CHAPTER 02: The Way the Earth Works: Plate Tectonics

MULTIPLE CHOICE

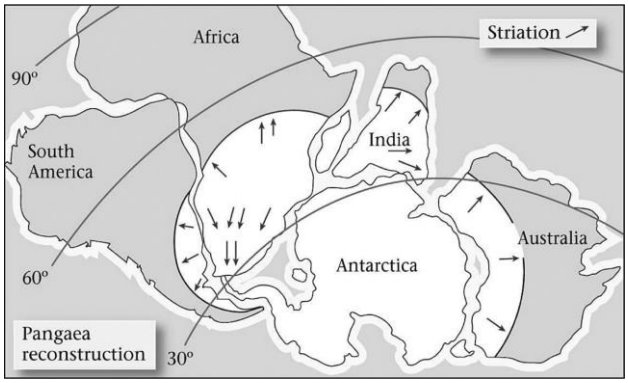
1. In Wegener's evidence for continental drift, continents were proposed to fit together, such as the east coast of South America with the _____.
   a. west coast of Europe
   b. east coast of Africa
   c. west coast of Greenland
   d. lower west coast of Africa

   ANS: D DIF: Moderate REF: 2.2
   OBJ: Understand Wegener's evidence for continental drift. MSC: Remembering

2. Evidence that glaciers once covered an area might include _____.
   a. till and striations
   b. backwash and striations
   c. till and grabens
   d. backwash and grabens

   ANS: A DIF: Moderate REF: 2.2
   OBJ: Understand Wegener's evidence for continental drift. MSC: Remembering

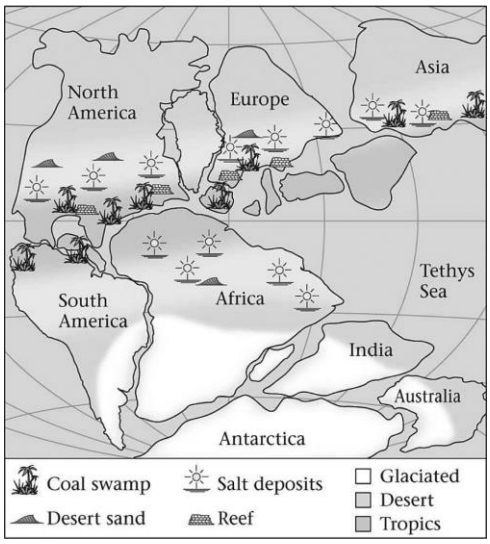
3. Late Paleozoic glacial deposits are NOT found in which of the following places?



   a. India
   b. southern Africa
   c. North America
   d. South America

   ANS: C DIF: Easy REF: 2.2
   OBJ: Understand Wegener's evidence for continental drift. MSC: Understanding

4. Consult the figure below. Abundant swamps led to the formation of coal during the Late Paleozoic in which of the following places?



a. India
b. southern Africa
c. North America
d. Antarctica

ANS: C DIF: Easy REF: 2.2
OBJ: Understand Wegener's evidence for continental drift. MSC: Understanding

5. Wegener's idea of continental drift was rejected by American geologists because _____.
   a. his English was too poor to be understood by them
   b. he could not conceive of a valid mechanism that would cause continents to shift positions
   c. he had relatively little evidence supporting the existence of a supercontinent
   d. the apparent fit of continental coastlines is blurred when the margins are defined by the edges of continental shelves rather than sea level

   ANS: B DIF: Moderate REF: 2.1 | 2.2
   OBJ: Understand Wegener's evidence for continental drift. MSC: Understanding

6. If a geologist discovered coal in a modern-day cold, snowy location, he or she could conclude that _____.
   a. a meteorite must have struck the area
   b. the area was once covered with swamps and/or jungles
   c. the area was once covered with an ocean
   d. this discovery was anomalous

   ANS: B DIF: Difficult REF: 2.2
   OBJ: Understand Wegener's evidence for continental drift. MSC: Applying

7. If a geologist discovered striations (scratches) on bedrock surfaces and small hills composed of poorly sorted sediment, what could he or she conclude about the area?
   a. that a fault used to run through the area
   b. that the area used to be a beach along an ocean
   c. that glaciers had once covered the area
   d. that mountains had once covered the area

