Special Subjects in Music Theory

By:
Catherine Schmidt-Jones
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C O N N E X I O N S
Rice University, Houston, Texas
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Chapter 1

Transposition

1.1 Transposing Instruments

In order to make things run smoothly for composers, performers, piano tuners, and instrument makers, a standard has been developed that assigns a particular pitch to every written note. In other words, to save time and hassle, everybody has already agreed on what a C sounds like. This standard is called concert pitch. Most instruments are C instruments. The music for a C instrument is read and played at concert pitch.

A pianist, a cellist, a trombonist, and a flautist all see a C written in their parts. They may play the C in different octaves, but they will all play a note that the others recognize as a C. This may seem obvious, but a clarinetist who sees a C on the page will play a note that does not sound like a C to the other players. This is because the clarinet is a transposing instrument. The music for transposing instruments is not written or read at concert pitch. The clarinetist, for example, seeing a C on the page, will play a note that sounds like a Bb. The clarinet is therefore called a Bb instrument. A French horn player, seeing a C on his "horn in F" or "F horn" part, will play a note that sounds like an F. Obviously, not just the C but all the notes are different. For a Bb instrument, for example, not just the C sounds a whole step lower, but every note sounds a whole step lower than written. In order to be read correctly by most players, music for transposing instruments must be properly transposed (Section 1.2).

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1 This content is available online at <http://cnx.org/content/m10672/2.14/>.
2 "Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>.
3 "Octaves and the Major-Minor Tonal System" <http://cnx.org/content/m10862/latest/>.
4 "Clarinet" <http://cnx.org/content/m12604/latest/>.
5 "The French Horn" <http://cnx.org/content/m11617/latest/>.
6 "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>.
Since every note of the scale is changed, the result is a different scale\textsuperscript{7}. This means that the part for the transposing instrument will also be in a different key\textsuperscript{8} and have a different key signature\textsuperscript{9} than the parts for C instruments.

**Common Transposing Instruments**

- **Clarinet** is usually a Bb instrument. The most common clarinet\textsuperscript{10} sounds one whole step lower than written, so parts for it must be written one whole step higher than concert pitch. Like French horns, clarinets used to come in several different keys, and clarinets in A (with parts that are written a minor third higher) and other keys can still be found.
- **Alto and Baritone Saxophone** are Eb instruments. Parts for alto saxophone\textsuperscript{11} are transposed up a major sixth. Parts for bari sax are transposed up an octave plus a major sixth.
- **Tenor and Soprano Saxophone** are Bb instruments. Parts for soprano sax are written a step higher than they sound, and parts for tenor sax are transposed up an octave plus a whole step (a major ninth).
- **English Horn** is an F instrument. Parts for English horn\textsuperscript{12} are transposed up a perfect fifth.
- **Trumpet and Cornet**\textsuperscript{13} can be in B flat or C, depending on the individual instrument. B flat is the more common key for cornet. If you are writing for a particular player, you may want to find out if a C or B flat part is expected.

\textsuperscript{7}``Major Keys and Scales'' <http://cnx.org/content/m10851/latest/>
\textsuperscript{8}``Major Keys and Scales'' <http://cnx.org/content/m10851/latest/>
\textsuperscript{9}``Key Signature'' <http://cnx.org/content/m10881/latest/>
\textsuperscript{10}``Clarinets'' <http://cnx.org/content/m12604/latest/>
\textsuperscript{11}``Saxophones'' <http://cnx.org/content/m12611/latest/>
\textsuperscript{12}``The Oboe and its Relatives'' <http://cnx.org/content/m12615/latest/>
\textsuperscript{13}``Trumpets and Cornets'' <http://cnx.org/content/m12606/latest/>
• **French horn**14 parts are usually written in F these days, up a perfect fifth. However, because of the instrument’s history, older orchestral parts may be in any conceivable transposition, and may even change transpositions in the middle of a piece. Because of this, some horn players learn to transpose at sight.

• **Alto flute**15 is in G, written a fourth higher than it sounds.

• Tubas16 and euphoniums17 may also be transposing instruments. Some tuba and euphonium parts are written as bass clef C parts (sometimes even when the instrument played is nominally not a "C instrument"; see below (Some Non-transposing, Non-C Instruments, p. 5) for more about this). But in British-style brass bands, BBb and Eb tubas (called basses) are written in treble clef. The BBb is written two octaves and a major second higher than it sounds, and the Eb an octave and a major sixth higher than it sounds. In France (and in the case of parts printed in France), you find Bb euphoniums (called basses or petites basses) written for in bass clef transposing by a major second, and bass tubas (called contrebasses) in Bb written for in bass clef transposing by a major ninth. If you are writing for a particular group or player, you may want to check to see what kind of instrument is available and what transposition the player is comfortable with.

Some transposing instruments do not change key, but play an octave higher or lower than written.

• **Guitar**18 parts are written one octave higher than they sound.

• **Men’s voices**, when given a melody written in treble clef, will usually sing it one octave lower than written.

• **String Bass** parts are written one octave higher than they sound.

• **Piccolo**19 parts are written one octave lower than they sound.

• **Contrabassoon** parts are written one octave higher than they sound.

• **Handbell** and **handchime** parts are written one octave lower than they sound.

Things do run more smoothly when everyone agrees on the same name for the same sound. So why are there transposing instruments? The instruments that transpose an octave have either a very high or very low range. Transposition puts their written parts comfortably in the staff and avoids using too many harder-to-read ledger lines.

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14"The French Horn" <http://cnx.org/content/m11617/latest/>
15"Alto flute" <http://cnx.org/content/m12603/latest/>
16"Tubas" <http://cnx.org/content/m12617/latest/>
17"Baritones and Euphoniums" <http://cnx.org/content/m12650/latest/>
18"Guitars" <http://cnx.org/content/m12745/latest/>
19"Flutes" <http://cnx.org/content/m12603/latest/>
Some transpositions are for the convenience of the player. Someone who has learned to play C trumpet, for example, associates a particular note with a particular fingerling. If he switches to a B flat trumpet, he can use the same fingerings for the written notes, as long as the part has been appropriately transposed. If it has not (and some modern composers do not bother with transposition), he must learn to associate the same fingerings with different written notes, which can be confusing.

Other transpositions used to be for the convenience of the player, but are now mostly accidents of history. For example, there was a time when French horns, like harmonicas, came in every key, and could only play well in that key or closely related keys. French horn players could switch between different instruments playing what looked like the same set of notes, but which actually sounded in whatever key was needed. As the horn became capable of playing all notes equally well, the horn in F was the one that was chosen as having the nicest sound, so players still read parts in F.

There are also instruments that do not transpose but are also not considered C or concert-pitch instruments. Players of these instruments read concert-pitch music, but the instruments are considered to be fundamentally pitched on a note other than C. This is of very little practical importance, but is an issue that confuses some people, so let’s take two examples. Soprano and tenor recorders, when all the finger-holes are covered (so that the air must go through the entire instrument), play a C. Alto recorders, when all the finger-holes are covered, play an F. Like B flat trumpets, this would seem to make alto recorder a good candidate to be a transposing instrument. If it were, a player could easily switch from one size recorder to another; a written C would have the same fingerling on all instruments. But recorder history and tradition differ from trumpet history and tradition; so, although alto recorder can be considered to be "pitched in F", alto players learn to read at concert pitch, associating the fingerings with different notes than a soprano or tenor player would.

The second example is from brass instruments. The fundamental pitch of a woodwind (the recorder, for example) is considered to be the lowest note it can play when all holes are closed. The fundamental pitch of a brass instrument, on the other hand, is considered to be the fundamental of the harmonic series it plays when no valves are being used. For example, the C trumpet, using no valves, plays a harmonic series based on C, while a B flat (transposing) trumpet plays a B flat harmonic series. Tubas, on the other
hand, can be based on several different harmonic series, including C, B flat, F, and E flat. But these are not necessarily transposing instruments. A tuba player playing a B flat instrument may read a transposing B flat part, or may read concert-pitch music and simply use different fingerings for the same note than a player on a C instrument.

**Some Non-transposing, Non-C Instruments**

- **Alto recorder** - Fundamental note is an F.
- **Various tubas**[^25] - Can be in B flat, F, or E flat as well as C, and may be transposing or non-transposing, depending on the piece of music, the player, and the local tradition for the instrument.
- **Trombone**[^26] - "First position" is based on the B flat harmonic series.
- **Baritone and Euphonium**[^27] - These instruments are pitched in B flat, and may or may not be treated as a transposing instrument. Players may read either a bass clef[^28] non-transposed part, or a treble clef B flat transposed part in which the part is written a major ninth (an octave plus a whole step) higher than it is played. This curious circumstance accommodates both tuba players (who are accustomed to playing non-transposing bass clef parts) and cornet players (accustomed to playing treble clef B flat parts) who want to switch to the less-common baritone when needed.

### 1.2 Transposition: Changing Keys[^29]

Changing the key[^30] of a piece of music is called transposing the music. Music in a major key[^31] can be transposed to any other major key; music in a minor key[^32] can be transposed to any other minor key. (Changing a piece from minor to major or vice-versa requires many more changes than simple transposition.) A piece will also sound higher or lower once it is transposed. There are some ways to avoid having to do the transposition yourself, but learning to transpose can be very useful for performers, composers, and arrangers.

#### 1.2.1 Why Transpose?

Here are the most common situations that may require you to change the key of a piece of music:

- To put it in the right key for your **vocalists**. If your singer or singers are struggling with notes that are too high or low, changing the key to put the music in their range[^33] will result in a much better performance.
- Instrumentalists may also find that a piece is **easier to play** if it is in a different key. Players of both bowed and plucked strings generally find fingerings and tuning to be easier in sharp keys, while woodwind and brass players often find flat keys more comfortable and in tune.
- **Instrumentalists with transposing instruments** will usually need any part they play to be properly transposed before they can play it. Clarinet[^34], French horn[^35], saxophone[^36], trumpet, and cornet[^37] are the most common transposing instruments (Section 1.1).

[^25]: "Tubas" <http://cnx.org/content/m12617/latest/>
[^26]: "Trombones" <http://cnx.org/content/m12802/latest/>
[^27]: "Baritones and Euphoniums" <http://cnx.org/content/m12650/latest/>
[^28]: "Clef" <http://cnx.org/content/m10941/latest/>
[^29]: This content is available online at <http://cnx.org/content/m10668/2.13/>.
[^30]: "Major Keys and Scales" <http://cnx.org/content/m10851/latest/>
[^31]: "Minor Keys and Scales" <http://cnx.org/content/m10856/latest/>
[^32]: "Range" <http://cnx.org/content/m12381/latest/>
[^33]: "Clarinet" <http://cnx.org/content/m12604/latest/>
[^34]: "The French Horn" <http://cnx.org/content/m12617/latest/>
[^35]: "Saxophones" <http://cnx.org/content/m12606/latest/>
[^36]: "Trumpets and Cornets" <http://cnx.org/content/m12606/latest/>
1.2.2 Avoiding Transposition

In some situations, you can avoid transposition, or at least avoid doing the work yourself. Some stringed instruments - guitar for example - can use a capo to play in higher keys. A good electronic keyboard will transpose for you. If your music is already stored as a computer file, there are programs that will transpose it for you and display and print it in the new key. However, if you only have the music on paper, it may be easier to transpose it yourself than to enter it into a music program to have it transposed. So if none of these situations apply to you, it’s time to learn to transpose.

**NOTE:** If you play a chordal instrument (guitar, for example), you may not need to write down the transposed music. There are instructions below (Section 1.2.6: Transposing Chord Names) for transposing just the names of the chords.

1.2.3 How to Transpose Music

There are four steps to transposition:

1. Choose your transposition.
2. Use the correct key signature.
3. Move all the notes the correct interval.
4. Take care with your accidentals.

1.2.3.1 Step 1: Choose Your Transposition

In many ways, this is the most important step, and the least straightforward. The transposition you choose will depend on why you are transposing. If you already know what transposition you need, you can go to step two. If not, please look at the relevant sections below first:

- Are you rewriting the music for a transposing instrument (Section 1.2.4.2: Transposing Instruments)?
- Are you looking for a key that is in the range of your vocalist (Section 1.2.4.1: Working with Vocalists)?
- Are you looking for a key that is more playable (Section 1.2.4.3: Playable Keys) on your instrument?

1.2.3.2 Step 2: Write the New Key Signature

If you have chosen the transposition because you want a particular key, then you should already know what key signature to use. (If you don’t, see Key Signature.) If you have chosen the transposition because you wanted a particular interval (say, a whole step lower or a perfect fifth higher), then the key changes by the same interval. For example, if you want to transpose a piece in D major up one whole step, the key also moves up one whole step, to E major. Transposing a piece in B minor down a major third will move the key signature down a major third to G minor. For more information on and practice identifying intervals, see Interval. For further information on how moving music up or down changes the key signature, see The Circle of Fifths.

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38 Guitars
39 Key Signature
40 Interval
41 Pitch: Sharp, Flat, and Natural Notes
42 Key Signature
43 Interval
44 Half Steps and Whole Steps
45 Interval
46 The Circle of Fifths
Find the New Key

**Figure 1.3:** You must know the interval between the old and new keys, and you must know the new key signature. This step is very important; if you use the wrong key signature, the transposition will not work.

1.2.3.3 Step 3: Transpose the Notes

Now rewrite the music, changing all the notes by the correct interval. You can do this for all the notes in the key signature simply by counting lines and spaces. As long as your key signature is correct, you do not have to worry about whether an interval is major, minor, or perfect.
CHAPTER 1. TRANSPOSITION

Move all the Notes

Original key is F major.

Move the key and every note up a perfect fourth.

Move the key and every note down a minor third.

New key is B flat major.

New key is D major.

Figure 1.4: Did you move the key down a minor third? Simply move all the notes down a third in the new key; count down three lines-or-spaces to find the new spot for each note. Did you move the key up a perfect fourth? Then move all the notes up four lines-and-spaces. Remember to count every line and every space, including the ones the notes start on and end on. Once you get the hang of it, this step is very straightforward, but it may take a while if you have a lot of music.

1.2.3.4 Step 4: Be Careful with Accidentals

Most notes can simply be moved the correct number of lines and spaces. Whether the interval is minor, major, or perfect will take care of itself if the correct key signature has been chosen. But some care must be taken to correctly transpose accidentals. Put the note on the line or space where it would fall if it were not an accidental, and then either lower or raise it from your new key signature. For example, an accidental B natural in the key of E flat major has been raised a half step from the note in the key (which is B flat). In transposing down to the key of D major, you need to raise the A natural in the key up a half step, to A sharp. If this is confusing, keep in mind that the interval between the old and new (transposed) notes (B natural and A sharp) must be one half step, just as it is for the notes in the key.

NOTE: If you need to raise a note which is already sharp in the key, or lower a note that is already flat, use double sharps or double flats.\(^{47}\)

\(^{47}\)"Pitch: Sharp, Flat, and Natural Notes", Figure 6 <http://cnx.org/content/m10943/latest/#g22f>
Transposing Accidentals

Original E flat major

Transposed to D major

Transposed to E major

Figure 1.5: Flats don’t necessarily transpose as flats, or sharps as sharps. For example, if the accidental originally raised the note one half step out of the key, by turning a flat note into a natural, the new accidental may raise the note one half step out of the key by turning a natural into a sharp.

Exercise 1.1 (Solution on p. 19.)
The best practice for transposing is to transpose a piece you know well into a new key.

1.2.4 Choosing Your New Key

Before you can begin transposing, you must decide what your new key will be. This will depend on why you are transposing, and what kinds of vocalists and instrumentalists you are working with.

1.2.4.1 Working with Vocalists

If you are trying to accommodate singers, your main concern in choosing a key is finding their range. Is the music you are working with too high or too low? Is it only a step too high, or does it need to be changed by a third or a fifth? Once you determine the interval needed, check to make certain this will be a comfortable key for your instrumentalists.

Example 1
A church choir director wants to encourage the congregation to join in on a particular hymn. It is written in four parts with the melody in the soprano part, in a range slightly too high for untrained

48 "Major Keys and Scales" <http://cnx.org/content/m10851/latest/>
49 "Range" <http://cnx.org/content/m12381/latest/>
50 "Interval" <http://cnx.org/content/m10867/latest/>
singers. The hymn is written in the key of E flat. Lowering it by a minor third (one and a half steps) will allow the congregation to sing with gusto.

