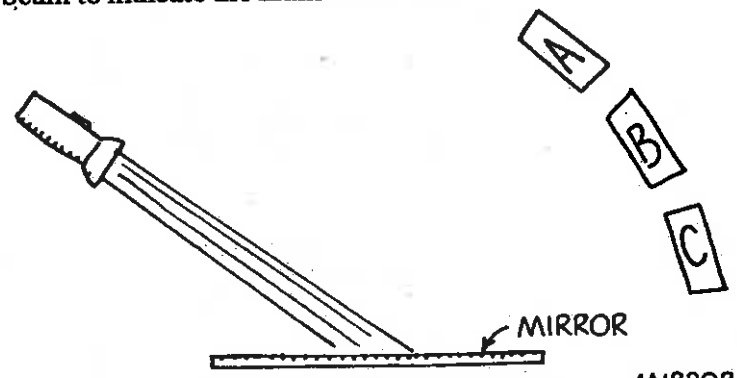
Name Period Date

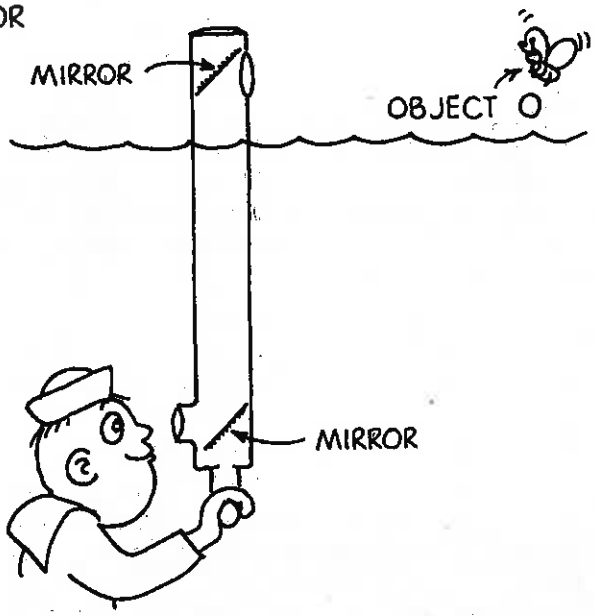
Concept-Development Practice Page 29-1

Reflection

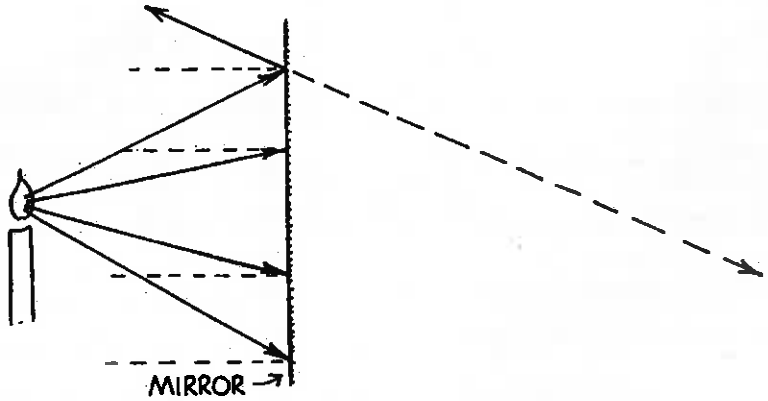
1. Light from a flashlight shines on a mirror and illuminates one of the cards. Draw the reflected beam to indicate the illuminated card.



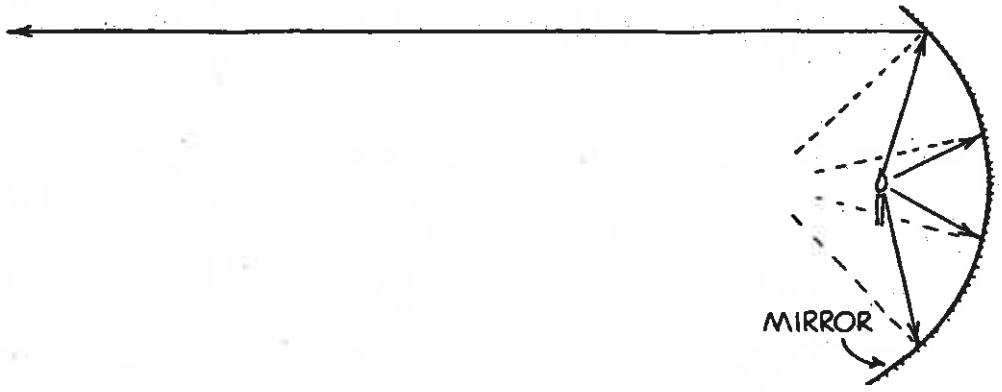
2. A periscope has a pair of mirrors in it. Draw the light path from the object "O" to the eye of the observer.

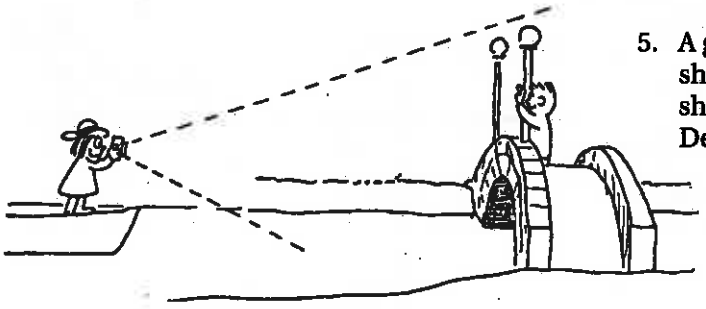


3. The ray diagram below shows the extension of one of the reflected rays from the plane mirror. Complete the diagram by (1) carefully drawing the three other reflected rays, and (2) extending them behind the mirror to locate the image of the flame. (Assume the candle and image are viewed by an observer on the left.)

