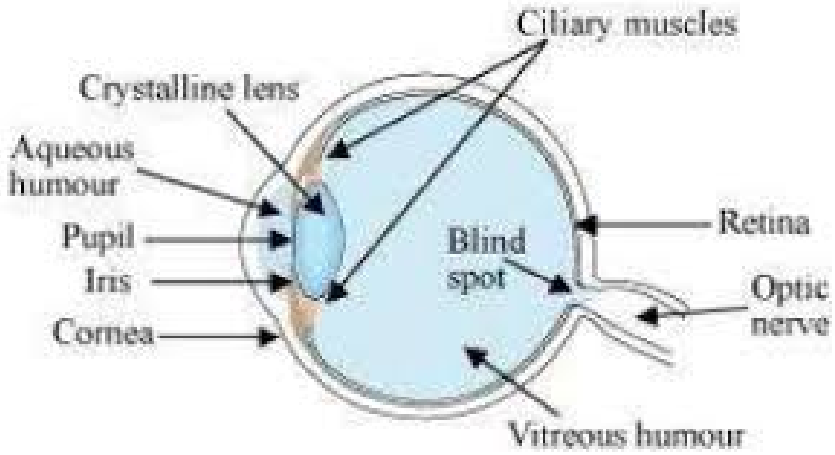
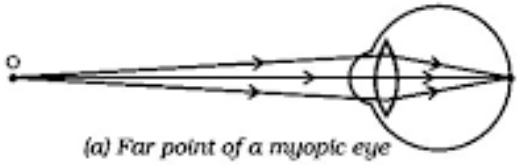
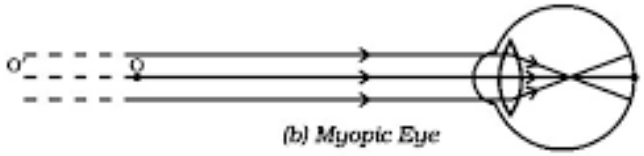
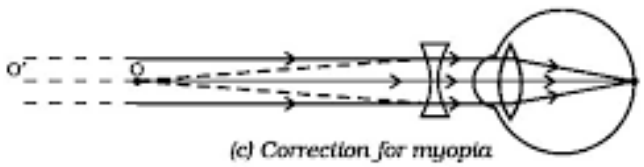
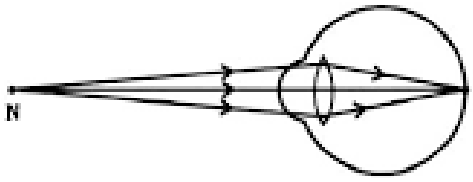
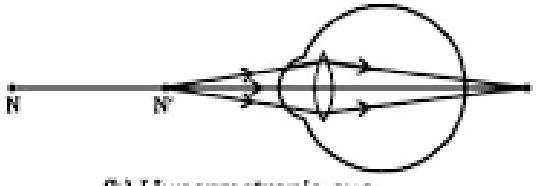
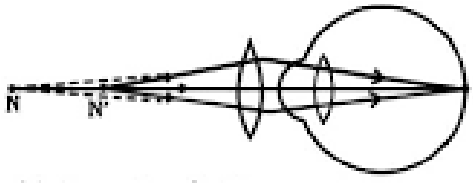
CHENNAI PUBLIC SCHOOL

Anna Nagar Chennai -600 101

	PHYSICS class notes –CLASS X
	CHAPTER-Human eye and the colourful world
	The human eye enables us to see the wonderful world and the colors around us. The human eye is roughly spherical in shape with diameter of about 2.3 cm. **Structure of human eye** The main parts of the human eye are : Cornea ,Iris ,Pupil, Ciliary muscles, Eye lens, Retina ,and Optic nerve 
	Cornea: Light enters the eye through a thin membrane called the cornea. It forms the transparent bulge on the front surface of the eyeball Most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea.
	Iris and Pupil: Iris is a dark muscular diaphragm that controls the size of the pupil.Iris adjusts the size of the pupil according to the intensity of light received by the eye. The pupil regulates and controls the amount of light entering the eye. Pupil appears black as no light is reflected from it

