Astronomy 212 EXAM 3 2007 April 24

Answer *TRUE* or *FALSE* (<u>not</u> *T* or *F*) (2 pts each)

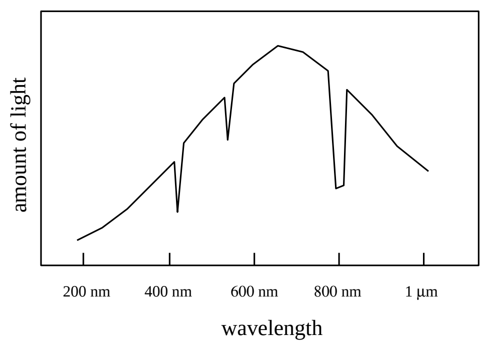
1. As a protostar the Sun was cooler and more luminous than it is today.
2. Interstellar clouds with high temperatures and densities are the most likely to collapse into stars.
3. HII is ionized hydrogen; H_2 is molecular hydrogen; ^2H is heavy hydrogen (deuterium).
4. The Orion Nebula is near a giant molecular cloud.
5. In main sequence stars a bit more massive than the Sun, the CNO cycle replaces the proton-proton chain as the usual method of fusion.
6. Spica was born after the Sun was born.
7. Degenerate gas can be transformed into normal gas just by raising its temperature sufficiently.
8. The speed of electrons in a degenerate electron gas is largely independent of the temperature, but strongly dependent on the density.
9. When we talk about the "radius" of a black hole, we usually mean the Schwarzschild radius—from inside of which nothing can escape.
10. White dwarf: the mass of the Sun packed into an object approximately the size of the Earth.
11. If mass is added to a white dwarf, it shrinks in radius. If enough mass is added so its mass exceeds the Chandrasekhar limit (about 1.4 times the mass of the Sun), gravity wins over the outward pressure of the degenerate electrons.
12. If the Sun were to become a black hole, the planets would be sucked into the hole.
13. Messier made a famous list of objects that were not comets (and hence of little interest to him).
14. The Sun is a Population I star.
15. Generally speaking, population II stars are older, not found in the disk, and have a lower "metal" concentration than do population I stars.
16. Astronomers think there is a black hole — with a mass a billion times the mass of the Sun — at the center of the Milky Way Galaxy.
17. The center of our Galaxy is in the direction of the constellation Sagittarius.
18. Astronomers look for *type II supernovae* (which our book calls 'massive star' supernovae) in globular clusters in order to determine their distance.
19. Type I supernovas (which our book calls 'white dwarf' supernovae) and novas are both thought to involve the binary companion of a white dwarf dumping material onto that white dwarf.
20. On Hubble's tuning fork, lenticular galaxies (S0) bridge the gap between spirals and ellipticals.

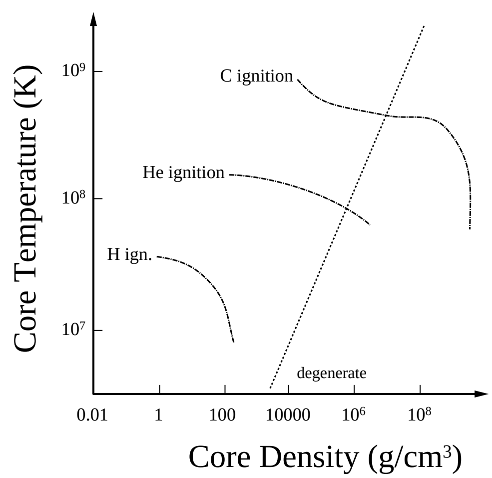
Give a short explanation (5 pts each)

21. Where should you look to see new stars forming? What sort of telescope should you use? Why?

22. For each of the below quantities report how dust along the line of sight would affect the quantity (e.g., no effect, increases, decrease, etc.): apparent magnitude, color, spectral type.

