

قسم هندسة الليزر والالكترونيات البصرية

ماده / بصريات هندسية

مرحلة ثانية

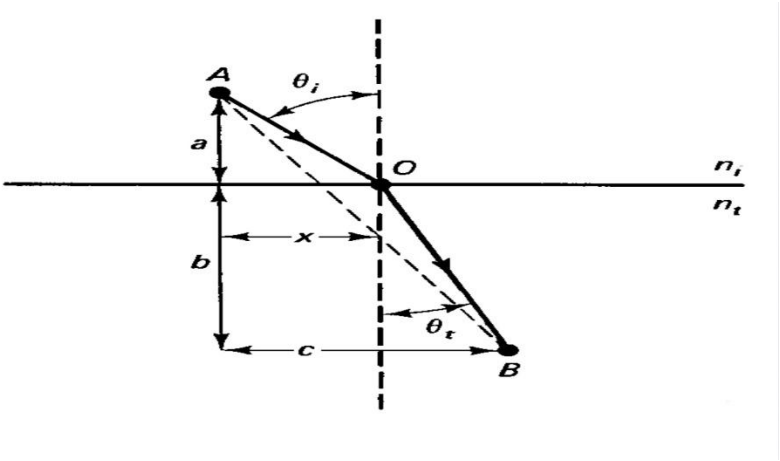
م.م فاطمة حيدر

Fermat's principle

states that “light travels between two points along the path that requires the least time, as compared to other nearby paths.” From Fermat's principle, one can derive (a) the law of reflection [the angle of incidence is equal to the angle of reflection] and (b) the law of refraction [Snell's law].

Optical path (OP)

is the trajectory that a light ray follows as it propagates through an optical medium. The geometrical optical-path length or simply geometrical path length (GPD) is the length of a segment in a given OP.



Law of Reflection

When a ray of light is reflected at an interface dividing two uniform media, the reflected ray remains within the plane of incidence, and the angle of reflection equals the angle of incidence. The plane of incidence includes the incident ray and the normal to the point of incidence.

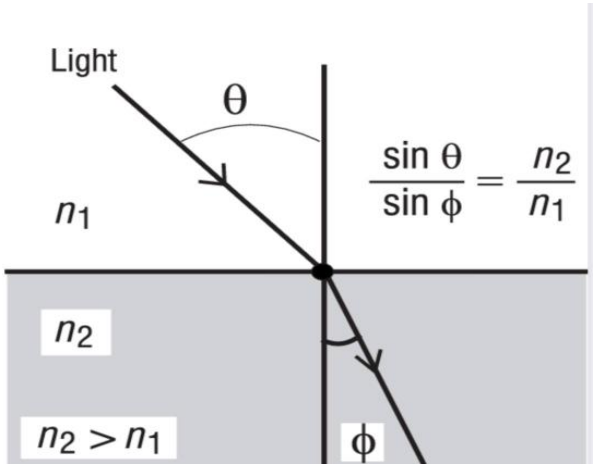
Law of Refraction (Snell's Law)

When a ray of light is refracted at an in-terface dividing two uniform media, the transmitted ray remains within the plane of incidence and the sine of the angle of refraction is directly proportional to the sine of the angle of incidence.

Snell Law say that $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$$\sin\theta_c = \left(\frac{n_2}{n_1}\right)\sin 90 = \frac{n_2}{n_1}$$

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$



The transit time of a ray through a medium of thickness x and with refractive index of n is → $t = \frac{x}{v} = \frac{nx}{c}$

Reflection at spherical surface

Spherical mirror is either convex or concave relative to the object O, depending on whether the center of curvature C is in the same side OR opposite side of the surface.

The mirror in figure is convex , and the image is constructed

from two ray:

normal to the surface at the vertex V, reflects back on itself.

an arbitrary one at point P, incident at specific angle θ.

