Shake, Rattle, and Roll

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Shake, Rattle, and Roll - Earthquakes

Lesson Plan - Day One

I. **Objective:**

A. Student will be able to read and label a two axis graph.
B. Student will be able to translate a map scale from ruler measurement to actual.
C. Student will be able to half recorded times using minutes and seconds.

II. **Rationale:**

A. Reading and knowing the parts of graphs will be necessary to analyze and record earthquake data.
B. Translating a map scale will be necessary for reading a map and determining how far an earthquake's effects can be felt.
C. Manipulations of times will be a necessary skill when working with p-waves and s-waves.

III. **Materials Needed:**

A. Sample graphs for overhead and hand-out graphs for student to label.
B. Sample maps for overhead, hand-out map for student to read, and rulers.
C. Blank overhead transparency to write out sample time problems. Students will need their own paper and pencils.

IV. **Introductory Activity:**

Show "Living Room" picture and ask, "What would you think if you woke up and your living room looked like this"" Discuss possibilities. Inform students how close to a fault line they are located. Let students know that you must learn some basics about interpreting data before you can study earthquakes.

V. **Procedures:**

A. Graphs

1. Show Graph I and allow students to point out as much as they can before giving them the information. Discuss how to read the horizontal (x) and vertical (y) axis. Stress the importance of the title of the graph. Show how to locate points on the graph and how to notice any trends occurring.
2. Show Graph II and have students read graph orally together.
3. Show Graph III. Label axis, title, and plot point using the given information.
4. Give WS I to students. Front - completed graph with questions regarding graph. Back - blank graph with data listed to label and plot points.

B. Map

2. Show overhead map and how to measure distances with ruler and convert to miles or km using map scale.
3. Give students WS II and a ruler. Together as a class measure three specified distances with the ruler and using the map scale convert to miles and km.
4. Assign three to five specified distances for student to measure and convert on their own.

C. Map

1. Ask students how many seconds are in a minute. Ask how many seconds are in 2 minutes, in 3 minutes, in 4 minutes. Ask them what half of' 2 minutes, 3 minutes, and 4 minutes would be. Then ask what half of 2 minutes and 30 seconds would be. Finally ask what half of 3 minutes and 20 seconds would be. Explain to students how to convert the minutes first to seconds, add them together with the given seconds, then half that for your answer in seconds. They should then realize one must divide that by 60 to find how many minutes there are and that- the remaining will be the seconds. Work out sample problems on overhead transparency

5 min, 30 sec	7 min, 20 sec	1 min, 55 sec

2. On their paper students will work problems assigned on overhead.

3 min, 50 sec	5 min, 45 sec	1 min, 10 sec

VI. **Closure:**

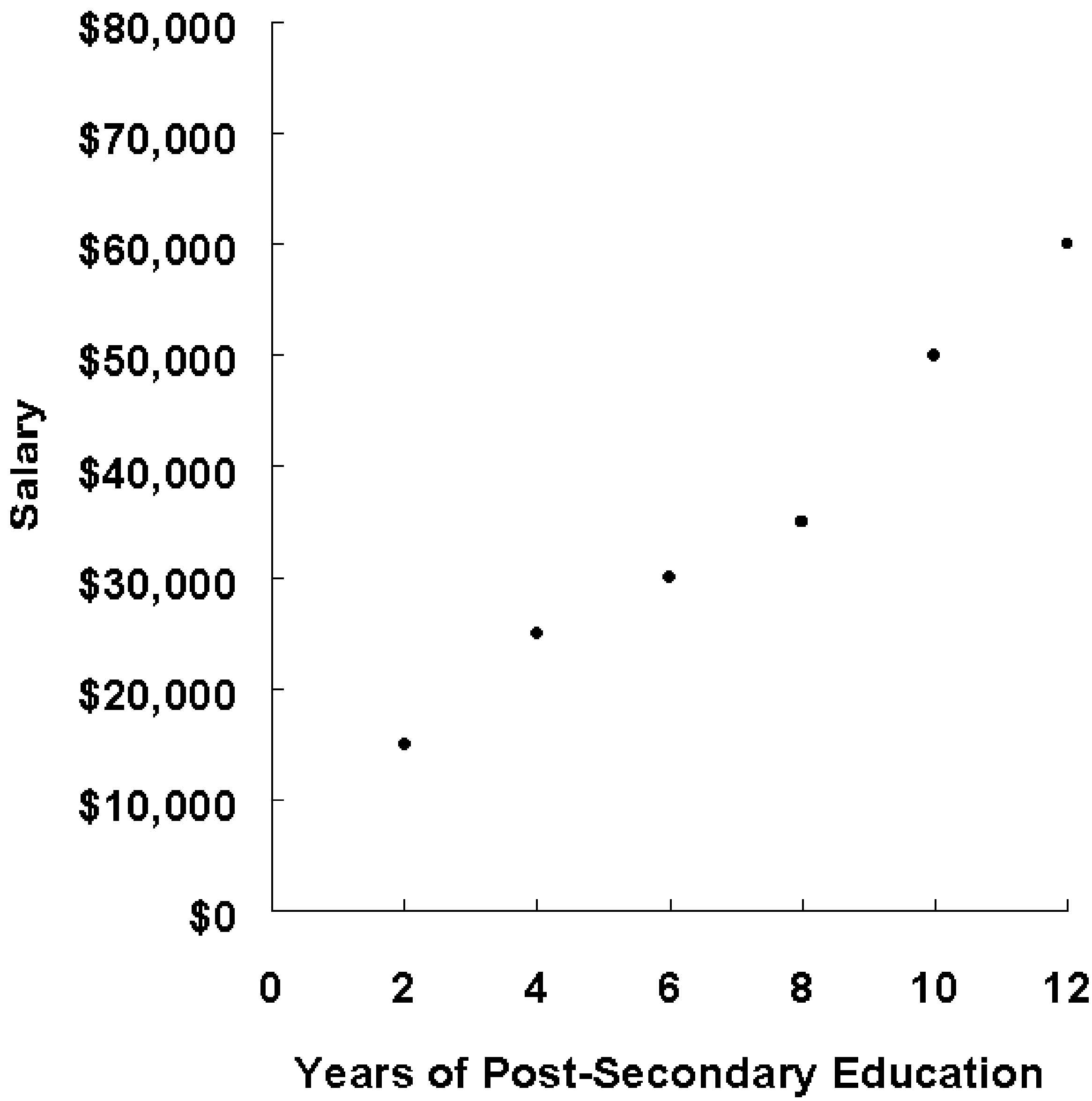
Restate that students must be able to do these things (read and make graphs, read map distances to scale, and manipulate times) to work with earthquakes.

