Plane Mirrors – ID: 8737

By Peter Fox

Time required
45 minutes

Activity Overview

In this activity, students investigate the relationship between an object and its image in a plane mirror. Understanding how plane mirrors work provides a useful scaffold for understanding more complex situations, such as those involving concave and convex mirrors.

Concepts

- *Object and image relationships in a plane mirror*

Materials

To complete this activity, each student will require the following:

- *TI-Nspire™ technology*
- *pen or pencil*
- *blank sheet of paper*

TI-Nspire Applications

Graphs & Geometry, Notes

Teacher Preparation

Students should be familiar with reflections in plane (flat) mirrors from their everyday lives. However, they may not have thought about reflection in a quantitative way. This activity will allow students to explore reflection in plane mirrors without potential confusion caused by imperfections in real mirrors. However, providing students with physical mirrors, objects, and rulers will add dimensions to student understanding and produce a greater connectedness with the "real world."

- *The screenshots on pages 2–7 demonstrate expected student results. Refer to the screenshots on pages 8 and 9 for a preview of the student TI-Nspire document (.tns file).*
- ***To download the .tns file, go to education.ti.com/exchange and enter "8737" in the search box.***

Classroom Management

- *This activity is designed to be **teacher-led** with students following along on their handhelds. You may use the following pages to present the material to the class and encourage discussion. Note that the majority of the ideas and concepts are presented only in **this** document, so you should make sure to cover all the material necessary for students to comprehend the concepts.*
- *Students may answer the questions posed in the .tns file using the Notes application or on notebook paper.*
- *In some cases, these instructions are specific to those students using TI-Nspire handheld devices, but the activity can easily be done using TI-Nspire computer software.*

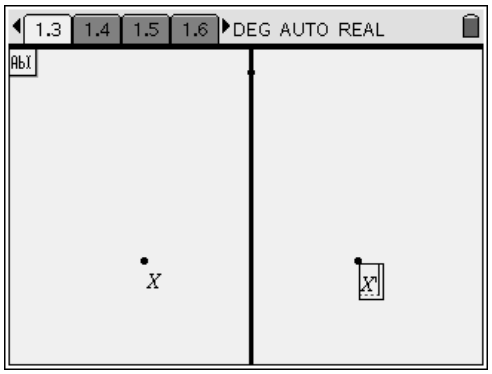
The following question will guide student exploration in this activity:

- What are the properties of reflections in plane mirrors?

Students will explore various properties of plane mirrors using simulated mirrors. Students will use the simulated mirrors to address common misconceptions about plane mirror reflections.

Problem 1 – Basic properties of plane mirror reflections

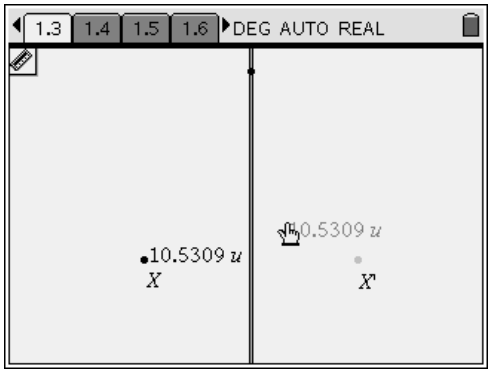
Step 1: Students should open the file **PhyAct07_plane_mirrors_EN.tns** and read the first two pages. Page 1.3 shows a single object (**X**) and a plane mirror. Students should use the **Reflection** tool (**Menu** > **Transformation** > **Reflection**) to reflect this point in the mirror. To use the **Reflection** tool, students should first click on the point they wish to reflect, and then on the line that should be used as the reflection plane. They should then use the **Text** tool (**Menu** > **Actions** > **Text**) to label the image "**X'**". They should then answer question 1 on page 1.4.



Q1. Move the object up and down and then away from and toward the mirror. Describe how the object's image moves as you move the object.

