PHY132 Winter 2021
Active Learning Homework for Module 2

Part a

Activity 23.1.3 Test your idea

Justin and Isabel are investigating the location of the image of a candle produced by a plane mirror. Justin says that the image is on the surface of the mirror. Test his idea by designing an experiment whose outcome contradicts the prediction based on Justin's idea.

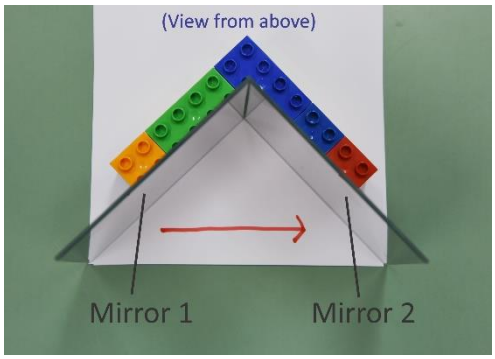
a. Describe an experiment to test Justin's idea.

b. Predict the outcome of the experiment based on Justin's idea.

c. If you have the equipment you need, perform the experiment and record the outcome. Discuss whether the experiment disproves the idea that the image is on the surface of the mirror.

Activity 23.1.4 Test your idea

a. You have vertical mirrors on a flat surface so that their faces make a right angle as shown on the right. You draw an arrow as shown in the figure. What will you see in the mirrors?



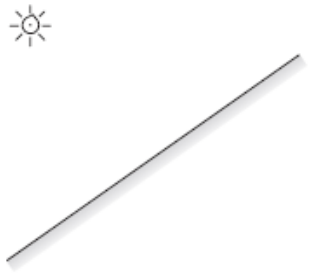
b. Use a ray diagram to make a prediction. Once you are done, compare your prediction to the outcome of the experiment in this video. Explain which part of the arrow is the result of reflection from mirror 1 and which one is the result of reflection from mirror 2.

c. Now watch this experiment and compare the outcome to your explanation in part **b**. Explain the discrepancies.

Activity 23.1.5: Represent and reason

A candle burns in front of a plane mirror, as shown in the figures below. Consider the flame to be a point-like source of light. For each case, locate the flame's image by drawing any two rays on the illustration. (Rays can extend in any direction that strikes the mirror.) Upload your images here.

a.



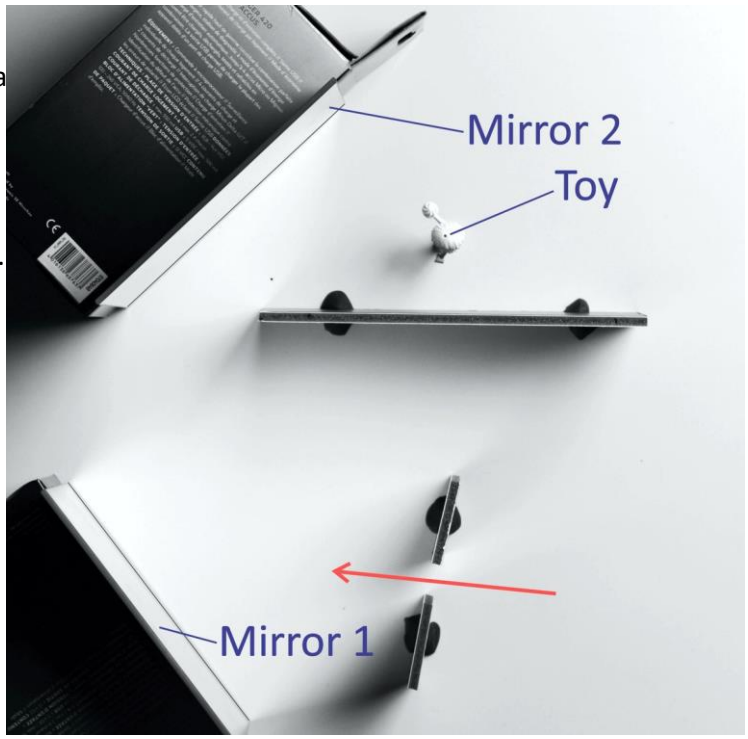
b.