   ANS: C DIF: Difficult REF: 2.2
   OBJ: Understand Wegener's evidence for continental drift. MSC: Applying

8. Limestone reefs and salt deposits are important rocks in the reconstruction of Earth's history because they _____.
   a. can be used to infer the ancient climate of Earth; they are deposited in environments that

are restricted to warm climates
b. automatically provide age information; all such deposits occurred between 200 and 400 million years ago
c. are deposited in warm climates today, but there is good reason to think that they were deposited in cold climates millions of years ago
d. pinpoint the locations of old subduction zones

ANS: A DIF: Moderate REF: 2.2
OBJ: Understand Wegener's evidence for continental drift. MSC: Analyzing

9. The apparent tendency of the north (or south) magnetic pole to vary in position over time is termed _____.
a. dipole
b. magnetic declination
c. magnetic inclination
d. polar wander

ANS: D DIF: Easy REF: 2.3
OBJ: Understand how the study of paleomagnetism proves that continents move.
MSC: Remembering

10. What does an ordinary compass indicate?
a. magnetic inclination
b. magnetic declination
c. magnetic north
d. true north

ANS: C DIF: Moderate REF: 2.3
OBJ: Understand how the study of paleomagnetism proves that continents move.
MSC: Remembering

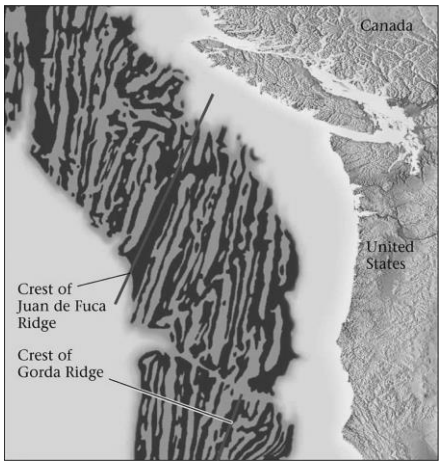
11. In the geologic past, the polarity of Earth's magnetic field is _____.
a. unknown, but it is assumed to have been identical to today's
b. known to have stayed constant through geologic time, as shown by remnant magnetization of iron-rich minerals in rocks
c. known to have experienced numerous reversals, as shown by remnant magnetization of iron-rich minerals in rocks
d. known to have stayed constant through time, based on theoretical calculations

ANS: C DIF: Easy REF: 2.3
OBJ: Understand how the study of paleomagnetism proves that continents move.
MSC: Understanding

12. Regions of the seafloor with positive magnetic anomalies were formed during times when Earth's magnetic field _____.
a. was exceptionally strong
b. was exceptionally weak
c. had normal polarity
d. had reversed polarity

ANS: C DIF: Easy REF: 2.5
OBJ: Understand how the study of paleomagnetism proves that continents move.
MSC: Understanding

13. According to the figure below, marine magnetic anomalies lay roughly _____ to mid-ocean ridges.



a. perpendicular
b. parallel
c. adjacent
d. at an obtuse angle

ANS: B DIF: Easy REF: 2.5
OBJ: Understand how the study of paleomagnetism proves that continents move.
MSC: Applying

14. Seafloor spreading _____.
a. recycles old oceanic crust
b. closes ocean basins
c. creates new continental crust
d. creates new oceanic crust

ANS: D DIF: Easy REF: 2.4
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Remembering

15. Seafloor spreading occurs at _____ boundaries.
a. divergent
b. convergent
c. transform
d. transvergent

ANS: A DIF: Easy REF: 2.4
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Remembering

16. The discovery of seafloor spreading finally provided a mechanism for _____.
a. subduction zones
b. continental drift
c. transgressions
d. normal faulting

ANS: B DIF: Moderate REF: 2.4
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Remembering

17. Seafloor spreading is driven by volcanic activity _____.
a. in the middle of abyssal plains
b. along mid-ocean ridges
c. at the edges of continental shelves
d. along fracture zones

ANS: B DIF: Easy REF: 2.4
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Understanding

18. The rate of seafloor spreading exactly matches the rate of _____.
a. ocean subsidence
c. subduction

b. transgression
d. erosion of the seafloor

ANS: C DIF: Moderate REF: 2.4
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Understanding

