# Lab 8: Reflection and Mirrors

**LEARNING GOALS OF THE LAB:**

1. To learn how to experimentally test a hypothesis.
2. To understand that each point on a light source radiates light in all directions (emits an infinite number of rays).
3. To understand that drawing a line perpendicular to the point of incidence on a mirror (known as the ‘normal line’) is crucial for finding the path of a reflected ray.

## I. TESTING EXPERIMENT: WHERE IS THE IMAGE IN A PLANE MIRROR FORMED?

### RUBRICS

<table>
<thead>
<tr>
<th>Scientific Ability</th>
<th>Missing</th>
<th>Inadequate</th>
<th>Needs some improvement</th>
<th>Adequate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A10</strong> Ray Diagram</td>
<td>No representation is constructed.</td>
<td>The rays that are drawn in the representation do not follow the correct paths. Object or image may be located at wrong position.</td>
<td>Diagram is missing key features but contains no errors. One example could be the object is drawn with the correct lens/mirror but rays are not drawn to show image. Or the rays are too far from the main axis to have a small-angle approximation.</td>
<td>Diagram has object and image located in the correct spot with the proper labels. Rays are correctly drawn with arrows and contain at least two rays.</td>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>C3</strong></td>
<td>No prediction is made. The experiment is not treated as a testing experiment.</td>
<td>A prediction is made but it is identical to the hypothesis.</td>
<td>A prediction is made and is distinct from the hypothesis but does not describe the outcome of the designed experiment.</td>
<td>A prediction is made, is distinct from the hypothesis, and describes the outcome of the designed experiment.</td>
</tr>
<tr>
<td><strong>C4</strong></td>
<td>No attempt to make a prediction is made.</td>
<td>A prediction is made that is distinct from the hypothesis but is not based on it.</td>
<td>A prediction is made that follows from the hypothesis but there are reasoning errors</td>
<td>A correct prediction is made that follows from the hypothesis.</td>
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<tr>
<td>C7</td>
<td>Is able to decide whether the prediction and the outcome agree/disagree</td>
<td>No mention of whether the prediction and outcome agree/disagree.</td>
<td>A decision about the agreement/disagreement is made but is not consistent with the outcome of the experiment.</td>
<td>A reasonable decision about the agreement/disagreement is made but experimental uncertainty is not taken into account.</td>
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<tr>
<td>C8</td>
<td>Is able to make a reasonable judgment about the hypothesis</td>
<td>No judgment is made about the hypothesis.</td>
<td>A judgment is made but is not consistent with the outcome of the experiment.</td>
<td>A judgment is made and is consistent with the outcome of the experiment but assumptions are not taken into account.</td>
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Your friend Noelle suggests the following hypothesis: “The image of an object formed by a plane mirror is formed on the surface of the mirror.” Design an experiment to test Noelle’s hypothesis.

**Available equipment:** Plane mirror on stand, object, masking tape, paper, whiteboard, meter stick.

Design and describe the experiment that you plan to perform. Remember that your prediction of the outcome of the experiment must follow from the hypothesis you are testing. Then perform the experiment and record the outcome. Explain the outcome using a ray diagram. Discuss whether the outcome agrees or disagrees with the prediction. If it disagrees, how would you convince Noelle that her hypothesis has been disproven?

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II. TESTING EXPERIMENT: COVERING THE IMAGE

Your friend Joshua suggests the following hypothesis: “The fraction of the image that is visible in a plane mirror depends on how much of the mirror is covered.” Design an experiment to test Joshua’s hypothesis.

**Available equipment:** Plane mirror on stand, object, masking tape, paper, whiteboard, meter stick.

Design and describe the experiment that you plan to perform. Remember that your prediction of the outcome of the experiment must follow from the hypothesis you are testing. Then perform the experiment and record the outcome. Explain the outcome using a ray diagram. Discuss whether the outcome agrees or disagrees with the prediction. If it disagrees, how would you convince Joshua that his hypothesis has been disproven?

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III. APPLICATION EXPERIMENT: SAVING MONEY WHILE BUYING A MIRROR

You’ve just moved into a new apartment and need to buy a mirror for your wall. You do not have any housemates so the only person who is going to be using the mirror is you. You want to know the answers to the following two questions before you make your purchase so that you can save money.

1. What are the dimensions (height and width) of the smallest plane mirror that you can buy so that you can still see all of yourself without having to move your head?

2. At what position should you mount the mirror on the wall?

**Available equipment:** Wall mirror (to the right of the whiteboard), paper to cover parts of the mirror, meter stick, masking tape.

First, use your understanding of reflection to answer these two questions. Once you have done that, use the available equipment to see if your mirror functions as designed. Include the following in your writeup:

*Note: Even though an application experiment normally requires two independent methods you only need to design and perform a single method for this experiment.*
a) Draw a ray diagram to help you quantitatively determine how the size and position of the mirror are related to your height, width, and/or other measurable quantities. (Remember, you need to be able to see the top of your head, the bottom of your feet, and both of your arms simultaneously).

b) What assumptions did you make in drawing the diagram?

c) Decide what quantities you need to measure and what quantities you need to calculate. Come up with a mathematical procedure for making these calculations. Collect the data, perform the calculations, and answer the two questions. Also, determine if the dimensions and/or position of the mirror depend on how far you are standing from the mirror.

d) Estimate the uncertainty in your results.

e) Perform the experiment by mounting the mirror in the way you determined (by covering the parts you do not need with paper). If you cannot see your entire body, make adjustments to the mirror so that you can. Record the dimensions and position of the mirror that allowed you to see your entire body. Were these measurements consistent with the dimensions and position that you thought the mirror should have had?

f) Were you able to see your entire body at different distances? If not, try to explain why. Examine each assumption to determine how reasonable they are. Determine specifically how the assumption affects the dimensions/position of the mirror (meaning, does the assumption increase, decrease, or randomly affect these quantities). Try to estimate quantitatively the effect of the assumption you think was the most significant.

IV. WHY DID WE DO THIS LAB?

a) Write a short paragraph describing how today’s experiments addressed learning goal number 2.

b) Discuss whether it makes sense to you that the size of the mirror that you need to buy does not depend on how far you are from the mirror. Why does this result seem to contradict your everyday experience?

c) Imagine that you have an explanation for why something happens and you want to test it experimentally. List the steps that you will take to do it.

V. HOMEWORK:

Describe a method to accurately measure small angles (about 1°). Use some reasonable values and estimate the uncertainty in this measurement. What steps can you take to minimize uncertainties in this measurement? (Hint#1: Consider a specific situation where you would want to be able to measure very small angles. Hint #2: Avoid using a protractor.)