer below:

9. If you have time, test your robot in warm and cold water. Does it behave differently? Do you have to adjust the weights?

YOU DID IT!

Part III: Diving into Data - Mission Journals

Now that your robot is ready to launch, it's time to learn more about how to read and understand the scientific information (data) the robot will send back to you during the mission. Just like weather forecasters who use data to understand high- and low-pressure systems in the atmosphere to predict the weather, scientists use ocean robot data to develop ocean forecasts! This information helps us understand things like the direction an oil spill is moving in the ocean currents, how the ocean is reacting to climate change, how and where hurricanes are forming and where we can find large phytoplankton blooms and the fish that feed on them.

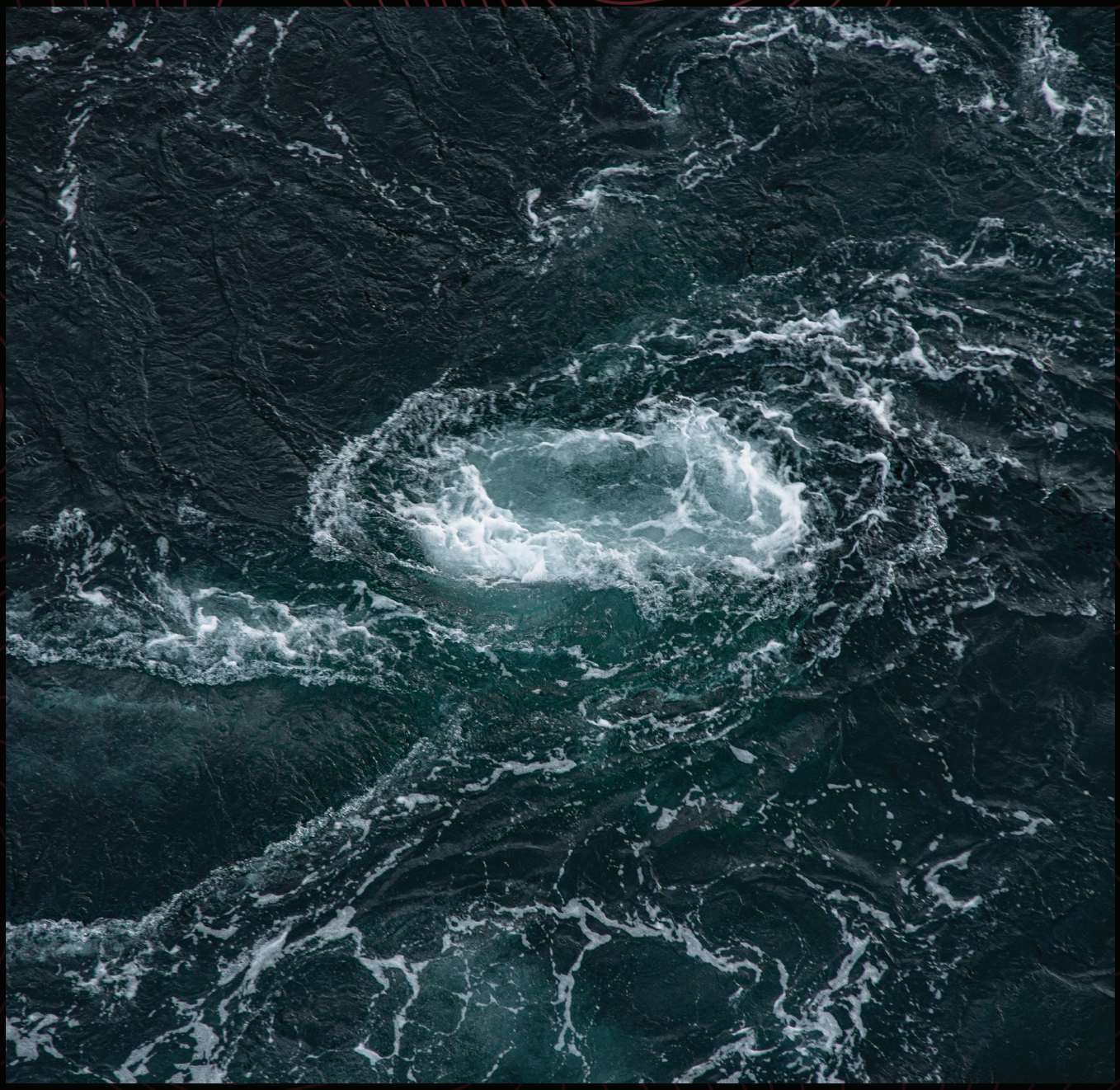
1. Find the mission data on side #2 of your mission card. This side shows the data we received from the ocean robot. The robot's journey through the ocean gives us lots of information on the health and water quality of the ocean. Scientists use this data to understand things like water temperature, salinity, oxygen levels and chlorophyll (how much microscopic phytoplankton or plants are in the water).
2. Read about the mission and try to answer the data questions on the card. Fill in your interpretation of the data and learn about what scientists are studying with ocean robots.

What would you do?

1. Your mission is coming to an end when you notice your robot is almost out of battery power. What do you do?
    a. Keep going! It is probably not a problem.
    b. Have the robot connect to the lab via its onboard communications system and provide its location so it can be picked up by the ship.
2. Your glider encounters a hurricane which sends it off course! What do you do?
    a. Let it keep going!
    b. Send it new instructions via its communication system to get it back on course.
    c. Go pick it up with the ship as soon as possible!
3. Do you think being an ocean robot pilot would be fun? What would be exciting? What would be challenging about it? What other ocean related careers are interesting to you?

ACTIVITY:

Ocean Expedition



Instructions

Your robot is ready to travel the world! Scientists are always discovering new things about the ocean. Navigate your game piece around the ocean while testing your ocean knowledge and discover some new facts along the way. Before starting your journey, think about these questions: What are three things you already know about the ocean? What are two things you wonder about the ocean?

Expedition Preparation

Write your thoughts here then share them with a partner. Remember, most of the ocean is yet to be explored, so what you wonder about the ocean is also what scientists wonder!

Expedition Board Game

GAME CARDS
On your turn, choose a card. Read the ocean scenario and move your glider along the board accordingly.

TRIVIA CARDS
For older or more advanced players, try the trivia version of the game for an extra challenge! Each player must stop at all "Surface!" spots. Another player will choose a trivia card and ask the player a trivia question. If correct, the player moves the number of spaces indicated on the card. If incorrect, the player moves back three spaces, then gameplay continues.

NEGATIVE BOARD SPACES
If a player lands on a negative space on the board, they are stuck and lose a turn. A player can opt for "Emergency Surface" where they attempt to answer a trivia question from the deck. If correct, they move ahead one space and don't skip their next turn. If incorrect, they move back one space and skip their next turn.

SHORTCUT SPACES
If a player lands on a shortcut space, immediately move to the space the arrow points to.

AUGMENTED REALITY CONNECTION
Place the AR card near the board when you reach it. Scan the QR code (or use this URL: 4-H.org/OE1) and watch the board come to life!

Check out the full game instructions in the facilitator guide or board game box to play!