19. Marine magnetic anomalies can be used to estimate the _____.
a. rate of seafloor spreading
b. rate of seafloor subsidence
c. age of the seafloor sediments
d. rate of Earth's expansion

ANS: A DIF: Difficult REF: 2.5
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Understanding

20. Younger oceanic crust will have _____ ocean sediments, while older oceanic crust will have _____ oceanic sediments.
a. older; younger
b. carbonate; silicic
c. thicker; thinner
d. thinner; thicker

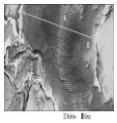
ANS: D DIF: Difficult REF: 2.5
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Understanding

21. Using the image below, which marine magnetic anomalies show a reversed polarity?

a. A, D, E
b. A, B, F
c. B, C, F
d. C, D, F

ANS: C DIF: Easy REF: 2.5
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Applying

22. According to the image below, where is new oceanic crust being formed?



a. A
b. B
c. C
d. D

ANS: A DIF: Moderate REF: 2.4
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Applying

23. A geologist aboard a deep-sea research vessel has collected several drill cores of oceanic crust from the bottom of the ocean. The cores are collected in order from east to west along the bottom of the basin and are labeled A1, B1, C1, and D1, respectively. Core A1 has 2.88 meters (m) of clay and siliceous ooze covering 4.86 m of pillow basalt. Core B1 has 2.37 m of muddy, clayey ooze covering 3.57 m of basalt. Core C1 has 2.11 m of clay and siliceous ooze followed by 3.2 m of basalt. Core D1 has 1.87 m of siliceous ooze over 2.54 m of basalt. Which core is closest to the mid-ocean ridge?
a. A1
c. C1

b. B1 d. D1

ANS: D DIF: Difficult REF: 2.5
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Applying

24. Which of the following was NOT used as evidence for seafloor spreading?
a. high heat flow at mid-ocean ridges
b. jigsaw puzzle fit of the continents
c. progressive change in age of crust
d. changes in thickness of sediments

ANS: B DIF: Difficult REF: 2.5
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Applying

25. Why was the discovery of marine magnetic anomalies so important to the theory of seafloor spreading?
a. because they show a record of marine fossils, which can be linked to geologic time
b. because they proved that Earth's magnetic field reverses polarity throughout history
c. because they show an accurate record of the creation and movement of oceanic crust
d. because they allowed geologists to record the amount of oceanic crust formed

ANS: C DIF: Moderate REF: 2.5
OBJ: Understand how seafloor spreading works, and how geologists can prove that it takes place.
MSC: Analyzing

26. Continental coastlines that occur within the interior of a tectonic plate are called _____ margins.
a. internal
b. passive
c. active
d. inert

ANS: B DIF: Easy REF: 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Remembering

27. The theory of _____ states that the lithosphere is broken into a series of plates that move relative to each other.
a. plate drift
b. seafloor spreading
c. continental drift
d. plate tectonics

ANS: D DIF: Easy REF: 2.1
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Remembering

28. Compared to typical oceanic lithosphere, the thickness of continental lithosphere is _____.
a. less
b. greater
c. approximately the same
d. There is not a consistent pattern of lithospheric thickness.

ANS: B DIF: Moderate REF: 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Remembering

29. Under the theory of plate tectonics, the plates themselves are _____.
a. discrete pieces of lithosphere at the surface of the solid Earth that move with respect to one another

b. discrete layers of lithosphere that are vertically stacked one atop the other
c. composed only of continental rocks that plow through the weaker oceanic rocks
d. very thick (approximately one-quarter of Earth's radius)

ANS: A DIF: Easy REF: 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Understanding

30. Unlike the lithosphere, the asthenosphere _____.
a. is able to flow over long periods of time
b. has a density similar to the core
c. varies in thickness from place to place
d. is relatively cool

ANS: A DIF: Moderate REF: 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Understanding

31. The thickness of oceanic lithosphere is _____.
a. nearly uniformly 100 kilometers
b. greatest at the geographic poles and least near the equator
c. greatest near the mid-ocean ridges and thins out away from the ridges
d. least near the mid-ocean ridges and thickens away from the ridges

ANS: D DIF: Moderate REF: 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Applying

