Why it Matters

Compact Disc Players

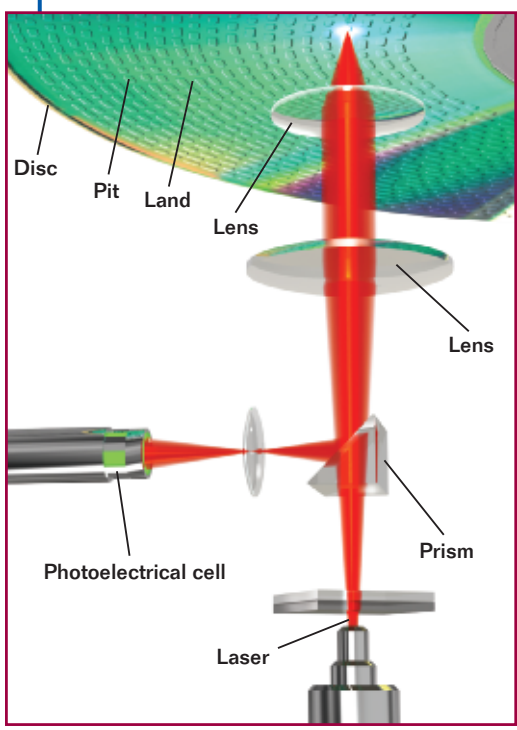
An interesting application of the laser is the compact disc (CD) player. In a CD player, light from a laser is directed through a series of optics toward a compact disc on which the music or data have been digitally recorded. The CD player "reads" the data in the way the laser light is reflected from the compact disc.

In digital recording, a sound signal is sampled at regular intervals of time. Each sampling is converted to an electrical signal, which in turn is converted into a series of binary numbers. Binary numbers consist only of zeros and ones. The binary numbers are coded to contain information about the signal, including the frequencies and harmonics that are present, the volume for the left and right channels, and the speed of the motor that rotates the disc. This process is called *analog-to-digital* (a-d) conversion.

These binary, digital data in a CD are stored as a series of pits and smooth areas (called *lands*) on the surface of the disc. The series of pits and lands is recorded starting at the center of the disc and spiraling outward along *tracks* in the CD. These tracks are just 500 nm wide and spaced 1600 nm apart. If you could stretch the data track of a CD out, it would be almost 5 km long!

When a CD is played, the laser light is reflected off this series of pits and lands into a detector. In fact, the depth of the pit is chosen so that destructive interference occurs when the laser transitions from a pit to a land or from a land to a pit. The detector records the changes in light reflection between the pits and lands as ones and smooth areas as zeros—binary data that are then converted back to the analog signal you hear as music. This step is called *digital-to-analog* (d-a) conversion, and the analog signal can then be amplified to the speaker system.

A CD read-only memory (CD-ROM) drive on your computer works in much the same way. Data from a computer are already in a digital format, so no a-d or d-a conversion is needed.



Light from a laser is directed toward the surface of the compact disc. Smooth parts of the disc reflect the light back to the photoelectrical cell.

You may wonder how a CD-recordable (CD-R) disc is different. These discs don't have any pits and lands at all. Instead, they have a layer of light-sensitive dye sandwiched between a smooth reflective metal, usually aluminum, and clear plastic. A CD-R drive has an additional laser, about 10 times more powerful than a CD reading laser, that writes the digital data along the tracks of the CD-R disc. When the writing laser shines on the light-sensitive dye, the dye turns dark and creates nonreflecting areas along the track. This process creates the digital pattern that behaves like the pits and lands, which a standard CD player can read.

A digital versatile disc (DVD) player operates on the same principle. However, the laser in a DVD player has a shorter wavelength than the laser in a CD player. This shorter wavelength allows the DVD player to read data that are spaced closer together than data on a CD. Additionally, some DVDs contain two layers of data and may even be written on both sides! The lower layer of a two-layer DVD has a thinner coating of reflective material, usually gold, that allows some of the light to pass through it so that the upper level of the DVD can be read.