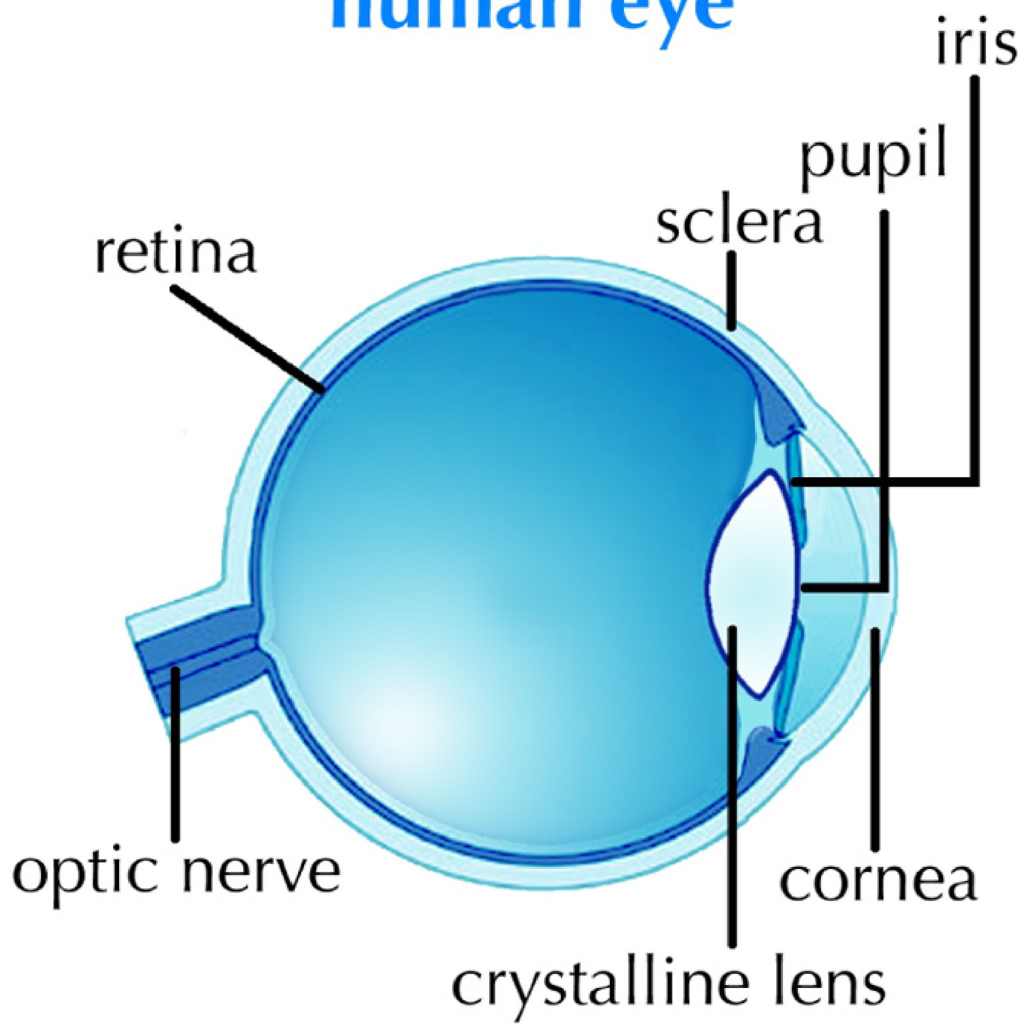
human eye



The human eye actually has two lenses:

crystalline lens + cornea f = 1.67 cm

image on retina is inverted

Distant Objects

As the object distance approaches infinity, what number does the quantity ($1/d_O$) approach?

A. Infinity
B. Zero
C. Undefined

$$\frac{1}{d_O} + \frac{1}{d_i} = \frac{1}{f}$$

When object is "distant" (beyond about 5 or 10 meters?)

$$\frac{1}{d_O} = 0 \quad \text{and} \quad \frac{1}{f} = \frac{1}{d_i} \quad \text{so } f = d_i$$