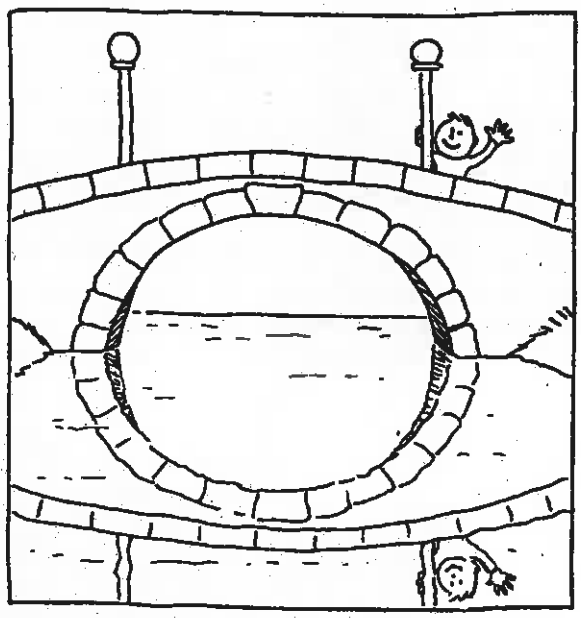


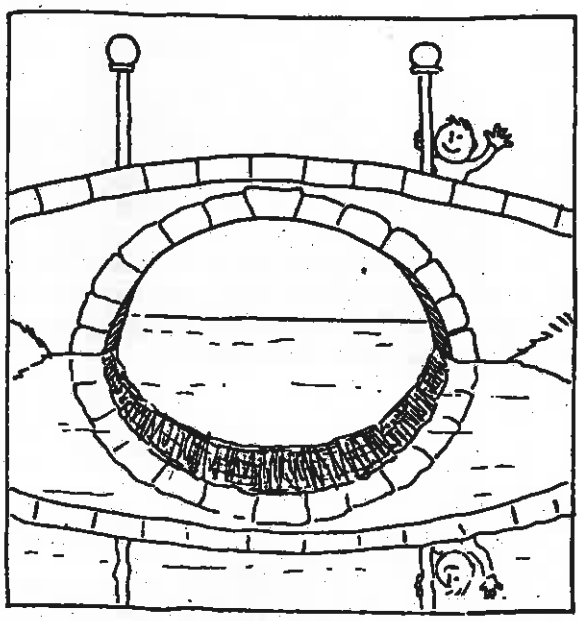
4. The ray diagram below shows the reflection of one of the rays that strikes the parabolic mirror. Notice that the law of reflection is obeyed, and the angle of incidence (from the normal, the dashed line) equals the angle of reflection (from the normal). Complete the diagram by drawing the reflected rays of the other three rays that are shown. (Do you see why parabolic mirrors are used in automobile headlights?)





5. A girl takes a photograph of the bridge as shown. Which of the two sketches correctly shows the reflected view of the bridge? Defend your answer.





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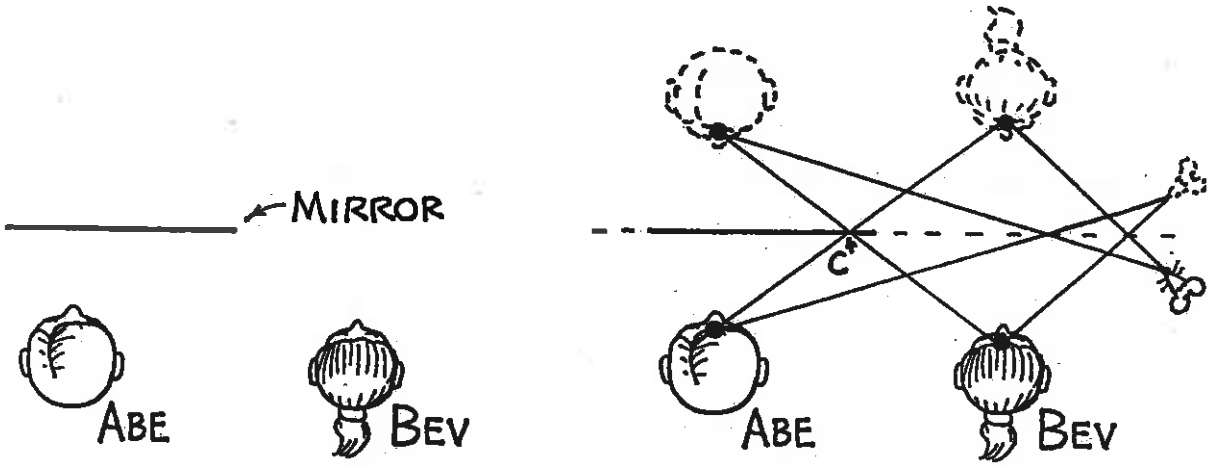
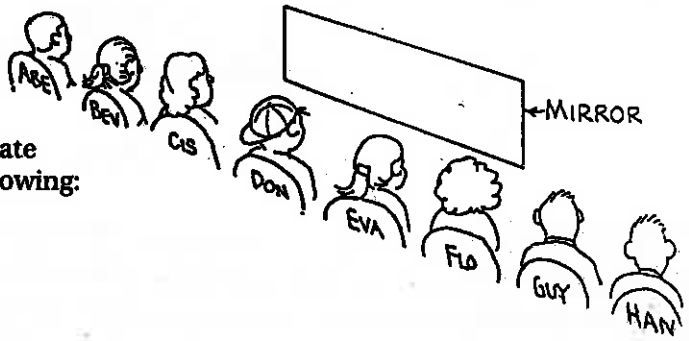
Reflection



Abe and Bev both look in a plane mirror directly in front of Abe (left, top view). Abe can see himself while Bev cannot see herself—but can Abe see Bev, and can Bev see Abe? To find the answer we construct their artificial locations "through" the mirror, the same distance behind as Abe and Bev are in front (right, top view). If straight-line connections intersect the mirror, as at point C, then each sees the other. The mouse, for example, cannot see or be seen by Abe and Bev.

