



What do we USE logarithms for??? We will see 3 types of applications of logarithms

(A) Formulas

For studying earthquakes, we have a log based function $R = \log(a/T) + B$, where R is the Richter scale magnitude, a is the amplitude of the vertical ground motion (measured in microns), T is the period of the seismic wave (measured in seconds) and B is a factor that accounts for the weakening of the seismic waves.

1. Determine the intensity of an earthquake if the amplitude of vertical ground motion is 150 microns, the period of the wave is 2.4 s, and $B = 2.4$
2. Determine the amplitude of a seismic wave of an earthquake that measures 5.5 on the Richter scale, whose wave had a period of 1.8 seconds and $B = 3.2$

Also in the study of earthquakes, the formula $R = 0.67\log(0.01E) + 1.46$ can be used to look at the relationship between the Richter scale magnitude, R , and the energy released by an earthquake, E , measured in megajoules.

3. Determine the amount of energy released by an earthquake that measures 6.1 on the Richter scale.
4. If another earthquake measures a 7.1 magnitude on the Richter scale, how much more energy is released by the second earthquake?

Atmospheric Pressure: The relationship between the altitude, A measured in km, and atmospheric pressure, P ,

measured in kiloPascals kPa, is given by the formula $A = \frac{500(-2 + \log(P))}{27}$.

5. What is the atmospheric pressure at sea level?
6. To ensure passenger safety in an airplane, the atmospheric pressure in an airplane cabin is kept at 100 kPa. What pressure difference must the airplane be designed to withstand if the plane is designed to fly at heights of 40,000 ft?
7. Determine the atmospheric pressure on the top of Mount Everest (elevation of 8850 m)

(B) Scales

Another formula for comparison of earthquakes uses the following formula \rightarrow we can compare intensities of earthquakes using the formula: $\log(I_1/I_2) = \log(I_1/S) - \log(I_2/S)$ where I_1 is the intensity of the more intense earthquake and I_2 is the intensity of the less intense earthquake and $\log(I_1/S)$ refers to the magnitude of a given earthquake.

1. The recent Haiti earthquake had a magnitude of 7.0 on the Richter scale while a moderately destructive earthquake has a magnitude of 5.75. How many times more intense was the Haiti earthquake?



- The San Francisco earthquake of 1906 had a magnitude of 8.3 on the Richter scale while an earthquake of magnitude 5.0 can be felt, but is rarely destructive. How many times more intense was the San Francisco earthquake?

Loudness of sounds is measured in decibels. The loudness of a sound is always given in reference to a sound at the threshold of hearing (which is assigned a value of 0 dB.) The formula used to compare sounds is $y = 10 \log (i/i_r)$ where i is the intensity of the sound being measured, i_r is the reference intensity and y is the loudness in decibels.

- If a sound is 100 times more intense than the threshold reference, then the loudness of this sound is...?
- Your defective muffler creates a sound of loudness 125 dB while my muffler creates a sound of 62.5 dB. How many times more intense is your muffler than mine?

the pH scale is another logarithmic scale used to measure the acidity or alkalinity of solutions. a neutral pH of 7 is neither acidic nor basic and acidic solutions have pHs below 7, while alkaline solutions have pHs above 7.

Mathematically, $\text{pH} = -\log (\text{concentration of } \text{H}^+)$ → so the concentration of H^+ in a neutral solution is 1×10^{-7} moles/L . an increase in 1 unit on the pH scale corresponds to a 10 fold decrease in acidity (for acidic solutions) while an increase in 1 pH unit for bases corresponds to a 10 fold increase in alkalinity

- What is the pH of a solution if the concentration of H^+ is 3.5×10^{-5} mol/L
- What is the concentration of H^+ ions if the pH of a solution is 8.4?
- If the pH of apple juice is 3.1 and the pH of milk is 6.5, how many more times acidic is apple juice than milk?

(C) Changing Bases

Is 4 a power of 2? Is 8 a power of 2? Is 1024 a power of 2? What about 7? Is 7 a power of 2?? → Use common base (10) to develop formula

**(D) Creating Exponential & Logarithmic Models – Linearizing Data**

We can analyze data gathered from some form of “experiment” and then use our math skills to develop equations to summarize the information: Consider the following data of drug levels in a patient:

Time	0	1	2	3	4	5	6	7	8	9	10
Drug level	10	8.3	7.2	6.0	5.0	4.4	3.7	3.0	2.5	1.9	1.5

Create an algebraic model to describe the data using: (a) common ratios, (b) regression, (c) semi log paper