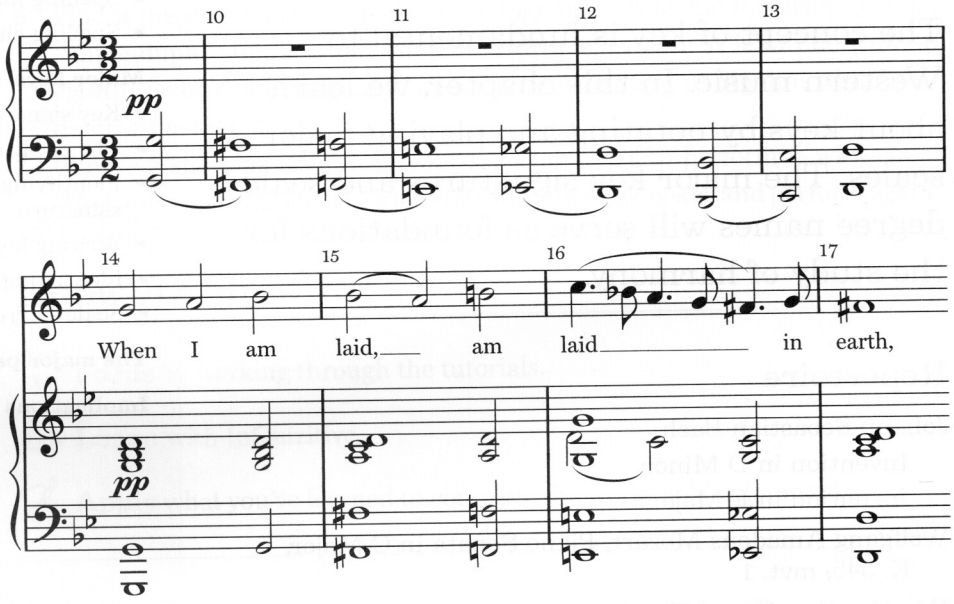
Chromatic and Diatonic Collections

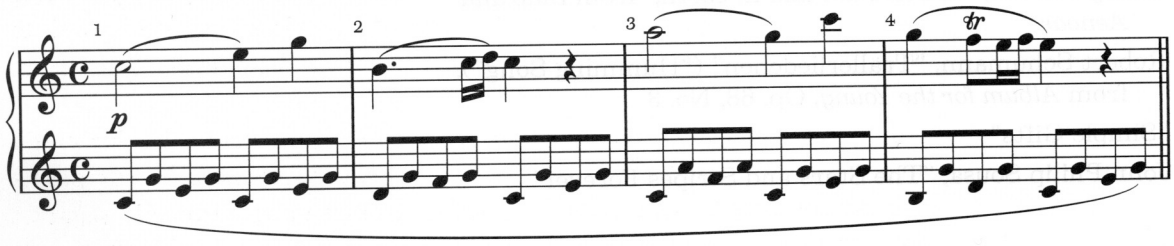
Listen to excerpts from two compositions written almost exactly 100 years apart: Purcell's *Dido and Aeneas* (1689, Example 3.1) and Mozart's Piano Sonata in C Major (1788, Example 3.2). Below the examples, write the letter names of the pitch classes in each excerpt, writing each letter name only once, in any order. When finished, you will have written a **pitch-class collection** for each excerpt—that is, the group of pitch classes found in the music, with no particular order and no duplications.

Example 3.1: Purcell, "When I am laid in earth," mm. 10-17



Pitch-class collection: G

Example 3.2: Mozart, Piano Sonata in C Major, mvt. 1, mm. 1-4



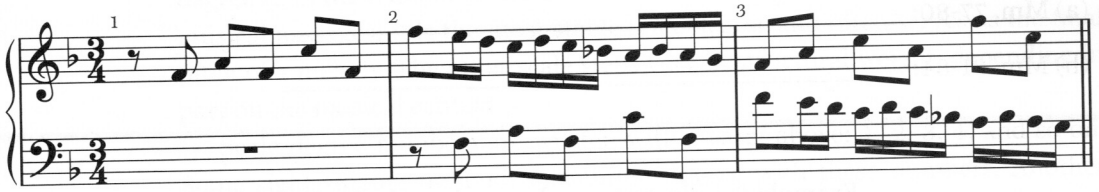
Pitch-class collection: C

The Purcell passage includes ten of the twelve possible pitch classes; two more and it would constitute a complete **chromatic** collection. (The word "chromatic" comes from the Greek *chroma*, meaning "color"; chromatic collections contain one of each possible pitch-class "color.") In contrast, the Mozart excerpt features only seven different pitch classes; these form a **diatonic** collection—seven different letter names in a particular arrangement. Because no ordering guidelines were given, you could have listed C D E F G A B, or C E G B D F A, or any other order. A diatonic collection is a subset of the chromatic collection.

Try it #1

Write the pitch-class collection for the passage shown below, and identify its collection type.

Bach, Invention in F Major, mm. 1–3



Pitch-class collection: **F**

Circle one: chromatic collection diatonic collection

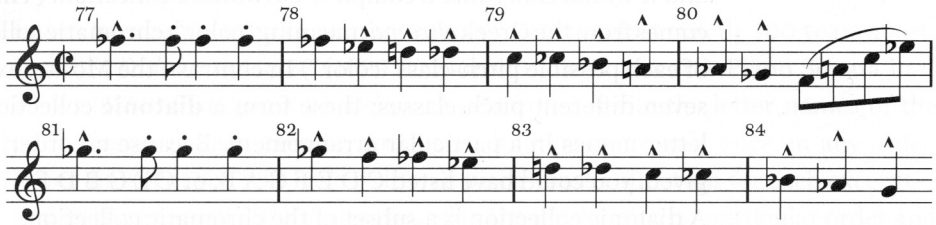
Scales: Ordered Pitch-Class Collections

Listen again to the opening of the Mozart sonata (Example 3.2), and sing the pitch that seems to be more stable than the rest. This pitch, C, provides the foundation for a special type of diatonic collection called a **major scale**.

Scales differ from collections in that they are ordered. When you play or sing a scale, there is a beginning pitch and an order to the notes that corresponds to the musical alphabet—in this case, C D E F G A B C, the pitches of a C major scale.

Similarly, when the chromatic collection is ordered, it becomes the **chromatic scale**, made up entirely of consecutive half steps. In musical works, composers may include only a segment of this scale. A descending chromatic segment often colors a slow, sad movement, like Purcell's aria (Example 3.1). Chromatic passages may also appear in showy music as a decorative or virtuosic element. For an example, listen to the Trio section of "The Stars and Stripes Forever" (Example 3.3).

Example 3.3: Sousa, "The Stars and Stripes Forever," mm. 77-84



Try it #2

In Example 3.3, circle the longest continuous chromatic scale segment in each line. Look for numerous accidentals and consecutive half steps. Write the letter names of the scale segments below.

