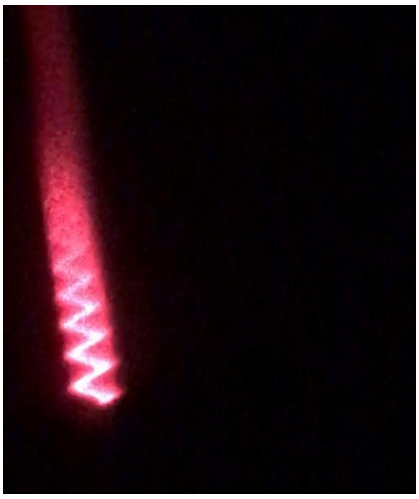
Tuning Fork Sine Waves with Lasers

Demonstration



Visualize waves and sound generation with a tuning fork and a laser.

Number of Participants: Unlimited

Audience: Middle (ages 11-13) and up

Duration: 5 -10 mins

Difficulty: Level 2

Materials Required:

- Tuning fork
- Laser
- Small mirror piece
- Hot Glue Gun
- Binder clip or tape
- Rubber mallet for tuning fork

Setup:

1. Gather all materials listed above.

Figure 1 Gathered materials for this demo.

2. Affix the small piece mirror to side of tuning fork using a small amount of hot glue. Using too much hot glue will result in poor mechanical stability. The reflective side should be pointing away from the tuning fork.

Figure 2 Mirror hot glued down to tuning fork.

Figure 3 Keeping the laser pointer on with a binder clip, hit the tuning fork to set into vibration, and move it up and down to observe the sine waves off the laser's reflection. Image will be on the wall to the right of this setup.

3. Turn on the laser pointer and keep it on using a binder clip, tape, or equivalent.

4. Reflect the laser off the tuning fork mirror. Slightly move the tuning fork up and down while vibrating to see sine wave created by the tuning fork on the opposite wall, as in Figure 3.

Presenter Brief:

Understand basic mechanics of longitudinal waves, sound waves, and simple harmonic motion.

Vocabulary:

- Sine (sinusoidal) wave – curve describing a smooth periodic oscillation.
- Longitudinal waves – waves that move parallel to their motion, such as sound waves.
- Resonance – synchronous vibration from a neighboring or touching object.

- Resonant frequency – the natural undamped frequency of an object, a frequency at which an object will strongly vibrate.

Physics & Explanation:

Middle (ages 11-13) and general public:

Tuning forks create sound waves by moving its prongs back and forth at a particular frequency, as seen in Figure 1.

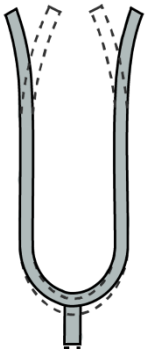


Figure 4 The principle mode of tuning fork vibration.

- A tuning fork's motion is too fast to see with the naked eye.

Although the vibration of a tuning fork is too fast to see with the naked eye, the vibrations can be tracked and visualized with a laser and a mirror. The mirror will resonate with the tuning fork, and you can track these oscillations by pointing a laser at the mirror and observing the reflected laser beam.

- A tuning fork's motion is rapid and sinusoidal in time.

Highschool and up (14+):

Our ears are very sensitive to frequency measurement tools. Human ears can pick up differences smaller than 0.1%, so each tuning fork frequency will sound distinct to us. Can we see the difference as well as hear it?

- Frequency can be heard as a single pitch, and seen as a clean sine wave.

  Try different tuning forks (in particular, use a low frequency and high frequency tuning fork) and make predictions with participants if the sine waves will be change in wavelength or amplitude.

Additional Resources:

- Rossing Moore & Wheeler *The Science of Sound* 2002. p. 33-34.
- Good visual demonstration (4:00-4:30) https://www.youtube.com/watch?v=vNuDxc9tZMk&t=245s
- Other possible setups http://demoweb.physics.ucla.edu/content/50-laser-sine-wave-tuning-fork