

1. Define habitat and describe how geologic processes influence habitats.

Habitats are the natural environments in which organisms live. They are directly shaped by geological processes, which influence the shape of coastlines, the depth of water, whether the bottom is sandy or muddy, and many other features of the marine habitat. Even the history of marine life is related to geology.

2. How much of the earth's surface is covered by sea water?

The oceans cover about 71% of the earth's surface.

3. How are the oceans distributed between the Northern and Southern Hemispheres?

There is more land and less ocean in the Northern Hemisphere compared to the Southern Hemisphere. About 80% of the Southern Hemisphere is ocean, whereas only about 61% of the Northern Hemisphere is ocean.

4. Name the five oceans (include the Southern Ocean). Compare and contrast all five except the Southern Ocean with respect to a) size and b) depth.

The four "traditional" oceans are the **Pacific, Atlantic, Indian, and Arctic**. The **Southern Ocean** is the continuous body of water that surrounds Antarctica. All of the oceans are interconnected and form one world or global ocean. The Pacific Ocean is the largest and deepest ocean (almost as large as all the others combined). The Atlantic Ocean is slightly larger than the Indian Ocean and they are similar in depth. The Arctic Ocean is the smallest and shallowest ocean. Your textbook doesn't include depth and size info for the Southern Ocean, but I've summarized it for you anyways.

Ocean	Ocean Size (million square km)	Average Depth (m)
Pacific	166.2	4,188
Atlantic	86.5	3,736
Indian	73.4	3,872
Arctic	9.5	1,330
Southern	20.3	4-5,000

5. Define density and describe how it is calculated.

Density is the mass of a given volume of a substance. It allows us to compare the mass of equal volumes of different substances (e.g., the density of lead is greater than the density of Styrofoam if equal volumes of the two are compared). Substances of low density will float on substances of higher density. Density is calculated by dividing mass by volume (e.g., grams per cubic centimeter).

6. Describe the earth's core.

The earth's **core** is the innermost layer of the earth. It is composed of a mixture of iron and other metals. It is the densest layer of the earth. The pressure in the core is a millions times that of the surface, and the temperature is estimated to be over 4,000°C (7,200°F). It is made up of a solid **inner core** and a liquid **outer core**. It is thought that the motion of the liquid outer core is responsible for the earth's magnetic field.

7. Describe the earth's mantle.

The **mantle** is the middle layer of the earth's interior (between the core and the crust). It is intermediate in density. Most of the mantle is solid; however, because its temperature is close to the melting point of rocks, much of the mantle flows almost like a liquid (but very, very slowly).

8. Describe the earth's crust.

The **crust** is the outermost (and therefore least dense) layer of the earth. It is extremely thin compared to the other layers and much more rigid. The composition and characteristics of the crust vary greatly between the oceans and continents.

9. Compare and contrast continental and oceanic crust.

Continental and oceanic crust have physical and chemical differences. **Oceanic crust** makes up the sea floor and is composed of a type of rock called **basalt**. Basalt is dark in color and denser than the rocks that make up the continental crust. **Continental crust** is made up a type of rock called **granite**, which is light in color and less dense than oceanic crust. The density of oceanic crust is 3.0 g/cm³ and the density of continental crust is 2.7 g/cm³.

Oceanic crust is much thinner than continental crust—about 5 km (3 mi) compared to 20 to 50 km (12 to 30 mi).

10. How does the density difference between continental and oceanic crust create oceans and continents?

The continents can be thought of as thick blocks of crust floating on the mantle much as icebergs float in water. Oceanic crust floats on the mantle but not as high as the continental crust. As a result, it is covered with water—the oceans.

11. Describe Continental Drift and relate it to the supercontinent Pangaea.

In 1912 Alfred Wegener, a German geophysicist, combined multiple lines of evidence and suggested that in the past all of the continents had formed one supercontinent (which he named **Pangaea**) that began breaking up about 180 million years ago. He proposed that the continents move (or drift) over time. He called his hypothesis **Continental Drift**. Evidence for the movement of the continents included the fact that the coasts of

the continents on opposite sides of the Atlantic fit together like pieces of a jigsaw puzzle and that rocks and fossils match each other on opposite sides of the Atlantic.

12. Why was Continental Drift not widely accepted?

Continental Drift was not widely accepted because Wegener could not supply a plausible mechanism to account for the motion of the continents.

13. Define the term mid-ocean ridge.

The **mid-ocean ridge** is a continuous chain of volcanic submarine mountains that encircles the globe. The mid-ocean ridge system is the largest geological feature on the planet.

14. What are trenches?

Trenches are deep depressions in the sea floor. They are particularly common in the Pacific Ocean.

15. What is sediment?

Sediment is loose material such as mud or sand. It settles on the sea floor, creating thicker and thicker piles over time.

16. What unusual characteristics did geologists find as they studied the mid-ocean ridges and trenches?

Both are very geologically active—earthquakes cluster at the ridges and volcanoes are common near trenches. Layers of sediment get thicker and thicker moving away from the mid-ocean ridges (and towards the continents on either side). Also, deep-sea drilling revealed that the oldest, deepest sediments are found the farthest away from the mid-ocean ridges.

