(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 \( \theta \) 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