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

1. Generally speaking, the bigger the musical instrument the bigger the frequency it produces.
2. For sound or light: the smaller the wavelength the bigger the frequency.
3. Doppler effect: Stopped in the station the train's whistle sounds an A (440 Hz), but when it approaching me at a railroad crossing it sounds an A$^\sharp$ (466 Hz).
4. Analogy: Air pressure is to sound as "electromagnetic stuff" is to light.
5. Standard incandescent (Edison) light bulbs produce an emission spectra.
6. At high temperatures nature favors disorder; at low temperatures it favors low energy.
7. High temperatures break apart composites.
8. The ions in a plasma are atoms than have lost electrons.
9. Every isotope of carbon has the same number of protons in its nucleus.
10. Deuterium is like normal hydrogen, except it has exactly one neutron.
11. While both are electrically neutral, the neutrino and the neutron are as different as the electron and the proton, i.e., not closely related.
12. A microwave photon carries more energy than a ultraviolet photon.
13. Radio waves move slower through space than X-rays.
14. The main reason for building large Earth-based telescopes is to magnify the tiny images of stars.
15. Smaller resolution is the aim of a radio interferometer.
16. A telescope able to resolve two arc seconds is better than one able to resolve one arc second.
17. In astronomy, poor *seeing* means it's cloudy outside.
18. Electric currents are the source of magnetic field both in an electromagnet and in the Sun.
19. Most stars consist almost entirely of hydrogen and helium, with everything else constituting at most a few percent of the total mass.
20. Optical binaries are a pair of stars that can be seen to orbit around each other.

Give a short explanation (5 pts each)

21. Rank order the following types of light from from longest to shortest wavelength: infrared, red, yellow, blue, gamma ray.

22. Consider two lenses: Lens **A** is 2" in diameter and has a focal length of 2"; Lens **B** is 3" in diameter and has a focal length of 6". Which lens will work faster for burning holes in paper using the image of the Sun? (Hint: f-number) Which lens will burn larger holes in paper using the image of the Sun? (Hint: image size)

23. Draw a picture of an atom. Label: electron, nucleus, proton, neutron. Where could quarks be found?

24. An electron was initially in the ground state. It absorbed a blue-light photon to jump to an excited state and then it emitted a red-light photon. Draw a picture showing the energy levels and leaps.

25. Sketch a Cassegrain reflecting telescope. Show and label: the direction to the stars, the objective, aperture, eyepiece, and focal length of the objective.

26. How do we know the temperature deep inside the Sun?

27. What is fusion? What is fission? Exactly what set of reactions power the Sun?

28. What are solar neutrinos? Why do we measure them?

29. Define two methods of energy transfer. Give a (commonplace) example of each.

30. Describe exactly what astronomical photos would be needed to measure the parallax angle of a star (like 61 Cygni, whose parallax Bessel found in 1838). (I.e., what is parallax?)

31. Select two of the following list of stellar properties and describe how those properties could be measured from Earth: mass, radius, luminosity, temperature.

32. Albereo is the double star (i.e., two stars orbiting around each other) at the foot of the northern cross. When viewed through the telescope, Albereo looks like a yellowish star (magnitude 3) next to a blue star (magnitude 5). Compare the two stars by reporting which is brighter, which has the larger radius, and which has the higher surface temperature.

33. How do the spectra of stars differ? (Note: this question asks how *spectra* differ not how stars differ, e.g., how does an O spectra differ from an M spectra?) Why do they differ?

34. The following reasoning comes to an incorrect conclusion and hence must contain a logical flaw. Explain that flaw!

    "Stars are all made of pretty much the same stuff, and each type of stuff has characteristic absorption and emission lines, so every star's spectra has much the same set of absorption and emission lines."

35. Draw a HR (Hertzsprung-Russell) diagram. Label: axes, the region of the diagram where main sequence stars are found, the region where red giants are found and the region where supergiants are found.

Write out a complete answer (10 pts each)

36. 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 furthest away?

(h) Which star is the closest?

(i) Which star has the largest radius?

(j) Which star is the hottest main-sequence star?

37. Answer this question by directly drawing/labeling on the (rotated) graph directly to the right.

(a) What are the x and y axes?

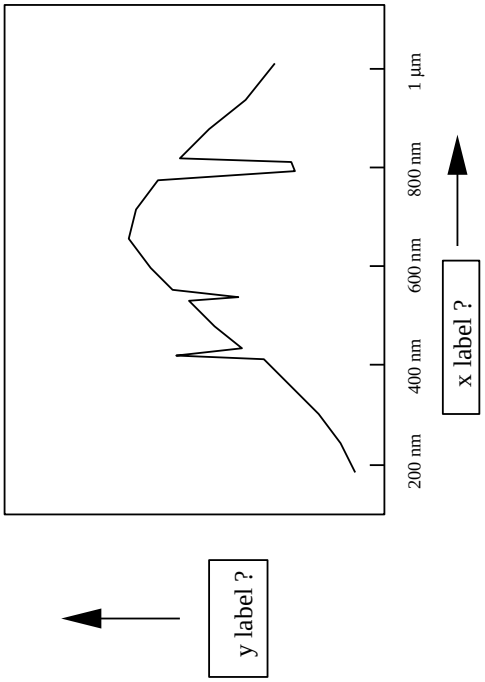
(b) Label: absorption line, emission line

(c) What is the numerical value of the peak wavelength?

(d) Sketch how the graph would change if the object producing the light were cooler.

(e) Sketch how the graph would change if the quantum leap producing your labeled emission line were smaller.

(f) Sketch how the graph would change if electrons made the quantum leaps corresponding to your labeled absorption line *less* frequently.



38. Describe why the Sun doesn't explode. Your explanation should include a full statement of the Virial theorem, an explanation of why things "usually" explode, and an explanation of why you haven't seen anything explode recently.

39. Sketch a cross section of the Sun. Show and label: chromosphere, core, corona, convective zone, photosphere, and radiative zone. Rank the previous items in terms of temperature from highest to lowest. Label in your sketch where the apparent surface of the Sun is and where thermonuclear reactions take place.

40. Identify the below three constellations.