PHYSICS 113
Assignment #6
SOLUTIONS

Chapter 9

16. An astronomer discovers a type M star with a large luminosity. How is this possible? What kind of star is it?

A type M star is a star with a low surface (effective) temperature. Normally, stars on the main sequence show a strong correlation between increasing surface temperature and increasing luminosity (e.g., a low temperature star has a low luminosity). However, **as a star evolves, it becomes a giant star with a low surface temperature but a large luminosity**. The star is bright because it has such a large surface area over which to radiate its energy. Thus, if an astronomer discovers a type M star that has a large luminosity, it must be a **giant**. In fact, it is probably what astronomers refer to as a red giant.

Chapter 10

16. A star has a temperature of 10,000K and a luminosity of 10^{-2} $L_\odot$ (= 0.01 solar luminosities). What kind of star is it?

We are given that the star has a temperature of 10,000 K and a luminosity of 0.01 solar luminosities. According to the HR diagram, a star with the surface temperature of 10,000 Kelvin is a star with a B spectral type. Moreover, if the star were on the main sequence, then it would have a luminosity nearly 100 times more than that of the sun. However since the actual luminosity is 10,000 times smaller than this, this star must be a **white dwarf**.

Chapter 12

12. The evolutionary track for star with one solar mass remains nearly vertical in the HR diagram for a while (see Figure 12.12). How is its luminosity changing during this time? Its temperature? Its radius? What is its source of energy?

The evolutionary track of a one solar mass star remains nearly vertical in the HR diagram while it is a protostar that is contracting to become a main sequence (i.e., equilibrium) star. As can be seen from the diagram, **the luminosity (brightness) is decreasing**, and the surface temperature remains nearly constant (decreases slightly). This implies that its radius must also decrease. Recall that the luminosity of a star is proportional to the star's radius squared and is proportional to the star's surface temperature to the fourth power. Thus, if the star's **surface temperature is nearly constant**, then its luminosity is proportional to its radius squared. Since luminosity decreases, the **radius must also decrease**. Also note that the source of energy generation during this phase of the protostar's contraction is **gravitational energy** (the energy associated with the contraction). Gravity squeezes the gas thereby increasing its pressure and temperature.