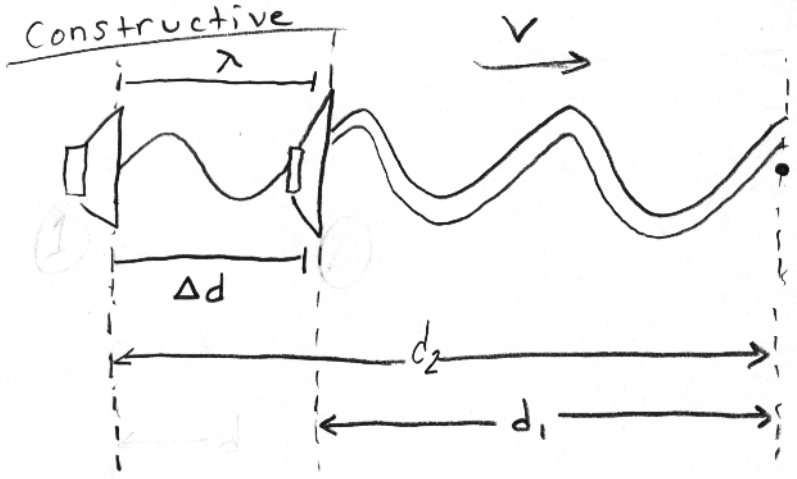
Interference from 2 sources

- Waves can pass through each other.
- waves interfere as the sum of the amplitudes.
  - in phase  constructive
  - out of phase  destructive

Constructive

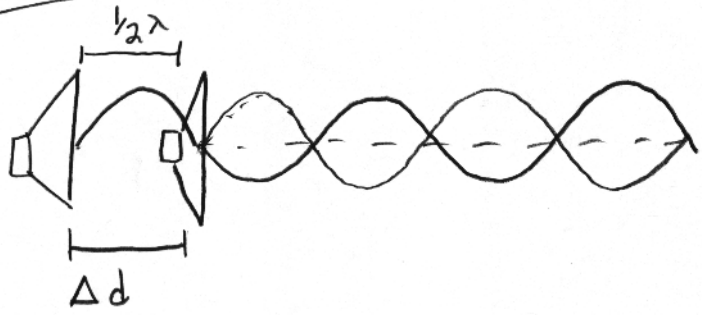


In phase!

when $\Delta d = \lambda, 2\lambda, 3\lambda \ldots$

Δd - path length difference

Destructive

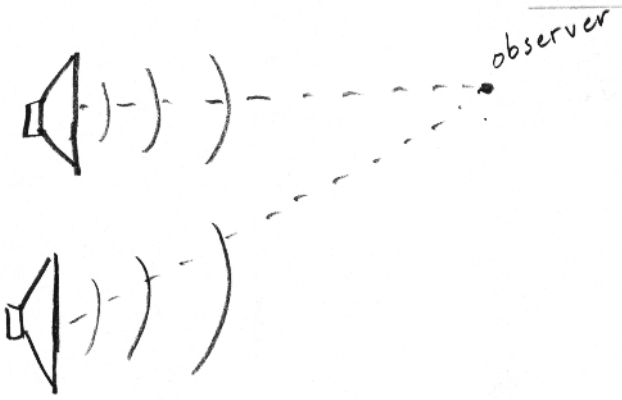


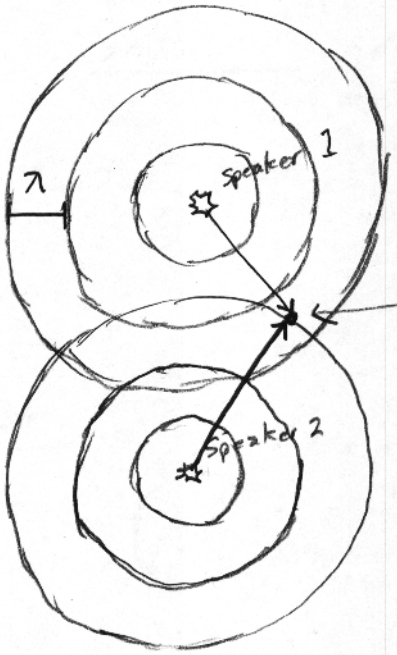
out of phase!

when Δd is $\frac{1}{2}\lambda$

In phase	out of phase
$\Delta d = n\lambda$	$\Delta d = \left(n + \frac{1}{2}\right)\lambda$

overlapping spherical sound waves





$r_1 = \frac{5}{2}\lambda$

$r_2 = 3\lambda$

$\Delta r = r_2 - r_1 = \frac{1}{2}\lambda$

constructive occurs when

$\Delta r = n\lambda$

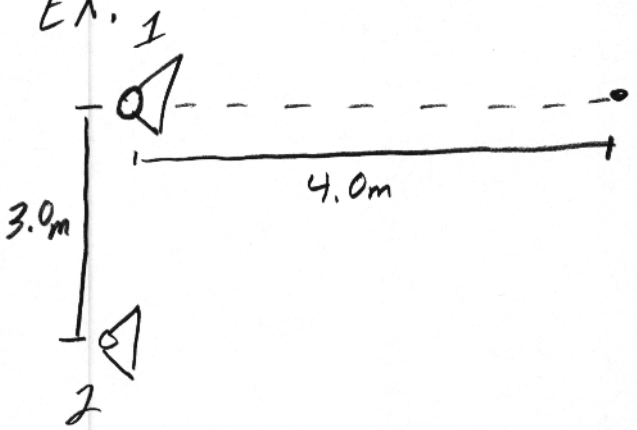
Destructive occurs when

$\Delta r = \left(n + \frac{1}{2}\right)\lambda$

How to solve

1) Identify the path length from each source.
2) Find path length difference. $\boxed{\Delta r = r_2 - r_1}$
3) Find wavelength (λ)
4) If path-length difference is a whole number of wavelengths its constructive
5) If Δr is $\frac{1}{2}$ plus a whole wavelength (destructive)

EX:



$f = 170\,Hz$

$T = 20°C$

Will the observer be in a loud or quiet spot?

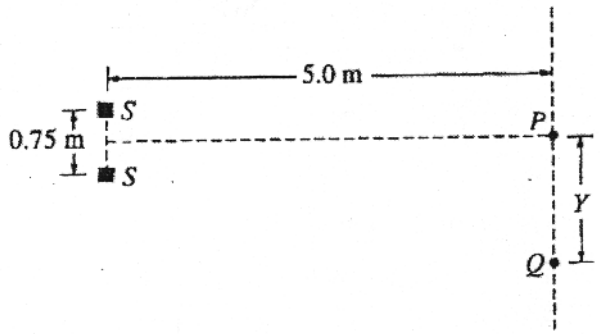
Beats

- Occur when sound waves of different frequencies alternate between constructive and destructive interfernce.
  - Sound goes up and down in volume.

$$f_{beat} = |f_1 - f_2|$$

$$f_{beat} = |440Hz - 438Hz| = 2\,Hz$$

2 beats per second



Note: Figure not drawn to scale.

2004B4 (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.

(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.

(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.

(d)

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

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