Discourse Sentence Stems

Can you tell me more?

Can you show your answer in a different way?

Can you repeat what you said please?

What is your evidence?

I agree with

____

because__________.

I disagree with

____

because

________.

Can you tell my why you think that is true?

I heard___________say__________.

I would like to add

______________________________.

Name: ____ Period: _______ Date: ________

Lesson (and date)	Part of the Model	What We Figured Out That We Added to Our Model

These materials were developed with support from the Gordon and Betty Moore Foundation to Northwestern University and support from the NGSX Project at Clark University, Tidemark Institute, and Northwestern University.

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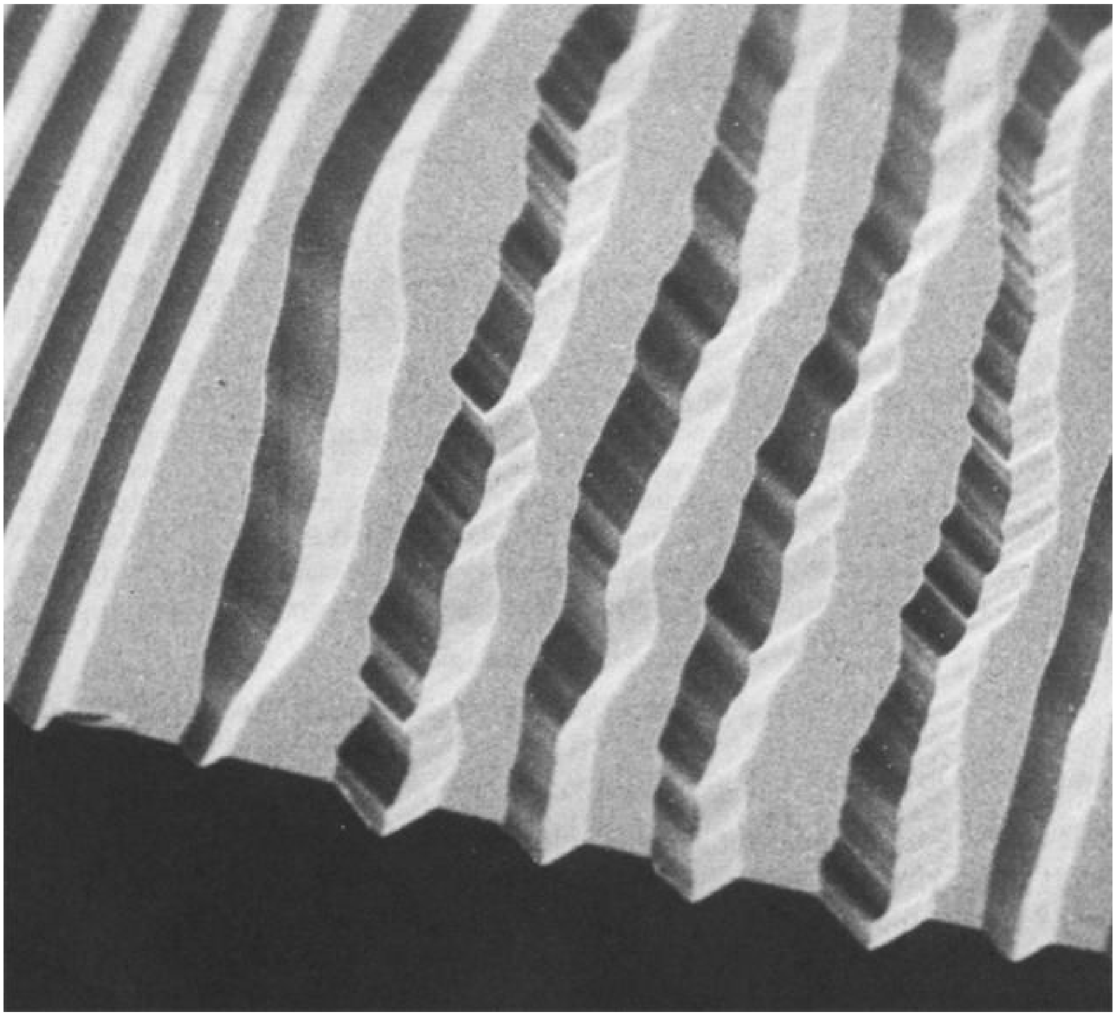
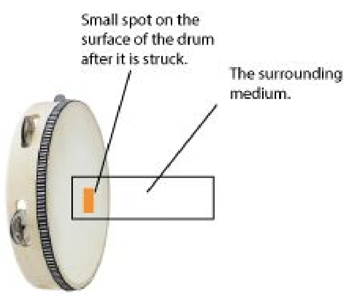
L2- Projected Image - Microscope Photograph of Record Surface

