THE HUMAN EYE

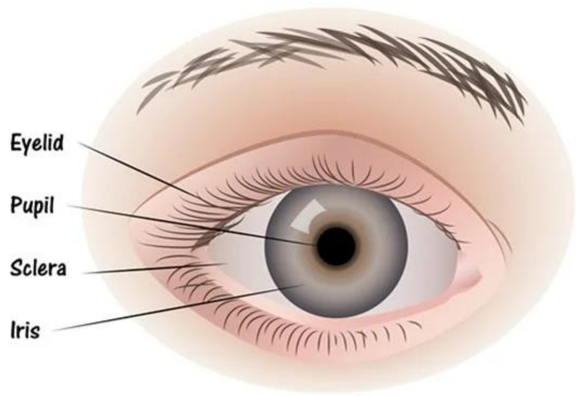
The human eye is a remarkable organ with intricate components that work together to facilitate vision. It contains following parts:

Cornea: The cornea is the clear, dome-shaped, outermost layer of the eye.

- **Function**: It is the primary refractive surface, responsible for bending light as it enters the eye. The cornea's transparency and curvature are critical for focusing light onto the retina. It also serves as a protective barrier against dust, germs, and other foreign particles. The cornea is avascular (lacks blood vessels), relying on tear fluid and aqueous humour for oxygen and nutrients.

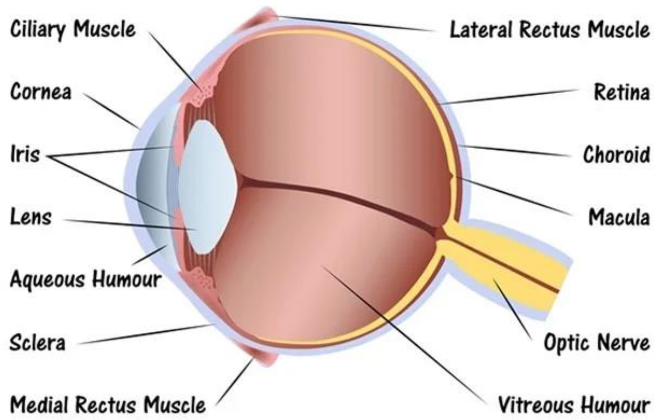
Sclera: The sclera is the white, fibrous, and opaque outer layer of the eye.

- **Function**: It provides structural support and protection to the internal components of the eye. The sclera's toughness helps maintain the eye's shape, preventing deformation due to internal pressure or external impact. It also serves as an attachment point for the extraocular muscles, which control eye movement.



Iris: The iris is the coloured portion of the eye, lying between the cornea and the lens.

- **Function**: The iris controls the size of the pupil, regulating the amount of light that enters the eye. It contains smooth muscles that contract or relax to adjust the pupil's size. The iris's pigmentation determines its colour, which varies among individuals. It also contributes to eye aesthetics, with unique patterns and textures.



Pupil: The pupil is the black circular opening in the centre of the iris.

- **Function**: It regulates the amount of light entering the eye. The size of the pupil changes in response to light intensity: it constricts (gets smaller) in bright light to reduce glare and dilates (gets larger) in low light to allow more light in. This adaptive mechanism is known as the **pupillary light reflex**.

Lens: The lens is a transparent, flexible, biconvex structure located behind the iris.

- **Function**: The lens focuses light onto the retina. It changes shape through a process called **accommodation**, which allows for clear vision at various distances. The lens becomes more rounded for near objects and flatter for distant objects. This flexibility decreases with age, leading to conditions like **presbyopia** (difficulty focusing on near objects).

Ciliary Body: The ciliary body is a ring-shaped structure surrounding the lens, containing ciliary muscles and processes.

- **Function**: The ciliary muscles control the shape of the lens for accommodation, adjusting focus. The ciliary body also produces aqueous humour which fills the space between the cornea and lens, maintaining intraocular pressure and providing nutrients to the cornea and lens.

Aqueous Humour: A clear, watery fluid that fills the anterior chamber between the cornea and lens.

- **Function**: It helps maintain intraocular pressure, nourishes the cornea and lens, and removes metabolic waste. It also provides a clear medium for light to pass through without distortion.

