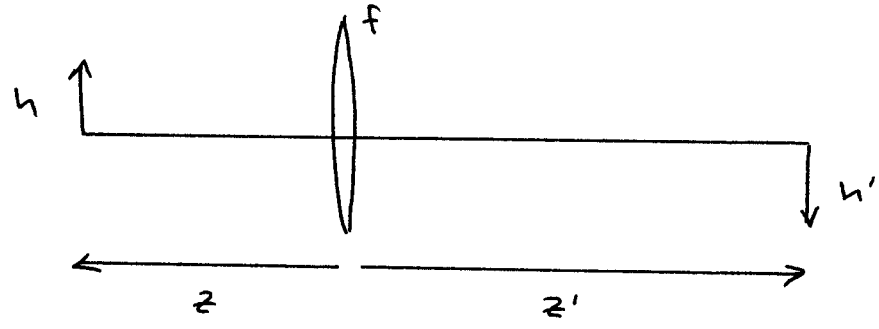
Object - Image Distance

z, z' measured from the lens

$$\frac{z}{f} = \frac{1}{m} - 1 \qquad \frac{z'}{f} = 1 - m$$



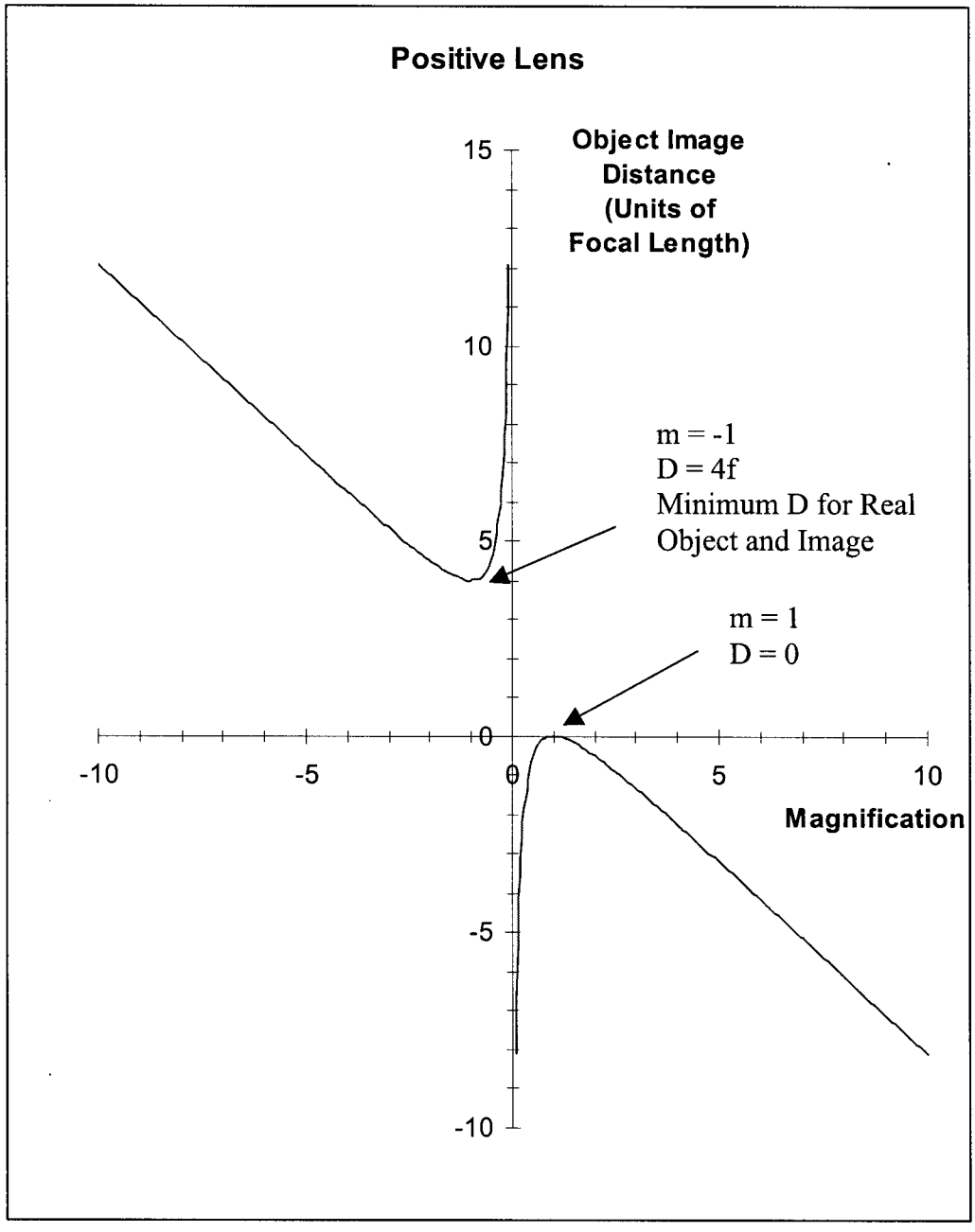
$$D = z' - z$$

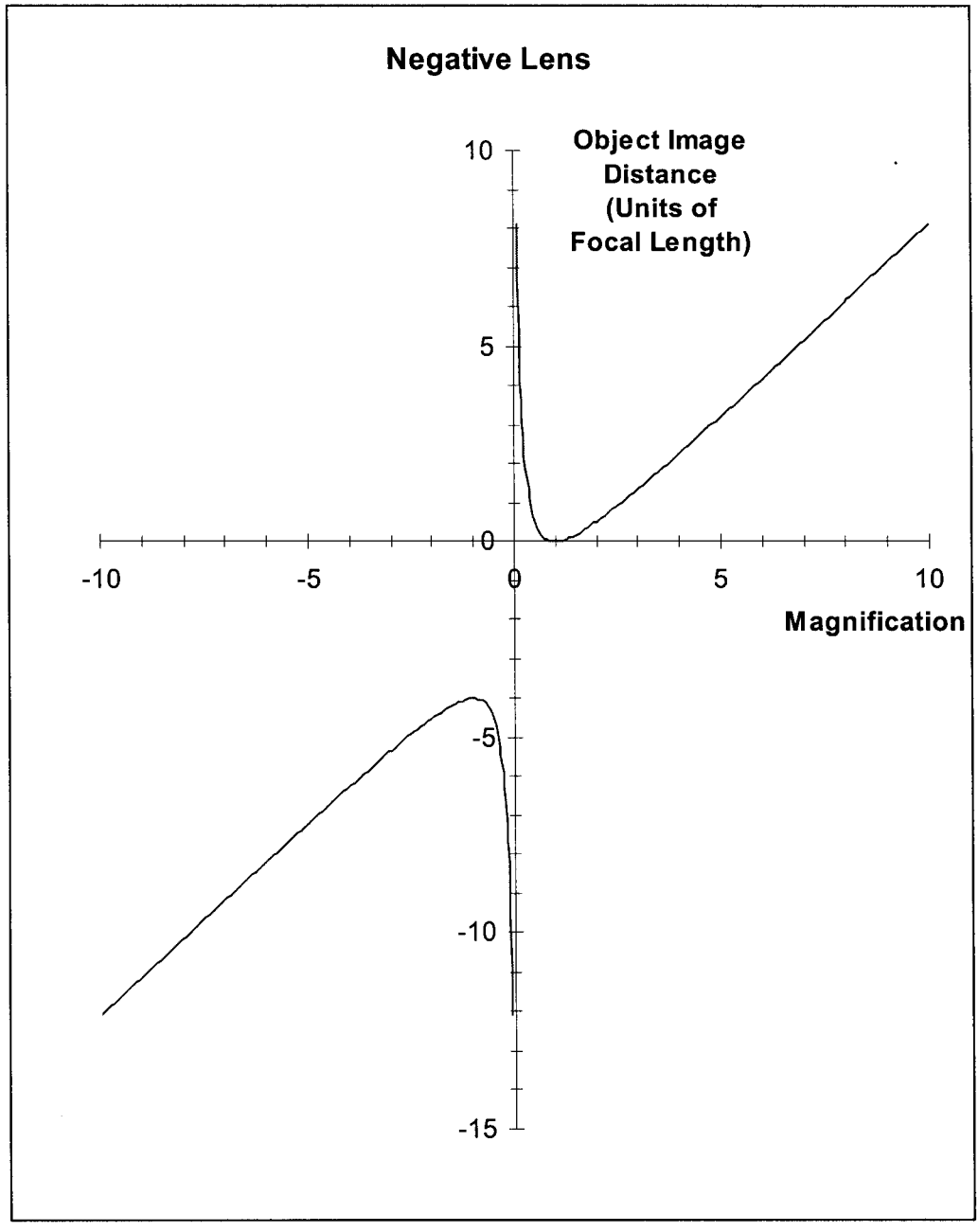
$$D = (1-m)f - \left(\frac{1}{m} - 1\right)f$$

$$D = \left(2 - m - \frac{1}{m}\right)f$$

$$D = -\frac{(m^2 - 2m + 1)}{m} f$$

$$D = -\frac{(m-1)^2}{m} f$$


Positive Lens
Object Image Distance (Units of Focal Length)
15
10
5
0
-5
-10
-10
-5
0
5
10
Magnification
m = -1
D = 4f
Minimum D for Real Object and Image
m = 1
D = 0


Negative Lens
Object Image Distance (Units of Focal Length)
10
5
0
-5
