***Earth: An Introduction to Physical Geology***

**Plate Tectonics: A Scientific Revolution Unfolds**

2.1 Multiple-Choice Questions

1) Which scientist developed the idea of Continental Drift?

A) Isaac Newton

B) Charles Darwin

C) Albert Einstein

D) Alfred Wegener

Answer: D

Earth Science LO: 1.5 - Earth scientists use their understanding of the past to forecast Earth's future.

2) Which war was indirectly responsible for the development of the more modern tools that made the theory of Plate Tectonics possible?

A) World War I

B) World War II

C) Korean War

D) Vietnam War

Answer: B

Earth Science LO: 1.7 - Technological advances, breakthroughs in interpretation, and new observations continuously refine our understanding of Earth.

3) What is the name of the supercontinent proposed by Alfred Wegener?

A) Pangaea

B) Rodinia

C) Amasia

D) Nuna

Answer: A

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

4) Although the jigsaw-puzzle fit of the southern continents was noted, opponents of Continental Drift argued that, even if continental displacement had occurred, a good fit between the continents today would be unlikely. What geological evidence did they cite to support this claim?

A) Deposition in river deltas had changed the longshore current, resulting in erosion

B) The tensional stress of splitting sheared the continents beyond all repair

C) Wave erosion and coastal deposition have changed the shape of the continents

D) Fissure eruptions along continental margins had created new land

Answer: C

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Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

5) Even before the proposal of Continental Drift, paleontologists recognized that some sort of land connection was needed to account for the identical fossil organisms found on multiple continents. Which of the following was **not** one of their hypotheses?

A) Glacial forebulges raising the land surface

B) A chain of island stepping stones

C) Floating debris used as rafts

D) A transoceanic land bridge

Answer: A

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

6) When the continents were assembled and mountain ranges were matched up, mountains in Scandinavia and the British Isles matched up perfectly with which North American mountain range?

A) Rocky Mountains

B) Appalachian Mountains

C) Sierra Nevada Mountains

D) Olympic Mountains

Answer: B

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

7) When considering evidence of glaciation on the southern continents, why did Wegener reject the explanation that the entire planet had experienced a period of extreme cooling?

A) Because the glacial debris was localized to a few small mountain valleys

B) Because he knew the "glacial debris" was actually a misinterpreted landslide

C) Because geologic evidence supported the existence of tropical swamps in the Northern Hemisphere

D) Because the 16O/18O ratios in fossils supported an ice-free period

Answer: C

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

8) In which decade was the Theory of Plate Tectonics developed?

A) 1940s

B) 1960s

C) 1970s

D) 1990s

Answer: B

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

9) In the mid-20th century, researchers dredging the seafloor could not find any materials older than \_\_\_\_\_\_\_\_.

A) 6,000 years

B) 1.2 million years

C) 180 million years

D) 1.5 billion years

Answer: C

Earth Science LO: 2.4 - Earth's crust has two distinct types: continental and oceanic.

10) Which of the following is **not** one of the major tectonic plates on the Earth's surface?

A) Juan de Fuca Plate

B) North American Plate

C) African Plate

D) Pacific Plate

Answer: A

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

11) The lithosphere is composed of material from the \_\_\_\_\_\_\_\_ and the rigid part of the \_\_\_\_\_\_\_\_.

A) Outer Core; Inner Core

B) Mantle; Outer Core

C) Crust; Lower Mantle

D) Crust; Upper Mantle

Answer: D

Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

12) Which plate boundary accounts for the smallest percentage of all plate boundaries on the surface of the Earth?

A) Convergent Boundaries

B) Divergent Boundaries

C) Transform Boundaries

Answer: C

Focus/Concepts: 2.7

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

13) Continental crust is mainly composed of \_\_\_\_\_\_\_\_ whereas oceanic crust is mainly composed of \_\_\_\_\_\_\_\_.

A) Olivine; Basalt

B) Limestone; Gabbro

C) Granite; Basalt

D) Gabbro; Granite

Answer: C

Earth Science LO: 2.4 - Earth's crust has two distinct types: continental and oceanic.

14) Why are the mid-ocean ridges higher in elevation than the surrounding ocean floor?

A) Due to the high volume of magma issuing from the fissure

B) Warmer material near the ridge is less dense, so floats higher on the mantle

C) The collision of the tectonic plates is forcing material higher

D) Thermal springs developing in stress fractures are depositing large volumes of material, increasing the height

Answer: B

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

15) A location where continental rifting is occurring today is \_\_\_\_\_\_\_\_.

