



Lenses and Telescopes

It is often easy to overlook the important role that lenses play in many day-to-day applications. Lenses are used in telescopes to see stars and planets clearly. Lenses form the basis for microscopes that make tiny things visible to us like the cells inside our bodies. Lenses have helped to unlock both the macroscopic and microscopic secrets of our world.

! Facts to remember

- ▶ Lenses are “named” after the curvature of their surfaces. Both surfaces are curved on “bi-concave/convex” lenses and “plano concave/convex” lenses have one curved surface and one flat surface.
- ▶ The focal length (f) of a lens in air depends on its radius of curvature and can be calculated using the “Lens maker’s formula”:

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

Where n is the refractive index of the lens material in air, R_1 is the radius of curvature of the lens surface closest to the object, R_2 is the radius of curvature of the lens surface farthest from the light source and d is the thickness of the lens. When d is small this formula becomes the 'thin lens formula' (without the last term).

- ▶ The focal point is the point where:
 - a convex lens focuses all parallel rays (on the side opposite of the object)
 - all parallel rays appear to be coming from behind a concave lens (on same side as the object)
- ▶ Lenses can form real and virtual images depending on the kind of lens and where the object is in relation to the focal point.

Lenses – entertaining us for several decades!

The invention of the magnifying glass in the 1200s led to the idea that certain materials, when polished to certain angles, could refract and reflect light to help us see better! Today, lenses are an essential part of our world. Understanding how a lens works and discovering new ways to manufacture and shape lenses has unlocked a whole new world!

The entertainment industry would be quite different today without lenses. Projectors use a combination of lenses to ensure that we can watch a movie clearly. Photographers have a wide variety of lenses to capture all kinds of images even in the dark! Even digital technologies such as DVD players rely on mirrors and lenses to read the data from a disc.

While most lenses can refract light in the visible part of the spectrum, researchers also concentrate on making lenses for the infra-red and ultra-violet parts of the spectrum – although these are still quite expensive!

Lenses have also been used to give scientists insight into making an invisibility cloak!