(a) Mm. 77-80: _____

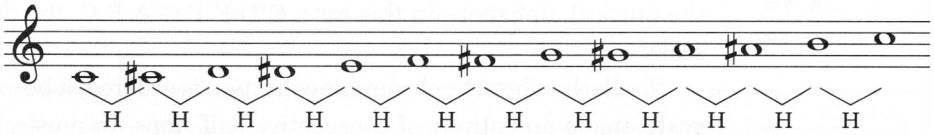
(b) Mm. 81-84: _____

Example 3.4 illustrates a chromatic and a major scale, with whole and half steps identified for comparison. The chromatic scale's steps are all the same size: a half step (H, part a). In contrast, the pattern of whole (W) and half steps in the major scale (part b) is W–W–H–W–W–W–H. When you hear a half step in a major scale, you know it is in one of two specific locations, while in a chromatic scale the half step could be anywhere. The position of the half step thus helps us quickly locate the most stable pitches in a major scale.

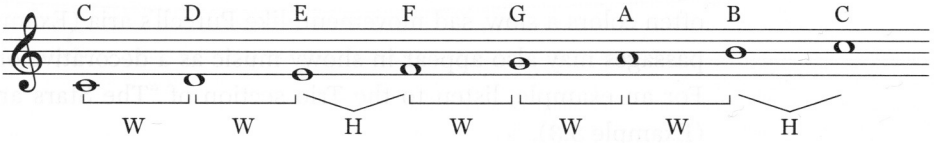
KEY CONCEPT A major scale may begin on any pitch. It must include each of the seven letter names, as in Example 3.4b, and follow the W–W–H–W–W–W–H arrangement of whole and half steps from bottom to top.

Example 3.4: Chromatic and major scale patterns

(a) Chromatic



(b) Major



Another Way

One way to remember the W–W–H–W–W–W–H pattern is to think of the white-key notes on the piano: they match exactly the sequence of notes from C up to C.

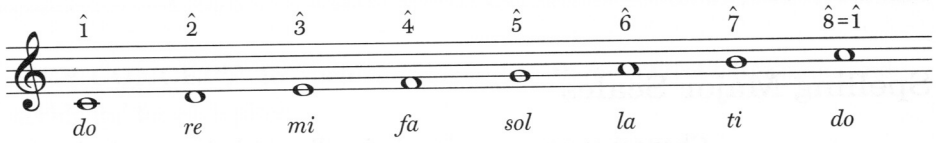
Scale Degrees

The word "scale" comes from the Latin *scalae* (or the Italian *scala*), meaning "stairs" or "ladder." Each pitch of the scale is a **scale degree**—or **scale step**, in keeping with the stairs image. When you write or play a scale, its beginning note, called the **tonic**, is usually repeated one octave higher at the end. The tonic scale degree (C in the C major scale) is crucial to the sound and structure of scales and musical passages; it is the most stable scale degree and often serves as the final pitch of a melody. The other scale steps vary in structural weight, depending in part on the musical context.

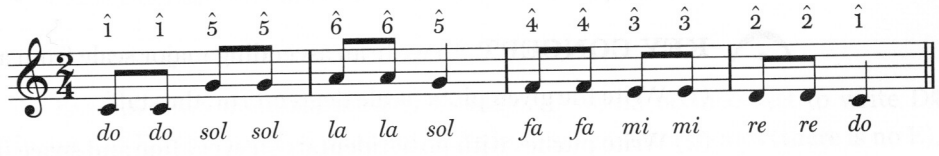
Scale-degree numbers are written with a caret above: $\hat{1}$, $\hat{2}$, $\hat{3}$, $\hat{4}$, and so on. Some sight-singing methods encourage singing with these numbers. Another method, **movable-do solfège**, or **solfège** for short, assigns each scale degree a syllable—*do*, *re*, *mi*, *fa*, *sol*, *la*, *ti*, *do*—as in Example 3.5a. Part (b) gives scale-degree numbers and solfège syllables for the beginning of "Twinkle, Twinkle, Little Star."

EXAMPLE 3.5: Solfège syllables and scale-degree numbers

(a) Scale beginning on C



(b) "Twinkle, Twinkle, Little Star" (mm. 1–4)

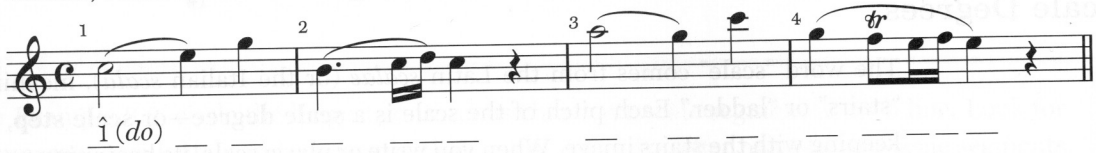


Try it #3

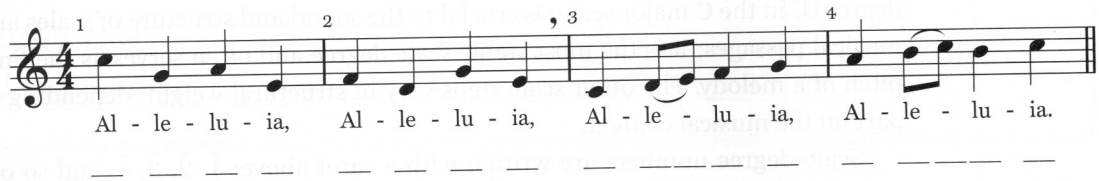
For practice hearing scale-degree relationships in melodies:

(a) Sing up and down a major scale on scale-degree numbers or solfège syllables beginning on any C in a comfortable range. Then write the appropriate number or syllable below each pitch of the two melodies below (assuming C is $\hat{1}$, or *do*).

Mozart, Piano Sonata in C Major, mvt. 1, mm. 1-4



Mozart, "Alleluia," mm. 1–4



(b) Sing the melodies above on scale-degree numbers or solfège in any comfortable octave. After giving yourself the starting pitch, use a piano or other instrument to check your pitch only if necessary. For now, don't worry about the rhythm; focus on singing the scale degrees in tune. After singing, listen to the sound file to check your accuracy.

(c) For more practice, sing some familiar tunes on numbers or solfège, such as "Frère Jacques" ("Are You Sleeping?"), which starts $\hat{1}$-$\hat{2}$-$\hat{3}$-$\hat{1}$ (*do-re-mi-do*); or "Happy Birthday," $\underline{\hat{5}}$-$\underline{\hat{5}}$-$\underline{\hat{6}}$-$\underline{\hat{5}}$-$\hat{1}$-$\underline{\hat{7}}$ (*sol-sol-la-sol-do-ti*). An underlined number or syllable indicates that it falls below the tonic.

Spelling Major Scales

Chances are, you are already familiar with the sound of major scales from playing and singing them as technical warm-ups. Here's how to write them.

KEY CONCEPT To write an ascending major scale from any given pitch:

(1) Write the given pitch (scale degree $\hat{1}$) on the staff.

(2) Write pitches with no accidentals on every line and space from that pitch, up to and including the same pitch class an octave higher (Example 3.6a).

