TASK: In 2010, a major earthquake struck Haiti, destroying or damaging over 285,000 homes. One year later, another, stronger earthquake devastated Honshu, Japan, destroying or damaging over 332,000 buildings, like those shown below. Even though both caused substantial damage, the earthquake in 2011 was 100 times stronger than the earthquake in Haiti. How do we know? The magnitudes of earthquakes are measured on a scale known as the Richter Scale. The Haitian earthquake registered a 7.0 on the Richter Scale whereas the Japanese earthquake registered a 9.0.

The Richter Scale is a base-ten logarithmic scale. In other words, an earthquake of magnitude 8 is not twice as great as an earthquake of magnitude 4. It is $10^{8-4} = 10^4 = 10{,}000$ times as great! In this lesson, we will investigate the nature of the Richter Scale and the base-ten function upon which it depends.

In order to analyze the magnitude of earthquakes or compare the magnitudes of two different earthquakes, we need to be able to convert between logarithmic and exponential form. For example, suppose the amount of energy released from one earthquake were 500 times greater than the amount of energy released from another. We want to calculate the difference in magnitude. The equation that represents this problem is $10^x = 500$, where x represents the difference in magnitudes on the Richter Scale. How would we solve for x?

We can solve for x by using ***logarithms***. Pause this task and start watching the video linked to our website reviewing logarithms before continuing this task.

1. Write the following logarithmic equations in exponential form.

(*a*) $\log_6\left(\sqrt{6}\right) = \frac{1}{2}$ (*b*) $\log_3(9) = 2$ (*c*) $\log_{10}(1{,}000{,}000) = 6$ (*d*) $\log_5(25) = 2$

2. Write the following exponential equations in logarithmic form.

(a) $2^3 = 8$ (b) $5^2 = 25$ (c) $5^3 = 125$ (d) $10^{-4} = \frac{1}{10,000}$

3. Solve without using a calculator (convert to exponential form).

(a) $y = log_4(64)$ (b) $y = log_{121}(11$

4. Evaluate without using a calculator.

(a) $y = log_{121}\left(\frac{1}{27}\right)$ (b) $y = log_2\left(\frac{1}{32}\right)$ (c) $y = log\,(1,000)$ (d) $y = log\,(1,000,000)$

5. Evaluate to four decimal places using a calculator.

(a) $y = log\,(123)$ (b) $y = log\,(321)$ (c) $y = ln\,(-500)$