



THE OCEAN BOOK Study Guide

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INTRODUCTION

Summary

In the beginning God created the heavens and the earth (Genesis 1:1), and the word water appears ten times in this first chapter of God's history book.

Part of God's design for man's use of the oceans includes their protection, provision, and power. Man has an obligation to understand marine environments in order to exercise good stewardship of their resources, yet the oceans still remain a vast and fascinating frontier.

Terms to Know and Spell

Locations of the various oceans and seas

Fill in the blanks or answer the questions.

1. The oceans cover ____% of the earth's surface area and contain ____% of all the surface water on the planet.
2. How do the oceans protect the earth?
3. How do the oceans provide both food and oxygen for mankind?
4. What are some of the sources of power in the ocean?
5. About how much of the current production of oil and petroleum comes from the ocean?
6. The oceans have been used throughout history as a means of _____; this is one of the reasons that three-fourths of the American population lives within _____ miles of a seacoast.
7. List what contributes to the color variations of seawater:
blue
yellow
green
brown

Discussion Questions

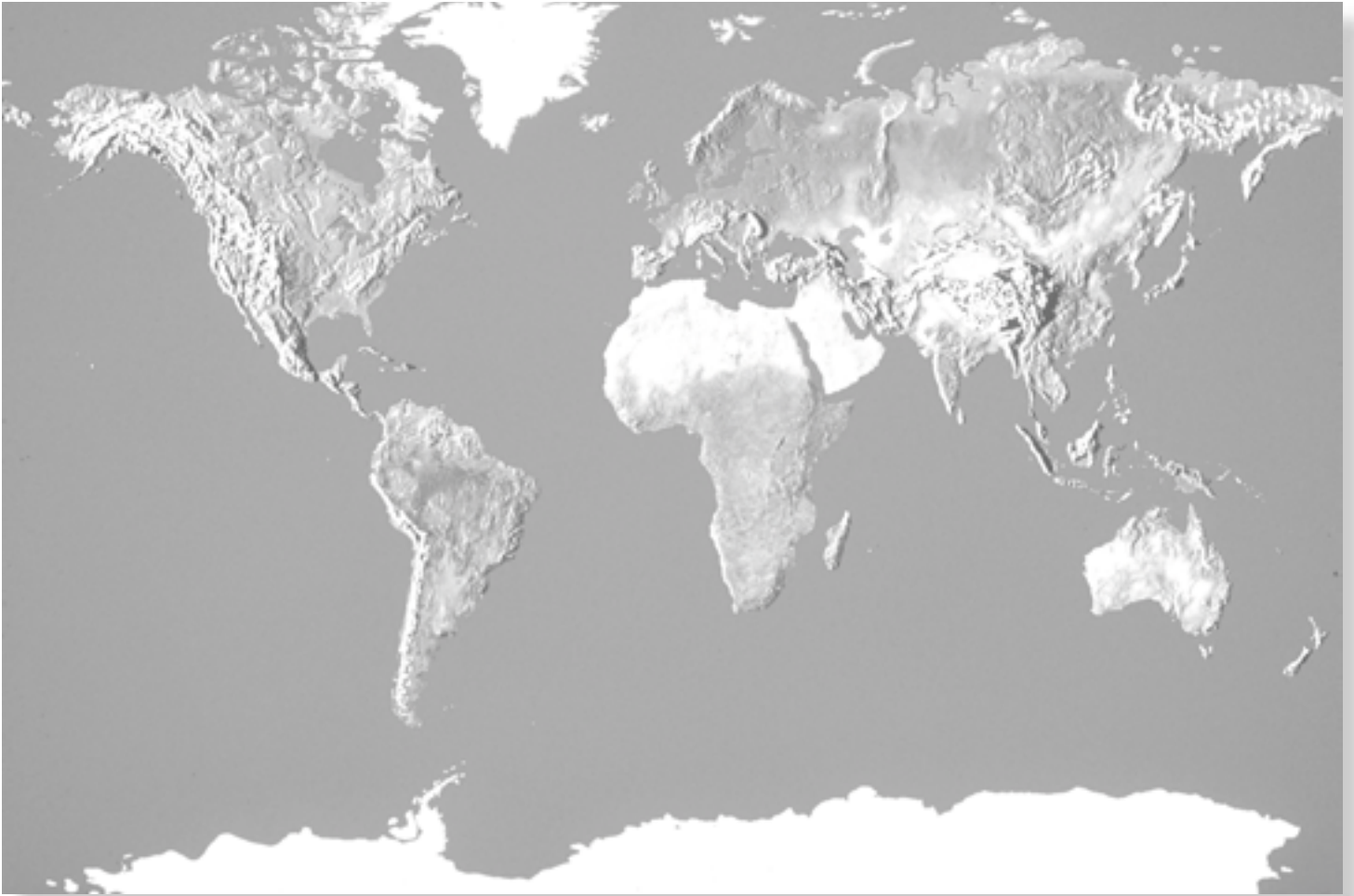
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- a. The questions may be answered on a sheet of paper as essay questions.
 - b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.
 - c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.
1. How might life on earth be different if the oceans were larger or smaller than they are now?
 2. Why should we care about what lives in the oceans when we can only live on land?
 3. Should one country have a say in how another country cares for its neighboring marine habitats? Give examples to explain your answer.

Activities Together

1. On a blank map of the world, label: (*See map on page 5*)

Arctic Ocean
Atlantic Ocean
Indian Ocean
Pacific Ocean
Arabian Sea
Bay of Bengal
Bering Sea
Caribbean Sea
Coral Sea
East China Sea
Greenland Sea
Great Barrier Reef
Gulf of Mexico
Labrador Sea
Mediterranean Sea
North Sea
Norwegian Sea
Philippine Sea
Red Sea
Scotia Sea
Sea of Japan
Sea of Okhotsk
South China Sea
Weddell Sea



(Activity map key at the end of the book)

2. Memorize and recite Genesis 1:1–9.

Projects to Do on Your Own

Memorize Bible verses that tell how God reveals himself in His creation. Some verses to start with: Romans 1:20, Colossians 1:16–17, Hebrews 1:3.

Do an Internet research project on the appearance of seawater along the coasts of various continents. (Beach resort cities might be the most fun to research, or you can begin with areas along the bodies of water listed above.) Prepare an electronic spreadsheet and categorize your data according to color, temperature, latitude, and physical features of the neighboring coastline or island. Post a photo in a separate electronic album or notebook. Search for similarities or differences among the data and record your observations and conclusions in summary statements. Share your research with your family or study group.

CHAPTER 1 — RESEARCH AND THE DEEP OCEANS

Summary

Although man has embarked on seafaring adventures for thousands of years, relatively little is known about the vastness of the oceans and their resources. In 1872, the HMS Challenger was the first oceanographic research vessel. However, more oceanographic research has been done since 1950 than in all of the years of history prior to that date. Scientists, politicians, and the general populace work to decide on the best use of marine resources.

Terms to Know and Spell

ability to transmit sound and light

acidity of sea water

air-sea interaction

animal and plant life

biological oceanography

chemical and physical changes

chemical composition of sea water

chemical cycles

chemical oceanography

currents

density

food webs

interaction of life with its surroundings

marine geology and geophysics

nature of dissolved gases and solids

oceanic sediments and rocks

physical oceanography

properties of magnetism, gravity, electricity, heat flow, and seismic methods

sea ice

temperature

tides

waves

Answer the following questions in complete sentences.

1. What are the four major branches of oceanography, and how are they differentiated?
2. Name seven human endeavors that benefit from knowledge of oceanography.

3. How was the Challenger expedition able to disprove Professor Edward Forbes's theory?
4. Name two other discoveries made by the Challenger.
5. What is a seismic profile?
6. In what ways have exploration methods changed since the 1990s?

Discussion Questions

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- a. The questions may be answered on a sheet of paper as essay questions.
 - b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.
 - c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.
1. Compare the attitudes of Earth's citizens toward the ocean 50 to 100 years ago with attitudes in the 21st century.
 2. Discuss the human endeavors that benefit from knowledge of oceanography in greater depth. (Leader should draw a connection between this discussion and Introduction.)

Activities Together

1. Memorize and recite Psalm 107:23–31.
2. Prepare an outline as shown:
 - I. Branches of Oceanography
 - A.
 - 1.
 - 2.
 - 3.
 - 4.
 - B.
 - 1.
 - 2.
 - 3.
 - 4.

- 5.
- 6.
- 7.
- 8.

C.

- 1.
- 2.
- 3.
- 4.

D.

- 1.
- 2.

Complete the outline, using the letters to represent the four branches of oceanography listed in the terms above, and the numbers to categorize the sub-topics for each.

Projects to Do on Your Own

Rewrite Psalm 107:23–31, paraphrased in your own words.

Choose one branch of oceanography that interests you. Do 1–3 hours of research on the subject and jot down some notes. Turn in a one-page reflection on what you learned to your supervisor, or discuss the principles with family or classmates.

CHAPTER 2 — PHYSICAL CHARACTERISTICS OF THE OCEAN

Summary

Without its covering of water and all of its inhabitants, the land formations of the ocean would present themselves with features as fascinating as any seen on the continents themselves. Underwater mountains and valleys are both higher and deeper than any known on the continents, and each geographic area is unique in terms of its formation and ecology.

Terms to Know and Spell

abyssal plain
beach
brackish water
coast
continental margin
estuary
harbor
hydrothermal vent

inlet
lagoon
oceanic ridges
salinity
salt marsh
shoreline
subduction
trench

Short Answer

On a separate paper, write answers for the directions or questions below.

