

**Answer *TRUE* or *FALSE* (not *T* or *F*) (2 pts each)**

1. For sound waves, higher pitch means higher frequency.
2. Generally speaking, the larger the musical instrument, the larger the frequency produced.
3. High energy photons have short wavelengths.
4. Blue light has a smaller wavelength than red light.
5. Standard incandescent light bulbs produce an emission spectra.
6. Given a choice between a telescope with a big focal length and a telescope with a big aperture, astronomers will favor the one with the big aperture.
7. The spectra of a star approaching us at high speed shows lines shifted to longer wavelengths than we would see in the lab.
8. Dispersion of light is the bane of astronomers.
9. There are few equatorial mounted telescopes as there are few mountains on the equator.
10. Smaller resolution is the aim of a radio interferometer.
11. Molecules consist of atoms bonded together.
12. In an ion the number of protons does not equal the number of electrons.
13. When a photon is absorbed by an atom, an electron jumps to an orbit closer to the nucleus.
14. Deuterium is an isotope of hydrogen.
15. In the Sun's core, protons are thrown together at high speed, but almost always no reaction occurs.
16. The protons in the Sun's corona are moving much faster than those in the photosphere.
17. Iron ( $^{56}\text{Fe}$ ) is "unburnable" ash: the neutrons and protons have combined to produce the lowest energy state.
18. The only thing from the Sun that reaches the Earth is light.
19. The high gravitation field of the Sun crushes its core to densities much higher than lead.
20. In the Sun's core, antimatter electrons (positrons) are annihilated producing light that takes a million years to escape to the surface, whereas zillions of neutrinos escape to the surface at essentially the speed of light.

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

21. Define *wavelength*, *frequency*, and *amplitude*.
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. Report four types of light (other than visible light) ranked from longest to shortest wavelength. Report one type of celestial light (other than visible) that can be observed from the surface of the Earth.
24. How would you find the focal length of a lens?
25. Why are some telescopes put in space?
26. *Seeing* is believing, but in astronomy it means something else too. What is it? What causes it?
27. What is the difference between hot gas and cool gas, i.e., on the atomic scale what changes as temperature increases?
28. Imagine that you put an ice cube in an absolutely unopenable "lock-box". Describe how the composition of the stuff inside the box would change as you raised the temperature from freezer temperature to the temperature at the center of the Sun.
29. Albereio is the double star (i.e., two stars orbiting around each other) at the foot of the northern cross. When viewed through the telescope, Albereio 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.
30. What is *solar seismology*? What is the purpose of this area of study?
31. What is a *sunspot*? What is the *sunspot cycle*?
32. Exactly what powers the Sun? (Give reaction details if you can.)
33. Graph an *absorption spectra* with exactly two absorption lines. Label one absorption line **A** and the other **B**. Also remember to label axes! In your drawing, label with **C** the wavelength that produces the most light.
34. Graph #33 again displaying how it would change if the underlying continuum source were to increase in temperature (and everything else remained the same).
35. Which absorption line (**A** or **B**) corresponds to the larger energy jump? Graph #34 again displaying how it would change if at these increased temperatures, the material causing the two absorption lines in #33 became ionized.

**Write out a complete answer (10 pts each)**

36. Describe why the Sun doesn't explode. Your explanation should include a statement of the Virial theorem, an explanation of why things "usually" explode, and an explanation of why you haven't seen anything explode recently.
37. 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. If you were traveling through the Sun in a heat-proof "submarine", how could you tell if you were in the convective zone or the radiation zone?
38. Draw and label a Newtonian reflecting telescope and a refracting telescope. For each telescope show the direction to the stars, the objective, aperture, eyepiece, and focal length of the objective. What would you have to do to increase the magnification of these telescopes?
39. Many properties of stars are determined by carefully examining the spectra of stars. Consider the temperature of the "surface" of the star, the composition of the atmosphere of the star, and the velocity of the star. Describe how each of these properties could be determined by looking at the spectra of the star.
40. Identify the below three constellations.