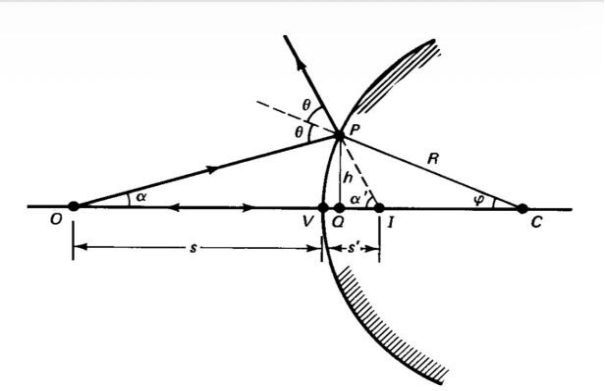
Mirror equation can be written as,

$$\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}$$

Where s is the object distance

, s'is the image distance

$$f=-\frac{R}{2}\begin{cases}>0, & \text{concave mirror}\\ <0, & \text{convex mirror}\end{cases}$$



The lateral magnification

is defined by the ratio of lateral image size to correspond- ing lateral object size, giving:

$$m=\frac{h_i}{h_o}=\frac{s_i}{s_o}$$

The sign conversion must be include within the magnification, a positive magnification for the case of erected image and negative magnification for the inverted image

$$m=-\frac{s_i}{s_o}$$

Refraction at spherical surface

By using snells law, paraxial approximation the general form of the refraction eq. is

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$$

$$m = \frac{h_i}{h_o} = -\frac{n_1 s'}{n_2 s}$$

Lens makers equations is :

$$\frac{1}{f} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

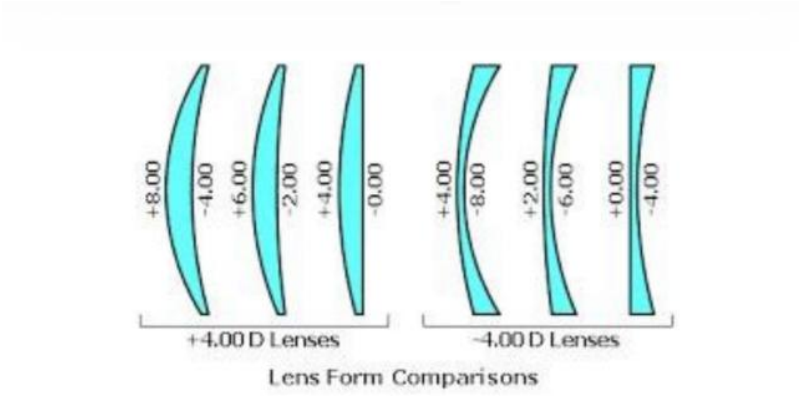
$$m = -\frac{s'}{s}$$

Exercise:

find and describe the intermediate and final image Produced by a two lens system of the top figure with f١=١٥cm ,f٢=١٥cm with a separation of ٦٠ cm. object distance from the first lens is ٢٥ cm

The power of the lens:

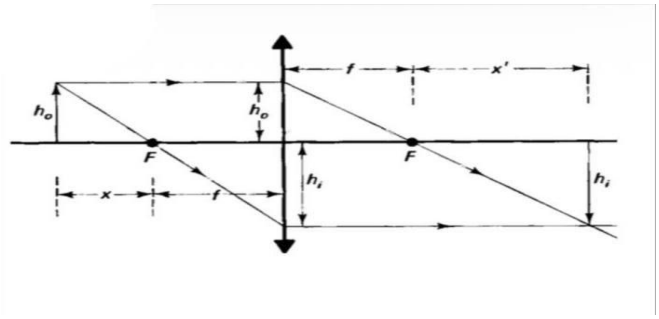
The change from the object space to the image space that happen due to the refracting power of lens define as a lens power which measured in a reciprocal lengths units called diopters (D)



Lens Form Comparisons

Newton equation for the thin lens

If the object and image distance measured relative to the focal points of a lens as shown in the figure above x & x′, the resultant thin lens equation called Newtonian form.



$$\frac{h_i}{h_o} = \frac{f}{x} \quad \text{and} \quad \frac{h_i}{h_o} = \frac{x'}{f}$$

The magnification is given by

$$m = -\frac{f}{x} = -\frac{x'}{f}$$

Newtonian eq. is

$$xx' = f^2$$

H.W

A concave mirror forms an image on a screen twice as large as the object. Both object and screen are then moved to produce an image on the screen that is three times the size of the object. If the screen is moved ٧٥ cm in the process, how far is the object moved? What is the focal length of the mirror?