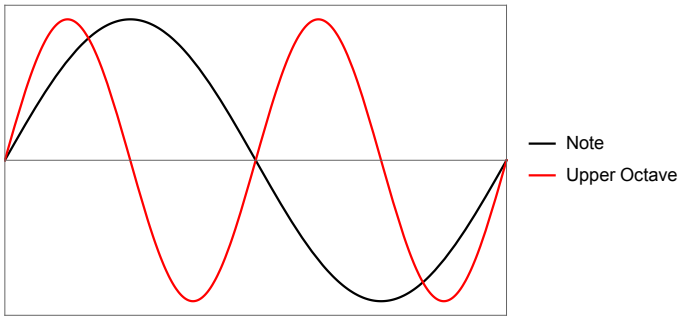
1) Why do you think sound travels faster in different substances? For example, the speed of sound is about 343 meters per second in this room, but it travels at a speed of 1484 meters per second through water, and 5120 meters per second through iron!

2) The program is ready to play just a single note, called middle C (labelled C4), which is defined by the frequency 261.63 Hz. Run the program music.py to play this note. Can you make it play the note longer?

3) The upper octave of a note is the same note but its frequency is doubled:



Similarly, the lower octave is the same note but its frequency is halved.
In the program, assign the appropriate frequencies to all upper and lower octaves of middle C (C4).

4) Find a way to play three octaves of C (C4, C5 and C6) separately. Then make a new "chord" containing each octave to play all three of them at once.

5) There are 11 other notes in between two octaves, each of a different frequency. Take the "chord" from the previous question and raise one of the C notes to a slightly higher frequency, i.e. change C5 to C#5. Play these three notes together. Why do you think it sounds so bad?

6) Other combinations of notes sound much better together. For example, change the C#5 from the previous question to a middle G (G4) and play the chord.

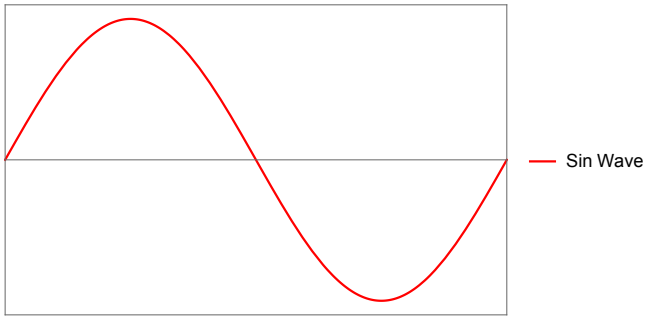
7) Why does a C sound nice with a note like G but not with a note like C#? Hint: what is the frequency of middle G divided by the frequency of middle C?

8) Now replace the C6 of the previous problem with E4. These three notes (C, E, and G) form what is called a C major chord. Play the chord, followed by the other chords that are already written for you: C minor (Cm), C diminished (CD), C^7 (C7), and C augmented (Caug).

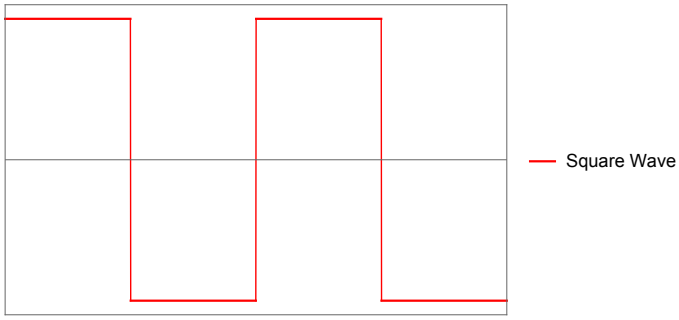
9) The types of chords differ by the frequencies that make them up. For example, the notes in a C major chord are the root note C, the fourth note up E, and the seventh note up G. Similarly, an A major chord contains the root note A, the fourth note up C#, and the seventh note up E. Can you make other combinations of chords? Which chords do you think sound better together in sequence? Which don't?

10) If middle C is defined by a particular frequency, then how come a C note on one instrument, like a piano, sounds different than a C note on another instrument, like a violin? The reason for this is because different instruments produce sounds in a complicated way; a piano string vibrates much differently than a violin string. Though they both produce a C note, there are other frequencies that make very small contributions to that note, these other frequencies are called the harmonics of the instrument and they are the reason why different instruments and different voice boxes produce different sounds.

11) Harmonics and other overtones have the ability to change the *shape* of a wave, resulting in the same note but a different sound.
For example, here is what a sin wave looks like:



With some fancy math tricks, one can produce a square sound wave that looks like this:



Computers can create wave functions very easily, and thus mimic musical instruments quite well. The program allows you to play chords and frequencies with six different types of wave shapes. Play and compare them all.

12) An arpeggio is a broken chord, where the notes of a chord are played in sequence, in rising or descending order. An arpeggio excerpt from a piece by J.S. Bach is written for you. Play the song. Can you make your own arpeggios from the chords you've created?

13) In music language, a *half step* up from a note is just the next note up, and a *whole* step up is two notes up. For example, a half step up from C is C#, and a whole step up from C is D. *Scales* are sequences of notes played in a particular order. For example, the major scale starts at the base note and plays the subsequent notes after the following steps:
Whole - Whole - Half - Whole - Whole - Whole - Half
Thus, a C major scale is given by the following notes:
C - D - E - F - G - A - B - C
Have your program play a C major scale? Another major scale?

15) There are many types of scales. Minor scales have the following step sequence:
Whole - Half - Whole - Whole - Half - Whole - Whole
Can you play a C minor scale? Or other minor scales?

14) There is another piece written for you in the code, Fur Elise by Beethoven. Play the song. Take the rest of the time to write your own song to play for the rest of the group!