1. What are five major geo-physical features of the ocean? (Choose your answers from the list above.)
2. Define and/or illustrate the other terms listed above.
3. Explain what forces cause coastlines to differ in appearance.
4. What difference(s) exist between a fjord and a lagoon?
5. What are the parts of the continental margin?
6. Trenches, oceanic ridges, and hydrothermal vents are all part of the _____ .
7. Contrast trenches with oceanic ridges.
8. Describe the compound word “hydrothermal” in terms of its parts, and tell how these combine to define the term.
9. Compare the temperature of water from a hydrothermal vent to the temperature of the water boiling in a pan on the stove.
10. Describe three creatures that thrive near hydrothermal vents.

Discussion Questions

The following approaches may be used for answering the questions below:

- a. The questions may be answered on a sheet of paper as essay questions.

- b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.
 - c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.
1. Describe guyots and seamounts in terms of their appearance. How or why is each one thus shaped?
 2. What formed the trenches in the ocean floor?
 3. Tell how the geological activity in Iceland or the hostile environments of deep-sea hydrothermal vents can be used to support the theory of special creation.
 4. What principles should town councils and residents in eastern America's coastal cities consider in constructing edifices along the coast?

Activities Together

1. This chapter is full of fascinating trivia. Divide into groups of 2–3, and copy interesting statements, leaving out a key word. Conduct a “sea bee,” much like a spelling bee, and see who can remember the most information.
2. Discuss what physical features or forces cause coastlines to differ in appearance.
3. Gather information from news media or the Internet about beach cities affected by erosion or suddenly changing coastlines.
4. Study the Pacific Ocean on a globe to locate the island arcs and other formations described on p. 14b.

Projects to Do on Your Own

1. Use paper mache, play dough, or modeling clay to construct a model showing the five major physical characteristics of the ocean floor. When dry, label each of the features with a letter (A–E). On a sheet of paper, make a key to your model which names each of your features and gives a brief description of each.

2. Research and find out if Juan de Fuca Strait, which lies between the Olympic peninsula of Washington State and Vancouver Island, British Columbia, Canada, is formed by the Juan de Fuca Ridge.

Chapter 3 COMPOSITION OF THE OCEAN'S WATERS

Summary

“Water, water, everywhere, and not a drop to drink!” This chapter discusses the chemical elements in seawater — mainly salt — and their importance in history and commerce. Frozen freshwater masses, known as icebergs, loom in formidable shapes and are studied and charted from safe distances.

Terms to Know and Spell

commodity

dehydration

desalination plant

pinnacle iceberg

salinity

tabular iceberg

Fill in the blanks or answer the questions below.

1. What are the most common elements of seawater?
2. Since every 1,000 grams of ocean water contains 35 grams of salt, what percentage of seawater is salt?
3. Where does the salt in seawater come from?
4. Why is it dangerous for humans to drink seawater?
5. Why is seawater not of uniform salinity all over the world?
6. What is an iceberg?
7. Only ____% of an iceberg can be seen above water; ____% of its bulk threatens because it is hidden below.
8. Most pinnacle icebergs are formed in the _____. Tabular icebergs break off ice sheets formed near the _____.

9. Why is April 14–15, 1912, considered as one of the most disastrous events in maritime history?

Discussion Questions

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- c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.

1. Define and review each of the terms above.
2. Discuss how the answer to #8 above helps to explain what caused the Titanic tragedy.
3. Consider why salt was such an important commodity in history. Then consider Jesus' words in Matthew 5:13. Why do you think Christ compared His followers to salt?

Activities Together

1. Memorize and recite Matthew 5:13.
2. Use an etymological (word origins) dictionary to find the origin of the word "salary." What did you learn about the importance of salt throughout history that would explain what the words "not worth his salt" or "salary" means in today's culture.
3. Float an ice cube in a clear glass or measuring cup. Using a centimeter ruler, measure how much of the ice cube protrudes above the water's surface and how much extends below. Compare your data to the 10%/90% ratio of icebergs. Would you expect results to be the same? Why or why not?

Projects to Do on Your Own

1. Try rubbing a small piece of raw meat with a lot of salt. Will this simple procedure allow the meat to dry without rotting?

2. Research how submarines and aircraft carrier crews are able to furnish a large number of soldiers with fresh water, while they are at sea for extended periods. Construct a model of a desalination plant, or experiment with a simplified evaporation system.
3. Do research to locate the various “salt flats” of the world. Which countries produce and/or export the most salt?
4. Find out which oceans are the least salty and the most salty.

CHAPTER 4: TIDES, WAVES, AND CURRENTS

Summary

The powerful forces of the restless waves fascinate many an observer. Sailors have learned to judge the periodic tides which are governed by gravitational forces between the sun, earth, and moon. Tsunamis are devastating waves formed by submarine geologic activity. Oceanic currents both benefit transportation and explain global climactic conditions.

Terms to Know and Spell

centripetal acceleration

Coriolis effect

current

diurnal/semidiurnal

gravitational pull

gyre

landmass

neap

neap tide

nutrient upswelling

oscillate

quadrature

revolve/revolution

riptide

spring tide

surf

syzygy

tide

tsunami

undertow

wave

Fill in the Blanks and Short Answer

1. The rising and falling of the level of the ocean near a shore is called the _____.
2. What affects the amount of surf along a coastline?
3. The force of gravity can be described as the measurable and descriptive function of the mass of the objects involved and _____.
4. Who was the first scientist to apply the law of gravitational forces to the predictable nature of the tides?
5. Syzygy occurs when the sun, moon, and earth all line up in a row, which results in very high or very low _____ tides.
6. When the positions of the sun, moon, and earth form a ninety-degree angle, _____ tides occur. This _____ causes the lowest _____ and the _____.
7. _____ - _____ tides form two high tides and two low tides each day.
8. Most waves are formed by _____.
9. What factors influence the amount of surf along a beach on a particular day?
10. A _____, or tidal wave, is a devastating, giant-sized wave caused by _____.
11. What do the red or blue arrows on a map of ocean currents mean?
12. What are the most famous ocean currents for North and South Americans?

Discussion Questions

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- c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.

1. Why is it important that seafarers be aware of the tides?
2. What kind of person is compared to waves? Read James 1:5–8 and discuss its implications.
3. Role-play tides, currents, quadrature, and syzygy. Choose one student to “stir” invisible water up and down in a vertical circle. Position another student nearby who will stir the water around and around in horizontal fashion. Select two more students to act the part of the sun and the moon and position them in alignment or at 90-degree angles to the “currents.” The currents should lean closer to the moon and the sun as directed, to model the gravitational effects on the tides.

Activities Together

1. Memorize and recite James 1:5–8.
2. Locate “no tide” Tahiti and the infamous high-tide Bay of Fundy on a map or globe. Have various students discuss their personal (humorous) experiences with tides or surf.
3. Define each of the terms listed above.
4. Divide the class into 3 groups: the waves, the tides, and the currents. Have students write questions or true/false trivia statements pertaining to their subject area. Conduct a “sea-bee,” much like a spelling bee, or “whirl-pool” like a knowledge bowl, and see who can remember the most information. Celebrate the success of the winner by doing a group “wave” cheer.

Projects to Do on Your Own

1. Research the life and writings of Sir Isaac Newton. Find out if he was a creation scientist because it was the fashion of the day, because scientific observation supported his conclusions, or because of some other matter.
2. Construct an artificial beach with clay, sand, and water in a large pan and experiment with the force and motion of waves.
3. Study the diagram and explanation of the tides on page 24. Gather balls of various sizes, and use them to symbolize the gravitational forces on the tides at the various positions. If possible, use a digital camera to record the sequence. Share the images with classmate(s) as you describe the tidal terminology.

CHAPTER 5: WEATHER

Summary

The oceans control all large weather patterns on Earth because they collect, store, and release heat. The Coriolis effect determines the direction of the world's major weather patterns. Both winds and ocean currents are deflected to the left or the right, depending upon the hemisphere and relative latitude. It also accounts for major disturbances in weather. From tropical depression, to tropical storm, to classification as a typhoon or hurricane, meteorologists study the changing conditions and try to warn residents of the path of the storm and subsequent storm surge. Most of the earth's rainfall comes from storms spawned at sea, and coastal climates are also affected by warming or cooling temperatures of nearby air or water currents.

Terms to Know and Spell

Coriolis effect
density
depression
El Niño
eye of a hurricane
hurricane
hypothermia
La Niña
meteorology, meteorological
storm surge
thermocline
tropical storm

Fill in the Blanks and Short Answer

Fill in each blank in the sentences below, or answer the question with a complete sentence.

1. Devastating Hurricane Andrew pummeled _____ with winds gusting up to 177 mph in August 1992.
2. _____ is a warm water current which appears around Christmastime off the coast of Peru.
3. List two to four effects of El Niño.

4. _____ is a seasonal cold-water current that keeps photo plankton from growing, and many marine creatures starve due to a lack of nutrients.
5. At the equator, the earth turns at a rate of approximately _____ mph.
6. Since the earth spins to the _____, waters tend to accumulate at the _____ shores of the continents.
7. An area of warm air with low pressure over a large body of water is called a _____.
8. A tropical depression with winds greater than 50 mph is called a _____.
9. A hurricane is rated as a category 1 to 4 storm based on its _____.
10. A hurricane in the Indian Ocean is called a _____.
11. A hurricane in the South China Sea is called a _____.
12. Due to the Coriolis effect, hurricane winds spin (clockwise/counterclockwise) in the Northern Hemisphere and (clockwise/counterclockwise) in the Southern Hemisphere.
13. Why do hurricanes become so strong in the open sea?
14. Out of about 50 tropical depressions, only ____ or ____ become hurricanes.
15. Water heats and cools more _____ than land does.
16. The _____ is an area of increasingly cold water that reaches from the surface zone down to about half a mile below sea level.

