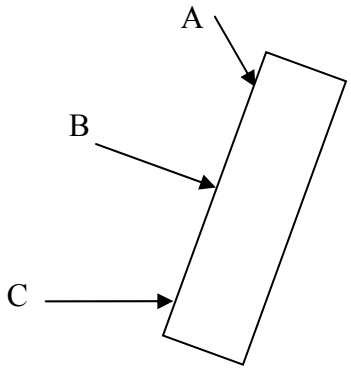
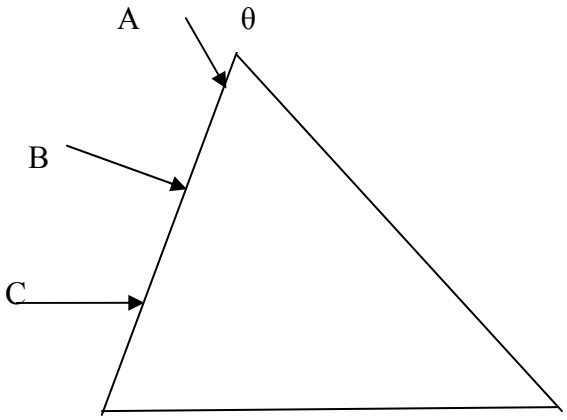
Homework #1:

Problem
Three rays are incident on the face of a plane-parallel plate of glass prism in air. Ray B is normal to the first face. Sketch the ray paths through the plate, describe and explain your answer.

Label the rays within the plate as A', B', C' and past the plate as A'', B'', and C''. No calculations are needed.



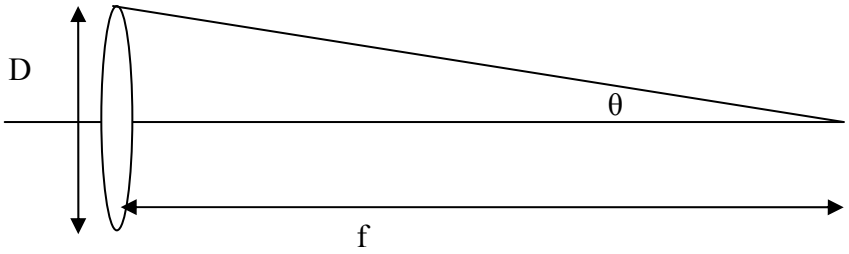
Problem
Three rays are incident on the face of a glass prism in air. The prism vertex angle is equal to the critical angle. Ray B is normal to the prism face. Sketch the ray paths, describe and explain your answer. No calculations are needed.



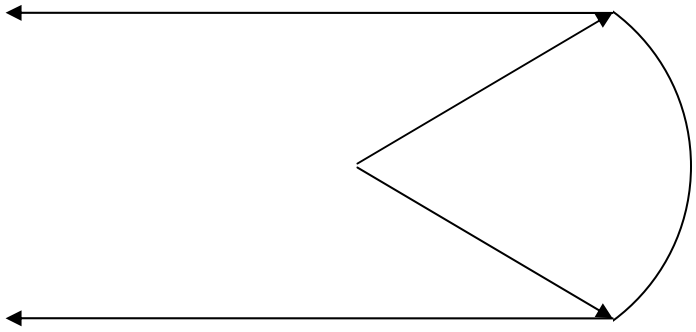
Problem

The f-number of a lens is $F/\#_{\infty} = f/D$ for an object at infinity. The numerical aperture in image space of a lens in air is $NA = \sin(\theta)$, regardless of the object conjugate. The working or effective f-number is defined as $F/\# = 1/2NA$.

Paraxial optics assumes all angles are small, and therefore $\sin(\theta) = \tan(\theta) = \theta$. At what NA is there a 1% error in the small angle approximation? What working F/#?



Problem.



The sag formula for a spherical surface, $s = \rho^2/2R_V$, approximates the surface as a parabola, where s is the sag, ρ is the radial coordinate, and R_V is the vertex radius. A

parabola converts a point source at its focus to a plane wave, but is more costly to make than a spherical surface.

A collimated beam 100 mm in diameter is required. What is the maximum wavefront error (OPD) in waves due to using a perfect F/10 spherical mirror as a collimator instead of a parabola at 633 nm (red HeNe)?

What happens to the OPD error if the F/# is held constant and the beam diameter is reduced to 50 mm?

Problem

When an autostigmatic microscope is focused on a plane mirror normal to the optical axis the spot position on the detector is the location of the optical axis on the camera. When an autostigmatic microscope is focused at the center-of-curvature of a spherical surface the point image will be at the same location on the detector as the cat's eye image.

What happens to the point image on the camera when the mirror is moved perpendicular to the axis of the microscope a distance Δx? Explain your reasoning.

Problem

The schematic autostigmatic microscope shown in class and below has some deficiencies in its design. Stray light is a big issue. What should be done about stray light?