قسم تقنيات البصريات

اخطاء الانكسار

المرحلة الثانية

المحاضرة الاولى

Department of Optics Techniques

Lecture1

The Interaction of Light with Matter

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The Interaction of Light with Matter

The interaction of light with matter is what makes life interesting. Light causes matter to vibrate. Matter in turn emits light, which interferes with the original light.

Light interacts with matter in five ways:

1. Reflection
2. Refraction
3. Emission
4. Absorption
5. Transmission

The interaction between light and matter determines the appearance of everything around us:

Figure (1): Interaction of light with matter

Reflection: Bouncing back of light at an interface between two media.

The laws of reflection are:

a. The angle of incidence= the angle of reflected.
b. The incident ray; the normal and the reflected ray lie in one plane.

Refraction: The change in direction of light when it passes from one transparent medium into another of different optical density.

The laws of refraction are:

a. The angle of incidence and the angle of refraction related by snells law:

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

b. The incident and refracted ray are on opposite sides of the normal and all the three in the same plane.

Mirror: - A smooth and well –polished surface that reflects regularly most of the light falling on it.

Types of mirrors

- **Plane mirror: -** It's a plane sheet of glass whose one side is silvered and other side is polished.

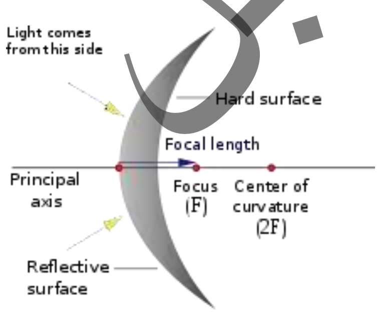
The properties of images formed by a plane mirror:-

- Same size as an object.
- Same distance behind the mirror.
- Laterally inverted.
- Virtual in nature.

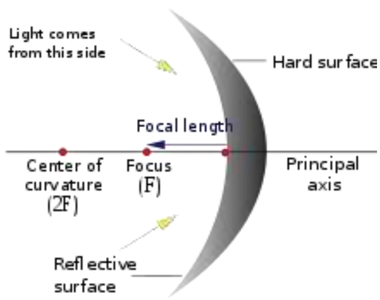
- **Spherical mirror: -** It's a part of hollow sphere whose one side is silvered and the other is polished.

Types of spherical mirrors are:

- Concave mirror
- Convex mirror



Convex mirror



Concave mirror

Figure (2): Types of spherical mirrors

The lenses

A lens is a transparent refracting medium bounded by two surfaces that form a part of a sphere (spherical lens) or a cylindrical (cylindrical lens).

Lenses are usually made of glass or plastic and are used to refract light rays in a desired direction.

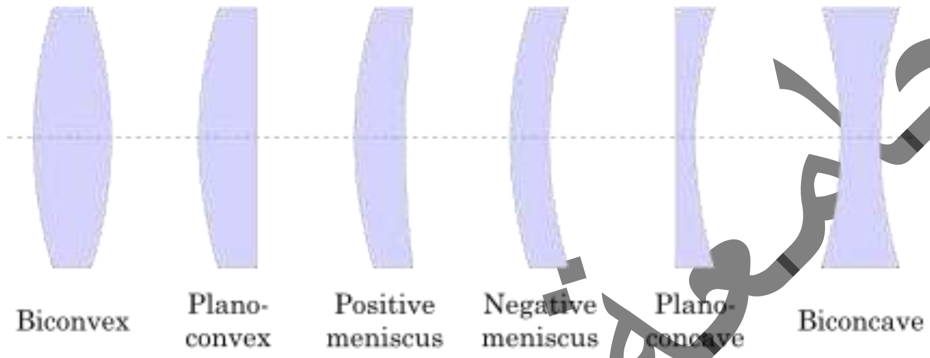


Figure (3): Types of lenses

Table (1): Comparison between (convex and concave) lens

Convex lens (+)	Concave lens (-)
Converging	Diverging
Biconvex; plano-convex; concavo-convex	Biconcave; plano-concave and convexo-concave
Thick in the center	Thin in the center
An object held close to the lens appear magnified	An object seen through it appears minified
It used for correction of hypermetropia as example	It used for correction of myopia

Spherocylindrical Lenses

The lenses and mirrors discussed thus far have been radially symmetric about an optical axis, so a flat diagram has sufficed. Now, however, we need to think in 3 dimensions in order to discuss the lenses used to correct regular astigmatism of the *eye.*

A cylinder has no curvature in one direction and has spherical curvature in the meridian perpendicular to that direction. A spherocylindricallens has the shape of a torus. That is, its shape is similar to that of the outer surface of a bicycle tire or barrel, with a greater and a lesser circular curvature meeting at right angles where the tire (or the barrel lying on its side) touches the ground-at the point where we would find the optical center of a spherocylindrical spectacle lens, figure (4).

