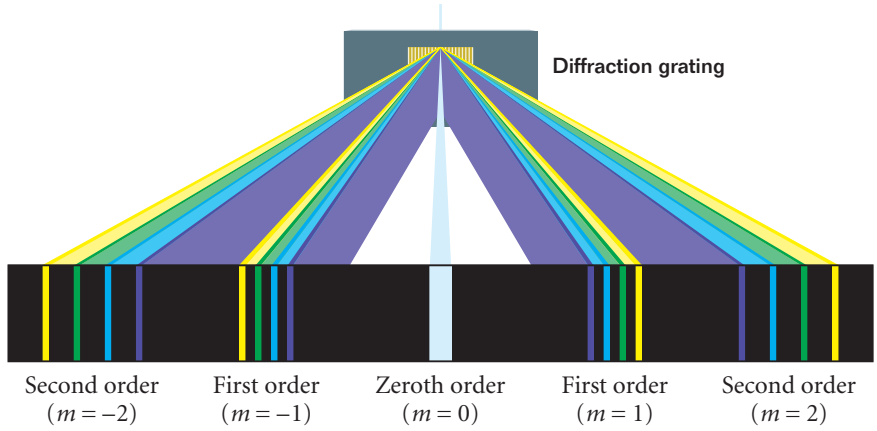

Figure 17
Light is dispersed by a diffraction grating. The angle of deviation for the first-order maximum is smaller for blue light than for yellow light.

Note in **Figure 17** that all wavelengths combine at $\theta = 0$, which corresponds to $m = 0$. This is called the *zeroth-order maximum*. The *first-order maximum,* corresponding to $m = 1$, is observed at an angle that satisfies the relationship $\sin\theta = \lambda/d$. The *second-order maximum*, corresponding to $m = 2$, is observed at an angle where $\sin\theta = 2\lambda/d$.

The sharpness of the principal maxima and the broad range of the dark areas depend on the number of lines in a grating. The number of lines per unit length in a grating is the inverse of the line separation d. For example, a grating ruled with 5000 lines/cm has a slit spacing, d, equal to the inverse of this number; hence, $d = (1/5000)\ \text{cm} = 2 \times 10^{-4}\ \text{cm}$. The greater the number of lines per unit length in a grating, the less separation between the slits and the farther spread apart the individual wavelengths of light are.

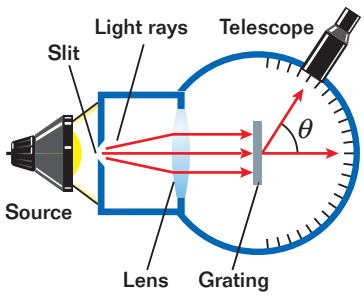

Figure 18
The spectrometer uses a grating to disperse the light from a source.

Diffraction gratings are frequently used in devices called *spectrometers,* which separate the light from a source into its monochromatic components. A diagram of the basic components of a spectrometer is shown in **Figure 18.** The light to be analyzed passes through a slit and is formed into a parallel beam by a lens. The light then passes through the grating. The diffracted light leaves the grating at angles that satisfy the diffraction grating equation. A telescope with a calibrated scale is used to observe the first-order maxima and to measure the angles at which they appear. From these measurements, the wavelengths of the light can be determined and the chemical composition of the light source can be identified. An example of a spectrum produced by a spectrometer is shown in **Figure 19.** Spectrometers are used extensively in astronomy to study the chemical compositions and temperatures of stars, interstellar gas clouds, and galaxies.

Figure 19
The light from mercury vapor is passed through a diffraction grating, producing the spectrum shown.