

## Physics 108 Midterm Exam

(Spring of 2018)

### 1. **Thin lens:**

A thin lens made with a material of refractive index  $n_c = 1.376$  and radii of curvature  $R_1 = + 7.3$  mm and  $R_2 = + 5.6$  mm is submerged in water. The refractive index of water is  $n_w = 1.333$ .

- (a) **(15 points)** Find the image location of a real object in the water *infinitely* far away from the lens.
- (b) **(10 points)** If the left side of the lens is in contact with air instead water and the right side is still in contact with water, find the image location of a real object in air infinitely far away from the lens.

### 2. **Thin lens:**

You have a converging thin lens with focal length  $f = 5$  cm.

- (a) **(15 points)** If you want to form a real image from a real object of  $y_0 = 1$  cm such that the image is 10 times as large as the object, where should you place the object from the lens?
- (b) **(15 points)** If you want to form a virtual image from a real object such that the image is 20 times as large as the object, where should you place the object from the lens?
- (c) **(extra 6 points)** If you view the object immediately behind the lens, can you see a clear image in Part (b) (explain your answer instead of just yes or no)? If you can, what is the angular size of the image?

### 3. **Mirror and Magnifying glass:**

A simple telescope is made of a concave mirror with a radius of curvature  $R = - 250$  cm and a magnifying glass with a focal length  $f_e = + 2.5$  cm.

- (a) **(10 points)** On the Earth, the angular size of the Moon is 0.5 degree or 0.0085 radians to an unaided eye. What is the image size of the Moon at the focal plane of the concave mirror?
- (b) **(10 points)** If you view the image of the Moon on the focal plane of the mirror with the magnifying glass, what is the angular size of the Moon?

### 4. **Gap between a pair of glass slides**

You have a pair of square glass slides that have the dimension of 2 cm  $\times$  2 cm. Along one edge, the slides are pressed together with no gap. Along the opposite edge, the slides are pressed together but separated by a spacer. This makes a wedge-shaped gap between the slides.

- (a) **(10 points)** If the spacer is 0.1 mm thick, what is the spacing of the interference fringes if you view the slides near normal incidence?
- (b) **(10 points)** If the spacer thickness is unknown, but you count 20 fringes from one edge to the other edge, what is the thickness of the spacer?
- (c) **(5 points)** If you fill the gap in Part (b) with water and view the slide at  $45^\circ$  from the normal, how many fringes can you see now?