University of Calgary
Winter semester 2008

PHYS 471: Optics

Homework assignment 3

Due Wednesday, February 27, 2008

Problem 3.1. Parallel rays are focused by a convex lens of focal length f with the optical axis oriented at angle α to these rays. At which point will the rays converge?

Problem 3.2. A laser field of length λ ns propagate through a Fresnel biprism with the apex angle α. Find the period of the interference fringes behind the prism if the index of glass is n.

Problem 3.3. Is a person who can see normally in water near- or far-sighted? Explain your answer.

Problem 3.4. A telescope has lenses of focal lengths $F = 500$ mm, $f = 10mm$.

a) What is the distance between lenses if the telescope is aligned to function normally (the image of distant stars is located infinitely far away)?

b) What distance between the lenses is needed to make a car located 100 m away appear 2 m away?

c) A nearsighted person who normally wears prescription lenses of optical power -2 Diopters looks through this telescope at distant stars without glasses. What distance should be set between the lenses to make the stars appear at his far point? What will the magnification of the telescope be in this case?

Problem 3.5. Light propagates from air into glass at normal incidence through a flat layer of water. Find the fraction of energy that will enter the glass

a) neglecting interference

b) taking interference into account and assuming that the waves reflected from both interfaces interfere destructively. Find the thickness of the water layer required for such destructive interference.

Compare your answer with the situation when the light enters glass directly from air. Neglect double reflection. The index of glass is $n_g = 1.5$, water $n_w = 1.33$.

Problem 3.6. In class, we found that two lenses placed directly against each other are equivalent to a single lens with optical power equal to the sum of the optical powers of the components. Verify this finding by determining the final image distance for a system of two concave lenses with focal lengths f_1 and f_2.

Problem 3.7. A biconvex glass lens is placed horizontally onto water surface, so that its top surface (curvature radius R_1) is in air, and bottom (curvature radius R_2) in water. What is the focal length of this lens? Is it the same for rays propagating from water into air and the other way? All indices of refraction are known.

Problem 3.8. A microscope has objective lens with $f_o = 5$ mm and an eyepiece with $f_e = 25$ mm. The lenses are separated by $L = 150$ mm. By using rules for constructing images of thin lenses, find the magnification of the microscope and the distance between the object and the objective lens such that the final image is located $s'' = 250$ mm behind the eyepiece. Compare your magnification with the equation $M \approx Ls''/(f_o f_e)$ derived in class.

Problem 3.9. A person with normal eyesight is trying to enhance the magnification of the microscope of the previous problem by wearing glasses. She can choose between $\mathcal{D}_1 = 5$ Diopters and $\mathcal{D}_2 = -5$ Diopters. Which should she choose? What will be the new magnification? Assume that the glasses are placed directly in front to the eyepiece, and that the final image is located at the same position as in Problem 3.8.

The midterm examination will take place on Friday, February 29, instead of a lecture. Open book setting.