PHY 1120 - Dr. Rowley

Chapter 26 - Optical Instruments

Summer 2020

Sign Conventions - Mirrors

- Focal length is positive if on the reflective side of the mirror and negative if on the back side of the mirror
- h_i is positive if the image is "upright" compared to the object.
- d_o and d_i are positive if on the reflective side of the mirror and are negative if on the back (non-reflective) side of the mirror

Sign Conventions - Lenses

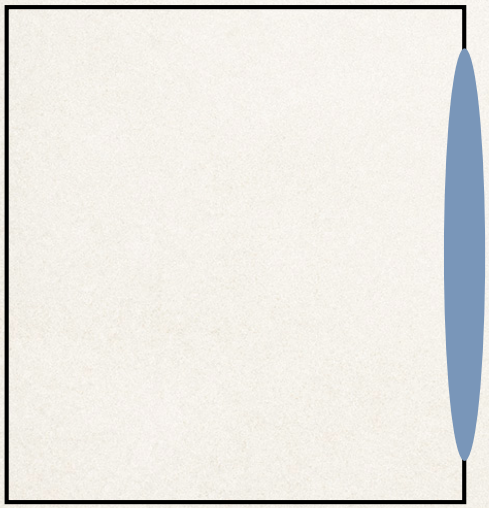
- f is positive for a convex lens and negative for a concave lens
- d_o is positive if it is on the side of the lens the light is coming from.
- d_i is positive if on the opposite side the light is coming from.
- h_i is positive if the image is “upright” compared to the object.

Test Tips

- Make sure you identify and label θ_i and θ_r
- Use the Law of Reflection and Snell's Law as appropriate
- Make sure on refraction the refracted ray is at the correct quadrant
- Be sure to understand the path AND direction the light travels.

Cameras

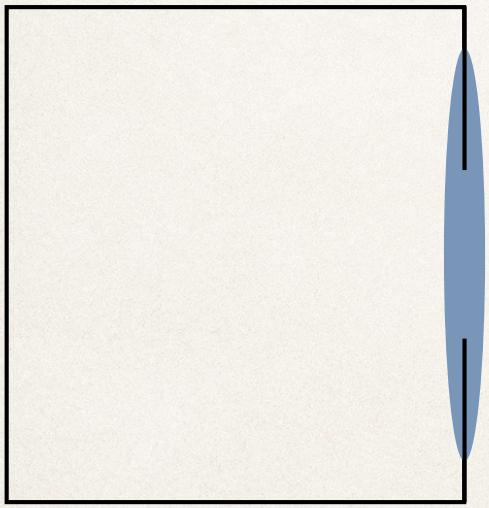
- Do cameras (their lenses) produce real or virtual images?



Cameras

- What is the f-stop

$$f-stop = \frac{f}{D}$$



Cameras

- What is the f-stop of a 20 cm lens that has a iris diameter of 15 mm

$$f-stop=\frac{f}{D}$$

$$f-stop=\frac{20\text{ cm}}{1.5\text{ cm}}$$

$$\boxed{f-stop=13.3\text{ !}}$$

Cameras

- Questions to ask…
  - What happens to the f-stop if you double/half f?
  - What happens to the f-stop if you double/half D?
  - What happens to the intensity of light hitting the film/CCD if you double the diameter of the iris?

Cameras

- What happens to the intensity of light hitting the film / CCD if you double the diameter of the iris?

$$f-stop = \frac{f}{D}$$

$$\left(f-stop\right)' = \frac{f'}{D'} \quad \text{… but} \quad f' = f \quad \text{… and} \quad D' = 2D$$

$$\left(f-stop\right)' = \frac{f}{2D} \quad \text{… so, the f-stop is 1/2 the original, but…}$$

