PH202 Reading Guide

Chapter 17: Wave Optics

Wow, part 5 of our book – 3 chapters of optics. No worries, we will start with a chapter about wave optics—the interference and diffraction of light— which is a continuation of Chapter 16, where interference was introduced. We will extend the concepts to the domain of optics. Wave optics is important for all effects that have to do with light interacting with small openings or thin films.

Student Learning Objectives

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

- Use the wave model of light, and understand the domain of its applicability.
- Understand how the index of refraction affects light waves in a medium.
- Understand the importance of path-length difference in determining the kind of interference—constructive or destructive—that is observed.
- Calculate the positions and angles of bright and dark fringes in double-slit interference.
- Understand the diffraction grating in terms of many interfering slits, and be able to predict the positions and angles of the maxima.
- Understand the conditions for constructive and destructive interference in thin films.
- Understand the inevitable spreading of waves due to diffraction.
- Understand how light diffracts through single slits and circular apertures.

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 picture including light waves that allow to determine the path difference of various light waves.
- Graphically derive constructive and destructive interference for light waves.

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

Section 17.1 (page 537-539): What is Light?

What are the three models of light?

What is diffraction?

What is a typical wavelength of visible light?

What is the index of refraction of water? What is the index of refraction of glass?

What is the speed of light in water?

Does the frequency of light change when the light waves moves from one medium to another?

Section 17.2 (page 540-543): The Interference of Light

When did Thomas Young perform the double slit experiment the first time?

What did Thomas Young observe?

What is the path difference of the second maximum to the right side of the center maxium of a double slit interference pattern of light with a wavelength of 550nm?

Section 17.3 (page 544-547): The Diffraction Grating

How can you distinguish the intensity pattern on the screen from double slit diffraction from the intensity pattern from a diffraction on a grating with the same slit distance d?

Section 17.4 (page 548-551): Thin Film Interference

Why does light reflected from a thin film show interference effects?

What is the thickness of optical films that are used as antireflection coatings on lenses?

Is the refractive index of soap water significantly different from the refractive index of pure water?

Why does the top of a soap bubble look black?

Section 17.5 (page 552-555): Single slit Diffraction

Which principle is used to explain single slit diffraction?

What are the two parts of that principle?

Section 17.6 (page 555-557): Circular Aperture Diffraction

A relatively smaller hole results in what shape of a diffraction pattern?

When you make a small hole larger, do the diffraction fringes of the interference pattern have a larger or smaller spacing?

Suggested Workbook Problems (best is answering all workbook questions)

Chapter 17: 1, 2, 3, 4, 5, 6, 7, 8, 9