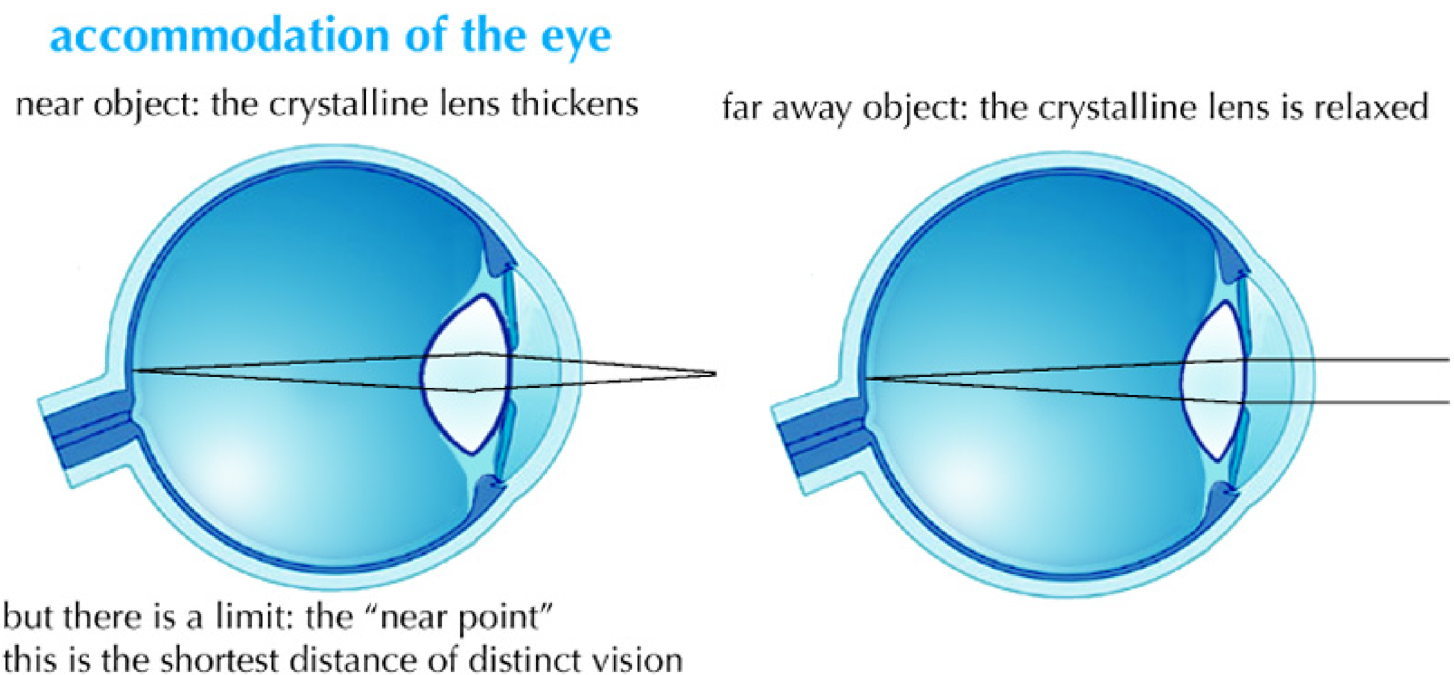
Suppose you want a distant object to form an image on the back of the eye. If the eye has a diameter of 1.70 cm, what is the focal length of the combination of the cornea and lens?

