

SOUND WAVES

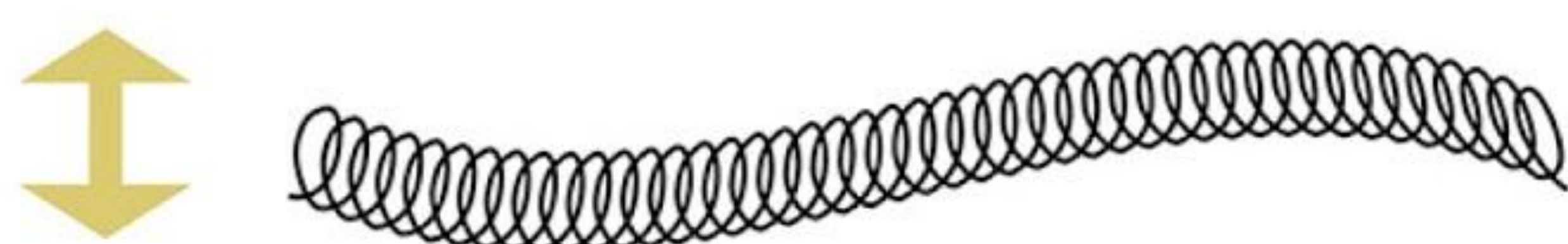
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Waves are defined as rhythmic disturbances that carry energy without carrying matter. As a wave travels, the energy moves from one point to another. The matter through which the wave travels, known as a **medium**, vibrates but does not drastically change position.

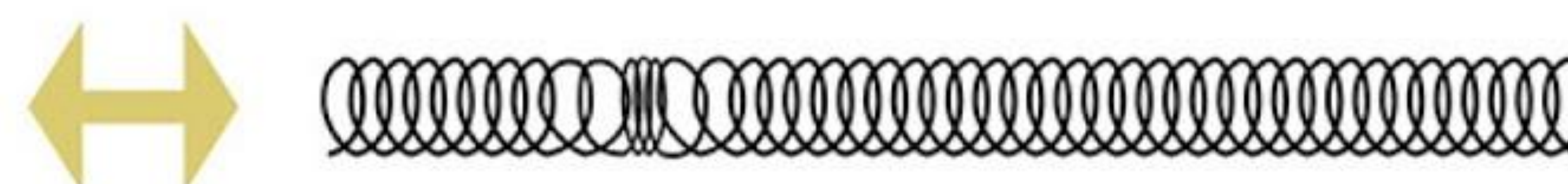
Imagine a stadium full of people doing (you guessed it!) the wave. Each person stands up as the wave passes, but they don't leave their area. This is also how sound waves pass through materials. Each particle vibrates as the energy of the wave passes through it, but it eventually returns to its resting point.

Waves that require a medium to travel are known as **mechanical waves**. Light is not a mechanical wave because it can travel through empty space. Sound, on the other hand, is a mechanical wave because it cannot exist without a material to travel through. Usually, sound's medium is air. As the energy of sound passes through the air, the molecules it passes through are disturbed and vibrate left and right.

Mechanical sometimes create disturbances that cause particles to vibrate up and down. These are known as a **transverse waves**. Other times, the particles that are disturbed vibrate left and right, creating a **compression** or **longitudinal wave**. Sound is a **compression wave**.



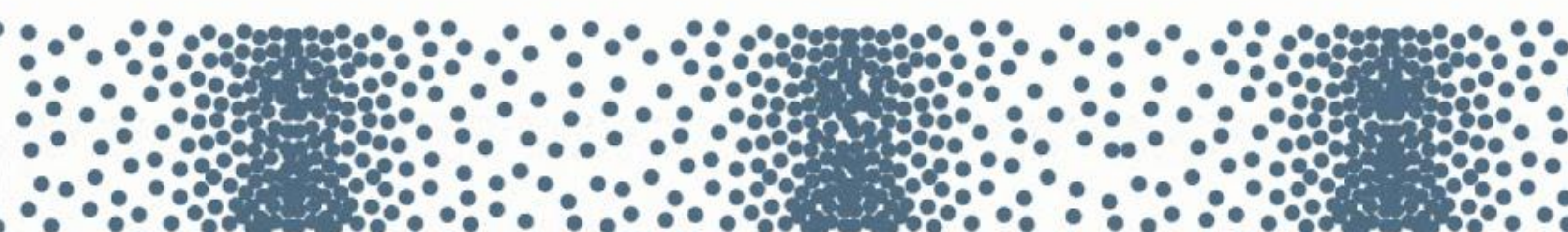
transverse wave



longitudinal wave

To better illustrate the differences between these two waves, imagine a slinky stretched out between two students. If one student wiggles the slinky up and down, a transverse wave is created. On the other hand, if one student pushes the slinky in the same direction that it is stretched, a wave of compressed springs will travel along the slinky until it reaches the other side. This is the way that a sound wave behaves.

Sound is created when air particles are compressed by a speaker, vocal cord, or any other vibrating object. The air particles closest to the disturbance will move slightly in the direction away from the vibrating material before returning to their original location. When the particles are displaced, they press up against more air particles, which will vibrate away in response as well. This creates a domino effect in which the vibrating energy travels outward from the source, just like the compressed slinky in the example above.

