

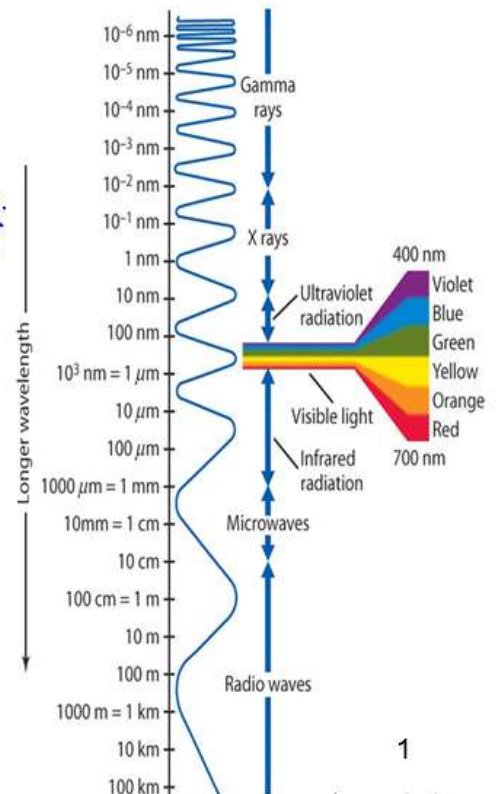
Chapter 34

Images

34-1 Properties Of Light

- light is an Electromagnetic wave which are transverse.
- Visible light is part of the electromagnetic spectrum of waves.
- Light ranges from violet (400 nm) to red (700 nm) (Violet, Blue, Green, Yellow, Orange & Red).
- It has a constant speed in space.
- The actual speed of light is 2.9979×10^8 m/s.
- Identify the characteristic properties of waves:
 - Reflection
 - Refraction
 - Interference
 - Diffraction
 - Doppler Effect

Electromagnetic Spectrum

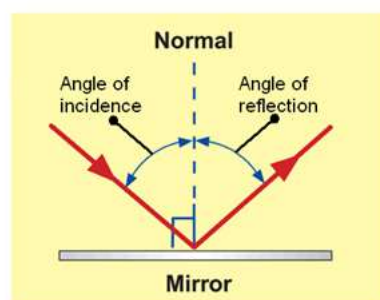


34-1: Properties Of Light

Reflection

The law of reflection states:

Reflection



The angle of incidence = The angle of reflection

$$\theta_{\text{incidence}} = \theta_{\text{reflection}}$$

34-1: Properties Of Light

Refraction

n is index of refraction

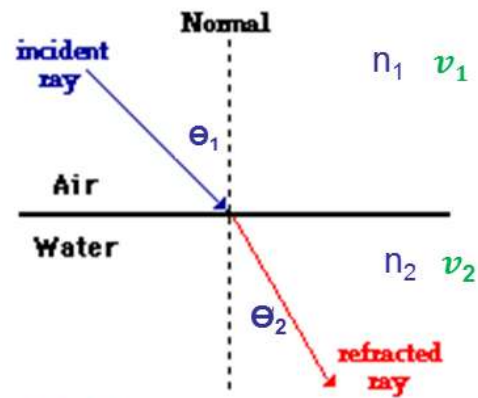
$$n = \frac{c}{v}$$

index of refraction

velocity of light in vacuum

velocity of light in the medium

Medium	Index of Refraction, n	Medium	Index of Refraction, n
Air	1.00029	Vacuum	1.00000
Ice	1.31	Acetone	1.36
Water	1.33	Ethyl Alcohol	1.36



Snell's Law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

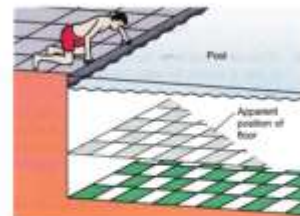
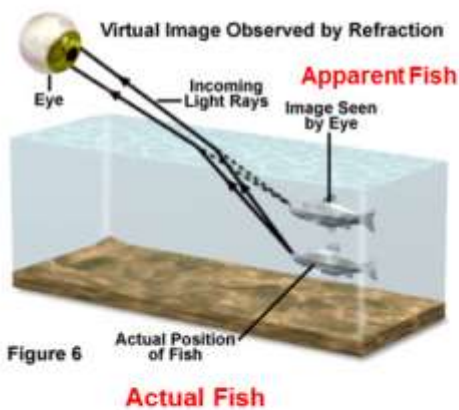
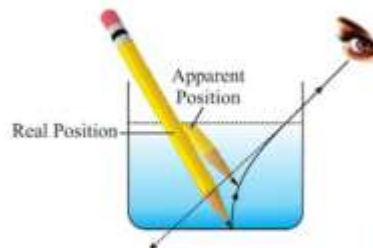
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34-1: Properties Of Light

