

WORKSHEET 2

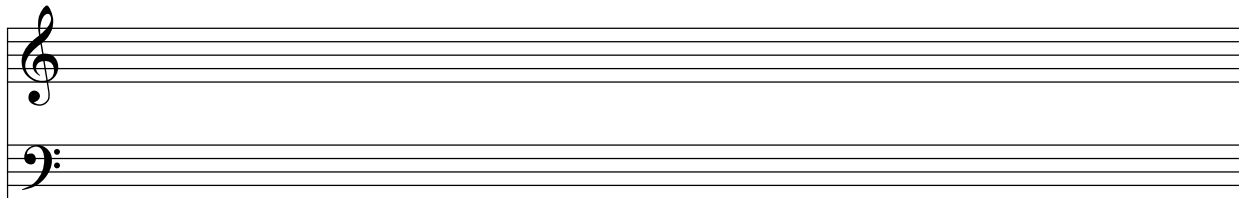
The Harmonic Series, Pitch Notation & Natural Interval Frequency Ratios

An article describing the *harmonic series* and its role in the understanding of music intervals, scales, tuning and timbre is available on the Web at:

<http://www.music.sc.edu/fs/bain/atmi02/hs/>

Use this document to help you answer the following questions. You may use a calculator and/or Tom Erbe's *PitchFork PPC* to complete this assignment.

- Using whole note heads, write out the first 16 partials of a *harmonic series* for the fundamental pitch C2 on the grand staff provided below. Number each partial between the staves. Use black note heads (no stems) to indicate that partials 7, 11, 13 and 14 are out of tune with respect to the widely accepted tuning standard for modern pianos—*12-tone equal temperament* (12TET).



- Complete the chart:** Using the harmonic series diagram for C2 you produced above, determine the natural interval frequency ratio for each of the following traditional tonal intervals. Use the simplest ratio available and be sure not use the 7th, 11th, 13th or 14th partials in any of your ratios. Then, indicate the pitch that would result if you used that ratio to build an interval on A4, 440 Hertz (Hz). Express the resulting pitch as 1) a pitch above A4 using pitch notation, and 2) as a frequency above A4. Round your frequency calculations to the nearest 1/100 Hz.

Traditional tonal interval name	Ratio ¹	Pitch above A4 ²	Freq. above A4 440 Hz. ³	Traditional tonal interval name	Ratio	Pitch above A4	Freq. above A4 440 Hz.
a. octave	2 : 1	A 5	880 Hz.	g. minor sixth			
b. perfect fifth	3 : 2	E 5	660 Hz.	h. minor seventh			
c. perfect fourth			586.67 Hz.	i. major second			
d. major third				j. major seventh			
e. major sixth				k. minor second			
f. minor third							

¹ **Ratio** – Simplest (smallest) natural interval frequency found among the first 16 partials of the harmonic series.

² **Pitch above A4** – For example, a perfect fourth above A4 is D5. The Acoustical Society of America recommends the following pitch notation: *pitch name with octave subscript* where C4 is middle C, B3 is the B below middle C, C5 is the C an octave above middle C, C3 is the C an octave below middle C, and so on.

³ **Freq. above A4, 440 Hz.** - Use the natural frequency ratio in the ratio column to determine the exact frequency of the pitch above A4 that would be produced by that interval. For example, the frequency of the pitch a 3:2 perfect fifth above 440 Hz. may be calculated in the following way: $(440 \times 3)/2 = 1320/2 = 660$ Hz.