

# Human Eye and Colourful world

# The Human Eye

"The Human eye is one of the most valuable and sensitive sense organs"



# (a) Cornea

It is the front bulged out transparent portion of the eyeball. Light enters the eye through this thin membrane of the eye.

# (b) Aqueous humor

It is a watery liquid filled in the space between the cornea and lens of eye, its function maintaining pressure and provide nutrients to the cornea and lens.

# (c) Vitreous humor

It is a jelly like material filled in the space between eye lens and the retina. It help in holding its typical spherical shape.

# (d) Iris

Iris is a coloured flexible muscular diaphragm behind the cornea. It has colour pegment.



# (e) Pupil

A small opening in the iris is called pupil. Light falling on the pupil goes inside the eyeball

- Iris controls the opening of the pupil.
- Bright Light pupil contracts.
- Dim Light pupil expands.



# (f) Retina

It is the innermost layer in the backside of the eyeball. It consists of many-many light sensitive cells (about 125 million) called receptors. There are two type of light sensitive cells 'rod shaped' and 'cone shaped'.

Rod shaped cells	Sensitive to intensity of light
Cone shaped cells	Sensitive to colour of light

# (g) Optic nerve

It consists of millions of nerve tissues connecting light sensitive cells of the retina to the brain. Signal from the light sensitive cells is transmitted to the brain through this nerve.

#### (h) Eye lens

The eye lens is composed of a fibrous, jelly-like material. It provides finer adjustment required to focus objects on the retina.

# (i) Ciliary muscles

Attached to eye lens holds the lens in correct position and modified the curvature of the lens.

- **Q.** The human eye can focus objects at different distances by adjusting the focal length of the eye lens. This is due to
  - (a) presbyopia
  - (b) accommodation
  - (c) near sightedness
  - (d) far sightedness

# Ans. (b) Accommodation

# Q. The human eye forms the image of an object at its

- (a) cornea
- (b) iris
- (c) pupil
- (d) retina

Ans. (d) Retina

# **Power of Accommodation**

"The ability of the eye lens to adjust its focal length is called accommodation. This is done by changing the curvature of the eye lens."

- Near Point The minimum distance at which objects can be seen most distinctly without strain is called near point of the eye. It is 25 cm for a normal human eye.
- Far Point The farthest point up to which the eye can see object clearly is called the far point of the eye. It is infinity for a normal eye.
- **Q.** What is meant by power of accommodation of the eye ?
- **Ans.** The power of accommodation of the eye is the maximum variation of its power for focusing on near and far (distant) objects.

# Defects of vision and their correction

# Myopia

- ▶ It is also known as nearsightedness.
- A person with myopia can see nearby objects clearly but cannot see distant objects distinctly.
- > It's far point is nearer than infinity. Image is formed before retina in a myopic eye.

#### Myopia may arises due to

- Excessive curvature of the eye lens.
- Elongation of the eyeball.
- ▶ It can be corrected by using a concave lens of suitable power.



# Hypermetropia

- ▶ It is also known as far-sightedness.
- A person with this can see distant objects clearly but cannot see nearby distinctly.
- ➢ It's near point more than 25 cm.
- Image is formed behind retina.

# Hypermetropia may arises due to

- $\blacktriangleright$  The focal length of the eye lens is too long.
- The eyeball has become too small
- ▶ It can be correct by using a convex lens of suitable power.



# Presbyopia

- The power of accommodation of the eye usually decreases with ageing. It is also known as old age hypermetropia.
- It is the eye defect due to which an aged person fails to see nearby objects clearly due to shifting of his distance of distinct vision more than 25 cm.

# **Causes of presbyopia**

- (i) Weakening of ciliary muscles with age
- (ii) Lack of flexibility of the eye lens.

# Astigmatism

It is a kind of defect in human eye due to which a person can not see a focus simultaneously horizontal and vertically lines both.



