CH # 14 REFRACTION OF LIGHT AND OPTICAL INSTRUMENT

REFRACTION:

"The change of direction of light rays as they pass obliquely from one medium to another medium is called refraction of light."

LAWS OF REFRACTION OR SNELLIS LAW

FIRST LAW OF REFRACTION:

"The incident rays the normal at the point of incidence and the refracted ray all lay on the same plane."

SECOND LAW OF REFRACTION (SNELL'S LAW):

Second law of refraction is concluded by a scientist named Snell so it is called Snell's law.

Statement:

"The ratio of sine angle of incidence to the sine of angle of refraction is constant for all rays passing from one medium to another."

$$n = \frac{Sin < i}{Sin < r}$$

Where 'n' is known as refractive index of the second medium with respect to the first medium.

REFRACTIVE INDEX:

"The ratio of sine angle of incidence to the sine of angle of refraction is constant for two medium and this constant is known as refractive index."

$$n = \frac{Sin < i}{Sin < r}$$

OR

"The ratio of speed of light in vacuum (Air) to the speed of light in the given medium is called refractive index."

$$Refractive\ index = \frac{Speed\ of\ light\ in\ air}{Speed\ of\ light\ in\ given\ medium}$$

CONDITION: WHEN LIGHT RAY INCIDENT PERPENDICULAR ON THE MEDIUM:

If the coming light ray is perpendicular on the refracting medium then it will be parallel to the normal because normal is also a perpendicular line on the surface of medium and angle of incident will be zero i.e.

$$< i = 0$$

According to Snell's law;

$$n = \frac{Sin < i}{Sin < r}$$

Where $< i = 0$;

$$n = \frac{Sin(0)}{Sin < r}$$

$$nSin < r = 0 \qquad \text{as sine(0) = 0}$$

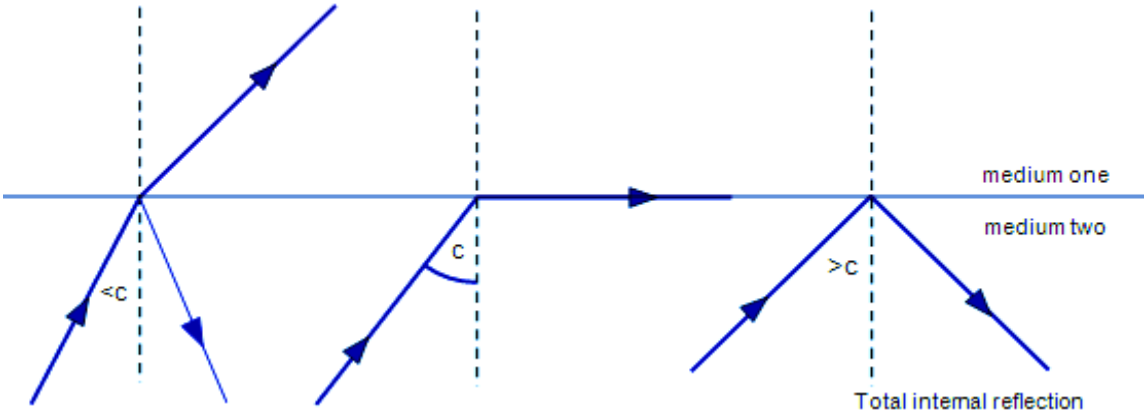
$$Sin < r = 0$$

$$< r = 0$$

Above result shows that if coming light ray is perpendicular on the medium then there is no change in its direction or in other words its angle of reflection is equal to angle of incidence.

TOTAL INTERNAL REFLECTION:

"When light ray passing from the denser medium to the rare medium and the angle of incidence is greater than the angle of refraction of light doesn't take place and the incident ray is totally reflected back in the denser medium this phenomenon is called the total internal reflection."



CONDITIONS FOR TOTAL INTERNAL REFLECTION:

- The ray of light should be incident from a denser medium to a rare medium.
- The angle of incidence should be greater than the angle of refraction.

