TechSound Springboard: Interference and Beats

Felix

APPARATUS
__computer (iBook or equivalent) __DataStudio with WavePort
__headphones and signal splitters (optional)

SET UP
a. Start the computer (PhyzMac iBook). While it is starting up...

b. Connect the headphones so that each member gets a set. Use signal splitters as needed.

c. When the computer has completed its start-up cycle, make sure the sound volume level is turned up to its maximum setting. (Use the Sound Tool on the Control Strip.) If you find the sound level too high later on, you may turn it down at the Control Strip or on the headphone cord if available.

d. Start DataStudio; when asked what you would like to do, select "Open Activity."

e. Choose "Interference and Beats." (X PhyzMac X / DataStudio / eLabs / Phyz TechLabs / *Unitnumber* / Interference and Beats.) Click "OK" to the warning that the file is locked and cannot be changed.

1. THE PHASE TOOL
a. Click the on-screen speaker picture-button to initiate sound generation. (If sound generation does not begin, click the on-screen speaker again.) Notice that there are two "tone buttons" in the top window. Right now, only the red tone is playing.

b. Do NOT adjust either the wavelength or the amplitude. Notice there is a third adjustment (hand) in the top window. This is called the Phase Tool.

i. What aspect of the wave does the Phase Tool control?

The position of the wave

ii. How—if at all—does this adjustment affect the sound?

It doesn't affect the sound in any way

c. Return the red tone wave to its original phase.*

2. TWO TONES
Notice that the speaker **(in the BOTTOM window)** has two inputs. One red and one green. Turn off the red tone input and turn on the green tone input. What difference—if any—does this make on the tone and why?

The same sound is generated because the green tone has the same frequency (or wavelength) and amplitude as the red tone.

[Response must include a correct reason WHY the tone is the same.]

**If you cannot return things to their original state, simply close the activity (don't save) and reopen it.*

3. INTERFERENCE

a. Prediction. **Turn the sound off** by clicking the speaker. What will happen if both tones are sent to the speaker at the same time? Compared to either tone by itself, what kind of tone will be produced by adding the two tones together?

{Something, such as "It will be louder." This is a prediction, so correctness is not an issue.]

b. Observation. Activate both red and green speaker inputs and play the tone by clicking the speaker. Compared to the original tone, what kind of tone is produced?

The tone is LOUDER but has the SAME frequency

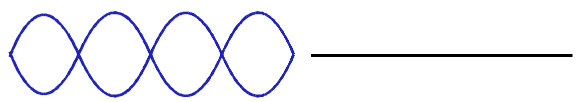
c. Notice that the individual waveforms are shown in the top window and the sum of the waves (superposition) is shown in the bottom window. Use the Phase Tool to adjust the phase of one of the waves.

i. What is the effect of changing the phase of one of the waves?

The amplitude of the combined waves can be reduced to zero or increased to twice the amplitude of a single wave. The sound is reduced or amplified.

ii. Distinguish between "in phase" and "out of phase." Include diagrams and descriptions of the corresponding sounds.

In Phase
sound is twice as loud
Constructive Interference



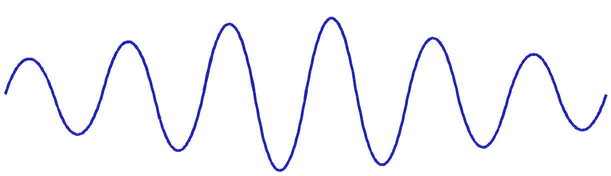
Out of Phase
sound is weak or non-existent
Destructive Interference

iii. Apply the labels "Constructive Interference" and "Destructive Interference" to the correct diagrams above.

4. BEATS

a. Set the two waves back to their original, "in phase," state.*

b. Now adjust the frequency of one of the tones. Describe the result using words and pictures.



[The sound "wobbles;" getting louder and softer and louder and softer...]

c. Set one tone to 440.0 Hz and the other to 441.0 Hz. Now listen for the **beat frequency.** The beat frequency is equal to the difference between the two tones. That is, the beat frequency is 441.0 Hz – 440.0 Hz = 1.0 Hz.

i. You should hear a 1.0 Hz "wah-wah" pattern. This is called the "beat frequency."

ii. How else can you generate a 1.0 Hz beat frequency without changing the 440.0 Hz tone? Try it!

Make the second tone 439 Hz.

iii. Experiment with other two-tone beats. Low frequencies are pretty interesting.

5. WEBQUEST: PHONE HOME...PAGE

When you push a key on a telephone, a sound is generated. The sound is a combination of pure frequencies. Access the World Wide Web to find the answers to the following questions.

a. What is the URL of the website where you found the answer to the question below?

`http://`

b. What are the **pure** frequencies played for each specific key? When you find the answers, arrange to play them in DataStudio. Listen to their sounds and view their waveforms.

"1" =	697 Hz + 1209 Hz	"2" =	697 Hz + 1336 Hz
"3" =	697 Hz + 1477 Hz	"4" =	770 Hz + 1209 Hz
"5" =	770 Hz + 1336 Hz	"6" =	770 Hz + 1477 Hz
"7" =	852 Hz + 1209 Hz	"8" =	852 Hz + 1336 Hz
"9" =	852 Hz + 1477 Hz	"*" =	941 Hz + 1209 Hz
"0" =	941 Hz + 1336 Hz	"#" =	941 Hz + 1477 Hz

c. What are the **beat** frequencies for each key?

"1" =	512 Hz	"2" =	639 Hz	"3" =	780 Hz
"4" =	439 Hz	"5" =	566 Hz	"6" =	707 Hz
"7" =	357 Hz	"8" =	484 Hz	"9" =	625 Hz
"*" =	268 Hz	"0" =	395 Hz	"#" =	536 Hz

d. What are the additional keys on military telephones and what are they used for?