17. Briefly discuss earth's magnetic field and its reversals over time.

The earth's magnetic field reverses direction (**polarity**) a few times every million years. The current orientation where a magnetic compass points north is called "**normal**" orientation. During reversed periods, a magnetic compass would point south. The cause of these reversals is thought to be related to the movement of material in the molten outer core.

18. Briefly discuss the impact of the earth's magnetic field switching polarity on oceanic crust.

Basalt rocks (which make up oceanic crust) contain magnetic minerals. The magnetic orientation of those minerals is "set" to point towards the magnetic pole when the rock cools and forms. If oceanic crust forms when the earth's magnetic field is reversed, it will retain that orientation even after the magnetic field switches.

19. Describe the pattern of magnetic anomalies in oceanic crust.

The **magnetic anomaly stripes** run parallel to the mid-ocean ridges and represent zones in which the basalt rocks on the sea floor alternate between normal and reversed magnetization. The bands are symmetric around the ridge, so that the pattern on one side of the ridge is the mirror image of the pattern on the other side. These magnetic anomalies, therefore, formed at different times during the earth's history and can be used to help establish dates for past events.

20. What is a rift? What happens at a rift?

The oceanic crust is separating at the mid-ocean ridges, creating a crack or **rift** in the crust. Hot, molten mantle material moves up into the crack. This pushes the oceanic crust around the rift upwards, creating the mid-ocean ridge. When the molten mantle material reaches the sea floor, it cools and forms new oceanic crust (with its magnetic minerals locked into either a normal or reversed polarity).

21. Describe sea-floor spreading.

New oceanic crust is continuously added to the mid-ocean ridges in the process of **sea-floor spreading** that was described in the answer to question 20. New oceanic crust is pushed to each side of the mid-ocean ridge as new magma moves up into the rift. Because they are the site of sea-floor spreading, mid-ocean ridges are also called **spreading centers**.

22. Relate the pattern of sediment accumulation on the sea floor to sea-floor spreading.

The sea floor closest to the mid-ocean ridges is relatively young and has not had time to accumulate a layer of sediment. The age of the sea floor increases moving in either direction away from the mid-ocean ridges; the older the sea floor, the more time it has had to accumulate sediment. The thickest layers of sediments typically are found farthest from the mid-ocean ridges.

23. What is the lithosphere?

The **lithosphere** is a layer, about 100 km (60 mi) thick, that is fairly rigid and is made up of the crust and the uppermost part of the mantle.

24. What are lithospheric plates?

The lithosphere is broken into a number of sections, each of which is called a **plate**. A plate can contain continental crust, oceanic crust, or both. The lithospheric plates "float" on top of the **asthenosphere**, a denser and more plastic layer of the mantle that lies directly below the lithosphere.

25. Describe the process of subduction.

Sea-floor spreading adds new material (in the form of oceanic crust) to the lithospheric plates. **Subduction** is a process that destroys lithospheric plates. The two processes are balanced (or the earth would be getting bigger or smaller).

Lithospheric plates are destroyed at deep-sea trenches, which form when two lithospheric plates collide and one of the plates dips below the other and sinks back down into the mantle, where it melts. Deep-sea trenches are called **subduction zones**, because this is where subduction occurs.

26. Describe subduction of an oceanic plate beneath a continental plate.

When an oceanic plate collides with a continental plate, it is always subducted beneath the continental plate because it is denser. This collision results in the development of continental volcanoes that occur on the continental side of the deep-sea trench. These volcanoes often form coastal mountain ranges. Examples include the Andes in South America. Earthquakes are also common.

27. Describe subduction of an oceanic plate beneath an oceanic plate.

When an oceanic plate collides with an oceanic plate, one of the plates dips beneath the other to form a trench. Earthquakes and volcanoes that rise from the sea floor to create chains of volcanic islands are common. The Aleutian, Japanese, Philippine, and Mariana island chains are examples.

28. Describe the collision between two continental plates.

Because both plates are of relatively low density, neither plate is subducted. Therefore, no trench forms. Instead, the continents push against each other with tremendous force and "weld" together. Eventually, the continental rocks buckle and fold like an accordion, and the huge folds form mountain ranges. The Himalayas, for example, formed when India collided with Asia.

29. Describe a shear boundary between lithospheric plates.

Unlike subduction (which destroys lithospheric plates) and sea-floor spreading (which creates new plates), this type of plate tectonic boundary is "neutral." In this case, the two plates move past each other. The zone where the movement occurs is called a **transform fault**, and in the fault zone there is a great deal of friction between the plates. This keeps the plates from sliding smoothly past one another. Instead, they move episodically, causing earthquakes. The San Andreas Fault in California is the largest and most famous example of a shear boundary.

31. Describe Pangaea 200 million years ago.

200 million years ago all of the continents were assembled into one supercontinent called Pangaea. Pangaea was surrounded by a single, vast ocean called **Panthalassa**; it is the ancestor of today's Pacific ocean.