Then, devise a rule that can be used to locate plane-mirror images without using rays.

Activity 23.1.8: Apply

Equipment needed: a protractor and a ruler. (If you do not have this equipment, you may use the free MB-ruler protractor with the Chrome web browser.)

a. In the photo on the right you see a top view of an arrangement of two mirrors and a toy (a girl holding ice cream in her right hand) in front of mirror 2 and a red arrow in front of mirror 1. The red arrow indicates the direction in which the camera is pointed. Will the camera see the toy? If it does see the toy, will the girl that the camera sees hold ice cream in her right or her left hand? Use a ruler and a protractor to answer these questions.

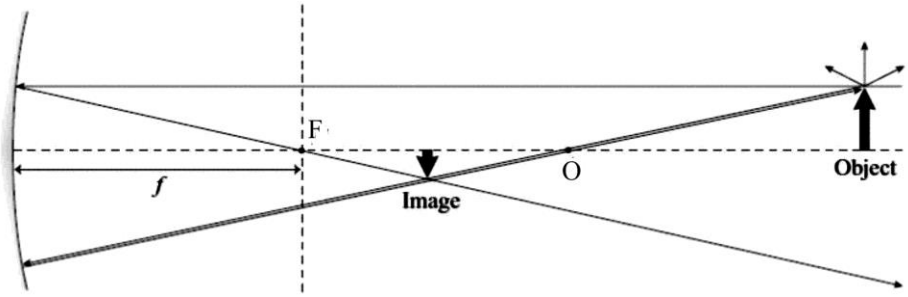


b. Check out this video taken by the camera pointed in the direction of the red arrow. Did your prediction match the outcome of the experiment?

Part b

Activity 23.2.6: Represent and reason

A small, shining object is placed above the main axis of a concave mirror at a distance $s > R$ from the mirror. Two rays are used to find the image of the top of the object. Point *O* is the center of curvature of the mirror—that is, the center of the sphere from which the mirror was cut. The focal point is indicated by *F*, and the focal length is *f*.

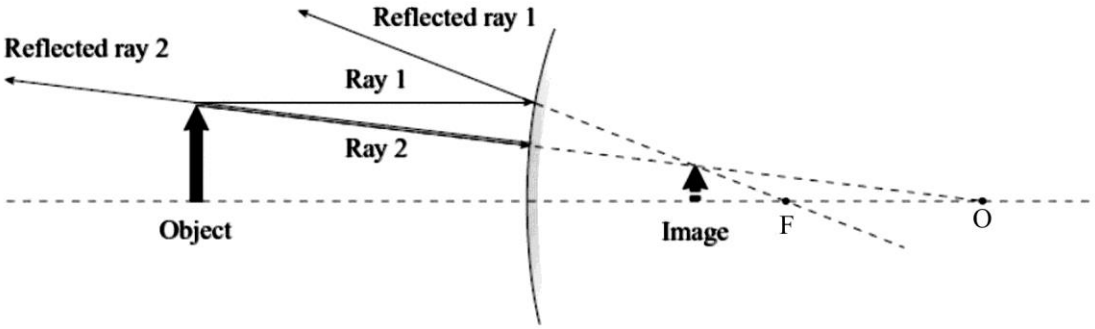


a. Explain the path of each ray in the figure.

b. What assumptions were made in the diagram?

Activity 23.2.12: Represent and reason

A ray diagram helps us understand how to find the image of an object produced by a convex mirror. Explain the path of each ray in the figure below and how we know where the image is located.



Why is the image in the figure above drawn with a dashed line? What assumptions were made in the diagram? For help, read and interrogate Physics Tool box 23.2 on page 720.