	Eye lens is a convex lens which forms an inverted real image of the object on the retina. Eye lens is flexible and adjust its shape using ciliary muscles to focus objects at different distances on the retina.
	Ciliary musles: Eye lens is held in position by the ciliary mucles.Ciliary muscles change the thickness of eye lens while focusing.
	Retina: The eye lens forms an inverted real image of the object on the retina. The retina is a delicate membrane having enormous number of light-sensitive cells. The light-sensitive cells get activated upon illumination and generate electrical signals. These signals are sent to the brain via the optic nerves. The brain interprets these signals, and finally, processes the information so that we perceive objects as they are.
	Rods and cones: Retina consists of two types of light sensitive cells – rod cells and cone cells. The rod shaped cells respond to the intensity or brightness of the focussed light whereas the cone shaped cells of the retina respond to the colours. Thus, the cone cells of the retina make colour perception possible. A person having defective cone cells is not able to distinguish between the different colours. This defect is known as **Colour Blindness**.
	Blind spot is a small area of the retina insensitive to light where optic nerve leaves the eye.
	Power of Accommodation The ability of the eye lens to adjust its focal length to see the nearby and for away objects is called power of accommodation The range of vision of a normal eye is from 25 cm to infinity. The near point of of the eye is 25 cm and the far point is infinity.
	Note: 1)The smallest distance, at which the eye can see objects clearly without strain, is called the near point of the eye or the least distance of distinct vision. For a young adult with normal vision, it is about 25 cm.
	2) When you are looking at objects closer to the eye, the ciliary muscles contract. This increases the curvature of the eye lens. The eye lens then becomes thicker.

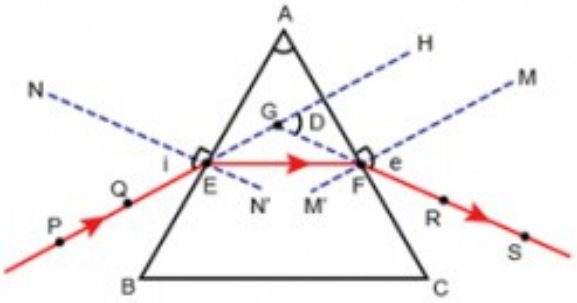
	Consequently, the focal length of the eye lens decreases. This enables us to see nearby objects clearly. 3) When the muscles are relaxed, the lens becomes thin. Thus, its focal length increases. This enables us to see distant objects clearly.
	4)You might have experienced that you are not able to see objects clearly for some time when you enter from bright light to a room with dim light. After sometime, however, you may be able to see things in the dim-lit room. –Give reason The pupil of an eye acts like a variable aperture whose size can be varied with the help of the iris.When the light is very bright, the iris contracts the pupil to allow less light to enter the eye. However, in dim light the iris expands the pupil to allow more light to enter the eye. Thus, the pupil opens completely through the relaxation of the iris.
	Defects of vision: There are mainly three common refractive defects of vision. These are (i) myopia or near-sightedness, (ii) Hypermetropia or farsightedness, and (iii) Presbyopia.
	Myopia or near sightedness A person with myopia can see nearby objects clearly but cannot see distant objects distinctly.In a myopic eye, the image of a distant object is formed in front of the retina and not at the retina itself. Causes: This defect may arise due to (i) excessive curvature of the eye lens, or (ii) elongation of the eyeball.  *(a) Far point of a myopic eye* Image formed on the retina  *(b) Myopic Eye* Image infront of the retina  *(c) Correction for myopia*

	Correction using a concave lens Correction: This defect can be corrected by using spectacle with a concave lens of suitable power
	Hypermetropia or Far sightedness: A person with hyper metropia can see distant objects clearly but cannot see nearby objects distinctly. This is because the light rays from a close by object are focused at a point behind the retina  *(a) Near point of a Hypermetropic eye* Image is formed on the retina  *(b) Hypermetropic eye* Image is formed behind the retina  *(c) Correction for Hypermetropic eye* Correction using a convex lens

