



Waves and Optics

B. Physical Optics (Ch 24)

Interference and Diffraction:

Students should apply the principles of interference to coherent sources so they can:

- ◆ Determine locations of interference maxima or minima for two sources or determine the frequencies or wavelengths that can lead to constructive or destructive interference at a certain point. (24.2 & 24.6)

Students should apply the principles of interference and diffraction to waves that pass through a single or double slit or through a diffraction grating so they can:

- ◆ Sketch or identify the intensity pattern that results when monochromatic waves pass through a single slit and fall on a distant screen, and describe how this pattern will change if the slit width or the wavelength of the waves is changed. (24.6 - 24.7)
- ◆ Calculate, for a single-slit pattern, the angles or the positions on a distant screen where the intensity is zero. (24.6 - 24.7)
- ◆ Sketch or identify the intensity pattern that results when monochromatic waves pass through a double slit, and identify which features of the pattern result from single-slit diffraction and which from double-slit interference. (24.2 & 24.6)
- ◆ Calculate, for a double-slit interference pattern, the angles or the positions on a distant screen at which maxima or minima occur. (24.2)
- ◆ Describe or identify the interference pattern formed by a diffraction grating, calculate the location of intensity maxima, and explain qualitatively why a multiple-slit grating is better than a double-slit grating for making accurate determinations of wavelength. (24.8)

Students should apply the principles of interference to light reflected by thin films so they can:

- ◆ State under what conditions a phase reversal occurs when light is reflected from the interface between two media of different indices of refraction. (24.3)
- ◆ Determine whether rays of monochromatic light reflected from two such interfaces will interfere constructively or destructively, and thereby account for Newton's rings and similar phenomena, and explain how glass may be coated to minimize reflection of visible light. (24.4)

Dispersion and Electromagnetic Spectrum:

Students should understand dispersion and the electromagnetic spectrum so they can:

- ◆ Relate a variation of index of refraction with frequency to a variation in refraction. (22.5 - 22.6)
- ◆ Know the names associated with electromagnetic radiation and be able to arrange in order of increasing wavelength the following: visible light of various colors, ultraviolet light, infrared light, radio waves, x-rays, and gamma rays. (21.12)

Transverse Light Waves:

Students should understand the transverse nature of light waves so they can:

- ◆ Explain qualitatively why light can exhibit polarization. (24.7)

Equations – Interference & Diffraction (Ch 24):

$$d \cdot \sin \theta = m \cdot \lambda$$

$$x_m \approx \frac{m \cdot \lambda \cdot L}{d}$$

C. Geometrical Optics (Ch 22 & 23)

Reflection and Refraction:

Students should understand the principles of reflection and refraction so they can:

- ◆ Determine how the speed and wavelength of light change when light passes from one medium into another. (22.3 - 22.4)
- ◆ Show on a diagram the directions of reflected and refracted rays. (22.2 - 22.4)
- ◆ Use Snell's Law to relate the directions of the incident ray and the refracted ray, and the indices of refraction of the media. (22.3 - 22.4)
- ◆ Identify conditions under which total internal reflection will occur. (22.8)

Equations – Reflection and Refraction (Ch 22):

$$n = \frac{c}{v} \qquad n_1 \cdot \sin \theta_1 = n_2 \cdot \sin \theta_2 \qquad \sin \theta_c = \frac{n_2}{n_1}$$

Mirrors:

Students should understand image formation by plane or spherical mirrors so they can:

- ◆ Locate by ray tracing the image of a real object formed by a plane or spherical mirror, and determine whether the image is real or virtual, upright or inverted, enlarged or reduced in size. (23.1 - 23.3)
- ◆ Relate the focal point of a spherical mirror to its center of curvature. (23.2)
- ◆ Use the mirror equation to relate the object distance, image distance, and focal length for a mirror, and determine the image size in terms of the object size. (23.2 - 23.3)

Lenses:

Students should understand image formation by converging or diverging lenses so they can:

- ◆ Determine whether the focal length of a lens is increased or decreased as a result of a change in the curvature of its surfaces or in the index of refraction of the material of which the lens is made or the medium in which it is immersed. (23.6)
- ◆ Determine by ray tracing the location of the image of a real object located inside or outside the focal point of the lens, and state whether the resulting image is upright or inverted, real or virtual. (23.6)
- ◆ Use the thin lens equation to relate the object distance, image distance, and focal length for a lens, and determine the image size in terms of the object size. (23.6)
- ◆ Analyze simple situations in which the image formed by one lens serves as the object for another lens. (23.6)

Equations – Mirrors & Lenses (Ch 23):

$$\frac{1}{s_i} + \frac{1}{s_o} = \frac{1}{f} \qquad M = \frac{h_i}{h_o} = -\frac{s_i}{s_o} \qquad f = \frac{R}{2}$$