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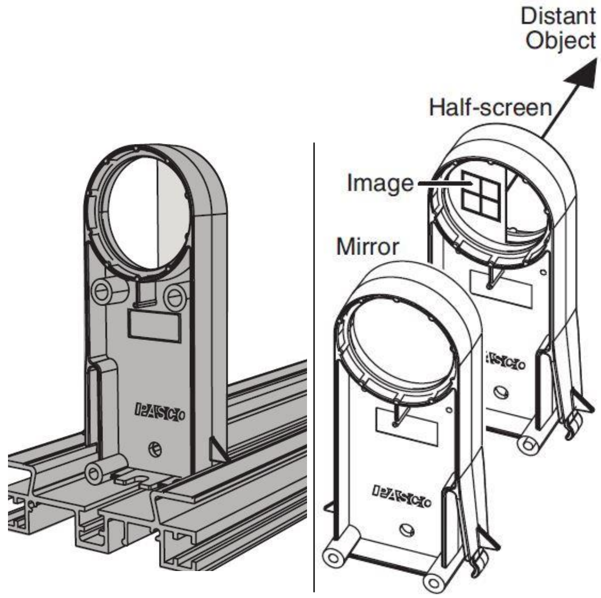
LAB 24. RAY OPTICS: IMAGES OF CONCAVE/CONVEX MIRRORS

AP PHYSICS II

Driving Question | Objective

Where are the images of concave/convex mirrors located? How can you locate images if they are real or virtual?

You will use our PASCO equipment to design an experiment to determine the quantitative relationship between these two variables.



Design and Conduct Your Experiment

Concave mirrors behave very similarly to convex lenses. In fact, if the mirror is then enough, the thin lens equation $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ can be used for mirrors as well.

Materials and Equipment

- Light Source (Image Side)
- Optics Bench
- Metric Ruler
- Half-Screen
- Concave/Convex Mirror
- Viewing Screen
- Masking Tape
- Calipers
- Graphing Calculator

Experimental Design Pt. 1 – Concave Mirrors: Object at Infinity

1. In this part, you will determine the focal length of the concave mirror by making a single measurement of d_i with $d_o \cong \infty$.

2. Hold the mirror in one hand and the half-screen in the other hand. Use the concave side of the mirror to focus the image of a *distant* bright object.

3. Have your partner measure the distance from the mirror to the screen. This is the image distance d_i.

4. **Image Distance**: d_i = ___________9 cm__________.

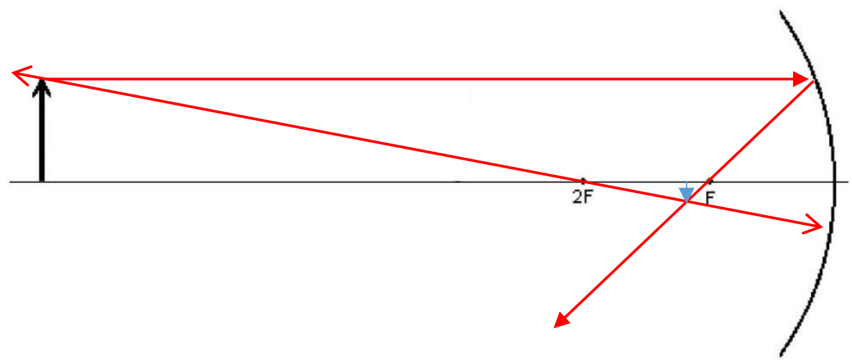
5. Using the thin lens equation, if $d_o \cong \infty$, how does f compare with d_i

6. **Focal Length**: f = _________9 cm_____________.

Experimental Design Pt. 2 – Concave Mirrors: Object Closer than Infinity

1. This time, we will determine focal length of the mirror by measuring several pairs of object and image distances and plotting $\frac{1}{d_i}$ $vs.\frac{1}{d_o}$.

2. Using what you know about ray tracing for a concave mirror, estimate where you believe the image of an object located will be located.



3. Is the image **(virtual), (inverted), (minified)**? Will it be possible to project this image onto a screen because of these conditions? (No)

4. Place the light source and the mirror on the optics bench a distance away from the light source. Place the half-screen between them and adjust its position until an image is formed as seen the figure below.

5. It might not be ideal to measure the size of the image that forms on the half screen with a metric ruler. Instead, use the calipers to accurately measure the image size.

