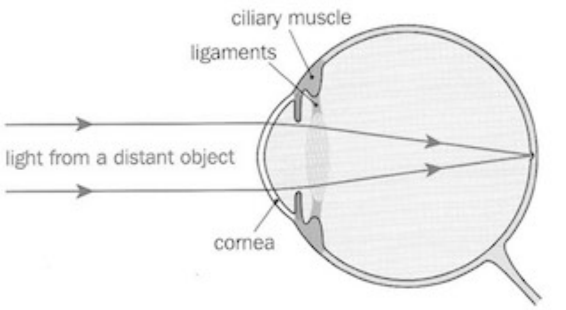
The human eye

The eye and accommodation

As light enters the curved cornea of your eye, it is refracted, and then refracted again as it goes into the liquid in front of the lens, then into the lens, and then into the liquid behind the lens.

Most of the bending takes place at the cornea: this is where there is the biggest relative refractive index.

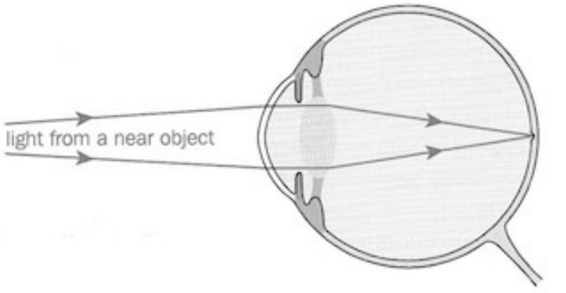


ciliary muscles relaxed and lens pulled thin

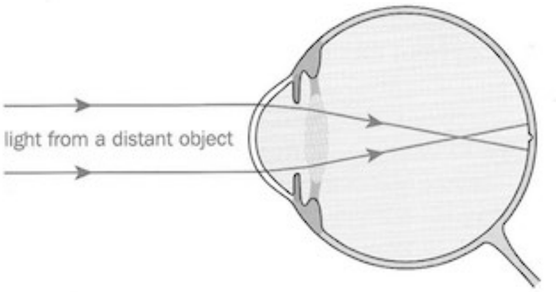
The cornea is convex, so it makes light rays converge towards the retina.
The lens is optically denser than the fluids in the eye, and so it makes the rays from the cornea converge slightly more.

Your eye adjusts the power of the lens until there is a sharp image on the cornea – this action is called ***accommodation***.

The lens is elastic, and in its natural state is fat, with greater power. The ciliary muscle is a ring of muscle round the eye, and the lens is attached to it by lots of ligaments.
When the ciliary muscle is relaxed, the lens is pulled thinner by the ligaments and becomes less powerful, so that the eye is focused at distant objects.
When the ciliary muscle is contracted, the ligaments become slack and the lens moves back into its natural fat shape.



ciliary muscles contracted and so lens relaxes, gets fatter



light converges in front of the retina

Short sight

In some eyes, the eyeball is too long, or the cornea is too sharply curved.
Even with the lens at its thinnest, the light converges to a point in front of the retina, except for very close objects. Because the light does not converge on to the retina, the image is blurred.

If you are **short sighted**, this is the probable cause.

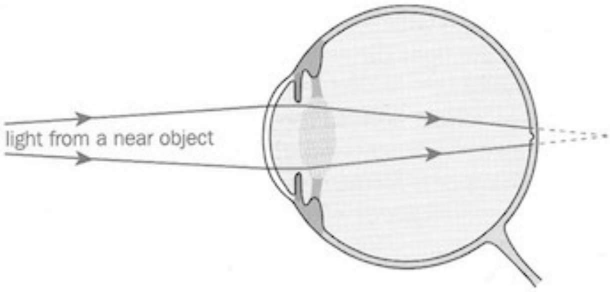
The defect is easily corrected by wearing ***concave*** (diverging) spectacles or contact lenses.
These make the light diverge slightly. Because the light now converges on to the retina, the image is clear.

Long sight

In some eyes, the eyeball is too short, or the cornea is not sharply curved enough.
Even with the lens at its fattest, the light converges to a point behind the retina, except for very distant objects.

This is **long sight**. It can be corrected by wearing *convex* (converging) lenses. Because these make the light converge slightly, on to the retina, the image is clear.

Older people often become long-sighted for a different reason – the eye lens loses its elasticity with age, and cannot change back fully into its fattest shape.



light converges behind the retina

from: Advanced Physics for You, Nelson Thornes Ltd.

Focal length and refractive power

The power of a lens is the inverse of its focal length in meters.

symbol: P (not to be confused with mechanical power in Watts)

unit: D (dioptre or diopter; $1\text{D} = \frac{1}{\text{m}}$)

$$\boxed{P = \frac{1}{f}}$$

f in meters

Example 1:	$f = 80.0$ cm	$P = \frac{1}{f} = \frac{1}{0.800\ \text{m}} = \underline{\underline{1.25\ \text{D}}}$	(converging lens)
Example 2:	$f = -50.0$ cm	$P = \frac{1}{f} = \frac{1}{-0.500\ \text{m}} = \underline{\underline{-2.00\ \text{D}}}$	(diverging lens)
Example 3:	$D = 5.0$ dpt.	$f = \frac{1}{P} = \frac{1}{5.0}\ \text{m} = \underline{\underline{0.20\ \text{m}}} = \underline{\underline{20\ \text{cm}}}$	(converging lens)
Example 4:	$D = -2.5$ dpt.	$f = \frac{1}{P} = \frac{1}{-2.5}\ \text{m} = \underline{\underline{-0.40\ \text{m}}} = \underline{\underline{-40\ \text{cm}}}$	(diverging lens)

Magnifying glasses

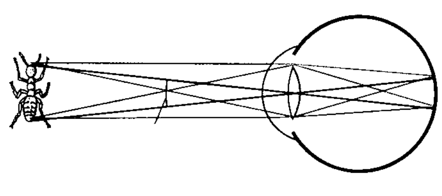
A converging lens can be used as a magnifying glass by placing the object within the focal length of the lens.

There are two ways of using a magnifying glass:

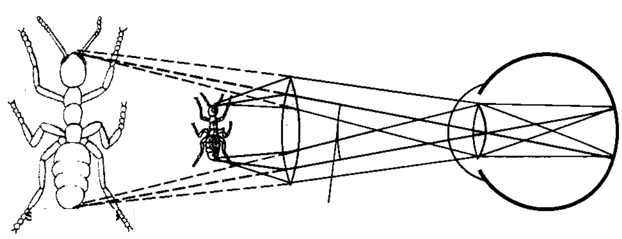
a) holding it close to the object, further away from the eye (usual way)

b) holding it close to the eye, bringing the object even closer (this is the way it's used by a goldsmith)

In either case, a magnified virtual image of the object is observed.



without magnifiying glass



with magnifiying glass