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.