Before we generate sound, let's look at how a typical speaker works. Sound exists as varying pressure waves that are created when a physical object moves, vibrating the air next to it. These air pressure waves travel through the air in all directions at about 343 m/sec. Sound can also be generated in water, where it travels at 1484 m/sec. Our ears can sense sounds from 20 Hz to about 20 kHz. In other words, the pressure wave must be oscillating faster than 20 Hz and slower than 20 kHz for us to hear it. See Figure 13.4.

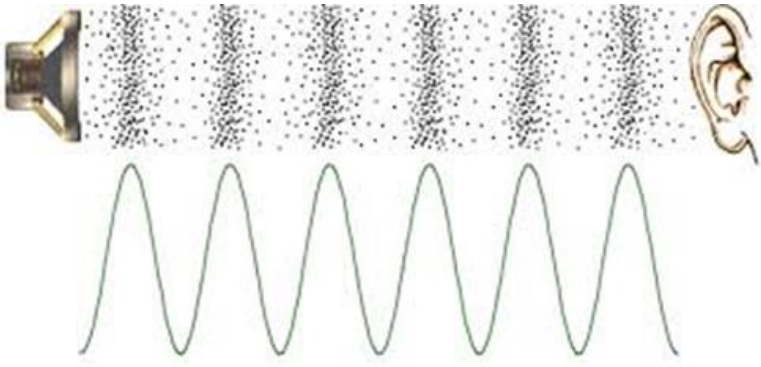
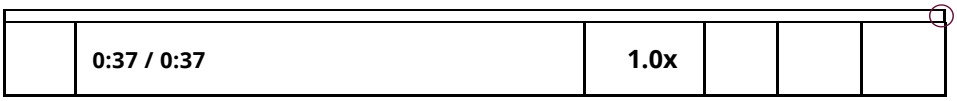


Figure 13.4. Sound waves exist as pressure waves in media such as air, water, and non-porous solids. For more information on sound, see http://www.mediacollege.com/audio/01/sound-waves.html (http://www.mediacollege.com/audio/01/sound-waves.html)

VIDEO 13.6 HOW DOES A SPEAKER WORK?

DR. JONATHAN VALVANO: Hi, in this demo we

C13 6 How a speaker works YouTube



will show you two aspects of generating sound.

The first is amplitude.

The amplitude of the sound will be a function

of the electrical power applied to the speaker.

We can see in this demo that we're generating about 6 volts at 1 amp.

6 volts times 1 amp is 6 watts.

So the amplitude of the sound is going to be 6 watts.

The second aspect of the sound is the frequency or pitch.

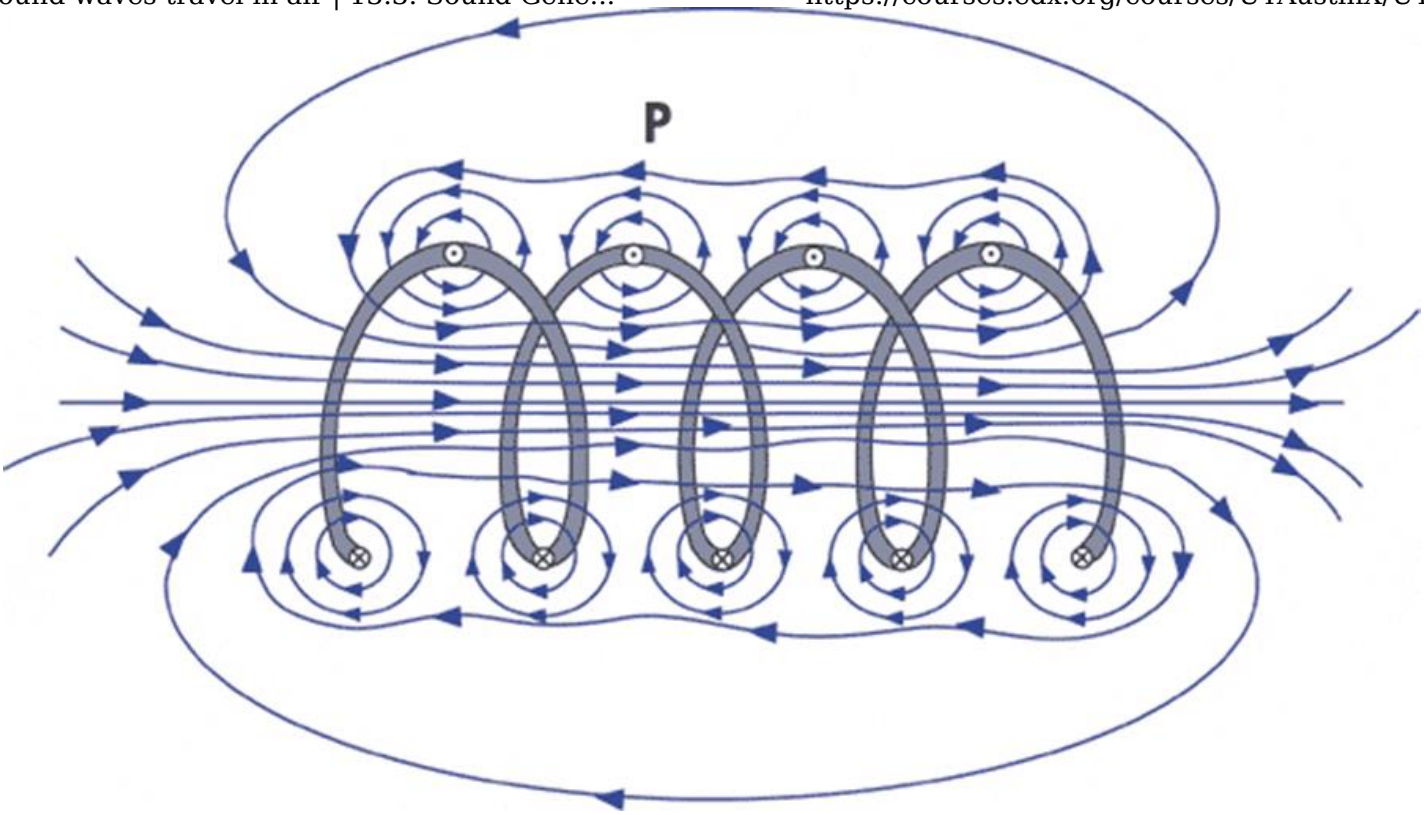
We've slowed it way down so you can see the cone move.

