

STRUCTURE OF HUMAN EYE

An eye is the most important organ of the human body. It is associated with vision and acts as a vital optical instrument. Human beings contain two eyes embedded in the eye sockets. It is spherical in shape and is covered externally by a hard thick and opaque layer called Sclerotica. The human eye is the most important organ. It is used to see the beautiful nature and the natural phenomena. The main parts of an eye and their functions are given below:

1. **Cornea:-** It is transparent part of eye and allows the light to enter in the eye. Cornea is also known as the window or aperture of the eye.
2. **Iris:-** It is a circular diaphragm having a hole in its centre. This hole is called pupil. The circular diaphragm has muscles and coloured pigments. The colour of an eye depends upon the colour of these pigments. The function of iris is to control the amount of light entering the eye through the pupil. The pupil becomes small when bright light falls on the eye. However, it becomes wide when there is dim light.
3. **Lens:-** The eye lens is a crystalline double convex lens and made of transparent and flexible tissues. It is behind the pupil and held by the muscles called ciliary muscles. It focuses the images of objects on the retina of the eye.
4. **Ciliary muscles:-** These muscles hold the eye lens in position. Ciliary muscles control the focal length of the eye lens. When these muscles contract, the focal length of the lens increases. On the other hand, when they expand, they exert inward pressure on the eye lens and decrease the focal length of the lens.
5. **Retina:-** It acts as a screen to obtain the image of the object. It contains number of cells in the form of rods and cones which are sensitive to light. These cells convert light energy into nerve impulses or signals.
6. **Optic nerve:-** Optic nerve is formed by the nerve fibres coming from the retina. It carries nerve impulses or signals to the brain. The brain finally interprets the signal.

WORKING OF THE EYE

The light rays reflected from object surfaces fall on the exposed portion of the eyes. These rays enter into the eye through the pupil and fall on the convex lens, or eye lens. It converges the incident light rays and forms a real and inverted image of the object on the yellow spot of the Retina. The image formed on the Retina is then converted into nerve impulses and sent to brain through the optic nerve, which gives rise to the sensation of vision. The sensation of vision produced is correct and complete and shows no effect of the inverted image formed on the Retina. However, the amount of incident light rays entering into the eye is regulated by the iris. By adjusting the size of its pupil. If the amount of light rays incident on the eye is high. The pupil decreases its size and thus reduces the intensity of light and if the intensity of the incident light is low the size of the pupil is increased so as to facilitate entrance of sufficient amount of light into.

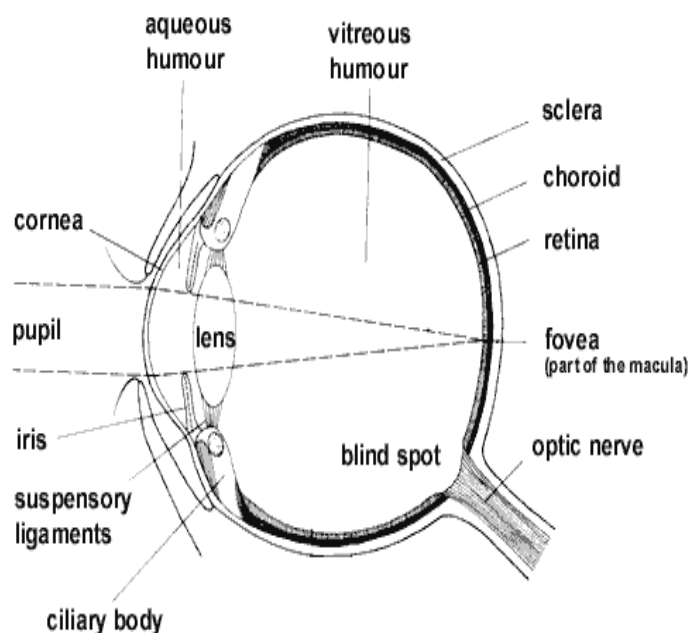


Diagram Showing Structure of Human Eye.