$$\frac{1}{f} = \frac{1}{d_O} + \frac{1}{d_I} = 0 + \frac{1}{d_I}$$

$\rightarrow$ f = 1.70 cm

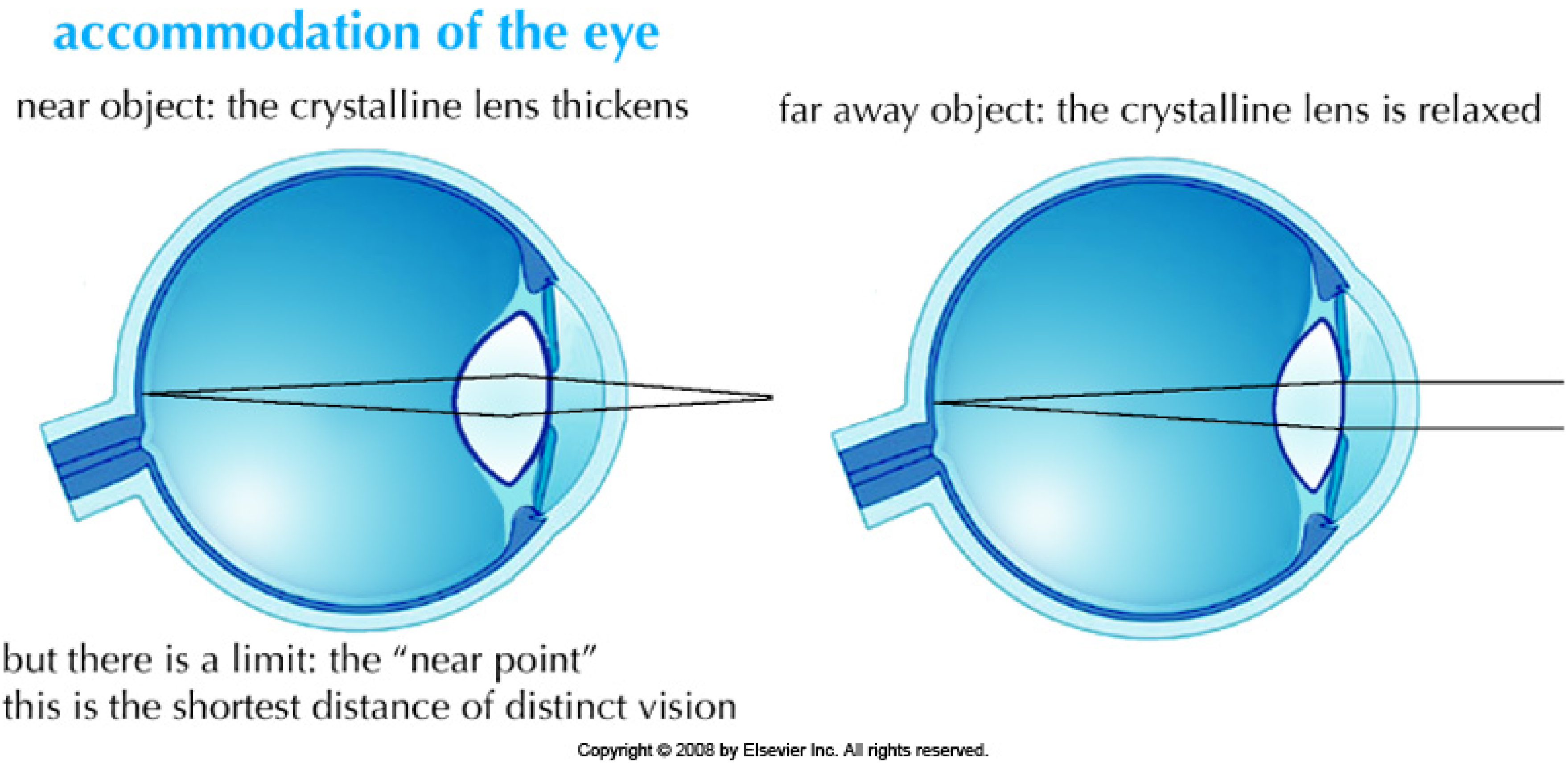
$$f = d_I$$

Focal length positive (converging)