A. *The image moves up when the object moves up, down when the object moves down, away from the mirror when the object moves away from the mirror, and toward the mirror when the object moves toward the mirror.*

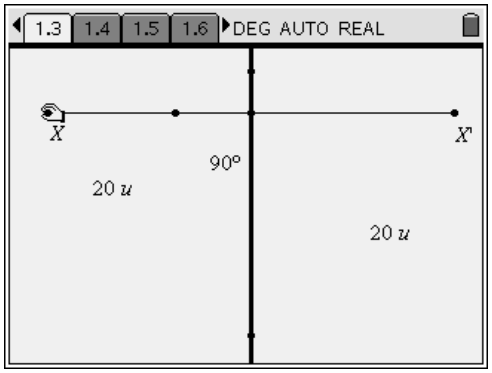
Step 2: Next, students should use the **Length** measurement tool (**Menu** > **Measurement** > **Length**) to measure the distance between the object and the mirror and between the image and the mirror. Students should then answer question 2 on page 1.5.



Q2. What is the relationship between these distances? Does this relationship hold when you move the object?

A. *The image is the same distance from the mirror as the object is. This relationship holds no matter how the object is moved relative to the mirror.*

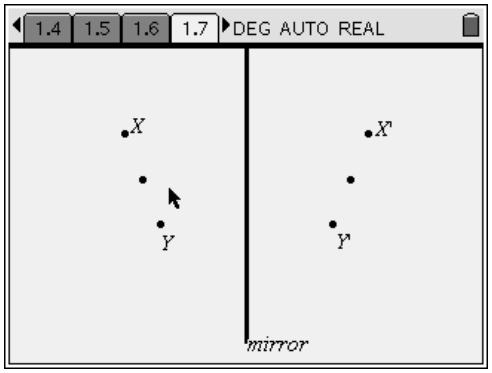
Step 3: Students should now construct a segment (**Menu** > **Points & Lines** > **Segment**) connecting the object **X** to the image **X′**. Students should use the **Angle** measurement tool (**Menu** > **Measurement** > **Angle**) to measure the angle between the segment and the mirror. They should then move point X around the screen and observe the angle measurements. They should then answer question 3 on page 1.6.



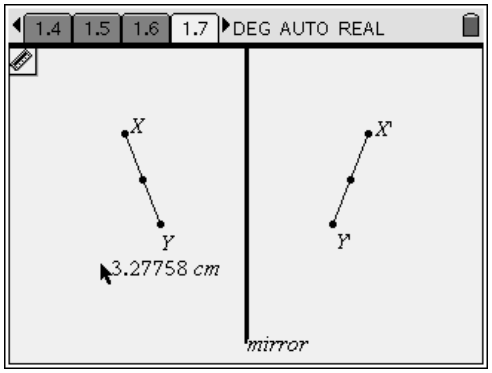
Q3. What angle does the connecting segment make with the mirror? Does this angle change when you move the object?

A. *The segment is perpendicular to the mirror. It remains perpendicular even when the object is moved.*

Step 4: Next, students should advance to page 1.7. This page shows two points, **X** and **Y**, along with their reflections (**X'** and **Y'**). Students should create a midpoint between **X** and **Y** (**Menu** > **Construction** > **Midpoint**) and then create a reflection of that midpoint in the mirror. They should then move points **X** and **Y** up, down, left, and right and observe how the positions of the midpoint and of the midpoint's image change.



Step 5: Next, students should connect points **X** and **Y** with a line segment. They should also connect points **X'** and **Y'** with a line segment. Then, they should use the **Length** measurement tool to measure the length of each line segment. They should move points **X** and **Y** and observe the resulting lengths of the line segments. Then, they should answer question 4 on page 1.8.

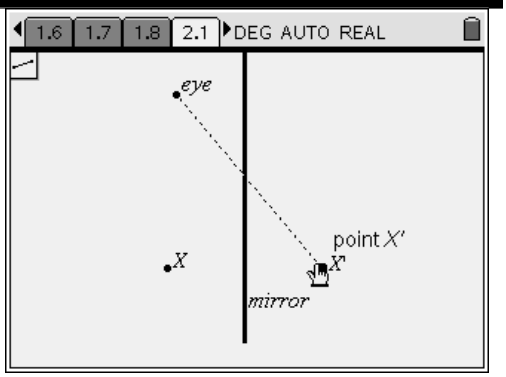


Q4. What happens to the length of an object (e.g., a line) when it is reflected in a plane mirror?

