HEARING AID ACADEMY

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VIDEO COURSE TRANSCRIPT
MODULE-4 | VIDEO-6

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This part of this lesson is a total gear switch. We are now gonna deal with algorithms, math and everything it takes to begin to understand sound and their relationships.

We are going to now begin to develop our understanding of what we call sound. Each of the aspects linked to sound are related in some way to one another, as the definition of sound is built such as,

- Inverse Square Law
- Pressure
- Mechanical Waves
- Intensity
- Decibels
- Loudness

Alright, now, let's take just a second in sort to get a grip of some of these elements that are linked to sound.

Inverse Square law, that may sound a little bit complicated and a little bit mathematical, but we already have a sense of it, some qualitative conceptual sense of it, that helps us to understand such phenomenon in everyday life.

The sense of it is, that the further away the sound, is the fainter it is. Basically, this law just allows us to pinpoint mathematically why that happens, and it happens, as it turns out, in a very orderly fashion. It happens in a way that gives legs to this concept that we have.

Pressure, when we first started talking about this subject you may felt under pressure to learn new things. Well, that is not exactly the pressure we are talking about. The medium that we are the most concerned with is air, and you will find that air is really pretty uniform. Its randomness occurs when it comes to sound.

Mechanical waves. We are going to talk about waves and what they mean, and in doing that, we are going to have to include the sine-wave.

We are going to talk about amplitudes.

We are going to talk about how intense, for example, a sound would have to be in order for us to learn how to measure.

We are going to talk about decibels. Decibels are simply relationships from one sound to another, from a threshold sound, or at a beginning level compared to another level, and the means that we use.

The last concept that we are going to talk about is the concept of loudness.

Something may be warm to me, but neutral to you. Something may be freezing to me, but warm to an Eskimo. You may put your backpack next to the fire and go, "Uh, this feel so good". If Julie is right beside you, she may say, "I am burning up".

So, we are back to the objective, subjective relationship when we deal with loudness. You will find that there are ways that we measure loudness in this section, even though it subjective.

So, all of these are related, and we are going to take them one by one right now. Okay, we are going to define this, now.

Sound, is used to mean sound which can be perceived by the human ear. Sound refers to an audible sound, unless otherwise indicated. Now, here's what has may be tough about this.

Plenty of people have, maybe had, a little bit too much to drink; and come up with that question. If a tree falls in the forest, and if nobody is there to hear it, is it still a sound? Well, the answer is for our intent no. No sound? You may think there is a thunderous crash, but if there is nobody there to see it, it doesn't apply the definition that we are going to build out for the definition of sound.

So, just keep in mind, that if there not an audible sound and there is no ear to hear it, it is not sound. So, what is it?

Well, the standard definition is that it is a pressure wave. That it has a frequency between 20 Hz, which is the lowest level of human hearing capacity, and about 20,000 Hz, which is the highest level of human capacity, and with an intensity above the standard threshold of hearing.

We know that when we hear something, our ears are surrounded with air or it could be with water. But, what we know, is the sound waves are constrained or limited to be longitudinal waves.

We are going to get into detail about that, in a second. Normal ranges for sound pressure and sound intensity may also be specified. Sound has a certain power at the origin of its source. It radiates out into the space, where we receive it with our ears. It declines in this power, as a function of time, due to how it radiates in space.

For example, here is the source of the power with is denoted by capital P. The area immediately surrounding the source of this power is this link right here, to this point on the circle right there, but yet it goes outward.

Know that the intensity at the surface is, basically, right here. It's expanded, not to confuse you, but to allow you to see how we project it on to the area around the sphere, and it's now a circle. It's a sphere. It's a perfectly round balloon which is suitable for the purpose of this explanation.

So, when it is right at this point, this sphere, this sound, hits like this, and spreads over a certain area. This area is the power which is divided by the intensity and now at that point the sound goes further and further.

The energy is twice as far from the source, as it actually spreads over ¼ of the area and hits ¼ of the intensity as received. If it is spread at a distance 3 times radius, as one, two, three, and the sphere from the sound it is trying to reach. If it's intense enough, that big, then it is spread out 1,2,3,4,5,6,7,8,9 times of that area.

Since the number of air molecules, even though they are random, is relatively the same in this area as this area, they have to be spread over that distance, so it diminishes.

Okay, let's look at this again. The area of the sphere is 4 power squared, the power source is, at this point. The intensity which is capital I is equal to the power distributed over and divided is called the inverse square law.

The energy, which is twice as far from the source, spread over four times that area, ends at 1.4 the intensity. You may be asked some form of this question on your licensing.

