Thurs: Seminar

Fri: HW by 5pm

Supp 111, 114, 117, 118, 119

Ch 18 Q 19

Ch 18 Prob 34, 59

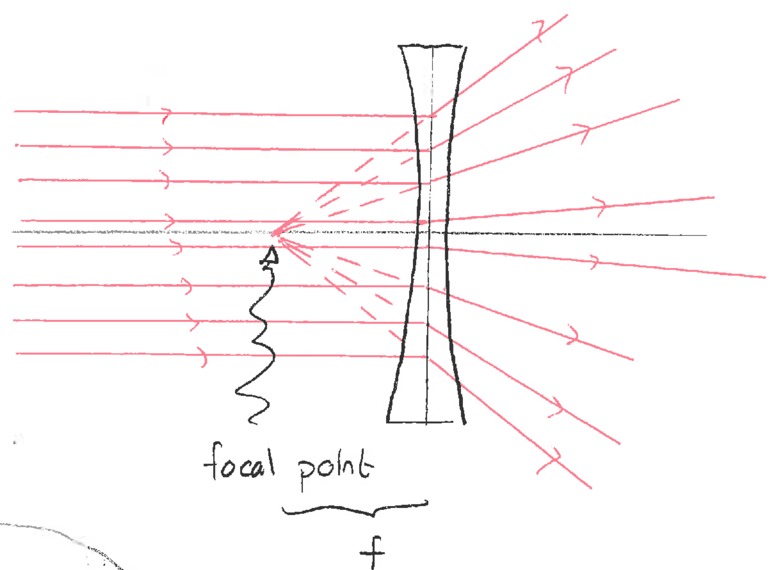
Mon: Warm Up L3

Concave/diverging lenses

A concave lens will cause light rays to diverge. The rays that arrive traveling parallel to the optical axis are bent as illustrated

They all appear to emanate from a common point behind the lens. This is the focal point of the diverging lens

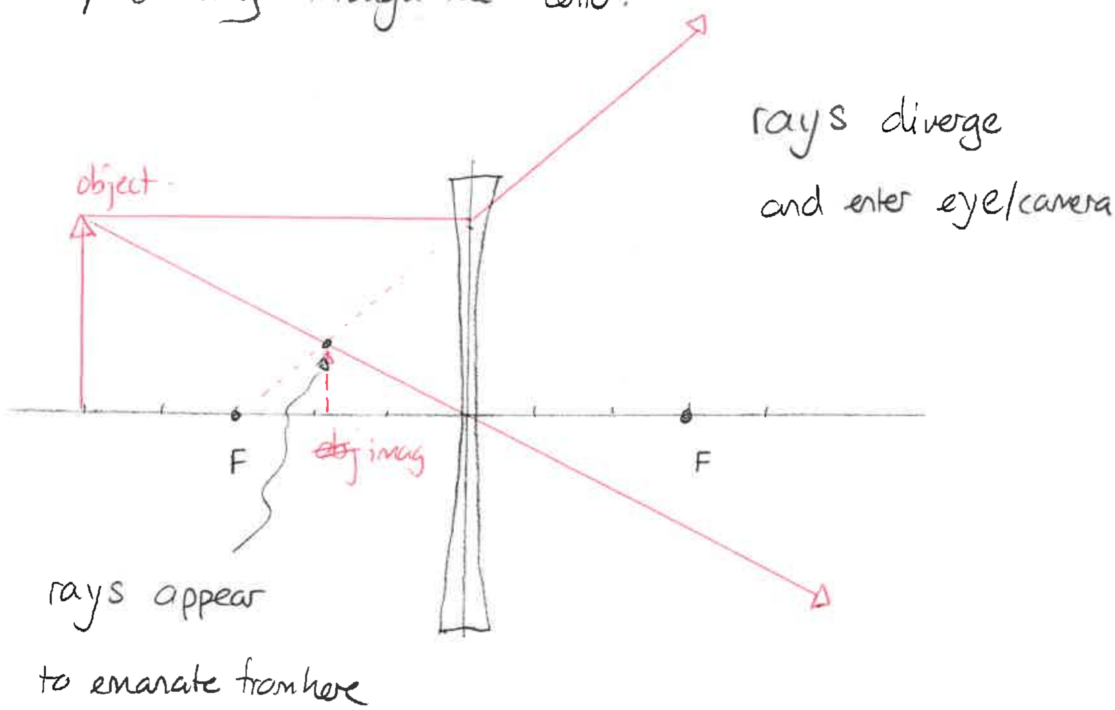
The focal length is the distance from the lens to this point and