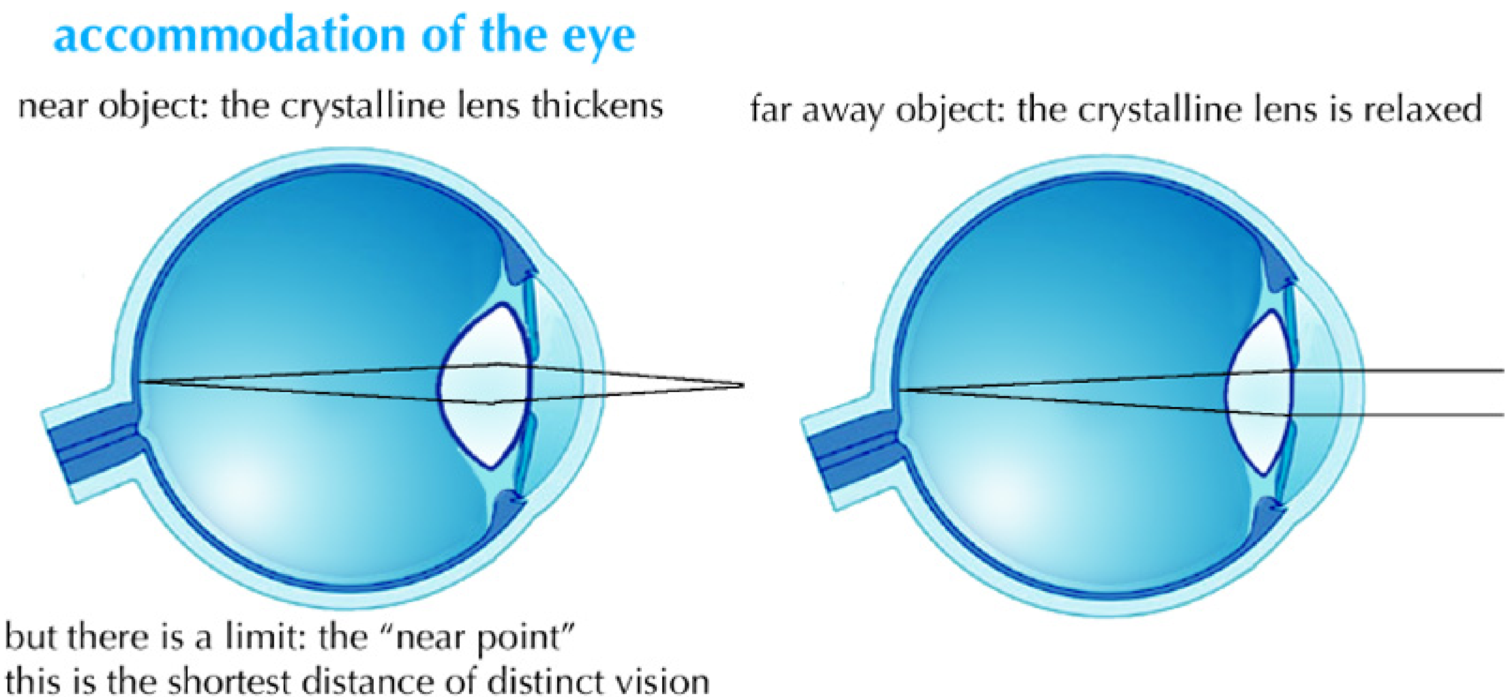
Eye

Eye: focuses by adjusting focal length (accommodation)



Suppose you want an object at a distance 25cm from the eye to form an image on the back of the eye. If the eye has a diameter of 1.70 cm, what is the focal length of the combination of the cornea and lens?

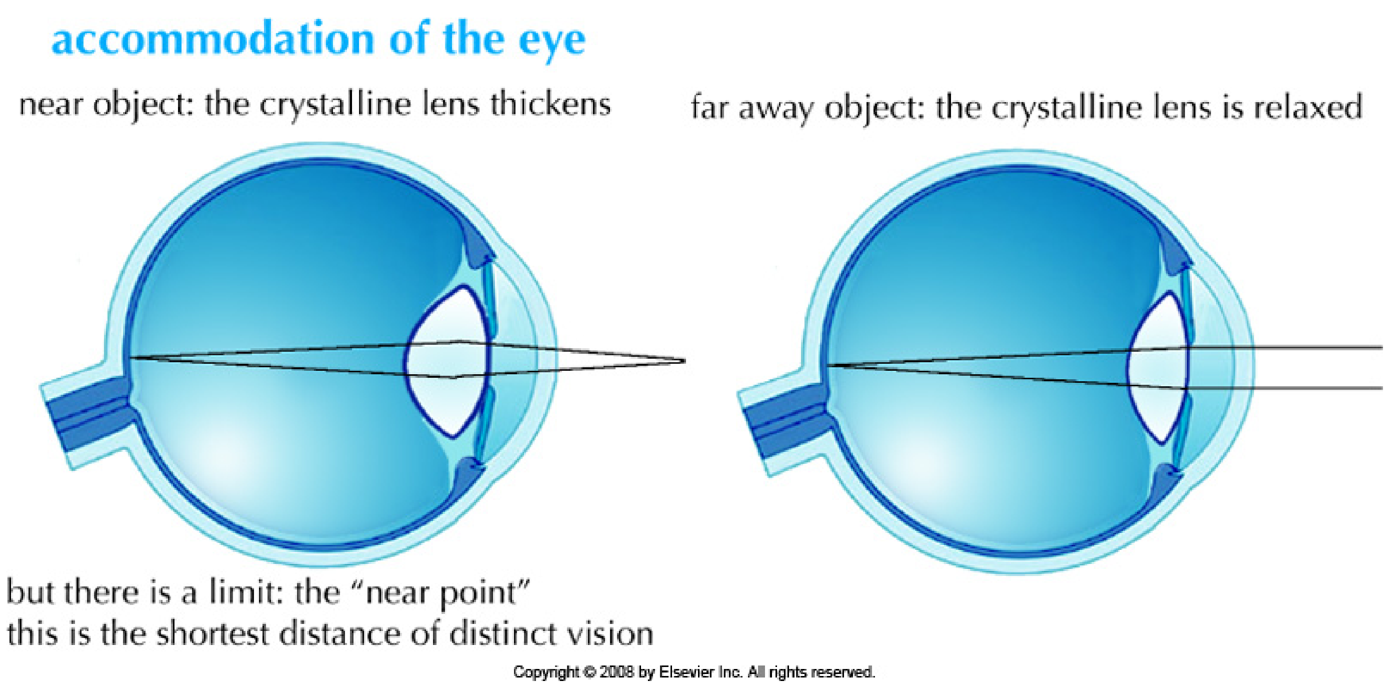
$$\frac{1}{f} = \frac{1}{d_O} + \frac{1}{d_I} = \frac{1}{25cm} + \frac{1}{1.7cm} \qquad \rightarrow f = 1.59 \text{ cm}$$