Discussion Questions

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- c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.

1. Reread the section on the Coriolis effect (page 36), and ocean currents (pages 27–30). Then read historical accounts of the age of explorers, circa 1450–1850. Discuss how the two scientific principles may have affected human history.
2. Compare and contrast the times, locations, causes, and effects of El Nino and La Nina weather phenomena.
3. If a hurricane carries 100+mph winds, why does it only travel 25–35 miles per hour, unlike a tornado which gives almost no “escape” time?
4. Ask students who have weathered a hurricane to retell their experiences. Then conduct a discussion as to what various people’s responses should be toward preparedness and cleanup. (i.e., a home builder, a property owner, a parent, a businessman, a law enforcement officer, etc.)

Activities Together

1. Memorize and recite Matthew 7:24–27.
2. Prepare a small hurricane pinwheel and label it with the name and date of the most devastating hurricanes of the last century. Plot the pinwheels on a map to show where major hurricanes have struck coastlines on North America or Asia.

Projects to Do on Your Own

1. Obtain and study a week-long series of weather maps or satellite photos. Find high-pressure areas and low-pressure areas. Does the air in the high-pressure area move directly to the low-pressure area? Why or why not?
2. If a hurricane is currently developing somewhere in the ocean, obtain several satellite photos that show its progression. See if you can predict its precise landfall before it is reported by newscasters.

CHAPTER 6: HARVESTING THE OCEAN

Summary

The world's oceans contain a plentiful food supply for both man and beast. Most visible of seafaring operations is the fishing industry. Fishing techniques include trapping, gill netting, long lining, and purse seining. International agreements must deal with the stewardship of marine resources, particularly overfishing and bykill. Meanwhile, aquaculture and mariculture produce shellfish, fish, seaweed, and other products for human consumption. While energy plants harness the ocean's movement to produce electric power, other resources, such as manganese, iron, natural gas, and oil are mined.

Terms to Know and Spell

shellfish

trawling

dredging

overfishing

bykill

Fill in the Blanks or Short Answer

1. Most of the ocean's living creatures are found in the upper ____ feet of the sea.
2. Name at least two different small, medium, and large fish and some shellfish harvested from the ocean.
3. What happens to caught fish that are not used for food?
4. How has modern equipment and technology helped fishermen?
5. What is overfishing and what does it mean?
6. What is an "aquaculture" farm, and what is produced there?
7. Name three of the most abundant "crops" from mariculture.
8. Put the following terms in order of their importance in producing energy from the ocean: tides, salinity, thermal gradients, currents, waves.
9. Although thermal gradients are capable of producing enormous amounts of energy, why aren't more power plants being built?

10. What nonliving resources are also harvested from the sea?

Discussion Questions

The following approaches may be used for answering the questions below:

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 - b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.
 - c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.
1. From 1950 to 1990, the world fish catch increased from 20 million tons to more than 90 million tons. Discuss whether or not this increase can continue, and the implications of overfishing. Should fishing restrictions be imposed and enforced? If so, by whom?
 2. What are some ways that overfishing can be prevented?
 3. Discuss the benefits and detractions of offshore oil or gas production.

Activities Together

1. Memorize and recite Luke 5:3–7a, the great draught of fish.
2. Form small groups to learn more about fishing techniques, such as dredging, drift netting, gill netting, longlining, purse seining, and trapping. Research the purpose, equipment, method, and product of the technique, as well as statistics on the amount of marine produce harvested (in tons). Share your data with the class.
3. Research and discuss the fishing production from the Grand Banks by decade over the last hundred years. How have changes in fishing affected the lives of area residents?

Projects to Do on Your Own

1. What kinds of fish or shellfish are sold at your local supermarket? Do research to determine how they are harvested and brought to market.
2. Learn more about how hydroelectricity is produced from tidal power.
3. Find out why manganese nodules are so valuable.

CHAPTER 7: MARINE LIFE

Summary

Intricately intertwined food webs are based on the concept of a food chain, with organisms such as diatoms, copepods, herring, and humpback whales each playing a part in God's plan for the marine world. The Creator's genius can be seen in the various classifications of plankton, algae, crustaceans, mollusks, aquatic mammals, and bony and cartilaginous fish, each fashioned for its particular habitat.

Terms to Know and Spell

algae
aquatic mammals
benthic zone
bioluminescence
bony fish
cartilaginous fish
cephalopod
crustacean
gastropod
horizontal zone
intertidal zone
kelp
midnight zone
mollusk
neritic zone
oceanic zone
pelagic zone
phytoplankton
plankton
red tide
sunlit zone
twilight zone
vertical zone
zooplankton

Short Answer

Use the facts you know, as well as simple reasoning, to answer the questions below. Refer to the terms in the list above for assistance.

1. Why do most living marine organisms inhabit the sunlit zone?
2. Why is an abundance of plankton so vital to marine biology?
3. What are the major differences between phytoplankton and zooplankton?
4. What is a kelp forest?
5. Name and describe the four kinds of marine algae.
6. Lobsters and spiders are both arthropods. What do lobsters have that spiders do not have?
7. How are fish classified?
8. What are chordates?
9. How might you tell which classification a certain fish may be, if you cannot see its skeleton?
10. Why does the natural behavior of barnacles irritate seamen?
11. Give an example of a food chain.
12. Compare a food chain to a food web.
13. Study the photo of the blackdevil anglerfish on page 55. What special designs did God give this creature to ensure its survival?

Discussion Questions

The following approaches may be used for answering the questions below:

- a. The questions may be answered on a sheet of paper as essay questions.
 - b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.
 - c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.
1. Although many more creatures inhabit warmer waters (phytoplankton), diatoms are abundant in coldwater regions. How could this be one of God's special provisions for Arctic or Antarctic ecosystems? Can your answer help to refute evolutionary theory?

2. How can a jawless fish eat if it has no jaws?
3. How are whales like fish?
4. What does the fossil record reveal concerning the origin of fish?

Activities Together

1. Make a mural with pictures of commonly harvested marine life.
2. Memorize and recite Genesis 1:20–22.
3. On a large map, label the various productive fishing areas of the world. If possible, list the types of fish harvested from each area and the fishing techniques employed.
4. If you live near the coast, plan a field trip to a tidal pool or aquarium or other marine park. If possible, have students touch the invertebrates found in a tidal pool.

Projects to Do on Your Own

1. Purchase, prepare, and taste some of the varieties of fish available for human consumption.
2. Read the labels on pet food and yard fertilizers to see if they contain marine products.
3. Some sharks look like bony fish. Research the swimming and “breathing” capabilities of sharks and bony fishes to discover identifying behaviors.
4. Do further reading on recent research concerning whale migration patterns and use of echolocation.

CHAPTER 8: EXPLORING THE CORAL REEF

Summary

Coral reefs are underwater equatorial limestone formations that, by nature, nurture a variety of tropical life forms due to plentiful sunlight and water temperatures above 70 degrees Fahrenheit. Three main types of coral reefs are atolls, such as in (Pacific) Micronesia; barrier reefs, such as in northeastern Australia; and fringing reefs, such as in the Hawaiian Islands. Coral reefs tend to grow by nature of living coral growing on top of skeletons of dead coral. Many coral reefs also have mangroves, a type of tree that flourishes in tidal flats and impedes shoreline erosion.

Terms to Know and Spell

atoll
barrier reef
coral bleaching
equatorial region
fringing reef
Great Barrier Reef
mangrove
polyp
shoal

Fill in the Blank or Short Answer

Use the facts you know, as well as simple reasoning, to answer the questions below. Refer to the terms in the list above for assistance.

1. Some of the marine invertebrates that inhabit a coral reef include _____.
2. Sinking underwater volcanoes formed _____ and _____ reefs.
3. Masses of dead coral skeletons harden and turn into _____.
4. A jellylike creature that will grow into a mature coral is called a _____.
5. An underwater extinct volcano sank, and the circle-shaped coral reef that encloses it is called a/n _____.
6. How did the Great Barrier Reef get its name?

Discussion Questions

The following approaches may be used for answering the questions below:

- a. The questions may be answered on a sheet of paper as essay questions.
- b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.
- c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.

1. Define each of the terms in the list above.
2. Tell how a coral polyp is like a plant and like an animal.
3. Give several examples to describe how particular characteristics of a mangrove tree helps tropical habitats to flourish.
4. Why are coral reefs dangerous to ships?
5. Tell how does the coral growth rate measured in 1997 helps to refute evolutionary uniformitarianism and support the special creation model of origins.

Activities Together

1. If you live near the coast, plan a field trip to a salt marsh, intertidal zone, or marine park; or have experienced students describe their experiences with snorkeling or diving in the sea.
2. If you live in a “land-locked” state, contact a local pet store to find the location of the nearest saltwater aquarium. If possible, obtain a specimen of a living coral or sea anemone for students to observe. An alternative would be to view a documentary on an underwater excursion at a coral reef.
3. There are many different kinds and colors of coral. Have groups or individual students study geographic regions to determine which areas sport various types of coral and pertinent reef formations. If possible, make a wall chart to compare and contrast the type of reef, type of coral, pattern of growth, and examples of other life supported by the coral reef. A good place to start is with popular tourism spots that advertise snorkeling or scuba diving.