Here we have eight students in front of a small plane mirror. Their positions are shown in the diagram below. Make appropriate straight-line constructions to answer the following:



ABE BEV CIS DON EVA FLO GUY HAN

Who can Abe see? _____ Who can Abe not see? _____
Who can Bev see? _____ Who can Bev not see? _____
Who can Cis see? _____ Who can Cis not see? _____
Who can Don see? _____ Who can Don not see? _____
Who can Eva see? _____ Who can Eva not see? _____
Who can Flo see? _____ Who can Flo not see? _____
Who can Guy see? _____ Who can Guy not see? _____
Who can Han see? _____ Who can Han not see? _____

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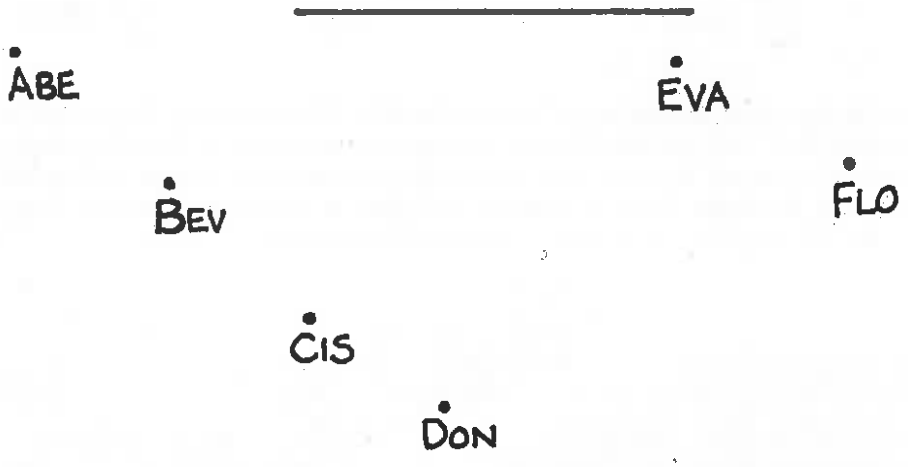
thanx to Marshall Ellenstein

Six of our group are now arranged differently in front of the same mirror. Their positions are shown below. Make appropriate constructions for this more interesting arrangement, and answer the questions below.



Who can Abe see? _____ Who can Abe not see? _____

Who can Bev see? _____ Who can Bev not see? _____

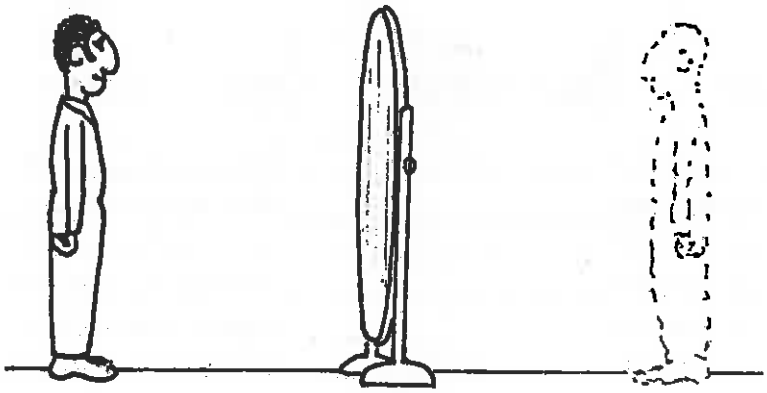
Who can Cis see? _____ Who can Cis not see? _____

Who can Don see? _____ Who can Don not see? _____

Who can Eva see? _____ Who can Eva not see? _____

Who can Flo see? _____ Who can Flo not see? _____

Harry Hotshot views himself in a full-length mirror (right). Construct straight lines from Harry's eyes to the image of his feet, and to the top of his head. Mark the mirror to indicate the minimum area Harry uses to see a full view of himself.



Does this region of the mirror depend on Harry's distance from the mirror?

