Lesson: “Why are some sounds high and some sounds low?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! There are probably lots of sounds that you like to hear. Imagine the sound of waves crashing at the beach. Or the sound of people laughing, having a good time. Or you probably have a favorite song or musical performer. Those are sounds you like. But are there sounds you dislike? I'll tell you about one that will probably drive you mad. It's a sound made by an invention called The Mosquito. That's this speaker here. You see, one day, back in 2005, the owner of a convenience store was having problems with some teenagers hanging around outside his store. They were causing trouble. Speaking rudely to the customers as they walked in, that kind of thing. An inventor heard about this problem and came up with a solution. The inventor knew about a certain sound, a sound so high that, actually, not everyone can hear it. And that's what's so remarkable about this sound. It's a sound that can only be heard by people under the age of 25. The reason is that once you're older than 25, your hearing starts to get a little worse and so you just can't hear really high sounds. This really high sound sounds like a really high-pitched whistle, or the annoying buzz of a mosquito in your ear. If you're under the age of 25, it's definitely not a sound you'd enjoy hearing. So the inventor's idea was to blare this sound from a speaker outside the convenience store, which stopped teenagers, and anyone under the age of 25, from wanting to hang around out there. And it worked. Not everyone agrees it's a great solution, though. Some people have pointed out that there's plenty of teenagers it bothers who aren't doing anything wrong. Not to mention, it also would bother any little kids coming near the store. But some teenagers have turned this whole idea on its head and they've gotten their revenge. There are ringtones for cellphones that use this sound, and so some teenagers have used this secret high sound in order to send text messages to each other in class without their teacher noticing, and it works. The sound is really high. It's so high that a teacher can't hear it. You know that sound is a vibration, so if all sounds are just vibrations, what is it that makes some sounds different from each other? What is it that makes The Mosquito sound super high and other sounds so much lower? Are the vibrations of high sounds different from the vibrations of low sounds in some way? What do you think?

EXPLORATION VIDEO 2

Why are some sounds higher and others lower? Is there something different about their vibrations? It would help if we had a sound-maker that let us see the vibrations being made. Then we could get a closer look at them. What we need are some musical instruments that we can experiment with. Like, I have a guitar. Now, first of all, notice that when we talk about how high or how low a sound is, we're talking about something different from just how hard or strongly you hit them. Watch. Strumming a guitar gently or strumming it hard doesn't change how high or low the sound is. It just changes how quiet or how loud the sound is. We call that the sound's volume. When we're talking about how high or how low a sound is, that's what we call the sound's pitch. Let me show you what I mean by that. Here's a note with a high pitch. And now here's a note with a low pitch. A guitar is an instrument that can make both really high-pitched sounds and really low-pitched sounds. But there are some instruments that are more limited in their range, like a flute. It's really only capable of making high-pitched sounds. What about an instrument that only makes low-pitched sounds? I can think of no better example than a tuba. So what makes sounds have a high pitch or a low pitch? Well, we know sound starts with a vibration. So let's look at the vibrations that make these sounds. These are guitar strings seen close-up. Let's compare the vibration of a guitar string when we make it high pitch and low pitch. Here, I'm going to pluck the string and get a high pitch. Now let's hear a low pitch. I'm going to pluck the same string, but I've got it tuned very low. Did you see any difference in how they vibrate? It's hard to tell unless we compare them side-by-side in slow motion, like this. See any difference now? How did the vibrations look for sounds with a high pitch versus sounds with a low pitch?

