SECTION IV

Optics and an Introduction to Quantum Physics

Solar energy is, for the most part, relatively cheap and available in most parts of the world. However, one of the major problems with solar renewable energy sources is that the Sun is available only during the daytime, and thus one must accumulate and store the energy for its later use during the nighttime. The widespread use of solar renewable energy is also hampered by competition from fossil fuels, which are still considerably less expensive to exploit. However, the cost of electrical energy generated by solar panels has been dropping constantly during the past several decades, and the efficiency of currently available solar panels has been constantly improving.

In order to further improve the efficiency of currently available solar panels, one would need to understand the underlying physics of a solar cell and related optics phenomena, such as the geometrical laws of reflection and refraction, the electromagnetic nature of light and its interaction with matter, polarization effects, and quantum properties of light. In this section of the resource guide, we will introduce some basic principles of the electromagnetic nature of light, the laws of **geometrical optics**—such as the laws of reflection and refraction—and the essence of the polarization of light, and we will also discuss solid state theory, the photoelectric effect, and the band structure of metals and **semiconductors**.

Geometrical and Physical Optics

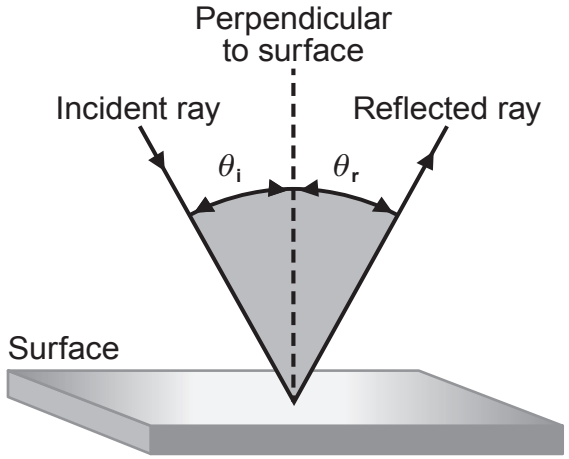
Geometrical optics treats light as straight beams of rays. This is an approximation of the basic nature of light, which is an electromagnetic wave with a wavelength from 400 nm (violet light) to about 700 nm (red light).

The Laws of Reflection and Refraction

The laws of **reflection** and **refraction** are the most fundamental laws of geometrical optics. These two laws are very intuitive, and you can find many examples of them in everyday life—for example, when you look at yourself in a mirror. The laws of reflection and refraction can be stated as follows:

Given that the **incident**, **reflected**, and **refracted** beams are all located on a single plane:

FIGURE 4.1



SOURCE: OpenStax College. "The Law of Reflection." Connexions. July 5, 2012. http://cnx.org/content/m42456/1.4/.

The Law of Reflection: incident and reflected light rays are located in the same plane, and the incident angle is equal to the angle of reflection.