1.5.15 80 decibels.

1.5.16 40 decibels.

1.5.17 120 decibels.

1.5.18 160 decibels.

1.5.19 The range of multiples of I_o is from $10^2 I_o$ to $10^{10} I_o$.

1.5.20 $10^{15} I_o$.

Chapter 2

Section 2.1

2.1.1 F, A, G, C, C, A, G, B, E, D, F, C, B, $G^\sharp$, $D^\flat$, B.

2.1.2 C, E, D, F, B, E, A, C, $D^\sharp$, B, $G^\flat$, E, C, B, A, A.

2.1.3 Upper Staff: E, G, B, B, G, E, A, G, A, B, $C^\sharp$, $D^\flat$.
Lower Staff: G, F, C, D, F, E, B, E, A, C, $B^\flat$, $G^\sharp$.

2.1.4 Upper Staff: G, E, B, D, F, $E^\flat$, $C^\sharp$, A, $D^\flat$, A, $D^\sharp$, G.
Lower Staff: D, F, A, C, A, $E^\flat$, $B^\flat$, D, G, $D^\flat$, $A^\sharp$, D.

2.1.5 A, C, B, E, B, F, $D^\flat$, $B^\flat$, $G^\sharp$, D, F, A, $C^\sharp$, A, C, D.

2.1.6 E, G, $G^\flat$, B, $G^\flat$, C, $A^\flat$, F, $E^\flat$, A, C, D, $G^\sharp$, E, F, A.

2.1.7 Treble Clef Staff: G, B, D, G, E, $C^\flat$, $A^\sharp$, F Alto Clef Staff: E, C, A, F, $G^\sharp$, B, D, $G^\flat$
Tenor Clef Staff: F, B, G, E, $C^\sharp$, F, A, D Bass Clef Staff: A, $G^\flat$, E, $A^\sharp$, C, E, $F^\sharp$, A.

Section 2.2

2.2.1 The equations with fractions for the three measures are

$$\frac{1}{8}+\frac{1}{8}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}=\frac{4}{4}$$
$$\left(\frac{1}{4}+\frac{1}{8}\right)+\frac{1}{8}+\frac{1}{2}=\frac{4}{4}$$
$$\frac{3}{32}+\frac{1}{32}+\frac{1}{8}+\frac{1}{4}+\frac{1}{2}=\frac{4}{4}$$

2.2.2 The equations with fractions for the three measures are

$$\frac{1}{8}+\frac{1}{8}+\frac{1}{4}+\left(\frac{1}{8}+\frac{1}{16}\right)+\frac{1}{16}+\frac{1}{4}=\frac{4}{4}$$
$$\frac{1}{2}+\left(\frac{1}{16}+\frac{1}{32}\right)+\frac{1}{32}+\frac{1}{8}+\frac{1}{8}+\frac{1}{8}=\frac{4}{4}$$
$$\frac{3}{32}+\frac{1}{32}+\frac{1}{8}+\left(\frac{1}{4}+\frac{1}{8}\right)+\frac{1}{8}+\frac{1}{4}=\frac{4}{4}$$

2.2.3 The equations with fractions for the three measures are

$$\frac{1}{8}+\frac{1}{8}+\frac{1}{8}+\frac{1}{8}+\frac{1}{16}+\frac{1}{16}+\frac{1}{8}=\frac{3}{4}$$

$$\frac{1}{4}+\left(\frac{1}{16}+\frac{1}{32}\right)+\frac{1}{32}+\frac{1}{8}+\frac{1}{4}=\frac{3}{4}$$

$$\frac{3}{32}+\frac{1}{32}+\frac{1}{8}+\frac{1}{32}+\frac{1}{32}+\frac{1}{16}+\left(\frac{1}{32}+\frac{1}{64}\right)+\frac{1}{64}+\frac{1}{16}+\frac{1}{4}=\frac{3}{4}$$

2.2.4 The equations with fractions for the three measures are

$$\frac{1}{8}+\frac{1}{8}+\frac{1}{4}+\frac{1}{4}=\frac{3}{4}$$

$$\frac{2}{8}+\frac{1}{16}+\frac{1}{16}+\frac{1}{8}+\frac{1}{4}=\frac{3}{4}$$

$$\frac{1}{32}+2\left(\frac{1}{16}+\frac{1}{32}\right)+\frac{1}{32}+\left(\frac{1}{32}+\frac{1}{64}\right)+\frac{1}{64}+\left(\frac{1}{16}+\frac{1}{32}\right)+\frac{1}{32}+\frac{1}{16}+\frac{1}{4}=\frac{3}{4}$$

2.2.5 For the first measure, the equation is

$$\left(\frac{1}{4}\right)+\frac{1}{8}+\frac{1}{8}+\frac{2}{8}=\frac{3}{4}.$$

For the triplet, each note is $\frac{1}{12}$ duration.