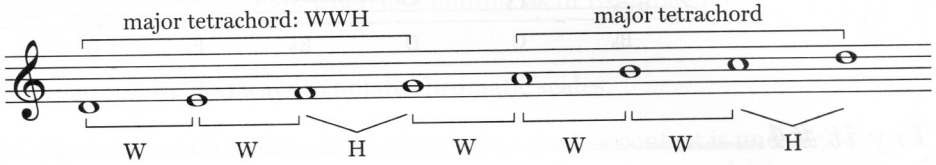
(3) Label the space between each pair of consecutive pitches, from bottom to top, W–W–H–W–W–W–H (part b).

(4) Add an accidental (♯ or ♭) as needed to make the appropriate whole or half step (part c).

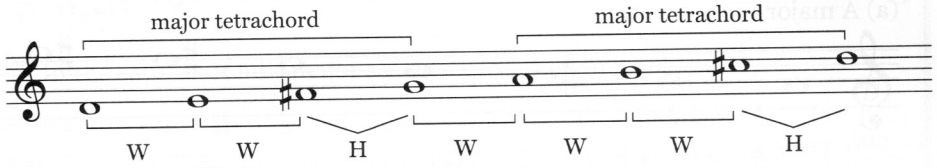
EXAMPLE 3.6: Steps in constructing a D major scale

(a) Write note heads on the staff.

(b) Label the correct order of whole and half steps.



(c) Add appropriate accidentals.



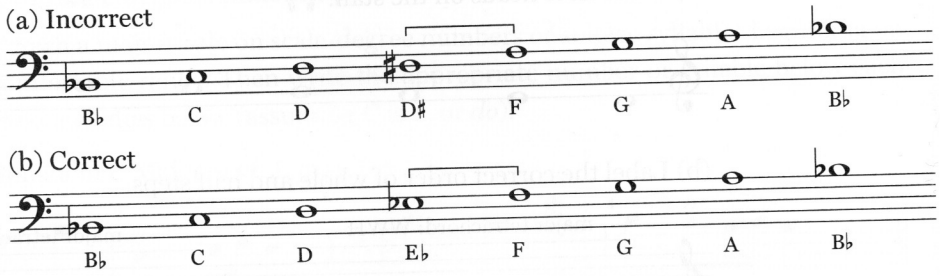
Another way to remember the whole- and half-step pattern is to divide the scale into two four-note groups, or **major tetrachords** ("tetra-" means "four"): $\hat{1}$-$\hat{2}$-$\hat{3}$-$\hat{4}$ and $\hat{5}$-$\hat{6}$-$\hat{7}$-$\hat{8}$. Each major tetrachord consists of the pattern W–W–H, and the two tetrachords are a whole step apart, as marked in Example 3.6. Play major tetrachords, beginning on various pitches, on a keyboard or other instrument to become familiar with their sound.

KEY CONCEPT To "spell" a major scale with the correct letter name and accidental for each pitch:

- Write eight pitches—all seven letters of the alphabet plus the repeated tonic.
- Use accidentals that are either all sharps or all flats, not a mixture.

As Example 3.7a demonstrates, in B♭ major it would be incorrect to write D♯ instead of E♭: this spelling does not include all seven letter names (there is no E), and it mixes flats with sharps. Part (b) provides the correct spelling. When spelling scales, never change the given pitch. If your scale doesn't conform to these guidelines, go back and check your work.

Example 3.7: Notation of the B♭ major scale

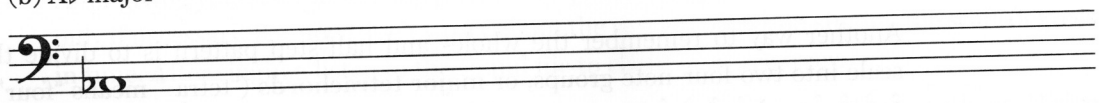


Try it #4

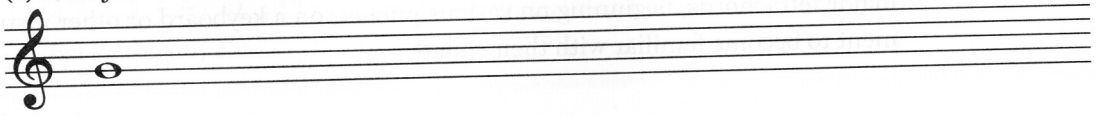
Follow the steps above to write a major scale from each given pitch.

(a) A major

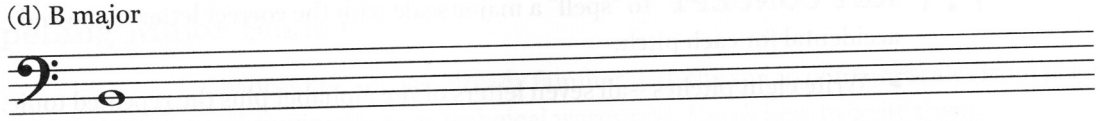
(b) A♭ major



(c) G major



(d) B major



Spelling Chromatic Scales

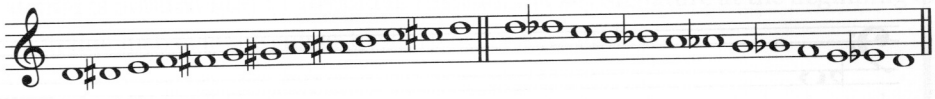
Unlike major scales, chromatic scales must include some letter names more than once.

KEY CONCEPT A half step spelled D-D♯ is a **chromatic half step**: the same letter name plus a chromatic alteration. A half step spelled D-E♭ is a **diatonic half step**: different letter names for adjacent pitches in a diatonic scale.

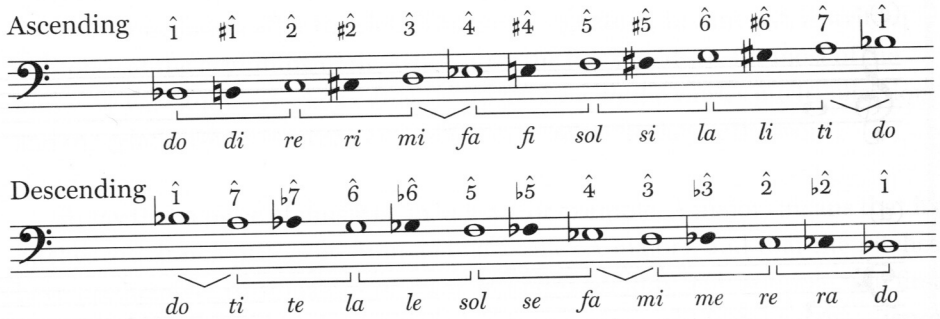
Chromatic scales may be notated in one of two ways, depending on the context. When no key is specified or the key is unclear, simply raise notes when ascending and lower them when descending, as in Example 3.8a.

EXAMPLE 3.8: Two ways to notate chromatic scales

(a) Sharps ascending, flats descending (when the key context is unclear)



(b) In the context of a B♭ major scale (represented in whole notes)



Part (b) shows the chromatic scale spelled in the context of a B♭ major scale. If a key is specified, first write the underlying major scale in whole notes, then fill in each whole step with a chromatic half step: raise the scale degrees with ♯ or ♮ going up, and lower them with ♭ or ♮ going down. This results in a scale with mixed accidentals (and additional solfège syllables), but a clear underlying tonal context.