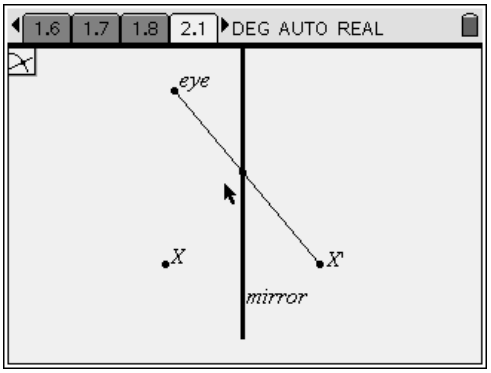
A. *The object's image is the same size as the object itself.*

Problem 2 – Appearance of plane mirror reflections to observers

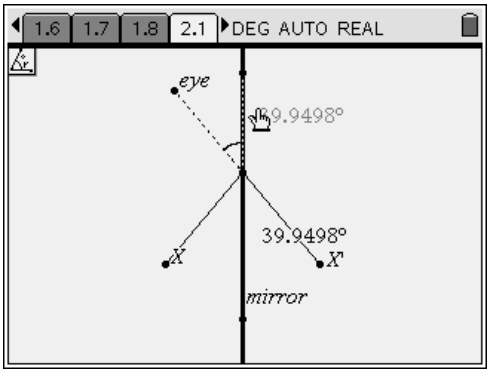
Step 1: Next, students should move to page 2.1. This page shows an object **X**, its reflection **X'**, and a third point, which represents the eye of an observer. The **eye** marked in the diagram can look directly at the image **X′**. Students should draw a line segment connecting the **eye** to the image **X'**. This line represents the "line of sight" to the image.



Step 2: Next, students should construct a point of intersection (**Menu** > **Points & Lines** > **Intersection Point(s)**) between the mirror and the line segment from **eye** to **X'**. Then, they should construct a line segment from this point of intersection to the point **X**. Students may wish to change one or more of the lines to dotted lines by modifying the attributes of the lines.



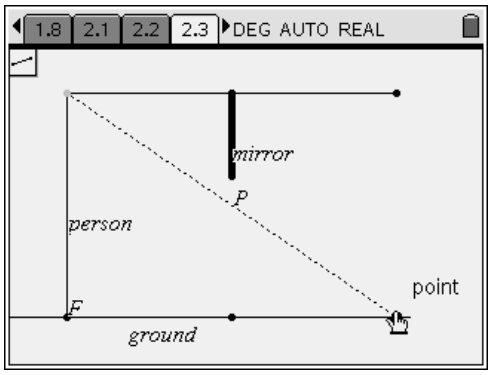
Step 3: Next, students should move point **X** and the **eye** around the screen. They should use the **Length** and **Angle** measurement tools to measure any angles or lengths they think are related. Encourage students to make hypotheses about the relative positions of **X, X',** and the observer and then to use the simulation to test their hypotheses. Then, students should answer question 5 on page 2.2. Encourage students to compare the angles of incidence and reflection to help them understand that these angles are equal.



Q5. An object is 15 cm in front of a mirror. An observer is standing 40 cm away from the mirror and looking at the image of the object. How far behind the mirror will the image appear to the observer? Will this distance change if the observer moves closer to the mirror? Explain your answer.

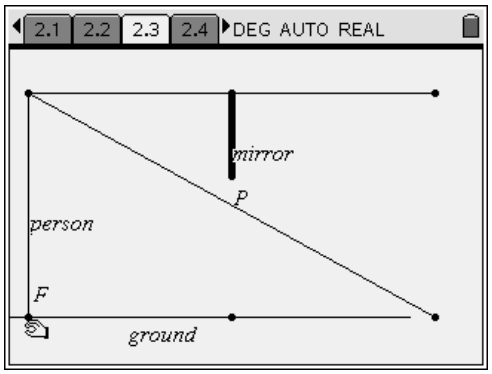
A. *The image will appear to be 15 cm behind the mirror, no matter where the observer stands. The distance between the image and the mirror is always the same as the distance between the object and the mirror, even to an observer.*

Step 4: Next, students should move to page 2.3. This page shows a person (represented by a line) and a vertical mirror. The mirror's length can be adjusted by sliding point **P**, and the person can move closer to and further from the mirror by dragging point **F** (the person's feet) along the ground. In the initial scenario, the person cannot see his or her feet in the mirror. To confirm this, students should construct reflections of the person's head and feet in the mirror and then construct lines of sight from the person's head to each image. Then, students should answer questions 6–9 on pages 2.4 and 2.5. Note: Make sure students do not change the length of the mirror until they reach question 8.



