\[ g - p \text{ plot: } \frac{1}{f} = \frac{1}{p} + \frac{1}{q} \]

\[ q = \frac{1}{\frac{1}{f} - \frac{1}{p}} = \frac{f}{1 - \frac{f}{p}} \]

1. \( p = \infty, \quad q = f \)
2. \( p = 2f, \quad q = \frac{f}{1 - \frac{f}{2}} = 2f \)
3. \( p = f + ef, \quad \frac{f}{q} = \frac{f}{f(1 - e)} \approx 1 - e, \quad q = \frac{f}{1 - (1 - e)} = \frac{f}{e} \rightarrow \infty \)
4. \( p = f - ef, \quad q = \frac{f}{-e} \rightarrow -\infty \)
5. \( p = \frac{f}{2}, \quad q = \frac{f}{1 - \frac{f}{2}} = -f \)
6. \( p = 0, \quad q = \frac{1}{\frac{f}{p} - \frac{1}{f}} = \frac{f}{f - 1} = \frac{1}{1} = 1 \)

\[ \text{Graph with points labeled: } 1, 2, 3, 4, 5 \]
Lens 2

Object: \( p = |x_o| > 0 \), \( h = y_o \)

Image: \( q = x_i \), \( h' = |y_i| \)

\[ M = \frac{y_i}{y_o} = -\frac{q}{p} \]

Properties of image:

\[ \frac{h'}{h} = \begin{cases} 1 \text{ enlarged} & y_i < 0 \text{ inverted} \\ < 1 \text{ reduced} & y_i > 0 \text{ upright} \end{cases} \]

\[ q: \begin{cases} > 0, \text{ in front of the lens, real image} \\ < 0, \text{ behind the lens, virtual image} \end{cases} \]
Examples: Convergent lens

Image: Virtual, enlarged, upright

Divergent lens:

Image: Virtual, reduced, upright

Near sighted:

Cannot see clearly beyond the near point a.
Correction: Bring distant object image to a.
Verify: Lens needed has f < 0

Far sighted:

Cannot see clearly closer than far point b.
Correction: Bring close object image to far point.
Verify: Lens needed has f > 0.