Pasta Quake Magnitude Activity
Grade Level: 9-12

Adapted from the Cascadia Earthscope Earthquake Tsunami Education Project (CEETEP) https://ceetep.oregonstate.edu

Purpose: Students will learn about earthquake magnitude by breaking different size bundles of uncooked spaghetti noodles. This activity introduces the concept of earthquake size (magnitude) and energy and an understanding that the earthquake magnitude scale is not a linear one.

Time: 50 minutes of class time for the activity. An additional 50 minutes of class time for part 1(c). 60 minutes of preparation time for teacher if doing all the set up yourself.

Educational Standards:
ESS1, ESS2-1, WHST.9-12.2.a-e, MP.2

Materials: 1 pound package of thin spaghetti or a two pound package of regular spaghetti Optional: plastic tarp of at least 8' diameter and a measuring tape.
•Materials explanation: You will need a single strand of pasta (representing a magnitude 5 earthquake on the Pasta Magnitude Scale [M5], a bundle of 30 [M6], and a bundle of 900 [M7] – this is an M6 multiplied by 30[M7]

For additional background information read Dengler Notes on Magnitude

Procedure:

For background information, listen to the podcast:
https://www.khsu.org/post/shaky-ground-magnitude-our-seismic-times#stream/0

1. Prepare your pasta bundles ahead of time.
(a) Do this yourself or organize students into groups to make a minimum of 30 bundles of 30 strands of spaghetti. This will allow you to demonstrate the energy in an M5 (1 strand), an M6 (30 strands) and an M7 (900 strands) earthquake.
(b) To demonstrate the energy of an M8 earthquake, you would need 900 bundles of 30 strands each (27,000 strands). Rather than make this huge bundle of 27,000 strands of spagehtti, go to:
https://www.iris.edu/hq/inclass/video/pasta_quake_modeling_magnitude_scale_using_spaghetti for visual demonstrations of an M5, M6, M7, M8 and an M9 earthquake.
(c) Another way to demonstrate the magnitude of an M6, M7, M8 and an M9 earthquake is to cut circles out of a tarp with the diameter of the bundle specifications listed here:

Pasta Quake Math

Magnitude	Strands of Spaghetti	Diameter of the bundle=tarp diameter
5	1	
6	30	1.2 cm = 0.47 in
7	900	6.8 cm = 2.67 in
8	27000	38.47 cm= 15.14 in
9	810,000	217.62 cm = 85.68 in = 7ft 14in

2. As part of your preparation, go to: https://www.iris.edu/hq/inclass/video/pasta_quake_modeling_magnitude_scale_using_spaghetti for a video demonstration of the Pasta Quake Activity as well as an explanation of how to model the difference between a magnitude 6 and a magnitude 9 earthquake. (Please note the demonstration is using the value of 30 to demonstrate differences in magnitude while more accurate multiplier is 32.)

3. Demonstrate and/or do with the students-
[adapted from https://ceetep.oregonstate.edu/sites/ceetep.oregonstate.edu/files/10-pasta_quake.pdf]

Complete this activity with the students, explaining and/or demonstrating what to do and having students complete the activity for a Magnitude 5 and Magnitude 6 earthquake. Consider only demonstrating the magnitude 7 earthquake (with 900 pieces of spaghetti) as this bundle is spaghetti resource intensive!

(a) Hold up one piece of spaghetti. Bend the piece between your hands until it breaks. Notice the work it takes to break the spaghetti. Call this a 5 on the Pasta Magnitude scale. Hold up a bundle of 30 pieces 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. Hold up 900 pieces of pasta, the remainder of the package. Bend the bundle until it breaks. Notice the work it takes to break the bundle. This is a Pasta Magnitude 7 break.

(b) Explain to the students –
•What's Going On? The magnitude scales for earthquakes are logarithmic scales. In particular for the Richter scale, each increase of 1 unit on the scale, say from 6 to 7, represented an increase of one order of magnitude, i.e. times 10, in the amount of motion recorded on a particular type of seismograph. The now-common Moment Magnitude scale was defined because the Richter scale does not adequately

differentiate between the largest earthquakes. The new "moment magnitude" scale is a new technique of using the Richter scale.
Go to: https://wiki.ubc.ca/Course:Math110/003/Teams/Ticino/The_Richter_Scale for a good diagram explaining the Richter scale.
Go to: https://www.sms-tsunami-warning.com/pages/richter-scale#.XILo3BNKgnU for a link with an explaination on the Richter Scale

•In the moment-magnitude scale a magnitude increase of one unit corresponds to a factor of 30 increase in the energy released by the breaking of the fault in an earthquake. That's why we increased the number of spaghetti noodles from 1 to 30 to 900 (900 =30 x 30).
•So what? In order to release the energy of one M 7 earthquake you would have to have 30 M 6 quakes or 900 magnitude 5's. Notice also all the little "quakes" before and after the big-quake break.
•In this model, what does the spaghetti represent? (The earth, rocks, tectonic plates)
•What do your hands represent? (Forces, stress, another plate)
•What does the breaking spaghetti represent? (An earthquake)

4. Optional, after the activity, review the video https://www.iris.edu/hq/inclass/video/pasta_quake_modeling_magnitude_scale_using_spaghetti following the activity to reinforce what the students (or you) did to demonstrate earthquake magnitude.

5. Ask students to explain orally and/or in writing how the breaking of the spaghetti strands models earthquake magnitude. Students should explain that earthquake intensity magnitude increases on a logarithmic scale (see #3b above). Have students write a summary comparing different earthquake magnitudes (M5, M6, M7), based on their experiences in this Pasta Quake Magnitude activity. Students can then add their interpretation of a magnitude 9 as in the Japan 2011 earthquake in the Kamome story.

6. Earthquakes don't happen all at once. It takes more time to rupture a larger fault and produce a bigger magnitude earthquake. An earthquake that lasts only a few seconds is small (magnitude 2 or 3). The longer an earthquake lasts, even if the shaking isn't strong, the larger the magnitude. This can be important if you are at the beach or live in a tsunami zone. Listen to the podcast (1.5 minutes) https://www.khsu.org/post/shaky-ground-when-earthquakes-happen that talks about how you can use the duration of shaking to determine if the earthquake is big enough to produce a tsunami. After listening, ask the students how they could tell if they should evacuate to higher ground.

Extension Activities:
1. Seismic Wave Energy in Earthquakes Energy Equivalents graphic https://earthquake.usgs.gov/learn/topics/mag-intensity/images/Mag-Energy-Freq-lg.gif

2. For an online - Try It Yourself Calculator - to compare earthquake magnitudes https://earthquake.usgs.gov/learn/topics/how_much_bigger.php

3. An activity for high school teaching about the difference between intensity and magnitude: Learning About Earthquakes: Quake-Catcher Network Magnitude and Intensity Lab https://earthref.org/SCC/lessons/2009/earthquakes/magnitude-intensity-lab/

4. Students research recent earthquakes and write about and/or diagram recent earthquakes in the past day or week – globally or in a specific area (such as the region in which they live). . Go to: https://earthquake.usgs.gov/earthquakes/map/

5. For activities from the Berkeley Seismology lab: seismo.berkeley.edu/outreach/activities.html

6. For specific practice with logarithmic problems go to https://spacemath.gsfc.nasa.gov/Insight/Insight17.pdf