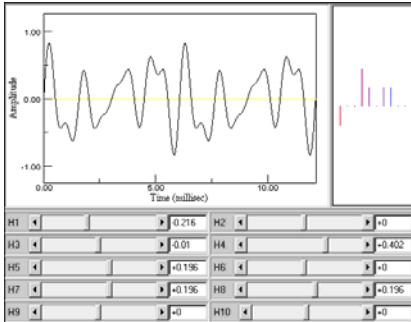# Worksheet for Exploration 18.1: Creating Sounds by Adding Harmonics

Begin by choosing the first harmonic (represented by the H#, with H1 being the fundamental or first harmonic) and drag the slider to add that harmonic to the total wave. As you do this, note that the frequency remains the same, but the amplitude slowly decreases. Continue to decrease the value of H1 so that it is negative. Notice that the negative sign simply inverts the shape of the sound wave. Therefore, the slider controls the amplitude and phase (0 or π only) of the harmonic of the sound wave. In addition to the overall wave form, the relative size of the components of the wave is shown in the graph on the right. Restart .

a. Measure the fundamental's period.

   T=_____

b. What is the fundamental frequency?

   f=_____

Consider the following values for the harmonics:

H	Case A	Case B	Case C	Case D
1	1.000	1.000		1.000
2			0.500	0.500
3	-0.111	0.333		0.333
4			0.250	0.250
5	0.040	0.20		0.20
6			0.166	0.166
7	-0.020	0.142		0.142
8			0.125	0.125
9	0.0123	0.111		0.111
10			0.100	0.100

c. What wave patterns develop from these values?

   Case A:

   Case B:

Case C:

Case D:

d. Can you write down a mathematical formula describing each case? (Hint: it is a sum.)
    i. First consider a relation between the harmonic number and amplitude for each term.

Case A:

Case B:

Case C:

Case D: