620.

Problem 44.24 (RHK)

We have to show that the distance between a real object and its real image formed by a thin converging lens is always greater than or equal to four times the focal length of the lens.

Solution:

As we are considering a real object and its real image formed by a thin converging lens, in the sign conventions that we are using the object distance *o*, and the image distance i will be real and positive numbers. The focal length *f* of a converging lens is also a real positive number. Let us call the distance between the object and its real image *d*. We have

$d = o + i$.

We consider the thin lens equation

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

or

$$\frac{1}{(d-i)}+\frac{1}{i}=\frac{1}{f},$$

or

$$i^2-id+fd=0.$$

The roots of this quadratic equation are

$$i=\frac{d\pm\sqrt{d^2-4fd}}{2}.$$

As the image is real, the roots have to be real and positive. This imposes the condition that

$$d^2-4fd\geq 0,$$

or

$$d\geq 4f.$$