NAME: Key

TECTONICS NOTES

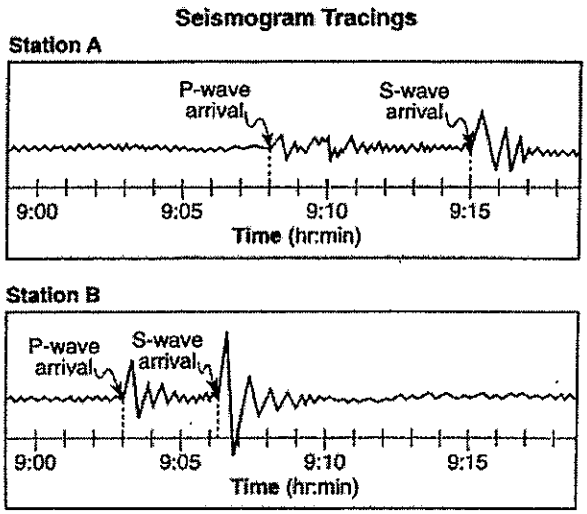
Log onto YouTube and search for **jocrisci** channel.

EARTH'S INTERIOR (Videos 5.1 ESRT 10)

1. What is the density of the continental crust?
2. What is the density of the oceanic crust?
3. What is the upper plastic part of the mantle called?
4. At what depth is the boundary between the mantle and the core?
5. Which zone of the Earth is found at each of the following depths: 6000 km? 4500 km?
6. What is the temperature at each of the following depths: 2000 km? 3000 km?
7. What is the pressure at each of the following depths: 1000 km? 2500 km?

EARTHQUAKES (Videos 5.2 ESRT 11 Study this!!)

1. Explain how the seismic tracings recorded at station A and station B indicates that station A is farther from the earthquake epicenter than station B.
2. Seismic station A is located 5,400 kilometers from the epicenter of the earthquake. How much time would it take for the first S-wave produced by this earthquake to reach seismic station A?
3. Using the difference in time for station A, determine how far away station A is located from the earthquake epicenter.
4. Using the difference in time for station B, determine how far away station B is located from the earthquake epicenter.



5. Using the two seismographs to the right, you would not be able to pinpoint the location of the epicenter. What **additional information** would you need? Once you had it what else would you do with it?

PLATE TECTONICS (Videos 5.3, 5.4, 5.5, 5.6 ESRT 5)

1. Pangaea is the name given to the supercontinent that existed 200 million years ago. What are **four** evidences that prove Pangaea did in fact exist? Be sure to explain your answer not just list them.
2. Be able to read and interpret page 5 ESRT which shows the various types of plate boundaries.
3. What type of plate boundary is shown in the diagram? How can you tell?
4. What part of Earth's mantle are the convection currents located?
5. As you go further from the mid-ocean ridge what happens to rock age?
6. How do the rocks located on either side of the mid-ocean ridge show that Earth's magnetic polarity has reversed?

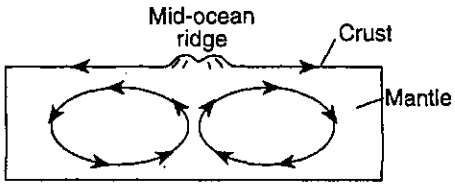


Plate Tectonics Facts

(ESRT pages 5, 10, 11)

Vid 5.1 ESRT 10

1. Ocean crust is / high density, young age, thin, mafic, and made of basalt (ESRT pg. 10)
2. Continental crust is / low density, old age, thick, felsic, & made of granite (think Mt. Everest)
3. Inferences about the Earth's layers and interior come from / studying seismic data

   Example: Mohorovicic found the asthenosphere due speed changes (density differences)

Video 5.2 ESRT 11!!

4. Earthquake is / the sudden movement of earth's crust along a fault
5. **Most earthquakes and volcanoes are located / at or near plate tectonic boundaries**
6. Prepare for an earthquake by / creating a plan, learn first aid, make buildings stronger
7. P-waves / faster than S- waves, travels through solids and liquids
8. S-waves / slower, S-motion, solids only (all start with S)
9. We know the outer core is liquid because / S-waves can't go through it
10. Use the difference in time of P and S waves to get / the distance to Epicenter (P-wave slide)
11. One seismograph can give you / epicenter distance (Big circles = Big distance)
12. To get the exact location of an epicenter you need / three seismographs

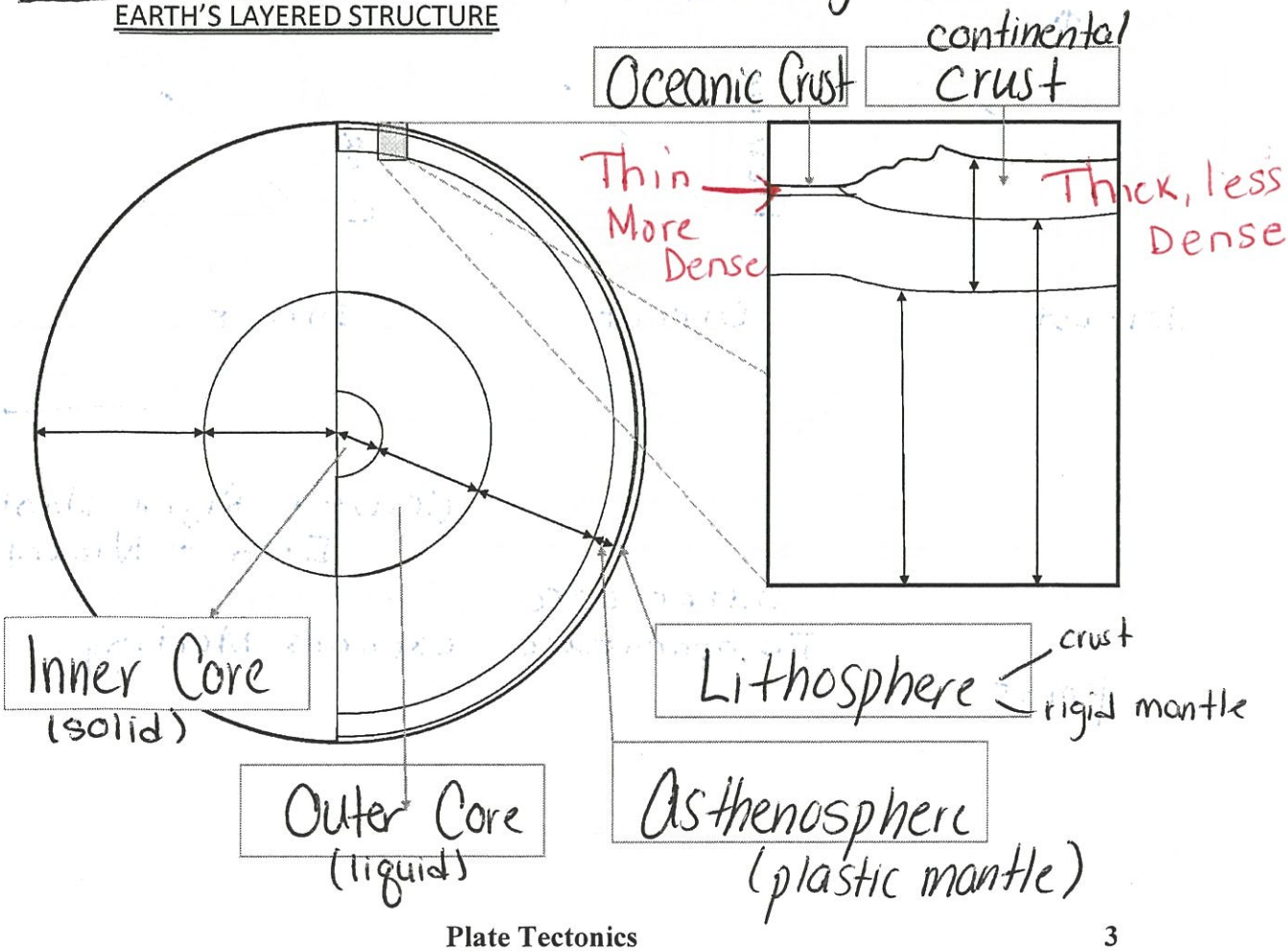
Video 5.3 – 5.6 ESRT 5

13. Proof of continental drift / continents fit together, fossils/rocks/mts. all match up along coasts, climate evidence (Palm tree fossil and Alfred Wegner)
14. Plate tectonics says / the earth's lithosphere is divided into pieces called plates that move
15. Plate tectonics is caused by / convection currents in the asthenosphere (upper mantle)
16. Divergent boundary / plates move away, forms a mid-ocean ridge or rift valley where magma rises (less dense) forming new rock (basalt)
17. The farther you go from the center of a ridge / the older the rocks get
18. Proof of sea floor spreading / (1) the age of the ocean floor is younger at the mid ocean ridges and gets older as you move away (2) Matching pattern of earth's magnetic polarity on either side of the ridge (Earth's poles have flipped in the past)
19. Convergent boundary / two plates come together forming a trench (volcanoes)
20. Subduction occurs at convergent plates because /ocean crust is more dense than continental
21. Transform boundary / plates slide past each other ex. San Andreas Fault
22. Hot spot / magma burns through middle of plate and forms a series of islands like Hawaii
23. Marine (shell) fossils in mountains prove / crustal uplift occurred (an uplifted sea floor)

Properties of Earth's Interior

Lithosphere	The solid outermost part of the earth.
Crust	The rocky solid shell that "floats" on the asthenosphere. • includes ocean floor •
Asthenosphere	Plastic Mantle - made of molten material.
Stiffer Mantle	Located between the outer crust and asthenosphere.
Outer Core	Liquid - moves around the solid inner core creating a magnetic field.
Inner Core	- solid, earths magnet.

EARTH'S LAYERED STRUCTURE



Earth's Interior & Tectonics

Fact(s) to memorize: 1 - 3

Earth's interior We Know what is down there by _____ waves.

ESRT page _____

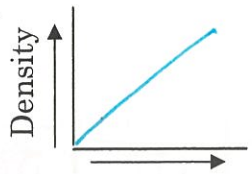
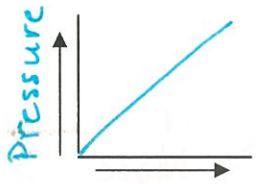
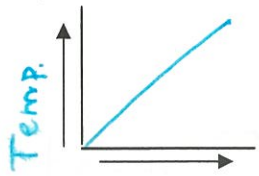
Determine the following:	Density		Composition / Rock Type
Continental Crust	2.7	g/cm³	Granite
Oceanic Crust	3.0	g/cm³	Basalt

MOHO - _____

_____

Layer	Density Range (g/cm³)	Pressure Range (millions of atmospheres)	Temperature Range (°C)
Mantle	-	-	-
Outer Core	-	-	-
Inner Core	-	-	-

State and **draw** the following relationships:

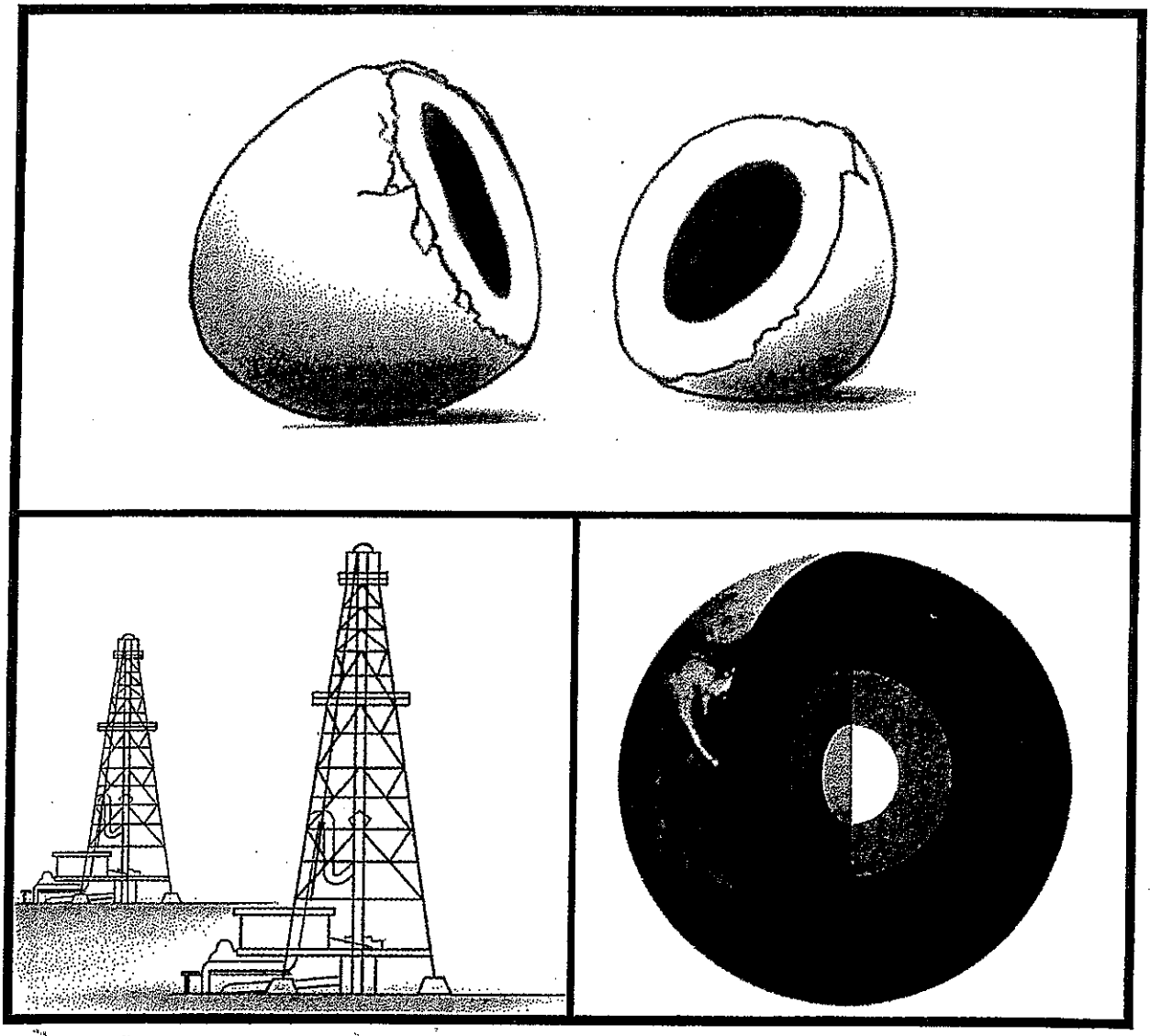
Depth vs. Density	Depth vs. Pressure	Depth vs. Temperature
As depth increases, density ↑	As Depth ↑ pressure ↑	As Depth ↑ Temp ↑
		
Direct	Direct	Direct

Determine the following by referring to the Earth Science Reference Tables page 10, "Inferred Properties of Earth's Interior"

1. What two layers make up the lithosphere? Crust + Rigid Mantle
2. Name the two elements that compose the inner core. Iron + Nickel
3. Which layer is a liquid? Outer core Explain how you can tell by looking at the chart. Temperature exceeds Melting Point
4. What is the pressure at the stiffer mantle and outer core boundary? _____ mil atm.
5. What is the temperature at a depth of 3000 km? _____ °C
6. What is the temperature at a depth of 500 km? _____ °C

Lesson 5

What is inside the earth?



KEY TERMS

crust: thin outer layer of the earth

mantle: thick layer of rock between the crust and above the core

core: inner layer or center of the earth

LESSON 5 | What is inside the earth?

If you could dig a hole all the way to the center of the earth, what would you see? Would the earth look the same all the way through?

Scientists have wondered about the inside of the earth. They have found ways to study it. They use special tools to dig out samples from deep inside. Special instruments "look into" parts of the earth we cannot see.

The scientists have learned that the earth is not the same all the way through. The materials are different, so are the temperature and pressure. Temperature becomes greater the deeper you go. Pressure becomes greater too.

The earth has three different layers. They are the **crust**, the **mantle**, and the **core**. Each layer of the earth is made up of different materials.

CRUST The thin outer layer of the earth is called the crust. The crust is thick in some places and thin in others. Beneath the oceans, the crust is between 5 and 10 km thick. However, under the continents, the crust is between 32 and 70 km thick. The crust is made up of loose rocks and soil. Under the rocks and soil, the crust is solid rock. We live on the crust.

MANTLE The layer of earth found below the crust, and above the core, is called the mantle. The mantle is about 2,900 km thick. More than two-thirds of the mass of the earth is in the mantle. The mantle has two parts. The upper mantle is "plastic" solid rock that can flow like a thick liquid. The lower mantle is solid rock.

CORE The inner layer, or the center of the earth is called the core. The core is about 3,500 km thick. The core has two parts, the outer core and the inner core. The outer core is a liquid layer that is about 2,200 km thick. It contains melted iron and nickel. The inner core is about 1,300 k thick. The inner core is not liquid as many people think. The inner core is made up of solid iron and nickel.

THE EARTH'S LAYERS

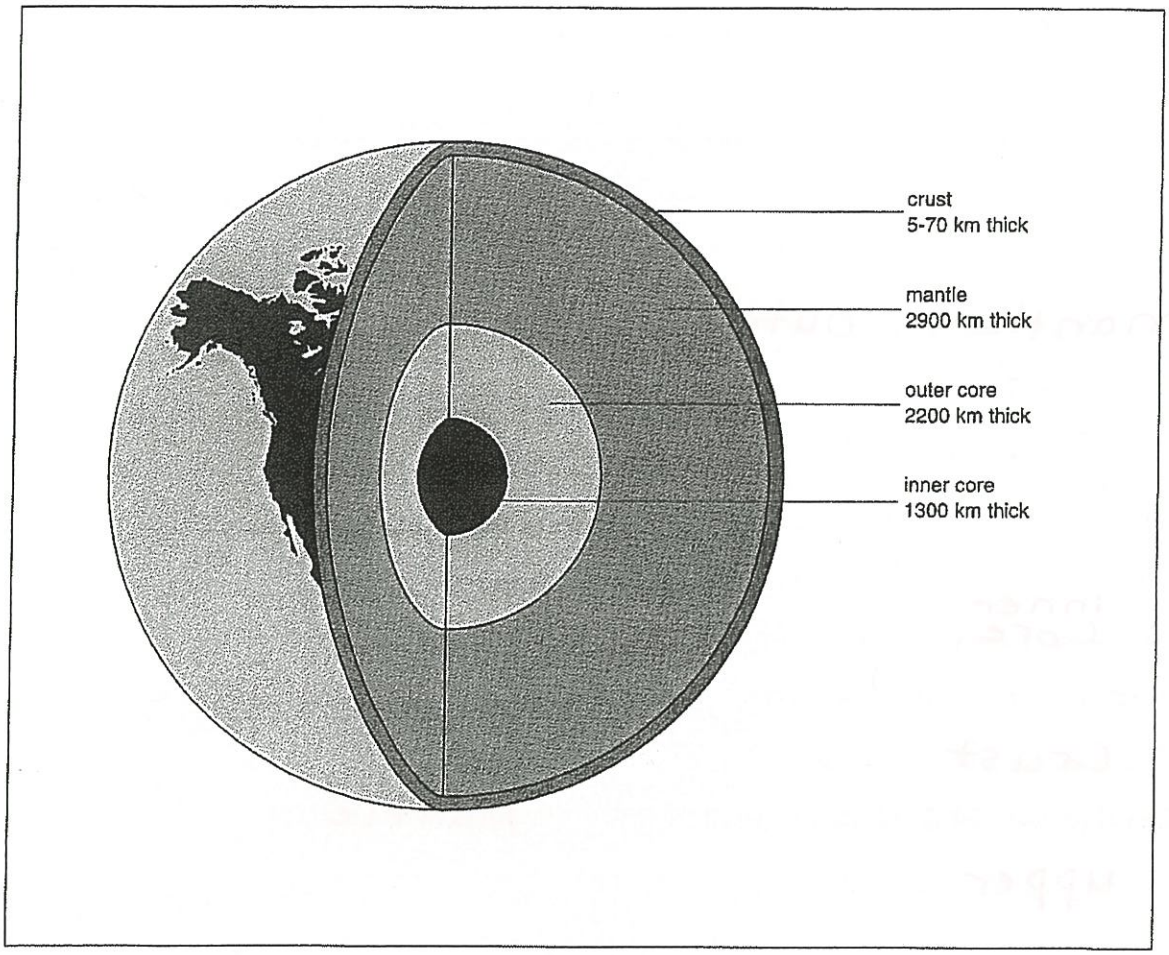


Figure A

1. Which layer is the thickest? Mantle
2. Which layer is the thinnest? Crust
3. On which layer do we live? Crust
4. Which layer is the hottest? inner core
5. Which layer is the coolest? Crust
6. Which layer touches the atmosphere? Crust
7. Which layer is made up of melted iron and nickel? outerCore
8. What is the center layer called? Core
9. Name the layer between the crust and the outer core. asthenosphere
10. Name the layer between the inner core and the mantle. outer core

FILL IN THE BLANK

Complete each statement using a term or terms from the list below. Write your answers in the spaces provided. Some words may be used more than once.

mantle	crust	inner core
upper	outer core	continents
lower		

1. Starting with the top layer, the layers of the earth are the Crust, the mantle, the outer core, and the inner core.
2. The layer that has melted iron and nickel is the outer core.
3. The thickest crust is found below the continents.
4. The layer that has the highest temperature is the inner core.
5. The layer that has the lowest temperature is the Crust.
6. The inner core is made up of solid iron and nickel.
7. The layer of the earth between the core and crust is the mantle.
8. The Crust is made up of loose rocks and soil.
9. More than two-thirds of the earth's mass is in the Mantle.
10. The upper part of the mantle can flow like a thick liquid.

TRUE OR FALSE

In the space provided, write "true" if the sentence is true. Write "false" if the sentence is false.

F 1. Every layer of the earth is the same thickness.

F 2. The mantle contains soil.

T 3. The mantle is the thickest layer.

T 4. We live on the crust.

F 5. The deeper we go into the earth, the cooler it becomes.

F 6. Most of our planet is made of soil.

T 7. The lower part of the atmosphere touches the crust.

T 8. Pressure is greatest in the inner core.

MATCHING

Match each term in Column A with its description in Column B. Write the correct letter in the space provided.

	Column A	Column B
B	1. mantle	a) we live on this layer
A	2. crust	b) layer below the crust
F	3. inner core	c) contains melted iron and nickel
C	4. outer core	d) layer of air
D	5. atmosphere	e) contains solid iron and nickel

WORD SCRAMBLE

Below are several scrambled words you have used in this Lesson. Unscramble the words and write your answers in the spaces provided.

1. TELNAM — MANTLE
2. STRUC — CRUST
3. KILNEC — NICKEL
4. SEPREURS — PRESSURE
5. LOSI — SOIL

REACHING OUT

Scientists believe that our planet was once all melted material. While melted, the different materials separated into layers. How would this explain the fact that the lightest rocks are found in the crust, and heavier materials are found deeper down?

Hint: Throw a penny and a piece of wood into a bowl of water. Watch what happens and think about it.

The Heavier item will sink First

Fact(s) to memorize: 13 - 15

Plate Tectonics

Continental Drift: Theory that the Earth's Crust is floating on a fluid like material that allows it to float.

The crust is broken up into pieces called Tectonic plates.

Pangea Supercontinent - one large land mass.

Evidence for Continental Drift

Shape of the Coast

Continents fit together like a puzzle.

Correlations

Fossils and Rocks match across ocean basins

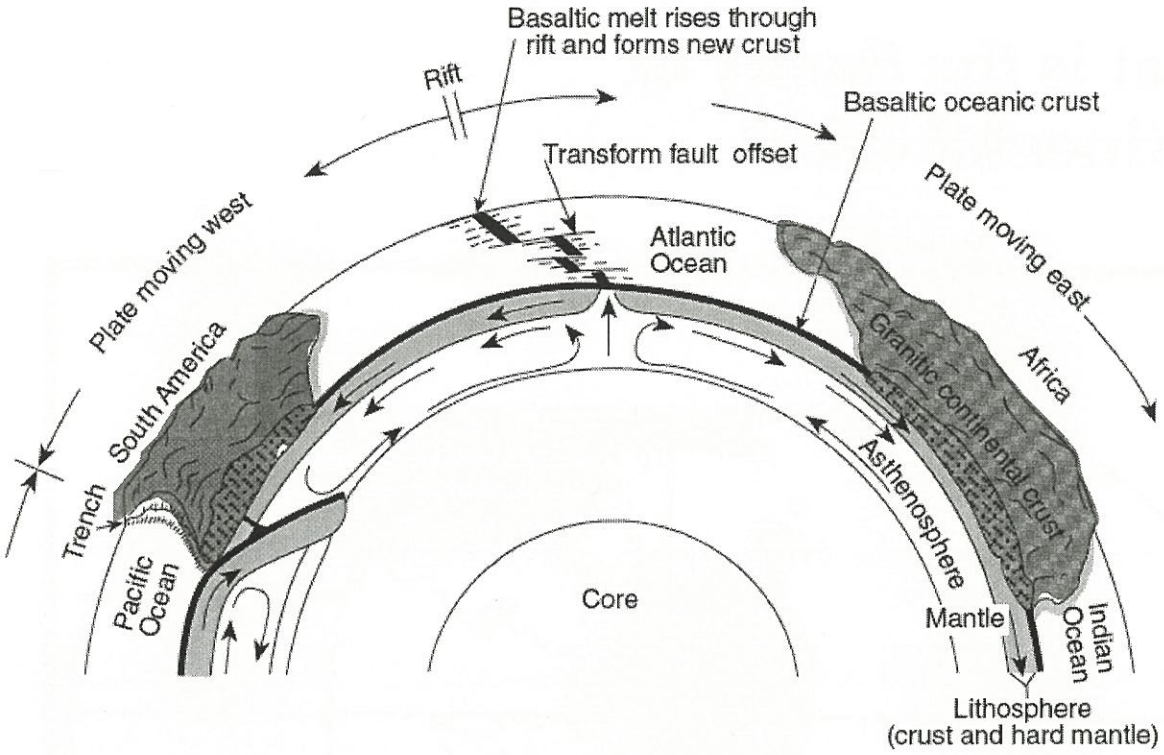
Mountain Ranges

_____ on different _____ seem to _____

Fact(s) to memorize: 13 - 15

Movement of Plates

Convection currents in the _____ move the plates.



