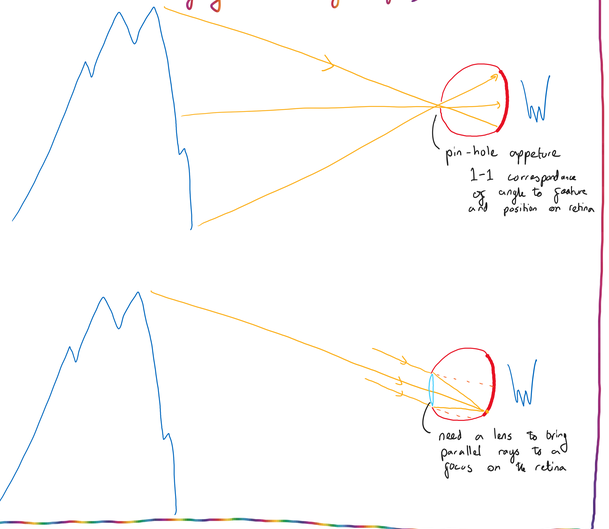
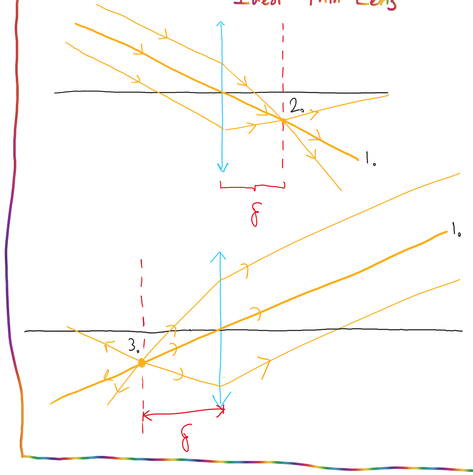
Physics of visual systems

Imaging Far-away Objects



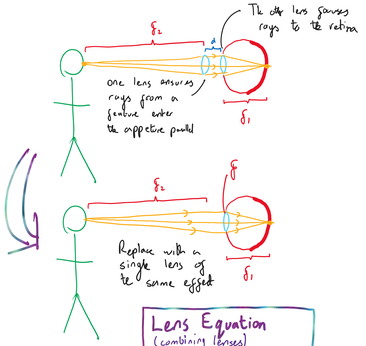
Ideal Thin Lens



Thin Lens Laws

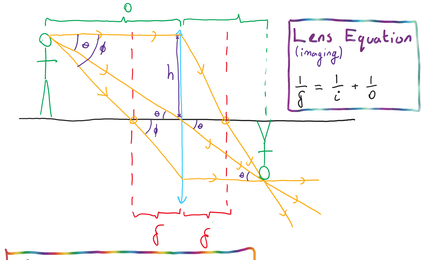
1. Rays passing through the centre of a lens are undeviated
2. Parallel rays entering a lens come to focus at a point on the focal plane
3. Rays from a point source in the focal plane leave parallel.

Imaging Nearby Objects



Lens Equation
(combining lenses)

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$$



Lens Equation
(imaging)

$$\frac{1}{f} = \frac{1}{i} + \frac{1}{o}$$

Bonus
proof of lens equation

- $h = o \tan\theta$
- $h = (o-f)\tan\phi$
- $f \tan\phi = i \tan\theta$

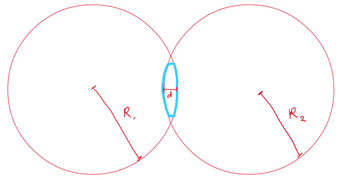
$$\Rightarrow o\tan\theta = (o-f)\tan\phi$$

$$\Rightarrow o\tan\theta = (o-f)\frac{i}{f}\tan\theta$$

$$\frac{fo}{oif} = \frac{oi}{oif} - \frac{fi}{oif}$$

$$\Rightarrow \boxed{\frac{1}{f} = \frac{1}{o} + \frac{1}{i}}$$

Spherical Lenses



Lens Maker Equation

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} + \frac{1}{R_2}\right] - \frac{(n-1)d}{nR_1R_2}$$

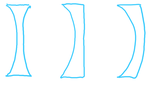
refractive index of lens

* Sign convention: R is positive for convex lens faces

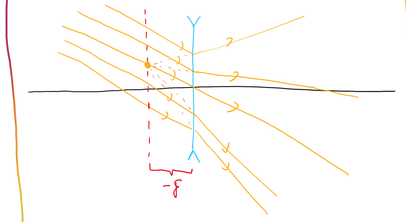
Converging lenses, $f > 0$



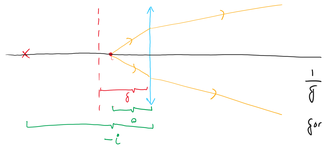
Diverging lenses, $f < 0$



Diverging Lens



VR example



$$\frac{1}{f} = \frac{1}{o} - \frac{1}{i}$$

for $i > 0$, $f > 0$

Want rays from a near source to appear as if they came from a far source

