Chapter 10
Oceans

Includes:

**LEVELED ASSESSMENT**
- Chapter Review
- Chapter Tests
  - Test A (Below Level) **BL**
  - Test B (On Level) **OL**
  - Test C (Advanced Learner) **AL**

**LABS**
- For leveled labs, use the CD-ROM.
- Lab worksheets from Student Edition Labs
  - MiniLab
  - Lab: Version A (Below Level) **BL**
  - Lab: Version B (On Level) **OL**
  - (Advanced Learner) **AL**

**UNIVERSAL ACCESS/LEVELED RESOURCES**
- Target Your Reading
- Chapter Content Mastery English (Below Level) **BL**
- Chapter Content Mastery Spanish (Below Level) **BL**
- Reinforcement (On Level) **OL**
- Enrichment (Advanced Learner) **AL**

**READING SUPPORT**
- Content Vocabulary
- Chapter Outline

**TEACHER SUPPORT AND PLANNING**
- Chapter Outline for Teaching
- Teacher Guide and Answers
Photo Credits
Cover: Alamy Images
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## To the Teacher

Reproducible Student Pages

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## Assessment

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## Teacher Support and Planning

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Additional Assessment Resources available with Glencoe Science:

- ExamView® Assessment Suite
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at [science.glencoe.com](http://science.glencoe.com)
- Interactive Classroom
- The Glencoe Science Web site at [science.glencoe.com](http://science.glencoe.com)
- An interactive version of this textbook along with assessment resources are available online at [mhln.com](http://mhln.com).
Student Lab/Activity Safety Form

Student Name: ________________________________

Date: ________________________________

Lab/Activity Title: ________________________________

In order to show your teacher that you understand the safety concerns of this lab/activity, the following questions must be answered after the teacher explains the information to you. You must have your teacher initial this form before you can proceed with the activity/lab.

1. How would you describe what you will be doing during this lab/activity?

2. What are the safety concerns associated with this lab/activity (as explained by your teacher)?
   •
   •
   •
   •
   •

3. What additional safety concerns or questions do you have?

MiniLab
Different densities?

Recall that the hot water from the Launch Lab rose to the surface of the fish tank. This resulted because the hot water was less dense than the cold water.

Procedure
1. Read and complete a lab safety form.
2. Place a colored ice cube in a container of hot water. Observe what happens.
3. Use a stopwatch to record the amount of time it takes for the two colors to mix.

Analysis
1. Describe what happened to the cold water from the ice cube.

2. Infer how convection currents are involved in this experiment.
Different beaches have different types of rocks and minerals in their sand. An examination of a sample of beach sand can reveal what types of rocks and minerals are in the area.

**Procedure**

1. Read and complete a lab safety form.
2. Examine the **sand** your teacher has given you. Make a note of the various sizes, shapes, and colors of the grains.
3. Study the grains with a **magnifying lens**. Try to identify the types of minerals and rocks that are present in your sample—quartz, feldspar, shell fragments, or volcanic rock.
4. Wrap a large **magnet** in a **plastic bag** and pass it through your sample. Are there any sand grains attracted to the magnet?

**Analysis**

1. **Summarize** the composition of your sand sample. What rocks or minerals could you identify? What colors and shapes were the different grains? Where do you think the sand came from?

2. **Compare** your summaries to other students’. Did everyone have the same type of sand?

3. **Infer** What type of mineral would you find using a magnet?
Lab

Mapping the Ocean Floor

**Problem** Mapping the ocean floor is a challenging activity involving data collection and analysis. In this lab, you will make a model of the ocean floor and then collect data to make a map.

**Form a Hypothesis** How can you make a bathymetric map?

**Materials**
- shoebox with lid
- dowel rod marked in centimeters
- modeling clay
- colored markers

**Safety Precautions**

**Procedure**

**Directions:** Check the boxes below as you complete each step of the procedure.

**Build the Ocean Floor**

☐ 1. Read and complete a lab safety form.
☐ 2. Obtain a shoebox.
   - Use the modeling clay to make a model of the ocean floor at the bottom of the shoebox.
☐ 3. Your model should include some of the features of the ocean floor, such as ridges, abyssal plains, trenches, the continental shelf, and the continental slope. Do not allow other groups to see your ocean floor.
☐ 4. Place the lid on the box.
   - Make a grid on the top of the box to resemble the table below. It should have equally sized rows and equally sized columns.
   - Make a hole inside each grid square large enough for a small dowel rod to fit in.
   - Exchange your box with another group.

**Collect Data**

☐ 1. Examine the grid on top of the lid.
☐ 2. Design a data table like the one shown at right that has the same number of squares as the grid on the box.

☐ 3. Starting at square A1, put the dowel rod into the hole in each square of the grid.
   - **Remember:** Your dowel rod should have lines marked in centimeters.
☐ 4. Find the square on your table that matches the square on the box lid.
   - Record the depth to the nearest centimeter.
   - Continue until you have recorded a depth for each square.
   - Do not open the box until your teacher instructs you to do so.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<tr>
<td>1</td>
<td></td>
<td></td>
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<td></td>
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<td>2</td>
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<td>5</td>
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<td></td>
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<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lab: Version A  CONTINUED

Analyze and Conclude
1. **Interpret** the data you have collected. Use the table on the next page to color code your data table. Color each square of your table the color that corresponds most closely to a measurement found in the table on the previous page in which you recorded your measurements.