Projects to Do on Your Own

1. Research your local library for more information about the types of fish that inhabit coral reefs. Where do they live? What do they eat? Why are they suited for living among coral?
2. “Surf” the Internet for photos and information about atolls, fringing reefs, and barrier reefs, as well as the forms of life dwelling there. Compile a scrapbook with pictures and captions. Include pertinent labels regarding geographic locations.
3. Plan a trip to a major aquarium or tropical reef. Popular tourist attractions include the Hawaiian Islands, Bermuda, and the Virgin Islands. Some major U.S. cities such as San Diego, San Francisco, Denver, Orlando, and New Orleans have marine parks or aquariums.

4. Further develop your computer technology skills to design a tri-fold travel brochure to a luxurious location near a coral reef. Include tantalizing descriptions and visuals of a snorkeling expedition to the reef.

CHAPTER 9: OCEANIC VESSELS

Summary

Much of what we know about the ocean is the product of research conducted on an oceanic research vessel. From the first unmanned submersible to today's grandiose submarines, we can see how complicated equipment can be utilized to furnish information about life underwater or on land. Some of the research vessels discussed in this chapter include the diving bell, bathysphere, bathyscaph, deep sea submersible (DSV), remotely operated vehicle (ROV), deep submergence research vessel (DSRV), and submarine.

Terms to Know and Spell

Archimedes principle
ballast
displace
diving plane
hull
mid-water drifter
oceanographic research ships
Polynesia
submersible

Fill in the Blank or Short Answer

Use the facts you know, as well as simple reasoning, to answer the questions below. Refer to the terms in the list above for assistance.

1. A _____ is any device that can successfully venture into the deep and return to the surface carrying information about the underwater world.
2. What kinds of equipment can be found on most submersibles?

3. Prepare a chart from a large sheet of butcher paper or newsprint that lists all of the submersibles named in the list of terms above. Then list the purpose or mission for each one and the particular equipment used. Tell whether it is manned or remotely operated. If possible, include a picture example of each.

diving bell
bathysphere
bathyscaph
DSV
ROV
DSRV
submarine

4. How does a bathysphere differ from a bathyscape?
5. What is a Nansen bottle?
6. Why aren't nuclear submarines used more frequently during peace times?
7. What was the Trieste?
8. The study of liquids and the forces of pressure is called _____.
9. Archimedes principle states that the force holding a vessel in water is _____ to the _____ of the fluid being displaced (pushed out of the way).

Discussion Questions

The following approaches may be used for answering the questions below:

- a. The questions may be answered on a sheet of paper as essay questions.
 - b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.
 - c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.
1. How have advances in technology improved marine research techniques in the last 70 years?
 2. How does a submarine dive and surface?

3. Submersibles, oceanic research vessels, and submarines are very costly to construct, use, and maintain. Is oceanic research really worth it?

Activities Together

1. Memorize and recite Psalm 139:9–10.
2. Obtain articles, with photos, of various kinds of submersibles. Have students write summary paragraphs about special features (capabilities) and pertinent information obtained in research expeditions.
3. View a documentary film or video on oceanographic research by Jacques Cousteau, or interview a U.S.S. sailor who has served aboard a submarine.
4. Have small groups of students experiment with the Archimedes principle with objects of various sizes and shapes. If desired, use calibrated containers, and measure the weight of water displaced.

Projects to Do on Your Own

1. Read the book *Kon-Tiki* by Thor Heyerdahl to learn about this man's determination to sail across the Pacific Ocean in a balsa wood craft.
2. Contact a personal acquaintance or Navy recruiter to learn about the particular training or preparation needed to live and work on a submarine for extended tours at sea.
3. Visit a dry dock area at a seaport. Study the size of the ships and the shapes of their hulls. Notice the color variations painted on the sides of a ship, indicating fill-weight limitations. If possible, observe a ship being loaded and setting out to sea. Consider how the Archimedes Principle applies to these ocean-going vessels.

CHAPTER 10 : THE GENESIS FLOOD

Summary

God sent a catastrophic flood covering the entire earth thousands of years ago. It was neither a local nor a "peaceful" flood, but one of unimaginable ferocity, altering the very crust of the earth. Scripture clearly teaches the fact and extent of the Flood in both the Old and New Testaments. The Bible also explains the reason for the Flood as recorded in Genesis 6:5. Today, we find geologic processes occurring both on Earth and Mars that supports the model of rapid hydraulic carving and sedimentation processes on a large scale.

Terms to Know and Spell

dimensions
hydraulic
sedimentation
Halocline diagram
density gradient
Mount St. Helens
submarine canyon
uniformitarianism
sediment gravity flows
cichlid fish
Cambrian

Fill in the Blank or Short Answer

Use the facts you know, as well as simple reasoning, to answer the questions below. Refer to the terms in the list above for assistance.

1. _____ was designed by God to withstand the ravages of the Genesis flood.
2. What verses may be found that support the fact of a worldwide Flood?
3. Recently scientists discovered evidence of “water roaring out of an overfilled lake [that] carved an instant “Grand Canyon” not on Earth, but on the planet _____.
4. What is the name of the diagram that shows the density gradient between salt and fresh water?
5. Massive underwater avalanches are also called?
6. In one day of geologic activity in 1982, a 1/40 scale model of Grand Canyon was formed where?
7. According to Genesis chapters 7 and 8, the Flood lasted _____ year(s).

Discussion Questions

The following approaches may be used for answering the questions below:

- a. The questions may be answered on a sheet of paper as essay questions.
- b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions.

c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.


1. Is it logical to assume that massive layers of sediment found, for example, spread across the United States, are due to slow processes over millions of years of time (uniformitarianism)? Would a catastrophic event (i.e., a flood) better explain what is found — such as the St. Peter sandstone described on page 71?
2. If one were to reinterpret the biblical teaching of a worldwide flood to that of only a local event, what would this do to interpreting other important doctrines in Scripture?
3. Why did God send the Flood?

Activities Together

1. Memorize and recite Genesis 7:21–22.
2. Prepare a drawing of Noah's ark on a large sheet of paper. Use the principle of ratios to determine the approximate size of the ark compared to people and animals such as horses and cows. How many doors would you put on the ark? Why?

Projects to Do on Your Own

1. Look up the 2002 article of a grand canyon on Mars by Paul Recer. After doing some cross-referencing in different publications, write a report of this amazing geological event on the Red Planet.
2. Research the Mount St. Helens eruptions of 1980 and 1982. Although the sediments laid down were of volcanic origin, scientists know the thousands of layers were clearly formed over a short time period. See if you can find pictures of these sediment layers. Do they look like the layers of sediment found at the Grand Canyon?



THE
OCEAN
BOOK
Study Guide
ANSWERS

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INTRODUCTION

1. The oceans cover 71% of the earth's surface area and contain 97% of all the surface water on the planet.

2. How do the oceans protect the earth?

The oceans help to distribute heat and cold; without the oceans, climate variations would be much more severe.

3. How do the oceans provide both food and oxygen for mankind?

Half of the world's supply of fresh oxygen is produced by marine micro-organisms, and many fish and other food products are harvested from the ocean.

4. What are some of the sources of power in the ocean?

Surf, tides, currents, (later) geologic vents

5. About how much of the current production of oil and petroleum comes from the ocean?

Approximately one-third

6. The oceans have been used throughout history as a means of transportation; this is one of the reasons that three-fourths of the American population lives within 50 miles of a seacoast.

7. List what contributes to the color variations of seawater:

blue: water depth and atmospheric conditions

yellow: phytoplankton

green: phytoplankton and clay particles

brown: clay and other sedimentary particles

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. How might life on earth be different if the oceans were larger or smaller than they are now?

The discussion should compare temperature fluctuations in various areas; drought; lack of oxygen; possible food shortages

2. Why should we care about life in the oceans when we can only live on land?

Discussion should elaborate that ecology is a concern because pollution destroys marine habitats; also, everyone needs the oxygen that fragile phytoplankton produce.

3. Should one country have a say in how another country cares for its neighboring marine habitats? Give examples to explain your answer.

Discussion should conclude that there must be certain international agreements (and enforcements) to see that one country's fishing practices or pollution does not inhibit another country's marine resources.

CHAPTER 1 — RESEARCH AND THE DEEP OCEANS

1. What are the four major branches of oceanography, and how are they differentiated?

Although they overlap somewhat, the four differentiations include:

Chemical oceanography focuses on the properties of seawater.

Physical oceanography relates seawater to its physical characteristics such as temperature, motion, and ability to transmit energy.

Biological oceanography focuses on marine flora and fauna.

Geological/geophysical oceanography concerns the larger geological features of the marine systems of the earth.

2. Name seven human endeavors that benefit from knowledge of oceanography.

Shipping products between nations

Navies for defense

Engineering — construction of seagoing structures

Communications — laying cables

Iceberg location for safety

Mineral and petroleum exploration
Meteorology — weather patterns

3. How was the Challenger expedition able to disprove Professor Edward Forbes's theory?

The scientists found a variety of bizarre creatures that had never been seen before.

4. Name two other discoveries made by the Challenger.

Manganese nodules shaped like potatoes, and the mid-oceanic ridge

5. What is a seismic profile?

A picture made by sound waves.

6. In what ways have exploration methods changed since the 1990s?

Exploration used to be done by ship, but now satellites and deep sea robots are used.