Refraction

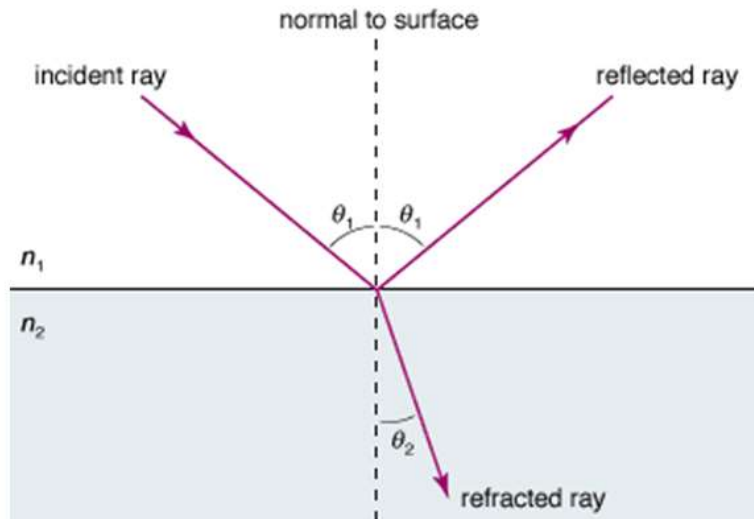
Snell's Law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$



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34-1: Properties Of Light



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Reflection

$$\theta_{\text{incidence}} = \theta_{\text{reflection}}$$

Refraction

$$\text{Snell's Law: } n_1 \sin \theta_1 = n_2 \sin \theta_2$$

n is index of refraction

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34-1: Properties Of Light

Principal Applications

Applications of Reflected light
plane and curved mirrors, CDs, DVD

Applications of Refraction of light
Lenses, prisms, and fiber-optic.

Mirrors

Plane Mirrors

Flat mirror



المرآة المستوية

Spherical Mirrors

Curved Mirrors

A curved mirror is a section of a sphere.

Concave Mirrors

Convex Mirrors



المرآة المقعرة

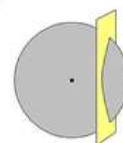
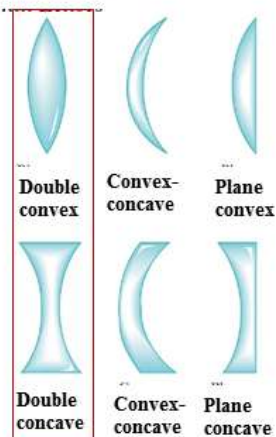


المرآة المحدبة

If the inside surface is reflecting, the mirror is concave.

If the outside surface of the sphere is reflecting, the mirror is convex.