2. **Classify** the different areas of the bottom of the box. Are there any ridges, trenches, or abyssal plains?

3. **Describe** what the bottom of the box looks like. Did you find anything unexpected?

4. **Think critically** about the method you used to make your map. How does it differ from how scientists make their maps? Is it similar to any other method you have learned about?

5. **Analyze** the bottom of the box once your teacher opens the lid. How closely did your map mirror the bottom of the box?
Lab: Version A  CONTINUED

<table>
<thead>
<tr>
<th>Ocean Depth (cm)</th>
<th>Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Black</td>
</tr>
<tr>
<td>10</td>
<td>Purple</td>
</tr>
<tr>
<td>8</td>
<td>Dark Blue</td>
</tr>
<tr>
<td>7</td>
<td>Light Blue</td>
</tr>
<tr>
<td>5</td>
<td>Green</td>
</tr>
<tr>
<td>4</td>
<td>Yellow</td>
</tr>
<tr>
<td>3</td>
<td>Orange</td>
</tr>
<tr>
<td>2</td>
<td>Red</td>
</tr>
<tr>
<td>1</td>
<td>Pink</td>
</tr>
</tbody>
</table>

**Communicate**

**Write an Advertisement**  Suppose you make bathymetric maps of near-shore areas based on data collected by scientists. You want to sell the maps to boat captains and other navigators. Write an ad to be placed in a boating magazine to sell your maps.
Problem  Mapping the ocean floor is a challenging activity involving data collection and analysis. In this lab, you will make a model of the ocean floor and then collect data to make a map.

Form a Hypothesis  How can you make a bathymetric map?

Materials
shoebox with lid
modeling clay
dowel rod marked in centimeters
colored markers

Safety Precautions  

Procedure

Directions:  Check the boxes below as you complete each step of the procedure.

Build the Ocean Floor

☐ 1. Read and complete a lab safety form.
☐ 2. Obtain a shoebox. Use the modeling clay to make a model of the ocean floor at the bottom of the shoebox.
☐ 3. Your model should include some of the features of the ocean floor, such as ridges, abyssal plains, trenches, the continental shelf, and the continental slope. Do not allow other groups to see your ocean floor.
☐ 4. Place the lid on the box. Make a grid on the top of the box to resemble the table to the right. Make a hole inside each grid square large enough for a dowel to fit in. Exchange your box with another group.

Collect Data

☐ 1. Examine the grid on top of the lid.
☐ 2. Design a data table like the one shown at right that has the same number of squares as the grid on the box.

Analyze and Conclude

1. Interpret the data you have collected. Use the table on the next page to color-code your data table. Color each square of your table the color that corresponds most closely to a measurement found in the table above in which you recorded your measurements.
2. **Classify** the different areas of the bottom of the box. Are there any ridges, trenches, or abyssal plains?

3. **Describe** what the bottom of the box looks like. Did you find anything unexpected?

4. **Think critically** about the method you used to make your map. How does it differ from how scientists make their maps? Is it similar to any other method you have learned about?

5. **Analyze** the bottom of the box once your teacher opens the lid. How closely did your map mirror the bottom of the box?

<table>
<thead>
<tr>
<th>Depth and Color</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ocean Depth (cm)</strong></td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>
Lab: Version B  CONTINUED

Going Further

Challenge

6. Imagine that a new planet was discovered with a large ocean. A probe sent to explore the planet recorded no evidence of current or past tectonic activity. **Speculate** about what a map of the ocean floor would look like.

7. Until recently, little was known about the shape and depth of the ocean floor. **Determine** what conditions made the exploration of the ocean floor difficult.

8. **Compare** and **Contrast** How are ocean floor features similar to and different from land features above sea level?

Extension

Ask most people which is taller, Mt. Everest or the Hawaiian Islands, and they will usually respond with Mt. Everest. If you placed the two features side by side, however, the Hawaiian Islands would tower above Mt. Everest. Choose five land features and five ocean features. Choose at least one ocean feature that is above sea level, like the Hawaiian Islands. Research to find the elevation/depth of each feature. Create a line graph to show the elevation of each feature. Place sea level as a horizontal line on your graph with a value of zero. What do you notice about the different elevations/depths?

Communicate

**Write an Advertisement** Suppose you make bathymetric maps of near-shore areas based on data collected by scientists. You want to sell the maps to boat captains and other navigators. Write an ad to be placed in a boating magazine to sell your maps.
**Oceans**

**CHAPTER 10**

Use this to focus on the main ideas as you read the chapter.

1. **Before you read** the chapter, respond to the statements below on your worksheet or on a numbered sheet of paper.
   - Write an **A** if you **agree** with the statement.
   - Write a **D** if you **disagree** with the statement.

2. **After you read** the chapter, look back to this page to see if you’ve changed your mind about any of the statements.
   - If any of your answers changed, explain why.
   - Change any false statements into true statements.
   - Use your revised statements as a study guide.