Figure 1.6: The hymn is originally in E flat. The melody that goes up to an F is too high for most untrained vocalists (male and female).

Figure 1.7: The same hymn in C is more easily singable by a congregation.

Example 1.2
An alto vocalist would like to perform a blues standard originally sung by a soprano or tenor in
B flat. She needs the song to be at least a whole step lower. Lowering it by a whole step would put it in the key of A flat. The guitar, bass, and harmonica players don’t like to play in A flat, however, and the vocalist wouldn’t mind singing even lower. So the best solution is to lower it by a minor third, and play in the key of G.

Figure 1.8: (a) The key of this blues standard is comfortable for a soprano or tenor, as shown in this excerpt. (b) An alto or baritone can deliver a more powerful performance if the music is transposed down a minor third.

Exercise 1.2  
(Solution on p. 19.)  
You’re accompanying a soprano who feels that this folk tune in C minor is too low for her voice. The guitar player would prefer a key with no flats and not too many sharps.

Figure 1.9: Tune in C minor too low for some sopranos voices.

1.2.4.2 Transposing Instruments

**Transposing instruments** are instruments for which standard parts are written higher or lower than they sound. A very accomplished player of one of these instruments may be able to transpose at sight, saving you the trouble of writing out a transposed part, but most players of these instruments will need a transposed part written out for them. Here is a short list of the most common transposing instruments. For a more complete list and more information, see Transposing Instruments (Section 1.1).

**Transposing Instruments**

- Clarinet is usually (but not always) a B flat instrument. Transpose C parts up one whole step for B flat instruments. (In other words, write a B flat part one whole step higher than you want it to sound.)
CHAPTER 1. TRANSPOSITION

- Trumpet and Cornet\textsuperscript{54} parts can be found in both B flat and C, but players with B flat instruments will probably want a B flat (transposed) part.
- French Horn\textsuperscript{55} parts are usually in F these days. However, because of the instrument’s history, older orchestral parts may be in any conceivable transposition, even changing transpositions in the middle of the piece. Because of this, some horn players learn to transpose at sight. Transpose C parts up a perfect fifth to be read in F.
- Alto and Baritone Saxophone\textsuperscript{56} are E flat instruments. Transpose parts up a major sixth for alto sax, and up an octave plus a major sixth for bari sax.
- Soprano and Tenor Saxophone\textsuperscript{57} are B flat instruments. Tenor sax parts are written an octave plus one step higher.

\textbf{NOTE:} Why are there transposing instruments? Sometimes this makes things easier on instrumentalists; they may not have to learn different fingerings when they switch from one kind of saxophone to another, for example. Sometimes, as with piccolo, transposition centers the music in the staff (rather than above or below the staff). But often transposing instruments are a result of the history of the instrument. See the history of the French horn\textsuperscript{58} to find out more.

The transposition you will use for one of these instruments will depend on what type of part you have in hand, and what instrument you would like to play that part. As with any instrumental part, be aware of the range\textsuperscript{59} of the instrument that you are writing for. If transposing the part up a perfect fifth results in a part that is too high to be comfortable, consider transposing the part down a perfect fourth instead.

\begin{enumerate}
\item \textbf{To Decide Transpositions for Transposing Instruments}
\begin{enumerate}
\item Ask: what type of part am I transposing and what type of part do I want? Do you have a C part and want to turn it into an F part? Do you want to turn a B flat part into a C part? \textbf{Non-transposing parts are considered to be C parts.} The written key signature has nothing to do with the type of part you have; only the part’s transposition from concert pitch (C part) matters for this step.
\item Find the interval between the two types of part. For example, the difference between a C and a B flat part is one whole step. The difference between an E flat part and a B flat part is a perfect fifth.
\item Make sure you are transposing in the correct direction. If you have a C part and want it to become a B flat part, for example, you must transpose up one whole step. This may seem counterintuitive, but remember, \textbf{you are basically compensating for the transposition that is "built into" the instrument.} To compensate properly, always transpose by moving in the opposite direction from the change in the part names. To turn a B flat part into a C part (B flat to C = up one step), transpose the part down one whole step. To turn a B flat part into an E flat part (B flat to E flat = down a perfect fifth), transpose the part up a perfect fifth.
\item Do the correct transposition by interval (Section 1.2.3.2: Step 2: Write the New Key Signature), including changing the written key by the correct interval.
\end{enumerate}
\end{enumerate}

\textbf{Example 1.3}
Your garage band would like to feature a solo by a friend who plays the alto sax. Your songwriter has written the solo as it sounds on his keyboard, so you have a C part. Alto sax is an E flat instrument; in other words, when he sees a C, he plays an E flat, the note a major sixth\textsuperscript{60} lower. To compensate for this, you must write the part a major sixth higher than your C part.

\textsuperscript{54}"Trumpets and Cornets" <http://cnx.org/content/m12606/latest/>
\textsuperscript{55}"The French Horn" <http://cnx.org/content/m11617/latest/>
\textsuperscript{56}"Saxophones" <http://cnx.org/content/m12611/latest/>
\textsuperscript{57}"Saxophones" <http://cnx.org/content/m12611/latest/>
\textsuperscript{58}"The French Horn": Section History <http://cnx.org/content/m11617/latest/#s2>
\textsuperscript{59}"Range" <http://cnx.org/content/m12381/latest/>
\textsuperscript{60}"Interval": Major and Minor Intervals <http://cnx.org/content/m10867/latest/#list22a>
Figure 1.10: In the top line, the melody is written out in concert pitch; on the second line it has been transposed to be read by an alto saxophone. When the second line is played by an alto sax player, the result sounds like the first line.

Example 1.4
Your choral group is performing a piece that includes an optional instrumental solo for clarinet. You have no clarinet player, but one group member plays recorder, a C instrument. Since the part is written for a B flat instrument, it is written one whole step higher than it actually sounds. To write it for a C instrument, transpose it back down one whole step.

Figure 1.11: (a) Melody for B flat clarinet (b) Melody transposed for C instruments

Exercise 1.3
(Solution on p. 19.)
There’s a march on your community orchestra’s program, but the group doesn’t have quite enough trombone players for a nice big march-type sound. You have extra French horn players, but they can’t read bass clef C parts.

Figure 1.12: Trombone line from a march
1.2.4.3 Playable Keys

Transposition can also make music easier to play for instrumentalists, and ease of playing generally translates into more satisfying performances. For example, transcriptions for band of orchestral works sometimes change the (often sharp) orchestral key to a nearby key with more flats. A guitar player, given a piece written in A flat for keyboard, will often prefer to play it in A or G, since the fingerings for chords in those keys are easier. Also, instrumentalists, like vocalists, have ranges that need to be considered.

Example 1.5

Your eighth grade bassoon player would like to play a Mozart minuet at a school talent show with a flute-playing friend from band. The minuet is in C, but the melody is a little too low for a flute, and the bassoonist would also be more comfortable playing higher. If you transpose the whole piece up a minor third to E major, both players can hit the lowest notes, and you may also find that fingerings and tunings are better in the flat key.

![Example Minuet](http://cnx.org/content/m12745/latest/)

Figure 1.13: (a) An excerpt from a Mozart Minuet in C. The upper part is too low for a flute player. (b) Both young instrumentalists would be more comfortable playing in this key.

Exercise 1.4

You’ve brought your guitar and your capo to the sing-along because you’d like to play along, too. Going through the music beforehand, you notice that your favorite song is in A flat. The pianist isn’t prepared to play it in any other key, but you really don’t like those thin-sounding chords in A flat. You can use your capo to raise the sound of your instrument (basically turning it into a transposing instrument in C sharp, D, D sharp, or even higher), but the less you raise it the more likely you are to still sound in tune with the piano.

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61 "Guitars" <http://cnx.org/content/m12745/latest/>
62 "Range" <http://cnx.org/content/m12381/latest/>
63 "Bassoons" <http://cnx.org/content/m12612/latest/>
64 "Flutes" <http://cnx.org/content/m12603/latest/>
65 "Guitars" <http://cnx.org/content/m12745/latest/>
1.2.5 Transposing at Sight

Transposing at sight means being able to read a part written in one key while playing it in another key. Like any other performance skill, it can be learned with practice, and it is a skill that will help you become an extremely versatile instrumentalist. (Vocalists transpose at sight without even thinking about it, since they don’t have to worry about different fingerings.) To practice this skill, simply start playing familiar pieces in a different key. Since you know the piece, you will recognize when you make a mistake. Start with pieces written in C, and play them only a half step or whole step lower or higher than written. When this is easy, move on to more challenging keys and larger intervals. Practice playing in an unfamiliar clef\[^{66}\] for example bass clef if you are used to reading treble clef. Or, if you play a transposing instrument (Section 1.1), work on being able to play C parts on sight. You may find more opportunities to play (and earn the gratitude of your fellow musicians) if you can say, "we can change keys if you like", or "I can cover that bass clef C part for you, no problem."

1.2.6 Transposing Chord Names

If you are transposing entire chords, and you know the name of the chord, you may find it easier to simply transpose the name of the chord rather than transposing each individual note. In fact, transposing in this way is simple enough that even a musician who can’t read music can do it.

\[^{66}\text{Clef}\] <http://cnx.org/content/m10941/latest/>
CHAPTER 1. TRANPOSITION

Chromatic Circle

Figure 1.15: When transposing, you can use the chromatic\textsuperscript{67} circle both to change the name of the key (as above (Figure 1.3: Find the New Key)) and to change chord names, because the basic idea is the same; the entire piece (chords, notes, and key) must move the same number of half steps\textsuperscript{68} in the same direction. If you’re using a chromatic circle to transpose the names of all the chords in a piece, just make sure that you move each chord name by the same amount and in the same direction.

1.2.6.1 Step 1: Choose Your Transposition

Your choice of new key will depend on why you are transposing, but it may depend on other things, also.

- If you are transposing because the music is too low or too high, decide how much higher or lower you want the music to sound. If you want the music to sound higher, go around the chromatic circle (Figure 1.15: Chromatic Circle) in the clockwise direction. If you want it lower, go in the counterclockwise direction. The further you go, the more it will change. Notice that, since you’re going in a circle, raising the music a lot eventually gives the same chords as lowering it a little (and vice-versa). If some keys are easier for you to play in than others, you may want to check to make sure the key you choose has "nice" chords. If not, try another key near it.
- If you are changing keys in order to make the chords easy to play, try changing the final chord so that it names an easy-to-play-in key. (Guitarists, for example, often find the keys G, D, A, E, C, Am, Em, and Dm easier to play in than other keys.) The last chord of most pieces will usually be the chord that names the key. If that doesn’t seem to work for your piece, try a transposition that makes the most common chord an easy chord. Start changing the other chords by the same amount, and in the same direction, and see if you are getting mostly easy-to-play chords. While deciding on a new key, though, keep in mind that you are also making the piece higher or lower, and choose keys accordingly. A guitarist who wants to change chords without changing the pitch\textsuperscript{69} should lower the key (go counterclockwise on the circle) by as short a distance as possible to find a playable key. Then capo\textsuperscript{70} at the fret that marks the number of keys moved. For example, if you moved counterclockwise by three keys, put the capo at the third fret.

\textsuperscript{67} "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/#p0bb>
\textsuperscript{68} "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>
\textsuperscript{69} "Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>
\textsuperscript{70} "Guitars" <http://cnx.org/content/m12745/latest/#p9c>
• If you are changing keys to **play with another instrumentalist** who is transposing or who is playing in a different key from you, you will need to figure out the correct transposition. For a transposing instrument (p. 11), look up the correct transposition (the person playing the instrument may be able to tell you), and move all of your chords up or down by the correct number of half steps. (For example, someone playing a B flat trumpet will read parts one step - two half steps - lower than concert pitch (p. 1). So to play from the same part as the trumpet player, move all the chords counterclockwise two places.) If the instrumental part is simply written in a different key, find out what key it is in (the person playing it should be able to tell you, based on the key signature\(^{71}\)) and what key you are playing in (you may have to make a guess based on the final chord of the piece or the most common chord). Use the chromatic circle to find the direction and number of half steps to get from your key to the other key.

### 1.2.6.2 Step 2: Change the Names of All the Chords

Using the chromatic circle to count keys, change the note names in all of the chords by the same amount (the same number of half steps, or places in the chromatic circle) and in the same direction. Change only the note names (things like "F" and "C sharp" and "B flat"); don’t change any other information about the chord (like major, minor, dim., 7, sus4, add11, etc.). If the bass note of the chord is written out as a note name, change that, also (using the same chromatic circle).

Check your transposition by playing it to see if it sounds right. If you don’t like playing some of the chords in your new key, or if you have changed the key too much or not enough, try a different transposition.

**Example 1.6**

Say you have a song in the key of G, which is too low for your voice. If it’s just a little too low, you can go up two keys to A. If this is still too low, you can go up even further (5 keys altogether) to the key of C. Maybe that’s high enough for your voice, but you no longer like the chords. If that is the case, you can go up two more keys to D. Notice that, because the keys are arranged in a circle, going up seven keys like this is the same as going down five keys.

<table>
<thead>
<tr>
<th>Original Key</th>
<th>G</th>
<th>B♭</th>
<th>B♭6</th>
<th>B♭M7</th>
<th>E♭M7</th>
<th>E♭+</th>
<th>A7</th>
<th>D/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 keys higher</td>
<td>A</td>
<td>C</td>
<td>C6</td>
<td>C M7</td>
<td>F M7</td>
<td>F+</td>
<td>B7</td>
<td>E/B</td>
</tr>
<tr>
<td>5 keys higher</td>
<td>C</td>
<td>E</td>
<td>E♭6</td>
<td>E♭M7</td>
<td>A♭M7</td>
<td>A♭+</td>
<td>D7</td>
<td>G/D</td>
</tr>
<tr>
<td>7 keys higher</td>
<td>D</td>
<td>F</td>
<td>F6</td>
<td>F M7</td>
<td>B♭M7</td>
<td>B♭+</td>
<td>E7</td>
<td>A/E</td>
</tr>
</tbody>
</table>

**Figure 1.16**

**Example 1.7**

Now say you have a song in the key of E flat. It’s not hard to sing in that key, so you don’t want to go far, but you really don’t like playing in E flat. You can move the song up one key to E, but you might like the chords even better if you move them down one key to D. Notice that if you are a guitar player, and everyone else really wants to stay in E flat, you can write the chords out in D and play them with a capo on the first fret; to everyone else it will sound as if you’re playing in E flat.

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\(^{71}\)"Key Signature" - [http://cnx.org/content/m10881/latest/]
Exercise 1.5

Now say that you have a song that is in B flat, which is more than a little (more than one key) too high for you. Find a key a bit lower that still has nice, easy-to-play chords for guitar.

\[
\begin{align*}
\text{Original Key} & : & E^b & Gm & A^b & D^b & B^b7 & B^b9 & Cm & Gm \\
1 \text{ key higher} & : & E & G^b & A & D & B & B & C & G^\#m \\
1 \text{ key lower} & : & D & F^b & G & C & A^7 & A & 9 & B & F^b & G^\#m
\end{align*}
\]  

Figure 1.17

(Solution on p. 20.)
Solutions to Exercises in Chapter 1

Solution to Exercise 1.1 (p. 9)
Play the part you have transposed; your own ears will tell you where you have made mistakes.

Solution to Exercise 1.2 (p. 11)
Transposing up a major third\(^\text{72}\), to E minor, puts the song in a better range for a soprano, with a key signature that is easy for guitars.

![Figure 1.19: Moving tune up to E minor puts it in a better key for sopranos.](image)

Solution to Exercise 1.3 (p. 13)
The trombone part is in C in bass clef; the horn players are used to reading parts in F in treble clef. Transpose the notes up a perfect fifth and write the new part in treble clef.

