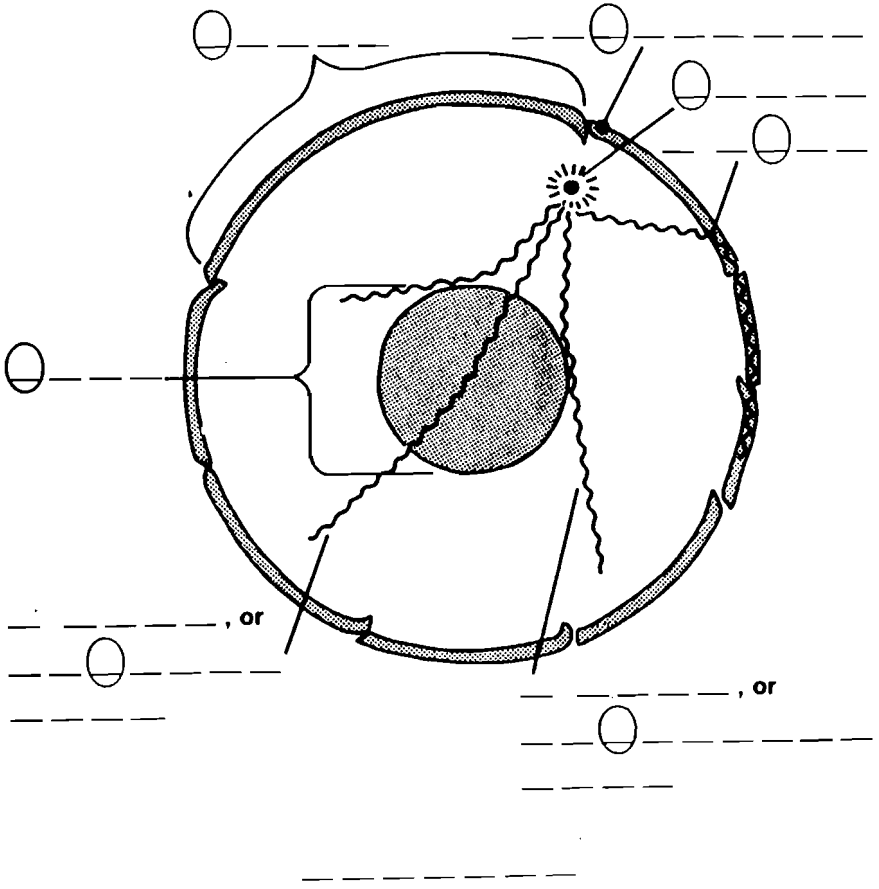
Earth Cross Section

Name _____ Class _____ Date _____

The drawing below shows the earth in cross section during an earthquake that occurs in one of its seismic zones. Fill in the blanks with the letters that spell out the names of the features indicated. Then write the seven circled letters in the blanks below the drawing. Unscramble these circled letters to spell the name of a large tectonic plate that borders one of the earth's most active seismic zones.



Refer to the drawing on page 12 to complete the following statements.

1. The innermost layer of the earth is the _____ .
2. The earth's surface is made up of huge moving sections of rock called _____ .
3. Surface seismic waves are called _____ .
4. The point at which an earthquake's movement begins is the _____ .
5. The place on the earth's surface directly above an earthquake's focus is the _____ .
6. The kind of seismic wave that causes rock particles to vibrate back and forth in the direction of the wave is _____ . push-pull waves
7. The kind of seismic wave that causes rock particles to vibrate at right angles to the direction of the wave is _____ . side-to-side waves

Earthquake Facts

Use the following clues to fill in the crossword puzzle on page 17 with the correct words.