Activities Together

2. (Outline)

I. Branches of Oceanography

A. Chemical Oceanography

1. Chemical composition of sea water
2. Nature of dissolved gases and solids
3. Chemical cycles
4. Acidity of sea water

B. Physical Oceanography

1. Temperature
2. Density
3. Waves
4. Currents
5. Tides
6. Sea ice
7. Air-sea interaction
8. Ability to transmit sound and light

C. Biological Oceanography

1. Animal and plant life
2. Chemical and physical changes

3. Food webs
4. Interaction of life with its surroundings

D. Marine Geology and Geophysics

1. Oceanic sediments and rocks
2. Properties of magnetism, gravity, electricity, heat flow, and seismic methods

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Compare the attitudes of earth's citizens toward the ocean 50 to 100 years ago with attitudes in the 21st century.

People used to consider the ocean a good place to dump their garbage, but now we understand the dangers of pollution and the importance of taking care of the oceans.

2. The discussion leader should draw a connection between this discussion and Introduction, question 2, that a healthy ocean is a benefit for all people.

CHAPTER 2 — PHYSICAL CHARACTERISTICS OF THE OCEAN

Short Answer

1. What are five major geo-physical features of the ocean? Choose your answers from the list above.

coast, continental margin, trenches, oceanic ridges, sea floor with hydrothermal vents

2. Define and/or illustrate the other terms listed above.

abyssal plain — basin on the bottom of the ocean which extends for miles

beach — sloping coastland covered by sand between the sea and the coast

brackish water — part freshwater, part saltwater; sometimes stationary

coast — the region behind the shoreline; the geographic line where land ends and sea begins

continental margin — the wide area between a continent's coast and the deep-sea floor — the bottom of the ocean, as opposed to its ridges

estuary — an area at the mouth of a river, where fresh water mixes with salt water

harbor — a naturally or artificially sheltered area of water with few or low waves

hydrothermal vent — a chimney-shaped formation that releases jets of poisonous, dark, mineral-rich water from the ocean floor; a black smoker chimney

inlet — any waterway going into land from a larger, open body of water; harbors, bays, lagoons, and fjords are inlets

lagoon — a shallow body of still ocean water, mostly separated from the ocean by a sand bar, coral reef, or barrier island

oceanic ridges — underwater mountain ranges

salinity — a measure of the total amount of dissolved solids or minerals in water

salt marsh — a swampy coastal area with plants washed by low waves from the sea, otherwise known as wetlands

seamount — geologic formation which protrudes from the seafloor

shoreline — the high-water mark of the tide; the constantly shifting dividing line between land and sea

subduction — the geologic process whereby a heavier oceanic plate slides under another, lighter crustal plate

trench — a deep area of the ocean, some have steep valleys

3. Explain what forces cause coastlines to differ in appearance.

The shaping influences are wave action, currents, tides, actions of oysters, mussels, other sea creatures, and various types of vegetation.

4. What difference(s) exist between a fjord and a lagoon?

A lagoon is a shallow body of brackish or ocean water separated from the ocean by a sandy ridge. Fjords may be hundreds of feet deep. The sides of a fjord are U-shaped and steep.

5. What are the parts of the continental margin?

The continental margin includes the continental shelf, or submerged land adjacent to the continent ; the continental slope, or the true edge of the continent; the continental rise, the distance between the slope and the plain; and abyssal plain, the greater depth of the ocean.

6. Trenches, oceanic ridges, and hydrothermal vents are all part of the sea floor or deep ocean.

7. Contrast trenches with oceanic ridges.

Oceanic ridges are underwater mountain ranges, some higher than Mount Everest; trenches descend deep into the sea floor, deeper than the tallest mountains. Trenches are located at the base of continental slopes, whereas oceanic ridges form a chain of mountain ranges which protrude from the sea floor.

8. Describe the compound word “hydrothermal” in terms of its parts, and tell how these combine to define the term.

“Hydro” indicates water, and “thermal” pertains to heat; hydrothermal vents are spouts of water heated by underground pockets of molten rock.

9. Compare the temperature of water from a hydrothermal vent to the temperature of the water boiling in a pan on the stove.

It’s three times as hot. Water boils at 212°F. Water spewing from a thermal vent can reach 666°F.

10. Describe three creatures that thrive near hydrothermal vents.

There are high numbers of individuals that have a large body size, such as 10–13 foot-long tubeworms, giant white clams, translucent jellyfish, and blind crabs and shrimp.

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Describe guyots and seamounts in terms of their appearance. How or why is each one thus shaped?

Guyots are flat-topped seamounts with peaks close to the surface which have had their peaks eroded by wave action.

2. What formed the trenches in the ocean floor?

Creation scientists believe that trenches, the deepest areas of the oceans, are what’s left from subduction activity of crustal movement at the time of the Genesis flood. (See Genesis 8:2.)

3. Tell how the geological activity in Iceland or the hostile environments of deep-sea hydrothermal vents can be used to support the theory of special creation.

In Iceland, a new island with new shorelines appeared in the early 1960’s, but with the appearance of having been formed long before. The conditions of hydrothermal vents are actually hazardous to life, yet a few creatures do live in their proximity.

4. What principles should town councils and residents in eastern America’s coastal cities consider in constructing edifices along the coast?

Harsh weather conditions, such as hurricanes and floods can drastically alter the shoreline so citizens should be prevented from building on property too close to the shifting beach.

CHAPTER 3: COMPOSITION OF THE OCEANS' WATERS

1. What are the most common elements of seawater?

Oxygen, hydrogen, chlorine, sodium, magnesium, sulfur, calcium, potassium, bromine, carbon

2. Since every 1,000 grams of ocean water contains 35 grams of salt, what percentage of seawater is salt?

$$35/1000 = 3.5\%$$

3. Where does the salt in seawater come from?

God may have formed seawater with salt in it from the beginning. Other salts are deposited through erosion.

4. Why is it dangerous for humans to drink seawater?

Humans do not possess a "salt gland." To process the salt in ingested seawater; people must drink three times as much water as an amount of salt water for their kidneys to do the same job as a seafaring animal's salt gland. Without a supply of freshwater, the human body will die of dehydration.

5. Why is seawater not of uniform salinity all over the world?

The water near the mouth of (especially) large rivers is diluted with fresh water.

7. What is an iceberg?

An iceberg is a mountain-sized chunk of frozen freshwater floating freely in seawater; most icebergs are broken pieces of compressed snow, ice sheets, or glaciers.

8. Only 10% of an iceberg can be seen above water; 90% of its bulk threatens because it is hidden below the water's surface.

9. Most pinnacle icebergs are formed in the Arctic. Tabular icebergs break off ice sheets formed near the Antarctic.

10. Why is April 14-15, 1912, considered as one of the most disastrous events in maritime history?

The RMS *Titanic* sank after it struck an iceberg which tore open its hull and left 1,500 people in frigid waters.

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Define and review each of the terms above.

commodity — a resource that is sold or traded

dehydration — the process of removing water; drying out

desalination plant — machinery designed to remove salt from seawater to prepare it for human consumption

pinnacle iceberg — an iceberg that sticks up, like a mountain shape; pinnacle icebergs are “born” in the Arctic

salinity — the measure of the amount of dissolved salt in seawater

tabular iceberg — an iceberg that is long and flat, like a table; these icebergs are formed in Antarctica

2. Discuss how the answer to #8 above helps to explain what cause the Titanic tragedy.

Because the Titanic was traveling at a high rate of speed at night, navigators were unable to discern the projected underwater bulk of the fateful iceberg in time for the massive ship to take elusive measures to avoid a collision.

3. Consider why salt was such an important commodity in history. Then consider Jesus’ words in Matthew 5:13. Why do you think Christ compared His followers to salt?

“You are the salt of the earth” refers to both a Christian’s importance as a commodity and as a way to prevent the rottenness of depraved man from spreading. Just as salt that is no longer salty is worthless, so is a Christian who mars his testimony with sin and excuses.

Activities Together

2. Use an etymological (word origins) dictionary to find the origin of the word “salary.” What did you learn about the importance of salt throughout history that would explain what the words “not worth his salt” or “salary” means in today’s culture.

“Salary” became the term we use for the fixed amount of money paid to a person on a regular basis for services. Indeed, a lazy man is “not worth his salt.”

3. Float an ice cube in a clear glass or measuring cup. Using a centimeter ruler, measure how much of the ice cube protrudes above the water’s surface and how much extends below. Compare your data to the 10%/90% ratio of icebergs. Would you expect it to be the same? Why or why not?

While most of the ice cube will be below the surface, we would not expect the ratio to be the same because the ice cube has no salt and is therefore different in basic constitution.

CHAPTER 4: TIDES, WAVES, AND CURRENTS

Terms to Know and Spell

tide — the periodic rise and fall of the level of water relative to the beach

wave — movement of surface water, noticed mostly at the beach

current — massive movement of water beneath the surface

landmass — a large body of land, such as a continent

gravitational pull — the force of magnetic attraction between two large bodies

centripetal acceleration — the speed at which one body revolves around another

oscillate — to move back and forth with a steady rhythm

revolve/revolution — to move around a central point; one complete circle of movement

diurnal/semidiurnal — daily; twice daily

neap tide — lower high and higher low tides because of quadrature

spring tide — higher high and lower low tides because of syzygy

tsunami — a gigantic, devastating wave caused by landslides, earthquakes, volcanic activity, or hurricanes

Coriolis effect — the combination of the atmospheric marine conditions based on the rotation of the earth and the heating and cooling conditions based upon latitude or distance from the equator

gyre — large continuous circulatory currents in the Atlantic and Pacific Oceans

riptide — a dangerous surface current that carries large amounts of water back to sea

surf — surface water that crashes onto shore in rhythmic fashion

syzygy — occurs when the sun, moon, and earth all line up, resulting in very high or very low “spring” tides

quadrature — when the positions of the sun, moon, and earth form a ninety-degree angle

neap — the lowest low and the highest high tides

undertow — a type of current that occurs after a breaker crashes on a beach

nutrient upswelling — a curious movement of water that carries nutritious deep water toward the surface for marine animals to consume

Short Answer

1. The rising and falling of the level of the ocean near a shore is called the tide.
2. What affects the amount of surf along a coastline?

