# Introduction to Music Theory

**Collection Editor:**
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**C O N N E X I O N S**

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# Pitch and Interval

## 1.1 Octaves and the Major-Minor Tonal System[1]

### 1.1.1 Where Octaves Come From

Musical notes, like all sounds, are made of sound waves. The sound waves that make musical notes are very evenly-spaced waves, and the qualities of these regular waves - for example how big they are or how far apart they are - affect the sound of the note. A note can be high or low, depending on how often (how frequently) one of its waves arrives at your ear. When scientists and engineers talk about how high or low a sound is, they talk about its frequency[2]. The higher the **frequency** of a note, the higher it sounds. They can measure the frequency of notes, and like most measurements, these will be numbers, like "440 vibrations per second."

[1] This content is available online at <http://cnx.org/content/m10862/2.25/>.
[2] "Frequency, Wavelength, and Pitch" <http://cnx.org/content/m11060/latest/#p1e>

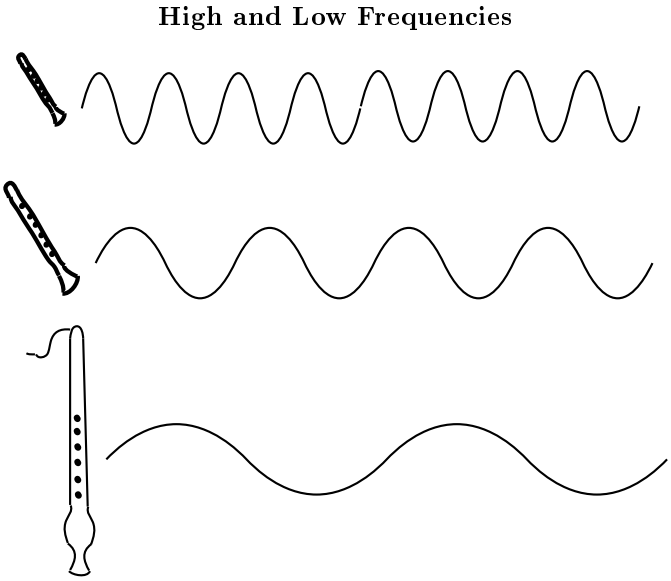



**Figure 1.1:** A sound that has a shorter wavelength has a higher frequency and a higher pitch.

But people have been making music and talking about music since long before we knew that sounds were waves with frequencies. So when musicians talk about how high or low a note sounds, they usually don't talk about frequency; they talk about the note's pitch[3]. And instead of numbers, they give the notes names, like "C". (For example, musicians call the note with frequency "440 vibrations per second" an "A".)

But to see where octaves come from, let's talk about frequencies a little more. Imagine a few men are singing a song together. Nobody is singing harmony; they are all singing the same pitch - the same frequency - for each note.

Now some women join in the song. They can't sing where the men are singing; that's too low for their voices. Instead they sing notes that are exactly double the frequency that the men are singing. That means their note has exactly two waves for each one wave that the men's note has. These two frequencies fit so well together that it sounds like the women are singing the same notes as the men, in the same key (Section 2.1). They are just singing them one octave higher. **Any note that is twice the frequency of another note is one octave higher.**

Notes that are one octave apart are so closely related to each other that musicians give them the same name. A note that is an octave higher or lower than a note named "C natural" will also be named "C natural". A note that is one (or more) octaves higher or lower than an "F sharp" will also be an "F sharp". (For more discussion of how notes are related because of their frequencies, see The Harmonic Series[4], Standing Waves and Musical Instruments[5], and Standing Waves and Wind Instruments[6].)

[3] "Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>
[4] "Harmonic Series" <http://cnx.org/content/m11118/latest/>
[5] "Standing Waves and Musical Instruments" <http://cnx.org/content/m12413/latest/>
[6] "Standing Waves and Wind Instruments" <http://cnx.org/content/m12589/latest/>

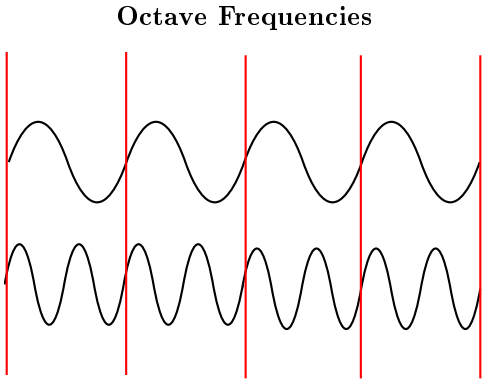



**Figure 1.2:** When two notes are one octave apart, one has a frequency exactly two times higher than the other - it has twice as many waves. These waves fit together so well, in the instrument, and in the air, and in your ears, that they sound almost like different versions of the same note.

