NATIONAL GEOGRAPHIC EDUCATOR'S GUIDE

NEXT GENERATION SCIENCE STANDARDS AND CLASSROOM ACTIVITIES

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NATIONAL GEOGRAPHIC KiDS

Instructional **NOTE:**

The Next Generation Science Standards (NGSS) are built on the Core Disciplinary Ideas (CDIs) of the *Framework for K–12 Science Education*. In this Educator's Guide, activities introduce, review, or otherwise address one or more of the CDIs used as the basis for the NGSS performance expectations for each grade level.

ETS1.B: ***Developing Possible Solutions*** Design can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)

Designing the Future

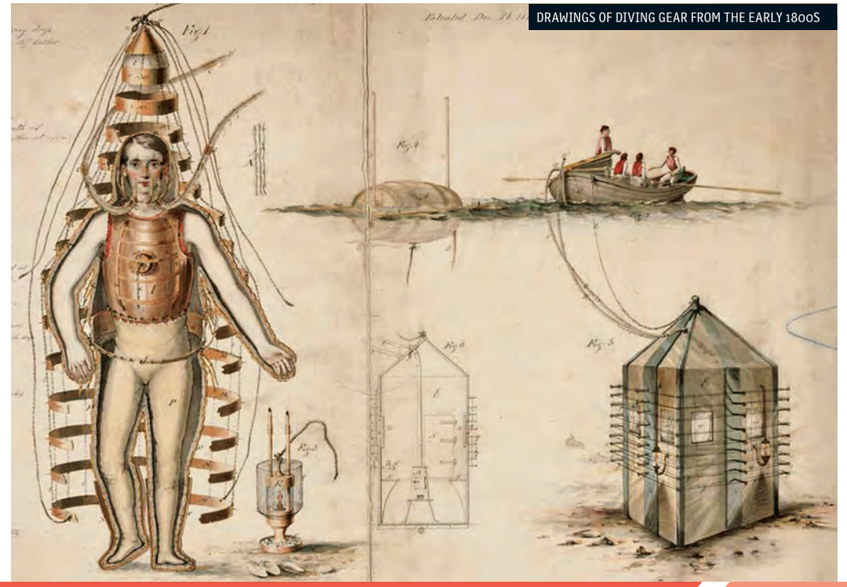
MATERIALS

- Drawing tools
- Paper
- Imagination

Prior to reading Chapter 4, read aloud the chapter's headline: "Why Do We Explore?" As a class, brainstorm potential answers to this question.

Then read the chapter aloud. As you read, pause to discuss relationships between the text, photos, captions, and illustrations. When you are done reading the chapter, revisit the question asked in the headline. Encourage students to add to their earlier thoughts. Guide them to recognize that the answer to this question lies in the first sentence of the chapter: Humans are curious.

Then point out to the class that this chapter doesn't just ask why people explore. It also examines when, where, and how we explore. In some cases, it even tells who did the exploring. Inform students that asking and answering question words like these is how people solve problems and learn new things.



DRAWINGS OF DIVING GEAR FROM THE EARLY 1800S

Divide the class into two groups. Identify one group as "space" and the other as "sea." Assign each group its corresponding timeline on pages 58–59. Instruct groups to search the chapter for information about each entry on their timelines. Challenge them to write a caption answering as many of the question words as they can. Invite groups to share their captions with the class. Compare and contrast how technology has changed the way people explore sea and space environments.

Then review the activity "Design Your Own Space Suit" on pages 72–73. As a class, discuss the questions posed in the "Things to Think About" section. Brainstorm a list of other problems that would need to be addressed when designing a new sea or space suit. Encourage students to share ideas for solutions.

Then give each student two pieces of paper and access to drawing tools. Give students time to draw pictures of both a sea suit and a space suit that could be used on future missions. Remind them to include all the tools and safety equipment they might need for the trip.

Invite students to share their drawings with the class. Compare and contrast the different kinds of suits. Discuss how identifying problems and solutions before they began drawing helped students create better suits.

LS4.C: ***Adaptation*** For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

Adapting to New Environments

MATERIALS

- Drawing tools
- Paper

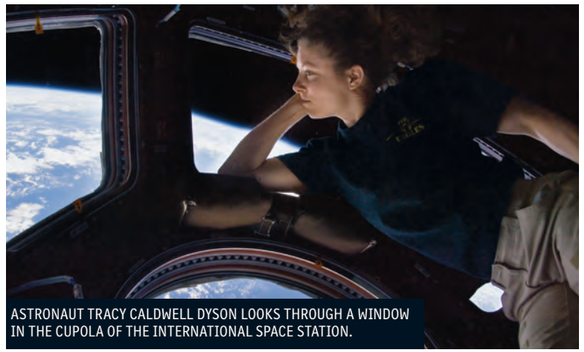
Read aloud Chapter 3, "Making a Home," on pages 44–57. As you read, pause to discuss relationships between the text, photos, diagrams, and captions.

After reading the chapter, create a Venn diagram. Encourage students to compare and contrast the size, shape, location, contents, and accommodations in sea and space habitats. Challenge the class to create a list of items people would need to survive in each place. Encourage students to review the chapter to ensure they don't overlook anything essential, such as air, food, power, or a way to communicate with mission control on Earth's surface.

Point out to students that sea and space habitats are research stations. People live and work in them for a limited amount of time. There is not room for anything that isn't essential to the mission. Because of that, people can't take everything they want on the trip. They must adapt to survive with the items that are available.

Give each student a piece of paper and access to drawing tools. Tell students to draw a design for their own sea or space habitats. Challenge them to include all of the essential items the class identified earlier.