-10
-15
-10
-5
0
5
10
Magnification

Reciprocal Magnifications:

$$D = -\frac{(m-1)^2}{m} f$$

$$mD = -(m^2 - 2m + 1) f$$

$$m^2 + (D/f - 2)\, m + 1 = 0$$

$$\boxed{m = (1 - D/2f) \pm \sqrt{D^2/4f^2 - D/f}}$$

Show $m_1 = 1/m_2$

$$(1 - D/2f) + \sqrt{D^2/4f^2 - D/f} \stackrel{?}{=} \frac{1}{(1 - D/2f) - \sqrt{D^2/4f^2 - D/f}}$$

$$(1 - D/2f)^2 - (D^2/4f^2 - D/f) \stackrel{?}{=} 1$$

$$1 - D/f + D^2/4f^2 - D^2/4f^2 + D/f = 1 \quad \checkmark$$

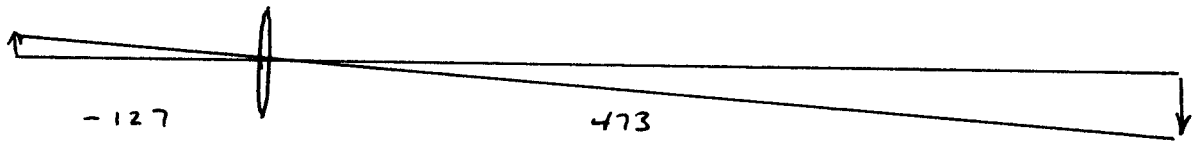
Example: $f = 100$ mm $\quad D = 600$ mm

$m_1 = -.268$ $\quad m_2 = -3.732$

$z_1 = -473$ mm $\quad z_2 = -127$ mm

$z_1' = 127$ mm $\quad z_2' = 473$ mm

m_2:



m_1: