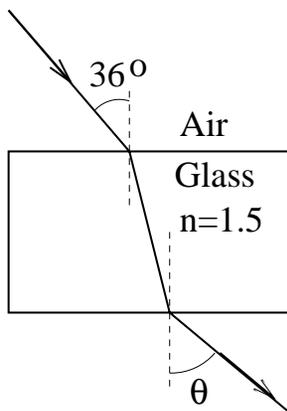


1003. A source containing a mixture of two isotopes of the same element emits light at **two** wavelengths whose average value is 495 nm and whose separation is 0.0962 nm. Find the minimum number of lines needed in a diffraction grating that can resolve these lines in second order.

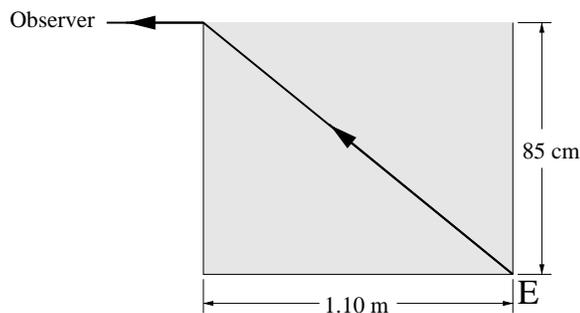
16. A ray of light goes from air into a flat block of glass (index of refraction = 1.5) at an angle of 36° with the normal to the interface. After passing through the glass, at what angle to the normal will the ray emerge into air?

- a) 67°
 b) 62°
 c) The ray won't emerge into air, because it will be totally internally reflected in the glass.
 d) 36°
 e) 23°



17. When the rectangular metal tank in the figure is filled to the top with an unknown liquid, an observer (in air) with eyes level with the top of the tank can just see the corner, *E*. What is the index of refraction of the liquid?

- a) 1.64
 b) 1.5
 c) 1.29
 d) 1.26
 e) .77



18. Which of the following quantities remains unchanged when light passes from a vacuum into a slab of glass with a 45° angle of incidence

- a) its polarization
 b) its direction of travel
 c) its frequency
 d) its wavelength
 e) its speed

19. A concave mirror forms a real image which is twice the size of the object. If the object is 20 cm from the mirror, the radius of curvature of the mirror must be about:

- a) 27 cm
 b) 40 cm
 c) 20 cm
 d) 80 cm
 e) 13 cm

20. A concave mirror has focal length $f > 0$. A real object is placed a distance $2f$ from the mirror. Then the image is

- a) Real; inverted; same size as object
 b) Virtual; upright; bigger
 c) Real; inverted; bigger
 d) Virtual; upright; smaller
 e) Real; inverted; smaller

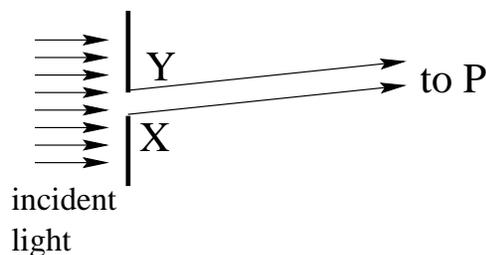
21. An object is placed 12 cm from a lens. The image is upright and one-third as big as the object. What is the focal length of the lens?

- a) +6 cm
 b) +9 cm
 c) +18 cm
 d) +3 cm
 e) -6 cm

22. In a double slit interference experiment, the angular spacing between the second and third maxima on the left is observed to be 2° . What is the ratio of wavelength to slit spacing, λ/d ?
- a) 0.91
 - b) .011
 - c) .035
 - d) 2
 - e) .5
23. Monochromatic light is normally incident on a grating which is 1 cm wide and has 10,000 slits. The first order maximum is deviated at a 30° angle. What is the wavelength of the incident light?
- a) 600 nm
 - b) 500 nm
 - c) 400 nm
 - d) 1,000 nm
 - e) 300 nm
24. A beam of X-rays is incident on a crystal whose planes of atoms have a spacing of 0.314 nm. A second-order maximum is observed for diffracted x-rays making an angle of 24.1° with the plane of atoms. What is the wavelength of these X-rays?
- a) About 0.52 nm
 - b) About 0.39 nm
 - c) About 0.13 nm
 - d) About 1.04 nm
 - e) About 0.26 nm
25. An unpolarized beam of light is incident on three parallel polarizing sheets that are lined up so that the transmission axis of each is rotated by 30° with respect to the preceding sheet. What fraction of the incident *intensity* is transmitted?
- a) $1/8$
 - b) $9/32$
 - c) $3/8$
 - d) $27/64$
 - e) $1/3$
26. A few years ago, the Metropolitan Museum of Art in New York City featured a special exhibition of the work of the Impressionist painter Georges Seurat, who used a technique called "pointillism", in which his paintings are composed of small, closely-spaced dots of pure color, each about 2 mm in diameter. From what minimum distance should the paintings be viewed to maintain the illusion of the colors blending together smoothly in the eye of the viewer? Take the pupil diameter of the eye to be 3 mm, and use a wavelength of 400 nm. (This choice is near the minimum of the visible spectrum, so as to assure that the illusion is present for all wavelengths).
- a) About 1 meter
 - b) About 15 m
 - c) About 30 meters
 - d) About 12 meters
 - e) About 500 cm
27. A camera lens is coated with a thin film to eliminate reflection of light whose wavelength is λ_A in air and λ_F in the film. The index of refraction of the film is less than that of the lens. What must the thickness of the coating be?
- a) $\lambda_F/4$
 - b) λ_F
 - c) $\lambda_A/2$
 - d) $\lambda_F/2$
 - e) $\lambda_A/4$

28. The figure shows a single slit with the direction to a point P on a distant screen. At P , the pattern has its maximum nearest the central maximum. If X and Y are the edges of the slit, what is the approximate path length difference $(PX) - (PY)$?

- 2λ
- λ
- $\lambda/2$
- $3\lambda/4$
- $3\lambda/2$



29. Three identical radio antennas, A, B, and C radiate at wavelength λ . The antennas are separated from one another by half a wavelength along an east-west line. The antennas oscillate in phase. An observer at point P along the line on which the antennas are located receives a signal with a power $1\mu W$. Then antenna B is turned off. After antenna B is turned off the power in the signal received at point P is

- not enough information to give an answer
- the same
- zero
- larger
- smaller but not zero



30. A soap film, (4×10^{-7}) m thick, is suspended in air and illuminated by white light normal to its surface. The index of refraction of the film is 1.50. Which wavelengths will be intensified in the reflected beam?

- 320 nm and 533 nm
- 400 nm and 600 nm
- 400 nm and 800 nm
- 480 nm and 800 nm
- 510 nm and 720 nm

31. Light of wavelength 440 nm passes through a double slit, yielding the diffraction pattern of intensity I versus deflection angle θ shown. What is the width, a , of each slit?

- $10\mu\text{ m}$
- $5.0\mu\text{ m}$
- $3.3\mu\text{ m}$
- $19\mu\text{ mm}$
- $42\mu\text{ m}$