![Figure 1.20:](image)

Solution to Exercise 1.4 (p. 14)
Put the capo on the first fret to raise the sound by one half step. Then transpose the chords down one half step. You will be playing in G, a nice strong key for guitar, but sounding in A flat. For more on transposing chords, see the final section below (Section 1.2.6: Transposing Chord Names)

\(^{72}\)"Interval": Major and Minor Intervals <https://cnx.org/content/m10867/latest/#list22a>
Solution to Exercise 1.5 (p. 18)
The best solution here is probably to put the song in the key of G. This is three keys lower, and has easy chords.

\[
\begin{align*}
G & \quad Em & \quad Am7 & \quad D7 & \quad C & \quad A9 & \quad G9 & \quad Em
\end{align*}
\]

Figure 1.22
Chapter 2

Rhythm

2.1 Syncopation

A syncopation or syncopated rhythm is any rhythm that puts an emphasis on a beat, or a subdivision of a beat, that is not usually emphasized. One of the most obvious features of Western (Section 3.1) music, to be heard in most everything from Bach to blues, is a strong, steady beat that can easily be grouped evenly into measures. (In other words, each measure has the same number of beats, and you can hear the measures in the music because the first beat of the measure is the strongest. See Time Signature and Meter for more on this.) This makes it easy for you to dance or clap your hands to the music. But music that follows the same rhythmic pattern all the time can get pretty boring. Syncopation is one way to liven things up. The music can suddenly emphasize the weaker beats of the measure, or it can even emphasize notes that are not on the beat at all. For example, listen to the melody in Figure 2.1.

![Expected emphasis on beats 1 and 3](image)

**Figure 2.1:** A syncopation may involve putting an "important" note on a weak beat, or off the beat altogether.

The first measure clearly establishes a simple quadruple meter ("ONE and two and THREE and four and"), in which important things, like changes in the melody, happen on beat one or three. But then, in the

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1This content is available online at <http://cnx.org/content/m11644/1.4/>.
2"Rhythm" <http://cnx.org/content/m11646/latest/>
3"Time Signature": Section Beats and Measures <http://cnx.org/content/m10956/latest/#s1>
4"Time Signature": Section Beats and Measures <http://cnx.org/content/m10956/latest/#s1>
5"Time Signature" <http://cnx.org/content/m10956/latest/>
6"Meter in Music" <http://cnx.org/content/m12405/latest/>
7<http://cnx.org/content/m11644/latest/Syncopation.MID>
8"Meter in Music" <http://cnx.org/content/m12405/latest/>
second measure, a syncopation happens; the longest and highest note is on beat two, normally a weak beat. In the syncopation in the third measure, the longest note doesn’t even begin on a beat; it begins half-way through the third beat. (Some musicians would say "on the up-beat" or "on the 'and' of three".) Now listen to another example from a Boccherini minuet. Again, some of the long notes begin half-way between the beats, or "on the up-beat". Notice, however, that in other places in the music, the melody establishes the meter very strongly, so that the syncopations are easily heard to be syncopations.

Figure 2.2: Syncopation is one of the most important elements in ragtime music, as illustrated in this example from Scott Joplin’s Peacherine Rag. Notice that the syncopated notes in the melody come on the second and fourth quarters of the beat, essentially alternating with the strong eighth-note pattern laid down in the accompaniment.

Another way to strongly establish the meter is to have the syncopated rhythm playing in one part of the music while another part plays a more regular rhythm, as in this passage from Scott Joplin (see Figure 2.2). Syncopations can happen anywhere: in the melody, the bass line, the rhythm section, the chordal accompaniment. Any spot in the rhythm that is normally weak (a weak beat, an upbeat, a sixteenth of a beat, a part of a triplet) can be given emphasis by a syncopation. It can suddenly be made important by a long or high note in the melody, a change in direction of the melody, a chord change, or a written accent. Depending on the tempo of the music and the type of syncopation, a syncopated rhythm can make the music sound jaunty, jazzy, unsteady, surprising, uncertain, exciting, or just more interesting.

Figure 2.3: Syncopation can be added just by putting accents in unexpected places.

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9 http://cnx.org/content/m11644/latest/metasync.mp3
10 "Ragtime" <http://cnx.org/content/m10878/latest/>
11 http://cnx.org/content/m11644/latest/sync2.mid
12 "Melody" <http://cnx.org/content/m11647/latest/
13 "Harmony": Accompaniment <http://cnx.org/content/m11654/latest/#l0c>
14 "Harmony": Accompaniment <http://cnx.org/content/m11654/latest/#l0c>
15 "Dynamics and Accents in Music" <http://cnx.org/content/m11649/latest/#p0d>
16 "Tempo" <http://cnx.org/content/m11648/latest/>
17 "Dynamics and Accents in Music" <http://cnx.org/content/m11649/latest/#p0d>
Other musical traditions tend to be more rhythmically complex than Western music, and much of the syncopation in modern American music is due to the influence of Non-Western (Section 3.1) traditions, particularly the African roots of the African-American tradition. Syncopation is such an important aspect of much American music, in fact, that the type of syncopation used in a piece is one of the most important clues to the style and genre of the music. Ragtime, for example, would hardly be ragtime without the jaunty syncopations in the melody set against the steady unsyncopated bass. The "swing" rhythm in big-band jazz and the "back-beat" of many types of rock are also specific types of syncopation. If you want practice hearing syncopations, listen to some ragtime or jazz. Tap your foot to find the beat, and then notice how often important musical "events" are happening "in between" your foot-taps.

18“Ragtime” <http://cnx.org/content/m10878/latest/>
Chapter 3

Non-Western Music

3.1 What Kind of Music is That?

One of the first things needed when you begin the study of any subject is a little introduction to the "lingo." Since music is such a huge subject, some of the words used to talk about it are the terms that divide it up into smaller subjects, the way science is divided into biology, physics, and so on. So here are a few terms that may be useful if you are wondering what kind of music you want to learn more about.

3.1.1 Western and Non-Western

Most of the music books you'll find on the shelf are about Western music. From the end of the Middle Ages to modern times, composers and performers in western Europe gradually developed widely accepted standards for tuning (Section 3.2), melody\(^1\), harmony\(^2\), meter\(^3\), notation\(^4\), form\(^5\), counterpoint\(^6\) and other music basics. These rules are a sort of grammar for the language of music. Just as the basic rules for putting together sentences and paragraphs help people understand each other, knowing what to expect from a piece of music helps people understand and like it.

Of course, music, like language, changes through the centuries. A Bach invention, a Brahms symphony, and a Beatles song are different forms in different genres, and at first they may sound as if they have nothing in common. But they all use the same musical "language" and follow basically the same rules. They are all examples of Western music, and are all more like each other than they are like a Navajo lullaby, a Chinese opera, or a west African praise song.

Wherever Europeans went during the colonial era, they took their music with them. So, in places like Australia and the Americas, not only do most of the people speak European languages, much of their music also sounds Western. What are the rules of this European musical language? A complete answer to that question would be long and complex, since Western music, like any living language shared by many different communities, has many "local dialects". The short answer is: Western music is generally tonal (Section 3.1.3: Tonal, Atonal, and Modal Music), based on major\(^8\) or minor\(^9\) scales, using an equal temperament tuning (Section 3.2.3.2: Equal Temperament), in an easy-to-recognize meter\(^10\), with straightforward rhythms\(^11\),

\(^1\)This content is available online at <http://cnx.org/content/m11421/1.8/>.
\(^2\)"Melody" <http://cnx.org/content/m11647/latest/>
\(^3\)"Harmony" <http://cnx.org/content/m1354/latest/>
\(^4\)"Meter in Music" <http://cnx.org/content/m12405/latest/>
\(^5\)"The Staff" <http://cnx.org/content/m10880/latest/>
\(^6\)"Form in Music" <http://cnx.org/content/m10842/latest/>
\(^7\)"An Introduction to Counterpoint" <http://cnx.org/content/m13653/latest/>
\(^8\)"Major Keys and Scales" <http://cnx.org/content/m10851/latest/>
\(^9\)"Minor Keys and Scales" <http://cnx.org/content/m10856/latest/>
\(^10\)"Meter in Music" <http://cnx.org/content/m12405/latest/>
\(^11\)"Rhythm" <http://cnx.org/content/m11646/latest/>
fairly strict rules on harmony\textsuperscript{12} and counterpoint\textsuperscript{13}, and not much improvisation. This is, of course, a huge generalization. Twentieth century art music, in particular, was very interested in breaking down or even rejecting these rules. But because they are flexible enough to allow plenty of interesting but easy-to-grasp music, the rules are still widely used, particularly in popular music. In fact, the use of these traditional rules for Western music is now so widespread that it is sometimes called \textit{common practice}. They are what makes Western music sound familiar and easy to understand.

\textbf{Non-Western music} is any music that grew out of a different culture or musical tradition than the European. For someone who grew up listening to Western music, Non-Western music will have a recognizably exotic sound. This comes from the use of different tuning systems (Section 3.2), different scales (Section 3.3), different vocal styles and performance practices, and different approaches to melody and harmony.

\textit{Note:} You may find the terms "Western" and "Non-Western" to be too Eurocentric, but they are very well entrenched, so you’ll need to know what they mean. If you want to avoid using the terms yourself, you can be more specific. You can speak, for example, of European classical or the European-American folk tradition, as opposed to Indian Classical\textsuperscript{14}, Japanese folk, or African-American musics.

\textbf{3.1.2 Jazz, Blues, and World Music}

Much of the music that is popular today cannot really be classified as completely Western or Non-Western. Since colonial times, when European cultures came into contact with many Non-Western cultures, musicians on all sides have been experimenting with music that is a blend of "the best of both worlds." Many musical styles have been invented that mix Western and Non-Western traditions. Perhaps the oldest and most widely popular of these styles are the ones that join European and African musical traditions. These include various \textit{Latin} (from Central and South America, some of which also include Native American influences) and \textit{Caribbean} traditions, and from North America, many different kinds of \textit{jazz} and \textit{blues}. Most American popular (Section 3.1.5: Folk and Popular music) musics also grew out of this blending of traditions.

But the process of inventing new ways of fusing Western and Non-Western music continues today in countries all over the world. The term \textbf{World Music} is often used as a catch-all category referring to almost any music with widespread popularity that clearly does not sound like North American popular music. This includes older blended traditions such as rumba and samba, newer but well-established blended genres such as reggae and Afrobeat, and groups with unique experimental sounds borrowing from more than one tradition. Folk and traditional music from around the world is also sometimes included, but the most popular genres in this category tend to be those, such as Flamenco, Hungarian folk, and Celtic music, that are easy for Western-trained ears to understand. African-American traditions are so basic to popular music that they are generally not included in World music, but other North American traditions, such as Native American and Cajun traditions, sometimes are.

\textbf{3.1.3 Tonal, Atonal, and Modal Music}

As mentioned above, Western music has not remained static through the centuries, either. It has changed and evolved as composers experimented with new sounds, ideas, and even new or evolving instruments.

Medieval European music, like many Non-Western traditions, was modal (Section 3.4). This means that a piece of music was not in a particular key\textsuperscript{15} based on a major\textsuperscript{16} or minor\textsuperscript{17} scale. Instead, it was in a particular \textit{mode}. A mode may look very much like a scale, since it lists the notes that are "allowed" in the piece of music and defines the tonic\textsuperscript{18} of the music. But a mode is usually also a collection of melodies,
melo dic phrases, or patterns that are found in that mode and not others (since the various modes are more different from each other than the various scales). Modes also may imply or suggest specific moods or they may be meant to have particular effects on the character of the listener.

Different keys may also evoke different moods, but the main purpose of a key is to define the chords\(^\text{19}\) and harmonic progressions\(^\text{20}\) that will be expected from a piece of music. From the Renaissance to the present day, most Western music has tended to be tonal. Tonal music is music in which the progression of the melody and harmony gives the strong feeling that the piece has a note and chord that are its "home base", so to speak (the tonic\(^\text{21}\) of the key). Think of a very familiar tune, perhaps "Row, Row, Row your Boat" or "Happy Birthday to You". Imagine how frustrating it would be to end that tune without singing the last note or playing the final chord. If you did this, most people would be so dissatisfied that they might supply that last note for you. That note is the tonal center of the tune, and without it, there is a feeling that the song has not reached its proper resting place. In tonal music, just about any melody is allowed, as long as it fits into the harmonies as they wander away from and then head back to their home base. Most Western tonal music is based on major and minor scales, both of which easily give that strongly tonal feeling. Some other scales, such as blues scales (Section 3.3.5: Constructing a Blues Scale), also work well within a tonal framework, but others, such as whole-tone scales (p. 41), do not.

Most of the Western music that is popular today is tonal, but around the beginning of the twentieth century, composers of "Classical" or Art music (see below (Section 3.1.4: Classical and Art Music)) began experimenting with methods of composing atonal music. "Atonal" literally means "not tonal". As the name implies, atonal music treats all notes and harmonies as equal and in fact tries to avoid melodies and harmonies that will make the piece sound tonal. One type of atonal music is twelve-tone music, which seeks to use each of the notes of the chromatic scale\(^\text{22}\) equally. Other pieces may even dispense with the idea that music has to consist of notes; compositions may be collections of sounds and silences. Since the music is not organized by the familiar rules of Western music, many people have trouble appreciating atonal music without some help or study.

Music can be more or less tonal without becoming completely atonal, however. Music that does not stray at all from its key is called diatonic. Many Western children's songs, folk songs, and pop songs are in this category. But composers often add some notes or even whole sections of music that are from a different key, to make the music a little more complex and interesting. Music that goes even further, and freely uses all the notes of the chromatic scale\(^\text{23}\), but still manages to have a tonal "home", is called chromatic. Music that has more than one tonal center at the same time (Ives was particularly fond of this composition technique) is called polytonal.

### 3.1.4 Classical and Art Music

Popular music is, by definition, music that appeals to many people. You don’t have to know anything about music to like a pop tune - it’s "catchy". Art music is a catch-all term for any music that is enjoyed by a smaller crowd. This can include the more challenging types of jazz and rock music, as well as Classical. Most people agree that the appreciation of art music requires some study, careful listening, or other extra effort. But it can be harder to agree on what exactly belongs in this category. This is at least partly because popular tastes do change. For example, most operas were written to be popular, middle-class entertainments, and artists such as Liszt and Paganini enjoyed rock-star-like fame and popularity in their day. Today, however, nineteenth century operas are no longer considered popular entertainment, and popular works that could technically be considered opera - except for the fact that they are written in popular musical styles - are instead grouped with musicals. As another example, ragtime\(^\text{24}\) was wildly popular during Scott Joplin’s\(^\text{25}\)
lifetime. It later fell out of favor and was known only to some jazz connoisseurs. Then in the 1970's it became popular again.

Classical music is a confusing term with more than one meaning. In the visual arts, the term classical refers to ancient Greece and Rome. In the 1700's, Western Europeans became very interested in the ancient classical style, which was imitated by many artists, sculptors, and architects. Art historians call that period the neoclassical ("new classical"). Unfortunately, nobody really knows what the music of ancient times sounded like. So instead of being influenced by the sound of ancient Greek music, eighteenth-century composers were influenced by the ideals of classical art. The music of Mozart, Haydn, and the early works of Beethoven are in this style, which we call classical rather than neoclassical, because the original classical music of ancient Greece and Rome is lost. (And actually, it probably would sound very exotic and Non-Western to us if we could listen to it!)

So the original classical music comes from one fairly short era. The other great composers of Western music lived during other periods: Bach and Handel were Baroque era composers, for example; Brahms and Wagner, Romantic; and Ravel and Debussy, Impressionist. But most people do not know which music is from which period. So all of the music of the great Western composers of the past (as well as modern art music that is part of the same tradition) is lumped together and called classical. The art music of other cultures is also often called classical; for example, people speak of the classical music of India.

3.1.5 Folk and Popular music

The terms "folk music" and "pop music" also have more than one meaning. The folk music of a culture is the music that is passed down from one generation to the next, often without writing it down. It includes many different kinds of music: lullabies and children's singing games, tunes that everyone enjoys singing together or dancing to, songs for celebrations, ceremonies, and holidays. Folk music can gradually change as it gets passed along. Usually nobody remembers who originally wrote it, or who changed it, and there may be more than one version of any particular folk song. Since ancient times, folk music has been the music of ordinary people, not the ruling class or professional musicians. In every culture, children learned and remembered the music that everyone enjoyed the most, and the music that was important to their traditions.