Vitreous Humour: A clear, gel-like substance filling the posterior chamber between the lens and the retina.

- **Function**: It maintains the eye's shape, supporting the retina's structure and keeping it in place. It also serves as a medium for light to travel through without obstruction or distortion.

Retina: The retina is the innermost layer at the back of the eye, containing photoreceptors (rods and cones) and other neural cells.

- **Function**: It receives light focused by the lens and converts it into electrical signals that the brain can interpret. The retina has several layers, including the pigment epithelium, rods and cones, bipolar cells, and ganglion cells. Rods are responsible for low-light and peripheral vision, while cones handle colour vision and high-resolution central vision.

Optic Nerve: A bundle of over one million nerve fibres connecting the retina to the brain.

- **Function**: It carries visual information from the retina to the brain, allowing for the interpretation of images. The optic nerve originates at the optic disk, a region on the retina devoid of photoreceptors (creating the blind spot).

Choroid: The choroid is a vascular layer situated between the retina and the sclera.

- **Function**: It provides oxygen and nutrients to the retina and absorbs excess light to reduce internal reflections. The choroid's rich blood supply is crucial for maintaining the health and function of the retina.

Macula and Fovea: The macula is the central region of the retina, containing the fovea at its core.

- **Function**: The macula is responsible for high-acuity vision and colour perception. The fovea, located at the centre of the macula, contains the highest concentration of cones, enabling sharp, detailed, and colour-rich vision. It's the focal point for tasks requiring fine detail, such as reading and recognizing faces.

Together, these components work in harmony to allow us to see and perceive the colourful world around us. They enable us to focus on objects at different distances, distinguish colours, and navigate our environment effectively.

Factors Impacting Visual Functioning and Light Adaptation in the Human Eye

Visual functioning depends on several key structures that work together to transmit light, convert it to electrical impulses, and send those impulses to the brain for interpretation. Damage or malfunction in any of these parts can lead to visual impairment.

- **Light Transmission**: Light passes through the cornea, pupil, lens, and humours (aqueous and vitreous) before reaching the retina. Issues with any of these structures, like corneal damage or cataracts (clouding of the lens), can affect vision.
- **Light Conversion**: The retina, containing photoreceptor cells (rods and cones), converts light into electrical signals. If damaged, as in conditions like **macular degeneration** or **retinitis pigmentosa**, vision is impaired.
- **Signal Transmission**: The optic nerve transmits these electrical signals from the retina to the brain. Damage to the optic nerve, such as in **glaucoma**, can lead to vision loss.
- **Pupil Adjustment**: The pupil, controlled by the iris, adjusts its size based on light intensity. In bright light, the iris contracts the pupil to reduce the amount of light entering the eye, protecting it from excessive glare. In dim light, the iris relaxes, allowing the pupil to expand and let in more light, improving visibility.
- **Adaptation to Light Changes**: The adjustment from bright to dim light takes time. This is due to the iris needing a few moments to relax and let more light in, as well as the rods in the retina adapting to low light conditions. This process, known as **dark adaptation**, is why vision might be unclear when moving from a brightly lit area to a dimly lit room.

Power of Accommodation

The "**Power of Accommodation**" refers to the eye's ability to adjust its focus to see objects clearly at varying distances. This process is primarily managed by the lens, which changes shape to shift focus between near and distant objects. Let's delve into the key aspects of accommodation:

How Accommodation Works

- **Lens Flexibility**: The lens is naturally flexible, allowing it to change shape. This flexibility is controlled by the ciliary muscles in the ciliary body.
- **Focusing on Near Objects**: When looking at something close, the ciliary muscles contract, allowing the lens to become more rounded. This increased curvature enhances the lens's refractive power, enabling clear focus on near objects.
- **Focusing on Distant Objects**: For distant objects, the ciliary muscles relax, causing the lens to flatten, reducing its refractive power, which allows for clear distant vision.

The Near Point and the Far Point

- **Near Point (Least Distance of Distinct Vision):** This is the minimum distance at which objects can be seen clearly without strain. For a young adult with normal vision, this is about 25 cm.
- **Far Point:** This is the farthest distance at which objects can be seen clearly. For a normal eye, this is effectively infinity.

Measurement of Accommodation

- **Dioptres**: The power of accommodation is typically measured in dioptres, indicating the degree of refractive change the lens can achieve. A higher dioptre value indicates greater accommodation capability.
- **Testing Accommodation**: Eye care professionals test accommodation by assessing how well you can focus on objects at different distances. A common method involves reading text or looking at objects while adjusting the distance.

Changes with Age

1. **Presbyopia**: As people age, the lens becomes less flexible, reducing its capacity to change shape. This age-related condition, known as presbyopia, typically becomes noticeable after age 40 and results in difficulty focusing on close objects.

- **Symptoms**: Symptoms of presbyopia include the need to hold reading material at arm's length, eye strain, and blurred near vision.
- **Treatment**: Presbyopia is often managed with reading glasses, bifocals, or multifocal contact lenses.

2. **Cataract**: A cataract is a condition in which the eye lens becomes milky or cloudy due to protein changes in the lens. This cloudiness impairs the lens's ability to focus light, leading to partial or complete vision loss.

- **Symptoms**: Cataracts can cause blurry vision, glare, difficulty with night vision, and faded colours.
- **Treatment:** Cataract surgery can restore vision. The procedure involves removing the cloudy lens and replacing it with an artificial intraocular lens (IOL).

Importance of Accommodation

Accommodation is crucial for everyday activities that require switching focus between near and distant objects, such as reading, driving, and working on computers. Without accommodation, it would be challenging to perform these tasks effectively.

The Benefits of Having Two Eyes for Vision

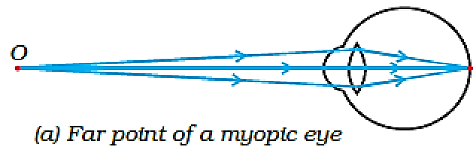
Having two eyes provides several advantages over having just one, contributing to a broader field of view, improved detection, and better depth perception.

- **Wider Field of View**: Two eyes provide a horizontal field of view of about 180°, compared to 150° with one eye, allowing for better spatial awareness and safety.

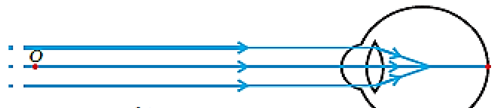
- **Enhanced Detection**: With two detectors, our ability to see faint objects is enhanced, offering improved sensitivity to visual cues.
- **Depth Perception**: Binocular vision (using both eyes) gives us stereopsis, the ability to perceive depth and three-dimensionality, essential for navigation and coordination.
- **Enhanced Coordination**: Depth perception allows for better judgment of distances and coordination in various tasks, from simple movements to complex activities.

DEFECTS OF VISION AND THEIR CORRECTION

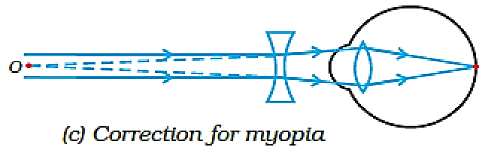
Refractive defects of the eye refer to conditions where the eye's ability to focus on objects is compromised due to issues with the lens's curvature or the shape of the eyeball. There are three common refractive defects: myopia, hypermetropia, and presbyopia. Here's an explanation of each defect and its correction:



(a) Far point of a myopic eye



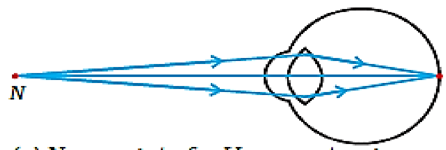
(b) Myopic Eye



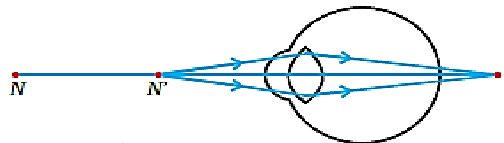
(c) Correction for myopia

Myopia (Near-Sightedness): Myopia, or near-sightedness, occurs when a person can see nearby objects clearly but has difficulty seeing distant objects. This is because the image of distant objects is formed in front of the retina, rather than on it.

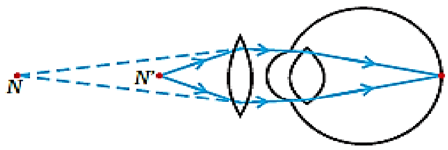
- **Causes**: Myopia may result from an excessive curvature of the eye lens or elongation of the eyeball.
- **Correction**: Myopia is corrected using concave lenses, which help diverge light rays so that they focus correctly on the retina.



(a) Near point of a Hypermetropic eye



(b) Hypermetropic eye



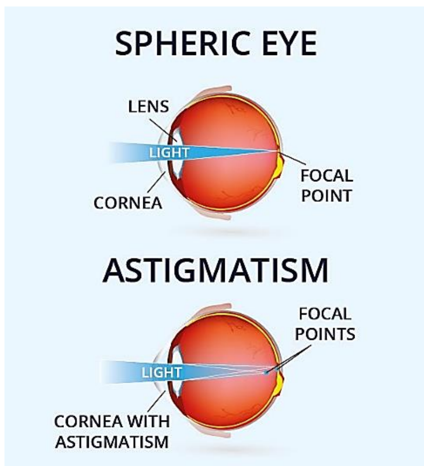
(c) Correction for Hypermetropic eye

Hypermetropia (Far-Sightedness): Hypermetropia, or far-sightedness, is when a person can see distant objects clearly but struggles with nearby objects. The image is formed behind the retina, making close-up objects appear blurry.

- **Causes**: Hypermetropia can occur due to a focal length that's too long or a smaller-than-normal eyeball.
- **Correction**: Convex lenses are used to correct hypermetropia. These lenses converge light rays to help focus them on the retina.

Presbyopia: Presbyopia is an age-related refractive defect. It manifests as difficulty in focusing on close objects due to the loss of accommodation ability, typically from the weakening of ciliary muscles and reduced flexibility of the lens.

- **Correction**: Presbyopia is commonly corrected with bifocal lenses or progressive lenses. Bifocal lenses have a concave part for distant vision and a convex part for near vision. Progressive lenses provide a gradual transition between different lens powers. Presbyopia can also be corrected with contact lenses or surgical interventions.



Astigmatism: Astigmatism occurs when the cornea or lens has an irregular shape, causing distorted or blurred vision at all distances.

- **Causes**: It is often due to an irregular curvature of the cornea or lens, creating multiple focal points on or around the retina.
- **Correction**: Cylindrical lenses are used to correct astigmatism, focusing light on a single point on the retina. Contact lenses and refractive surgery are additional correction methods.

The Gift of Vision: Eye Donation After Death

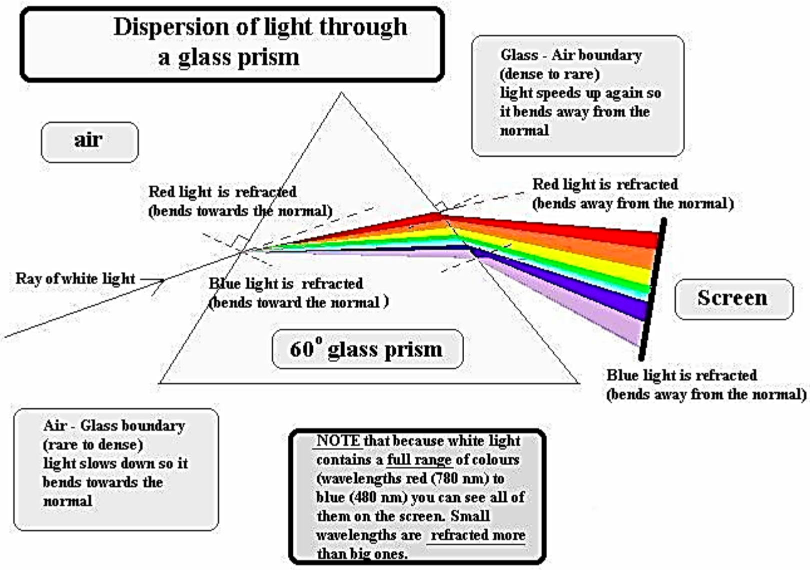
Eye donation after death provides a chance to restore sight to those with corneal blindness. The part of the eye that is typically donated for transplantation is the cornea. The cornea is the clear, dome-shaped surface that covers the front of the eye, including the iris and the pupil. It plays a crucial role in focusing light as it enters the eye.

