2.71/2.710 Optics   **Spring '14**
Problem Set #1   Posted Feb. 10, 2014 — Due Tuesday, Feb. 18, 2014

1. **(Modified from Pedrotti 2-2)** In the xy- plane, we need to design a glass (index of refraction n=1.5) refracting surface to form a 'perfect' image of an object. The object is placed in air, on the optical axis, 20cm from the vertex of the glass surface. The conjugate image point forms 10cm inside the glass.

   a. Assume the origin of the coordinates is at the object point, find the equation of the refracting surface.

   b. Plot the surface together with sample rays.

2. Your ice-cream spoon can be used as a concave mirror, which forms an image half the size of the object. Then, you moved the spoon with respect to the object, to produce an image that is one third (1/3) the size of the object. If the spoon moved 2.5cm in this process, how far has the image moved? What is the focal length of the spoon concave mirror?

3. A horse is 2.25 m tall, and it stands with its face 15 m away from the plane of a thin lens camera whose focal length is 3 m.
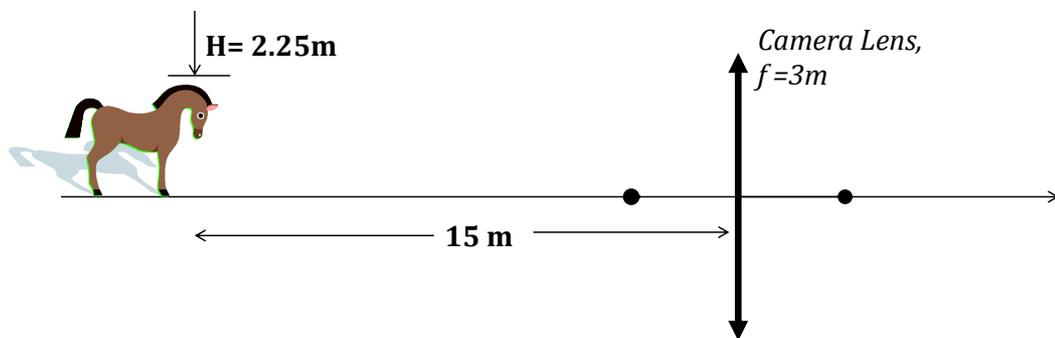
   (a) Determine the location of the image of the nose of the horse. Assume the height of the nose to be 2.25m.

   (b) What is the orientation of the image in the x and z direction? What is the magnification?

   (c) How tall is the image?

   (d) If the tail of the horse is located 17.5 m from the lens, how long is the image of the horse (from nose to the tail)?

4. A prism pair is used to expand or shrink a beam in one dimension without deflecting its angle, as shown here. The pair consists of two identical prisms with wedge angle α and the refractive index n. The beam enters each prism at normal incidence to the front surface. As a model of the beam, it is useful to consider parallel rays as shown.
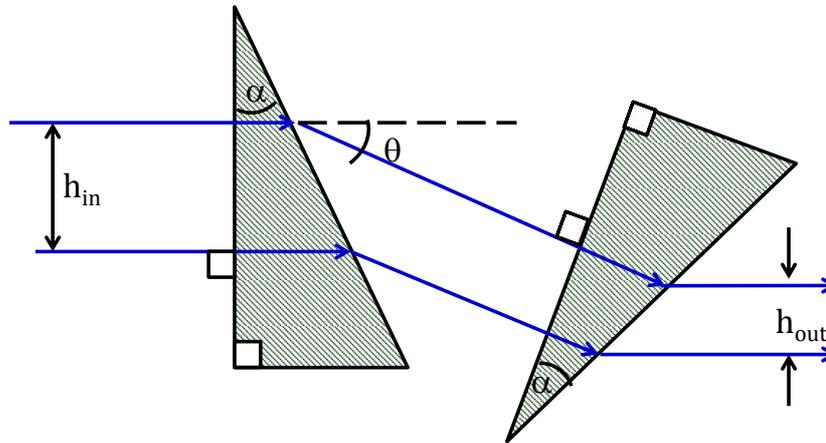
a. Write down an expression that relates the deflection angle θ after the first prism to wedge angle α and refractive index n.

b. By how much is the beam reduced after the first and second prism? Write your answer in terms of n and α only.

5. (**Pedrotti 3-16**) A telephoto lens consists of a combination of two thin lenses having focal lengths of +20cm and -8cm, respectively. The lenses are separated by a distance of 15cm. Determine the focal length of the combination, distance from the negative lens to the film plane, and the image size of a distant object subtending an angle of 2° at the camera.

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