Homework Set #8 **Due: 5-21-12**

(1) pinhole camera

In the following you may wish to refer to Figure 4.24. Let the distance between the object plane and pinhole plane be s_o and the distance between the pinhole plane and observing screen be s_i. Let the diameter of the pinhole be a. Assume paraxial conditions. Except for part (a), work with an object point that is on axis.

(a) What is the magnification, m? Follow standard sign conventions.

(b) Neglecting diffraction and using ray optics only, the object point is "imaged" onto an illuminated circle of what diameter d?

(c) According to ray optics alone, choosing a small pinhole diameter will yield a smaller d, improving image quality at the cost of less light reaching the screen and a longer exposure time. However, if a is small enough, diffraction effects will produce a diffraction pattern as big as the diameter d, greatly reducing image quality.

The first minimum in the diffraction pattern from a round pinhole is approximately given by: $a \sin\theta = 1.22\,\lambda$. Here θ is the angle of the line extending from the center of the pinhole to the diffraction minimum. Let's guess that a reasonable way to include the effect of diffraction is to define the actual diameter of the illuminated circle on the screen as: $D = d + 2w$, where w is the distance from the center of the circle to the diffraction minimum. Find the pinhole diameter that gives you the smallest D.

(d) For 550 nm light, an object distance of 10 m and a magnification of -1/100, what is the minimum D possible?

(2) text 4.44

(3) text 4.45

(4) text 5.4

(5) text 5.5

(6) test 5.6