EXAMPLES OF TOTAL INTERNAL REFLECTION:

- Totally reflecting prism.
- Optical fiber.
- Periscope.
- Mirage.

CRITICAL ANGLE:

"An angle of incidence for which angle of refraction is 90^0 is called critical angle."

LENS:

"Lens is the portion of a transparent refracting medium bounded by one or two spherical surfaces."

TYPES OF LENS:

- Concave lens.
- Convex lens

CONCAVE LENS (DIVERGING LENS):

"Those lenses which diverge a parallel beam of light rays are called concave lens. Concave lenses are thicker at the edges and thinner at the centre."

TYPES OF CONCAVE LENS (DIVERGING LENS):

- Double concave lens.
- Plano concave lens.

- Convexo-concave lens.

CONVEX LENS (CONVERGING LENS):

"Those lenses which converge a parallel beam of light rays are called concave lens. Concave lenses are thinner at the edges and thicker at the centre."

TYPES OF CONVEX LENS (CONVERGING LENS):

- Double convex lens.
- Plano convex lens.
- Concavo-convex lens.

SOME USEFUL TERMS:

OPTICAL CENTRE:

"The centre of the lens is called its optical centre."

CENTRE OF CURVATURE(2F):

"Centre of spherical surface of which the lens is part is called centre of curvature."

PRINCIPLE AXIS:

"The straight line joining the centre of curvature of two spherical surfaces of lens is called principle axis."

APERTURE:

"Diameter of the lens is called aperture."

PRINCIPAL FOCUS:

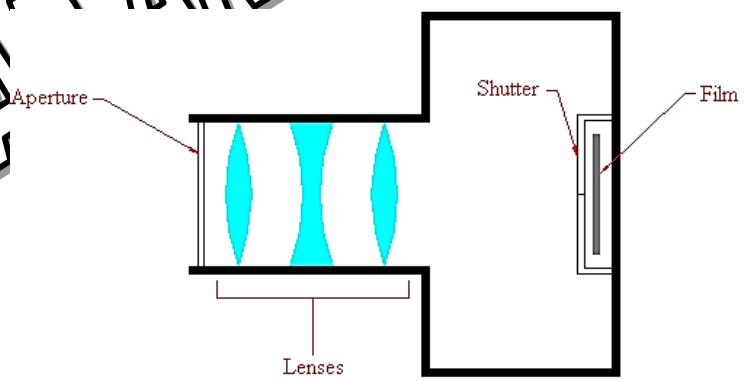
"The point on principal axis where all rays of light are meeting is called principal focus."

FOCAL LENGTH:

"Distance from the principal focus to the optical centre of the lens is called focal length."

CAMERA:

"A camera is a light proof container blackened inside to absorb light."



CONSTRUCTION:

Optically it consist of combination of lenses and a photographic film and a shutter which control amount of light.

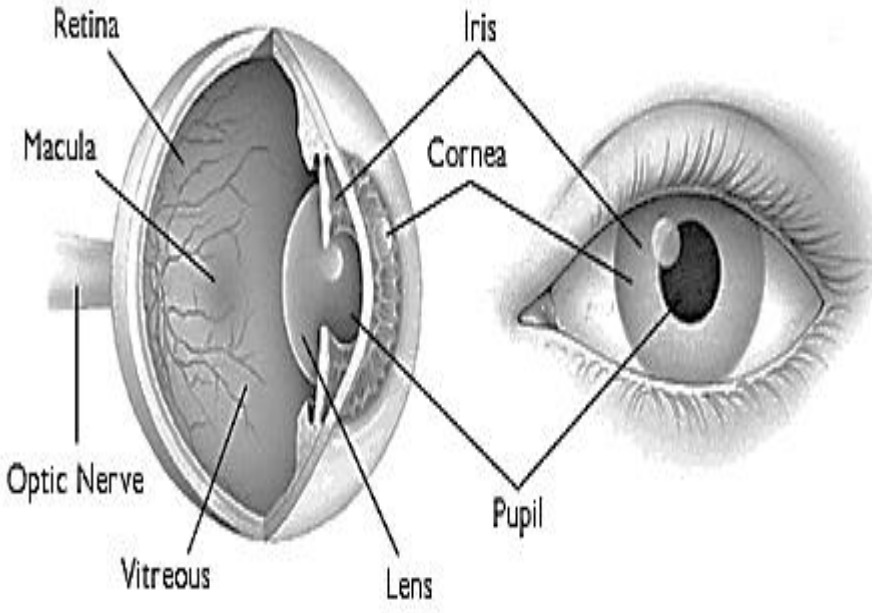
WORKING:

Controlled amount of light enter into the camera through shutter after passing through the combination of lenses produces real and inverted image of object on photographic plate.

EYE:

Human eye consist of the following parts.

- Layers.
- Lens.
- Chambers.



- **LAYERS OF THE EYE:**

1. SCLEROTIC:

It is the outermost layer of the eye. Its front portion is slightly convex and transparent called "cornea".

2. CHOROID:

It is the middle layer of the eye ball its front colour portion called "iris" which contain a central aperture called pupil which controls the amount of light.

3. RETINA:

It is the inner most "nervous" layer of the eye.

- **LENS:**

Behind the iris is a convex lens made of hard transparent gelatinous matter. Colliery muscles hold the lens

- **CHAMBERS OF THE EYE BALL:**

1. AQUEOUS CHAMBERS:

It is present in front of the lens and filled with the aqueous humour.

2. VITREOUS CHAMBERS:

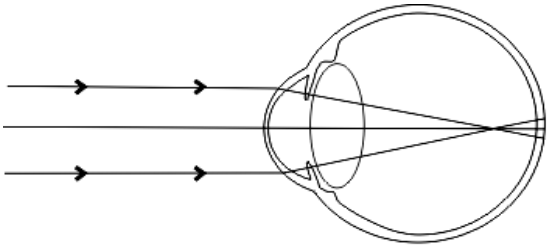
It is present in behind the lens and filled with the vitreous humour.

LEAST DISTANCE OF DISTINCT VISION:

"Distance of a nearest point to the eye at which a small object can be clearly seen is called least distance of distinct vision. For normal eye 25 cm is least distance of distinct vision"

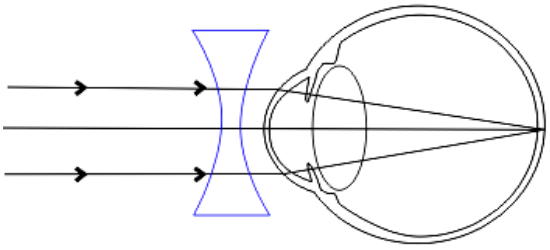
DEFECTS OF VISION

There are four main defects of human eye.



1. SHORT-SIGHTEDNESS(MYOPIA):

"It is a disease in which a person cannot see distant objects but can see near objects."



REASON:

It occurs when the eye ball becomes too converging or eye ball becomes too long.

EFFECT:

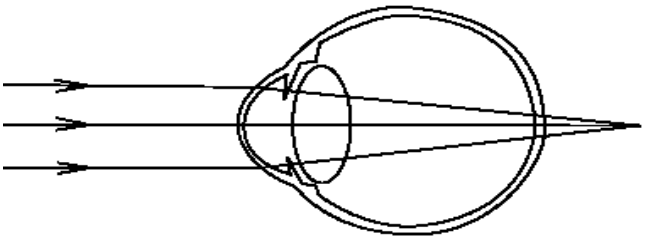
Due to above reason the image of the distant object is formed in front of the retina and thus cannot be see clearly.

CORRECTION:

Short-sightedness of the eye can be corrected by using a concave lens of suitable focal length in front of the eye.

2. LONG-SIGHTEDNESS(HYPERMETROPIA):

"It is a disease in which a person cannot see near objects clearly but can see clearly the distant objects."



REASON:

It occurs when the eye ball becomes less converging or eye ball becomes too small.