for a concave lens f is negative

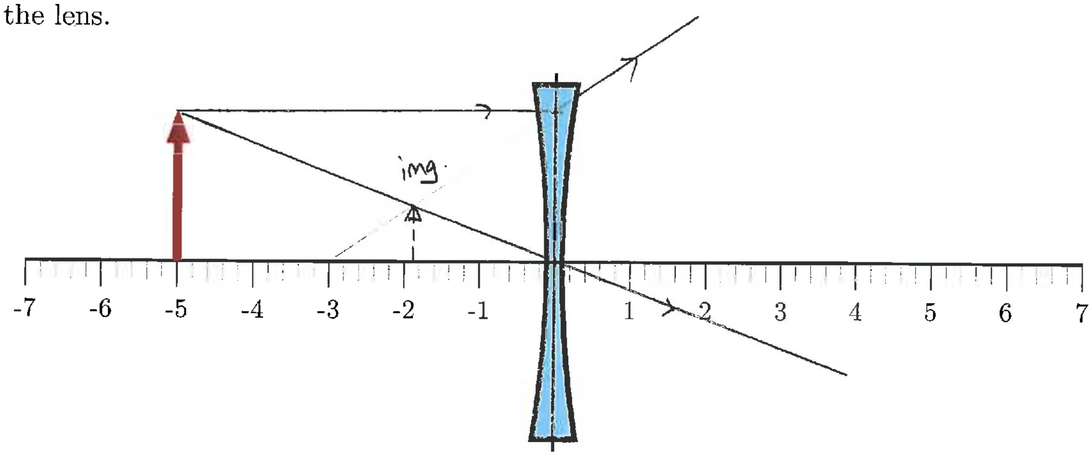
In order to determine how the lens produces its image we trace the same two rays:

1. parallel to optical axis and deviating as though it had emanated from the focal point.
2. a ray directly through the center.



109 Image formation by a concave lens

A concave lens has focal length $-3.0\,\text{cm}$. An arrow with height $2.0\,\text{cm}$ is placed $5.0\,\text{cm}$ left of the lens.



a) Trace two rays from the tip of the arrow to determine where the image of the tip is produced.

b) Determine the distance from the lens plane to the image of the arrow.

c) Determine the height of the image of the arrow. Determine the magnification

$$m := \frac{h'}{h}$$

where h is the height of the object and h' is the height of the image.

The thin lens equation relates the positions of the object and the image via

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

where s is the distance from the lens to the object and s' is the distance from the lens to the image.

d) Use the thin lens equation to predict the location of the image. Check this against your diagram.

e) The magnification equation predicts

$$m = -\frac{s'}{s}.$$

Use this to predict the magnification and the height of the image. Check this against your diagram.