EXPLORATION VIDEO 3

So now you've seen that the vibrations I create when making a high-pitched sound and a low-pitched sound look different from each other. I notice that when I made a high-pitched sound, the vibration moved back and forth more quickly. It looked fast. When I made a low-pitched sound, that vibration looked like it wobbled back and forth a bit more slowly. So what about the vibration as it comes to my ear? When you're listening to a guitar, for example, you know that those vibrations from the guitar strings have to travel through the air to get to your ears. It would be nice if you could see those sound vibrations as they travel through the air, not just the vibrating string that made them. Well, it turns out there is a way to do that. Scientists have actually invented a way to see sound vibrations as they travel through the air. They use this special setup. It's a slow motion camera, plus some very special lighting conditions, and that allows them to see what's happening in the air when a sound is made. Here we go. This is the sound of a book landing on a table. Watch that again. You can see the vibrations move outward. And here's a speaker playing music. And, finally, the sound as a firecracker explodes. Let's see that again. Does this remind you of anything? To me, it looks like a ripple in a pond, like if you drop something in water, right, and the ripples spread outward? It might surprise you that sound vibrations in air look like waves or ripples. But think about those ripples you see on the surface of water. Where do they come from? The ripples come from something vibrating the water. When I vibrate my hand on the surface of water, it creates a ripple, or wave, that spreads outward from the vibration, like this. And just like in water, when a sound=maker vibrates the air, the vibrations travel outward as ripples or waves of air. So, sound vibrations are traveling waves in the air. Sound is a wave. You've just seen visual proof of it. So, knowing that sound is a wave, we can ask: do high-pitched sounds and low-pitched sounds make different waves? You could find out for yourself if only you could set up this slow motion camera technique in your own classroom. That way, you could experiment with making different pitches and seeing what kind of sound waves they make. Unfortunately, this camera setup is not easy, but there's another way for us to see sound waves. Instead of having a direct camera view of the air, we can use a machine that will do something similar. It's called an oscilloscope. It takes sound from the microphone, like on your computer, and shows the sound vibration waves, not from top-down like ripples in a pond, but in more of a sideways view, more like a classic wave, like this, the kind of waves you'd draw if someone asked you to draw ocean waves. So I'll try talking into an oscilloscope right now so that you can see what it looks like. See here, I'm talking right now, and you can see a line moving on the screen. This line is a sort of picture of the sound waves. It's not showing me the real sound waves themselves. It's more like a graph, kind of like a diagram. But the diagram changes in response to the real sounds I'm making right now. There's a lot going on here. And a lot of it doesn't really look like nice smooth ripples or waves. It looks like the ocean in a storm. So I played around with lots of sounds, and I found out that a whistle, like this, made a nice wave. Now watch as I make a low-pitched sound. And now, a high-pitched sound. It's hard to see what's going on. Everything moves so quickly. So I'm going to use a button that freezes the picture. Here's the high-pitched sound again. Just listen. OK, draw that on your worksheet. Be sure you draw just as many waves as you see on the screen. You can pause the video if you want so that you have more time to draw. I'm going to move on to the low-pitched sound now. Here's a low-pitched sound again. And I froze it, so you can get a good look at it. Now draw what you see on your worksheet. Be sure you draw just as many waves as you see on the screen. Again, you can pause the video if you want to, so you have more time to draw. So, can you see a difference in how the sound waves look, as viewed here from the side? How would you describe the differences between a high-pitched sound wave and a low-pitched sound wave?

EXPLORATION VIDEO 4

When you compared the image of the high-pitched wave to the low-pitched wave, how are they different? You might have noticed that when the sound is a high pitch, the waves are more squished together. But when the sound is a low pitch, the waves are more spread out. Instead of calling them squished together or spread out, scientists look at the length of the two kinds of waves. Notice how the waves of the high-pitched sound are short and the waves of the low-pitched sound are long? Scientists call this property of a wave its wavelength. Look at the questions about wavelength on your worksheet now, and circle the right words. You can pause the video if you need to. So, high-pitch sounds, like this, have a short wavelength, and low-pitch sounds, like this, have a long wavelength. Let's connect that back to the vibrations that high -pitched and low-pitched sounds make, like we saw when we looked at guitar strings in slow motion. Think about it. A high-pitch sound came from a guitar string that had a fast vibration. It was going back and forth more rapidly. With each vibration, it makes a sound wave. So it makes sense that when you've got something vibrating in the air very rapidly, that's going to create very squished together waves in the air. And you saw that with a low-pitch sound. That's more of a slow vibration. It was going back and forth less rapidly. With each vibration, it makes a sound wave. So it makes sense that when you've got something vibrating in the air less often or more slowly, that's going to create more spread out waves in the air. So now you know why sounds have different pitches. It has to do with how often the vibration goes back and forth. The difference in those vibrations creates different waves in the air. So let's practice. Just from looking at these images, can you tell how high or low the pitch would be?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you'll experiment with making waves in a rope. Your hand is going to be the vibration that makes waves. The challenge is to make waves in a rope that look like the pictures you saw of different kinds of sound waves. To do that, you'll need to think about which kind of vibration makes each kind of wave. You'll start with a long rope on a smooth floor. First, you'll want to make one wave travel down the rope. You do this by jerking the rope to one side and back again, like this. That's one vibration, and it makes one wave. This looks easy, but it might take you a few tries to get it right. If you're in a class, you'll need to take turns making waves. So you'll want to work together and experiment to figure out how to do it well. Like, if the rope is too tight, you'll wobble the whole rope and you won't see a wave. Or if you don't move your hand far enough, the wave won't get all the way to the end. So figure out how to make one wave, and then you can figure out how to make many waves, like this. You can vibrate the rope to make waves that look like a picture of a high-pitch sound, and you can vibrate it to make waves that look like a low-pitched sound. Ready to experiment? Get your handout. The instructions will walk you through the experiment, step by step. Have fun, and stay curious!