Name: _____ Date: _____

BLM 2–5

Chapter 2 Case Study

Tools

- graphing calculator

Software Engineer

- Asma Khalid has a degree in computer science and works as a software engineer for a company that makes synthesizer keyboards. She designs software programs to simulate different musical instruments.
- Asma works regular hours and her annual salary is $55 000.
- Sound involves vibrations of particles in the air that travel from the source to the listener.
- A pure sound signal consists of sinusoidal waves. Such a sound is produced by a flute or when someone whistles. This pure sound is referred to as a fundamental frequency.
- Different notes have different frequencies of vibration or pitch. A low note corresponds to a slow vibration. A high note corresponds to a fast vibration.
- Different instruments playing the same note sound different because of their distinct timbre or quality of sound. Most sounds are not pure; more than one frequency is produced at once.
- The frequency is the number of cycles per second. It is measured in Hertz (Hz).
- These other frequencies, called harmonics, are integer multiples of the fundamental frequency. For example, the A note above middle C has a fundamental frequency of 440 Hz. The second harmonic has a frequency of 880 Hz. The third harmonic has a frequency of 1320 Hz, and so on.

Questions

1. The sinusoidal wave of a certain fundamental frequency can be modelled by the equation $y = 50 \sin 23\,400x$, where x is time, in seconds, and y represents the height of the wave.

a) The amplitude of the wave is a measure of the loudness of the sound. What is the amplitude of this wave?

b) What is the period, in seconds, of this wave?

c) The frequency, in Hertz, is equal to the reciprocal of the period. Determine the frequency of this note. This closely matches C2, the note one octave below middle C.

2. Graph two cycles of the function $y = 50 \sin 23\,400x$. Describe the shape of the graph.

3. To simulate the hollow sound of a wind instrument such as an oboe, add harmonic frequencies of odd multiples of the fundamental frequency using the formula $y = 50 \sin \theta + \frac{50 \sin 3\theta}{3} + \frac{50 \sin 5\theta}{5}$.

a) For this fundamental frequency, what value should be substituted for θ?

b) After making the substitution, graph the corresponding relation. Describe the shape of the graph.

c) Predict how the shape will change if more odd multiples of the fundamental frequency are added to the equation. Graph to test your prediction.

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