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## Spherical Mirror Equation

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$f > 0$  concave mirror

$f < 0$  convex mirror

$d_o$  always positive

$d_i > 0$  on object side (real side)

$d_i < 0$  on other side (virtual side)

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Magnification

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

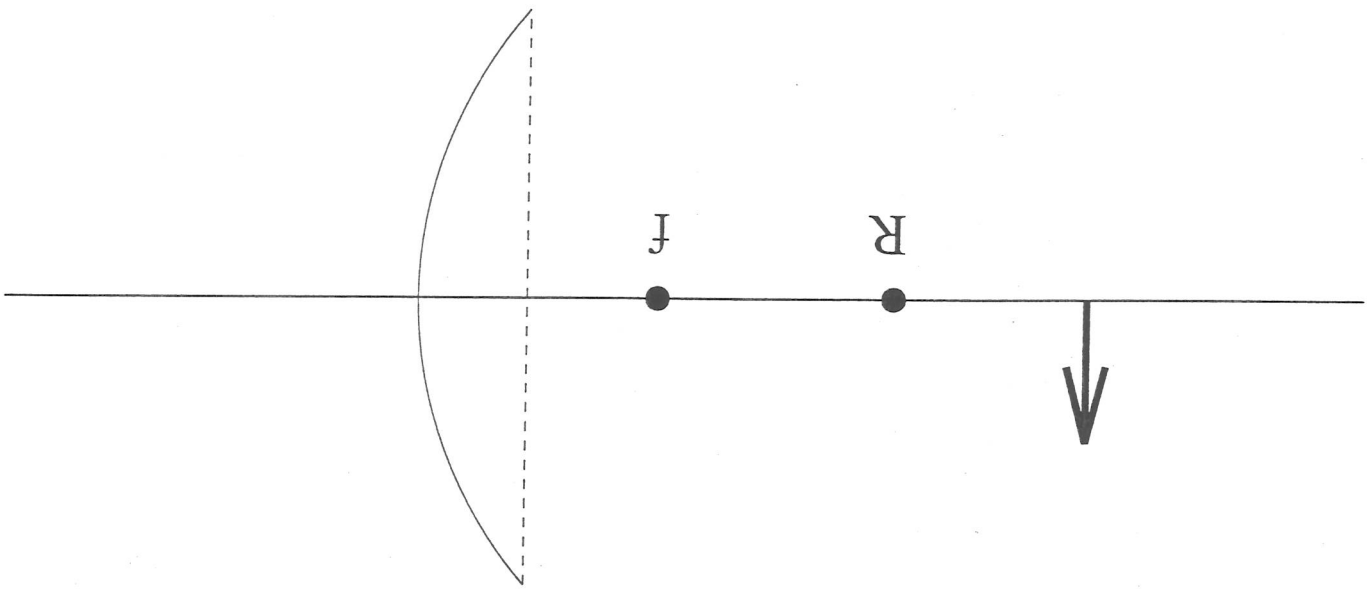
$M < 0$  image is inverted

$M > 0$  image is upright

$|M| > 1$  enlarged  $|M| < 1$  reduced

Object

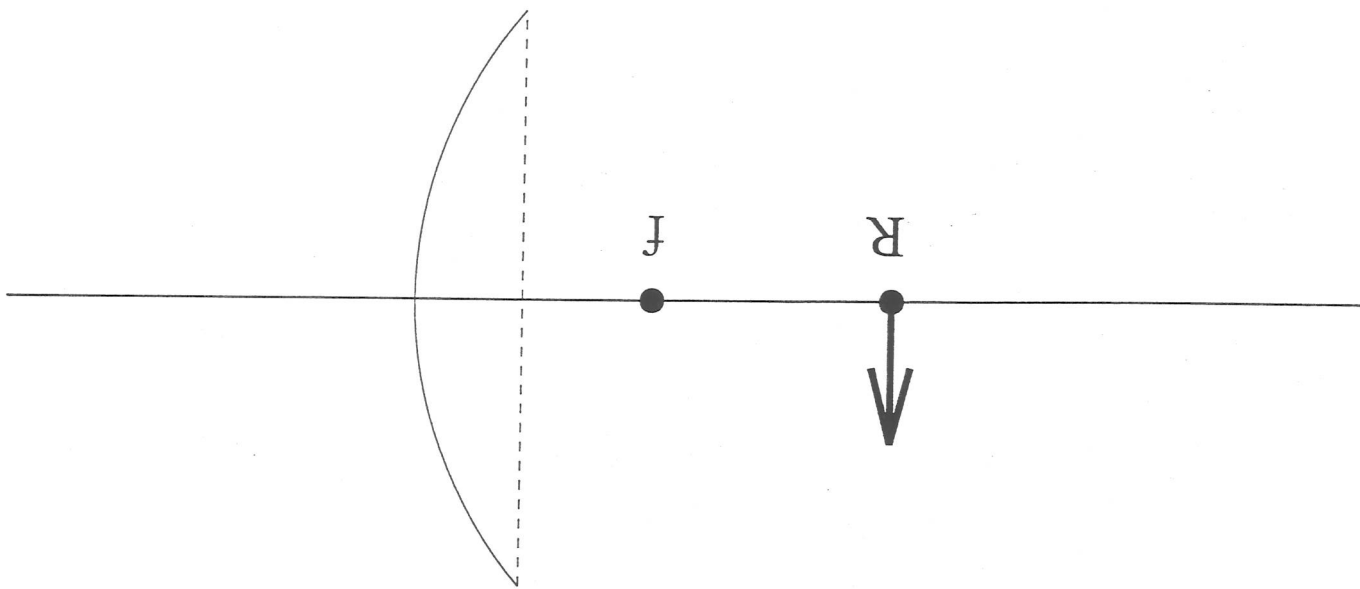
Image



Concave Mirror

Object

