2) If a star has a surface temperature of 20,000 K, at what wavelength will it radiate the most energy?

To solve this problem, we use Wien's Law of Blackbody Radiation, namely that the product of the peak wavelength and the temperature is a constant.

\[ \lambda_{\text{max}} \times T = 3 \times 10^6 \]

\[ \lambda_{\text{max}} = \frac{3 \times 10^6}{T} = \frac{3 \times 10^6}{20,000} = 150 \text{ nm} \]

3) Infrared observations of a star show that it is most intense at a wavelength of 2000 nm. What is the temperature of the star's surface?

Again, we use Wien's Law, this time solving for temperature:

\[ \lambda_{\text{max}} \times T = 3 \times 10^6 \]

\[ T = \frac{3 \times 10^6}{\lambda_{\text{max}}} = \frac{3 \times 10^6}{2000} = 1500 \text{ K} \]

4) If you double the temperature of a blackbody, by what factor will the total energy radiated per second per square meter increase?

Here, we use the second law of Blackbody Radiation which tells us that the amount of energy radiated per second per unit area is proportional to the temperature to the fourth power. As a result, if the temperature increases by a factor of two, the energy radiated will increase by a factor of 2^4, or 16.
3) The nebula shown below contains mostly hydrogen excited to emit photons. What kind of spectrum would you expect the nebula produce?

A nebula is a low-density gas. A low density gas “excited to emit” photons is analogous to the discharge tubes we looked at in class, each with its own fingerprint, or pattern, of colors. This is an emission line spectrum.