When someone donates their eyes after death, the cornea is removed and can be transplanted into a person with corneal blindness or damage. Corneal transplants can restore vision in cases where the cornea has been damaged by injury, disease, or other conditions. In some cases, other parts of the eye may also be used for research or education, but the cornea is the primary component used for vision restoration through transplantation.

Dispersion of White Light by a Glass Prism

Dispersion of white light by a glass prism is the process through which a beam of white light is split into its component colours as it passes through a glass prism. This occurs because different colours (wavelengths) of light refract by varying degrees as they move through the prism, resulting in a visible spectrum.

How Dispersion Works



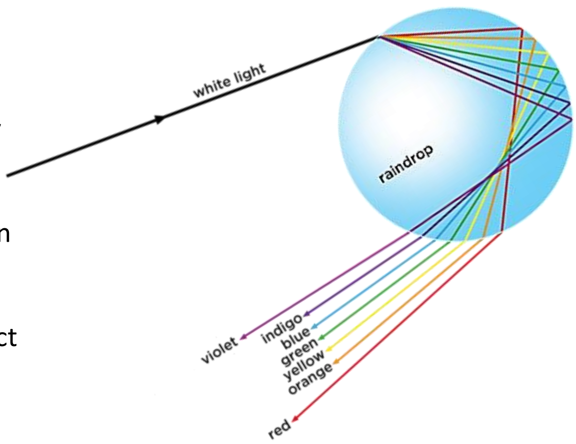
- **Prism Structure**: A glass prism has two triangular bases and three rectangular lateral surfaces, with two inclined angles.
- **Incident Light**: When white light enters the prism, it refracts (bends) due to the change in medium from air to glass. As each colour has a different wavelength, they refract at slightly different angles, leading to separation.
- **Emergent Spectrum**: The dispersed colours create a spectrum of visible light, typically ranging from violet (most refracted) to red (least refracted), forming the familiar rainbow pattern.

Applications

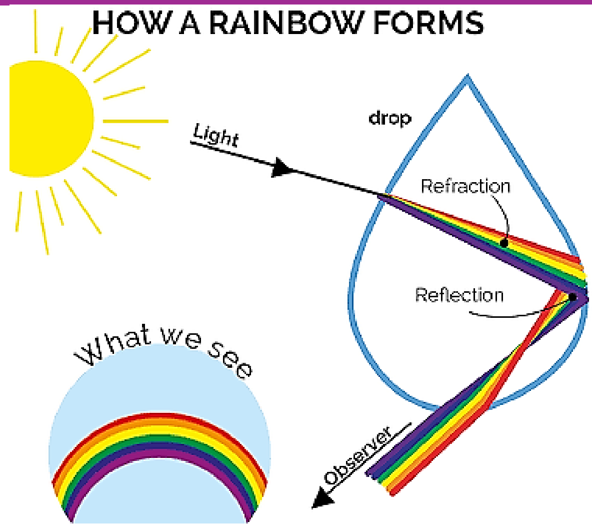
- **Spectroscopy**: Scientists use dispersion to analyse light in spectrometers, identifying the wavelengths and gathering information about the source.
- **Optical Instruments**: Optical devices like spectrometers and prisms use dispersion to separate and manipulate light.
- **Rainbows**: In nature, rainbows occur due to dispersion of sunlight as it passes through water droplets in the atmosphere.

Formation of a Rainbow

A rainbow is a beautiful and natural spectrum of colours that appears in the sky, often after a rain shower. It is caused by the dispersion of sunlight by tiny water droplets in the atmosphere. Here's how a rainbow is formed:



- **Direction**: A rainbow always forms in the sky opposite to the direction of the Sun.
- **Role of Water Droplets**: The tiny water droplets in the atmosphere act like small prisms. They refract (bend) and disperse the incident sunlight into its constituent colours, just like a glass prism does.