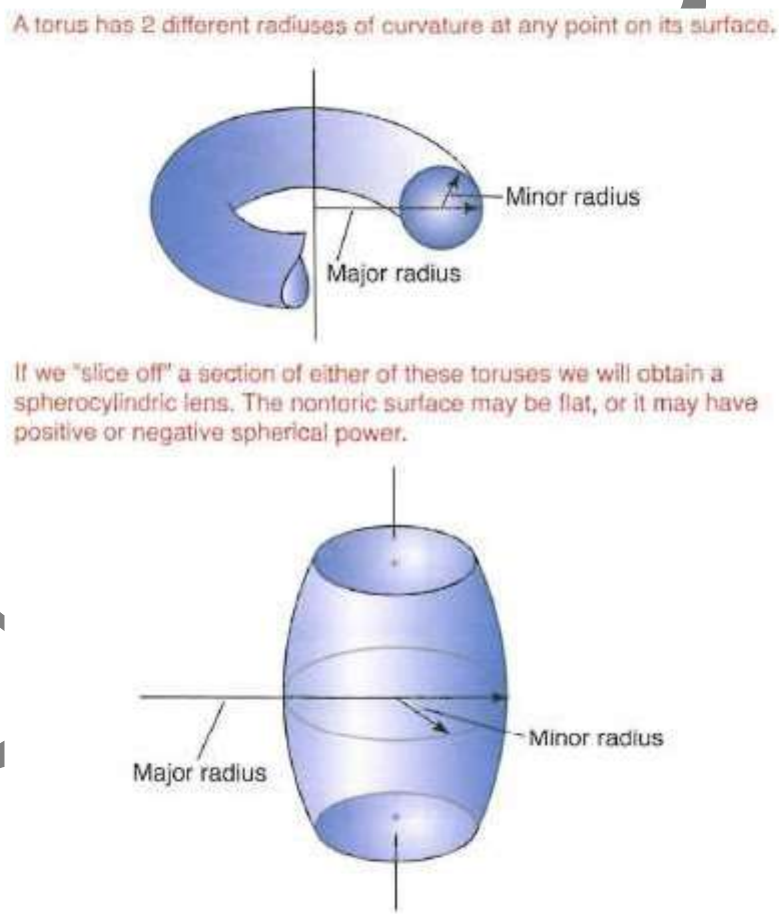


Figure (4): Toric surfaces

To convert a prescription from positive cylinder form to negative cylinder form (or conversely), consider the following points:

• The new sphere is the algebraic sum of the old sphere and cylinder.

• The new cylinder has the same value as the old cylinder but with opposite sign.

• The axis needs to be changed *by* 90°.

Prisms

Prism power is defined by the amount of deviation produced as a light ray traverses the prism. The deviation is measured as the number of centimeters of deflection measured at a distance of 100 cm from the prism (Fig 1-5) and expressed in prism diopters (Δ) .

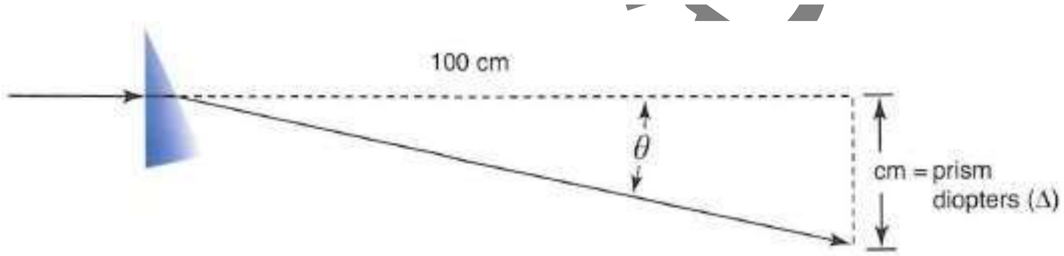


Figure (5) Definition of prism diopter. The power of the prism, when held in this particular position, is defined to be the number of centimeters of deflection of a ray, measured 100 cm after passage through the prism and expressed in prism diopters.

