IRIS

www.iris.edu/educate

Pasta Quake*

Modeling earthquake magnitude in the classroom

www.iris.edu/hq/inclass/video/201

Incorporated Research Institutions for Seismology
Original activity by Paul Doherty (www.exploratorium.edu/snacks/pasta-quake; used with permission.
Revised by Robert Butler (University of Portland) and Roger Groom (Mt. Taber Middle School, Portland).

OVERVIEW

How can you help students understand the difference between earthquakes of magnitude 7 and magnitude 8? Earthquakes are reported using a logarithmic scale, thus it can be a challenge to understand the gigantic step-wise increases in magnitude. Using strands of uncooked spaghetti, you and your class can investigate the amount of energy released for each level of the earthquake magnitude scale. The surprising results give students a physical model to understand the energy released in incrementally larger earthquakes.

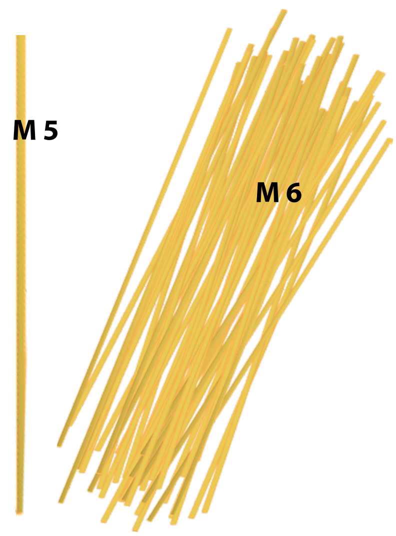


Figure 1: *If one pasta represents a M 5 earthquake, then 32 pieces represent M 6.*

The demonstration begins with one piece of spaghetti. Bend it slowly until it breaks. Notice the work it takes to break the spaghetti. Call this a Magnitude 5 on the Pasta Magnitude scale. What would you need to multiply this single piece of spaghetti by to equal the energy released by a Magnitude 6 earthquake?" "The answer is by a factor of 32 (Figure 1). What about a M7? Or M8? Now imagine a M9!

Beginner

15 min 30 min

Whole Class

Demo Materials

TABLE OF CONTENTS

OBJECTIVES

Students will gain an understanding of

- the difference between magnitude and intensity
- the magnitude scale by breaking different amounts of spaghetti
- the step-wise increases on the log scale
- the relative differences between magnitudes on the log scale

MATERIALS

- 1 lb package of thin spaghetti *or*
- 2 lb package of regular spaghetti
- Rubber bands for binding spaghetti bundles

TEACHER BACKGROUND

- Student Worksheets require some knowledge of: P, S, and Surface Waves; Epicenter and Hypocenter (Focus); and the difference between Intensity, Richter Magnitude and Moment Magnitude. For review of these concepts, see Teacher Background in **Appendix A** and gray box at right.
- Watch a Pasta Quake demo: *www.iris.edu/hq/inclass/video/201*.
- Pasta-quake values are shown in Figure 2.
- Math calculations for the cross-sectional area of the pasta bundles are in Appendix B, *"Doing the math"* on Page 6. This activity can be done as a simple demonstration, or you can include the math to help understand Moment Magnitude, the preferred earthquake magnitude scale most commonly used today.

TEACHER PREP

This lesson can be done as a simple demonstration, or you could have the students participate along with the demonstration for the first few steps of the activity. This hands-on approach keeps students engaged and maximizes the learning potential by personal involvement.

To use this lesson as a demonstration:

- Make your bundles of spaghetti before class and cover them with a cloth to be revealed later.

To use this lesson as a student activity, provide:

- Student worksheets
- 1 strand of spaghetti for each student (M5)
- One 32 strand bundle of spaghetti (M6) for each student team. (Students take turns flexing the bundle before it is then broken.) Use a rubber band on each end of the bundle to bind the spaghetti.
- One 1,024 strand bundle (M7) for each student team. (Students take turns flexing the bundle but they do not break the bundle – for demonstration only)

- **Tip:** Make one bundle of 1,024 strands of spaghetti bound with rubber bands. Weigh the bundle, then use the weight to measure and create additional spaghetti bundles. Make enough bundles for each student team for one class since they won't be broken, they can be reused many times!

