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

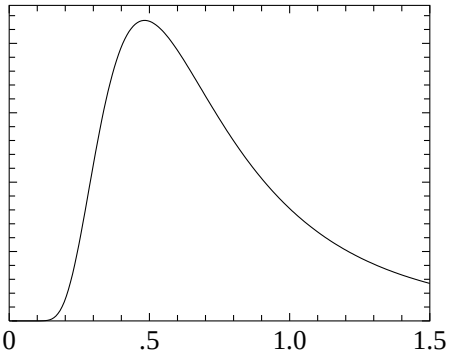
1. Generally speaking, the bigger the musical instrument the bigger the frequency it produces.
2. For sound: the bigger the wavelength the higher the pitch.
3. Standard incandescent (Edison) light bulbs produce an emission spectra.
4. *Temperature* is a measure of the kinetic energy of the constituent particles (e.g., atoms).
5. At high temperatures nature favors disorder; at low temperatures it favors low energy.
6. High temperatures break apart composites.
7. The ions in a plasma are atoms that have lost electrons.
8. Deuterium is like normal hydrogen, except its nucleus contains exactly one neutron.
9. A microwave photon carries more energy than a ultraviolet photon.
10. Radio waves move slower through space than X-rays.
11. The main reason for building large Earth-based telescopes is to magnify the tiny images of stars.
12. The main reason for building space-based telescopes is to get them closer to the stars.
13. Smaller resolution is the aim of a radio interferometer.
14. A lens with a long focal length will make big images, but the images will be dim unless the f-number is small.
15. In a refracting telescope the objective is a lens.
16. In the Sun, convection dredges up newly created helium from the core.
17. Electric currents are the source of magnetic field both in an electromagnet and in the Sun.
18. Prominence: chromospheric material suspended in the corona by magnetic fields.
19. Optical binaries are a pair of stars that can be seen to orbit around each other.
20. If space is transparent, the ratio of blue light to red light will not change with distance; i.e., color would not depend on distance.

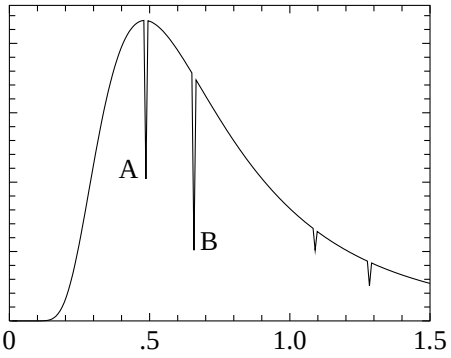
Give a short explanation (5 pts each)

21. Rank order the following types of light from from longest to shortest wavelength: infrared, microwave, ultraviolet, X-ray, yellow.
22. Draw a picture of an atom. Label: electron, nucleus, proton, neutron. Where could quarks be found?
23. How would you measure the focal length of a lens?

24. The two most famous telescopes currently in active use are the Hubble Space Telescope (HST) and the Keck telescope. HST is a f/13, 2.4 meter telescope which is deployed in low-Earth orbit (about 600 km above the Earth). The f/1.75, 10 meter Keck telescope is on the summit of Hawaii's dormant Mauna Kea volcano, 4 km above sea level. Which telescope should you use to photograph dim objects? Which telescope shows the finest details? Which telescope produces the most "magnified" images?

25. The below left is a spectra of a thermal (blackbody) light source at a temperature of 6000 K. Sketch directly on this graph the spectra of an otherwise identical thermal light source at a temperature of 4000 K. Label **B** where blue light would appear on this graph; label **R** where red light would appear.





26. The above right is a spectra with features labeled **A** and **B**. What is the name of these features? What causes these features? On your answer sheet show/label a set of energy levels and quantum leaps (including direction) that would produce these two features.

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

28. Define *resolution*. What is *atmospheric seeing*? What does it have to do with resolution?

29. What is fusion? What is fission? Report the proton-proton chain of reactions.

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

31. What is a *sunspot*? What is the *sunspot cycle*?

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

33. 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."

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

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.

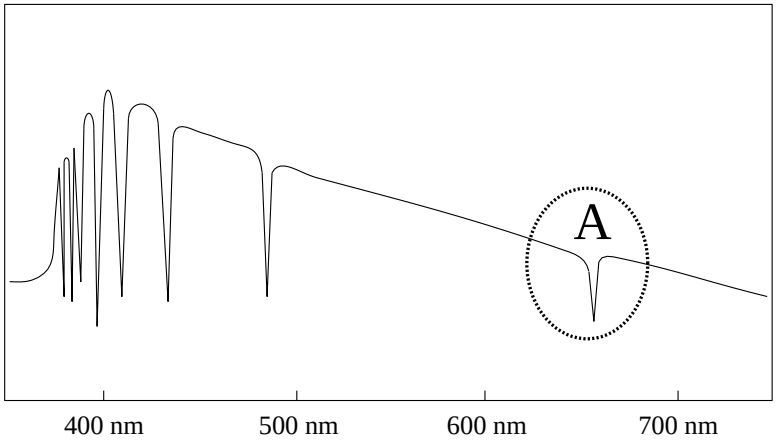
Star Name	Apparent Magnitude m_V	Absolute Magnitude M_V	Spectral Type	Luminosity Class
1. Spica	$+1.0$	-3.5	B1	III
2. Antares	$+1.0$	-3.8	M2	I
3. Sirius	-1.5	$+1.4$	A1	V
4. Rigel Kent	$+0.0$	$+4.4$	G2	V
5. Fomalhaut	$+1.2$	$+2.0$	A3	V
6. Deneb	$+1.3$	-7.2	A2	I
7. Canopus	-0.7	-3.5	F0	II
8. Regulus	$+1.4$	-0.7	B7	V
9. Aldebaran	$+0.9$	-0.5	K5	III

Which star...

(a) would look the brightest in the sky?
(b) is intrinsically the brightest?
(c) has the highest surface temperature?
(d) has the lowest surface temperature?
(e) has the largest radius?
(f) has the smallest radius?
(g) is furthest away?
(h) is the closest?
(i) is a blue-white giant star?
(j) is most similar to the Sun?

37. The below graph displays a somewhat simplified spectra of the A7 V star Altair. The feature labeled **A** is produced by hydrogen gas in the atmosphere of the star.

(a) What are the x and y axes?
(b) How would **A** change in a A7 I star?
(c) How would **A** change if Altair were moving away from the Earth at high speed?
(d) How would **A** change if Altair were spinning rapidly?
(e) How would **A** change if there were fewer hydrogen atoms in Altair's atmosphere?



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. Label (directly on this sheet) the below three constellations with each constellation's name.