Elephants and Subsonic Sound

Humans cannot make sounds of very low frequency, because humans do not have the right body structure and strength to do so. In addition, human hearing can’t detect sounds below about 20 Hz.

**Low Frequency Communication**

However, the elephant is strong enough and has the right body structure to produce low frequency sound waves. Until recently, scientists did not know how elephants communicated over large distances. They thought perhaps the elephants produced a chemical that could be smelled in the air, but that proved false. As it turns out, elephants actually do communicate with each other, but they do it with sound rather than smell.

The front of an elephant’s skull is very large, broad, and flat. Elephants also have large lungs and muscles that enable them to produce loud sounds. If you have ever heard an elephant trumpet in a movie or on television, you know it can make quite a loud sound by blasting air through its trunk and mouth. This impressive noise is one form of communication used by elephants.

1. Why can’t humans make very low sounds?

2. What are three things elephants have that help them make low sounds?

3. Why do elephants make low-frequency sounds?

4. How can you tell if an elephant is making subsonic sounds?
You may have heard that some opera singers can break a glass with their voice. Maybe you saw a joke on television about someone shattering glass with sound? Can this really happen? Under certain circumstances, sound waves can have a shattering effect on glass.

It all starts with the glass. Some types are more easily shattered than others, but in theory any glass can be broken. When you tap a glass, say a water glass, you can hear a slight sound or ringing. That sound is the resonant frequency of the glass. Each glass has its own resonant frequency. When tapped, the glass vibrates back and forth. The thickness and purity of the glass will determine the rate at which it vibrates. Fine crystal usually has resonant frequencies that are easy to hear.

**Singing Vibrations**

When a singer, or some other sound source, produces the exact frequency (pitch) of the glass, it will vibrate. This is resonance, or one vibration making another vibration.

If the amplitude of the singer’s vibration frequency increases, the glass vibrations will also increase.

The problem for the glass is that it is made of a material that has molecules bound together in tight positions. Air is like a liquid and can move freely; the molecules in glass cannot. If the amplitude and resulting force of the initial vibration source gets too big it will vibrate the glass much too hard. The molecules in the glass cannot move as fast or as far as they are being pushed. The result is that the glass will shatter.

**Yelling Won’t Help**

But yelling loudly at a glass most likely will not break it. The resonant frequencies of glass are usually very high. It also takes a pure tone, like the kind opera singers can produce, to resonate the glass. This is difficult to do. However, if you play an electric musical instrument with a pure and high note at a loud volume, it’s possible that an expensive piece of crystal may shatter.

1. What are some things that determine the resonant frequency of glass?

2. What is resonance?

3. How can a singer make a glass resonate?

4. Why does the glass break from sound?
Architectural Acoustics

Read the following paragraphs, and complete the exercises below.

The speed of sound waves depends on the medium in which the sound travels. The table below shows the speed of sound in some common materials. People who work in the field of architectural acoustics are concerned with controlling sound that travels in a closed space. Their goal is to make rooms and buildings quiet yet suitable for people to enjoy talking and listening to music.

<table>
<thead>
<tr>
<th>Material</th>
<th>Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>344</td>
</tr>
<tr>
<td>Water</td>
<td>1,433</td>
</tr>
<tr>
<td>Concrete</td>
<td>3,231</td>
</tr>
<tr>
<td>Glass</td>
<td>3,962</td>
</tr>
<tr>
<td>Hard wood</td>
<td>3,962</td>
</tr>
<tr>
<td>Brick</td>
<td>4,176</td>
</tr>
<tr>
<td>Aluminum</td>
<td>4,877</td>
</tr>
<tr>
<td>Steel</td>
<td>5,029</td>
</tr>
</tbody>
</table>

One factor that affects the acoustical quality of a room is the way the room reflects sound waves. Sound waves bounce off surfaces including floors, ceilings, and walls. Using materials that absorb sound reduces sound wave reflection. Materials that have small pockets of air that can trap the sound vibrations and keep them from reflecting are most sound absorbent. Sound-absorbing floor and ceiling tiles, curtains, and upholstered furniture all help to control sound wave reflection.

When the goal is to try to keep sound from leaving a room, standard approaches include absorbing vibrations, blocking the vibration path, and breaking the vibration path. Installing insulation materials such as fiberglass between the walls and floors can absorb vibrations. Building extra thick walls, floors, and ceilings also helps block the path of vibrations.

EXERCISES

1. Through which material does sound travel slowest?

2. If you wanted to control sound reflection in an office, would you install metal, wood, or cork partitions? Explain your answer.
The Sound Barrier & The Sonic Boom

Most people have heard of “breaking the sound barrier” but what does that really mean? The sound barrier is “broken” when an aircraft exceeds the speed of sound. More accurately, it is the point at which the object’s speed increases from the transonic range (slower than sound) to the supersonic range (faster than sound).

As an object passes through the air, the air resistance creates a series of pressure waves both in front of and behind that object, similar to how the hull of a boat creates wake in the water. These pressure waves travel at the speed of sound, which for most aircraft isn’t a problem. As the speed of the object increases however, the waves are forced together, or compressed, because they cannot get out of each other’s way. By the time the object reaches the speed of sound, these pressure waves are compressed so tightly they become a single wave, with the pressure being as high as 7,000 Pa, or 144 pounds per square foot. It is this increase in pressure that creates the infamous “Sonic Boom”.

In rare instances, you can actually see the sound barrier being broken. Image 1, which is also on the cover of this lesson, is an F/A-18 Hornet with a white cloud enveloping the rear of the aircraft. This cloud was created by a large drop in air pressure behind the wing at the precise moment the aircraft broke the sound barrier. Notice the smaller cloud that also formed near the rear of the cockpit, which is another sonic boom.

Pilots of jet aircraft often refer to their speed in relation to the speed of sound, using the term “mach number”, which is the ratio of the aircraft’s speed compared to that of the speed of sound. Mach 1, for example, is the speed at which sound travels, while Mach 2 equates to twice the speed of sound. Most airliners move fairly slowly for takeoff and landing but fly at approximately Mach .80 (M .80), or 80% of the speed of sound, when up at cruising altitude.

While sound waves are not usually able to be seen as they are when some aircraft break the sound barrier, the following activity will allow students to visualize sound waves firsthand.