ACROSS

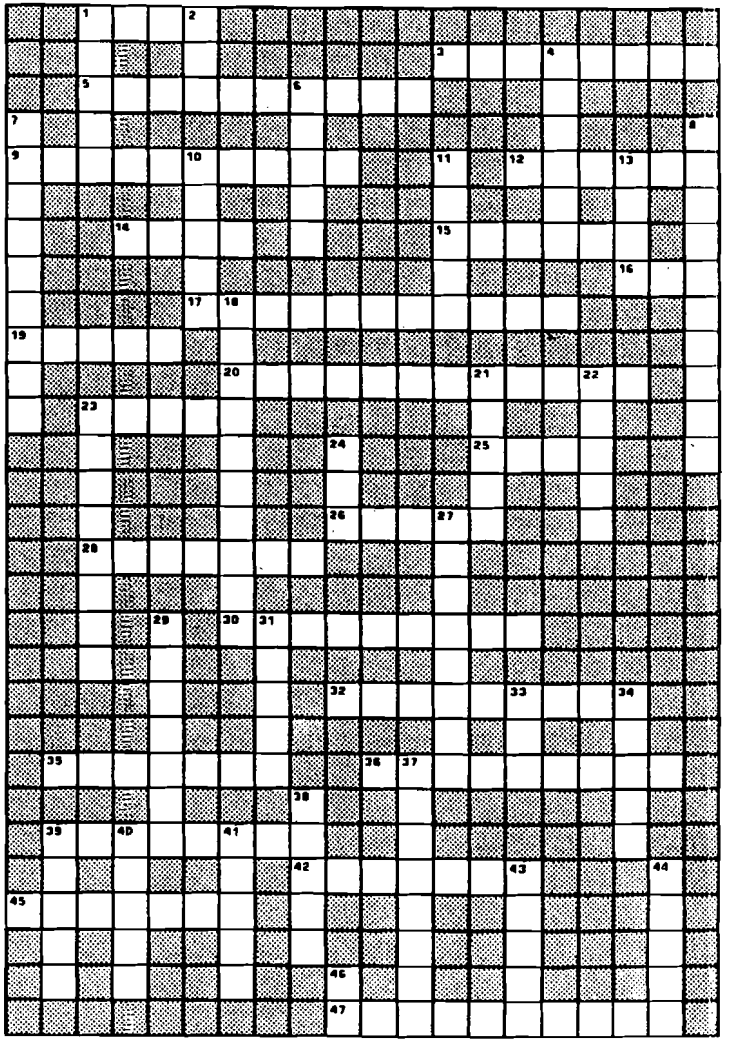
1. Indonesian island near the Ring of Fire
3. A pushing force per unit area
5. Forecasting; a goal of earthquake research
9. A pattern of earthquake activity that surrounds the Pacific (three words)
12. Geometrical curved figure used to determine epicenter location
14. The plural of #10 down
15. A vibrating motion
16. A variety of tree
17. An instrument used to measure earthquakes
19. To move back and forth, as buildings do during an earthquake
20. A standard range used to measure earthquake strength (two words)
23. A break in the earth's surface along which movement has occurred
25. Large continent bordered by the Ring of Fire
26. A large, slowly moving section of the earth's crust
28. A giant sea wave
30. The point on the earth's surface directly above an earthquake focus
32. The strength of an earthquake
35. Area of the earth along which L waves move
36. What the "S" stands for in "S wave"
39. To remove people from an area of danger
42. A mountain out of which hot, liquid rock emerges
45. The number of times stronger an earthquake rated 3 is than an earthquake rated 1
47. A long-range goal of earthquake research

DOWN

1. Island nation in the North Pacific, near the Ring of Fire
2. A common conjunction
4. A chemical element found in table salt
6. The number of observatories necessary to determine an earthquake epicenter's location
7. City struck by a major earthquake: San _____
8. The record of seismic waves
10. The point of origin of an earthquake
11. Substance that makes up a tsunami
13. The center layer of the earth
18. A seismic vibration
21. A seismic wave that causes vibrations at right angles to the direction in which the wave moves (two words; short form)
22. A surface seismic wave (two words; short form)
23. A force that tends to keep plates from moving
24. A representation of the earth's surface
27. Plate _____ theory

DOWN *(continued)*

29. The largest ocean
31. Primary wave (two words; short form)
33. The highest number on the Richter scale
34. The planet on which you live
37. Same as #39 across
38. The magnitude of an earthquake that is ten times stronger than a magnitude-6 earthquake
39. What volcanoes do
40. A South American mountain range
41. Same as #40 down
43. The Pacific is an example of this
44. Same as #43 down
46. The direction of an epicenter from the point of view of its focus



Geology II Student Notes **Name _____**
Earthquakes **Date _____**
Chapter 6 **Period _____**

Vocabulary: Please number and define each term below in a complete sentence on a separate sheet of paper (Those terms with a * please illustrate)

Aftershock	Earthquake	Elastic Rebound Theory
Epicenter*	Fault Zone	Focus
Intensity	L Wave*	Mercalli Scale
Microquake	P Wave*	Pacific Ring of Fire*
Richter Scale*	S Wave*	Seismic Gap
Seismograph	Tsunami*	Seismogram
Triangulation*		

6.1 Earthquakes and Plate Tectonics

1. How is an earthquake produced?
   -Rocks normally pressed together at _____
   -_____n prevents rocks from moving
   -Stress overwhelms fault and rocks suddenly grind past each other releasing _____
2. What is Elastic Rebound Theory?
   -Rocks stressed eventually fractures at the weakest point releasing _____
3. How is a focus different than an epicenter or a fault?
   -_____- is where is the slippage occurs
   -_____- the point on the Earth's surface directly above the focus, the most shaking occurs here
   -Fault- a break or crack in the crust along which _____
4. What is the difference between a(n):
   -Shallow focus- >70 km to surface- _____
   -Intermediate focus- 70-300 km below surface
   -Deep focus- 300-650 km below surface- found near at _____
   -How can earthquakes don't occur deeper than 6500 km?
5. What are the three major earthquake zones of the world?
   -_____- combination of transform and subduction zones
   -_____- Divergent boundaries
   -Eurasian-Melanesian Mountain Belt- caused by Eurasian, Indian and African Plate
6. What are fault zones and where is a good example of one?
   -fault zones form at plate boundaries due to intense stress in opposite directions-ex. _____

7. Where were the most widely felt series of earthquakes in U.S. history, why there (read page 102 “Big Squeeze”)?
   -New Madrid, Missouri 1812
   -North American Plate began breaking apart _____ then stopped being pressed from mid-Atlantic ridge

6.2 Recording

1. How does a seismograph work?
   -3 sensing devices- 1 vertical, 2 horizontal- north to south, east to west, record on seismogram- _____
   -using a heavy weight attached to _____ which holds the weight still even when the Earth moves

2. Define the following seismic waves:
   -_____- primary, push/pull waves, travel through solid and liquids, fastest waves 1.7 times faster than S Wave
   -_____- secondary, side to side, travel only through solids
   -_____- Long, surface waves, move up and down, travel through all materials, slowest and most damaging
   -P and S waves are sometimes called body waves because they travel through the body of the Earth, L waves do not
   -_____- areas that do not receive body waves due to the outer core being liquid, P waves are refracted and S wave never penetrate

3. How do we locate the epicenter/focus of an earthquake?
   -Need _____seismographs in three different locations
   -After reading a seismogram and using a time-travel graph can locate radius of how far away the _____ is from that station
   -Using three stations can locate exact epicenter and focus through process of _____

4. How is an earthquake measured?
   -The strength, energy, power or magnitude of an earthquake is measured using the _____
   -The scale was developed by Charles Richter in the 1940’s
   -The scale goes from 1 being the weakest to 10 strongest
   -Each number on the scale is _____ times more energy than the previous value
   -A number higher than a 6 is a destructive earthquake
   -_____ measures intensity of an earthquake, the damage done, not as accurate, based on observation

6.3 Earthquake Damage

1. What kind of damage occurs due to earthquakes?
   -collapsing buildings, falling objects, flying glass, explosions caused by broken gas and electric lines, flooding from collapsed dams, tsunami
   -Most building survive large _____ movements; few buildings survive up and down movements
   -_____- buildings on solid rock experience little damage; buildings on landfills collapse

2. What causes some earthquakes to be more damaging than others?
   -a less sever earthquake which has a longer duration can be more damaging than a more severe brief earthquake
   -earthquake _____, strength of the buildings and time of day

3. What causes a tsunami?
   -faulting and underwater _____
   -depending on the depth and shape of the coastlines, _____ heights can vary

4. Why is the Seismic Sea Wave System important?
   -Can predict a tsunami more rapidly _____

5. Impact on Society: "The Great Hanshin Earthquake"
   Date: 11/17/1995
   Where: _____
   Magnitude: 7.2
   Property loss: 190,000 buildings destroyed from collapses and fires= $100 billion and 5,500 deaths, thousands injured and 310,000 homeless

6. What are some precautions that should be taken if your in an earthquake?
   -keep a supply of canned food, bottled water, flashlights, batteries, portable radio
   -be able to turn off the gas, water and electricity
   -stand in a _____ when it occurs, stay away from windows, heavy furniture

7. Career Focus: Earth Forces
   What's the difference between a Volcanologist and an Exploration Geophysicist?
   -_____- monitor and predict volcano eruptions by using a seismograph, also study ancient lava flows which can save future lives
   -_____- study Earth's subsurface, to locate sources of fresh water, petroleum by using seismic surveys- used to find certain types of rock where petroleum might be found, then find the best place to drill

8. What are some ways that seismologists are trying to predict earthquakes?
   -_____- can possible sense the coming catastrophe
   -Based on the _____ can make approximate future predictions

9. What is a seismic gap?
   -_____ around faults, zones of immobile rock called seismic gaps
   -place where rock is locked and unable, no earthquakes for _____- likely locations of future earthquakes, several sites on the San Andreas Fault

10. What are some other signs of a possible future earthquake?
   -scientists detect a slight tilting of the ground before an eq
   -detect _____ due to stress
   -magnetic and electric properties of rocks change
   -increased _____ from strained rocks
   -decrease in P waves from other earthquakes, the longer the decrease in speed last the stronger the earthquake will be
   -_____ often goes up and down, becomes cloudy or increases in radon

11. What could be one possible solution to weakening earthquakes, based on tests from Rangely, CO?
   -_____, weakens earthquakes

Name: _____

Earthquake Study Guide

Key Vocabulary

Earthquake	Epicenter	Fault(ing)	Focus
Mercalli Scale	L-Wave	P-Wave	S-Wave
Richter Scale	Seismograph	Tsunami	Magnitude
Density	Slippage	Core	Lag time
Amplitude	Seismologist	Latitude	Longitude

Key Concepts:

1. Levels of Focus
    a.
    b.
    c.
2. 3 Major Earthquake Zones
    a.
    b.
    c.
3. How do we locate an epicenter?
    a. ____ number of seismographs in different locations
    b. Find the _____
    c. 3 stations to do the process of _____
4. Richter scale
    a. Each number is _____ times greater than the previous value
    b. A 5 on the Richter Scale is _____ times greater than a 3 on the scale?
5. Damages during an earthquake
    a.
    b.
    c.
6. Explain Tsunami

7. Signs of a possible Earthquake?
    a.
    b.
    c.
    d.

8. Draw the 3 types of faulting:
    a. External (Divergent)

    b. Compressional (Convergent)