The shape of the coastline, the composition of the continental shelf, the height of the tide, the gravitational forces (which may be affected by the season), and pleasant or adverse local weather conditions

3. The force of gravity can be described as the measurable and descriptive function of the mass of the objects involved and the distance between them.
4. Who was the first scientist to apply the law of gravitational forces to the predictable nature of the tides?

Sir Isaac Newton (a noted creation scientist)

5. Syzygy occurs when the sun, moon, and earth all line up in a row, which results in very high or very low spring tides.
6. When the positions of the sun, moon, and earth form a ninety-degree angle, neap tides occur. This quadrature causes the lowest high and the highest low.
7. Semi-diurnal tides form two high tides and two low tides each day.
8. Most waves are formed by winds moving just the top layer of water.
9. What factors influence the amount of surf along a beach on a particular day?

The steepness of the coast, the height of the tide, and amount of wind present relative to any storm activity

10. A tsunami, or tidal wave, is a devastating, giant-sized wave caused by underwater geological activity, such as an earthquake, landslide, or volcanic eruption.
11. What do the red or blue arrows on a map of ocean currents mean?

Red symbolizes warm water currents, and blue stands for cold water currents. The direction of the arrow indicates how the current travels.

12. What are the most famous ocean currents for North and South Americans?

The Gulf Stream is a warm water current east of the United States. The Humboldt is a cold-water current off the west coast of South America.

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Why is it important that seafarers be aware of the tides?

It is safer to launch or dock a ship at high tide, especially if the bay is shallow; many a ship has run aground at low tide. Unusually high or low tides can occur monthly or seasonally.

2. What kind of person is compared to waves? James 1:5–8 and discuss its implications.

A double-minded man is compared to the instability of waves which move to and fro constantly. A doubter will always be subject to changing nature of circumstances or opinions; a man of faith will trust in God's unchanging truths.

3. Have students study the map on page 28 while someone reads aloud from the end of page 27 through the first paragraph on page 29 to help them better understand the movement of the world's ocean currents. Notice how currents circulate clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.

CHAPTER 5: WEATHER

Coriolis effect — the movement of atmospheric winds due to the rotation of the earth.

density — regarding marine water, colder water is more salty and dense because some water has already evaporated

depression — an area of low atmospheric pressure

El Nino — a warm-water current that appears at Christmastime

eye of a hurricane — the relatively windless center of the vortex, approximately ten miles wide

hurricane — a severe storm characterized by very strong winds and heavy rainfall

hypothermia — a condition experienced when the body gets too cold

La Nina — a cold-water condition that may interfere with the role of plankton in the food chain

meteorology, meteorological — the science of weather; having to do with weather

storm surge — the high waves and pronounced surf that accompanies a heavy storm

thermocline — an area of seawater where the temperature decreases sharply in comparison to its depth

tropical storm — a storm that has resulted from a tropical depression, yet is not strong enough to be called a hurricane.

Fill in the Blanks

1. Devastating Hurricane Andrew pummeled Florida with winds gusting up to 177 mph in August 1992.
2. El Niño is a warm water current which appears around Christmastime off the coast of Peru.
3. List two to four effects of El Niño.

Warm water temperatures, dead fish, starving sea birds and mammals, heavy rains in some areas, drought in others

4. La Niña is a seasonal cold-water current that keeps photo plankton from growing, and many marine creatures starve due to a lack of nutrients.
5. At the equator, the earth turns at a rate of approximately 1,000 mph.
6. Since the earth spins to the east, waters tend to accumulate at the western shores of the continents.
7. An area of warm air with low pressure over a large body of water is called a depression.
8. A tropical depression with winds greater than 50 mph is called a tropical storm.
9. A hurricane is rated as a category 1 to 4 storm based on its wind speed.
10. A hurricane in the Indian Ocean is called a cyclone.
11. A hurricane in the South China Sea is called a typhoon.
12. Due to the Coriolis effect, hurricane winds spin counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.
13. Why do hurricanes become so strong in the open sea?

No large land mass interferes with the circulating winds.

14. Out of about 50 tropical depressions, only 2 or 3 become hurricanes.
15. Water heats and cools more slowly than land does.
16. The thermocline is an area of increasingly cold water that reaches from the surface zone down to about a half a mile below sea level.

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Reread the section on the Coriolis effect (page 36), and ocean currents (pages 27–30). Then read historical accounts of the age of explorers, circa 1450–1850. Discuss how the two scientific principles may have affected human history.

(Example:) Because Christopher Columbus sailed from the Iberian Peninsula, he was able to travel on the Gulf Stream which, when compounded by a storm, propelled his ships at an amazing pace. Later, until travelers understood the propulsion of the Gulf Stream, voyages from Great Britain to the Americas took much longer than the return trip.

2. Compare and contrast the times, locations, causes, effects, of El Niño and La Niña weather phenomena.

(Answers will vary.) El Niño tends to bring extra rain to the western coast of North America, while eastern Asia suffers heat and drought. La Nina mostly affects South America.

3. If a hurricane carries 100+ mph winds, why does it only travel 25–35 miles per hour, unlike a tornado which gives almost no “escape” time?

The high-speed winds in a hurricane are circular in nature. At the same time, the vortex can travel in another direction. To simulate this, fill a pan or sink with water, and stir up a vortex with a straw or spoon handle. Then try moving the vortex to a different location in the pan without dissipating it.

4. Ask students who have weathered a hurricane to retell their experiences. Then conduct a discussion as to what various people’s responses should be toward preparedness and cleanup. (i.e., a home builder, a property owner, a parent, a businessman, a law enforcement officer, etc.)

CHAPTER 6: HARVESTING THE OCEAN

Terms to Know and Spell

shellfish — clams, oysters, scallops; also some crustaceans, such as crabs, lobsters
trawling — a fishing technique which drags lines or nets to the side or stern of a ship
purse seining — a fishing technique which uses a type of large net that spreads out and then closes around all marine life and deposits them on the ship
dredging — a fishing technique which harvests bottom dwellers
overfishing — harvesting more fish than can reproduce for population maintenance
bykill — other creatures that are inadvertently caught with the intended prey

Fill in the Blanks or Short Answer

1. Most of the ocean's living creatures are found in the upper 600 feet of the sea.
2. Name at least two different small, medium, and large fish and some shellfish harvested from the ocean.

Small: anchovies, sardines, herring

Medium: mackerel, salmon, perch, flounder

Large: halibut, tuna, shark

Shellfish: crab, lobster, scallops, clams, oysters

3. What happens to caught fish that are not used for food?

They are used for bait, pet food, fertilizer, and glue. Sometimes they are simply dumped overboard and wasted.

4. How has modern equipment and technology helped fishermen?

Ships are now equipped with power tools to deal with heavy cargo. Electronic detection devices help to locate schools of fish. Some vessels can process and can or freeze their catch while still at sea.

5. What is overfishing and what does it mean?

Overfishing means that a type of fish has been harvested beyond its ability to reproduce enough to keep its population steady, and not enough fish remain to breed new stock.

6. What is an aquaculture farm, and what is produced there?

An aquaculture farm is an area near shore where marine animals are grown under protected conditions for the purpose of human consumption.

7. Name three of the most abundant “crops” from mariculture.

Algae, oysters, salmon

8. Put the following terms in order of their importance in producing energy from the ocean: tides, salinity, thermal gradients, currents, waves.

Waves, tides, currents, salinity, thermal gradients

9. Although thermal gradients are capable of producing enormous amounts of energy, why aren't more power plants being built?

The plants would need to be located in the tropics where storms are frequent; they require large amounts of both hot and cold water; they could endanger marine life.

10. What nonliving resources are also harvested from the sea?

Magnesium, bromine, salt, zinc, iron, copper, diamonds, gravel, sand, oil, natural gas

Discussion Questions

The following approaches may be used for answering the questions below:

- a. The questions may be answered on a sheet of paper as essay questions
- b. If the number of children permits, the children may be organized in discussion groups to discuss answers to the questions;
- c. If the number of children permits, the parent or teacher may guide a class discussion to answer the questions.

1. From 1950 to 1990 the world fish catch increased from 20 million tons to more than 90 million tons. Discuss whether or not this increase can continue, and the implications of overfishing. Should fishing restrictions be imposed and enforced? If so, by whom?

The discussion should consider that living resources have their bounds, and that overfishing can affect other populations as well as local economies. Some fishing restrictions should be incorporated, but how they would be regulated is difficult to determine. God puts a priority on the needs of human life, but He also mandates a proper stewardship of Earth's resources.

2. What are some ways that overfishing can be prevented?

Since the fishing industry has a natural tendency toward profit rather than population control, it seems that the only way to prevent overfishing is to institute governmental regulations, such as provisional licensing, weight restrictions, and fines for disobedience.

