Physics 108 Midterm Exam (Spring of 2021)

1. ***Thin lens combination***

(**20 points**) You have two thin glass lenses. Their focal lengths in air are $f^{(1)}$ and $f^{(2)}$, respectively. When they are placed closely so that the distance between them can be neglected, show that they act as one thin lens with a focal length f give by

$$\frac{1}{f} = \frac{1}{f^{(1)}} + \frac{1}{f^{(2)}}$$

2. ***Glass ball***

A glass ball has refractive index n_g = 1.5 and radius R = 3 cm. In air, a 1-mm high object is placed at a distance 3 cm in front of the ball. The object and the glass ball center define the optical axis for this imaging system.

(a) (**10 points**) Find the image of the object after refraction at the front surface;

(b) (**10 points**) Find the image of the object after refraction at the rear surface;

(c) (**10 points**) Find the size and orientation of the final image after refraction at the rear surface.

3. ***Mirror***

You have a concave mirror with radius of curvature |r| = 4 cm. A small object of 1 mm in height can be placed anywhere in front of the mirror.

(a) (**10 points**) What is the largest angular size of the object if you view it directly and clearly without the mirror ?

(b) (**10 points**) Find the linear size of the image when you place the object 1.9 cm in front of the mirror;

(c) (**10 points**) When you are 4 cm in front of the mirror, what is the angular size of the image that appears to you now ?

4. **Air gap between a pair of glass slides**

A pair of glass slides are pressed together to form a uniform air gap of 5 μm in thickness. The gap is illuminated with a monochromatic light at λ_0 = 0.5 μm. Intensities of reflected light from two surfaces of the gap are same by themselves.

(a) (**10 points)** When the illumination is at normal incidence from the air, show that the intensity of the reflected light from the air gap is zero;

(b) (**10 points**) Find the angle of illumination from the air at which the intensity of the reflected light from the gap reaches its first maximum;

(c) (**Extra 10 points**) When a white light illuminates the gap at normal incidence, at what wavelengths between 0.4 μm and 0.7 μm the reflected light appears bright?