Answer #334

The answer is (b): the sound will slowly become much louder as the speakers separate, as heard in an mpeg video by clicking your mouse on the photograph below.

Note that when the video begins the two speakers are in phase. The reversing switch is flipped, making the two speakers out of phase and thus reducing the sound level picked up at the microphone. With the phase of one speaker reversed, the speakers are then separated.

There is a spatial as well as a temporal effect on the sound from stereo speakers. As the speakers are separated, the distance between each speaker and your ears is no longer exactly one-half wavelength, so the waves from the two speakers are no longer exactly out of phase. The phase difference between the waves from the two speakers at your ears (or the microphone) becomes monotonically less than 180^{o}, closer to being *in phase*. Therefore, the sound becomes monotonically louder as the two speakers are separated.

In fact, if you spearate the two speakers so that their distance from the microphone is the same, they should be exactly out of phase and their waves should exactly cancel. This clearly does not happen, because there are lots of standing waves in the lecture hall that fill up the hall with random phases of the 100 Hz sound.

If you listen carefully, it does appear that there is a slight maximum in the sound picked up by the microphone when the moving speaker is directly in front of the microphone, which would be the condition for maximum sound in the absence of any nearby reflecting surfaces.

Here is the extra credit question: Suppose that the second speaker has now moved away from the first speaker with the switch in the "REVERSE" (out of phase) position. Without changing the position of the speaker I will now flip the switch back to the "NORMAL" (in phase) position. What will happen to the sound?

With the speakers separated, when the switch is flipped back to its "NORMAL" position the sound will:

- (a) become considerably louder.
- (b) become considerably softer.

- (c) remain at about the same loudness.

The answer can be heard in a video by clicking your moue on the photograph below. (Click after deciding on an answer.)

Note that the two sources are not necessarily out of phase with each other or in phase with each other either when the switch is in the "in phase" or the "out of phase" position. Therefore the amplitude of the sound will be somewhere between the maximum and the minimum, dependent on the exact phase difference between the two signals. This is relatively difficult to determine and to hear due to the issues discussed above, so they will typically sound about the same intensity. Exact comparison of the intensities of the two sum waves depends on the details of the room acoustics; here the sum wave is, surprisingly, a bit louder when the speakers are out of phase!!

Click here to hear the complete sequence of sounds for the entire demonstration. Note that some "dead spots" have been removed by editing the video, so the operator seems to move very rapidly at those times.

Question of the Week

Outreach Index Page

Lecture-Demonstration Home Page

For questions and comments regarding the *Question of the Week* contact
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