Destructive sound interference

FizziQ activity · High school · 45 min

Scan to open in FizziQ

Two smartphones emit a 680 Hz tone while a third maps zones of silence and reinforcement with the FizziQ sound meter, explaining active noise cancellation.

Learning objectives

- Observe and identify zones of constructive and destructive interference between two coherent sound sources
- Measure the spatial distribution of interference fringes and relate it to the wavelength
- Understand the relationship between wavelength, frequency, and the speed of sound
- Explain the operating principle of active noise cancellation technology
- Develop experimental skills in acoustic measurement using smartphone sensors

Instruments and sensors

Synthesizer (sound source generator) · Sound level meter · Microphone

Materials

- Three smartphones with the FizziQ application (two used as sound sources via the Synthesizer, one as the sound level meter)
- A quiet space with few echoes
- A tape measure to measure distances
- FizziQ experiment notebook
- Note: the protocol remains adaptable to any comparable sound level measurement tool.

Protocol

1. Open the FizziQ application on all three smartphones. On two of them, go to the Synthesizer tool and set the frequency to exactly 680 Hz on both devices.
2. Place the two emitter smartphones on a flat surface, approximately 50 cm apart, with their speakers facing upward. Ensure they are at the same height.
3. On the third smartphone (the measuring device), open FizziQ and select the Sound Level (dB) sensor from the measurement tools.
4. Start the sound emission on both smartphones simultaneously. Verify that both are producing a steady 680 Hz tone.
5. Hold the measuring smartphone at the same height as the speakers, midway between the two sources. Record the initial sound level reading.
6. Slowly move the measuring smartphone along the line connecting the two sources, pausing every 2 cm to record the sound level.
7. Note the positions where the sound level is maximum (constructive interference) and where it is minimum (destructive interference).
8. Measure the distance between two consecutive minima. This distance should be approximately equal to half the wavelength (about 25 cm for 680 Hz).
9. Record at least 10 measurements at different positions between the two sources in your FizziQ experiment notebook.
10. Now move the measuring smartphone perpendicular to the line connecting the sources, starting from the

midpoint. Observe how the interference pattern changes.

11. Try changing the frequency to 440 Hz on both emitters and repeat the measurements. Compare the spacing of the interference fringes.
12. Record all your data and create a graph of sound level versus position in your FizziQ notebook.

Expected results

Students should observe clear alternation between zones of high sound intensity (constructive interference, where the sound level approaches the sum of both sources) and zones of low intensity (destructive interference, where the sound level drops significantly, potentially by 10-20 dB). The distance between consecutive minima should be approximately 25 cm for 680 Hz, corresponding to half the wavelength. When the frequency is changed to 440 Hz, the spacing between fringes should increase to about 39 cm. The interference pattern will not be perfectly regular due to reflections from walls and furniture, background noise, and slight differences between the two smartphone speakers. Students should expect measurement noise of ±2-3 dB and may find that the minima are not as deep as theoretically predicted.

Questions

- Why does the distance between interference fringes change when you modify the frequency of the emitted sound?
- What would happen if the two sources emitted slightly different frequencies instead of identical ones?
- Why are noise-canceling headphones more effective against low-frequency sounds than high-frequency ones?
- How does the interference pattern change if you increase the distance between the two sources?
- What role does the speed of sound play in determining the interference pattern?
- Why is perfect destructive interference difficult to achieve in a real room environment?

Going further

- Use different frequencies (340 Hz, 1000 Hz, 1500 Hz) to observe how the fringe spacing varies with wavelength
- Perform the experiment outdoors to reduce wall reflections and obtain cleaner interference patterns
- Add a third sound source and observe the more complex interference pattern that emerges
- Use the FizziQ oscilloscope mode to visualize the waveform at constructive and destructive interference points
- Compare the results with a theoretical calculation of the expected fringe positions