# **Cause of astigmatism**

Cause of astigmatism is that the cornea, or the eye lens of bot of them are differently curved in different planes. In order words, when they are not exactly spherical, then the eye suffer from astigmatism.

Astigmatism can be corrected by using cylindrical lenses.

#### Cataract

- The crystalline lens of people at old age becomes milky and cloudy. This condition is called cataract. This causes partial or complete loss of vision.
- To correct this defect, surgery is performed to replace the defective lens with an artificial lens.



A triangular glass prism has two triangular bases and three rectangular lateral surfaces.
These surfaces are inclined to each other.
The angle between its two lateral faces is

called the angle of the prism.

**Distinguish between Mass and Weight** 

PE -- Incident ray







- EF Refracted ray
- FS Emergent ray
- $\angle A$  Angle of the prism
- $\angle i$  Angle of incidence
- $\angle r$  Angle of refraction
- $\angle e$  Angle of emergence
- $\angle D$  Angle of deviation

# **Dispersion of Light**

"The splitting of white light into band of seven colours through a prism is known as dispersion of light."



Glass Prism

- > The various colour seen are violet, Indigo, Blue, Green, Yellow, Orange and Red.
- The red light bends the least while violet the most. Thus the rays of each colour emerge along different paths and thus become distinct.

Isaac Newton placed a second identical prism in an inverted position with respect to the first prism, and obtained white light again. This implied that white light consists of seven colours.



# **Formation of Rainbow**

- Due to Dispersion of sunlight by tiny water droplets, which refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop.
- A rainbow is always formed in a direction opposite to that of the sun.



# **Atmospheric Refraction**

"The refraction of light taking place in the atmosphere is known as atmospheric refraction."

- > Atmospheric refraction is responsible for various phenomena
- (a) twinkling of stars
- (b) advanced sunrise
- (c) delayed sunset

# **Twinkling of Stars**

- The temperature and density of different layer of atmosphere keeps varying. Hence, we have different medium.
- Distant star act as point source of light. When the starlight enter the Earth's atmosphere, it undergoes refraction continuously, due to changing refractive index i.e. from Rarer to denser. It bends towards the normal.
- Due to this, the apparent position of the star is different from actual position. The star appear higher than its actual position.
- Hence, the amount of light enters our eyes fluctuate sometimes bright and sometime dim. This is the "Twinkling effect of star".

# Advance Sunrise and delayed Sunset

Actual sun rise happens when it is below the horizon in the morning.





The rays of light from the sun below the horizon reach our eyes because of refraction of light.
This is due to atmospheric refraction. Because of this sun is visible about 2 minutes earlier than

actual sunrise and about 2 minutes after the actual sun set.

# **Scattering of Light**

"The phenomenon in which light is scattered by very small particles in its path that makes the particles visible is known as Tyndall effect or Tyndall scattering."

The scattering of light depends on the size of the scattering particles and wavelength of the light.



# **Applications of Scattering of Light**

# Colour of sun at sunrise and sunset

> The reddish appearance of the sun at sunrise or sunset is due to scattering of light.



- Light from the sun near the horizon passes through thicker layers of air and covers the larger distance in the earth's atmosphere before reaching our eyes.
- Most of the blue light and light of shorter wavelength is scattered away by the particles.
- So, only red light, being of higher wavelength reaches us which gives reddish appearance of the sun at sunrise or sunset.

# Why is the colour of sky blue?

- During the daytime, the sky appears blue. This is because the size of the particles in the atmosphere is smaller than the wavelength of visible light.
- These are more effective in scattering light of shorter wavelength that is towards blue end.
- When sunlight passes through atmosphere the find particles in air scatter blue colour more strongly than red.

# Why at noon sun appears white?

At noon, the sun is overhead and sunlight would travel shorter distance relatively through the atmosphere.



Hence, at noon, the sun appear white as only little of the blue and violet colours are scattered.