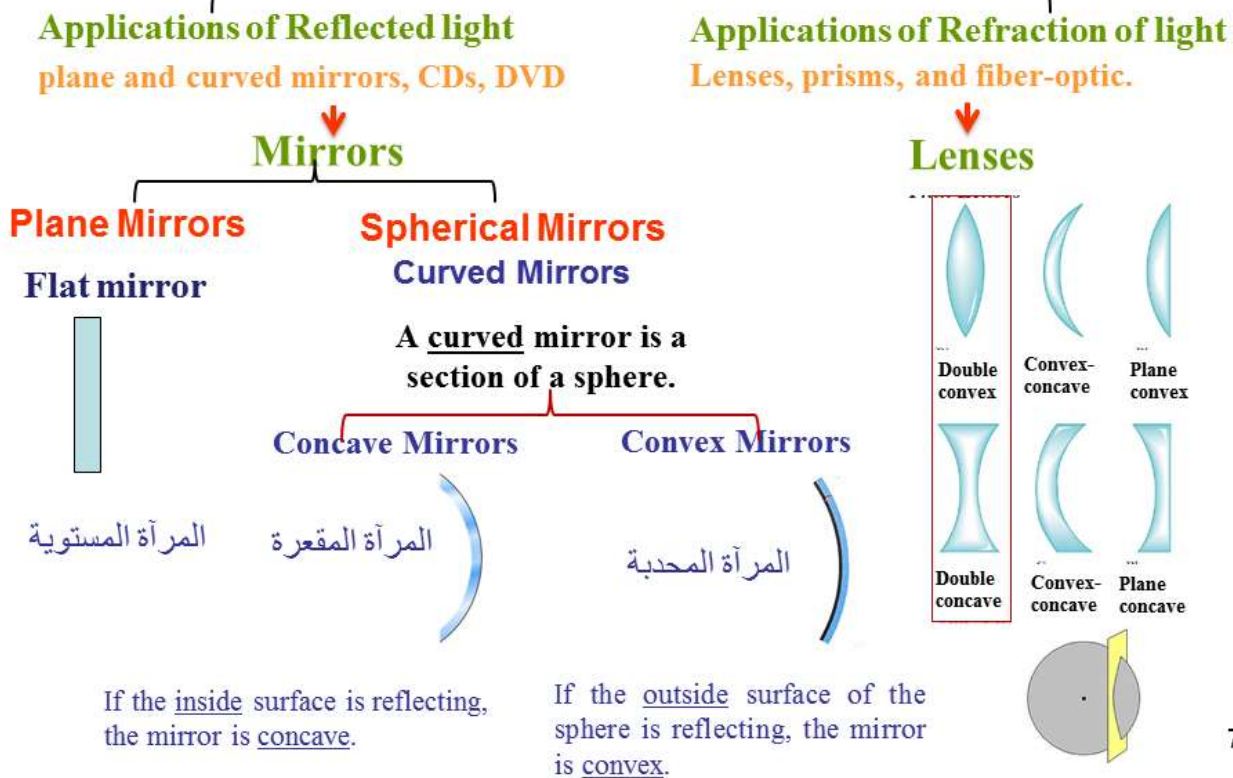
Lenses



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34-1: Properties Of Light

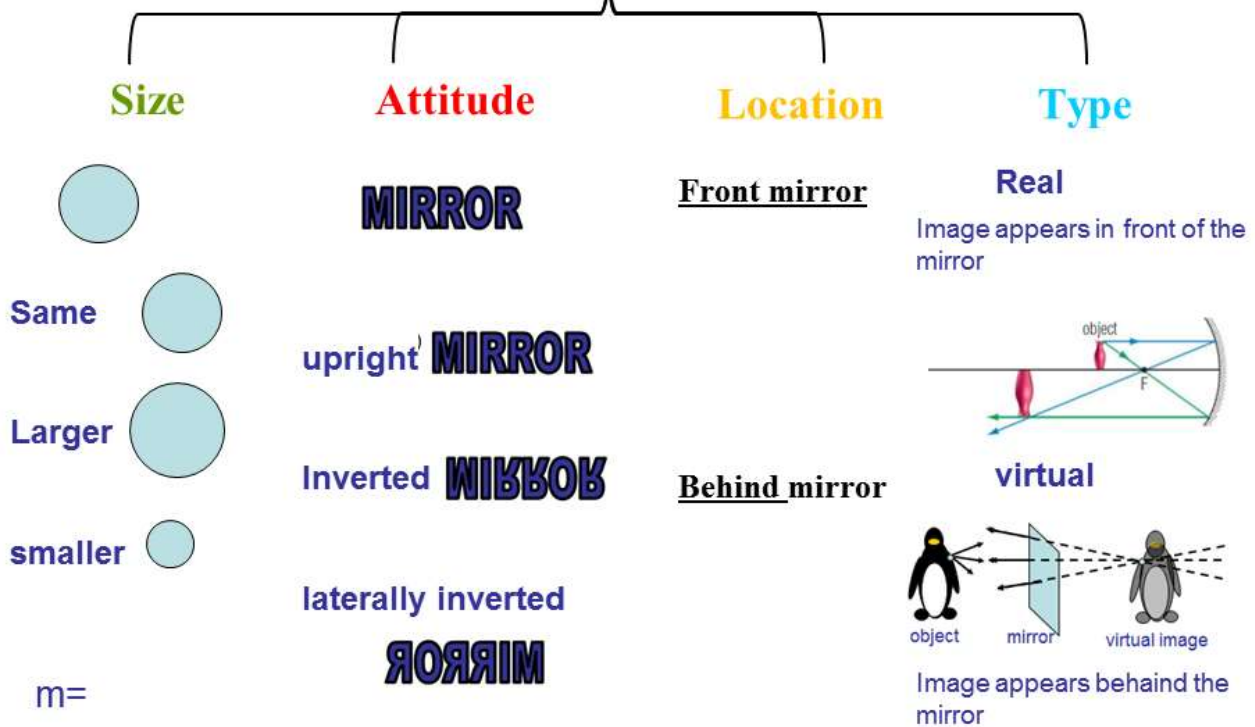
Principal Applications



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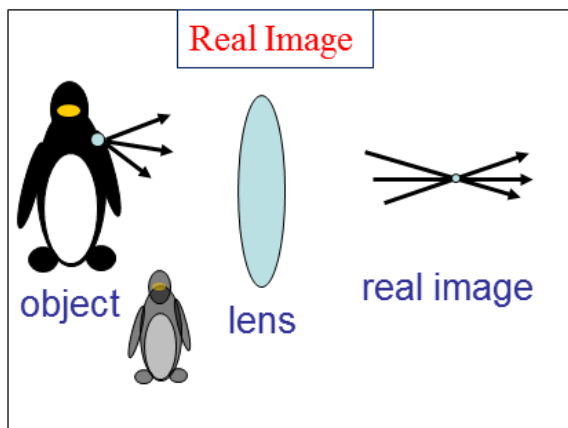
Reflection Characteristics

