

Applications of Logarithms

Logarithmic Scales are used for quantities that vary greatly from *lowest* extreme to *highest* extreme.

3 Commonly Used Logarithmic Scales

1) Richter Scale – Intensities of Earthquakes

$$M_2 - M_1 = \log\left(\frac{I_2}{I_1}\right) \quad \text{where: } M_x \text{ is the magnitude of an earthquake.}$$

I_x is the intensity of an earthquake.

An increase of 1 in magnitude indicates a ten-fold increase in power.

Example 1: How many times more intense is a “7” earthquake than a “5.5” earthquake?

$$7 - 5.5 = \log\left(\frac{I_2}{I_1}\right)$$

$$1.5 = \log\left(\frac{I_2}{I_1}\right)$$

$$10^{1.5} = \frac{I_2}{I_1}$$

$$31.6 = \frac{I_2}{I_1}$$

$$31.6I_1 = I_2$$

A “7” earthquake is 31.6 times more intense than a “5.5” earthquake.

2) Decibel Scale – Sound Intensity

$$\beta_2 - \beta_1 = 10\log\left(\frac{I_2}{I_1}\right) \quad \text{where: } \beta_x \text{ is the “loudness” of a sound in decibels.}$$

I_x is the intensity of the sound.

Example 2: How many times louder is a music concert of 125dB than a conversation of 53db?

$$125 - 53 = 10 \log \left(\frac{I_2}{I_1} \right)$$

$$72 = 10 \log \left(\frac{I_2}{I_1} \right)$$

$$7.2 = \log \left(\frac{I_2}{I_1} \right)$$

$$10^{7.2} = \frac{I_2}{I_1}$$

The rock concert is about 15.8 million times louder than the conversation.

3) pH Scale – Acidity

$pH = -\log[H^+]$ where: pH is the measure of the liquid's acidity.
[H⁺] is the concentration of the hydrogen ion in mol/L

Example 3: Determine the pH of a solution with an H⁺ concentration of 0.0022

$$pH = -\log(0.0022)$$

$$\doteq 2.66$$

Homework: pg. 353 #1, 2, 6 – 12, 19, 22