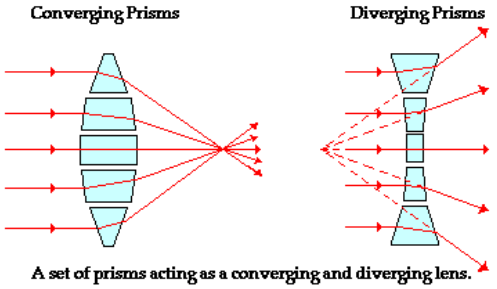
THE ANATOMY OF A LENS

If a piece of glass or other transparent material takes on the appropriate shape, it is possible that parallel incident rays would either converge to a point or appear to be diverging from a point. A piece of glass that has such a shape is referred to as a lens.

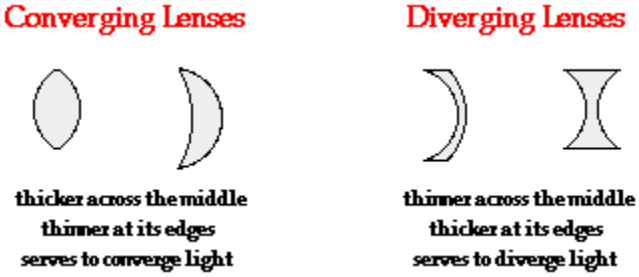


A set of prisms acting as a converging and diverging lens.

A lens is merely a carefully ground or molded piece of transparent material that refracts light rays in such as way as to form an image. Lenses can be thought of as a series of tiny refracting prisms, each of which refracts light to produce their own image. When these prisms act together, they produce a bright image focused at a point.

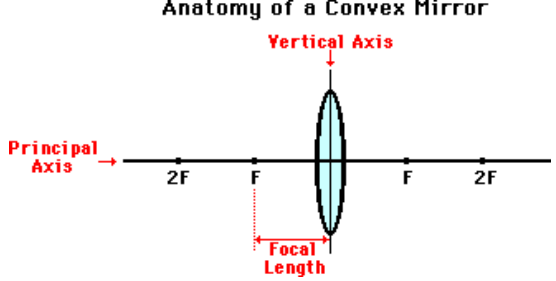
Types of Lenses

There are a variety of types of lenses. Lenses differ from one another in terms of their shape and the materials from which they are made. Our focus will be upon lenses that are symmetrical across their horizontal axis - known as the **principal axis**. In this unit, we will categorize lenses as converging lenses and diverging lenses. A **converging lens** is a lens that converges rays of light that are traveling parallel to its principal axis. Converging lenses can be identified by their shape; they are relatively thick across their middle and thin at their upper and lower edges. A **diverging lens** is a lens that diverges rays of light that are traveling parallel to its principal axis. Diverging lenses can also be identified by their shape; they are relatively thin across their middle and thick at their upper and lower edges.



The Language of Lenses

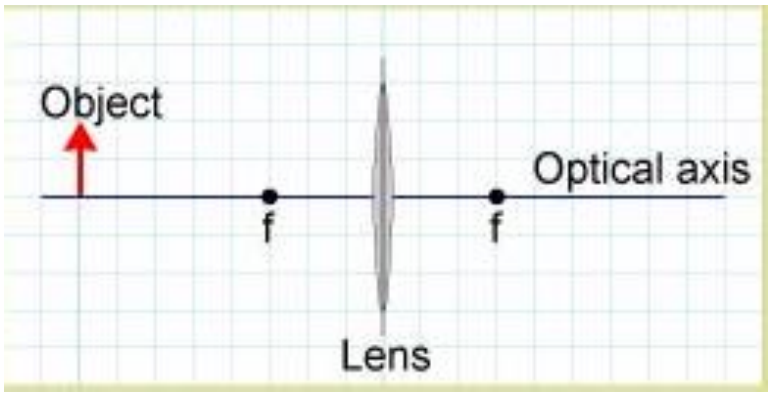
If a symmetrical lens were thought of as being a slice of a sphere, then there would be a line passing through the center of the sphere and attaching to the mirror in the exact center of the lens. This imaginary line is known as the principal axis. A lens also has an imaginary vertical axis that bisects the symmetrical lens into halves. As mentioned above, light rays incident towards either face of the lens and traveling parallel to the principal axis will either converge or diverge. If the light rays converge (as in a converging lens), then they will converge to a point. This point is known as the focal point of the converging lens. If the light rays diverge (as in a diverging lens), then the diverging rays can be traced backwards until they intersect at a point. This intersection point is known as the focal point of a diverging lens. Note that each lens has two focal points - one on each side of the lens. Unlike mirrors, lenses can allow light to pass through either face, depending on where the incident rays are coming from. Technically, a lens does not have a center of curvature. However a lens does have an imaginary point that we refer to as the 2F point. This is the point on the principal axis that is twice as far from the vertical axis as the focal point is.

