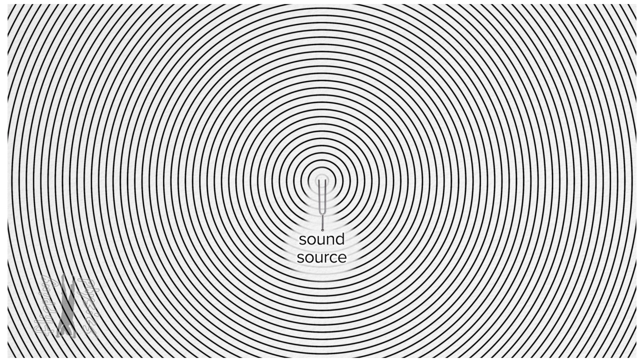
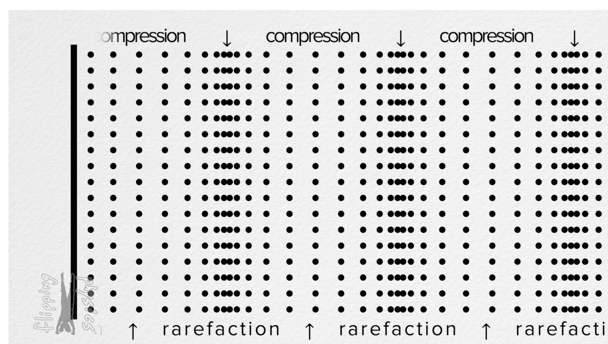
Flipping Physics Lecture Notes:

What is Sound?
https://www.flippingphysics.com/sound.html



A tuning fork is the simplest way to understand sound. After you bang a tuning fork against something, the tines of the tuning fork oscillate back and forth in simple harmonic motion at a defined frequency. Often, the sound waves which spread out from a sound source like a tuning fork are represented by a ring of circles increasing in size. But what does this animation[1] really represent?

In order to understand this animation, we need to take a closer look at what is happening to the tuning fork. The frequency of this tuning fork is 440 Hz. That means the tines of this tuning fork are going back and forth 440 times every second. Even when I slow the video down to 32 times slower than real speed, it is difficult to see the motion of the tuning fork. On a side note (he he), the reason I chose 440 Hz is because that is typically what is considered to be “concert pitch” and is the note you will hear orchestras play when they are all trying to tune to one another. The frequency of a sound is interpreted by our brains as “pitch”. A higher frequency means a higher pitch. 440 Hz or “concert pitch” is the A above the middle C on a piano. Okay, in order to see what is happening with the tuning fork, let’s actually switch to a speaker creating the same 440 Hz frequency and then lower that frequency down to where we can actually see the movement of the speaker. Let’s choose 55 Hz which is an A, 3 octaves below concert pitch. Now we can show the speaker moving back and forth at 55 Hz slowed down 32 times slower than real speed. What you see here is the cone of the speaker going back and forth in simple harmonic motion 55 times per second just like the tines of the tuning fork. What you hear as sound is the air being compressed and rarified, 55 times every second.

