Inquiry Investigation 10-A

Applying the Laws of Reflection

In this investigation, you will make predictions about an image in a plane mirror. Then you will test your predictions using a ray box.

Skill Check

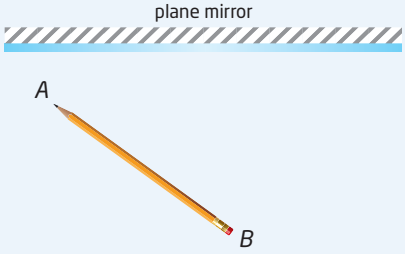
- ✓Initiating and Planning
- ✓Performing and Recording
- ✓Analyzing and Interpreting
- ✓Communicating

Safety Precautions

- The edges of the mirror may be sharp. Be careful not to cut yourself.
- Be careful not to drop the mirror.

Materials

- blank sheet of paper (letter size)
- pencil
- ruler
- small object (such as a small pencil)
- small plane mirror with support stand
- putty (if mirror stand is unavailable)
- ray box
- protractor



In step 2, arrange your object as shown here.

Question

How accurately will you be able to predict the position of an image using a ray diagram?

Prediction

Predict the size and orientation of the reflected image.

Procedure

1. Near the centre of a blank sheet of paper, draw a straight line to represent the surface of a plane mirror. Show which side of the line represents the mirror by drawing hatch marks on the non-reflecting side.
2. Place an object 10 cm from the line. Label one end of the object "A" and the other end "B," as in the diagram below. Trace the object. Remove the object, and draw a ray diagram.
3. Place the plane mirror in its stand on the sheet of paper, so that the reflecting surface is on the line representing the mirror.
4. Use the ray box to shine a single beam of light along each incident ray. Compare the reflected ray you produced with the reflected ray you predicted. If the reflected ray was not close to your predicted ray, sketch the location of the reflected ray.
5. Replace the object on the paper in its outline. Examine the image in the mirror, and compare it with the image you drew. Does your drawing agree with the image in the mirror?

Analyze and Interpret

1. If your predicted incident and reflected rays were not close to the actual reflected rays, explain why they were not close.

Conclude and Communicate

2. How well did your image correspond to the image that you saw in the mirror?

Extend Your Inquiry and Research Skills

3. **Inquiry** Plan and test a method that allows you to make better predictions.

Inquiry Investigation 10-B

Skill Check

Initiating and Planning

✓ **Performing and Recording**

✓ **Analyzing and Interpreting**

✓ **Communicating**

Studying the Laws of Reflection

When you look in a plane mirror, light reflects off your face in all directions. Some of the light reflects off the mirror into your eyes. This light must follow a consistent pattern because you always see the same image of your face in a mirror. In this investigation, you will be guided through the process of making a ray diagram. When your ray diagram is complete, you will analyze the relationship between incident and reflected rays.

Safety Precautions

- The edges of the mirror may be sharp. Be careful not to cut yourself.
- Be careful not to drop the mirror.

Materials

- blank sheet of paper (letter size)
- pencil
- ruler
- small object that is shorter than the plane mirror and has a pointed end (for example, a short pencil)
- small plane mirror (about 5 cm × 15 cm) with support stand
- putty (if support stand is unavailable)
- ray box
- protractor

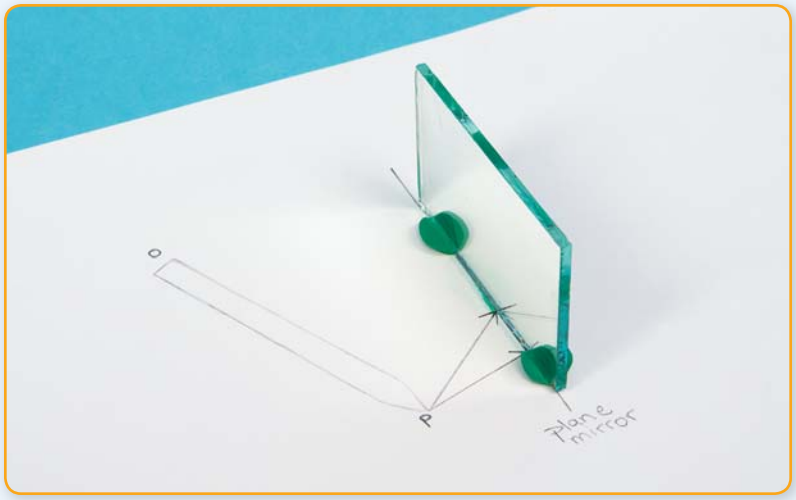
Question

How does light behave when it reflects off a flat surface?

Procedure

1. Near the middle of the blank sheet of paper, draw a straight line to represent the reflecting surface of the plane mirror. Label the line "plane mirror." Show which side of the line represents the mirror by drawing hatch marks on the non-reflecting side.
2. Lay the small object on the paper. Place it about 5 to 10 cm in front of the line that represents the plane mirror. Trace the shape of the object. Label the pointed end "P" and the blunt end "O."
3. Remove the object. Draw two different straight lines from point P to the "plane mirror." On each line, draw an arrowhead pointing toward the mirror. These lines represent the paths of two incident light rays that travel from the object to the mirror.
4. Carefully place the mirror in its stand on the sheet of paper as shown in the photograph below. Make sure that the reflecting surface of the mirror is exactly along the line you drew in step 1.

