ConcepTest 16.4a Sound Intensity I

You stand a certain distance away from a speaker and you hear a certain intensity of sound. If you double your distance from the speaker, what happens to the sound intensity at your new position?

1) drops to 1/2 its original value
2) drops to 1/4 its original value
3) drops to 1/8 its original value
4) drops to 1/16 its original value
5) does not change at all

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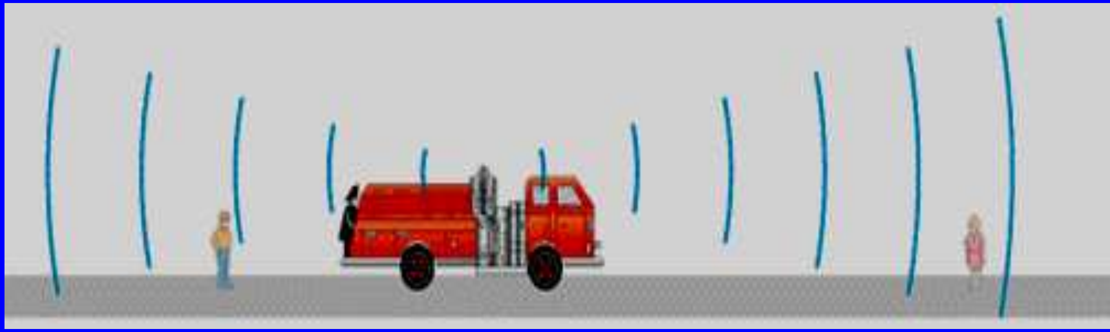
For a source of a given power P, the intensity is given by $I = P/4\pi r^2$. So if the **distance doubles**, the intensity must **decrease to one-quarter** its original value.

Follow-up: What distance would reduce the intensity by a factor of 100?

ConcepTest 16.4b Sound Intensity II

You hear a fire truck with a certain intensity, and you are about **1 mile** away. Another person hears the same fire truck with an intensity that is about **10 times less**. Roughly, how far is the other person from the fire truck?

1) about the same distance
2) about 3 miles
3) about 10 miles
4) about 30 miles
5) about 100 miles



ConcepTest 16.4b Sound Intensity II

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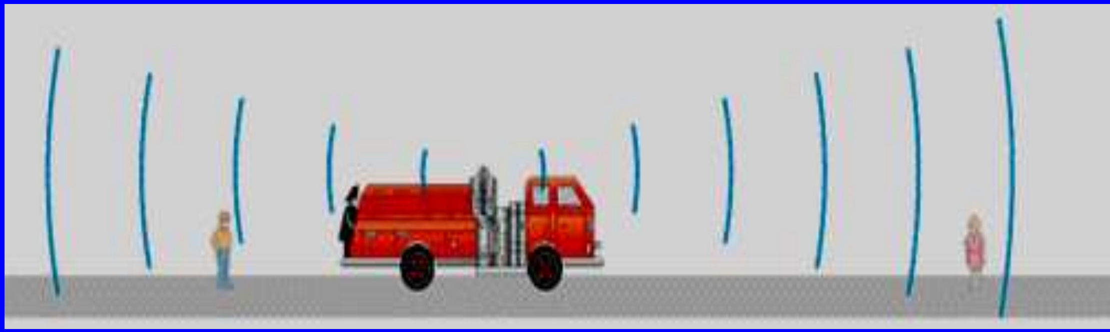
1) about the same distance
2) about 3 miles
3) about 10 miles
4) about 30 miles
5) about 100 miles

Remember that intensity drops with the inverse square of the distance, so if intensity drops by a factor of 10, the other person must be $\sqrt{10}$ farther away, which is about a factor of 3.



$$\frac{I_2}{I_1} = \frac{P/4\pi r_2^2}{P/4\pi r_1^2} = \frac{r_1^2}{r_2^2}$$

ConcepTest 16.5a Decibel Level I

When Mary talks, she creates an intensity level of 60 dB at your location. Alice talks with the same volume, also giving 60 dB at your location. If both Mary and Alice talk simultaneously from the same spot, what would be the new intensity level that you hear?

1) more than 120 dB
2) 120 dB
3) between 60 dB and 120 dB
4) 60 dB
5) less than 60 dB

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Recall that a difference of 10 dB in intensity level β corresponds to a factor of 10^1 in intensity. Similarly, a difference of 60 dB in β corresponds to a factor of 10^6 in intensity!! In this case, with two voices adding up, the intensity increases by only a factor of 2, meaning that the intensity level is higher by an amount equal to: $\Delta\beta = 10 \log(2) = 3$ dB. The new intensity level is $\beta = 63$ dB.

ConcepTest 16.5b Decibel Level II

A quiet radio has an intensity level of about 40 dB. Busy street traffic has a level of about 70 dB. How much greater is the intensity of the street traffic compared to the radio?

1) about the same
2) about 10 times
3) about 100 times
4) about 1000 times
5) about 10,000 times

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5) about 10,000 times

increase by 10 dB ⇒⇒ increase intensity by factor of 10^1 (10)

increase by 20 dB ⇒⇒ increase intensity by factor of 10^2 (100)

increase by 30 dB ⇒⇒ increase intensity by factor of 10^3 (1000)

Follow-up: What decibel level gives an intensity a million times greater?

ConcepTest 16.5c Decibel Level III

Intensity level is given by β = 10 log(I/I_0) with $I_0 = 10^{-12}$ W/m^2. The usual threshold of human hearing is defined as intensity level of β = 0 dB. What does this actually mean in terms of sound intensity?

1) intensity is undefined at that level
2) intensity is 10^0 W/m^2
3) intensity is 0.0 W/m^2
4) intensity is 10^{-12} W/m^2
5) intensity is 1.0 W/m^2

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In order for β to be equal to zero, the term log(I/I_0) must also be zero. This occurs when the argument is 1.0, because log(1.0) = 0. In other words, the value of I must be equal to I_0.