VII. **Evaluation:**

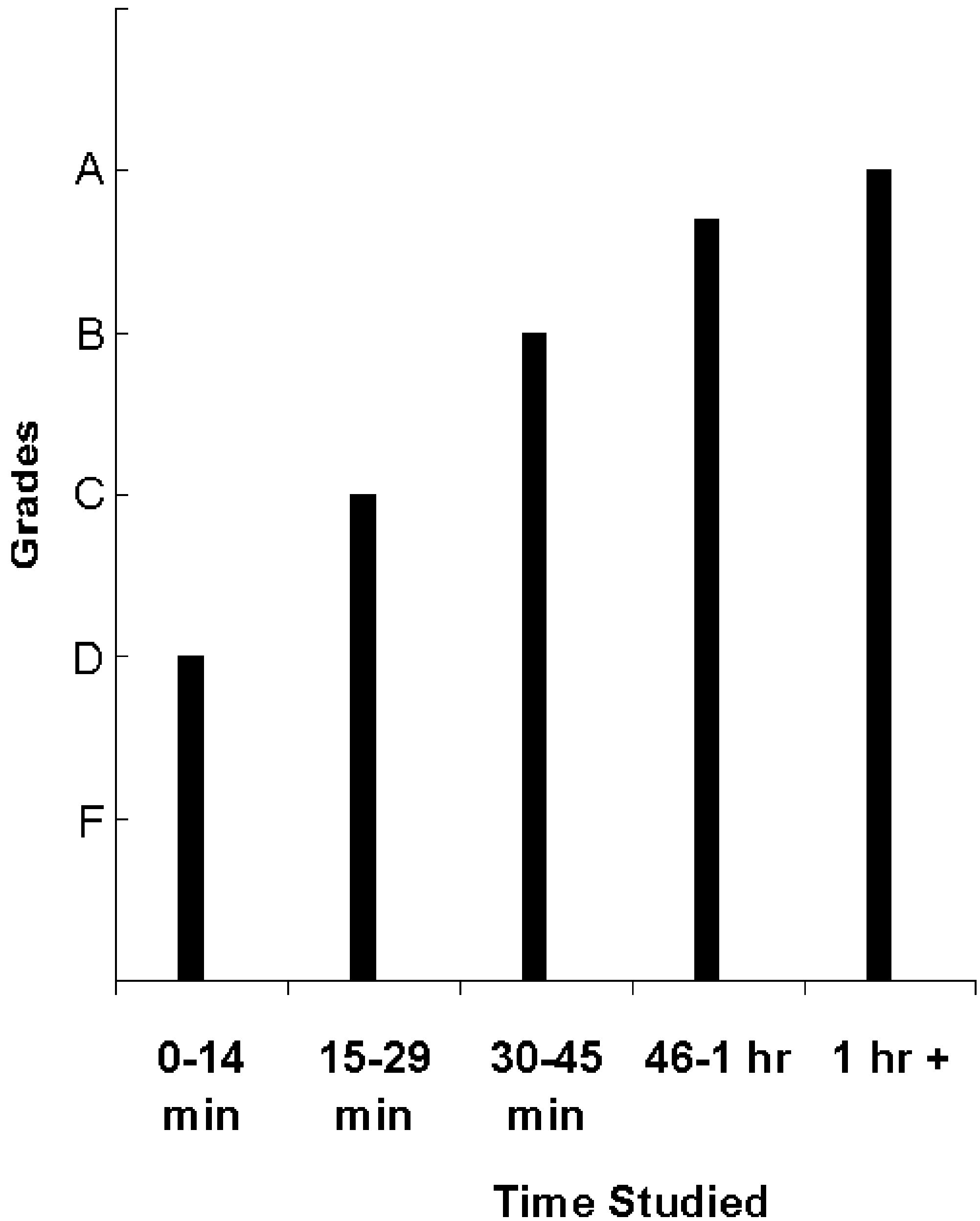
No formal evaluation (test) will be given today. Student progress should be monitored throughout the lesson to guarantee they are acquiring the necessary skills to move on to the next lesson.

<u>Self-Evaluation of the Lesson Effectiveness</u>

Graph I - Average Starting Salaries Based on Education



Graph II - Student Grades and Study Times



Graph III - Average Monthly Temperatures

January	30 degrees	July	76 degrees
February	38 degrees	August	79 degrees
March	45 degrees	September	74 degrees
April	55 degrees	October	68 degrees
May	66 degrees	November	54 degrees
June	71 degrees	December	43 degrees

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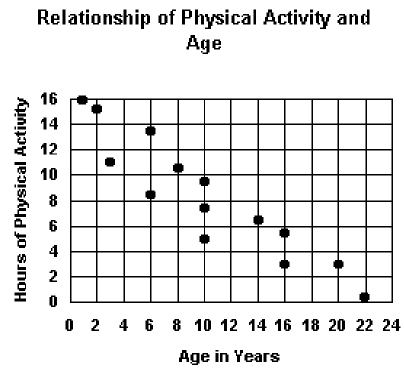
Worksheet I - Scatter Plots

A scatter plot of physical activity and age is shown at the right.

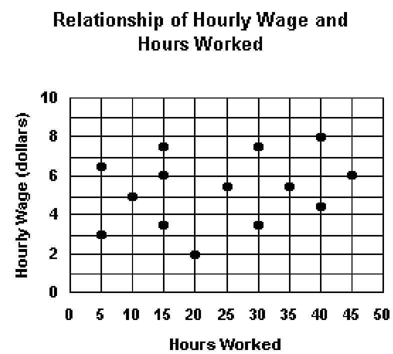


1. What relationship (positive, negative, or none) does this data show between physical activity and age?

2. Where on the plot are the points showing the hours of physical activity as people grow older?

3. What happens to the number of hours of physical activity as people grow older?

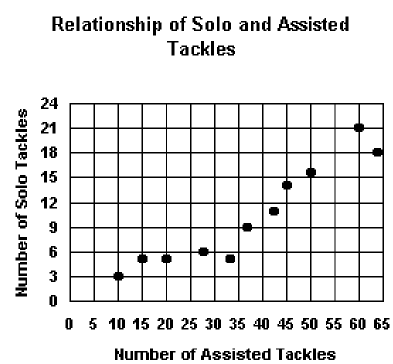
A scatter plot of hours worked and hourly wage is shown at the right.



1. What relationship does this data show between hours worked and hourly wage?

5. How many people are shown on the plot?

A scatter plot of assisted tackles and solo tackles for each player during a football season is shown at the right.