32. Deformed (bent, stretched, or cracked) lithosphere occurs _____.
a. randomly over the surface of Earth
b. primarily within the interiors of tectonic plates
c. primarily on the margins of tectonic plates
d. primarily at hot spots

ANS: C DIF: Moderate REF: 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Applying

33. The primary difference between lithospheric and asthenospheric mantle that gives rise to numerous different patterns of physical behavior is _____.
a. physical state: the lithosphere is solid; the asthenosphere is liquid
b. chemical composition: the lithosphere is mafic; the asthenosphere is felsic
c. temperature: the lithosphere is cooler than the asthenosphere
d. chemical composition: the lithosphere is felsic; the asthenosphere is mafic

ANS: C DIF: Difficult REF: 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Analyzing

34. At a subduction zone, the down-going (subducting) plate _____.
a. is always composed of continental lithosphere
b. is always composed of oceanic lithosphere
c. may be composed of either oceanic or continental lithosphere
d. is composed entirely of asthenosphere

ANS: B DIF: Easy REF: 2.8

OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Remembering

35. The distribution of _____ across the globe provides the primary indicator of boundaries between all tectonic plates.
a. mountain ranges
b. volcanoes
c. mid-ocean ridges
d. earthquakes

ANS: D DIF: Easy REF: 2.6
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Remembering

36. Which of these parts of the deep-ocean floor is flat and nearly featureless?
a. ridge axis
b. abyssal plain
c. guyot
d. trench

ANS: B DIF: Easy REF: 2.4
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Remembering

37. Beneath a blanket of sediments, oceanic crust is primarily composed of _____.
a. granite
b. basalt
c. limestone
d. coal

ANS: B DIF: Moderate REF: 2.4
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Remembering

38. With increasing distance from a mid-ocean ridge, the age of oceanic crust _____.
a. increases
b. decreases
c. stays constant
d. varies randomly

ANS: A DIF: Easy REF: 2.7
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Understanding

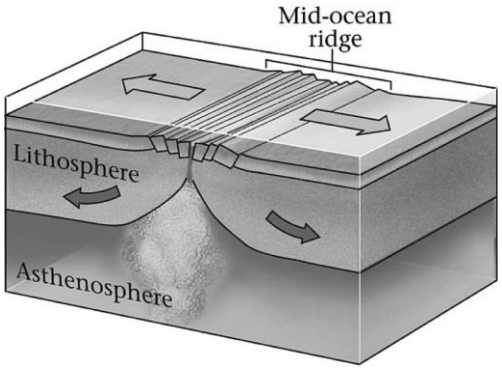
39. Slab pull occurs because subducting slabs are _____.
a. less mafic, and therefore less dense, than surrounding asthenosphere
b. cooler, and therefore more dense, than surrounding asthenosphere
c. hotter, and therefore more dense, than surrounding asthenosphere
d. cooler, and therefore less dense, than surrounding asthenosphere

ANS: B DIF: Moderate REF: 2.12
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Understanding

40. Transform boundaries occur most frequently along _____boundaries in order to break the _____ into segments so as to accommodate motion on a sphere.
a. convergent; accretionary prisms
b. convergent; deep ocean trenches
c. divergent; mid-ocean ridges
d. divergent; magnetic anomalies

ANS: C DIF: Difficult REF: 2.9
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Understanding

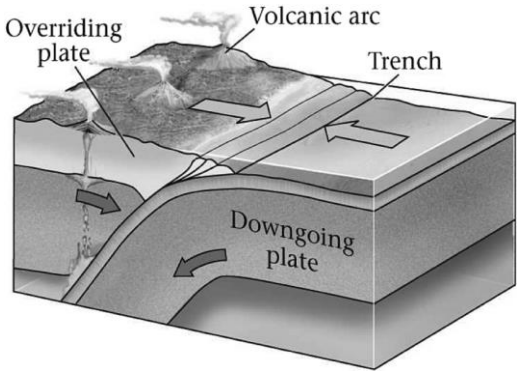
41. Which basic type of plate boundary is shown in the image below?



a. divergent
b. convergent
c. transvergent
d. transform

ANS: A DIF: Easy REF: 2.7
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Applying

