

concave

$$F = 45 \text{ cm}$$

$$h_o = 30 \text{ cm}$$

$$d_o = 55 \text{ cm}$$

$$h_i =$$

$$d_i = \checkmark$$

real image

$$h_i = 25 \text{ cm}$$

$$d_i = 45 \text{ cm}$$

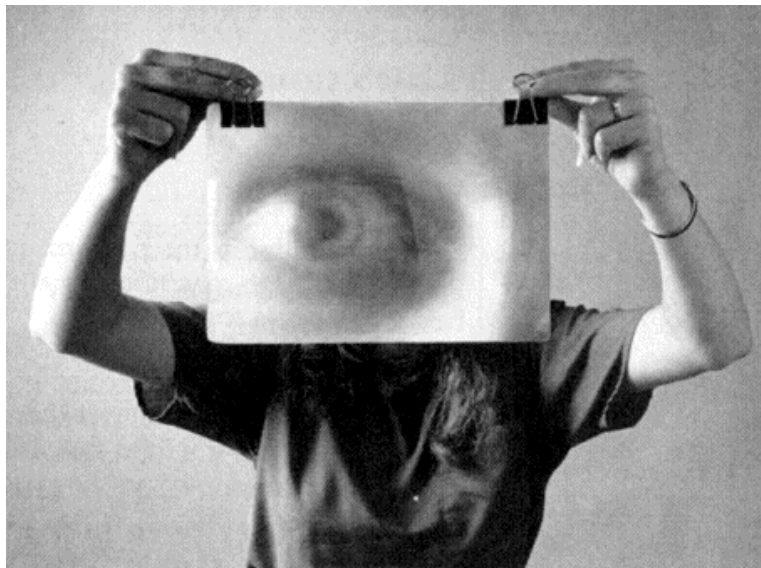
$$C = 1.1 \text{ m}$$


$$d_o = ?$$


$$h_o = ?$$

Lenses

19.2

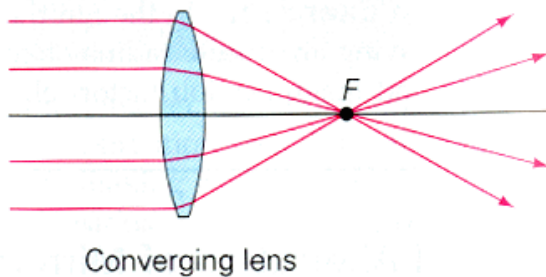
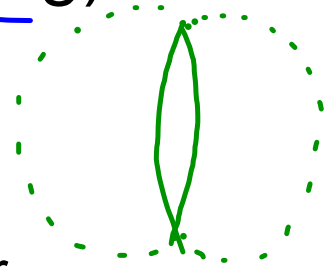


 binocular soccer

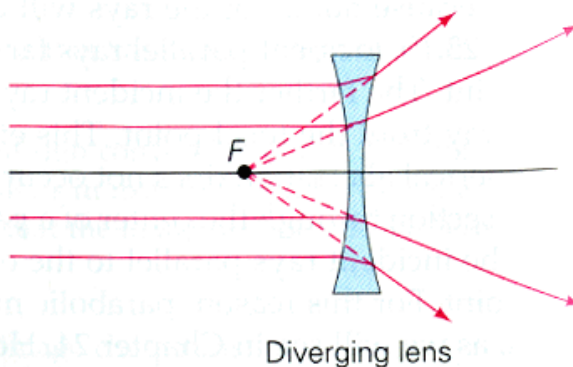
 optical illusion eye

Convex Lens (Converging)

- Thinner on edges, curved outward in center
- Rays all go to focal point if object is far away
- Magnifying glass, movie projector