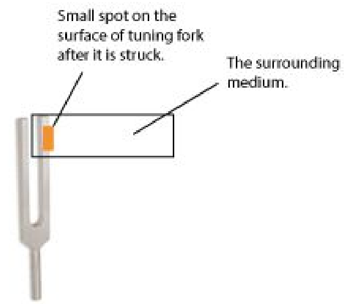


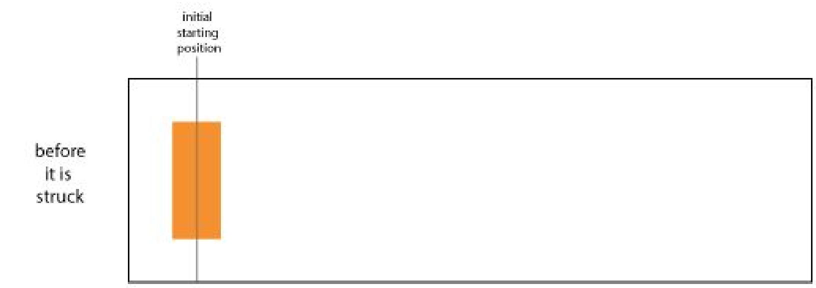
Scanning electron microscope photograph by the Victor Company of stereo record grooves at 100x magnification showing independent modulation of each groove wall, from *Handbook of Recording Engineering,* 1986, p. 323.

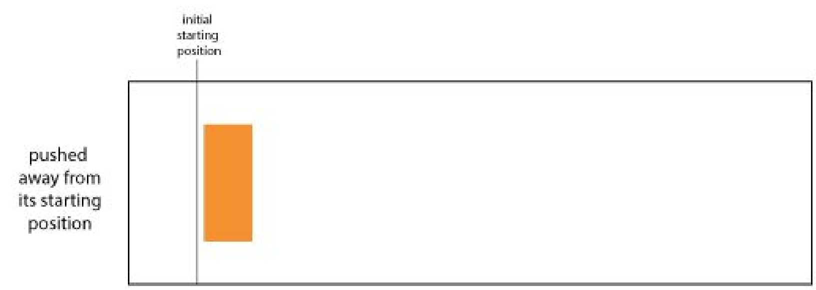
- We know that somehow the sound is moving across the matter.
- We know that matter is made of particles to small to see.
- What we still don’t know is how the sound is actually moving across the matter.

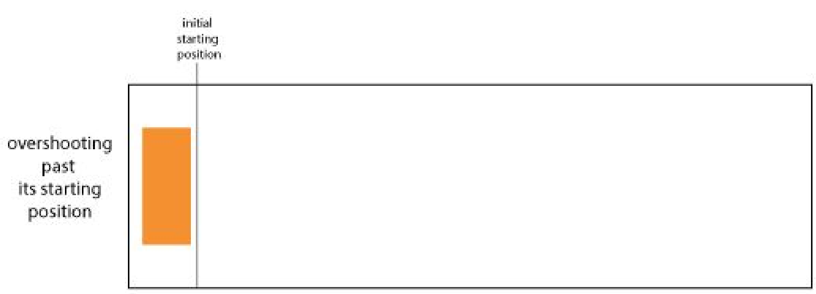
Re-draw one of your team’s models (liquid or gas) that would be next to this surface. Then **show what you predict would happen to the matter in the medium as the tuning fork started vibrating.** We will share our models at the start of the next lesson.











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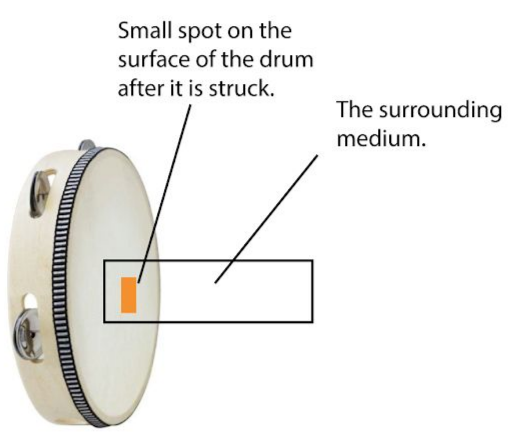
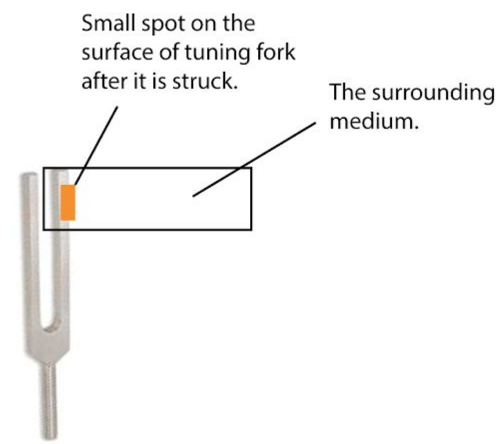
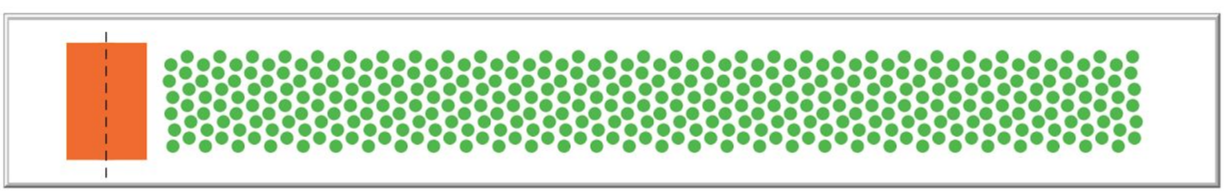




