

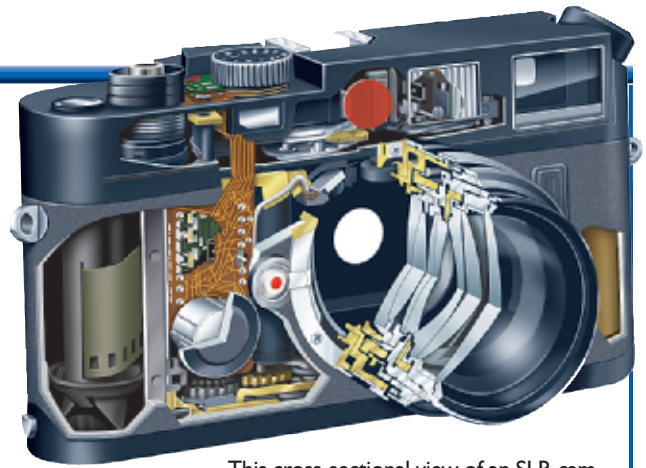
## Cameras

**C**ameras come in many types and sizes, from the small and simple “point-and-shoot” camera you might use to snap photos on a vacation to the large and complex video camera used to film a Hollywood motion picture. Most cameras have at least one lens, and more complex cameras may have 30 or more lenses and may even contain mirrors and prisms. However, the simplest camera, called a *pinhole camera*, consists of a closed, light-tight box with a small (about 0.5 mm) hole in it. A surprisingly good image can be made with a pinhole camera! The film is placed on the wall opposite the hole and must be exposed for quite a long time because not much light passes through the hole.

Making the hole a bit larger and adding a single, converging lens and a shutter, which opens and closes quickly to allow light to pass through the lens and expose the film, can make another simple camera called a *fixed-focus camera*. The film is located at the focal length of

the lens, and a typical disposable camera is of this kind. This type of camera usually gives good images only for objects far from the camera. For close objects, the focus falls behind the film. Because the film location is fixed, the lens must be able to be moved away from the film and thus be “focused.”

There are many types of camera lenses, and they are easily interchangeable on most *single-lens reflex* (SLR) cameras. A normal lens is one that provides about the same field of view as a human eye. Sometimes, however, a photographer wants to photograph distant objects with more detail or capture a larger object without taking multiple shots. A *wide-angle lens* has a very short focal length and can capture a larger field of view than a normal lens. A *telephoto lens* has a long focal length and increases magnification. Telephoto lenses

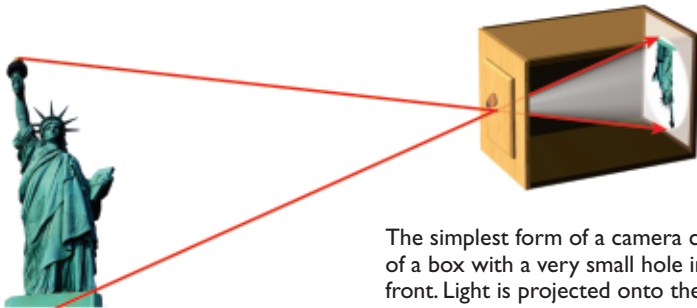


This cross-sectional view of an SLR camera shows the many optical elements used to form an image on the film.

have a narrow angle of view. *Zoom lenses* allow you to change the focal length without changing lenses. These camera lenses contain multiple lenses that can be moved relative to one another.

High-quality cameras contain quite a few lenses, both converging and diverging, to minimize the *distortions* and *aberrations* that are created by a single converging lens. The most prevalent aberration occurs because lenses bend light of different colors by different amounts, causing, in effect, rainbows to appear in the image.

You may be wondering how the optics change for digital cameras. The lenses and shutters are essentially the same as those used in film cameras. However, the film is replaced by a *charge-coupled device* (CCD) array, an array of tiny sensors that produce a current when hit by light from the subject being photographed. Lenses must still focus the light coming from the subject onto the CCD array, as they must on film.



The simplest form of a camera consists of a box with a very small hole in the front. Light is projected onto the inside back of the box.