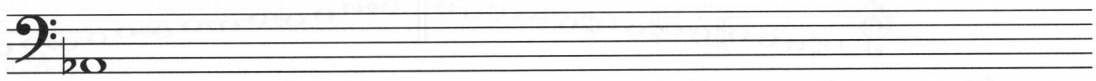
It is important to pay careful attention to how you spell scales and other musical elements. In practical terms, the correct spelling makes a score easier to sight-read. Once you are used to the look and feel of a particular key, unusual spellings can be distracting or confusing. Spelling anything incorrectly—even if the spelling "sounds" the same—changes its musical meaning.

Try it #5

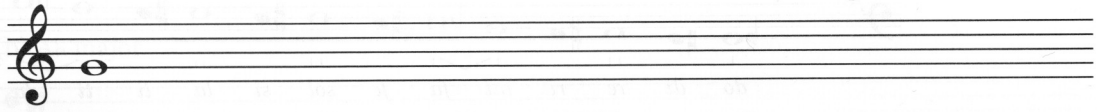
Write a chromatic scale (ascending and descending) beginning with the pitches shown below. Base the spelling on the corresponding major scales you wrote for *Try it #4*. Label the diatonic scale degrees, and write these pitches with whole notes. Then fill in the half steps between them (with filled note heads) as appropriate.

(a)

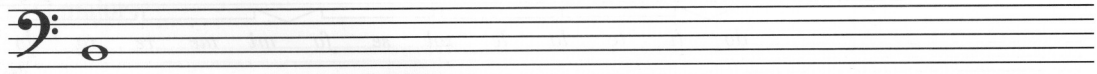
(b)



(c)



(d)

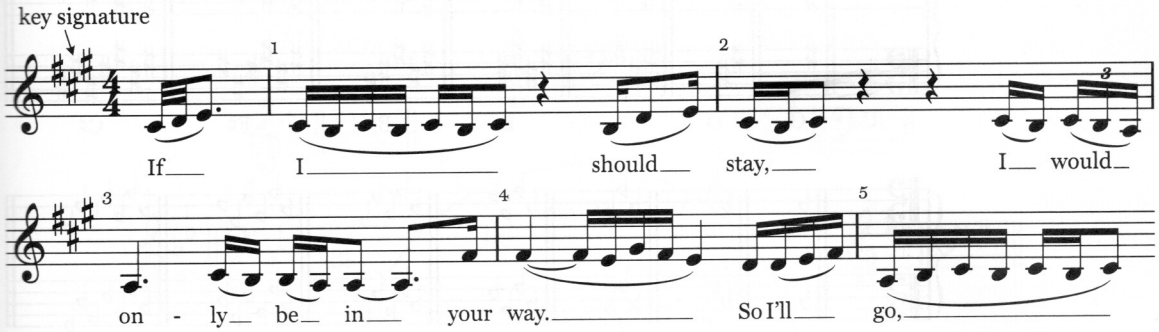


Major Keys

Key Signatures

In writing scales so far, we have added an accidental next to any note that needed it. In tonal music, however, this type of notation is not standard practice. Instead we use a shorthand notation, called a key signature, at the beginning of the score to specify consistent accidentals for the whole piece. Look at the beginning of Dolly Parton's "I Will Always Love You," given in Example 3.9.

EXAMPLE 3.9: Parton, "I Will Always Love You," mm. 1-5

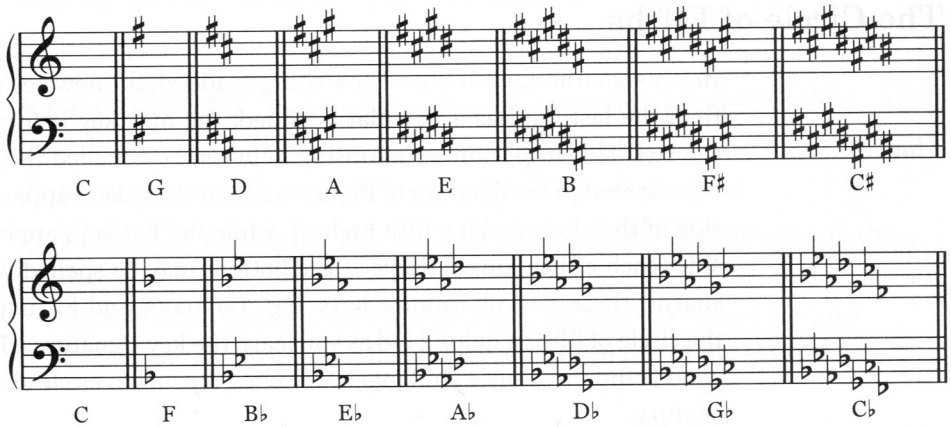


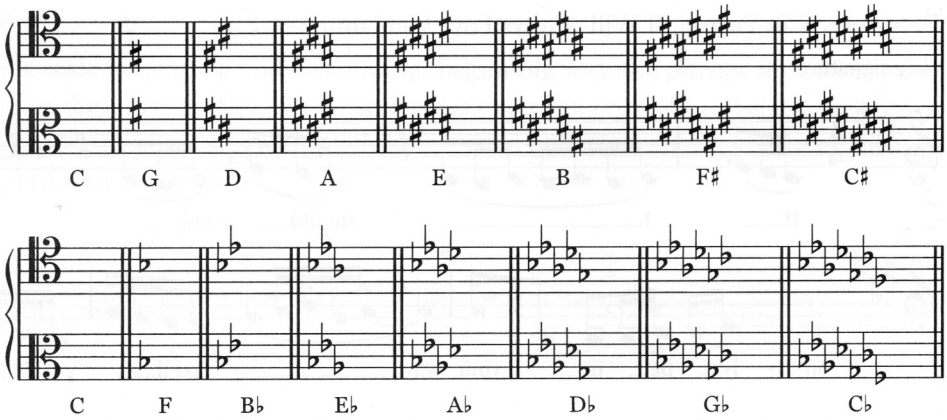
This song is in A major, whose scale includes three sharps, yet not a single accidental is notated next to any pitch. Instead, the key signature at the beginning of each line instructs the singer to sharp every F, C, and G.

KEY CONCEPT **A key signature** shows which pitches are to be sharped or flatted consistently throughout a work. It appears at the beginning of each line of a score, immediately after the clef. (The meter signature, in contrast, is written only once at the beginning of the score, after the key signature, for most of the music we will study.) The key signature, together with the work's pitch collection and the relationships between its pitches, determine the key of the work.

To say that a piece of music is "in" a key (for example, A major) means that its pitches are drawn primarily from a single scale (A major), and that the pitches have predictable relationships of stability and instability. For example, the first note of the scale (Î) is the most stable (where a piece will usually end). Figure 3.1 presents all the major key signatures. Memorize them, together with their position on the staff, since many skills you will learn in later chapters build on this knowledge.