A) San Andreas Fault

B) Mid-Continent Rift

C) Juan de Fuca Trench

D) East African Rift Valley

Answer: D

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

16) At a \_\_\_\_\_\_\_\_, one colliding plate will be forced beneath another because of differences in density.

A) Subduction Zone

B) Continental Rift

C) Transform Boundary

D) Twilight Zone

Answer: A

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

17) How will the age and temperature of the subducting plate affect its angle of descent?

A) Older and cooler plates will have a shallow angle of descent

B) Older and warmer plates will have a steeper angle of descent

C) Younger and warmer plates will have a shallow angle of descent

D) Younger and colder plates will have a steeper angle of descent

Answer: C

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

18) A \_\_\_\_\_\_\_\_ is a geographic low marking the location where oceanic lithosphere descends into the mantle.

A) Fold and Thrust Mountains

B) Deep-Ocean Trench

C) Benioff Zone

D) Mid-Ocean Rift

Answer: B

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

19) Which type of convergence will result in a continental volcanic arc?

A) Oceanic-Continental

B) Oceanic-Oceanic

C) Continental-Continental

Answer: A

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

20) Which type of convergence will result in a volcanic island arc?

A) Oceanic-Continental

B) Oceanic-Oceanic

C) Continental-Continental

Answer: B

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

21) Where are the majority of transform faults located?

A) Southern California

B) On the ocean floor offsetting segments of oceanic ridge

C) Radiating from convergent boundaries as stress fractures

D) Along mountain ranges that have been thrust up due to collision

Answer: B

Section: 2.7 - Transform Plate Boundaries

Focus/Concepts: 2.7

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

22) What is a mantle plume?

A) The magma that rises up from the mantle at a divergent plate boundary

B) Material rising up from a subducting plate going through partial melting

C) A form of batholith composed of ferromagnesian materials

D) An upwelling of hot material from the Earth's interior that is cylindrical in shape

Answer: D

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.2 - Earth, like other planets, is still cooling, though radioactive decay continuously generates heat.

23) \_\_\_\_\_\_\_\_ is when iron particles in lavas align their magnetic fields with magnetic north, preserving a record of that pole's location at that moment in time.

A) Mantle Plume

B) Paleomagnetism

C) Magnetic Reversal

D) Seafloor Spreading

Answer: B

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

24) A typical rate of seafloor spreading in the Atlantic Ocean is *\_\_\_\_\_\_\_\_*.

A) 2 meters per year

B) 0.1 inches per year

C) 20 feet per year

D) 2 centimeters per year

Answer: D

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

25) All of the following are evidence supporting the theory of plate tectonics except for *\_\_\_\_\_\_\_\_*.

A) Changes in the Moon's orbit due to shifting plates

B) Ocean floor drilling

C) Hot spots

D) Measurements of plate motions

Answer: A

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

26) Where is the top of the asthenosphere is closest to Earth's surface?

A) Along a mid-ocean ridge

B) Above a deep mantle hot spot

C) Along a transform fault

D) Along a subduction zone

Answer: A

 & 2.5 - Divergent Plate Boundaries and Seafloor Spreading

 & 2.5

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

27) Which of the following statements best describes the tectonic setting for Mount St. Helens and the other Cascade volcanoes?

A) A chain of young, active volcanoes built on a continental margin above a sinking slab of oceanic lithosphere

B) A chain of young, active, volcanoes built as western North America moved over a mantle plume

C) Old, deeply eroded volcanoes built before the Pacific Ocean existed

D) Old, deeply eroded, basaltic volcanoes built when western North America was over the present-day site of the Hawaiian hot spot

Answer: A

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Focus/Concepts: 2 & 7

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

28) How did researchers in the mid-20th century obtain ocean floor samples in order to determine the age of the seafloor?

A) Satellite imagine

B) Manned submersibles

C) Hydraulic vacuum tubes

D) Drilling ships

Answer: D

Earth Science LO: 1.3 - Earth science investigations take many different forms.

29) Samples from the seafloor around the Mid-Atlantic Ridge and the East Pacific Rise show that both areas have been creating new material in the last five million years. Samples from the East Pacific Rise show the five million year old seafloor is three times as wide as similarly aged material from the Mid-Atlantic Ridge. What does this say about the rate of seafloor growth in the East Pacific?

