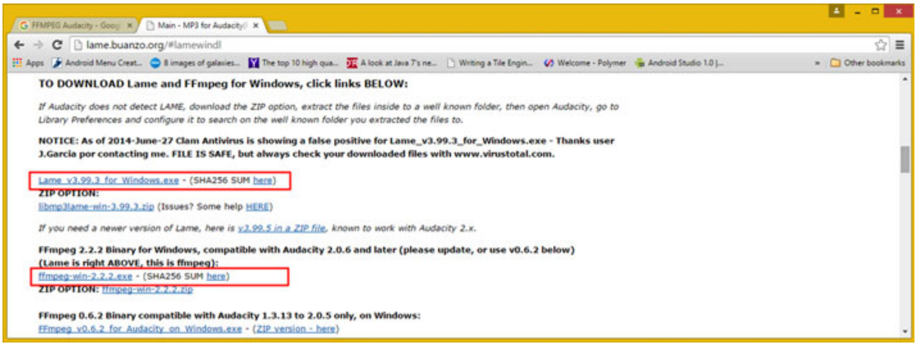

Figure 1-9. *Download LAME 3.99.3 and FFMPEG 2.2.2 libraries*

Installing these libraries is easy and requires no option specifications or shortcut icons. When you launch the Audacity software after these libraries are installed, you are able to read and write all the audio file formats covered in this book; they are supported in Android, HTML5, iOS, Java, JavaFX, Blackberry, Linux, Mac OS, and Windows.

Now let's take a look at the foundation for all audio—a sound wave, which can be generated using both analog and digital audio technology. After all, this is Chapter 1, so you should get something under your belt besides installing an impressive open source digital audio editor and a special effects software application.

A Foundation for Audio: The Sound Wave

Digital audio editing, synthesis, MIDI sequencing, composition, sweetening, sound design, and special effects can all be quite complex, especially at the professional level. Even though this is a "fundamentals" title, I am going to try and cover a lot of concepts, history, techniques, terminology, formats, platforms, and work processes, so that you really get your money's worth out of this digital audio editing fundamentals (and more) book.

Part of the complexity comes from the need to "bridge" analog audio technology and digital audio technology together. This is necessary because modern-day devices use digital audio, but we still have analog audio in our lives—in our cars, home stereos, home theaters, movie theaters, at live concerts, sports stadiums, broadcast radio, live theater, clubs, and so forth. Therefore, I cover both analog audio and digital audio in this first chapter, as they both ultimately use sound waves to create the music, dialog, effects, and other audio that we experience.

Analog Audio: Sound Waves Formed Out of Air

Analog audio is generated by using speaker cones of different sizes, which are manufactured using resilient membranes made out of one space-age material or another. Many of us have these speakers in our homes. I have 15-inch speakers right here on my desk. Larger 18- and 24-inch speakers are common in public venues, such as stadiums, theaters, and concert halls. These speakers generate sound waves by vibrating—or more accurately, pulsing—the sound waves into existence. Our ears receive these analog audio waves in exactly the opposite fashion, by catching or receiving those pulses of air, or vibrations, with different wavelengths, and then turning them back into "data" that our brain can process. This is how we "hear" the sound waves. Our brains then interpret the different audio sound wave frequencies as notes, tones, speech, sounds of nature, music, or sound effects.

A sound wave generates a different tone depending on the **frequency** of the sound wave, or the **width** (horizontal size) of the wave. Wide, long, or infrequent wave cycles produce a lower (bass) tone; whereas narrow, short, or frequent wavelengths produce a higher treble tone. Figure 1-10 visualizes this using a sine wave.

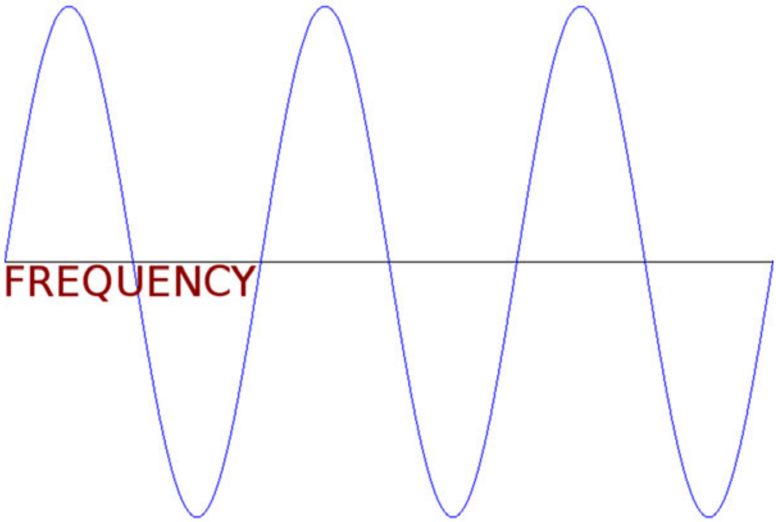

Figure 1-10. *Frequency is the width of one full wave cycle*

It is interesting to note that different frequencies of light produce different colors; so there is a very close correlation between analog sound (audio) and analog light (color). Both are "bridged" from analog to digital, and the same principles therefore carry through to digital production techniques, work processes, and principles. I point out these similarities throughout the book, in case you are interested in digital imagery compositing. In fact, I also have a *Digital Image Compositing Fundamentals* (Apress, 2015) title, which goes into these areas.

