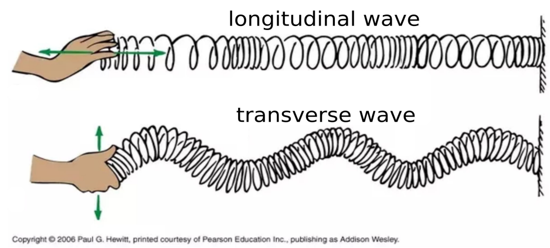
Waves and Harmonics with Slinkies and Rubber Bands

- Waves are vibrations tied together in neighboring pieces of a material
- **Frequency:** how often a piece of material moves back and forth.
- Waves can be **longitudinal** (back-and-forth motion) or **transverse** (up-and-down motion).
- When a wave is caught in between walls, it will bounce back and forth to create a **standing wave**, but only if its frequency is just right.
- **Sound** is a longitudinal wave that moves through air and other materials. The pitch you hear (low or high sound) is the frequency of the sound wave.

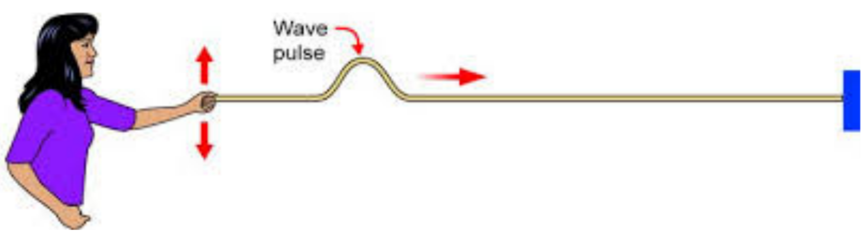


Making Waves with a Slinky

Take turns being the "wall" (hold end steady) and the slinky mover.

1. Each of you should hold one end of the slinky. Stand far enough apart that the slinky is slightly stretched.

2. Try making a **transverse wave pulse** by having one partner move a slinky end up and down while the other holds their end fixed.



What happens to the wave pulse when it reaches the fixed end of the slinky? Does it return: upside down or same way up ?

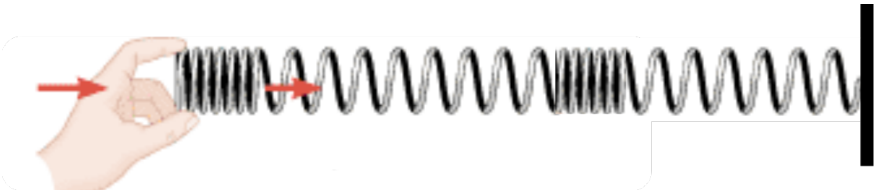
Try moving the end up and down once, <u>faster</u>:
Does the wave pulse get: narrower or wider?

Does the wave pulse reach the other partner noticeably faster? Yes / No

3. <u>Without moving further apart</u>, pull the slinky tighter, so it is more stretched (scrunch up some of the slinky in your hand. Be gentle!). Make a transverse wave pulse again.

When the slinky is stretched more tightly, does the wave pulse reach the end:
faster or slower?

4. Try making a **longitudinal wave pulse** by folding some of the slinky into your hand and then letting go. This may be easiest to do with the slinky on the floor.



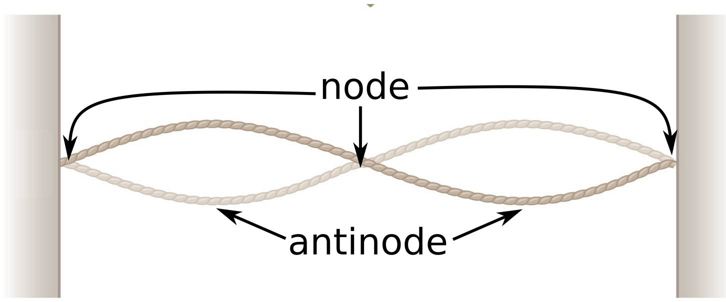
Slinky Standing Waves

1. Have one partner make a **transverse wave** by shaking the slinky end up and down with an even rhythm, while the other partner holds their end fixed.

2. Try shaking with different **frequencies.** Do not shake very hard --- make small movements of your hand.

Can you find a frequency such that small movements of your hand make a large wave in the slinky?

This wave will look like it is standing still, with some parts of the slinky (the anti-nodes) moving a lot while others (the nodes) barely move. The special frequency you're shaking with is called a **resonant frequency** of your slinky.



How many anti-nodes does your standing wave have?

3. Can you find other frequencies that make different numbers of anti-nodes?

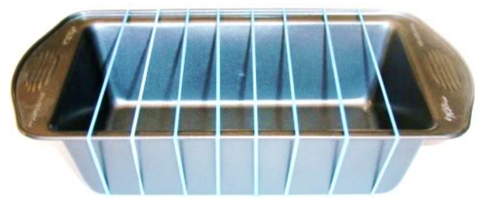
How many anti-nodes were you able to make?

4. If you pull the slinky tighter, do you have to shake with a higher or lower frequency to make a standing wave with one node in the middle?

When a string instrument (violin or guitar) makes a note, the string vibrates and makes a **standing wave** with certain resonant frequencies. The frequency of the vibrating string determines the frequency of the sound produced. We hear this as different pitches (high and low).

Rubber Band Guitars

1. Put several rubber bands of different thicknesses onto your box or can or cup so that the rubber band is stretched across the open end of the container.



2. Pluck the different rubber bands.

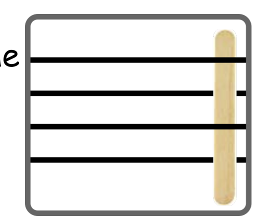
Do the thinner bands make a higher or lower pitched sound?

3. Based on what you learned with the slinky, make a prediction:

If you pull a rubber band tighter do you expect it to make a higher or lower pitch?

Try the experiment. Was your prediction correct?

This is how violin and guitar strings are tuned: by changing the tension!



4. Try inserting a craft stick through the bands towards one end of the container. This lets you make the strings shorter.

Do the shorter strings make higher or lower pitched sound?

Discuss: have any of you played a string instrument (or watched someone play)? How do they make a more high-pitched ? Why does that work?