A) The seafloor at both sites is growing at the same rate

B) The seafloor at the East Pacific Rise is growing more slowly

C) The seafloor at the Mid-Atlantic is growing more quickly

D) The seafloor at the Mid-Atlantic is growing more slowly

Answer: D

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

30) What two pieces of information would researchers need to have in order to calculate the rate of plate motion for seafloor spreading?

A) Age of the continent and depth of the water

B) Distance from the rift and age of seafloor sample

C) Age of the seafloor sample and age of the continent

D) Type of rock and distance from the rift

Answer: B

Earth Science LO: 1.3 - Earth science investigations take many different forms.

31) How can satellites and GPS receivers be used to monitor plate motion?

A) GPS receivers are placed on landmasses to track their locations

B) Satellites send lasers to measure the distance to continents

C) GPS receivers send signals to each other to see if the units are getting closer together

D) Satellites track seafloor spreading

Answer: B

Earth Science LO: 1.3 - Earth science investigations take many different forms.

32) How can the orientation of transform faults provide information about the direction of plate motion?

A) Transform faults are oriented perpendicular to the direction of plate motion

B) Transform faults radiate out from the rift zone located in the center

C) Transform faults are parallel to the direction of plate motion

D) Transform faults are parallel to convergent boundaries

Answer: C

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

33) Which is denser: 100 million year-old oceanic lithosphere near a convergent boundary, 15 million year-old oceanic lithosphere near a rift, or the upper part of the asthenosphere?

A) 15 million year-old oceanic lithosphere

B) 100 million year-old oceanic lithosphere

C) Upper Asthenosphere

D) They all have the same density

Answer: B

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

34) What generates the heat necessary for convection in the Earth?

A) Volcanic Eruption

B) Friction between moving slabs

C) Chemical reactions between geologic materials and hydrothermal fluids

D) Decay of radioactive materials

Answer: D

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.2 - Earth, like other planets, is still cooling, though radioactive decay continuously generates heat.

35) \_\_\_\_\_\_\_\_ is when cold oceanic lithosphere are more dense than the underlying warm lithosphere.

A) Slab Pull

B) Slab Push

C) Ridge Push

D) Mantle Drag

Answer: A

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

36) Along which tectonic boundary is ridge push going to be most important?

A) Convergent Boundary

B) Divergent Boundary

C) Transform Boundary

Answer: B

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

37) Which factor contributes the most toward plate motion?

A) Ridge Push

B) Mantle Drag

C) Slab Pull

D) Friction

Answer: C

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

38) In which layer of the Earth does the convection necessary for plate motion occur?

A) Crust

B) Mantle

C) Outer Core

D) Inner Core

Answer: C

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

39) Which model of convection describes how the interior is divided into several levels of convection cells?

A) Layer Cake Model

B) Whole-Mantle Convection

C) Plume Model

D) Differentiation Model

Answer: A

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

40) In the Whole-Mantle Convection model, what feature balances the deeply descending lithosphere by transporting hot material toward the surface?

A) Kimberlites

B) Decompression Melting

C) Mantle Plumes

D) Rift Zones

Answer: C

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

2.2 True/False Questions

1) Wegener was the first scientist to notice the jigsaw puzzle fit of the southern continents.

Answer: FALSE

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

2) One explanation for the wide distribution of Glossopteris seeds is, because they were so small, they could be globally distributed by the wind.

Answer: FALSE

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

3) The interpretations and evidence used in Continental Drift were sound and did not need modification in order to be used for the Theory of Plate Tectonics.

Answer: FALSE

Section: 2.3 - The Great Debate

Focus/Concepts: 2.3

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

4) Oceanic Lithosphere is thickest along oceanic ridges because this is where the new lithospheric material is forming.

Answer: FALSE

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Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

5) The surface of the earth is broken up into seven plates.

Answer: FALSE

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

6) The majority of divergent plate boundaries are associated with oceanic ridges.

Answer: TRUE

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

7) The global ocean ridge system is the longest topographic feature on the Earth's surface.

Answer: TRUE

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

8) Oceanic lithosphere will get thicker the farther it gets from the mid-ocean ridge.

Answer: TRUE

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

9) A convergent plate boundary is a destructive boundary.

Answer: TRUE

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

10) Subduction zones will only develop between a continental plate and an oceanic plate.

Answer: FALSE

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

11) An oceanic plate that has been permeated by water before subduction will melt at a lower temperature than a "dry" oceanic plate.