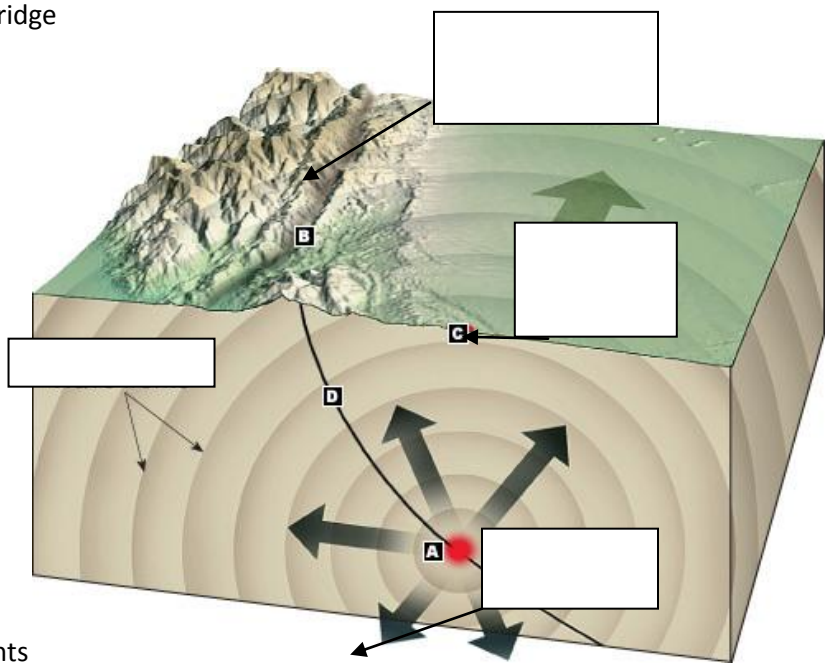
    c. Transform

9. Big Quakes…what do you know?

    a. Good Friday

    b. Kobe

    c. Northridge



10. Name the points
11. Draw a seismograph reading…
    a. Locate the P-Waves, S-Waves, L-Waves, and how to tell the amplitude!

Name _____

Date _____

EARTHQUAKES
REVIEW 1

Get the Facts

1. In what year did the Good Friday quake occur?

2. Why were many homes in Turnagain Heights destroyed?

3. What caused the destruction of Seward, Alaska?

4. What force destroyed Valdez, Alaska?

5. How was Kodiak, Alaska, destroyed?

6. Why was the death toll from the quake so low?

7. Name two records set by the Good Friday quake.

What Do You Think?

8. Ten people in Crescent City, California, were drowned by a tsunami caused by the Alaskan earthquake. The town had adequate warning to evacuate. Why do you think many people did not do so?

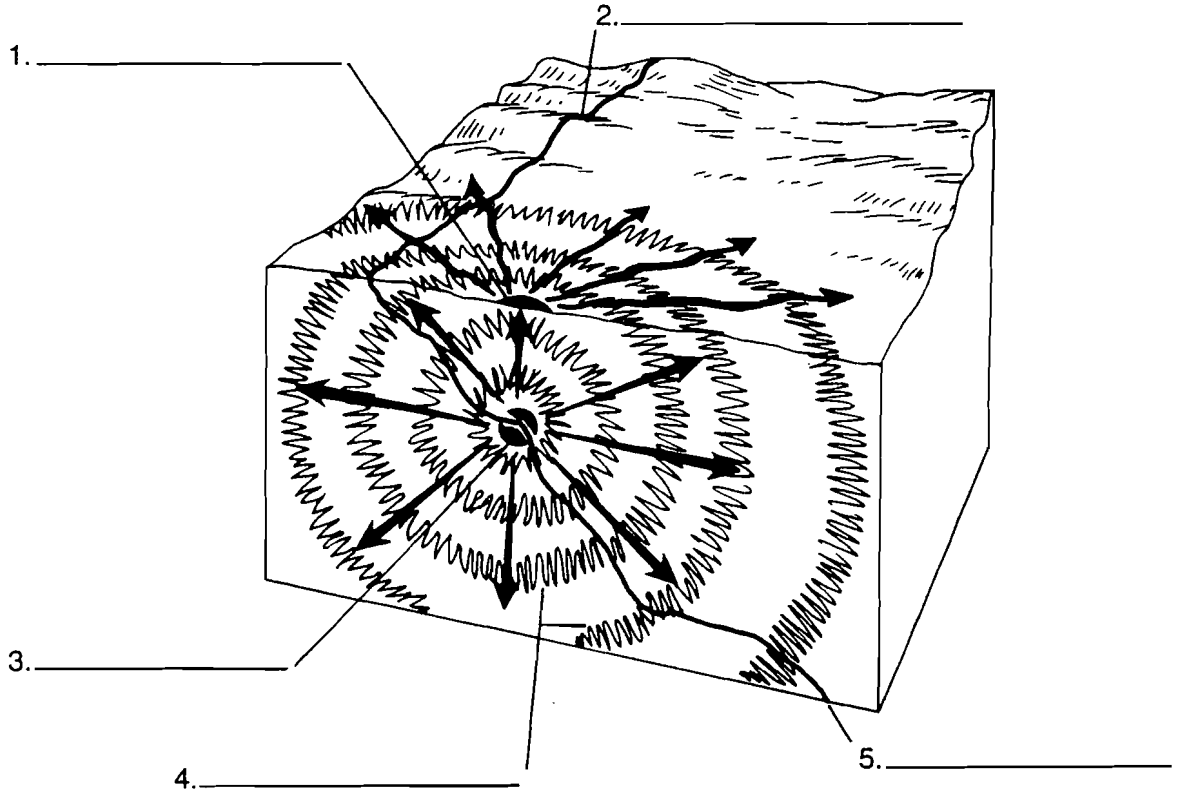
9. In Turnagain Heights, many expensive homes were built on the edge of a cliff overlooking the water. They were destroyed by the quake. Do you think people should be restricted from building in such locations? Why or why not?

