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

1. High energy photons have high frequencies.
2. Red light has a longer wavelength than blue light.
3. Microwave light has a longer wavelength than infrared light.
4. Fluorescent light bulbs (like those in this classroom) produce an emission spectra.
5. A lens with a long focal length will make big images, but the images will be dim unless the $f$-number is small.
6. The main reason for building large Earth-based telescopes is to magnify the tiny images of stars.
7. Smaller resolution is the aim of a radio interferometer.
8. A telescope able to resolve two arc seconds is better than one able to resolve one arc second.
9. In astronomy, poor *seeing* means it's cloudy outside.
10. High temperatures break down composites.
11. *Plasma* is a "gas" of ions and unbound electrons.
12. All isotopes of carbon have the same number of protons.
13. The Sun's corona converts hydrogen to helium using the proton-proton chain.
14. The radial outflow of subatomic particles from the Sun is called the solar wind.
15. In the Sun, convection dredges up newly created helium from the core.
16. In the Sun's core, antimatter electrons (positrons) are annihilated producing light that takes a millions years to escape to the surface, whereas zillions of neutrinos escape to the surface at essentially the speed of light.
17. Although sunspots appear to be dark, in fact they are brighter than an incandescent light bulb's filament.
18. The Sun is a G2 V star.
19. Most stars consists almost entirely of hydrogen and helium, with everything else constituting at most a few percent of the total mass.
20. The combined magnitude of two stars shining together is less than the magnitude of either star by itself.

**Give a short explanation (5 pts each)**

21. Define *wavelength*, *frequency*, and *amplitude*.

22. 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.

23. How would you measure the focal length of a lens?

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

25. Why are some telescopes put in space?

26. 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?

27. What is the difference between hot gas and cool gas, i.e., on the atomic scale what changes as temperature increases?

28. What is *solar seismology*? What is the purpose of this area of study?

29. What is fusion? What is fission? Exactly what reactions power the Sun?

30. The Sun's corona shows emission lines from highly ionized iron. The Sun's photosphere shows absorption lines from unionized iron. What causes the difference?

31. Define/describe energy transfer by (a) radiation and (b) convection.

32. The following table contains absolute magnitude ($M_V$) and color index ($B-V$) data for stars of spectral type: (a) F V, (b) G V, (c) K V, (d) K III, (e) K I. Which spectral type goes with which row of the following table? WHY?

| row | $M_V$ | $B-V$ |
|---|---|---|
| 1 | 5.9 | .89 |
| 2 | 2.6 | .27 |
| 3 | $-5.0$ | 1.39 |
| 4 | 4.4 | .58 |
| 5 | 0.5 | 1.07 |

33. How do the spectra of stars differ? 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 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)**

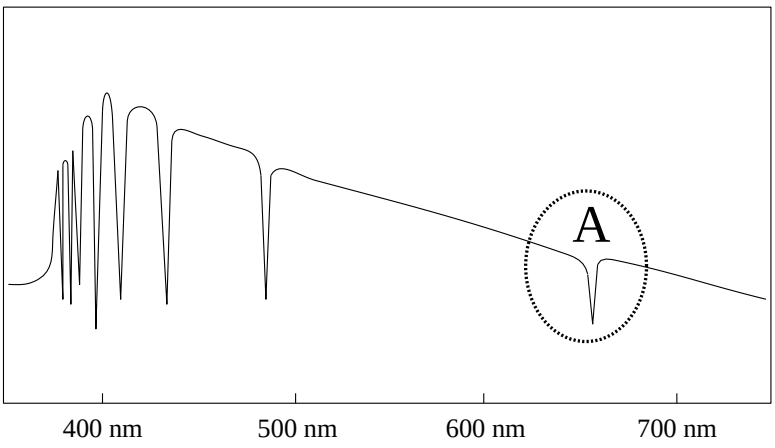
36. Answer the following questions using the following data.

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

(a) Which star has the greatest apparent brightness?
(b) Which star is a blue-white giant star?
(c) Which star is intrinsically the brightest?
(d) Which star is a red-colored supergiant?
(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. 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.

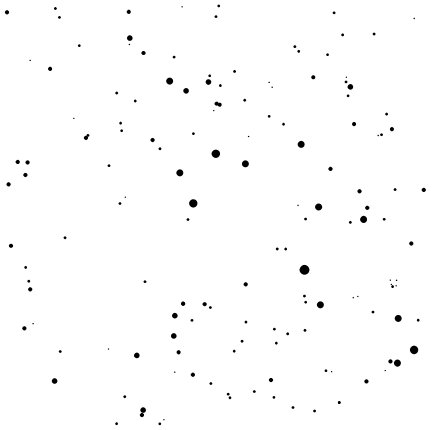
(a) What are the $x$ and $y$ axes?
(b) How would **A** change in a A7 I star?
(c) How would **A** change if Altair were moving away from the Earth at high speed?
(d) How would **A** change if Altair were spinning rapidly?
(e) Sketching directly on the below plot, show how the spectra would change if the star producing it were of type O4 III.



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.



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