S.A.L.T

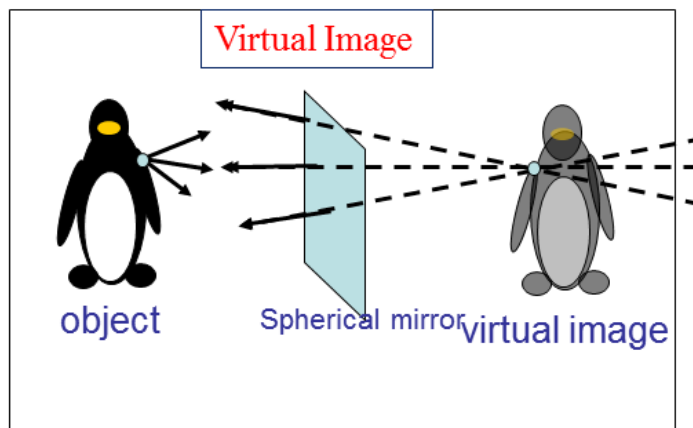


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34-2: Two Types of Image



Real Image is formed by the actual intersection of light rays.

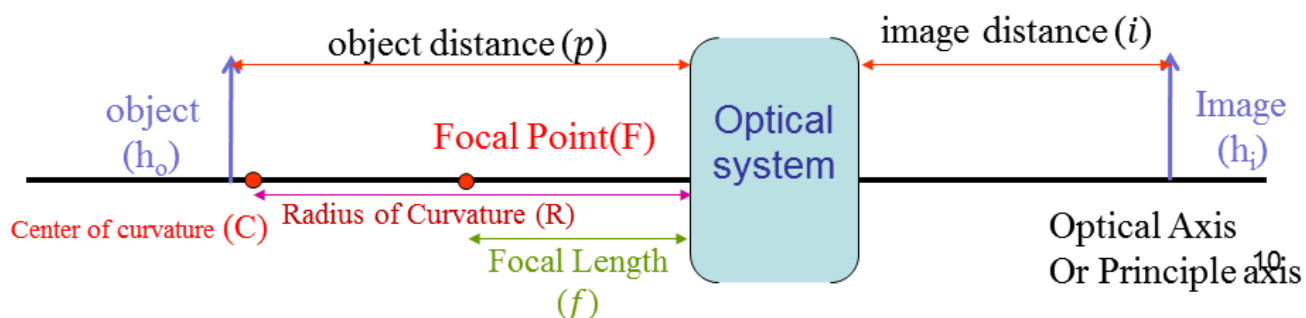


Virtual Image is formed by the imaginary intersection of light rays.

