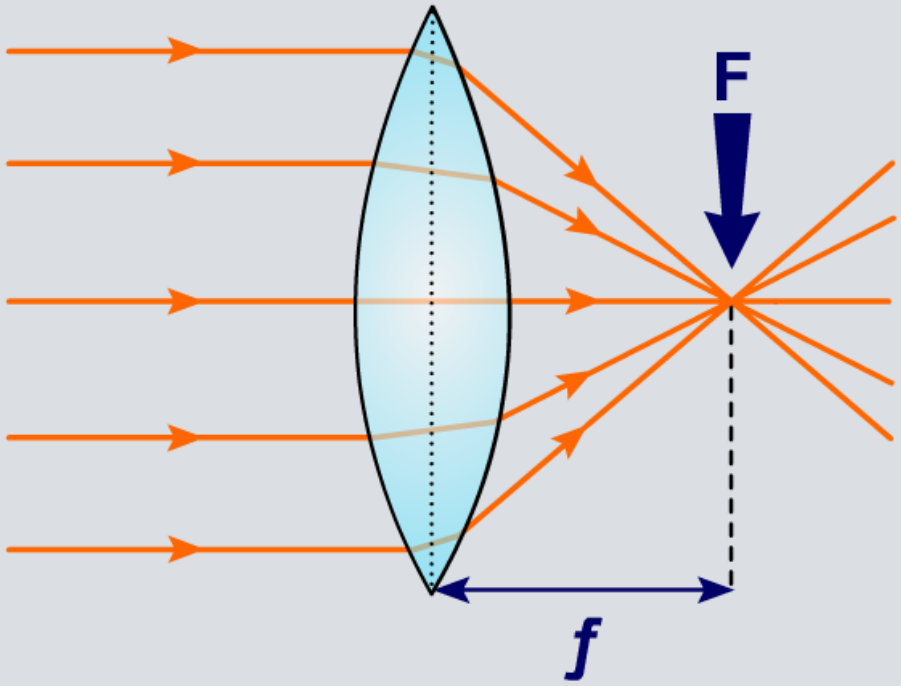
Lenses

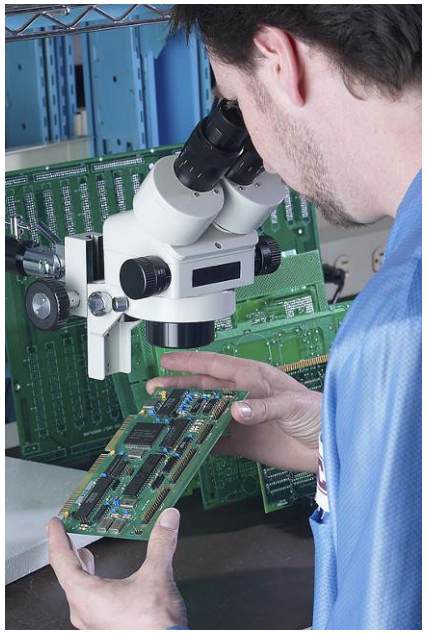


What are lenses?

Lenses alter the path of any light rays passing through them, refracting them toward or away from a single point.

Lenses must be made of a transparent medium with a curved surface. It is the curve of the lens that determines the amount of refraction.

There are two major types of lens, concave and convex, both of which have many uses in modern life.



Convex lenses

A **convex lens** bulges in the center.

Convex lenses are also called **converging** lenses. This means that they refract light rays towards a single point.

The point at which the rays cross over is determined by the distance between the lens and the light source.

Uses for convex lenses include:

eye

glasses for far-sightedness

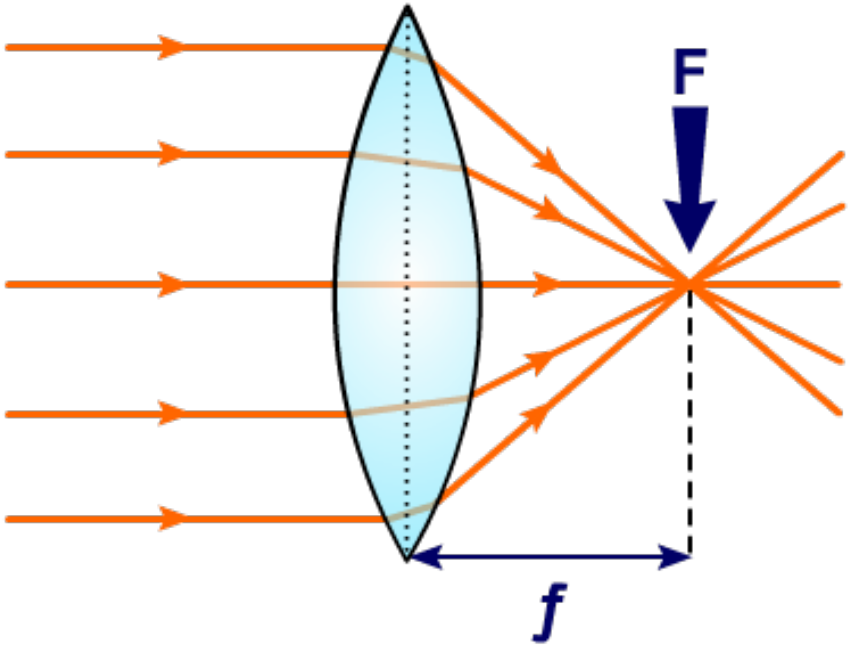
camera lens

magnifying glass

Convex lenses and parallel rays

For light rays to be parallel when they enter the lens, the object must be an **infinite** distance away.

A convex lens will cause such parallel rays to converge at the **focal point (F)**.



The position of an object relative to this point is crucial when trying to establish the type of image formed by a convex lens.

Convex lenses and diverging rays

How does a convex lens affect light from different distances?

Diverging rays of light spread out from a point. Such rays are brought together by a convex lens, often causing the rays to cross over. This is called **convergence**.

Select different light source positions to discover how distance affects convergence.

light source position

- before *f*
- at *f*
- beyond *f*
- distant

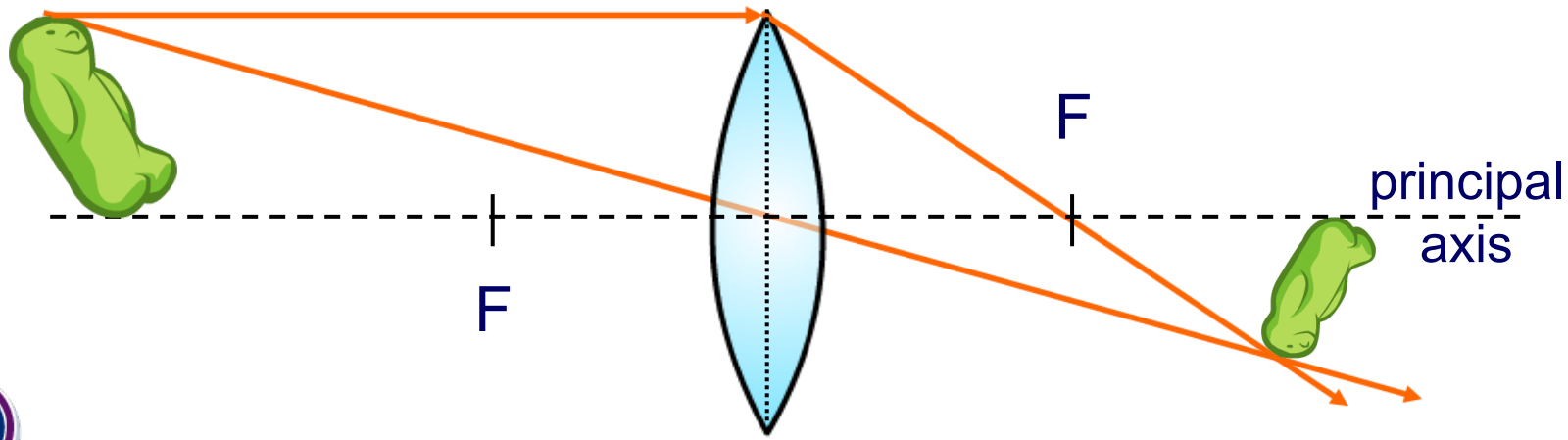
Drawing ray diagrams for convex lenses

We can use ray diagrams to predict the type of image different convex lenses will produce.

The image will form at the point of convergence of two light rays, which originate from a single point on the object.

The first ray can be drawn passing straight through the center of the lens.

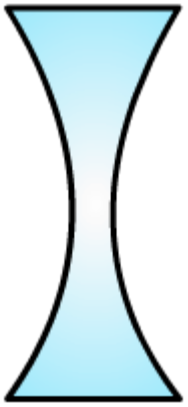
The second should be drawn parallel to the principal axis, and pass through the focal point (F) after it leaves the lens.