before the sound source starts vibrating
(particles in the medium are not visible)

Orange sound source

before the sound source starts vibrating
(particles in the medium are visible)



Orange sound source

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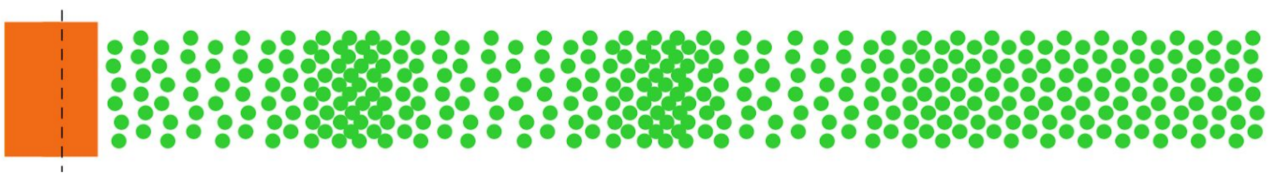
Frame 1

Frame 2



Frame 3

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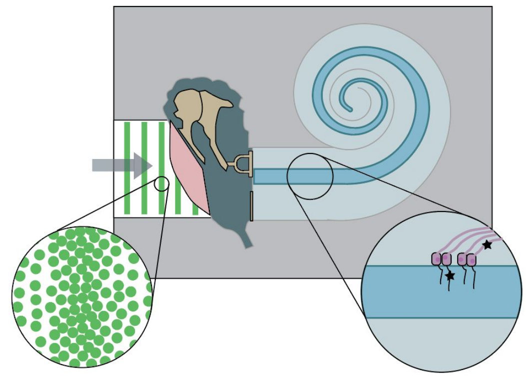
Lesson 14 In-Class Reading: Information from the experts on hearing

The information summarized from these interview questions was compiled with the help of Dr. Keith Lertsburapa (an otolaryngologist with Amita Health in Downers Grove, Illinois) and Dr. Jon Seigel (a neurobiologist and associate professor at Northwestern University).

What happens to the vibrations in our ear after they get to the eardrum?



- *After sounds cause the eardrum to vibrate, they pass that vibration along a series of bones in the inner ear. This transmits the vibration into the fluid of the cochlea, where the sound wave travels along the basilar membrane (the dark blue line in the diagram to the right) which allows us to detect the variety of pitch in the sounds we hear. The path of these vibrations (and an animation of a diagram similar to the one shown on the right) can be seen at this web address:* *http://www.neuroreille.com/promenade/english/ear/fear.htm*

How do we hear different pitches and volumes of sound?

- *When the vibrations enter the cochlea, different pitches will vibrate different areas of the cochlea more. Basically, the basilar membrane (represented above as the dark blue coil in the cochlea) has a different area that reacts more strongly to each pitch. When a sound of that pitch goes into your cochlea, that area of your basilar membrane vibrates more strongly. An animation of what this looks like can be found here: https://www.youtube.com/watch?v=fuEswszwFRg&t=2s Every different pitch that vibrates the basilar membrane also causes some of the hair cells in that area to vibrate, and this is the final step of the process. Different hair cells vibrate in response to different pitches of sounds. When those hair cells vibrate, they send an electrical impulse to the brain, and we finally hear that sound. If you'd like to see that up close, you can see a video of one of those hair cells here: https://www.youtube.com/watch?v=MGj-cdn2M9o*

Why do we lose our hearing as we get older?

- *This is actually not the case for all people as they get older. Hearing loss due to aging (presbycusis) only affects 30% of people over the age of 65. The loss of ability to hear sounds of a higher pitch can be related to the structure of the cochlea. Higher pitched sounds are detected by the hair cells at the base of the cochlea (where all sounds first enter the cochlea) so as a result of being the first to receive those vibrations, they take the biggest beating over time, and eventually wear out.*

So how does hearing loss work?