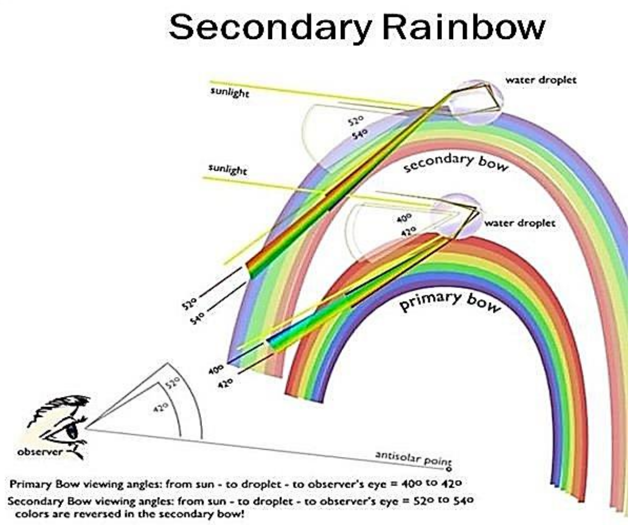
- **Internal Reflection**: Inside each droplet, the light undergoes internal reflection, bouncing off the inside surface of the droplet.
- **Emergence and Refraction**: After internal reflection, the light exits the droplet, refracting again as it passes from water back into the air. This refraction causes the light to spread out into the spectrum of colours that form the rainbow.

Colours of the Rainbow

The sequence of colours in a rainbow follows the same pattern as dispersion through a prism: Violet, Indigo, Blue, Green, Yellow, Orange, and Red (**VIBGYOR**). Red is at the outer edge of the rainbow, while violet is at the inner edge.

Observing a Rainbow

To see a rainbow, you need to have the Sun behind you and rain or mist in front of you. This is why rainbows often appear in the sky after a rain shower or when you look at a waterfall or a water fountain on a sunny day. The key is to be in the right position relative to the Sun and the water droplets.



Double Rainbow and Other Phenomena

- Double Rainbow: Sometimes, a secondary rainbow appears outside the primary rainbow. This is caused by two internal reflections within the water droplets, resulting in a reversed colour sequence (with red on the inner edge and violet on the outer edge).
- Rainbow Variations: Rainbows can vary in intensity and size depending on the size of the water droplets, the Sun's position, and atmospheric conditions.

Atmospheric refraction

Atmospheric refraction refers to the bending of light as it passes through the Earth's atmosphere. This phenomenon occurs because light travels at different speeds through different layers of the atmosphere, which vary in temperature and density. Here's an explanation of atmospheric refraction and some of its associated phenomena:

Causes of Atmospheric Refraction

- **Density Variations**: The Earth's atmosphere is not uniform; it has layers with varying densities and temperatures. As light travels through these layers, it changes speed, leading to refraction or bending of its path.
- **Gradient of Refraction**: The bending effect is more pronounced when light travels through denser air near the Earth's surface and less pronounced at higher altitudes.

Key Phenomena of Atmospheric Refraction

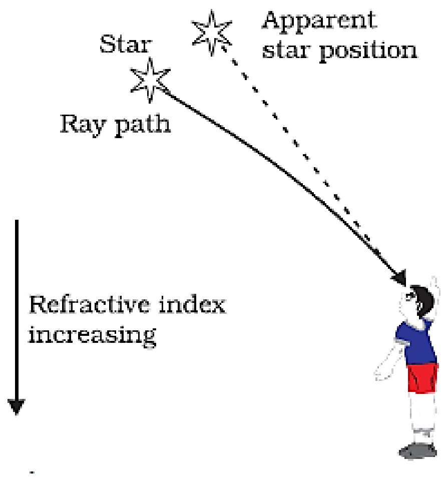
- **Twilight**: The gradual transition between day and night is influenced by atmospheric refraction. As the Sun sets, its light is bent, allowing us to see the Sun even after it has technically dropped below the horizon. This phenomenon creates a soft, extended twilight period.
- **Mirages**: This occurs when light is refracted by air layers of differing temperatures. In hot environments like deserts, cooler air on top of warm ground can create the illusion of water or distant objects.