Answer: TRUE

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

12) Transform boundaries provide the means by which oceanic crust created at divergent boundaries can be carried to the sites of destruction at convergent boundaries.

Answer: TRUE

Section: 2.7 - Transform Plate Boundaries

Focus/Concepts: 2.7

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

13) The magnetic poles roughly correspond to the locations of the geographic poles.

Answer: TRUE

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

14) A transform boundary is usually not associated with volcanism.

Answer: TRUE

Section: 2.7 - Transform Plate Boundaries

Focus/Concepts: 2.7

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

15) A convergent boundary is usually associated with rift valleys and volcanic arcs.

Answer: FALSE

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

16) The total size of tectonic plates does not change.

Answer: FALSE

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

2.3 Short Answer Questions

1) Alfred Wegener provided several pieces of evidence supporting the idea that the planet's continents were once joined in a single landmass. List four of them.

Answer: Answers will vary, but can include any four of the following:

- Jigsaw puzzle fit of the southern continents

- Matching fossils of multiple continents

- Matching mountain ranges across multiple continents

- Matching rock types across multiple continents

- Matching glacial debris on multiple continents

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Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

2) Which two continents did Wegener cite as having the best evidence of a close fit?

Answer: South America and Africa

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

3) The \_\_\_\_\_\_\_\_ is a hotter, weaker region in the mantle that lies below the lithosphere and responds to forces by flowing.

Answer: Asthenosphere

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

4) Which is denser: Oceanic lithosphere or continental lithosphere?

Answer: Oceanic lithosphere

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

5) Analyze and explain how the respective temperatures of the lithosphere and asthenosphere affect those layers' rigidities and responses when force is applied.

Answer: The lithosphere is cooler and more rigid, so will bend or break when force is applied. The asthenosphere is warmer and more pliable, so will flow when force it applied.

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

6) There is an expression in American society that it would only take one good earthquake and the state of California would sink into the ocean. Using what you know about Plate Tectonics, explain why this may or may not be possible.

Answer: To start with, the geology of California is much more complex than this scenario would allow! However, the simplest answer would be that the largest plate boundary in California is a transform boundary, which primarily moves horizontally, not vertically.

 & 2.7 - Transform Plate Boundaries

Focus/Concepts: 2.7

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

7) \_\_\_\_\_\_\_\_ is the name of the process by which new seafloor is generated at mid-ocean ridges.

Answer: Seafloor Spreading

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

8) If there is no compositional difference between two oceanic plates, what factor will determine which will become the subducted plate and why?

Answer: Temperature - colder plates are denser and therefore will become the subducted plate.

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

9) If new plate material is being created at divergent plate boundaries, is the Earth growing larger? Explain why or why not.

Answer: The Earth is remaining the same size because although new plate material is being created, old plate material is being destroyed at convergent boundaries.

 & 2.6 - Convergent Plate Boundaries and Subduction

 & 2.6

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

10) \_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_ drive water from the pores of a subducted oceanic plate, which leads to partial melting.

Answer: Heat; Pressure

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

11) At a Continental-Continental convergence, will continental plate material descend into the mantle during subduction? Why or why not?

Answer: No. Due to its lower density, it is too buoyant to be forced into the mantle. Instead, the colliding continental materials will shorten and thicken.

Earth Science LO: 4.7 - Landscapes result from the dynamic interplay between processes that form and uplift new crust and processes that destroy and depress the crust.

12) Lava solidifying during a period of reverse polarity will align the magnetic fields of its iron particles toward the \_\_\_\_\_\_\_\_ pole.

Answer: South

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

2.4 Matching Questions

Match the tectonic boundary with its direction of motion.

A) Two plates pull apart from each other

B) Two plates move toward each other

C) Two plates slide past each other

1) Convergent Boundary

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

2) Divergent Boundary

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

3) Transform Boundary

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

Answers: 1) B 2) A 3) C

Match the tectonic boundary with what the boundary is doing to the crust.

A) Crust is being destroyed

B) Crust is being conserved

C) Crust is being created

4) Convergent Boundary

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

5) Divergent Boundary

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

6) Transform Boundary

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

Answers: 4) A 5) C 6) B

Match the tectonic boundary with the type of stress affecting it.