Expedition Debrief

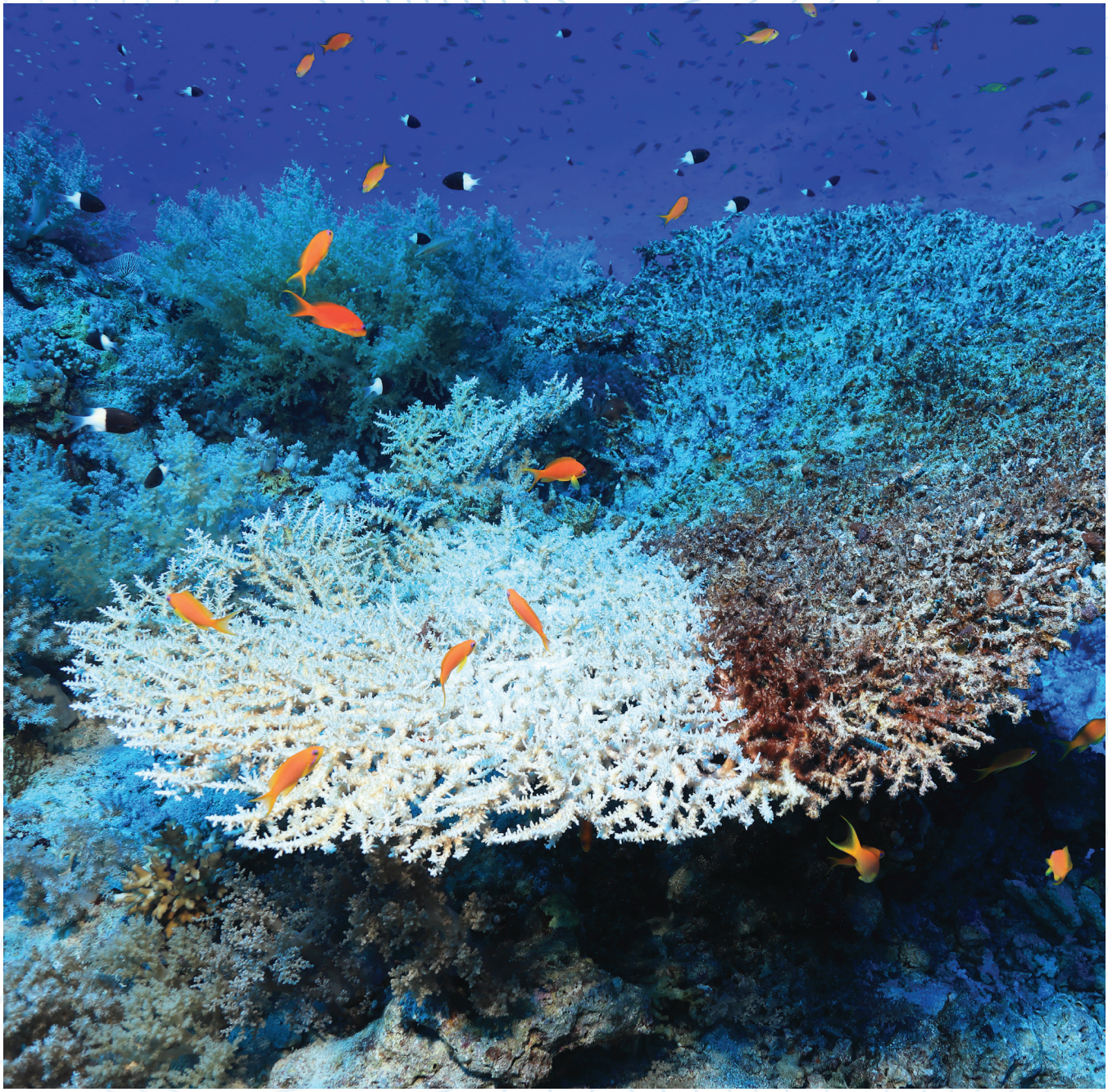
Write down two things you learned about the ocean from this game:

Pair with another player to talk about what you learned, then share with the group.

Remember, there is only ONE ocean, which you can see on the game board. Humans named five "ocean basins," but since they all connect there is only one true ocean.

ACTIVITY:

Ocean Communicator



Instructions

In this activity you will investigate challenges that ocean scientists, engineers and technologists are currently addressing. Each challenge requires collective innovations, technical solutions and public action to overcome. Follow the steps below to start your investigations!