<table>
<thead>
<tr>
<th>Before You Read A or D</th>
<th>Statement</th>
<th>After You Read A or D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The ocean floor is completely flat.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>A map of the ocean floor can be made using sound waves.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>A continuous chain of underwater volcanoes extends through all oceans.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Surface currents in the ocean are caused by wind.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Deep currents in the ocean are caused by wind.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Waves cause erosion along the shoreline.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Sand is transported by currents along the beach.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Beaches can be made of different types of sand.</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Hurricanes do not occur in California.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>The rocky shore has a high diversity of organisms.</td>
<td></td>
</tr>
</tbody>
</table>
**Chapter Content Mastery**

**Earth’s Oceans**

**Directions:** Match the term in the first column with the definition in the second column by writing the correct letter in the space provided.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. continental shelf</td>
<td>A. level of the sea’s surface halfway between high and low tide</td>
</tr>
<tr>
<td>2. abyssal plain</td>
<td>B. steep slope between a continent and the deep ocean</td>
</tr>
<tr>
<td>3. mid-ocean ridge</td>
<td>C. region of flat ocean floor</td>
</tr>
<tr>
<td>4. continental slope</td>
<td>D. deepest location in the Pacific Ocean</td>
</tr>
<tr>
<td>5. trench</td>
<td>E. shows the contours of the ocean floor and its geologic features</td>
</tr>
<tr>
<td>6. Mariana Trench</td>
<td>F. shallow offshore area moving from the edge of the continent toward the ocean</td>
</tr>
<tr>
<td>7. sea level</td>
<td>G. place where tectonic plates are moving away from each other and new seafloor is being created.</td>
</tr>
<tr>
<td>8. ocean floor</td>
<td>H. deep valley that extends along the edges of the ocean</td>
</tr>
<tr>
<td>9. bathymetric map</td>
<td>I. Earth’s surface underneath the ocean water</td>
</tr>
</tbody>
</table>

**Directions:** Study the following diagram. Then label the ocean floor using terms 1–5 from the numbered list in Column I above.

[Diagram showing ocean floor with labeled terms 10-14]
**Directions:** Match the first half of the sentence on the left with the correct second half of the sentence on the right.

1. Ocean currents act like
   - A. Earth spinning on its axis.
2. An important property of water is
   - B. heavy rains.
3. Wind moves the surface water
   - C. rivers in the ocean.
4. The Coriolis effect is caused by
   - D. temperature and salinity.
5. Water density depends on
   - E. strong westerly winds.
6. Differences in density form
   - F. faster than the wave is moving, causing whitecaps.
7. The Antarctic Circumpolar Current is driven eastward by
   - G. that a large amount of heat can be added or removed before it changes temperature.
8. The El Niño effect can cause
   - H. deep ocean currents.

**Directions:** Write the letter of the direction in which each of the five major gyres rotates.

- A. clockwise
- B. counter-clockwise

9. North Atlantic Gyre
   - A.
10. South Pacific Gyre
    - B.
11. Indian Ocean Gyre
    - A.
12. North Pacific Gyre
    - B.
13. South Atlantic Gyre
    - B.

14. What causes the formation of the two types of ocean currents?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Chapter Content Mastery

The Ocean Shore

Directions: Study the picture. Then label the parts using the terms below.

beach longshore current shoreline wave movement

1. _________________  2. _________________  3. _________________  4. _________________

Directions: Complete the paragraph by filling in the blanks with the terms below.

baymouth bars coarse deposition erode sand sea arches sediments shoreline

The appearance of the (5) ________________________ depends upon the intensity of wind and waves and the type of rock found in the area. As waves (6) ________________________ rocks, shoreline features such as (7) ________________________ and sea stacks are created. (8) ________________________ eroded from one area are carried by wave action to another area. (9) ________________________ occurs where wave energy is low. Shoreline features such as (10) ________________________ and tombolos are formed by the deposition of sediment. (11) ________________________ is the term used to describe rocks between 0.0625 mm and 2 mm in size. Within this range, sand is categorized as very (12) ________________________, coarse, medium, fine, and very fine.
Directions: Choose the answer that completes each sentence below and write its letter on the line at the left.

1. The geology of California is based on the movement of _________________.
   A. sediments
   B. hurricanes
   C. tectonic plates
   D. ocean currents

2. Coastal _________________ stretch along the entire state of California.
   A. tombolos
   B. sea stacks
   C. abyssal plains
   D. mountain ranges

3. Tsunamis are often caused by _________________ under the ocean.
   A. gyres
   B. salinity
   C. tornadoes
   D. earthquakes

4. The chill in the ocean off California is caused by the _________________.
   A. Davidson Current
   B. California Current
   C. Southern California Bight
   D. Antarctic Circumpolar Current

5. The power of a _________________ comes from the warm water in tropical areas.
   A. hurricane
   B. rip current
   C. breakwater
   D. tectonic plate

6. Between 1858 and 1983, _________________ of the marsh area in San Francisco Bay was developed for agriculture or construction.
   A. about 50 percent
   B. almost 95 percent
   C. less than 10 percent
   D. more than 80 percent
**Los océanos de la Tierra**

**Instrucciones:** Coincide el término en la primera Columna con la definición en la segunda Columna escribiendo la letra correcta en el espacio.

