HII Region Emission

a) Suppose there is an O5V star embedded in a hydrogen cloud of uniform density \( n = 10^4 \text{ cm}^{-3} \), at a distance of 460 pc from the Earth (the distance of the Orion nebula, the closest region of high-mass star-formation). What is the flux (W m\(^{-2}\) Hz\(^{-1}\)) you would expect to observe from the resulting HII region at a wavelength of 20 cm? Radio astronomers define a unit called the Jansky (1 Jy=10\(^{-26}\) W m\(^{-2}\) Hz\(^{-1}\)). What is the flux of the HII region in Jy?

**Hint:** You may assume that the gas in the HII region has been heated to a temperature of 10,000 K and that the source acts like a blackbody of that temperature. Also, at these long wavelengths, the Rayleigh-Jeans approximation to the Planck formula can be used, namely,

\[
B = I_\lambda = \frac{2kT}{\lambda^2}
\]

Also, you may assume that the source can be treated as a uniformly bright sphere. Hence, you can use the result of your earlier homework problem, namely,

\[
f_\lambda = \pi R^2 B \frac{1}{r^2}
\]

**Second hint:** The solution to this problem requires more than one step.

b) Now consider a 100 W light bulb in your room. Calculate the effective temperature of such a light bulb, assuming it radiates as a blackbody (you can approximate the shape of the filament as a cylinder with reasonable dimensions). What is the flux of this light bulb at 5000 Å? (For this calculation, treat the filament as a uniformly bright sphere of area equal to its surface area, and choose a reasonable room-sized distance from which to observe it.) How does this flux compare to that of the HII region? What does that tell you about the sensitivity of astronomical radio receivers?