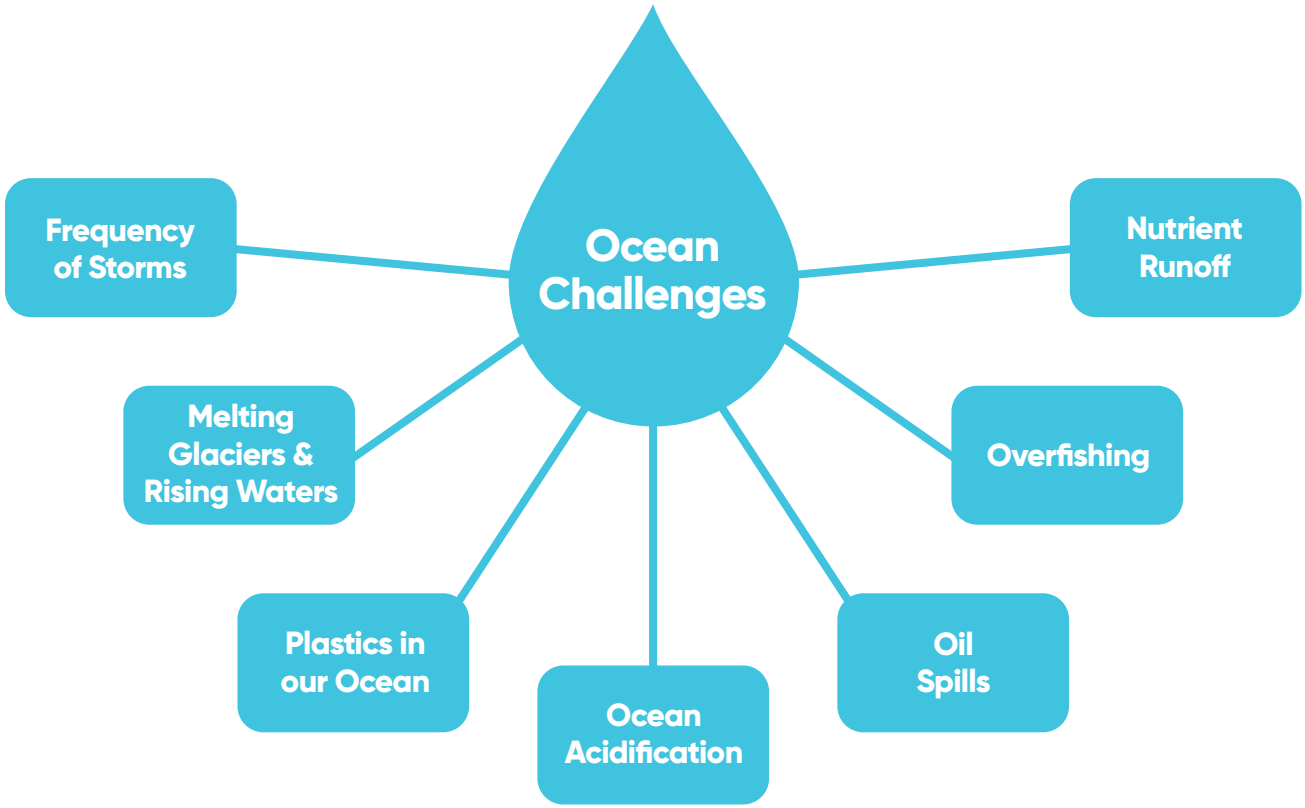
1. **Share your Ocean Knowledge** - Review the challenges listed below and share anything you know about these challenges.
2. **Match the Ocean Challenge image cards with their corresponding fact cards** to connect each challenge with a description of the ocean issue and how we are innovating solutions.
3. **Create a Public Service Announcement (PSA)** about why your friends, family, peers and community should be interested in and care about your selected ocean challenge.

    STEP 1: Select the Ocean Challenge Card that you find most interesting. See references to further explore your challenge on page 26.

    STEP 2: Use the 4-H Strong template to plan out some of the information you want to include in your PSA.

    STEP 3: Select Your Science Communication Tool. See page 21 for ideas and examples.

    STEP 4: Create Your PSA!



Using the worksheet on page 23, brainstorm your ideas for the PSA using the four Hs as a guide:

1. Use your **HEAD** to make people think.
2. Use your **HANDS** to create a call to action.
3. Use your **HEART** to make people feel something.
4. Use your **HEALTH** to address improving our world's ocean.

4-H Strong

You have the power to make a change!

Every day, young people across the nation are standing up, lending their voice and rolling up their sleeves to make changes and improve the health of our ocean planet. In 4-H we make the best better! Craft an impactful message to your family and friends:

HEAD

What is the problem? Explain the ocean challenge you want to address in your own words.

HEART

Why should we care about it?

HANDS

What is the solution? Can you explain an innovative idea you have to solve the problem?

HEALTH

How would this innovation meet the challenge/solve the problem to restore the ocean's health?

Who am I going to share this message with?

We have a duty to take care of Planet Earth for ourselves and for future generations. Let's be caretakers of the ocean and pass it on in good condition to those who follow us.

Now, choose a creative medium to make your PSA:

- **Take Action**

  Plan a way to take action in your local community. Even making simple changes in your everyday life can make a big impact. Look here for some inspiration: **oceanservice.noaa.gov/ocean/help-our-ocean.html**

- **Creative Art Piece**

  Create a drawing, painting, collage, sculpture, textile piece, photograph or craft.

- **Letter to the Editor or your local or state representatives.**

  This can include the importance of understanding your ocean challenge of choice, what scientists are doing to combat the challenge, why it is important to understand and its effects on life and the planet.

