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

1. A KV star has more mass than a BV star.
2. Distant stars have been seen to alternately move towards and away from the Earth; big planets are the suspected cause.
3. Stars which start with less hydrogen fuel than the Sun actually burn longer than the Sun.
4. The importance of carbon burning to stars is that carbon burns at a lower temperature than hydrogen or helium.
5. Through all the various twists on the HR diagram, there is one constant provided by the virial theorem: stellar cores become hotter and denser until they become degenerate (and only then can either cool or explode).
6. By carefully plotting a star's monthly motion on the HR diagram, astronomers have observed the rapid expansion and brightening of main sequence stars into red giants.
7. Degenerate gas, when heated sufficiently, becomes normal gas.
8. Red giants are further "evolved" than main sequence stars and hence were born before main sequence stars.
9. Other things being equal (e.g., same surface temperature), the more massive the white dwarf, the less luminous it will be.
10. All pulsars are thought to be neutron stars.
11. If the Sun were to become a black hole, the planets would be sucked into the hole.
12. M1 is the first item on Messier's list of things that might be mistaken for a comet.
13. Supernovas are thought to produce what I called "hot vacuum".
14. HII is found where the temperature is cool; H_2 is found where the temperature is warm.
15. The Orion Nebula is near a giant molecular cloud.
16. *Planetary nebulae* are young stars just starting to to produce a disk that will end up as planets.
17. Because of interstellar reddening, the absorption lines of distant O stars get shifted to the red.
18. You shouldn't look for OV stars in globular clusters.
19. Stars in an open cluster have nearly equal $B - V$.
20. Population I stars are more likely to have planets like the Earth than Population II stars.

Give a short explanation (5 pts each)

21. Why are cepheid variable stars useful to astronomers?

22. Why are visual binary stars useful to astronomers?

23. 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.

24. The star ζ^1 Sco is a B1Ia star with a color redder than Procyon. What could cause this effect? How would we know that ζ^1 Sco is B1Ia rather than having a spectral type similar to Procyon?

25. If we look up the typical absolute magnitude of a B1Ia star like ζ^1 Sco, we find $M_V \approx -6.7$. The apparent magnitude of ζ^1 Sco is 4.7, yielding a distance modulus corresponding to about 2,000 pc. This is probably *not* a very accurate distance to ζ^1 Sco. Why? Is the actual distance likely to be more than 2,000 pc, less than 2,000 pc, or just totally indeterminant? Why?

26. Why is it hard to see stars in the process of formation?

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

28. Sort the following list of objects from oldest to most recently born: globular cluster, O association, planetary nebula, Spica and the Sun.

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

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

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

30. In question 39, 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 "Everyone of those carbon atoms [in your finger] was once inside a red giant star". What is the basis of such a sweeping statement? How did your atoms get out of that star and end up here on Earth?

33. Why is a higher temperature needed for helium fusion than for hydrogen fusion?

34. Describe the evidence for "dark matter" in our Galaxy.

35. What sort of light should you use to see the center of our Galaxy? Why?

Write out a complete answer (10 pts each)

36. Draw a face-on view and a side view of our galaxy. Label and show spiral arm, disk, nuclear bulge, globular cluster, open cluster, O association, Population I star, Population II star and the Sun's position. What is the diameter of our galaxy?

37. Answer the following questions using the following data.

Star Name	Absolute Magnitude (M_V)	Apparent Magnitude (m_V)	Spectral Type	Luminosity Class
1. Canopus	-4.7	-0.7	F0	Ib
2. Wolf 359	16.7	13.5	M8	V
3. Gacrux	-2.5	1.6	M3	II
4. λ Ser	4.4	4.4	G0	V
5. El Nath	-1.1	1.7	B7	III
6. α UMa	-0.7	1.8	K0	III
7. α Aqr	-3.8	3.0	G2	I
8. Achernar	-2.5	0.5	B3	V
9. β Aqr	-3.5	2.9	G0	I

(a) Which star would look the brightest in the sky?

(b) Which star could not be seen with the unaided eye?

(c) Which star is most similar to the Sun?

(d) Which star is intrinsically the brightest?

(e) Which star has the highest surface temperature?

(f) Which star has the lowest surface temperature?

(g) Which star is farthest away?

(h) Which star is closest?

(i) Which star has the largest radius?

(j) Which main sequence star is the most luminous?

38. Draw a HR diagram. Label axes, the region of the HR diagram where main sequence stars are found, the region where red giants are found, and the region where supergiants are found. Show where each star from the previous problem would be found.

39. 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 objects draw a cross-section of the object displaying its structure.

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.