

10. (I) A widely used “short-wave” radio broadcast band is referred to as the 49-m band. What is the frequency of a 49-m radio signal?
11. (II) Our nearest star (other than the Sun) is 4.2 light-years away. That is, it takes 4.2 years for the light it emits to reach Earth. How far away is it in meters?
12. (II) A light-year is a measure of distance (not time). How many meters does light travel in a year?
13. (II) How long would it take a message sent as radio waves from Earth to reach Mars (a) when nearest Earth, (b) when farthest from Earth? [Hint: see Table 5–2, p. 125.]
14. (II) What is the minimum angular speed at which Michelson’s eight-sided mirror would have had to rotate to reflect light into an observer’s eye by succeeding mirror faces (Fig. 22–10)?
15. (II) A student wants to scale down Michelson’s light-speed experiment to a size that will fit in one room. A six-sided mirror is available, and the stationary mirror can be mounted 12 m from the rotating mirror. If the arrangement is otherwise as shown in Fig. 22–10, at what minimum rate must the mirror rotate?
16. (II) Who will hear the voice of a singer first—a person in the balcony 50.0 m away from the stage (Fig. 22–19), or a person 3000 km away at home whose ear is next to the radio? How much sooner? Assume that the microphone is a few centimeters from the singer and the temperature is 20°C.

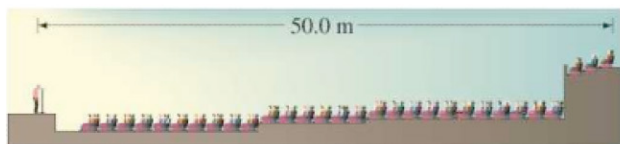


FIGURE 22–19 Problem 16.

17. (II) Pulsed lasers used in science and medicine produce very short bursts of electromagnetic energy. If the laser light wavelength is 1062 nm (this corresponds to a Neodymium-YAG laser), and the pulse lasts for 32 picoseconds, how many wavelengths are found within the laser pulse? How short would the pulse need to be to fit only one wavelength?
- * 22–5 Energy in EM Waves
- * 18. (I) The \vec{E} field in an EM wave in free space has a peak of 21.8 mV/m. What is the average rate at which this wave carries energy across unit area per unit time?
- * 19. (II) The magnetic field in a traveling EM wave has an rms strength of 28.5 nT. How long does it take to deliver 235 J of energy to 1.00 cm² of a wall that it hits perpendicularly?
- * 20. (II) How much energy is transported across a 1.00-cm² area per hour by an EM wave whose E field has an rms strength of 38.6 mV/m?
- * 21. (II) A spherically spreading EM wave comes from a 1200-W source. At a distance of 10.0 m, what is the average intensity, and what is the rms value of the electric field?
- * 22. (II) A 12.8-mW laser puts out a narrow beam 1.75 mm in diameter. What are the average (rms) values of E and B in the beam?
- * 23. (II) Estimate the average power output of the Sun, given that about 1350 W/m² reaches the upper atmosphere of the Earth.
- * 24. (II) If the amplitude of the B field of an EM wave is 2.5×10^{-7} T, (a) what is the amplitude of the E field? (b) What is the average power per unit area of the EM wave?
- * 25. (II) A high-energy pulsed laser emits a 1.0-ns-long pulse of average power 2.8×10^{11} W. The beam is 2.2×10^{-3} m in radius. Determine (a) the energy delivered in each pulse, and (b) the rms value of the electric field.
- * 22–6 Radiation Pressure
- * 26. (II) Estimate the radiation pressure due to a 100-W bulb at a distance of 8.0 cm from the center of the bulb. Estimate the force exerted on your fingertip if you place it at this point.
- * 22–7 Radio, TV
- * 27. (I) What is the range of wavelengths for (a) FM radio (88 MHz to 108 MHz) and (b) AM radio (535 kHz to 1700 kHz)?
- * 28. (I) Estimate the wavelength for 1.9-GHz cell phone reception.
- * 29. (I) Compare 940 on the AM dial to 94 on the FM dial. Which has the longer wavelength, and by what factor is it larger?
- * 30. (I) What are the wavelengths for two TV channels that broadcast at 54.0 MHz (Channel 2) and 806 MHz (Channel 69)?
- * 31. (I) The variable capacitor in the tuner of an AM radio has a capacitance of 2800 pF when the radio is tuned to a station at 550 kHz. What must the capacitance be for a station near the other end of the dial, 1610 kHz?
- * 32. (I) The oscillator of a 96.1-MHz FM station has an inductance of 1.8 μ H. What value must the capacitance be?
- * 33. (II) A certain FM radio tuning circuit has a fixed capacitor $C = 840$ pF. Tuning is done by a variable inductance. What range of values must the inductance have to tune stations from 88 MHz to 108 MHz?
- * 34. (II) An amateur radio operator wishes to build a receiver that can tune a range from 14.0 MHz to 15.0 MHz. A variable capacitor has a minimum capacitance of 82 pF. (a) What is the required value of the inductance? (b) What is the maximum capacitance used on the variable capacitor?
- * 35. (II) A satellite beams microwave radiation with a power of 10 kW toward the Earth’s surface, 550 km away. When the beam strikes Earth, its circular diameter is about 1500 m. Find the rms electric field strength of the beam.
- * 36. (III) A 1.60-m-long FM antenna is oriented parallel to the electric field of an EM wave. How large must the electric field be to produce a 1.00-mV (rms) voltage between the ends of the antenna? What is the rate of energy transport per square meter?