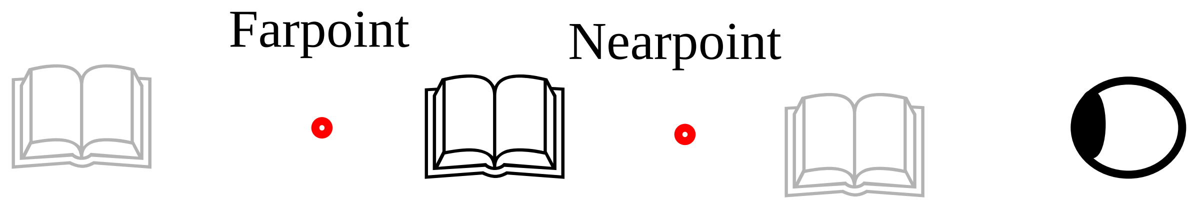
Suppose you want an object at a distance 25cm from the eye to form an image on the back of the eye 1.70cm from the lens. If the object is 20cm tall, how tall (in cm) is the image on the back of the eye? (Give the absolute value. Do not include the negative sign.)

$$m = -\frac{d_I}{d_O} = -\frac{1.70cm}{25\ cm} = -0.068$$

$$m = \frac{h_I}{h_O} \qquad\qquad h_I = mh_O = (-0.068)(20\text{cm}) = 1.36\text{cm}$$

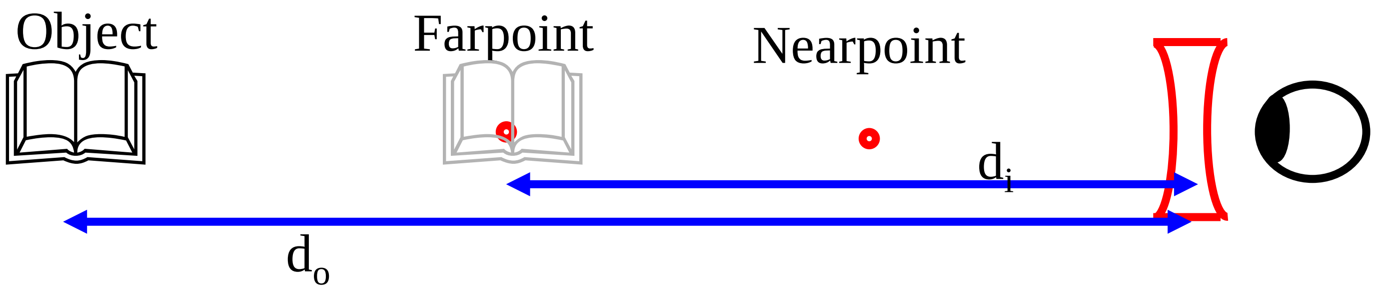


The eye can only focus on something if it seems to be between the near point and far point.



Some eyes have near points and/or far points that aren't ideal.

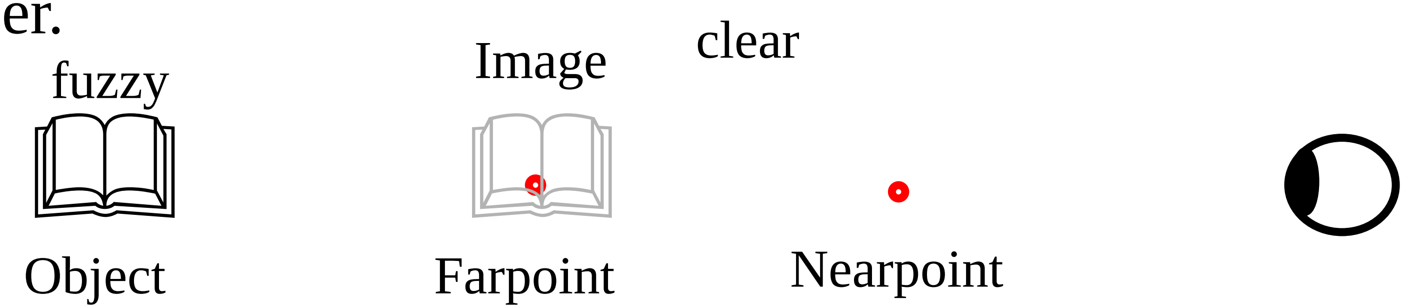
Lenses can make things appear closer or farther away.