VOCABULARY

Intensity—The intensity describes the severity of an earthquake in terms of its effects on the earth's surface and on humans and their structures (i.e., what is experienced). It is represented by a number written as a Roman numeral on the Modified Mercalli Scale (Appendix C. The intensity of shaking varies depending on where you are during the earthquake.
ANIMATION: www.iris.edu/hq/inclass/animation/517

Magnitude—The size of the earthquake is called its magnitude which is characterized by a number that represents its relative size. Magnitude is based on measurement of the maximum motion recorded by a seismograph.
For types of magnitude, see **Appendix A**
ANIMATION: www.iris.edu/hq/inclass/animation/205

ONLINE MAGNITUDE APP

The USGS *has a fun calculator called "How Much Bigger...?" That offers an explanation of the magnitude of an earthquake versus the strength, or energy release, of an earthquake... with a little bit of math.*

After you enter the magnitudes you wish to compare, scroll down to see the difference in the amount of energy released between the two:

https://earthquake.usgs.gov/learn/topics/calculator.php

LESSON DEVELOPMENT

1) **Magnitude 5 (M5):** Hold up one piece of spaghetti. Bend the piece slowly between your hands until it breaks. Notice the work it takes to break the spaghetti. Call this a 5 on the Pasta Magnitude scale (M5).

? ? *What numerical factor would you need to multiply this single piece of spaghetti by to equal a Pasta Magnitude 6?*
(Answer is 32.)

2) **Magnitude 6 (M6):** Hold up the smallest bundle of 32 strands of spaghetti. Bend the bundle until it breaks. Notice the work it takes to break the bundle. If the pasta magnitude scale were like the earthquake magnitude scale, this would be a Pasta Magnitude 6 break. Notice that the bundle is about the diameter of a large/fat drawing pencil (1.2 cm or .47 in).

? ? *What did you notice? Was it still fairly easy to break? How did the bundle break? All at once? Or a strand at a time?*
We will come back to this a little later.

3) **Magnitude 7 (M7):** We can now find out how large a bundle of spaghetti would represent a M7. We start by multiplying 32 pieces of spaghetti representing Pasta M6 by 32. That equals 1,024 pieces of spaghetti to represent M7.
We can determine the new cross sectional area by multiplying the area of the M6 (1.135 cm^2) by 32 which gives us 36.32 cm^2 for an M7. To find out how large this new bundle will be, we will calculate the diameter of the circular area. (Refer to the Pasta Quake Math, Appendix B.) The new diameter of the Pasta M7 is 6.8 cm (2.67 inches).

Now hold up the 32-strand bundle and the large bundle of 1,024 strands of spaghetti. Notice that the scale of magnitude has increased from the cross sectional area of a fat pencil = M6, to a tennis ball = M7.

? ? *How much energy do you think it would take to break a bundle of spaghetti this large?*
You can then break the large bundle of spaghetti, or flex it without breaking to show that it takes much more effort to make the bundle break.

4) **Magnitude 8 (M8):** Hold up the M7 bundle of pasta.

? ? *What would you need to multiply this bundle by to equal a Pasta M8?* (Again, the answer is 32.)

We start by multiplying 1,024 pieces of spaghetti representing Pasta M7 by 32 = 32,768 pieces of spaghetti representing an M8. We can determine the new cross sectional area by multiplying the area of the M7 (36.32 cm^2) by 32 which gives us 1,162.24 cm^2 for a M8. To find out how large this new bundle will be, we will calculate the diameter of the circular area. (Refer to the Pasta Quake Math, Page 7-8.) (See "**TIP** for > M 8" right.)

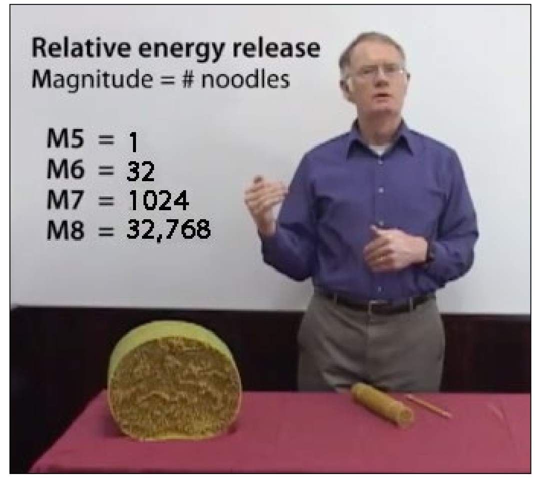


Figure 2: *Screen shot of Dr. Robert Butler, University of Portland OR with bundles of pasta representing magnitudes 5–8. Students in his class made the magnitude 8 32,768-piece bundle. Watch video at:* *www.iris.edu/hq/inclass/video/201*

TIP FOR > M 8

Figure 2 has a large bundle representing the M 8, but rather than count all those noodles, you can hold up a circle with the new 38.46 cm (15.14 in) diameter.

