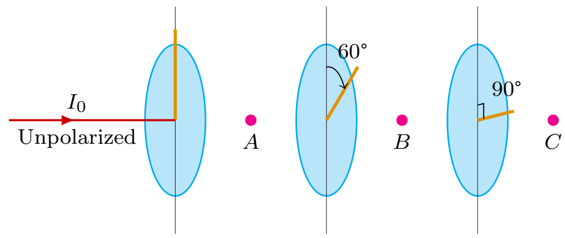
3 Mirrors, Lenses, and Polarization

8/16:

1) Young and Freedman (2019): Problem 33.29.

A beam of unpolarized light of intensity I_0 passes through a series of ideal polarizing filters with their polarizing axes turned to various angles as shown in the following figure.

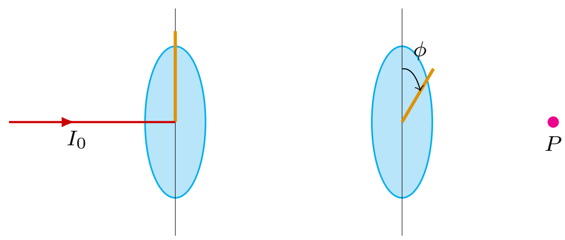


(a) What is the light intensity (in terms of I_0) at points A, B, and C?

(b) If we remove the middle filter, what will be the light intensity at point C?

2) Young and Freedman (2019): Problem 33.30.

Light of original intensity I_0 passes through two ideal polarizing filters having their polarizing axes oriented as shown in the following figure. You want to adjust the angle ϕ so that the intensity at point P is equal to $I_0/10$.



(a) If the original light is unpolarized, what should ϕ be?

(b) If the original light is linearly polarized in the same direction as the polarizing axis of the first polarizer the light reaches, what should ϕ be?

3) Young and Freedman (2019): Problem 34.40.

A converging lens with a focal length of 12.0 cm forms a virtual image 8.00 mm tall, 17.0 cm to the right of the lens. Determine the position and size of the object. Is the image erect or inverted? Are the object and image on the same side or opposite sides of the lens? Draw a principal-ray diagram for this situation.

4) Young and Freedman (2019): Problem 34.43.

Combination of Lenses I. A 1.20 cm-tall object is 50.0 cm to the left of a converging lens of focal length 40.0 cm. A second converging lens, this one having a focal length of 60.0 cm, is located 300.0 cm to the right of the first lens along the same optic axis.

(a) Find the location and height of the image (call it I_1) formed by the lens with a focal length of 40.0 cm.

(b) I_1 is now the object of the second lens. Find the location and height of the image produced by the second lens. This is the final image produced by the combination of lenses.

5) Young and Freedman (2019): Problem 34.69.

You are in your car driving on a highway at 25 m/s when you glance in the passenger-side mirror (a convex mirror with radius of curvature 150 cm) and notice a truck approaching. If the image of the truck is approaching the vertex of the mirror at a speed of 1.9 m/s when the truck is 2.0 m from the mirror, what is the speed of the truck relative to the highway?

6) Young and Freedman (2019): Problem 34.77.

   (a) You want to use a lens with a focal length of 35.0 cm to produce a real image of an object, with the height of the image twice the height of the object. What kind of lens do you need and where should the object be placed?

   (b) Suppose you want a virtual image of the same object, with the same magnification — what kind of lens do you need, and where should the object be placed?

7) Young and Freedman (2019): Problem 34.86.

   An object is placed 22.0 cm from a screen.

   (a) At what two points between object and screen may a converging lens with a 3.00 cm focal length be placed to obtain an image on the screen?

   (b) What is the magnification of the image for each position of the lens?

8) Young and Freedman (2019): Problem 34.90.

   Two Lenses in Contact.

   (a) Prove that when two thin lenses with focal lengths f_1 and f_2 are placed *in contact*, the focal length of the combination is given by the relationship

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

   (b) A converging meniscus lens has an index of refraction of 1.55 and radii of curvature for its surfaces of magnitudes 4.50 cm and 9.00 cm. The concave surface is placed upward and filled with carbon tetrachloride (CCl_4), which has $n = 1.46$. What is the focal length of the CCl_4-glass combination.

9) We start out with vertically polarized light. This light then passes through a stack of N sheets of Polaroid. The first sheet has its transmission axis oriented $90^\circ/N$ from the vertical. Subsequent sheets are oriented such that each is rotated by $90^\circ/N$ relative to the one before it, so that the last sheet is oriented horizontally. Show that in the limit as $N \to \infty$, there will be *no* loss of intensity through the stack.