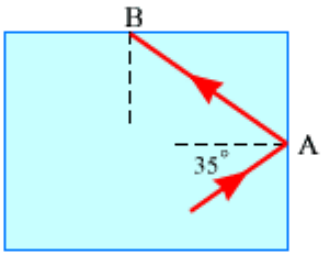
Problem set 1
Due date: 15th Rabi Althani

Problem 1:

The drawing shows a rectangular block of glass (n_g = 1.52) surrounded by air. A ray of light starts out within the glass and travels toward point A, where some or all of it is reflected toward point B. At which points does some of the light escape the glass?

(a) Only at point A
(b) Only at point B
(c) At both points A and B
(d) At neither point A nor point B



Write your answer in detail.

Problem 2:

A small object is placed 20 cm from the first of a train of three lenses with focal lengths, in order, of 10, 15 and 20 cm. The first two lenses are separated by 30 cm and the last two by 20 cm. Calculate the final image position relative to the last lens and its linear magnification relative to the original object when (a) all three lenses are positive, (b) the middle lens is negative, (c) the first and last lenses are negative. Provide ray diagram for each case.

Problem 3:

A convex thin lens with refractive index of 1.50 has a focal length of 30 cm in air. When immersed in a certain transparent liquid, it becomes a negative lens with a focal length of 188 cm. Determine the refractive index of the liquid.

Problem 4:

In about 1965, engineers at the Toro Company invented a gasoline gauge for small engines, diagrammed in (Fig 43 p. 1134). The gauge has no moving parts. It consists of a flat slab of transparent plastic fitting vertically into a slot in the cap on the gas tank. None of the plastic has a reflective coating. The plastic projects from the horizontal top down nearly to the bottom of the opaque tank. Its lower edge is cut with facets making angles of 45o with the horizontal. A lawnmower operator looks down from above and sees a boundary between bright and dark on the gauge. The location of the boundary, across the width of the plastic, indicates the quantity of gasoline in the tank. Explain how the gauge works. Explain the design requirements, if any, for the index of refraction of the plastic.