Near point and far point property of eye independent of corrective lens
Normal near point: about 25 cm, far point: ∞

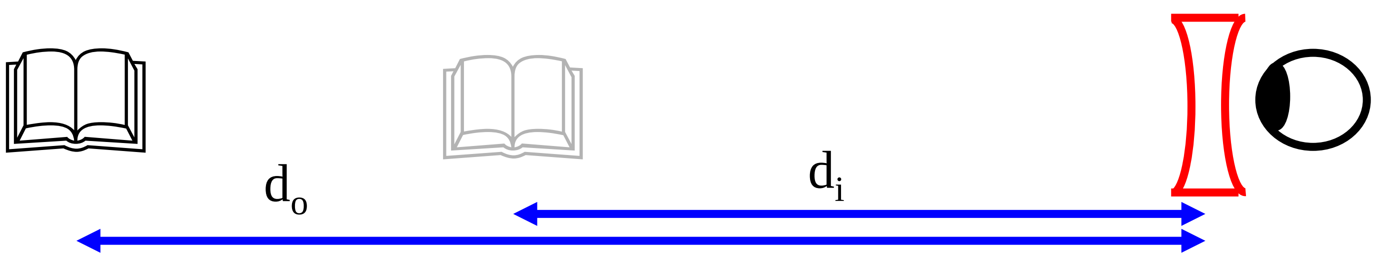
Corrective Lenses – Nearsighted - Myopia

Far point not as far as you'd like …Need to make distant objects seem closer.



So need to find a lens that can be close to the eye that will make a distant object seem to be closer (at far point) Diverging lens

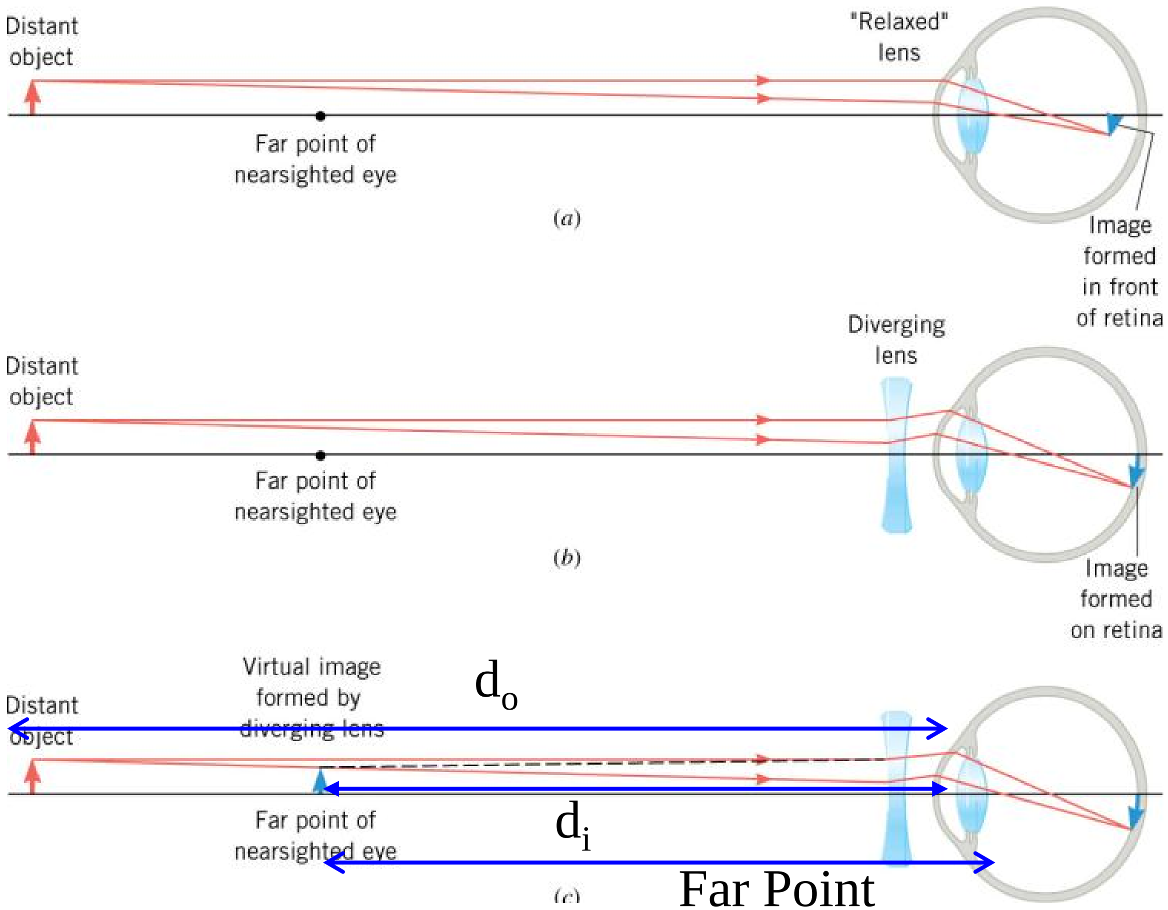
(“Map” from distant point to closer point)