	Causes: This defect arises either because (i) the focal length of the eye lens is too long, or (ii) the eyeball has become too small. Correction; This defect can be corrected by using a spectacle with convex lens of appropriate power
	NOTE: **MYOPIA :** Object distance u = α Image distance, *v* = **-** person's far point **Hypermetropia:** Object distance u = - 25 cm Image distance, *v* = **-** defective near point
	Presbyopia The power of accommodation of the eye usually decreases with ageing. For most people, the near point gradually recedes away. They find it difficult to see nearby objects comfortably and distinctly without corrective eye-glasses. This defect is called Presbyopia. Causes: It arises due to the gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens. Sometimes, a person may suffer from both myopia and hypermetropia. Such people often require bifocal lenses. A common type of bi-focal lenses consists of both concave and convex lenses. The upper portion consists of a concave lens. It facilitates distant vision. The lower part is a convex lens. It facilitates near vision.
	it is possible to correct the refractive defects with contact lenses or through surgical interventions.
	Cataract Sometimes, 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. It is possible to restore vision through a cataract surgery.
	Why do we have two eyes for vision and not just one? (i) Two eyes give a wider field of view. A human being has a horizontal field of view of about 180° with two eyes. (ii) The ability to detect faint objects is, enhanced with two eyes (iii) Having two eyes enable us to judge distances more accurately (iv) Because our eyes are separated by a few centimetres, each eye sees a slightly different image. Our brain combines the two images into one, using the extra information to tell us how close or far away things are.
	EYE DONATION: ➢ Eye donors can belong to any age group or sex. People who use spectacles, or those operated for cataract, can still donate the eyes. ➢ People who are diabetic, have hypertension, asthma patients and those without communicable diseases can also donate eyes. ➢ Eyes must be removed within 4-6 hours after death. Inform the nearest eye bank immediately. ➢ The eye bank team will remove the eyes at the home of the deceased or at a hospital. ➢ Eye removal takes only 10-15 minutes. It is a simple process and does not lead to any disfigurement. ➢ Persons who were infected with or died because of AIDS, Hepatitis B or C, rabies, acute leukemia, tetanus, cholera, meningitis or encephalitis cannot donate eyes.

REFRACTION OF LIGHT THROUGH A PRISM

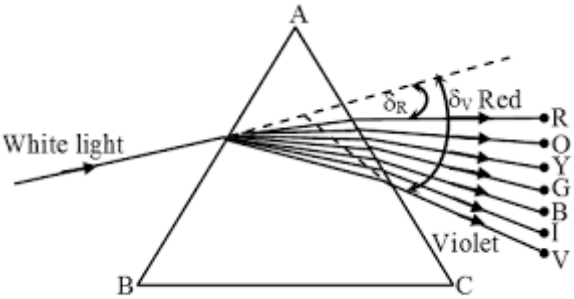


PE - Incident ray
EF - Refracted ray
FS - Emergent ray
A - Angle of the prism

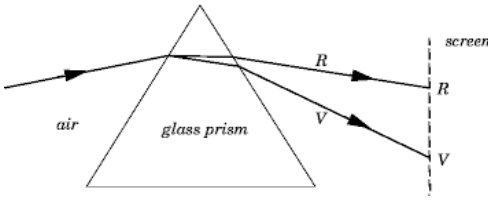
∠i - Angle of incidence
∠r - Angle of refraction
∠e - Angle of emergence
∠D - Angle of deviation

- A prism has two triangular bases and three rectangular lateral surfaces.
- When a ray of light passes through a prism ,it bends towards the base of the prism
- The emergent ray of light in a glass prism is not parallel to the incident ray of light.because the opposite faces of the glass prism are not parallel to one another
- The angle between its two lateral faces is called the angle of the prism.(<A)
- The angle between the incident ray and emergent ray is called angle of deviation(<D)

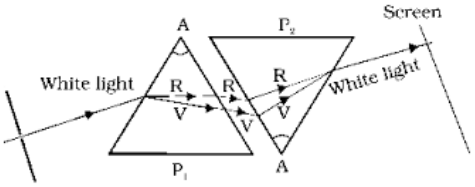
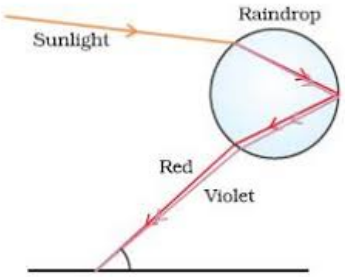
DISPERSION OF WHITE LIGHT BY A GLASS PRISM