### 1.1.2 Naming Octaves

The notes in different octaves are so closely related that when musicians talk about a note, a "G" for example, it often doesn't matter which G they are talking about. We can talk about the "F sharp" in a G major scale (Section 2.1) without mentioning which octave the scale or the F sharp are in, because the scale is the same in every octave. Because of this, many discussions of music theory don't bother naming octaves. Informally, musicians often speak of "the B on the staff" or the "A above the staff", if it's clear which staff[7] they're talking about.

But there are also two formal systems for naming the notes in a particular octave. Many musicians use **Helmholtz** notation. Others prefer **scientific pitch notation**, which simply labels the octaves with numbers, starting with C1 for the lowest C on a full-sized keyboard. Figure 3 shows the names of the octaves most commonly used in music.

[7] "The Staff" <http://cnx.org/content/m10880/latest/>

**Naming Octaves**

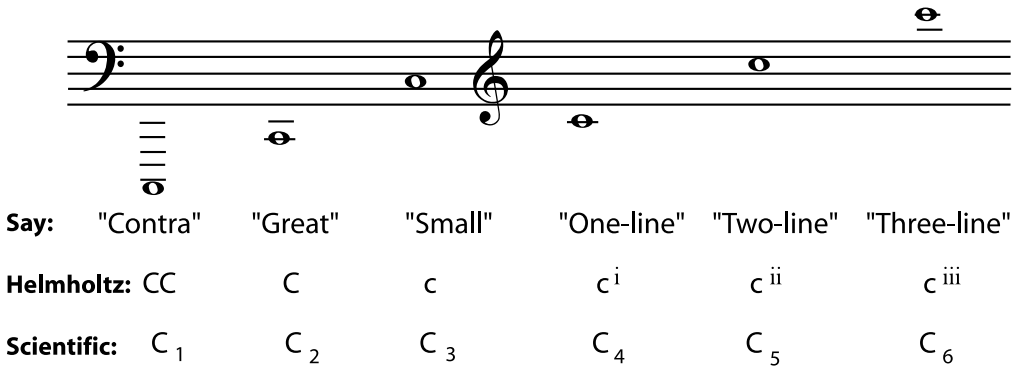



**Figure 1.3:** The octaves are named from one C to the next higher C. For example, all the notes in between "one line c" and "two line c" are "one line" notes.

The octave below contra can be labelled CCC or Co; higher octaves can be labelled with higher numbers or more lines. Octaves are named from one C to the next higher C. For example, all the notes between "great C" and "small C" are "great". **One-line c is also often called "middle C". No other notes are called "middle", only the C.**

**Example 1.1**

**Naming Notes within a Particular Octave**

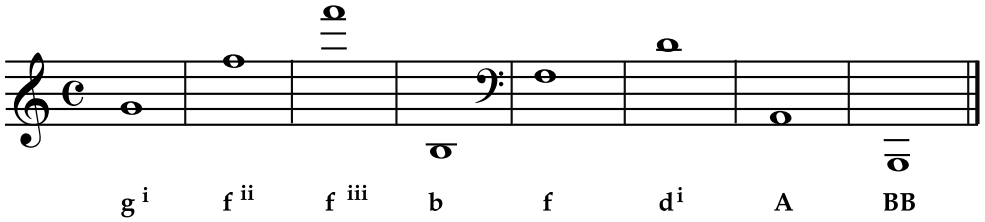



**Figure 1.4:** Each note is considered to be in the same octave as the C below it.

**Exercise 1.1.1** ***(Solution on p. 25.)***

Give the correct octave name for each note.