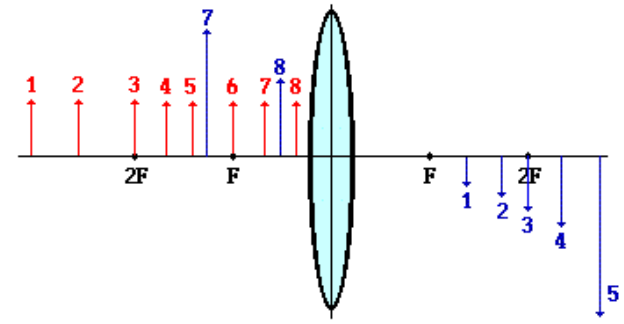


RAY DIAGRAMS FOR LENSES

Refraction Rules for a Converging Lens

- Any incident ray traveling parallel to the principal axis of a converging lens will refract through the lens and travel through the focal point on the opposite side of the lens.
- Any incident ray traveling through the focal point on the way to the lens will refract through the lens and travel parallel to the principal axis.
- An incident ray that passes through the center of the lens will in effect continue in the same direction that it had when it entered the lens.



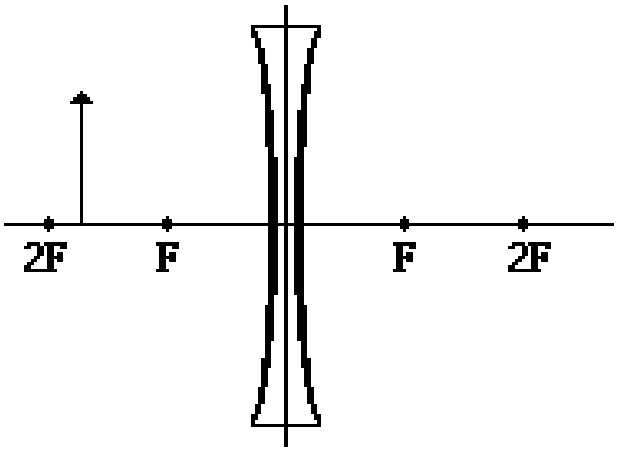


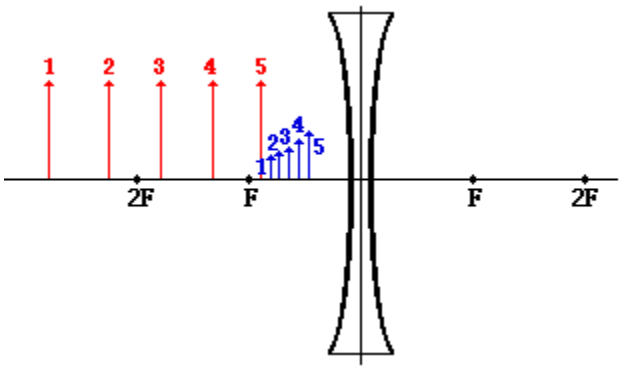
Each of the numbered objects (except #6) has an image with the corresponding number; its relative location, size, and orientation are shown.

1. What type of an image will a converging lens give you?

Refraction Rules for a Diverging Lens

- Any incident ray traveling parallel to the principal axis of a diverging lens will refract through the lens and travel *in line with* the focal point (i.e., in a direction such that its extension will pass through the focal point).
- Any incident ray traveling towards the focal point on the way to the lens will refract through the lens and travel parallel to the principal axis.
- An incident ray that passes through the center of the lens will in effect continue in the same direction that it had when it entered the lens.





2. What type of an image will a diverging lens give you?