Tutorial 3 Problems

A selection of the following problems were done:

Workbook (2nd edition)
Chapter 23:
4–9, 11–13, 15, 17

23 Ray Optics

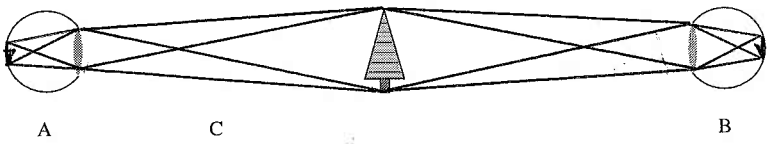
Note: Please use a ruler or straight edge for drawing light rays.

23.1 The Ray Model of Light

1. If you turn on your car headlights during the day, the road ahead of you doesn't appear to get brighter. Why not?

There is already much more light scattered from the road to your eye from the ambient day light.

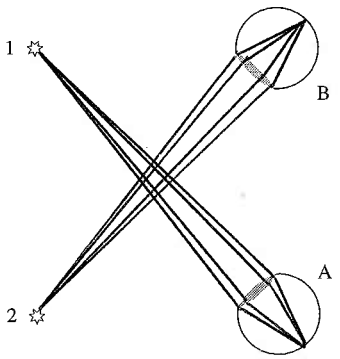
2. a. Draw four or five rays from the object that allow A to see the object.
   b. Draw four or five rays from the object that allow B to see the object.



   c. Describe the situations seen by A and B if a piece of cardboard is lowered at point C.

Light from the tree to A will be blocked by the cardboard. Light from the tree to B will not.

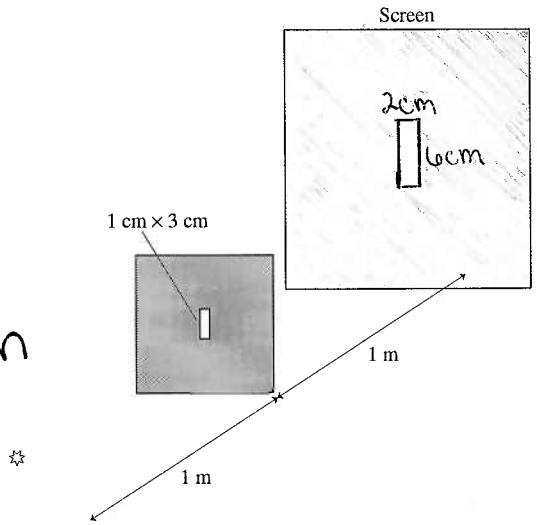
3. a. Draw four or five rays from object 1 that allow A to see object 1.
   b. Draw four or five rays from object 2 that allow B to see object 2.
   c. What happens to the light where the rays cross in the center of the picture?



Nothing happens. The light passes through in both directions.

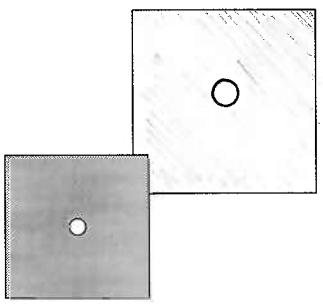
4. A point source of light illuminates a slit in an opaque barrier.
   a. On the screen, sketch the pattern of light that you expect to see. Let the white of the paper represent light areas; shade dark areas. Mark any relevant dimensions.
   b. What will happen to the pattern of light on the screen if the slit width is reduced to 0.5 cm?

The pattern on the screen is also narrowed.

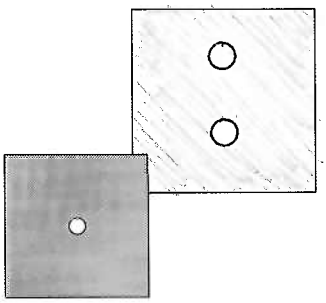


5. In each situation below, light passes through a 1-cm-diameter hole and is viewed on a screen. For each, sketch the pattern of light that you expect to see on the screen. Let the white of the paper represent light areas; shade dark areas.