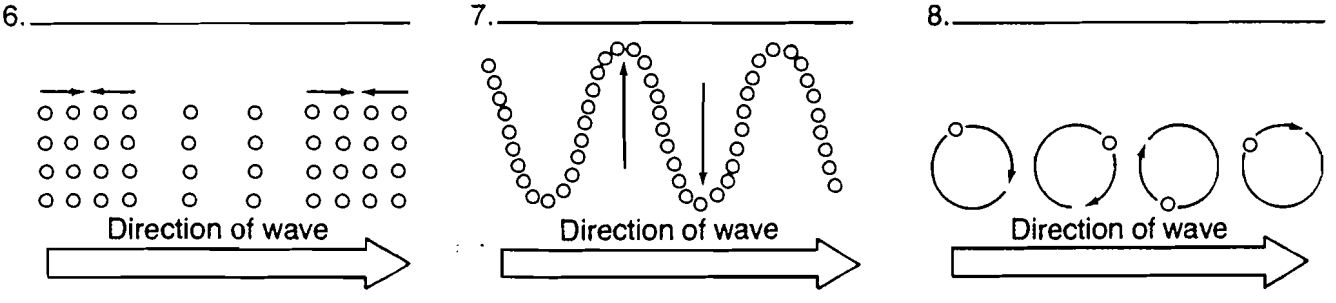
Name _____ Class _____ Date _____

Earthquake Characteristics

Fill in the blanks associated with each diagram by choosing the correct word or words from the list below.

L wave	Focus
Seismic waves	Fault
Fault	P wave
S wave	Epicenter





Analyzing a Seismogram

The drawing on page 19 shows a seismogram recorded during an earthquake. Note that the scale of numbers represents the number of seconds elapsed between waves. Assume that the distance (in kilometers) to the earthquake's epicenter can be calculated by multiplying the time lag (in seconds) between the first appearance of the first kind of seismic wave to arrive and the first appearance of the second kind of seismic wave to arrive. Study the figure and answer the following questions.

1. What is the name of the first kind of wave to appear?

   _____

2. After a total of how many seconds does this kind of wave appear on the seismogram? _____
3. What is the name of the second kind of wave to appear?

   _____

4. After a total of how many seconds does this kind of wave appear on the seismogram? _____
5. What is the time lag, in seconds, between the appearance of the first and the second kinds of waves?

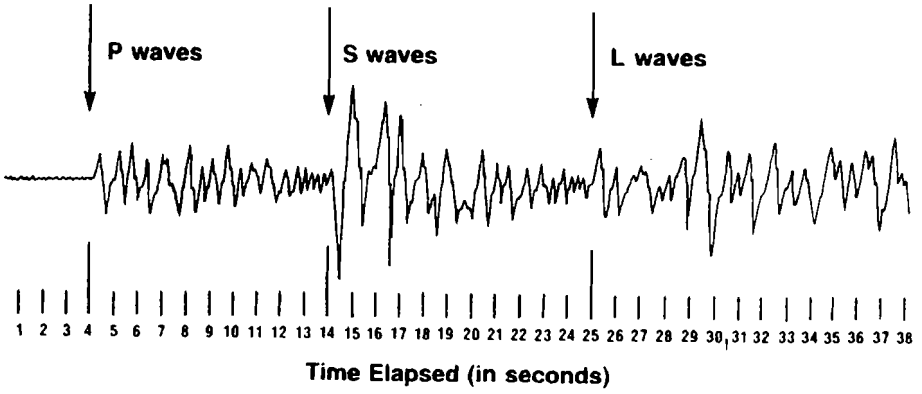
   _____

6. How far away (in kilometers) from the seismograph is the earthquake's epicenter? _____
7. What is the name of the third kind of wave to appear?

   _____

8. After a total of how many seconds does this kind of wave appear on the seismogram? _____
9. Which kind of wave passes down into the earth but cannot pass through the core? _____
10. Which kind of wave tends to do the most damage?

    _____



Name _____

LAB: Locating Patterns of Earthquake and Volcano Distribution

Problem

What is the path of earthquake and volcano distribution worldwide?

Materials (*per student*)

Earthquake and volcano locations
World map showing latitude and longitude
2 different colored pencils

Procedure

1. Using the information in the table on earthquakes, plot the location of each earthquake on the map on the following page. Make a dot on the map for each earthquake using one of the colored pencils.

2. Using the information in the table on volcanoes, plot the location of each volcano on the map on the following page. Make a dot on the map for each volcano using the other colored pencil.

3. If directed by your teacher, also plot the location of recent earthquakes and volcanoes. Remember to use the same colored pencils as before.

