MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Mechanical Engineering

2.71/2.710 Optics
Spring 2014

Quiz 1

Monday, March 3, 2014

PLEASE DO NOT TURN OVER UNTIL EXAM STARTS

DURATION: 80min (9:35–10:55)

TOTAL PAGES: 3

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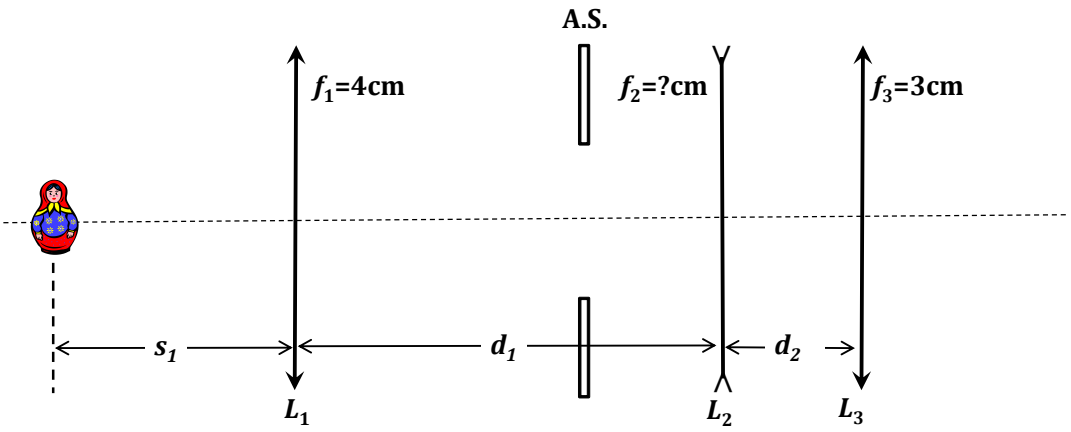
1. You are given an optical system that is composed of two converging (L_1, f_1=4cm and L_3, f_3=3cm) and one diverging lens (L_2, f_2 unknown). The lens L_2 is placed to the right of L_1 with a gap of d_1=6cm and L_3 is placed to the right of L_2 by a gap of d_2=1.4cm. By doing experiments, you found that the 3 lenses in combination is *afocal*, that is, rays that enter parallel emerge parallel.



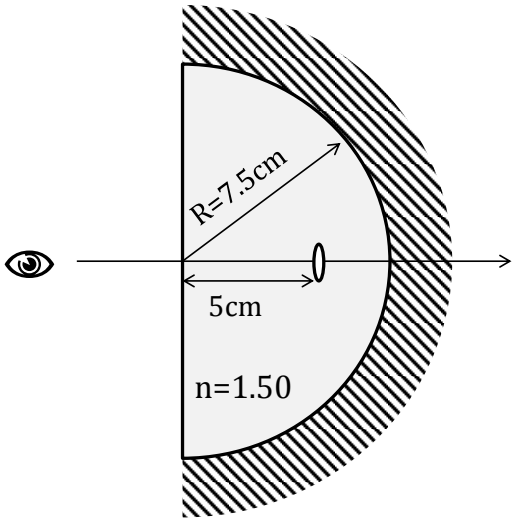
a) **(20 points)** Assuming all elements are thin lenses, calculate the focal length f_2 of the diverging lens L_2 to satisfy the requirement.

b) **(10 points)** Calculate the angular magnification power of the telescope system.

c) **(10 points)** For a doll placed at 4cm in front of lens L_1, locate the image of the doll behind the lens L_3.

d) **(20 points)** An aperture (AS) is placed inside the system, at a distance of **4.5cm** to the right of the lens f_1. For the image in part c), please locate the entrance pupil and exit pupil, and calculate the size of the aperture for numerical aperture NA=0.25.

2. **Silvered Glass Hemisphere:** A glass hemisphere is silvered over its curved surface. A tiny air bubble in the glass is located on the central axis through the hemisphere, 5cm from the plane surface. The radius of curvature of the hemisphere is 7.5cm, and the glass has index of refraction of 1.50. We may assume paraxial imaging condition throughout the problem.



a) (10 points) For an array of parallel beam normally incident from the flat side of the hemisphere, geometrically find the focal point of the combined system by ray tracing.

b) (10 points) Looking along the axis into the plane surface, one sees two images of the bubble. Where do they appear?

c) (10 points) Calculate the effective focal length of the optical system.

d) (10 points, 2.710 only) Locate the principle planes.

GOOD LUCK!

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