- *As you can now see, hearing is a very complex mechanism. In order for us to detect sound, the vibrations need to be transmitted many times: from our eardrum, to the bones of the inner ear, to the fluid of the cochlea, to the part of the basilar membrane that detects that pitch, and finally to the hair cells, which send the electric signal to our brain. You can imagine this like a line of dominoes, if any of those mechanisms is broken, or if they have a defect, then hearing will be impaired. This can be especially true for the hair cells, because of their structure. These hair cells have tiny detectors, called stereocilia, that respond to vibrations. Exposure to sounds that are too loud or too high pitched can damage the stereocilia, causing the hair cells to stop working. This can mean temporary damage (causing ringing in our ears) or permanent damage leading to hearing loss. To see stereocilia that have been permanently damaged from exposure to sound, visit:* *http://www.dangerousdecibels.org/virtualexhibit/2howdowehear.html*

Class Results from All Groups

Group	Investigation 1: Frequency vs. Energy			Investigation 2: Amplitude vs. Energy		
	When the frequency of the waves was 2 times the original value, how many times more energy was transferred? (Q6)	When the frequency of the waves was 3 times the original value, how many times more energy was transferred? (Q7)	When the frequency of the waves was 4 times the original value, how many times more energy was transferred? (Q8)	When the amplitude of the wave was 2 times the original value, how many times more energy was transferred? (Q9)	When the amplitude of the wave was 3 times the original value, how many times more energy was transferred? (Q10)	When the amplitude of the wave was 4 times the original value, how many times more energy was transferred? (Q11)

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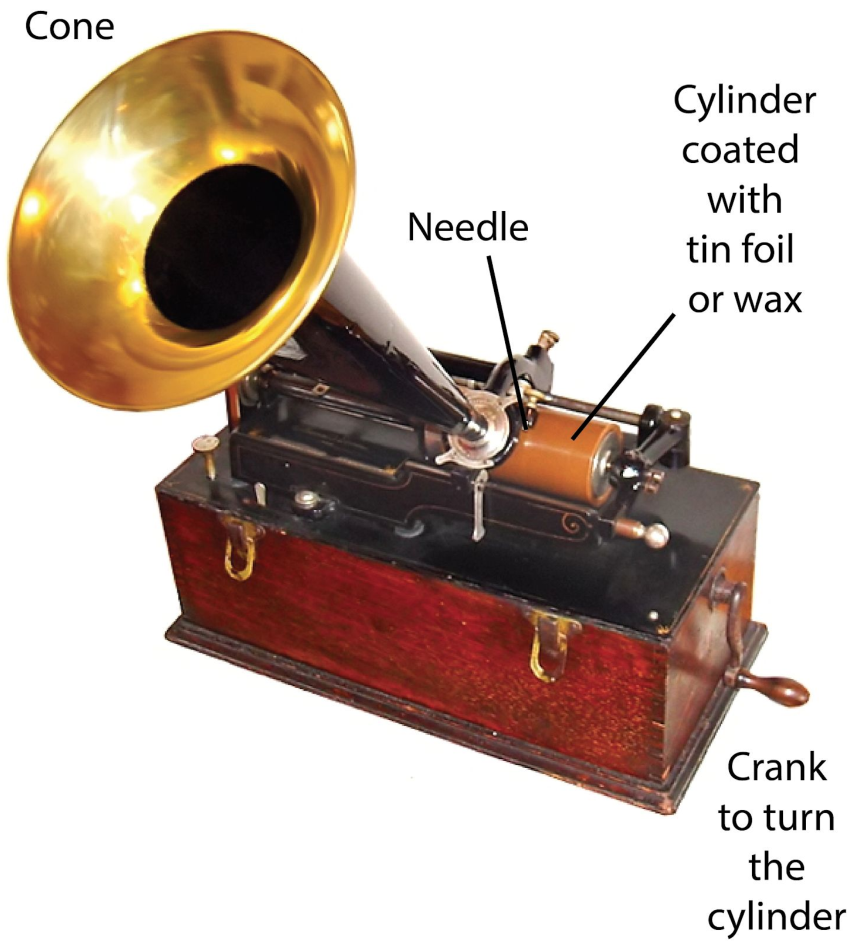
Lesson 23: PI - Edison Cylinder - How were audio recordings made, copied, and played back long ago vs. now?

Text adapted from: https://en.wikipedia.org/wiki/Phonograph_cylinder

The first audio recordings ever made were produced on a device similar to the one shown to the right.

On July 18, 1877, Thomas Edison and his team invented the phonograph. His first successful recording and playback of intelligible sounds were achieved early the following December. It used a thin sheet of tin foil wrapped around a hand-cranked grooved metal cylinder to record the sounds on. The photograph to the right shows the basic parts of the device.



Original image from https://en.wikipedia.org/wiki/Phonograph_cylinder

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