PH202 Reading Guide

Chapter 16: Superposition and Standing Waves

The principle of superposition distinguishes waves from particles. If you have ever played pool billiard you know that particles collide and the colliding balls most often go in new directions after the collisions. Waves can be superimposed, particles cannot. Superposition is essential to an understanding of topics ranging from standing waves and beats to optical interference. You will learn how interference arises. You might have heard or even used some of the amazing new ear phones for airplanes that based on interference reduce the noise getting into your ears. Or have you ever been in a concert hall and felt that you are at a particular loud spot or a particular quiet spot? You were not dreaming! We will conclude the chapter with a discussion of beat frequencies.

You will learn and see that standing waves are a superposition of traveling waves, and therefore this chapter forms a continuation of chapter 15.

Student Learning Objectives

In covering the material of this chapter, students will learn to

- Understand the principle of superposition.
- Understand how standing waves are generated.
- Calculate the allowed wavelengths and frequencies of standing waves on strings and standing sound waves in tubes and pipes.
- Understand the difference between constructive and destructive interference and how the interference between two sources produces a pattern of constructive and destructive interference.
- Calculate beat frequencies for two sources with nearly equal frequencies.

When reading the text

- Answer all “Stop To Think” questions (the answers are in the back of the chapter)
- Understand all examples
- Answer the following questions to ensure you understood the text

Physics Tools

- Draw standing waves with different boundary conditions for standing waves (fixed and open end)
- Draw picture to show path length difference for interference
- Determine phase difference from path difference

Some questions that successful students can answer after reading the text:

Section 16.1 (page 501-502): The Principle of superposition

Can two soundwaves pass through each other without resulting in disturbance of the waves?

What is the principle of superposition?

What is constructive interference?

What is destructive interference?

Section 16.2 (page 502-504): Standing Waves

What do we call a standing wave?

What is a node of a standing wave? What is an antinode?

Do particles at the position of a node move at all?

Section 16.3 (page 504-509): Standing Waves on a String

Does the amplitude of a traveling wave reflected on a boundary?

What creates a standing wave in a string?

What are the possible wavelength in a string with a length L?

Section 16.4 (page 509-514): Standing Sound Waves

Is the open end of a pipe a node or an antinode of a standing pressure wave?

Section 16.5 (page 514-516): We will not cover this section

Section 16.6 (page 516-520): The Interference of Waves from Two Sources

What is the path length difference from two sound sources?

What do we call "out of phase"?

What path difference results in destructive interference of two sources?

What path difference results in constructive interference of two sources?

Section 16.7 (page 520-522): Beats

What is the beat frequency of two sound sources, one with a frequency of 404Hz, and one with a frequency of 406Hz?

Suggested Workbook Problems (best is answering all workbook questions)

Chapter 16: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11