

Musical Intervals Lab

Teacher's Guide

Topic:

Sound and Music

The following information is provided to the student:

Question:

How do the sounds produced by two nearby keys (within seven half-steps apart) on the piano keyboard sound when played together? Are certain frequency ratios more pleasing than others?

Purpose:

To play nearby notes (not more than 7 keys apart) on the piano keyboard in order to determine if there are certain frequency ratios which sound more pleasing than others.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion. The Data section should include the provided table. The Conclusion/Discussion section should identify the collection of frequency ratios associated with notes which sound pleasant when played simultaneously. Specific trials in the Data section should be referenced as supporting evidence. If additional data need to be collected, then it should be added to the Data section.

Materials Required:

Computer interfaced microphone; toy music keyboard; [Frequency Cheat Sheet](#).

Description of Procedure:

Students adjust the settings of a piano keyboard to play the flute. They then simultaneously play two keys and listen carefully to the sound. They make a judgment of the relative pleasantness of the two sounds when played together. A sample of the sound is *captured* with the computer interfaced microphone; a sketch of the repeating section of the waveform is drawn. The frequencies of the two sounds are recorded and the ratio of the high frequency to low frequency is calculated. Students repeat the process for several key combinations, making an effort to experiment with various frequency ratios.

Alternative Materials and Procedure:

If a computer interfaced microphone is not available, the lab can still be performed; the waveform column of the data table will have to be skipped. If only a single keyboard is available, then the experiment can still be performed as a demonstration lab.

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

1. Toy keyboards can often be purchased at department stores for \$10 or less. The best prices can be found during the Christmas season. They typically have 30 or more keys stretching across nearly three octaves. The inexpensive variety typically have synthesized sounds for a variety of musical

The Laboratory

instruments. There are usually a few other features which give students great pleasure and teachers much aggravation.

- It might be useful to construct a [Frequency Cheat Sheet](#) similar to the one provided here. Tape it to the underside of each keyboard as a quick student reference. Reduce its size when printing so that it fits the width of the keyboard.
- Of all the synthesized sounds on the keyboard, the flute sound tends to be the most pure. While students enjoy experimenting with the different sounds, best results on this lab are typically obtained when the keyboard is set to play the sound of the flute.
- With very little guidance and simply working on their own, students will usually conclude that keys with frequency ratios of 5:4 (1.25), 4:3 (1.33), and 3:2 (1.5) produce relatively pleasing sounds. The take home lesson is that sounds whose frequencies have simple whole number mathematical relationships are perceived by the ear as being pleasing. These sounds typically have relatively clean waveforms associated with them.
- Many students will not be able to make judgments of the *pleasantness* of two sounds without an initial demonstration. Before passing out the keyboards, describe the purpose and then play two notes which are an octave apart (e.g, C₄ and C₅); these two notes sound pleasant when played together. Then play two notes like C₄ and A₅^b; these two notes sound unpleasant or dissonant.

Auxiliary Materials:

The following page is provided to the student for completion and inclusion in the Data section of their lab notebook.

| Key A | Key B | Freq. of A (Hz) | Freq of B (Hz) | Ratio: f_B / f_A | Waveform | Pleasant? 1 = No 5 = Yes |
|-------|-------|-----------------|----------------|--------------------|----------|-----------------------------|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

The Laboratory

| | | | | | | |
|--|--|--|--|--|--|--|
| | | | | | | |
| | | | | | | |
| | | | | | | |

Scoring Rubric:

| S8. Musical Intervals Lab | Score |
|--|----------------|
| <ul style="list-style-type: none"> ___ Included, labeled and organized all parts of the lab report. ___ Data section includes the completed table with some note pairs which sound good and some which sound bad. May include class data; class data is labeled as such and organized. Results are reasonably accurate. ___ Conclusion/Discussion identifies the frequency ratios which are associated with consonant and dissonant sounds; specific examples and reasoning is provided to support the conclusion. Conclusions are consistent with either individual data or class data reported in the Data section. | <p>___/___</p> |

Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/sound/u1113a.cfm>

Connections to Minds on Physics Internet Modules:

There are no sublevels of Minds on Physics which pertain to the topic of consonance and dissonance.