4. Answer the questions on the back of this paper.

Earthquakes	
Longitude	**Latitude**
120°W	40°N
110°E	5°S
77°W	4°S
88°E	23°N
121°E	14°S
34°E	7°N
74°W	44°N
70°W	30°S
10°E	45°N
85°W	13°N
125°E	23°N
30°E	35°N
140°E	35°N
12°E	46°N
75°E	28°N
150°W	61°N
68°W	47°S

Volcanoes	
Longitude	**Latitude**
150°W	60°N
70°W	35°S
120°W	45°N
61°W	15°N
105°W	20°N
75°W	0°
122°W	40°N
30°E	40°N
60°E	30°N
160°E	55°N
37°E	3°S
145°E	40°N
120°E	10°S
14°E	41°N
105°E	5°S
35°E	15°N
70°W	30°S

LAB: Locating Patterns of Earthquake and Volcano Distribution (continued)

Questions to answer:

1. Are earthquakes scattered randomly over the surface of the earth or are they concentrated in definite zones? _____

2. Are volcanoes scattered randomly or concentrated in definite zones?

   _____

3. Are most earthquakes and volcanoes located near the edges or near the center of continents? _____

4. Are there any active volcanoes located near your home?_____

5. Has an earthquake occurred near your home? _____

6. Describe any patterns you observe in the distribution of earthquakes and volcanoes. _____

   _____

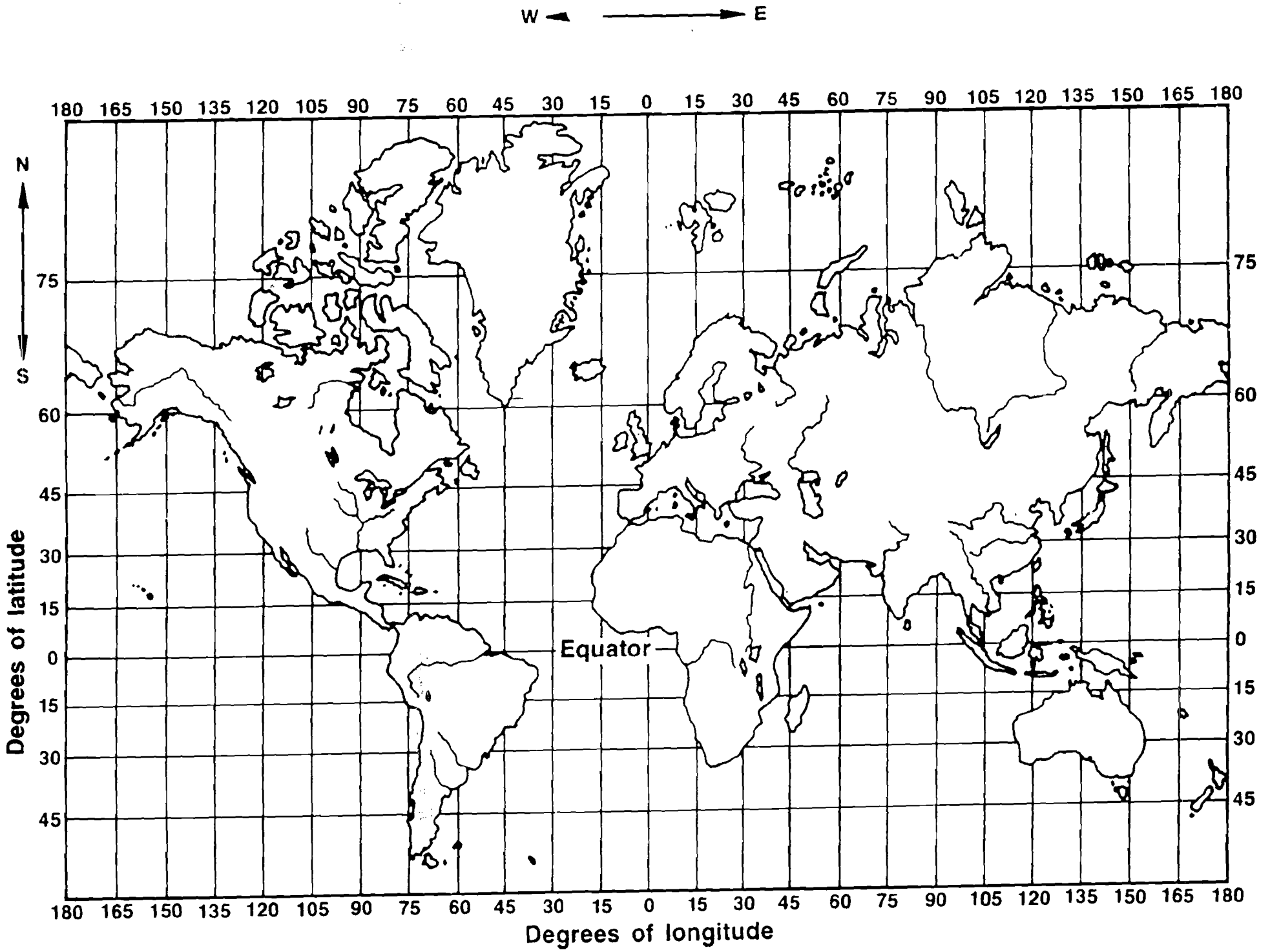
   _____

7. What relationship exists between the locations of earthquakes & volcanoes?

   _____

   _____

   _____


W
E
N
S
180 165 150 135 120 105 90 75 60 45 30 15 0 15 30 45 60 75 90 105 120 135 150 165 180
75
60
45
30
15
0
15
30
45
Equator
Degrees of latitude
Degrees of longitude

Name _____

Nova: The Day the Earth Shook

Directions: Listen to the video and try to answer as many of the following questions as possible.

