Two-Mirror Reflection

Purpose:

To understand reflection qualitatively. The law of reflection with multiple mirrors will also be studied.

Pre-lab:

1. Figure 1 below shows two light rays coming out of an object. Complete the path of the rays using the law of reflection. You will need to use a protractor to measure the angles *very accurately*. Write down your measurement of the angles of incident in the diagram.

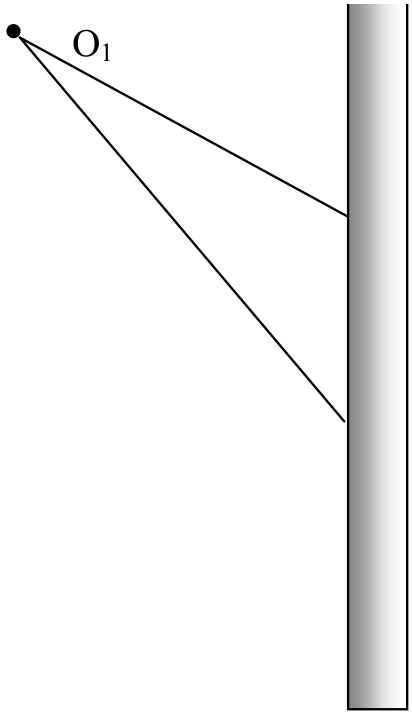


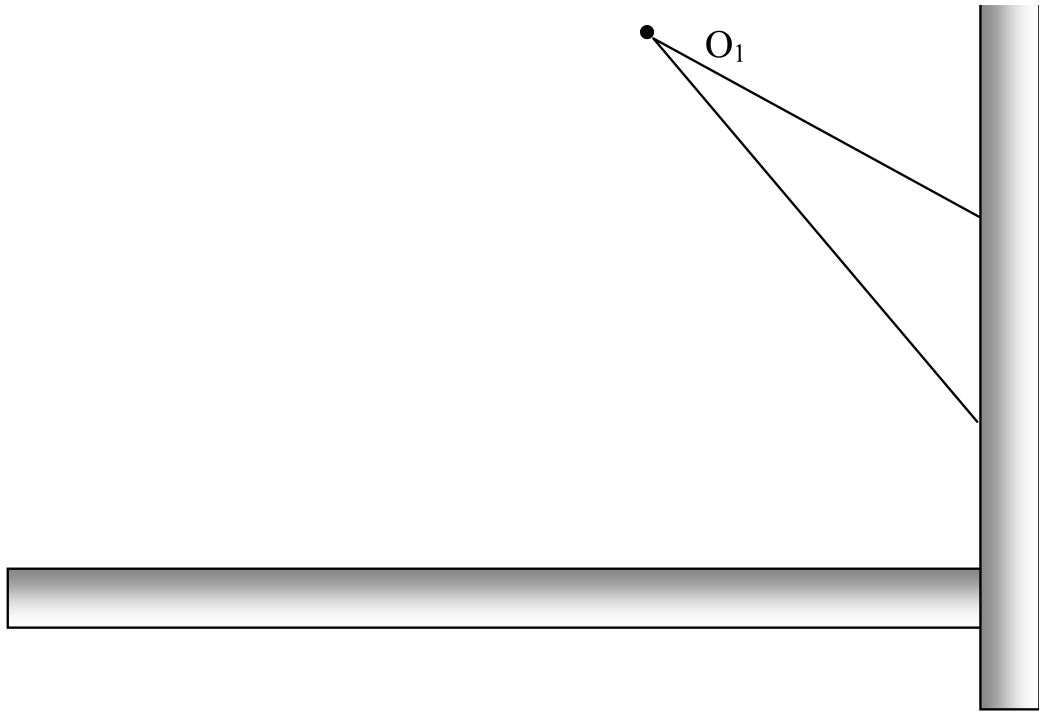
Figure 2

2. Identify the image from the diagram and label it by "***I***".
3. Measure the distance d_0 between the object and the mirror, and also the distance d_i between the image and the mirror. Are they the same?

Two-Mirror Reflection

4. A second mirror is now added, as shown in Figure 2. Complete the path of the light rays and identify the new image.

Figure 3



Two-Mirror Reflection

Equipment:

Optics Bench, Light Source, Ray Table and Base, Component Holder, Slit Plate, Ray Optics Mirror, Protractor.