The modern recording industry has changed things, though. In many cultures, pop music has largely replaced folk music as the music that everyone knows. Unlike folk music, it has usually been written recently and belongs to professional musicians, and new popular tunes quickly replace old ones. Even the types of music that are considered popular can change quickly. The term pop music can refer to a specific kind of popular music, as in "bubblegum pop". Popular music is also a general term for any type of music that is or has been a top seller. This includes most types of rock music and some kinds of jazz.

As the rise of recording pushed aside traditional music, some musicians made a point of recording traditional folk songs, so they would not be lost altogether. Some also wrote new songs in a "folk" style that enjoyed some popularity, particularly in the 1960's. Although these modern tunes do not fit the traditional definition, they are also called folk music.

3.1.6 Suggestions for Listening and Further Study

It can be difficult to follow a discussion of music without hearing some examples. If you would like to hear some music in the categories above, or you are planning to present this lesson to a class, here are some easy-to-find suggestions. Some categories also include suggestions for where to start if you want more information.

3.1.6.1 Tonal, Atonal, and Modal Music

- To hear tonal music, turn on the radio and listen to just about any station, unless your Classical station is playing twentieth century music.

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26 "The Music of the Romantic Era" <http://cnx.org/content/m11606/latest/>
In the modal music category, medieval chant and the classical music of India are easiest to find.

Even in the category of twentieth century music, the shelves tend to be stocked with the work of composers who stayed with some sort of tonality (Ralph Vaughan Williams, George Gershwin, and Aaron Copland, for example). For atonality look for John Cage, Arnold Schoenberg, Anton Webern, or Edgard Varese.

3.1.6.2 Western Classical

- From the actual classical period: listen to anything by Mozart or Haydn, or Beethoven's early works.
- From other periods: listen to Bach or Vivaldi (Baroque), Brahms, Schubert, Chopin, or Tchaikovsky, or Beethoven's later works (Romantic), Ravel or Debussy (Impressionist), Stravinsky, Hindemith, or Schoenberg (Modern).
- A *History of Western Music* by Donald Jay Grout is a scholarly source of information.
- Most standard music dictionaries and encyclopedias also focus almost exclusively on Western Classical music.
- For children, there are many appropriate picture books and even videos on the lives and music of the most famous composers. Also, look for picture books that summarize the plot of a famous opera or ballet.
- Any standard music theory book or course will introduce the basics of Western music.

3.1.6.3 Non-Western Classical

- The only easy-to-find items in this category are Indian Classical music, for example the performances of Ravi Shankar.
- A web search for classical music from a particular country may turn up some sound clips. At the time of this writing, for example, sound clips could be found of Chinese Opera\(^\text{27}\) and Tunisian\(^\text{28}\) classical music.

3.1.6.4 Western Folk

- For the sound of traditional Western folk music, look for collections of folk music from England or Australia, sea shanties, or American cowboy songs. For young students, Wee Sing's *"Fun 'n' Folk"* and *"Sing-Alongs"* book-and-tape sets are good sources.
- To hear modern folk-style music, listen to Joan Baez, John Denver, Bob Dylan's protest music, Simon and Garfunkel, or Peter, Paul and Mary.
- The Rough Guide series of books and recordings includes some that examine modern folk artists. This would be a good place to start learning more on the subject of modern folk music.

3.1.6.5 Non-Western Folk

- If you live in a Western culture, it can be difficult to find recordings of non-Western folk music, since most Western listeners do not have a taste for it. For children, Wee Sing publishes an *"Around the World"* book and tape with children's songs from all over.
- The Music for Little People catalogue also has some recordings that introduce children to music from other cultures.


\(^{28}\) [http://www.radiotunis.com/music.html](http://www.radiotunis.com/music.html)
• For adults, Ellipsis Arts publishes traditional music from non-Western cultures. Check your local library’s recording section for music from Africa or Asia, or for the music of native Americans or Australians.
• Some of the Rough Guide series focus on specific folk or traditional musics.

3.1.6.6 Music that Combines Western and Non-Western Traditions

• For music that has been combining elements of both for long enough to have developed its own traditions, listen to any jazz, blues, gospel, Latin dance, or reggae. There are many books on these musics, particularly on jazz and reggae. For a comprehensive audiovisual overview of jazz, try Ken Burns’ PBS documentary.
• Almost all popular music is heavily influenced by both African and European traditions. Turn on the radio.
• To hear what is going on in modern Non-Western cultures as their musicians are influenced by American and European pop, listen to "World" music. The Rough Guide series is a good place to start learning about this subject.

3.2 Tuning Systems

3.2.1 Introduction

The first thing musicians must do before they can play together is "tune". For musicians in the standard Western music (Section 3.1) tradition, this means agreeing on exactly what pitch (what frequency) is an "A", what is a "B flat" and so on. Other cultures not only have different note names and different scales, they may even have different notes - different pitches - based on a different tuning system. In fact, the modern Western tuning system, which is called equal temperament, replaced (relatively recently) other tuning systems that were once popular in Europe. All tuning systems are based on the physics of sound. But they all are also affected by the history of their music traditions, as well as by the tuning peculiarities of the instruments used in those traditions.

NOTE: To understand all of the discussion below, you must be comfortable with both the musical concept of interval and the physics concept of frequency. If you wish to follow the whole thing but are a little hazy on the relationship between pitch and frequency, the following may be helpful: Pitch; Acoustics for Music Theory; Harmonic Series I: Timbre and Octaves; and Octaves and the Major-Minor Tonal System. If you do not know what intervals are (for example, major thirds and perfect fourths), please see Interval and Harmonic Series II: Harmonics, Intervals and Instruments. If you need to review the mathematical concepts, please see Musical Intervals, Frequency, and Ratio and Powers, Roots, and Equal Temperament. Meanwhile, here is a reasonably nontechnical summary of the information below: Modern Western music uses the equal temperament (Section 3.2.3.2: Equal Temperament) tuning system. In this system, an octave...
(say, from C to C) is divided into twelve equally-spaced notes. "Equally-spaced" to a musician basically means that each of these notes is one half step\(^{41}\) from the next, and that all half steps sound like the same size pitch change. (To a scientist or engineer, "equally-spaced" means that the ratio of the frequencies of the two notes in any half step is always the same.) This tuning system is very convenient for some instruments, such as the piano, and also makes it very easy to change key\(^{42}\) without retuning instruments. But a careful hearing of the music, or a look at the physics of the sound waves involved, reveals that equal-temperament pitches are not based on the harmonics\(^{43}\) physically produced by any musical sound. The "equal" ratios of its half steps are the twelfth root of two, rather than reflecting the simpler ratios produced by the sounds themselves, and the important intervals that build harmonies can sound slightly out of tune. This often leads to some "tweaking" of the tuning in real performances, away from equal temperament. It also leads many other music traditions to prefer tunings other than equal temperament, particularly tunings in which some of the important intervals are based on the pure, simple-ratio intervals of physics. In order to feature these favored intervals, a tuning tradition may do one or more of the following: use scales in which the notes are not equally spaced; avoid any notes or intervals which don't work with a particular tuning; change the tuning of some notes when the key or mode (Section 3.4) changes.

### 3.2.2 Tuning based on the Harmonic Series

Almost all music traditions recognize the octave\(^{45}\). When note Y has a frequency\(^{46}\) that is twice the frequency of note Z, then note Y is one octave higher than note Z. A simple mathematical way to say this is that the ratio\(^{47}\) of the frequencies is 2:1. Two notes that are exactly one octave apart sound good together because their frequencies are related in such a simple way. If a note had a frequency, for example, that was 2.11 times the frequency of another note (instead of exactly 2 times), the two notes would not sound so good together. In fact, most people would find the effect very unpleasant and would say that the notes are not "in tune" with each other.

To find other notes that sound "in tune" with each other, we look for other sets of pitches that have a "simple" frequency relationship. These sets of pitches with closely related frequencies are often written in common notation\(^{48}\) as a harmonic series\(^{49}\). The harmonic series is not just a useful idea constructed by music theory; it is often found in "real life", in the real-world physics of musical sounds. For example, a bugle can play only the notes of a specific harmonic series. And every musical note you hear is not a single pure frequency, but is actually a blend of the pitches of a particular harmonic series. The relative strengths of the harmonics are what gives the note its timbre\(^{50}\). (See Harmonic Series II: Harmonics, Intervals and Instruments\(^{51}\); Standing Waves and Musical Instruments\(^{52}\); and Standing Waves and Wind Instruments\(^{53}\) for more about how and why musical sounds are built from harmonic series.)

\(^{41}\)"Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>  
\(^{42}\)"Major Keys and Scales" <http://cnx.org/content/m10851/latest/>  
\(^{43}\)"Harmonic Series I: Timbre and Octaves" <http://cnx.org/content/m13682/latest/>  
\(^{44}\)"Major Keys and Scales" <http://cnx.org/content/m10851/latest/>  
\(^{45}\)"Octaves and the Major-Minor Tonal System" <http://cnx.org/content/m10862/latest/>  
\(^{46}\)"Acoustics for Music Theory": Section Wavelength, Frequency, and Pitch <http://cnx.org/content/m13246/latest/>  
\(^{47}\)"Musical Intervals, Frequency, and Ratio" <http://cnx.org/content/m1880/latest/>  
\(^{48}\)"The Staff" <http://cnx.org/content/m10880/latest/>  
\(^{49}\)"Harmonic Series I: Timbre and Octaves" <http://cnx.org/content/m13682/latest/>  
\(^{50}\)"Timbre: The Color of Music" <http://cnx.org/content/m11059/latest/>  
\(^{51}\)"Harmonic Series II: Harmonics, Intervals, and Instruments" <http://cnx.org/content/m13686/latest/>  
\(^{52}\)"Standing Waves and Musical Instruments" <http://cnx.org/content/m12413/latest/>  
\(^{53}\)"Standing Waves and Wind Instruments" <http://cnx.org/content/m12589/latest/>
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Harmonic Series on C

Figure 3.1: Here are the first sixteen pitches in a harmonic series that starts on a C natural. The series goes on indefinitely, with the pitches getting closer and closer together. A harmonic series can start on any note, so there are many harmonic series, but every harmonic series has the same set of intervals and the same frequency ratios.

What does it mean to say that two pitches have a "simple frequency relationship"? It doesn’t mean that their frequencies are almost the same. Two notes whose frequencies are almost the same - say, the frequency of one is 1.005 times the other - sound bad together. Again, anyone who is accustomed to precise tuning would say they are "out of tune". Notes with a close relationship have frequencies that can be written as a ratio\(^54\) of two small whole numbers; the smaller the numbers, the more closely related the notes are. Two notes that are exactly the same pitch, for example, have a frequency ratio of 1:1, and octaves, as we have already seen, are 2:1. Notice that when two pitches are related in this simple-ratio way, it means that they can be considered part of the same harmonic series, and in fact the actual harmonic series of the two notes may also overlap and reinforce each other. The fact that the two notes are complementing and reinforcing each other in this way, rather than presenting the human ear with two completely different harmonic series, may be a major reason why they sound consonant\(^55\) and "in tune".

**Note:** Nobody has yet proven a physical basis for why simple-ratio combinations sound pleasant to us. For a readable introduction to the subject, I suggest Robert Jourdain’s *Music, the Brain, and Ecstasy*

Notice that the actual frequencies of the notes do not matter. What matters is how they compare to each other - basically, how many waves of one note go by for each wave of the other note. Although the actual frequencies of the notes will change for every harmonic series, the comparative distance between the notes, their interval\(^56\), will be the same.

For more examples, look at the harmonic series in Figure 3.1 (Harmonic Series on C). The number beneath a note tells you the relationship of that note’s frequency to the frequency of the first note in the series - the **fundamental**. For example, the frequency of the note numbered 3 in Figure 3.1 (Harmonic Series on C) is three times the frequency of the fundamental, and the frequency of the note numbered fifteen is fifteen times the frequency of the fundamental. In the example, the fundamental is a C. That note’s frequency times 2 gives you another C; times 2 again (4) gives another C; times 2 again gives another C (8), and so on. Now look at the G’s in this series. The first one is number 3 in the series. 3 times 2 is 6, and number 6 in the series is also a G. So is number 12 (6 times 2). Check for yourself the other notes in the series that are an octave apart. You will find that the ratio for one octave\(^57\) is always 2:1, just as the ratio for a unison.

\(^{54}"Musical Intervals, Frequency, and Ratio" <http://cnx.org/content/m11808/latest/>

\(^{55}"Consonance and Dissonance" <http://cnx.org/content/m11953/latest/>

\(^{56}"Interval" <http://cnx.org/content/m10867/latest/>

\(^{57}"Octaves and the Major-Minor Tonal System" <http://cnx.org/content/m10862/latest/>
is always 1:1. Notes with this small-number ratio of 2:1 are so closely related that we give them the same name, and most tuning systems are based on this octave relationship.

The next closest relationship is the one based on the 3:2 ratio, the interval of the perfect fifth (for example, the C and G in the example harmonic series). The next lowest ratio, 4:3, gives the interval of a perfect fourth. Again, these pitches are so closely related and sound so good together that their intervals have been named "perfect". The perfect fifth figures prominently in many tuning systems. In Western (Section 3.1) music, all major and minor chords contain, or at least strongly imply, a perfect fifth. (See Triads and Naming Triads for more about the intervals in major and minor chords.)

3.2.2.1 Pythagorean Intonation

The Pythagorean system is so named because it was actually discussed by Pythagoras, the famous Greek mathematician and philosopher, who in the sixth century B.C. already recognized the simple arithmetical relationship involved in intervals of octaves, fifths, and fourths. He and his followers believed that numbers were the ruling principle of the universe, and that musical harmonies were a basic expression of the mathematical laws of the universe. Their model of the universe involved the "celestial spheres" creating a kind of harmony as they moved in circles dictated by the same arithmetical relationships as musical harmonies.

In the Pythagorean system, all tuning is based on the interval of the pure fifth. Pure intervals are the ones found in the harmonic series, with very simple frequency ratios. So a pure fifth will have a frequency ratio of exactly 3:2. Using a series of perfect fifths (and assuming perfect octaves, too, so that you are filling in every octave as you go), you can eventually fill in an entire chromatic scale.

The main weakness of the Pythagorean system is that a series of pure perfect fifths will never take you to a note that is a pure octave above the note you started on. To see why this is a problem, imagine beginning on a C. A series of perfect fifths would give: C, G, D, A, E, B, F sharp, C sharp, G sharp, D sharp, A sharp, E sharp, and B sharp. In equal temperament (which doesn't use pure fifths), that B sharp would be exactly the same pitch as the C seven octaves above where you started (so that the series can, in essence, be turned into a closed loop, the Circle of Fifths). Unfortunately, the B sharp that you arrive at after a series of pure fifths is not the same pitch as the one you started with.

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58 "Interval" <http://cnx.org/content/m10867/latest/>
59 "Interval" <http://cnx.org/content/m10867/latest/#p21b>
60 "Interval" <http://cnx.org/content/m10867/latest/#p21b>
61 "Triads" <http://cnx.org/content/m10877/latest/>
62 "Naming Triads" <http://cnx.org/content/m10890/latest/>
63 "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/#p0bb>
64 "The Circle of Fifths" <http://cnx.org/content/m10865/latest/>
fifths is a little higher than that C.

So in order to keep pure octaves, instruments that use Pythagorean tuning have to use eleven pure fifths and one smaller fifth. The smaller fifth has traditionally been called a wolf fifth because of its unpleasant sound. Keys that avoid the wolf fifth sound just fine on instruments that are tuned this way, but keys in which the wolf fifth is often heard become a problem. To avoid some of the harshness of the wolf intervals, some harpsichords and other keyboard instruments were built with split keys for D sharp/E flat and for G sharp/A flat. The front half of the key would play one note, and the back half the other (differently tuned) note.

Pythagorean tuning was widely used in medieval and Renaissance times. Major seconds and thirds are larger in Pythagorean intonation than in equal temperament, and minor seconds and thirds are smaller. Some people feel that using such intervals in medieval music is not only more authentic, but sounds better too, since the music was composed for this tuning system.

More modern Western music, on the other hand, does not sound pleasant using Pythagorean intonation. Although the fifths sound great, the thirds are simply too far away from the pure major and minor thirds of the harmonic series. In medieval music, the third was considered a dissonance and was used sparingly - and actually, when you're using Pythagorean tuning, it really is a dissonance - but most modern harmonies are built from thirds (see Triads). In fact, the common harmonic tradition that includes everything from Baroque counterpoint to modern rock is often called triadic harmony.

