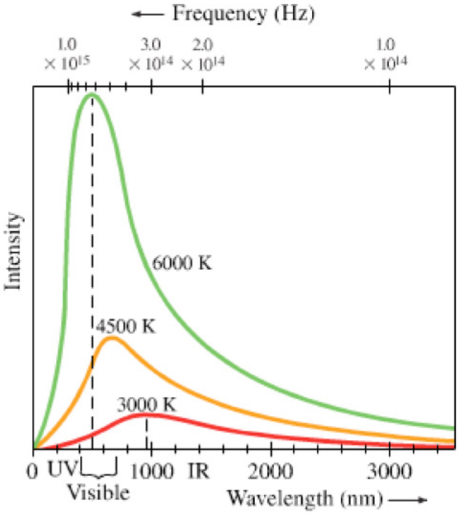

FIGURE 27–4 Measured spectra of wavelengths and frequencies emitted by a blackbody at three different temperatures.

The spectrum of light emitted by a hot dense object is shown in Fig. 27–4 for an idealized **blackbody**. A blackbody is a body that would absorb all the radiation falling on it (and so would appear black under reflection when illuminated from outside). The radiation such a blackbody would emit when hot and luminous, called **blackbody radiation** (though not necessarily black in color), is the easiest to deal with, and the radiation approximates that from many real objects. The 6000-K curve in Fig. 27–4, corresponding to the temperature of the surface of the Sun, peaks in the visible part of the spectrum. For lower temperatures, the total radiation drops considerably and the peak occurs at longer wavelengths (or lower frequencies). Hence the blue end of the visible spectrum (and the UV) is relatively weaker at lower temperatures. (This is why objects glow with a red color at around 1000 K.) It is found experimentally that the wavelength at the peak of the spectrum, λ_{P}, is related to the Kelvin temperature T by

Blackbody radiation

$$\lambda_{\mathrm{P}} T = 2.90 \times 10^{-3}\,\mathrm{m \cdot K}. \qquad \textbf{(27–2)}$$

This is known as **Wien's law**.

EXAMPLE 27–1 **The Sun's surface temperature.** Estimate the temperature of the surface of our Sun, given that the Sun emits light whose peak intensity occurs in the visible spectrum at around 500 nm.

APPROACH We assume the Sun acts as a blackbody, and use $\lambda_{\mathrm{P}} = 500\,\mathrm{nm}$ in Wien's law (Eq. 27–2).

SOLUTION Wien's law gives

$$T = \frac{2.90 \times 10^{-3}\,\mathrm{m \cdot K}}{\lambda_{\mathrm{P}}} = \frac{2.90 \times 10^{-3}\,\mathrm{m \cdot K}}{500 \times 10^{-9}\,\mathrm{m}} \approx 6000\,\mathrm{K}.$$

EXAMPLE 27–2 **Star color.** Suppose a star has a surface temperature of 32,500 K. What color would this star appear?

APPROACH We assume the star emits radiation as a blackbody, and solve for λ_{P} in Wien's law, Eq. 27–2.

SOLUTION From Wien's law we have

$$\lambda_{\mathrm{P}} = \frac{2.90 \times 10^{-3}\,\mathrm{m \cdot K}}{T} = \frac{2.90 \times 10^{-3}\,\mathrm{m \cdot K}}{3.25 \times 10^{4}\,\mathrm{K}} = 89.2\,\mathrm{nm}.$$

The peak is in the UV range of the spectrum, and will be way to the left in Fig. 27–4. In the visible region, the curve will be descending, so the shortest visible wavelengths will be strongest. Hence the star will appear bluish (or blue-white).

NOTE This example helps us to understand why stars have different colors (reddish for the coolest stars, orangish, yellow, white, bluish for "hotter" stars.)

EXERCISE A What is the color of an object at 4000 K?