EE119 Discussion Section 3

(02/08/10)

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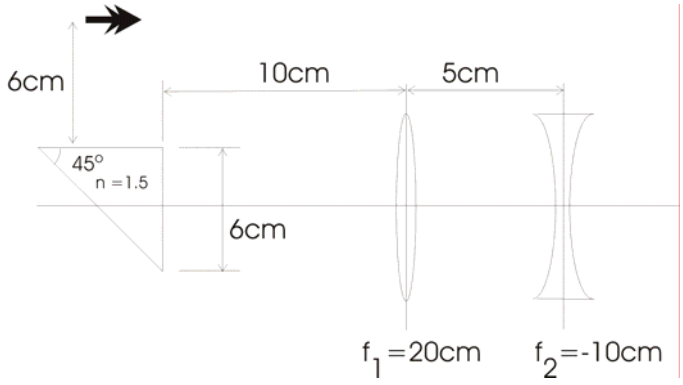
1. More on Lenses

(1) Uncle QK finds a lens on his way to the lab and wants to determine the focal length of the lens. He constructs an optical axis between a fixed object and a fixed screen, at a distance L apart (note: L is at least four times the focal length of the lens). He notices two positions of the lens that focus an image of the object on the screen, magnified in one case and reduced in the other.

a) If the two lens positions differ by a distance D, prove to Uncle QK that he can determine the focal length of the lens by $f = (L^2 - D^2)/4L$. (This is known as **Bessel's method** for finding the focal length of a lens)

b) Why does L have to be at least four times the focal length of the lens for Bessel's method to work? (i.e. prove that the minimum separation between conjugate real object and image points for a thin positive lens is 4f)

(2) For the combination of one prism and 2 lenses shown (Fig. 1), find the location and size of the final image when the object, length 1 cm, is located as shown in the figure. [Hint: Treat the prism as a mirror, but you have to take into account the image shift caused by the prism (equivalent to a glass plate of thickness 6 cm)]



2. Aperture Stop

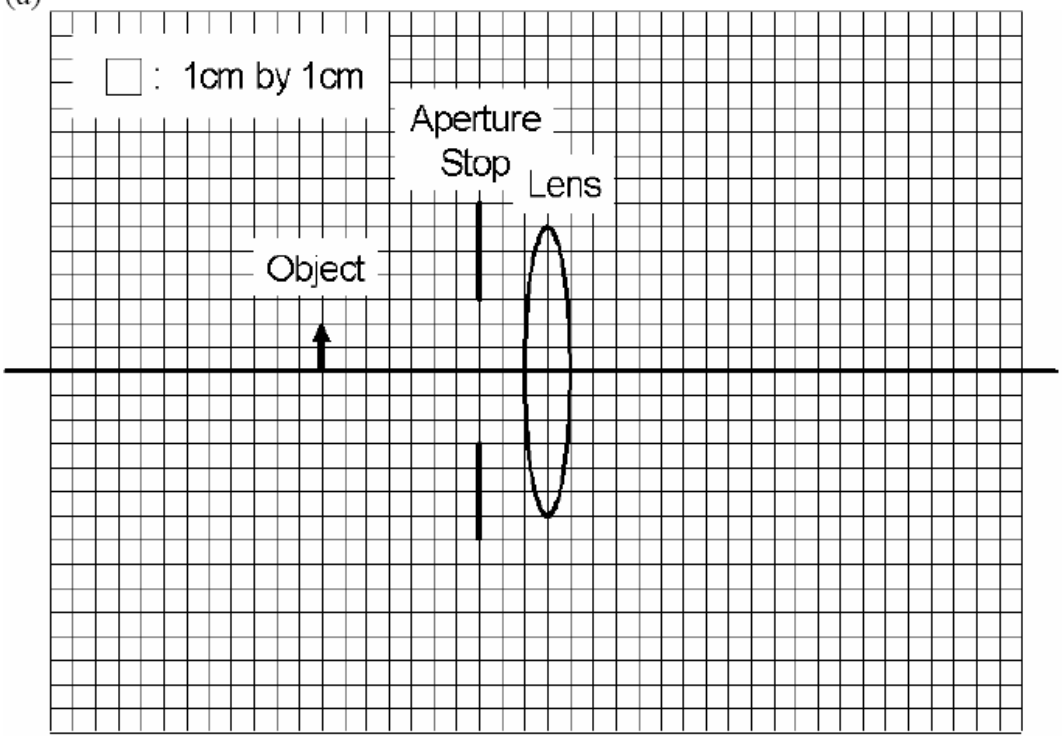
Consider the following simple imaging systems (a) (b). The focal length of the lens is f = 5cm, and the diameter of the hole in the aperture stop is D_{AS}=6cm. The object is 2cm high above the optical axis.

(a) Determine the position and size of the entrance and exit pupils.