Notice that the scale of magnitude has increased from the cross sectional area of a fat pencil = M6, to a tennis ball = M7, to the size of a beach ball = M8.

The new diameter of the Pasta M8 is 38.46 cm (15.14 in).
TIP: Figure 2 has a large bundle, but rather than count all those noodles, you can hold up a circle with the new 38.46 cm or 15.14 in diameter. Notice that the scale of magnitude has increased from the cross sectional area of a fat pencil = M6, to a tennis ball = M7, to the size of a beach ball = M8.

? ? *How much energy do you think it would take to break a bundle of pasta this large?*

5) **Magnitude 9 (M9):** Now let's consider a Pasta Magnitude 9 earthquake. How big of a spaghetti bundle do you think this will be? Have the students look around the room for a comparable diameter and make educated guesses based on how the sizes have been progressing.
Let's do the math. Once again, we start by multiplying 32,768 pieces of spaghetti representing Pasta M8 by 32 = 1,048,576 pieces of spaghetti representing an M9. We can determine the new cross sectional area by multiplying the area of the M8 (1,162.24 cm^2) by 32 which gives us 37,191.68 cm^2 for the M9. To find out how large this new bundle will be, we will calculate the diameter of the circular area. (Refer to the Pasta Quake Math page.) The new diameter of the Pasta M9 is 217.62 cm (85.38 in, which is also 7' 14"!)

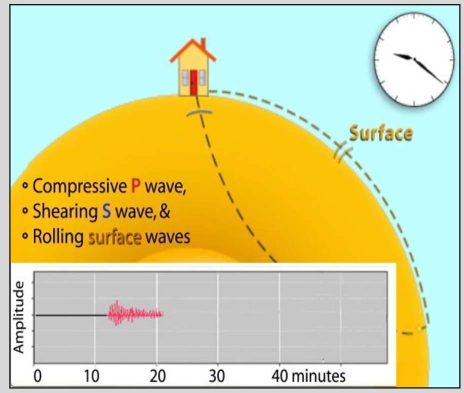
You could hold up a circle of plastic tarp with this new diameter. Notice that we have changed from the cross-sectional diameter of a fat drawing pencil = M6, to a tennis ball = M7, to the size of a beach ball = M8 and now to a circle with the diameter slightly larger than the height of a door.

? ? *How much energy do you think it would take to break a bundle of spaghetti this large?*

Now we can begin to understand the energy involved in a great megathrust earthquake like the 2004 Sumatra earthquake, or the 2011 Tohoku earthquake in Japan.

APPENDIX A—TEACHER BACKGROUND

Concepts used in Student Worksheets (blue links to urls)



Watch a short animation about P, S, and Surface waves:

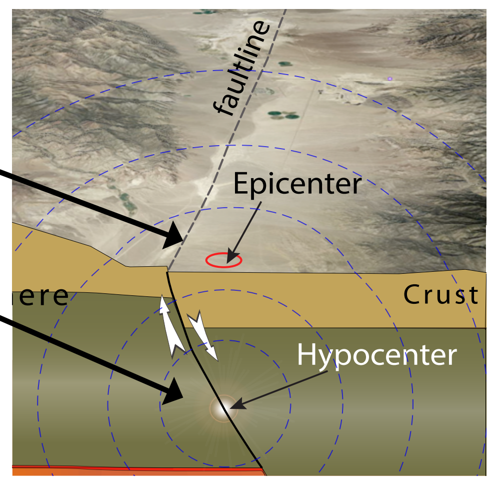
www.iris.edu/hq/inclass/animation/114

Seismic Wave—Seismic waves travel either through the Earth's interior or near Earth's surface with characteristic speed and style of motion. There are four basic types of seismic waves; two preliminary body waves (P & S) that travel through the Earth, and two slower surface waves (Love and Rayleigh) that travel along the surface of the Earth. Speeds vary depending on the density and the properties of the material they pass through. Seismic waves travel several kilometers per second.

