

How Sound is Produced in a Violin

Sound is a series of vibrations that move through a medium and occur at a range of frequencies, which may or may not be heard by the ears of an animal or human. While sound exists both above and below the audible range, humans can only hear sound in the frequencies between 20 and 20,000 Hertz. There are many different ways that audible sound can be produced, but one of the most well-known methods is through the use of musical instruments like the violin.

Although there have been many variations of the violin, the modern violin was first invented in the 16th century. The modern violin is a stringed instrument that has four strings and a higher pitch than other stringed instruments. Producing sound is the primary purpose of the violin, and the process of how sound is produced in a violin can be broken down into three main phases: the initial vibration, the amplification and conversion of the vibration, and the projection of the vibration through the air.

The Initial Vibration in the Strings

The process of sound production always requires some kind of initial vibration. For a violin, this vibration is started when one or more of the strings on the instrument are displaced by some force, such as a pluck of the string by someone's finger. The tension in the string will cause it to move back to its original position and oscillate, or vibrate, around this original position. There are three factors that can affect the initial vibration: string tension, string length, and string design and material.

String Tension

The tension of the string primarily affects the *frequency* of the initial vibration. If the tension in the string is increased, the frequency of the vibrations in that string is also increased. Likewise, a decrease in tension results in a decrease in frequency (the rate at which a vibration completes one oscillation). The tension of the strings is controlled by the pegs and fine tuners of the instrument (see Figure 1). The pegs work by wrapping a portion of the string around the base of the peg and turning it to tighten the string. The fine tuners work by using a hook on the end of the fine tuner to pull and tighten the string.

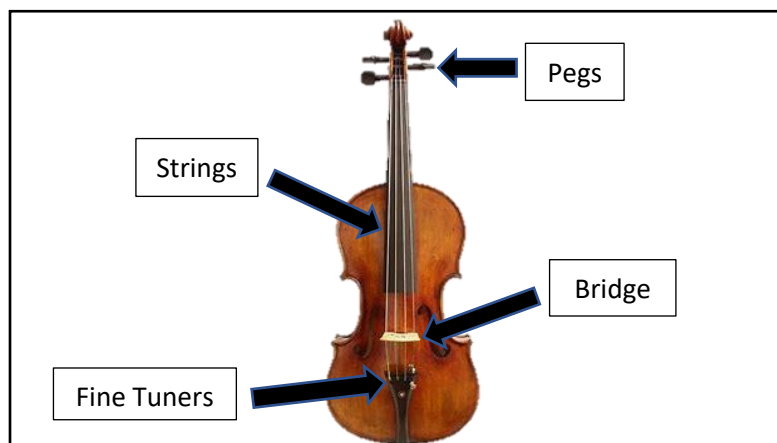


Figure 1. Important Features of a Violin That Affect Sound Production

Source: palomavaleva.com/en/produit/unique-violin-de-thracy/

String Length

Like the string tension, the string length also affects the frequency of the vibrations in the string. When a player applies his or her fingers to the strings and holds them down at specific points, the string vibrates with a higher frequency than its normal frequency when not touched. This higher frequency is the result of a change of length of the portion of the string that is vibrating. Shorter strings at a constant tension will vibrate with a higher frequency than longer strings.

String Design and Material

In addition to frequency, the design and material of the string affect other aspects of the vibrations. One of these aspects is the intensity. Strings are designed to vibrate easily in order to vibrate with enough intensity to be able to start the process of making sound. Different materials have different properties that affect how an object made of that material will vibrate. Violin strings today are typically made up of a core string, which primarily determines the properties of the string, and a wrapping of another material, which is usually steel. The steel wrapping, which makes the strings more durable, decreases the frequency of the vibrations in the string because it increases the diameter and mass of the string.

Amplification and Conversion of the Vibrations from the Strings

The initial vibration itself does not directly cause the sound we hear from a violin. Instead, the initial vibrations in the strings travel through the bridge (see Figures 1 and 2) and into the violin. Once inside the instrument, the vibrations travel across the sound post, bass bar, and the top and bottom plates of the instrument (see Figure 2). The vibrations of the plates transfer to the air inside the instrument. The larger surface area of the plates of the violin are able to displace more air when it vibrates than the other parts of the instrument when they vibrate, which results in a louder sound that can be clearly heard by the human ear. This transfer of the vibrations to the air can be affected by altering the bridge or the body of the instrument.

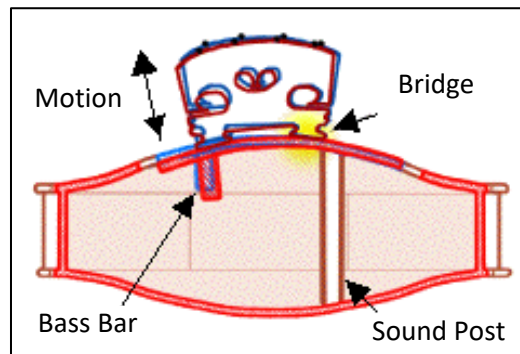


Figure 2. Cross Section of the Body of a Violin
Source: newt.phys.unsw.edu.au/jw/violintro.html

The Bridge

The bridge is the main component that is responsible for transferring the initial vibrations from the strings to the inside of the violin, and any change in this part can cause a significant change in the final sound from the instrument. The bridge is designed to transmit the right amount of vibrational energy to the inside of the instrument.

