Vergence: Lenses

Basic Optics, Chapter 2
The term **vergence** describes what light rays are doing in relation to each other.

With respect to a given point, light rays can:
- spread out (**diverge**)
- come together (**converge**)
- run parallel (**vergence = zero**)

(From the last slide-set)
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(From the last slide-set)

- Vergence is measured in **diopters** ($D$)
  - Dioptic power is defined as the reciprocal of the distance (in meters) to the point where light rays would intersect
Important point: *Light rays emanating from any point are always divergent!*
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- For the most part, converging rays rarely appear in the ‘natural world’
- Convergence requires a refracting surface, e.g., a *lens* *

*Or a curved mirror—a subject we’ll get to down the road*
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Take note of two conventions used in vergence problems:
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1) *Light always moves left to right*
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Take note of two conventions used in vergence problems:

1) *Light always moves* left to right

2) *Distances are negative to the left of the lens, positive to the right*
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- There are two basic types of spherical lenses:
  - Plus
  - Minus
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- *Plus lens*: induces convergence
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- *Plus lens*: induces convergence

In this example, a plus lens causes previously parallel rays to converge to a point.
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- **Plus lens**: induces convergence

Rays exiting this plus lens are diverging; however, they are less divergent than they were prior to encountering it (i.e., convergence has been added)
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- *Minus* lens: induces divergence
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- **Minus lens**: induces divergence

*In this example, a minus lens causes previously parallel rays to diverge from a point*
Of course, the light isn’t really diverging from this point; that’s why the rays were extended with dashed lines. In fact, as we will soon see, this location is actually a focal point for this lens. A very important image is being formed at this location, although it’s not the kind of image that can be projected onto a screen. More later!

In this example, a minus lens causes previously parallel rays to diverge from a point

- *Minus* lens: induces divergence
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- *Minus* lens: induces divergence

*Rays exiting this minus lens are converging; however, they are less convergent than they were prior to encountering it (i.e., divergence has been added)*
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- The ability of a lens to induce vergence is expressed in diopters
  - **Dioptric power of a lens**: The reciprocal of the distance (in meters) to the point where incoming parallel light rays would intersect after passing through the lens
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  - Dioptric power of a lens: The reciprocal of the distance (in meters) to the point where incoming parallel light rays would intersect after passing through the lens
  - A +1D lens will focus parallel rays at 1m
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- The ability of a lens to induce vergence is expressed in diopters
  - Dioptric power of a lens: The reciprocal of the distance (in meters) to the point where incoming parallel light rays would intersect after passing through the lens
  - A +2D lens will focus parallel rays at 1/2 m

\[ \text{Distance} = 0.5 \text{ m} \]
\[ \text{Reciprocal} = 1/0.5 \]
\[ \text{Diopters} = +2 \]
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- The ability of a lens to induce vergence is expressed in diopters
  - Dioptric power of a lens: The reciprocal of the distance (in meters) to the point where incoming parallel light rays would intersect after passing through the lens
  - A -1D lens will ‘focus’ parallel rays at 1 m to the left of the lens

Distance = -1 m  
Reciprocal = 1/-1  
Diopters = -1