P Wave—the primary body wave is the first ***seismic wave*** detected by seismographs. Also called compressional or longitudinal waves, they compress and expand (oscillate) the ground back and forth in the direction of travel, like sound waves that move back and forth as the waves travel from source to receiver. The P wave is the fastest wave, and is able to move through both liquid and solid rock.

S Waves—shear waves (secondary body waves) that oscillate the ground perpendicular to the direction of wave travel. They travel about 1.7 times slower than P waves. Because liquids will not sustain shear stresses, S waves will not travel through liquids like water, molten rock, or the Earth's outer core. S waves produce vertical and horizontal motion in the ground surface.

Surface Wave—waves that move close to or on the outside surface of the Earth rather than through the deep interior like the faster P or S waves. Two principal types of surface waves, Love and Rayleigh waves, are generated during an earthquakes. Rayleigh waves cause both a rolling vertical and horizontal ground motion, and Love waves cause horizontal motion only. They both produce ground shaking at the Earth's surface but very little motion deep in the Earth. Because the amplitude of surface waves diminishes less rapidly with distance than the amplitude of P or S waves, surface waves are often the most important component of ground shaking far from the earthquake source.



Epicenter—the point (map location) on the Earth's surface directly above the ***hypocenter***, or *focus* of an earthquake**.**

Hypocenter— commonly termed the ***focus***, this is the point within the earth where an earthquake rupture starts. It is directly below epicenter generally between 1–50 km depth, but can be as deep as 600 km in subduction zones.

Magnitudes: Watch the animations in gray box on Page 2.

Moment Magnitude—Seismologists now use the Moment Magnitude scale because it can more accurately calculate not just the size, but what happened during large earthquakes. the preferred measure of earthquake size (magnitude) in which takes into account the stiffness of the rock, the average slip on the rupture plane, and the area of the rupture plane in addition to the maximum motion (amplitude) recorded by a seismograph (the "moment" of the earthquake).

Richter Scale— The Richter scale, once the standard for earthquake measurements, is really only good for local earthquakes that are less than M7. This scale uses the amplitude of an earthquake to determine the magnitude. It is applicable for local earthquakes below magnitude 7.

Body Wave and Surface Wave magnitudes—Less common, and not elaborated on here, Body Waves calculate the magnitude of an earthquake using the amplitude of the initial P-wave. Surface Wave magnitudes are based on measurements of the amplitude of the Rayleigh surface waves.

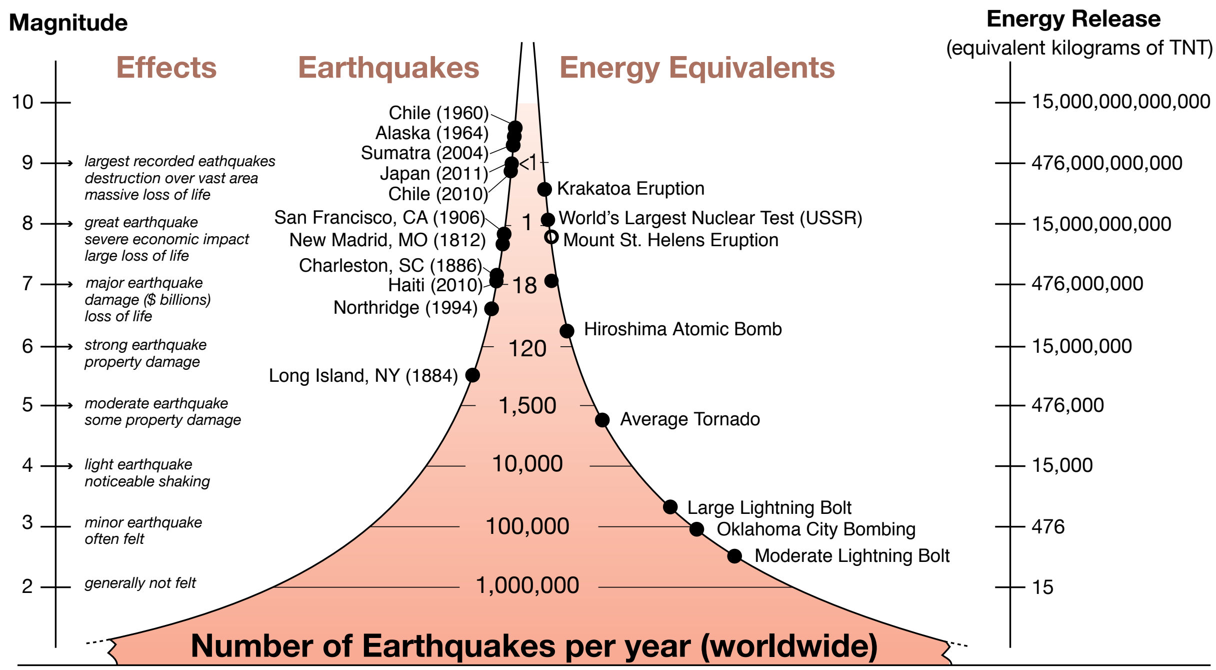
How often do earthquakes occur?