For the second measure, the equation is

$$\left(\frac{1}{16}\right)+\frac{1}{16}+\frac{1}{8}+\left(\frac{1}{2}\right)=\frac{3}{4}.$$

For the first triplet, each note is $\frac{1}{48}$ duration. For the second triplet, each note is $\frac{1}{6}$ duration.

For the third measure, the equation is

$$\left(\frac{1}{32}\right)+\frac{1}{32}+\frac{1}{32}+\frac{1}{32}+\frac{1}{8}+\frac{1}{2}=\frac{3}{4}.$$

For the triplet, each note is $\frac{1}{96}$ duration.

2.2.6 For the first measure, the equation is

$$\frac{1}{4}+\left(\frac{1}{4}\right)+\frac{1}{4}=\frac{3}{4}.$$

For the quintuplet, each note is $\frac{1}{20}$ duration.

For the second measure, the equation is

$$\left(\frac{1}{4}\right)+\frac{1}{8}+\frac{1}{8}+\frac{1}{4}=\frac{3}{4}.$$

For the 6-tuplet, each note is $\frac{1}{24}$ duration.

For the third measure, the equation is

$$\frac{1}{2}+\frac{1}{8}+\left(\frac{1}{8}\right)=\frac{3}{4}.$$

For the quintuplet, each note is $\frac{1}{40}$ duration.

2.2.7 For the first measure, the equation is

$$\left(\frac{1}{8}\right)+\frac{1}{8}+\left(\frac{1}{4}\right)+\left(\frac{1}{4}+\frac{1}{8}\right)+\frac{1}{8}=\frac{4}{4}.$$

For the first triplet, each note is $\frac{1}{24}$ duration. For the second triplet, each note is $\frac{1}{12}$ duration.

For the second measure, the equation is

$$(1) = \frac{4}{4}.$$

Each note in the triplet is $\frac{1}{3}$ duration.

For the third measure, the equation is

$$(1) = \frac{4}{4}.$$

The first two notes in the triplet are $\frac{1}{3}$ duration. The last two notes are each $\frac{1}{6}$ duration.

2.2.8 For the first measure, the equation is

$$\frac{1}{4} + \left(\frac{1}{4}\right) + \frac{1}{2} = \frac{4}{4}.$$

For the 7-tuplet, each note is $\frac{1}{28}$ duration.

For the second measure, the equation is

$$\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \left(\frac{1}{4}\right) = \frac{4}{4}.$$

For the 5-tuplet, each note is $\frac{1}{20}$ duration.

For the third measure, the equation is

$$\frac{1}{2} + \left(\frac{1}{2}\right) = \frac{4}{4}.$$

For the 7-tuplet, each note is $\frac{1}{14}$ duration.

2.2.9 The lengths are 1 sec, 0.234375 sec, and 0.5 sec, respectively.

2.2.10 *Adagio:* 1.5 sec. *Allegro:* 0.5 sec. *Andante:* 0.75 sec.

2.2.11 The equations with fractions for the four measures are

$$\begin{aligned}
&\frac{2}{8} + \frac{1}{8} + \frac{1}{8} = \frac{2}{4}\\
&\frac{2}{8} + \frac{1}{4} = \frac{2}{4}\\
&\frac{2}{8} + \left(\frac{1}{8} + \frac{1}{16} + \frac{1}{32}\right) + \frac{1}{32} = \frac{2}{4}\\
&\frac{4}{8} = \frac{2}{4}.
\end{aligned}$$

2.2.12 For the upper staff, the equations for each measure are

$$\begin{aligned}
&\left(\frac{1}{4} + \frac{1}{8}\right) + \left(\frac{1}{4} + \frac{1}{8}\right) = \frac{6}{8}\\
&\left(\frac{1}{4} + \frac{1}{8}\right) + \left(\frac{1}{4} + \frac{1}{8}\right) = \frac{6}{8}\\
&\left(\frac{1}{4} + \frac{1}{8}\right) + \frac{3}{8} = \frac{6}{8}.
\end{aligned}$$

For the lower staff, the equation

$$\frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{1}{8} = \frac{6}{8}$$

describes each of the three measures.

2.2.13 Adding the $1/32^{\text{nd}}$ note produces the given equation. Solving for x we have

$$\begin{aligned} x &= \frac{3}{4} - \frac{1}{32} \\ &= \frac{24-1}{32} = \frac{23}{32} \\ &= \frac{16+4+2+1}{32} = \frac{1+2+4+16}{32} \\ &= \frac{1}{32} + \frac{1}{16} + \frac{1}{8} + \frac{1}{2}\,. \end{aligned}$$

2.2.14 **(a)** The rests are $1/32$, then $1/8$, and then $1/2$. **(b)** The rests are $1/32$, then $1/8$, then $1/4$, and then $1/2$. **(c)** The rests are $1/16$, then $1/4$.