(Not drawn to scale)

Convection currents driving motion due to Changes in Density

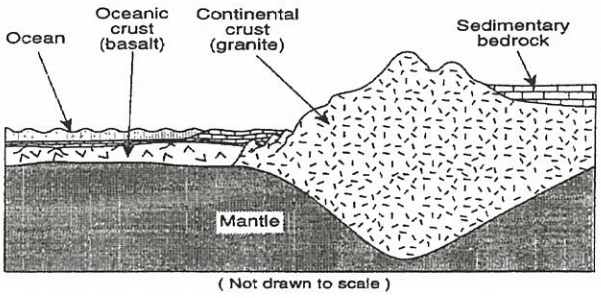
Rising currents Hot, less dense rises

* divergent boundaries *

Falling currents Cold, more dense Sinks

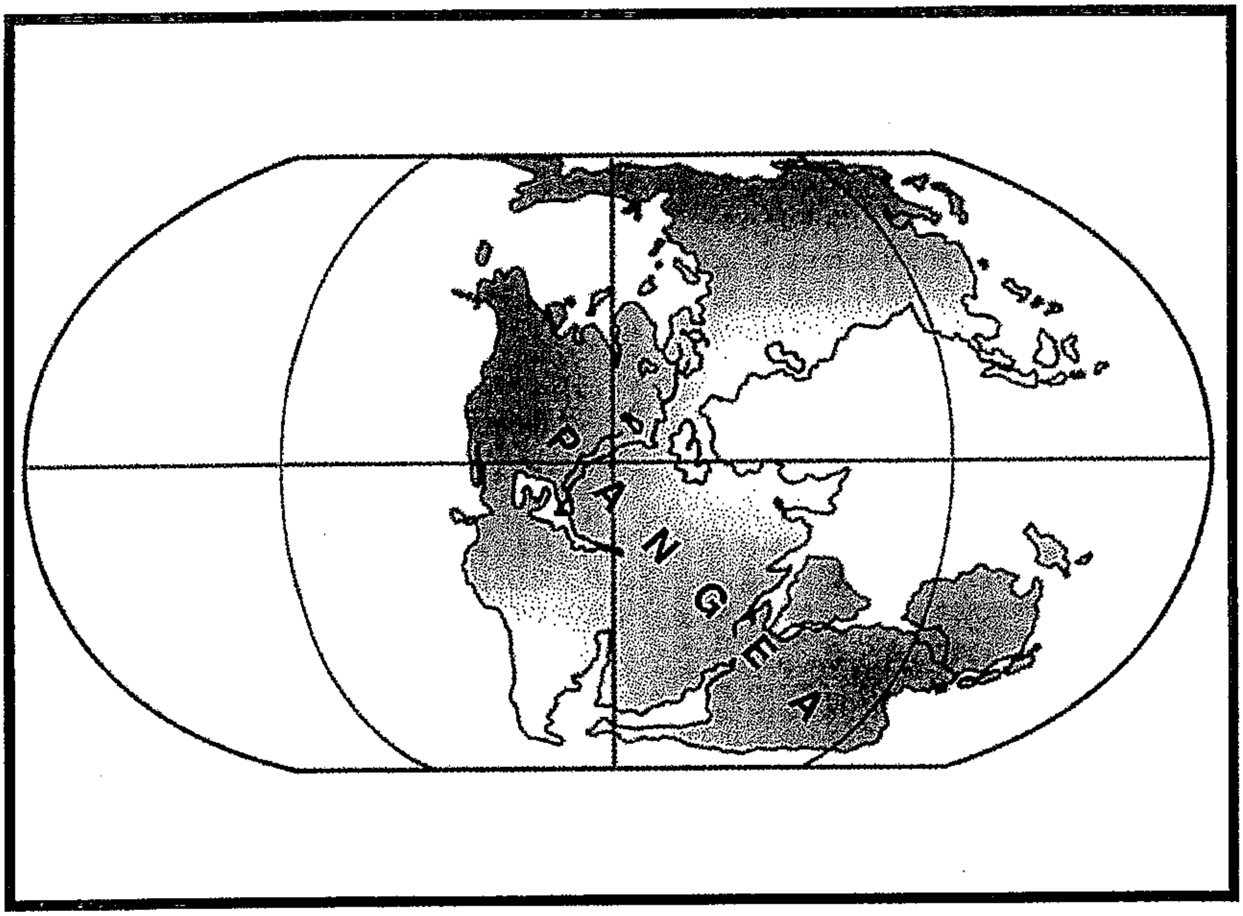
* convergent boundaries *

	Continental Crust	Oceanic Crust
Composition	Granite	Basalt
Density	2.7	3.0
Thickness	Thick	Thin



Lesson 20

What is the theory of continental drift?



KEY TERM

continental drift: idea that states the continents were once a giant land mass, and broke into pieces that moved to the positions they are in today

LESSON 20 | What is the theory of continental drift?

You may find it hard to believe, but the seven continents are moving. A continent is a large land mass. In fact, most scientists think that at one time, there was only one giant continent. It was named Pangaea [pan-JEE-uh]. Pangaea is Greek for "all the land." Then, about 200 million years ago, Pangaea began to break apart. The pieces began to move apart. They became today's seven continents. How fast did the pieces move? VERY SLOWLY — no more than 2½ centimeters each year. Today the continents continue to move.

The idea that the continents were once part of a giant land mass is called **continental** [KAYNT-un-ent-ul] **drift.** It was first stated in 1912 by Alfred Wegener, a German scientist.

Wegener based his idea of continental drift upon his study of the coastlines of the continents. He noticed that in many places, coastlines seemed to fit together, like pieces of a giant jigsaw puzzle.

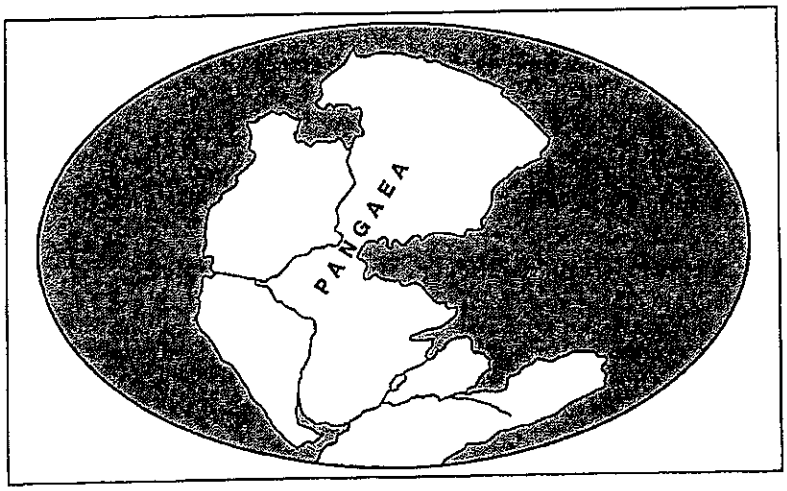
Look at Figure C on the next page. Notice how the coastlines of South America and Africa seem to fit together. The shape of coastlines is strong evidence to support the theory of continental drift. There is other strong evidence as well. It includes:

FOSSIL EVIDENCE Fossils are the remains of living things that lived long ago. Similar plant and animal fossils have been discovered in places that are far apart, in matching coastlines on different continents.

MOUNTAIN EVIDENCE Some mountain ranges on different continents seem to match. For example, a mountain range in eastern Canada seems to match one found in Norway and Sweden. The mountains would have separated when the continents started drifting apart.

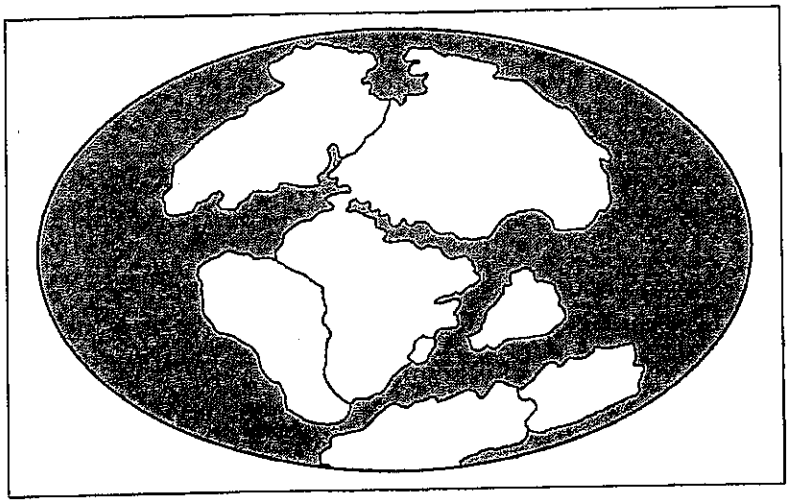
ROCK EVIDENCE The age and kind of rocks and minerals along the edge of one continent match rocks and minerals along the edge of another continent.

Most scientists support the theory of continental drift. Some, however, are not convinced. They point to evidence and questions that this theory cannot explain.



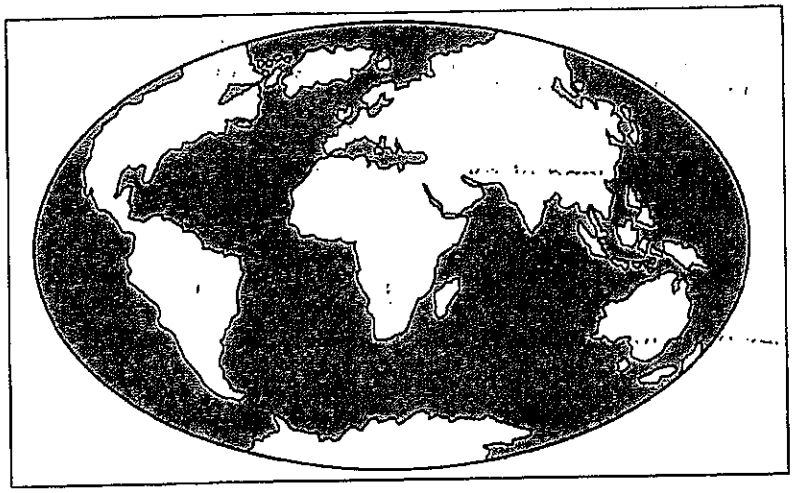
200 million years ago one giant land mass existed.

Figure A *200 million years ago*



The land mass started separating. The pieces slowly drifted apart.

Figure B *135 million years ago*



Today the pieces are the seven continents.

Figure C *Today*

FILL IN THE BLANK

Complete each statement using a term or terms from the list below. Write your answers in the spaces provided. Some words may be used more than once.

mountain ranges	Wegener	continental drift
one	Pangaea	200 million years
fossils	coastlines	rocks and minerals
	continues	move apart

1. More than 200 million years ago, the earth had only ___one___ large land mass.
2. The earth's original land mass is called ___Pangea___.
3. About 200 million years ago, the earth's single land mass broke up and started slowly to ___move apart___ That movement ___continues___ even today.
4. The idea that the earth's land masses were once just one large land mass is called ___Continental Drift___.
5. It took about ___200 Mill years___ for the continents to look as they do today.
6. The idea of continental drift started from the study of the continent's ___fossils___.
7. The theory of continental drift was first proposed by the scientist ___Wegener___.
8. Evidence from ___fossils___, ___Rocks + Min.___, ___mountain ranges___, and the shapes of ___coastlines___ support the theory of continental drift.