This graphic shows how many earthquakes of each magnitude occur each year.

Download the entire Fact Sheet from: www.iris.edu/hq/inclass/fact-sheet/how_often_do_earthquakes_occur

Earthquakes are always happening somewhere.

Magnitude 2 and smaller earthquakes occur several hundred times a day world wide.
Major earthquakes, greater than magnitude 7, happen more than once per month.
"Great earthquakes", magnitude 8 and higher, occur about once a year.



The left side of the figure above describes the effects of an earthquake by magnitude. The larger the number, the bigger the earthquake. Significant earthquakes are noted on the left side of the shaded tower. The shaded area indicates how many earthquakes of each magnitude occur every year. The events on the right side of the tower show equivalent energy release.

APPENDIX B—EXTENSION

Pasta Quake Math

Moment magnitude, which has replaced the Richter scale for large earthquakes, uses not only the amplitude of the seismic waves (as the Richter scale does) but calculates the distance te fault moved by the area of the fault that ruptured to determine how much energy was released. Although the student worksheets don't address the area of a fault surface, for a math-intensive class, for a more advanced class you might include a variation on these calculations. See next page for advanced calculations.

Doing the math:

To calculate increasing magnitudes, we will work with the cross section area of bundles of spaghetti. To increase the magnitude, the cross section area in cm^2 is multiplied by 32; the log factor representing the energy released for each level. We will also find the diameter of the bundle to see how the size of the bundles of spaghetti increases with each magnitude.

Magnitude 6:
A 32 strand bundle of spaghetti = an area of 1.14 cm^2.
To determine the diameter of the bundle, divide the area by π (3.14159) = .36 cm^2.
Next, take the square root of the product to determine the radius √ .36 cm^2 = .6 cm.
And finally multiply by 2 to determine the new diameter .6 cm x 2 = 1.2 cm (2.67 in).

To increase a **M6** to **M7**, multiply the area of **M6** 1.14 cm^2 by 32 = 36.32 cm^2

Magnitude 7:
1,024 strand bundle. Area = 36.32 cm^2.
To determine the diameter of the new bundle, divide the area by π (3.14159) = 11.56 cm^2
Next, take the square root of the product to determine the radius √ 11.56 cm^2 = 3.4 cm.
And finally multiply by 2 to determine the new diameter 3.4 cm x 2 = 6.8 cm (2.67 in).

To increase a **M7** to **M8**, multiply the area of **M7** 36.32 cm^2 by 32 = 1,162.24 cm^2

