Focus on the Screen

Use lens-bench measurements to locate a projected image.

PHY.4.8 "Use ray diagrams and thin lens equations to solve real-world problems involving object distance from lenses, using a lens bench, online simulations, and/or laboratory experiences."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the definitions of object distance and image distance, and circle the thin lens equation. Number the two ray paths 1 and 2 so you can use them to check where an image forms.

Finding a Sharp Image

1. A school theater uses a converging lens to project a tiny arrow onto a screen. On a lens bench, an arrow lamp, lens, and screen slide along one straight track. The arrow is 3 cm tall. Students move the screen until its image looks sharp, then measure distances from the center of the lens.

2. The table records four sharp images with the same lens. Object distance, d_o, runs from the arrow to the lens. Image distance, d_i, runs from the lens to the screen. For a thin lens, $1/f = 1/d_o + 1/d_i$; this lens has focal length f = 12 cm.

LENS-BENCH MEASUREMENTS

Arrow to lens (cm)	Lens to sharp screen (cm)	Image height (cm)
18	36	6
24	24	3
36	18	1.5
48	16	1

3. For a ray sketch, draw a vertical lens and a horizontal axis. Mark the focal points on both sides. From the arrow tip, draw one ray parallel to the axis that bends through the far focal point, and one through the lens center that stays straight. Their crossing marks an inverted image. Image height divided by object height equals d_i/d_o.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use the 18 cm trial and the thin lens equation to calculate the focal length. Show your substitution.

2. If the arrow is placed 30 cm from this lens, how far from the lens should the screen be for a sharp image? Show your calculation.

3. In the 18 cm trial, use the distance ratio to calculate image height. Is the image upright or inverted according to the ray paths?

4. The arrow is 36 cm from the lens, but the screen is 24 cm from the lens. How far and in which direction must the screen move to show a sharp image?

3 YOUR TURN

Your own words

A different converging lens has a focal length of 8 cm. Draw a ray diagram for a 2 cm tall object 24 cm to its left, labeling the focal points, both ray paths, and the image's distance, height, and orientation. Write one sentence telling where to place a screen.

ANSWER KEY

Focus on the Screen

PART 1 · READ AND MARK

Underline the definitions of object distance and image distance, and circle the thin lens equation. Number the two ray paths 1 and 2 so you can use them to check where an image forms. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use the 18 cm trial and the thin lens equation to calculate the focal length. Show your substitution.	**1/f = 1/18 + 1/36 = 1/12, so f = 12 cm.**
2	If the arrow is placed 30 cm from this lens, how far from the lens should the screen be for a sharp image? Show your calculation.	**$1/d_i = 1/12 - 1/30 = 1/20$, so the screen should be 20 cm from the lens.**
3	In the 18 cm trial, use the distance ratio to calculate image height. Is the image upright or inverted according to the ray paths?	**The image height is 3 × (36/18) = 6 cm. It is inverted.**
4	The arrow is 36 cm from the lens, but the screen is 24 cm from the lens. How far and in which direction must the screen move to show a sharp image?	**The 36 cm trial gives a sharp image 18 cm from the lens. Move the screen 6 cm toward the lens.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The sketch places the lens at 0 cm, focal points 8 cm on each side, and a 2 cm tall object 24 cm to the left. A ray from the object tip travels parallel to the axis, then bends through the right focal point. A second ray passes straight through the lens center. They cross 12 cm to the right at the tip of a 1 cm tall inverted image. Place the screen 12 cm to the right of the lens.

Accept equivalent calculations and ray sketches with correctly labeled distances. For Your Turn, the two rays must meet at an inverted image 12 cm from the lens.