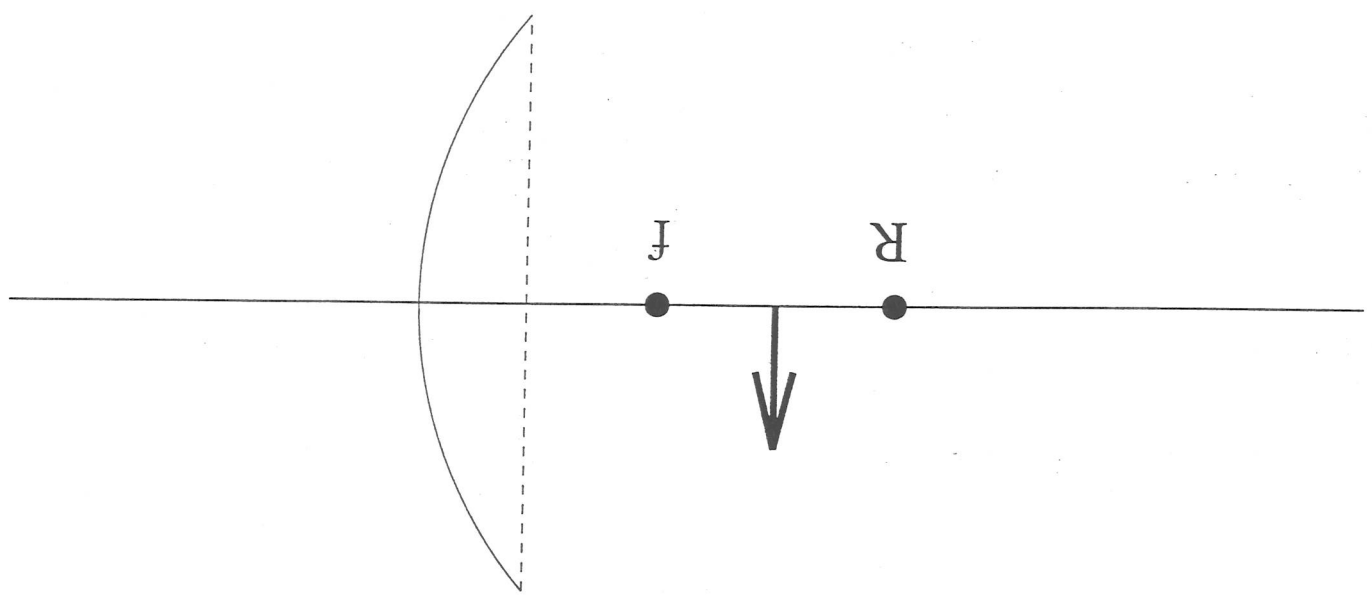
Image



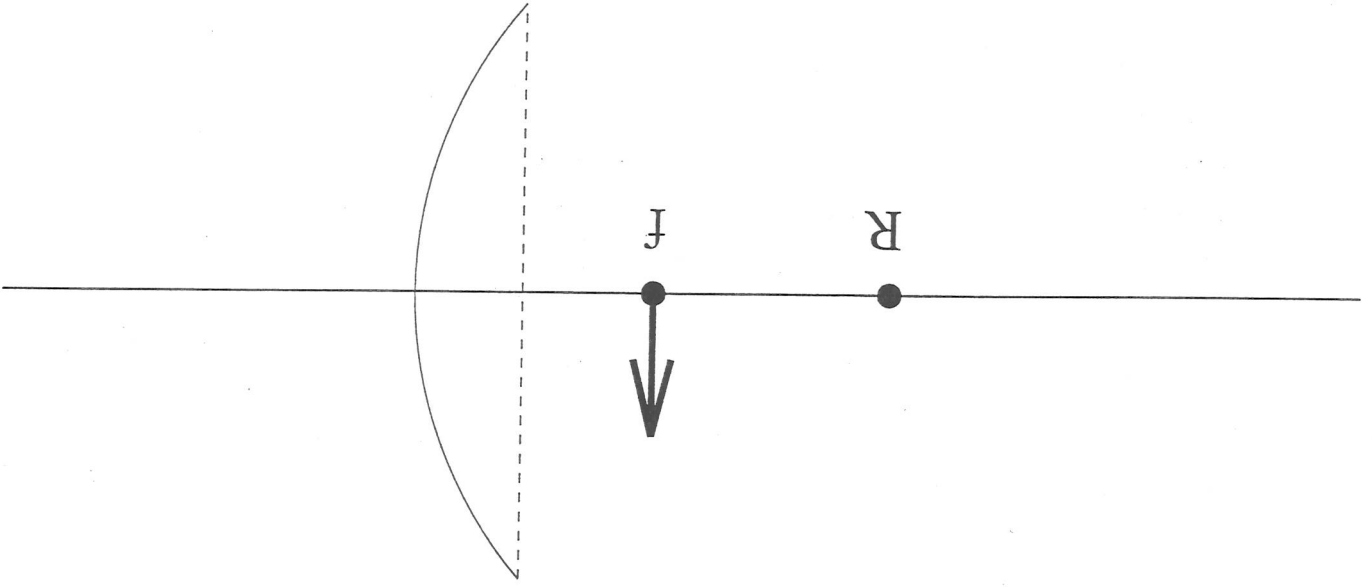
Concave Mirror

Object

Image



Concave Mirror



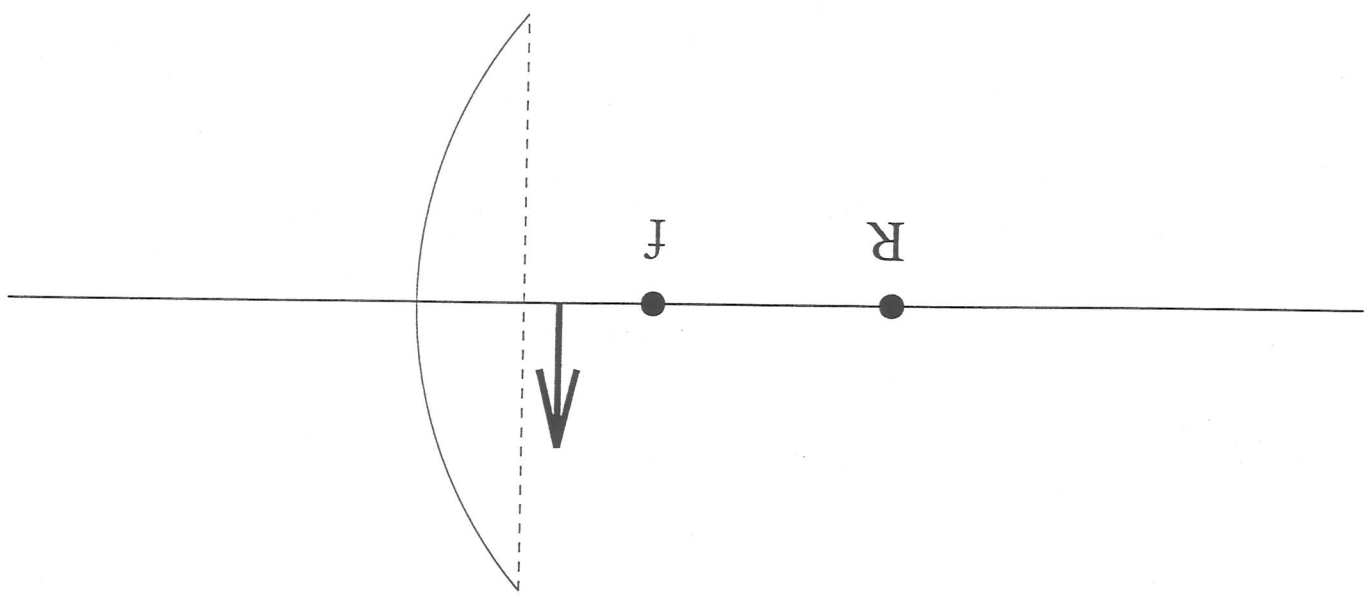
Object

Image

Concave Mirror

Object

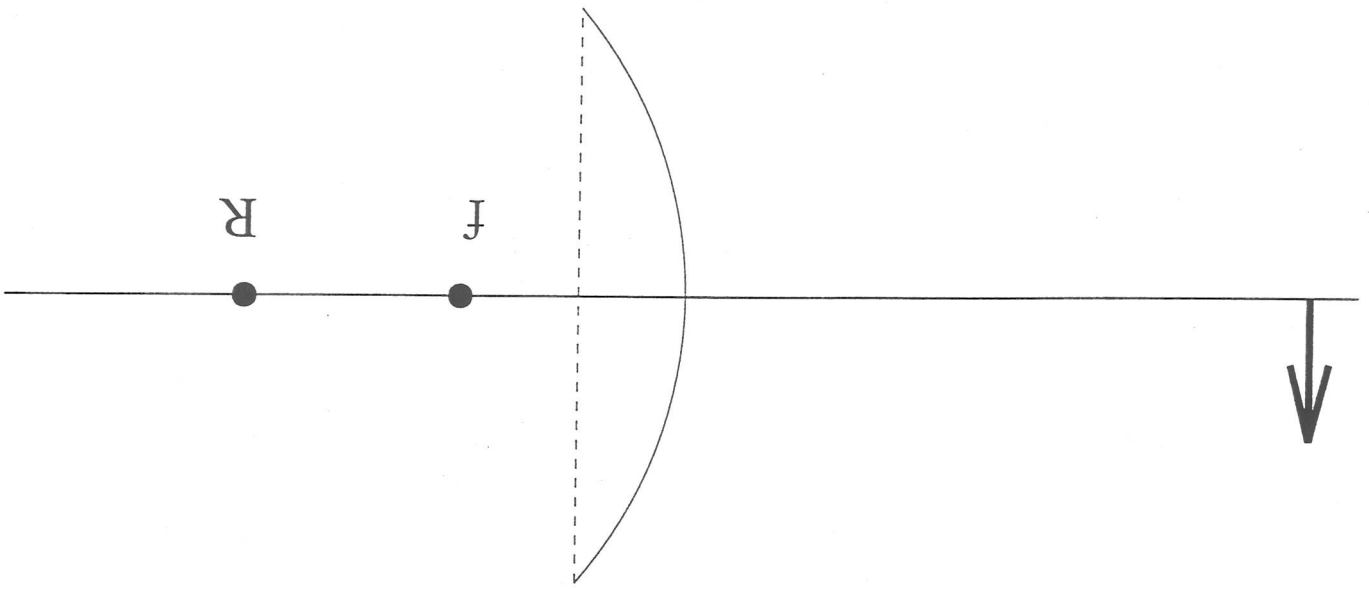
Image



Concave Mirror

Object

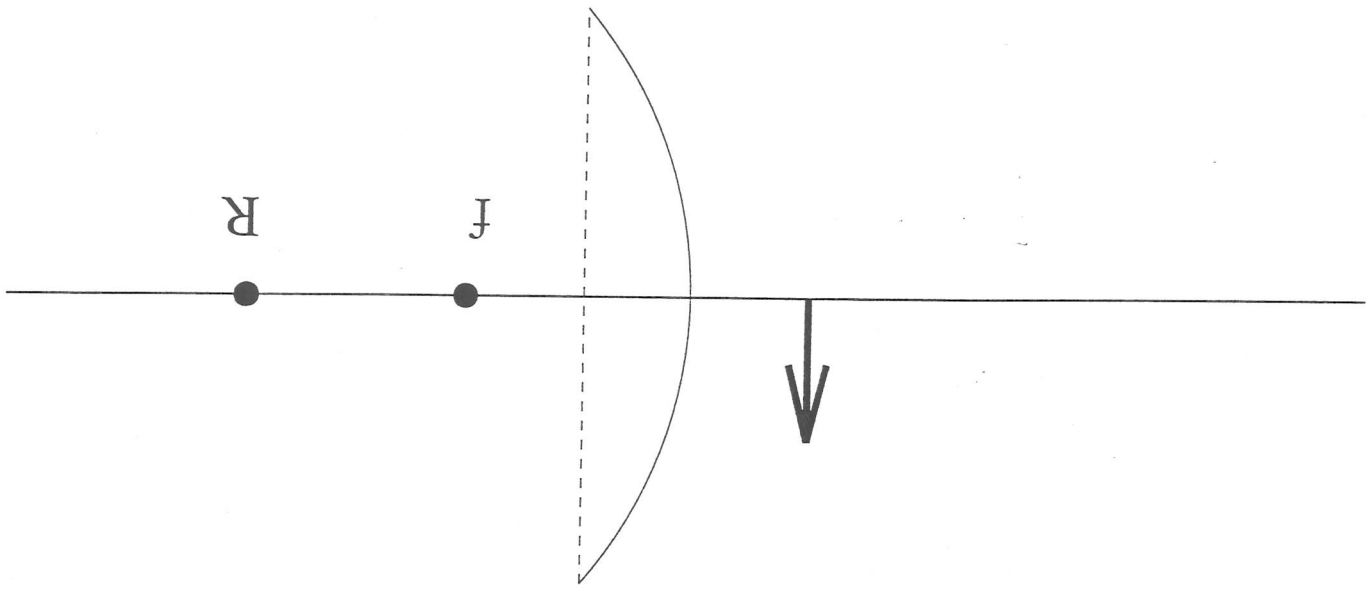
Image



Convex Mirror

Object

Image



Convex Mirror



# Spherical Mirror Equation and Lens

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$f > 0$  concave mirror

$f < 0$  convex mirror

$d_o$  always positive

$d_i > 0$  on object side (real side)

$d_i < 0$  on other side (virtual side)