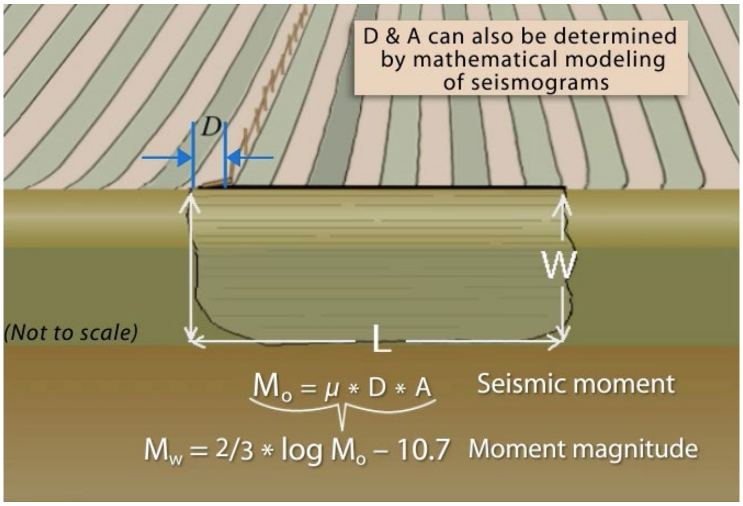
Magnitude 8:
32,768-strand bundle of spaghetti. Area = 1,162.24 cm^2.
To determine the diameter of the new bundle, divide the area by π (3.14159) = 369.95 cm^2.
Next, take the square root of the product to determine the radius √ 369.95 cm^2 = 19.23 cm.
And finally multiply by 2 to determine the new diameter 19.23 cm x 2 = 38.46 cm (15.14 in).

To increase a **M8** to **M9,** multiply the area of M8 1,162.24 cm^2 by 32 = 37,191.68 cm^2

Magnitude 9:
1,048,576-strand bundle. Area = 37,191.68 cm^2.
To determine the diameter of the new bundle, divide the area by π (3.14159) = 11,838.49 cm^2.
Next, take the square root of the product to determine the radius √ 11,838.49 cm^2 = 108.81 cm.
And finally multiply by 2 to determine the new diameter 108.81 cm x 2 = 217.62 cm (85.68 in which also equals *7.14 feet!!*)

Table 1: *The number of stands of spaghetti needed to represent each step-wise increase in magnitude beginning with Magnitude 5. If you gather enough spaghetti for a magnitude 9 earthquade, the diameter would be over 7 feet across!!!!! See math on next page.*

Magnitude	Strands of Spaghetti	Area of the bundle	Diameter of the bundle
5	1		
6	32	1.135 cm^2	1.2 cm or 0.47 in
7	1,024	36.32 cm^2	6.8 cm or 2.67 in
8	32,768	1,162.24 cm^2	38.46 cm or 15.14 in
9	1,048,576	37,191.68 cm^2	217.62 cm or 85.68 in or 7' 2"



*Cross section of a fault surface (**L** x **W**) plugged into the "seismic moment" equation to the right. **D** is how far the fault slipped.*

*Screen grab from animation "**Moment Magnitudes Explained**" available here: www.iris.edu/hq/inclass/animation/205*

Seismic Moment (Mo) is a measure of the size of an earthquake based the physical characteristics of the fault and can be determined either from seismograms or fault dimensions. The equation is:

$$Mo = A \times D \times \mu$$

A = Area

D = Displacement

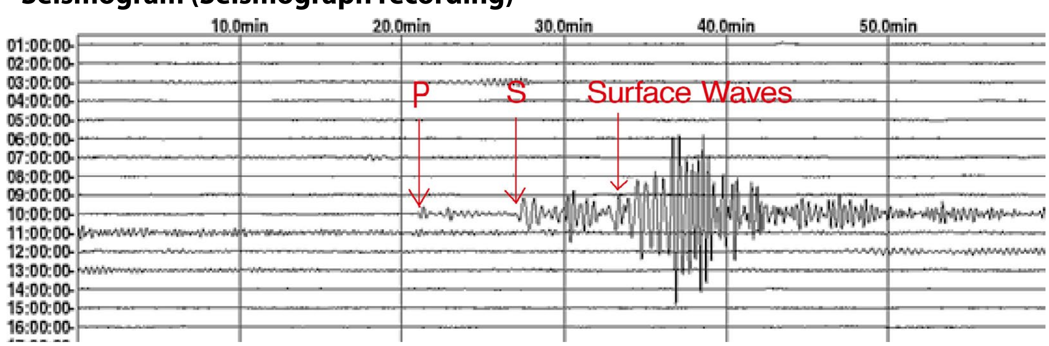
μ = Rigidity of the rock

Moment Magnitude (Mw) based on the concept of Seismic Moment where constants in the equation have been chosen so the moment magnitude scale correlates with other magnitude scales.

$$Mw = 2/3 \log Mo - 10.7$$

Moment Magnitude is the preferred measure of earthquake size (magnitude) in which takes into account the stiffness of the rock, the average slip on the rupture plane, and the area of the rupture plane in addition to the maximum motion (amplitude) recorded by a seismograph.

