

Plane mirror

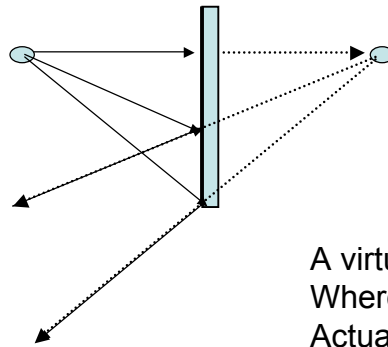
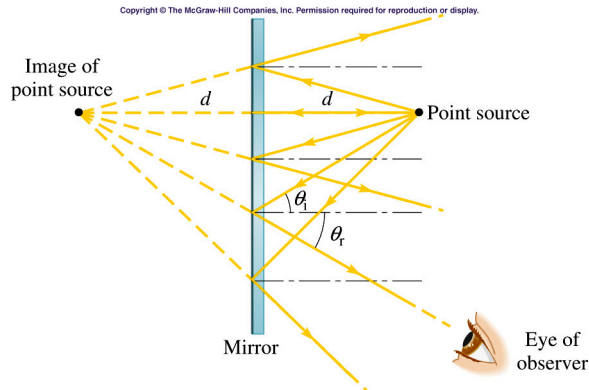
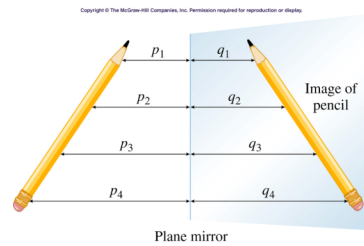


Image is Upright and virtual

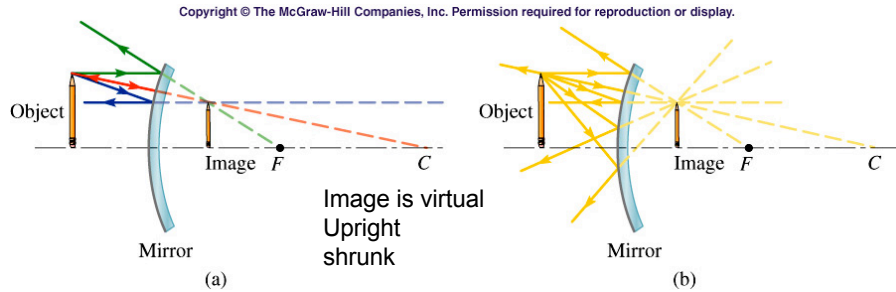
A virtual image exists Where there are no Actual light rays.



The source and image are the Same distance from the mirror On opposite sides.



Convex mirror

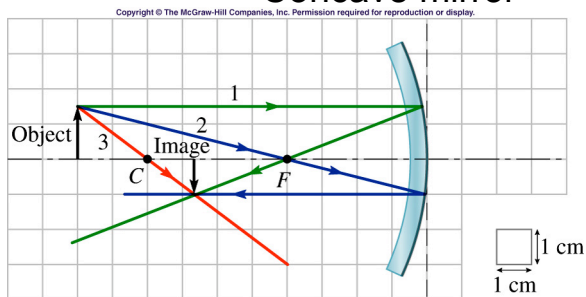


Principal rays

1. A ray parallel to the principal axis is reflected as if it came from the focal point
2. A ray along a radius is reflected back upon itself.
3. A ray directed toward the focal point is reflected parallel to the principal axis.

http://www.phy.ntnu.edu.tw/java/Lens/lens_e.html

Concave mirror

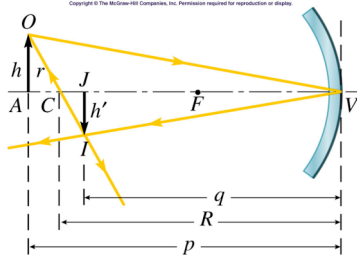


Principal rays

1. A ray parallel to the principal axis is reflected through the focal point
2. A ray along a radius is reflected back upon itself.
3. A ray directed toward the focal point is reflected parallel to the principal axis.