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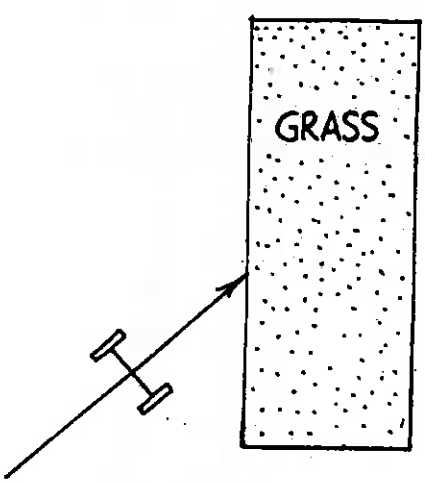
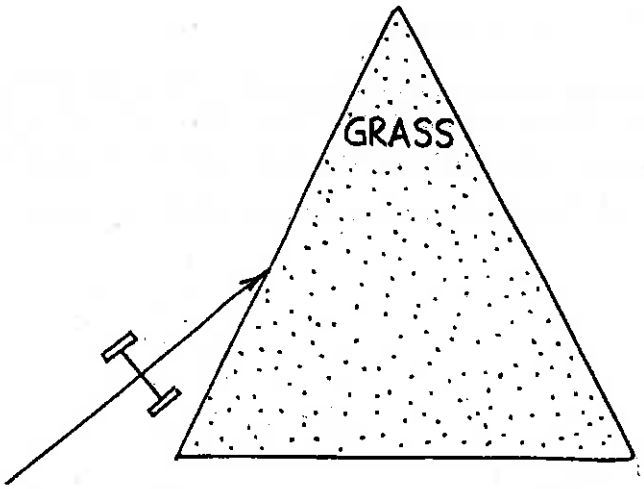
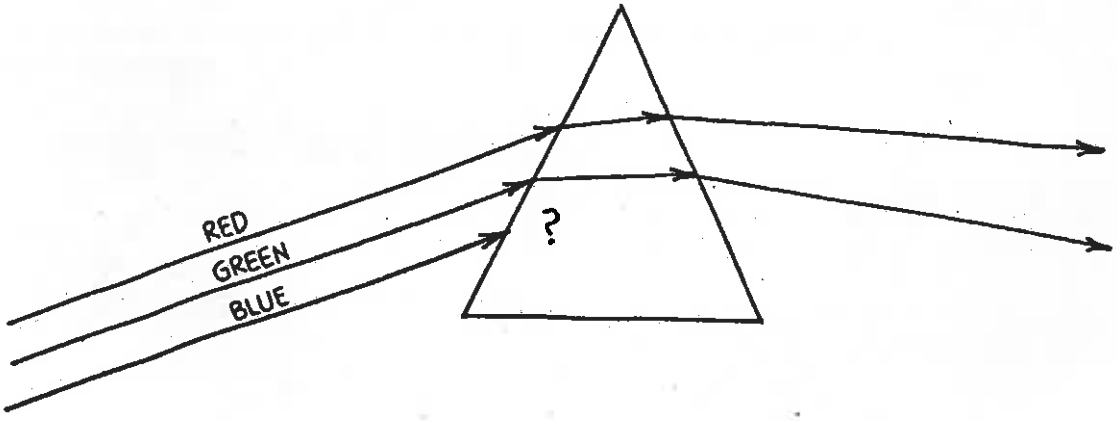
Refraction

1. A pair of toy cart wheels are rolled obliquely from a smooth surface onto two plots of grass — a rectangular plot as shown at the left, and a triangular plot as shown at the right. The ground is on a slight incline so that after slowing down in the grass, the wheels speed up again when emerging on the smooth surface. Finish each sketch and show some positions of the wheels inside the plots and on the other side. Clearly indicate their paths and directions of travel.





2. Red, green, and blue rays of light are incident upon a glass prism as shown. The average speed of red light in the glass is less than in air, so the red ray is refracted. When it emerges into the air it regains its original speed and travels in the direction shown. Green light takes longer to get through the glass. Because of its slower speed it is refracted as shown. Blue light travels even slower in glass. Complete the diagram by estimating the path of the blue ray.



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3. The sketch shows that due to refraction, the man sees the fish closer to the water surface than it actually is.

   a. Draw a ray beginning at the fish's eye to show the line of sight of the fish when it looks upward at 50° to the normal at the water surface. Draw the direction of the ray after it meets the surface of the water and continues in the air.

   b. At the 50° angle, does the fish see the man, or does it see the reflected view of the starfish at the bottom of the pond? Explain.

