Sound and Resonance

Vanderbilt Student Volunteers for Science

2018-2019 VINSE/VSVS Rural

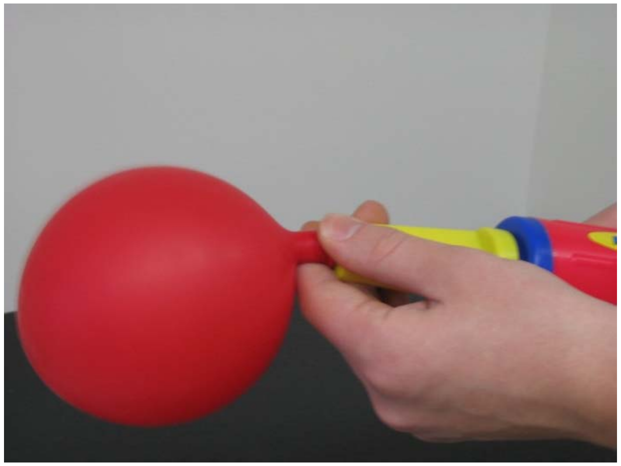
Training Presentation

Important!

- Please use this resource to reinforce your understanding of the lesson! Make sure you have read and understand the entire lesson prior to picking up the kit!
- We recommend that you work through the kit with your team prior to going into the classroom.
- This presentation does not contain the entire lesson—only selected experiments that may be difficult to visualize and/or understand.

I. How is sound produced?

- **<u>Pre-lesson set-up:</u>** Insert a hex nut into 16 balloons (or enough so each **<u>pair</u>** of students can share a balloon). Inflate the balloons using the pump and use the balloon clip to tie-off the balloon.
- Show the students how to make the hex nut start spinning (Hold the balloon with both hands and make a circular motion).
- What does the experiment tell us about sound?
  - Sound is produced by vibrations.
  - The faster the vibrations occur, the higher the pitch.

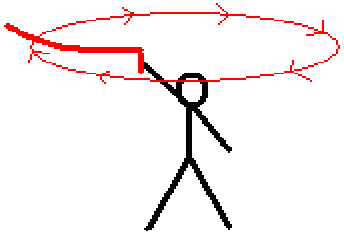


II. Sound Waves: Demonstration

- A. Demonstration
- Two VSVSers will hold the slinky so that there is no slack between the two ends.
  - For **longitudinal wave**:
    - have one volunteer pull several coils back, as if cocking a spring. Continue to hold both ends and release the compressed coils.
    - Tell the students that sound waves are ***longitudinal waves.***
  - For the **transverse wave:**
    - have one volunteer slowly move the slinky up and down (the other volunteer holds it steady.)
    - Light is ***transverse wave***

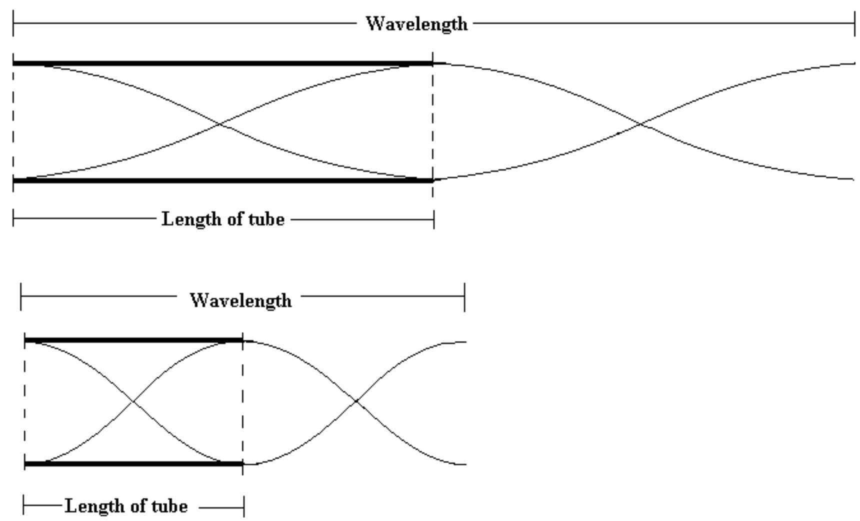
III. What is natural frequency?

- A. Demonstration
- Look to make sure you will not hit anything.
- Slowly twirl the longer tube so that a CONSTANT low pitch is heard.
  - Twirling the tube forces air up the tube.
  - The ridges in the tube make the tube and its air **vibrate**.
  - Since the tube always produces the same **pitch**, the **frequency** of the wave produced by the tube is always the same.
  - This frequency that the tube vibrates at is called its **natural frequency.**



III. What is natural frequency? (cont.)

- Show the students the second **shorter** tube, and repeat the demonstration.
- Explain that the two tubes have different **<u>NATURAL FREQUENCIES.</u>**
  - Each tube vibrates at its natural frequency. This natural frequency is determined by the **LENGTH** of the tube.
  - When the frequency of sound in the air matches the natural frequency of the tube, it gets reinforced many times so that the sound is magnified and can be heard above the rest of the sound mixture. This is called **<u>RESONANCE.</u>**
  - Resonance occurs when the wavelength “fits” the tube.
    - Information for VSVS members: The length of the tube is actually half the wavelength.