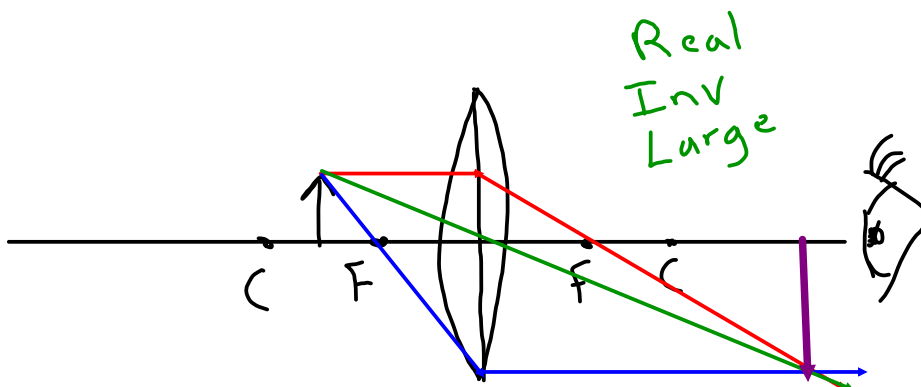
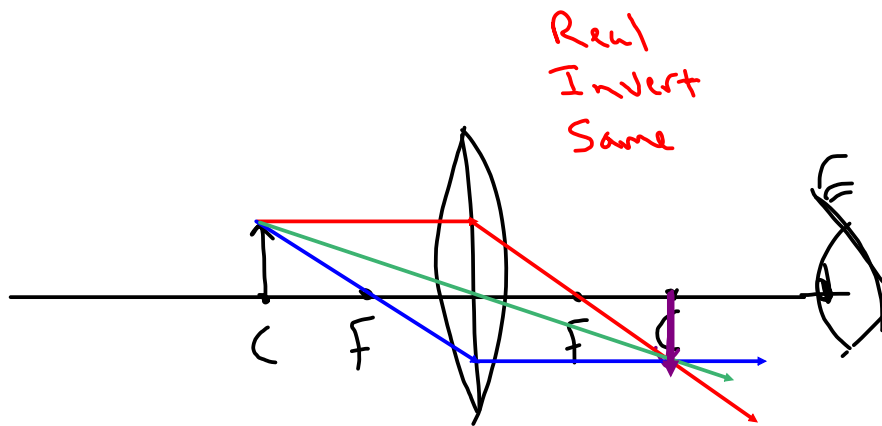
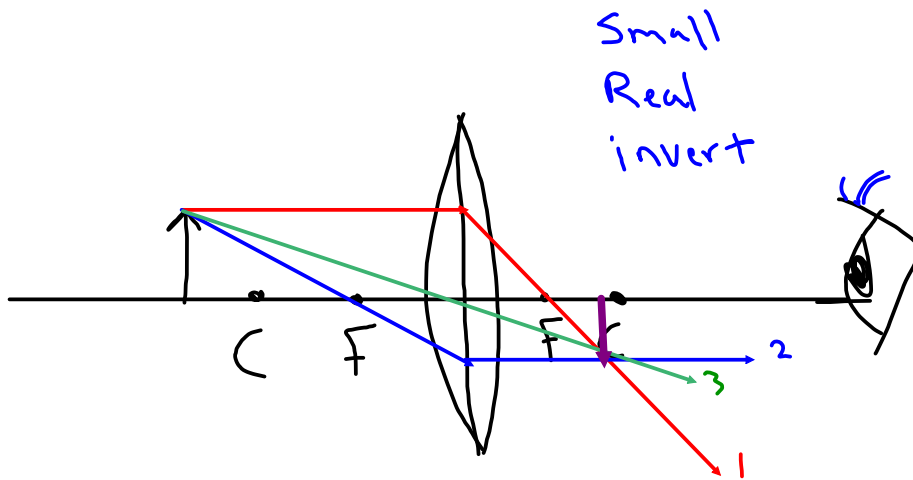
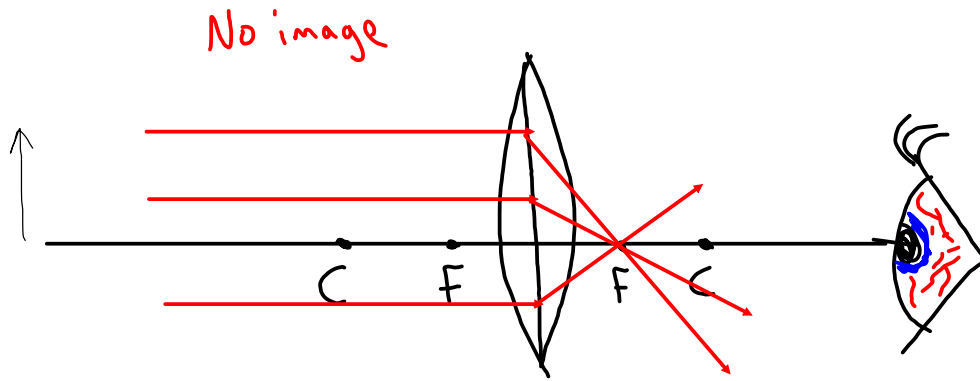