6. What relationship does this data show between assisted tackles and solo tackles?

7. What is the greatest number of assists shown on the plot?

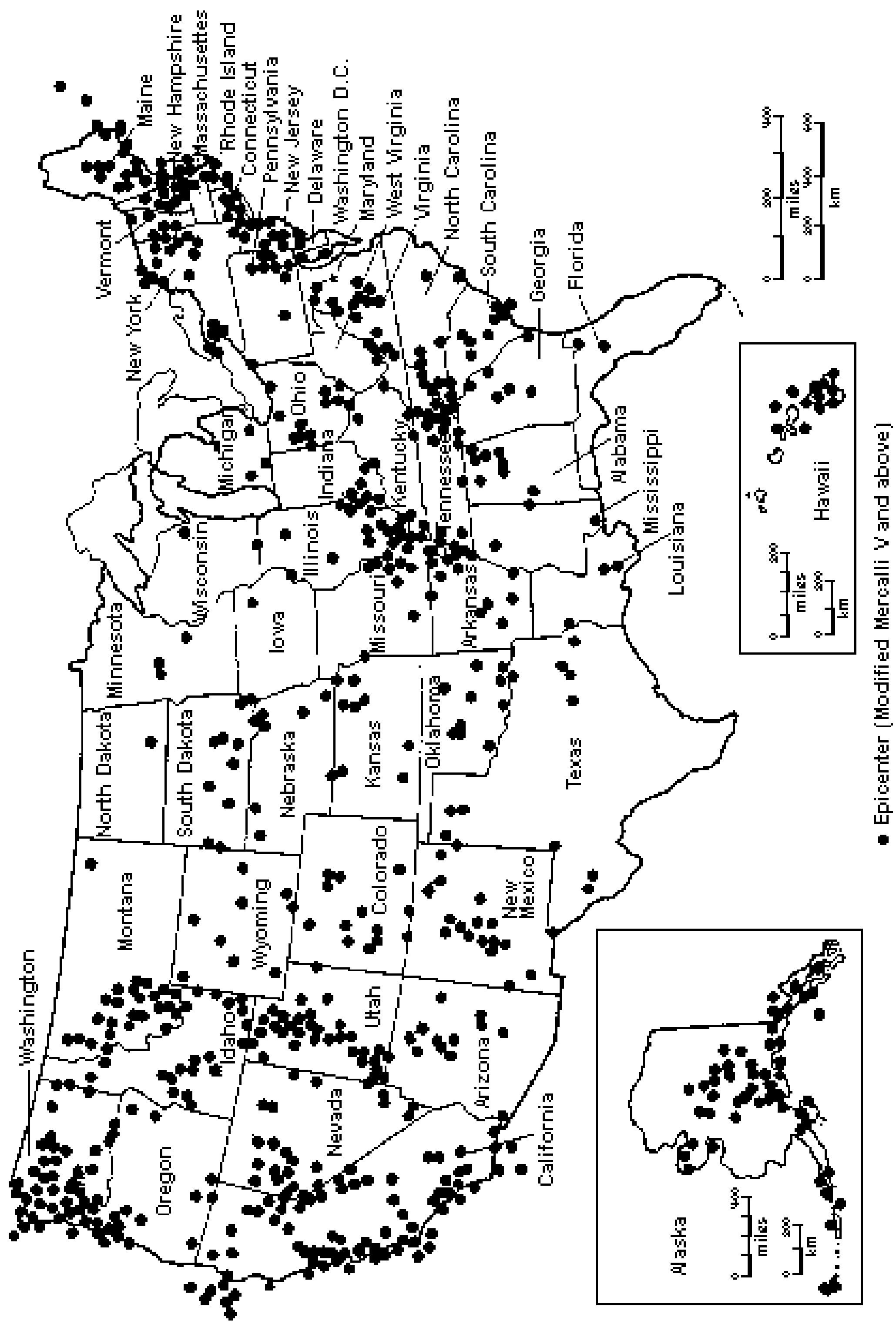
8. What is the least number of solo tackles shown on the plot?

Complete the graph above using this data:

Louise wants to know if there is a relationship between the grades earned on a test and the amount of time spent studying for the test. She collected the data shown in the chart.

Student	Study Time	Test Score
Doug	10 min	65
Rebecca	15 min	68
Bradley	70 min	87
Justine	60 min	92
Allison	45 min	73
Tami	90 min	95
Mick	60 min	83
Montega	30 min	77
Christy	120 min	98

Worksheet II - U.S. Map with Epicenters



EARTHQUAKES - NSTA/FEMA

Shake, Rattle, and Roll - Earthquakes

Lesson Plan - Day Two

I. **Objective:**

A. Students will be able to define and describe the terms earthquake, seismic waves, tension, compression, shearing, fractures, faults, folds, magnitude, intensity, Richter Scale, and Mercalli Scale.
B. Students will be able to convert pounds to tons.
C. Students will be able to identify the intensity of an earthquake based on the Richter Scale.
D. Students will be able to identify the intensity of an earthquake based on the Mercalli Scale.
E. Students will be able to determine if an earthquake is considered a "major" earthquake based on the Richter scale.

II. **Rationale:**

A necessary prerequisite for application of seismic data.

III. **Materials Needed to Accomplish Objective:**

A. Text
B. Richter Scale Handout
C. Killer Earthquakes Handout
D. Mercalli Scale Handout
E. Pictures of Earthquakes Handout

IV. **Introductory Activity:**

Students will look at pictures of various earthquake damage and try to assess the damage and what possit

V. **Procedures:**

A. Discuss and describe sections 19-1 and 19-2 in the text on earthquakes. Specific terms, Richter Scale, and Mercalli scale will be reviewed.
B. Students will complete activity sheet on the Richter Scale and graph results.
C. Students will determine earthquakes on the Mercalli Scale by looking at photographs.
D. Students will be given homework - Killer Earthquakes.

VI. **Closure:**

Questions will be asked to the students to review the facts learned in this lesson.

VII. **Evaluation of the Learner:**

Students will be assessed by the results from their in class activities, homework, class discussion, and the closure section of this lesson.

Self-Evaluation of the Lesson Effectiveness

Shake, Rattle, and Roll - Earthquakes

The Richter Scale

Richter Magnitude	TNT Energy Equivalent	Example
1.0	6 ounces	
1.5	2 pounds	
2.0	13 pounds	
2.5	63 pounds	
3.0	397 pounds	
3.5	1,000 pounds	
4.0	6 tons	Small Atomic Bomb
4.5	32 tons	Average Tornado
5.0	199 tons	
5.5	500 tons	Massena, NY, 1994
6.0	6270 tons	
6.5	31,550 tons	Coalinga, CA, 1983
7.0	199,000 tons	Hebgen Lake, MT 1959
7.5	1,000,000 tons	
8.0	6,270,00 tons	San Francisco, CA 1906
8.5	31,550,000 tons	Anchorage, AK, 1964
9.0	199,999,000 tons	

Shake, Rattle, and Roll - Earthquakes

The Modified Mercalli Intensity Scale

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally - total destruction. Although numerous *intensity scales* have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at that place. After the occurrence of widely-felt earthquakes, the Geological Survey mails questionnaires to postmasters in the disturbed area requesting the information so that intensity values can be assigned. The results of this postal canvass and information furnished by other sources are used to assign an intensity within the felt area. The maximum observed intensity generally occurs near the epicenter.

