Physics 108 Midterm Exam  (Spring of 2006)

1. **Thick lens**

   A *thick* plano-concave lens (as shown below) in the air is used to image an object placed at a distance $s_0 = 35$ cm in front of the first surface of the lens.

   ![Diagram of a thick lens](image)

   (1) (15 points) Treating the lens as two separate refractive surfaces, find the location of the image after refraction at the second surface by using the refraction equation $\frac{n_1}{s_0} + \frac{n_2}{s_i} = \frac{(n_2 - n_1)}{R}$ repeatedly;

   (2) (15 points) Find the $A'B'C'D'$-matrix for this thick lens;

   (3) (10 points) Using the $A'B'C'D'$-matrix, find the location and linear magnification of the image after refraction at the second surface.

2. **Curved mirror  (Reflector on the right side of a car)**

   A 0.4-m object is placed at $s_0 = 10$ m in front of a spherically curved mirror with radius of curvature $R = + 20$ m as shown below.

   ![Diagram of a curved mirror](image)

   (1) (10 points) Find the location and the linear size of the image

   (2) (10 points) If you are 2 m away from the curved mirror and look into the mirror, what is the angular size of the image?

   (3) (10 points) If the curved mirror is replaced by a flat mirror and again you are 2 m in front of the mirror looking into the mirror, is the angular size of the image larger or smaller than that in Part (2)?
3. **Interference**

A collimated monochromatic light beam with a wavelength $\lambda = 0.0005$ mm uniformly illuminates a pair of long parallel thin slits (identical in width) in $x$-direction. The two slits are separated by $d = 0.1$ mm. A screen is placed at a long distance $L = 1$ m away and is parallel to $x$-$y$ plane. The apparatus is in air.

(1) (10 points) Find the intensity of the light at the center of the screen, namely at $y = 0$ on $z$-axis in terms of the intensity when one of the slits is blocked;

(2) (10 points) Find the separation between two neighboring intensity maxima along $y$-axis near the center of the screen;

(3) (10 points) Now you gradually add a positive phase $\phi$ to the light that passes through the top slit (by for example tilting the illuminating beam upward). As $\phi$ increases from 0 to $+10\pi$, determine the direction and the magnitude of the movement of the interference pattern on the screen.