Follow the Image

Connect lens distances, graphs, and ray sketches.

HS-PSII-8.3 "Develop graphical, mathematical, and pictorial representations (e.g., ray diagrams) that describe the relationships between the focal length, the image distance..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the lens equation and distance sign rules, then circle each description of a ray's path so you can connect calculations to sketches.

Moving an LED Along an Optical Bench

1. On an optical bench, an LED moves while a lens stays fixed. A screen catches an image only if rays meet on the far side of the lens. Measure distances from the lens: object distance d_o is positive on the LED side. Image distance d_i is positive on the far side and negative on the LED side.

2. A converging lens has positive focal length f; a diverging lens has negative f. For either lens, $1/f = 1/d_o + 1/d_i$. The table compares lenses with equal focal-length magnitude. On a graph with d_o horizontal and d_i vertical, negative image distances plot below zero. Notice how the two lenses respond differently when the LED moves.

LENS DISTANCES

Lens	f (cm)	d_o (cm)	d_i (cm)
Converging	+10	20	+20
Converging	+10	30	+15
Diverging	-10	20	-6.7
Diverging	-10	30	-7.5

3. Sketch a ray from the LED tip parallel to the axis. After a converging lens, it aims toward the far focal point; after a diverging lens, it spreads as if from the near focal point. A ray through the lens center continues straight. The image lies where rays meet or where their backward extensions meet.

2 ANSWER WITH EVIDENCE

Use the passage

1. For the converging lens, the LED moves from 20 cm to 30 cm from the lens. What happens to d_i? Give the two points you would plot as (d_o, d_i).

2. For the diverging lens, the LED moves from 20 cm to 30 cm from the lens. How does d_i change, and does the image move closer to or farther from the lens?

3. Use the converging-lens row with d_o = 30 cm to calculate focal length. Show your substitution into the lens equation.

4. For the diverging lens at d_o = 20 cm, where would the rays or their backward extensions meet? Could a screen on the far side catch that image?

3 YOUR TURN

Your own words

Use an object distance of 40 cm for each lens in the table. In two labeled panels, calculate each image distance and sketch rays showing the object, lens, focal points, and image; label each image real or virtual.

Follow the Image

PART 1 · READ AND MARK

Underline the lens equation and distance sign rules, then circle each description of a ray's path so you can connect calculations to sketches. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	For the converging lens, the LED moves from 20 cm to 30 cm from the lens. What happens to d_i? Give the two points you would plot as (d_o, d_i).	**d_i decreases from +20 cm to +15 cm. Plot (20, 20) and (30, 15).**
2	For the diverging lens, the LED moves from 20 cm to 30 cm from the lens. How does d_i change, and does the image move closer to or farther from the lens?	**d_i changes from -6.7 cm to -7.5 cm. The image moves farther from the lens on the LED side.**
3	Use the converging-lens row with d_o = 30 cm to calculate focal length. Show your substitution into the lens equation.	**1/f = 1/30 + 1/15 = 1/10, so f = +10 cm.**
4	For the diverging lens at d_o = 20 cm, where would the rays or their backward extensions meet? Could a screen on the far side catch that image?	**The backward extensions meet 6.7 cm from the lens on the LED side. A screen on the far side cannot catch this virtual image.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Converging panel: The object is 40 cm left of the lens, with focal points 10 cm on each side. A parallel ray refracts through the right focal point, and a center ray continues straight. They meet at an inverted, real image 13.3 cm right of the lens. $1/10 = 1/40 + 1/d_i$, so d_i = +13.3 cm. Diverging panel: The object is 40 cm left of the lens, with focal points 10 cm on each side. A parallel ray spreads as if from the left focal point, and a center ray continues straight. Their backward extensions meet at an upright, virtual image 8 cm left of the lens. $-1/10 = 1/40 + 1/d_i$, so d_i = -8 cm.

Accept rounded values near +13.3 cm and -8 cm. In the diverging sketch, the backward extensions, not the outgoing rays, must meet on the object side.