Tutorial No 3, Semester 2, 2023/24

1. A string which has 7 antinodes between its two ends is vibrating with a frequency of 1,120 Hz. A second string which has 5 nodes between its two ends (not counting the nodes at either end) is vibrating at a frequency of 1,680 Hz and is 80 cm long. What is the length of the first string which is vibrating with 7 antinodes? A third string which is 70 cm long is vibrating at a frequency of 1,600 Hz. How many nodes would this third string have between its two ends (not counting the nodes at either end)? (Assume that the three strings are similar in all respects except length.)

2. A canoe is travelling along the surface of the sea in the same direction and the same speed as the water waves on the surface of the sea, and it can be observed that the total length of the canoe is exactly equal to 4 complete wavelengths of the water waves. If the waves are moving with a speed of 1.2 metres per second and have a frequency of 1 Hz, calculate the length of the canoe. The frequency of the waves then increases to 1.2 Hz and the speed of the waves increases to 1.5 metres per second. When this happens, what would be the number of wavelengths of the waves which would exactly equal the length of the canoe?

3. A string vibrating with 6 antinodes between its two

ends has a fundamental frequency of 280 Hz. Its frequency is the same as that of a closed pipe of length k cm which is vibrating with 3 nodes between its two ends (not counting the node at one end). Calculate the fundamental frequency of the closed pipe. When the closed pipe vibrates with 7 nodes between its two ends (not counting the node at one end), its frequency is the same as that of an open pipe vibrating with 8 antinodes between its two ends (not counting the antinodes at both ends). What is the length of the open pipe?

4. A string which is 34 cm long is vibrating with 4 nodes (not counting the nodes at both ends). The note produced by the string combines with a note from a closed pipe resulting in beats of 15 Hz. The closed pipe has a fundamental frequency of 150 Hz and is vibrating with 5 nodes between its two ends (not counting the node at one end). The string is then slightly shortened, and the beat frequency decreases (without passing through 0 Hz). What is the fundamental frequency of the string? The string is then shortened from 34 cm to 32.7 cm, and assuming that the beats are still produced by the same harmonics of the string and the closed pipe as before, what is the new beat frequency? If the length of the closed pipe is decreased to 80% of its original length, calculate what the beat frequency would then be, assuming that the string is still 32.7 cm long.

5. Using an electronic tuner which is producing a musical note with a frequency of 440 Hz to help her,

a violinist is tuning her violin's A string. She can hear beats of 5 Hz when the note from the A string combines with the note from the tuner. The violinist then gradually loosens the A string of the violin and the beat frequency gradually decreases (without passing through 0 Hz) to 4 Hz. Calculate the frequency of the note produced by the violin's A string when the beat frequency was equal to 5 Hz. To make the frequency of the A string come as close as possible to 440 Hz, what should the violinist do? If the beat frequency had increased to 6 Hz instead of decreasing when the string was loosened, what would the A string's frequency have been when the beat frequency was 5 Hz?

Scientific Inquiry discussion points

The Equal-tempered scale is obtained by dividing an octave into twelve equal steps. This gives us a scale with twelve notes, which has become the basis of most of Western music, whether classical, popular, folk, rock or any other genre of music. The democratic equality of these twelve notes enables music to modulate into any of the twelve available keys with ease, using just twelve notes in one octave. This greatly simplifies the design of musical instruments and how they are played. But this is not a "perfect" system in mathematical terms, as the important interval of the fifth is not exactly 3/2 as in the Just and Pythagorean scales, but deviates by ever so slightly an amount which is not apparent to most listeners. Are there other examples in science and technology where imperfections are an important part of the basis of an actual working system?