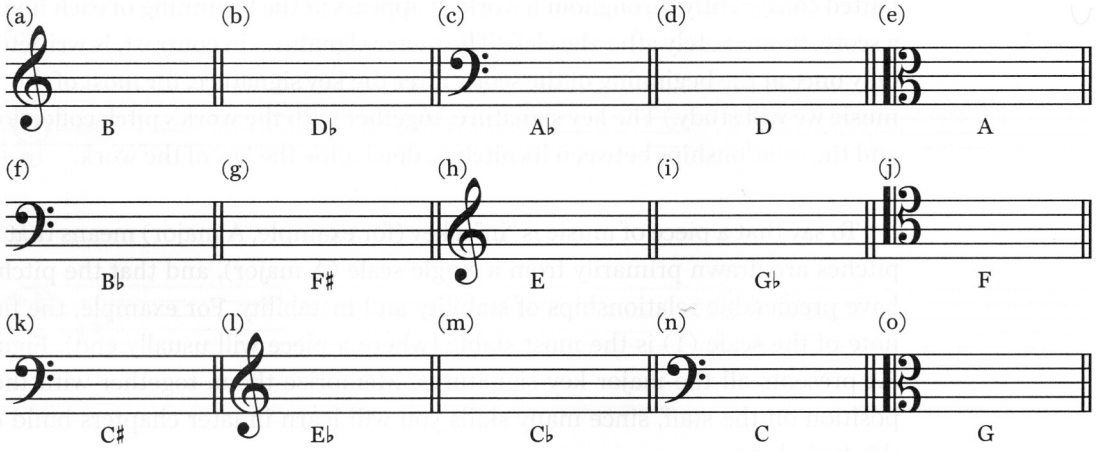
FIGURE 3.1: Major key signatures in four clefs





Try it #6

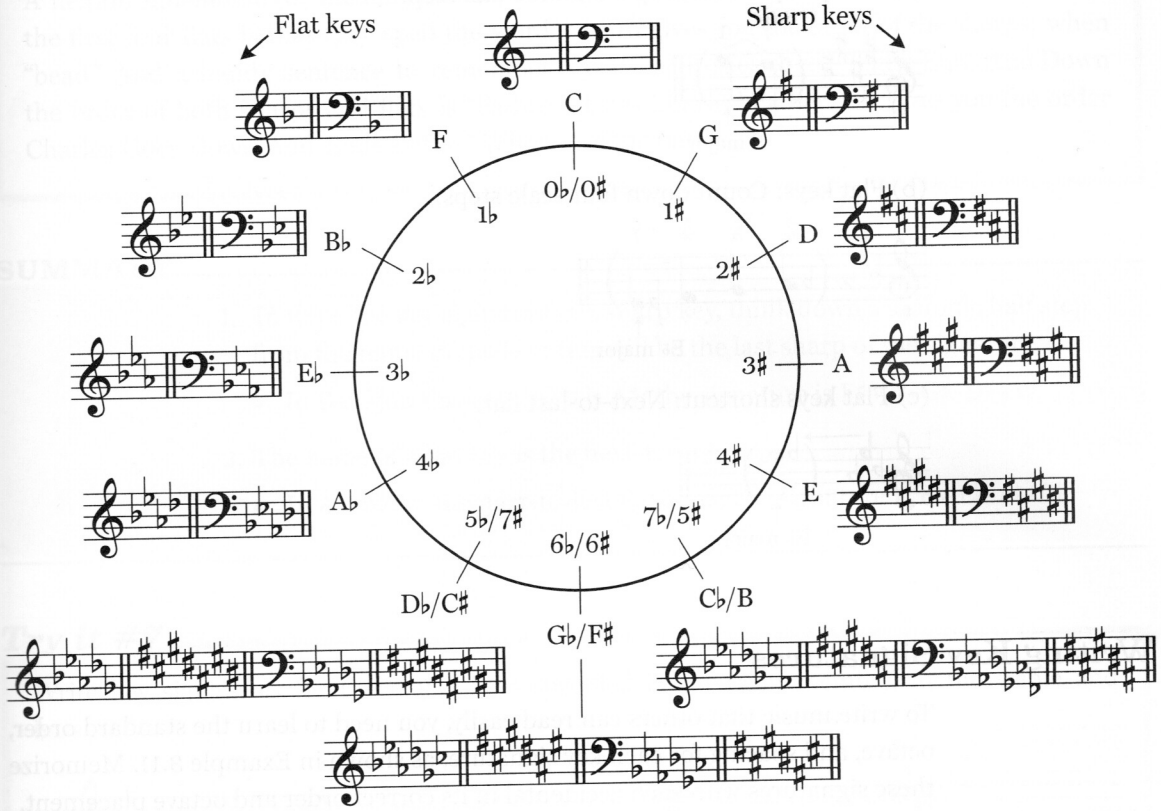
On the staves below, copy the major key signatures requested, taking Figure 3.1 as your model. Center each accidental on the appropriate line or space.



The Circle of Fifths

In key signatures, each time a new sharp is added, the new key is five steps higher than the last; and as a new flat is added, the new key is five steps lower than the last. This important relationship between keys, called the **circle of fifths**, is represented in the diagram in Figure 3.2. The sharp keys appear around the right side of the circle (each a fifth higher), while the flat keys appear around the left side (each a fifth lower). Keys at the bottom may be spelled with either flats or sharps; these are enharmonic keys (e.g., G♭ major and F♯ major). You may find the circle of fifths a helpful aid as you learn the key signatures. If so, you will be in good company: music students have relied on such a circle since the eighteenth century.

FIGURE 3.2: Circle of fifths



Identifying a Key from a Key Signature

Although you should memorize which key goes with each signature, you can also calculate the name of the key from the signature.

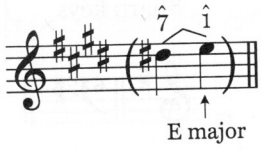
KEY CONCEPT To determine the major key from a key signature:

- For sharp keys, the last sharp of the signature is scale degree $\hat{7}$ (or *ti*). To find the tonic ($\hat{1}$, or *do*), go up a diatonic half step (Example 3.10a).
- For flat keys, the last flat is $\hat{4}$ (or *fa*); count down four diatonic steps to the tonic (part b).

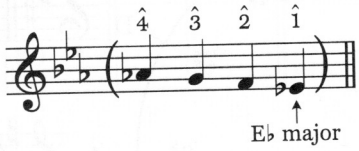
  Shortcut: Since flats are spaced a fourth apart, the next-to-last flat (in a signature with two or more flats) represents the name of the key (part c).

EXAMPLE 3.10: Determining the major key

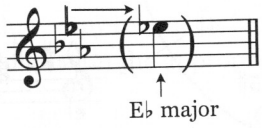
(a) Sharp keys: Count up a diatonic half step.



(b) Flat keys: Count down four scale steps.



(c) Flat keys shortcut: Next-to-last flat.