After removing the object, draw the rays.



Position the mirror as shown here.

5. Use the ray box to shine a thin beam of light along one of the incident rays that you drew from point P. Mark the reflected ray with a series of dots along the path of the reflected light.

6. Remove the mirror and the ray box. Draw a line through the dots, ending at the mirror. Draw an arrowhead pointing away from the mirror to indicate that this line is a reflected ray.

7. At the point where the incident ray and its corresponding reflected ray meet the mirror, draw a line at 90° to the mirror. Label this line as the normal.

8. Measure and record the angle of incidence (the angle between the normal and the incident ray).

9. Measure and record the angle of reflection (the angle between the normal and the reflected ray).

10. Repeat steps 5 to 9 for the second incident ray from point P.

11. If time permits, repeat steps 3 to 9 for point O.

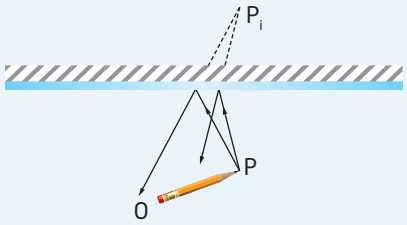
12. Place the mirror and the object back on the sheet of paper. Observe the image of the object and the reflected rays that you drew. From what point do the reflected rays seem to come?

Analyze and Interpret

1. You drew two rays from point P to the mirror. If you had enough time, how many rays could you have drawn between point P and the mirror? (You do not need to draw all the rays. Just think about how many you could have drawn.)

2. How does the angle of reflection compare with the angle of incidence?

3. Extend each reflected ray behind the mirror using a dashed line. Label the point where the two dashed lines meet "P_i." This is the location of the image of point P.
   a. Measure the perpendicular distance between point P (the object) and the mirror.
   b. Measure the perpendicular distance between point P_i (the image) and the mirror.
   c. Compare the distance between the object and the mirror, and the distance between the image and the mirror.



Compare the distance between the object and the mirror, and the distance between the image and the mirror.

Conclude and Communicate

4. Based on your measurements, describe a method for drawing a reflected ray without using a ray box.

5. Based on your measurements, describe a method for locating the image distance for a point placed in front of a plane mirror without tracing back reflected rays.

Extend Your Inquiry and Research Skills

6. **Inquiry** Place a small pointy object in front of two plane mirrors joined to make an angle of 120°. Use ray diagrams to explain why you see two images of the point.

7. **Research** Multiple images are popular in fun houses. Conduct research on multiple images, and explain how the following formula for multiple images works.

$$\text{Number of images} = \frac{360°}{\text{angle between mirrors}} - 1$$

Inquiry Investigation 10-C

Testing for Real and Virtual Images

In this investigation, you will test several mirrors and predict which mirrors will form real images on a screen and which mirrors will form virtual images that you can see in the mirror, but not on a screen.

Skill Check

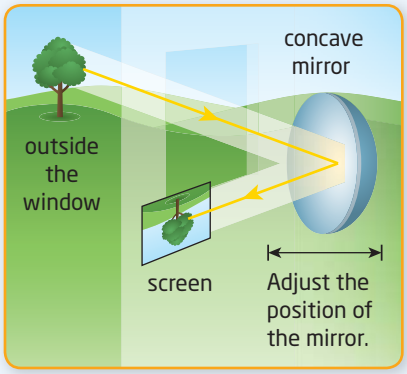
- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

Safety Precautions

- The edges of the mirror may be sharp. Be careful not to cut yourself.
- Be careful not to drop the mirrors.

Materials

- 3 concave mirrors with different curvatures
- flat (plane) mirror
- convex mirror
- white cardboard for screen
- room with a window



This drawing shows the set-up described in step 4.

Prediction

Predict which type of mirror will form real images on a screen.

Procedure

1. Create a table to organize your observations. Your table should include room for a labelled sketch of the mirror used and a description of the image you observed. Where applicable, indicate the distance between the mirror and the screen that resulted in a focussed image.
2. Working with a partner, decide who will hold the mirrors and who will hold the cardboard screen.
3. Hold one mirror between 2 and 3 m from the window so that it reflects light onto the cardboard screen about 1 m away.
4. Move the mirror and/or the cardboard screen until light from the window is reflected onto the screen. Adjust the distance between the mirror and the screen, and try to obtain a focussed image of the scene outside the window.
5. Record what you see on the screen. Repeat steps 1 to 4 with the other mirrors, and record what you see.

Analyze and Interpret

1. With which mirrors were you able to obtain a focussed image on the screen?
2. Compare the sizes of the images on the screen with the mirrors that produced the images.

Conclude and Communicate

3. Write a paragraph that explains which kinds of mirrors produce real images and which kinds of mirrors produce virtual images. Include supporting details in your paragraph.

Extend Your Inquiry and Research Skills

4. **Inquiry** Predict the image characteristics of an image produced by a concave mirror that is as large as a person.