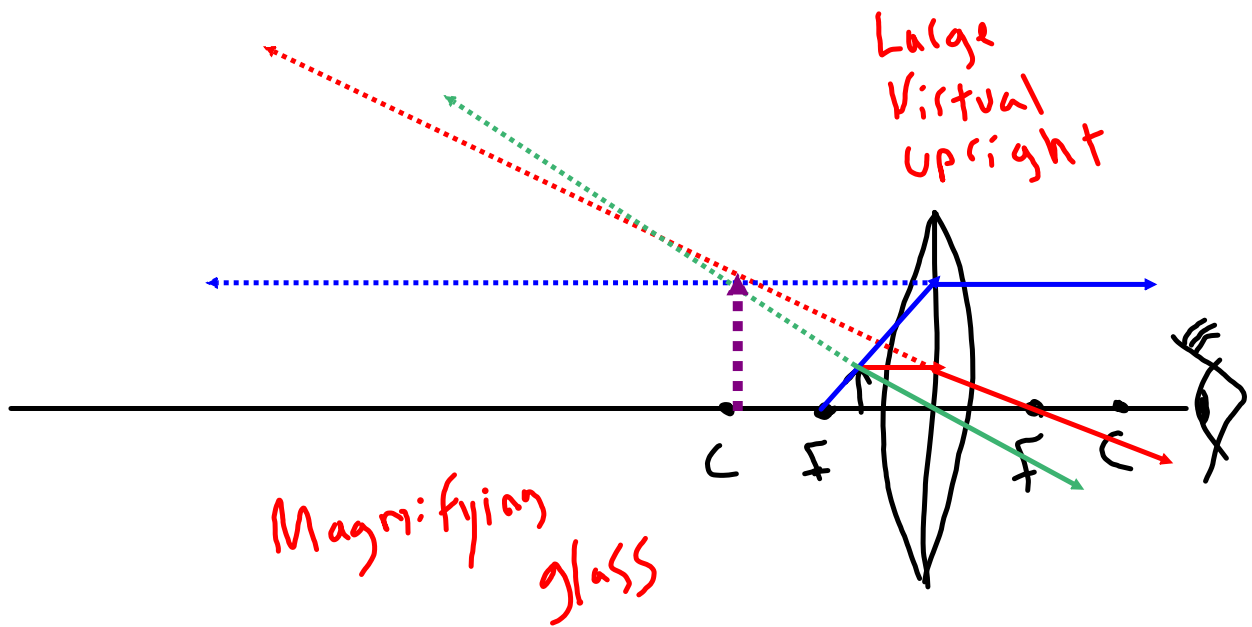
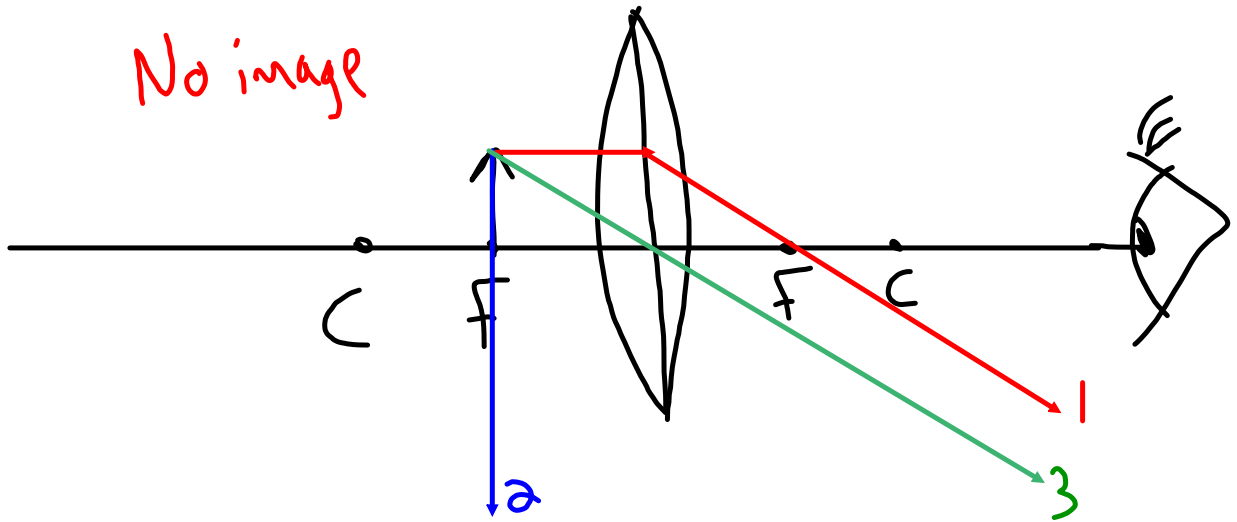
Converging lens



