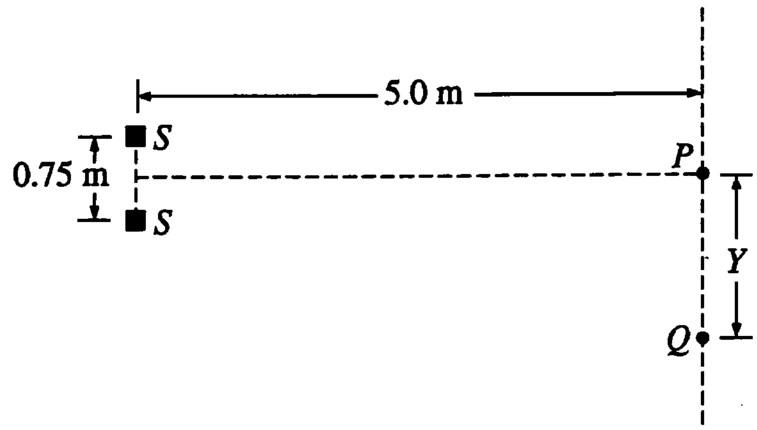
AP® Physics B (Operational)
2004 Sample Student Responses



Note: Figure not drawn to scale.

4. (15 points)

Two small speakers S are positioned a distance of 0.75 m from each other, as shown in the diagram above. The two speakers are each emitting a constant 2500 Hz tone, and the sound waves from the speakers are in phase with each other. A student is standing at point P, which is a distance of 5.0 m from the midpoint between the speakers, and hears a maximum as expected. Assume that reflections from nearby objects are negligible. Use 343 m/s for the speed of sound.

(a) Calculate the wavelength of these sound waves.

$v = f\lambda$

$343\text{ m/s} = (2500\text{ Hz})\lambda$

$[\lambda = .1372\text{ m}]$

(b) The student moves a distance Y to point Q and notices that the sound intensity has decreased to a minimum. Calculate the shortest distance the student could have moved to hear this minimum.

$x_m \approx \frac{m\lambda L}{d}$

$Y \approx \frac{\frac{1}{2}(.1372)(5\text{ m})}{.75\text{ m}}$

$[Y \approx .4573\text{ m}]$

A2

(c) Identify another location on the line that passes through P and Q where the student could stand in order to observe a minimum. Justify your answer.

$$Y \approx \frac{\frac{3}{2}(.1372)(5m)}{.75m}$$

$$[Y \approx 1.372m]$$

(d)

i. How would your answer to (b) change if the two speakers were moved closer together? Justify your answer.

The distance (y) would be greater; $y \propto \frac{1}{d}$

ii. How would your answer to (b) change if the frequency emitted by the two speakers was increased? Justify your answer.

The distance (y) would be less; $y \propto \lambda \propto \frac{1}{f}$

Y is directly proportional to wavelength which is inversely related to frequency.

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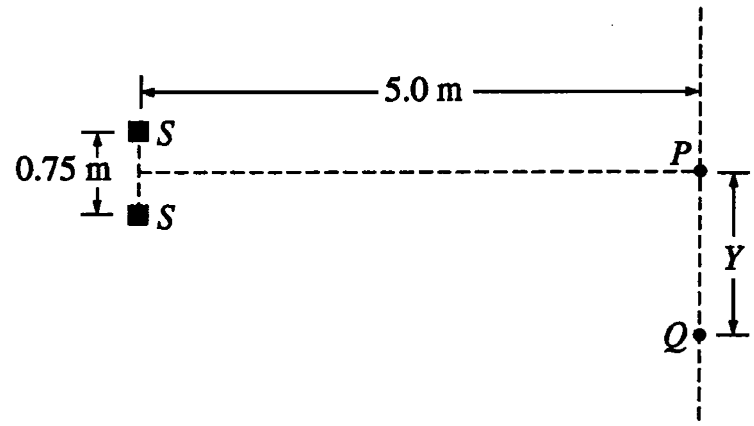
B1



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Two small speakers S are positioned a distance of 0.75 m from each other, as shown in the diagram above. The two speakers are each emitting a constant 2500 Hz tone, and the sound waves from the speakers are in phase with each other. A student is standing at point P, which is a distance of 5.0 m from the midpoint between the speakers, and hears a maximum as expected. Assume that reflections from nearby objects are negligible. Use 343 m/s for the speed of sound.

(a) Calculate the wavelength of these sound waves.

$\lambda = v/f = \frac{343 \text{ m/sec}}{2500 \text{ Hz}} = .1372 \text{ m}$

(b) The student moves a distance Y to point Q and notices that the sound minimum. Calculate the shortest distance the student could have moved to hear this minimum.

$x_m \approx \frac{m \lambda L}{d} = \frac{.1372 \text{ m} \cdot 5.0 \text{ m}}{.75 \text{ m}} = .915 \text{ meters}$

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(c) Identify another location on the line that passes through P and Q where the student could stand in order to observe a minimum. Justify your answer.

That location could be the point S on line PQ where S is y distance away from P, because here the sound patterns are symmetric, with P being a maximum. In other words, .915 meters above P on line PQ

(d)

i. How would your answer to (b) change if the two speakers were moved closer together? Justify your answer.

The two speakers would no longer be in phase with one another and since $x_m \approx \frac{m\lambda L}{d}$, if d decreased, then x_m would increase. The necessary distance to go to find a minimum would be more than .915 meters

ii. How would your answer to (b) change if the frequency emitted by the two speakers was increased? Justify your answer.

If the frequency increased then the wavelength would decrease, because $\lambda = v/f$. So, if λ decreases, the minimum distance to go to be at a minimum sound intensity would decrease, because $x_m \approx \frac{m\lambda L}{d}$

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