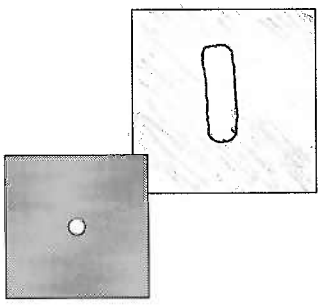
a.



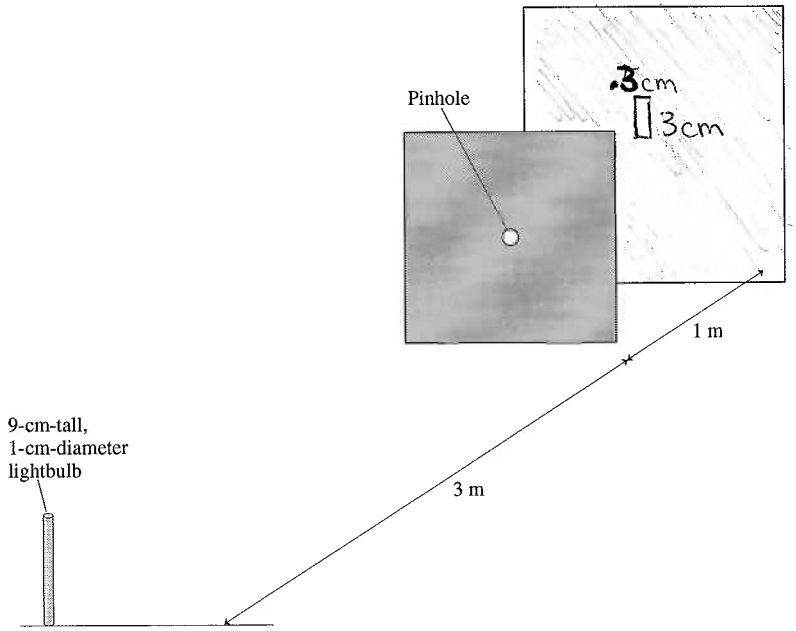
b.



c.

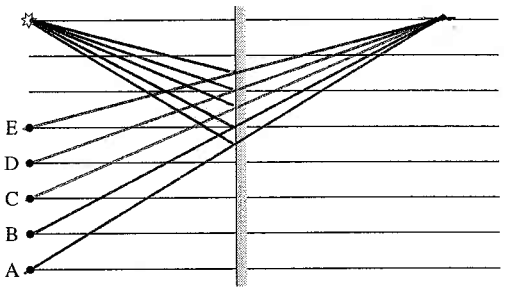


6. Light from a bulb passes through a pinhole. On the screen, sketch the pattern of light that you expect to see.



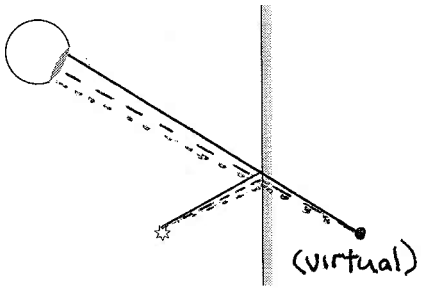
23.2 Reflection

7. a. Draw five rays from the object that pass through points A to E after reflecting from the mirror. Make use of the grid to do this accurately.
   b. Extend the reflected rays behind the mirror.
   c. Show and label the image point.



8. a. Draw *one* ray from the object that enters the eye after reflecting from the mirror.
   b. Is one ray sufficient to tell your eye/brain where the image is located?

No.

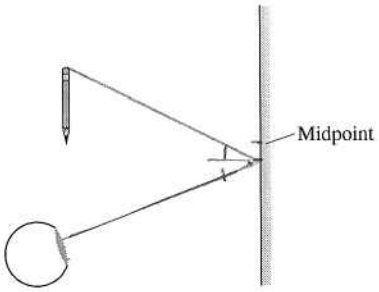


   c. Use a different color pen or pencil to draw two more rays that enter the eye after reflecting. Then use the three rays to locate (and label) the image point.
   d. Do any of the rays that enter the eye actually pass through the image point?

No.

9. You are looking at the image of a pencil in a mirror.
   a. What happens to the image you see if the top half of the mirror, down to the midpoint, is covered with a piece of cardboard? Explain.