MATCHING

Match each term in Column A with its description in Column B. Write the correct letter in the space provided.

Column A		Column B
D	1. fossils	a) move apart slowly
A	2. drift	b) large land mass
B	3. continent	c) "super continent"
E	4. theory of continental drift	d) traces of past life
C	5. Pangaea	e) supported by most scientists

Place the drawings of the way the earth looked in the correct order based upon continental drift. Write the number of years ago in the space provided. Use these labels: **250 million years ago, 150 million years ago, 100 million years ago, 50 million years ago, present.**

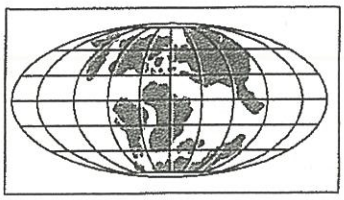


Figure F

1. 100 MYA

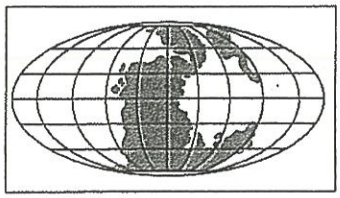


Figure G

2. 250 MYA

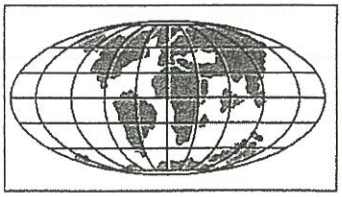


Figure H

3. 50 MYA

Figure I

4. Present

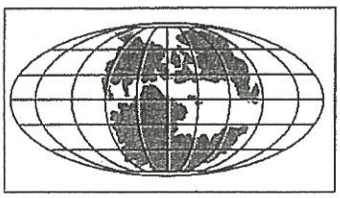


Figure J

5. 150 MYA

Place a check mark beside each statement that supports continental drift.

T 1. Alfred Wegener named a giant land mass Pangaea.

T 2. There are seven continents.

T 3. Similar fossils are found in Africa and South America.

F 4. Canada, the United States, and northern Europe have similar climates.

T 5. Mountain ranges on different continents seem to match.

T 6. Rocks along the edges of one continent match those along the edge of another continent.

F 7. The continents are surrounded by water.

T 8. The coastlines of South America and Africa seem to fit together like jigsaw puzzle pieces.

REACHING OUT

Scientists believe that the continents will always drift.

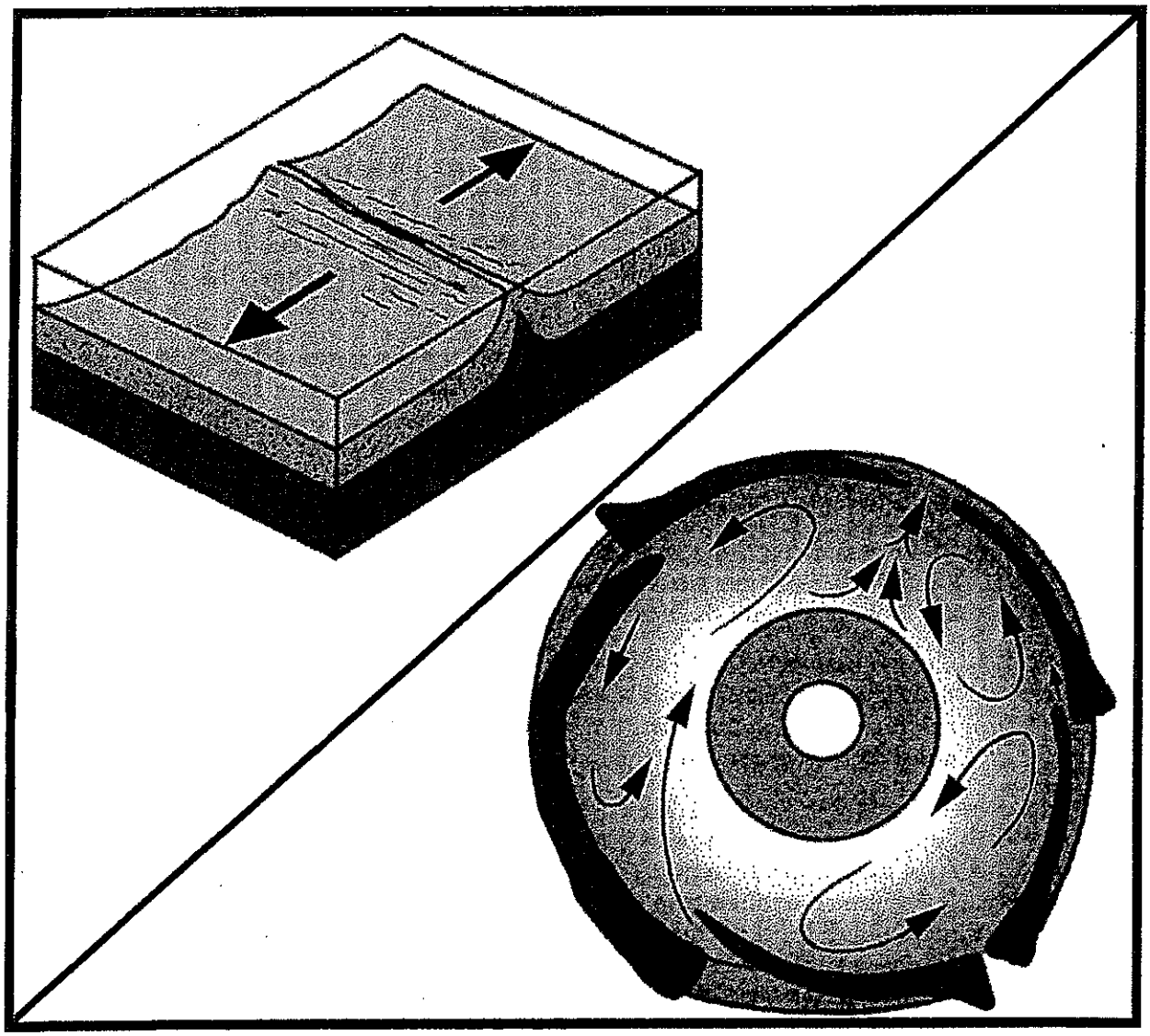
If that is true, what might happen in a few hundred million years?

They will be farther away

Building up the Earth

Lesson 21

What is the theory of plate tectonics?



KEY TERMS

theory of plate tectonics
crustal plates
convection currents
mid-ocean ridge
subduction

LESSON 21 | What is the theory of plate tectonics?

For many years, most geologists did not accept the theory of continental drift. The main reason was that it did not explain why or how the continents drifted apart.

Today, scientists have a theory to explain how the continents are drifting apart. The **theory of plate tectonics** [tek-TAHN-ics] states how and why the continents move. It also explains how natural events such as earthquakes, volcanoes, and mountain building occur.

There are two main points of the theory of plate tectonics:

- The lithosphere is the solid layer of the earth. It is broken up into **crustal plates.** There are seven main plates and several smaller ones. The continents and the ocean floor rest upon the plates.
- Crustal plates float on the upper part of the mantle. This part of the mantle is made up of solid rock that flows like a thick liquid. The crustal plates float like rafts on a lake. The continents and oceans are carried on the plates like the passengers on a raft.

What causes plate tectonics? Scientists think that giant **convection** [kuhn-VEK-shun] **currents** in the earth's mantle cause the movement of crustal plates. A convection current is the movement of a gas or a liquid caused by differences in temperature. The mantle rock close to the center of the earth is hot. The rock farther away is cooler. The hot rock rises and the cooler rock sinks. As the cooler rock gets closer to the earth's center, it heats up. Then it rises. This process repeats itself in an endless cycle. The crustal plates are carried along like packages on a moving conveyor belt.

CONVECTION CURRENTS

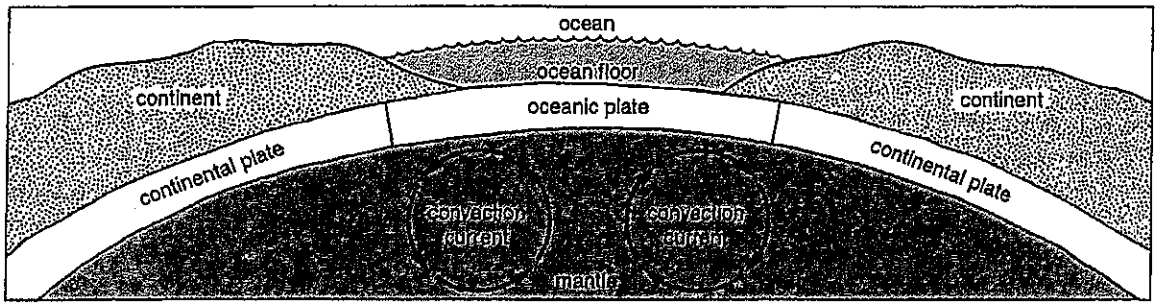


Figure B *Convection current movement in the mantle*

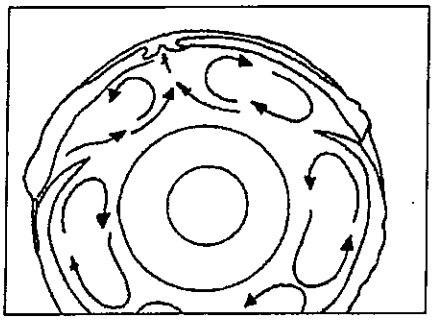


Figure C shows how some scientists believe convection currents in the upper mantle cause the crustal plates to move. The mangle rock near the earth's core is hot. The hot mantle rock rises. The cooler mantle rock sinks closer to the core and gets heated up. This cycle repeats over and over. When the heated rock rises, it causes the crustal plates to move.

Figure C

MULTIPLE CHOICE

In the space provided, write the letter of the word that best completes each statement.

A 1. A convection current is caused by differences in
   a) temperature. b) mass.
   c) air pressure. d) color.

D 2. Scientists think that the movement of crustal plates is caused by
   a) conveyor belts. b) pressure in the earth's core.
   c) the core. d) convection currents.

B 3. The mantle rock close to the center of the earth is
   a) cold. b) hot.
   c) frozen. d) sinking.

C 4. The center of the earth is called the
   a) crust. b) mantle.
   c) core. d) lithosphere.

C 5. If you added cold water to a container of hot water, the cold water would
   a) rise. b) get colder.
   c) sink. d) stay on top.

CRUSTAL MOVEMENT

The crustal plates move in different ways.

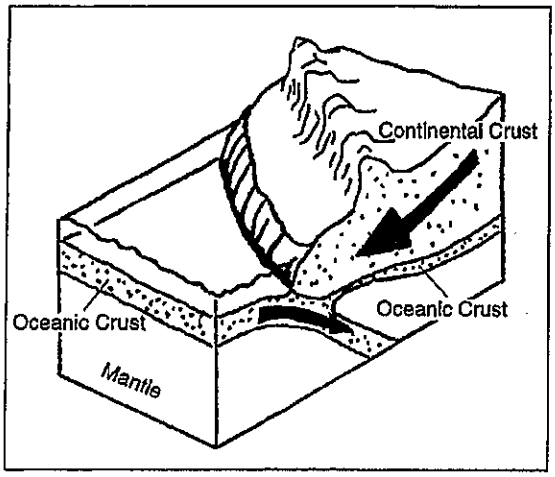


Figure D *Some plates are moving toward each other. At these places, two plates hit each other. Sometimes the oceanic crust is pushed under the continent's crust.*

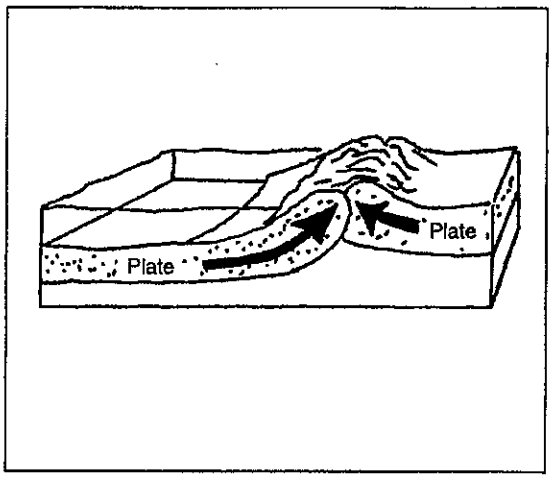


Figure E *Sometimes two plates carrying continents crumple upward when plates collide.*