32. What does the type of sediment on the sea floor indicate about past climate and conditions?

The sediments laid down on the sea floor reflect the prevailing conditions in the ocean above. Oceanographers can learn about the past history of the earth, the oceans, and climate by studying the record of the sediments.

33. What are lithogenous and biogenous sediments?

Lithogenous sediment is derived from the breakdown, or weathering, of rocks. The most common lithogenous sediment on the open ocean floor is a fine sediment called red clay.

Biogenous sediment is made up of the skeletons and shells of marine organisms. Biogenous sediment is made mostly of calcium carbonate or silica. When biogenous sediments are the most common sediment on the sea floor, they are called **oozes**.

34. What are the two main regions of the sea floor?

The two main regions of the sea floor are the **continental margins**, which are the submerged edges of the continents, and the **deep-sea floor**.

35. List and briefly describe the parts of the continental margin.

The continental margin consists of a shallow, gently sloping **continental shelf**, a steeper **continental slope** seaward of the continental shelf, and another gently sloping region, the **continental rise**, at the base of the continental slope. The continental shelf ends at the **shelf break**, where the slope abruptly steepens.

	Width	Depth	Slope	Info
Continental Shelf	0.6 to 470 miles wide	0 to 400-600 feet	very gently sloping	–biologically rich –part of the continent –submarine canyons
Shelf Break		400-600 feet		–transition from shelf to slope
Continental Slope		400-600 to 10,000-16,500 feet	steep (2-6 degrees)	–edge of the continent
Continental Rise		400-600 to 10,000-16,500 feet	less steep	–deep-sea fans –lower part of the cont. slope

36. Distinguish between active and passive continental margins.

Active continental margins have narrow shelves, steep slopes, and little or no continental rises. They occur at lithospheric plate boundaries, where subduction and trenches are common. The West Coast of the United States is an example of an active continental margin.

Passive continental margins have wide shelves, relatively gentle slopes, and well-developed rises. They occur far from tectonic boundaries. The East Coast of the United States is an example.

37. List and briefly describe the parts of the deep-ocean basin.

The deep-sea floor lies at a depth of 10,000 to 16,500 feet and averages about 13,000 feet of depth. The deep-ocean basin is made up of the **abyssal plain**, a very flat, extensive area that gently slopes up to the mid-ocean ridges. The abyssal plain contains **seamounts** and volcanic islands. Features indicative of plate tectonic activity interrupt the abyssal plains: mid-ocean ridges where sea-floor spreading occurs and trenches, where subduction occurs. Trenches are the deepest place on earth (the Mariana Trench in the western Pacific is 36,163 feet deep).

38. Briefly describe hydrothermal vents.

Hydrothermal vents are associated with lithospheric plate boundaries. Cracks in the sea floor in this area allow sea water to seep down close to the rising magma and to be heated to very high temperatures (as high as 660°F). This hot water forces its way back to the sea floor, where it creates hydrothermal vents, which are deep-sea hot springs. Hydrothermal vents release hot, mineral-rich water, which mixes with the surrounding cold, mineral-poor water. Unexpectedly rich marine life is found at hydrothermal vents.

Critical Thinking Questions

39. The process of plate tectonics is occurring today in the same way as in the past. Can you project future positions of the continents by looking at a map of their present positions and the positions of the mid-ocean ridges? (See Fig. 2.6)

North and South America will be farther west toward the Pacific, Europe and Asia farther to the southeast, Australia farther to the northeast, and Africa farther east. The Pacific therefore is expected to be narrower and the Atlantic wider.

40. Why are most oceanic trenches found in the Pacific Ocean?

The Pacific Ocean is shrinking and lithospheric plates are descending below the surrounding lithospheric plates along its edges during the process of subduction, hence the creation of trenches.

41. Scientists who study forms of marine life that lived more than approximately 200 million years ago usually obtain fossils not from the sea floor but from areas that were once underwater and have been uplifted onto the continents. Why do you think this is?

Part of what was the sea floor at that time is now above sea level. This is partly because sea level has changed over time and partly because plate tectonic collisions between lithospheric plates have pushed sea floor sediments and rocks onto the continents.

42. What are some of the major pieces of evidence for the theory of plate tectonics? How does the theory explain these observations?

Evidence includes: the fitting together of the coasts of the continents on opposite sides of the Atlantic Ocean, the similarity of geologic formations and fossils found on the opposite sides of the oceans, a geologically active mid-ocean ridge running along the central Atlantic between the opposite coasts, bottom sediments that get thicker the farther one travels from the ridge, and rocks on the sea floor on one side of the ridge show magnetic bands that are mirror images of rocks found on the opposite side of the ridge. All of these observations are explained by sea-floor spreading at the mid-ocean ridge.

Practice Test Answers:

1. c	11. e	21. e	31. b	41. c
2. d	12. e	22. a	32. c	42. e
3. b	13. d	23. e	33. d	43. c
4. d	14. e	24. d	34. c	44. a
5. a	15. d	25. b	35. e	45. c
6. e	16. e	26. e	36. d	46. a
7. a	17. e	27. d	37. d	47. d
8. b	18. a	28. e	38. b	
9. c	19. a	29. a	39. e	
10. b	20. c	30. d	40. e	