As object gets closer, image also gets closer – if image inside near point, things get fuzzy again

Nearsightedness/Myopia – "map" object at infinity to image at far point

Closer objects appear closer



Example:

An optometrist wants to correct the vision of a nearsighted person by mapping an object at infinity (a distant object) to a virtual image at 50cm (their far point). What is the focal length of the required lens?

$(1/d_0) + (1/d_i) = (1/f)$

$(1/\infty) + (1/(-50\text{cm})) = (1/f)$

$f = -50\text{cm}$

Diverging lens

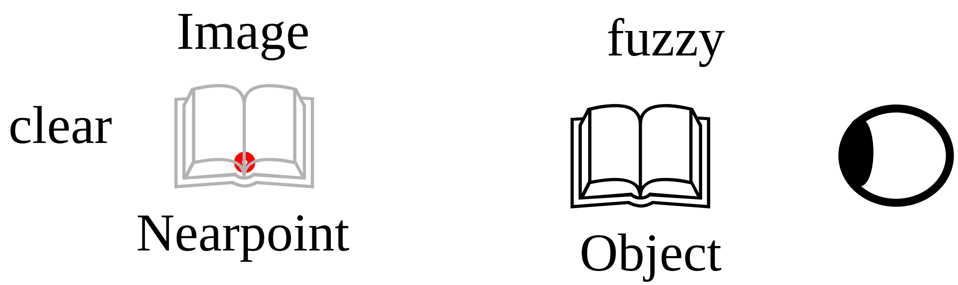
In Diopters:

Refractive Power = $(1/-0.5\text{m})$

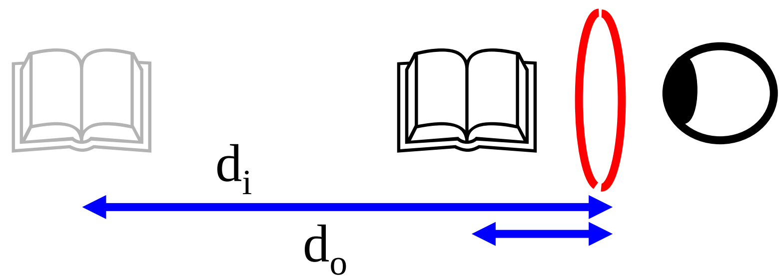
$= -2.0$ Diopters

Corrective Lenses – Farsighted - Hyperopia

Near point not as close as you'd like …Need to make near objects seem farther away.



