Geometrical Optics EOP 501
Third Exam (In Class)
11 December 2002

1. Define (3 points each)
   (a) Marginal focus of spherical aberration
   (b) Landscape lens
   (c) Caustic
   (d) Telecentric system
2. What four properties are controlled in the design of an achromatic doublet? (4 points)
3. Draw examples of barrel distortion and pincushion distortion. (2 points)
4. What are the central core and flare regions of spherical aberration? (3 points)
5. Why are transverse chromatic aberration and distortion zero for a thin lens? (4 points)

6. Answer true or false (1 point each)

   (a) **T F** For a positive thin lens with flat object field, the image field curves towards the lens.

   (b) **T F** The Petzval contribution to field curvature is zero if astigmatism is corrected.

   (c) **T F** An achromatic lens has the same focal length for all wavelengths.

   (d) **T F** Distortion and Field Curvature affect image position but not image blur (on the best focal surface).

   (e) **T F** Astigmatism can not be corrected by changing the shape of a lens.

   (f) **T F** Fourth-order spherical aberration depends on the position of the stop.

   (g) **T F** For a positive thin lens the more curved side goes toward the long (infinite) conjugate.

   (h) **T F** A thin lens has a longer focal length for red light than blue light.

   (i) **T F** Spherical aberration is a systematic variation in focus as a function of pupil radius.

   (j) **T F** The central ray for coma intersects at the edge of the geometric blur.

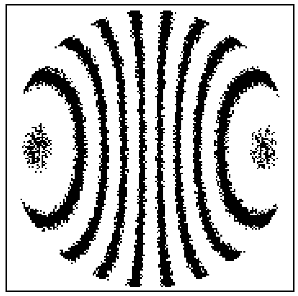
   (k) **T F** Fourth-order astigmatism has a uniformly illuminated elliptical blur spot predicted by geometrical optics.

   (l) **T F** Diffraction effects are most important when the geometrical spot size is approximately the Airy diameter.

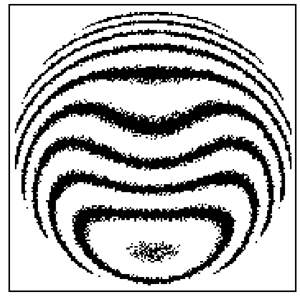
7. State Petzval's Theorem and define the Petzval sum. (4 points)

8. Given a thin lens of focal length 80 and index $n_g = 1.5$, find the radius of curvature of the image surface if the object surface is flat. (3 points)

9. Match the corresponding pictures and identify the aberration or reference pattern from the following choices: spherical aberration, coma, astigmatism, distortion, field curvature, focus, tilt, cylinder. (8 points)



A______________



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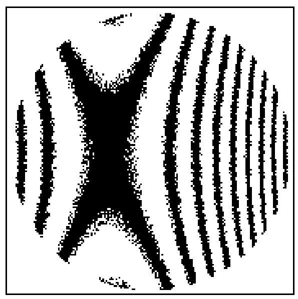

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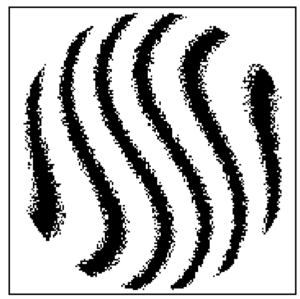

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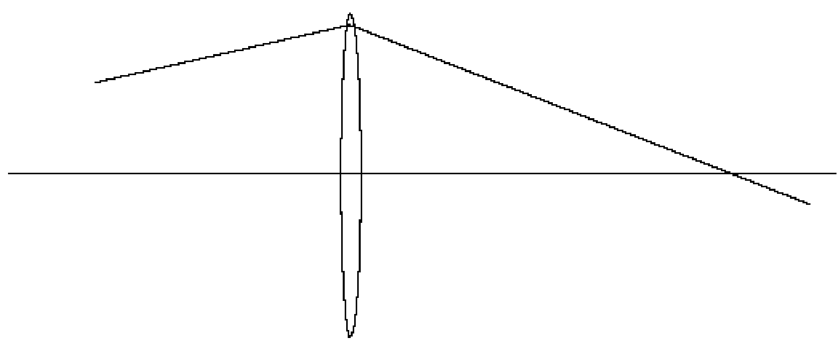
10. The figure below shows a ray path through a thin lens. Draw a single ray through the lens to locate the back focal plane. Explain your result. (5 points extra credit)



Geometrical Optics EOP 501
Third Exam (take-home)
4 December 2002

1. Use OSLO to design an f/15 landscape lens (BK7 glass) with a focal length of 55 mm and a 12° half-field of view. Fix the lens thickness at a reasonable value and vary the curvatures and distance to the stop. Show a drawing of the lens, a print-out of the lens description, the paraxial setup data, and the Seidel wavefront aberrations. Find the geometric spot size on axis and at full-field. (15 points)

2. Use OSLO to design an f/4 55-mm focal length achromatic doublet using the glasses BK7 and SK5. Assume a 4-degree half-field angle. Place the crown glass (BK7) in front. Fix the lens thicknesses at reasonable values and vary the curvatures. Show a drawing of the lens, a print-out of the lens description, the paraxial setup data, the Seidel wavefront aberrations, and chromatic ray aberrations. Plot the focal length of the lens as a function of wavelength over the range 0.4 to 0.7 μm. (15 points)

3. Given a focal shift of -1.5 mm to minimize the rms spot size for spherical aberration. Assume a pupil diameter of 24 mm, an image distance of 100 mm, and a wavelength of 0.55 μm. Find the magnitude of the spherical aberration in waves. (5 points)

4. Measurements through focus show line foci 0.8 mm apart for light of 0.63 μm. The pupil has a diameter of 20 mm and the image distance is 100 mm. Find the magnitude of the astigmatism in waves. (5 points)

5. Given an f/4 concave spherical mirror with a focal length of 55 mm. Find the radius of curvature of the mirror and the wavefront aberrations for a distant point object at a 4-degree half-field angle. Assume a wavelength of 0.5876 μm for this calculation. You can use OSLO for this problem. How do the wavefront aberrations compare to the achromatic doublets designed previously? (5 points)