ACCOMMODATION

A normal eye can visualize the distant objects as well as a nearby object. This is achieved with the help of ciliary muscles, which changes the thickness and hence the focal length of the eye lens. Resulting in the alteration of converging power of our eyes. This ability of an eye to focus the distant objects as well as the nearby objects on the Retina by changing the focal length or the converging power of its lens is called as Accommodation. The accommodation power of a normal eye varies in between infinity and 25 cms i.e., a normal eye is capable to focus the objects as far as infinity and as close as 25 cms on the Retina.

RANGE OF VISION

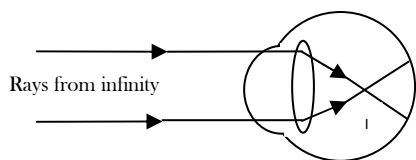
The maximum distance within which an eye can focus the various object is called as the range of vision. It varies in between infinity and 25 cms from an eye i.e., a normal human eye can focus the objects clearly lying in between infinity and 25 cms from it.

DEFECTS OF VISION

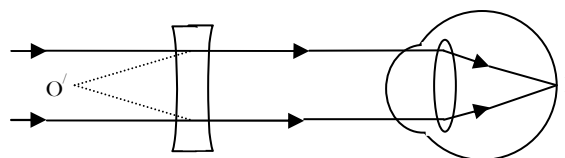
There are various defects which can occur in the human eye like Myopia. Hypermetropia. Presbiopia, Astigmatism and Cataract etc. the commonly occurring defects are explained as:-

1) **Myopia Or Short-sightedness:-** Myopia is commonly occurring defect of the eye which makes it unable to visualize clearly the distant objects, though it can see nearby objects. Thus defect is due to the high converging power of the eye lens, which is created by the insufficient relaxation of the ciliary muscles as a result the image of distant object is formed in front of the Retina.

However the defect can be corrected by using spectacles containing Concave lenses. This diverges the incident light rays coming from the distant object and helps the lens to focus the image on the right spot of the Retina and so that the eyes can see it clearly.

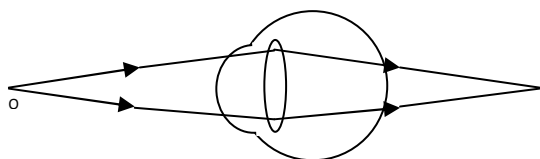


MYOPIA EYE

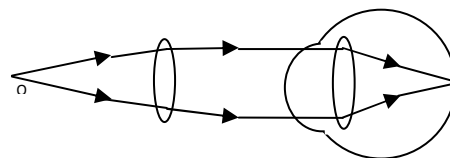


CORRECTION

2) **Hypermetropia or Far-sightedness:-** Hypermetropia is a defect of the eye in which an eye is unable to see the nearby objects perfectly though it can see the distant objects clearly. This defect is caused due to the low converging power of the eye lens, which is mainly due to weakening of the ciliary muscles, resulting in the reduction of the ability of the ciliary muscles. Due to the low converging power of the eye lens, the image of the nearby object is however, the defect can be corrected by using spectacles containing convex lenses, which converges the incident light rays from a nearby object and helps the eye lens in forming the image at the right spot of the Retina. So that an eye can see it clearly



HYPERMETROPIA EYE



CORRECTION

3) **Presbiopia:-** A human eye which cannot see the near object as well as far off (or distant) objects clearly is said to suffer from a defect known as Presbyopia. This defect arises due to the ageing of a person. The ciliary

THE HUMAN EYE AND REFRACTION

muscles are weakened and the flexibility of the crystalline lens of the human eye decreases with age of the person. As a result, human eye is unable to see the near as well as distant objects clearly.

