Tutorial No 2, Semester 2, 2025/26

1. If a 90 cm long string vibrates at a frequency of 750 Hz when you place your finger 30 cm from one end of the string, what is the fundamental frequency of the string? If the string's length is increased by 25%, what is the distance your finger should be placed from the nearer end of the string to enable the string to vibrate with a frequency of 1,200 Hz?

2. A string vibrating at a frequency of 1,600 Hz with 8 antinodes between its two ends is 80 cm long, and a second string is vibrating at a frequency of 1,250 Hz with 5 antinodes between its two ends. Calculate the length of the second string. A third string vibrating at a frequency of 1,120 Hz is 100 cm long. 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. If we start from a first musical note and then go upwards by the interval of a Just sixth, we arrive at a second note. If we start again from the same first note and go up again, but this time by the interval of a Pythagorean sixth, we will arrive at a third note. Which of these two notes i.e. the second and the third notes, has the higher frequency? Calculate the ratio of the interval between these two notes. If the frequency of the first note is 150 Hz, what are the

frequencies of the second and third notes? If we had gone down instead of up from 150 Hz by the same two intervals i.e. the Just sixth and the Pythagorean sixth, what would be the frequencies of the second and third notes?

4. Playing only the black notes on the piano keyboard in sequence gives us the well-known common pentatonic scale often used in the folk songs of many musical cultures. Because it consists of only five notes (not counting the note one octave above the beginning of the scale, this scale is called "pentatonic" which means "five notes". This 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. Starting from Middle C, give the letter names of the notes making up these two different pentatonic scales. Starting instead from the F just Middle C, give the names of the notes making up these two pentatonic scales.

5. The strings of a violin are tuned in Just fifths as is normal for a violin, with its A string tuned to a frequency of 440 Hz. The six strings of a guitar are tuned relative to each other as is normal for a guitar, with its A string at a frequency of 110 Hz. Calculate the frequencies of the violin's G string and its E

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 the same as these two notes on the violin, 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 G3 note and the violin's E5 note. (Take the ratio of an Equal-tempered semitone to be equal to 1.05946 for your calculations.)

6. The frequency spectrum of a musical note is represented by a graph with vertical lines along the x-axis, where the positions of the lines on the x-axis represent the frequencies of the harmonics and the lengths of the lines represent the amplitudes of the harmonics. A note sounded by an ancient wind instrument has a spectrum showing its fundamental frequency and all its harmonics (odd and even) up to the 21st harmonic. The 8th line from the left in this spectrum has the same frequency as the 6th 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 2,700 Hz, calculate 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?