EFFECT:

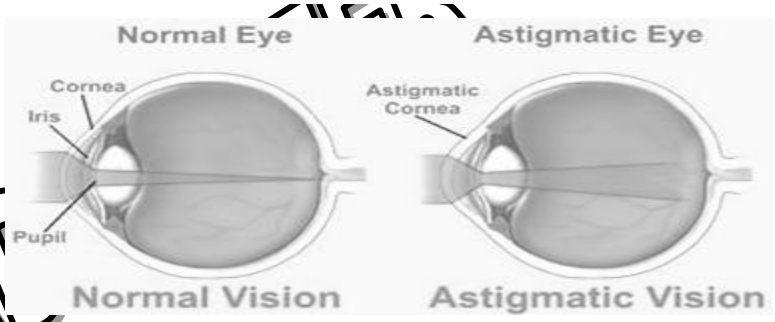
Due to above reason the image of the near object is formed behind the retina and thus cannot be see clearly.

CORRECTION:

Long-sightedness of the eye can be corrected by using a convex lens of suitable focal length in front of the eye.

3. ASTIGMATISM:

"It is a disease in which a cornea of the eye becomes non-spherical."



EFFECT:

Due to above reason person cannot be seeing clearly.

CORRECTION:

This defect can be corrected by using asymmetrical lenses of different radii with spherical surfaces.

4. Lack of accommodation (PRESBYOPIA):

"Loss of accommodative power called Presbyopia."

Due to old age the lens and the ciliary muscle losses their elasticity and it is not possible for the lens to attain the required focal length in due time. That's why diseases of long sightedness develop. Hence long sightedness due to old age is called lack of accommodation

CORRECTION:

It can be corrected by using bifocal lenses I.e. convex part in the lower side to see near objects and concave part in the upper side to see distant objects.

POWER OF LENS:

"The reciprocal of focal length of a lens which is expressed in meter is called power of lens."

$$P = \frac{1}{f}$$

Unit:

The unit of power of lens is DIOPTRE.

DIOPTRE:

"If the focal length of the lens is one meter then power of lens is called dioptre or one dioptre."

COMPOUND MICROSCOPE:

"Microscope is an optical instrument which is used to see the magnified image of very small objects such as germs etc."

CONSTRUCTION:

Compound microscope consists of two convex lenses fixed at the ends of two tubes which can move into one another.

- **Objective:**
  The lens toward the object is called objective.

- **Eye piece:**
  The lens toward the eye of the observer is called eye-piece. Its focal length is greater than the focal length of the objective.

WORKING:

In compound microscope combination of two lenses is used. When an object is placed between 'F' and '2F' of a convex lens, a real magnified and inverted image of the object is formed. When an object is placed inside the focal length of a convex lens, magnified erect and virtual image of the object is seen through the lens.

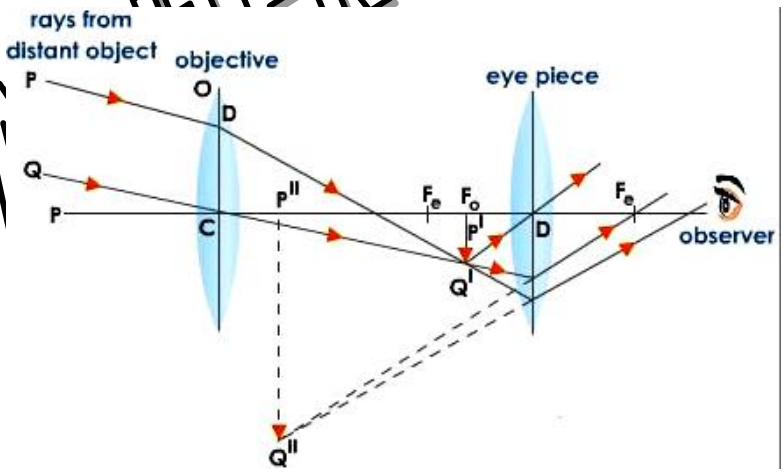


IMAGE PROPERTIES:

Final image is highly magnified, Virtual and inverted with respect to the original object.