42. Which basic type of plate boundary is shown in the image below?



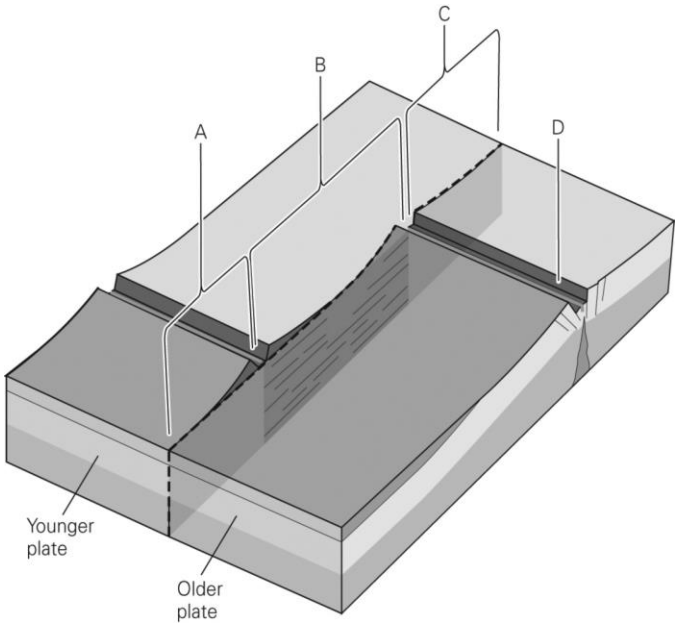
a. divergent
b. convergent
c. transvergent
d. transform

ANS: B DIF: Easy REF: 2.8
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Applying

43. At transform plate boundaries, _____.
a. earthquakes are common but volcanoes are absent
b. volcanoes are common but earthquakes do not occur
c. both earthquakes and volcanoes are common
d. neither earthquakes nor volcanoes are common

ANS: A DIF: Moderate REF: 2.9
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Applying

44. The image below shows a view of a typical segmented mid-ocean ridge. Which letter below marks the location of the active transform fault?



a. A
b. B
c. C
d. D

ANS: B DIF: Difficult REF: 2.9
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Applying

45. The mid-ocean ridges are elevated above the surrounding seafloor because _____.
a. ridge rocks are hot and therefore have relatively low density
b. the lithosphere is thickest at the ridges so they stand up taller
c. rising ocean currents create a vacuum that pulls ridges up
d. ridge rocks are mafic, which are less dense than ultramafic ocean basin rock

ANS: A DIF: Difficult REF: 2.7
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Analyzing

46. The rate of motion of a lithospheric plate with respect to a stationary location inside Earth is termed _____ *plate velocity*, while the motion of a plate with respect to another is termed _____ *plate velocity*.
a. absolute; relative
b. relative; absolute
c. Both are measures of absolute velocity.
d. Both are measures of relative velocity.

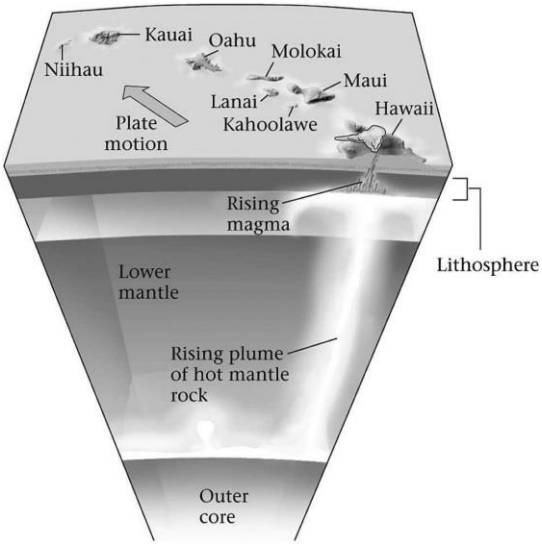
ANS: A DIF: Moderate REF: 2.12
OBJ: Understand how fast plates move, and how we can measure the rate of movement.
MSC: Remembering

47. Summed over the entire surface of Earth, the rate of spreading at divergent boundaries is _____ lithospheric consumption at subduction zones.
a. faster than
b. slower than
c. equal to
d. This cannot yet be measured by geologists.

ANS: C DIF: Moderate REF: 2.8
OBJ: Understand how fast plates move, and how we can measure the rate of movement.