  Use the template on the next page to help organize your letter.

  Locate your state representatives or local legislators using the following sites:

  house.gov/representatives/find-your-representative

  congress.gov/state-legislature-websites

- **Creative Writing Piece**

  Write a short story, poem or song.

Fill in the template below to create a letter to the editor or a letter to your local or state representative!

Your Address:
Date:

Dear Editor (or name of policymaker),

I am writing to express my views on (state your ocean challenge and why you think it is important to address):

_____

_____

There are numerous things we can do to help. First, (name a solution to address the challenge, along with an innovation):

_____

_____

Secondly, (name another solution or innovation to address the challenge):

_____

_____

In addition, (explain what the public and your community can do to address the challenge):

_____

_____

To conclude, I feel that (your concluding thoughts on the challenge and hopes for the future):

_____

_____

Thank you for your time. I hope you give my suggestions your serious consideration.

Sincerely,

_____

Use this space to plan your Creative Art piece, Creative Writing piece or Take Action ideas.

Career Connections

Biological Oceanographer: A scientist or marine biologist who studies plants and animals in the marine environment. They are interested in the numbers and types of marine organisms, how they develop, relate to one another and adapt to their environment.

Chemical Oceanographer: Scientists that examine the chemical composition of the ocean. Their work may include analysis of seawater components, the effects of pollutants and the impacts of chemical processes on marine organisms.

Physical Oceanographer: Scientists that explore fluid motion and patterns of ocean circulation. They are interested in properties such as temperature and salinity. They study the ocean's physical processes such as waves, currents, eddies, gyres and tides.

Ocean Modeler: Scientists that develop and interpret numerical models of ocean properties and their circulation. Models play a large role in our understanding of the ocean's influence on weather and climate.

Ocean Engineer: A type of engineer that designs and builds instruments and scientific sampling tools that can endure the harsh conditions of the ocean environment.

Maritime Lawyer: The International Maritime Organization (IMO) is a specialized agency of the United Nations that oversees laws and rules involving the ocean around the world. These rules may relate to safety at sea, trade among countries and pollution prevention.

Marine Communicator: There are many ways to be a marine communicator. Some scientists serve as advisors to policymakers. For example, the Intergovernmental Panel on Climate Change (IPCC) provides policymakers with information on human induced climate change. Other communicators may spend their careers educating the public on ocean issues to inspire change.

Appendix

Optional

If allowed, work with your adult facilitator to create a social media post which includes a call to action.

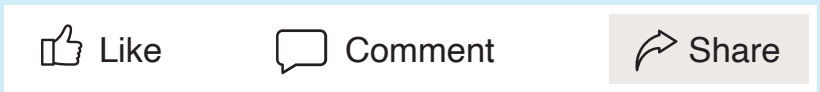
- Example: Did you know the United Nations has committed to a "**Decade of Ocean Science for Sustainable Development**".
- Please tag **@4HRutgersScienceProgram** and **@4H** and hashtag **#4HSTEMChallenge2022** so we can see and share your posts!
- If you cannot submit a social media post, create a handwritten one in the template below!

State the *Challenge*:

State the *Motivation*, or why we should care about it:

State the *Innovation(s)*, or what scientists and engineers are doing to address the challenge:

State *Solution(s)* to the challenge:



Ocean Communicator Activity

Storms:

whoi.edu/know-your-ocean/did-you-know/how-does-the-ocean-affect-storms/

svs.gsfc.nasa.gov/4947

Ocean Acidification:

oceanacidification.noaa.gov/OurChangingOcean.aspx

noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification

Melting Glaciers:

polar-ice.org/polar-literacy-initiative/principle-2/

climate.gov/climatedashboard

cpo.noaa.gov/warmingworld/glaciers.html#

Oil Spills:

pwsrcac.org/outreach/youth-involvement/

un.org/en/chronicle/article/our-oceans-our-lives

noaa.gov/education/resource-collections/ocean-coasts/oil-spills

Ocean Plastics:

oceanservice.noaa.gov/facts/microplastics.html

marinedebris.noaa.gov/discover-marine-debris/how-help

Overfishing:

njaes.rutgers.edu/fisheries/

fisheries.noaa.gov/podcast/end-overfishing

nationalgeographic.com/environment/article/critical-issues-overfishing

Nutrient Runoff:

oceanservice.noaa.gov/facts/eutrophication.html

academickids.com/encyclopedia/index.php/Eutrophication

kids.britannica.com/kids/article/eutrophication/33307/related#nodeId=main&page=1

Part I – Ocean Robot Activity

Watch a short video to meet the scientists joining you on this mission.

