

Math Modeling
Lesson: The Sound of Music
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When we hear a noise, our ear drums are being hit by a vibration passing through the air. Our ear drums are feeling a sound wave, and a vibrating object is the source of the noise. The vibrating object could be the vocal cords of a person, the vibrating string and sound board of a guitar, violin, the vibrating diaphragm of a radio speaker, a book dropping to the floor, a car door slamming shut, and so on. Regardless of what is creating the sound wave, the particles of air through which the sound is moving vibrate in a back and forth motion. If a sound wave is drawn we will see a repeating pattern. It repeats itself in a periodic and regular fashion over both time and space.

Let's look at the anatomy of a wave.

Here are models of some different sound waves. It is easy to see the repeating pattern, but notice how the pattern can change.

Frequency: When we speak of frequency we need to think how often does something occur? How frequently do you mow the yard in the spring? Oh, one time per week the answer might be. Notice it is a rate. For sound waves the frequency is the number of complete cycles per unit of time. We measure number of waves/second or **hertz, 1 Hz-1 cycle/second**.

Pitch: When the ear hears different frequencies, the sensation is commonly referred to as the **pitch** of a sound. A high pitch sound corresponds to a high frequency sound wave and a low pitch sound corresponds to a low frequency sound wave. Think about the sound in movies. The slow motion running is accompanied with that low slow sound. And then the character is sped up and is going real fast the music is always really high pitched.

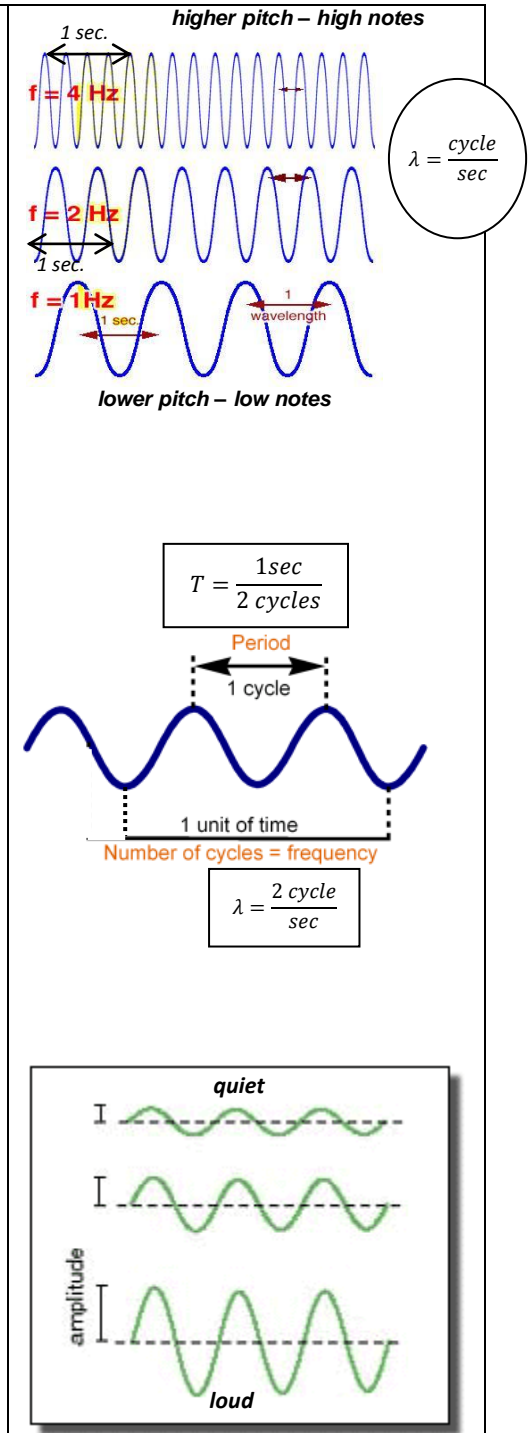
Period: The period of a wave is the time for a particle in the air to make one complete vibrational cycle. Period, being a time, is measured in units of time such as seconds, hours, days or years. The period of orbit for the Earth around the Sun is approximately 365 days; it takes 365 days for the Earth to complete a cycle. If you are sitting in a boat on water you are rocking up and down. The period is the time it takes for you to complete one cycle of moving up and then back down.

