PH202 Reading Guide

Chapter 15: Traveling Waves and Sound

Based on the understanding of the Harmonic Oscillator we are now studying Waves. Some physicists see waves just as a long chain of simple harmonic oscillators, and I hope you will also see how closely related the harmonic oscillator is to the phenomenon of traveling and standing waves. Waves are indeed one of the two great *models* of classical physics, and wave phenomena appear throughout the sciences. With waves, we move from the physics of particles to the physics of continuous media. Many of the ideas introduced during the study of waves will later be important for understanding optics at the end of PH202, electromagnetic waves (PH203), and quantum-mechanical wave functions. We will be able to cover sound waves and light waves as well as waves in springs, strings, and matter.

Our ears and eyes are extraordinary sensitive and insensitive at the same time. This results in a huge span of light and sound intensities that can be detected using our eyes and ears, without destroying them. We will learn about a new scale to be able to express the intensity of light and sound conveniently without having to write that a sound is 100000000000 times louder. For loudness this is the logarithmic or decibel scale.

Student Learning Objectives

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

- Understand that oscillatory motion occurs in systems with a linear restoring force.
- Understand how waves travel through a medium.
- Understand the mathematical description of sinusoidal waves.
- Apply the wave model generally, and understand how it applies to the specific cases of waves on strings, sound waves, and light waves.
- Apply energy and power concepts to waves.
- Use the decibel scale for sound intensity.

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

- Snapshot graphs
- History graphs
- Sinusoidal graphs, functions that are dependent on two variables (x and t)
- Logarthmic graphs / scales

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

Section 15.1 (page 471-472): The Wave Model

When we talk about a traveling wave, what is traveling?

Is any matter transported in the direction of the traveling wave? E.g. is water transported to the shore, when you watch a water wave at the ocean?

What is the difference between a transverse wave and a longitudinal wave?

Name an example for a transverse wave and a longitudinal wave respectively.

Section 15.2 (page 472-476): Traveling Waves

What does the speed of a traveling wave depend on?

What does the speed of a traveling wave not depend on?

Does the speed of sound depend on the loudness of the sound?

Section 15.3 (page 476-480): Graphical Mathematical Description of Waves

What is a snapshot graph of a wave?

What is a history graph of a wave?

What is the period of a sinusoidal wave?

How are wavelength and period of a traveling wave related?

Section 15.4 (page 480-483): Sound and Light Waves

What frequencies are human beings able to hear with their ears? How about dogs?

What is the speed of sound at 20°C and atmospheric pressure?

What is the speed of light?

What is the range of wavelengths of visible light?

Section 15.5 (page 483-485): Energy and Intensity

How is the intensity of a traveling wave defined?

How does the intensity of a spherical wave decrease over a distance r?

How does the intensity of a plane wave of power P decrease over a distance r?

Section 15.6 (page 485-488): Loudness of Sound

What is the lowest sound intensity humans can hear?

Over how many orders of magnitude of loudness do our ears function?

Sadly enough you will need to learn the definition of the decibel scale. It might help to remember that the intensity goes up by 10dB when the sound is 10 times louder.

What is the lowest sound intensity we can hear using the decibel scale?

Section 15.7 (page 488-492): The Doppler Effect and Shock Waves

How does the pitch of a sound change when the sound source approaches you?

How does the pitch of a sound change when the sound source approaches you?

How does the pitch of a sound change when you approach/recede the source?

Suggested Workbook Problems (best is answering all workbook questions)

Chapter 15: 1, 2, 3, 4, 6, 7, 8, 9, 12, 13, 14, 18, 19, 20, 21