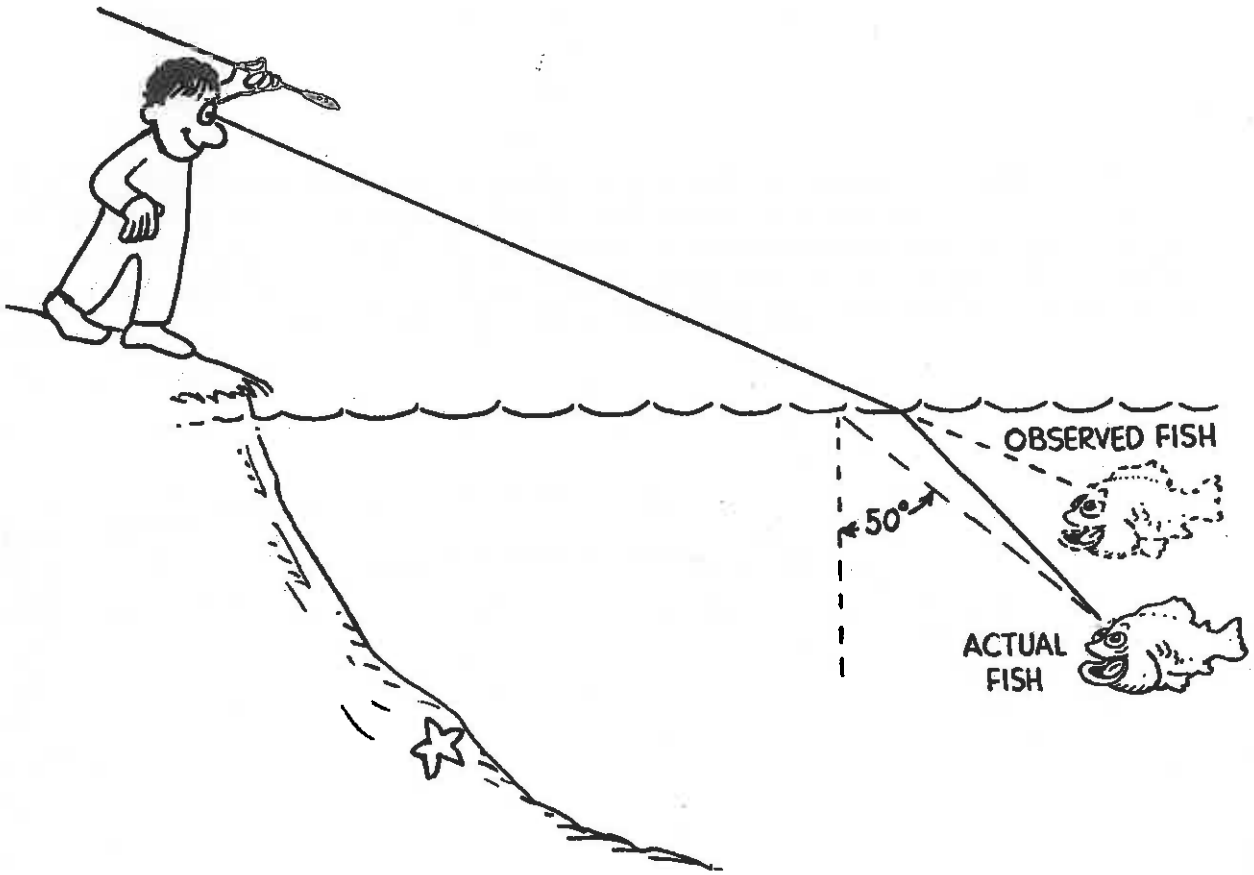
   _____

   _____

   c. To see the man, should the fish look higher or lower than the 50° path?

   _____

   d. If the fish's eye were barely above the water surface, it would see the world above in a 180° view, horizon to horizon. The fisheye view of the world above as seen beneath the water, however, is very different. Due to the 48° critical angle of water, the fish sees a normally 180° horizon-to-horizon view compressed within an angle of _____.



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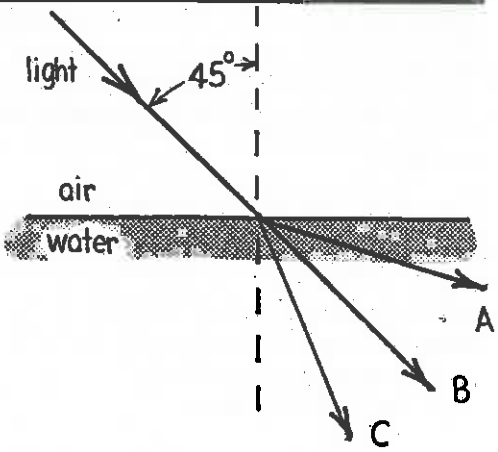
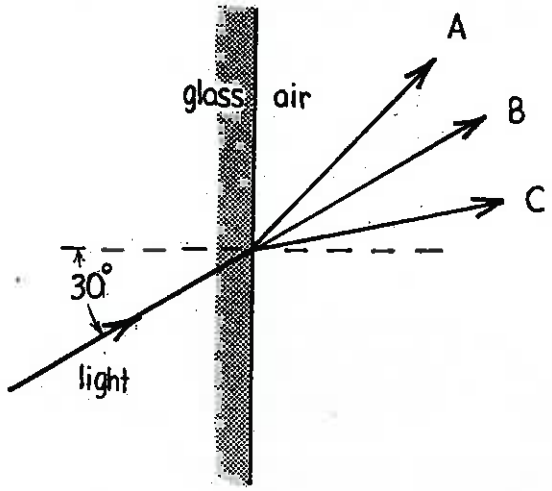
Refraction

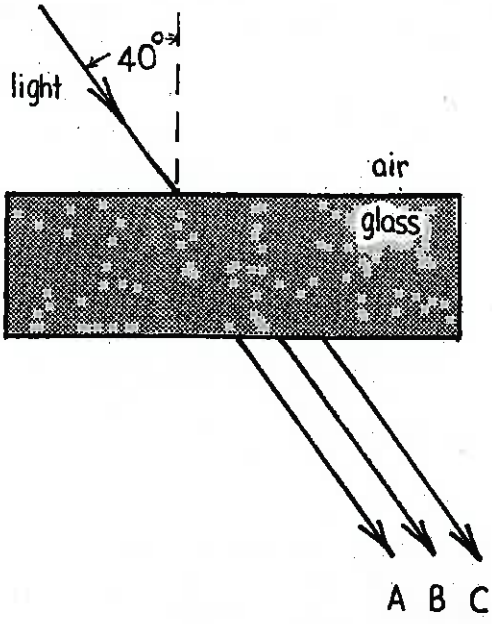
1. The sketch to the right shows a light ray moving from air into water, at 45° to the normal. Which of the three rays indicated with capital letters is most likely the light ray that continues inside the water?



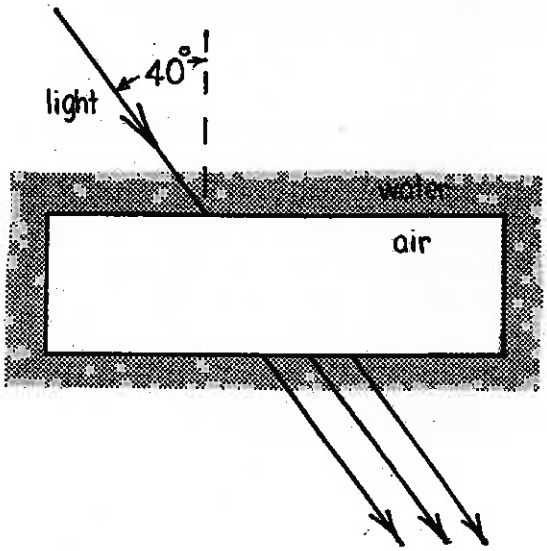


2. The sketch on the left shows a light ray moving from glass into air, at 30° to the normal. Which of the three is most likely the light ray that continues in the air?