1. What statistics characterize each of the earthquakes in the video? How does Makiko Yoshihara describe her experiences in both earthquakes?

2. Why was there a delay in people outside Kobe finding out about the quake? Describe the experience of Norio Seki in the Kobe newsroom.

3. Describe the damage in Kobe. What impeded assistance to the victims? What other problems made the situation worse?

4. What do seismologists know about the causes of the Kobe and Northridge quakes? Why was it difficult to obtain seismic records of what caused them?

5. How were the earthquakes in Kobe and Northridge different? How were they similar? Why was there so much more damage in Kobe?

6. Describe the impact of building construction in a major earthquake. What other damages were prevalent? Describe the destruction of freeways, bridges and docks.

7. What were the economic effects of the Northridge and Kobe quakes?

8. Why do different areas experience different levels of shaking? What is Dr. Irikura's theory about basin originated waves, and how does it apply to Kobe?

9. What lessons have been learned from the Kobe earthquake? In what ways is Tokyo prepared for a major quake?

10. What information can computer simulation provide? How will it help rescue efforts? Describe the characteristics of the response systems now in place in Japan and the U.S.

The Richter Scale

Seismologist _____

_____ 1. What is the highest number on the Richter Scale?

_____ 2. What is the lowest number on the Richter Scale?

_____ 3. How many earthquakes greater than magnitude 7.4 occur each year?

_____ 4. What effect would a magnitude 8.4 earthquake have in a populated area?

_____ 5. How many earthquakes with magnitudes of 2.0-3.4 occur each year?

_____ 6. What effect would a magnitude 2.7 earthquake have in a populated area?

_____ 7. What magnitude must an earthquake have to damage buildings?

_____ 8. What does magnitude mean?

_____ 9. When the Richter magnitude number goes up one, the energy goes up _____ times.

_____ 10. An earthquake of magnitude **2** is _____ times stronger than a magnitude **1**.

_____ 11. An earthquake of magnitude **3** is _____ times stronger than a magnitude **1**.

_____ 12. An earthquake of magnitude **7** is _____ times stronger than a magnitude **3**.

_____ 13 An earthquake of magnitude **6** is _____ times stronger than a magnitude **5**.

_____ 14. An earthquake of magnitude **8** is _____ times stronger than a magnitude **6**.

_____ 15. An earthquake of magnitude **10** is _____ times stronger than a magnitude **1**.

The Richter Scale

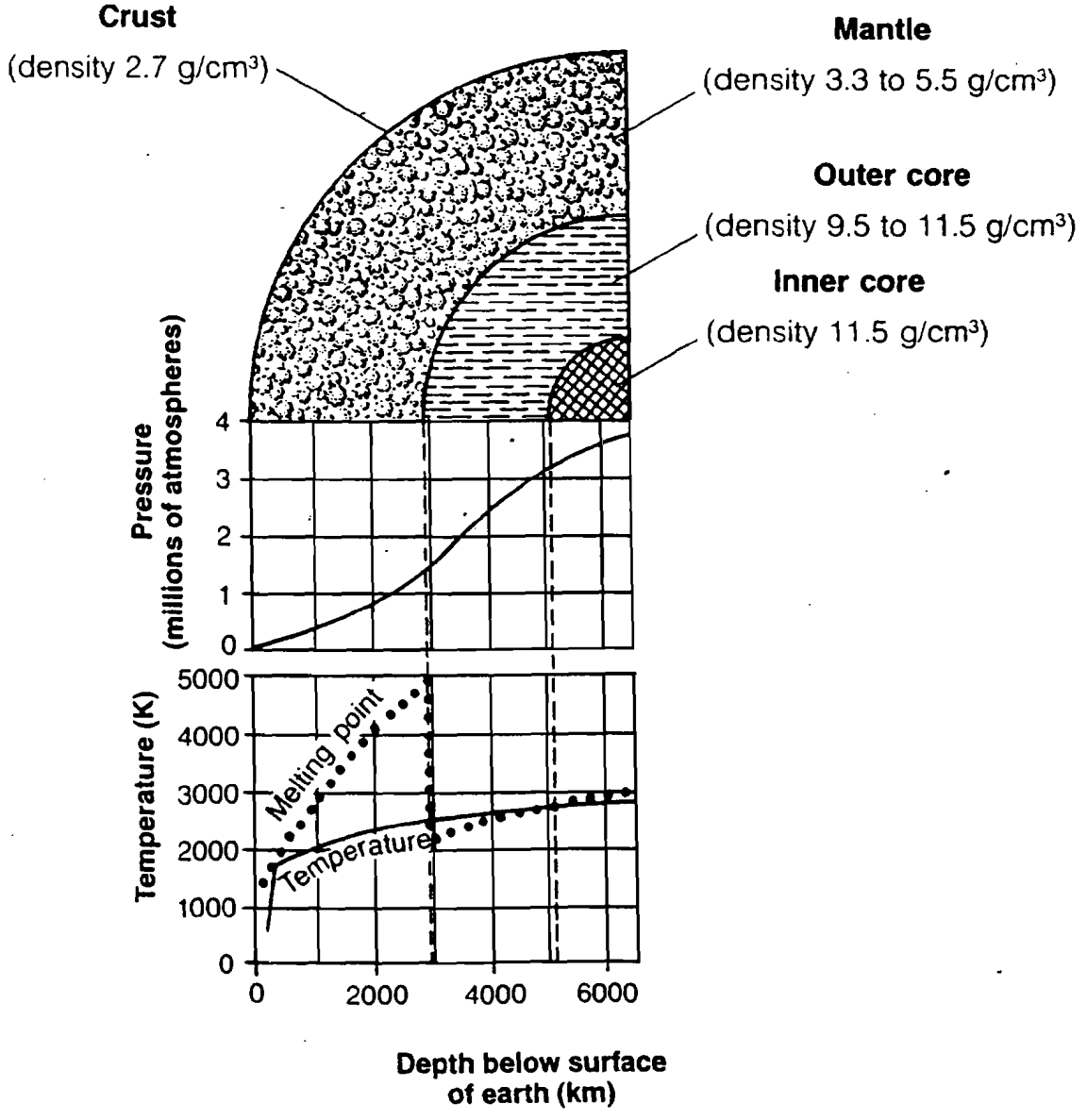
Characteristic effects of shallow shocks in populated areas	Approximate magnitude	Number of earthquakes per year
Damage nearly total	≥ 8.0	0.1 - 0.2
Great damage	≥ 7.4	4
Serious damage, rails bent	7.0 - 7.3	15
Considerable damage to buildings	6.2 - 6.9	100
Slight damage to buildings	5.5 - 6.1	500
Felt by all	4.9 - 5.4	1,400
Felt by many	4.3 - 4.8	4,800
Felt by some	3.5 - 4.2	30,000
Not felt, but recorded	2.0 - 3.4	800,000