Watch a short video of an ocean robot engineer describing how a glider works.

Watch this short animation of a glider moving through the ocean in a zig-zag pattern.

Part II - Ocean Robot Activity

In this video you can see a real glider being ballasted in a test tank.

Ballasting Weights:

OBJECT	APPROXIMATE WEIGHT OF 1 ITEM(g)	APPROXIMATE NUMBER OF OBJECTS BETWEEN 100 & 125 GRAMS
MIXED COINS * THIS COMBINATION WORKED BEST	• Quarters 5g • Dimes 2g • Nickels 5g • Pennies 2.5g	• 13 Quarters and • 5 Dimes and • 3 Nickels and • 8 Pennies
INDIVIDUAL COINS	• Quarter 5g • Dime 2g • Nickel 5g • Penny 2.5g	• 25 Quarters or • 60 Dimes or • 25 Nickels or • 50 Pennies
GLASS GEMS	4g	25
DECORATIVE STONES	7g	17
ROCKS (FROM YARD)	10g	11
FISHING WEIGHTS	5g, 7g, 10g or 15g	Varies depending
SOCKETS	• 19mm-60g • 16mm-40g • 14mm-56g • 9mm-12g	Varies depending

This list provides other ideas for materials you can use to fine tune your ocean robot's buoyancy.

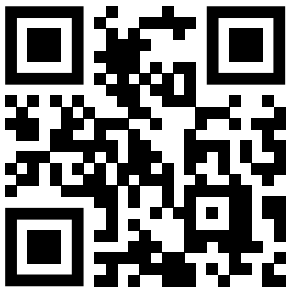
OBJECT	APPROXIMATE WEIGHTS (g)
Screws, washers, bolts, nuts, etc.	Ex: • Every 10, ½ in screws weighs 6g • ¼ in nut weighs 2g • ½ in nut weighs 12g
Pushpins	20 weighs 6g
Small magnets	5g each
Modeling clay (1 tube)	22g
Dried beans, popcorn kernels or rice	¼ cup of each weighs between 35g and 50g
Marbles	5g each
House key	10g
Sand or Soil	Varies depending on material

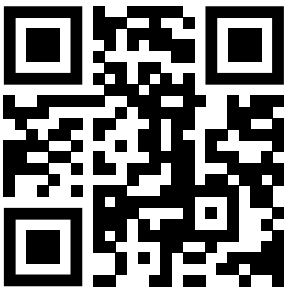
This list is not exhaustive. There are many household materials that would fulfill the objective of this activity.

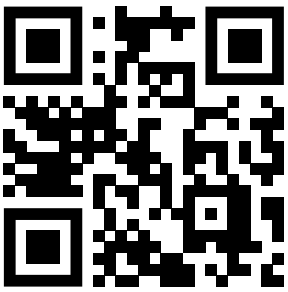
Note: Use water safe materials! (Example: No batteries, key fobs, wires, lights, etc.)

Ocean Expedition Activity

Here is where you can view the Augmented Reality (AR) parts of the board game:





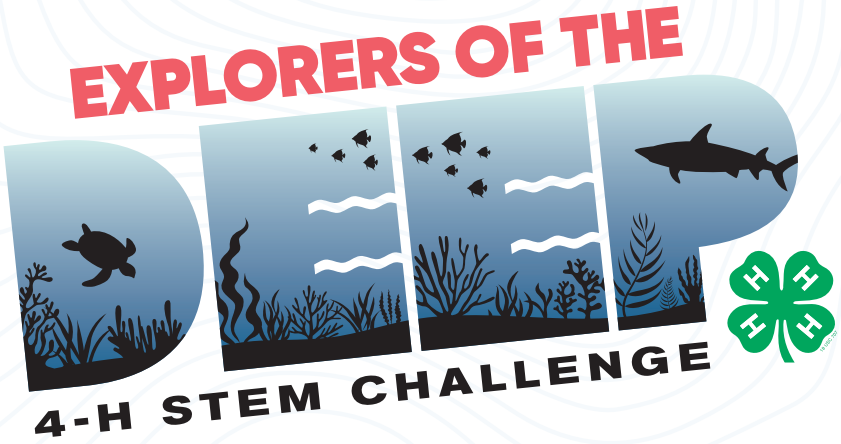


CONGRATULATIONS!