3. To the right, a light ray is shown moving from air into a glass block, at 40° to the normal. Which of the three rays is most likely the light ray that travels in the air after emerging from the opposite side of the block?



Sketch the path the light would take inside the glass.



4. To the left, a light ray is shown moving from water into a rectangular block of air (inside a thin-walled plastic box), at 40° to the normal. Which of the three rays is most likely the light ray that continues into the water on the opposite side of the block?

Sketch the path the light would take inside the air.

thanx to Clarence Bakken

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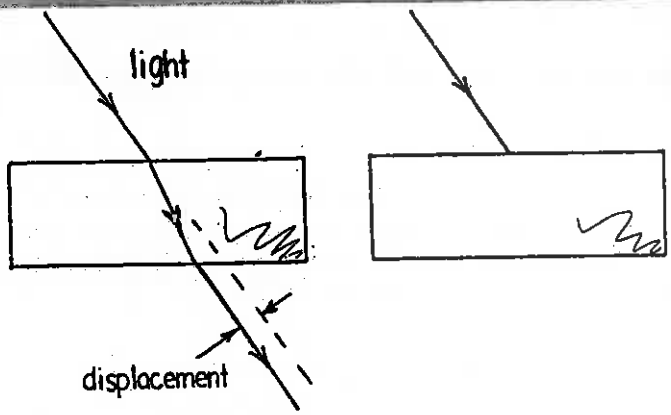
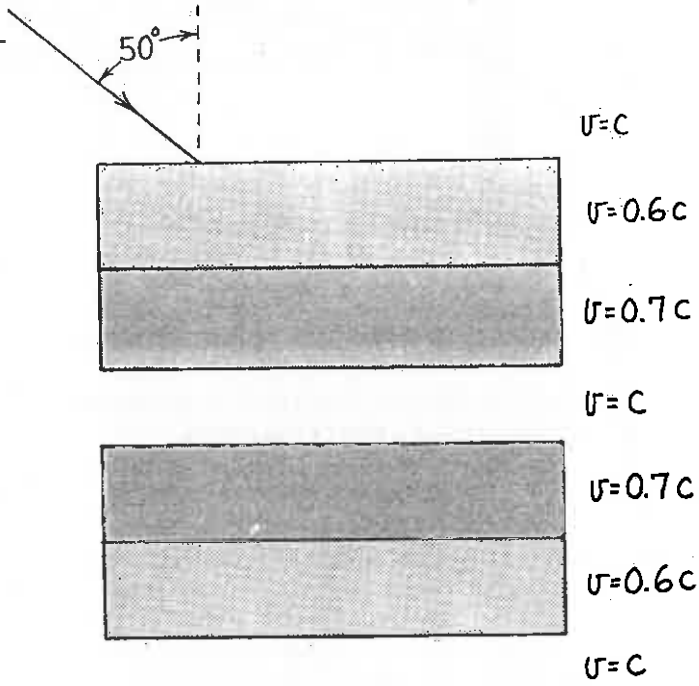
5. The two transparent blocks (right) are made of different materials. The speed of light in the left block is greater than the speed of light in the right block. Draw an appropriate light path through and beyond the right block. Is the light that emerges displaced more or less than light emerging from the left block?

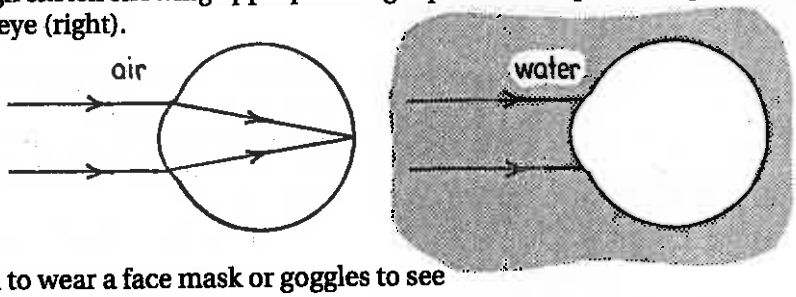


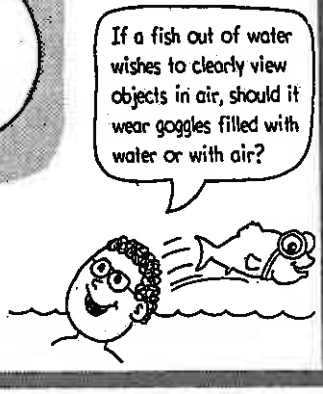
6. Light from the air passes through plates of glass and plastic below. The speeds of light in the different materials is shown to the right (these different speeds are often implied by the "index of refraction" of the material). Construct a rough sketch showing an appropriate path through the system of four plates.

Compared to the 50° incident ray at the top, what can you say about the angles of the ray in the air between and below the block pairs?



7. Parallel rays of light are refracted as they change speed in passing from air into the eye (left). Construct a rough sketch showing appropriate light paths when parallel light under water meets the same eye (right).