3. Discuss the benefits and detractions of offshore oil or gas production.

Offshore drilling brings a boon to the local economy, with jobs and money aplenty. However, both construction and production disturb the marine environment which can bring pollution to local shores. Many states have a proximity limit on offshore drilling enterprises. Do other countries as well?

CHAPTER 7: MARINE LIFE

Terms to Know and Spell

algae—various kinds of oceanic plants; includes yellow, red, brown, and green

aquatic mammals — warm-blooded, air-breathing sea creatures; include whales, dolphins, seals, sea lions, sea otters, walruses, and more

benthic zone — the floor of the oceanic horizontal zone that supports bottom-dwelling life forms; includes the intertidal zone, too

bioluminescence — a living organism's ability to produce its own light, usually via electricity

bony fish — sea creatures, other than mammals, that have a structure made of bone; largest class of fish

cartilaginous fish — fish that have a structure of cartilage rather than bones; includes sharks, rays

cephalopod — “head-foot” creatures, such as the octopus and squid

crustacean — marine arthropods commonly called shellfish; includes krill, barnacles, shrimp, crayfish, lobster, crab, daphnia

gastropod — “stomach foot” creatures, such as sea snails and other univalves

horizontal zone — marine area which extends from the shoreline low-tide mark to the open sea; includes the neritic and oceanic zones

intertidal zone — the shoreline area between the low- and high-tide water marks

kelp — a type of algae, commonly called seaweed

midnight zone — coldest, deepest (vertical) area, greater than 3,000 feet in depth, where no light penetrates from the surface; contains few nutrients

mollusk — univalve and bivalve creatures, as well as cephalopods and gastropods; includes cockles, scallops, mussels, oysters, octopuses

neritic zone — horizontal area from low-tide mark to edge of the continental shelf

oceanic zone — horizontal area from edge of continental shelf throughout the open sea

pelagic zone — area which includes all oceanic water but not including the sea floor

phytoplankton — plantlike plankton which carry on photosynthesis

plankton — tiny organisms that inhabit the sunlit zone and function as a food source for other marine life

red tide — an abnormal growth of red-brown dinoflagellates that can cause some fish to die

sunlit zone — (vertical) area from 0–600 feet in depth, where the most sunlight penetrates and photosynthesis occurs; contains greatest variety of life forms

twilight zone — vertical area from 600–3,000 feet in depth,

vertical zone — area where marine life exists, from the surface to the sea floor; includes the sunlit, twilight, and midnight zones

zooplankton — animal plankton which may include protozoa, diatoms, copepods, sea jellies, mollusks

Short Answer

1. Why do most living marine organisms inhabit the sunlit zone? Light penetration enables photosynthesis and results in an abundance of food for both plant eaters and carnivores.
2. Why is an abundance of plankton so vital to marine biology? Plankton are tiny plant and animal organisms that inhabit the ocean. Phytoplankton produce oxygen through photosynthesis. Zooplankton and phytoplankton are the base of oceanic food chains.
3. What are the major differences between phytoplankton and zooplankton? Phytoplankton are plants that undergo photosynthesis. Zooplankton are animals that do not produce their own food.
4. What is a kelp forest? A kelp forest is a proliferation of giant brown algae that can grow up to 200 feet in length.
5. Name and describe the four kinds of marine algae. Yellow algae are mostly diatoms, the base of the marine food chain. Red algae grow in coral reefs and are used to produce scientific agar and chemical or food additives. Brown algae include several kinds of seaweed, grass, and kelp. Green algae, such as plankton and sea lettuce, may grow near shore.
6. Lobsters and spiders are both arthropods. What do lobsters have that spiders do not have?
Antennae
7. How are fish classified? There are three main classifications of fish: jawless, cartilaginous, and bony.

8. What are chordates? Chordates are fish with bones, specifically backbones.
9. How might you tell which classification a certain fish may be, if you cannot see its skeleton? Unlike other fish, jawless fish lack paired pectoral or pelvic fins. Most cartilaginous fish are shark or rays. Other fish are bony fish.
10. Why does the natural behavior of barnacles irritate seamen? Barnacles produce a cementing substance and attach themselves to boat hulls, where they live by gleaning floating food particles. This inhibits “smooth sailing” by increasing friction and drag, and decreasing the ability of a boat to sail rapidly.
11. Give an example of a food chain. Answers will vary. An example: diatoms, krill, penguins.
12. Compare a food chain to a food web. Answers will vary. Using the previous example of a food chain, we can show how whalebone whales also eat krill; therefore, the penguins and whales are “woven” into a food web because they both depend on the same source of food.
13. Study the photo of the blackdevil anglerfish on page 55. What special designs did God give this creature to ensure its survival? Bioluminescence allows it to see, communicate, and attract prey in deep-sea darkness. Large jaws and sharp teeth increase the likelihood of a successful attempt to capture food. Light near its tail serves to distract predators.

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Although many more creatures inhabit warmer waters, (phytoplankton) diatoms are abundant in coldwater regions. How could this be one of God’s special provisions for Arctic or Antarctic ecosystems? Can your answer help to refute evolutionary theory? (Example) Diatoms are the main food source for krill, which, in turn, are the major food source for many other Arctic creatures, such as squid, petrels, penguins, and various whales. If diatoms could not survive in frigid conditions, these other animals could not flourish either. Evolutionary principles cannot explain how these creatures, each dependent upon its food source, could evolve and survive without the food evolving at just the right time also. These organisms were clearly designed to coexist.
2. How can a jawless fish eat if it has no jaws? Jawless marine fish are akin to freshwater leeches; they obtain their food by sucking body fluids from their prey.
3. How are whales like fish? How are they different from fish? Whales live their entire lives in water, swim, and are predatory. While most fish hatch from eggs, some types of fish and all

whales bear live young. However, whales breathe air with lungs, while fish breathe through gills. (Not mentioned in this book: Fish have fins and swim with a side-to-side motion, and whales have fins and tail flukes that enable them to swim with an up and down undulating motion.)

4. What does the fossil record reveal concerning the origin of fish? Evolutionists would maintain that lampreys and sharks are precursors to bony fish. However, fossils of rays and sharks like their modern counterparts have been discovered. Clearly, if evolution was to adhere to its meaning of “change,” these fish should have changed in form from pre-history to today. Microevolution enables small changes that allow new species of fish to form, but the three scientific classes of fish remain — jawless, cartilaginous, and bony.

CHAPTER 8: EXPLORING THE CORAL REEF

Terms to Know and Spell

atoll — circle-shaped coral reefs that enclose a lagoon; often formed around sunken volcanoes

barrier reef — an offshore coral reef with a deep, wide lagoon between it and the shore

coral bleaching — an unhealthy condition which occurs when algae no longer grows on a coral reef, and it loses its brilliant color

equatorial region — warm water marine areas near the equator where most coral reefs are located

fringing reef — a reef of both hard and living coral, usually formed around volcanic islands, such as in Hawaii

Great Barrier Reef — largest, world-famous reef located off the coast of Australia

mangrove — a tropical tree that flourishes in tropical salt marshes

polyp — free-floating immature stage of a coral that will attach itself to a rock or dead coral, feed, and grow

shoal — an underwater sandbar or land ridge, not always covered with coral, that posts a hazard to ships

Fill in the Blank or Short Answer

1. Some of the marine invertebrates that inhabit a coral reef include coral, sponges, sea anemones.
2. Sinking underwater volcanoes formed atolls and fringing reefs.
3. Masses of dead coral skeletons harden and turn into coral reefs.
4. A jellylike creature that will grow into a mature coral is called a polyp.

5. An underwater extinct volcano sank, and the circle-shaped coral reef that encloses it is called a/n atoll.
6. How did the Great Barrier Reef get its name? The reef is great due to its tremendous size (more than a thousand miles long). It is a barrier to sea trade because ships cannot navigate its shallow waters with hardened coral formations.

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Define each of the terms above. See list above.
2. Tell how a coral polyp is like a plant and like an animal.

A coral polyp is an animal because it catches its food from the water that flows past it. It appears to be a plant, though, because it usually stays in one location after it attaches itself to a rock or limestone formation made of dead coral.

3. Give several examples to describe how the particular characteristics of a mangrove tree help tropical habitats to flourish.

A mangrove tree is able to live along the shoreline. It tolerates brackish water. Its twisted, entangled roots keep sand from washing away and encourage other vegetative growth. Its fruit is a berry that germinates before planting, anchors quickly in the mud, and provides a haven for many coral reef animals, such as tropical fish, shrimp, and crabs.

4. Why are coral reefs dangerous to ships?

When large groups of coral die, their formations harden into limestone with sharp, rough edges that can do serious damage if a ship forcefully hits it.

5. Tell how the coral growth rate measured in 1997 helps to refute evolutionary uniformitarianism and support the special creation model of origins.

Based on the measured growth rate of the coral, scientists determined that the Great Barrier Reef could have been formed in only a few thousand years, rather than several million years, as recommended by evolutionists.