6. Using Table 1 below, collect data with 5 distinct values of the object distance, d_o.

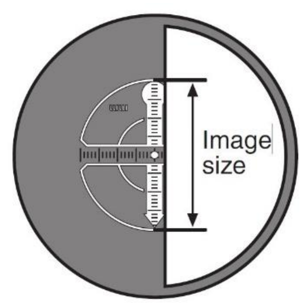


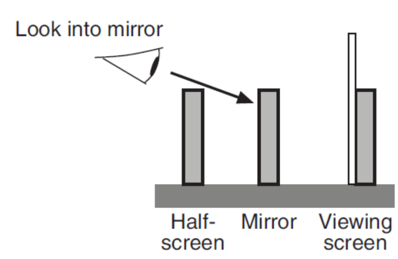
Table 1

d_o	d_i	h_o	h_i	$1/d_o$	$1/d_i$	f
70	12	1.613 in	.284 in	1/70	1/12	10.24
60	12	1.613 in	.368 in	1/60	1/12	10
50	12.5	1.613 in	0.424 in	1/50	1/12.5	10
40	13.5	1.613 in	0.573 in	1/40	1/13.5	10.093
30	15	1.613 in	0.840 in	1/30	1/15	10

7. Use your graphing calculator to analyze $\frac{1}{d_i}$ $vs.\frac{1}{d_o}$. How does this graph compare with the graph from the "Images Formed by Convex Lenses lab? (The graph shows an exponential growth compared to the other linear graph.

Experimental Design Pt. 3 – Images for Convex Mirrors

1. In this part, you will attempt to find the location of a virtual image formed by a convex mirror. You will not be using the light source in this part.

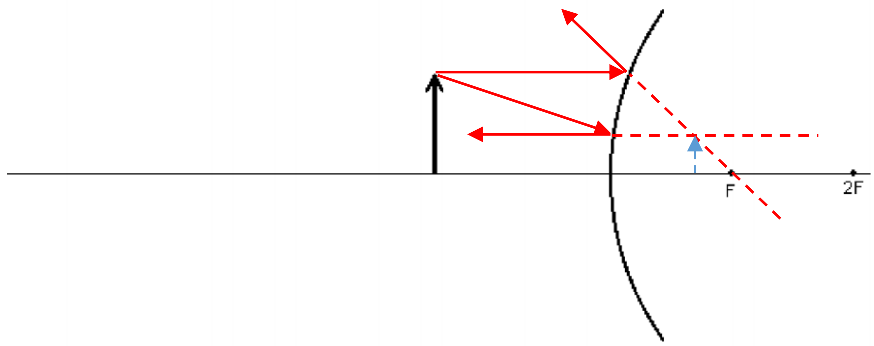


2. Place the half-screen on the bench near one end. Turn the screen so its edge is vertical. Place the convex mirror on the bench such that the convex side faces the half-screen.

3. **Object Distance: d_o = __________20 cm__________.**

4. Look through the half screen into the mirror. Is it **upright/inverted**, **minified/magnified**? Using parallax, is the image of the half-screen **in front/behind** the mirror?

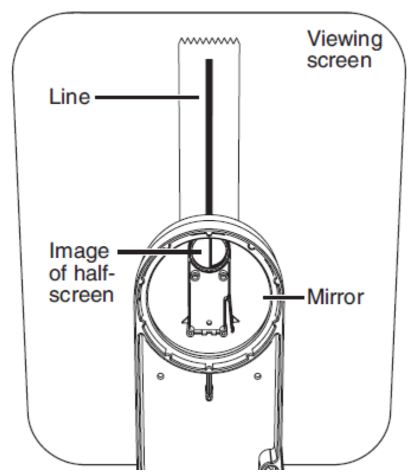
5. Use what you know about ray tracing to locate an estimated position for the image of an object



6. Is the image **real/virtual, upright/inverted, magnified/minified**? Will it be possible to project this image onto a screen because of these conditions?

7. Make an educated approximation as to the location of the image on the bench. Place the full-size screen at this location, as seen in the figure on the top right of this page.

8. Look over the top half of the half-screen so you can see the image of the half-screen and the line drawn on the viewing screen at the same horizontal location (see figure to the right).



9. Use Parallax and move your head side to side. If you guessed the right spot, the line on the tape should stay lined up with the middle of the image of the half-screen. Make adjustments if needed until you have located the image position.

10. **Image distance: d_i = ________8 cm________.**

11. **Magnification of image: $M = |d_i/d_o|$ = ________2/5________.**

12. Does this magnification agree with the properties of your ray tracing sketch (magnified/minified)?

Analysis

1. For the concave mirror, were there any values of object distance which did not project an image onto the half-screen. If so, what were these values?

   NO, there were no distance values where no image was projected onto the half-screen.

❓ 2. How were the magnifications of the concave/convex images similar? How were they different?

Both minified the image produced, but the convex produced a virtual image.

❓ 3. The true focal length of both mirrors is 10 cm. Using your data from Part 2 – Concave Mirrors: Objects Closer than Infinity, how far off were you?

Consulting the data collected in Part 2, we determined the focal length to be at distances of: 10.24, 10, 10, 10.093, and 10 cm.

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