The *lower* numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The *higher* numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

The following is an abbreviated description of the 12 levels of Modified Mercalli intensity.

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

II. Felt only by a few persons at rest, especially on upper floors of buildings.

III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.

IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.

VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.

XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

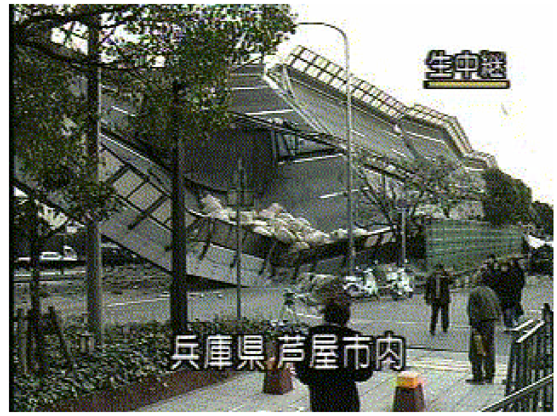
United States Geological Survey
National Earthquake Information Center

URL http://www.neic.crusgs.gov/neis/generallhandouts/mercalli.htmI

Shake, Rattle, and Roll - Earthquakes

Earthquake Damage

Wooden Building - Kobe, Japan



Highway - Kobe, Japan

Apartments - Kobe, Japan

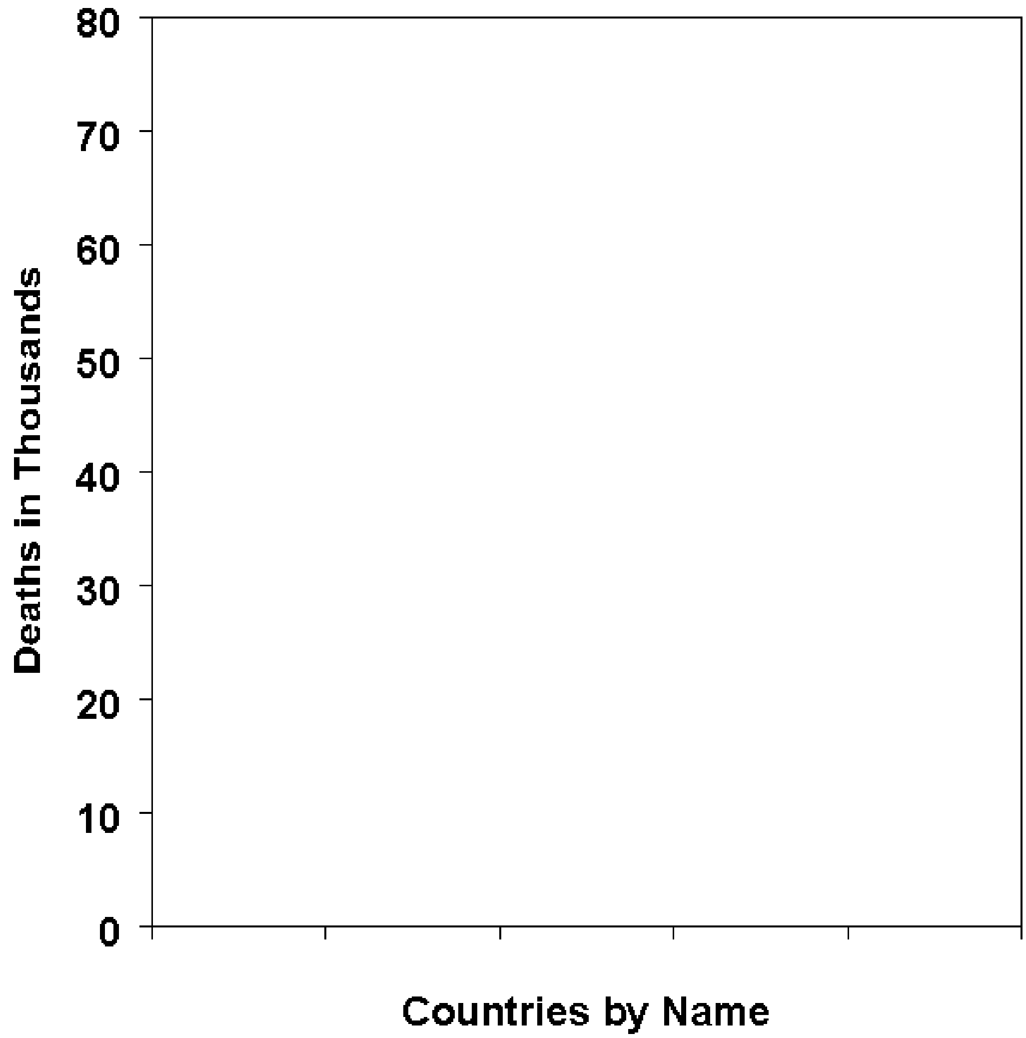
2-Story Building - Kobe, Japan

Fire - Kobe, Japan

Shake, Rattle, and Roll - Earthquakes

Killer Earthquakes

Name: ___________________________



Year	Magnitude	Location	Deaths
1968	7.3	Iran	12,100
1970	7.8	Peru	67,000
1972	7.1	China	20,000
1976	7.5	Guatemala	23,000
1978	7.7	Iran	15,000
1985	8.1	Mexico	9,000

Shake, Rattle, and Roll - Earthquakes

Lesson Plan – Day Three

I. **Objective:**

A. Students will be able to define and describe the terms: focus, epicenter, intensity, magnitude, seismologists, seismograph, and seismograms.
B. Students will be able to access current seismographic data on the Internet.
C. Students will be able to apply current seismographic data using a world map.

II. **Rationale:**

A necessary pre-requisite for graphing seismic data.

III. **Materials Needed to Accomplish Objective:**

A. Text
B. US Map with 14 Epicenters Handout
C. Selected US Earthquakes of the 20' century Handout
D. Computer with Internet Access
E. World Map
F. Colored Push Pins

IV. **Introductory Activity:**

Ask students if they have ever heard of Reelfoot Lake.
Explain to them how it came to be and where the nearest epicenter is on the New Madrid Fault, etc.

V. **Procedures For the Lesson:**

A. Students will discuss and describe sections 19-3, 19-4, and 19-5 in the text.
B. Students will complete handout on US Map with 14 Epicenters using handout on Selected US Earthquakes of the 20'th Century.
C. Students will look up current seismic data and display data on world map using corresponding push pins.

