February 17, 1999

P360 - Optics

Alex R. Dzierba

Instructions for Exam I:

- this is a 50-min in-class exam
- show all your work on these sheets
- you may use your text (Hecht) and notes
- please print your name below
- Part 1 is worth 50 points and consists of 5 short questions
- Part 2 is worth 50 points and consists of 2 problems

You can also take a copy of this exam and work the problems at a more liesurely pace. If as a result you want to change your answers to any of the questions/problems please send me an e-mail by 5 pm Friday with your amended answers. You must 'show your work' as well. I will take this into consideration in grading the exam. You may attach a text file as part of the e-mail - as long as I can read it on my Mac.

Name (please print)

Part 1

Question 1

Suppose that the playing area of a football field is entirely covered by a panel painted in black. On a perfectly sunny day, with no shadows on the field, give a rough estimate of the force (in newtons) exerted on the panel by radiation pressure from the Sun.

Question 2

We have two lenses. One is a positive meniscus with the radii of curvature being 5 cm and 10 cm made of a glass with index of refraction 1.5. The second lens is a plano-concave lens with radius of curvature 6 cm and made of glass with index of refraction 1.6. The two lenses are in direct contact. What is the effective focal length of the pair?

Question 3

In case 1 you see an upright image of yourself in a spherical mirror. In case 2 you see your image inverted using the same mirror.

(a) Qualitatively describe the mirror and briefly give the reason for your answer.

(b) In case 1 you want to take a picture of your image with a camera. Should you focus the camera on a point in front of or in back of the mirror? Answer the same question for case 2.

Question 4

An electric dipole is located at the origin and lies in the x-y with its axis parallel to the x direction. The dipole is oscillating and emitting electromagnetic radiation. Consider a circle centered at the dipole and of radius D where D >> dimensions of the dipole.

(a) Where along the circle is the time-averaged magnitude of the electric field associated with the radiation a maximum ?

(b) For the locations you find in the answer to part (a), what is the orientation of the electric field?

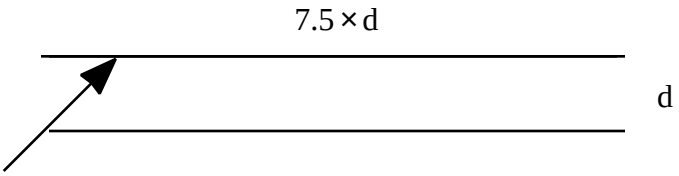
(c) For the locations you find in the answer to part (a), what is the orientation of the associated magnetic field?

Question 5

A laser beam enters a channel made by two parallel planar mirrors separated by distance d. The length of the channel is $7.5 \times d$. The light enters at a 45^{o} angle with respect to the top mirror and just misses the bottom mirror. The mirrors reflect 95 % of the light.

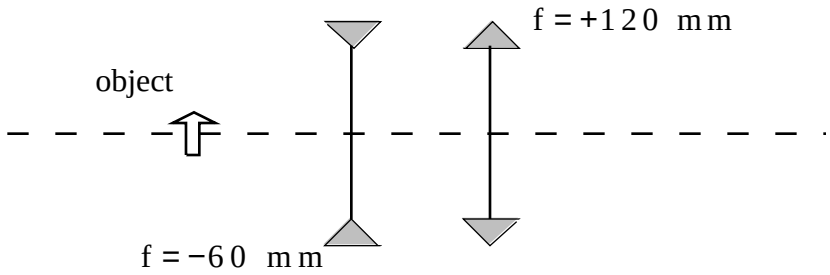
(a) Describe the direction of the light beam as it leaves the channel.

(b) If the initial intensity of the beam is I_o, what is the intensity as it leaves the channel?



Problem 1 (25 points)

The two lenses shown below are separated by 120 mm. An object is placed 180 mm in front of the diverging lens. The goal is to find the position and magnification of the image using the matrix technique. Explain what you are doing at each step.



Problem 2 (25 points)

Points A and B are fixed. A light ray travels from A to B by bouncing off a mirror. The distance from point A to the mirror is d and from B to the mirror is D. Find an expression for the time of travel in terms of x and then use the Principle of Least Time to show that the angle of incidence equals the angle of reflection.