Chasing Sound Waves

Model how motion changes the pitch a listener hears

PS.2.d "Use models to illustrate the Doppler effect and explain the changes in sound perception associated with it."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentences that explain wavefront spacing, and circle the words that describe pitch. Number the two ways motion can change how often wavefronts reach a listener.

Why a Siren Changes Pitch

1. A city ambulance travels down a straight street with its siren sounding steadily. A person on the sidewalk hears a higher pitch as the ambulance approaches and a lower pitch after it passes. Pitch depends on how many sound wavefronts reach an ear each second. Each wavefront is a region of compressed air moving outward from the siren. The siren does not need to change its own note to produce this shift. Motion changes how often the wavefronts arrive. This change in perceived frequency due to motion between a sound source and a listener is called the Doppler effect.

2. Imagine marking each new wavefront as a ring around the siren at the instant it is made. While the ambulance moves forward, each later ring starts farther down the street. In front of the moving siren, neighboring rings are closer together. A listener there receives more wavefronts each second and hears a higher pitch. Behind it, the rings are farther apart, so a listener receives fewer wavefronts each second and hears a lower pitch. In still air, the speed of sound is not higher in front and lower behind. The spacing and arrival rate, not a change in sound speed, explain the difference.

3. The listener can move instead. Picture a person jogging toward a fixed outdoor speaker that produces one continuous note. The speaker sends out wavefronts with even spacing in the air. Because the jogger moves toward the incoming fronts, more of them reach the jogger each second than would reach a person standing still. The jogger hears a higher pitch even though the spacing in the air has not changed. If the jogger turns and moves away, fewer fronts reach each second, and the pitch sounds lower. In either case, the motion affects what the listener hears, not the note the speaker makes.

2 ANSWER WITH EVIDENCE

Use the passage

1. A delivery van drives toward a person while its alarm sounds steadily. In a model of the sound waves, how would you space the wavefronts between the van and the person? What pitch would the person hear?

2. A train sounding a steady horn has just passed a person. Use a wavefront model to explain the pitch the person now hears. Does the speed of sound in still air need to change?

3. A tractor with a steady engine sound moves between two people, one ahead of it and one behind it. How would the wavefront spacing and heard pitch differ for the two people?

4. A person walks away from a fixed air conditioner that hums steadily. Compared with standing still, how often does the person meet its wavefronts, and what happens to the heard pitch?

3 YOUR TURN

Your own words

Make two labeled sketches using sound sources you choose: one with a moving source and a stationary listener, and one with a stationary source and a moving listener. Show motion with arrows, show wavefront spacing, label the pitch each listener hears, and write one sentence comparing why the pitches change.

ANSWER KEY

Chasing Sound Waves

HIGH SCHOOL · PS.2.d

PART 1 · READ AND MARK

Underline the sentences that explain wavefront spacing, and circle the words that describe pitch. Number the two ways motion can change how often wavefronts reach a listener. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	A delivery van drives toward a person while its alarm sounds steadily. In a model of the sound waves, how would you space the wavefronts between the van and the person? What pitch would the person hear?	**Draw wavefronts closer together in front of the van. More fronts arrive each second, so the person hears a higher pitch.**
2	A train sounding a steady horn has just passed a person. Use a wavefront model to explain the pitch the person now hears. Does the speed of sound in still air need to change?	**Behind the train, wavefronts are farther apart and arrive less often, so the person hears a lower pitch. The speed of sound in still air does not need to change.**
3	A tractor with a steady engine sound moves between two people, one ahead of it and one behind it. How would the wavefront spacing and heard pitch differ for the two people?	**Wavefronts are closer together ahead of the tractor, where the pitch sounds higher. They are farther apart behind it, where the pitch sounds lower.**
4	A person walks away from a fixed air conditioner that hums steadily. Compared with standing still, how often does the person meet its wavefronts, and what happens to the heard pitch?	**The person meets fewer wavefronts each second and hears a lower pitch.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1: A lawn mower moves toward a stationary listener; arrows show its motion, and wavefronts are drawn closer together in front of it. The listener hears a higher pitch. Panel 2: A listener rides toward a fixed buzzing transformer; an arrow shows the listener's motion, and wavefronts stay evenly spaced. This listener also hears a higher pitch. In both cases, more wavefronts reach the listener each second, but only the moving source compresses their spacing in the air.

Accept any steady sound source and correctly labeled motion. For a moving listener, wavefront spacing in the air remains even; for a moving source, spacing changes ahead of and behind it.