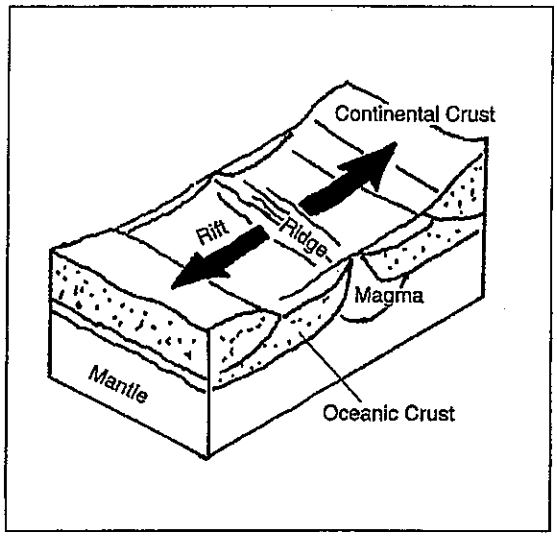


Figure F *Some plates are moving apart.*

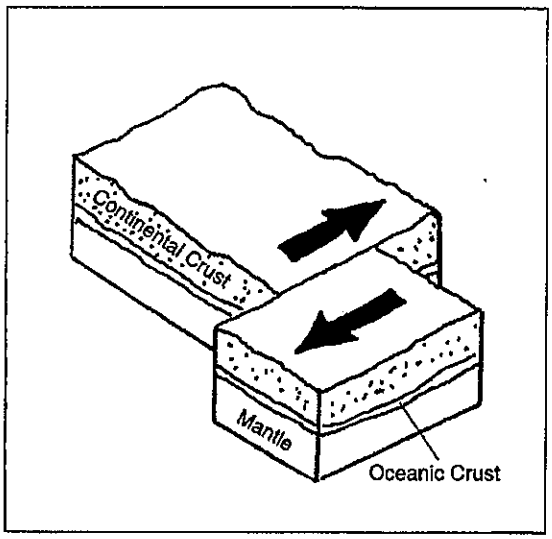


Figure G *Some plates slide past each other.*

- The movement of crustal plates causes changes on the earth's surface.
- In some areas where crustal plates slide past each other, the movement causes earthquakes.
- When oceanic crust is pushed down under continental crust, the continental crust crumples. It is pushed upward to form new mountains.
- When two crustal plates carrying continents collide, the continents buckle upward and form mountains. The Himalaya mountains were formed in this way when the plate carrying India collided with the Eurasian plate.

On each diagram, draw arrows to show the different ways in which crustal plates move.

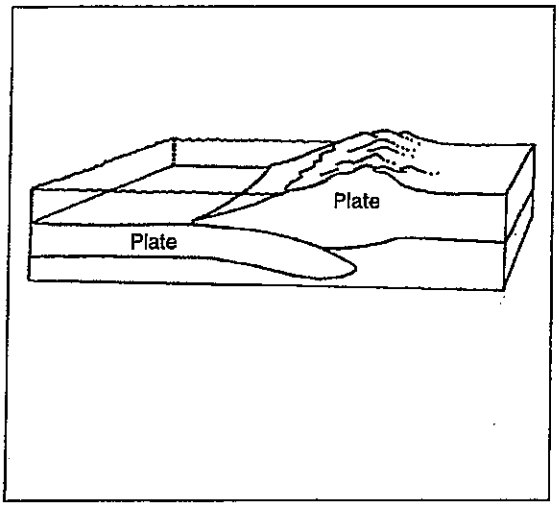


Figure H

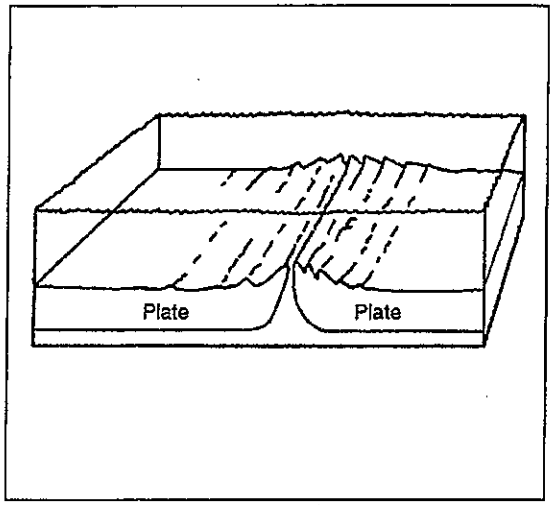


Figure I

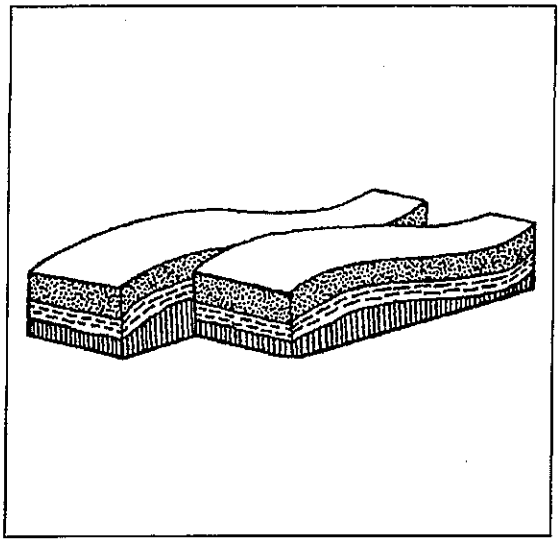


Figure J

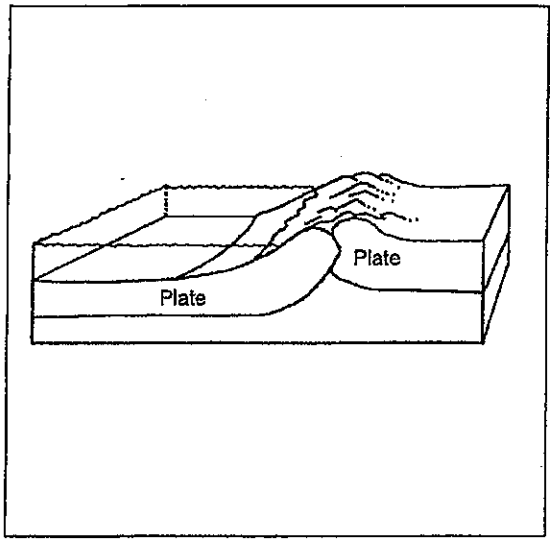


Figure K

Answer the following.

5. The movement of crustal plates sliding past each other causes _____ .
   earthquakes, mountain building

6. Sometimes when two plates collide _____ crust is pushed down under
   continental, oceanic
   the _____ crust.
   continental, oceanic

8. When two plates carrying continents collide, the continents buckle _____ .
   upward, downward

9. This causes _____ .
   an earthquake, mountain building

FILL IN THE BLANK

Complete each statement using a term or terms from the list below. Write your answers in the spaces provided.

collide	flows	plate tectonics
continents	mantle	rises
convection currents	move	sinks
crustal plates	ocean floor	solid

1. The idea that explains how and why continents drift is called the theory of Plate Tectonics
2. The lithosphere is made up of large moving sections called Crustal Plates
3. The lithosphere is Solid.
4. Crustal plates float on the upper layer of the mantle.
5. Giant Convection Currents in the earth's mantle cause the crustal plates to move.
6. The upper layer of the mantle is solid rock that flows like a thick liquid.
7. Crustal plates carry the Continents and Ocean floor
8. Mountains may form where plates Collide.
9. Hot rock in the mantle rises while cooler rock sinks.
10. Scientists believe that the continents, along with the ocean floor, will continue to move.

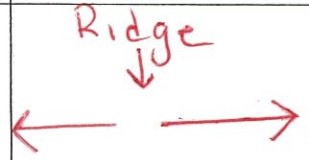
REACHING OUT

Upon which plate is each of the following places located? Check an atlas or encyclopedia and Figure A.

	Plate		Plate
1. Canada	North American Plate	6. Brazil	South American Plate
2. France	Eurasian Plate	7. Nigeria	African Plate
3. Hawaii	Pacific Plate	8. Australia	Indian Australian Plate
4. Russia	Eurasian Plate	9. Panama	Caribbean Plate
5. South Pole	Antarctic Plate	10. YOU!	North American Plate

Fact(s) to memorize 16 - 21

Types of Plate Boundaries

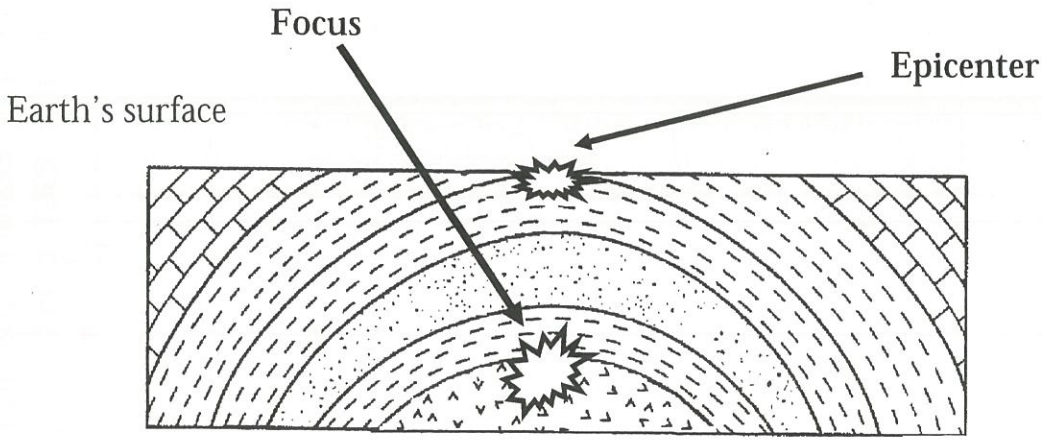
Type of Boundary	Sketch of Boundary	Direction of Movement	Description/Features of Plate Boundary (ex. Volcano chains or large earthquakes)	Examples (Use page 5 of ESRT to find examples.) Page 5
Divergent Plate Boundary		Away	New land	
Transform Boundary		Slide Past	Earthquakes	
Convergent Plate Boundary (Collision, no subduction)	Continental-Continental 	Converge	Mountains	
Convergent Plate Boundary (Subduction)	Oceanic-Continental or Oceanic-Oceanic 	Converge	trenches	

Earthquakes

Fact(s) to memorize: 4 - 6

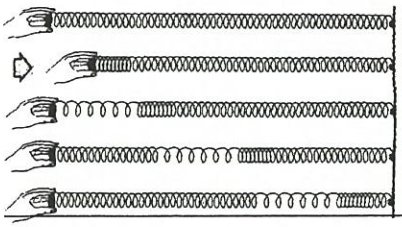
1. What is an earthquake? Shaking of earths crust caused by a release of Energy.
2. Possible causes? Interaction between lithospheric plates.
3. Damages
4. Focus Located under the epicenter where the earthquake began
5. Epicenter On Earths Surface above the focus

6. Most earthquakes and volcanoes occur at or near Plate Boundaries



Fact(s) to memorize: 7 - 9

Two Main Types of Earthquake Waves

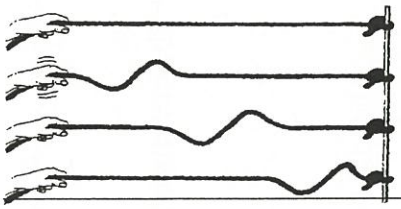


P – waves: (Primary) * arrive first *

(1) Back + Forth motion.

(2) Travels fast.

(3) goes through Solid, liquid, Gas.



S – waves: (secondary) * arrive second *

(1) Travels in an up and down motion.

(2) Slower then P-waves.

(3) only goes through Solid.

Measuring an Earthquake:

Richter scale - -Measures an earthquakes magnitude.

Mercalli Scale - -Measures an earthquakes intensity.

-Based on reports from observers.