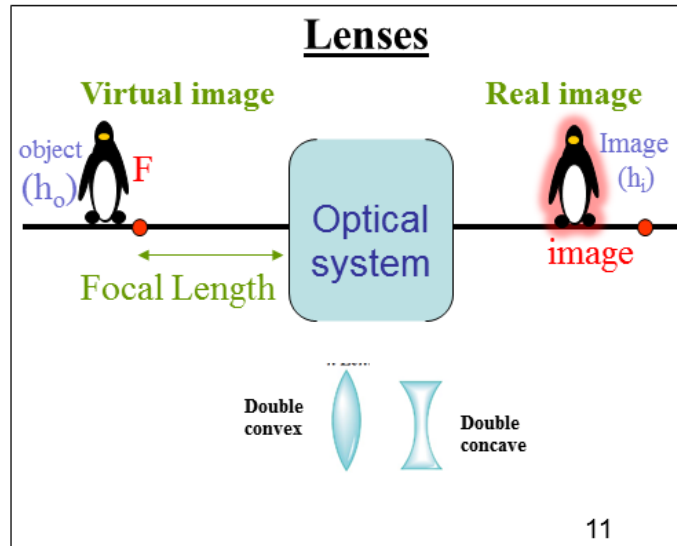
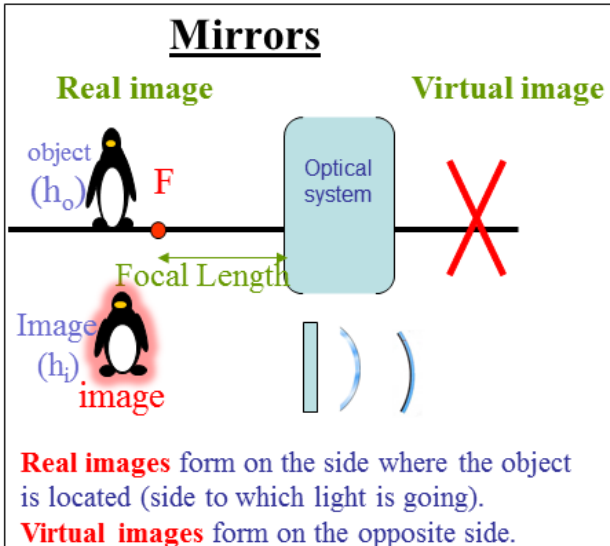
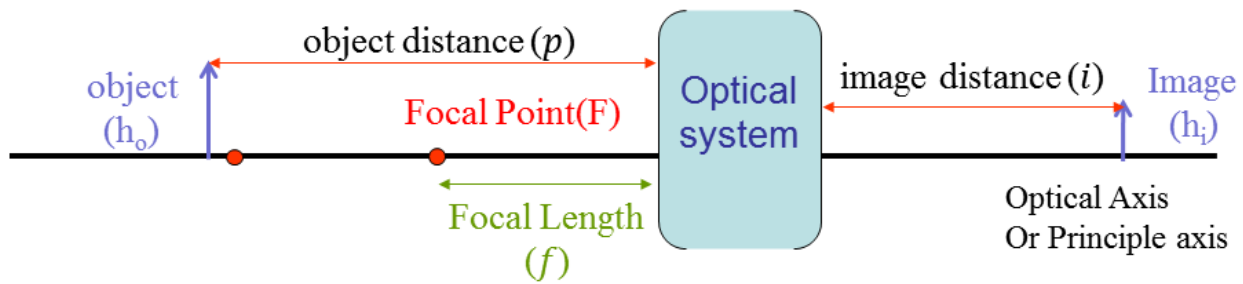
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34-2: Two Types of Image Terms you need to know

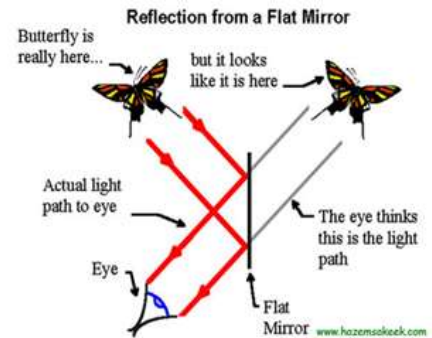
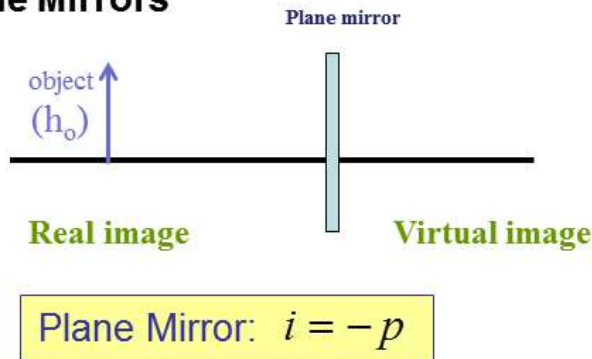
Term	Definition	Symbol(s)
Optical Axis	Base line through the center of a mirror or lens	
Center of Curvature	The center of the spherical shell of which the mirror is a small part	C
Radius of Curvature	The distance from the mirror's surface to the center of curvature	R
Focal Length	Focal length is equal to half the radius of curvature	f
Focal Point	Point where reflected or refracted rays meet & image is formed	F
Height of object	The height of the object	h_o
Height of image	The height of the image	h_i
Object distance	The distance between the object and the mirror	p ; d_o
Image distance	The distance between the image and the mirror	i ; d_i