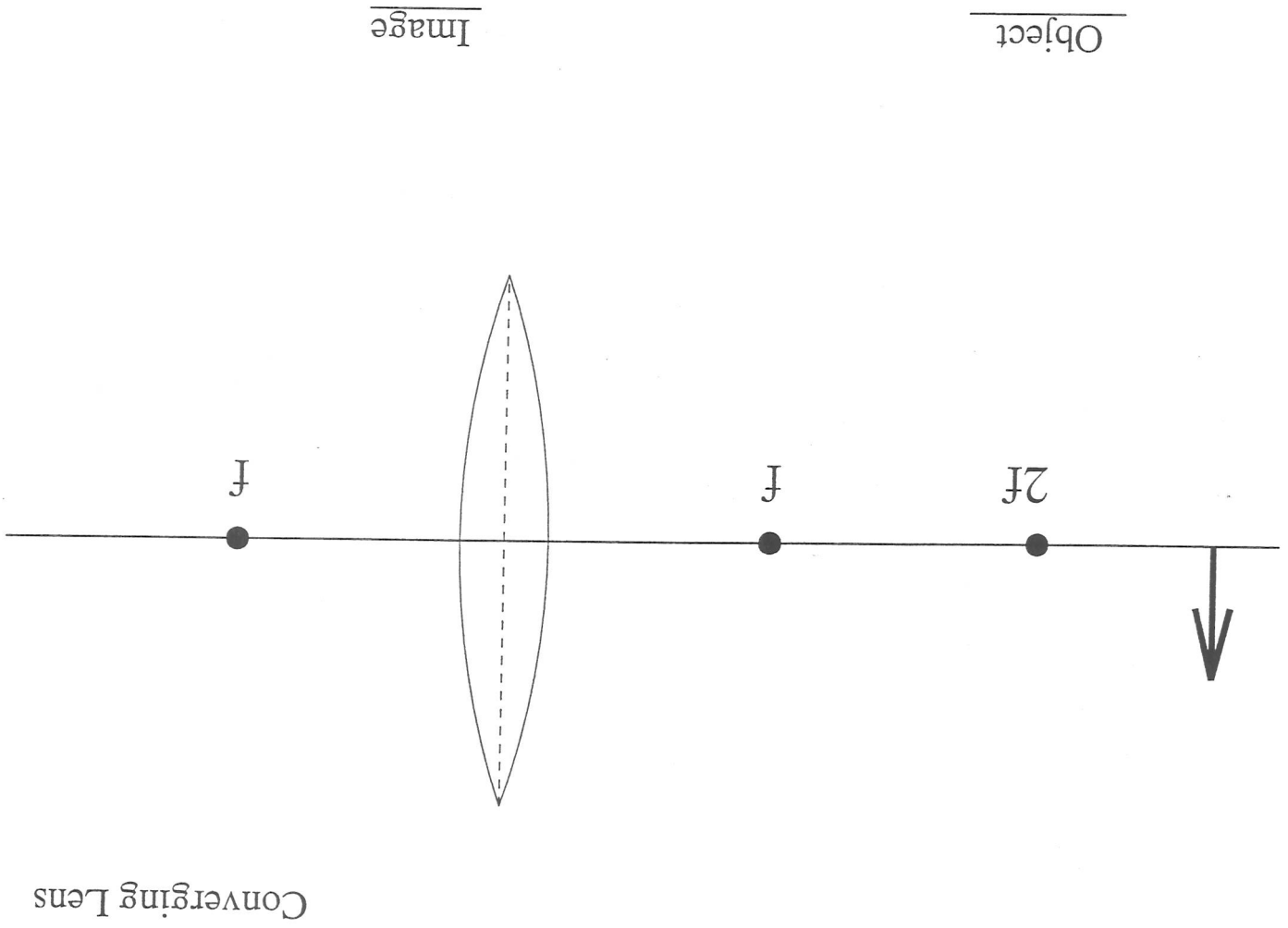
## Magnification

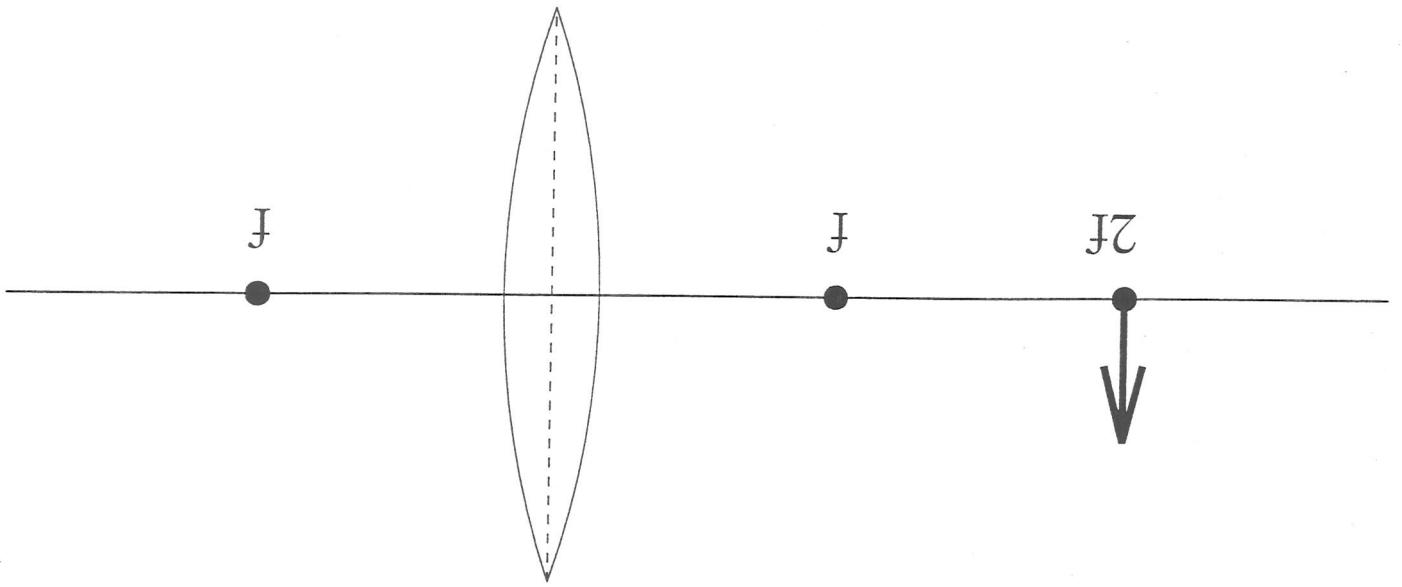
$$M = -\frac{d_i}{d_o}$$

$M < 0$  image is inverted

$M > 0$  image is upright

$|M| > 1$  enlarged  $|M| < 1$  reduced





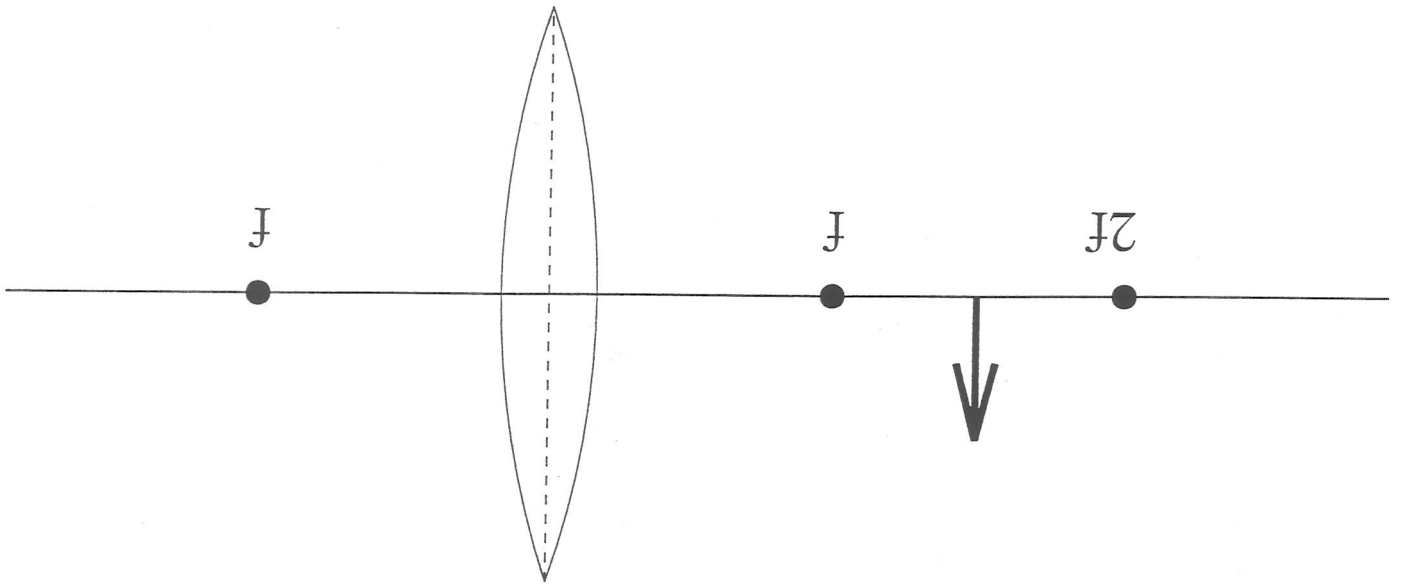
Object

Image

Converging Lens

Object