Some modern Non-Western music traditions, which have a very different approach to melody and harmony, still base their tuning on the perfect fifth. Wolf fifths and ugly thirds are not a problem in these traditions, which build each mode (Section 3.4) within the framework of the perfect fifth, retuning for different modes as necessary. To read a little about one such tradition, please see Indian Classical Music: Tuning and Ragas (Section 3.5).

3.2.2.2 Mean-tone System

The mean-tone system, in order to have pleasant-sounding thirds, takes rather the opposite approach from the Pythagorean. It uses the pure major third. In this system, the whole tone (or whole step) is considered to be exactly half of the pure major third. This is the mean, or average, of the two tones, that gives the system its name. A semitone (or half step) is exactly half (another mean) of a whole tone.

These smaller intervals all work out well in mean-tone tuning, but the result is a fifth that is noticeably smaller than a pure fifth. And a series of pure thirds will also eventually not line up with pure octaves, so an instrument tuned this way will also have a problem with wolf.

As mentioned above, Pythagorean tuning made sense in medieval times, when music was dominated by fifths. Once the concept of harmony in thirds took hold, thirds became the most important interval; simple perfect fifths were now heard as "austere" and, well, medieval-sounding. So mean-tone tuning was very popular in Europe in the 16th through 18th centuries.

But fifths can't be avoided entirely. A basic major or minor chord, for example, is built of two thirds, but it also has a perfect fifth between its outer two notes (see Triads). So even while mean-tone tuning was enjoying great popularity, some composers and musicians were searching for other solutions.
3.2.2.3 Just Intonation

In just intonation, the fifth and the third are both based on the pure, harmonic series interval. Because chords are constructed of thirds and fifths (see Triads\textsuperscript{73}), this tuning makes typical Western harmonies particularly resonant and pleasing to the ear; so this tuning is often used (sometimes unconsciously) by musicians who can make small tuning adjustments quickly. This includes vocalists, most wind instruments, and many string instruments.

As explained above (p. 33), using pure fifths and thirds will require some sort of adjustment somewhere. Just intonation makes two accommodations to allow its pure intervals. One is to allow inequality in the other intervals. Look again at the harmonic series (Figure 3.1: Harmonic Series on C).

![Figure 3.3: Both the 9:8 ratio and the 10:9 ratio in the harmonic series are written as whole notes. 9:8 is considered a major whole tone and 10:9 a minor whole tone. The difference between them is less than a quarter of a semitone.](image)

As the series goes on, the ratios get smaller and the notes closer together. Common notation\textsuperscript{74} writes all of these "close together" intervals as whole steps (whole tones) or half steps (semitones), but they are of course all slightly different from each other. For example, the notes with frequency ratios of 9:8 and 10:9 and 11:10 are all written as whole steps. To compare how close (or far) they actually are, turn the ratios into decimals.

**Whole Step Ratios Written as Decimals**

- \(9/8 = 1.125\)
- \(10/9 = 1.111\)
- \(11/10 = 1.1\)

These are fairly small differences, but they can still be heard easily by the human ear. Just intonation uses both the 9:8 whole tone, which is called a major whole tone and the 10:9 whole tone, which is called a minor whole tone, in order to construct both pure thirds and pure fifths.

**Note:** In case you are curious, the size of the whole tone of the "mean tone" system is also the mean, or average, of the major and minor whole tones.

The other accommodation with reality that just intonation must make is the fact that a single just-intonation tuning cannot be used to play in multiple keys. In constructing a just-intonation tuning, it matters which steps of the scale are major whole tones and which are minor whole tones, so an instrument tuned exactly to play with just intonation in the key of C major will have to retune to play in C sharp major or D major. For instruments that can tune almost instantly, like voices, violins, and trombones, this is not a problem; but it is unworkable for pianos, harps, and other other instruments that cannot make small tuning adjustments quickly.

\textsuperscript{73}“Triads” \textsc{<http://cnx.org/content/m10877/latest/>}

\textsuperscript{74}“The Staff” \textsc{<http://cnx.org/content/m10860/latest/>}
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As of this writing, there was useful information about various tuning systems at several different websites, including The Development of Musical Tuning Systems\(^{75}\), where one could hear what some intervals sound like in the different tuning systems, and Kyle Gann's Just Intonation Explained\(^{76}\), which included some audio samples of works played using just intonation.

### 3.2.3 Temperament

There are times when tuning is not much of an issue. When a good choir sings in harmony without instruments, they will tune without even thinking about it. All chords will tend towards pure fifths and thirds, as well as seconds, fourths, sixths, and sevenths that reflect the harmonic series. Instruments that can bend most pitches enough to fine-tune them during a performance - and this includes most orchestral instruments - also tend to play the "pure" intervals. This can happen unconsciously, or it can be deliberate, as when a conductor asks for an interval to be "expanded" or "contracted".

But for many instruments, such as piano, organ, harp, bells, harpsichord, xylophone - any instrument that cannot be fine-tuned quickly - tuning is a big issue. A harpsichord that has been tuned using the Pythagorean system or just intonation may sound perfectly in tune in one key - C major, for example - and fairly well in tune in a related key\(^77\) - G major - but badly out of tune in a "distant" key like D flat major. Adding split keys or extra keys can help (this was a common solution for a time), but also makes the instrument more difficult to play. In Western music (Section 3.1), the tuning systems that have been invented and widely used that directly address this problem are the various temperaments, in which the tuning of notes is tempered slightly from pure intervals. (Non-Western music traditions have their own tuning systems, which is too big a subject to address here. See Listening to Balinese Gamelan\(^{78}\) and Indian Classical Music: Tuning and Ragas (Section 3.5) for a taste of what's out there.)

#### 3.2.3.1 Well Temperaments

As mentioned above (p. 33), the various tuning systems based on pure intervals eventually have to include "wolf" intervals that make some keys unpleasant or even unusable. The various well temperament tunings that were very popular in the 18th and 19th centuries tried to strike a balance between staying close to pure intervals and avoiding wolf intervals. A well temperament might have several pure fifths, for example, and several fifths that are smaller than a pure fifth, but not so small that they are "wolf" fifths. In such systems, tuning would be noticeably different in each key\(^79\), but every key would still be pleasant-sounding and usable. This made well temperaments particularly welcome for players of difficult-to-tune instruments like the harpsichord and piano.

**NOTE:** Historically, there has been some confusion as to whether or not well temperaments and equal temperaments are the same thing, possibly because well temperaments were sometimes referred to at the time as "equal temperament". But these well temperaments made all keys equally useful, not equal-sounding as modern equal temperament does.

As mentioned above (Section 3.2.2.2: Mean-tone System), mean-tone tuning was still very popular in the eighteenth century. J. S. Bach wrote his famous "Well-Tempered Klavier" in part as a plea and advertisement to switch to a well temperament system. Various well temperaments did become very popular in the eighteenth and nineteenth centuries, and much of the keyboard-instrument music of those centuries may have been written to take advantage of the tuning characteristics of particular keys in particular well temperaments. Some modern musicians advocate performing such pieces using well temperaments, in order to better understand and appreciate them. It is interesting to note that the different keys in a well temperament tuning were sometimes considered to be aligned with specific colors and emotions. In this way they may have had more in common with various modes and ragas (Section 3.4) than do keys in equal temperament.

\(^{75}\)http://www.midicode.com/tunings/index.shtml

\(^{76}\)http://www.kylegann.com/tuning.html

\(^{77}\)"The Circle of Fifths" <http://cnx.org/content/m10865/latest/>

\(^{78}\)"Listening to Balinese Gamelan: A Beginners' Guide" <http://cnx.org/content/m15795/latest/>

\(^{79}\)"Major Keys and Scales" <http://cnx.org/content/m10861/latest/>
3.2.3.2 Equal Temperament

In modern times, well temperaments have been replaced by equal temperament, so much so in Western music (Section 3.1) that equal temperament is considered standard tuning even for voice and for instruments that are more likely to play using just intonation when they can (see above (Section 3.2.2.3: Just Intonation)). In equal temperament, only octaves\(^80\) are pure (Section 3.2.2.1: Pythagorean Intonation) intervals. The octave is divided into twelve equally spaced half steps\(^81\), and all other intervals\(^82\) are measured in half steps. This gives, for example, a fifth\(^83\) that is a bit smaller than a pure fifth, and a major third\(^84\) that is larger than the pure major third. The differences are smaller than the wolf tones (p. 33) found in other tuning systems, but they are still there.

Equal temperament is well suited to music that changes key\(^85\) often, is very chromatic (p. 27), or is harmonically complex\(^86\). It is also the obvious choice for atonal (p. 27) music that steers away from identification with any key or tonality at all. Equal temperament has a clear scientific/mathematical basis, is very straightforward, does not require retuning for key changes, and is unquestioningly accepted by most people. However, because of the lack of pure intervals, some musicians do not find it satisfying. As mentioned above, just intonation is sometimes substituted for equal temperament when practical, and some musicians would also like to reintroduce well temperaments, at least for performances of music which was composed with well temperament in mind.

3.2.4 A Comparison of Equal Temperament with the Harmonic Series

In a way, equal temperament is also a compromise between the Pythagorean approach and the mean-tone approach. Neither the third nor the fifth is pure, but neither of them is terribly far off, either. Because equal temperament divides the octave into twelve equal semi-tones (half steps), the frequency ratio of each semi-tone is the twelfth root of 2. If you do not understand why it is the twelfth root of 2 rather than, say, one twelfth, please see the explanation below (p. 38). (There is a review of powers and roots in Powers, Roots, and Equal Temperament if you need it.)

\[
\frac{\sqrt[12]{2}}{2} = \text{a semitone (half step)} \\
\left(\frac{\sqrt[12]{2}}{2}\right)^2 = \text{a whole tone (whole step)} \\
\left(\frac{\sqrt[12]{2}}{2}\right)^4 = \text{a major third (four semitones)} \\
\left(\frac{\sqrt[12]{2}}{2}\right)^7 = \text{a perfect fifth (seven semitones)} \\
\left(\frac{\sqrt[12]{2}}{2}\right)^{12} = 2 = \\text{an octave (twelve semitones)}
\]

Figure 3.4: In equal temperament, the ratio of frequencies in a semitone (half step) is the twelfth root of two. Every interval is then simply a certain number of semitones. Only the octave (the twelfth power of the twelfth root) is a pure interval.

\(^{80}\)"Octaves and the Major-Minor Tonal System" <http://cnx.org/content/m10862/latest/>
\(^{81}\)"Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>
\(^{82}\)"Interval" <http://cnx.org/content/m10867/latest/>
\(^{83}\)"Interval" <http://cnx.org/content/m10867/latest/#p21b>
\(^{84}\)"Interval": Major and Minor Intervals <http://cnx.org/content/m10867/latest/#list22a>
\(^{85}\)"Major Keys and Scales" <http://cnx.org/content/m10861/latest/>
\(^{86}\)"Beginning Harmonic Analysis" <http://cnx.org/content/m11643/latest/>
In equal temperament, the only pure interval is the octave. (The twelfth power of the twelfth root of two is simply two.) All other intervals are given by irrational numbers based on the twelfth root of two, not nice numbers that can be written as a ratio of two small whole numbers. In spite of this, equal temperament works fairly well, because most of the intervals it gives actually fall quite close to the pure intervals. To see that this is so, look at Figure 3.5 (Comparing the Frequency Ratios for Equal Temperament and Pure Harmonic Series). Equal temperament and pure intervals are calculated as decimals and compared to each other. (You can find these decimals for yourself using a calculator.)

<table>
<thead>
<tr>
<th>Interval</th>
<th>Equal Temperament Frequency Ratio</th>
<th>Approximate Difference</th>
<th>Harmonic Series Frequency Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unison</td>
<td>$(\sqrt[12]{2})^0$ = 1.0000</td>
<td>0.0</td>
<td>$1.0000$ = 1/1</td>
</tr>
<tr>
<td>Minor Second</td>
<td>$(\sqrt[12]{2})^1$ = 1.0595</td>
<td>0.0314</td>
<td>$1.0909$ = 12/11</td>
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<tr>
<td>Major Second</td>
<td>$(\sqrt[12]{2})^2$ = 1.1225</td>
<td>0.0025</td>
<td>$1.1250$ = 9/8</td>
</tr>
<tr>
<td>Minor Third</td>
<td>$(\sqrt[12]{2})^3$ = 1.1892</td>
<td>0.0108</td>
<td>$1.2000$ = 6/5</td>
</tr>
<tr>
<td>Major Third</td>
<td>$(\sqrt[12]{2})^4$ = 1.2599</td>
<td>0.0099</td>
<td>$1.2500$ = 5/4</td>
</tr>
<tr>
<td>Perfect Fourth</td>
<td>$(\sqrt[12]{2})^5$ = 1.3348</td>
<td>0.0015</td>
<td>$1.3333$ = 4/3</td>
</tr>
<tr>
<td>Tritone</td>
<td>$(\sqrt[12]{2})^6$ = 1.4142</td>
<td>0.0142</td>
<td>$1.4000$ = 7/5</td>
</tr>
<tr>
<td>Perfect Fifth</td>
<td>$(\sqrt[12]{2})^7$ = 1.4983</td>
<td>0.0017</td>
<td>$1.5000$ = 3/2</td>
</tr>
<tr>
<td>Minor Sixth</td>
<td>$(\sqrt[12]{2})^8$ = 1.5874</td>
<td>0.0126</td>
<td>$1.6000$ = 8/5</td>
</tr>
<tr>
<td>Major Sixth</td>
<td>$(\sqrt[12]{2})^9$ = 1.6818</td>
<td>0.0151</td>
<td>$1.6667$ = 5/3</td>
</tr>
<tr>
<td>Minor Seventh</td>
<td>$(\sqrt[12]{2})^{10}$ = 1.7818</td>
<td>0.0318</td>
<td>$1.7500$ = 7/4</td>
</tr>
<tr>
<td>Major Seventh</td>
<td>$(\sqrt[12]{2})^{11}$ = 1.8897</td>
<td>0.0564</td>
<td>$1.8333$ = 11/6</td>
</tr>
<tr>
<td>Octave</td>
<td>$(\sqrt[12]{2})^{12}$ = 2.0000</td>
<td>0.0</td>
<td>$2.0000$ = 2/1</td>
</tr>
</tbody>
</table>

**Figure 3.5:** Look again at Figure 3.1 [Harmonic Series on C] to see where pure interval ratios come from. The ratios for equal temperament are all multiples of the twelfth root of two. Both sets of ratios are converted to decimals (to the nearest ten thousandth), so you can easily compare them.

Except for the unison and the octave, none of the ratios for equal temperament are exactly the same as for the pure interval. Many of them are reasonably close, though. In particular, perfect fourths and fifths and major thirds are not too far from the pure intervals. The intervals that are the furthest from the pure intervals are the major seventh, minor seventh, and minor second (intervals that are considered dissonant\(^{87}\) anyway).

Because equal temperament is now so widely accepted as standard tuning, musicians do not usually even speak of intervals in terms of ratios. Instead, tuning itself is now defined in terms of equal-temperament, with tunings and intervals measured in cents. A cent is 1/100 (the hundredth root) of an equal-temperament semitone. In this system, for example, the major whole tone discussed above measures 204 cents, the minor whole tone 182 cents, and a pure fifth is 702 cents.

Why is a cent the hundredth root of a semitone, and why is a semitone the twelfth root of an octave? If

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\(^{87}\)“Consonance and Dissonance” [http://cnx.org/content/m11953/latest/](http://cnx.org/content/m11953/latest/)
it bothers you that the ratios in equal temperament are roots, remember the pure octaves and fifths of the harmonic series.

---

**Frequency Relationships**

<table>
<thead>
<tr>
<th>Octaves:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Frequency = ( \text{Lower Frequency} \times 2 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>( (2 \times 2) )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fifths:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Frequency = ( \text{Lower Frequency} \times \frac{3}{2} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1</th>
<th>3/2</th>
<th>9/4</th>
<th>27/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>( (3/2 \times 3/2) )</td>
<td>( (9/4 \times 3/2) )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Figure 3.6:** Remember that, no matter what note you start on, the note one octave higher has 2 times its frequency. Also, no matter what note you start on, the note that is a perfect fifth higher has exactly one and a half times its frequency. Since each of these intervals is so many "times" in terms of frequencies, when you add intervals, you multiply their frequencies. For example, a series of two perfect fifths will give a frequency that is \( \frac{3}{2} \times \frac{3}{2} \) (or 9/4) the beginning frequency.

