

Chapter 31 Diffraction and Interference

Summary

THE BIG IDEA : The wave model of light explains diffraction and interference.

31.1 Huygens' Principle

- ✓ Huygens stated that light waves spreading out from a point source may be regarded as the overlapping of tiny secondary wavelets, and that every point on any wave front may be regarded as a new point source of secondary waves.
- The idea that wave fronts are made up of tinier wave fronts is called **Huygens' principle**.
- Each point along a wave front is the source of a new wavelet that spreads out in a sphere from that point.
- Huygens' principle can be observed in water waves that are made to pass through a narrow opening.

31.2 Diffraction

- ✓ The extent of diffraction depends on the relative size of the wavelength compared with the size of the obstruction that casts the shadow.
- Any bending of a wave by means other than reflection or refraction is called **diffraction**.
- If waves pass through an opening that is large compared with the wavelength of light, the spreading effect is small. As the opening becomes smaller, the diffraction of waves becomes more pronounced.
- When light is of a single color, diffraction can produce sharp *diffraction fringes* at the edge of the shadow. In white light, the fringes merge together to create a fuzzy blur at the edge of a shadow.
- When the wavelength is long compared with an obstruction that casts a shadow, the wave diffracts more. Short wavelengths don't diffract as much.

31.3 Interference

- ✓ Within an interference pattern, wave amplitudes may be increased, decreased, or neutralized.
- If you drop a couple of stones into water at the same time, the two sets of waves that result cross each other and produce what is called an *interference pattern*.
- When the crest of one wave overlaps the crest of another, their individual effects add together; this is *constructive interference*.
- When the crest of one wave overlaps the trough of another, their individual effects are reduced; this is *destructive interference*.

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31.4 Young's Interference Experiment

- ✓ Young's interference experiment convincingly demonstrated the wave nature of light originally proposed by Huygens.
- In 1801 the British physicist and physician Thomas Young discovered that when **monochromatic** light—light from a single color—was directed through two closely spaced pinholes, fringes of brightness and darkness were produced on a screen behind.
- A multitude of closely spaced parallel slits makes up what is called a **diffraction grating**.
- Many spectrometers use diffraction gratings rather than prisms to disperse light into colors. Whereas a prism separates the colors of light by refraction, a diffraction grating separates colors by interference.

31.5 Interference From Thin Films

- ✓ The colors seen in thin films are produced by the interference in the films of light waves of mixed frequencies.
- The phenomenon in which the interference of light waves of mixed frequencies produces a spectrum of colors is known as **iridescence**.
- A thin film, such as a soap bubble, has two closely spaced surfaces. Light that reflects from one surface may cancel light that reflects from the other surface.
- Interference provides the principal method for measuring the wavelengths of visible light as well as the wavelengths of light in other regions of the electromagnetic spectrum.

31.6 Laser Light

- ✓ Laser light is emitted when excited atoms of a solid, liquid, or gas emit photons.
- Light emitted by a common lamp is incoherent. In **incoherent** light, the crests and troughs of the light waves don't line up with one another (and there are many different frequencies as well).
- A beam of light that has the same frequency, phase, and direction is said to be **coherent**.
- Coherent light is produced by a **laser** (whose name comes from *light amplification by stimulated emission of radiation*). A laser is not a source of energy. It is simply a converter of energy. Lasers come in many types and have many different uses.

31.7 The Hologram

- ✓ A hologram is produced by the interference between two laser light beams on photographic film.
- A **hologram** is a three-dimensional version of a photograph that contains the whole message or entire picture in every portion of its surface.
- To the naked eye, it appears to be an imageless piece of transparent film, but on its surface is a pattern of microscopic interference fringes.