Ray diagrams for convex lenses

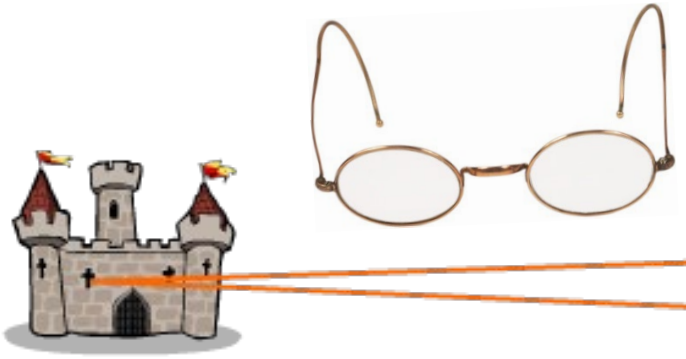
Concave lenses

A **concave** lens is one which tapers inwards at its center.

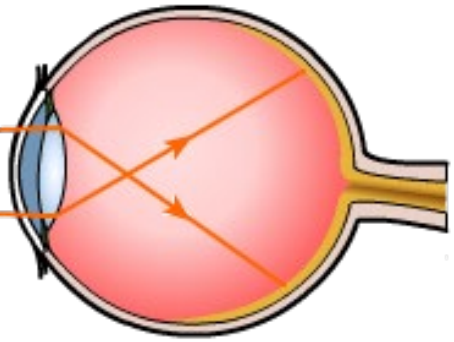


Concave lenses are also called **diverging** lenses. This means the lens refracts light away from a single point.

Uses for concave lenses include:



glasses for near-sightedness

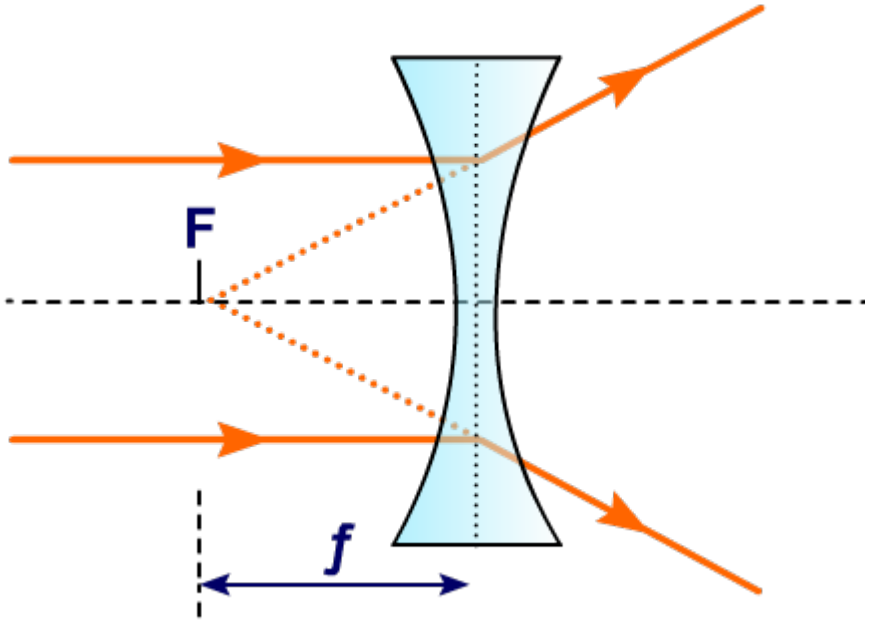


How would a concave lens correct this eye's short sightedness?

Focal length of a concave lens

To find the focal length of a **concave** lens, rays parallel to the principal axis must be directed through it.

As the rays **diverge**, we must trace their path backwards to find the point where they cross over.

