PHY385H1F – "Introductory Optics"

Term Test 2 November 10, 2011 Duration: 50 minutes

NAME:_____ **Student Number:**_____.

Aids allowed: A pocket calculator with no communication ability. "Optics" 4th Edition (Copyright 2002) by Eugene Hecht. Up to 2 single-sided pages (8.5"×11") with hand-written notes.

Possibly helpful information:

The speed of light in a vacuum is $c = 3.00 \times 10^{8}$ m s^{-1}
Planck's constant is $h = 6.626 \times 10^{-34}$ J s
Boltzmann's constant is $k_B = 1.38 \times 10^{-23}$ J K^{-1}
The index of refraction of air is $n_{air} = 1.000$

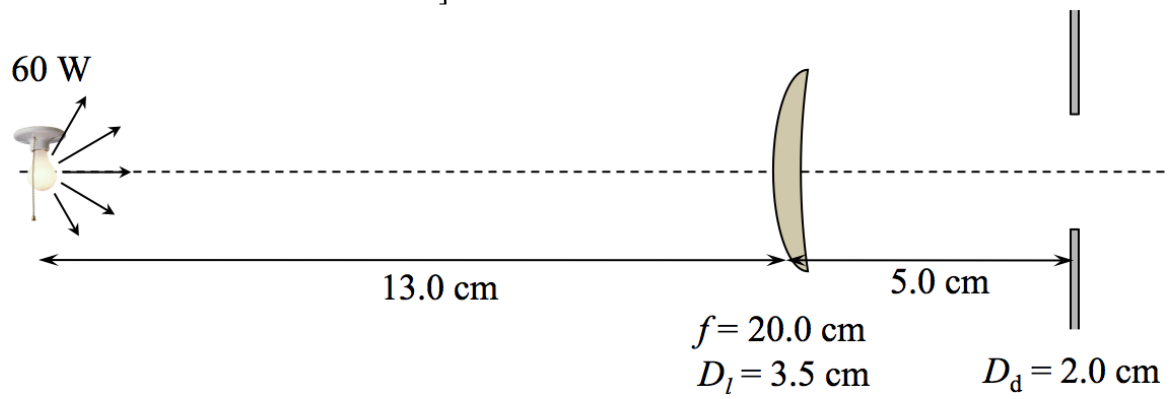
You may not communicate with anyone other than the invigilator during the test.

Please complete the following problems in the examination booklet provided. Show all your work, and if there is a final answer, please draw a box around it.

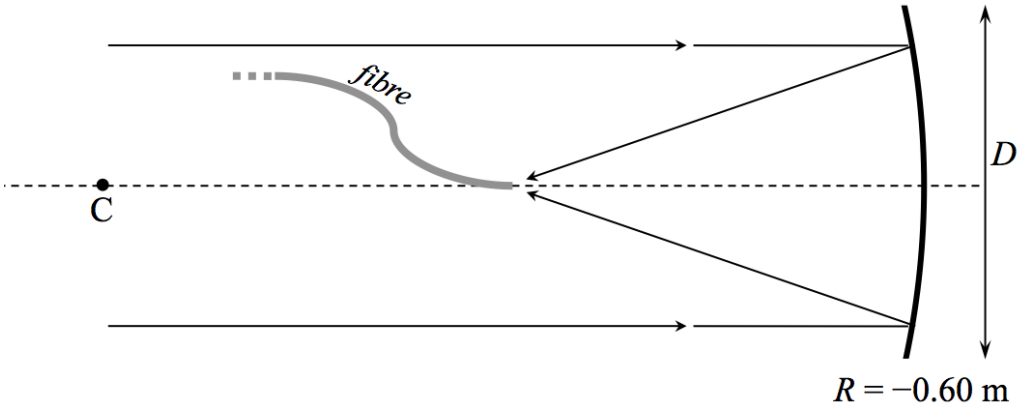
Total Possible Points: 20

1. A mosquito is embedded in a spherical piece of amber whose diameter is 14.5 cm. A researcher (in air) observes that the mosquito *appears* to be 2.5 cm below the surface of the amber, and it *appears* to have wings that are 0.8 cm in length. Correcting for the refraction at the surface of the amber, which has an index of refraction of 1.546,
(a) [**2 points**] what is the true depth of the mosquito below the surface of the amber?
(b) [**2 points**] what is the true length of the mosquito's wings?

2. A 60 Watt point-source of light is placed $s_o = 13.0$ cm in front of a thin lens of diameter $D_l = 3.5$ cm and focal length $f = 20.0$ cm. A circular diaphragm with diameter $D_d = 2.0$ cm is located 5.0 cm behind the lens, as shown.
(a) [**2 points**] Assuming the circular diaphragm is the aperture stop, what is the location of the entrance pupil relative to the lens, and diameter of the entrance pupil?
(b) [**2 points**] In this situation, which is the *effective* aperture stop: the lens itself or the circular diaphragm?
(c) [**2 points**] How much power passes through both the lens and the diaphragm? [Assume no losses due to reflections at the surfaces of the thin lens.]



3. (a) [**1 point**] Determine the numerical aperture of a single clad optical fibre, given that the core has an index of 1.58 and the clad 1.52.
(b) [**1 point**] When immersed in air, what is the maximum acceptance angle of this fibre?
(c) [**3 points**] The tip of this fiber is placed at the prime focus of a spherical concave mirror, as shown. The object is very distant ($s_o \to \infty$) so the incoming rays are parallel. The radius of curvature of this mirror is R = –0.60 m. What is the maximum useful diameter D of this mirror so that all of the rays that reflect off the mirror enter the core of the fibre and are propagated along its length?



4. (a) [**1 point**] At what wavelength does a blackbody at 6000 K radiate the most per unit wavelength?
(b) [**4 points**] If the blackbody is a 1 mm diameter hole in a cavity radiator at this temperature, find the power radiated through the hole in the narrow wavelength region: λ = 550-551 nm.