<table>
<thead>
<tr>
<th>Columna I</th>
<th>Columna II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. plataforma continental</td>
<td>A. el nivel de la superficie del mar entre la marea alta y la baja</td>
</tr>
<tr>
<td>2. llanura abisal</td>
<td>B. la cuesta empinada entre un continente y el mar profundo</td>
</tr>
<tr>
<td>3. cresta en medio del océano</td>
<td>C. región del extremadamente suelo marino</td>
</tr>
<tr>
<td>4. cuesta continental</td>
<td>D. el lugar más profundo en el Océano Pacífico</td>
</tr>
<tr>
<td>5. zanjas</td>
<td>E. muestra el contorno del suelo marino y sus rasgos geológicos</td>
</tr>
<tr>
<td>6. Zanja Mariana</td>
<td>F. un área poco profunda cercana a la costa moviéndose de la orilla del continente hacia el océano</td>
</tr>
<tr>
<td>7. nivel del mar</td>
<td>G. lugar donde las placas tectónicas están alejándose una de la otra y donde nuevo suelo marino se está creando</td>
</tr>
<tr>
<td>8. suelo marino</td>
<td>H. valles profundos que se extienden a lo largo de las orillas del océano</td>
</tr>
<tr>
<td>9. mapa batimétrica</td>
<td>I. la superficie de la Tierra debajo del agua del océano</td>
</tr>
</tbody>
</table>

**Instrucciones:** Estudia el siguiente diagrama. Entonces, etiqueta el suelo marino usando los términos 1-5 de la lista en la Columna I de arriba.

![Diagrama del suelo marino](Image)
Las corrientes del océano

Instrucciones: Coincide la primer parte de la oración a la izquierda con la parte correcta de la oración a la derecha.

1. Las corrientes del océano actúan como
   A. la Tierra está girando sobre su propio eje.

2. Una propiedad importante del agua es
   B. lluvias muy pesadas.

3. El aire mueve la superficie del agua
   C. ríos en el océano.

4. El efecto Coriolis se debe a que
   D. la temperatura y la salinidad.

5. La densidad del agua depende en
   E. vientos fuertes del oeste.

6. Las diferencias en la densidad forman
   F. más rápido de lo que se está moviendo la ola causando capas blancas.

7. La corriente circumpolar antártica se mueve hacia el este debido a
   G. que una cantidad grande de calor se puede añadir o retirar antes de que cambie su temperatura.

8. El efecto del Niño puede causar
   H. corrientes oceánicas profundas.


Instrucciones: Escribe la letra de la dirección en la cual cada una de las rotaciones importantes se forman.

A. en el sentido de las agujas del reloj   B. en el sentido opuesto al de las agujas del reloj

9. Rotación del Atlántico norte

10. Rotación del Pacífico sur

11. Rotación del Océano de la India

12. Rotación del Pacífico norte

13. Rotación del Atlántico sur

14. ¿Qué causa la formación de las dos clases de corrientes oceánicas?

________________________________________________________________________

________________________________________________________________________
Instrucciones: Estudia la ilustración. Entonces, etiqueta las partes usando los siguientes términos.

playa corriente de la costa línea costera movimiento de marea

1. _______________
2. _______________
3. _______________
4. _______________

Instrucciones: Completa el párrafo usando las siguientes palabras.

arcos marinos arena barras embocaduras deposición erosión grueso línea costera sedimentos

La apariencia de la (5) __________________________ depende de la intensidad de los aires y las mareas y de la clase de roca que se encuentra en el área. Mientras las mareas (6) __________________________ las rocas, se hacen rasgos en la línea costera, como (7) __________________________ y pilas marinas. (8) Los __________________________ erosionados en un área se mueven por medio de las mareas a otra área. (9) La __________________________ ocurre cuando la energía de las mareas está baja. Rasgos de la línea costera como las (10) __________________________ y tómbolos se forman debido a la deposición del sedimento. (11) La __________________________ es el término que se usa para describir rocas entre 0.0625 mm y 2 mm de tamaño. Dentro de este rango, la arena está clasificada como muy (12) __________________________, gruesa, mediana, fina, y muy fina.
1. La geología de California se basa en el movimiento de los
   (las) ________________.
   A. sedimentos
   B. huracanes
   C. placas tectónicas
   D. corrientes oceánicas

2. Los (Las) ________________ de la costa se extienden a lo largo de todo el estado de California.
   A. tómbolos
   B. pilas marinas
   C. llanuras abisales
   D. sierras montañosas

3. Los maremotos frecuentemente resultan por ________________ debajo del océano.
   A. las rotaciones
   B. la salinidad
   C. los tornados
   D. los terremotos

4. La sensación de frío en el océano cerca de la costa de California resulta debido a
   la ________________.
   A. corriente Davidson
   B. corriente California
   C. corriente Bight de California sur
   D. corriente circumpolar antártica

5. La fuerza de un(a) ________________ viene del agua templada en áreas tropicales.
   A. huracán
   B. corriente de resaca
   C. rompeolas
   D. placa tectónica

   A. acerca de 50 por ciento
   B. casi 95 por ciento
   C. menos de 10 por ciento
   D. más de 80 por ciento
Reinforcement Earth’s Oceans

Directions: Respond to each question or statement below.

