

Name: _____

Date: _____

Physics of Music & Sound

Fundamental Frequency: this is “the note” that you are playing. It is the smallest frequency where a spike is seen in the Fourier Transform plot.

Overtones: (or resonant frequencies) are all other spikes in frequency. In *music* the overtones are almost always integer multiples of the fundamental known as **harmonics**.

Timbre: the relative volumes of the overtones, giving instruments different perceived sounds.

LAB SET-UP:

- You and a partner should be at a computer, with a microphone plugged into CH1
- Check that “Phys101Exp5” is open on the computer (otherwise open it)
- From the **Experiment** menu, select **Data Collection** – this should be **Time Based** with a **Duration** of **0.2 seconds** and a **Sampling Rate** of **10,000 samples/second**.

LAB PROCEDURE:

1. Practice singing a note. Select **Collect** while singing a note into the microphone. Repeat as needed until you have a set of data:

- **Top plot** – shows the Pressure versus Time of the note you are singing/playing (this is like the slinky, showing a traveling wave of increases/decreases in pressure).
- **Bottom plot** – Fourier Transform of the top plot. This shows the amplitudes (volume) of each frequency that you were singing (if you recorded a single *perfectly* exact note, there would be only one spike in this plot).

2. Decide what kind of comparison study you want to start with:

- Same note on different instruments?
- Different notes on the same instrument? Octaves?
- Differences between singing “Ahhhh”, “Eeeee”, “Oooh”?
- Other ideas?

3. Collect some data. From the **Analyze** menu select **Examine** and use the cursor to determine the resonant frequencies. Record in table below.

4. Whenever you have a plot you want to save, select **Print**. Under **Print Footer: Name:** enter your name(s), and any other identifying details (*example:* instrument and/or note played). Under **Print Range**, print *only* Page 1.

5. Estimate the approximate relative amplitude of the frequency peaks – assign the largest a value of 10, and then estimate the size of the other peaks relative to this one. Record in table.

6. Repeat steps 3-5 to complete your comparison study. If you have time, try more instruments or get creative and carry out your own investigation of frequencies and sound.

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|--|--------------------|--|--|--|--|
| Instrument | <i>example</i> | | | | |
| Fundamental Frequency Observed [Hz] | 220 Hz | | | | |
| Frequencies of overtones [Hz] | 440, 660 Hz | | | | |
| Relative amplitudes of the frequency peaks | 10, 4, 6 | | | | |

9. **Discuss the results of your study.** Use the vocabulary at the top of this handout to describe the comparison you have investigated.

10. How do you know what instrument you are listening to? Why do different instruments (and people) sound different when they are playing (or singing) the same note?