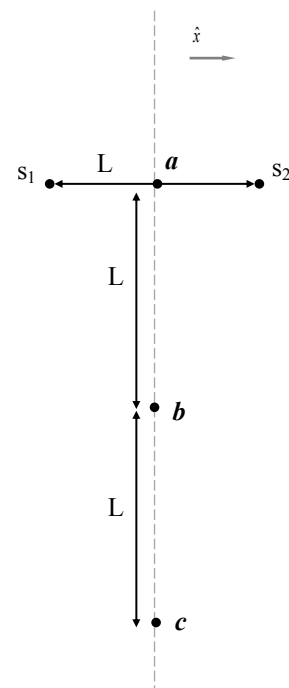


KC's Quantitative Problems

Energy & Intensity

- *Waves-Oscillations.Energy-Intensity.QP.KC.1:* According to US government regulations, the maximum sound intensity level in the workplace is 90.0 dB. Within one factory, 32 identical machines produce a sound intensity level of 92.0 dB. How many machines must be removed to bring the factory into compliance with the regulation?
- *Waves-Oscillations.Energy-Intensity.QP.KC.2:* A glass window is installed in a window space and the intensity level of the sound entering through the window is reduced from 72 dB to 47 dB. What is the factor, by which the acoustic power entering the chamber is reduced by the glass window?
- *Waves-Oscillations.Energy-Intensity.QP.KC.3:* An array of 10 speakers is blaring sound and at your location the decibel level is 99 dB. (a) If you assume your eardrum is a round disk of radius 4 mm, how many hours must the sound be playing for your eardrum to absorb 1.0 J of energy? (b) If you move 3 times as far away and 3 of the speakers turn off, what will be the new sound intensity level?
- *Waves-Oscillations.Energy-Intensity.QP.KC.4:* The sound level intensity is found to be 60 dB at some location. If the power of the source increases by a factor of 4, by what percent will the dB level change?
- *Waves-Oscillations.Energy-Intensity.QP.KC.5:* Supposed that sound is emitted uniformly in all directions by a public address system. The intensity at a location 22 m away from the sound source is $3.0 \times 10^{-4} \text{ W/m}^2$. What is the (a) intensity and (b) sound intensity level at a spot that is 78 m away? (c) At the closer distance, 22 m away, how long would it take to increase the temperature of a mug of coffee 80 °C? Assume the following: all the sound energy is transferred to thermal energy in the coffee, the mug is perfectly insulated, the cross-sectional area of your mug is a square of side length 4 cm, and your mug holds a quarter of a liter of coffee (water mostly).
- *Waves-Oscillations.Energy-Intensity.QP.KC.6:* You're convinced the opera is almost over because of the large women singing a loud vibrato. (a) If the sound intensity level (dB) increases from one note to the next by 1 dB, what is the percent increase in the intensity? The singer comes over to your side of the stage, only 10 m away, and your phone applet tells you the sound intensity level is 85 dB. (b) What is the power coming from her voice? All of the sudden 4 more identically loud women come out of nowhere and join her - you think to yourself, will it ever end. Three of them are standing next to her and the fourth is on the other side of the stage, twice as far from you as the group of singers. (c) What is the sound intensity level now?

- *Waves-Oscillations.Energy-Intensity.QP.KC.7:* Carl and Lenny are trying to find Carl's lost keys - he attached a device to beep when you whistle for just this purpose. The line connecting Carl and the keys is perpendicular to the line connecting Lenny and the keys. Carl is 4 m away from the keys. If the sound intensity at Lenny's location is two thirds as large as at Carl's, (a) how far away is Lenny from the key's and (b) how far away is Lenny from Carl?
- *Waves-Oscillations.Energy-Intensity.QP.KC.8:* A sound engineer is testing a bank of speakers for loudness. Initially the sound level meter reads 88 dB when one of the speakers is on. The engineer walks to a distance three times as far and instructs the crew to turn on four more speakers. What will the sound level meter read now?
- *Waves-Oscillations.Energy-Intensity.QP.KC.9:* A salesperson claimed that a stereo system had a maximum audio power of 120 W. Testing the system with several speakers set up so as to simulate a point source, the consumer noted that she could get as close as 1.2 m with the volume full on before sound hurt her ears (120 dB). Should she report the firm to the Consumer Product Safety Commission?
- *Waves-Oscillations.Energy-Intensity.QP.KC.10:* Two boys are whispering in the library. The radiated sound power from one boy's mouth is 1.2×10^{-9} W and it spreads out uniformly in all directions. (a) What is the minimum distance the boys must be away from the librarian so that she will not be able to hear them? The librarian is onto the boys talking and she closes in on them, cutting the distance found in part (a) in half. Even worse, the number of boys has tripled. What will be the sound intensity level at the librarian's new location?
- *Waves-Oscillations.Energy-Intensity.QP.KC.11:* In what can be described only as a strange physics nightmare you find yourself in an open field halfway between two identical speakers (point **a**) that themselves are separated by 10 m, as shown in the figure. The speakers are chanting "The white zone is for loading and unloading only," and the average sound intensity level is obnoxiously high at 110 dB. (a) What is the average power of one of the speakers? (b) What is the average sound intensity at point **b**? (c) What is the average sound intensity level at point **c**? (d) Find an equation for the average sound intensity level as a function **x** only, where **x** equals the distance from point **a**, along a line between the two speakers.



- *Waves-Oscillations.Energy-Intensity.QP.KC.12:* The howler monkey is the loudest land animal and can be heard up to a distance of 2.5 km. Assume the acoustic output of a howler to be uniform in all directions. If a monkey is screaming for 3 seconds, then is quiet for 2 more seconds, and then continues to repeat this pattern. (a) How much sound energy have they produced in 5 mins? (b) Is that the same amount of energy the monkey needed to consume (*jelly donuts*) to do the howling? Explain your reasoning. (c) If the monkey was a distance of 10 m away, what would the sound intensity level be?
- *Waves-Oscillations.Energy-Intensity.QP.KC.12:* The radius of a typical human eardrum is about 4.00 mm. Find the energy incident on the eardrum over a period of an hour when it listens to sound that is (a) at the threshold of hearing and (b) at the threshold of pain.