Pasta Quake Activity

North Carolina Geological Survey

www.deq.nc.gov/geoscience-education

This activity is based on the "Earthquake Magnitude – Modeling with Pasta Quake" activity produced by the IRIS Consortium (www.iris.edu) . Original activity by Paul Doherty (xo.net/~pauld/index.html). Revised by Amy Pitts, P.G. Senior Geologist, NC Geological Survey / January 2024.

Overview:

The severity of an earthquake can be expressed by its **magnitude** (how much energy is released at the hypocenter of the earthquake) and/or by its **intensity** (the amount of damage to buildings, people, and natural features caused by ground shaking). You can demonstrate the concepts of magnitude and earthquake energy by using strands of uncooked spaghetti.

Targeted Grade Level(s):

6th

2023 Science Standard(s):

PS.6.3.1 Use models of a simple wave to explain wave properties in seismic, light, and sound waves that include: waves having a repeating pattern with a specific amplitude, frequency, and wavelength, and the amplitude of a wave is related to the energy of the wave.
ESS.6.2.2 Construct an explanation to illustrate how the movement of lithospheric plates can create geologic landforms and cause major geologic events such as earthquakes and volcanic eruptions.

Objectives:

This activity gives students a physical model to help them understand the logarithmic increase of energy released during large earthquakes by breaking, or attempting to break, strands of uncooked spaghetti.

Estimated Time:

10-20 minutes

Materials:

- One or two 1-pound packages of uncooked THIN spaghetti, or
- One or two 2-pound packages of uncooked REGULAR spaghetti,
- Rubber bands for binding the spaghetti

Teacher Background & Prep:

- This activity can be a quick demonstration in front of the class (5-10 min) or you could allow the students to attempt it themselves (20 min).
- Make your spaghetti bundles before class and cover them for a fun reveal.
- For spaghetti & spaghetti bundles, you will need:
  - One strand of spaghetti (OR one for each student if allowing them to attempt themselves)
  - One bundle of 30 strands with a rubber band on each end to hold it together (OR one bundle of 30 strands per student group if allowing student attempts)
  - One bundle of 900 strands with a rubber on each end
  - ***TIP for the 900-strand bundle*** – Make one 100-strand bundle. Weigh it. Multiple that weight by 9. That weight should equal the weight of a 900-strand bundle so add strands to your 100 bundle until it equals the weight of a 900-strand bundle

Earthquake Energy

Geoscientists use two scales to determine the strength and the energy of earthquakes – the Moment Magnitude Scale and the Modified Mercalli Intensity Scale. These two scales are quite different and can tell us about different properties of an earthquake.