23. Describe how conditions at the core of the Sun change as the Sun evolves from main sequence to its final "death". Plot those conditions directly on the below right diagram.





24. Consider the effects of looking at a star through a cloud of *dust*. The above left spectrum represents the light *produced* by a star and viewed without dust in the way. Draw *directly on the above diagram* what the spectrum would look like if observed through a dust cloud. Label your modified spectra #24.

25. Consider the effects of looking at a star moving rapidly away from the Earth. Assume the above left spectrum represents the light produced by an identical star that is not moving away. Draw *directly on the above diagram* the spectrum of the rapidly receding star as observed from Earth. Label you modified spectra #25.

26. Describe one of the following three objects: white dwarf, neutron star, black hole. Include: how it is formed, how it is observed, composition, typical mass and size.

27. I described several principles of stellar evolution including: (A) the virial theorem, (B) the Russell-Vogt theorem, (C) sequential thermonuclear fusion leading to nonburnable iron. Briefly define each of the above and describe its role in stellar evolution.

28. Describe two types of interstellar gas clouds. Be sure to include the composition of the gas and how the cloud is detected.

29. Draw a Hertzsprung-Russell diagram. Properly label axes. Show star paths (and direction) that:

    (a) show a star increasing its luminosity while keeping its temperature constant

    (b) show a star decreasing its temperature while keeping its radius constant

30. In question 36, I ask you to report the evolution of the Sun. Describe here how the evolution of stars much more massive than the Sun (say, 30 $M_\odot$) and stars much less massive than the Sun (say, $\frac{1}{10}$ $M_\odot$) differs from that of the Sun.

31. Sketch the HR diagram of an old star cluster and a young star cluster. Why the difference?

32. Our book asserts that “we and our planet are made of stuff produced in stars that lived and died long ago”. What is the basis of such a sweeping statement? How did those atoms get out of that star and end up here on Earth?

33. Since we can’t see through our own Galaxy with visible light, e.g., to the galactic center, how can we see with visible light other galaxies which are much further away?

34. Most ways of measuring distance in astronomy are based on the distance modulus: $m - M$ (where m is the easily measured apparent magnitude and M is the absolute magnitude). Describe three ways one can know the absolute magnitude of a distant object.

35. There are two problems with distance modulus measurements: (A) they can be affected by dust and (B) absolute magnitude can be misjudged (because of mis-calibration). What would indicate that (A) is a problem? Why has (B) often been a problem historically?

Write out a complete answer (10 pts each)

36. A star like the Sun is believed to go through the following stages: planetary nebula, protostar, red giant, double shell burning, He flash, main sequence, and white dwarf. Describe (in words) the characteristics of each stage. Order these stages from first to last, and locate them on an HR diagram. For two of these situations draw a cross-section of the Sun displaying the situation. Remember to label the axes of your HR diagram!

37. Draw a face-on view and a side view of our Galaxy. Label and show spiral arm, disk, nuclear bulge, globular cluster, open cluster, halo, population I star, population II star and the Sun’s position. What is the diameter of our galaxy? What is the thickness of our Galaxy’s disk?

38. Draw Hubble’s “tuning fork” diagram showing the various types of galaxies. Sketch E0, E5, Sa, Sc, and SBb galaxies. Other than shape, how do these galaxies differ?

39. Consider the history of the discovery of the nature of our Galaxy. Given an example of each of the following:

    (a) mismeasurement leads to misunderstanding
    (b) wrong assumptions lead to misunderstanding
    (c) where Occam’s Razor failed (i.e., where simple assumptions — assumptions of the least possible novelty — produced incorrect conclusions)
    (d) a crucial measurement quickly settles a scientific argument
    (e) measurement of the mundane produces far-reaching conclusions (e.g., unexpected connections)

40. The below diagram shows the winter hexagon. Eight 8 of these dots are stars you should know. Circle these “important” stars and label with the name and spectral type of the star. Label and name the constellations of the winter hexagon.