

Homework: Ch. 27

1. Show that when light passes from air to water, its wavelength decreases to 0.750 times its original value.
2. Calculate the wavelength of light that has its third minimum at an angle of 30.0° when falling on double slits separated by $3.00 \mu\text{m}$.
3. Find the largest wavelength of light falling on double slits separated by $1.20 \mu\text{m}$ for which there is a first-order maximum. Is this in the visible part of the spectrum?
4. Find the angle for the third-order maximum for 580 nm wavelength yellow light falling on a diffraction grating having 1500 lines per centimeter.
5. Calculate the wavelength of light that has its second-order maximum at 45.0° when falling on a diffraction grating that has 5000 lines per centimeter.
6. The yellow light from a sodium vapor lamp seems to be of pure wavelength, but it produces two first-order maxima at 36.093° and 36.129° when projected on a 10,000 line per centimeter diffraction grating. What are the two wavelengths to an accuracy of 0.1 nm ?
7. (a) What is the width of a single slit that produces its first minimum at 60.0° for 600 nm light? (b) Find the wavelength of light that has its first minimum at 62.0° .
8. (a) Find the angle of the third diffraction minimum for 633-nm light falling on a slit of width $20.0 \mu\text{m}$. (b) What slit width would place this minimum at 85.0° ?
9. (a) What is the minimum width of a single slit (in multiples of λ) that will produce a first minimum for a wavelength λ ? (b) What is its minimum width if it produces 50 minima? (c) 1000 minima?
10. A double slit produces a diffraction pattern that is a combination of single and double slit interference. Find the ratio of the width of the slits to the separation between them, if the first minimum of the single slit pattern falls on the fifth maximum of the double slit pattern. (This will greatly reduce the intensity of the fifth maximum.)
11. Diffraction spreading for a flashlight is insignificant compared with other limitations in its optics, such as spherical aberrations in its mirror. To show this, calculate the minimum angular spreading of a flashlight beam that is originally 5.00 cm in diameter with an average wavelength of 600 nm .

12. A telescope can be used to enlarge the diameter of a laser beam and limit diffraction spreading. The laser beam is sent through the telescope in opposite the normal direction and can then be projected onto a satellite or the Moon. (a) If this is done with the Mount Wilson telescope, producing a 2.54 m diameter beam of 633 nm light, what is the minimum angular spread of the beam? (b) Neglecting atmospheric effects, what is the size of the spot this beam would make on the Moon, assuming a lunar distance of 3.84×10^8 m?
13. You are told not to shoot until you see the whites of their eyes. If the eyes are separated by 6.5 cm and the diameter of your pupil is 5.0 mm, at what distance can you resolve the two eyes using light of wavelength 555 nm?
14. When dots are placed on a page from a laser printer, they must be close enough so that you do not see the individual dots of ink. To do this, the separation of the dots must be less than Rayleigh's criterion. Take the pupil of the eye to be 3.0 mm and the distance from the paper to the eye of 35 cm; find the minimum separation of two dots such that they cannot be resolved. How many dots per inch (dpi) does this correspond to?
15. (a) The planet Pluto and its Moon Charon are separated by 19,600 km. Neglecting atmospheric effects, should the 5.08 m diameter Mount Palomar telescope be able to resolve these bodies when they are 4.50×10^9 km from Earth? Assume an average wavelength of 550 nm. (b) In actuality, it is just barely possible to discern that Pluto and Charon are separate bodies using an Earth-based telescope. What are the reasons for this?