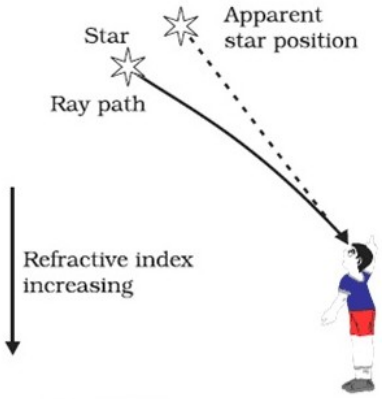


Dispersion of white light by a glass prism

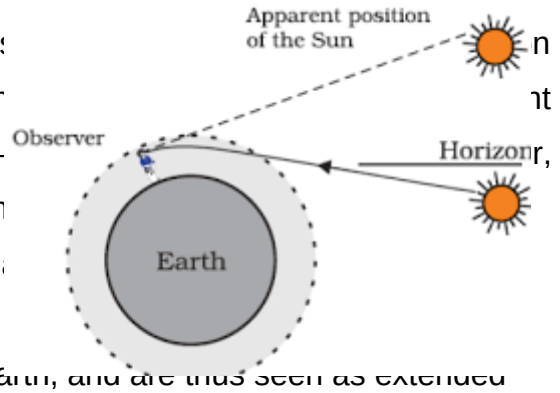


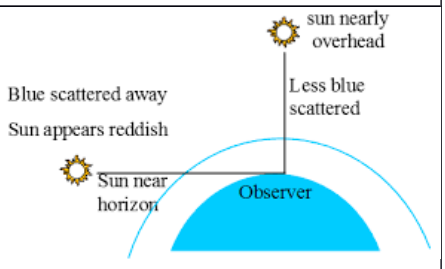
- The splitting of white light into its component colours ,when it passes through a prism is called dispersion of light.
- When a beam of white light passes through a prism, the band of seven colours

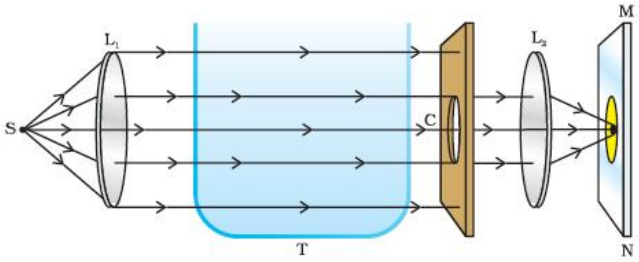
	formed on a screen is called spectrum ➢ Cause of dispersion: White light consists of seven colors. When white light passes through a prism ,each color is deviated by a different angle, as the colors of white light travel at different speeds through the glass prism. With a result seven colors spread out to form a spectrum. ➢ Red color is deviated the least and violet color deviates the most ➢ The seven colors of the spectrum :VIBGYOR ➢ Natural phenomena of dispersion of light : Rainbow formation
	Recombination of the spectrum of white light:  Isaac Newton was the first to use a glass prism to obtain the spectrum of sunlight He then placed a second identical prism in an inverted position with respect to the first prism. This allowed all the colours of the spectrum to pass through the second prism. He found a beam of white light emerging from the other side of the second prism. This observation gave Newton the idea that the sunlight is made up of seven colour.
	Rainbow formation:  ➢ A rainbow is a natural spectrum appearing in the sky after a rain shower. ➢ It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop . Due to the dispersion of light and internal reflection, different colours reach the observer's eye. (Refraction, Dispersion , Total internal reflection and refraction) ➢ A rainbow is always formed in a direction opposite to that of the Sun. ➢ You can also see a rainbow on a sunny day when you look at

	the sky through a waterfall or through a water fountain, with the Sun behind you.
1)	ATMOSPHERIC REFRACTION Air in the atmosphere is not at the same temperature. The cooler air layers of atmosphere behave as optically denser medium for light rays and hotter air layers behave as optically rarer medium .When light rays pass through the atmosphere having air layers of different optical densities, refraction of light takes place.This is known as atmospheric refraction.
2)	If we look at the objects through hot air over a fire ,it appear to be moving slightly. Give reason The air just above the fire becomes hotter than the air further up. The hotter air is lighter (less dense) than the cooler air above it, and has a refractive index slightly less than that of the cooler air. Since the physical conditions of the refracting medium (air) are not stationary, the apparent position of the object, as seen through the hot air, fluctuates and gives wavering effect.
3)	Stars twinkle at night but planets do not twinkle. Give reason.(OR) The stars seem higher than they actually are. Give reason ➢ The twinkling of a star is due to atmospheric refraction of starlight. ➢ The starlight, on entering the earth's atmosphere, undergoes refraction continuously before it reaches the earth. ➢ The atmospheric refraction occurs in a medium of gradually changing refractive index. ➢ Since the atmosphere bends starlight towards the normal, the apparent position of the star is slightly different from its actual position.  *Apparent star position due to atmospheric refraction* ➢ The star appears slightly higher (above) than its actual position when viewed near the horizon . ➢ Further, this apparent position of the star is not stationary, but keeps on