- **Scintillation (Twinkling of Stars)**: Stars appear to twinkle due to atmospheric turbulence. As light passes through turbulent layers of the atmosphere, its path changes, causing rapid fluctuations in brightness.
- **Advanced Sunrise and Delayed Sunset**: Atmospheric refraction can cause the Sun to appear earlier than it rises and set later than it does. The bending of light rays extends the visible duration of sunrise and sunset.
- **Rainbow Formation**: Atmospheric refraction, combined with dispersion and internal reflection, creates rainbows. Water droplets in the atmosphere act as prisms, bending and dispersing sunlight to create a spectrum of colours.

Twinkling of Stars

The twinkling of stars, also known as "stellar scintillation," is a phenomenon caused by atmospheric turbulence. Here's an explanation of why stars twinkle, and the factors involved:

What Causes Stars to Twinkle? (NCERT)



- **Atmospheric Turbulence**: The Earth's atmosphere is not a consistent medium. It consists of various layers with differing temperatures, densities, and wind patterns. These variations create turbulence, leading to irregularities in the path that light takes as it travels through the atmosphere.
- **Refraction Variability**: As starlight passes through the turbulent atmosphere, it is refracted, or bent, in different directions. Because the air density and temperature change frequently, the amount and direction of refraction vary, causing the light's apparent position to shift rapidly.
- **Fluctuations in Brightness**: The constant changes in refraction cause the light from a star to fluctuate in intensity and direction, leading to the appearance of twinkling or scintillation. This effect is more noticeable in stars because they are point sources of light.

Why Don't Planets Twinkle as Much? (NCERT)

- **Extended Apparent Size**: Unlike stars, which appear as tiny points of light, planets have a larger apparent size when observed from Earth. This larger apparent size means that light from different parts of a planet's disk is refracted in different ways, which tends to cancel out the twinkling effect.
- **Light Averaging**: Since the light from planets is effectively spread out over a larger area, the atmospheric turbulence has less impact on their overall brightness and position.

Where is Twinkling More Prominent?

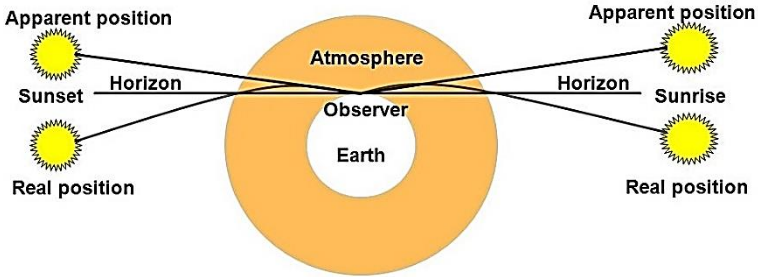
- **Closer to the Horizon**: The twinkling effect is more pronounced when a star is near the horizon because the light must travel through a thicker layer of the Earth's atmosphere. This longer journey through turbulent air results in more significant variations in refraction.
- **Atmospheric Conditions**: Conditions with greater turbulence, such as strong winds, temperature fluctuations, or unstable weather, tend to increase the twinkling effect.

Advance sunrise and delayed sunset

Advance sunrise and delayed sunset occur due to atmospheric refraction, where light bends as it passes through Earth's atmosphere. This bending allows us to see the Sun earlier in the morning (advance sunrise) and later in the evening (delayed sunset) than the actual geometrical positions would suggest.

Why It Happens

ii) Advance sunrise and delayed sunset :-



- **Atmospheric Layers**: The Earth's atmosphere has varying densities, causing light to bend toward the denser air.
- **Bending Toward Earth**: As light bends toward the Earth, it creates the illusion of the Sun rising earlier and setting later.

Effects

- **Early Sunrise**: Light from the Sun is visible before it crosses the horizon, leading to an earlier apparent sunrise.
- **Late Sunset**: The Sun's light is visible even after it has set, causing a delayed sunset.

Key Factors

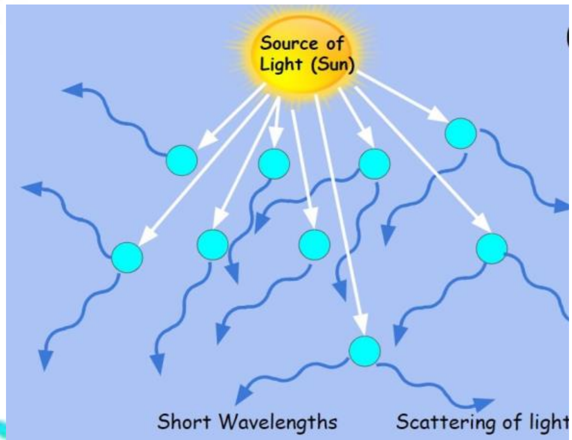
- **Atmospheric Conditions**: Refraction is influenced by temperature, pressure, and humidity.
- **Geographical Impact**: Higher latitudes often experience more pronounced effects.