Frequency and period are related. Frequency, how often does it happen. Period is how long for just one thing to happen. In equation form the period is the reciprocal of frequency.

$$T = \text{period} = \frac{\text{seconds}}{\text{cycle}} = \frac{1}{\text{frequency}}$$

$$\lambda = \text{frequency} = \frac{\text{cycles}}{\text{second}} = \frac{1}{\text{period}}$$

Amplitude: This is what we perceive as **loudness**. The louder the vibration the greater the height of the sound wave. This measurement is amplitude.



Math Modeling Potpourri

Statistics-

Outlier: These are values that are way different compared to the rest of the data set by being especially small or large in numerical value.

Measure of central tendency: A measure of central tendency is a single value that attempts to describe a set of data

Mean: this is an "average." $mean = \frac{\text{sum of the data items}}{\text{total number of data items}}$ You use mean when the data is grouped together. That is, you have no outliers. *When you have a large or small number that is not close to the majority of numbers, use median.*

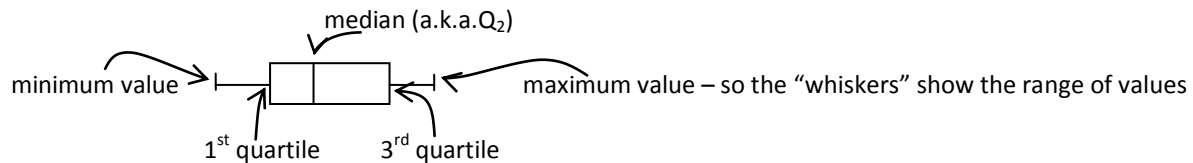
Median: The median is the middle score for a set of data that has been arranged in order. For a set containing an even number of data, the median is the average of the two middle values. The median is less affected by outliers, *so when you have an outlier, use median.*

Mode: The mode is the data item that occurs the most times. Normally, the mode is used for categorical data where we want to know what the most common category is.

Range: *NOT a measure of central tendency.* The range of a set of data is the difference between the greatest and least values. The range gives you a measure of the spread of the data.

Box and Whisker Plot

This is a graphical way to present the median, and tack in your range. Also, it adds another bit of data called quartiles. The first quartile or Q_1 is the median of the lower half of the data and the 3rd quartile Q_3 is the median of the upper half of the data. AND YES!! Your real median or the middle value is also called the 2nd quartile or Q_2 ! Whew!

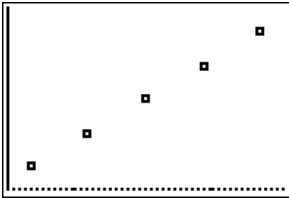

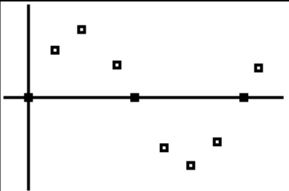


STAT PLOT When do you use your STAT PLOT feature on the calculator???? (aka regression)

STAT PLOT EDIT to enter the lists of data.

2ND Y= to turn on the stat plot

ZOOM 9 to view the data

| | | | |
|---|---|--|--|
| <p>What does the data look like? Depending on the shape, to calculate the equation you have 3 choices.</p> | <p>Is it a straight line?</p>  | <p>STAT CALC 4 VARS Y- VARS 1 ENTER ENTER</p> | |
| <p>Does it resemble a parabola?</p>  | <p>STAT CALC 5 VARS Y- VARS 1 ENTER ENTER</p> | <p>Woo! Does it look like a sound wave?</p>  | <p>> toggle left/right and up/down to estimate the values of x and y</p> |