---

Every octave has the same frequency ratio; the higher note will have 2 times the frequency of the lower note. So if you go up another octave from there (another 2 times), that note must have 2 x 2, or 4 times the frequency of the lowest note. The next octave takes you up 2 times higher than that, or 8 times the frequency of the first note, and so on.

In just the same way, in every perfect fifth, the higher note will have a frequency one and a half (3/2) times the lower note. So to find out how much higher the frequency is after a series of perfect fifths, you would have to multiply (not add) by one and a half (3/2) every time you went up another perfect fifth.

All intervals work in this same way. So, in order for twelve semitones (half steps) to equal one octave, the size of a half step has to be a number that gives the answer "2" (the size of an octave) when you multiply it twelve times: in other words, the twelfth root of two. And in order for a hundred cents to equal one semitone, the size of a cent must be the number that, when you multiply it 100 times, ends up being the same size as a semitone; in other words, the hundredth root of the twelfth root of two. This is one reason why most musicians prefer to talk in terms of cents and intervals instead of frequencies.

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### 3.2.5 Beats and Wide Tuning

One well-known result of tempered tunings is the aural phenomenon known as **beats**. As mentioned above (p. 31), in a pure interval (Section 3.2.2.1: Pythagorean Intonation) the sound waves have frequencies that are related to each other by very simple ratios. Physically speaking, this means that the two smooth waves line up together so well that the combined wave - the wave you hear when the two are played at the same
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Time - is also a smooth and very steady wave. Tunings that are slightly off from the pure interval, however, will result in a combined wave that has an extra bumpiness in it. Because the two waves are each very even, the bump itself is very even and regular, and can be heard as a "beat" - a very regular change in the intensity of the sound. The beats are so regular, in fact, that they can be timed; for equal temperament they are on the order of a beat per second in the mid range of a piano. A piano tuner works by listening to and timing these beats, rather than by being able to "hear" equal temperament intervals precisely.

It should also be noted that some music traditions around the world do not use the type of precision tunings described above, not because they can't, but because of an aesthetic preference for wide tuning. In these traditions, the sound of many people playing precisely the same pitch is considered a thin, uninteresting sound; the sound of many people playing near the same pitch is heard as full, lively, and more interesting.

Some music traditions even use an extremely precise version of wide tuning. The gamelan of southeast Asia, for example, have an aesthetic preference for the "lively and full" sounds that come from instruments playing near, not on, the same pitch. In some types of gamelans, pairs of instruments are tuned very precisely so that each pair produces beats, and the rate of the beats is the same throughout the entire range of that gamelan. Long-standing traditions allow gamelan craftsmen to reliably produce such impressive feats of tuning.

3.2.6 Further Study

As of this writing:

- The Just Intonation Network had much information about Just Intonation, including some audio examples.
- Kyle Gann's An Introduction to Historical Tunings was a good source about both the historical background and more technical information about various tunings. It also includes some audio examples.
- The Huygens-Fokker Foundation had a very large on-line bibliography of tuning and temperament.
- Musemath had several animations illustrating equal temperament and the math necessary to understand it.

3.3 Scales that aren't Major or Minor

3.3.1 Introduction

Sounds - ordinary, everyday "noises" - come in every conceivable pitch and groups of pitches. In fact, the essence of noise, "white noise", is basically every pitch at once, so that no particular pitch is heard.

One of the things that makes music pleasant to hear and easy to "understand" is that only a few of all the possible pitches are used. But not all pieces of music use the same set of pitches. In order to be familiar with the particular notes that a piece of music is likely to use, musicians study scales.

The set of expected pitches for a piece of music can be arranged into a scale. In a scale, the pitches are usually arranged from lowest to highest (or highest to lowest), in a pattern that usually repeats within every octave.

NOTE: In some kinds of music, the notes of a particular scale are the only notes allowed in a given piece of music. In other music traditions, notes from outside the scale (accidentals) are allowed,

\[88\text{"Balinese Gamelan" }<\text{http://cnx.org/content/m15796/latest/>}
\[89\text{"Range" }<\text{http://cnx.org/content/m12381/latest/>}
\[90\text{http://www.justintonation.net/}
\[91\text{http://www.kylegann.com/histune.html}
\[92\text{http://www.xs4all.nl/~huygensf/doc/bib.html}
\[93\text{http://www.musemath.com}
\[94\text{This content is available online at }<\text{http://cnx.org/content/m11636/1.15/>}.
\[95\text{"Pitch: Sharp, Flat, and Natural Notes" }<\text{http://cnx.org/content/m10943/latest/>}
\[96\text{"Octaves and the Major-Minor Tonal System" }<\text{http://cnx.org/content/m10862/latest/>}
\[97\text{"Pitch: Sharp, Flat, and Natural Notes" }<\text{http://cnx.org/content/m10943/latest/#p0e>
but are usually much less common than the scale notes.

The set of pitches, or notes, that are used, and their relationships to each other, makes a big impact on how the music sounds. For example, for centuries, most Western music (Section 3.1) has been based on major\(^{98}\) and minor scales\(^{99}\). That is one of the things that makes it instantly recognizable as Western music. Much (though not all) of the music of eastern Asia, on the other hand, was for many centuries based on pentatonic scales, giving it a much different flavor that is also easy to recognize.

Some of the more commonly used scales that are not major or minor are introduced here. Pentatonic scales are often associated with eastern Asia, but many other music traditions also use them. Blues scales, used in blues, jazz, and other African-American traditions, grew out of a compromise between European and African scales. Some of the scales that sound "exotic" to the Western ear are taken from the musical traditions of eastern Europe, the Middle East, and western Asia. Microtones can be found in some traditional musics (for example, Indian classical music (Section 3.5)) and in some modern art (p. 27) music.

**NOTE:** Some music traditions, such as Indian and medieval European, use modes or ragas, which are not quite the same as scales. Please see Modes and Ragas. (Section 3.4)

### 3.3.2 Scales and Western Music

The Western (Section 3.1) musical tradition that developed in Europe after the middle ages is based on major and minor scales, but there are other scales that are a part of this tradition.

In the chromatic scale, every interval\(^{100}\) is a half step\(^{101}\). This scale gives all the sharp, flat, and natural\(^{102}\) notes commonly used in all Western music. It is also the twelve-tone scale used by twentieth-century composers to create their atonal music (p. 27). Young instrumentalists are encouraged to practice playing the chromatic scale in order to ensure that they know the fingerings for all the notes. Listen to a chromatic scale\(^{103}\).

![Chromatic Scale](https://example.com/chromatic_scale.png)

**Figure 3.7:** The chromatic scale includes all the pitches normally found in Western music. Note that, because of enharmonic\(^{104}\) spelling, many of these pitches could be written in a different way (for example, using flats instead of sharps).

In a whole tone scale, every interval is a whole step\(^{105}\). In both the chromatic and the whole tone scales, all the intervals are the same. This results in scales that have no tonal center\(^{106}\); no note feels more or less important than the others. Because of this, most traditional and popular Western music uses major

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\(^{98}\) "Major Keys and Scales" <http://cnx.org/content/m10851/latest/>

\(^{99}\) "Minor Keys and Scales" <http://cnx.org/content/m10856/latest/>

\(^{100}\) "Interval" <http://cnx.org/content/m10867/latest/>

\(^{101}\) "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>

\(^{102}\) "Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>

\(^{103}\) "Chromatic Scale" <http://cnx.org/content/m11636/latest/Chromatic.MID>

\(^{104}\) "Enharmonic Spelling" <http://cnx.org/content/m11641/latest/>

\(^{105}\) "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>

\(^{106}\) "Major Keys and Scales" <http://cnx.org/content/m10851/latest/>
or minor scales rather than the chromatic or whole tone scales. But composers who don't want their music
to have a tonal center (for example, many composers of "modern classical" music) often use these scales.
Listen to a whole tone scale\textsuperscript{107}.

\begin{center}
\begin{figure}[h]
    \begin{center}
    \includegraphics[width=0.5\textwidth]{whole_tone_scale.png}
    \end{center}
    \caption{A Whole Tone Scale}
    \end{figure}
\end{center}

\textbf{Exercise 3.1} \hspace{3cm} (\textit{Solution on p. 63.})
There is basically only one chromatic scale; you can start it on any note, but the pitches will end
up being the same as the pitches in any other chromatic scale. There are basically two possible
whole tone scales. Beginning on a b, write a whole tone scale that uses a different pitches than
the one in Figure 3.8 (A Whole Tone Scale). If you need staff paper, you can download this PDF
file\textsuperscript{108}.

\textbf{Exercise 3.2} \hspace{3cm} (\textit{Solution on p. 63.})
Now write a whole tone scale beginning on an a flat. Is this scale essentially the same as the one
in Figure 3.26 or the one in Figure 3.8 (A Whole Tone Scale)?

\section*{3.3.3 Pentatonic Scales}
In Western music, there are twelve pitches within each octave\textsuperscript{109}. (The thirteenth note starts the next
octave.) But in a tonal (Section 3.1.3: Tonal, Atonal, and Modal Music) piece of music only seven of these
notes, the seven notes of a major or minor scale, are used often.

In a \textit{pentatonic scale}, only five of the possible pitches within an octave are used. (So the scale will
repeat starting at the sixth tone.) The most familiar pentatonic scales are used in much of the music of
eastern Asia. You may be familiar with the scale in Figure 3.9 (A Familiar Pentatonic Scale) as the scale
that is produced when you play all the "black keys" on a piano keyboard.

\textsuperscript{107}See the file at \textless http://cnx.org/content/m11636/latest/WholeTone.mid\textgreater
\textsuperscript{108}See the file at \textless http://cnx.org/content/m11636/latest/staffpaper1.pdf\textgreater
\textsuperscript{109}"Octaves and the Major-Minor Tonal System" \textless http://cnx.org/content/m10862/latest/\textgreater
A Familiar Pentatonic Scale

Interval Key

<table>
<thead>
<tr>
<th>Key</th>
<th>Notation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>half step</td>
<td>m3 = minor third</td>
</tr>
<tr>
<td>W</td>
<td>whole step</td>
<td>M3 = Major third</td>
</tr>
</tbody>
</table>

Figure 3.9: This is the pentatonic scale you get when you play the "black keys" on a piano.

Listen to the black key pentatonic scale\textsuperscript{110}. Like other scales, this pentatonic scale is transposable (Section 1.2); you can move the entire scale up or down by a half step or a major third or any interval\textsuperscript{111} you like. The scale will sound higher or lower, but other than that it will sound the same, because the pattern of intervals between the notes (half steps, whole steps, and minor thirds) is the same. (For more on intervals, see Half Steps and Whole Steps\textsuperscript{112} and Interval\textsuperscript{113}. For more on patterns of intervals within scales, see Major Scales\textsuperscript{114} and Minor Scales\textsuperscript{115}.) Now listen to a transposed pentatonic scale\textsuperscript{116}.

Transposed Pentatonic Scale

Figure 3.10: This is simply a transposition of the scale in Figure 3.9 (A Familiar Pentatonic Scale)

But this is not the only possible type of pentatonic scale. Any scale that uses only five notes within one octave is a pentatonic scale. The following pentatonic scale, for example, is not simply another transposition of the "black key" pentatonic scale; the pattern of intervals between the notes is different. Listen to this different pentatonic scale\textsuperscript{117}.

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\textsuperscript{110}See the file at <http://cnx.org/content/m11636/latest/pentatonic1.mid>

\textsuperscript{111}"Interval" <http://cnx.org/content/m10867/latest/>

\textsuperscript{112}"Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>

\textsuperscript{113}"Interval" <http://cnx.org/content/m10867/latest/>

\textsuperscript{114}"Major Keys and Scales" <http://cnx.org/content/m10851/latest/>

\textsuperscript{115}"Minor Keys and Scales" <http://cnx.org/content/m10856/latest/>

\textsuperscript{116}See the file at <http://cnx.org/content/m11636/latest/pentatonic2.mid>

\textsuperscript{117}See the file at <http://cnx.org/content/m11636/latest/pentatonic3.mid>
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Figure 3.11: This pentatonic scale is not a transposed version of Figure 3.9 (A Familiar Pentatonic Scale). It has a different set of intervals.

The point here is that music based on the pentatonic scale in Figure 3.9 (A Familiar Pentatonic Scale) will sound very different from music based on the pentatonic scale in Figure 3.11 (Different Pentatonic Scale), because the relationships between the notes are different, much as music in a minor key is noticeably different from music in a major key. So there are quite a few different possible pentatonic scales that will produce a recognizably "unique sound", and many of these possible five-note scales have been named and used in various music traditions around the world.

Exercise 3.3
(Solution on p. 63.)
To get a feeling for the concepts in this section, try composing some short pieces using the pentatonic scales given in Figure 3.9 (A Familiar Pentatonic Scale) and in Figure 3.11 (Different Pentatonic Scale). You may use more than one octave of each scale, but use only one scale for each piece. As you are composing, listen for how the constraints of using only those five notes, with those pitch relationships, affect your music. See if you can play your Figure 3.9 (A Familiar Pentatonic Scale) composition in a different key, for example, using the scale in Figure 3.10 (Transposed Pentatonic Scale).

3.3.4 Dividing the Octave, More or Less
Any scale will list a certain number of notes within an octave. For major and minor scales, there are seven notes; for pentatonic, five; for a chromatic scale, twelve. Although some divisions are more common than others, any division can be imagined, and many are used in different musical traditions around the world. For example, the classical music of India recognizes twenty-two different possible pitches within an octave; each raga uses five, six, or seven of these possible pitches. (Please see Indian Classical Music: Tuning and Ragas (Section 3.5) for more on this.) And there are some traditions in Africa that use six or eight notes within an octave. Listen to one possible eight-tone, or octatonic scale\(^{118}\).

\(^{118}\)See the file at <http://cnx.org/content/m11636/latest/Octatonic.mid>
Many Non-Western traditions, besides using different scales, also use different tuning systems (Section 3.2); the intervals in the scales may involve quarter tones (a half of a half step), for example, or other intervals we don’t use. Even trying to write them in common notation can be a bit misleading.

Microtones are intervals smaller than a half step. Besides being necessary to describe the scales and tuning systems of many Non-Western traditions, they have also been used in modern Western classical music, and are also used in African-American traditions such as jazz and blues. As of this writing, the Huygens-Fokker Foundation\textsuperscript{119} was a good place to start looking for information on microtonal music.

3.3.5 Constructing a Blues Scale
Blues scales are closely related to pentatonic scales. (Some versions are pentatonic.) Rearrange the pentatonic scale in Figure 3.10 (Transposed Pentatonic Scale) above so that it begins on the C, and add an F sharp in between the F and G, and you have a commonly used version of the blues scale. Listen to this blues scale\textsuperscript{120}.

\textsuperscript{119}http://www.xs4all.nl/~huygensf/english/index.html
\textsuperscript{120}See the file at <http://cnx.org/content/m11636/latest/BlueScale.mid>
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3.3.6 Modes and Ragas

Many music traditions do not use scales. The most familiar of these to the Western (Section 3.1) listener are medieval chant and the classical music of India. In these and other modal traditions, the rules for constructing a piece of music are quite different than the rules for music that is based on a scale. Please see Modes and Ragas (Section 3.4) for more information.

3.3.7 Other Scales

There are many, many other possible scales that are not part of the major-minor system. Some, like pentatonic and octatonic scales, have fewer or more notes per octave, but many have seven tones, just as a major scale does. A scale may be chosen or constructed by a composer for certain intriguing characteristics, for the types of melodies or harmonies that the scale enables, or just for the interesting or pleasant sound of music created using the scale.

For example, one class of scales that intrigues some composers is symmetrical scales. The chromatic scale and whole tone (Figure 3.8: A Whole Tone Scale) scales fall into this category, but other symmetrical scales can also be constructed. A diminished scale, for example, not only has the "symmetrical" quality; it is also a very useful scale if, for example, you are improvising a jazz solo over diminished chords.