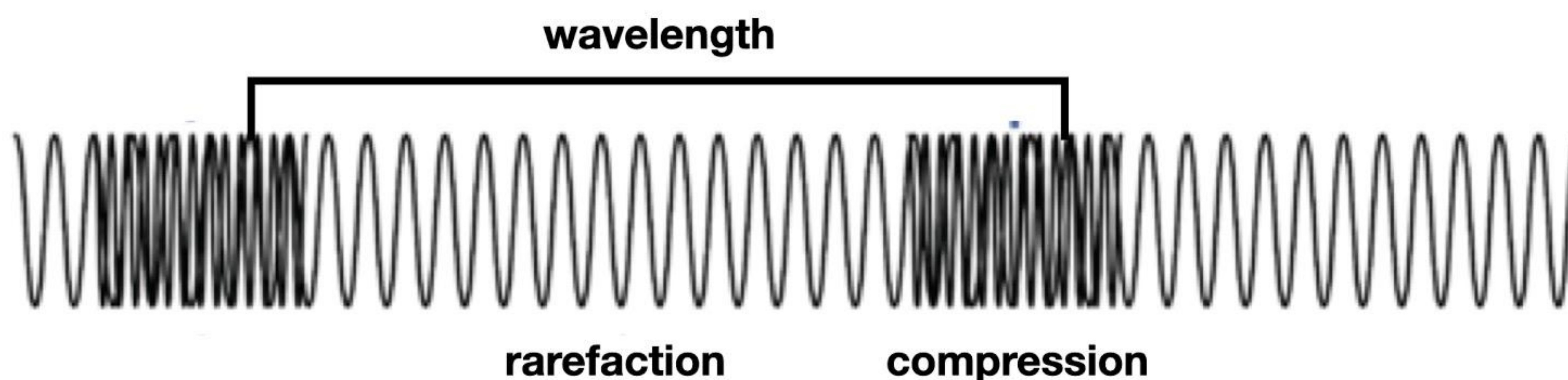


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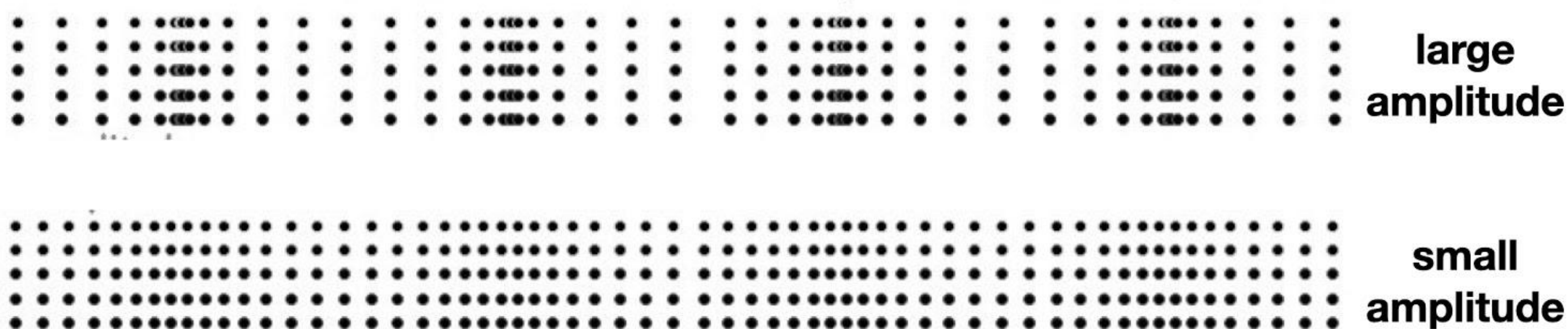
Sound Wave Properties

As a sound wave travels through a medium, particles compress and spread out again as they vibrate. Areas where particles are pushed together are known as **compressions** and areas where particles are spread out are known as **rarefaction**. The distance from one point on a wave to the same point on the next wave is known as the **wavelength**.



Amplitude is defined as the distance that particles vibrate from their resting point. In a wave with a large amplitude, particles will move far from their starting point before coming back again, such as in the first image below. If particles only move slightly away from their starting point, the amplitude is smaller. This can be seen in the second image below. *[It can be difficult to visualize amplitude without actually seeing the wave move or the particles vibrate. Consider searching Youtube or Google for some animated examples!]*

Waves with larger amplitudes have more energy, and are more disturbing to the molecules that they pass through. The more the particles are disturbed as the wave passes, the more damage can be done. For example, an earthquake with a large amplitude would be a lot more dangerous than one with a smaller amplitude. Sound waves with a greater amplitude are louder and travel further than sound with a small amplitude. Usually, this intensity of sound is measured in **decibels**.



The number of waves that pass a certain point in a certain amount of time is known as the **frequency**. Frequency is measured in hertz (Hz). Humans perceive frequency in sound as **pitch**. Higher frequency sound is heard as high pitch while lower frequency sounds are low pitch. On a musical scale, the note C has a frequency of 262 Hz, while E has a pitch of 330 Hz.

Just as there are parts of the visible spectrum which are not perceptible to humans, there are sound waves which humans cannot detect either. We are only able to hear sounds with frequencies from 20 Hz to about 20,000 Hz.