

Calculating Earthquake Magnitude

(Modified from material found in a Geology Lab Manual – source unknown.)

The Richter scale was developed by Charles Richter in the 1930s as a quick method of classifying the size of southern California earthquakes. To determine the Richter magnitude, you need to use a particular type of seismogram (one recorded on a Woods-Anderson seismograph), which is particularly sensitive to high-frequency earth vibrations. The seismogram must be recorded within 600 km of the epicenter. The figure on the next page provides a method for calculating earthquake magnitude based on the distance to the epicenter and the maximum amplitude of the seismogram. (Amplitude is the height above the center line of the largest wave on the seismogram.)

How large is the seismogram amplitude if the earthquake has a magnitude of 2 and the seismograph is 100 km from the epicenter? Draw a straight line from 100 on the distance scale to 2 on the magnitude scale. Extend your line to the amplitude scale.

1. Complete this table:

Distance from epicenter (km)	Magnitude	Amplitude (mm)
100	2	
100	3	
100	4	
100	5	

2. Based on your measurements, complete this sentence:

An increase of 1 on the magnitude scale increases the amplitude of the seismic waves by a factor of ____.

Estimating Energy Release (requires scientific calculator)

When slip occurs on a fault, elastic energy is released in much the same way that elastic energy is released when a rubberband is snapped. Some of this energy escapes in the form of seismic waves. There is a rough correlation between the amount of energy released during an earthquake and the magnitude of the earthquake:

$$\text{Energy (joules)} = 10 \text{ to the power of } (5.24 + (1.44 \times \text{Magnitude})) \quad E = 10^{(5.24 + (1.44 \times M))}$$

3. Modern seismographs can measure earthquakes with Richter magnitudes as small as -2. How much energy is released by an M=-2 earthquake?
4. How much energy is released by an M=-1 earthquake?
5. How much energy is released by an M=0 earthquake?
6. How much of an energy increase occurs as Richter magnitude increases by 1? What's the factor? (Divide the two numbers.)

As comparison, the energy released in an M=-2 earthquake is the same amount as released when a 23 kg (10.4 lb) weight is dropped from 1 meter. To make similar comparisons for other energy values, simply divide the energy released in the earthquake by 10, and you'll calculate the size weight that must be dropped from 1 meter to produce the same amount of energy.

**Note: The Moment Magnitude Scale – see class notes – replaces the Richter Magnitude Scale for final magnitude determination of an Earthquake, because it provides better results, independent of the seismograph and taking into account local bedrock.*