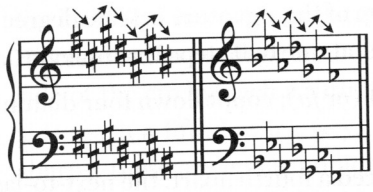


Writing Key Signatures

To write music that others can read easily, you need to learn the standard order, octave, and spacing for each key signature, as shown in Example 3.11. Memorize these signatures with each accidental in its correct order and octave placement.

KEY CONCEPT The key signature goes between the clef and meter signature, which is easy to remember if you just think alphabetical order: clef, key, meter. The order of the sharps is F-C-G-D-A-E-B; the order of the flats is the same, only backward: B-E-A-D-G-C-F. The sharps are positioned on the staff alternating "down-up," while the flats alternate "up-down." (This pattern is occasionally broken to avoid writing an accidental on a ledger line.)

EXAMPLE 3.11: Order of the sharps and flats



Another Way

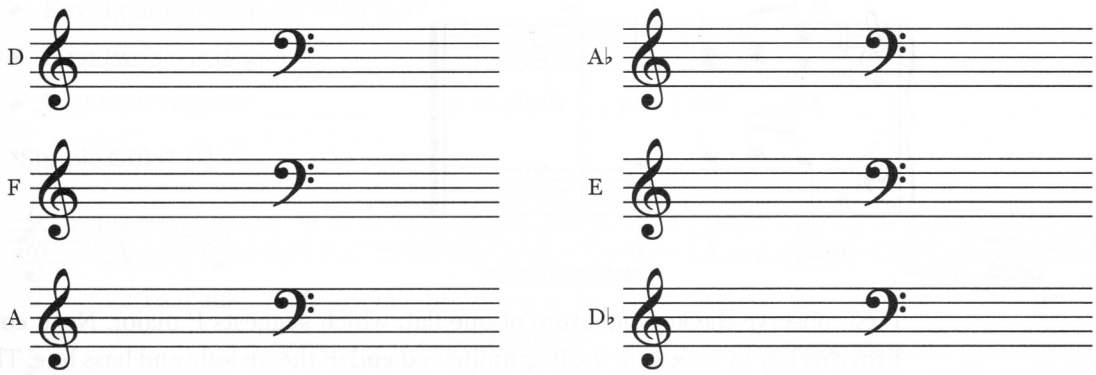
A helpful mnemonic (or memory device) for the first four flats is that they spell the word "bead." And a handy sentence to remember the order of both sharps and flats is "Father Charles Goes Down And Ends Battle." When you read it forward, the first letter of each word gives you the order of the sharps; when you read it backward ("Battle Ends And Down Goes Charles' Father"), it gives you the order of the flats.

SUMMARY

1. To write the key signature of a sharp key, think down a diatonic half step from the name of the key: this will be the last sharp of the signature.
   - In B major, the last sharp is A♯; the signature is F♯-C♯-G♯-D♯-A♯.
2. The name of a flat key is the next-to-last flat.
   - In A♭ major, the next-to-last flat is A♭; the signature is B♭-E♭-A♭-D♭.

Try it #7

Write key signatures for the major keys specified below from memory, in the treble and bass clefs.



Identifying the Key of a Piece

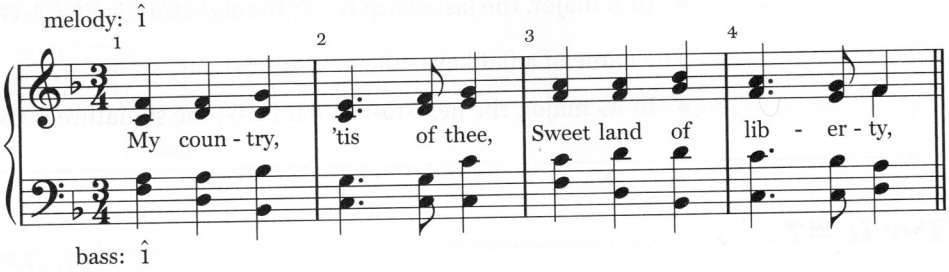
If a piece begins with a key signature of one flat, you might assume that it is in F major, but the key signature alone is not enough to determine the key of a piece. As we will see in Chapter 5, it can indicate either a major or minor key.

KEY CONCEPT To find the key of a piece, first check the key signature, then check the beginning and end of the piece for characteristic scale degrees. The last note of the melody usually ends on $\hat{1}$ of the key. Typical patterns at the end are $\hat{2}$-$\hat{1}$ or $\hat{7}$-$\hat{1}$ in the melody and $\hat{5}$-$\hat{1}$ in the lowest-sounding voice (the bass). The most common scale degrees at the beginning of both melody and bass are $\hat{1}$, $\hat{3}$, and $\hat{5}$.

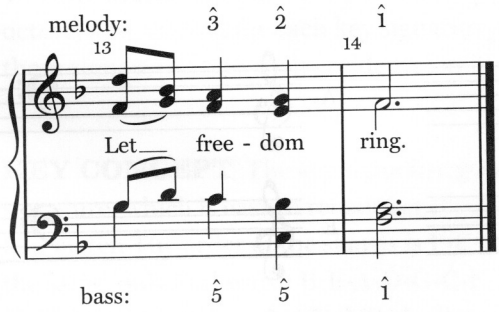
Listen to "My Country, 'Tis of Thee" (Example 3.12), and focus on the beginning and end to decide its key.

EXAMPLE 3.12: "My Country, 'Tis of Thee"

(a) Mm. 1-4



(b) Mm. 13-14

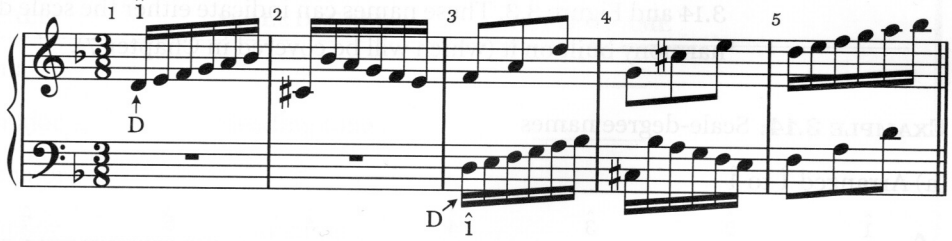


First, observe the key signature of one flat, which suggests F major. Next, confirm this key by checking the beginning and end of the melody and bass line. The melody begins on $\hat{1}$ (F) and ends with $\hat{3}$-$\hat{2}$-$\hat{1}$ in F major, while the bass begins on $\hat{1}$ and ends with $\hat{5}$-$\hat{1}$. Both clearly express the key of F major.

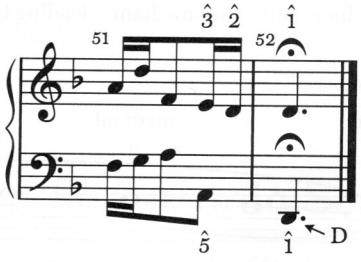
In contrast, look at the Bach invention excerpts given in Example 3.13. This piece also has a key signature of one flat, but the notes at the beginning and end emphasize D, not F. The melody begins in D in both voices (both lines), and it ends with $\hat{3}$-$\hat{2}$-$\hat{1}$ to D in the top voice and $\hat{5}$-$\hat{1}$ to D in the bottom voice. The piece is not in F major, but in D minor; minor keys will be discussed in Chapter 5.