CHAPTER 9: OCEANIC VESSELS

Archimedes principle — the basic principle that the force holding a vessel in the water is equal to the weight of the fluid displaced (pushed out of the way)

ballast — extra weight used to help a submersible sink

displace — to move something aside; in marine terms, “displaced” refers to the water that must part to let a vessel through

diving plane — a horizontal rudder on a submarine used when diving or surfacing

hull — the outer shape or shell of a boat

mid-water drifter — a submersible that can drift along with a current, below the surface

oceanographic research ships — a working scientific platform with special equipment, such as radar, satellite tracking gear, helicopter landing pads, deep sea vehicles, cranes, cable, and crew members — all used for the purpose of obtaining particular information from the marine world

Polynesia — groups of islands in the South Pacific Ocean

submersible — a specially equipped, manned or unmanned watercraft that can go underwater to obtain information

Fill in the Blank or Short Answer

Use the facts you know, as well as simple reasoning, to answer the questions below. Refer to the terms in the list above for assistance.

1. A submersible is any device that can successfully venture into the deep and return to the surface carrying information about the underwater world.
2. What kinds of equipment can be found on most submersibles?

Most oceanographic research vessels have mechanical arms, video cameras, sonar instruments, and devices to take sea-floor core samples. In this chapter, mostly manned submersibles are considered.

3. Prepare a chart from a large sheet of butcher paper or newsprint that lists all of the submersibles named in this chapter. Then list the purpose or mission for each one and the particular equipment used. Tell whether it is manned or remotely operated. If possible, include a picture example of each.

For answers, refer to terms defined here and to the text.

diving bell — one of the first submersibles, used for observing underwater habitat
bathysphere — a hollow steel ball lowered from a ship by a cable; first used in the 1930s
bathyscaph — a technologically advanced submersible that can maneuver up and down without the use of cables
DSV — a deep submergence vehicle that is used for research or rescue missions
ROV — a remotely operated vehicle — an unmanned submersible controlled by cable connections to the mother ship, used for researching deep water with a video recorder
DSRV — a deep submergence rescue vessel, designed to rescue crews of disabled submarines
submarine — boats designed to stay submerged for extended periods, even weeks at a time; large in size and somewhat restricted in maneuverability

4. How does a bathysphere differ from a bathyscaph?

A bathyscaph has no cables and can be independently controlled. A bathysphere is attached to a mother ship via cables, and maneuverability is usually controlled by devices on the mother ship.

5. What is a Nansen bottle?

A Nansen bottle is a device which can be submerged from an oceanographic research vessel to gather data, such as temperature or salinity, at specified depths.

6. Why aren't nuclear submarines used more frequently during peace times?

They cannot descend as deep as specially designed submersibles; however, they may carry ROVs that can do the necessary work.

7. What was the Trieste?

The Trieste was a bathyscaph that enabled researchers to descend seven miles into the deep for the first time in 1960.

8. The study of liquids and the forces of pressure is called hydraulics.

9. Archimedes principle states that the force holding a vessel in water is equal to the weight of the fluid being displaced (pushed out of the way).

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. How have advances in technology improved marine research techniques in the last 70 years?

The first submersibles were remotely operated, significantly limiting the human experience with the marine world. Later, manned vessels were developed. Sonar enables tracking and mapping, satellite technology enhances communications of pertinent information. Computer technology enables scientists to record and process data efficiently.

2. How does a submarine dive and surface?

A submarine has a space between its two hulls or ballast tanks on its outside, as well as a horizontal rudder called a diving plane. When descending, the ballast space is flooded with water, and the increased weight enables the submarine to descend in compliance with the law of gravity. To surface, the diving plane is angled upward, and the water is pumped out by means of compressed air, making the submarine more buoyant.

3. Submersibles, oceanic research vessels, and submarines are very costly to construct, use, and maintain. Is oceanic research really worth it?

Yes. Advances in knowledge about the oceans has made transportation routes safer, given populations advance notice of weather or water temperature changes, and led to more protective measures for marine animals. (See other chapters.) Some core sample research has led scientists to believe that special creation is more plausible than evolution.

CHAPTER 10 : THE GENESIS FLOOD

Summary

God sent a catastrophic flood covering the entire earth thousands of years ago. It was neither a local nor a “peaceful” flood, but one of unimaginable ferocity, altering the very crust of the earth. Scripture clearly teaches the fact and extent of the Flood in both the Old and New Testaments. The Bible also explains the reason for the Flood as recorded in Genesis 6:5. Today we find geologic processes occurring both on Earth and Mars that supports the model of rapid hydraulic carving and sedimentation processes on a large scale.

Terms to Know and Spell

dimensions — the height, width, and length of an object

hydraulic — fluids under pressure, doing work

sedimentation — particles of varying sizes transported and deposited in a liquid environment to later form rock

Halocline diagram — an illustration of the gradient in ocean salinity
density gradient — the distribution of salt at different levels of the ocean
Mount St. Helens — an active, volcanic peak in southwest Washington
submarine canyon — a deep, steep-sided underwater valley
uniformitarianism — the philosophy that the slow geological processes seen today have always been
in effect in the unobserved past, slowly changing the face of the earth
sediment gravity flow — liquid-suspended particles whose settling has been caused by gravity and
kinetic energy
cichlid fish — a unique freshwater tropical fish found mainly in African lakes
Cambrian — a layer of sediments defined by some as an ancient evolutionary “era.”
Creationists view these sediments as containing vertebrate and invertebrate life in the pre-
Flood seas

Fill in the Blank or Short Answer

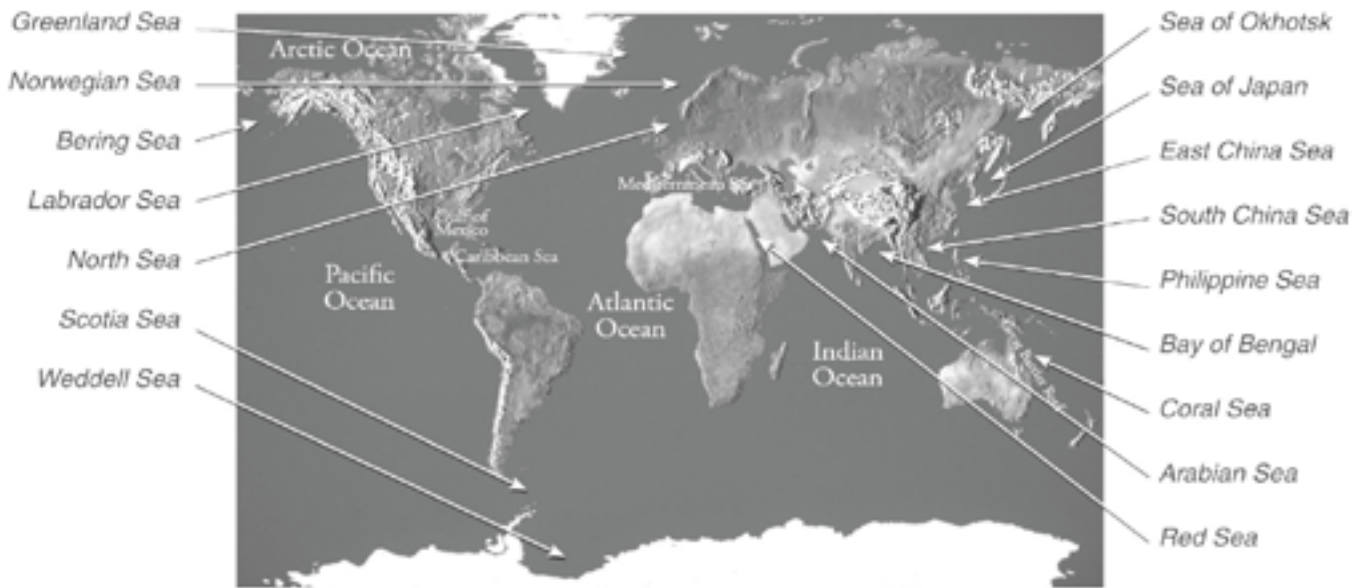
Use the facts you know, as well as simple reasoning, to answer the questions below. Refer to the terms in the list above for assistance.

1. Noah's ark was designed by God to withstand the ravages of the Genesis Flood.
2. What verses may be found that support the fact of a worldwide Flood?
Genesis 7:19–20; Genesis 6:8–9; 13:17–18; 2 Peter 3:3–7
3. Recently, scientists discovered evidence of “water roaring out of an overfilled lake [that] carved an instant Grand Canyon,” not on Earth, but on the planet Mars.
4. What is the name of the diagram that shows the density gradient between salt and fresh water?
Halocline diagram
5. Massive underwater avalanches are also called?
Sediment gravity flows
6. In one day of geologic activity in 1982, a 1/40 scale model of Grand Canyon was formed where?
Mount St. Helens
7. According to Genesis chapters 7 and 8, the Flood lasted one year.

Discussion Questions

The answers below are condensed. Actual discussion or essay answers may be much longer.

1. Is it logical to assume that massive layers of sediment found, for example, spread across the United States, are due to slow processes over millions of years of time (uniformitarianism)? Would a catastrophic event (i.e., a flood) better explain what is found — such as the St. Peter sandstone described on page 71?
The physical evidence points to a catastrophe on a very large scale. Even evolutionary geologists are turning away from a slow and gradual geologic process (uniformitarianism) in favor of catastrophism — although they still deny the scriptural teaching of a Flood (Genesis chapters 6–9).
2. If one were to reinterpret the biblical teaching of a worldwide flood to that of only a local event, what would this do to the interpretation of other important doctrines in Scripture?
It would show even the plain language of Scripture to be suspect and that God is unable to clearly express to His people what He is saying. The clear teaching of a worldwide judgment can also be “interpreted” as just a minor, local event. Other basic biblical teachings could also be radically reinterpreted.
3. Why did God send the Flood?
Because of the wickedness of mankind, the earth was “filled with violence.”



Study guide map key from page 5