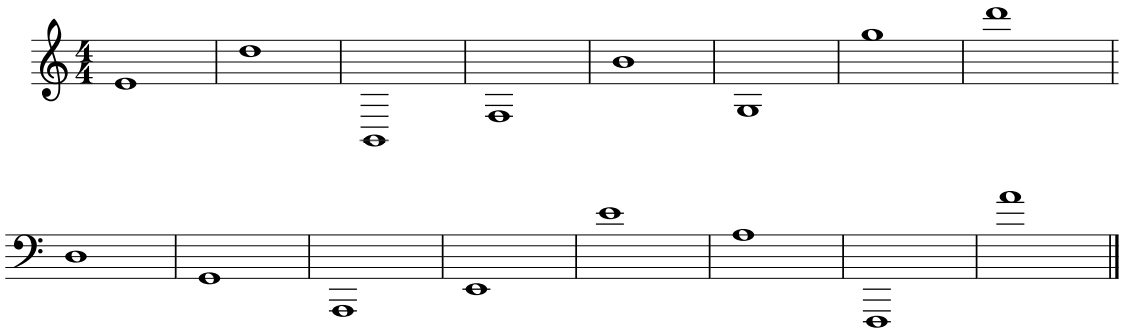


**Figure 1.5**

### 1.1.3 Dividing the Octave into Scales

The word "octave" comes from a Latin root meaning "eight". It seems an odd name for a frequency that is two times, not eight times, higher. The octave was named by musicians who were more interested in how octaves are divided into scales, than in how their frequencies are related. Octaves aren't the only notes that sound good together. The people in different musical traditions have different ideas about what notes they think sound best together. In the Western[8] musical tradition - which includes most familiar music from Europe and the Americas - the octave is divided up into twelve equally spaced notes. If you play all twelve of these notes within one octave you are playing a chromatic scale (p. 7). Other musical traditions - traditional Chinese music for example - have divided the octave differently and so they use different scales. (Please see Major Keys and Scales (Section 2.1), Minor Keys and Scales (Section 2.2), and Scales that aren't Major or Minor[9] for more about this.)

You may be thinking "OK, that's twelve notes; that still has nothing to do with the number eight", but out of those twelve notes, only seven are used in any particular major (Section 2.1) or minor (Section 2.2) scale. Add the first note of the next octave, so that you have that a "complete"-sounding scale ("do-re-mi-fa-so-la-ti" and then "do" again), and you have the eight notes of the **octave**. These are the **diatonic** scales, and they are the basis of most Western[10] music.

Now take a look at the piano keyboard. Only seven letter names are used to name notes: A, B, C, D, E, F, and G. The eighth note would, of course, be the next A, beginning the next octave. To name the other notes, the notes on the black piano keys, you have to use a sharp or flat[11] sign.

[8] "What Kind of Music is That?" <http://cnx.org/content/m11421/latest/>
[9] "Scales that are not Major or Minor" <http://cnx.org/content/m11636/latest/>
[10] "What Kind of Music is That?" <http://cnx.org/content/m11421/latest/>
[11] "Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>

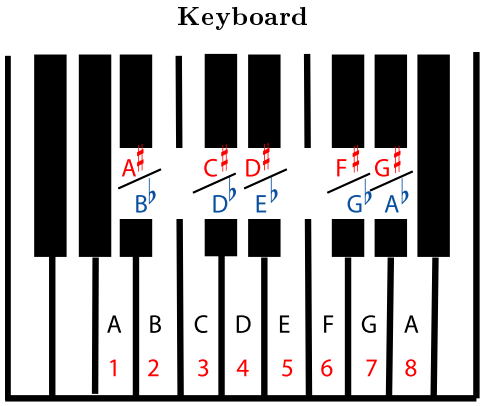



**Figure 1.6:** The white keys are the natural notes. Black keys can only be named using sharps or flats. The pattern repeats at the eighth tone of a scale, the octave.

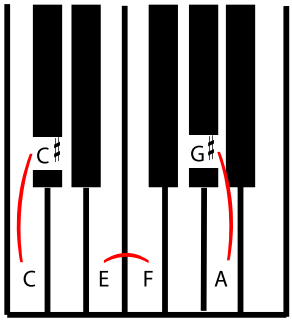
Whether it is a popular song, a classical symphony, or an old folk tune, most of the music that feels comfortable and familiar (to Western listeners) is based on either a major or minor scale. It is **tonal** music that mostly uses only seven of the notes within an octave: only one of the possible A's (A sharp, A natural, or A flat), one of the possible B's (B sharp, B natural, or B flat), and so on. The other notes in the chromatic scale are (usually) used sparingly to add interest or to (temporarily) change the key in the middle of the music. For more on the keys and scales that are the basis of tonal music, see Major Keys and Scales (Section 2.1) and Minor Keys and Scales (Section 2.2).

