2.5: Power

It will be evident that the function of a lens is to *change the convergence* of a beam of light. Indeed the difference between the initial and final convergence is called the *power P* of the lens, or of a refracting interface, or of a reflecting mirror. Thus, here is the only equation you need to know in geometric optics. (Well, maybe not quite true.)

Final convergence = initial convergence plus power,

or

$$C_2 = C_1 + P. \tag{2.5.1}$$

In order to solve a question in geometric optics, then, it is necessary to know the power of the optical system.

There are three basic optical elements for which we need to know the power, namely a lens, a refracting interface, and a reflecting surface.

I am now going to *tell you*, without proof, what the powers of these elements are. I shall supply proofs later. For the moment, I want us to become used to using the formulas, accurately and at speed.

1. The power of a lens of focal length f is

$$P = \frac{1}{f}. \tag{2.5.2}$$

Note that by the focal length of a lens I mean the focal length of the lens when it is in a vacuum, or, what amounts to almost the same thing, when it is in air.

Sign convention:

The focal length of a converging lens is positive;

The focal length of a diverging lens is negative.

2. The power of a refracting interface, of radius of curvature r, separating media of refractive indices n_1 and n_2, is

$$P = \frac{n_2 - n_1}{r}. \tag{2.5.3}$$

Sign convention:

The radius of curvature of a convex surface or interface is positive;

The radius of curvature of a concave surface or interface is negative.

3. The power of a reflecting spherical surface of radius of curvature r immersed in a medium of refractive index n is

$$P = -\frac{2n}{r}. \tag{2.5.4}$$

Power can be expressed in cm^{-1} or in m^{-1}. In this connection a m^{-1} is sometimes called a diopter. Thus a lens of focal length 5 cm has a power of 20 diopters.