A) Tension

B) Compression

C) Shear

7) Convergent Boundary

, 2.6 - Convergent Plate Boundaries and Subduction, & 2.7 - Transform Plate Boundaries

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

8) Divergent Boundary

, 2.6 - Convergent Plate Boundaries and Subduction, & 2.7 - Transform Plate Boundaries

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

9) Transform Boundary

, 2.6 - Convergent Plate Boundaries and Subduction, & 2.7 - Transform Plate Boundaries

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

Answers: 7) B 8) A 9) C

Match the convergent boundary with a real-world example.

A) Pacific & Philippine Plates

B) Indian & Eurasian Plates

C) North American & Juan de Fuca Plates

10) Oceanic-Continental

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Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

11) Oceanic-Oceanic

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Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

12) Continental-Continental

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Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

Answers: 10) C 11) A 12) B

2.5 Essay Questions

1) Explain how geologists regarded the positions of the ocean basins and the continents prior to the 1960s and how that perspective differs from how modern geologists regard those same features.

Answer: Prior to the 1960s, geologists viewed the ocean basins and continents as fixed features: they neither grew nor moved. They also believed both were incredibly old. However, after the development of the Theory of Plate Tectonics in the 1960s, geologists realized that the continents do migrate across the globe, which changes the size and shape of the ocean basins in the process. As a result, some ocean basins are much younger than was previously believed

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Focus/Concepts: 2.1

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

2) When Continental Drift was first proposed in 1912, geologists from one continent above all were strongly against the idea. Which continent's geologists were against the idea and why did they have difficulty accepting it?

Answer: Geologists from North America were strongly against Continental Drift. Part of the reason behind their reluctance was because the strongest evidence to support it was found in the southern continents (Africa, South America, and Australia), the geology of which was not as well-known to North American scientists.

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Focus/Concepts: 2.1

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

3) The acceptance of Plate Tectonics after the initial rejection of Continental Drift has been described as a scientific revolution. Explain why this scientific revolution took place and what tools were used to bring it about.

Answer: Scientists initially held on to the belief that the continents and ocean basins were fixed objects, both of which dated back to the earliest days of the Earth. When Continental Drift was proposed, which challenged this belief, scientists had difficulty accepting it because the evidence was not as clear to see outside of the southern continents. After World War II, modern tools like sonar, ocean drilling, and magnetometers were used to gather evidence about the age and bathymetry of the seafloor. This evidence (seafloor spreading and paleomagnetism) was used to support Continental Drift and develop the modern Theory of Plate Tectonics.

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, 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

4) Scientific research supports the existence of Alfred Wegener's proposed supercontinent approximately 300 million years ago. It has subsequently broken apart and the pieces - our modern continents - have migrated to the positions they occupy today. Based on your knowledge of the mechanics of tectonic motion, discuss the likelihood of such a supercontinent forming again. Your discussion should include plate boundaries present and how they would help or hinder such a prospect. Should you support this idea, also include in your discussion the probable location you believe the next supercontinent would form.

Answer: The break-up of Pangaea led to the creation of the Atlantic Ocean. The divergent plate boundary that exists today is still spreading, enlarging the basin and pushing North America, South America, Europe, and Africa farther apart. As this basin grows, the Pacific Ocean basin shrinks due to the convergent plate boundaries around the margins of the Pacific Plate. Recent studies indicate that the North American and Eurasian continents will meet over the North Pole (http://www.nature.com/nature/journal/v482/n7384/full/nature10800.html), though it would be reasonable for students to suggest that the next supercontinent would form in the Northern Pacific.

, 6, & 8

Section: 2.8 - Testing the Plate Tectonics Model & 2.9 - How is Plate Motion Measured?

 & 2.9

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

5) Why would using the continental shelves to reassemble to continents provide a better fit than using the margins of the continents?

Answer: The continental margins are continuously eroded by waves or are being built out by longshore currents, fluvial deposition, etc. This changes the shapes of the continents over time. The continental shelves are currently several hundred feet below the erosive power of the waves, so they are left relatively untouched. (The text quotes the depth of the shelf margins used for South America and Africa as 900 m.) This preserves much of the original dimensions of the continental margins.

, 7, & 8

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

6) Mesosaurus is a small aquatic freshwater reptile that existed in the Permian Period. It is only found in black shale deposits found in eastern South America and southwestern Africa. If the Mesosaurus is an aquatic reptile and the continents are separated by an ocean, evaluate why the Mesosaurus would be used as strong evidence **in favor** of Continental Drift rather than as evidence **against** it.

Answer: First, Mesosaurus is a freshwater reptile. It would not have been able to survive the trip across the southern Atlantic Ocean. Second, if it were able to swim such great distances to be able to cross an ocean, it would be reasonable to assume Mesosaurus remains would be more widespread.