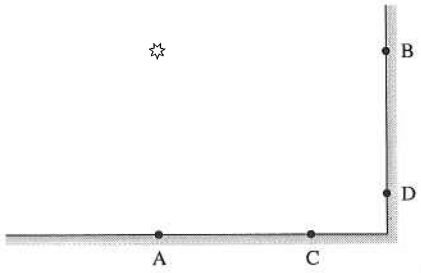
Nothing, the reflected rays from the top half do not reach your eyes.



   b. What happens to the image you see if the bottom half of the mirror is covered with a piece of cardboard? Explain.

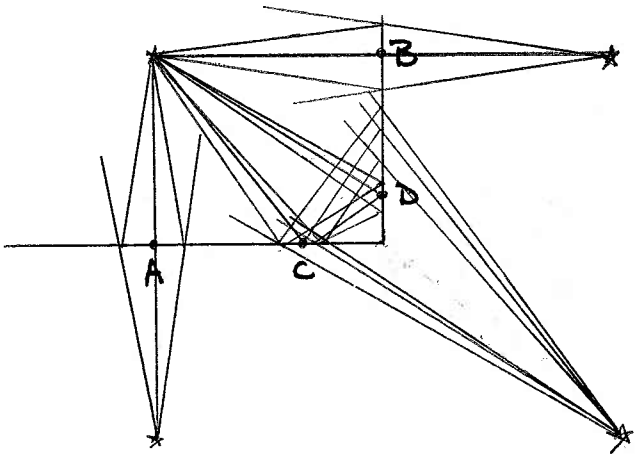
The image is no longer present. The rays from the pencil that would have reached your eye via the mirror are blocked.

10. The two mirrors are perpendicular to each other.
    a. *Use a ruler* to draw a ray directly from the object to point A. Then draw two rays that strike the mirror about 3 mm (1/8 in) on either side of A. Draw the reflections of these three rays, making sure each obeys the law of reflections, then extend the reflections either forward or backward to locate an image point.



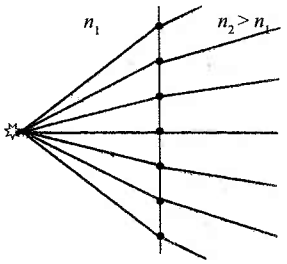
    b. Do the same for points B, C, and D.
    c. How many images are there, and where are they located?

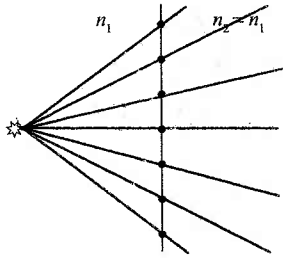
3 images, see sketch

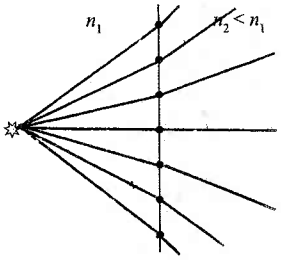


23.3 Refraction

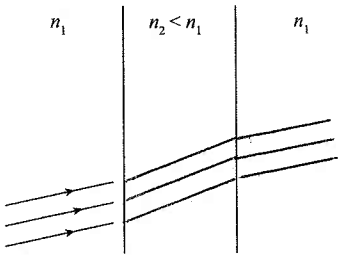
11. Draw seven rays from the object that refract after passing through the seven dots on the boundary.

a. 

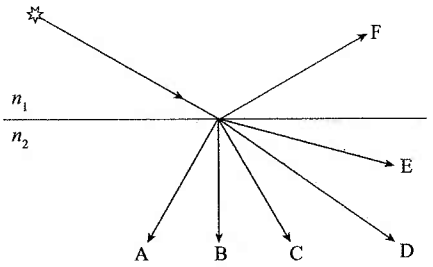
b. 

c. 

12. Complete the trajectories of these three rays through material 2 and back into material 1. Assume $n_2 < n_1$.



13. The figure shows six conceivable trajectories of light rays leaving an object. Which, if any, of these trajectories are impossible? For each that is possible, what are the requirements of the index of refraction n_2?



