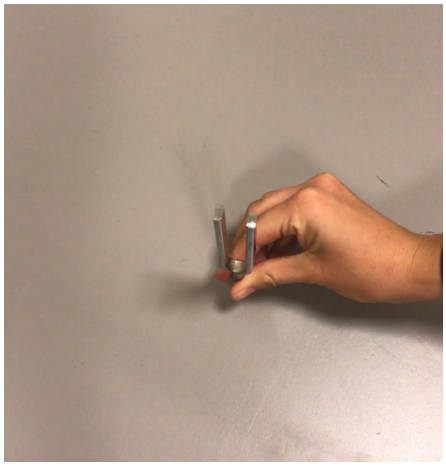
Tuning Fork Soundboard

Demonstration

Amplify the sound of a resonating tuning fork with your surroundings.



Number of Participants: Unlimited

Audience: Elementary (ages 5-10) and up

Duration: 5 -10 mins

Difficulty: Level 1

Materials Required:

- Tuning fork
- Rubber striker (for tuning forks)
- Local environment: desk, table, blackboard, or other large, hollow object

Setup:

1. Introduce a tuning fork to participants. Explain the concept of how sound waves are made. *Note: most tuning forks are not loud. Higher frequencies will tend to be perceived as louder by audience members.*
2. Illustrate how to use a tuning fork, if needed. Mention how the arms vibrate to make sound, at its resonance frequency, but also how the base of the fork moves up as well and can transfer energy.
3. Take the vibrating tuning fork and press it against a larger surface, such as a desk, wall, floor, really anything. Get creative. Ask participants if they think different materials will work as a soundboard. If possible, have audience members test different objects/materials around the room.

Presenter Brief:

Understand sound waves, acoustics, modes of vibration, and sympathetic vibrations. Know how to correctly use a tuning fork. Stress the concepts of resonance and sympathetic vibrations.

Vocabulary:

- mode – a system that is oscillating with simple harmonic motion at certain fixed frequencies
- acoustics – the study of sound and sound waves
- soundboard – a large area of vibrating material, typically amplifying sound.
- sympathetic vibrations – the vibrations of a large surface, set into motion by contact of vibrations from some other source.

- Longitudinal wave – a wave whose motion is parallel to its direction of propagation. Sound is a longitudinal wave.
- Energy transfer – when energy is moved from one form to another. Here the tuning fork's energy is transferred to the soundboard, causing it to vibrate.
- Resonance – the reinforcement of sound by the synchronous vibration of a neighboring object.

Physics & Explanation:

Elementary (ages 5-10):

The loudness of sound depends on the amount of air the sound moves. A tuning fork has one frequency it prefers to vibrate at, called its resonance frequency. It has arms, which vibrate very fast (hundreds of times a second) but do not move much air as it vibrates. It will vibrate a long time but not very loudly.

🔑 We hear the tuning fork by the small arms making small, repetitive pressure waves. The sound is soft because the arms are small and can only move a little air.

By pressing the base of the vibrating tuning fork against a larger surface, the large surface will vibrate as well, amplifying the sound, effectively making this surface a *soundboard* for the tuning fork. This is called sympathetic vibration. Note: because the larger surface is now vibrating as well, the sound will stop much more quickly because it's taking more energy to make a louder sound.

🔑 By pressing a vibrating tuning fork against a larger surface, the larger surface will vibrate as well, amplifying the sound.

Middle (ages 11-13) and general public:

Each tuning fork has a specific frequency it will resonate at, making a convenient standard for frequencies. What frequency it resonates at depends on the geometry and the length/thickness of the arms/base.

🔑 Tuning forks resonate at a distinct resonance frequency.

Each material has its own set of resonant frequencies it will vibrate at. When touching the larger surface with the tuning fork, the vibrations of the large surface create sympathetic vibrations. These vibrations do not need to occur at a frequency near a resonance of the large, flat object but they will amplify the sound because of the much larger surface moving the air.

As time allows, have participants experiment with different surfaces that do and do not sympathetically vibrate. For example, a concrete floor will not vibrate, as it is much too large to be moved by a small tuning fork.

Additional Resources:

- Rossing Moore & Wheeler *The Science of Sound* 2002. p. 33-34, 70-73.

- More on the science of soundboards
  https://physics.stackexchange.com/questions/100269/the-physics-of-sound-boards