Lecture 24

Thin lenses

Lens – transparent object w/ two refracting surfaces whose central axes coincide

converging lens – causes light rays parallel to central axis to converge
(for reading glasses)

diverging lens – causes light rays parallel to central axis to diverge
(for glasses for nearsightedness)

(show slides)

We only consider <u>thin lens</u>

- thickest part of lens is thin relative to object distance p, image distance i, & radii of curvature r_1 & r_2 of two surfaces of lens.

- only consider light rays that make small angles w/ central axis (exaggerated in figure)

- For these rays, a lens has a focal length f & i & p are related by

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{i}$$ (same as for mirrors)

Another equation to determine focal length (lens maker's equation)

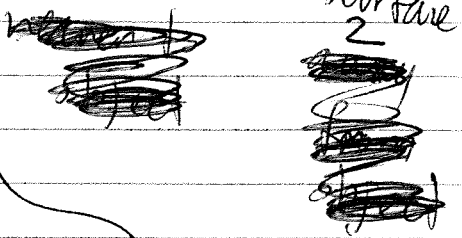
$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

f = focal length

n = index of refraction for lens material

r_1 = radius of curvature for lens surface 1

r_2 = radius of curvature for lens surface 2



these have signs (r_1 & r_2)

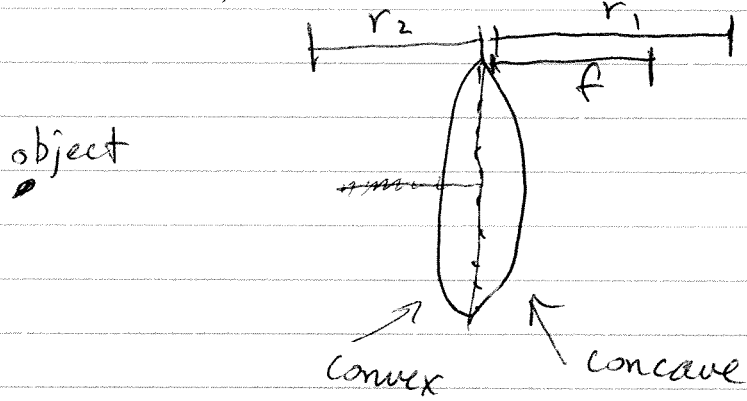
to determine signs,

when object faces a convex refracting surface, radius of curvature is positive.

when object faces a concave refracting surface, radius of curvature is negative.

Signs are important!

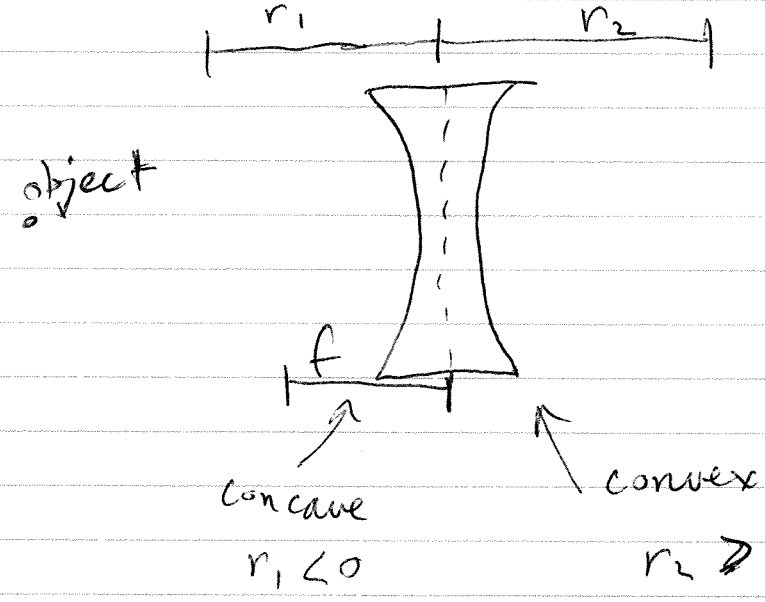
Applying these rules to converging lens



$\Rightarrow r_1 > 0 \qquad r_2 < 0$

$\Rightarrow$ focal length $f > 0$

Apply rules to diverging lens



$r_1 < 0 \qquad r_2 > 0$

$\Rightarrow$ focal length $f < 0$

Images from thin lenses

(show slides)

- converging lens can form a real image or a virtual image
- diverging lens produces a virtual image on the same side as object w/ same orientation
- real images form on side of lens opposite to object & virtual images form on same side.
- image distance positive for real images & negative for virtual images

equation for lateral magnification is

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

& $$m = \frac{-i}{p}$$

- image distance is positive for real images & negative for virtual images.

Locating Images by drawing rays.

can do so by considering 2 of 3 special rays

1. ray parallel to central axis passes through focal point F_2
2. ray passing through focal point F_1 emerges parallel to central axis

3. ray directed to center of lens emerges w/ no change in its direction.