EXAMPLE 3.13: Bach, Invention in D Minor

(a) Mm. 1-5



(b) Mm. 51-52

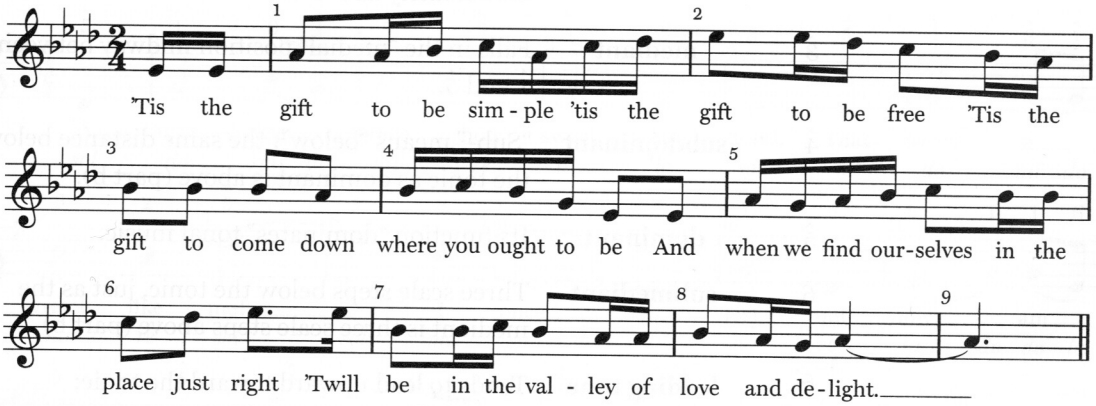


Try it #8

In what key is the excerpt below notated?

- Key signature suggests what key? _____
- First two scale degrees? _____
- Last scale degree? _____ Key of piece: _____

"Simple Gifts"

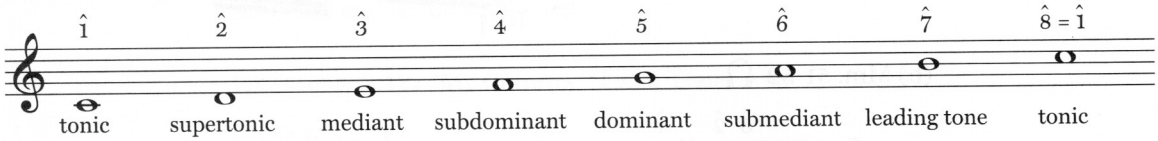


Scale-Degree Names

In addition to numbers, scale degrees also have names, as specified in Example 3.14 and Figure 3.3. These names can indicate either the scale degree itself or the harmony built on it (which will be covered in Chapter 7).

Example 3.14: Scale-degree names

(a) Arranged $\hat{1}$ to $\hat{1}$



(b) Arranged with $\hat{1}$ in the middle

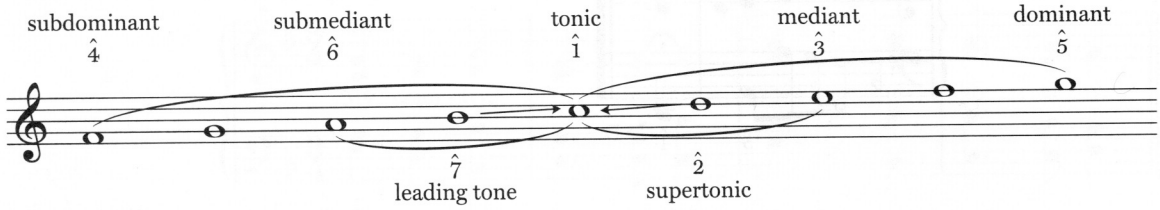


Figure 3.3: Scale-degree names and their meanings

SCALE DEGREE	NAME	MEANING
$\hat{1}$	**tonic**	The "tone" on which the scale is built.
$\hat{2}$	**supertonic**	"Super-" means "above"; its position is immediately above $\hat{1}$.
$\hat{3}$	**mediant**	Falls in the "medial" position midway between $\hat{1}$ and $\hat{5}$.
$\hat{4}$	**subdominant**	"Sub-" means "below"; the same distance below the tonic as dominant is above (part b).
$\hat{5}$	**dominant**	Its function "dominates" tonal music.
$\hat{6}$	**submediant**	Three scale steps below the tonic, just as the mediant is three scale steps above (part b).
$\hat{7}$	**leading tone**	Tends to lead upward toward the tonic; sometimes called a **tendency tone** because of this strong pull.

Try it #9

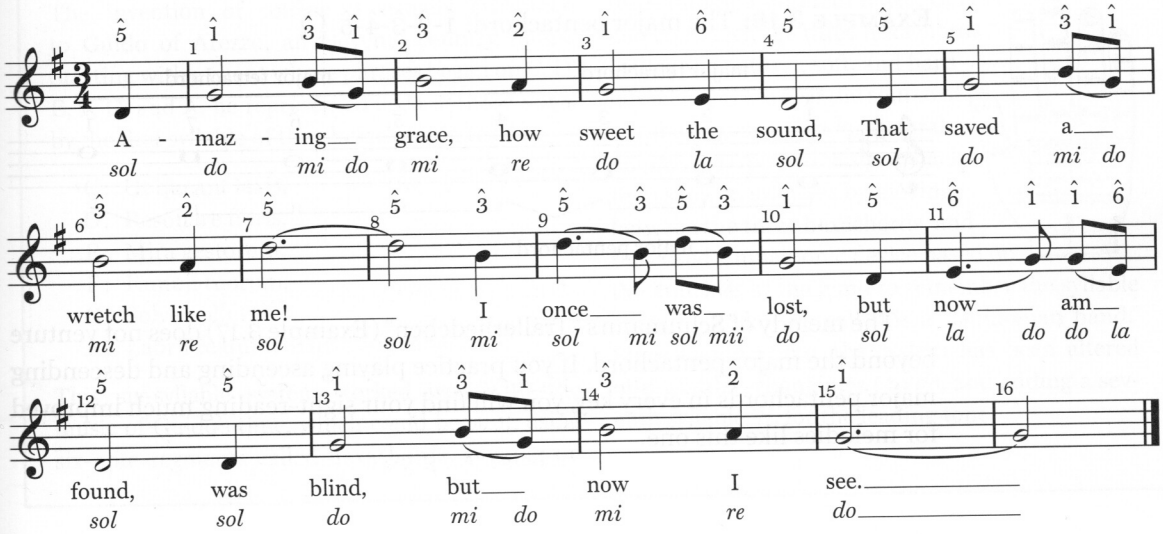
Fill in the letter name for the scale degree in each specified scale.