For angles less than 100 Δ (45°), each change in deviation *by* 2 prism diopters is approximately equal to a change of l 0.

• For larger angles, increasingly more prism diopters are required for an equivalent change *by* l 0

• Glass prisms are calibrated to be held in the Prentice position, that is, with one of the faces of the prism perpendicular to the light rays. A glass prism, then, is correctly held with the back face parallel to the plane of the iris-the direction the *eye* is turned. Ail of the refraction occurs at the opposite face and is greater than the minimum deviation for that prism. This is the manner in which prism in spectacle lenses of any material is measured on a lensmeter, with the back surface of the spectacle lens flat against the nose cone of the lensmeter. If the rear surface of a 40~ glass prism is erroneously held in the frontal plane of the subject's face, only 32~ of effect will be achieved.

Plastic prisms and prism bars, on the other hand, are calibrated according to the angle of minimum deviation. To approximate this angle clinically, these prisms are held with the rear surface in the frontal plane of the subject's face.

The path of a pencil of rays passing through a prism is bent toward the base of the prism to form a real image, which is shifted in the direction of the base of the prism. If *you* put a prism in front of *your* vision chart projector with the apex pointed toward the left side of the room, the letters on the screen will be shifted in the direction *you* are pointing the base of the prism-that is, to the right (Fig l-6).

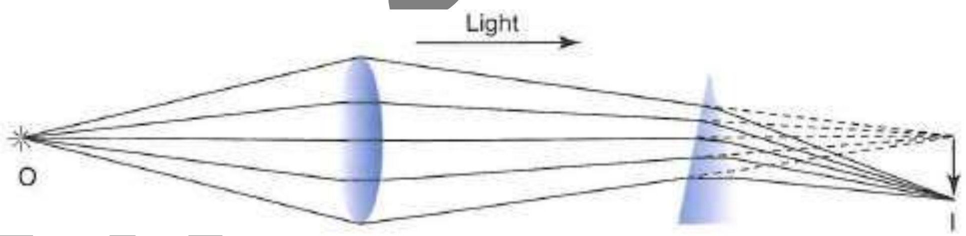


Figure (6): Real images are displaced by the prism toward the base of the prism .

On the other hand, if I am looking at a letter on the chart, a real object, and you interpose in front of my eye the same prism with its apex pointed toward the left side of the room, the prism will create a virtual image, which is displaced with respect to the original object, toward the apex of the prism. My eye sees those diverging rays as coming from an optically real object, which my eye brings to focus as a real image on my retina.

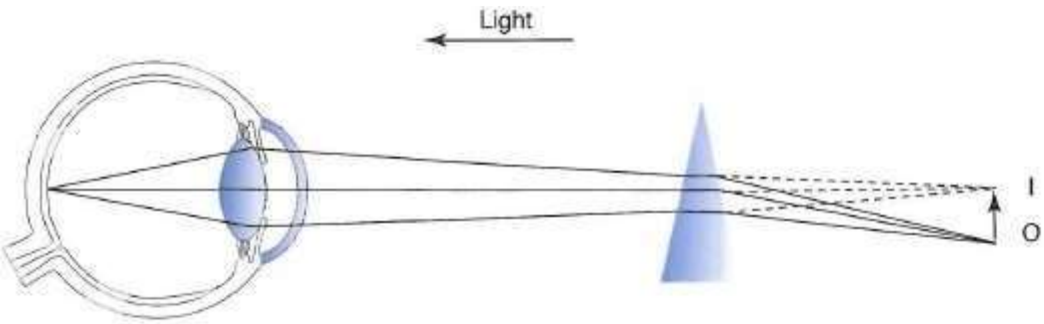


Figure (7): The prism forms a virtual image of a real object, and that virtua l image is displaced,compared with the original object. toward the apex of the prism .