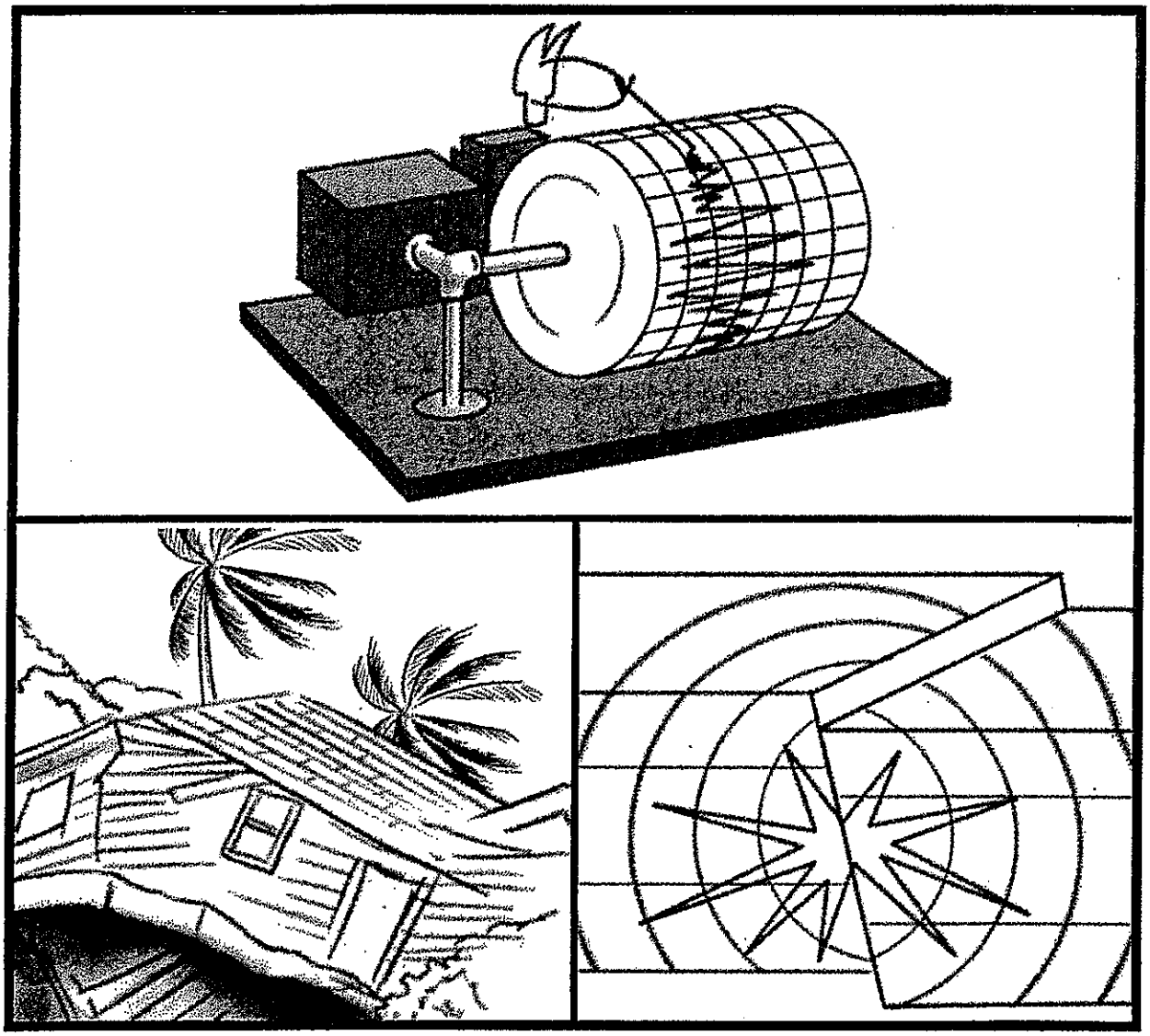
Richter number	Increase in Magnitude
1	1
2	10
3	100
4	1,000
5	10,000
6	100,000
7	1,000,000
8	10,000,000
9	100,000,000

Reading the Earthquake P-wave and S-wave Travel Time Chart, ESRT page 11

1. How long does it take a P-wave to travel 2,000 km? 4 min 5 sec
2. How long does it take an S-wave to travel 2,000 km? 7 min 20 sec
3. How far can an S-wave travel in 11 minutes? 3300 km
4. How far can a P-wave travel in 11 minutes? 7600 km
5. How long does it take a P-wave to travel 6,000 km? 9 min 30 sec
6. How far can an S-wave travel in 9 minutes 40 sec? 2800 km

Lesson 26

What are earthquakes?



KEY TERMS

LESSON 26 | What are earthquakes?

It was February 4, 1976, in Guatemala City. The time was 3 A.M. People were asleep. Suddenly the ground began to shake. It shook with great force. Walls tumbled, roofs caved in, whole buildings split in half, hillsides collapsed.

The shaking lasted only 39 seconds. In that short time, 26,000 people died in the city and countryside. Another 60,000 people were injured. Hundreds of thousands were left without homes.

An earthquake had struck in Guatemala. What is an earthquake? What causes earthquakes?

You have learned that faulting can build mountains. Faulting also causes earthquakes. When blocks of the earth's crust move, the movement shakes the earth. Sudden, strong movements of the earth's crust are called **earthquakes.**

Earthquakes begin deep inside the earth. The place where an earthquake starts is the **focus** [FOH-kus]. The place on the surface of the earth directly above the focus is called the **epicenter** [EP-ih-sen-ter]. The surface of the earth shakes hardest at the epicenter.

When rocks move, they release energy. The energy is in the form of waves—called **seismic** [SYZ-mik] **waves** or earthquake waves. These waves move out from the focus in all directions. Think of throwing a pebble into a pond. Where the pebble hits the water, you see waves move outward in all directions. Earthquake waves move out from the focus in the same way.

MEASURING EARTHQUAKES

A seismograph [SIZE-muh-graf] is an instrument that measures the strength of earthquakes. It makes a record of the movements of the earth's crust on a piece of paper. The record is called a seismogram [SIZE-muh-gram]. It looks like wavy lines. The higher the wavy lines, the stronger the earthquake. There are more than 500 seismograph stations. They are spread over every continent.

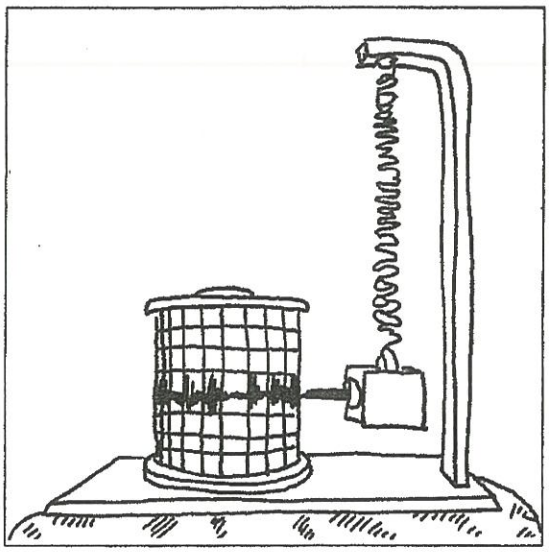


Figure A

Study Figures B and C and then answer the questions.

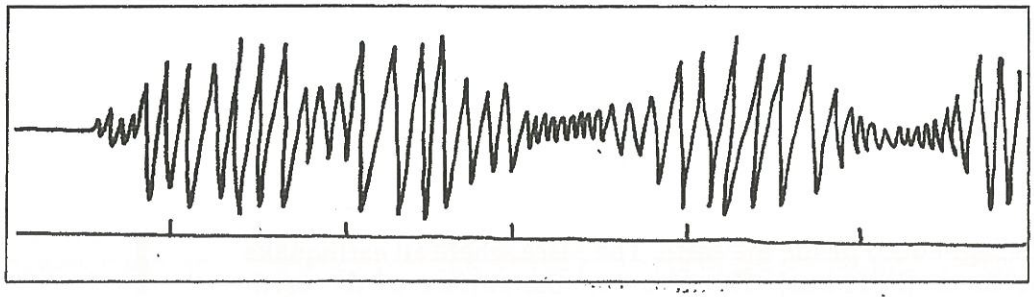


Figure B

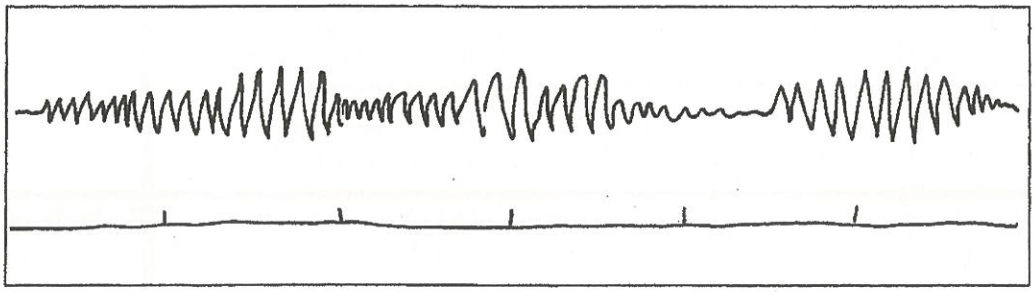


Figure C

1. What are Figures B and C? Seismograms
2. Which Figure shows the stronger earthquake? B
3. What instrument was used to get Figures B and C? Seismograph

SEISMIC WAVES

There are three kinds of seismic, or earthquake waves. They are P-waves, S-waves, and L-waves. You can see the three kinds of waves in Figure D.

P-waves
- are the fastest moving waves.
- cause particles to move back and forth in place.
- move through solids, liquids, and gases.

S-waves
- move slower than P-waves.
- cause particles in materials to move from side to side.
- travel only through solids.

L-waves
- are the slowest moving waves.
- cause the surface to rise and fall like ocean waves.
- cause the most damage.
- travel through solids, liquids, and gases

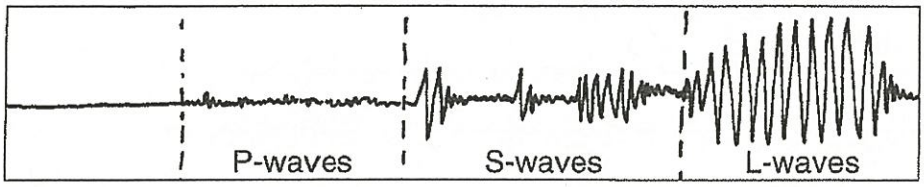


Figure D

COMPLETE THE CHART

Answer the questions by putting a "YES" or "NO" in the space provided.

Characteristics	P-waves	S-waves	L-waves
1. Travel through gases?	✓		✓
2. Travel through liquids?	✓		✓
3. Travel through solids?	✓	✓	✓
4. Fastest waves?	✓		
5. Surface waves?			✓
6. Slowest waves?			✓
7. Cause particles to move back and forth in place?	✓		
8. Cause particles to move from side to side?		✓	
9. Cause the most damage?			✓
10. Cause the surface to rise and fall like ocean waves?			✓

TRUE OR FALSE

In the space provided, write "true" if the sentence is true. Write "false" if the sentence is false.

F 1. An instrument that detects and measures earthquakes is a seismic wave.

T 2. The place inside the earth where an earthquake starts is called the focus.

F 3. Most earthquakes are caused by folding.

F 4. The place on the earth's crust directly above the place where an earthquake starts is called the focus.

F 5. An earthquake measuring less than 2.5 on the Richter scale can cause a lot of damage.

T 6. A seismogram is a record of the movement of the earth's crust.

F 7. Vibrations released during an earthquake are called focus waves.

T 8. Earthquakes under the ocean cause tidal waves.

F 9. The higher the lines on a seismogram, the weaker the earthquake.

T 10. During an earthquake, the earth's surface shakes hardest at the epicenter.

NOW TRY THIS

Use the listed terms to label the diagrams. Write your answers in the provided spaces.

epicenter focus seismograph seismogram seismic waves

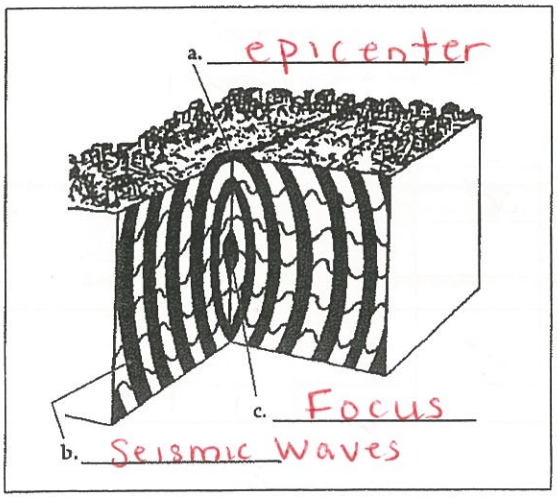


Figure F

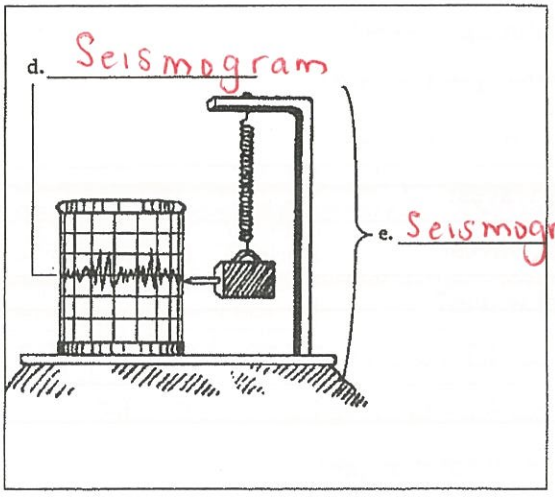


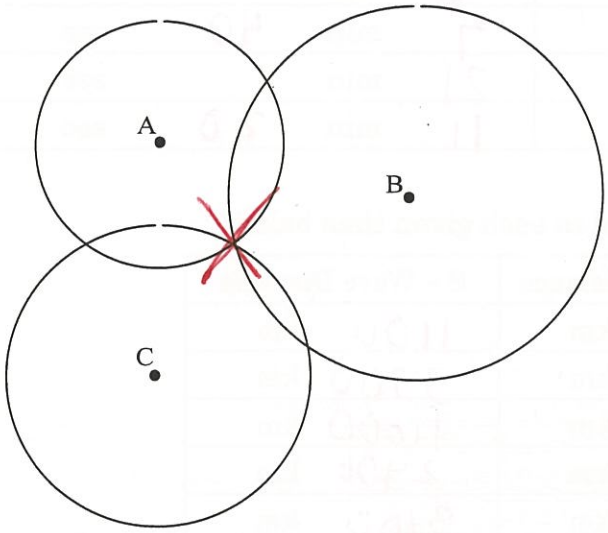
Figure G

Fact(s) to memorize: 10 - 12

Locating the Epicenter

A minimum of 3 seismic stations are needed to locate an earthquake epicenter.

