

ASTR1102-002

Practice Questions for Exam #2

1. Why do sunspots appear to be darker than most of the Sun's photosphere?
2. Sometimes the Sun's surface displays virtually no sunspots, while at other times its surface displays a relatively large number of sunspots. What is the typical length of time between sunspot minimums and sunspot maximum; that is, what is the typical length of the "sunspot cycle"?
3. Sunspots appear to be associated with regions of the Sun's surface where the magnetic field is especially _____ (weak or strong).
4. The north and south magnetic poles of the Earth reverse every 11 years. (True or False?)
5. Heat can be transported from the center to the surface of a star either by radiative diffusion, or by convection. Which one of these two processes is principally responsible for transporting heat in the surface layers of the Sun?
6. By tracking the changing position of sunspots across the surface of the Sun over many hours and days, astronomers have determined that the Sun rotates once every 24 hours. (True or False?)
7. Which of the following properties of the Sun can best be studied during a total solar eclipse?
 - a. Sunspots.
 - b. The Solar Corona.
 - c. Photospheric granulation.
 - d. Nuclear fusion in the Sun's core.
8. The central temperature of the Sun is _____. (Fill in the blank.)
 - a. approximately 5800 K.
 - b. approximately 16 million K.
 - c. orange.
 - d. not known.

9. If the Sun was not in **hydrostatic equilibrium**, how long would it take for the Sun's structure to noticeably change?
- A few hours.
 - Tens of thousands of years.
 - Approximately 10 million years.
 - Approximately 10 billion years.
10. If the Sun was undergoing **Kelvin-Helmholtz contraction**, how long would it take for the Sun's structure to noticeably change?
- A few hours.
 - Tens of thousands of years.
 - Approximately 10 million years.
 - Approximately 10 billion years.
11. Because heat generated through **nuclear fusion reactions** in the central core of the Sun is replenishing the heat that the Sun is steadily losing at its surface, how long can the Sun "live" without experiencing a noticeable change in its structure?
- A few hours.
 - Tens of thousands of years.
 - Approximately 10 million years.
 - Approximately 10 billion years.
12. What is the **average density** of material in the Sun? State your answer in units of kilograms per cubic meter and compare it to the density of water (1000 kg/m^3).
- HINT:** You can calculate the average density by dividing the Sun's total mass ($M_{\odot} = 2 \times 10^{30} \text{ kg}$) by the Sun's volume. Given the Sun's radius ($R_{\odot} = 7 \times 10^8$ meters), what is the Sun's volume?
13. According to the mathematical (theoretical) model of the Sun that has been developed by astronomers, what is the **central density** of the Sun? (See, for example, Table 16-2 or Figure 16-3.)
14. According to the mathematical (theoretical) model of the Sun that has been developed by astronomers, what is the **central temperature** of the Sun? (See, for example, Table 16-2 or Figure 16-3.)
15. How many neutrons are in the nucleus of the most common isotope of hydrogen (^1H)?
16. How many protons are in the nucleus of a ^1H atom?

17. How many protons are in the nucleus of a deuterium (^2H) atom?
18. How many neutrons are in the nucleus of a deuterium (^2H) atom?
19. How many protons are in the nucleus of a tritium (^3H) atom?
20. How many neutrons are in the nucleus of a tritium (^3H) atom?
21. How many protons are in the nucleus of a ^3He atom?
22. How many neutrons are in the nucleus of a ^3He atom?
23. How many protons are in the nucleus of a ^4He atom?
24. How many neutrons are in the nucleus of a ^4He atom?
25. How many protons are in the nucleus of a ^{12}C atom?
26. How many neutrons are in the nucleus of a ^{12}C atom?
27. How many neutrinos are created when four ^1H nuclei combine (via the proton-proton chain, nuclear fusion reaction) to form one ^4He nucleus?
28. What happens to the positron (e^+) shortly after it is created during the first step of a “proton-proton chain” nuclear reaction?
29. What is the chemical composition of the Sun? What two atomic elements are most abundant in the Sun?
30. What is the end product of a nuclear reaction when two ^3He atoms fuse together?
31. Discuss how measurements of the flux of neutrinos from the Sun have helped us (a) check the accuracy of our mathematical models of the Sun, and (b) establish a more fundamental understanding of the properties of neutrino particles.
32. Explain how measurements of solar oscillations have helped us check the accuracy of our mathematical models of the Sun.
33. Stars on the main sequence that are 15 times more massive than the Sun should live 15 times longer than the Sun because they have more fuel to burn. (True or False?)
34. Stars on the main sequence that are 3 times more massive than the Sun have luminosities that are 60 times brighter than the Sun. What should the lifetime of these stars be on the main sequence (relative to the Sun’s lifetime)?

35. What is the significance of Einstein's famous equation, $E = mc^2$, to our study of stars?
36. When hydrogen nuclei combine through a thermonuclear reaction to form the nucleus of a helium atom, the process is called "nuclear fusion." (True or False?)
37. When a heavy atomic nucleus, such as the nucleus of a uranium atom, spontaneously splits apart into two or more smaller atomic nuclei, the process is called "nuclear fusion." (True or False?)
38. What is special about the "iron-nickel group" of chemical elements in the context of our discussion of nuclear fusion and nuclear fission reactions?
39. The River Bend Nuclear Power plant (in St. Francisville, LA) derives its energy from the fusion of hydrogen into helium. (True or False?)
40. The atomic bombs that were developed and used during World War II derived their explosive energies from the fusion of hydrogen into helium. (True or False?)
41. In one or two sentences, explain why normal stars spend a much larger fraction of their "lives" on the main sequence than they spend as red giant stars.
42. How many neutrinos are created each time three ${}^4\text{He}$ nuclei fuse to form one ${}^{12}\text{C}$ nucleus? (Consider only the simplest possible way of combining 3 ${}^4\text{He}$ nuclei to make ${}^{12}\text{C}$.)

43. Make up (and answer) at least six questions about stellar evolution, based on the three schematic H-R diagrams depicted below.

