

## Determining the Frequency and Pitch of a Note using an Audio Editor

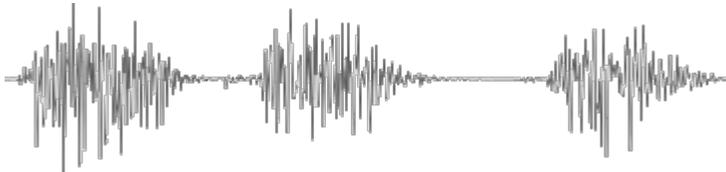
Frequency refers to the rate of vibration. For example, if an object such as the string on a guitar (or the vocal cords of a singer) is moving back and forth at a rate of 96 times per second, the frequency would be described as 96 times per second. (Note: the term *Hz* is also used to describe rate of vibration, so the back-and-forth movement could as be described as 96 Hz.)

Pitch is the perceptual correlate of frequency. A 96 Hz sound would be perceived as the musical note “G” in the Western chromatic scale. As frequency increases, the perceived pitch also increases. However, the relationship is not linear.

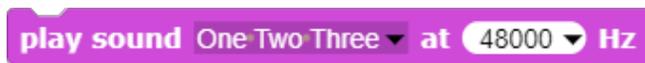
A microphone can be used to capture and record sound. When a microphone is connected to a computer, an analog-to-digital converter digitizes sound by recording the back-and-forth movements of a microphone. The movements of the microphone are converted into an electrical signal. The amplitude of the electrical signal is measured many times per second. The **Samples of Sound** block reports these measurements.



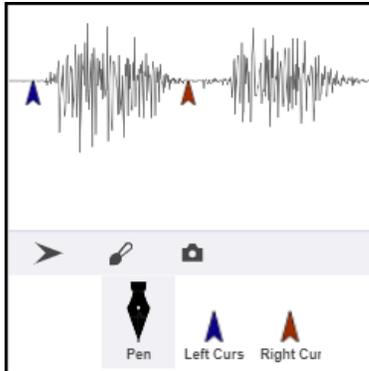
The default width of the Snap! stage is 480 turtle steps. If sound is sampled at a rate of 48,000 times per second, only one-hundredth of a second will be displayed when the samples are plotted on the screen. However, if only every one-hundredth sample is plotted, then a full second of the waveform of the sound can be displayed on the screen. The utterance “One Two Three” looks like this when every hundredth sample is displayed.



The words can clearly be distinguished at this resolution. The **Play Sound** block can be used to play the samples. A digital-to-analog converter reverses the process, converting digital measurements into back-and-forth movement of a diaphragm of a speaker. The recorded samples are converted back into an electrical signal, which in turn causes an electromagnet to move the diaphragm of a speaker back and forth.

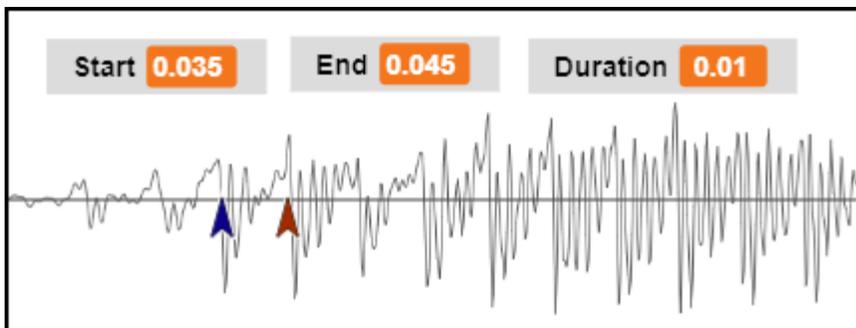


The TuneScope Audio Editor includes code blocks that can be used to display a digitized sound. Since the sound samples are stored in a Snap/ list of numbers, a portion of the sound can be played by playing different segments of the list. Two sprites labeled *Left Cursor* and *Right Cursor* provide pointers that serve as an index to select a segment of the utterance.