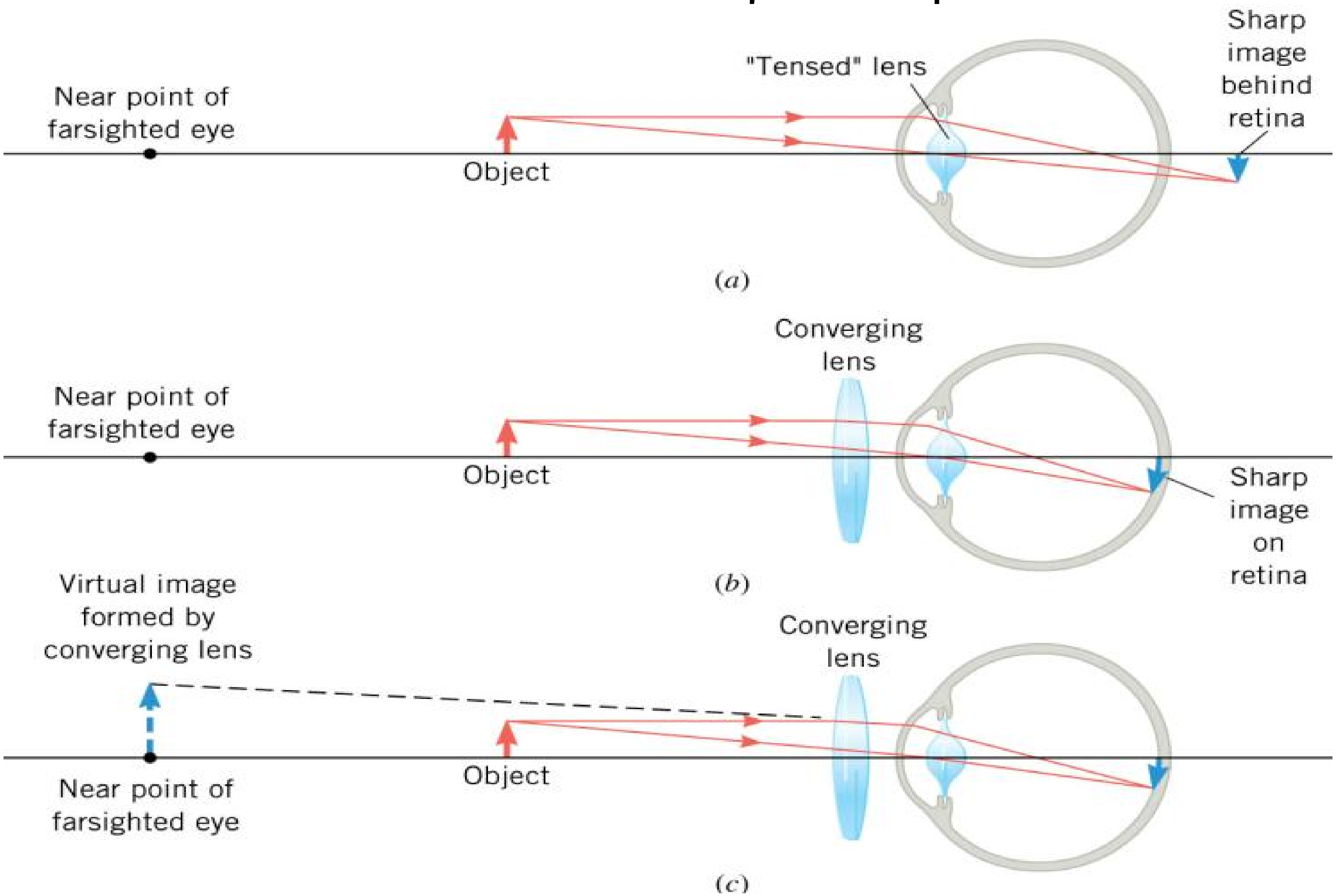
So need to find a lens that can be close to the eye that will make a close object seem to more distant (at near point)



What if object further than focal point?
Image becomes real – glasses no longer work

Farsightedness/Hyperopia – map close objects to image at near point

farther objects map farther away



Example:

An optometrist wants to correct the vision of a farsighted person by mapping an object at 25 cm to a virtual image at 60cm (their near point). What is the focal length of the required lens?

$(1/d_0) + (1/d_i) = (1/f)$

$(1/25\text{cm}) + (1/(-60\text{cm})) = (1/f)$

$f = +43\text{cm}$

Converging lens

In Diopters:

Refractive Power = $(1/-0.43\text{m})$

$= +2.3$ Diopters

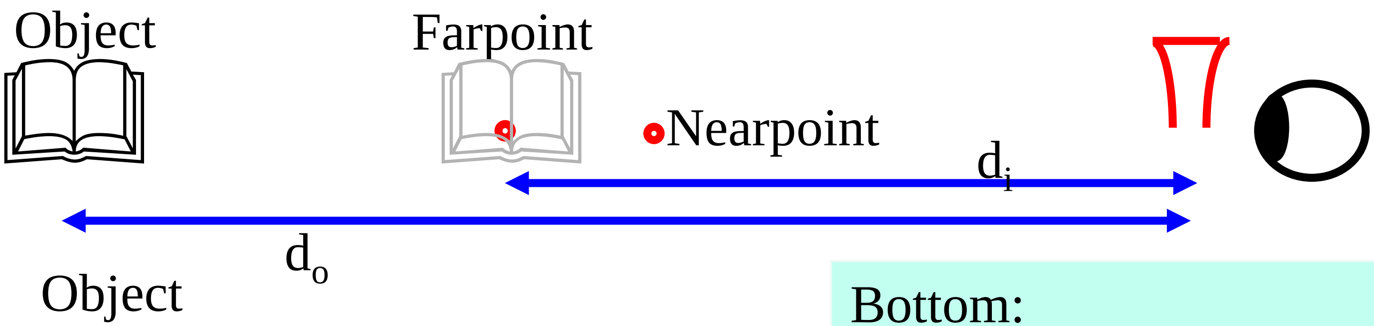
Eyeglasses - Bifocals

Both:

- FP not at infinity
- Near point too far away.

Glasses Split

- Look through top – correct for distant objects to be at Far point or closer



Bottom:

- Look through bottom to correct for objects that are too near