

WAVES, SOUND & PHYSICAL OPTICS DAY 9: AIR COLUMNS, SOUND, AND BEATS

CED 14.6 · Skill 2.B · FRQ: Multiple Representations

PREDICT

Two tuning forks with slightly different frequencies sound together. You hear:

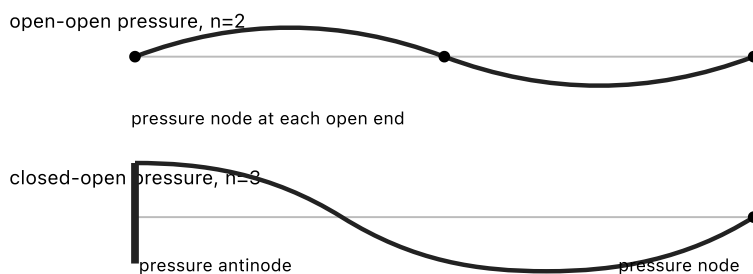
A. a periodic loud-soft wobble B. one perfectly steady tone C. silence D. a steadily rising pitch

Commit before the tones or trace are revealed.

SOUND IN AIR

Sound is a longitudinal pressure wave. Near room temperature, use $v_{\text{sound}} = 343 \text{ m/s}$.

NOTES / REASONING

OPEN AND CLOSED PIPES**PRESSURE PATTERNS AND END CONDITIONS****Open at both ends**

$$f_n = nv/(2L), \text{ with } n = 1, 2, 3, \dots$$

Closed at one end

$$f_n = nv/(4L), \text{ with } n = 1, 3, 5, \dots$$

For pressure drawings: open end = node; closed end = antinode.

NOTES / REASONING

CALCULATE THE HARMONICS

1. An open pipe has $L = 0.700 \text{ m}$. Find f_1 and f_3 .

2. A closed pipe has $L = 0.490 \text{ m}$. Find the first and second allowed resonances. State their harmonic labels.

The second resonance of a closed pipe is labeled $n = 3$, not $n = 2$.

BEATS AND REPRESENTATION CHECK

$$f_b = |f_1 - f_2|$$

1. Find the beat frequency for 438 Hz and 444 Hz.

2. A spectrum has peaks at 175, 525, and 875 Hz. Explain why it is consistent with one closed pipe.

3. Sketch the pressure pattern for the $n = 1$ closed pipe and mark both end conditions.

4. Explain why the fast oscillation and slow beat envelope represent different frequencies.