Derivation of Mirror Equation

conventions for mirrors:

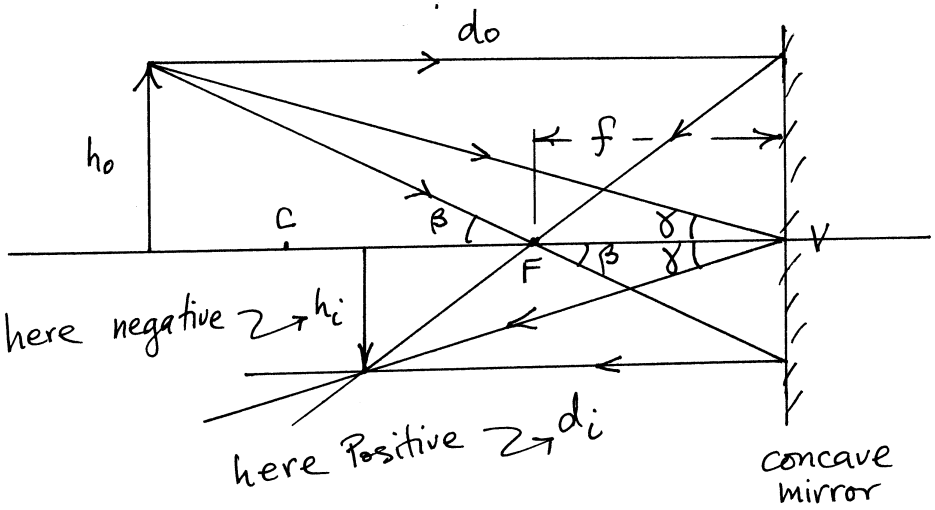
d_o is always positive (object is on left side of mirror)

d_i is positive when image is on left side of mirror (real image)

h_o is always positive (always draw object upright)

h_i is positive if image is upright (virtual image)

define magnification $m \equiv \frac{h_i}{h_o}$.



$$\tan\gamma = \frac{h_o}{d_o} = \frac{-h_i}{d_i} \Rightarrow \frac{-h_i}{h_o} = \frac{d_i}{d_o} \quad (1)$$

$$\tan\beta = \frac{h_o}{d_o - f} = \frac{-h_i}{f} \Rightarrow \frac{-h_i}{h_o} = \frac{f}{d_o - f} \quad (2)$$

Equating (1) & (2):

$$\frac{d_i}{d_o} = \frac{f}{d_o - f}$$

cross multiplying: $d_i(d_o - f) = d_o f$

$\div\, d_i d_o f$: $\quad \frac{1}{f} - \frac{1}{d_o} = \frac{1}{d_i}$

$$\boxed{\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}}$$ mirror eq'n.

From (1) $\boxed{m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}}$