

ANSWER KEY _____ Date _____

Students should include the units when they fill in this chart.

Earthquake Location and date	Earthquake magnitude	Earthquake depth (km)	Station code	Distance (deg and km)	Amplitude and units	Amplitude (microns/sec , convert if necessary)	Time since earthquake for maximum amplitude (show units)
Mindanao, Philippines 2007-04-25 11:52 GMT	5.5	27 km	JP.JOW	19.4 deg/2158 km	9.5 microns/second	9.5 microns/sec	4 min 20 sec
Vanuatu Islands 2007-04-25 13:34 GMT	6.3	55 km	IU.CTAO	20.5 deg/2280 km	27 microns/second	27 microns/sec	4 min 38 sec (zoom in around p wave)
Vanuatu Islands 2007-03-25 00:40 GMT	7.1	34 km	IU.CTAO	21.7 deg/2409 km	151 microns/sec	151 microns/sec	4 min 58 sec

South of Java, Indonesia 2006-07-17 08:19:25 GMT, South of Java	7.7	20 km	MY.LDM	18.1 deg/2015 km	450 microns /sec	450 microns/sec /sec	12 min 20 sec
East of Kuril Islands 2007-01-13 04:23 GMT	8.2	10 km	AK. ATKA	21.2 deg / 2357 km	2.75 mm/s	2750 microns/sec	12 min

Questions:

1. What variable was held almost constant in collecting the data for each earthquake? Why was this important? Station Distance.

Earthquakes are about the same distance away from the recording station. To compare two earthquakes with different magnitude, you want the waves to travel the same distance because seismic energy gets absorbed as waves travel.

2. Examine the log and the non-log plot comparing the values at each plotted point. Are they the same? How does using a logarithmic scale change the visualization of this relationship?

(Answer Key: The amplitude stays the same on both graphs. Look at the difference between a magnitude 6 earthquake versus a magnitude 7 earthquake; increasing the magnitude by one increases the amplitude 10 times. This is easier to see on the logarithmic scale. Students might provide an answer such as "Amplitude gets much bigger as magnitude gets bigger. In the logarithmic scale, it looks less." If there are answers like this, have students read the amplitude values off from both plots to confirm they are the same numbers.)

3. Why do you think a logarithmic scale is used to measure magnitude?

(Answer key: Magnitude is a linear scale (-1, 0, 5, 7, 8, etc...) It is exponentially related to shaking amplitude and has a power law relationship with radiated energy.

4. Using your graph to estimate, what would you expect the amplitude of ground motion to be 20° away from a magnitude 6.0 earthquake? For a 4.7 earthquake? Include units in your answer.

Approximately 20 microns/sen and 0.7 microns per second. Student's answers may vary because it is difficult to read the plot precisely.

5. Using your graph to estimate, what would you expect the amplitude of ground motion to be 20° away from a magnitude 8.7 earthquake?

Approximately 5400 microns per second, or 5.4 mm/s

6. What other factors might control how much the ground shakes from an earthquake?

The 3 most important factors are: Magnitude, distance away, and rock type/"stiffness."

Rock type is important at all points along the path the seismic waves travel from earthquake source to recording station because waves travel more easily through some types of rock than others. The rocks close to a seismometer (within a

hundred meters or so) can have a particularly strong impact on the shaking amplitude, especially since seismometers near the surface are often located on top of poorly consolidated (soft and squishy) near-surface soils that amplify shaking. Sedimentary basins can echo and reverberate, which amplifies shaking like the hollow body of an acoustic guitar.

For *distance* don't forget to consider earthquake depth and the size of the fault that ruptured. An example when depth matters: the world's deepest earthquakes come from more than 600 km down. Stations at the epicenter (the point on the surface directly above the earthquake starting point) are actually 600 km away from the earthquake source, even though they will show up as 0 km away from the earthquake epicenter. An example where fault size matters: The epicenter only describes where an earthquake starts. For the earthquake that caused the 2005 tsunami off Indonesia, the two plates moved everywhere along more than 1000 km of the plate boundary, and seismic waves radiated outward from every point along the way. That means that a station listed as 1000 km north of the epicenter might have been right on top of a slipping fault that generated seismic waves up close.

Advanced topic: Earthquakes do not radiate energy uniformly in all directions. In detail, the distribution of shaking depends on the orientation of the fault that slips. This pattern is different for P waves than for S waves. Interested readers can search for "earthquake radiation patterns."