2.2.15 In dancing to music, steps are usually taken on notes receiving emphasis. In rock music the melody typically has emphasis on the first and third beats, while the back beat has emphasis on the second and fourth beats. Therefore, *every* beat has emphasis from some part of the music, so you can not take a step on an off beat.

Section 2.3

2.3.1 The 7 sharp key signature is

which is $C^\sharp$-major, or $A^\sharp$-minor. Its notes are $C^\sharp$, $D^\sharp$, $E^\sharp$, $F^\sharp$, $G^\sharp$, $A^\sharp$, $B^\sharp$, $C^\sharp$. All the notes are now sharps, so no further key signatures with sharps appear on the Circle of Fifths. The notes $E^\sharp$ and $B^\sharp$ are enharmonic with the notes F and C, respectively. This key signature denotes a scale enharmonic with the scale for the $5\flat$ key signature on the Circle of Fifths.

The 7 flat key signature is

which is $C^\flat$-major, or $A^\flat$-minor. Its notes are $C^\flat$, $D^\flat$, $E^\flat$, $F^\flat$, $G^\flat$, $A^\flat$, $B^\flat$, $C^\flat$. All the notes are now flats, so no further key signatures with flats appear on the Circle of Fifths. The notes $C^\flat$ and $F^\flat$ are enharmonic with the notes B and E, respectively. This key signature denotes a scale enharmonic with the scale for the $5\sharp$ key signature on the Circle of Fifths.

2.3.2 **(a)** The scales are the following:

C	D	E	F	G	A	B	C
G	A	B	C	D	E	$F^\sharp$	G
D	E	$F^\sharp$	G	A	B	$C^\sharp$	D
A	B	$C^\sharp$	D	E	$F^\sharp$	$G^\sharp$	A
E	$F^\sharp$	$G^\sharp$	A	B	$C^\sharp$	$D^\sharp$	E
B	$C^\sharp$	$D^\sharp$	E	$F^\sharp$	$G^\sharp$	$A^\sharp$	B
$F^\sharp$	$G^\sharp$	$A^\sharp$	B	$C^\sharp$	$D^\sharp$	$E^\sharp$	$F^\sharp$
$C^\sharp$	$D^\sharp$	$E^\sharp$	$F^\sharp$	$G^\sharp$	$A^\sharp$	$B^\sharp$	$C^\sharp$.

As one cycles through the notes for each new scale, the new sharped note always occurs in the seventh position. This is exactly described by the sharped arrow in the diagram on the left of Figure 2.8.
(b) The scales are the following:

C	D	E	F	G	A	B	C
F	G	A	$B^\flat$	C	D	E	F
$B^\flat$	C	D	$E^\flat$	F	G	A	$B^\flat$
$E^\flat$	F	G	$A^\flat$	$B^\flat$	C	D	$E^\flat$
$A^\flat$	$B^\flat$	C	$D^\flat$	$E^\flat$	F	G	$A^\flat$
$D^\flat$	$E^\flat$	F	$G^\flat$	$A^\flat$	$B^\flat$	C	$D^\flat$
$G^\flat$	$A^\flat$	$B^\flat$	$C^\flat$	$D^\flat$	$E^\flat$	F	$G^\flat$
$C^\flat$	$D^\flat$	$E^\flat$	$F^\flat$	$G^\flat$	$A^\flat$	$B^\flat$	$C^\flat$.

As one cycles through the notes for each new scale, the new flatted note always occurs in the fourth position. This is exactly described by the flatted arrow in the diagram on the right of Figure 2.8.

2.3.3 The explanation is essentially the same as for major scales. On the left of Figure 2.8, if we view the scale marked by solid dots as beginning at hour 9, then it is the natural A-minor scale. If we also view the scale marked by open circles as starting at hour 4, then it is the natural E-minor scale. The diagram then shows the one note F as being sharped. Since every natural minor scale could be plotted in the same way as the natural A-minor scale, with its starting and ending hour at hour 9, this geometric argument applies to every natural minor scale. Similar reasoning, based on the diagram on the right of Figure 2.8, shows why going down a fifth produces a single flatted note.

2.3.4 **(a)** The scales are the following:

A	B	C	D	E	F	G	A
E	$F^\sharp$	G	A	B	C	D	E
B	$C^\sharp$	D	E	$F^\sharp$	G	A	B
$F^\sharp$	$G^\sharp$	A	B	$C^\sharp$	D	E	$F^\sharp$
$C^\sharp$	$D^\sharp$	E	$F^\sharp$	$G^\sharp$	A	B	$C^\sharp$
$G^\sharp$	$A^\sharp$	B	$C^\sharp$	$D^\sharp$	E	$F^\sharp$	$G^\sharp$
$D^\sharp$	$E^\sharp$	$F^\sharp$	$G^\sharp$	$A^\sharp$	B	$C^\sharp$	$D^\sharp$
$A^\sharp$	$B^\sharp$	$C^\sharp$	$D^\sharp$	$E^\sharp$	$F^\sharp$	$G^\sharp$	$A^\sharp$.