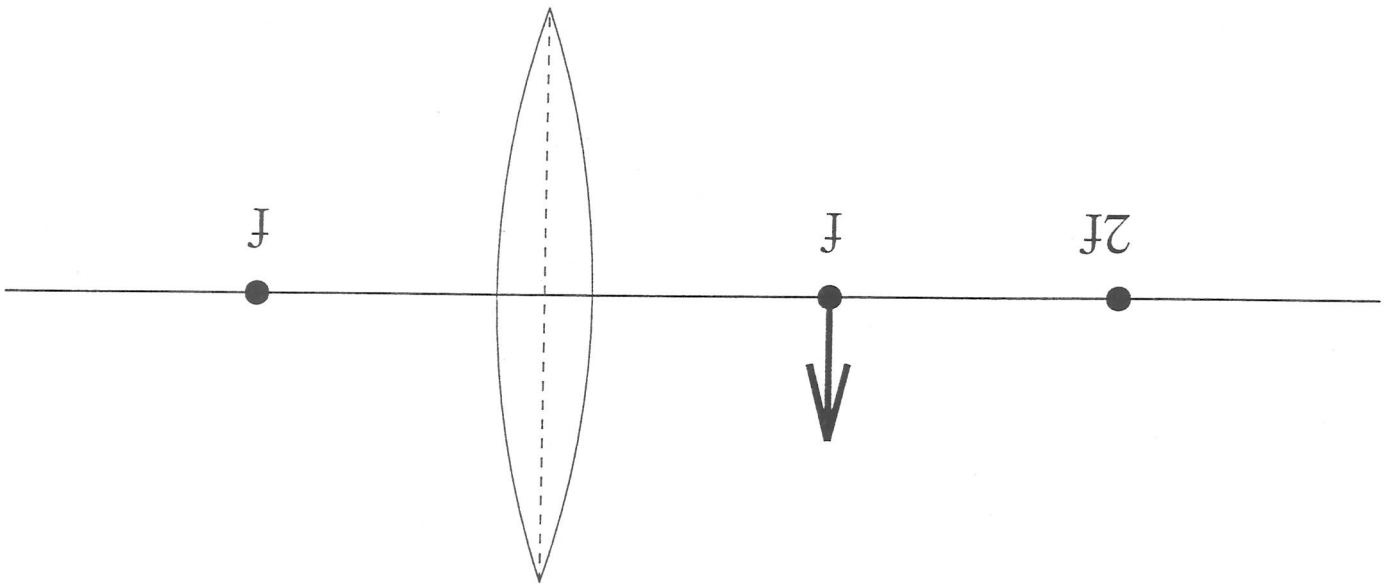
Image



Converging Lens

Object

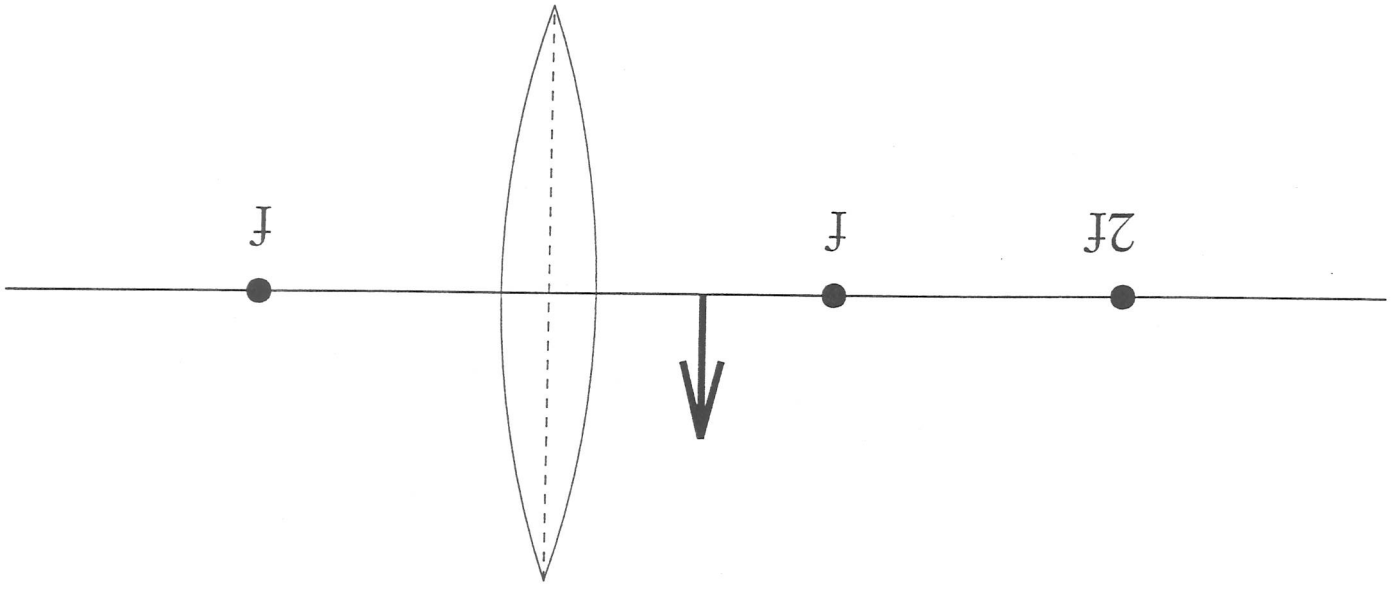
Image



Converging Lens

Object

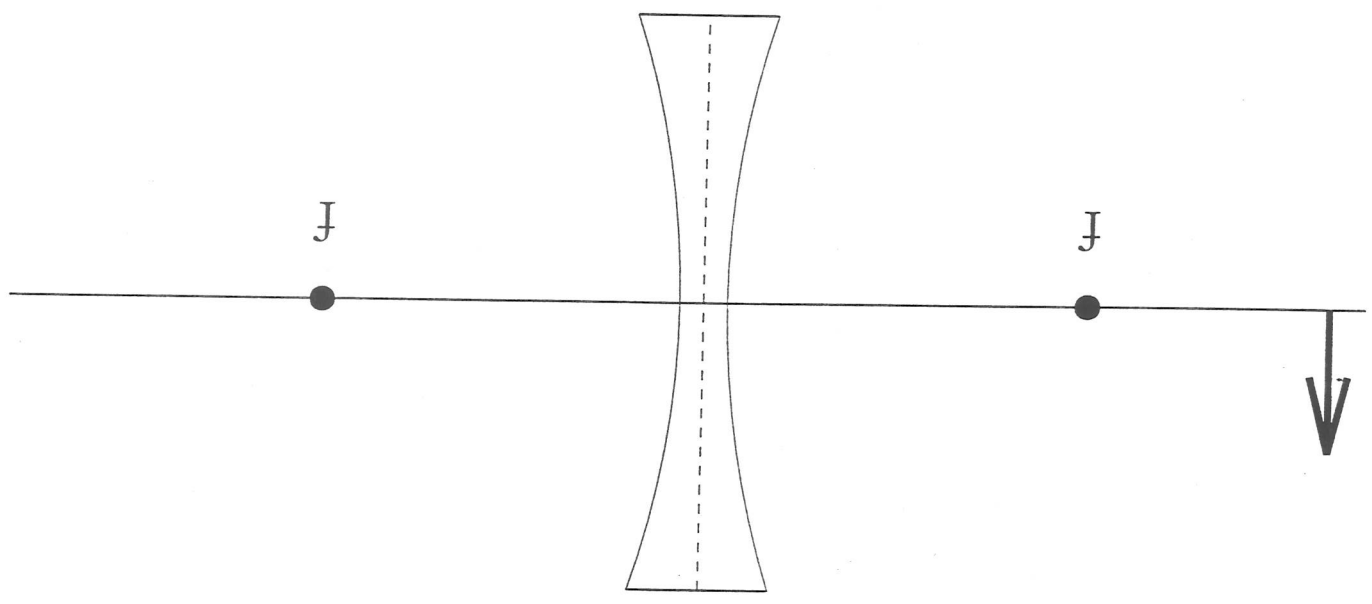
Image



Converging Lens

Object

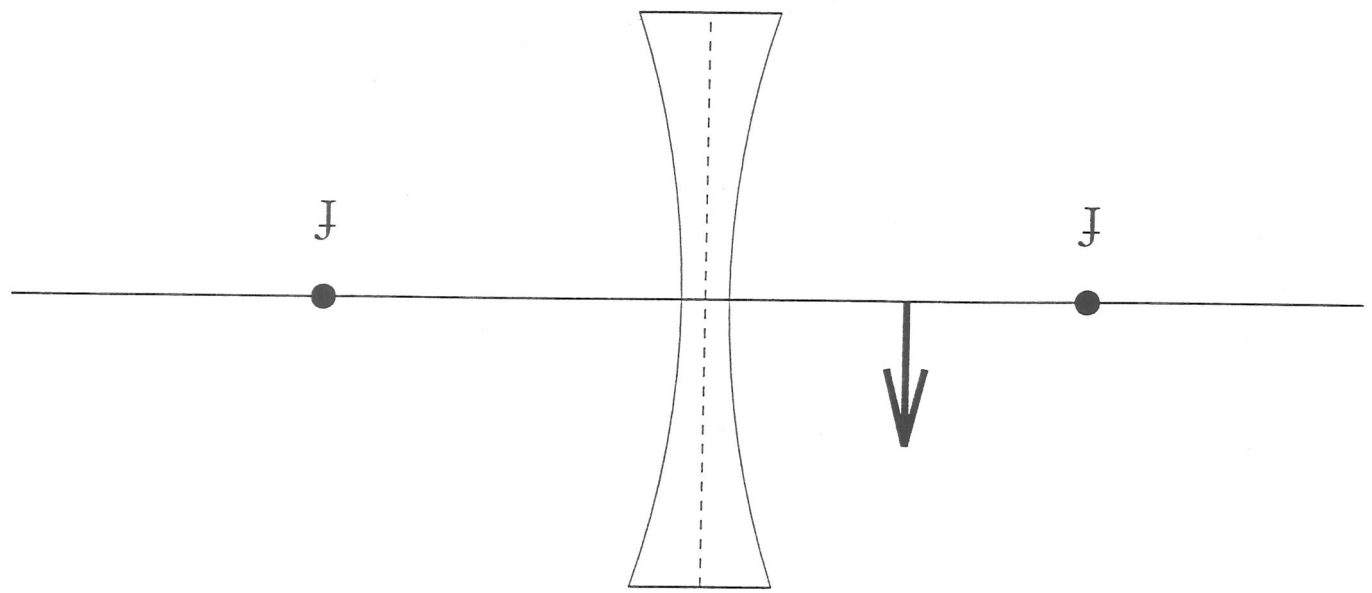
Image



Diverging Lens

Object

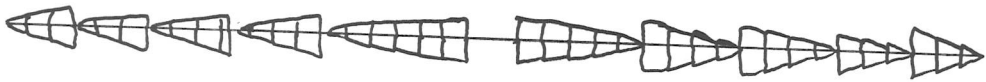
Image



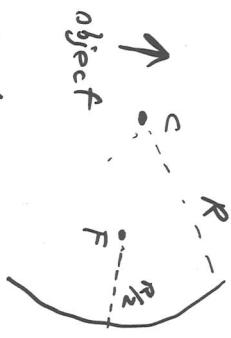
Diverging Lens



# Fresnel Lens



## Differences between Spherical Mirrors and Spherical Lenses



any ~~convex~~ mirror

$$C = 2F$$

$$M = \frac{d_i}{d_o}$$

Real side  $\leftarrow$  positive  $d_o$   
 Virtual side  $\rightarrow$  negative  $d_i$   
 $f > 0$  convex  
 $f < 0$  concave

object  $\uparrow$   $d_o$   $f$   $i$   $i$   $d_i$   
 Virtual side  $\leftarrow$  positive  $d_o$   
 Real side  $\rightarrow$  positive  $d_i$   
 $C \neq 2F$   
 $f > 0$  convex  
 $f < 0$  concave  
 $M_{convex} = \frac{d_i}{d_o}$   
 $M_{concave} = \frac{d_i}{d_o}$