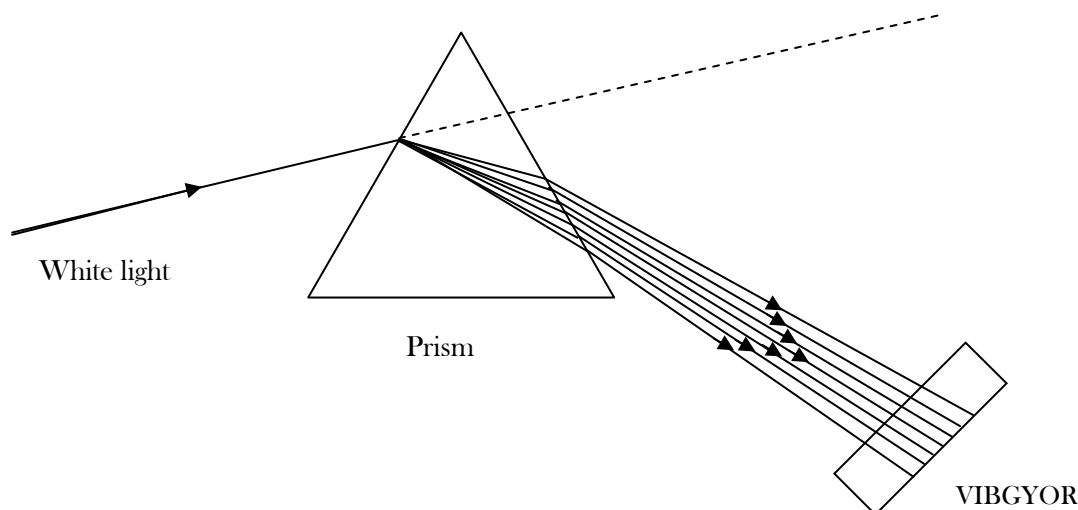
CORRECTION OF PRESBYOPIA

This defect can be corrected by using a bi-focal lens. A bi-focal lens consists of a concave lens which forms the upper surface of the bi-focal lens and a convex lens which forms the lower surface of the bi-focal lens. The upper surface of bi-focal lens (i.e the concave lens) enables the person to see distant objects clearly and the lower surface of the bi-focal lens (i.e., convex lens) enables the person to see the near objects.

DISPERSION OF WHITE LIGHT BY A GLASS PRISM

When white light passes through a glass prism, we get a band of seven colours on a white screen. The colours obtained on the screen are violet, indigo, blue, green, yellow, orange and red. These colours can be remembered as **VIBGYOR**.

From this observation, we can conclude the white light is a mixture of seven colours. The phenomenon of splitting white light into seven colors is known as dispersion.



DISPERSION OF LIGHT

The phenomenon of splitting white light into seven colors when it passes through a glass prism is called dispersion of white light.

CAUSE OF DISPERSION

White light consists of seven colours: red, orange, yellow, green, blue, indigo and violet. Each colour has its own wavelength. The wavelength of red colour is the longest and the wavelength of violet colour is the shortest. The speed of light or colour depends upon the wavelength. If wavelength of a colour is large, the speed of the colour is also large. Thus, each colour of light travels with different speeds in a given medium. The speed of red colour is more than the speed of orange colour in a medium. The speed of orange colour is more than the speed of yellow colour and so on. Therefore, the speed of red colour in a medium is the highest and the speed of violet colour is the least. Hence, all colours of white light are refracted by different amounts while passing through the glass prism. Therefore, when a white light passes through a glass prism, different constituent colours come out of the prism at different angles. This gives rise to the dispersion of white light.

ATMOSPHERIC REFRACTION

When sun light enters the earth's atmosphere, it continuously goes from rarer to the denser medium and hence refraction of light takes place. The refraction of light taking place in the atmosphere is known as atmospheric refraction.