1. Name Earth’s five oceans.
   ____________________________________________________________
   ____________________________________________________________

2. What is a bathymetric map?
   ____________________________________________________________
   ____________________________________________________________

3. Describe two methods for measuring the ocean’s depth.
   A. _________________________________________________________
      _________________________________________________________
   B. _________________________________________________________
      _________________________________________________________

Directions: Circle the term in parentheses that makes each statement correct.

4. New seafloor crust is forming at (the abyssal plain/mid-ocean ridges).

5. Ocean depth is measured from (the high tide line/sea level) to the ocean floor.

6. The flat seafloor in the deep ocean is called the (abyssal plain/continental shelf).

7. At (mid-ocean ridges/deep ocean trenches), tectonic plates are recycled into Earth’s interior.

8. (Sea level/The ocean floor) is Earth’s surface underneath the ocean water.
**Reinforcement Ocean Currents**

**Directions:** Find the mistakes in the statements below. Rewrite each statement correctly.

1. Trade winds function like rivers in transporting heat, nutrients, animals, and plants.

2. It takes twice as much heat to change the temperature of an area of land as it does to change the same area of water.

3. Most currents carry cold water from the poles to the tropics.

4. Surface currents are generally created by differences in density.

5. Cool or very salty water is less dense than warm or less salty water.

6. Warm water sinks to the bottom of the ocean, creating deep ocean currents.

7. Ocean currents tend to move in a counter-clockwise direction in the northern hemisphere and in a clockwise direction in the southern hemisphere.

8. There are four major gyres, or cycles of salinity, in Earth’s oceans.
Reinforcement  The Ocean Shore

Directions: For each item, write every other letter, beginning with the first letter, on line A. Next, beginning with the second letter, write every other letter on line B. Add spaces between words on line A and B. Then, on line C, write an explanation of the relationship between the terms on lines A and B.

   A. 
   B. 
   C. 

2. S B E E D A I C M H E E N S T
   A. 
   B. 
   C. 

   A. 
   B. 
   C. 

Directions: Answer each question or respond to each statement in complete sentences.

4. Name two artificial structures built to stabilize beaches, and describe their unintended effects.

   ____________________________________________________________

5. Why should you avoid swimming near rip currents?

   ____________________________________________________________

6. What types of minerals and rocks make up a white sand beach?

   ____________________________________________________________
Living on the California Coast

Directions: Answer each question or respond to each statement in complete sentences.

1. How were the coastal mountains of California created?

2. Why is the California coast at risk from tsunamis?

3. What is the relationship between the California Current and hurricanes in California?

4. Why are there large numbers of animal species in the Channel Islands?

5. In your own words, explain what a habitat is and of what it consists.

6. Describe a habitat near your own home and list some of the species that live there.

7. Define the word marine, and name three marine mammals.

8. What do California’s fisheries contain, and why must they be carefully managed?
Enrichment Finding Ocean Depth

When oceanographers use echosounding, they know how fast sound waves travel in water. Therefore, they know how far the waves travel during their round trip to the ocean’s floor and back to the surface. Half this distance is the depth of the ocean at that spot. The formula to find the ocean floor depth is

\[ D = \frac{v}{2t} \times v \]

In the formula, \( D \) stands for depth, \( t \) for time between sending and receiving, and \( v \) for the speed of sound in water. The speed of sound in water is 1,454 m/s.

The table below gives you some sonar sounding data. Calculate the ocean floor depth for each sounding. Then plot these depths on the graph below. Smoothly connect the points and you will have a cross-sectional map of the south Atlantic Ocean floor. (Note: These data are approximations.) Use the space below the tables for your calculations.

<table>
<thead>
<tr>
<th>Station</th>
<th>Time for Signal to Return (s)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.0</td>
<td>1.</td>
</tr>
<tr>
<td>2</td>
<td>5.2</td>
<td>2.</td>
</tr>
<tr>
<td>3</td>
<td>4.0</td>
<td>3.</td>
</tr>
<tr>
<td>4</td>
<td>2.4</td>
<td>4.</td>
</tr>
<tr>
<td>5</td>
<td>3.2</td>
<td>5.</td>
</tr>
</tbody>
</table>

Directions: Respond to each question or statement below.

6. Compare and contrast ocean depth at the station where the ocean is deepest and at the station where it is the most shallow. Find the difference in depths.

7. Conclude What type of ocean floor feature is evident in the cross-sectional map?

8. Speculate as to why it might be useful to have a map of the ocean floor.
Enrichment  Fishing in the Grand Banks

The Grand Banks region includes more than 350,000 km² of shallow ocean water above the continental shelf off the southeast coast of Newfoundland, Canada. Fish thrive there because the waters are a rich source of plankton—the tiny algae and animals that drift in the ocean currents. Plankton thrive in the Grand Banks because the water is shallow, and it mixes as the cold Labrador Current mingles with the warmer Gulf Stream. Commercially valuable fish include cod, flounder, haddock, herring, and redfish.

Recovery
In 1977, Canada claimed authority over all fishing as far as 370 km from its coastline. This included most of the Grand Banks. All fishing vessels, Canadian and foreign, must have a license to fish in these waters. Canada also restricted how many of certain types of fish can be caught. For example, in 1992 the Canadian government banned all cod fishing and reduced the number of other fish that could be caught. In April 2003, the moratorium on cod fishing was replaced by an outright closure of the cod fishery in the Grand Banks.