Okay, let's see sound as a mechanical wave. A mechanical wave is a wave which is not capable of transmitting energy though a vacuum. What does this mean? This means the mechanical waves require a medium in order to transport their energy from one point which is pi to another point, whether it is your ear or wherever that is.

Think of this now, a mechanical wave requires a medium in order to transport energy from one location to another. A soundwave is an example of a mechanical wave. Soundwaves absolutely do not ever ever travel through a vacuum, because they have to have particles to exert pressure against, in order to exist.

If you don't believe me, just wait until your licensing exam, when this question does come up. This question is real. It is serious and it is the precursor for any understanding about sounds.

Take a look at intensity. Sound intensity is defined as the sound power per unit area. The usual context in this measurement of intensity is in the air, at a listener's location. Where we are. The basic units are watts/m2 or watts/cm2.

Many sound intensity measurements are made relative to a standard threshold of hearing intensity which is I subscript O. So, the intensity that equals this, is 10 to the -12 watts/m2. How many watts does it take to make a horsepower 750? What is 10 to the -12, 10 to the -12 is one billionth of?

Let's move on and continue to the most common approach to sound intensity measurements to use. The decibel scale, as in I'd like to be a tenth of the man Alexander Graham was. The decibel, deci is 1/10 the bel, is the objective unit of intensity. It is attributed to Alexander Grayham Bell.

One decibel is from the formula that you just looked at in your previous graphic. The intensity, in decibels, is equal to 10 times the logorithm at the base 10 of the ratio of the intensity sound, as in proportion to the threshold level. The intensity, in dB, is equal to 10 times.

Where does the 10 come from? The 10 comes from just making this formula a little bit easier. We are including the logorithm as a convenience to us, because if we did not include the logorithmic scale, the graph that you would have to chart a hearing test on, would be about two miles long and about ten inches wide.

We don't think that you can get permission for you to build your desk that long in your neighborhood. So, what we've gone and had done, is people smarter and wiser and older than me, have created the log to give us a different frame of reference, and to create the decibel instead of a bel, to make it simpler, even further, for those of us who are trying to understand it.

So, the intensity in dB is equal to 10 times the log to the base 10 of the difference of intensities, with reference to our threshold of hearing intensity.

As I've mentioned, dB measures the ratio of a given intensity. I is for intensity to the threshold of hearing intensity, so at this threshold, we are going to say it takes the measure of the value of 0. That means 0 dB.

The reason the d is not capitalized, it's not an error, if you do a measurement here, that is Latin then you always make this lower case. This is 1/10th of deci, 1/1000th of milli like millimeter, okay? dB is named after Alexander Graham Bell.

Just a word on loudness.

To assess sound loudness as a distinction from the objective intensity, as it can be measured by any number of people who would have agree on the results, this is sensitivity of the ear that be factored in.

Let's just make sense of it real quick. If I have all my hearing, and Sortn his only half of it by now, something that is loud to me, because my ears are still sensitive. If he has lost half of his hearing, it may be a true statement to say, it would be about half as loud to him as it is to me.

Don't take this as gospel, you do not have a one-to-one relationship there, and we are going to find out why shortly.

You know what I want to tell you is the logarithm involved is just simply the power of 10 of the sound intensity expressed as a multiple of the threshold. What I mentioned before the ratio of the threshold of hearing, to the output, the intensity of the sound, so that this is not 1, this is the letter I. Don't get confused.

The intensity equals 10 times the logarithm to base 10 of the ratio. Now, if the intensity was 10,000 times the threshold of hearing then the ratio of this intensity is 10 to the 4, this is 10 thousand. This is 10 to the 4th or 10 times 4 which is 40 dB. The power of 10 is four. The power of 10, the log based 10, of this intensity difference, is 10 times 4 which becomes 40dB.

You practice with these logarithms about 10 or 15-20 times. Just get a high school math book out of the library and go back and look at logs. All you have to do is practice this 10 or 12 or 15 times with different log problems.

All of them have to be at the base 10, they have to be at the base 10. This is the threshold of hearing, and this is how loud. This is the intensity measurement of the sound.

What is the change in dB? dB are based on power of 10. Why the factor of 10? Here is an important point. It's not just 10 dB equal one Bel. It's that since 40 to 41 dB for example is about the JND (just noticeable difference in sound intensity) the decibel becomes the most convenient unit to use.

It is not outside of anyone's understanding, that's been in this healthcare field for a while. You also have to use that to be able to get the audiogram on less than 1 mile of paper.

END OF

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