Diverging lens

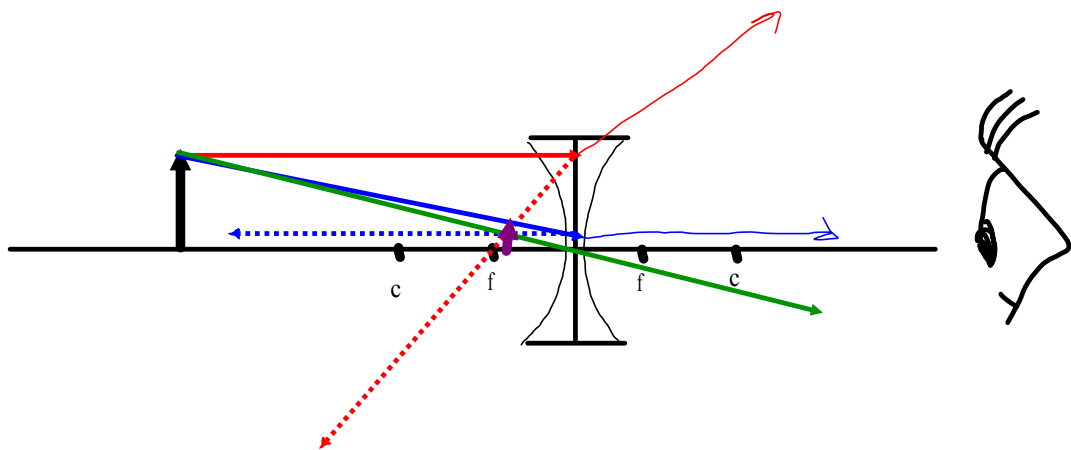
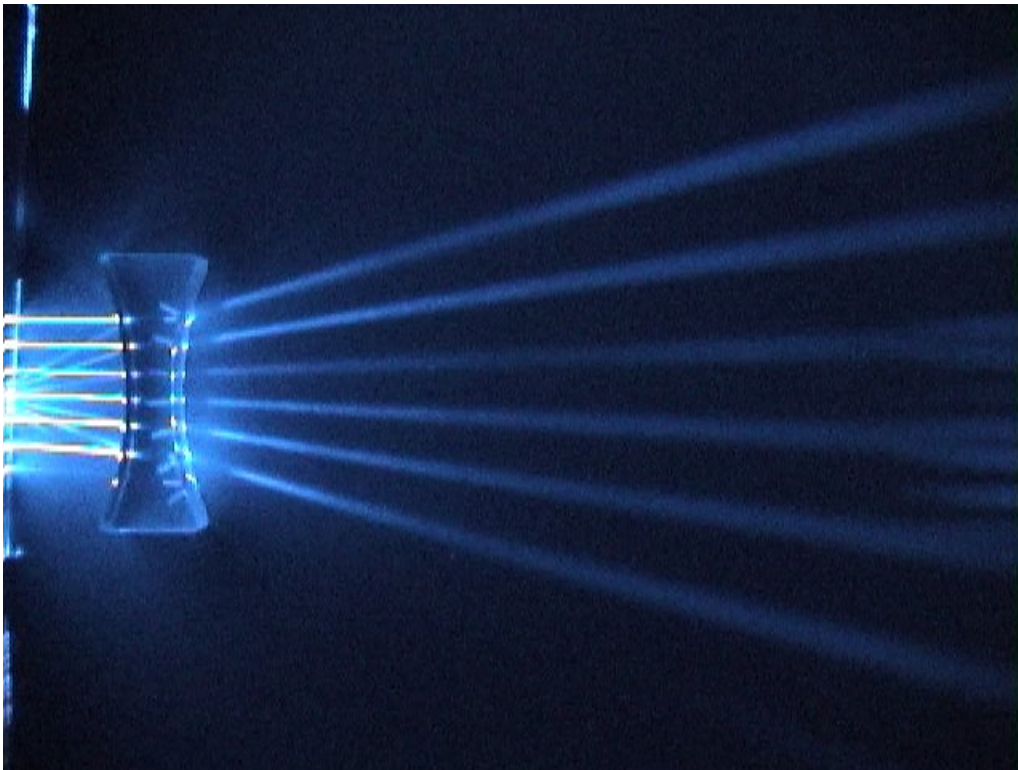
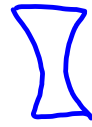
We use the same equations for lenses as we did for mirrors!