Seismogram (Seismograph recording)



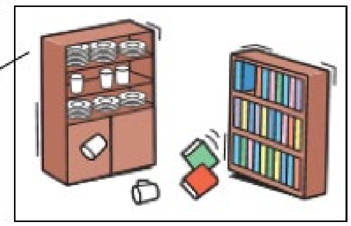
APPENDIX C—INTENSITY: THE MODIFIED MERCALLI INTENSITY SCALE

Watch an animation that explains **intensity** using some of the images below: www.iris.edu/hq/inclass/animation/517

The intensity is a number (written as a Roman numeral) describing the severity of an earthquake in terms of its effects on the earth's surface and on humans and their structures (i.e., what is experienced).

Intensity (Mercalli)	Observations (Mercalli)
I. Not felt	No effect
II. Weak	Noticed only by sensitive people
III. Weak	Resembles vibrations caused by heavy traffic
IV. Light	Felt by people walking; rocking of free standing objects
V. Moderate	Sleepers awakened; bells ring
VI. Strong	Trees sway, some damage from falling objects
VII. Very strong	General alarm, cracking of walls
VIII. Severe	Chimneys fall and some damage to building
IX. Violent	Ground crack, houses begin to collapse, pipes break
X. Extreme	Ground badly cracked, many buildings destroyed. Some landslides
XI. Extreme	Few buildings remain standing, bridges destroyed.
XII. Total destruction	Total destruction; objects thrown in air, shaking and distortion of ground






(Images are from the Japan Meteorological Agency seismic intensity scale, a seismic scale used in Japan.)

Earth and Human Activity

MS-ESS3-2 Performance Expectation:

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. MS-ESS3-2

Science and Engineering Practices

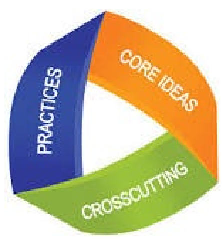
Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis

Disciplinary Core Ideas

ESS3.B: Natural Hazardss
Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)

Crosscutting Concepts

Patterns
Graphs, charts, and images can be used to identify patterns in data.(MS-ESS3-2)



NAME: ____

PERIOD: ________ DATE:________________________

IRIS
www.iris.edu/earthquake

PASTA QUAKE: UNDERSTANDING MAGNITUDE

An earthquake is the shaking or trembling of the ground that accompanies rock movement on or below the surface of the earth. When an earthquake occurs, seismic waves travel in all directions away from the hypocenter of the earthquake in all directions.

First, let's review. What are the 3 types of seismic waves? For each, give a brief description.

1. ____
2. ____
3. ____

4. What about exactly where earthquakes happen? Draw a diagram in the space below to show the difference between the earthquake **epicenter** and the **hypocenter** (also called the focus).

5. There are two main ways to measure the magnitude, or size of an earthquake, and there is one way to determine how the earthquake affects people.

Match up the 3 main scales to measure earthquakes with their descriptions:

Richter Scale	Measures the intensity of an earthquake. This is a measure of the strength of ground motion and has a scale of 1 – 12, but in Roman numerals, it's I – XII. One earthquake may have different ratings depending on the damage at different locations.
Moment Magnitude Scale	Measures the size of the seismic waves as shown on a seismograph. Good for small or close-by earthquakes.
Modified Mercalli Scale	Measures the total energy released by an earthquake and can be used for all sizes, near or far. This is usually what is used today.

On the Moment Magnitude Scale, each different number is a measure of the total energy released by an earthquake, and it is about 32 times greater between numbers of the scale.
We can demonstrate with uncooked spaghetti noodles:

Pasta Magnitude Scale	# of spaghetti pieces broken
4	1/30
5	1
6	32
7	1024
8	32,768
9	1,048,576

6. Below is a list of some major earthquakes and their Moment Magnitude ratings.
Put a check mark by the strongest one.

1811-12	New Madrid (Midwestern US)	8.1
1906	San Francisco, California	7.7
1960	Arauco, Chile	9.5
1964	Anchorage, Alaska	9.2
1971	San Fernando, California	6.7
1985	Mexico City, Mexico	8.1
1989	San Francisco, California	7.0
1995	Kobe, Japan	6.9

7. Which earthquake released about 32 times more energy than the Mexico City quake of 1985?

8. Two of the earthquakes released just a little more than 32 times more energy than the 1989 San Francisco quake. They were . . .