VI. **Closure:**

Review terms and concepts learned during the lesson.

VII. **Evaluation of the Learner:**

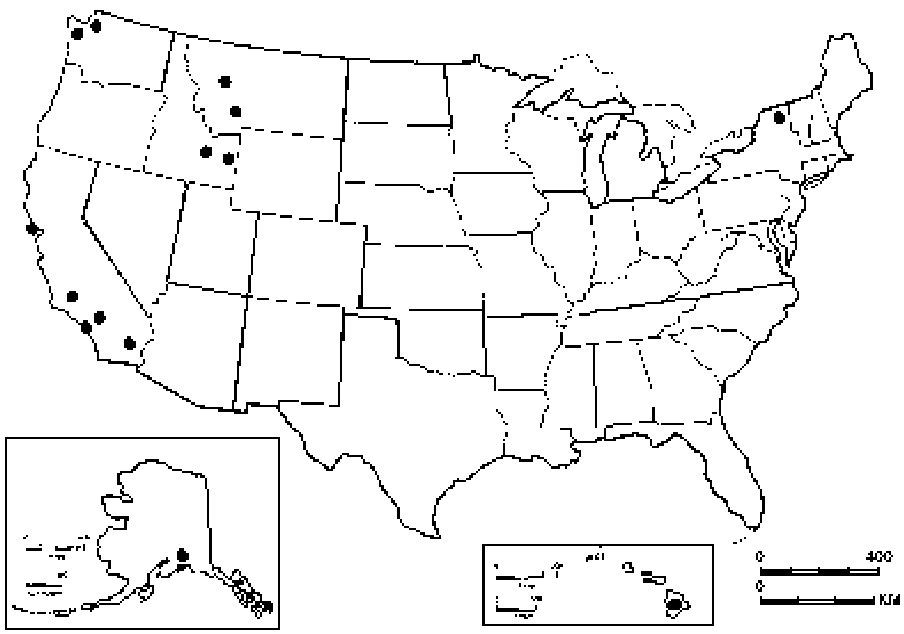
Students will be assessed based on the results of their activities in class and from feedback in the class discussion and closure section of this lesson.

Self-Evaluation of the Lesson Effectiveness

Shake, Rattle, and Roll - Earthquakes

U.S. Map with 14 Epicenters

Name ____________________________



1. ____________________________ **8.** ____________________________

2. ____________________________ **9.** ____________________________

3. ____________________________ **10.** ____________________________

4. ____________________________ **11.** ____________________________

5. ____________________________ **12.** ____________________________

6. ____________________________ **13.** ____________________________

7. ____________________________ **14.** ____________________________

Selected U.S. Earthquakes of the 20th Century

Location	Date	Dollar Damage (1979 dollars)	Magnitude
1. Pocatello Valley, ID	March 28, 1975	$1,000,000	6.1
2. Massena. NY	September 5, 1944	$8,000,000	5.6
3. Hilo, HI	April 26, 1973	$9,000,000	6.2
4. Borah Peak ID	October 2, 1983	$15,000,000	7.3
5. Helena. MT	October 19, 1935	$19,000,000	6.2
6. Hebgen Lake, MT	August 18, 1959	$26,000,000	7.1
7. Seattle, WA	April 29, 1965	$28,000,000	6.5
8. Coalinga. CA	May 2. 1983	$31,000,000	6.7
9. Imperial Valley, CA	May 19, 1940	$33,000,000	6.4
10. Olympia. WA	April 13, 1949	$80,000,000	7.0
11. Long Beach, CA	March 11, 1933	$266,000,000	6.3
12. Whittier, CA	October 1, 1987	$350,000,000	6.0
13. Prince William. Sound, AK	March 27, 1964	$1,020,000,000	8.2
14. San Francisco, CA	April 18, 1906	$2,000,000,000	8.2

Shake, Rattle, and Roll - Earthquakes

Lesson Plan - Day Four

I. **Objective:**

A. Students will be able to compute the distance of seismograph stations from earthquakes.
B. Students will be able to compute the location of an epicenter given information from seismographic stations.

II. **Rationale:**

This will be a follow-up cooperative learning activity to day three's lesson.

III. **Materials Needed:**

"Locating an Earthquake" activity worksheet
grade 8, title Earth Science, publisher Merril/Glencoe
Compass, Pencil, Ruler

IV. **Introductory Activity:**

Ask students, "How far from an earthquake's epicenter is a 'safe' distance?"

V. **Procedures:**

Discuss definitions of body waves, p-waves, s-waves, surface waves, shadow zone, crust, moho, mantle, outer core, inner core. Students should already be familiar with most of these terms.

A. Show how to use a compass.
B. Put students in cooperative groups (high-achievers blended with low-achievers).
C. Pass out hand-out, compass, and ruler.
D. Monitor student progress through the lab activity.

VI. **Closure:**

Orally let each group give/compare results.

VII. **Evaluation:**

Each group will receive a grade for their work completed. Formal evaluation (test) will be administered on day six..

NAME ____________________________ DATE ___________ CLASS ________________

LOCATING AN EARTHQUAKE

When an earthquake occurs, the shock sends outward vibrations in all directions. Both minor and major shocks are recorded by instruments called seismographs. When reports from at least three stations conducting earthquake watches are compared, the location of the epicenter can be determined. The epicenter is the point on Earth's surface directly above the focus, the actual rock break that caused the earthquake. The first vibration wave to reach the seismograph is called the P or primary wave. P-waves travel like sound waves, alternately compressing and expanding the rocks through which they pass. A second wave, the S-wave, takes twice as long to reach the station as the P-wave. S-waves are shear waves that shake the rocks in a manner similar to the way a bow vibrates violin strings.

Strategy

You will compute the distance of five different seismograph stations from a strong earthquake.

You will use information from five seismograph stations to compute the location of the epicenter of an earthquake.

Materials

compass
ruler

Procedure

1. Using the P-wave arrival times, compute the distance of each station from the earthquake center. The P-wave travels at a speed of 6 kilometers per second. Record the distances in Table 49-1.

2. On the map, Figure 49-1, draw an arc from each station using the computed distance as the radius of the circle. The map scale is 2 cm = 650 km.

3. Locate the epicenter of the earthquake. It is the point at which all arcs intersect (cross).

4. To check the accuracy of your epicenter determination, compute the arrival times of the S-waves. The S-wave travels at one-half the speed of the P-wave. Record in Table 49-1.