Q6. Will the person be able to see his or her feet if he or she moves farther from the mirror? Make a prediction.

A. *Students' predictions will vary. Most students will probably assume that moving farther from the mirror will allow the person to see his or her feet.*

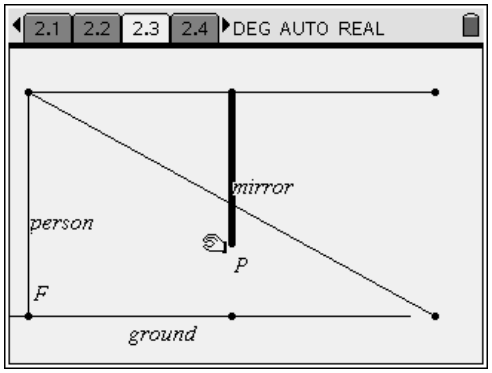


Q7. Now, use the simulation to test your prediction. Were you correct? If not, explain any errors in your reasoning.

A. *Students commonly have the misconception that moving farther from a mirror allows you to see more of your reflection. This misconception probably arises because you can see more of your reflection if you move away from plane mirrors in most common situations (in bathrooms, etc). However, this effect occurs because most mirrors are not perfectly vertical; they tilt away from the wall slightly. Work with students to help them understand that if a mirror is perfectly perpendicular to the floor, moving away from the mirror will not allow you to see more of your reflection.*

Q8. What would have to happen to allow the person to see his or her feet in the mirror? Make a prediction.

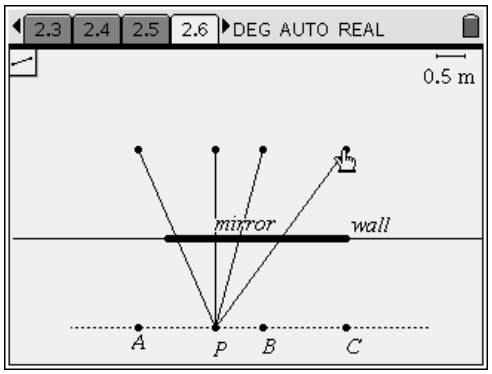
A. *Students' predictions will vary.*



Q9. Now, use the simulation to test your prediction. Were you correct? If not, explain any errors in your reasoning.

A. *Because the mirror is constrained to be vertical (i.e., perpendicular to the ground), the only way for the person to see his or her feet is for the mirror to be lengthened. In fact, the mirror must be at least half the person's height in order for the person's feet to be visible. Students may also hypothesize that adjusting the angle of the mirror might allow the person to see his or her feet. If you wish, you can have students construct new simulations to test this hypothesis.*

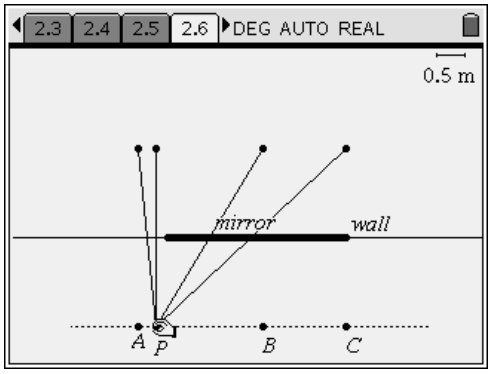
Step 5: Next, students should advance to page 2.6, which shows a plan view of the following scenario: A photographer (**P**) is standing in front of a mirror. Three other people (**A, B,** and **C**) are standing on either side of the photographer. All four people are the same distance from the mirror. Students should examine the scenario and then answer questions 10–12 on pages 2.7 through 2.9. Note: Encourage students to construct lines of sight to help them answer the questions.



Q10. Is it possible for the photographer to take a photograph of the reflections so that everyone appears in the mirror without anyone (except the photographer) having to move? Explain your answer.