Sometimes, the bridge will have masses, also known as mutes, attached to it to hinder its ability to transfer the vibrations to the instrument. More mass makes it more difficult for the bridge to vibrate. The result is a damped sound that is often quieter than it would be if the bridge was not muted. In addition, the proportions and size of the bridge itself determine the intensity of the vibrations it transfers to the inside of the instrument. A larger bridge has more mass, so it acts similarly to a smaller bridge that has a mute.

The Body of the Violin

The body of the violin is the structure that is responsible for the final transfer of vibrational energy to the air inside the violin. The body consists of the sound post, the bass bar, and the top and bottom plates of the instrument.

The Sound Post

The sound post serves the purpose of transferring the vibrations between the top and bottom plates of the violin. It is also important to provide support to the instrument, so the two plates are separated enough to allow sufficient air flow in and out of the instrument.

The Bass Bar

The bass bar serves the purpose of transferring the vibrations along the length of the top plate. The extra stiffness in the bass bar allows the vibrations to travel along the entire length of the top plate without weakening along the way.

The Top and Bottom Plates

The top and bottom plates serve the purpose of transferring the vibrational energy to the air inside the violin. Every part that vibrates transfers vibrational energy to the surrounding air, but the transferred energy is too small to be heard very well. The top and bottom plates are the largest part of the violin; therefore, they are capable of displacing more air than the other parts of the violin. This feature allows it to amplify the vibrational energy enough to be heard more clearly and gives the instrument its characteristic sound.

Projection of Vibrations Through the Air

Once the vibrations are transferred to the air inside the instrument, they begin to travel through holes on the top plate of the violin body, called f-holes because they are shaped like f's (see Figure 3). The vibrations travel through the air and eventually reach the ears of a person or animal where it is interpreted as audible sound. The final frequency of the vibrations is what determines the pitch (the specific note or tone that is heard) of the sound. The sound may also reflect off of different surfaces outside

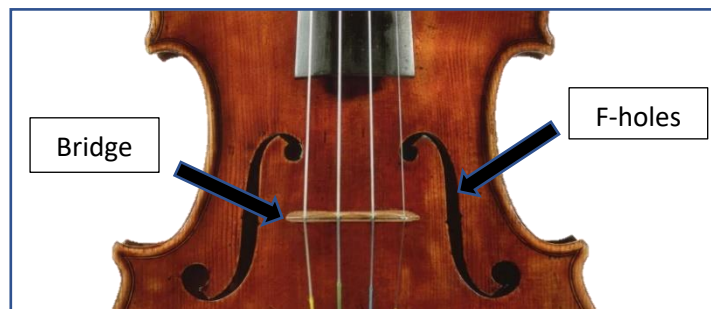


Figure 3. A Closer View of Important Features on a Violin
Source: www.wrti.org/post/evolution-violins-sound-and-design

of the instrument, such as walls or the floors. Reflected sound vibrations may be different from the direct sound coming from the violin, so the location of the performance is important when trying to optimize the sound heard from the violin. The location mostly affects the intensity of the sound, which is due to the distance the sound needs to travel to get to the listener. The more distance the sound travels, then the more the sound dissipates and loses energy before it can reach the ears of a person. This low energy sound is interpreted by our ears as a quiet sound. For example, being in a large space will result in a quieter sound than the sound in a small space. This characteristic of sound makes it difficult for the violin to be heard from longer distances, such as the distance from a stage to the back row of seats in an auditorium. Therefore, orchestras often have many violins playing the same music in order to produce sound that is loud enough and clear enough for the audience to enjoy.

References

Curtin, Joseph, and Thomas D Rossing. "Violin." *The Science of String Instruments*, Springer Science and Business Media, LLC, 2010, pp. 209–244.

I used this source as a reference for my current knowledge of the science of sound. I wanted to confirm that I was not missing any important details when talking about the sound production in a violin.

Revelle Team. "How Your Violin Produces Sound." *Connolly Music Company*, 21 Sept. 2016, www.connollymusic.com/stringovation/how-your-violin-produces-sound.

I used this source as a reference for the functions of the various parts of a violin. I wanted to see how other writers described the different parts of a violin and their functions.

StringOvation Team. "Why Do Gauge and Tension Matter for Violin Strings?" *Connolly Music Company*, 15 Mar. 2019, www.connollymusic.com/stringovation/why-do-gauge-and-tension-matter-for-violin-strings.

I used this source as a reference for the specific information about strings. I wanted to make sure that I was not forgetting any important information about the strings that would affect the sound production.

Wolfe, Joe. "How Does a Violin Work?" *Violin Acoustics: an Introduction*, 2007, newt.phys.unsw.edu.au/jw/violintro.html.

I used this source as another reference for the functions of the various parts of a violin. I wanted to have at least a few sources to reference for previous descriptions of the different parts of a violin.