5. Check your distance computations using the S-wave arrival times.

Data and Observations

Table 49-1

Station	P-Wave arrival time	Distance from epicenter using P-wave	S-wave arrival time	Distance from epicenter using S-wave
Rockville, MD	3 min, 20 sec			
Newport, WA	7 min, 55 sec			
Tucson AZ	5 min, 50 sec			
Rapid City, SD	3 min, 45 sec			
McMinnville, TN	1 min, 15 sec			

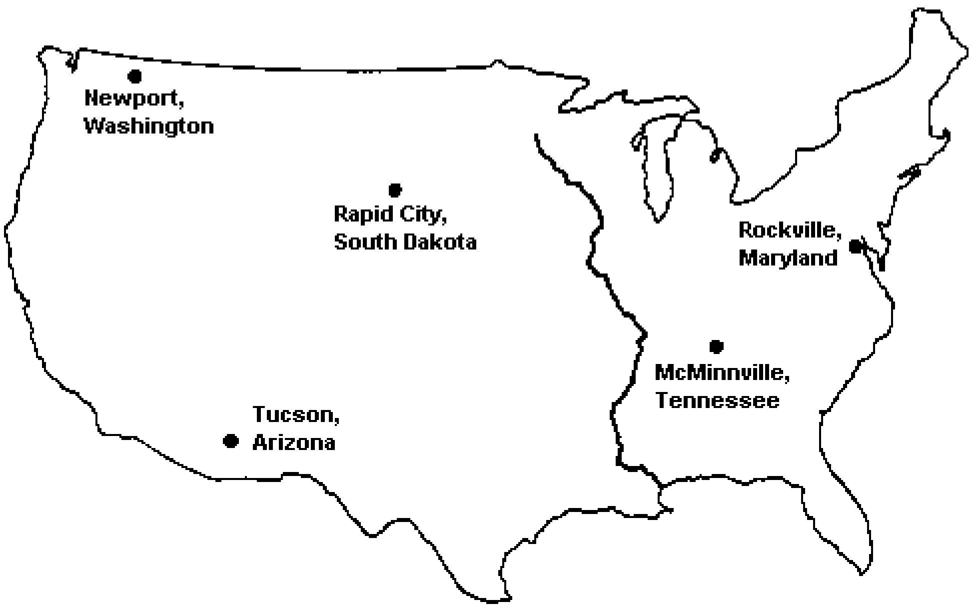


FIGURE 49-1

Questions and Conclusions

1. Where is the epicenter of an earthquake?

2. Do your figures for the S-wave agree with the distances computed from the P-wave arrival time?

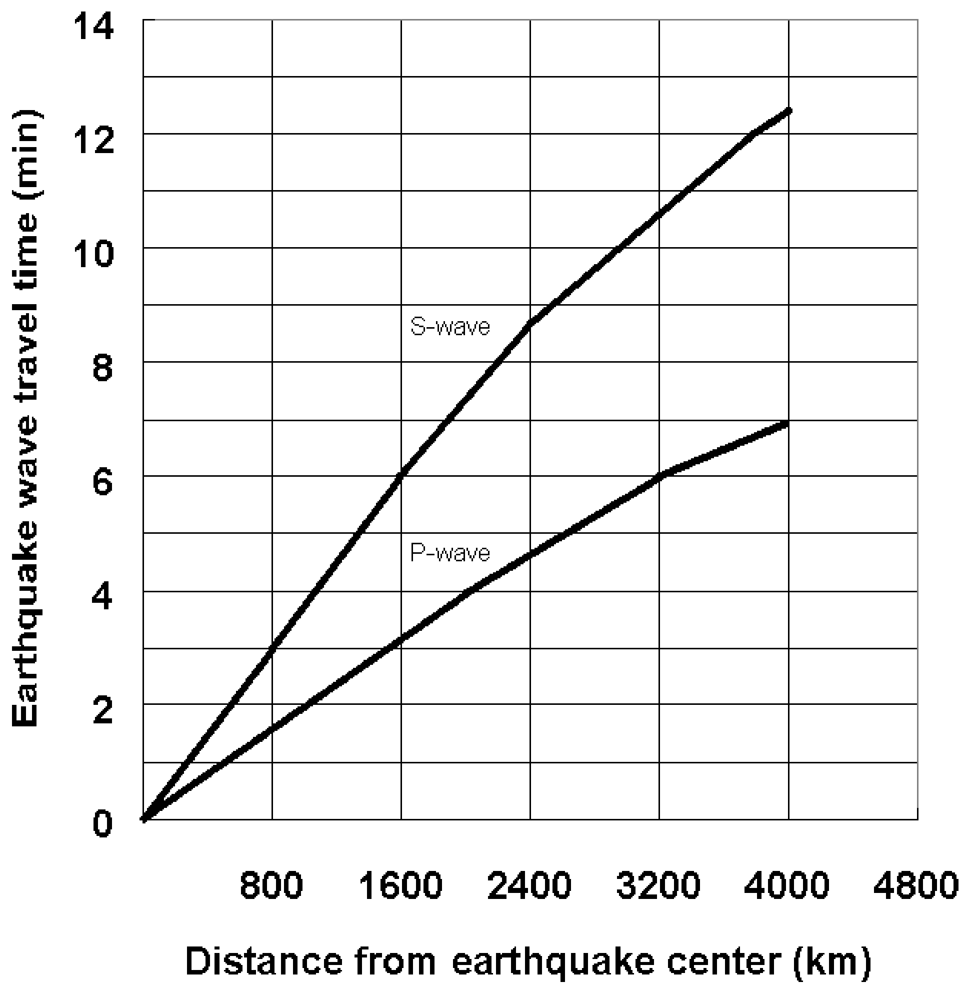
3. Near what city did the earthquake occur?

NAME ______________________________ DATE ____________ CLASS _________________

Using earthquake wave arrival times for many earthquakes, scientists have plotted travel-time curves. Travel-time curves are line graphs that show how long it takes for a type of earthquake wave to travel a certain distance. Use the travel-time curve below to answer the following **questions.**

Earthquake Travel Time

Table 49-2



4. If a seismograph were located 1600 kilometers from the earthquake's focus, how long would it take the P-wave to travel this distance?

5. How long would it take the S-wave to travel 1600 kilometers?

6. How long would it be after the seismograph recorded the arrival of the P-wave before the seismograph recorded the arrival of the S-wave?

7. An earthquake was recorded at three different stations, *A*, *B*, and *C*. Use the travel-time curve to determine the distance from each station to the earthquake epicenter.

Station	Time between P-and S-wave arrival (min)	Distance to epicenter (km)
A	2.3	
B	2.8	
C	3.0	

Sections of seismograms, records traced by a seismograph, from three stations, *A*, *B*, and *C*, are shown below. Each vertical line represents 1 minute of time. Use the diagram to help you answer the following questions.