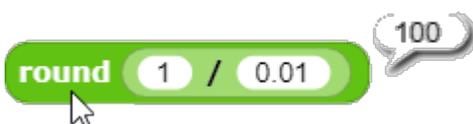
The position of the *Left Cursor* is recorded in a variable named *Start*. The position of the *Right Cursor* is recorded in a variable named *End*. The Duration of the sound segment selected is obtained by subtracting the value of *End* from *Start*.

Usually, a second or two of sound provides a reasonable time window to display. However, there are times when a more detailed look at the waveform is helpful. The horizontal axis of the waveform (time) can be magnified by displaying more points. For example, if every tenth sample of the waveform is displayed (instead of every hundredth point), the waveform is magnified by a factor of ten.



In the illustration above, the cursors have been used to mark the beginning and end point of a cycle of the waveform. (A cycle begins at the point at which the pattern begins to repeat itself.) In this instance, one cycle is one-hundredth of a second (0.01 seconds) in duration. Since a 0.01 second cycle of the waveform could be repeated one hundred times in a second. Therefore, the rate at which the cycle repeats, known as its frequency, is 100 cycles per second.

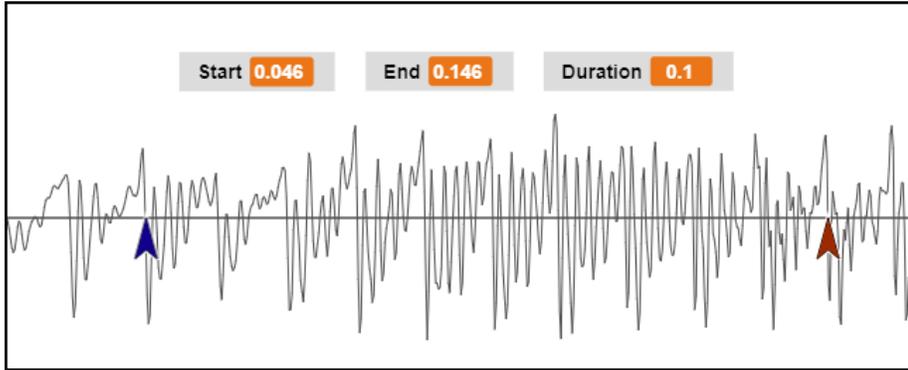
Since the period is the inverse of the frequency, the following code block can be used to make this calculation.



The variable *Duration* can be used in the denominator to obtain the same result.



Greater accuracy can be obtained by measuring the duration of more than one cycle. For example, in the example below, a total of ten cycles of the waveform have been selected.



If there are ten cycles of the waveform in one-tenth of a second, there would be 100 cycles of the waveform in a full second.

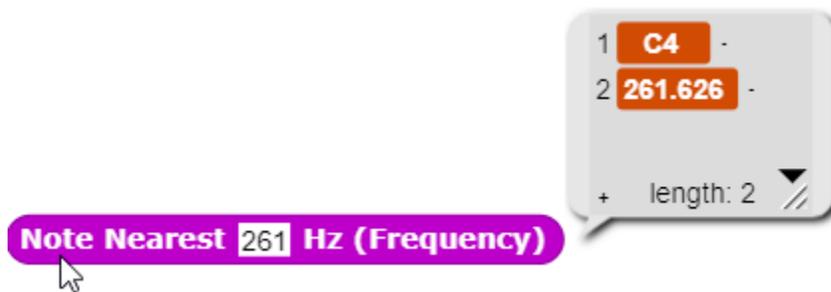


A frequency-to-note chart can then be used to determine that if the utterance were sung, a frequency of 100 cycles per second (sometimes called *Hz*) would fall between G and G#.

NOTE	OCTAVE 0	OCTAVE 1	OCTAVE 2	OCTAVE 3
G	24.5	49	98	196
G#/Ab	25.96	51.91	103.83	207.65

The ratio of the frequency of one note to the next note is always the same in the twelve note Western chromatic scale. This relationship can be used to determine the frequency of any note in Snap!

The following reporter block can also be used to identify the note that is closest to the specified frequency for octaves one through eight.



This reporter block checks a table of notes and frequencies to determine which note is closest to the frequency supplied as an input to the block.