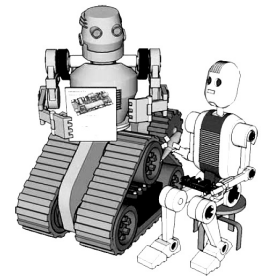


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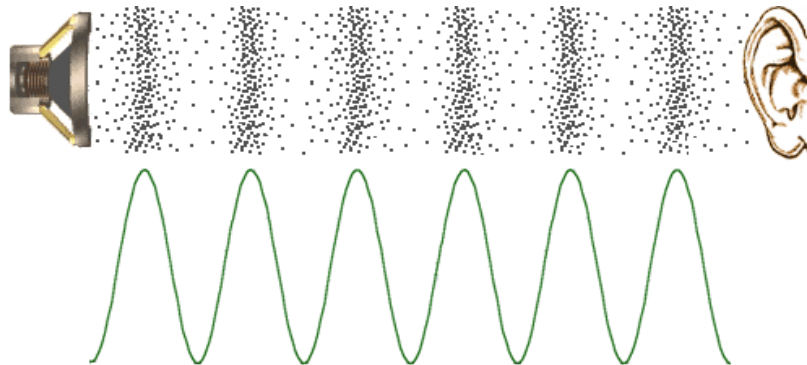
*Sound is vibration transmitted through a solid, liquid, or gas; particularly, sound means those vibrations composed of frequencies capable of being detected by ears.
The American Heritage Dictionary of the English Language, Fourth Edition.*

Making Sound

Sound includes voice, music, and noise. In this lesson we will make noise.

Humans hearing is limited to frequencies between about 20 Hz and 20,000 Hz (20 kHz), with the upper limit generally decreasing with age.

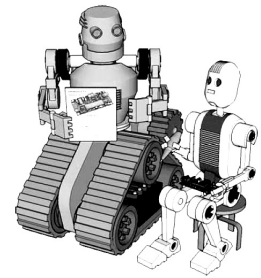
In air sound is transmitted by compression waves. We will create these compression waves using a common speaker salvaged from an obsolete computer.



The above illustration show how the density of the air (molecules per unit volume) varies periodically as the speaker vibrates. As the speaker cone moves forwards it increases the density, compresses the air. The compressed wave moves away from the speaker at the speed of sound. When the cone move backwards it reduces the density of the air. This less dense wave follows the compressed section away from the speaker.

It is important to keep in mind that the compression waves do not result in air traveling from the speaker to the ear.

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Weebles Wobble But They Don't Fall Down



Weebles were bottom heavy toy people. Because their center of gravity was very low they would rock back and forth but never fall over. The weight in the base righted them.

Suppose we lined up 10 weebles in a row. They are spaced such that the head of each will contact the head of the next when they wobble. When we wobble the 1st its head contacts the 2nd, which causes the 2nd to contact the 3rd etc. In a short time the 9th will contact the 10th. The weebles remain where they started but the original wobble has been transmitted to the other end of the line. This is how sound works. Like weeble, the air does not travel, but the compression wave does.

In a previous lesson we learned that frequency = 1/period and that period = 1/frequency. This tells us that the longer the period the low the frequency, and the shorter the period the higher the frequency.

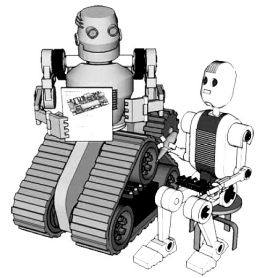
You do not have to know exact frequencies or periods for this lesson. Use the **try it and listen** approach.

Lets make some noise.

Our 18F1320 output ports provide enough current to drive a small speaker without an amplifier. Speakers typical have a resistance of 4, 8, or 16 Ohm. Using Ohms law we find that a 4 Ohm speaker will attempt to draw $(5V/4R)$ or over 1 amp from the PIC. To prevent this we will use a current limiting resistor just as we did when using LEDs. I have prepared a speaker with a built in limit resistor for each of you that can be used with the Junebug. To use the speaker insert the two pin plug into connector nearest the USB jack. Use GND and RB4.

In short, to make a sound we need to output a frequency between 20 and 20KHz on RB4.

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In Class Exercise.

Create a new project and write code to:

1. Create a continuous tone.
2. Alternate between and high and a low tone, each tone should sound for 1 second.
3. As above but use 4 tones.
4. Over a period of 4 seconds slide from a low to a high note.
5. As above but do high to low to high to low.
6. As above but reduce the slide time with each slide.

Additional Reading

How Sound Waves Work <http://www.mediacollege.com/audio/01/sound-waves.html>