

Flame Tube

https://www.youtube.com/embed/Zl-M4_jMCz0

This demo features our six foot Reuben's Tube, and is a very impressive demonstration on sound waves. this demonstration is a popular request, and is easily adapted to present to a variety of audiences.

Materials

- Flame Tube with hose
- Propane tank
- Speaker with amplifier
- Tone generator with cable
- Headphone jack cable
- Lighters (x2)
- Power strip
- Extension cord
- Optional: Keyboard with cable adapter

Safety Precautions

Read the fire safety section of the [Demonstration Safety](#) Page before performing this demonstration.

This demonstration requires: Safety Glasses

This demonstration is sensitive to wind, so do not use outdoors or in a breezy room. In order to present this demonstration, you will need two tables to set up.

Demonstration

Preparation

Set the Flame Tube on the first table, with both sets of feet resting on the same table. On the second table, set the speaker next to the Flame Tube, putting the speaker about half an inch away from the cellophane seal on the side of the tube, or as close as it can get without touching. Next to the speaker, place the amplifier and tone generator. Connect the tone generator cable to the amplifier using the back port labeled "Phono", and the audio cable in the "Aux" port. Put the switch for the ports in the "Phono" position. Make sure the main volume for the speaker is at zero, then plug in the amplifier and tone generator and turn them both on. Connect the propane tank to the flame tube, and before the start of the presentation open the propane tank fully. Attempt to ignite the holes on top of the propane tank once every minute, and once lit let it stand so the flames can grow.

Presentation

1. Explain briefly the setup you are using; A speaker system is set against the Flame Tube, and by turning on the speaker you will put a sound wave through the tube, which we will see as a Transverse wave in the fire. This is because of the sound compressing the propane gas inside the tube.
2. Set the tone generator to 210Hz, and turn up the speaker volume to 1/2 full. The flames will move, creating the wave!
3. Turn down the speaker volume, and name the parts of the wave: Peak (high point), Trough (low point), Node (mid point), Amplitude (height), Frequency (note heard), and Wavelength.
4. Ask the audience what will happen if we turn up the volume. Show that the amplitude increases, and therefore the amplitude is how loud a sound is.
5. Ask the audience to vote on this: If you doubled the frequency (or "went up an octave"), should we see more waves or less waves? After getting responses, set the tone generator to 420Hz and turn the volume up 1/2 full. The number of waves will double! What kind of relationship do frequency and wavelength have?
6. Flip the switch on the back of the amplifier to "Aux". Connect your phone or music player, and select a song to play for them! Songs that work well are:
 - Secrets (OneRepublic)
 - Let it Go (from Frozen)
 - Photograph (Ed Sheeran)
 - Fly Me to the Moon (Frank Sinatra)
 - Iron Man (Black Sabbath)
 - Stay the Night (Zedd, Haley Williams)
 - Bangarang (Skrillex)
 - NOTE: Use the two lighters to keep re-igniting the propane while you have a song playing. The music will put out flames as it plays. Only play 30-45 seconds of any

one song, so that you can play a few different songs

7. When you finish presenting the Flame Tube, turn off the propane tank and detach it. Place the speaker on its side, and prop the flame tube on it, with a set of feet resting on the speaker. Ignite the propane coming out of the lower end of the tube, and let it burn off until it is time to pack up.

Why This Works

This demonstration introduces Waves, which are a type of oscillation that accompanies an energy transfer. Sound Waves are Compression waves, which travel with an in-and-out motion through a medium. By using the flame tube, we are transforming the compression waves into transverse waves, so to make it easier to identify the different parts of the waves. When we look at the transverse wave we made with the flame tube, we can see that there are high points and low points. The Peak is the high point, and the Trough is the low point, with the mid point of the wave being called the Node. The height of a wave is the Amplitude, which is often shortened to amp. To make a wave taller or shorter, you have to adjust the volume, or amps. The distance from one peak to the next is the Wavelength, which with sound we can recognize it as a note. To change the note heard, you have to increase or decrease the wavelength. The Frequency of a wave is the inverse of the wavelength. A way to think of it is that the frequency is the number of waves per second. If you start at Center C on a piano and go up an octave, you are doubling the frequency of that note. Frequency and wavelength are inverse to each other, so when you double the frequency, you cut the wavelength in half! Likewise, if you cut the frequency in half, you would double the wavelength.

When we listen to music, we know that there are a lot of notes in the music working together or against each other. By playing a song through the Flame Tube, you can see how some notes work together, creating really high flames or easy-to-see waves. You can also see where the notes don't work together, when certain spots in the flame tube get really low flames, or get put out! When the notes are working together, we are seeing constructive interference, or interference that adds onto each other and amplifies. When the notes clash, we are seeing destructive interference, or interference that subtracts from each other and diminishes.

Additional Information

Try to avoid using the Flame Tube at the end of a show, and to not run the Flame Tube for any more than 25 minutes at a time. This is to minimize any fire hazard, and to allow time for the flame tube to empty after a presentation.

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