Concave lens (Diverging)

- Curved Inward at the center, thick at edges
- Always forms a virtual, smaller, upright image
 - Viewfinders of cameras, the small image is what you will see in the pic



$$h_o = 4 \text{ cm}$$

$$d_o = 200 \text{ cm}$$

$$f = 50 \text{ cm}$$

$$d_i = ?$$

$$h_i = ?$$

$$f = 15 \text{ cm}$$

$$d_o = 10 \text{ cm}$$

$$h_o = 7.5 \text{ cm}$$

$$h_i = ?$$

$$d_i = ?$$

$$f = 30 \text{ cm}$$

$$d_o = ?$$

$$h_i = 28 \text{ cm}$$

$$h_o = 7 \text{ cm}$$

$$d_i = ?$$

conv lens - real image

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

$$\frac{1}{30} = \frac{1}{d_o} + \frac{1}{4d_o}$$

$$\frac{1}{30} = \frac{1}{d_o} \left(1 + \frac{1}{4} \right)$$

$$\left(\frac{1}{30} \right) \left(\frac{4}{5} \right) = \frac{1}{d_o}$$

$$d_o = 37.5 \text{ cm}$$

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$\frac{-28}{7} = -\frac{d_i}{d_o}$$

$$4d_o = d_i$$

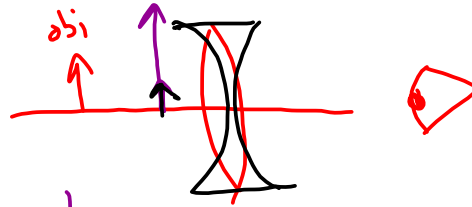
$$f = -32 \text{ cm}$$

$$d_o = 19 \text{ cm}$$

$$d_i = ?$$

$$M = ?$$

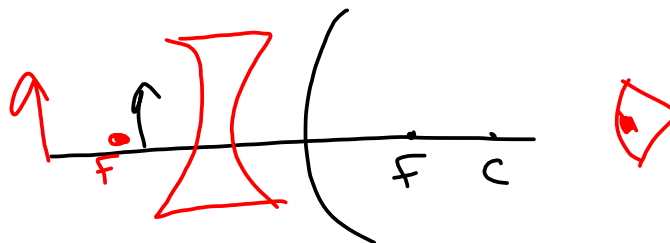
$d_o = 38 \text{ cm}$
 $d_i = -22 \text{ cm}$
 $F = ?$