http://www.phy.ntnu.edu.tw/java/Lens/lens_e.html

Mirror Equation



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

Magnification

$$m = \frac{\text{image height}}{\text{object height}} = \frac{h'}{h} = -\frac{q}{p}$$

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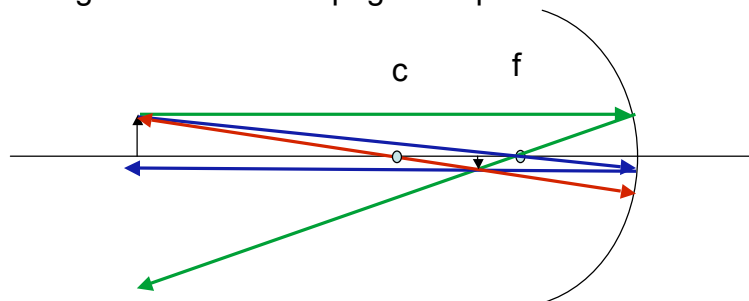
Table 23.2

Sign Conventions for Mirrors

Quantity	When Positive (+)	When Negative (-)
Object distance p	Always (for now)	Never (for now)
Image distance q	Real image	Virtual image
Focal length f	Converging mirror (concave)	Diverging mirror (convex)
Magnification m	Upright image	Inverted image

Mirror Example

- Problem 41:
A 1.80 cm high object is placed 20.0 cm in front of a concave mirror with a 5.00-cm focal length. What is the position of the image? Is it real or virtual? What is the magnification? Is it upright or upside down?



Thin Lens

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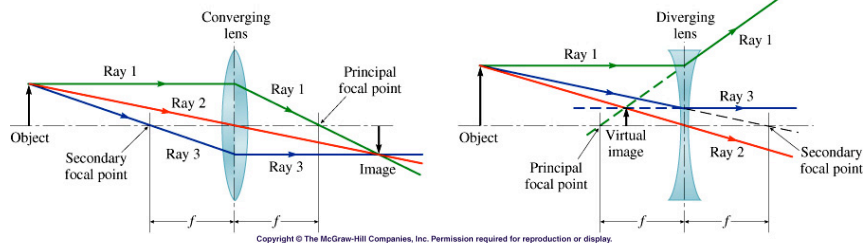


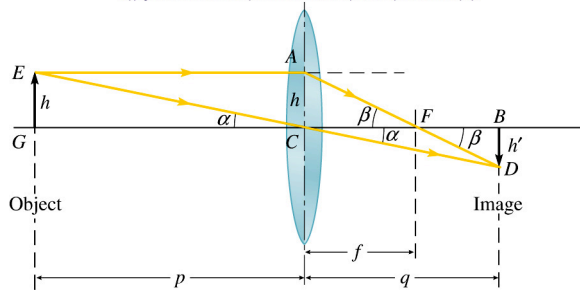
Table 23.3

Principal Rays and Principal Focal Points for Thin Lenses

	Converging Lens	Diverging Lens
Ray 1. An incident ray parallel to the principal axis	Passes through the principal focal point	Appears to come from the principal focal point
Ray 2. A ray incident at the optical center	Passes straight through the lens	Passes straight through the lens
Ray 3. A ray that emerges parallel to the principal axis	Appears to come from the secondary focal point	Appears to have been heading for the secondary focal point
Location of the principal focal point	Past the lens	Before the lens

Thin Lens Equation

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

Magnification

$$m = \frac{\text{image height}}{\text{object height}} = \frac{h'}{h} = -\frac{q}{p}$$

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Table 23.4

Sign Conventions for Mirrors and Lenses

Quantity	When Positive (+)	When Negative (-)
Object distance p	Always (for now)	Never (for now)
Image distance q	Real image	Virtual image
Focal length f	Converging lens or mirror	Diverging lens or mirror
Magnification m	Upright image	Inverted image

Thin Lens Examples

Problem 53:

When an object is placed 6.0 cm in front of a converging lens, a virtual image is formed 9.0 cm from the lens. What is the focal length of the lens?

Problem 54:

An object of height 3.00 cm is placed 12.0 cm from a diverging lens of focal length -12.0 cm. Find the height and position of the image.