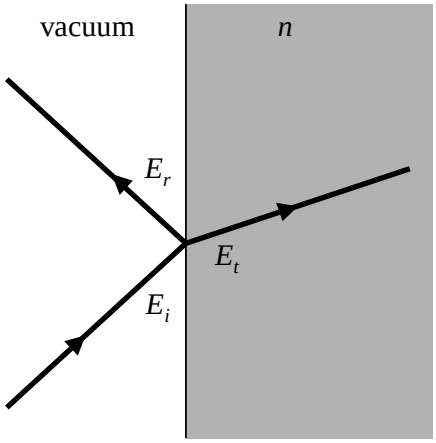
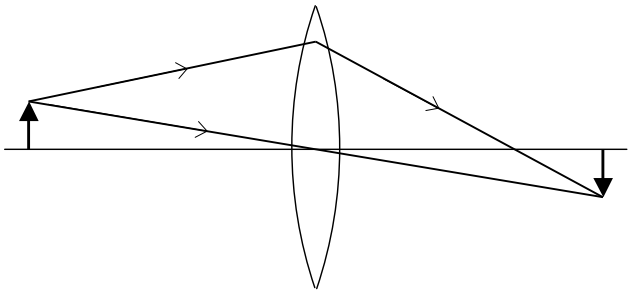
Questions



1. A plane wave in vacuum is incident on a medium of index n as shown. Here E_i, E_r, and E_t are respectively the incident, reflected, and transmitted electric fields at the surface of the medium. If no other fields or charges are present, indicate which of the statements below are definitely true:

(a) $E_i + E_r = E_t$
(b) $I_i = I_r + I_t$, where I_j is the irradiance associated with field j
(c) If n is complex, there is no transmitted field ($E_t = 0$).
(d) The polarizations of E_i, E_r and E_t all lie in the same plane.
(e) The phase velocity in the medium is lower than in vacuum.
(f) The oscillation frequency in the medium is the same as that in vacuum.
(g) The reflected field can be expressed as the field scattered by molecules in the medium.
(h) The transmitted field can be expressed as the field scattered by molecules in the medium.

2. For the imaging system shown below, the optical path length for the marginal ray is
(a) less than (b) equal to (c) greater than
that of the central ray.



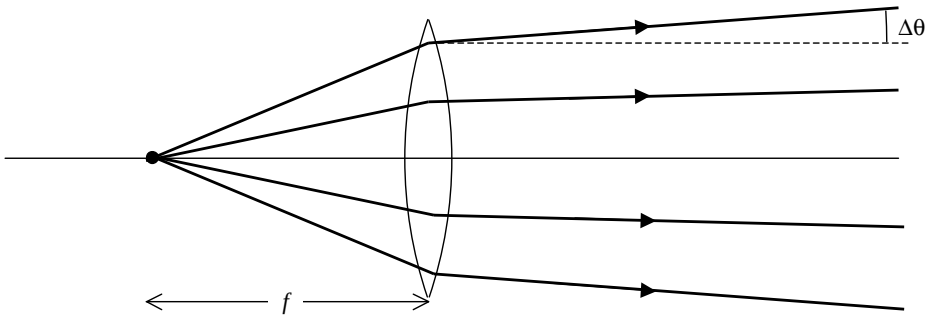
3. True or False:
An imaging system constructed using spherical mirrors will be free from chromatic aberrations.

4. True or False:
If a nonabsorbing glass plate with index of refraction n has thickness

$$t = \frac{\lambda}{n}\left(\frac{1}{8} + \frac{m}{2}\right)$$

for integer m, the total transmission through the plate will be zero for light of wavelength λ at normal incidence.

5. If light of wavelength λ is emitted by a point source and collected by an ideal thin lens of focal length f and distance $s_o = f$, the angular spread of the resulting rays $\Delta\theta$ will be of order
(a) D/f (b) λ/D (c) λ/f (d) zero, for a lens with no aberrations.



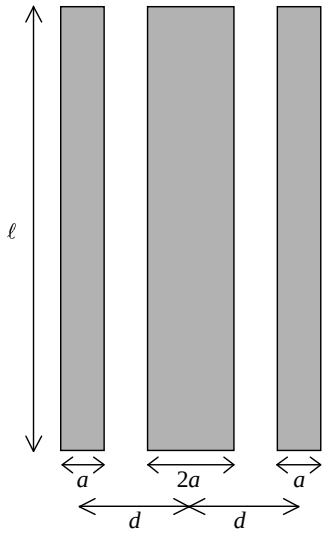
6. (i) If a plane wave encounters a circular aperture at normal incidence, the number of Fresnel zones transmitted depends on which of the following (mark all that apply):
(a) the frequency of the light
(b) the diameter of the aperture
(c) the location of the observation point

(ii) If only one zone is transmitted, the irradiance on axis will be:
(a) a maximum
(b) a minimum
(c) neither a maximum nor minimum
(d) indefinite, because additional information is required.

Problems

6. Show that when circularly polarized light is incident on an ideal polarizer, the transmission is independent of the angle of the polarizer.

7. Calculate the far field irradiance produced by diffraction from an aperture consisting of three slits as shown. The central slit has width $2a$, while the outer slits have width a. The center-to-center slit spacing is d. The slit length in the long direction is ℓ.



8. Consider an interferometer constructed from a single glass block, as shown. The three faces used for internal reflection have been coated to give a reflectance $R = 1$, while the input surface has real Fresnel coefficients r, t from air to glass, and r', t' from glass to air. Suppose that the phase shift resulting from one circuit of the block is ϕ.

(a) By energy conservation, all of the incident light must end up in the output beam. Prove this in detail by adding up the multiply reflected fields to get a total reflectance with magnitude 1.

(b) Find the phase shift between the incident and reflected beams, and sketch as a function of ϕ in the case $r \approx 1$.