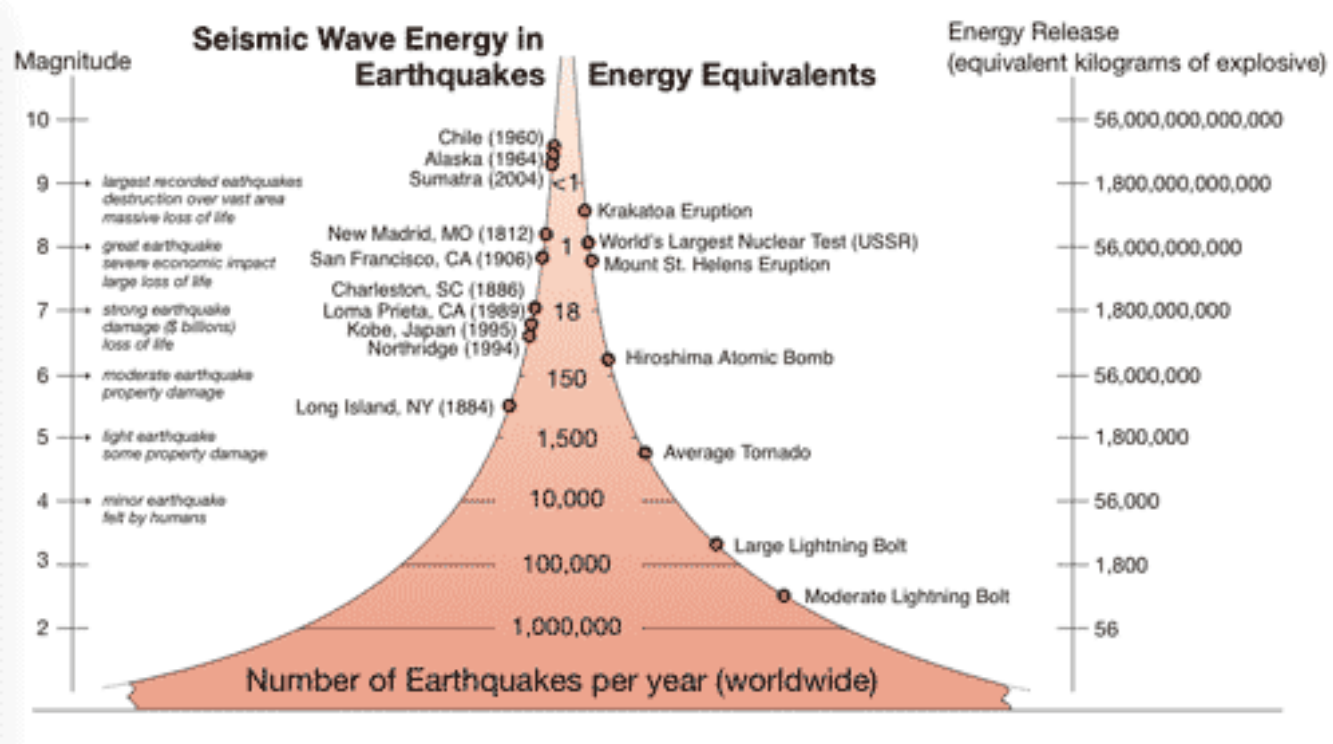
Modified Mercalli Intensity Scale

This scale attempts to measure the energy released by an earthquake by determining how the earthquake felt and how much destruction and ground shaking the earthquake caused. This scale has twelve levels that are designated by Roman numerals (I through XII). These Roman numerals symbolize the amount of ground shaking felt during the earthquake and the amount of damage seen after the earthquake. Roman numeral I designates that the earthquake was only felt by a few people. Roman numeral XII designates extreme shaking and destruction of most well-built structures. You can find more information on the USGS website.

Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest,especially on upper floors of buildings.
III	Weak	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	Light	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	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	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	Severe	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	Violent	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	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Moment Magnitude Scale

The Moment Magnitude Scale attempts to measure the energy released by an earthquake (the earthquake size) and is the number most people associate with an earthquake. This scale is similar to the Richter Scale, which you might be familiar with, except that this Scale is capable of more accurately measuring large and very large earthquakes. Geoscientists use seismometers to record the amplitude, frequency, and wavelength of seismic waves to determine the amount of earthquake energy. The Moment Magnitude Scale is a logarithmic scale, which means that an increase of one unit on the Scale (example from magnitude 3 to magnitude 4) is equal to a 30x (30 times) increase in released energy. This is the Scale we're going to use for our Pasta Quake activity.



Pasta Quake Activity

1. PASTA MAGNITUDE 5 EARTHQUAKE (**PM5**) – 1 strand of spaghetti

   Hold one strand of spaghetti at each end with your finger and thumb. ***SLOWLY*** bend it and as you do, be aware of the energy that you're exerting on the spaghetti strand. Continue to slowly bend it until it breaks. Did you feel the little bit of vibration (energy) that was released when the spaghetti broke?

   We will consider this to be the energy released during a Pasta Magnitude 5 (PM5) earthquake. This is our baseline.

   Key Question: We learned that every unit increase on the Moment Magnitude Scale is equal to a 30x (30 times) increase in energy. How many spaghetti strands will we need to represent a Pasta Magnitude (PM) 6 earthquake?
   Answer: **30**. 1 strand x 30 = 30 strands (PM6)

2. PASTA MAGNITUDE 6 EARTHQUAKE (**PM6**) – 30 strands of spaghetti

   Reveal the 30-strand bundle of spaghetti to the class. ***SLOWLY*** attempt to bend the bundle as you did before, until the bundle breaks. Can you tell the difference in the amount of energy it takes to break this bundle versus one strand? Did all the strands break at once? If the Pasta Magnitude Scale was the same as the Moment Magnitude Scale, the energy released during this attempt would be a Pasta Magnitude 6 (PM6) earthquake.

   Key Question: How many spaghetti strands will we need to represent a Pasta Magnitude 7 (PM7) earthquake?
   Answer: **900**. 30 strands x 30 = 900 (PM7)

3. PASTA MAGNITUDE 7 EARTHQUAKE (**PM7**)

   For fun, ask your students how large they think the next spaghetti bundle will be before you reveal it. TRY to bend the 900-strand bundle. Notice how much more energy you had to exert. We you able to break it? This energy represents the energy that would be released by a very large earthquake.

   Key Questions: If you were able to break this bundle, did it break all at once or a few strands at a time? How many spaghetti strands would we need to represent a Pasta Magnitude 8 (PM8) earthquake?
   Answer: **27,000**!! 900 strands x 30 = 27,000 (PM8). This would be about the size of a beach ball!

You should have noticed how differently one spaghetti strand broke compared to the larger bundles. This represents earthquake energy in real life, as most larger earthquakes release smaller amounts of energy before the rocks completely break and release large amounts of energy.

Discussion and Questions

1. In our pasta quake activity, what do the following represent?

    a. Spaghetti
    b. Our hands
    c. Breaking spaghetti

2. There are many forms of energy represented in this activity. Can you identify the type of energy associated with each step of the activity?

    a. Unbent/unbroken spaghetti strand(s)
    b. Breaking spaghetti

3. Can you explain how the amplitude of seismic waves is related to the energy of an earthquake?

Discussion and Questions – Answer Key

1. In our pasta quake activity, what do the following represent?

    a. Spaghetti – **Earth, rocks, tectonic plates**
    b. Our hands – **Forces, stress**
    c. Breaking spaghetti – **Earthquake**

2. There are many forms of energy represented in this activity. Can you identify the type of energy associated with these steps of the activity?

    a. Unbent/unbroken spaghetti strand(s) – **Potential energy**
    b. Breaking spaghetti – **Kinetic, sound energy**

3. Can you explain how the amplitude of seismic waves is related to the energy of an earthquake?
    The energy transported by seismic waves is in relation to the amplitude of the waves. Larger amplitude waves equal greater earthquake energy. Smaller amplitude waves equal smaller earthquake energy.