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

7) Which two aspects of Continental Drift were most objectionable to scientists of the early 20th century? What evidence was used to support their objections?

Answer:

- Mechanism for Continental Drift: Wegener proposed gravitational forces from the Sun and Moon that produce tides could gradually move the continents. However, if those forces were strong enough to move continents, the Earth's rotation would also have ceased.

- Continental Rocks vs. Oceanic Rocks: Wegener proposed that the continental landmasses broke through the thinner oceanic crust like an ice breaker. However, there was no evidence at the time to suggest such a feat was possible without severe deformation of the continents.

 & 8

Section: 2.3 - The Great Debate

Focus/Concepts: 2.3

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

8) Explain how the polar wandering paths for Europe and North America can be used to support the existence of Pangaea.

Answer: For the first 300 million years, the polar wandering paths for both continents were similar in shape and direction to the pole, but separated by several thousand miles. Starting in the middle of the Mesozoic, both paths began to converge on the North Pole. If these two continents are joined, these polar wandering paths overlap, supporting a unified supercontinent.

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 1.6 - Earth scientists construct models of Earth and its processes that best explain the available geological evidence.

9) Lava lamps are commonly used to illustrate how convection cells in the mantle convey heat from the core to the exterior of the Earth. Explain how convection in a lava lamp transfers heat.

Answer: The bulb at the base of the lamp warms the wax in the lamp. The thermal energy from the absorbed heat causes the atoms of the wax to move farther apart, making the wax less dense and allowing it to rise. Once at the top, the wax begins to cool, losing thermal energy. The atoms of wax move closer together, making the wax denser and forcing it to sink. Once the wax gets near the bulb again, it begins to warm again and the process starts all over.

Section: 2.10 - What Drives Plate Motions?

Focus/Concepts: 2.10

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

2.6 Visual

1)



Using the map provided, identify one convergent boundary, one divergent boundary, and one transform boundary anywhere on the globe.

Answer: See Figure 2.12

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

2)



Using the cross-section provided, explain how new plate material is created at a divergent plate boundary. Make sure your answer includes a discussion on the forces at work and the generation of magma beneath the rift.

Answer: Tensional stress pulls the plates apart, creating a rift between them. The creation of the rift means that there is not as much force (the weight of the overlying plates) pushing down on that part of the mantle, which results in decompression melting that generates magma. Magma is less dense than the surrounding rock and rises up, filling the gap between the two plates. However, the plates are still being pulled apart, so the new material is also pulled apart, with part adhering to each plate.

Earth Science LO: 4.5 - Many active geologic processes occur at plate boundaries.

3)



Label the oceanic and continental lithospheres in this figure.

Answer: See Figure 2.12B

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

4)



Indicate on the figure above which boundaries are divergent and which are transform.

Answer: See Figure 2.12

 & 3

Section: 2.7 - Transform Plate Boundaries

Focus/Concepts: 2.7

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

5) The Hawaiian Mantle Plume has left a chain of volcanic islands and seamounts stretching back for ~70 million years. Although the mantle plume has remained relatively stationary, the Pacific Plate above it has moved. Use the figure below to answer the following question.



What direction was the Pacific Plate moving between 65 and 43 million years ago?

Answer: North

 & 3

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.3 - Earth's interior is in constant motion through the process of convection, with important consequences for the surface.

6) The Hawaiian Mantle Plume has left a chain of volcanic islands and seamounts stretching back for ~70 million years. Although the mantle plume has remained relatively stationary, the Pacific Plate above it has moved. Use the figure below to answer the following question.



What direction has the Pacific Plate been moving for the last 40 million years?

Answer: NW

 & 3

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

7)



The Hawaiian Mantle Plume is still affecting the island of Hawaii. One of the volcanoes on the island is actively erupting because of it. Which volcano is currently erupting because of the mantle plume? (Think about the direction of plate movement you answered in the previous question.)

Answer: Kilauea

 & 3

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.

8) As the island of Hawaii continues to move away from the mantle plume, a new submarine volcano will be created. Off which coast would you expect the new submarine volcano to be forming?

Answer: Off the southeast coast

 & 3

Section: 2.8 - Testing the Plate Tectonics Model

Earth Science LO: 4.4 - Earth's tectonic plates consist of the rock crust and uppermost mantle, and move slowly with respect to one another.