

## Algebra Essentials and Applications Internet Activity

### ME1 Rational Functions Investigations

One of the basic equations in optics states

$$\frac{1}{x_{\text{obj}}} + \frac{1}{x_{\text{img}}} = \frac{1}{\text{Focus}} \quad \text{where} \quad \begin{cases} x_{\text{obj}} \text{ is the distance from the lens to the image} \\ x_{\text{img}} \text{ is the distance from the object to the lens} \\ \text{Focus is the focal distance of the lens} \end{cases}$$

Note that Focus is positive for a converging lens and negative for a diverging lens. The value of  $x_{\text{img}}$  can be either positive or negative. If  $x_{\text{img}}$  is positive, the image is a *real image* on the opposite side of the lens from the object. If  $x_{\text{img}}$  is negative, the image is a *virtual image* on the same side of the lens as the object. Solving the equation above for  $x_{\text{img}}$  we obtain:

$$\begin{aligned} \frac{1}{x_{\text{obj}}} + \frac{1}{x_{\text{img}}} &= \frac{1}{\text{Focus}} \\ \frac{1}{x_{\text{img}}} &= \frac{1}{\text{Focus}} - \frac{1}{x_{\text{obj}}} \\ \frac{1}{x_{\text{img}}} &= \frac{1}{\text{Focus}} \cdot \frac{x_{\text{obj}}}{x_{\text{obj}}} - \frac{1}{x_{\text{obj}}} \cdot \frac{\text{Focus}}{\text{Focus}} \\ \frac{1}{x_{\text{img}}} &= \frac{x_{\text{obj}} - \text{Focus}}{x_{\text{obj}} \cdot \text{Focus}} \\ x_{\text{img}} &= \frac{x_{\text{obj}} \cdot \text{Focus}}{x_{\text{obj}} - \text{Focus}} \end{aligned}$$

- At the Converging Lens site, use your mouse to position the object, the red arrow, 2 meters from the lens. What is the value of  $x_{\text{obj}}$ ?

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- Calculate  $x_{\text{img}}$ . Does this agree with the value shown on the screen?

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- Position the object 2.5 meters from the lens. Calculate  $x_{\text{img}}$ .

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4. Position the object 3 meters from the lens. Calculate  $x_{\text{img}}$ .

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5. Position the object 1 meter from the lens. Calculate  $x_{\text{img}}$ . Why does this answer occur? What does the screen have for an answer?

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6. If we could position the object 1000 meters from the lens, what would be the value of  $x_{\text{img}}$ ? As the object moves further to the left, or as  $x_{\text{obj}}$  increases, what happens to the value of  $x_{\text{img}}$ ? Where, then, is the image formed?

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7. At the Diverging Lens site, position the object, the red arrow, 1 meter from the lens—that is, on the focal point. Calculate  $x_{\text{img}}$ . Does this agree with the value shown on the screen?

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8. Position the object 2 meters from the lens. Calculate  $x_{\text{img}}$ .

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9. Position the object 3 meters from the lens. Calculate  $x_{\text{img}}$ .

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