Phys 5B: Lenses

by Kameron Gill

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Spherical mirriors equation: $\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}$

Only for rays close to center of mirror!

- Refraction at spherical surface

  Thin lens: two spherical surfaces seperated by minimal distances

  object at $d_o = \infty$ has image at $d_i = f$

  Focal length is same on both sides of lends

- Concave mirrior has f>0

- Converging lens f>0

- Divergeing lens has f<0su

- Power: $P = \frac{1}{f}$ with units are diopters $d = [m^{-1}]$

  +2.0D reading glasses have a focal length $f = \frac{1}{P} = \frac{1}{2.0m^{-1}} = .5m$

- with lens, usually objects and eyes on opposite sides of lengs

  the object distance and image dinstance given by $\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}$

  $m = \frac{h_i}{h_0} = -\frac{d_i}{d_0}$

- Example!

  Double convex lens (convering lens: f>0)

  Focal length: 5.0cm

  Object at height 10cm

  Rays will coverge to F if the ray is at object height of 10cm

  $\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f} \Rightarrow \frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_0} \Rightarrow \frac{1}{5.0\text{cm}} - \frac{1}{10\text{cm}} \Rightarrow \frac{1}{10} \qquad d_i = 10\text{cm}$

  $m = \frac{-d_i}{d_0} = \frac{-10}{10} = -1$

- Focal length>0 for converging

  focal length<0 for diverging

- $d_0 > 0$ if object is on side of lens with light source

- $d_i > 0$ if image is on side of lens opposite light source

  $d_i > 0$ is real image!

- Example: Double-concave lens (diverging f<0)

  $f = -5\text{cm} \quad d_0 = 10\text{cm}$

  virtual image

  $\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_0} \Rightarrow \frac{1}{-5\text{cm}} - \frac{1}{10\text{cm}} = \frac{-3}{10}\text{cm} \qquad d_i = \frac{10}{3}\text{cm}$

  $m = \frac{-\left(\frac{-10}{3}\right)}{10} = \frac{1}{3}$ virtual!!