- One seismic station gives you Distance only, and magnitude
- Two stations may give you 2 possible locations where the two circles intersect
- When 3 stations are used, the epicenter is where they all Meet



a. Which seismic station is closest to the epicenter? A
How can you tell by the diagram?
Smallest circle

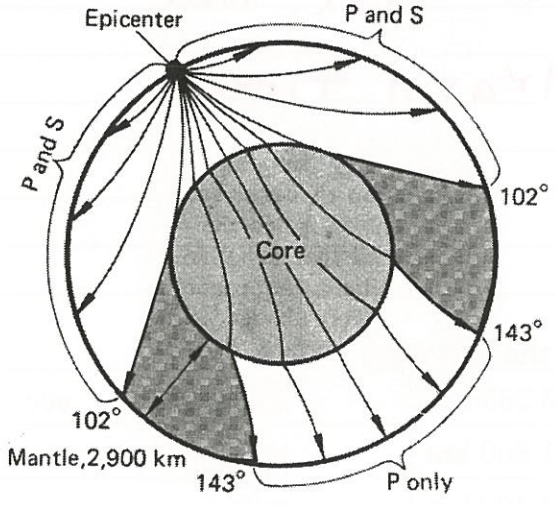
b. Which seismic station is farthest away from the epicenter? B
How can you tell by the diagram?
largest circle

c. Describe where the epicenter is.
where A, B, + C Meet

d. Place an "X" at the epicenter.

Shadow Zone Diagram

As P-waves and S-waves pass through different layers within Earth's interior they are _____ due to differences in _____



Some areas on Earth's surface only receive P-waves, because S-waves can only travel through Solid and the outer core is liquid.

Other sections on Earth's surface receive no earthquake waves because of the way the waves _____ within the Earth.

These areas are known as the _____

State how long it takes for the P-wave and the S-wave to travel the distances listed below:

Distance	P – Wave Travel Time	S – Wave Travel Time
7,000 km	10 min 30 sec	19 min sec
3,900 km	6 min 50 sec	12 min 20 sec
2,000 km	4 min 05 sec	7 min 20 sec
1,600 km	3 min 20 sec	6 min sec
2,100 km	4 min 10 sec	7 min 40 sec
8,200 km	11 min 30 sec	21 min sec
3,500 km	6 min 20 sec	11 min 20 sec

State how far a P-wave and an S-wave can travel in each given time below:

Given Time	P – Wave Distance	S – Wave Distance
4 min 20 sec	2200 km	1100 km
12 min 00 sec	8800 km	3700 km
6 min 20 sec	3200 km	11000 km
8 min 30 sec	5100 km	2400 km
10 min 20 sec	7000 km	3100 km
5 min 50 sec	3100 km	1500 km
9 min 40 sec	6200 km	2800 km

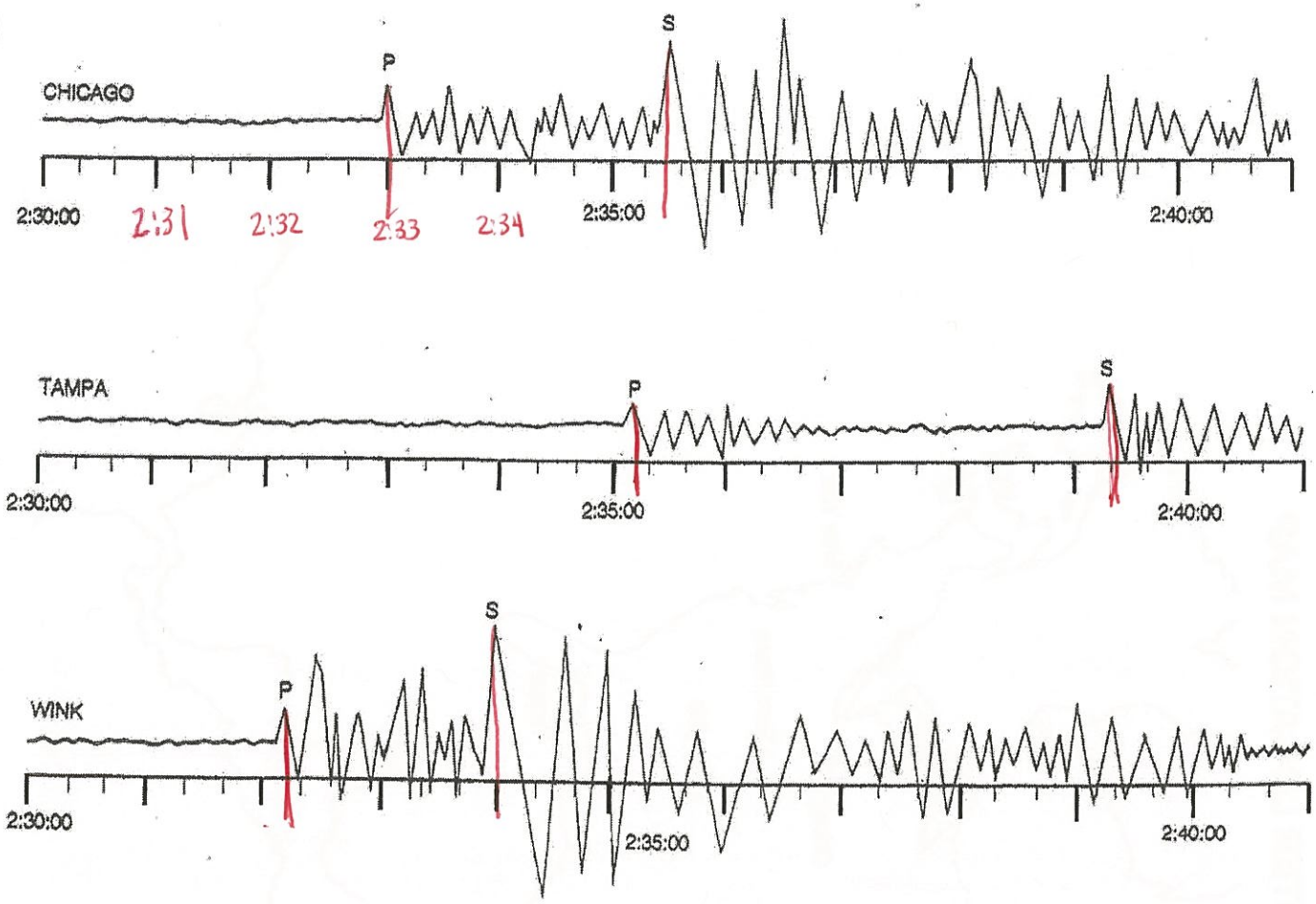
Determining the arrival time differences between P-waves and S-waves using the chart:

1. Find the distance
2. Go up to the P or S wave line
3. move left to the travel time
4.

Determine the difference in arrival time for each of the following:

8,000 km	min	sec
5,200 km	min	sec
9,600 km	min	sec
400 km	min	sec
6,400 km	min	sec

3,200 km	min	sec
1,800 km	min	sec
4,400 km	min	sec
2,100 km	min	sec
7,200 km	min	sec



32:70
- 1:50
2:30:20

23510
- :410
2:31:00

2 60
38:00
- 2:30
30

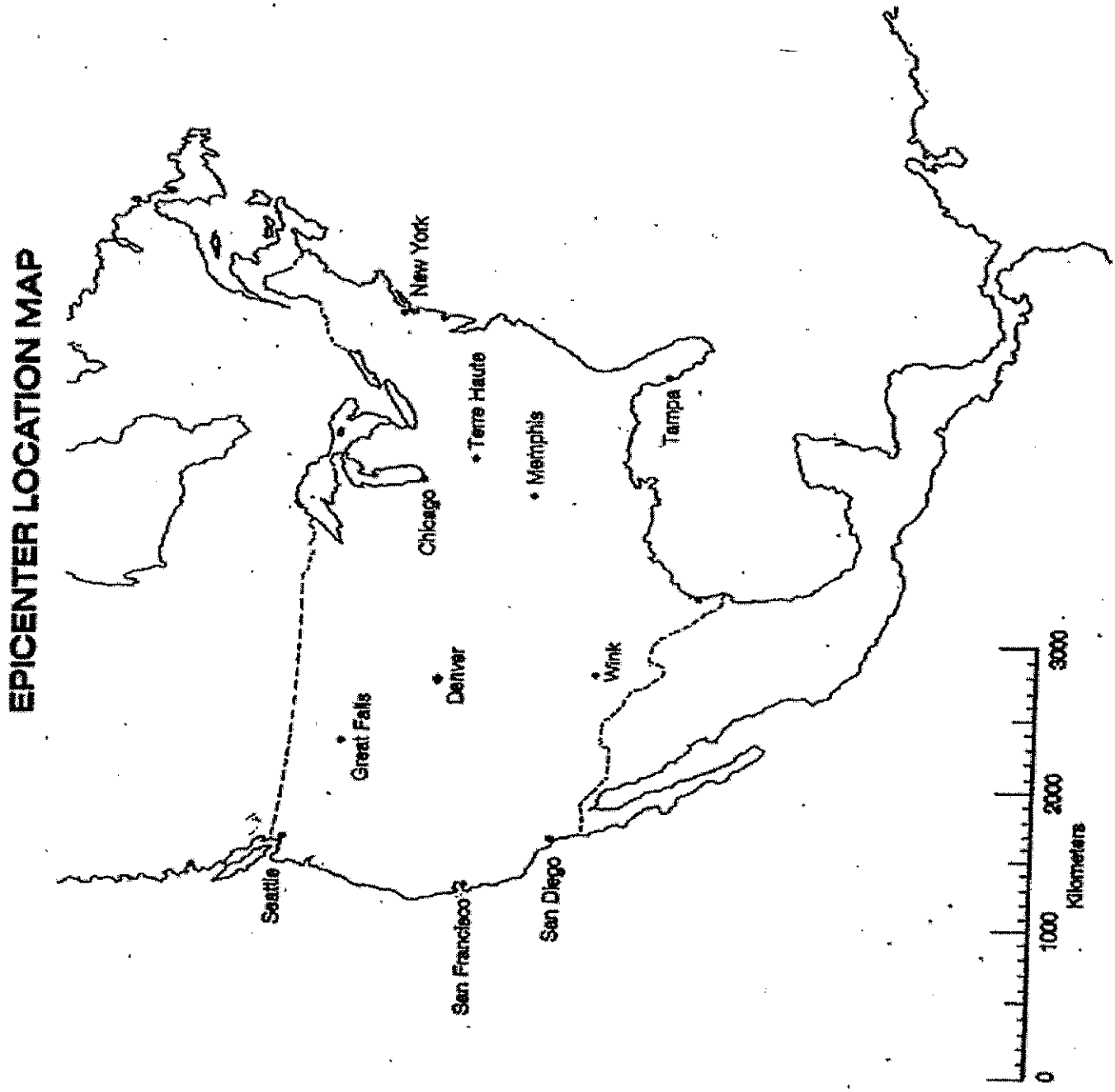
DATA CHART

Seismograph Station	P-Wave Arrival Time (hr, min, sec)	S-Wave Arrival Time (hr, min, sec)	Difference in Arrival Time (min. & sec.)	Distance to Epicenter (km)	P Wave Travel Time (min. & sec.)
CHICAGO	2:33:00	2:35:30	2:30	1400	2:30:30
TAMPA	2:35:10	2:39:20	4:10	3000	2:31:00
WINK	2:32:10	2:34:00	1:50	1,100	2:30:20

Chicago
2:35:30
- 2:33:00
2:30

Tampa
2:39:20
2:35:10
4:10

Wink
33 60
2:34:00
2:32:10
1:50


EPICENTER LOCATION MAP
New York
Terre Haute
Memphis
Tampa
Chicago
Denver
Great Falls
Wink
Seattle
San Francisco
San Diego
0
1000
2000
3000
Kilometers

NAME: _____ PERIOD: _____ DATE: _____

LAB PARTNERS: _____ LAB #19

THE GREAT EARTHQUAKE OF 1811 (THE MERCALLI INTENSITY SCALE)

INTRODUCTION

The Richter Scale is used to measure earthquake magnitude based on an analysis of P and S wave data from a seismogram. Another method of measuring earthquakes is the Mercalli Scale, which is not a measure of the amount of energy released by an earthquake, but the damage caused by it.