34-2: Two Types of Image



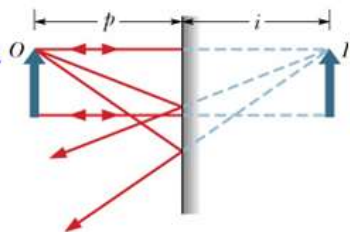
34-3: Plane Mirrors



S. Same object	A. upright	L. Behind mirror	T. Virtual
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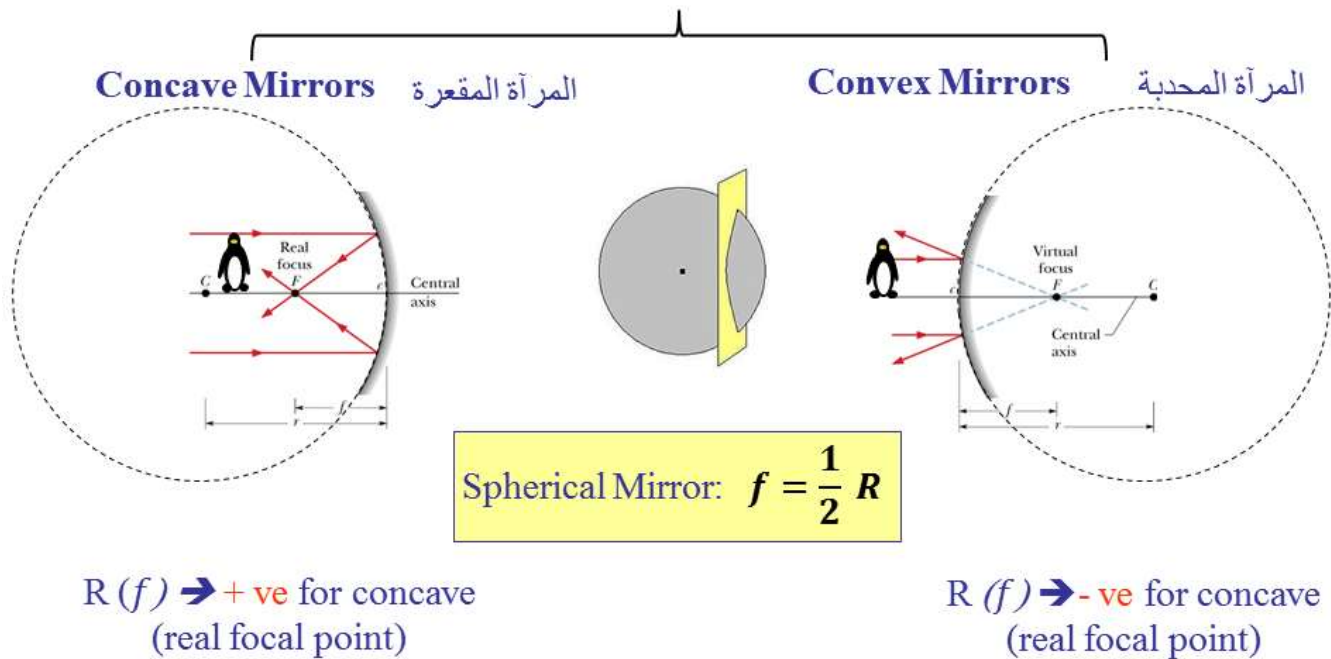
The image that is formed by a flat mirror has the following properties.

- The object and image distances from the mirror are equal.
- The image is unmagnified, virtual, and upright.
- The image has front-back reversal.