8. Why do we need to wear a face mask or goggles to see clearly when under water?

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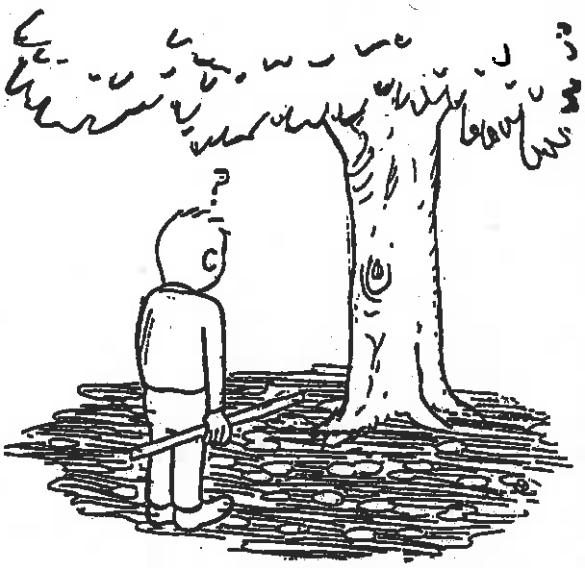
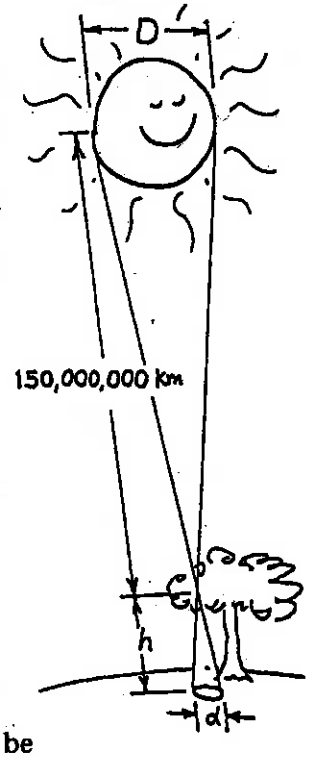
Pinhole Image Formation

Look carefully at the round spots of light on the shady ground beneath trees. These are sunballs, and are actually images of the sun. They are cast by openings between leaves in the trees that act as pinholes (see Activity 1 at the end of Chapter 30 in your textbook). Large sunballs, several centimeters in diameter or so, are cast by openings that are relatively high above the ground, while small ones are produced by closer "pinholes." The interesting point is that the ratio of the diameter of the sunball to its distance from the pinhole is the same as the ratio of the sun's diameter to its distance from the pinhole. We know the sun is approximately 150 000 000 km from the pinhole, so careful measurement of this ratio tells us the diameter of the sun. That's what this page is about. Instead of finding sunballs under the shade of trees, make your own easier-to-measure sunballs.





1. Poke a small hole in a piece of cardboard (like with a sharp pencil). Hold the cardboard in the sunlight and note the circular image that is cast. This is an image of the sun. Note that its size does not depend on the size of the hole in the cardboard, but only on its distance. The image will be a circle when cast on a surface that is perpendicular to the rays — otherwise it will be "stretched out" as an ellipse.

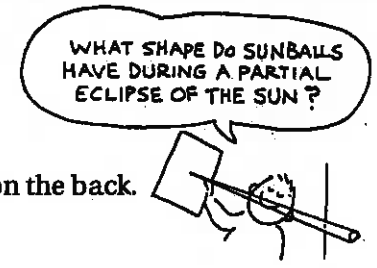
2. If you were doing this when the sun is partially eclipsed, what image shape would you expect to see? _____

3. Try holes of different shapes — say a square hole, or a triangular hole. What is the shape of the image when its distance from the cardboard is large compared to the size of the hole? _____ Does the shape of the "pinhole" make a difference? _____

4. Measure the diameter of a small coin. Then place the coin on a viewing area that is perpendicular to the sun's rays. Position the cardboard so the image exactly covers the coin. Carefully measure the distance between the coin and the the small hole in the cardboard. Complete the following:

$$\frac{\text{Diameter of sunball}}{\text{Distance to pinhole}} = \_\_\_\_\_$$

With this ratio, estimate the diameter of the sun. Show your work on the back.



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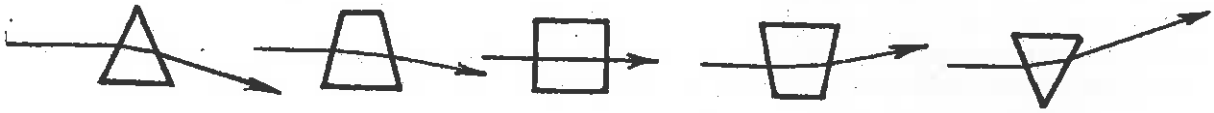
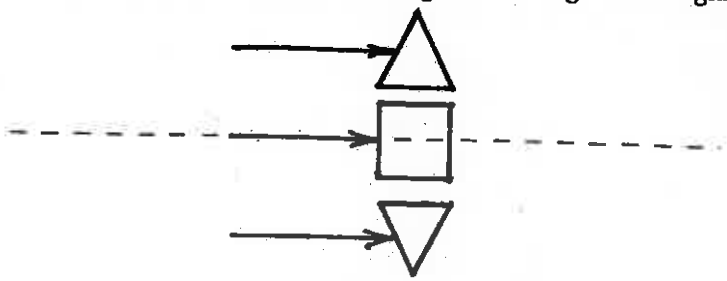
Lenses

Rays of light bend as shown when passing through the glass blocks.



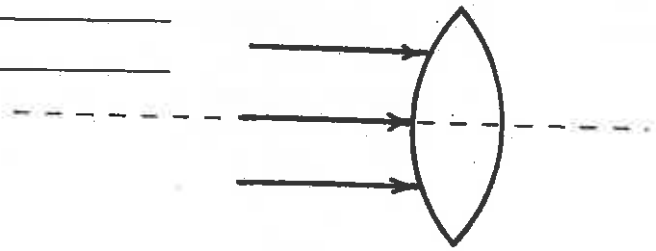
1. Show how light rays bend when they pass through the arrangement of glass blocks shown below.



