The Human Eye

The eye is a two lens system, consisting of both the cornea and the lens.

The optical power of the cornea is roughly 40 dpt (dioptres = m^{-1}). The lens can change shape due to ciliary muscles, its optical power is $20 + \Delta D$ dpt.

The imaging range of a 'normal' eye is from ∞ to 0.25m (by convention). For an object at >10m, the eyes optical power is roughly 60dpt. To focus on an object at 0.25m, the optical power needs to increase by 4 dpt.

Glasses

A far sighted person (hyperopia) needs a convergent lens to add more optical power to the eye.

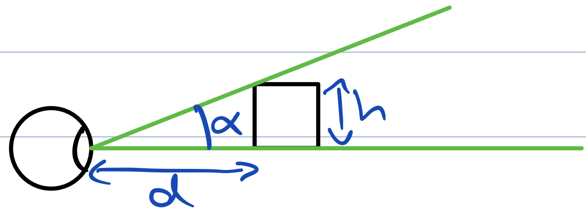
A near sighted person (myopia) needs divergent lenses to remove optical power from the eye.

Apparent Size

The apparent size is the percieved size of an object due to the image on the retina.

The apparent size depends on the <u>angular size</u>.

$$\alpha = \frac{h}{d}$$



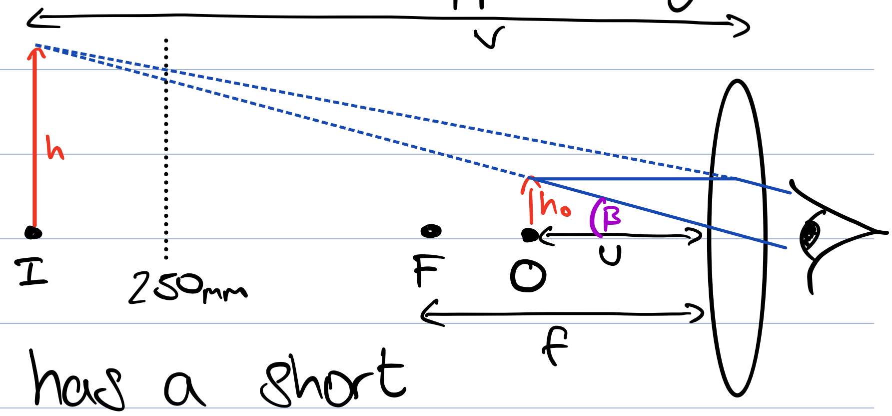
When there is a total solar eclipse the angular size of the sun equals the angular size of the moon.

The maximum distinct angular size is given by

$$\alpha_{250} = \frac{h}{250}$$

Objects closer than 250mm will appear larger but may be blurry.

Simple Lens Magnifier



The magnifying lens has a short focal length, f, and is placed close to the eye.

The object is placed at a distance $-u < f \ll 250$mm.
A virtual image is seen at $|v| > 250$mm by the eye.

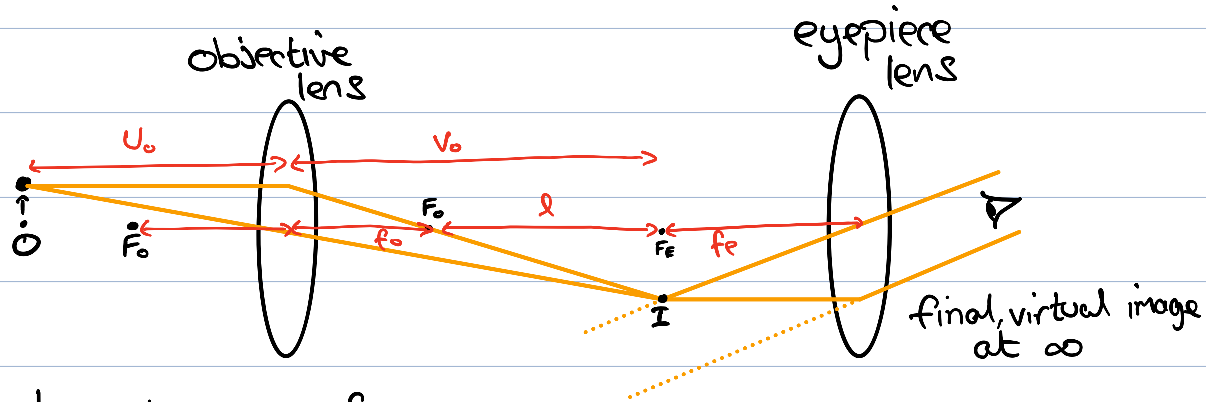
! For virtual images, a real measurement of size cannot be given. ∴ We use angular size (tangent of).

$$M = \frac{\tan(\text{angle with lens})}{\tan(\text{angle without lens})}$$

In a simple magnifier that means $M = \frac{\beta}{\alpha_{250}} = \frac{h_0/u}{h_0/250}$

$$M = \frac{250}{f}$$ ← in mm

In reality there is a limit to how small f can be and how close to the eye it can be. ∴ We use a compound microscope.



$$\frac{1}{U_o} = \frac{1}{f_o} - \frac{1}{V_o} = \frac{V_o - f_o}{V_o f_o}$$

$$M_o = -\frac{V_o}{U_o} = -\frac{V_o - f_o}{f_o} = -\frac{l}{f_o}$$

$$M_E = \frac{250}{f_E}$$

$$M_T = -\frac{l}{f_o} \cdot \frac{250}{f_E}$$

This is the equation for total magnification of a compound microscope.