Impossible A, B

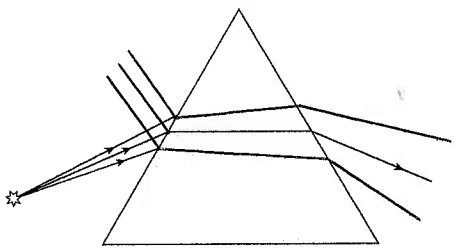
Requires $n_2 > n_1$ C

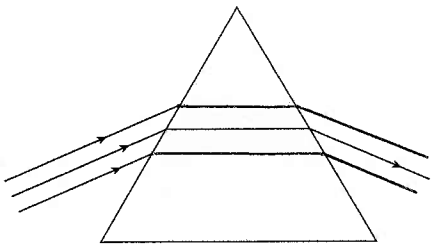
Requires $n_2 = n_1$ D

Requires $n_2 < n_1$ E

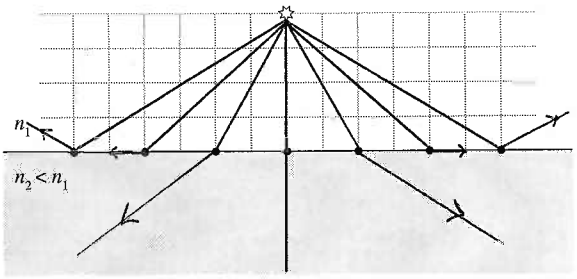
Possible for any $n_2 \neq n_1$ F

14. Complete the ray trajectories through the two prisms shown below.

a. 

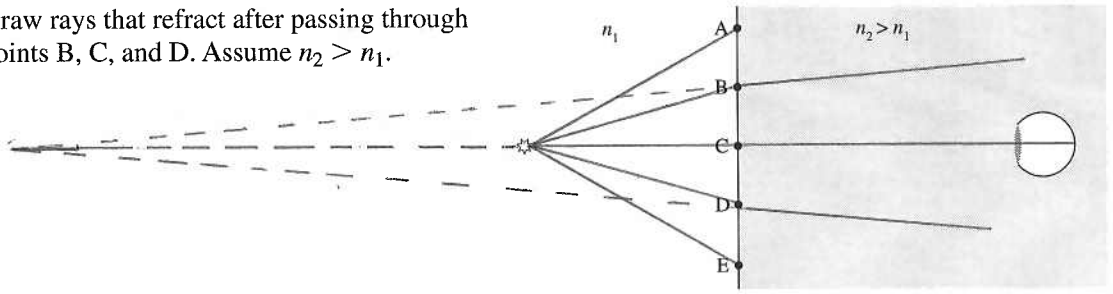
b. 

15. Draw the trajectories of seven rays that leave the object heading toward the seven dots on the boundary. Assume $n_2 < n_1$ and $\theta_c = 45°$.



23.4 Image Formation by Refraction

16. a. Draw rays that refract after passing through points B, C, and D. Assume $n_2 > n_1$.



b. Use dashed lines to extend these rays backward into medium 1. Locate and label the image point.

c. Now draw the rays that refract at A and E.

d. Use a different color pen or pencil to draw three rays from the object that enter the eye.

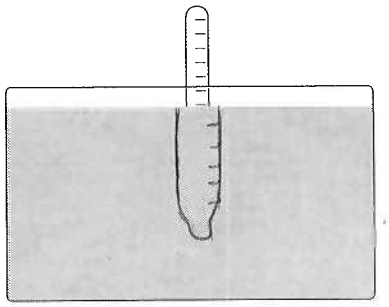
e. Does the distance to the object *appear* to be larger than, smaller than, or the same as the true distance? Explain.

The distance appears to be larger than the true distance. The image point is behind the object.

17. A thermometer is partially submerged in an aquarium. The underwater part of the thermometer is not shown.

a. As you look at the thermometer, does the underwater part appear to be closer than, farther than, or the same distance as the top of the thermometer?

It appears to be closer.



b. Complete the drawing by drawing the bottom of the thermometer as you think it would look.