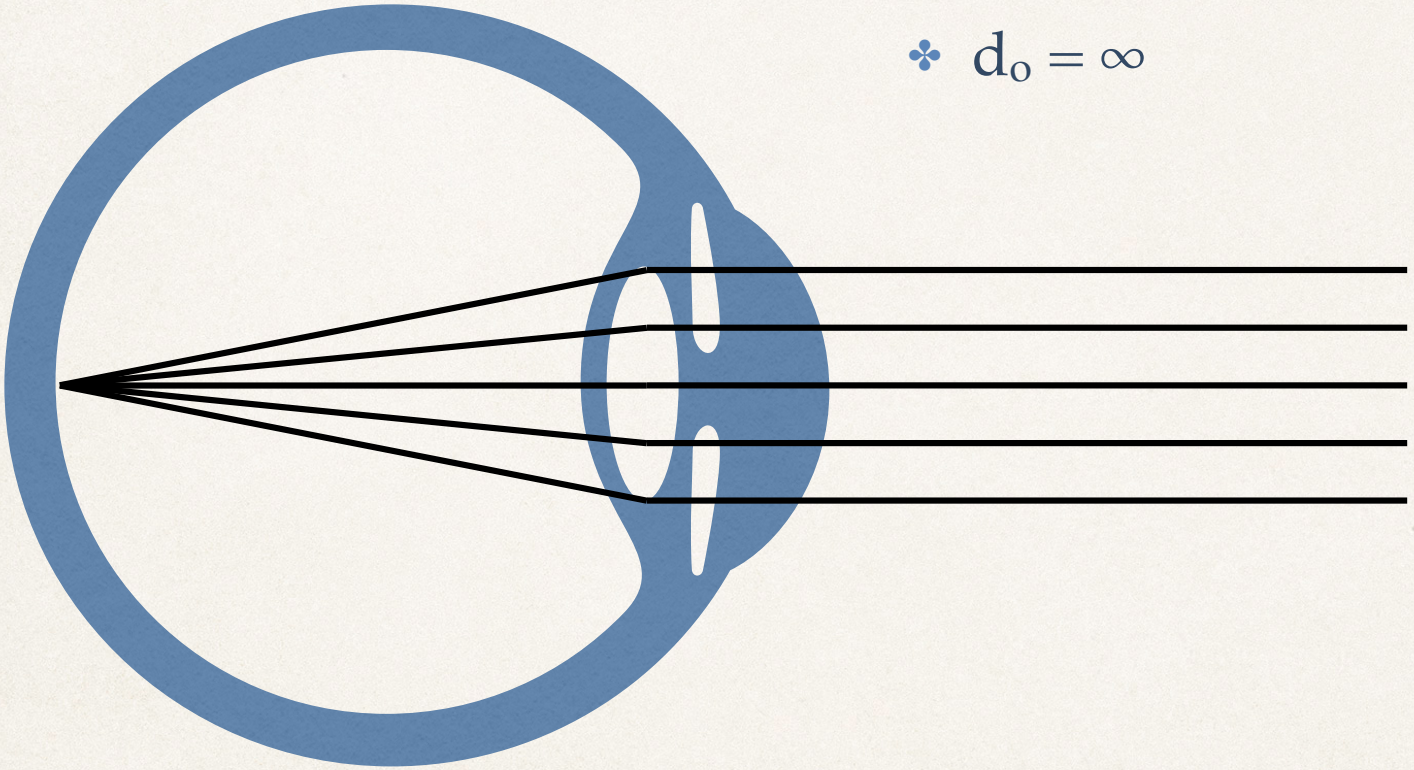
$$I \propto A \quad \text{… and} \quad A = \pi r^2 = \pi\left(2r\right)^2 = 4\pi r^2$$