SCALE	SCALE DEGREE	LETTER NAME
F major	$\hat{4}$	_____
G major	leading tone	_____
A♭ major	$\hat{5}$	_____
E major	mediant	_____
B major	supertonic	_____
D♭ major	$\hat{6}$	_____

The Major Pentatonic Scale

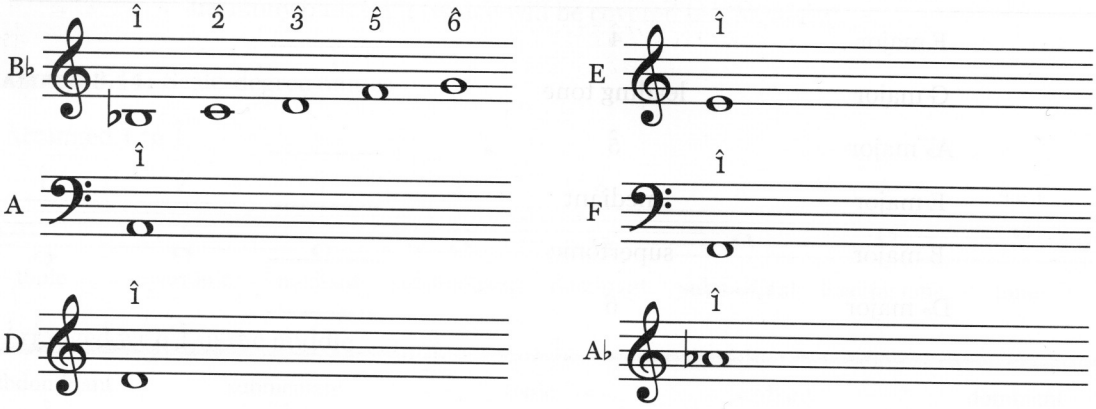
Listen to Example 3.15, "Amazing Grace," or sing it on solfège or scale-degree numbers. Although the melody sounds major, it includes only a subset of the major scale: $\hat{1}$, $\hat{2}$, $\hat{3}$, $\hat{5}$, and $\hat{6}$ (*do*, *re*, *mi*, *sol*, *la*), missing $\hat{4}$ and $\hat{7}$ (*fa* and *ti*). Because this collection features only five of the seven diatonic pitches, it is called a **pentatonic** scale ("penta-" means "five"). Of the numerous pentatonic collections found in folk and popular music, world music, rock, and jazz, this one is called the **major pentatonic** because it begins with the first three degrees of the major scale.

EXAMPLE 3.15: Newton, "Amazing Grace," mm. 1-16



Try it #10

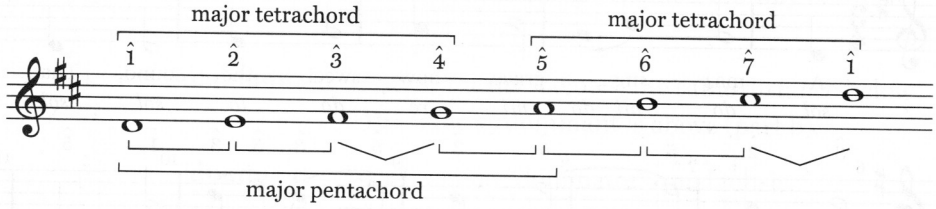
Write major pentatonic scales beginning on the following notes, and label the scale degrees $\hat{1}$-$\hat{2}$-$\hat{3}$-$\hat{5}$-$\hat{6}$ or *do-re-mi-sol-la*.



Implications for Performance

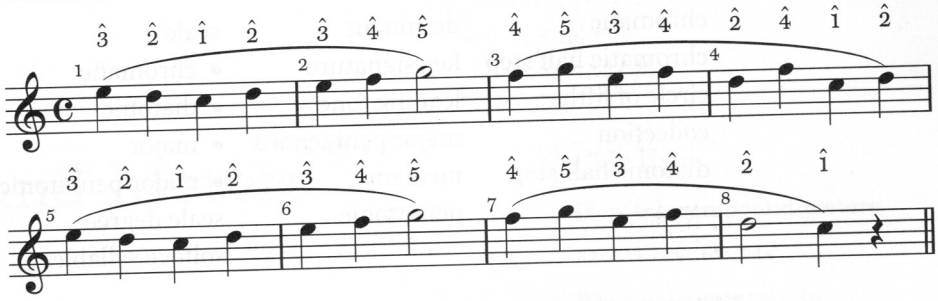
What are scales used for? For one thing, practicing scales on an instrument helps you gain finger facility in different keys, the better to meet the technical demands of works that include scalar passages. It also helps you to think in different keys, which in turn helps with memorization and improvisation. Melodies may not include all the notes of a scale; many are composed with only the first five, called the **major pentachord**, $\hat{1}$-$\hat{2}$-$\hat{3}$-$\hat{4}$-$\hat{5}$ (or *do-re-mi-fa-sol*; W-W-H-W).

Example 3.16: The major pentachord: $\hat{1}$-$\hat{2}$-$\hat{3}$-$\hat{4}$-$\hat{5}$



The melody of Schumann's "Trällerliedchen" (Example 3.17) does not venture beyond the major pentachord. If you practice playing ascending and descending major pentachords in every key, you will find your sight-reading much improved for melodies like this one.

EXAMPLE 3.17: Schumann, "Trällerliedchen," mm. 1-8



KEY CONCEPT The major pentachord is a scale segment of consecutive pitches: $\hat{1}$-$\hat{2}$-$\hat{3}$-$\hat{4}$-$\hat{5}$. Don't confuse it with the major pentatonic scale, which skips $\hat{4}$ and $\hat{7}$: $\hat{1}$-$\hat{2}$-$\hat{3}$-$\hat{5}$-$\hat{6}$.

Scales also make a helpful analytical tool: an abstraction from a piece that clarifies the function and relationship of pitches within it—especially the tendency tones and their expected resolutions (such as $\hat{7}$-$\hat{1}$). Eventually you may choose to bring out tendency tones and their resolutions in performance. In preparation for the analytical work in future chapters, you should be able to play all the major pentachords and major scales on a keyboard, as well as on your own instrument. Work with your performance teachers for the correct fingering and technique.

Did You Know?

The invention of solfège is usually attributed to Guido of Arezzo, an eleventh-century monk. Starting with a chant whose phrases began on C, D, E, F, G, and A, he represented each of those notes by the first syllable of the phrase's Latin text:

C: Ut queant laxis,
D: Resonare fibris,
E: Mira gestorum,
F: Famuli tuorum,
G: Solve polluti,
A: Labrii reatum, Sancte Johannes

This six-syllable system worked well with the music of Guido's time, which could be sung using six-note segments called hexachords, starting on three different different notes: C, F, and G. In fact, the three hexachords (called the natural, soft, and hard hexachords) are also the source of our modern notation for natural, flat, and sharp signs. Singers back then sang on syllables by moving between the three hexachords, and they used a mnemonic device based on the knuckles of the hand to remember the syllable changes. Today we call this a "Guidonian hand." Since Guido's time, the system has been altered only a little—changing *ut* to *do*, and adding a seventh syllable, *ti*, for the leading tone.