OBJECTIVES

After completing this investigation you will be able to:

1. Use the Modified Mercalli Intensity scale to assign earthquake intensities.
2. Evaluate earthquake hazards from historic seismic descriptions.
3. Use a map to find locations in the eastern part of the United States.
4. Determining the epicenter of an earthquake using the Modified Mercalli Scale

MATERIALS

Pen
Pencils with eraser
Modified Mercalli scale

APPROXIMATE TIME

2 periods

PROCEDURE

1. Using the Modified Intensity scale, determine an intensity for each locality given in this exercise. Write the Roman numeral in the column for 'Assigned Mercalli Intensity'.

2. On the U.S. map provided, write the Mercalli intensity Roman numeral on the map **IN PEN** next to the appropriate town.

3. Develop a field map of equal intensities (isolines). Use the same technique you would use for isotherms on a weather map or contour lines on a topographic map. You will use an interval of 1, drawing isolines: IV, V, VI, VII, VIII, IX, X, XI

4. Answer lab questions.

	Nashville Tennessee	Same as Henderson City, Kentucky
	Natchez Mississippi	Clocks stopped. Hanging art vibrated. Articles hanging from ceilings vibrated rapidly. Threw some articles off shelves. Damage slight, cracked some plaster.
	New Madrid Missouri	Awful noise resembling loud thunder, also from the cracking and falling of trees. Fowls and beasts cried. Mississippi flowed backwards, graveyard fell into river. All chimneys and all houses fell down. Earth rolled in waves a few feet high.
	New Orleans Louisiana	Slight shaking, dishes rattled
	Newark New Jersey	Several shocks felt, felt like a truck hitting the building
	Norfolk Virginia	Several clocks stopped. First awoke people from their sleep. Houses shook with great violence. Shaking of beds.
	Oklahoma City Oklahoma	Older buildings suffered most damage due to poor design to withstand earthquakes.
	Piney River Tennessee	Banks of river caved in. Some chimneys thrown down. Damage slight in well designed buildings.
	Pittsburgh Pennsylvania	Houses shaken. Clocks stopped.
	Quebec Canada	Shook furniture in houses and doors upon their hinges. Walls creaked.
	Raleigh North Carolina	Several slight shocks were felt. Standing cars rocked noticeably.
	Richmond Virginia	Bells on both floors of house in the most elevated part of the city rang. Some windows broken, trees disturbed.
	Riviere aux Tranches Canada	Felt many of the earthquake shocks. Walls creaked.
	St. Louis Missouri	Clamor of windows, doors, furniture. A few chimneys were damaged, a few stone houses were split. Noticed by persons driving cars.

	Savannah Georgia	Flash of light followed by rattling noises. Earth movement made people teeter as though on shipboard in heavy swell of sea. Many people nauseated. Doors disturbed.
	Vicksburg Mississippi	Same as Louisville, Kentucky
	Vicennes Indiana	Same as Vicksburg, Mississippi
	Waco Texas	Objects outside and inside homes overturned. Swaying of telephone poles and flag poles
	Washington D.C.	Rang church bells and cracked the pavement. Shook doors, windows and furniture. Clocks stopped.
	Wichita Kansas	Some brick chimneys cracked. Noticed by all persons.

LABORATORY QUESTIONS

1. What location on the map is closest to the earthquake epicenter? How can you tell?

2. What happens to the intensity of the earthquake and its corresponding damage to land and buildings as the distance from the epicenter increases?

3. Predict what the Mercalli Intensity number would have been for Maine.

4. What does the Mercalli Scale measure?

5. What does the Richter Scale measure?

6. What would be the Mercalli Intensity Scale number if a locality was described as:
   Ground separated
   Buildings moved off their foundations
   Landslides occurred

7. How does a magnitude #4 on the Richter Scale compare to a magnitude #5?

MODIFIED MERCALLI SCALE

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing truck. Duration estimated.

IV. During the day it is felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc. broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings, with partial collapse; great in poorly built structures; some chimneys broken. Noticed by persons driving cars.

IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed over banks.

XI. Few, if any masonry structures remain standing. Bridges destroyed. Broad fissures in the ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

NAME: _____ PERIOD: _____ DATE: _____

LAB PARTNERS: _____ LAB #17

WORLD WIDE GEOLOGIC ACTIVITY

INTRODUCTION

Studies of tectonics have shown that crustal activities are occurring worldwide. Earthquakes, volcanoes, and mountains do not occur randomly. There are special zones in which they occur. In this lab you will look for the relationships that exist between the locations of these crustal activities.

OBJECTIVES

When completed students will have:

1. Plotted the latitude and longitude of earthquake epicenters and volcanic eruptions.
2. Identified and compared the locations of earthquake and volcanic activity with that of mountain ranges.
3. Identify areas (or zones) on the Earth's surface where earthquakes, volcanoes, and mountain ranges occur.

MATERIALS

Color pencils

APPROXIMATE TIME

1-2 Periods

PROCEDURE

1. Referring to the earthquake data on page 2, mark the epicenters on the world map provided by placing an **X** in each area where earthquakes have occurred. Use a **blue or green** pencil.

2. Referring to the volcano data on page 2, mark the areas with active volcanoes by placing small **circles** in the regions where they occur. Use a **red or orange** pencil.

3. Referring to the world maps in the appendix of your textbook, indicate on your map the regions where mountain ranges occur by placing small **triangles** in the appropriate areas. Yours should include at least one mountain range on each continent as well as the mountain ranges located under the oceans. Include Appalachians, Rockies, Andes, Alps, Atlas, Ural, and Himalayans. Use a **brown** pencil.

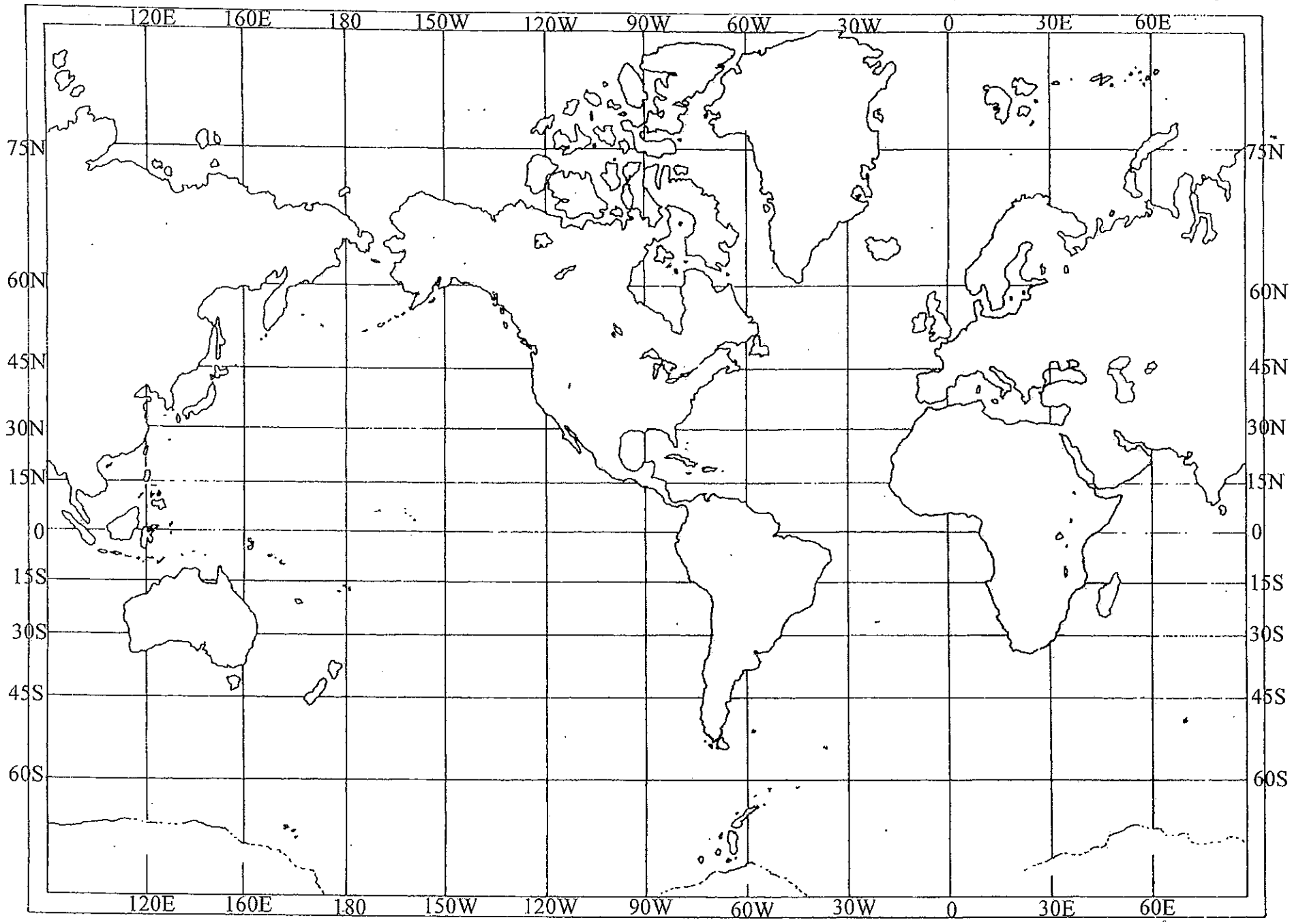
4. Answer lab questions # 1 through 7 using complete sentences.

EARTHQUAKES

	LATITUDE	LONGITUDE
1.	60° N	152° W
2.	45° N	125° W
3.	35° N	35° W
4.	30° N	115° W
5.	30° N	60° E
6.	20° N	75° W
7.	50° N	158° E
8.	40° N	145° E
9.	15° N	100° E
10.	15° N	105° W
11.	10° S	105° E
12.	5° S	150° E
13.	0°	80° W
14.	25° S	75° W
15.	50° S	75° W
16.	40° N	120° W
17.	5° S	110° E
18.	4° S	77° W
19.	23° N	85° E
20.	15° S	120° E
21.	5° N	35° E
22.	60° N	15° W
23.	45° N	30° W
24.	0°	15° W
25.	3° N	128° W

VOLCANOES

	LATIDUDE	LONGITUDE
1.	60° N	150° W
2.	45° N	120° W
3.	20° N	105° W
4.	0°	75° W
5.	65° N	15° W
6.	40° N	30° W
7.	17° N	25° W
8.	45° N	15° E
9.	30° N	60° E
10.	55° N	160° E
11.	40° N	145° E
12.	5° S	155° E
13.	10° S	120° E
14.	5° S	105° E
15.	15° S	60° E
16.	30° S	70° W
17.	55° S	25° W
18.	23° S	170° E
19.	10° S	20° W
20.	10° N	125° E
21.	7° N	125° E
22.	62° N	150° W
23.	60° N	148° W
24.	35° S	175° E
25.	5° S	152° E



WORLD-WIDE CRUSTAL ACTIVITY

LABORATORY QUESTIONS

1. Your world map should show that earthquakes do not occur at random locations. Describe two locations where you find a pattern of earthquake activity.

2. By referring to your map compare how the locations of earthquakes are related to the locations of volcanoes and mountains.

3. What regions of North and South America show the greatest crustal activity?

4. According ***to your map***, what is the probability of having either a major earthquake or having a volcano occur on Long Island? ***Explain*** your answer.

5. Explain what may cause movement along plate boundaries.

6. List the names of the three major types of plate boundaries.

7. On what plate can each of the following be found?

   Long Island _____ Hawaii _____

   Madagascar _____ Sweden _____