Answer a) By inspection $\approx -2.0\,cm$

b) " " $\approx 0.7\,cm$

c) $m = \dfrac{0.7\,cm}{2.0\,cm} = 0.35$

d) $\dfrac{1}{s} + \dfrac{1}{s'} = \dfrac{1}{f}$

$\Rightarrow \dfrac{1}{5\,cm} + \dfrac{1}{s'} = \dfrac{1}{-3\,cm} \Rightarrow \dfrac{1}{s'} = -\dfrac{1}{5\,cm} - \dfrac{1}{3\,cm}$

$= \dfrac{-3-5}{15\,cm}$

$= \dfrac{-8}{15\,cm}$

$\Rightarrow s' = -\dfrac{15\,cm}{8} = -1.88\,cm \Rightarrow \boxed{s' = -1.88\,cm}$

e) $m = -\dfrac{s'}{s} = -\left(\dfrac{-15\,cm}{8}\right) \Big/ 5\,cm = +\dfrac{3}{8} \Rightarrow \boxed{m = +0.375}$

$h' = hm \Rightarrow h' = 2\,cm \times 0.375 = \boxed{0.75\,cm}$

~~Warm Up 2~~

Quiz 1 80% – 100%

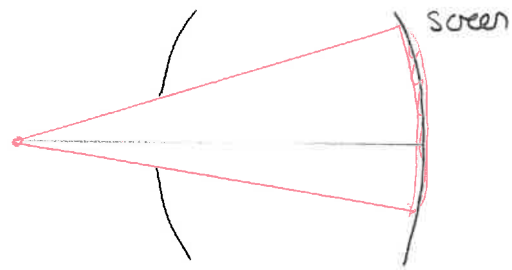
Human vision

The human eye uses a simple lens and screen system

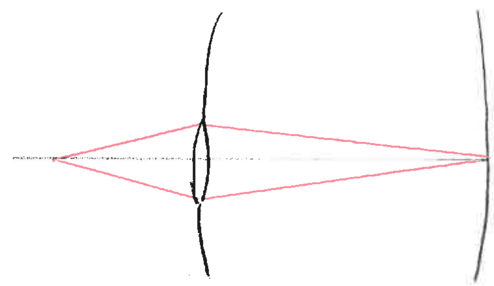
Demo: U Utah Webvision – image

Consider light emanating from a point source. If there were no lens, then what image would appear?

Quiz 2 25% – 50%

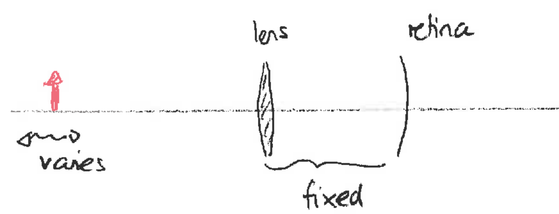


The lens serves to focus diverging rays to a single point



Lens accommodation

The human eye can form images of objects at various locations. However, the distance from the lens to image remains fixed

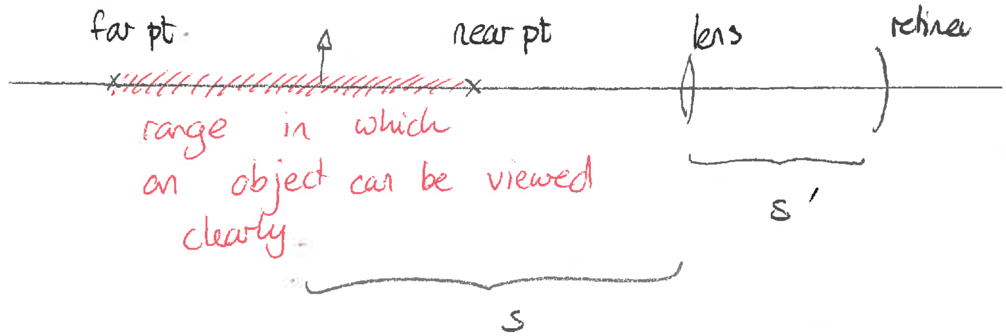


Quiz 3

The lens must adjust. There are two crucial points that vary from one person to another. These are:

1) near point = closest point at which lens can adjust to make a clear image

2) far point = furthest point at which lens can adjust to make a clear image



Now

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

and s' is fixed means that as s changes f must change. As s increases f increases and lens is less curved (becomes more relaxed). As s decreases, f decreases and lens is more curved. (becomes less relaxed).

For normal human vision, far point is at infinity and near point is about 25cm.