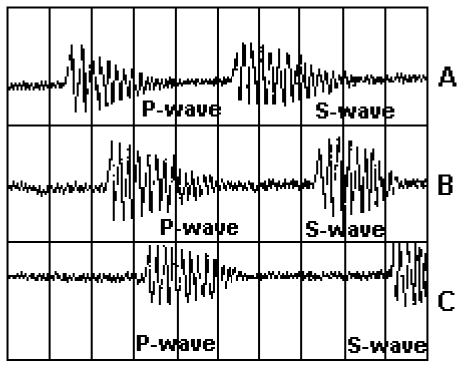


FIGURE 49-2

8. Estimate to the nearest half-minute the arrival times of the P- and S-waves at each station.

	Time of P-wave arrival	Time of S-wave arrival
Station A	____________________	____________________
Station B	____________________	____________________
Station C	____________________	____________________

9. Which station is closest to the epicenter? ______________________________________

Farthest from? ____

Strategy Check

Can you compute the number of kilometers from each station to the epicenter using P-wave arrival times?

Can you pinpoint the epicenter of the earthquake using your computed distances and the resulting arcs?

Can you check your computations using S-wave arrival times?

Shake, Rattle, and Roll - Earthquakes

Lesson Plan - Day Five

I. **Objective: (Review)**

A. Students will be able to read and label a two-axis graph.
B. Students will be able to translate a map scale from ruler measure to actual.
C. Students will be able to half recorded times using minutes and seconds.
D. Students will be able to define and describe terms related to earthquakes. (see Intro. Activity)
E. Students will be able to convert pounds to tons.
F. Students will be able to identify earthquake intensity based on the Mercalli and Richter scales.
G. Students will be able to define and describe terms related to earthquakes. (see Intro, Activity)
H. Students will be able to compute the distance of seismograph stations from earthquakes.
I. Students will be able to compute the location of an epicenter given information from seismographic stations.

II. **Rationale:**

Due to the extent of information presented in the previous four days, a review will better prepare students for assessment.

III. **Materials Needed:**

A. Text
B. Review Sheet (similar to test)
C. Ruler
D. Compass
E. Richter and Mercalli Scales
F. Two-axis graph and data handout (with pounds and tons)
G. Maps

IV. **Introductory Activity:**

Get students into groups of four and match the earthquake terms and their respective definitions.

V. **Procedures:**

While students are still in their groups, begin each topic in the objective with leading questions. Allow students to finish the following questions on their own. Give individual attention to the groups that need it. Also. monitor those groups that have no questions to be sure they are on task and are successfully completing their review sheets.

VI. **Closure:**

Announce that the test will consist of questions similar to those on the review sheet. Present a final situation involving an earthquake and include the terms, the Richter and Mercalli scales, and graphs associated with the earthquake.

VII. **Evaluation:**

A formal evaluation will be administered on day six.

Self-Evaluation of the Lesson Effectiveness

Shake, Rattle, and Roll - Earthquakes

Assessment - Day Six

- Students will be given the entire period to take the test over earthquakes.

- 100 points:

• Fifteen matching at two points each	30 points
• Ten multiple choice at four points each	40 points
• Interpreting a graph at ten points	10 points
• Interpreting a map at ten points	10 points
• Interpreting pictures of earthquakes at ten points	10 points
	100 points

Assign the vocabulary words for the next chapter, volcanoes, before handing out the test. This will keep students busy after they finish the test.

Shake, Rattle, and Roll - Earthquakes

Test

Name: ___________________________

Matching: 2 points each-Match only the letter of your vocabulary words with its definition below.

A. body waves	G. mantle	M. intensity
B. P-waves	H. inner core	N. seismograph
C. S-waves	I. outer core	O. seismogram
D. surface waves	J. earthquake	R. faults
E. focus	K. fractures	S. folds
F. crust	L. seismic waves	U. magnitude

_____ 1. Vibrations caused by the sudden movement of surface rocks.

_____ 2. Waves that move forward but vibrate at right angles to the direction of movement.

_____ 3. Breaks in rocks.

_____ 4. A system of forces pushing against a body from directly opposite sides and tends to squeeze it into folds.

_____ 5. Fractures along which movement takes place.

_____ 6. The actual point on the fault where movement occurs and vibrations begin.

_____ 7. An instrument used to record tremors traveling though the Earth.

_____ 8. The liquid part of the earth’s core.

_____ 9. Waves traveling outward from the focus in all directions through the Earth's interior.

_____ 10. The outermost layer of the Earth.

_____ 11. The strength of an earthquake.

_____ 12. Waves that travel forward and move individual rock particles back and forth along its travel path.

_____ 13. A stretching or "pulling apart" force.

_____ 14. Waves that travel along the surface outward from the epicenter.

_____ 15. Bends in rock layers.

<u>Multiple Choice:</u> 4 points each-place the letter of your choice in the blank provided.

_____ 16. The Richter Scale is used to measure the __________ of an earthquake.

A. Shadow Zone
B. mantle
C. fractures
D. magnitude

_____ 17. The Mercalli Scale is used the measure the __________ of an earthquake.

A. Shadow Zone
C. folds
C. intensity
D. p-waves

_____ 18. __________ is a system of forces that pushes against a body from different sides, producing twisting and tearing.

A. shearing
B. compression
C. fracture
D. mantle

_____ 19. __________ is how much damage an earthquake caused at the surface.

A. Richter
B. Mercalli
C. intensity
D. Moho

_____ 20. A __________ studies seismic data gathered from an earthquake.

A. seismograph
B. seismologist
C. seismogram
D. quaker

_____ 21. In p-waves and s-waves, the "p" stands for __________ and the “s” stands for __________ .

A. push and stop
B. perfect and sound
C. primary and secondary
D. print and script

_____ 22. What would the arrival time of and s-wave be given a p-wave arrival time of 3 minutes and 56 seconds?

A. 7 minutes and 12 seconds
B. 6 minutes and 12 seconds
C. 1 minute and 28 seconds
D. 1 minute and 58 seconds

_____ 23. What would the arrival time of a p-wave be given an s-wave arrival time of 2 minutes and 20 seconds?

A. 1 minute and 10 seconds
B. 4 minutes and 40 seconds
C. 3 minutes and 30 seconds
D. 2 minutes and 20 seconds

_____ 24. What would be the actual distance from city A to city B if, on the map, it measures 4.5 cm. (map scale: 1.5 cm=500 km.)

A. 2000 km.
B. 4.500 km.
C. 1500 km.
D. 500 km.

_____ 25. Using the same scale, what would the map measurement be between city C and city D if the actual distance is 7500 km?