The Fishing World
Fishing off the Grand Banks attracted fishing fleets from Europe as early as the 1500s. Over the years, large numbers of commercial fishing fleets came to the Grand Banks to fish. Fleets came from countries including England, France, Portugal, Spain, the Soviet Union, and the United States, as well as from Canada. By the 1960s, over-fishing had reduced the number of fish in the area significantly. So many fish were being removed that the total population dropped greatly.

Directions: Respond to each statement or question below as instructed.
1. Infer why the Grand Banks is such a productive area for fish and other living things.

2. Speculate about what might happen to the fish population if the pattern of deep currents changed.

3. Assess Canada’s efforts to increase the population of fish in the Grand Banks. What is the country doing, and do you agree with its policy? Explain. Write your answer on a separate sheet of paper.

4. Gauge the effect on the United States of closing the cod fishery in the Grand Banks. Write your answer on a separate sheet of paper.
The Natural Bridges at Santa Cruz, California

Natural Bridges State Park in Santa Cruz, California, provides an excellent example of the formation and erosion of the shoreline features called sea arches and sea stacks. The rock out of which these formations are carved is a sedimentary deposit known as the Santa Cruz mudstone, dating from 26 to 27 million years ago. This coastal area was once underwater and formed the outer continental shelf and upper continental slope. The properties of the rock make it both fairly hard and highly fractured with faults and cracks. The mudstone was also deposited at different times, so that there are differences in composition from layer to layer. These differences affect erosion rates.

**Sea Arches**

In a coastline with alternating bands of hard and soft rock, such as that at Santa Cruz, wave action causes fragmented rather than homogeneous erosion. Instead of a smooth coastline, a series of headlands and bays is formed. As waves enter the shallow waters of the bays, the wave fronts tend to bend back away from the shore. Most of the wave energy gets absorbed by the headland. If there are any zones of weakness, such as faults, in the headland, the waves begin to wear back-to-back holes, forming sea caves.

The continuous wave action eventually erodes the back-to-back caves until they meet, and a natural tunnel is produced. The top of this tunnel becomes an arch, extending from the headland to the mainland. At Natural Bridges State Park, three such caves formed in a single headland, creating three linked bridges.

**Sea Stacks**

As the wave action continues to erode the bedrock, the opening under the sea arch eventually expands so much that the arch can no longer support the weight of the overhanging rock. When this happens, the bridge collapses and a single pillar is left standing in the open sea. This type of offshore rock is known as a sea stack.

At Natural Bridges State Park, two of the three original sea arches have collapsed in this way, leaving only one arch and several stacks. What makes the park unique is that it provides geologists with a natural model of the cycle of sea arches and stacks. Here, one can observe the cycle of sea arch formation, life, and collapse into remaining sea stacks. In time, erosion will reduce the sea stacks to stumps, which will eventually be reclaimed by the sea.

**Directions:** Respond to each statement below.

1. **Analyze** and describe the conditions necessary for the formation of sea arches and sea stacks.

2. **Infer** where else on North America’s coast you might find sea arches and stacks.

3. **Illustrate** the stages of sea arch formation and decline, including the formation of headlands and bays, sea caves, sea arches, and sea stacks. Use a separate sheet of paper and label your drawings.
Enrichment  California’s Killer Tsunami

Crescent City, on the Northern California coast, has the distinction of being the only town in the continental United States where a tsunami has taken human life. This waterfront town of about 7,500 residents was swept by gigantic waves on March 28, 1964. The waves were caused by an earthquake in Alaska the previous afternoon. Its epicenter was beneath Prince William Sound.

More than 100 people died in the quake, which affected Anchorage and other Alaskan cities, but the destruction spread even wider. Waves were sent rippling down the Pacific coasts of Canada and the United States.

Warning

The town’s civil defense department had been warned that earthquake-generated waves were on the way, but this type of threat was nothing new. Crescent City had endured many tsunami watches and evacuations in the past. Because of Crescent City’s location on the coast and the angle at which it faces the ocean, the topography of the ocean floor is capable of steering waves toward its shoreline and concentrating their force. But no previous threat had ever developed into anything dangerous.

Devastation

The first wave, a relatively small one, struck just after midnight. Soon afterward, a wave more than 6 m high came crashing into the harbor. The tsunami destroyed the town’s business district and piled the ruins of automobiles, buildings, and other debris in heaps. Eleven people were killed.

Tsunami Warning Centers

Thanks to tsunami warning centers in Alaska and Hawaii, people often have time to relocate inland to higher ground, avoiding the brunt of tsunami waves. The residents of Crescent City now take such warnings seriously. If a warning system had been in place in the Indian Ocean before its catastrophic tsunami in 2005, thousands of lives might have been saved.

Directions: Respond to each statement or question below.

1. Deduce and explain why certain coastal towns are more vulnerable to tsunamis than others. Find Crescent City on a map and compare its location to other towns and cities on the Pacific Coast.

2. Find out more about tsunami warning centers. Where are they located, and what technologies do they use to detect and warn of potential tsunamis? Use your library.

