Tutorial No 2, Semester 1, 2026/27

1. When you place your finger 25 cm from one end of a vibrating string 150 cm long, it vibrates at a frequency of 540 Hz. Calculate the fundamental frequency of the string. If the string's length is increased by 20%, calculate the distance your finger should be placed from the nearer end of the string to enable the string to vibrate with a frequency of 600 Hz

2. A string 60 cm long is vibrating at a frequency of 1,200 Hz with 6 antinodes between its two ends. A second string is vibrating at a frequency of 400 Hz with 4 antinodes between its two ends. What is the length of the second string? A third string vibrating at a frequency of 360 Hz is 100 cm long. Calculate 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 upwards by the interval of a Pythagorean third , we arrive at a second note. Starting again from the same first note and going up again, but this time by the interval of a Just third, we arrive at a third note. Of these two notes i.e. the second and the third notes, which one has the higher frequency? What is the ratio of the interval between these two notes?

If the frequency of the first note is 120 Hz, what are the frequencies of the second and third notes? If we had gone down instead of up from 120 Hz by the same two intervals i.e. the Pythagorean third and the Just third, calculate the frequencies of the second and third notes in this case.

4. If we play only the black notes on the piano keyboard in sequence, this results in the well-known common pentatonic scale which is used in the folk songs of many countries. This scale consists of only five notes (not counting the note one octave above the beginning of the scale), so it is called "pentatonic" which means "five notes". This is the sequence of intervals in the common pentatonic scale: tone, tone, three semitones, tone, three semitones, arriving at the final note exactly one octave or 12 semitones above the starting note. A different type of pentatonic scale is the Balinese gamelan pentatonic scale. This scale has a different sequence of intervals: semitone, tone, 2 tones, semitone, 2 tones, which makes a total of 12 semitones. If we start from from the D just above Middle C, give the letter names of the notes making up these two different pentatonic scales. If we start instead from the A just below Middle C, give the names of the notes making up these two pentatonic scales.

5. The six strings of a guitar are tuned relative to each other as is usual for a guitar, with its A string at a frequency of 110 Hz. The strings of a viola are tuned in Just fifths as is usual for a viola, with its A string

tuned to a frequency of 440 Hz. What are the frequencies of the viola's C 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 the same as these two notes on the viola? What is the ratio between these two notes on the guitar? Calculate the ratio of the interval between the frequencies of the guitar's C3 note and the viola's A4 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 a newly invented wind instrument has a spectrum showing its fundamental frequency and all its harmonics (odd and even) up to the 21st harmonic. The 6th 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 7th line in the spectrum of the square wave is 3,978 Hz, what are the frequencies of the 3rd and 13th 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?

There are many examples of objective scientific inquiry coming into conflict with subjective perception. For example, many ancient civilisations believed in a system in which the sun revolved around the earth, as this seems to be supported by our subjective observation of the sun's motion. However, more detailed study of the sun's motion showed this was untenable, and eventually astronomers could explain it's actual motion only by adopting the theory that the earth revolves around the sun. A more recent example is the subjective belief that some races are superior to other races, simply because of factors such as the colour of their skin or other physical features. Modern understanding of genetics

has shown that there is no actual scientific objective basis for the notion of racial superiority.