Dispersion

1) $\lambda_{red} > \lambda_{violet}$

2) $v = \frac{\lambda}{T} \Rightarrow v_{red} > v_{violet}$

3) $v = \frac{c}{n} \Rightarrow n_{red} < n_{violet}$

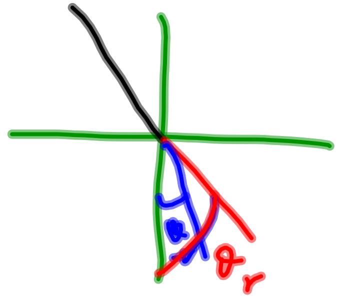
- the phenomena in which v of the wave depends on λ

4) $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\Uparrow$ incident — white light

$\Uparrow$ refracted

$\Uparrow$ if n_2 is larger θ_2 has to be smaller



$\Rightarrow$ violet refracts at smaller angle than red

- v increases with λ
- n decreases with λ
- θ_R increases with λ

Absorption - can be λ dependent &
creates colors in objects

Scattering

1) if light scatters from particles that are large compared to the λ_{light}, the light reflects. Reflection is NOT dependent on λ $\Rightarrow$ all colors are equally scattered

(example: white clouds)

2) if the particles are small compared to λ_{light} they get scattered via Rayleigh scattering $[1/\lambda^4]$

→ why sky is blue & sunsets are red

$$\frac{1}{\lambda^4}$$

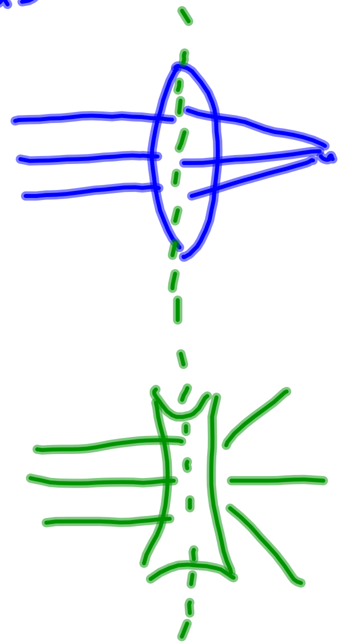
Lenses & mirrors

- transparent materials that use refraction at curved surfaces to form an image from light rays

Lenses
- eyeglasses ~ 13th century
- cameras
- magnifying glasses
....

We separate them as

1) Converging lenses



- thicker in the middle than at the edges
- rays REFRACT in a way that they converge

2) Diverging lenses

- thicker at the edges than in the middle
- rays refract in a way that they DIVERGE

- thin lenses so that all rays that fall on a thin lense are focused to a point called **FOCAL POINT**

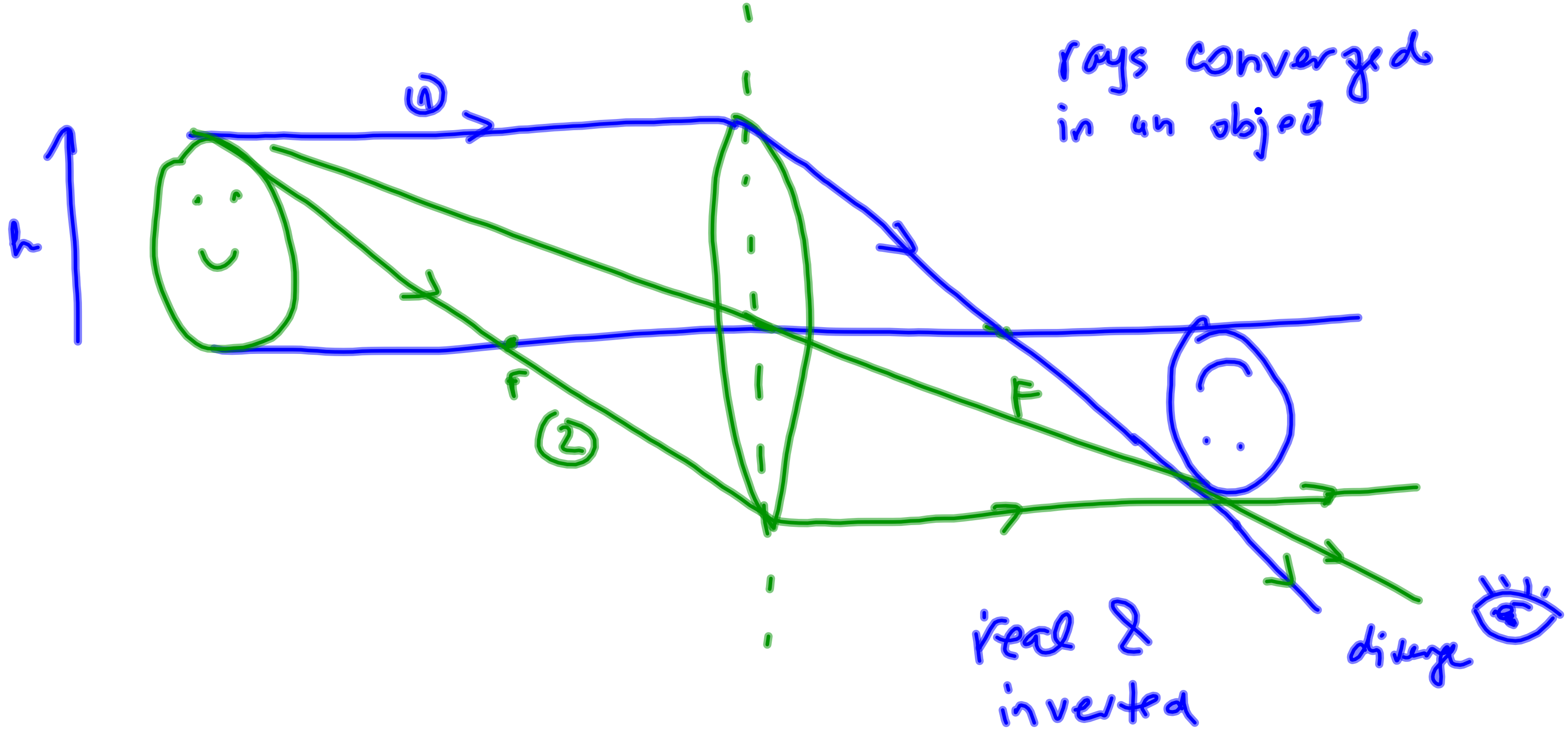
- the distance of the focal point from the center of the lens is called **FOCAL LENGTH**