3. Develop a tsunami response plan for a coastal town vulnerable to tsunamis. Consider how you would communicate warnings, circulate information, protect buildings and other structures, and organize evacuations. Write your answer on a separate sheet of paper.
Content Vocabulary

Directions: Fill in the terms across and down that match the numbered clues.

Across
1. amount of salt dissolved in water
2. cycle of currents
4. rocks between 0.0625 mm and 2 mm
5. place where an organism lives
6. land between low and high tide lines
7. word describing anything related to the ocean

Down
1. place where ocean meets land
3. area in which sediment is deposited
4. sea’s surface halfway between low and high tides
Content Vocabulary CONTINUED

Directions: For each term, write a sentence that demonstrates your knowledge of its meaning.

8. ocean floor

9. bathymetric map

10. ocean current

11. longshore current

12. longshore drift

13. rip current

14. California Current

15. Davidson Current

16. continental shelf

17. echosounding
Part A. Vocabulary Review

**Directions:** Write the name of the correct ocean current for each definition below.

**California Current** | **Davidson Current** | **longshore current** | **rip current**
---|---|---|---
1. a warm current flowing north from the tropics _______________________________________
2. a swift current that flows away from the beach _______________________________________
3. a narrow current that runs parallel to the shore _______________________________________
4. a cold current flowing south from the northern latitudes ______________________________

**Directions:** Define each term in the pairs below in a way that describes the relationship between them.

5. sea level, ocean floor
   ________________________________________________________________
   ________________________________________________________________

6. ocean current, gyre
   ________________________________________________________________
   ________________________________________________________________

7. bathymetric map, echosounding
   ________________________________________________________________
   ________________________________________________________________

8. shore, beach
   ________________________________________________________________
   ________________________________________________________________
Part B. Concept Review

Directions: Categorize the types of ocean floor features shown in the diagram by writing the term from the list below next to the correct number.

abyssal plain  continental shelf  continental slope
mid-ocean ridge  trench

1. __________________  2. __________________  3. __________________  4. __________________  5. __________________

Directions: Respond to each statement or question using complete sentences.

6. Compare and contrast the causes and effects of El Niño and La Niña.

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

7. Imagine if the Gulf Stream were to change direction or weaken. How would this affect the distribution of heat on Earth?

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

8. Infer why different beaches have different types of sand.

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

9. Speculate about how humans can change marine habitats.

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
Lesson 1: Earth’s Oceans

A. Mapping the _______________ is important to understanding Earth’s features.

1. Earth has five oceans: the Pacific, Atlantic, Indian, _______________, and Southern Oceans.

2. ________________ maps show the contours of the ocean floor and its geologic features.
   a. The depth of water is measured from ________________ to the ocean floor.
   b. Sea level is the level of the sea’s surface ________________ between high and low tides.
   c. The ocean floor is Earth’s surface ________________ the ocean water.
   d. Before modern technology, a method called ________________, which involved letting out a length of rope until it hit the ocean bottom, was used to measure depth.
   e. A bathymetric ________________ could be created by compiling a large number of soundings.

3. ________________ is a modern method of measuring depth using sound waves.
   a. Scientists measure the length of time it takes a ________________ to bounce off the ocean floor and return to the ship.
   b. Satellites use ________________ and light waves to detect bumps and dips in the ocean’s surface that reflect mountains and trenches on the ocean floor.

B. A bathymetric ________________ is a cross-section of the ocean showing its geologic features.

1. A ________________ is a shallow area offshore near the edge of a continent.

2. A continental ________________ is the steep slope between the continent and the deep ocean.

3. An ________________ is the flat area of the ocean floor beyond the continental slope.

4. Deep ocean ________________ are extremely deep underwater valleys.
   a. The deepest point in the ocean is 11,033 m below sea level in the ________________ Trench.
b. Ocean trenches are places where tectonic plates are ________________ into Earth’s interior.

5. ________________ are a continuous chain of underwater volcanoes where ________________ are moving away from each other and new seafloor is being created.

Lesson 2: Ocean Currents
A. Ocean water moves from place to place in ________________.

1. Like ________________, ocean currents transport water, heat, nutrients, and animals and plants.

2. A large amount of heat can be added to or removed from water before it changes ________________.
   a. It takes ________________ times more heat to change the temperature of an area of water than it does to change the same area of land.

3. Ocean currents redistribute ________________ around the planet.
   a. Heat is ________________ between 30ºN and 30ºS latitudes; heat is ________________ at latitudes above 40º.
   b. In general, ocean currents carry heat from the ________________ to the poles.

4. ________________ have the strongest effect on location and movement of surface currents.

5. The ________________, produced by Earth’s spinning, causes ocean currents to move ________________ in the northern hemisphere and ________________ in the southern hemisphere.

6. Deep ocean currents are driven by differences in the ________________ of water.
   a. ________________ is the amount of salt dissolved in water.
   b. Cooler, high-salinity water is ________________ dense than warmer, low-salinity water.
   c. Denser water ________________, flowing across the ocean floor and causing deep ocean currents.

7. Five major ________________, or cycles of currents, circulate in Earth’s oceans.
Chapter **Outline** CONTINUED

a. The North Atlantic and North Pacific Gyres rotate in a ____________________________ direction.

b. The South Atlantic, South Pacific, and Indian Ocean Gyres rotate ___________________.