Activity 23.2.14: Apply

Equipment: a metal tablespoon and a small object.

a. Take a tablespoon and a small object. Position the object in front of the spoon. Does the spoon work as a concave or a convex mirror? How do you know?

b. Find the side of the spoon that acts like a concave mirror and estimate its focal distance. Describe the experiment that you performed to do it and the data that you collected. Take photos of your experiment and upload them here.

Activity 23.3.3: Represent and reason

Use ray diagrams and the mirror equation to locate the **position**, **orientation**, and **type of image** (real or virtual) formed by an upright object held in front of a concave mirror of focal length +20 cm. The object distances are (a) 200 cm, (b) 40 cm, and (c) 10 cm.

Part c

Activity 23.4.4: Evaluate

Your friend Ritesh says that it's appropriate to call a convex lens a converging lens and a concave lens a diverging lens. How would you convince him that his classification is not always correct? *Hint:* think of the material of the lens and surrounding medium. Check out the experiment in Figure 23.14 on page 726 in the textbook.

Activity 23.5.1: Evaluate

After working through the derivation of the lens equation:

$$\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}$$

in the textbook (Section 23.5), evaluate its limits to see if it makes sense. In particular:

a. Does the relationship make sense when the object is infinitely far away? Support your answer with a ray diagram.

b. Does the relationship make sense if an object is placed right at the focal point? Support your answer with a ray diagram.

c. Does the relationship make sense when the object is between the lens and the focal point? Support your answer with a ray diagram.

d. Describe carefully all the assumptions that were made deriving the relationship.

e. Explain ray diagrams in Figure 23.19 in the textbook. Why are they important?

Activity 23.5.5: Represent and reason

Equipment: ruler.

Imagine you have a +20-cm focal-length convex lens. You place an object 15 cm from the lens on the main axis.

a. Draw a ray diagram to find the image of the object. Measure the location using a ruler.

b. Use the lens equation to calculate the location of the image.

c. Is the calculation consistent with the ray diagram?

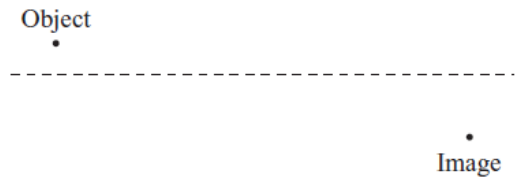
d. What is the meaning of the negative sign in the distance of the image?

Part d

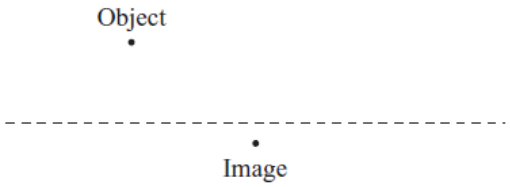
Activity 23.6.2: Diagram Jeopardy

In the figures below, you see the axis of a lens (the lens itself is not shown) and the location of a shining object and its image. Find the location and the type of the lens (convex or concave) that could produce this image, and find the focal points of the lens. When you think you have found an appropriate lens type and lens location, draw a ray diagram to help justify your choice and show the focal length on the diagram. Upload your diagram here.

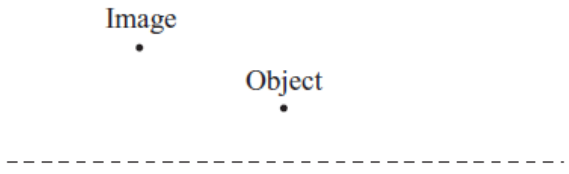
a.



b.



c.



Activity 23.6.6: Practice

Watch this experiment video 23.4.6 and explain:

a. Why do the color circles in the image appear in the inverse vertical order compared to the source (the blue on the bottom and the green on top)?

b. Why does the size of the images change as the lens is moved away from the source?

c. Why do sharp images of the lights appear in the same horizontal order as the point light sources (red, green, blue).