# **Notes End**

# **Important NCERT Questions**

# Q1. What is meant by power of accommodation of the eye?

**Sol.** The ability of the lens of the eye to adjust its focal length to clearly focus rays coming from distant as well from a near objects on the retina, is known as the power of accommodation of the eye.

# Q2. A person with a myopic eye cannot see objects beyond 1.2 m distinctly. What should be the type of corrective lens used to restore proper vision?

# Sol.

An individual with a myopic eye should use a concave lens of focal length 1.2 m so that he or she can restore proper vision.

# Q3. What is the far point and near point of the human eye with normal vision?

**Sol.** The minimum distance of the object from the eye, which can be seen distinctly without strain is called the near point of the eye. For a normal person's, this distance is 25 cm.

The far point of the eye is the maximum distance to which the eye can see object clearly. The far point of a normal person's eye is infinity.

# Q4. The student has difficulty reading the blackboard while sitting in the last row. What could be the defect the child is suffering from? How can it be corrected?

**Sol.** The student is suffering from short-sightedness or myopia. Myopia can be corrected by the use of concave or diverging lens of an appropriate power.

# Q5. The far point of a myopic person is 80 cm in front of the eye. What is the nature and power of the lens required to correct the problem?

**Sol.** The person is suffering from an eye defect called myopia. In this defect, the image of an object is formed in front of the retina. Hence, a concave lens is used to correct this defect of vision.

Object distance,  $u = infinity = \infty$ 

Image distance, v = -80 cm

Focal length = f

According to the lens formula,

$$\frac{1}{\upsilon} - \frac{1}{\upsilon} = \frac{1}{f}$$
$$\Rightarrow -\frac{1}{80} - \frac{1}{\infty} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{f} = -\frac{1}{80}$$

 $\Rightarrow$  f = -80cm or -0.8m

Power of the lens and the focus can be given as :

$$P = \frac{1}{f}$$
, (f is in meters)

$$\Rightarrow P = \frac{1}{-0.8} = -1.25D$$

Thus, a concave lens of power -1.25 D is required by the person to correct his defect.

#### Q6. Why does the sky appear dark instead of blue to an astronaut?

- **Sol.** Since there is no atmosphere in outer space that can scatter the sunlight, the sky appears dark instead of blue to an astronaut. Since the sunlight is not scattered in space, no scattered light reaches the astronaut's eyes and the sky appears black to them instead of blue.
- Q7. A person needs a lens of power 5.5 dioptres for correcting his distant vision. For correcting his near vision, he needs a lens of power + 1.5 dioptre. What is the focal length of the lens required for correcting

(a) distant vision?

Sol. The power P of a lens of focal length f is given by the relation  $P = \frac{1}{f}$  (f in metres)

Power of the lens used for correcting distant vision = -5.5 D

Focal length of the required lens,  $f = \frac{1}{P}$ 

$$\Rightarrow f = \frac{1}{-5.5} = -0.181m$$

The focal length of the lens for correcting distant vision is -0.181 m.

#### (b) Near vision?

Sol. Power of the lens used for correcting near vision = +1.5 D

Focal length of the required lens,  $f = \frac{1}{P}$ 

$$\Rightarrow f = \frac{1}{1.5} = +0.667$$

The focal length of the lens for correcting near vision is 0.667m.

#### Q8. The least distance of distinct vision for a young adult with normal vision is about.

**Sol.** The least distance of distinct vision refers to the minimum distance to see a clear and distinct image. This distance is 25 cm for a young adult with normal vision.

#### Q9. The change in focal length of an eye lens is caused by the action of the

**Sol.** The curvature of the eye lens is changed by the relaxation or contraction of ciliary muscles.

The focal length of the eyes is changed due to the change in curvature of the eye lens. Therefore, the change in focal length of an eye lens occurs due to the action of ciliary muscles.

#### Q10. The human eye forms the image of an object at its

Sol. The image of an object is formed by the human eye at its retina.