MSC: Understanding

48. Consult the figure below. Hawaii is an example of _____.



a. hot-spot volcanism
b. mid-ocean-ridge volcanism
c. a volcanic island arc formed by subduction
d. transform margin

ANS: A DIF: Easy REF: 2.12
OBJ: Understand how fast plates move, and how we can measure the rate of movement.
MSC: Applying

49. Hot spots can occur _____.
a. only within continental plates
b. only within oceanic plates
c. within either continental or oceanic plates
d. only when the thickness of the crust is less than 10 km

ANS: C DIF: Moderate REF: 2.1
OBJ: Understand how fast plates move, and how we can measure the rate of movement.
MSC: Applying

50. What would happen if the rate of seafloor spreading was faster than the rate of subduction?
a. Arc volcanoes would not form.
b. The ocean basins would shrink.
c. The Earth would become smaller.
d. The Earth would grow larger.

ANS: D DIF: Moderate REF: 2.8
OBJ: Understand how fast plates move, and how we can measure the rate of movement.
MSC: Analyzing

SHORT ANSWER

1. Explain why Wegener's theory of continental drift was not originally accepted by geologists of his time?

ANS:

Wegener could not provide a plausible mechanism for the movement of continents. He proposed that centrifugal force caused the continents to plow through the oceans. However, the magnitude of centrifugal force produced by the rotation of Earth is not sufficient to move such large masses. In addition, the continental crust is much too weak to plow through the much stronger oceanic crust.

DIF: Easy REF: 2.1 | 2.2
OBJ: Understand Wegener's evidence for continental drift. MSC: Understanding

2. Describe the process of seafloor spreading, making sure to address why the diameter of Earth is not growing.

ANS:
As plates move apart at a divergent plate boundary, magma rises into the new space, erupting at the surface to form pillow basalts and cooling along the sides of the fracture to form gabbro dikes. These pillow basalts and gabbro dikes become new oceanic crusts that then move away from each other, and again more magma moves toward the surface to start the process again. This slowly moves the plates apart, forming new oceanic crust and new ocean basins. The newly formed crust is balanced by the recycling of old oceanic crust into subduction zones at convergent boundaries on the opposite sides of ocean basins.

DIF: Moderate REF: 2.4
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Understanding

3. Plate tectonics theory is often referred to as the "unifying" theory in geology. Explain why plate tectonics is such an important theory to the study of Earth.

ANS:
There are many good answers to this; however, a few good answers might reference how before plate tectonics we did not really understand how mountains formed, why volcanoes formed where they did, why earthquakes occur where they do, and so on. Plate tectonics also allows us to explain how and why rocks move through the rock cycle, how oceans form, or why marine fossils can be found at the top of Mount Everest. Any good answer will explain that before the theory of plate tectonics there were very many processes we did not understand, and since plate tectonic theory has been around we have been able to explain many of these processes.

DIF: Difficult REF: 2.1 | 2.6
OBJ: Understand that the Earth's lithosphere is divided into about 20 plates that move relative to one another. MSC: Analyzing

4. Discuss where transform boundaries are primarily found and what their main purpose is.

ANS:
Transform boundaries are primarily found along mid-ocean ridges (MORs); however, they do appear on land in several places around the globe. The main purpose of transform boundaries is to break the MOR into smaller segments, which allows the spreading of the plates at MORs to be accommodated on the three-dimensional, spherical surface of Earth.

DIF: Difficult REF: 2.7 | 2.9
OBJ: Understand the three kinds of plate boundaries and the basis for recognizing them.
MSC: Analyzing

5. A geologist measures the amount of seafloor produced along a MOR to be 45 km. The oldest crust produced is 4.5 Ma. What is the spreading rate of the MOR in cm/yr? Show your work.

ANS:

First convert km → cm: $\frac{45\,km}{1} x \frac{1000\,m}{1\,km} x \frac{100\,cm}{1\,m} = 4,500,000\,cm$

Convert Ma → yr: $\frac{4.5\,Ma}{1} x \frac{1,000,000\,yr}{1\,ma} = 4,500,000\,yr$

Plug into v = d/t: $v = \frac{4,500,000\,cm}{4,500,000\,yr} = 1\,\frac{cm}{yr}$

DIF: Moderate REF: 2.12
OBJ: Understand how fast plates move, and how we can measure the rate of movement.
MSC: Applying