$$\frac{1}{F} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{F} = \frac{1}{38} + \frac{1}{-22}$$

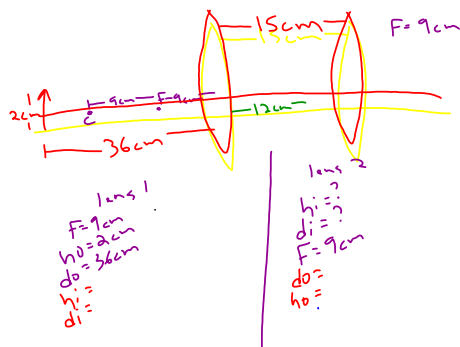
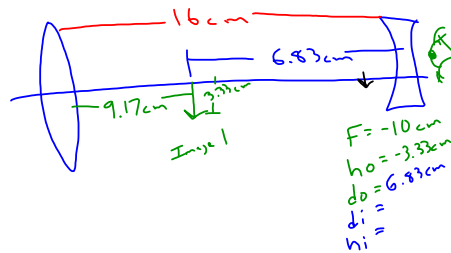
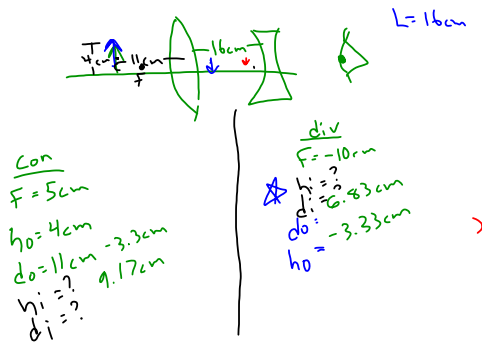
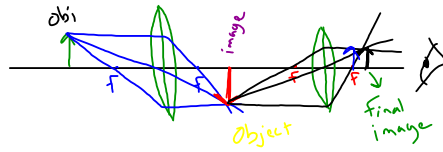
$F = -52.25 \text{ cm}$



Real images \rightarrow Concave mirror, (convex) converging lens
 inverted, ^{small} big, _{same}, $d_i \rightarrow (+)$
 $-h_i$

Virtual images \rightarrow Concave mirrors, converging lens
 if $d_o < F$, big, upright, virtual
 $+M$, $-d_i$, $h_i (+)$

Virtual image \rightarrow convex mirror, (convex) diverging lens
 $d_i \rightarrow (-)$, $F \rightarrow (-)$, small, upright, virtual
 $(+)M$
 $h_i (+)$