This certificate is awarded to:

_____

for completing



Presented by:

_____

Date:

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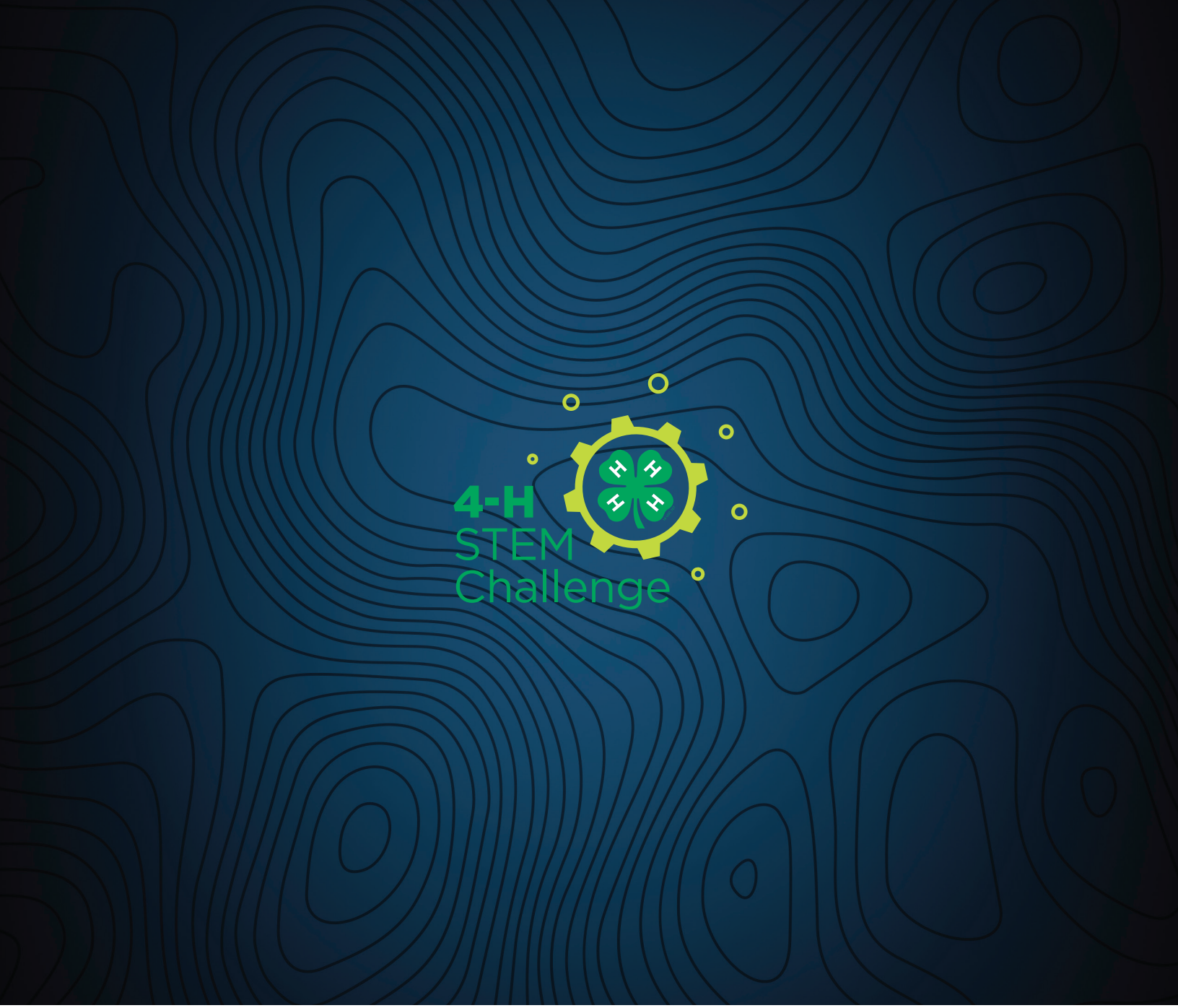

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