15. Why might orbiting telescopes be problematic for the radio portion of the electromagnetic spectrum?

Conceptual Questions

16. Monochromatic light shines through two different diffraction gratings. The second grating produces a pattern in which the first-order and second-order maxima are more widely spread apart. Use this information to tell if there are more or fewer lines per centimeter in the second grating than in the first.

17. Why is the resolving power of your eye better at night than during the day?

18. Globular clusters, such as the one shown below, are spherical groupings of stars that form a ring around the Milky Way galaxy. Because there can be millions of stars in a single cluster and because they are distant, resolving individual stars within the cluster is a challenge. Of the following conditions, which would make it easier to resolve the component stars? Which would make it more difficult?



a. The number of stars per unit volume is half as great.
b. The cluster is twice as far away.
c. The cluster is observed in the ultraviolet portion instead of in the visible region of the electromagnetic spectrum.
d. The telescope's mirror or lens is twice as wide.

Practice Problems

For problems 19–21, see Sample Problem B.

19. Light with a wavelength of 707 nm is passed through a diffraction grating with 795 slits/cm. Find the angle at which one would observe the first-order maximum.

20. If light with a wavelength of 353 nm is passed through the diffraction grating with 795 slits/cm, find the angle at which one would observe the second-order maximum.

21. By attaching a diffraction-grating spectroscope to an astronomical telescope, one can measure the spectral lines from a star and determine the star's chemical composition. Assume the grating has 3661 lines/cm.

a. If the wavelengths of the star's light are 478.5 nm, 647.4 nm, and 696.4 nm, what are the angles at which the first-order spectral lines occur?
b. At what angles are these lines found in the second-order spectrum?

LASERS

Review Questions

22. What properties does laser light have that are not found in the light used to light your home?

23. Laser light is commonly used to demonstrate double-slit interference. Explain why laser light is preferable to light from other sources for observing interference.

24. Give two examples in which the uniform direction of laser light is advantageous. Give two examples in which the high intensity of laser light is advantageous.

25. Laser light is often linearly polarized. How would you show that this statement is true?

MIXED REVIEW

26. The 546.1 nm line in mercury is measured at an angle of 81.0° in the third-order spectrum of a diffraction grating. Calculate the number of lines per centimeter for the grating.

27. Recall from your study of heat and entropy that the entropy of a system is a measure of that system's disorder. Why is it appropriate to describe a laser as an entropy-reducing device?

15 REVIEW

have adequate resolution, an orbiting radio telescope would have to be very large.

16. The sin θ is inversely proportional to d, which is the reciprocal of the number of lines per centimeter. The grating that spreads the pattern the most has the most lines per centimeter.

17. The pupil is larger at night, so the angle of resolution is smaller and resolving power is greater.

18. easier: a, c, d
harder: b

19. 3.22°

20. 3.22°

21. **a.** 10.09°, 13.71°, 14.77°
b. 20.51°, 28.30°, 30.66°

22. Laser light is coherent and monochromatic.

23. Light must be coherent for an interference pattern to form. An interference pattern is well defined with monochromatic light.

24. Answers may include distance measurements, compact disc players, and fiber-optic communications; Answers may include laser surgery and fiber-optic communications.

25. by rotating a polarizing sheet in front of the laser light—if the intensity of the transmitted light varies, the light is polarized

26. 6030 lines/cm

27. Energy (light, for example) added to the active medium's atoms is not highly ordered. This light travels in all directions, is incoherent, and is not monochromatic. The laser converts a portion of this energy into a beam of more coherent, monochromatic light.