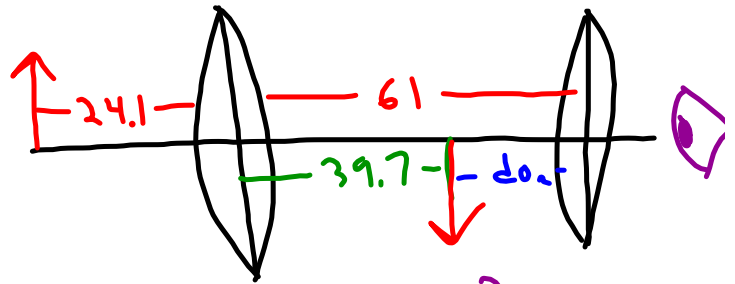
$F_1 = 15 \text{ mm}$

$F_2 = 25.5 \text{ mm}$

$L = 61 \text{ mm}$

$d_{o1} = 24.1 \text{ mm}$

$d_{i2} = ?$



1
 $F_1 = 15 \text{ mm}$
 $d_{o1} = 24.1$
 $d_{i1} = ?$

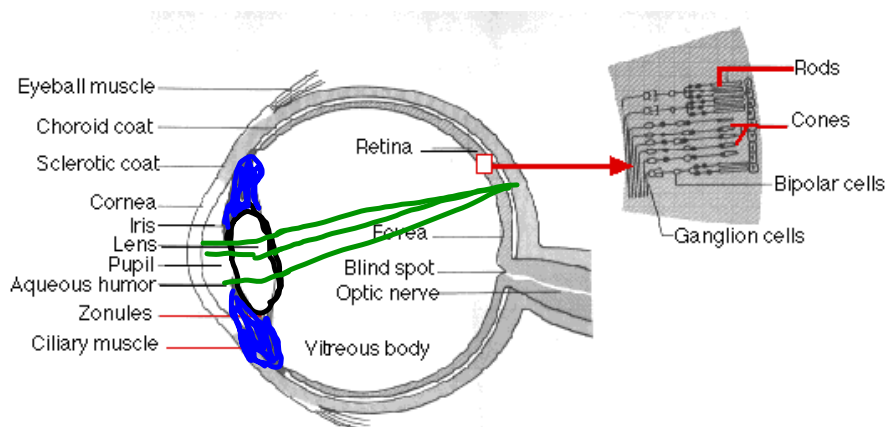
2
 $F_2 = 25.5 \text{ mm}$
 $d_{o2} = ? 21.3 \text{ mm}$
 $d_{i2} = ?$

$\frac{1}{F} = \frac{1}{d_o} + \frac{1}{d_i}$
 $\frac{1}{15} = \frac{1}{24.1} + \frac{1}{d_i}$
 $d_i = 39.7 \text{ mm}$

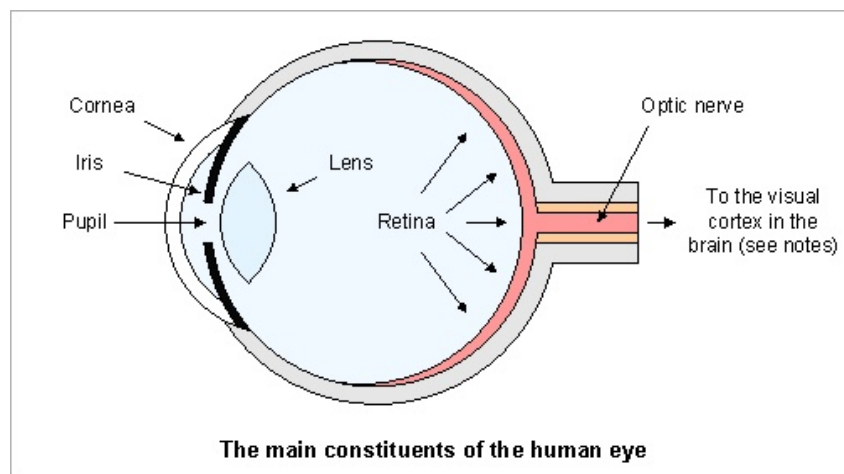
$\frac{1}{F} = \frac{1}{d_o} + \frac{1}{d_i}$
 $\frac{1}{25.5} = \frac{1}{21.3} + \frac{1}{d_i}$
 $d_i = -129 \text{ mm}$

Human Eye

- Light comes in pupil and then hits the lens, a flexible bag of fluid, convex - *converging*
- Focused image collects at the **Retina**
 - If the image does not form exactly at the retina the image is blurry

