616.

Problem 44.19 (RHK)

The formula

$$\frac{1}{o}+\frac{1}{i}=\frac{1}{f}$$

is called the Gaussian form of the thin lens formula. Another form of this formula, the Newtonian form, is obtained by considering the distance x from the object to the first focal point and the distance x' from the second focal point to the image. We have to show that

$$xx' = f^2.$$

Solution:

In a thin lens, there are two focal points, which are located at equal distances *f* from the lens on either side of the lens. When a point object is located at the *first focal point* F_1, parallel light emerges from the lens. The *second focal point* F_2 is the point where parallel light is focussed by the lens. In a diverging lens these definitions are suitably modified.

We consider a converging thin lens.

We define x the distance of the object from the first focal point as

$$x = o - f,$$

and x' the distance of the image from the second focal point as

$$x' = i - f.$$

In the following we rewrite the Gaussian form of the thin lens equation in two different ways:

$$\frac{1}{o} = \frac{i - f}{if} = \frac{x'}{if},$$

and

$$\frac{1}{i} = \frac{o - f}{of} = \frac{x}{of}.$$

We thus have the relation

$$\frac{1}{i} = \frac{x}{f} \times \frac{x'}{if},$$

or

$$xx' = f^2.$$