A. *In the initial construction, the photographer could take a photograph that includes all four people.*

Q11. If the photographer remains in his or her initial position and takes a photograph of the mirror, the photographer will appear in the photograph. Where could the photographer stand (along the line) so that he or she does not appear in the photograph? Will all three other people still be visible in the photograph? If not, who will be left out?



A. *The photographer could stand far to one side or the other. If the photographer stands far to the left, person A will not be included in the photo. If the photographer stands far to the right, person C will not be included in the photo.*

Q12. The photographer, standing in his or her initial position, needs to set the focus on the camera manually. In order to obtain a focused image of persons B and C, what should the approximate focal distance be?

A. *The photographer should focus on the midpoint between the image of person B and the image of person C. So, the focal distance should be about as far behind the mirror as persons B and C are in front of the mirror.*

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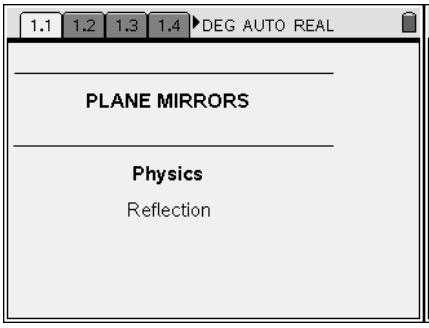
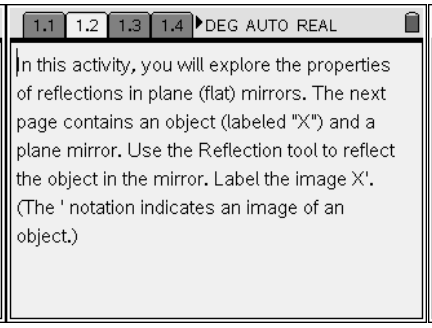
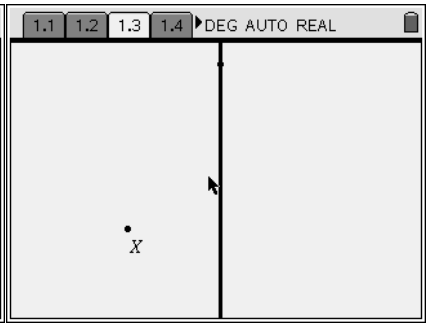
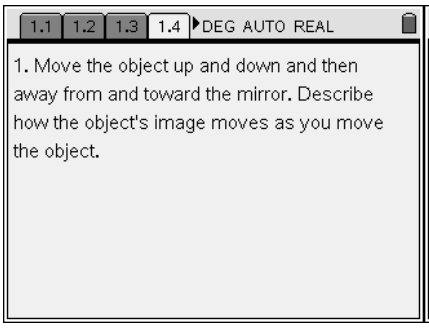
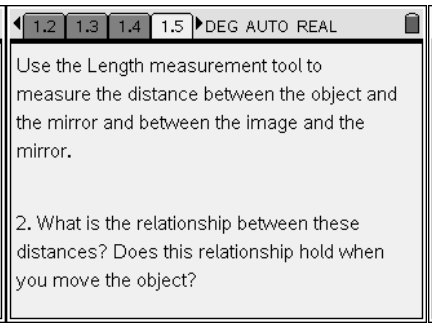
(Student)TI-Nspire File: *PhyAct07_plane_mirrors_EN.tns*