Name _____ Class _____ Date _____

Subsurface Changes on the Earth

Scientists use earthquake waves to investigate the internal structure of the earth in much the same way that a doctor uses X-rays to reveal information about the internal structure of a person.

The diagram summarizes information about the earth's interior that has been inferred from the analysis of earthquake waves. Using the diagram, answer the questions that follow it.



1. At what depth below the surface of the earth does the outer core begin? _____
2. Approximately how thick is the outer core? _____
3. List the four layers of the earth in order from the thickest layer to the thinnest layer.

   _____

   _____

   _____

   _____

4. What is the temperature of the interior of the earth at a depth of 1000 km? _____
5. At approximately what depth is the internal temperature of the earth thought to be 2500 K? _____
6. What information from the diagram supports the theory that the outer core of the earth is in the liquid state?

   _____

   _____

7. What happens to the internal pressure of the earth as depth below the surface increases? _____
8. What is the approximate density of crustal material? _____
9. In which of the four layers of the earth would you be most likely to find earth material with a density of 4.5 g/cm^3? _____
10. Which part of the earth contains the densest material? _____
11. What is the relationship between the density of earth materials and depth below the surface of the earth?

    _____

    _____

    _____

Name _____
Partner Name _____

Towering Toothpick Disaster (50 points)

Objective:
The student will design and build a three story tower that will withstand vibrations from a simulated earthquake.

Materials:
- Craft Sticks
- Wood Splints
- Toothpicks
- Glue
- Cotton Swabs (to apply glue)
- Meter Stick
- Glue Dish
- Wax Paper (to prevent glue from running onto table top)

Guidelines: (28 points)
1. A plan is drawn and approved by the instructor before construction. (4 pts)
2. The tower consists of 200 or less craft sticks, wood splints and toothpicks. (4 pts)
3. The tower is 45 cm tall. (4)
4. The tower has 3 stories. (4)
5. Each story is 15 cm tall. (4)
6. Each story has a floor. (4)
7. The tower has a roof. (2)
8. The tower does not have solid walls (instead, the structures should be more like scaffolding)
9. The tower base is 22.5 x 22.5 cm. (2)

After the Earthquake: (8 points)
(8 points) The tower's strength was incredible! The tower had little or no damage during the simulated earthquake.
(6 points): Only minor damage occurred due to the earthquake
(4 points): Half the structure held up after the earthquake
(2 points): An attempt was made to build a structure but it crumbled.
(0 points): The project was very incomplete or not done.

Analysis and Conclusions: (14 points)
1. Which aspect of your tower's design was the most successful? Explain.

2. Which aspect of your tower's design was the least successful? Explain.

3. How would you redesign your tower to make it perform better?

4. Should buildings, bridges and other structures be designed differently in earthquake prone areas? Explain.

Go to: http://pubs.usgs.gov/fs/2006/3016/ and click on the pdf. file

1. According to FEMA, what has estimated future annual earthquake losses in the United States at _____ a year.
2. What state is the most earthquake prone state in the U.S.? _____
3. In the United States, there are an average of six magnitude ___ or greater and ___ magnitude 5 or greater earthquakes each year.
4. What are the priorities of the USGS in relation to earthquakes: (should be 6):
   a.

   b.

   c.

   d.

   e.

   f.

5. List a practical reason that engineers continue to design taller and taller buildings, even though those buildings may be built in earthquake prone areas?

6. Research two examples of how architects try to limit sway due to earthquakes or wind?