A Diminished Scale

![Figure 3.14: Like chromatic and whole tone scales, a diminished scale is "symmetrical".](http://cnx.org/content/m10866/latest/#p0bb)

Some scales are loosely based on the music of other cultures, and are used when the composer wants to evoke the music of another place or time. These scales are often borrowed from Non-western traditions, but are then used in ways typical of Western music. Since they usually ignore the tuning, melodic forms, and other aesthetic principles of the traditions that they are borrowed from, such uses of "exotic" scales should not be considered accurate representations of those traditions. There are examples in world music (Section 3.1.2: Jazz, Blues, and World Music), however, in which the Non-western scale or mode (Section 3.4) is used in an authentic way. Although there is general agreement about the names of some commonly used "exotic" scales, they are not at all standardized. Often the name of a scale simply reflects what it sounds like to the person using it, and the same name may be applied to different scales, or different names to the same scale.

121"Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/#p0bb>
122"Naming Triads": Section Augmented and Diminished Chords <http://cnx.org/content/m10890/latest/#s2>
You may want to experiment with some of the many scales possible. Listen to one version each of: "diminished" scale\(^\text{123}\), "enigmatic" scale\(^\text{124}\), "Romanian" Scale\(^\text{125}\), "Persian" scale\(^\text{126}\) and "Hungarian Major" Scale\(^\text{127}\). For even more possibilities, try a web search for "exotic scales"; or try inventing your own scales and using them in compositions and improvisations.

\(^\text{123}\)See the file at <http://cnx.org/content/m11636/latest/Diminished.mid>
\(^\text{124}\)See the file at <http://cnx.org/content/m11636/latest/Enigmatic.mid>
\(^\text{125}\)See the file at <http://cnx.org/content/m11636/latest/Romanian.mid>
\(^\text{126}\)See the file at <http://cnx.org/content/m11636/latest/Persian.mid>
\(^\text{127}\)See the file at <http://cnx.org/content/m11636/latest/HungarianMajor.mid>
3.4 Modes and Ragas: More Than just a Scale

3.4.1 Introduction

In many music traditions, including Western music (Section 3.1), the list of all the notes that are expected or allowed in a particular piece of music is a scale. A long tradition of using scales in particular ways has trained listeners to expect certain things from a piece of music. If you hear a song in C major, for example, not only will your ear/brain expect to hear the notes from the C major scale, it will expect to hear them grouped into certain chords, and it will expect the chords to follow each other in certain patterns (chord progressions) and to end in a certain way (a cadence). You don’t have to have any musical training at all to have these expectations; you only need to have grown up in a culture that listens to this kind of music.

The expectations for music in a minor key are a little different than for music in a major key. But it is important to notice that you can move that song in C major to E major, G flat major, or any other major key. It will sound basically the same, except that it will sound higher or lower. In the same way, all minor keys are so alike that music can easily be transposed from one minor key to another. (For more on this subject, see Major Scales, Minor Scales, Scales that aren’t Major or Minor (Section 3.3), and Transposition (Section 1.2).)

This sameness is not true for musical traditions that use modes instead of scales. In these traditions, the mode, like a scale, lists the notes that are used in a piece of music. But each mode comes with a different set of expectations in how those notes will be used and arranged.
Figure 3.17: Compare the differences and similarities between the two major scales, and the differences and similarities between the two medieval church modes.

Figure 3.17 (Comparison of Scale and Mode) shows two scales and two modes. The two major scales\(^{136}\) use different notes, but the relationship of the notes to each other is very similar. For example, the pattern of half steps and whole steps\(^{137}\) in each one is the same, and the interval\(^{138}\) (distance) between the tonic\(^{139}\) and the dominant\(^{140}\) is the same. Compare this to the two church modes. The pattern of whole steps and halfl steps within the octave\(^{141}\) is different; this would have a major effect on a chant, which would generally stay within the one octave range. Also, the interval between the finalis (p. 51) and the dominant (p. 51) is different, and they are in different places within the range\(^{142}\) of the mode. The result is that music in one

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\(^{136}\)“Major Keys and Scales” <http://cnx.org/content/m10851/latest/>

\(^{137}\)“Half Steps and Whole Steps” <http://cnx.org/content/m10866/latest/>

\(^{138}\)“Interval” <http://cnx.org/content/m10867/latest/>

\(^{139}\)“Major Keys and Scales” <http://cnx.org/content/m10851/latest/#p1a>

\(^{140}\)“Beginning Harmonic Analysis”: Section Naming Chords Within a Key <http://cnx.org/content/m11643/latest/#s3>

\(^{141}\)“Octaves and the Major-Minor Tonal System” <http://cnx.org/content/m10862/latest/>

\(^{142}\)“Range” <http://cnx.org/content/m12381/latest/>
mode would sound quite different than music in the other mode. You can’t simply transpose (Section 1.2) music from one mode to another as you do with scales and keys; modes are too different.

### 3.4.2 The Classical Greek Modes

We can only guess what music from ancient Greek and Roman times really sounded like. They didn’t leave any recordings, of course, nor did they write down their music. But they did write about music, so we know that they used modes based on tetrachords. A *tetrachord* is a mini-scale of four notes, in descending pitch order, that are contained within a perfect fourth (five half steps) instead of an octave (twelve half steps).

![Tetrachords](Figure 3.18: Here are three possible Greek tetrachords, as nearly as they can be written in modern notation. The outer notes are a perfect fourth apart; we can be pretty certain of that, since the perfect fourth is a natural interval playable, for example, on many ancient wind instruments (See Harmonic Series II and Interval). The actual tuning of the inner notes can only be guessed, however, since our equal temperament (Section 3.2.3.2: Equal Temperament) is a relatively modern invention.

Since a tetrachord fills the interval of a perfect fourth, two tetrachords with a whole step between the end of one and the beginning of the other will fill an octave. Different Greek modes were built from different combinations of tetrachords.

![2 Diatonic Tetrachords](Figure 3.19: Each Greek mode was built of two tetrachords in a row, filling an octave.

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143"Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>
144"Interval": Section Perfect Intervals <http://cnx.org/content/m10867/latest/#s21>
145"Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>
146"Octaves and the Major-Minor Tonal System" <http://cnx.org/content/m10862/latest/>
147"Harmonic Series II: Harmonics, Intervals, and Instruments" <http://cnx.org/content/m13686/latest/>
148"Interval" <http://cnx.org/content/m10867/latest/>
149"Interval" <http://cnx.org/content/m10867/latest/#p21b>
150"Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>
really sounded like. The enharmonic, chromatic, and diatonic tetrachords mentioned in ancient descriptions are often now written as in the figure above. But references in the old texts to "shading" suggest that the reality was more complex, and that they probably did not use the same intervals we do. It is more likely that ancient Greek music sounded more like other traditional Mediterranean and Middle Eastern musics than that it sounded anything like modern Western (Section 3.1) music.

Western (Section 3.1) composers often consistently choose minor\textsuperscript{151} keys over major\textsuperscript{152} keys (or vice versa) to convey certain moods (minor for melancholy, for example, and major for serene). One interesting aspect of Greek modes is that different modes were considered to have very different effects, not only on a person’s mood, but even on character and morality. This may also be another clue that ancient modes may have had more variety of tuning and pitch than modern keys do.

3.4.3 The Medieval Church Modes

Sacred music in the middle ages in Western Europe - Gregorian chant, for example - was also modal, and the medieval Church modes were also considered to have different effects on the listener. (As of this writing the site Ricercare by Vincenzo Galilei\textsuperscript{153} had a list of the "ethos" or mood associated with each medieval mode.) In fact, the names of the church modes were borrowed from the Greek modes, but the two systems don’t really correspond to each other, or use the same name to indicate the same set of intervals. So some books prefer to name the church modes using a Roman numeral system. Each of these modes can easily be found by playing its one octave range, or ambitus, on the "white key" notes on a piano. But the Dorian mode, for example, didn’t have to start on the pitch we call a D. The important thing was the pattern of half steps and whole steps within that octave, and their relationship to the notes that acted as the modal equivalent of tonal centers\textsuperscript{154}, the finalis and the dominant. Generally, the last note of the piece was the finalis, giving it the same "resting place" function as a modern tonal center. The dominant, also called the reciting tone or tenor, was the note most often used for long recitations on the same pitch.

\textsuperscript{151}"Minor Keys and Scales" <http://cnx.org/content/m10856/latest/>
\textsuperscript{152}"Major Keys and Scales" <http://cnx.org/content/m10851/latest/>
\textsuperscript{153}http://www.recorderhomepage.net/galilei.html
\textsuperscript{154}"Major Keys and Scales" <http://cnx.org/content/m10851/latest/>
A mode can be found by playing all the "white key" notes on a piano for one octave. From D to D, for example is Dorian; from F to F is Lydian. Notice that no modes begin on A, B, or C. This is because a B flat was allowed, and the modes beginning on D, E, and F, when they use a B flat, have the same note patterns and relationships as would modes beginning on A, B, and C. After the middle ages, modes beginning on A, B, and C were named, but they are still not considered Church modes. Notice that the Aeolian (or the Dorian using a B flat) is the same as an A (or D) natural minor\textsuperscript{155} scale and the Ionian (or the Lydian using a B flat) is the same as a C (or F) major scale.

\textsuperscript{155}"Minor Keys and Scales" <http://cnx.org/content/m10856/latest/#p2a>
Figure 3.21: These modes are part of the same theoretical system as the church modes, but they were not used.

In our modern tonal system, any note may be sharp, flat, or natural\textsuperscript{156}, but in this modal system, only the B was allowed to vary. The symbols used to indicate whether the B was "hard" (our B natural) or "soft" (our B flat) eventually evolved into our symbols for sharps, flats, and naturals. All of this may seem very arbitrary, but it's important to remember that medieval mode theory, just like our modern music theory, was not trying to invent a logical system of music. It was trying to explain, describe, and systematize musical practices that were already flourishing because people liked the way they sounded.

\textsuperscript{156}"Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>
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3.4.4 Modal Jazz and Folk Music

Some jazz and folk music is also considered modal and also uses the Greek/medieval mode names. In this case, the scales used are the same as the medieval church modes, but they do not have a reciting tone and are used much more like modern major and minor scales. Modal European (and American) folk music tends to be older tunes that have been around for hundreds of years. Modal jazz, on the other hand, is fairly new, having developed around 1960.

It is important to remember when discussing these types of music that it does not matter what specific note the modal scale starts on. What matters is the pattern of notes within the scale, and the relationship of the pattern to the tonic\(^{159}\) /\(n\)al (p. 51). For example, note that the Dorian "scale" as written above starts on a D but basically has a C major key signature, resulting in the third and seventh notes of the scale being a half step\(^{160}\) lower than in a D major scale. (A jazz musician would call this flattened or flat thirds and sevenths.) So any scale with a flattened third and seventh can be called a Dorian scale.

**Exercise 3.4** *(Solution on p. 63.)*

You need to know your major keys\(^{161}\) and intervals\(^{162}\) to do this problem. Use the list of "white key" modes in Figure 3.20 to figure out the following information for each of the four modes below.

Before looking at the solutions, check your own answers to make sure that the answers you get for step 2 and step 4 are in agreement with each other:

1. List the flats and sharps you would use if this were a major scale rather than a mode.
2. In this mode, which scale tones are raised or lowered from the major key?
3. What is the interval between the mode and the major key with the same key signature?

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\(^{157}\) "Interval" <http://cnx.org/content/m10867/latest/#p21a>

\(^{158}\) "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>

\(^{159}\) "Major Keys and Scales" <http://cnx.org/content/m10851/latest/#p1a>

\(^{160}\) "Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>

\(^{161}\) "Major Keys and Scales" <http://cnx.org/content/m10851/latest/>

\(^{162}\) "Interval" <http://cnx.org/content/m10867/latest/>
4. List the flats or sharps in this key signature.
5. Write one octave of notes in this mode. You may print out this PDF file if you need staff paper. Check to make sure that your "modal scale" agrees with all the things that you have written about it already.

Example

1. D major has 2 sharps: F sharp and C sharp.
2. Looking at Figure 3.20, you can see that the Lydian mode starts on an F. The key of F major would have a B flat, but in the mode this is raised one half step, to B natural. Therefore the fourth degree of the Lydian mode is raised one half step.
3. F Lydian has the same key signature as C major, which is a perfect fourth lower. So all Lydian modes have the same key signature as the major key a perfect fourth below them.
4. We want D Lydian. The major scale beginning a perfect fourth below D major is A major. A major has three sharps: F sharp, C sharp and G sharp. Adding a G sharp does raise the fourth degree of the scale by one half step, just as predicted in step 2.

Example: D Lydian

<table>
<thead>
<tr>
<th>D Major</th>
<th>D Major Key Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D Lydian</th>
<th>A Major Key Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you start with a D major scale, and raise the fourth tone a half step (raise G natural to G sharp), you get D Lydian, which has the same key signature as A major, the key a perfect fourth lower than D major.

Figure 3.23

1. A Dorian
2. C Lydian
3. B flat Mixolydian
4. D Phrygian

3.4.5 The Ragas of Classical Indian Music

The ragas (Section 3.5) of classical India and other, similar traditions, are more like modes than they are like scales. Like modes, different ragas sound very different from each other, for several reasons. They may have different interval patterns between the "scale" notes, have different expectations for how each note of

\[\text{http://cnx.org/content/m11633/latest/staffpaper1.pdf} \]
the raga is to be used, and may even use slightly different tunings. Like the modal musics discussed above, individual Indian ragas are associated with specific moods.

In fact, in practice, ragas are even more different from each other than the medieval European modes were. The raga dictates how each note should be used, more specifically than a modal or major-minor system does. Some pitches will get more emphasis than others; some will be used one way in an ascending melody and another way in a descending melody; some will be used in certain types of ornaments. And these rules differ from one raga to the next. The result is that each raga is a collection of melodic scales, phrases, motifs, and ornaments, that may be used together to construct music in that raga. The number of possible ragas is practically limitless, and there are hundreds in common use. A good performer will be familiar with dozens of ragas and can improvise music - traditional classical music in India is improvised - using the accepted format for each raga.

The raga even affects the tuning of the notes. Indian classical music is usually accompanied by a tanpura, which plays a drone background. The tanpura is usually tuned to a pure (Section 3.2.2.1: Pythagorean Intonation) perfect fifth\(^{164}\), so, just as in medieval European music, the tuning system is a just intonation (p. 35) system. As in Western (Section 3.1) just intonation, the octave is divided into twelve possible notes, only some of which are used in a particular raga (just as Westerners use only some of the twelve notes in each key). But as was true for the church modes (Section 3.4.3: The Medieval Church Modes), using the pure perfect fifth means that some "half steps" will be larger than others. (If you would like to understand why this is so, please see Harmonic Series II\(^{165}\) and Tuning Systems (Section 3.2).) Even though the variations between these different "half steps" are small, they strongly affect the sound of the music. So, the tuning of some of the notes (not the ones dictated by the tanpura) may be adjusted to better suit a particular raga. (Please see Listening to Indian Classical Music\(^{166}\) and Indian Classical Music: Tuning and Ragas (Section 3.5) for more information on this subject.)

### 3.4.6 Other Non-Western Modal Musics

To the average Western listener, medieval European chant and classical Indian music are the two most familiar traditions that are not based on major and minor scales. But many other musical traditions around the world are not based on Western scales. Some of these have modes similar to the medieval Church modes; they also tend to be a list of notes (or a pattern of intervals\(^{167}\)) used with a specific finals, which may encourage certain types of melodies. While the church mode/jazz mode tradition features diatonic (p. 27) modes (which can be played using only the white keys of a piano), non-Western modes may use other types of scales (Section 3.3).

In other music traditions, modes are much more like Indian ragas, featuring important variations in tuning and melodic expectations from one mode to the next, so that each mode may be seen as a collection of related melodic ideas, phrases, and ornamentations that are traditionally played with a certain set of notes tuned in a certain way. (Some non-Indian traditions even use the term raga.) All of these musics have long traditions that are very different from the familiar major-minor tonal system, and usually also have a different approach to harmony, rhythm, and performance practice.