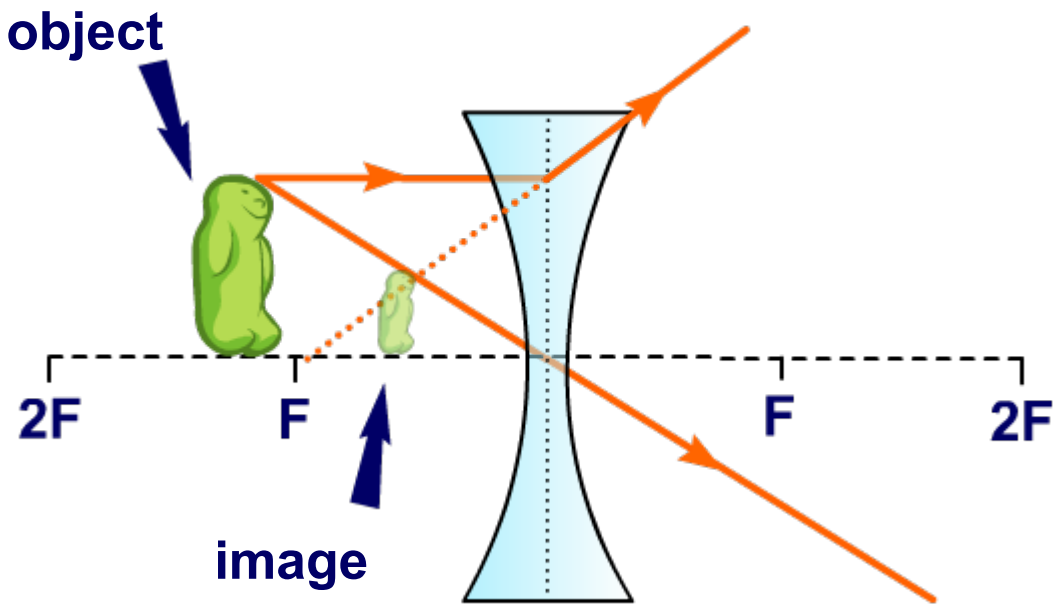


This is the focal point (F), while the distance from the focal point to the center of the lens is the focal length (f).

Ray diagrams for concave lenses

Ray diagrams for concave lenses can be drawn using the same method as for convex lenses.

In this case the ray parallel to the principal axis will intercept the focal point on the object's side of the lens when refracted.



virtual, reduced, not inverted

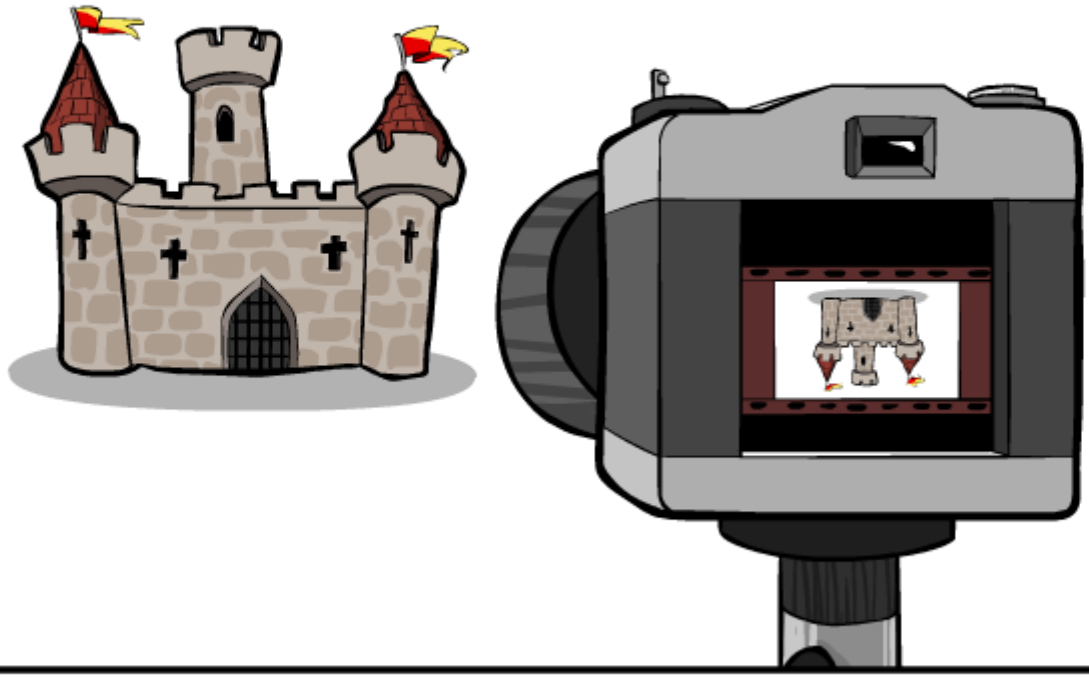
What happens to the image when the object is moved along the principal axis?

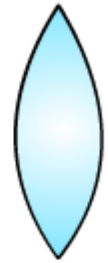
Images produced by concave lenses

Lenses summary

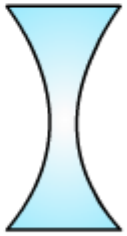
What type of lens can...

...be used in a camera?





convex lens



concave lens