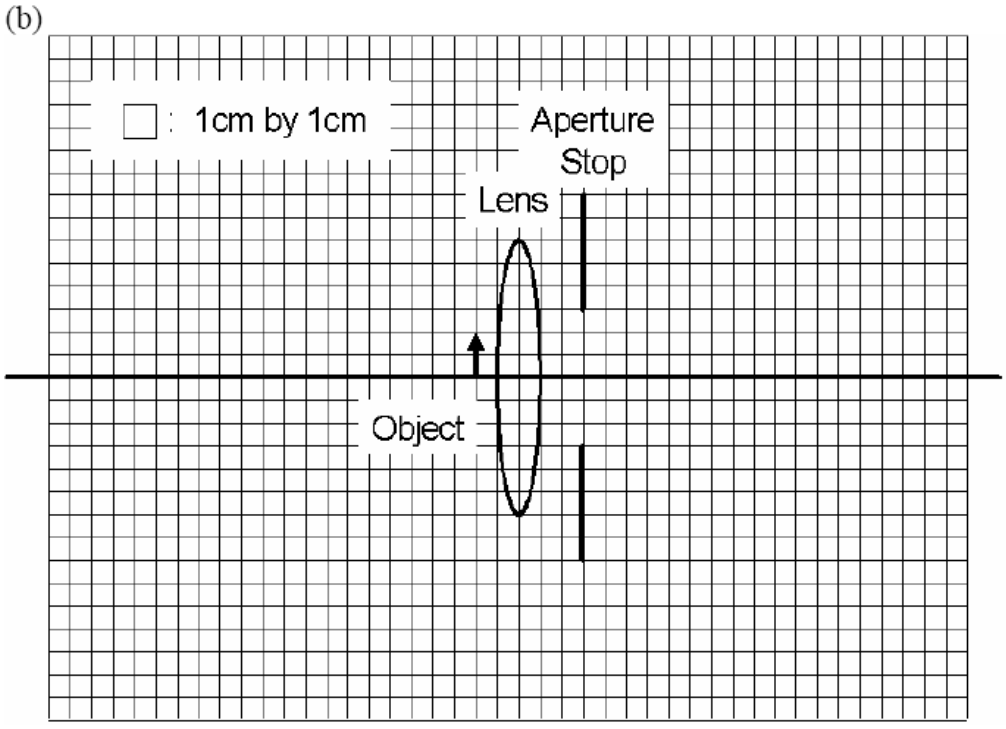
(b) Determine the position of the image point for an object point 2cm above the axis.

(c) Sketch the chief ray and two marginal rays from the tip of the object.

(a)



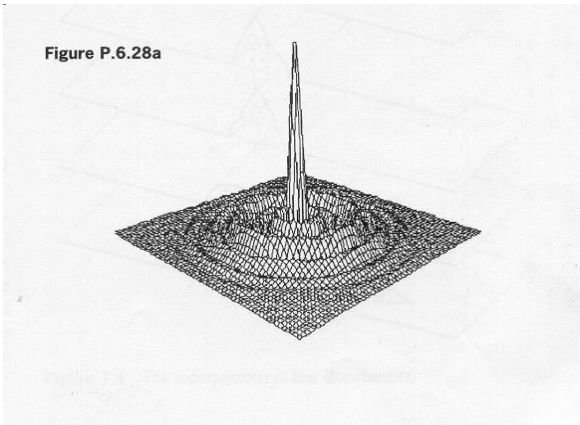
(b)

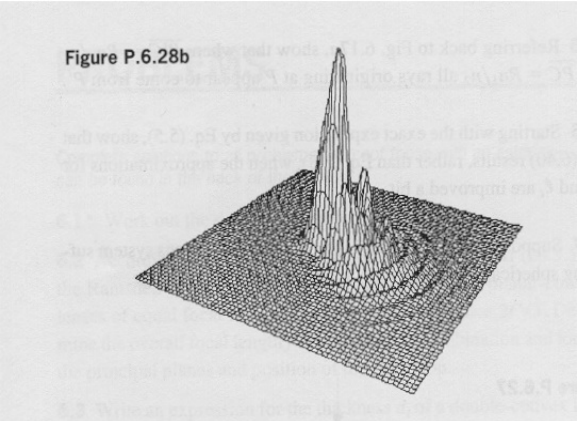


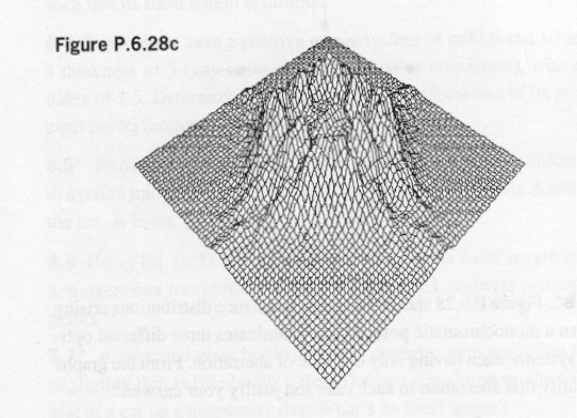
3. Aberration

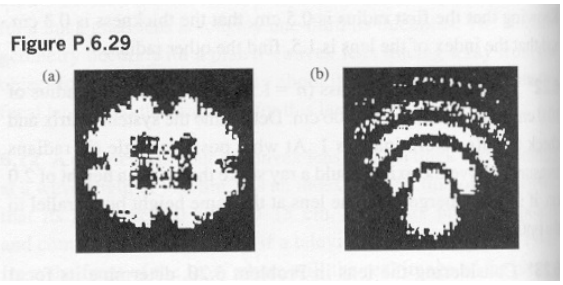
(1) [Hecht 6.28] Figure P.6.28 shows the image irradiance distributions arising when a monochromatic point source illuminates three different optical systems,

each having only one type of aberration. From the graphs identify that aberration in each case and justify your answer.









(2) [Hecht 6.29] Figure P.6.29 shows the distribution of light corresponding to the image arising when a monochromatic point source illuminates two different optically systems each having only one type of aberration. Identify the aberration in each case and justify your answer.