8. The __________________________ and deepest currents are found on the western sides of the gyres.

   a. The __________________________ is the largest western boundary current, transporting heat from the equator to the poles.

   b. The __________________________ Current, the largest ocean current, moves clockwise around Antarctica, connecting the Pacific, Atlantic, and Indian Oceans.

9. __________________________ winds cause the El Niño and La Niña effects.

   a. The __________________________ effect occurs when trade winds stop driving the South Equatorial Current, causing warm water to slosh back across the ocean.

   b. The __________________________ effect occurs when the trade winds resume with great strength, pulling warm water across the Pacific toward Australia.

**Lesson 3: The Ocean Shore**

A. The __________________________ is the area of land between the low and high tide lines.

1. The __________________________ is where the ocean meets the land; it constantly changes with the movement of the __________________________.

   a. A __________________________ is the area in which sediment is deposited.

   b. The size and composition of __________________________ depends on where it comes from.

2. Wind and waves constantly __________________________ the shoreline.

   a. Hard rocks, like granite and basalt, erode __________________________; soft rocks, like limestone and sandstone, wear away __________________________.

   b. Shoreline features such as __________________________ and sea stacks are created by erosion.

   c. Sediment eroded from one area is __________________________ in another where wave energy is low.

   d. Shoreline features such as baymouth bars and __________________________ are formed by deposition.
3. The processes of waves breaking on the beach at an ________________ and water running ________________ back to the ocean combine to move sand along the beach.
   a. The wave energy drives a narrow current, the ________________, parallel to shore.
   b. ________________ refers to the movement of sand both on the beach by breaking waves and in the longshore current.

4. ________________, in which water flows swiftly away from the beach, occur when the longshore current cannot move water along the beach fast enough.

5. People build artificial structures to try to ________________ beach areas.
   a. ________________, groins, and breakwaters extend from the beach out to the water.
   b. ________________ are built on land parallel to the shore.
   c. Structures that ________________ sediment stop longshore drift, depleting beaches down the coast.
   d. Seawalls ________________ wave energy, causing erosion on either side and underneath the structure.

B. ________________ is the term for rocks between 0.0625 mm and 2 mm.
   1. Sand can be ________________ as very coarse, coarse, medium, fine, and very fine.
   2. Sand is created as ________________ breaks boulders into smaller rocks, rain washes small rocks into rivers, and currents ________________ smaller fragments of rocks to beaches.

   3. The color of sand reflects its origins and mineral ________________.
      a. White sand can be ________________ or calcium carbonate from shells or ground-up coral; ________________ sand can be basalt, mica, or magnetite.
      b. Green sand can be ________________, pink or white sand can be ________________, and red sand can be from coral or ________________. 
4. Sand is continuously ________________ by the size of its grains by erosion, transportation, and deposition.
   a. Smaller grains of sand end up on beaches with ________________ waves.
   b. Larger grains of sand end up on beaches with ________________ waves.

Lesson 4: Living on the California Coast

A. California’s coastal ________________ is based on the movement of tectonic plates.
   1. The coastal mountains in Northern and Southern California were formed by the ________________ of the North American and Pacific Plates.
   2. The mountains in ________________ California were formed when the two plates changed direction and started slipping past one another about 30 million years ago.
   3. Most of California’s beaches are ________________, because few offshore islands protect them and ________________ waves leave large boulders and cobbles on the shoreline.
   4. California is at risk for ________________ because of tectonic activity in the Pacific Ocean.
      a. Tsunamis are caused by anything that displaces large amounts of water, including undersea ________________.
      b. Water displacement creates enormous ________________, which hit the shoreline like a fast, strong high tide.
      c. A sudden rise or ________________ in sea level is a warning of an approaching tsunami.

B. Two major ________________ influence the California coast.
   1. The ________________ is a wide, slow-moving current carrying cold water from the northern latitudes.
   2. The ________________ is a narrow, warm-water current flowing north from the tropics.
   3. The two currents ________________ near Point Conception, just north of Los Angeles.
Chapter Outline CONTINUED

a. At Point Conception, the Davidson Current pushes the California Current __________________.

b. The Davidson Current turns __________________, becoming a small gyre.

4. California has no __________________ because the California Current acts as a shield of cold water; hurricanes get their __________________ from warm tropical waters.

5. A __________________ is the place in which an organism lives.

   a. Critical elements of a habitat include food, shelter, moisture, and __________________ ranges.

   b. Ocean areas where warm and cold waters come __________________ are usually full of life.

   c. The __________________ Davidson Current and __________________ California Current meet at the Channel Islands.

   d. The Channel Islands are home to a wide variety of __________________ animals and plants.

   e. The habitat on the rocky shore between the low and high tide lines is called the __________________ zone.

C. Humans use __________________ areas for a variety of activities.

1. California __________________ contain herring, squid, sea urchin, sea bass and kelp.

   a. Fisheries are managed by laws to protect organisms from becoming threatened or __________________.

2. Human activities can change __________________.

   a. Between 1858 and 1983, more than 80 percent of San Francisco Bay’s __________________ area was developed.

   b. __________________ efforts have helped declining populations of organisms.