### 3.4.7 Bibliography

Donald Jay Grout’s *A History of Western Music* introduces both Greek and medieval modes. Lee Evans’s *Modes and Their Use in Jazz* is both comprehensive and accessible for any musician who wants to begin to study that subject. For Western musicians, an introduction to ragas, that is neither too vague nor too technical, does not seem to be available as of this writing.

\(^{164}\)"Interval" <http://cnx.org/content/m10867/latest/#p21a>

\(^{165}\)"Harmonic Series II: Harmonics, Intervals, and Instruments" <http://cnx.org/content/m13686/latest/>

\(^{166}\)"Listening to Indian Classical Music" <http://cnx.org/content/m12502/latest/>

\(^{167}\)"Interval" <http://cnx.org/content/m10867/latest/>
3.5 Indian Classical Music: Tuning and Ragas

3.5.1 Introduction

The music of India sounds quite exotic to most Western (Section 3.1) audiences. Two major reasons for this are the differences between the two traditions in tuning (Section 3.2) and scales (Section 3.3). The following is a short introduction to these differences, meant for someone who has a basic understanding of Western music theory but no knowledge of the Indian music tradition. For an introduction that concentrates on music appreciation and avoids music theory, please see Listening to Indian Classical Music. (For more about Western scales and tuning, please see Major Keys and Scales, Minor Keys and Scales, and Tuning Systems (Section 3.2).)

The term Indian Classical Music encompasses two distinct but related traditions. The Northern Indian tradition is called the Hindustani tradition. The Southern Indian tradition is called Carnatic. (As with many Indian words, there are a variety of spellings in common usage in English, including Karnatak and Karnatik.) Both traditions feature a similar approach to music and music theory, but the terms used are often different. For example, where the Hindustani tradition has that, the Carnatic has melā. The following discussion focuses on the Hindustani tradition, as it is more familiar to the rest of the world.

3.5.2 Ragas

One reason that Indian music sounds so different to the Westerner is that the major/minor tonal system is not used. Harmony, and specifically tonal (Section 3.1.3: Tonal, Atonal, and Modal Music) harmony, has been the basic organizing principle in Western music - classical, folk, and popular - for centuries. In this system, a piece of music is in a certain key, which means it uses the notes of a particular major or minor scale. The harmonies developed using those notes are an integral, basic part of the development and form of the music. Most of the complexity of Western music lies in its harmonies and counterpoint.

The music of India does not emphasize harmony and does not feature counterpoint. In fact, most Indian classical music features a single voice or instrument on the melody, accompanied by drone and percussion. There is no counterpoint and no chord progression at all. Instead, the interest and complexity of this music lies in its melodies and its rhythms. (Just as Indian music can seem confusing and static to someone accustomed to listening for harmonic progressions, Western melodies - based on only two types of scales - and Western rhythms - based on only a few popular meters - may sound overly similar and repetitive to someone accustomed to Indian music.)

Western music divides an octave into the twelve notes of the chromatic scale. But most pieces of music mainly use only seven of these notes, the seven notes of the major or minor key that the piece is in. Indian music also has an octave divided into twelve notes. These twelve notes are called swaras; they are...
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not tuned like the notes of the chromatic scale (please see below (Section 3.5.3: Tuning)). Also similarly to Western music, only seven notes are available for any given piece of music.

But there are important differences, too. Western scales come in only two different "flavors": major and minor. The two are quite different from each other, but any major key sounds pretty much like any other major key, and any minor key sounds basically like every other minor key. This is because the relationships between the various notes of the scale are the same in every major key, and a different set of relationships governs the notes of every minor key. (Please see Major Keys and Scales\textsuperscript{187} and Beginning Harmonic Analysis\textsuperscript{188} for more on this.)

The seven-note that of Indian music, on the other hand, come in many different "flavors". The interval\textsuperscript{189} pattern varies from one that to the next, and so the relationships between the notes are also different. There are ten popular thats in Hindustani music, and Carnatic music includes over seventy mela.

**NOTE:** Although the first note of an Indian scale is often given as C, Indian thats and ragas are not fixed in pitch\textsuperscript{190}; any raga may actually begin on any pitch. The important information about each that and raga "scale" is the pattern of intervals\textsuperscript{191}, the (relative) relationship between the notes, not absolute frequencies\textsuperscript{192}.

\textsuperscript{187}"Major Keys and Scales" <http://cnx.org/content/m10851/latest/>\textsuperscript{188}"Beginning Harmonic Analysis" <http://cnx.org/content/m11643/latest/>\textsuperscript{189}"Interval" <http://cnx.org/content/m10867/latest/>\textsuperscript{190}"Pitch: Sharp, Flat, and Natural Notes" <http://cnx.org/content/m10943/latest/>\textsuperscript{191}"Interval" <http://cnx.org/content/m10967/latest/>\textsuperscript{192}"Frequency, Wavelength, and Pitch" <http://cnx.org/content/m11060/latest/>
Making for even more variety, a piece of Indian classical music may not even use all seven of the notes in the that. The music will be in a particular raga, which may use five, six, or all seven of the notes in the that. And a that can generate more than just three ragas (one pentatonic (Section 3.3.3: Pentatonic Scales), one hexatonic (Section 3.3.4: Dividing the Octave, More or Less), and one full raga). For example, Bilawal raga includes all 7 notes of Bilawal that (which corresponds to the Western C major scale). Meanwhile, Deshkar and Durga are both five-note ragas that are also based on Bilawal that. Deshkar omits the two notes (Ma and Ni) corresponding to F and B; and Durga omits the two notes (Ga and Ni) corresponding to E and B.

Further confusing the issue for the novice, the two traditions often use the same name for completely different ragas, and there can be disagreement even within a tradition as to the name or proper execution of a particular raga. Ragas may be invented, combined, borrowed from other traditions, or dropped from the repertoire, so the tradition itself, including the "theory", is in some ways more fluid than the Western tradition.

It is also important to understand that a raga is not just a collection of the notes that are allowed to be played in a piece of music. There are also rules governing how the notes may be used; for example, the notes used in an ascending scale (arohana) may be different from the notes in a descending scale (avarohana). Some notes will be considered main pitches, the "tonic" or "most consonant" in that raga, while other notes are heard mostly as ornaments or dissonances that need to be resolved to a main note. Particular ornaments or particular note sequences may also be considered typical of a raga. The raga may even affect the tuning of the piece.

If this seems overly complicated, remember that the melodic and harmonic "rules" for major keys are
CHAPTER 3. NON-WESTERN MUSIC

quite different from those of minor keys. (Consider the melodic and harmonic minor scales, as well as the tendency to use different harmonic progressions.) This actually is quite analogous; the big difference is that Indian music has so many more scale types. Since the nuance and complexity of Indian music are focused in the melody rather than the harmony, it is this large number of scales that allows for a great and varied tradition.

Those who are particularly interested in modes and scales may notice that there is a rough correlation between some Hindustani thats and the Western church modes (p. 51). For example, the pattern of intervals in Asavari is similar to that of the Aeolian mode (or natural minor\(^{193}\) scale), and that of Bilawa is similar to the Ionian mode (or major\(^{194}\) scale). Some thats do not correlate at all with the Western modes (for example, take a close look at Purvi and Todi, above (Figure 3.24: Some Example That)), but others that do include Bhairavi (similar to Phrygian mode), Kafi (Dorian), Kalyan (Lydian), and Khama (Mixolydian). Even for these, however, it is important to remember the differences between the traditions. For example, not only is Asavari used in a very different way from either Aeolian mode or the natural minor scale, the scale notes are actually only roughly the same, since the Indian modes use a different system of tuning.

3.5.3 Tuning

The tuning of modern Western Music (Section 3.1) is based on equal temperament (Section 3.2.3.2: Equal Temperament); the octave is divided into twelve equally spaced pitches\(^{195}\). But this is not the only possible tuning system. Many other music traditions around the world use different tuning systems, and Western music in the past also used systems other than equal temperament. Medieval European music, for example, used just intonation (p. 35), which is based on a pure (Section 3.2.2.1: Pythagorean Intonation) perfect fifths\(^{196}\). (Please see Tuning Systems (Section 3.2) for more about this.)

The preferred tuning system of a culture seems to depend in part on other aspects of that culture’s music; its texture\(^{197}\), scales (Section 3.3), melodies\(^{198}\), harmonies\(^{199}\), and even its most common musical instruments. For example, just intonation (p. 35) worked very well for medieval chant, which avoided thirds, emphasized fifths, and featured voices and instruments capable of small, quick adjustments in tuning. But equal temperament (Section 3.2.3.2: Equal Temperament) works much better for the keyboard instruments, triadic\(^{200}\) harmonies, and quick modulations\(^{201}\) so common in modern Western music.

In India, the most common accompaniment instrument (as ubiquitous as pianos in Western music) is the tanpura. (There are several alternative spellings for this name in English, including tanpura and tambura.) This instrument is a chordophone\(^{202}\) in the lute family. It has four very long strings. The strings are softly plucked, one after the other. It takes about five seconds to go through the four-string cycle, and the cycle is repeated continuously throughout the music. The long strings continue to vibrate for several seconds after being plucked, and the harmonics\(^{203}\) of the strings\(^{204}\) interact with each other in complex ways throughout the cycle. The effect for the listener is not of individually-plucked strings. It is more of a shimmering and buzzing drone that is constant in pitch\(^{205}\) but varying in timbre\(^{206}\).

And the constant pitches of that drone are usually a pure (Section 3.2.2.1: Pythagorean Intonation)
perfect fifth. You may have noticed in the figure above (Figure 3.24: Some Example That) that C and G are not flattened or sharpened in any of those. Assuming tuning in C (actual tuning varies), two of the strings of the *tanpura* are tuned to middle C, and one to the C an octave higher. The remaining string is usually tuned to a G (the perfect fifth). (If a pentatonic or hexatonic raga does not use the G, this string is tuned instead to an F.) The pure perfect interval is still used however, and you may want to note that a perfect fourth is the inversion of a perfect fifth.) So a just intonation (p. 35) system based on the pure fifth between C and G (or the pure fourth between C and F) works well with this type of drone.

Pure intervals, because of their simple harmonic relationships, are very pleasing to the ear, and are used in many music traditions. But it is impossible to divide a pure octave into twelve equally spaced pitches while also keeping the pure fifth. So this brings up the question: where exactly are the remaining pitches? The answer, in Indian music, is: it depends on the *raga*.

Indian music does divide the octave into twelve swaras (p. 57), corresponding to the Western chromatic scale. Also, just as only seven of the chromatic notes are available in a major or minor scale, only seven notes are available in each that (p. 58). But because just intonation is used, these notes are tuned differently from Western scales. For example, in Western music, the interval between C and D is the same (one whole tone) as the interval between D and E. In Indian tuning, the interval between C and D is larger than the interval between D and E. Using the simpler ratios of the harmonic series, the frequency ratio of the larger interval is about 9/8 (1.125); the ratio of the smaller interval is 10/9 (1.111). (For comparison, an equal temperament whole tone is about 1.122.) Western music theory calls the larger interval a major whole tone (Section 3.2.2.3: Just Intonation) and the smaller one a minor whole tone (Section 3.2.2.3: Just Intonation). Indian music theory uses the concept of a *shruti*, which is an interval smaller than the intervals normally found between notes, similar to the concept of cents (p. 38) in Western music. The major whole tone interval between C and D would be 4 *shrutis*; the minor whole tone between D and E would be 3 *shrutis*.

In some ragas, some notes may be flattened or sharpened by one *shruti*, in order to better suit the mood and effect of that raga. So, for tuning purposes, the octave is divided into 22 *shrutis*. This is only for tuning, however; for any given that (p. 58) or raga, only twelve specifically-tuned notes are available. The 22 *shrutis* each have a specific designation, and the intervals between them are not equal; the frequency ratios between adjacent *shrutis* ranges from about 1.01 to about 1.04.

In spite of the fact that these tunings are based on the physics of the harmonic series, Indian music can sound oddly out of tune to someone accustomed to equal temperament (Section 3.2.3.2: Equal Temperament), and even trained Western musicians may have trouble developing an ear for Indian tunings. As of this writing, one site devoted to helping Western listeners properly hear Indian tunings was The Perfect Third.

### 3.5.4 Note Names

As mentioned above, Indian music, like Western music, recognizes seven notes that can be sharpened or flattened to get twelve notes within each octave. A flattened note is called *komal*. A sharpened note is called *teevra*.

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207["Interval" <http://cnx.org/content/m10867/latest/#p21a>]

208["Octaves and the Major-Minor Tonal System" <http://cnx.org/content/m10862/latest/>]

209["Interval": Section Inverting Intervals <http://cnx.org/content/m10867/latest/#s3>]

210["Harmonic Series" <http://cnx.org/content/m11118/latest/>]

211["Interval" <http://cnx.org/content/m10867/latest/>]

212["Half Steps and Whole Steps" <http://cnx.org/content/m10866/latest/>]

213["Harmonic Series" <http://cnx.org/content/m11118/latest/>]

214["Frequency, Wavelength, and Pitch", Figure 1: Wavelength, Frequency, and Pitch <http://cnx.org/content/m11060/latest/#fig1b>]

215["Musical Intervals, Frequency, and Ratio" <http://cnx.org/content/m11808/latest/>]

216["Interval" <http://cnx.org/content/m10867/latest/>]

217["Harmonic Series" <http://cnx.org/content/m11118/latest/>]

218["Ear Training" <http://cnx.org/content/m12401/latest/>]

219[http://www.perfectthird.com]
Indian Note Names

<table>
<thead>
<tr>
<th>Letter Name</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Name</td>
<td>Do</td>
<td>Re</td>
<td>Mi</td>
<td>Fa</td>
<td>Sol</td>
<td>La</td>
<td>Ti</td>
</tr>
<tr>
<td>Indian Name</td>
<td>Sa</td>
<td>Re</td>
<td>Ga</td>
<td>Ma</td>
<td>Pa</td>
<td>Dha</td>
<td>Ni</td>
</tr>
</tbody>
</table>

Figure 3.25: Since Indian scales are not fixed to particular frequencies, remember that it is more accurate to consider these scale names as being compared to a "moveable do" system (in which "do" may be any note) than a "fixed do" (in which do is always the C as played on a Western piano).

3.5.5 Acknowledgements and Suggested Reading

The author is grateful to Dr. S. S. Limaye, a professor of electronics at Ramdeobaba Engineering College and amateur musician, who provided much of the information on which this module is based. Any insights provided here are thanks to Dr. Limaye. Any errors due to misunderstanding are my own.

This is a very large subject. Those who wish to pursue it further may find the following helpful:

- B. Subba Rao’s 4-volume Raga Nidhi (Music Academy, Madras, 1996) is an encyclopedic resource that describes in detail both Hindustani and Karnatak ragas.
- As of this writing, Introduction to Indian Music had extensive audio and video examples, as well as easy-to-understand discussions of the subject.

---

220"Frequency, Wavelength, and Pitch" <http://cnx.org/content/m11060/latest/>  
221http://www.chandrakantha.com/articles/indian_music/
Solutions to Exercises in Chapter 3

Solution to Exercise 3.1 (p. 42)

Figure 3.26: This whole tone scale contains the notes that are not in the whole tone scale in Figure 3.8 (A Whole Tone Scale).

Solution to Exercise 3.2 (p. 42)

Figure 3.27: The flats in one scale are the enharmonic\textsuperscript{222} equivalents of the sharps in the other scale.

Assuming that octaves don’t matter - as they usually don’t in Western (Section 3.1) music theory, this scale shares all of its possible pitches with the scale in Figure 3.8 (A Whole Tone Scale).

Solution to Exercise 3.3 (p. 44)
If you can, have your teacher listen to your compositions.

Solution to Exercise 3.4 (p. 54)

\textsuperscript{222}Enharmonic Spelling" <http://cnx.org/content/m11641/latest/>
CHAPTER 3. NON-WESTERN MUSIC

A Dorian

C Lydian

B flat Mixolydian

D Phrygian

Figure 3.28
# Index of Keywords and Terms

**Keywords** are listed by the section with that keyword (page numbers are in parentheses). Keywords do not necessarily appear in the text of the page. They are merely associated with that section. *Ex.* apples, § 1.1 (1) **Terms** are referenced by the page they appear on. *Ex.* apples, 1

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