The volume of the sound wave is predicated upon the **amplitude** of that sound wave, or the **height** (vertical size) of the wave. Thus, the frequency of sound waves equates to how closely together the waves are spaced along the x axis, if you look at this in two dimensions, and the amplitude equates to how tall the waves are as measured along the y axis. This is shown in Figure 1-11 using a basic sine audio waveform.

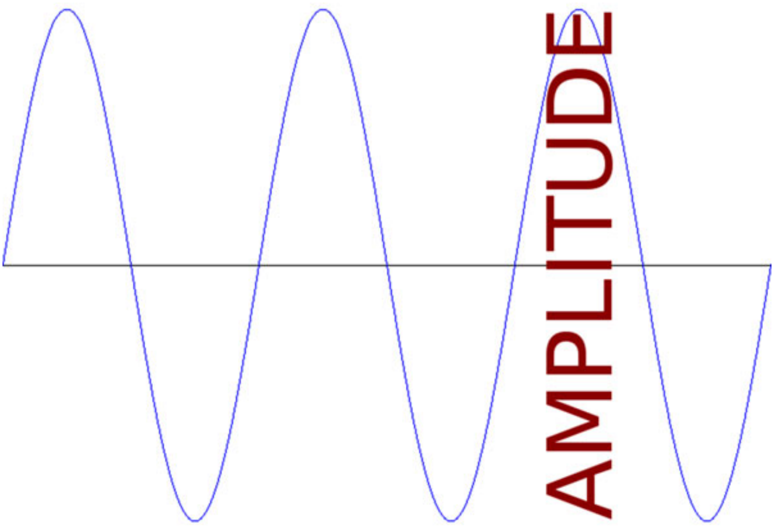

Figure 1-11. *Amplitude is the height of the sound wave*

A “baseline” sound wave type is called a **sine wave**. This type of sound wave is usually synthesized and it produces a clean, simple tone. You learned about these sine waves in your high school trigonometry class, when you learned about sine, cosine, and tangent mathematical functions.

Sound waves can be uniquely shaped, which allows them to mimic different sound effects. Those of you who are familiar with synthesizer keyboards are aware that there are many other shapes of sound waves that are used in sound design, including a **saw wave**, which looks like the edge of a saw—hence its name, or a **pulse wave**, which is shaped using right angles, resulting in immediate on-and-off sounds that translate into pulses.

Even **randomized waveforms**, such as **noise**, can be used in sound design to obtain an edgy sound result. As you will learn when we get into data footprint optimization, the more “chaos,” or noise, that is present in sound waves, the harder it is to compress in the compression algorithm (codec). This results in a significantly larger digital audio data footprint for that particular sound wave. Thus, cleaner sound waves compress better than dirtier (noisier) sound waves.

Digital Audio: Sound Waves Formed Out of Bytes

The way that analog audio is “bridged” over into the digital domain is by a process called “sampling,” which I cover in Chapter 3, as it is a very important topic for digital audio editing. This sound wave sampling process is one of the core tools of sound design and music synthesis, and it is named as such because you take “samples” of the analog sound wave to create a digital replica of that sound wave.

The audio wave sample has data sampled in a Y dimension, called the sample's **resolution**, and the number of samples taken in the X dimension is called the **sampling frequency**. This data sample can later be used by the digital device (smartphone, PC, tablet, e-reader, smartwatch, iTV) audio playback hardware to re-create that analog waveform and then send it back out of the speaker, or out of your headphones jack and into your headphones.

I'll cover how sampling is done and the various industry terms used, as well as the standard sample resolutions and standard sampling frequencies used in the industry.

These audio samples are used in MIDI synthesis keyboards, commonly called "samplers," as well as in sound design software such as Cakewalk SONAR, Ableton Live, or Propellerhead Reason.

Summary

In this chapter, I made sure that you had a digital audio editing software package installed and ready to master. I also covered the foundational element of both analog and digital audio, the sound wave.

You learned about sound wave frequency, or width, and amplitude, or height, and the different types of sound waves that are used in MIDI synthesizers.

Next, you looked at the concept of sampling, or taking data samples of a sound wave to convert it from an analog waveform into digital audio data.

In the next chapter, you look at the history of digital audio and the concept of MIDI sequencing.