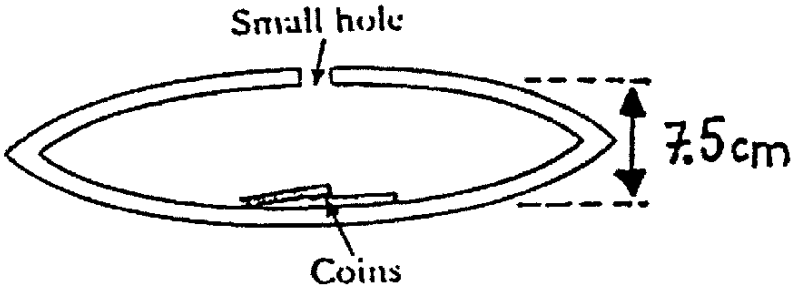
Physics 2P51 Assignment 3

Due: Friday, March 2, 2018 in drop box across from MC B210a by 12:00 noon.

1. Show, using graphical ray tracing that:
   (a) when a real object lies between the center of curvature and the focal length of a concave mirror that the image is real, inverted and magnified.
   (b) for a convex mirror, with a real object, the image is virtual, erect and reduced in size.

2. A floating coin illusion consists of two mirrors, each having a radius of curvature of 15cm, facing each other so that their centers are 7.5 cm apart.



   (a) Use the matrix method to find the locations of the first and second principal planes of the system. Assume the light reflects first from the top mirror, and do not be concerned by the fact that it has a hole in its center. Show the positions of h_1 and h_2 on a scale diagram.
   (b) Show that if a few coins are placed on the lower mirror, an image is formed at the small opening at the center of the top mirror.

3. In forming the image of an axial point object a $+4.0\text{m}^{-1}$ lens with a diameter of 6.0 cm gives a longitudinal spherical aberration of +1.0 cm. If the object is 50.0 cm from the lens determine the diameter of the blurred image at the paraxial focus.

4. A pinhole is placed 40 cm to the left of a spherical thin lens. A real image is formed 20 cm to the right of the lens. A cylinder is then added to the lens and a horizontal line image is formed 10 cm to the right of the two lenses. What is the power and orientation of the cylinder? (Assume the cylinder is thin, and is placed in contact with the spherical lens).

5. (a) An achromatic doublet consists of two positive lenses separated by 8.0 cm. The first lens has a focal length of 12.0 cm. What is the focal length:
      i. Of the second lens?
      ii. Of the whole system?
   (b) What are the required focal lengths of a crown lens and a flint lens placed in contact to produce an achromat of the same equivalent power? ($V_{crown} = 58.8$, $V_{flint} = 29.0$).

6. Two thin lenses, 5.0 cm in diameter each and of focal lengths +10 cm and +6.0 cm, respectively, are placed 4.0 cm apart. An aperture stop 2 cm in diameter is set halfway between the lenses. Find the diameters of the entrance pupil and the exit pupil. **NOTE: Do this problem by calculation and by graphical ray tracing.**