Then have students make a list of things they'd like to take but couldn't. Encourage them to identify creative ways to adapt existing supplies, the environment, or their own behaviors so they can—in some form—take these things on the trip, too.



ASTRONAUT TRACY CALDWELL DYSON LOOKS THROUGH A WINDOW IN THE CUPOLA OF THE INTERNATIONAL SPACE STATION.

Invite students to share their designs with the class. Then poll the class to see if students think it would be easier to adapt to life in a sea or space habitat. Challenge them to support their opinions with information from the chapter.

CONCEPT CITY ON MARS

MATERIALS

- Poster board
- Access to research resources, such as the Internet
- Access to a printer
- Scissors
- Glue or glue sticks

ESS2.B: ***Plate Tectonics and Large-Scale System Interactions*** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)

Learning From Earth's Systems

Invite students to read Chapter 5 in pairs or small groups. As they read, instruct students to pause and discuss relationships between the text, photos, captions, and illustrations.

After reading, remind students that people have learned a lot from exploration both in space and under the sea. Then point out that, with each new discovery, people want to learn more. They want to know what its like in the deepest parts of the ocean and the farthest reaches of space.

Unfortunately, we can't actually go to these far-off places. But we can use what we already know about water and landforms on Earth to help us understand them. Review the information on pages 76–77 comparing Hawaii's volcanoes and the potential icy volcano on Enceladus, one of Saturn's moons, as an example.

Divide the class into pairs. Give each pair a piece of poster board. Instruct students to lay down their poster board vertically and draw a line to divide it in half. Tell them to label the top section "What Can Space Teach Us About the Ocean?" Have them label the bottom section "What Can the Ocean Teach Us About Space?"

Give students time to conduct research. Challenge them to find at least one example that answers each question. Instruct them to gather pictures and write summaries explaining each ocean/space connection. Have pairs add the examples to their posters.

Invite students to share their posters with the class. Discuss how each connection could lead to important discoveries about the ocean or space in the future.

Astronauts go up in space. They also go deep under the water. While it may seem strange, NASA trains its astronauts in a facility that has long been used by aquanauts. The NASA Extreme Environment

MATERIALS

- 2 pieces of twine or string
  - 1 piece long enough to tie around your waist and your friend's with about 18 inches (46 cm) in between
  - 1 piece about 18 inches long
- A large plastic cup
- A tennis ball
- An eye screw
- A friend, an adult, and a large open space where you won't bump anything

ETS1.B: ***Developing Possible Solutions*** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)

Solving Problems Together

Prior to reading Chapter 2, "Blasting Off or Taking the Plunge," prepare a tennis ball and twine as outlined in the activity "Docking the ISS," on pages 42–43. If you wish, prepare more than one set.

Depending on how many tennis balls you prepared, select two volunteers or divide the class into pairs. Have students complete the experiment. Challenge them to apply what they learned from the experience as they answer the "Things to Think About" questions at the end of the activity.

Then have students read Chapter 2 in pairs, in small groups, or on their own. As students read, encourage them to pause to discuss relationships between the text, photos, and illustrations.

After reading, challenge students to explain why the activity "Docking the ISS" was a good way to demonstrate what this chapter is about. (It shows the importance of training, understanding forces, and communication. Space and deep-sea explorers rely on these things to solve problems when they work.)

Divide the class into small groups. Instruct each group to identify itself as astronauts or aquanauts. Then have each group write a script outlining communication between the explorers and mission control as they blast off into space or take the plunge into the sea. Instruct students to use details from the chapter to describe what they see as they go. Challenge them to write a plot in which they encounter and solve a problem along the way. Each group member must have a role in the script.

Invite groups to present their scripts to the class. As they do, have classmates discuss how training, understanding forces, and communication helped each crew survive its mission.

PS2.A: ***Forces and Motion*** The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)

MATERIALS

- A pen cap, otherwise known as your "submersible"
- A piece of clay or putty that is waterproof
- A 2-liter bottle filled with water
- Cap to the 2-liter bottle

Exploring Forces

Invite students to read Chapter 1, "Exploring New Environments," in pairs, in small groups, or on their own. As students read, encourage them to pause to discuss relationships between the text, photos, and illustrations.

After reading, provide access to the supplies required for the "Sink or Float" investigation on pages 24–25. Have students conduct the experiment in small groups or as a whole-class activity. Encourage students to compare the results they see to the illustrations as they complete each step.

Point out to the class that this experiment displays the connection between pressure, gravity, and buoyancy on an object in water. Understanding what these forces are and how they are connected is critical for aquanauts, who explore Earth's oceans. It's also important to the people who design their equipment. (See the sidebar "Why Are Submersibles Round?" on page 19.) But forces affect astronauts in space differently.

Divide the class into small groups. Identify half of the groups as astronauts and the other half as aquanauts. Instruct groups to review the chapter to summarize how forces affect people and other objects in space or under the sea. Then, using the sidebar on page 19 as an example, have each group compose five questions that illustrate how forces affect space or sea explorers. If they cannot find sufficient information to answer a question in the chapter, encourage them to conduct additional research. Challenge them to also find a photo or illustration related to each point.

Invite groups to share what they learned with the class. After all groups have presented, compare and contrast how forces affect people exploring in space and under the sea.

STANDARDS

Grade 2

ETS1.B: ***Developing Possible Solutions*** Design can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2))

Grade 3

LS4.C: ***Adaptation*** For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

Grade 4

ESS2.B: ***Plate Tectonics and Large-Scale System Interactions*** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)

Grade 5

ETS1.B: ***Developing Possible Solutions*** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)

Middle School

PS2.A: ***Forces and Motion*** The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)