## 1.2 Half Steps and Whole Steps[12]

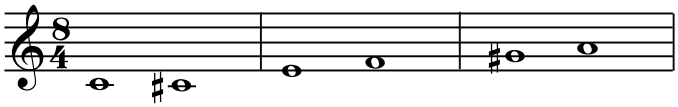
The **pitch** of a note is how high or low it sounds. Musicians often find it useful to talk about how much higher or lower one note is than another. This distance between two pitches is called the **interval** between them. In Western music[13], the small interval from one note to the next closest note higher or lower is called a **half step** or **semi-tone**.

[12] This content is available online at <http://cnx.org/content/m10866/2.22/>.
[13] "What Kind of Music is That?" <http://cnx.org/content/m11421/latest/>

**Half Steps**




(a)



(b)

**Figure 1.7:** Three half-step intervals: between C and C sharp (or D flat); between E and F; and between G sharp (or A flat) and A.

Listen[14] to the half steps in Figure 1.7 (Half Steps).

The intervals in Figure 1.7 (Half Steps) look different on a staff[15]; sometimes they are on the same line, sometimes not. But it is clear at the keyboard that in each case there is no note in between them.

So a scale (Section 2.1) that goes up or down by half steps, a **chromatic scale**, plays all the notes on both the white and black keys of a piano. It also plays all the notes easily available on most Western[16] instruments. (A few instruments, like trombone[17] and violin[18], can easily play pitches that aren't in the chromatic scale, but even they usually don't.)

**One Octave Chromatic Scale**

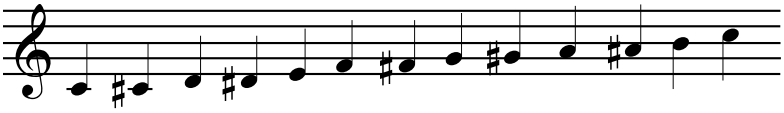


**Figure 1.8:** All intervals in a **chromatic scale** are half steps. The result is a scale that plays all the notes easily available on most instruments.

[14] See the file at <http://cnx.org/content/m10866/latest/6f.mid>
[15] "The Staff" <http://cnx.org/content/m10880/latest/>
[16] "What Kind of Music is That?" <http://cnx.org/content/m11421/latest/>
[17] "Trombones" <http://cnx.org/content/m12602/latest/>
[18] "Introduction to the Violin and FAQ" <http://cnx.org/content/m13437/latest/>

Listen[19] to a chromatic scale.

If you go up or down two half steps from one note to another, then those notes are a **whole step**, or **whole tone** apart.

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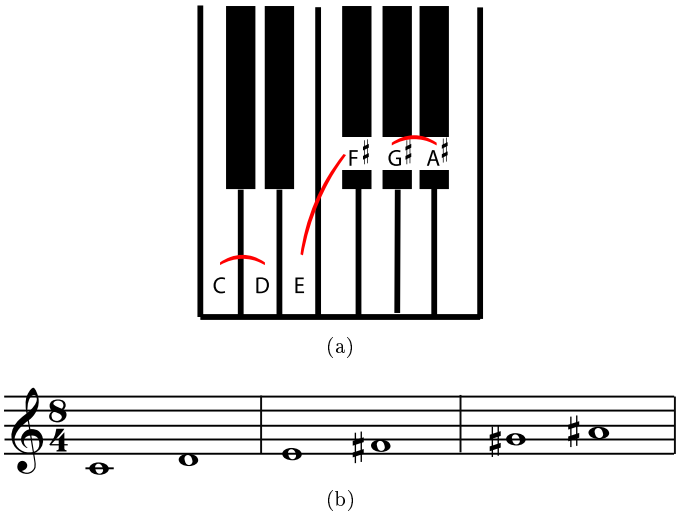
**Whole Steps**




(a)

(b)

**Figure 1.9:** Three whole step intervals: between C and D; between E and F sharp; and between G sharp and A sharp (or A flat and B flat).

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A **whole tone scale**, a scale made only of whole steps, sounds very different from a chromatic scale.

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**Whole Tone Scale**

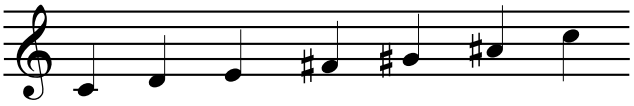

**Figure 1.10:** All intervals in a **whole tone scale** are whole steps.

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Listen[20] to a whole tone scale.