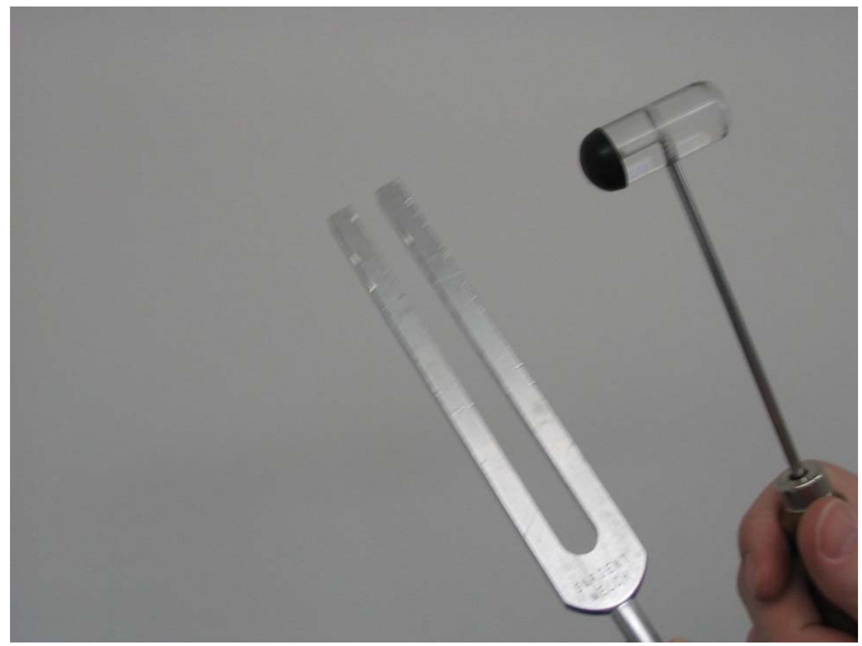


III. What is natural frequency? (cont.)

- **B. Student activity**
- Give each group one set of the plastic tubes.
- Tell each student to hold one of the tubes to an ear and listen.
- Then have pairs of students exchange tubes so that they can listen to a different length of tubing.
- Ask the students what they hear:
  - The pitch of the sound changes with the length of the tube.
  - The shorter tube produces a higher pitch.
  - The longer tube produces a lower pitch.
- Where does the sound come from?
  - The noise in a room is a mixture of different frequencies. These frequencies are heard as a low hum.

IV. How do tuning forks work?

- Each tuning fork is made to vibrate at **one frequency**, which is written on the fork. This frequency is its natural or resonant frequency.
- The number of times the tines vibrate in one second is called the **frequency**.
  - **Frequency** is directly related to **pitch**.
  - **The faster the vibrations occur, the higher the frequency and the higher the pitch.**



IV. How do tuning forks work? (cont.)

- Show the students how to hold the tuning fork at the **<u>handle</u>** and to hit the **<u>tines</u>** of the fork with the rubber side of the mallet so that the fork produces a sound.

- Show them that the sound is stopped as soon as the tines stop vibrating (do this by touching both tines).
- **<u>Caution the students NOT to hit the fork on any hard surface.</u>**

- Pass out the tuning fork that corresponds to the set of tubes that each group was given.

  <u>Set 0,2,4,6 needs the “A” tuning fork</u>

  <u>Set 1,3,5,7 needs the “G” tuning fork</u>

- Have ONE student in the group strike the tines of the fork with the rubber side of the mallet so that the fork produces a sound and have the rest of the group listen for the sound.

V. Finding the length of a tube at which resonance is heard

- Tell the students to do the following:
  - Place the set of tubes on the table in their numbered order.
  - Place the tines of the tuning fork at the opening of the shortest tube.
  - Hit the tuning fork to start it vibrating and listen for the resonance.
  - Move the tines to the opening of the next tube and repeat. Continue doing this until the resonant sound increases to its loudest level.
  - Continue moving the fork to the openings of the remaining longer tubes to show that the volume of the sound is no longer loud.
  - Record the number of the tube that gives the loudest resonance.
- The students should observe that:
  - Longer tubes are needed for the tuning fork with the lower frequency.
  - Shorter tubes are needed for the tuning fork with higher frequency.
  - The same length tube is needed for tuning forks with the same frequency.

VI. Play “Twinkle Twinkle Little Star”

- This can be done with just 3 VSVS members (each member will need 3 tubes), or as a class activity (have each student hold ONE tube).
- Each tube produces a note in the tune. One VSVS member can point to the numbers and tell the students to whack the tube on their thigh or hand (NOT THE TABLE).
- The tune is taped to the lid of the kit.

VII. Optional: Calculating the speed of sound

- Do this if you feel the class can do the math. Otherwise leave it for the teacher to do.
- The speed of sound in air at 68 degrees F is 344m/s (meters per second).
- The speed of sound can be calculated using the following formula:
  - **$v = f \times \lambda$**
  - Speed (**v**) = frequency (**f**) x wavelength (λ)
    - The speed can be calculated by using an **OPEN-ENDED** tube.
    - The frequency is obtained from the inscription on the tuning fork (or the Table).
    - The wavelength is found by measuring the length of the tube that the tuning fork resonates in and multiplying this by **2 .** This measurement must be converted to **METERS.**
- Tell the students to enter their measurements and observations on the observation sheet and to follow the steps to complete the calculation.