34-4: Spherical Mirrors

Spherical Mirrors, Focal Points of Spherical Mirrors



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34-5: Images From Spherical Mirrors

Images from Spherical Mirrors

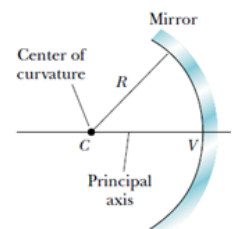
Spherical Mirror equation : $\frac{1}{p} + \frac{1}{i} = \frac{1}{f}$

$$\frac{1}{\text{object distance}} + \frac{1}{\text{image distance}} = \frac{1}{\text{focal length}}$$

Lateral Magnification: $m = -\frac{h_i}{h_o} = -\frac{i}{p}$

$$\text{Magnification} = -\frac{\text{image height}}{\text{object height}} = -\frac{\text{image distance}}{\text{object distance}}$$

Center of curvature : $R = 2f \rightarrow f = \frac{1}{2} R$



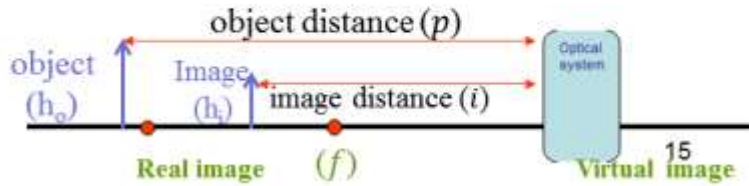
Real images form on the side where the object is located (side to which light is going).
Virtual images form on the opposite side.

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34-5: Images From Spherical Mirrors

Sign Conventions for Mirrors

object distance	p	+	Object is in front of mirror (real object)	الجسم امام المرآة (الجسم حقيقي)
		-	Object is behind mirror (virtual object)	الجسم خلف المرآة (الجسم تخيلي)
image distance	i	+	Image is in front of mirror (real image)	الصورة امام المرآة (الصورة حقيقي)
		-	Image is behind mirror (virtual image)	الصورة خلف المرآة (الصورة تخيلية)
Magnification	m	+	Image is upright	تكون الصورة معكدة
		-	Image is inverted	تكون الصورة مقلوبة
Magnification	m	>1	Image is large	تكون الصورة مكبرة
		<1	Image is small	تكون الصورة مصغرة
Focal Length	f	+	عندما يكون البعد البؤري امام المرآة	مرآة مقعرة concave mirror
		-	عندما يكون البعد البؤري خلف المرآة	مرآة محدبة convex mirror

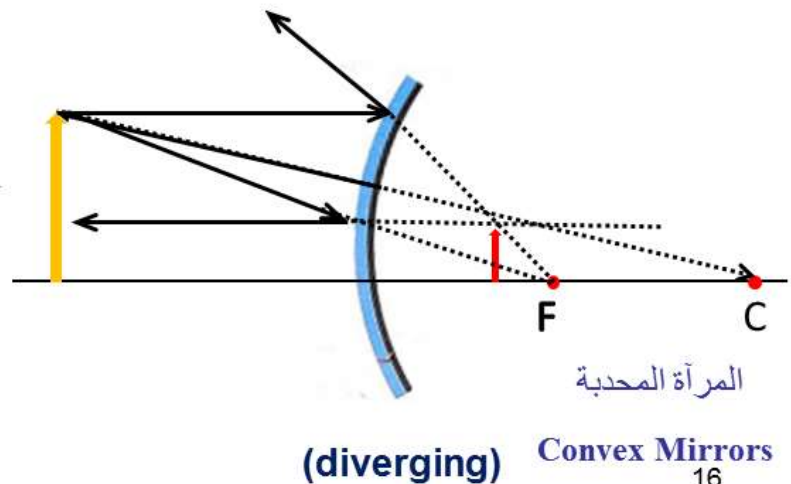
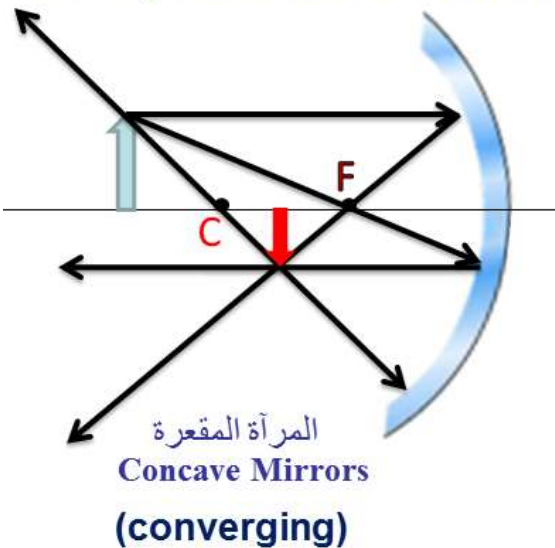