Atmospheric refraction gives rise to many optical phenomena which are discussed below:

1. ***Twinkling of stars:-*** light emitted by stars passes through the atmosphere of the earth before reaching our eyes. The atmosphere of the earth is not uniform but consists of many layer of different densities the layers close to the surface of the earth are optically denser. As we go higher and higher, the density of layers and refractive index decreases progressively. As the light from a star enters the upper most layer of the atmosphere, it bends towards the normal as it enters the next layer. This process continues till the light enters our eyes. So due to refraction of light, the apparent position of the star is different from the actual position of the star.

Moreover, the different layers of the atmosphere are mobile and the temperature and the density of layers of atmosphere changes continuously. Hence, the apparent position of the star changes continuously. The intensity of light coming from the star also changes with the change in the apparent position of the star. This leads to twinkling of a star. The change in the intensity of light entering our eyes due to the change in the apparent position of the star continuously leads to the twinkling of a star.

2) ***We can see the sun for few minutes even after it has actually set:-*** The sun sets when it is below the horizon in the evening. The rays of light from the sun below the horizon reach our eyes because of refraction of light. These rays appear to come from the apparent position of the sun which is about the horizon. Hence we can see the sun for few minutes (about 2 minutes) even after it has actually set. Similarly, the sun can be seen about 2 minutes before it actually rises. Thus, we gain about 4 minutes of additional daylight each day.

SCATTERING OF LIGHT

When sunlight enters the atmosphere of the earth, the atoms and molecules of different gases present in the atmosphere absorb this light. Hence, these atoms and molecules of the gases re-emit light in all direction. This process is known as scattering of light. The atoms or particles scattering light are known as scatterers.

Q. Why is the colour of clear sky blue?

When sunlight enters the earth's atmosphere the atoms or molecules of the gases present in the atmosphere scatter this light. Since wavelength of red colour is larger than the wavelengths of other colours in sunlight, so red colour is scattered the least. Violet colour is scattered the most followed by blue, green, yellow, orange and red colours respectively. Our eye is more sensitive to the blue light than the violet light. Therefore, scattered light in the sky contains blue colour in plenty and hence the clear sky appears blue.

Q. Why sunset and Sunrise are Red?

At the time of sunrise or sunset, the position of the sun is very far away from us. The sunlight travels longer distance through the atmosphere of the earth before reaching our eyes. Scattering of blue light is more than the scattering of red light. As a result of this, more red light reaches our eyes than any other colour. Hence sunset and sunrise appear red.

Q. An astronaut on the earth looks towards the clear sky. He observes the blue colour of the sky. However, when he is in space, he observed the sky as dark. Explain, why?

The sunlight scatters, when it enters the earth's atmosphere. The scattering of light in the earth's atmosphere is due to the presence of atoms, molecules, droplets and dust particles etc. the intensity of scattered light is more for the colour of less wave length. Since the wavelength of blue colour is less than the wave length of

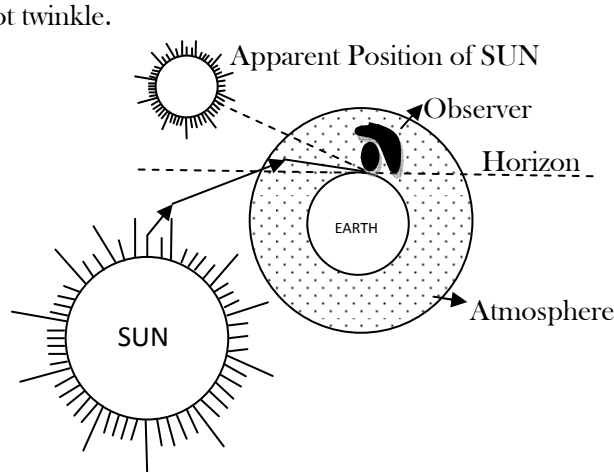
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red colour, so blue colours scatters more than the red colour. Hence, sky appears blue to an astronaut standing on the earth.

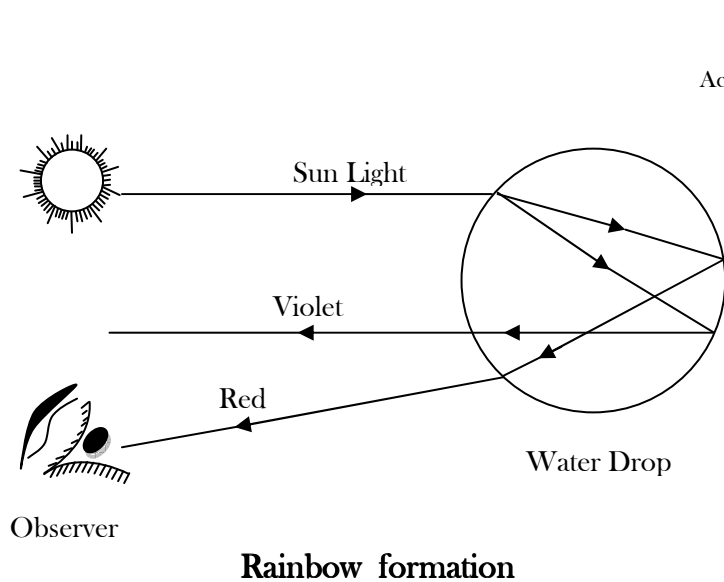
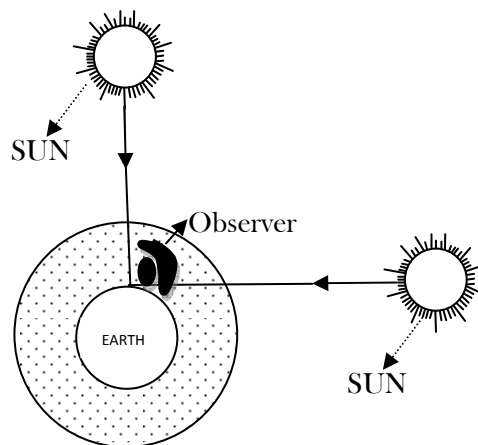
When the astronaut is in space, then there is no atmosphere (or atoms, molecules, droplets and dust particles) around him. Therefore, sun light does not scatter and hence sky appears dark.

Q. Explain why planets do not twinkle?

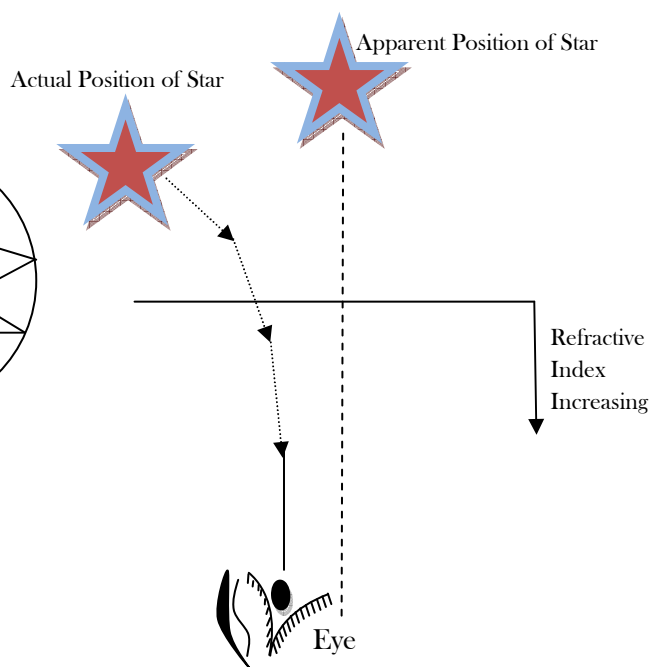
Planets are very close to the earth as compared to the stars. So the intensity of light we receive from the planet is very large. Therefore, the variation in the brightness of the planets is not detected. Hence, planets do not twinkle.



Actual Position of SUN



Rainbow formation



Twinkling of Star
