

OpenStax Astronomy, Ch.22: WS Problems (Apr-2021)

Review Questions

1. Astronomers find that 90% of the stars observed in the sky are on the main sequence of an H-R diagram; why does this make sense? Why are there far fewer stars in the giant and supergiant region?
2. Describe the evolution of a star with a mass similar to that of the Sun, from the protostar stage to the time it first becomes a red giant. Give the description in words and then sketch the evolution on an H-R diagram.
3. Describe the evolution of a star with a mass similar to that of the Sun, from just after it first becomes a red giant to the time it exhausts the last type of fuel its core is capable of fusing.
4. A star is often described as “moving” on an H-R diagram; why is this description used and what is actually happening with the star?
5. Certain stars, like Betelgeuse, have a lower surface temperature than the Sun and yet are more luminous. How do these stars produce so much more energy than the Sun?
6. Gravity always tries to collapse the mass of a star toward its center. What mechanism can oppose this gravitational collapse for a star? During what stages of a star’s life would there be a “balance” between them?
7. Why are star clusters so useful for astronomers who want to study the evolution of stars?
8. Would the Sun more likely have been a member of a globular cluster or open cluster in the past?
9. Suppose you were handed two H-R diagrams for two different clusters: diagram A has a majority of its stars plotted on the upper left part of the main sequence with the rest of the stars off the main sequence; and diagram B has a majority of its stars plotted on the lower right part of the main sequence with the rest of the stars off the main sequence. Which diagram would be for the older cluster? Why?
10. The nuclear process for fusing helium into carbon is often called the “triple-alpha process.” Why is it called as such, and why must it occur at a much higher temperature than the nuclear process for fusing hydrogen into helium?
11. Pictures of various planetary nebulae show a variety of shapes, but astronomers believe a majority of planetary nebulae have the same basic shape. How can this paradox be explained?
12. Describe the two “recycling” mechanisms that are associated with stars (one during each star’s life and the other connecting generations of stars).
13. In which of these star groups would you mostly likely find the least heavy-element abundance for the stars within them: open clusters, globular clusters, or associations?
14. Explain how an H-R diagram of the stars in a cluster can be used to determine the age of the cluster.
15. Where did the carbon atoms in the trunk of a tree on your college campus come from originally? Where did the neon in the fabled “neon lights of Broadway” come from originally?
16. What is a planetary nebula? Will we have one around the Sun?



17. Would you expect to find an earthlike planet (with a solid surface) around a very low-mass star that formed right at the beginning of a globular cluster's life? Explain.
18. In the H-R diagrams for some young clusters, stars of both very low and very high luminosity are off to the right of the main sequence, whereas those of intermediate luminosity are on the main sequence. Can you offer an explanation for that? Sketch an H-R diagram for such a cluster.
19. If all the stars in a cluster have nearly the same age, why are clusters useful in studying evolutionary effects (different stages in the lives of stars)?
20. Suppose a star cluster were at such a large distance that it appeared as an unresolved spot of light through the telescope. What would you expect the overall color of the spot to be if it were the image of the cluster immediately after it was formed? How would the color differ after 10^{10} years? Why?
21. Stars that have masses approximately 0.8 times the mass of the Sun take about 18 billion years to turn into red giants. How does this compare to the current age of the universe? Would you expect to find a globular cluster with a main-sequence turnoff for stars of 0.8 solar mass or less? Why or why not?