As one cycles through the notes for each new scale, the new sharped note always occurs in the second position. This is exactly described by the sharped arrow in the diagram on the left of Figure 2.8, provided the starting hours are shifted by -3 hours.
(b) The scales are the following:

A	B	C	D	E	F	G	A
D	E	F	G	A	$B^\flat$	C	D
G	A	$B^\flat$	C	D	$E^\flat$	F	G
C	D	$E^\flat$	F	G	$A^\flat$	$B^\flat$	C
F	G	$A^\flat$	$B^\flat$	C	$D^\flat$	$E^\flat$	F
$B^\flat$	C	$D^\flat$	$E^\flat$	F	$G^\flat$	$A^\flat$	$B^\flat$
$E^\flat$	F	$G^\flat$	$A^\flat$	$B^\flat$	$C^\flat$	$D^\flat$	$E^\flat$
$A^\flat$	$B^\flat$	$C^\flat$	$D^\flat$	$E^\flat$	$F^\flat$	$G^\flat$	$A^\flat$.

As one cycles through the notes for each new scale, the new flatted note always occurs in the sixth position. This is exactly described by the flatted arrow in the diagram on the right of Figure 2.8, provided the starting hours are shifted by -3 hours.

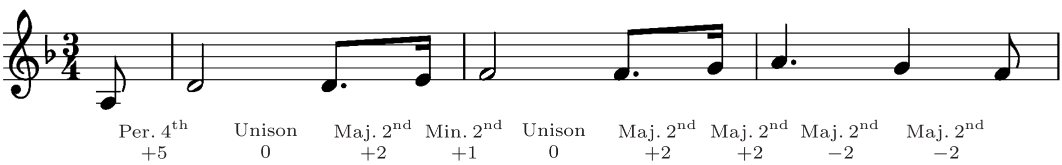
2.3.5 We know that $-3 + 7 = +7 - 3$, so the clock hours are the same as well. Adding -3 to all the hours for the notes of a major key produces a natural minor key. Adding $+7$ to all the hours for notes is equivalent to going up a fifth in both major and minor keys. If we first add -3, and then $+7$, this is equivalent to going up a fifth in a natural minor key. Since this equals adding $+7$, and then -3, this is also equivalent to obtaining the natural minor key *from the next key on the Circle of Fifths going clockwise*. Similar reasoning with -3 and $+5$ applies to going down a fifth.

2.3.6 The sharped note occurs one half step below the end note. So when you go up a fifth again, the end note and the note one half step below it will both go up a fifth as well. The flatted note occurs one whole step below the previous scale's end note. So when you go down a fifth again, that end note and the note one whole step below it will both go down a fifth as well.

Chapter 3

Section 3.1

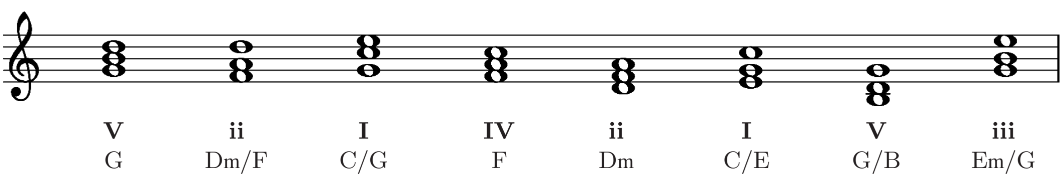
3.1.1 The solution is shown here:



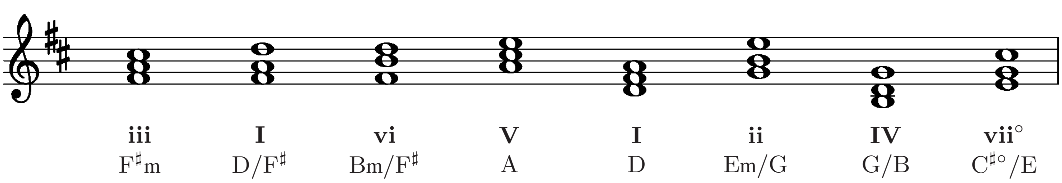
3.1.2 The intervals are:

Per. 4th	Maj. 2nd	Maj. 2nd	Maj. 3rd	Maj. 3rd	Maj. 2nd	Maj. 2nd	Maj. 2nd
+5	+2	+2	−4	+4	−2	−2	+2

3.1.3 The solution is shown here:



3.1.4 The solution is shown here:



3.1.5 The solution is shown here: