

Waves and Sound - Outline

1. Distinguish local particle vibrations from overall wave motion.
2. Label the parts of a wave.
3. Interpret waveforms of transverse and longitudinal waves.
4. Apply the relationship among wave speed, frequency, and wavelength to solve problems.
5. Relate energy and amplitude.
6. Apply the superposition principle.
7. Differentiate between constructive and destructive interference.
8. Predict when a reflected wave will be inverted.
9. Predict whether specific traveling waves will produce a standing wave.
10. Identify nodes and antinodes of a standing wave
11. Explain how sound waves are produced.
12. Relate frequency to pitch.
13. Compare the speed of sound in various media.
14. Relate plane waves to spherical waves.
15. Recognize the Doppler Effect, and determine the direction of a frequency shift when there is relative motion between a source and an observer.
16. Relate intensity, decibel level, and perceived loudness.
17. Explain why resonance occurs.
18. Differentiate between the harmonic series of open and closed pipes.
19. Calculate the harmonics of a vibrating string, open pipes, and closed pipes.
20. Relate harmonics and timbre.
21. Relate the frequency difference between two waves to the number of beats heard per second.

Notes

•Wave Motion

✓ What do Waves do?:

✓ Medium:

✓ Mechanical Waves:

•Wave Types

✓ Parts of a Wave:

✓ Crest:

✓ Trough:

✓ Amplitude:

✓ Wavelength:

✓ Transverse Waves:

✓ Longitudinal Waves:

• Period, Frequency, and Wave Speed

✓ Speed of a Wave:

• Wave Interference

✓ Principle of Superposition:

✓ Constructive Interference:

✓ Destructive Interference:

- Reflection:

- ✓ Fixed Boundary Reflection:

- ✓ Free Boundary Reflection:

- Standing Waves:

- ✓ Standing Waves:

- ✓ Nodes:

- ✓ Antinodes:

- The Production of Sound Waves:

- ✓ How Sound Waves are Produced and What Type of Wave is Sound?:

- ✓ Compression:

- ✓ Rarefaction:

- Characteristics of Sound Waves:

- ✓ Human Frequency Range for Sound:

- Infrasonic Waves:

- Ultrasonic Waves:

✓ Pitch:

✓ Medium and Speed of Sound:

• Doppler Effect:

• Sound Intensity:

✓ Intensity:

✓ Decibel:

• Forced Vibrations and Resonance:

✓ Forced Vibration

✓ Natural Frequency:

✓ Resonance:

• Harmonics – Standing Waves on a Vibrating String:

✓ Factors that Affect the Speed of Sound on a String:

✓ Fundamental Frequency (1st Harmonic):

✓ Harmonic Series:

• Harmonics – Standing Waves in an Air Column:

✓ Pipes Open at Both Ends

✓ Pipes with One End Closed:

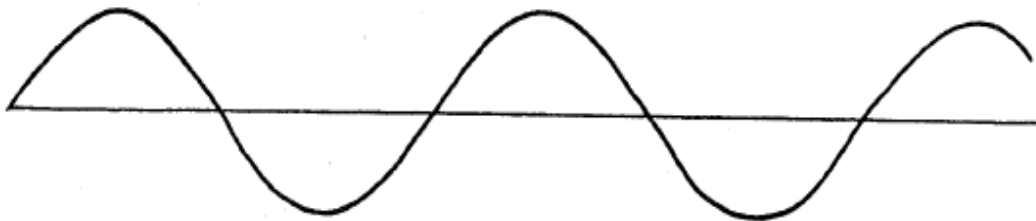
✓ Quality of Sound - Timbre:

✓ Beats:

• Sample/Practice Problems

A. Waves and Vibrations

1. A sine curve that represents a transverse wave is drawn below. With a ruler, measure the wavelength and amplitude of the wave.



a. Wavelength = _____

b. Amplitude = _____

2. A kid on a playground swing makes a complete to-and-fro swing each 2 seconds. The frequency of swing is

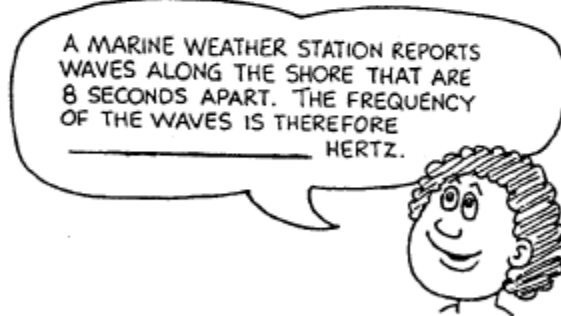
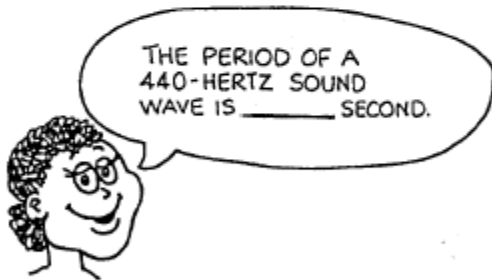
(0.5 hertz) (1 hertz) (2 hertz)

and the period is

(0.5 second) (1 second) (2 seconds)



3. Complete the statements.



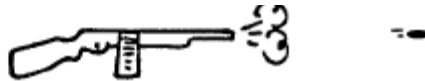
4. The annoying sound from a mosquito is produced when it beats its wings at the average rate of 600 wingbeats per second.

- a. What is the frequency of the soundwaves?

- b. What is the wavelength? (Assume the speed of sound is 340 m/s.)



5. A machine gun fires 10 rounds per second. The speed of the bullets is 300 m/s.



- a. What is the distance in the air between the flying bullets? _____

- b. What happens to the distance between the bullets if the rate of fire is increased?

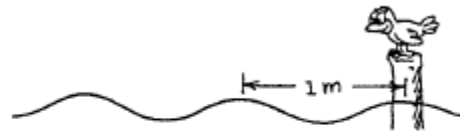
6. Consider a wave generator that produces 10 pulses per second. The speed of the waves is 300 cm/s.

- a. What is the wavelength of the waves? _____

- b. What happens to the wavelength if the frequency of pulses is increased?

7. The bird at the right watches the waves. If the portion of a wave between 2 crests passes the pole each second, what is the speed of the wave?

What is its period?



8. If the distance between crests in the above question were 1.5 meters apart, and 2 crests pass the pole each second, what would be the speed of the wave?

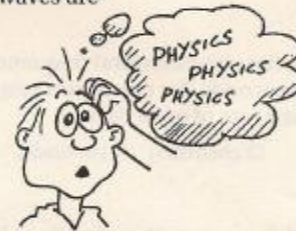
What would be its period?



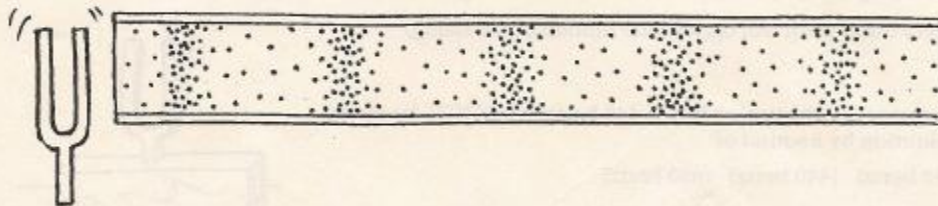
B. Sound

1. Two major classes of waves are *longitudinal* and *transverse*. Sound waves are
(longitudinal) (transverse)

2. The frequency of a sound signal refers to how frequently the vibrations occur. A high-frequency sound is heard at a high
(pitch) (wavelength) (speed)



3. The sketch below shows a snap shot of the compressions and rarefactions of the air in a tube as the sound moves toward the right. The dots represent molecules. With a ruler the wavelength of the sound wave is measured to be _____ cm.

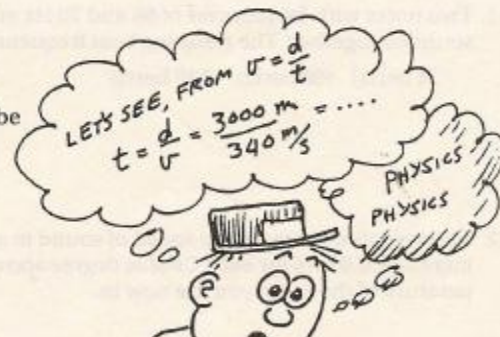


4. Compared to the wavelengths of high-pitched sounds, the wavelengths of low-pitched sounds are
(long) (short)

5. Suppose you set your watch by the sound of the noon whistle from a factory 3 km away.



- a. Compared to the correct time, your watch will be
(behind) (ahead)
- b. It will differ from the correct time by
(3 seconds) (6 seconds) (9 seconds)



6. Sound waves travel fastest in
 (solids) (liquids) (gases)
 (...same speed in each)

C. Sound Waves - Blue Study Guide, page 67

D. Doppler Effect

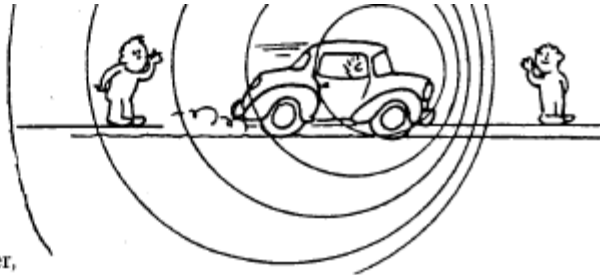
9. When an automobile moves toward a listener, the sound of its horn seems relatively

(low pitched) (normal)
 (high pitched)

and when moving away from the listener, its horn seems

(low pitched) (normal)
 (high pitched)

10. The changed pitch of the Doppler effect is due to changes in
 (wave speed) (wave frequency)



E. Resonance

(solids) (liquids) (gases)
 (...same speed in each)

7. If the child's natural frequency of swinging is once each 4 seconds, for maximum amplitude the man should push at a rate of once each

(2 seconds) (4 seconds) (8 seconds)

8. If the man in Question 7 pushes in the same direction twice as often, his pushes

(will) (will not)

be effective because

(the swing will be pushed twice as often in the right direction)
 (every other push will oppose the motion of the swing)

9. The frequency of the tuning fork is 440 hertz. It will NOT be forced into vibration by a sound of

(220 hertz) (440 hertz) (880 hertz)



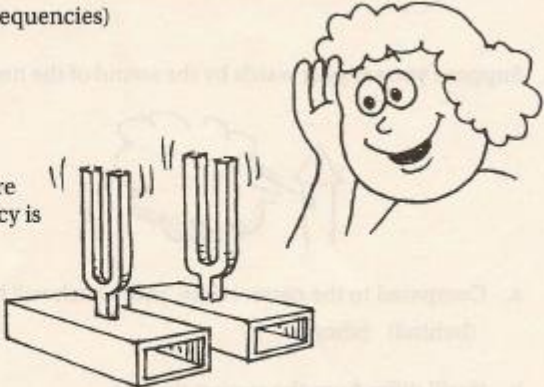
F. Harmonics – Blue Study Guide, page 69

G. Beats

10. Beats are the result of the alternate cancellation and reinforcement of two sound waves of (the same frequency) (slightly different frequencies)

11. Two notes with frequencies of 66 and 70 Hz are sounded together. The resulting beat frequency is (4 hertz) (68 hertz) (136 hertz)

12. The accepted value for the speed of sound in air is 332 m/s at 0°C. The speed of sound in air increases 0.6 m/s for each Celsius degree above zero. Compute the speed of sound at the temperature of the room you are now in.

An illustration showing two tuning forks on a wooden base. To the right, a cartoon character with curly hair is shown from the chest up, with one hand raised to their ear as if listening. The tuning forks have sound waves emanating from them.

Homework:

I. On Webpage - See Handout: Interference of Two Waves