34-5: Images From Spherical Mirrors

Locating Images by Drawing Rays

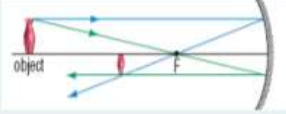
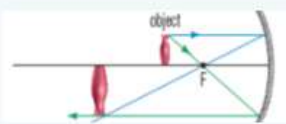
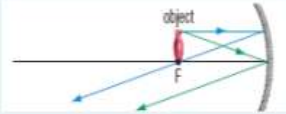
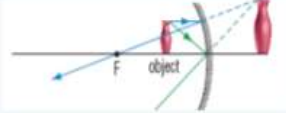
There are three rays that can be used to locate images formed by a mirror and that are easy to draw. These are:

1. A ray that is parallel to central axis reflects through F .
2. A ray that reflects from mirror after passing through F emerges parallel to central axis.
3. A ray that reflects from mirror after passing through C returns along itself.



34-5: Images From Spherical Mirrors

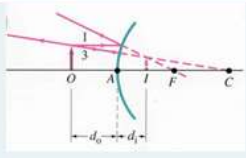
Concave Mirrors

	Distance of object from Mirrors		Type of Image formed		
1	$d_0 > R$	Object is more than two focal length	S: smaller L: front	A: inverted T: Real	
2	$R > d_0 > f$	Object is between curvature and focal length	S: larger L: front	A: inverted T: Real	
3	$d_0 = f$	Object is at focal point	No image is formed		
4	$d_0 < f$	Object is between mirror and focal point.	S: larger L: back	A: upright T: virtual	

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34-5: Images From Spherical Mirrors

Convex Mirrors

	Distance of object from Mirrors		Type of Image formed		
1	$d_0 > R$	Object is more than two focal length	S: smaller L: back	A: upright T: virtual	
2	$R > d_0 > f$	Object is between curvature and focal length	S: smaller L: back	A: upright T: virtual	
3	$d_0 = f$	Object is at focal point	S: smaller L: back	A: upright T: virtual	
4	$d_0 < f$	Object is between mirror and focal point.	S: smaller L: back	A: upright T: virtual	

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34-5: Images From Spherical Mirrors

Example (1):

Assume that a certain spherical mirror has a focal length of +10.0 cm. Locate and describe the image for object distances of f (+ve) → concave mirror مرآة مقعرة
(A) 25.0 cm, **(B) 10.0 cm, and** **(C) 5.00 cm.**

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

object is located at the focal point

$$\frac{1}{25} + \frac{1}{i} = \frac{1}{10}$$

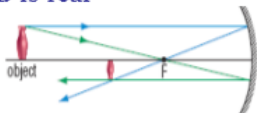
$$i = 16.7 \text{ cm}$$

$$m = -\frac{i}{p} = -\frac{16.7}{25} = -0.668$$

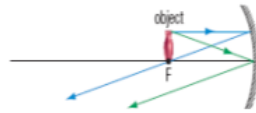
$|m| < 1$ → the image is smaller than the object

$m: -ve$ → image is inverted.

$i (+ve)$ → the image is located on the front side of the mirror and is real



S: smaller A: inverted L: front T: Real



No image is formed

$$\frac{1}{10} + \frac{1}{i} = \frac{1}{10}$$

$$\frac{1}{i} = 0$$

$$i = \infty$$

$$\frac{1}{5} + \frac{1}{i} = \frac{1}{10}$$

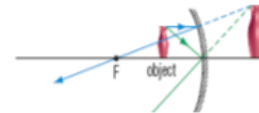
$$i = -10 \text{ cm}$$

$$m = -\frac{i}{p} = -\frac{-10}{5} = +2$$

$|m| > 1$ → the image is bigger than the object (twice)

$m: +ve$ → image is upright.

$i (-ve)$ → the image is located behind side of the mirror and is virtual



S: larger A: upright L: back T: virtual

34-5: Images From Spherical Mirrors

Uses of Mirrors

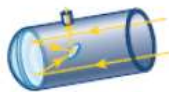
Concave Mirrors

Concave mirrors are specially designed to collect light and bring it to a single point.

Flashlight



Telescope



Cosmetic mirror



Headlights of a car



Convex Mirrors

Convex mirrors take objects in a large field of view and produce a small image

Because convex mirrors allow you to see more than plane mirrors, they are often used for security in stores as well as rear-view mirrors in cars.



مرآة محدبة مجهزة للتفتيش أسفل السيارة

