11. (a) Suppose one end of the object is a distance p from the mirror and the other end is a distance $p+L$. The position i_1 of the image of the first end is given by

$$\frac{1}{p}+\frac{1}{i_1}=\frac{1}{f}$$

where f is the focal length of the mirror. Thus,

$$i_1=\frac{fp}{p-f}\ .$$

The image of the other end is located at

$$i_2=\frac{f(p+L)}{p+L-f}\ ,$$

so the length of the image is

$$L'=i_1-i_2=\frac{fp}{p-f}-\frac{f(p+L)}{p+L-f}=\frac{f^2L}{(p-f)(p+L-f)}\ .$$

Since the object is short compared to $p-f$, we may neglect the L in the denominator and write

$$L'=L\left(\frac{f}{p-f}\right)^2\ .$$

(b) The lateral magnification is $m=-i/p$ and since $i=fp/(p-f)$, this can be written $m=-f/(p-f)$. The longitudinal magnification is

$$m'=\frac{L'}{L}=\left(\frac{f}{p-f}\right)^2=m^2\ .$$