The frequency at which it oscillates will

determine the frequency of the sound.

Help

There are two magnets in a speaker. There is a large permanent magnetic that creates a static magnetic field oriented in the direction the speaker is facing, and there is an electromagnet created by a spiral-wound coil oriented in the same direction. The microcontroller creates an alternating electrical signal to the electromagnet. The electrical power (voltage*current) determines the loudness of the sound, and the frequency of the alternating signal determines the pitch of the sound. Figure 13.5 shows a magnetic field generated by a cylindrically-wound coil.



Help

Figure 13.5. The magnetic field produced by a coil is very strong oriented in the direction of the cylinder. For more information on magnetic fields produced by a coil, see http://www.ndt-ed.org/EducationResources/CommunityCollege/MagParticle/Physics /CoilField.htm (http://www.ndt-ed.org/EducationResources/CommunityCollege/MagParticle/Physics/CoilField.htm)

The strength and direction of the magnetic field are related to the strength and direction of the electrical current conducted through the coiled wire. Figure 13.6 shows a cut away of a typical speaker. The alternating magnetic field generated by the coil interacts with the constant magnetic field produced by the permanent magnet. To generate sound we will create an oscillating current through the coil, this will create an oscillating magnetic field, and will vibrate the voice coil. The diaphragm and spider hold the voice coil to the suspension allowing it to vibrate up and down. When the voice coil vibrates up and down it creates sound waves. The frequency and amplitude of the sound is directly related to the frequency and amplitude of the current passing through the coil. The resistance of the coil in a typical headphone is 32 Ω.

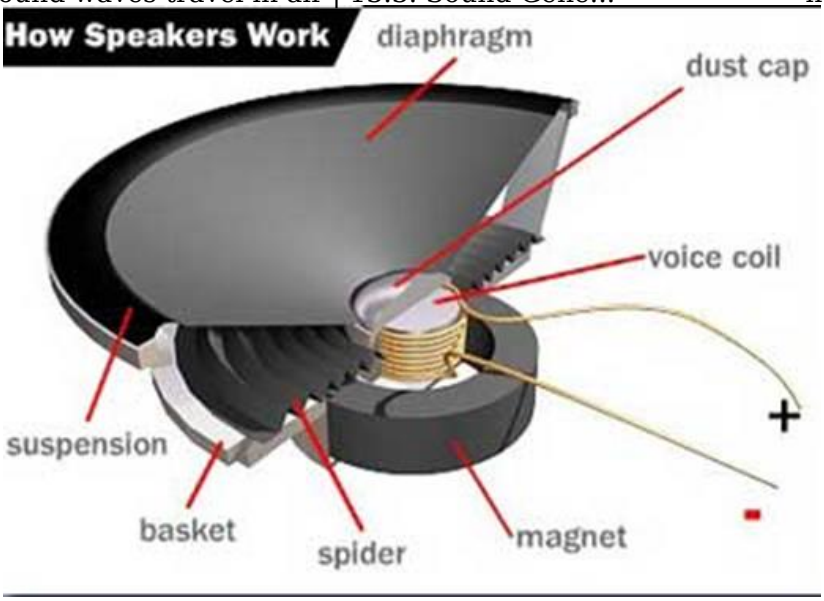


Figure 13.6. A speaker can generate sound by vibrating the voice coil using an electromagnet. For more information on speakers, see http://www.howstuffworks.com/speaker6.htm (http://www.howstuffworks.com/speaker6.htm) *or* http://www.audiocircuit.com/DIY/Dynamic-Speakers/Article:How-dynamic-loudspeakers-work (http://www.audiocircuit.com/DIY/Dynamic-Speakers/Article:How-dynamic-loudspeakers-work)

Help

CHECKPOINT 13.8

Some speakers are heavier than others. These heavy speakers have larger permanent magnets. Why would we want a permanent magnet that can create a larger magnetic field?

Hide Answer

A larger magnetic field means a larger force on the coil, which means it can generate a louder sound. There are some exceptions to the rule of heavier magnet means louder sound. For example Bose speakers can generate loud sounds without the heavy weight of a large magnet.

Help