Procedures:

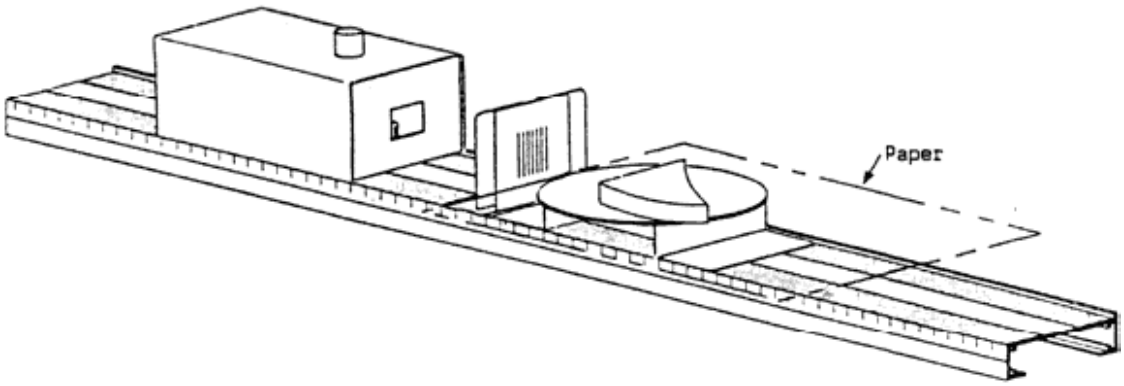


Figure 4

Part A.

1. Set up the equipment as in Figure 4 above.
2. Insert a blank piece of paper below the mirror. Use a pencil to mark out the circle made by the protractor. Mark on it the position of the angle of 0°. This will help you later (in step 6) when you remove the piece of paper and then put it back the way it was.
3. Place the mirror such that the plane mirror side is facing the light source.
4. Rotate the mirror so that the angle of incident is 10°.
5. Mark on the piece of paper the surface of the mirror, the incident ray and the reflected ray.
6. Trace out the path of the rays with a pencil. You could remove the paper and use a ruler to do this on the table if you find it more convenient. Label the mirror surfaces, the incident ray and the reflected ray by writing "10°" next to it.
7. Put the paper back to the original position under the mirror.
8. Repeat steps 4 to 7 with 4 different angles.
9. Take out the piece of paper and measure the angle of reflection in each case. Record your data in Table 1 below.

Two-Mirror Reflection

Table 1

Angle of incident	*Angle of reflection*	*Percentage difference*

Part B

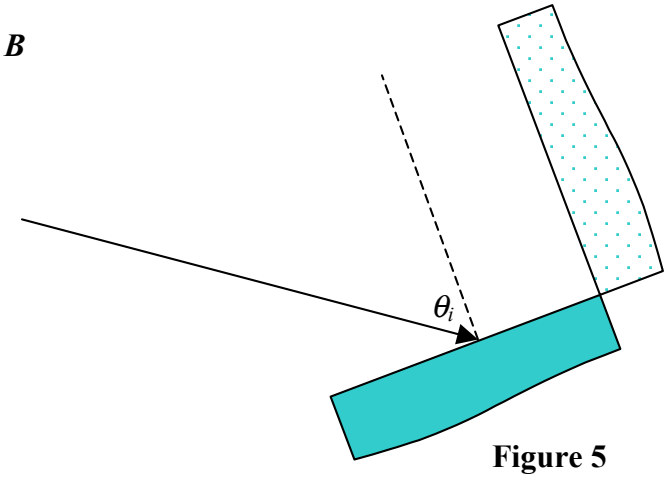


Figure 5

1. Take another mirror, and put it next to the first mirror so that they make right angle with each other as in Figure 5.
2. Suppose now a beam of light strikes one of the mirrors with angle of incident θ_i. Before you do the actual experiment, use the law of reflection to figure out where the ray will strike the other mirror and at what angle it will be reflect out. Complete the light ray in Figure 5 with the help of a protractor.
3. What angle does the outgoing beam make with the incoming beam? *Answer*: _____
4. Now do the experiment with five different θ_i and enter your results in Table 2. Make sure you adjust the position of the mirrors so that you have exactly two reflections for each light ray. Do the results agree with your answer in step 3?

Table 2

Angle of incident θ_i	*Angle between the outgoing and the incoming beam $\Delta\theta$*

5. Repeat step 4, this time with the mirrors making a 60° angle with each other. Enter you data in Table 3.

Table 3

Angle of incident θ_i	*Angle between the outgoing and the incoming beam* $\Delta\theta$

6. Does the angle between the outgoing beam and the incoming beam change with the angle of incident?

7. Calculate the mean (average) of $\Delta\theta$ for Table 3. Label it as $\langle\Delta\theta\rangle$.

8. Calculate the standard deviation for Table 3 by the formula (N denotes the number of data points):

$$\sigma = \sqrt{\frac{\sum_{k=1}^{N}(\Delta\theta_k - \langle\Delta\theta\rangle)^2}{N-1}}$$

9. Calculate the percentage deviation for Table 3, $\frac{\sigma}{\langle\Delta\theta\rangle}$.