Homework 25.

Lenses.

Last class we discussed how the phenomenon of refraction can be used to focus the parallel light beam. The "refractive" focusing can be done with optical device called "lens". There are two major types of lenses: convex (converging) and concave (diverging):

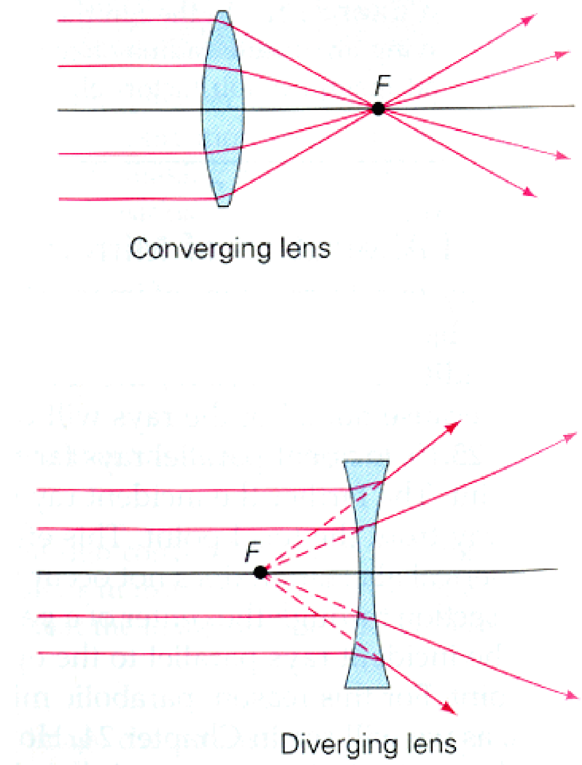

Figure 1. The lens types.

A lens can be used to create an image. This process is represented geometrically in Figure 2 below.

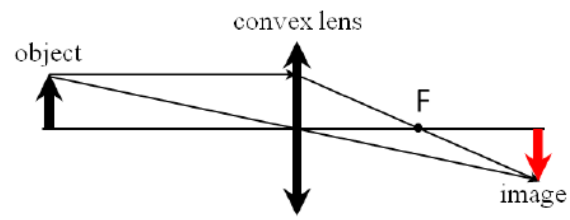

Figure 2. Imaging with a convex lens.

As in the case of spherical mirrors, to create the image of the tip of the arrow we use two rays. One goes parallel to the main optical axes and reaches the lens. Then, being refracted by the lens it passes through the focal point. Another ray passes through the center of the lens without refraction, since near the center a lens is similar to the flat plate which does not change the direction of the ray (we consider the lens thickness as very small comparing to the focal distance, so we neglected the displacement of the ray). The farther object from the lens, the smaller its image and the close it to the focal point. The focal distance of the lens depends on the radius of curvature of the lens and the refractive indices of the lens material and surrounding media.

The expression which we have earlier obtained for the convex and concave mirrors is valid for the lenses as well. It connects distance to the object $\boldsymbol{d_0}$, distance to the image $\boldsymbol{d_i}$ and focal distance $\boldsymbol{f}$:

$$\frac{1}{d_0}+\frac{1}{d_i}=\frac{1}{f}$$

You can also remember our “sign convention”: for the convex lens $f>0$ (for the concave one $f<0$).

Problems

1. Will the focal length of a lens change if we cut the edge of the lens?

2. How we can measure focal length of a lens in a sunny day?

3. How does a magnifying glass work (make a scheme)? What kind of an image is created by a magnifying glass: virtual or real?