You can count any number of whole steps or half steps between notes; just remember to count all sharp or flat notes (the black keys on a keyboard) as well as all the natural notes (the white keys) that are in between.

[19] See the file at <http://cnx.org/content/m10866/latest/6a.mid>
[20] See the file at <http://cnx.org/content/m10866/latest/6b.mid>

**Example 1.2**
The interval between C and the F above it is 5 half steps, or two and a half steps.

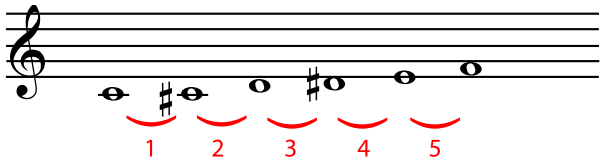


**Figure 1.11:** Going from C up to F takes five half steps.

**Exercise 1.2.1** ***(Solution on p. 25.)***
Identify the intervals below in terms of half steps and whole steps. If you have trouble keeping track of the notes, use a piano keyboard, a written chromatic scale, or the chromatic fingerings for your instrument to count half steps.

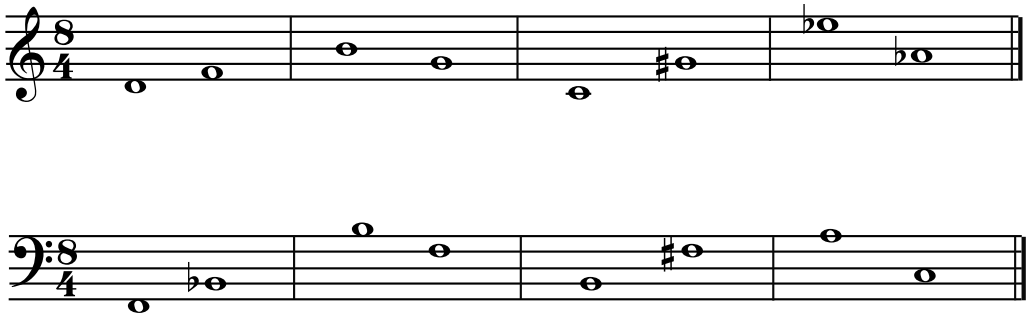

**Figure 1.12**

**Exercise 1.2.2** ***(Solution on p. 25.)***
Fill in the second note of the interval indicated in each measure. If you need staff paper for this exercise, you can print out this staff paper[21] PDF file.

[21] See the file at <http://cnx.org/content/m10866/latest/staffpaper1.pdf>

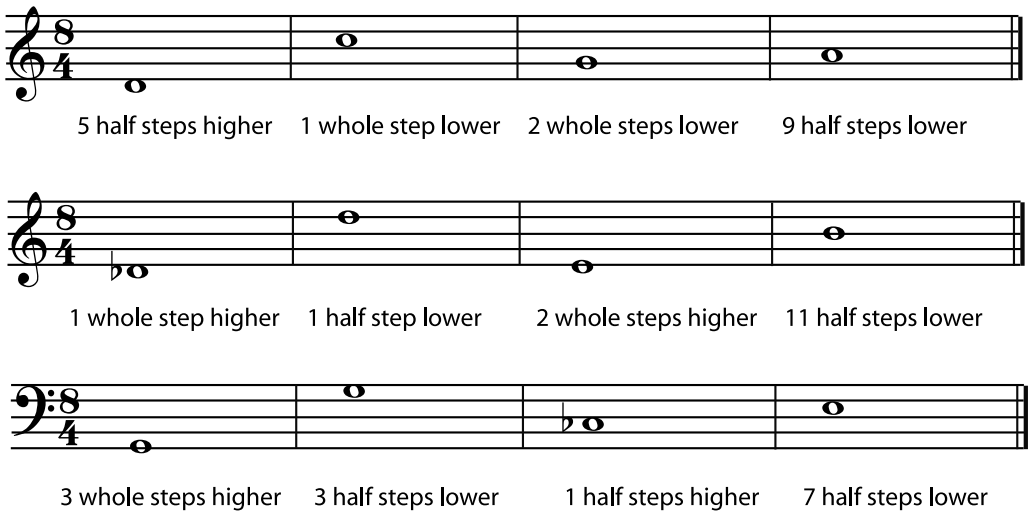


**Figure 1.13**

## 1.3 Interval[22]

### 1.3.1 The Distance Between Pitches

The **interval** between two notes is the distance between the two pitches[23] - in other words, how much higher or lower one note is than the other. This concept is so important that it is almost impossible to talk about scales (Section 2.1), chords[24], harmonic progression[25], cadence (Section 3.4), or dissonance (Section 3.5) without referring to intervals. So if you want to learn music theory, it would be a good idea to spend some time getting comfortable with the concepts below and practicing identifying intervals.