9. If the 1964 quake in Alaska released about 32 times more energy than the New Madrid quake, it released about 1000 times more energy than which quake?

10. EXTRA: Even though the Kobe earthquake was "only" a magnitude 6.9, it killed almost 6,000 people, injured 40,000 and destroyed 400,000 buildings. Why do you think this was?

INSTRUCTOR ANSWER KEY

NAME: ________________________________

PERIOD: ________ DATE:_______________

PASTA QUAKE: UNDERSTANDING MAGNITUDE

An earthquake is the shaking or trembling of the ground that accompanies rock movement on or below the surface of the earth. When an earthquake occurs, seismic waves travel in all directions away from the hypocenter of the earthquake in all directions.

First, let's review. What are the 3 types of seismic waves? For each, give a brief description.

1. P-Waves – primary waves – fastest, move straight through solids and liquids
2. S-Waves – secondary/shear waves – second fastest, cannot move through liquids
3. L-Waves – surface waves – slowest, travels along surface only

4. What about exactly where earthquakes happen? Draw a diagram in the space below to show the difference between the **epicenter** and the **focus** (also called the hypocenter).

cross section

There are two main ways to measure the magnitude, or size of an earthquake, and there is one way to determine how the earthquake affects people.

5. Match up the 3 main scales to measure earthquakes with their descriptions:

Richter Scale	Measures the intensity of an earthquake. This is a measure of the strength of ground motion and has a scale of 1 – 12, but in Roman numerals, it's I – XII. One earthquake may have different ratings depending on the damage at different locations.
Moment Magnitude Scale	Measures the size of the seismic waves as shown on a seismograph. Good for small or close-by earthquakes.
Modified Mercalli Scale	Measures the total energy released by an earthquake and can be used for all sizes, near or far. This is usually what is used today.

INSTRUCTOR ANSWER KEY

On the Moment Magnitude Scale, each different number is a measure of the total energy released by an earthquake, and it is about 32 times greater between numbers of the scale. We can demonstrate with spaghetti:

Pasta Magnitude Scale	# of spaghetti pieces broken
4	1/30
5	1
6	32
7	1024
8	32,768
9	1,048,576

6. Below is a list of some major earthquakes and their Moment Magnitude ratings.
Put a check mark by the strongest one.

	1811-12	New Madrid (Midwestern US)	8.1
✓	1906	San Francisco, California	7.7
	1960	Arauco, Chile	9.5
	1964	Anchorage, Alaska	9.2
	1971	San Fernando, California	6.7
	1985	Mexico City, Mexico	8.1
	1989	San Francisco, California	7.0
	1995	Kobe, Japan	6.9

7. Which earthquake released about 32 times more energy than the Mexico City quake of 1985?
   1964 Anchorage, Alaska

8. Two of the earthquakes released just a little more than 32 times more energy than the 1989 San Francisco quake. They were . . .
   1811 New Madrid and the 1985 Mexico City earthquakes

9. If the 1964 quake in Alaska released about 32 times more energy than the New Madrid quake, it released about 1000 times more energy than which quake?
   1989 San Francisco

10. EXTRA: Even though the Kobe earthquake was "only" a magnitude 6.9, it killed almost 6,000 people, injured 40,000 and destroyed 400,000 buildings. Why do you think this was?
   Accept reasonable answers. Poorly engineered buildings. The earthquake was a major wake-up call for disaster prevention authorities, and as a result now buildings are designed to withstand the largest earthquakes.

Incorporated Research Institutions for Seismology

IRIS

FACILITATE. COLLABORATE. EDUCATE.

Founded in 1984 with support from the National Science Foundation, IRIS is a consortium of over 100 US universities. In partnership with its Member Institutions and the scientific community, IRIS manages and operates comprehensive, high-quality geophysical facilities that enable exciting discoveries in seismology and the Earth sciences. IRIS programs contribute to scholarly research, education, earthquake hazard mitigation, and the verification of a Comprehensive Test Ban Treaty.

NSF