CONDITION FOR HIGH MAGNIFICATION:

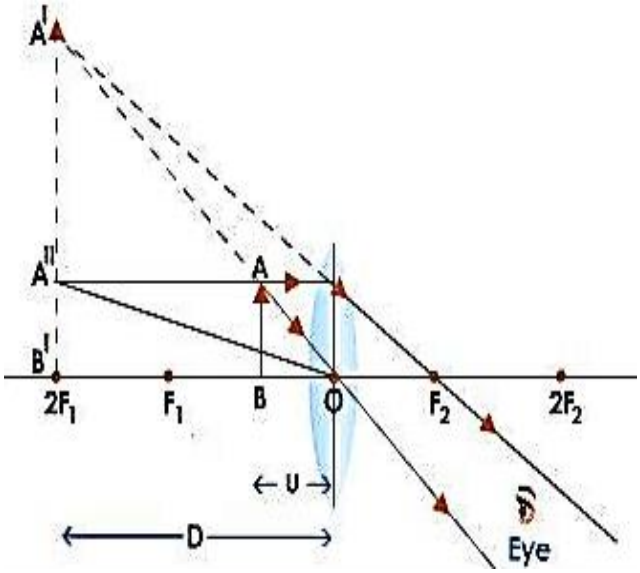
In order to get high magnification, the convex lenses of short focal length should be used.

SIMPLE MICROSCOPE:

"Microscope is an optical instrument which is used to see the magnified image of very small objects."

CONSTRUCTION:

Compound microscope consist is simply biconvex lens of a short focal length.



WORKING:

When an object is placed inside the focal length of a convex lens, a magnified, and erect and virtual image of the object is seen through the lens.

IMAGE PROPERTIES:

The image is enlarged, magnified, Virtual and erect with respect to the original object.

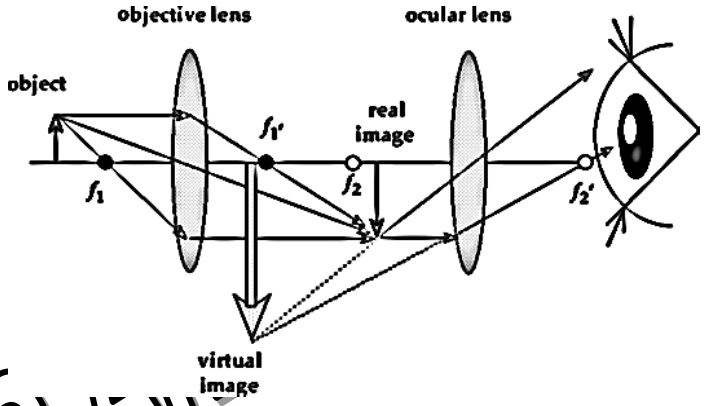
CONDITION FOR HIGH MAGNIFICATION:

In order to get high magnification, the convex lenses of short focal length should be used.

$$M = 1 + \frac{d}{f}$$

ASTRONOMICAL TELESCOPE:

"A telescope is used to see cleanly the objects lying at large distances. It is used to see heavenly objects such as moon, stars etc."



CONSTRUCTION:

A telescope consists of two convex lenses.

- Objective.
- Eye piece.

The focal length of the objective is greater than the focal length of the eye piece.

WORKING:

- Heavenly objects are very far from the objective of the telescope.
- Parallel rays from the heavenly bodies after passing through the objective from image 'AB' within the focal length of the eye-piece, which then magnifies it.
- Now eye piece is so adjusted that the magnified image is formed at the junction of F1 and F_2. Due to this rays after passing through the eye piece become parallel and final image is formed at infinity.

IMAGE PROPERTIES:

Final image is highly magnified, real and inverted with respect to the original object.

CONDITION FOR HIGH MAGNIFICATION:

In order to get high magnification, the convex lenses of short focal length should be used.