Scientists usually describe the distance between two pitches in terms of the difference between their frequencies[26]. Musicians find it more useful to talk about interval. Intervals can be described using half steps and whole steps (Section 1.2). For example, you can say "B natural is a half step below C natural", or "E flat is a step and a half above C natural". But when we talk about larger intervals in the major/minor system (Section 1.1), there is a more convenient and descriptive way to name them.

### 1.3.2 Naming Intervals

The first step in naming the interval is to find the distance between the notes **as they are written on the staff**. Count every line and every space in between the notes, as well as the lines or spaces that the notes are on. This gives you the number for the interval.

**Example 1.3**

[22]This content is available online at <http://cnx.org/content/m10867/2.27/>.
[23]"Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>
[24]"Harmony": Chords <http://cnx.org/content/m11654/latest/#l0b>
[25]"Harmony": Chords <http://cnx.org/content/m11654/latest/#l0b>
[26]"Frequency, Wavelength, and Pitch" <http://cnx.org/content/m11060/latest/>

**Counting Intervals**

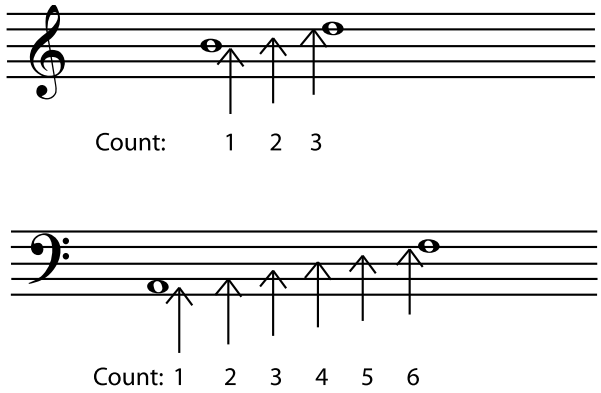


**Figure 1.14**

To find the interval, count the lines or spaces that the two notes are on as well as all the lines or spaces in between. The interval between B and D is a third. The interval between A and F is a sixth. Note that, at this stage, key signature[27], clef[28], and accidentals[29] do not matter at all.

The **simple intervals** are one octave or smaller.

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**Simple Intervals**

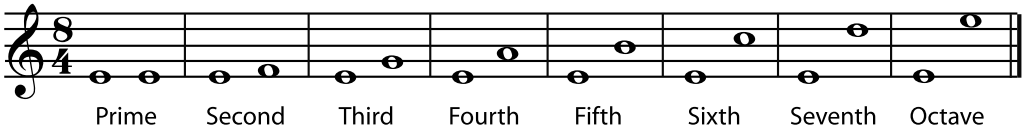


**Figure 1.15**

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If you like you can listen to each interval as written in Figure 1.15 (Simple Intervals): prime[30], second[31], third[32], fourth[33], fifth[34], sixth[35], seventh[36], octave[37].

**Compound intervals** are larger than an octave.

[27] "Key Signature" <http://cnx.org/content/m10881/latest/>
[28] "Clef" <http://cnx.org/content/m10941/latest/>
[29] "Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/#p0e>
[30] See the file at <http://cnx.org/content/m10867/latest/prime.mid>
[31] See the file at <http://cnx.org/content/m10867/latest/second.mid>
[32] See the file at <http://cnx.org/content/m10867/latest/third.mid>
[33] See the file at <http://cnx.org/content/m10867/latest/fourht.mid>
[34] See the file at <http://cnx.org/content/m10867/latest/fifth.mid>
[35] See the file at <http://cnx.org/content/m10867/latest/sixth.mid>
[36] See the file at <http://cnx.org/content/m10867/latest/seventh.mid>
[37] See the file at <http://cnx.org/content/m10867/latest/octave.mid>