4x the original area

Cameras

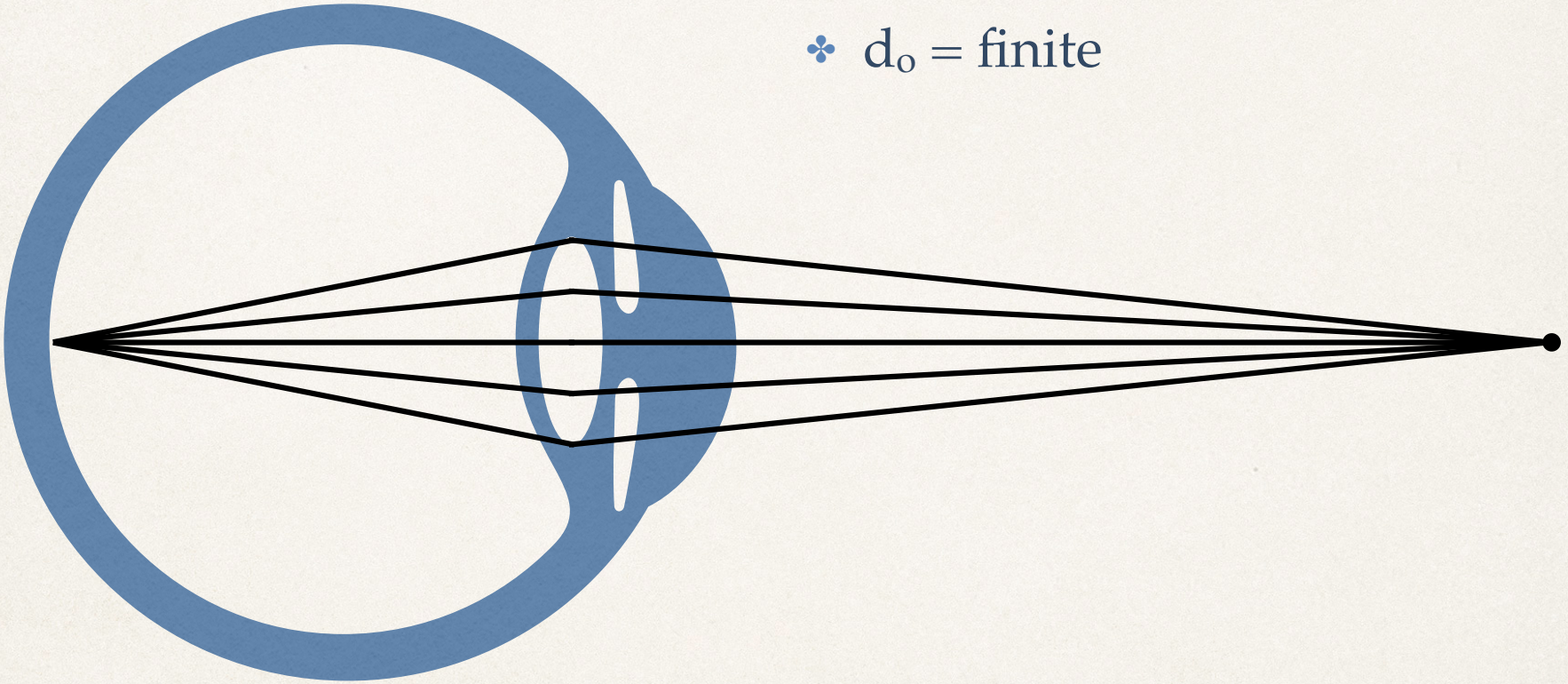
- Remember…
  - Thin lens equation still applies…
    - What is d_i if $d_o = \infty$?