A. 12 cm.
B. 13 cm.
C. 14 cm
D. 15 cm.

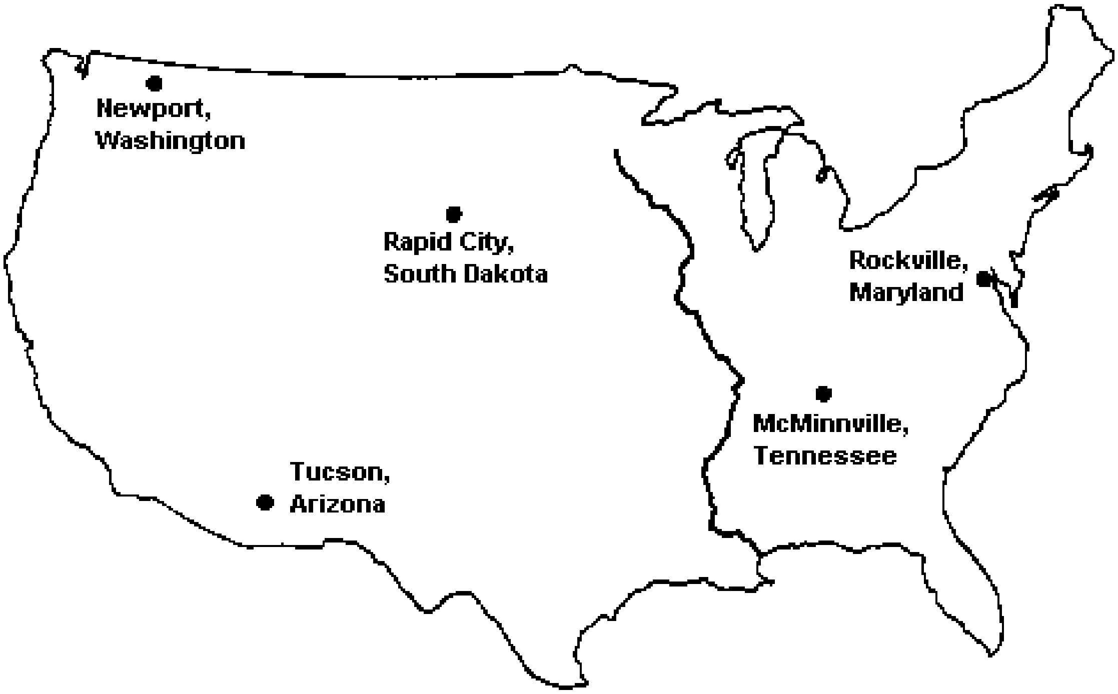
Constructing and Interpreting a graph: 10 points. Use the information below to construct a two-axes graph. Then, answer the questions that follow.

Richter Scale Measurement	**TNT Energy Equivalent**
2.5	63 pounds
3.0	397 pounds
3.5	1,000 pounds
4.0	6 tons
4.5	32 tons
5.0	199 tons
5.5	500 tons
6.0	6270 tons
6.5	31,550 tons
7.0	199,000 tons

26. An earthquake measuring 3.0 on the Richter Scale has a TNT energy equivalent of how many tons?

27. Between which two Richter Scale measurements can you find the biggest difference in TNT energy equivalent?

Interpreting a map: 10 points Use the map and a map scale of 2 cm. = 500 km. to answer the questions below.



Find the following distances.

28. Newport to Rapid City

29. Rapid City to Tucson

30. Rockville to McMinnville

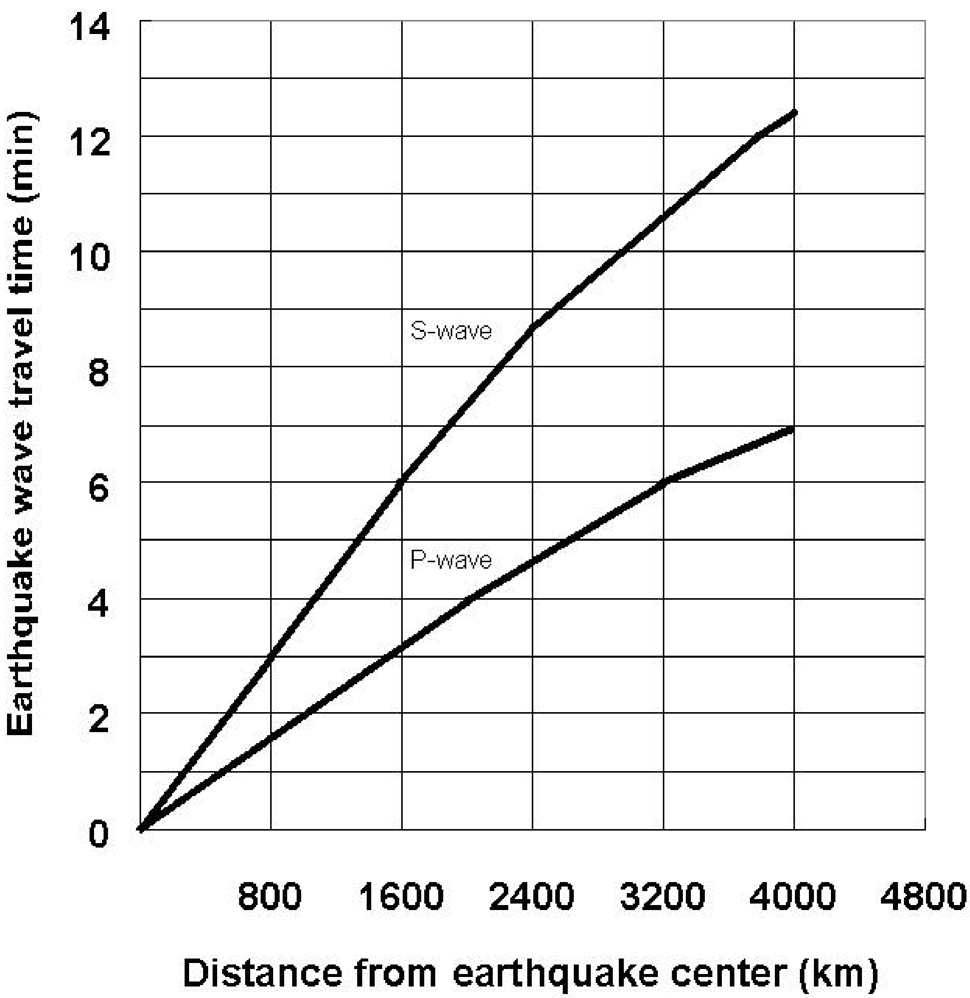
30. McMinnville to Rapid City

32. McMinnville to Tucson

Interpreting earthquake damage: 10 points-use the pictures to answer the following questions.

33. Using the Mercalli Scale, about how much damage has this earthquake caused?

Earthquake travel time: 3 bonus points-use the table to answer the following questions.



How long would it take the P-wave to travel 3200 km? ________________________

About how far would the S-wave travel in 8.5 minutes? ________________________

What's the difference In the P-wave and S-wave times at 4000 km? ________________________