	changing slightly, since the physical conditions of the earth's atmosphere are not stationary. As the path of rays n varying slightly, the apparent position nt of starlight entering the eye flickers – and at some other time, fainter, which ➢ Since the stars are very distant, they light. ➢ The planets are much closer to the earth, and are thus seen as extended sources. ➢ If we consider a planet as a collection of a large number of point-sized sources of light, the total variation in the amount of light entering our eye from all the individual point-sized sources will average out to zero, thereby nullifying the twinkling effect.
4)	**Advance sunrise and delayed sunset** The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction. The actual sunrise takes place when the Sun is above the horizon .When the Sun is slightly below the horizon,due to atmospheric refraction, the Sun appears to be raised above the horizon. The time difference between actual sunset and the apparent sunset is about 2 minutes.
	Note: The apparent flattening of the Sun's disc at sunrise and sunset is also due to the atmospheric refraction.
5)	SCATTERING OF LIGHT: Tyndall effect: The earth's atmosphere is a heterogeneous mixture of minute particles. These particles include smoke, tiny water droplets, suspended particles of dust and molecules of air. When a beam of light strikes such fine particles, the path of the beam becomes visible. The light reaches us, after being reflected diffusely by these particles. The phenomenon of scattering of light by the colloidal particles gives rise to Tyndall effect Tyndall discovered that the blue coloured light having shorter wavelength , present in sunlight is scattered much more easily ,than the red colour having longer wavelength.



	Examples of Tyndall effect: ➢ When a fine beam of sunlight enters a smoke-filled room through a small hole. ➢ When sunlight passes through a canopy of a dense forest. Here, tiny water droplets in the mist scatter light.
	Note: ➢ Very fine particles scatter mainly blue light ➢ Particles of larger size scatter light of longer wavelengths. ➢ If the size of the scattering particles is large enough, then, the scattered light may even appear white.
6)	Why is the colour of the clear Sky Blue? Scattering of light causes the blue colour of the sky. Sunlight consists of seven colours. The red light has a wavelength about 1.8 times greater than blue light. When sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red. The scattered blue light enters our eyes.
7)	The sky appears dark to passengers flying at very high altitudes . Give reason In the outer space , there is no atmosphere containing air is present, to scatter Sunlight. Since there is no scattering of light,the sky appears dark to passengers flying at very high altitudes.
8)	Danger signals are red in colour. Give reason Red light has a wavelength about 1.8 times greater than blue light. The red colour having longer wavelength is least scattered by fog or smoke. Therefore, it can be seen in the same colour at a distance.
9)	Why the Sun appears Red at Sunrise and Sunset? Sun appears Red at Sunrise and Sunset due to scattering of light. At the time of Sunrise and sunset ,when the Sun is near the horizon ,sunlight has to travel larger distancethrough the earth's atmosphere before reaching our eyes  During this time, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun.
10)	Why the Sun appears white when it is overhead in the sky? When the Sun is overhead (at noon) ,sunlight has to travel shorter distance through the

	earth's atmosphere before reaching our eyes. During this time,only a little of the blue color is scattered and the Sun appears white.
11)	Experiment to study the scattering of light  ➢ Place a strong source (S) of white light at the focus of a converging lens (L1). This lens provides a parallel beam of light. ➢ Allow the light beam to pass through a transparent glass tank (T) containing clear water. ➢ Allow the beam of light to pass through a circular hole (c) made in a cardboard. Obtain a sharp image of the circular hole on a screen (MN) using a second converging lens (L2) ➢ Dissolve about 200 g of sodium thiosulphate (hypo) in about 2 L of clean water taken in the tank. Add about 1 to 2 mL of concentrated sulphuric acid to the water. ➢ You will find fine microscopic sulphur particles precipitating in about2 to 3 minutes. ➢ As the sulphur particles begin to form, we can observe the blue light from the three sides of the glass tank. This is due to scattering of short wavelengths by minute colloidal sulphur particles. ➢ Observe the colour of the transmitted light from the fourth side of the glass tank facing the circular hole. ➢ It is interesting to observe at first the orange red colour and then bright crimson red colour on the screen.