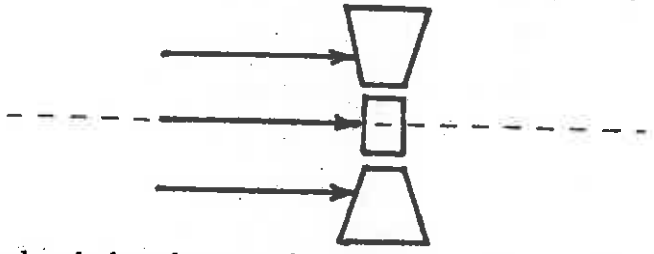
2. Show how light rays bend when they pass through the lens shown below. Is the lens a converging or a diverging lens? What is your evidence?

_____

_____



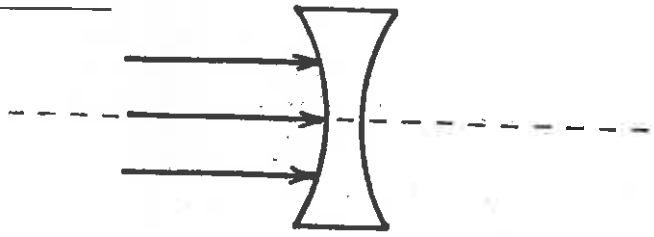
3. Show how light rays bend when they pass through the arrangement of glass blocks shown below.



4. Show how light rays bend when they pass through the lens shown below. Is the lens a converging or a diverging lens? What is your evidence?

_____

_____



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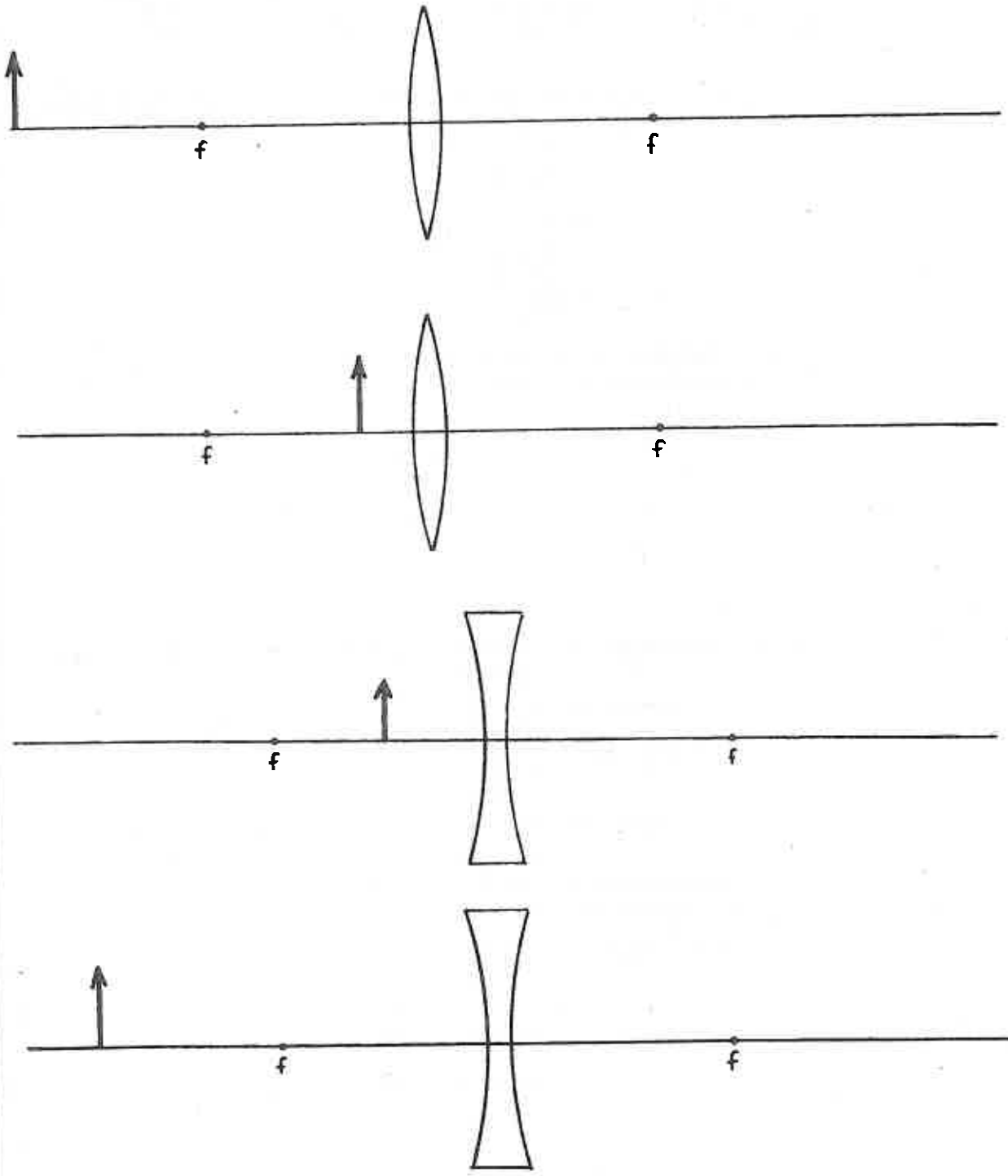
5. Which type of lens is used to correct farsightedness? _____

   Nearsightedness? _____

6. Use the ray-diagram technique (described in Section 30.3 of your text) to find the location and relative size of the arrow's image for each of the lenses below.



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