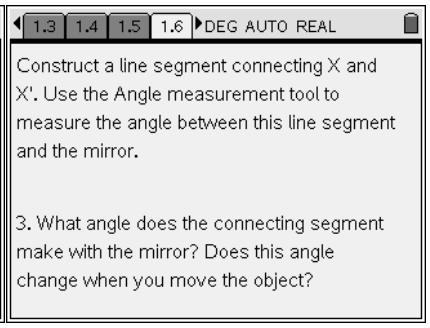


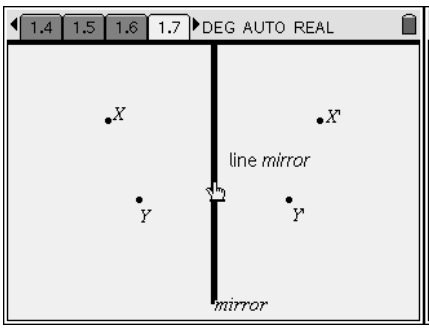


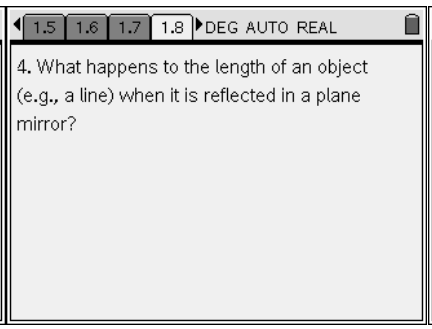


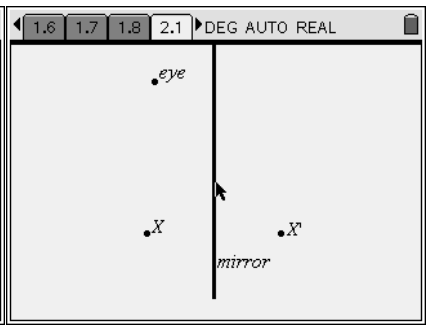


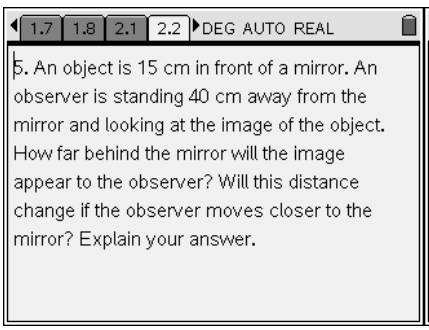


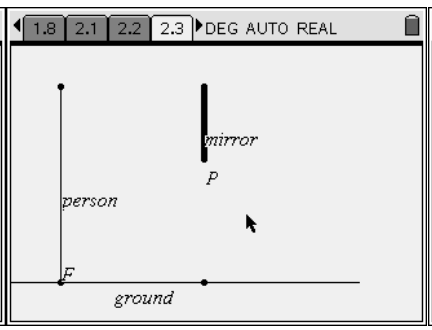


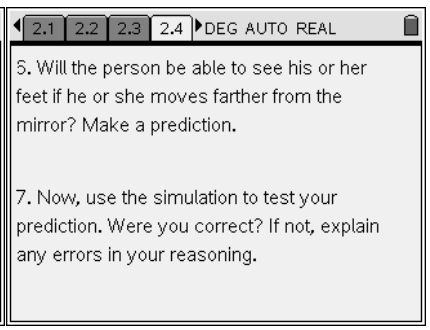










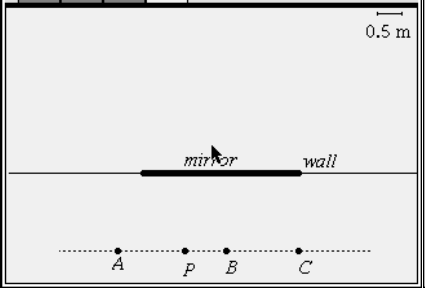


2.2 2.3 2.4 2.5 DEG AUTO REAL

8. What would have to happen to allow the person to see his or her feet in the mirror? Make a prediction.

9. Now, use the simulation to test your prediction. Were you correct? If not, explain any errors in your reasoning.

2.3 2.4 2.5 2.6 DEG AUTO REAL



2.4 2.5 2.6 2.7 DEG AUTO REAL

10. Is it possible for the photographer to take a photograph of the reflections so that everyone appears in the mirror without anyone (except the photographer) having to move? Explain your answer.

2.5 2.6 2.7 2.8 DEG AUTO REAL

11. If the photographer remains in his or her initial position and takes a photograph of the mirror, the photographer will appear in the photograph. (continued on next page)

2.6 2.7 2.8 2.9 DEG AUTO REAL

11. (continued) Where could the photographer stand (along the line) so that he or she does not appear in the photograph? Will all three other people still be visible in the photograph? If not, who will be left out?

2.7 2.8 2.9 2.10 DEG AUTO REAL

12. The photographer, standing in his or her initial position, needs to set the focus on the camera manually. In order to obtain a focused image of persons B and C, what should the approximate focal distance be?