5.4 Notes

Tuesday, March 3, 2015 12:30 PM

Algebra 2 Trig Honors
Section 5.4 Notes – Logarithmic Models

The book does an excellent job of explaining a very useful application of logs. Please read the first paragraph under the heading: **Logarithmic Scales.**

The decibel, named after the inventor of the telephone, Alexander Graham Bell, is defined as:

$D = 10 \log \frac{I}{I_0}$ where D is decibel level

I is intensity measured in watts per square meter

and I_o is 10^{-12}, the least audible sound that an average healthy person can hear

Example: Find the number of decibels from a jackhammer with sound intensity of 3.2 x 10^{-3} watts per square meter. Round your answer to the nearest hundredth.

$$D = 10 \cdot \log \frac{3.2 \times 10^{-3}}{10^{-12}} = 10 \cdot \log(3.2 \times 10^{9})$$

$$= 95.05 \text{ decibels}$$

Example: Find the number of decibels from a whisper with sound intensity 5.2 x 10^{-10} watts per square meter. Round your answer to the nearest hundredth.

$$D = 10 \log \frac{5.2 \times 10^{-10}}{10^{-12}} = 10 \log (5.2 \times 10^{2})$$

$$= 27.16 \text{ decibels}$$

Example: If the intensity of a sound from one source is 10,000 *times* that of another, how much *more* is the decibel level of the louder sound than the quieter sound?

$$D = 10 \log \frac{10^0}{10^{-12}} \qquad D = 10 \log \frac{10^4}{10^{-12}}$$

$$= 10 \log 10^{12} \qquad = 10 \log 10^{16}$$

$$= 120 \qquad = 160$$

40 decibel difference

In 1935, Charles Richter devised a logarithmic scale to measure the destructive power of earthquakes:

$M=\frac{2}{3}\log\frac{E}{E_0}$ where M is magnitude of the earthquake

E is energy measured in joules

E_o is $10^{4.4}$, the energy released by a very small reference earthquake

Example: In 1985 an earthquake in Central Chile release approximately 1.26 x 10^{16} joules of energy. What was the magnitude on the Richter scale? Round your answer to the nearest hundredth.

$$M = \frac{2}{3}\log\frac{1.26\times10^{16}}{10^{4.4}} = \frac{2}{3}\log(1.26\times10^{11.6}) = 7.80$$

Using your phone, look up the most intense earthquake recorded in the United States, using the Richter scale.

When and where did it occur? ______________________________

What was the magnitude? ____________________________

What was the energy released (based on our formula)? ________________________

Using your phone, look up the most intense earthquake recorded in the World, using the Richter scale.

When and where did it occur? ______________________________

What was the magnitude? ____________________________

What was the energy released (based on our formula)? ________________________

Example: How many *times* greater is a magnitude 7.5 earthquake compared to a 3.4 earthquake?

$7.5 = \frac{2}{3}\log\frac{E}{10^{4.4}}$

$4.47\times10^{15} = E$

$10^{15.65}$

$3.4 = \frac{2}{3}\log\frac{E}{10^{4.4}}$

$3,162,277,660 = E$

3.16×10^{9} $10^{9.5}$

$\frac{10^{15.65}}{10^{9.5}}$

$= 10^{6.15}$

$4.47 \times 10^5 = E$

$10^{15.65}$

$3,162,277,660 = E$

3.16×10^9 $10^{9.5}$ $= 10^{6.15}$

$= 1,412,537$