Tutorial No 2, Semester 1, 2024/25

1. When your finger is placed 15 cm from one end of a string which is 75 cm long, the string vibrates at a frequency of 600 Hz. What is the fundamental frequency of the string? If we increase the string's length by 20%, calculate the distance your finger should be placed from the nearer end of the string to make the string vibrate with a frequency of 800 Hz.
2. A string 50 cm long is vibrating with 6 antinodes between its two ends at a frequency of 1,440 Hz. If a second string is vibrating at a frequency of 1,600 Hz with 8 antinodes between its two ends, what is the length of the second string? A third string of length 80 cm is vibrating at a frequency of 750 Hz. What is the number of nodes which this third string has between its two ends (not counting the nodes at both ends)? (Assume that the three strings are similar in all respects except for length.)
3. Starting from a first musical note and then going up by the interval of a Just seventh, we will arrive at a second note. Starting again from the same first note, and going up again this time by the interval of a Pythagorean seventh, we will arrive at a third note. Of these two notes i.e. the second and third notes, which one has the higher frequency? Calculate the ratio of the interval between these two notes. If the frequency of the first note is 160 Hz, what

are the frequencies of the second and third notes? Starting again from the same first note with a frequency of 160 Hz, and going down instead of up by the same two intervals i.e. the Just seventh and the Pythagorean seventh, what would be the frequencies of the second and third notes?

4. On a piano keyboard, the common pentatonic scale often used in the folk songs of many musical cultures can be found by playing only the black notes on the keyboard in sequence. The term "pentatonic" which means "five notes" is the name of this scale because it consists of only five notes (not counting the note one octave above the beginning of the scale). The common pentatonic scale has the following sequence of intervals: tone, tone, three semitones, tone, three semitones, arriving at the final note exactly one octave or 12 semitones above the starting note. Another type of pentatonic scale is the Balinese gamelan pentatonic scale which has a different sequence of intervals: semitone, tone, 2 tones, semitone, 2 tones, making up a total of 12 semitones. If we start from the note E just above Middle C, what are the letter names of the notes making up these two different pentatonic scales? If we start instead from the A just below Middle C, what are the names of the notes making up these two pentatonic scales?

5. The strings of a viola are tuned in Just fifths as is usual for a viola, and the viola's A string is tuned to a frequency of 440 Hz. A guitar's six strings are tuned relative to each other as is usual for a guitar, and its

A string is tuned to a frequency of 110 Hz. What are the frequencies of the viola's G string and its D string and the ratio of the interval between these two frequencies? What are the frequencies of the two musical notes on the guitar which are equivalent to these two notes on the viola, and what is the ratio between these two notes on the guitar? Calculate the ratio of the interval between the frequencies of the guitar's B3 note and the viola's D4 note. (Take the ratio of an Equal-tempered semitone to be equal to 1.05946 for your calculations.)

6. The spectrum of a musical sound is represented by a graph which has vertical lines on the x-axis representing the fundamental frequency and harmonics of the sound. The positions of the lines on the horizontal x-axis represent their frequencies and the lengths of the lines represent the amplitudes of the harmonics. A newly discovered ancient musical wind instrument produces a note which has a spectrum showing its fundamental frequency and all its harmonics up to the 21st harmonic, and all harmonics (odd and even) are present in this spectrum. The 8th line from the left in this spectrum has the same frequency as the 9th line from the left in the spectrum of a square wave. If the frequency of the 5th line in the spectrum of the square wave is 1,440 Hz, what are the frequencies of the 4th and 15th lines from the left in the spectrum of the musical instrument's note?

Scientific Inquiry discussion points

1. The Pythagorean scale, said to be first defined by the

Greek mathematician after whom it is named, was based on the ratios of just two intervals -the octave (2/1) and the fifth (3/2). Its simplicity of construction served as the basis of the music of civilisations such as ancient Greece and China. The Pythagorean scale's drawback was that the ratio of the third was complex (81/64) and deemed unsatisfactory by many. As the interval of the third became more important, proponents of the Just scale, in which the ratio of the third was 5/4 instead of 81/64, much preferred it to the Pythagorean scale, as ratios with small numbers were considered by the Greeks to be more beautiful than ratios with large numbers. The proponents of the Pythagorean scale of course disagreed strongly. Here we see the objective scientific inquiry of Pythagoras coming into conflict with subjective aesthetic judgement. Can you think of other examples in which subjective judgements come into conflict with objective scientific inquiry?