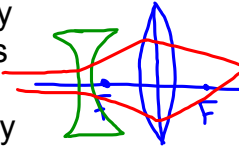


<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/V/Vision.html>

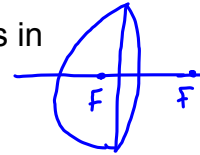


Correcting Vision

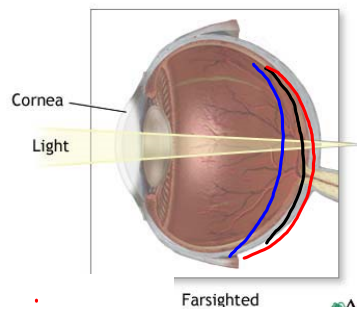
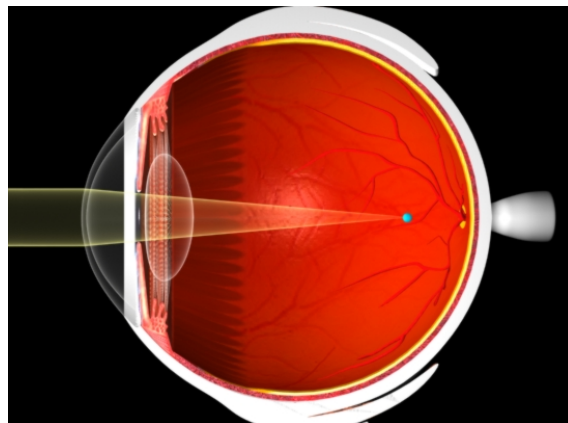
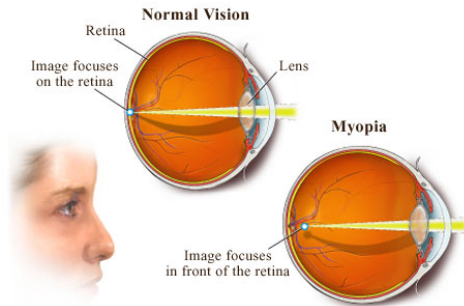
- Nearsighted- far objects are blurry
- Fix with concave (**diverging**) lens



- Farsighted- near objects are blurry
- Fix with convex (**Converging**) lens

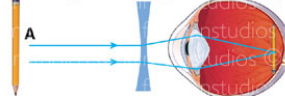


- Astigmatism- two different focal points in the lens of eye

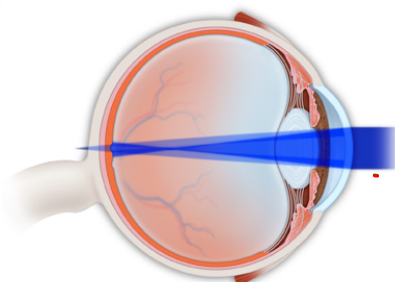
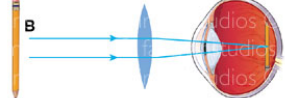


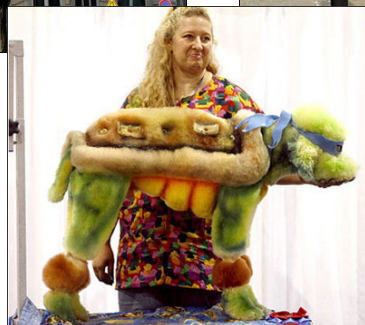
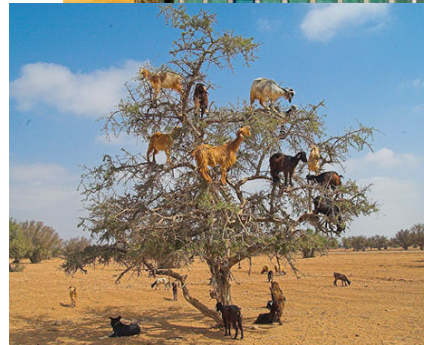
Farsighted

Nearsightedness (eyeball too long)



Farsightedness (eyeball too short)





<http://www.michaelbach.de/ot/>

water fountain

optical illusion good vid

<http://www.moillusions.com>



Darrell suspected someone had once again slipped him a spoon with the concave side reversed.

Optical Illusions

<http://www.michaelbach.de/ot/>

<http://www.moillusions.com/>



Attachments

binocular soccer

optical illusion eye

great whites

shark attack

water fountain

optical illusion good vid