The Human Eye



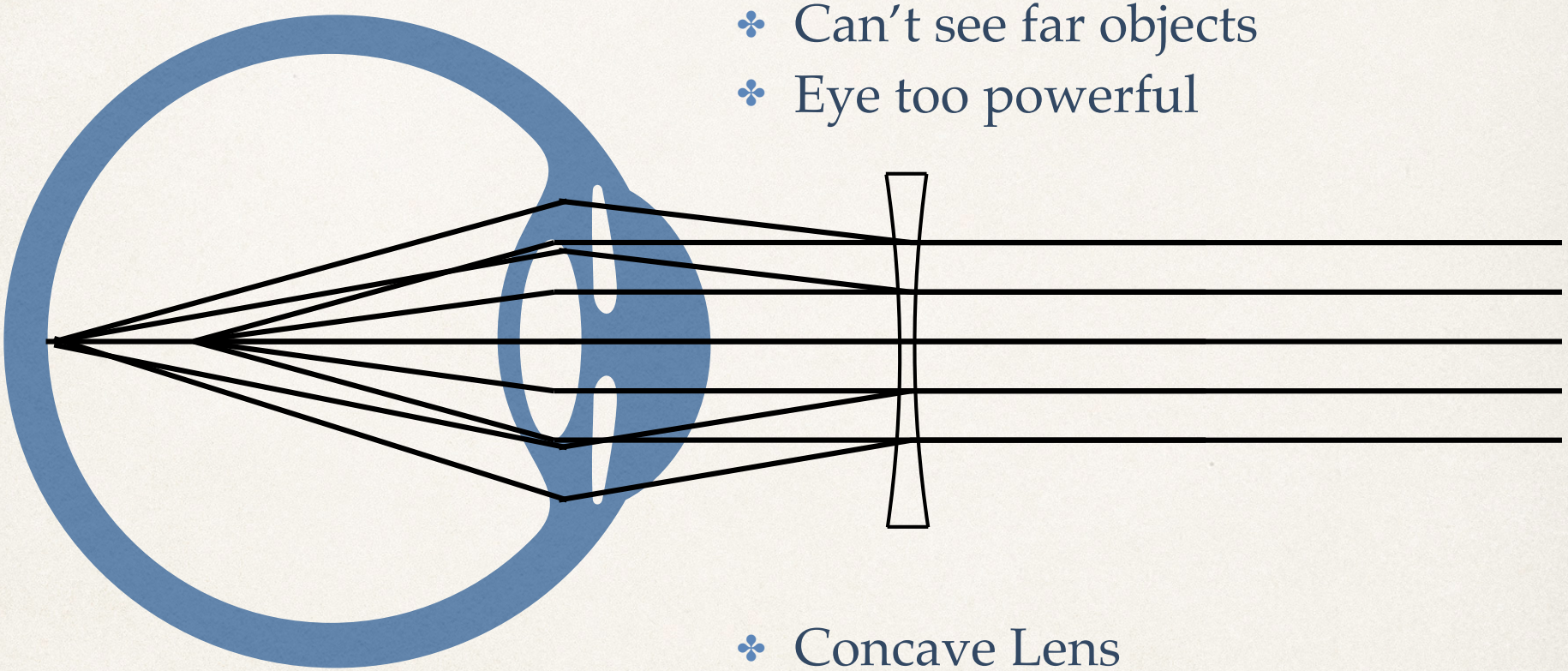
- $d_o = \infty$

The Human Eye



- d_o = finite

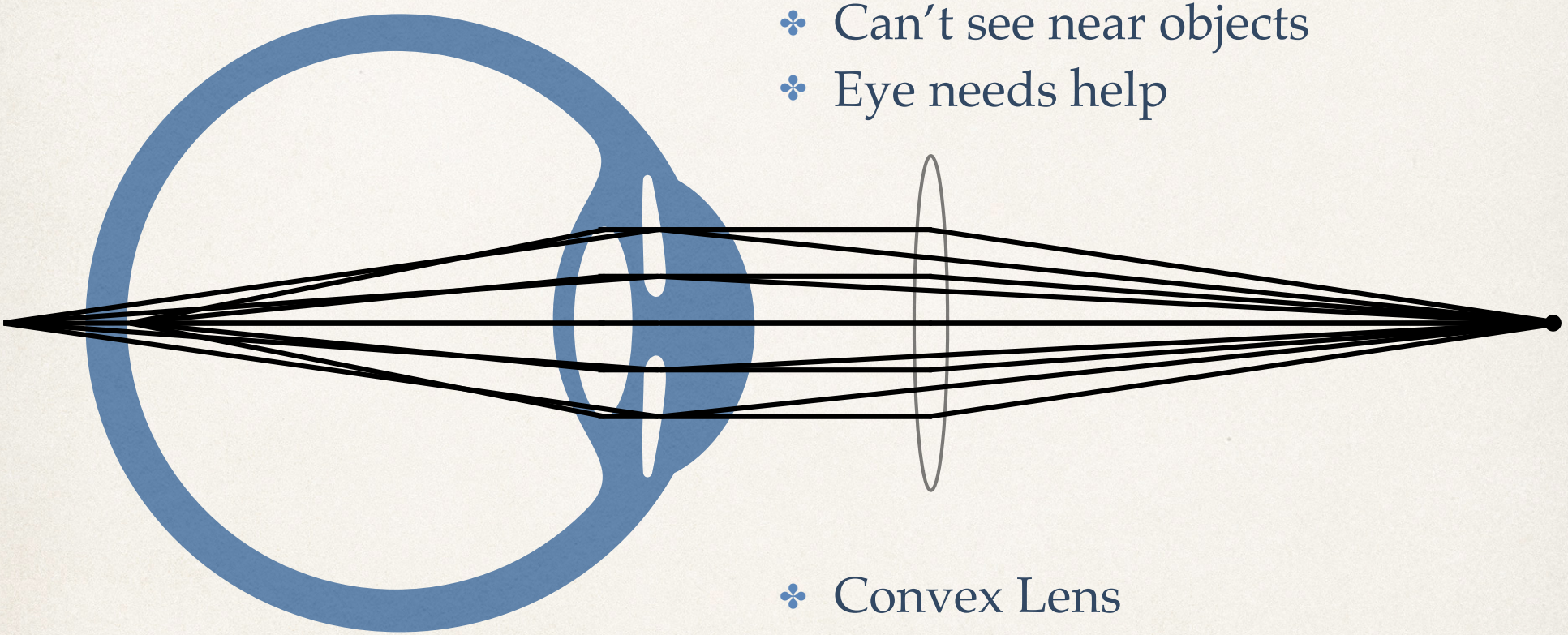
Nearsighted (myopia)



- Can't see far objects
- Eye too powerful

- Concave Lens

Farsighted (hyperopia)



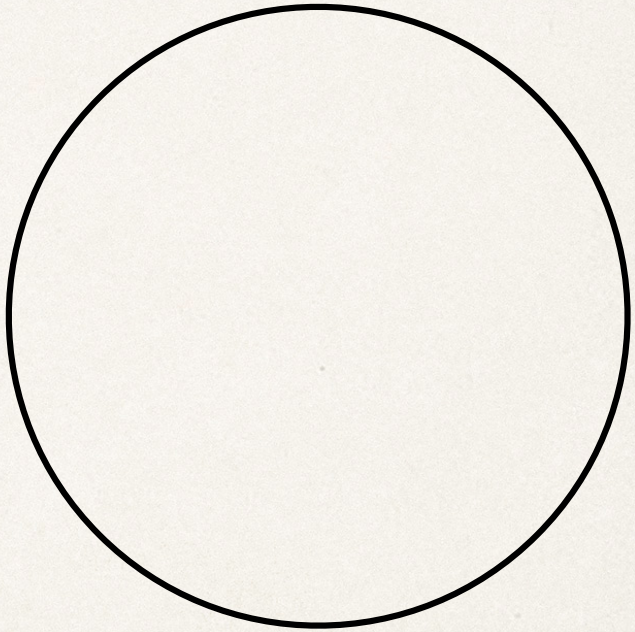
- Can't see near objects
- Eye needs help

- Convex Lens

The Human Eye

- Astigmatism - Asymmetry
- Different curve in each direction
- Measured along perpendicular axes

- 3 Types
  - Myopic,
  - Hyperopic,
  - Both!



The Human Eye

- What is the focal length of a lens which has a power of -8.75 diopters?

$$P\left(\text{in diopters}\right)=\frac{1}{f\left(\text{in meters}\right)}$$

$$f=\frac{1}{P}$$

$$f=\frac{1}{-8.75}=-0.114\ ?$$

- What does the negative mean?
- What's the unit of measurement?