1. Converging lenses

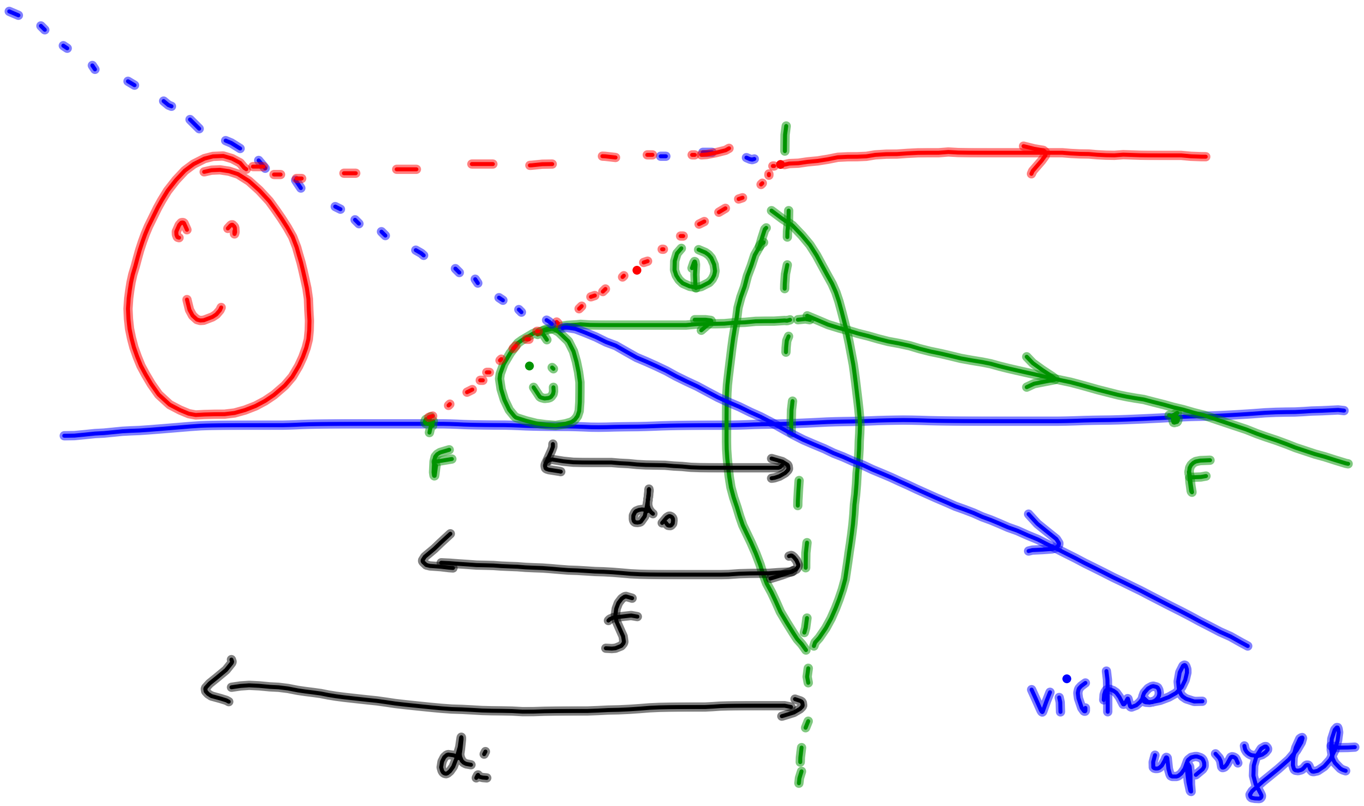
3 special rays will give us an image,

they start from the tip of the object

1. A ray parallel to the axis that refracts through the focal point behind the lens F
2. A ray that enters the lens through a focal point F and refracts parallel to the axis.
3. A ray through the center that doesn't bend


rays converged
in an object
h
①
②
F
F
real &
inverted
diverge

Example 2 - magnifying glass



- virtual image
- upright & bigger
- you don't see it on a screen

Real image - light passes through the image & can be seen if we place white paper on screen at the position of the image

(unlike virtual image)

Convergent lenses give all combinations of images.

Divergent lenses give only virtual image

(eye sees real & virtual)

The thin lens eqn & magnification

- h_o height of the ☺ object
- d_o distance between the object & lens center
- f focal length
  - d_i length of the ☺ image
    - h_i image height

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

- using the right triangles

thin lens eqn

(mirror eqn)

- f is positive for convergent lenses
  negative divergent -"-

d_o is positive if object is to the left of the lens

d_i image is on the other side of the lens

h_o ↑

h_i > 0 ↑ upright

< 0 ↓ inverted

Lateral magnification

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

magnification eqn

- if image is ↑ $m > 0$

$\Rightarrow d_i < 0$

$m > 0$ upright

< 0 inverted

Problem solving

1) draw a ray diagram
2) solve for unknowns in eqns
3) follow the sign convention
4) check if your answer makes sense (compare with picture!)