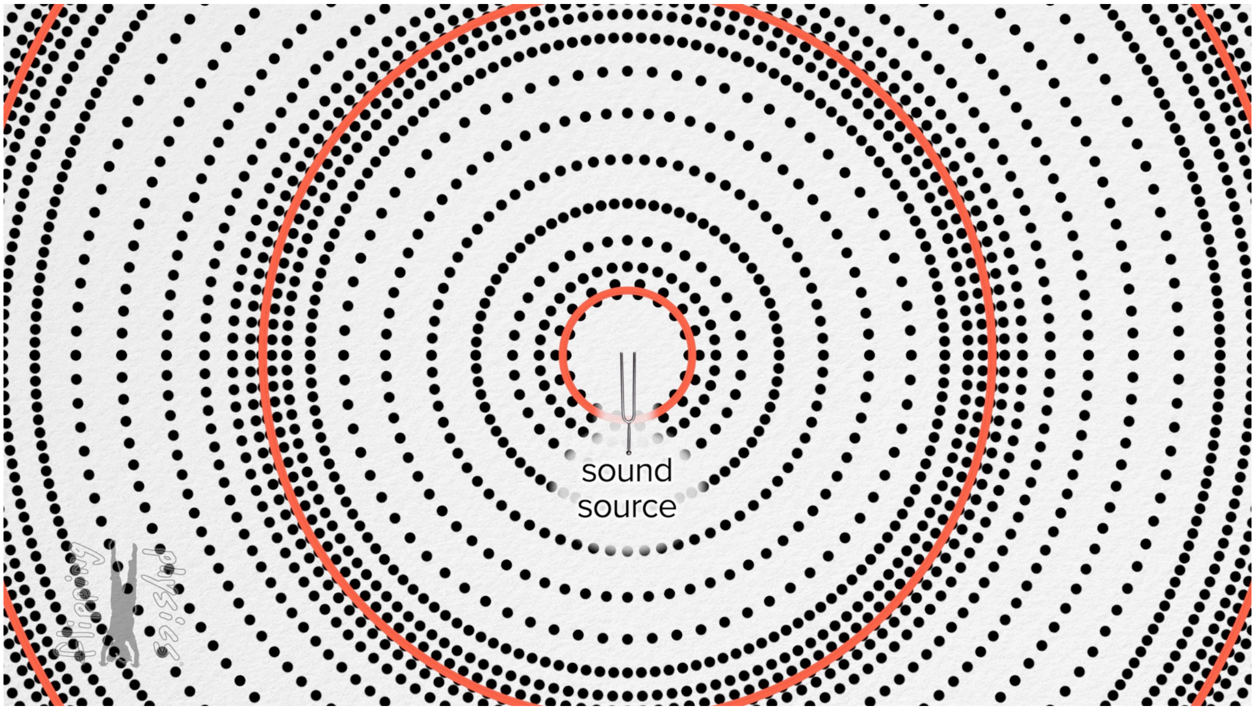


Unfortunately, you cannot see what is happening with the air to cause you to hear the 55 Hz frequency. So, I am going to show an animation of the speaker, represented by the vertical line, moving back and forth in simple harmonic motion and moving the air particles. You can see it compresses and rarifies the air particles in a simple harmonic motion pattern. Where the air is compressed, the air pressure is higher than atmospheric pressure, and where the air is rarified, the air pressure is lower than atmospheric air pressure. That is why a sound wave is often also called a pressure wave. A sound wave is also a longitudinal wave because the direction of the disturbance of the medium is parallel to the direction of wave propagation.

But we still have not connected this back to the original sound wave animation. So, looking at the speaker and air animation, notice how there are vertical lines of high density or high-pressure air. Those correspond to crests on a sinusoidal wave which represents the pressure of the air. Those vertical lines of high pressure, or crests on the sinusoidal wave, move linearly away from the speaker. But that is only from a very local perspective. A more accurate representation is that the sound waves move out in all directions from the sound source. In other words, the sound waves move out in a spherical shape away from the sound source. However, the medium you are looking at to understand sound waves is not three-dimensional, it is a two-dimensional space. And a two-dimensional slice of a sphere is a circle.

[1] Please watch the video so you can see the animations, really. https://www.flippingphysics.com/sound.html

So, coming back to the original animation of the circles increasing in diameter and emanating from the sound source. Those represent the crests of the pressure wave that our brains interpret as sound. And the crests represent locations of high pressure or high-density air. These circles, or rather spheres, are also called a wave fronts. This is a sphere of air which is all at the same location on the sinusoidal wave. So theses spheres are wave fronts of high pressure air which move away from the sound source.



But, we definitely need to answer the question “What is sound?” Sound is pressure waves travelling through a medium. For humans, the medium is typically air, however, sound can travel through any solid, liquid, or gas. The “pitch” of the 440 Hz tuning fork is your brain’s interpretation of that air pressure oscillating from high pressure, to low pressure, and back to high pressure 440 times every second.

It is important to remember that the medium is not displaced, only the disturbance of the medium moves through the medium, not the medium itself. And that disturbance of the medium, the wave front, is energy traveling through the medium.

Another important item to remember is that without the medium, the pressure waves that are sound, have no way to propagate. In other words, sound will ***not*** propagate through a vacuum. Sound can propagate through solids, liquids, and gases, however, sound will not propagate in the absence of a medium to compress and rarify to create high and low pressure waves.

End note: There is a term called “pressure amplitude” which is simply the amplitude of the pressure wave. That means it is the maximum difference between the local pressure of the air and the atmospheric pressure. This can be illustrated on the sinusoidal wave, just like all other wave amplitudes. Therefore, a higher pressure amplitude means greater pressure amplitudes and therefore a larger amount of energy transferred by the sound wave. Oh, and it’s louder too.