Scattering of light

Scattering of light refers to the process by which small particles in the atmosphere diffuse incoming light in various directions. This phenomenon is responsible for several natural occurrences, including the **blue colour of the sky and the reddish hues during sunrise and sunset.**

Types of Scattering

- **Rayleigh Scattering**: This occurs when light interacts with particles much smaller than its wavelength, such as air molecules. It is most effective for shorter wavelengths (blue and violet), which is why the sky appears blue.
- **Mie Scattering**: Occurs when light interacts with larger particles like dust or water droplets. This scattering is less dependent on wavelength, often causing a white or grey appearance, such as in clouds or fog.



Blue Sky

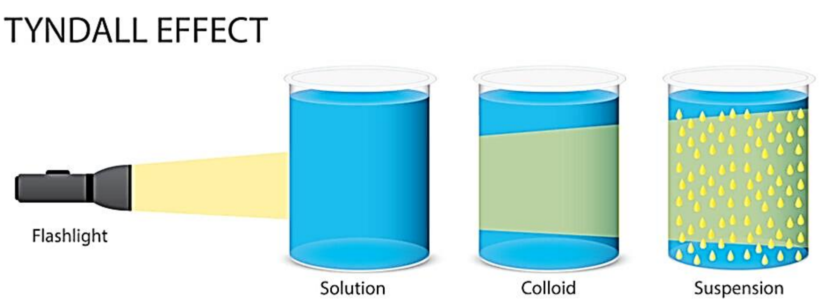
- **Rayleigh Scattering**: Shorter wavelengths (blue and violet) scatter more than longer wavelengths (red and orange). Since violet is absorbed more by the atmosphere and our eyes are more sensitive to blue, the sky looks blue.

Red Sunsets and Sunrises

- **Longer Path Through the Atmosphere**: During sunrise and sunset, the sunlight travels through more of the atmosphere, scattering the shorter wavelengths and leaving the longer wavelengths (red and orange). This results in the red and orange colours seen at these times.

Tyndall Effect

- **Visible Scattering**: When light passes through a colloid or suspension with larger particles, like a mist or smoke, it scatters and creates a visible beam, known as the Tyndall effect.



Question: Why is the colour of the clear Sky Blue?

Answer: The colour of the clear sky is blue due to Rayleigh scattering. This phenomenon occurs when sunlight passes through the Earth's atmosphere and is scattered by gas molecules like nitrogen and oxygen, which are much smaller than the wavelength of light. Shorter wavelengths, like blue and violet, scatter more effectively than longer wavelengths, like red and orange. However, our eyes are more sensitive to blue light, and some violet light is absorbed, which is why the sky predominantly appears blue.

Question: Why the Sun Appears Red or Orange?

Answer: The Sun appears orange or red at sunrise and sunset because of Rayleigh scattering. As the Sun is lower on the horizon during these times, its light travels through a thicker portion of Earth's atmosphere. Shorter wavelengths like blue and violet scatter away, leaving the longer wavelengths, such as red and orange, to dominate the sky. This gives the Sun and the sky near it a warm, reddish hue. Factors like air quality, atmospheric conditions, and the presence of clouds can influence the intensity and variation of these colours.

1. **Question**: What is the condition called when the eye lens becomes cloudy, leading to partial or complete loss of vision?
    - **Answer**: Cataract.
2. **Question**: Which defect of vision makes it difficult to see nearby objects, often requiring correction with convex lenses?
    - **Answer**: Hypermetropia, or far-sightedness.
3. **Question**: What is the role of the ciliary muscles in the human eye?
    - **Answer**: The ciliary muscles adjust the curvature of the lens to change its focal length, allowing the eye to focus on objects at different distances.
4. **Question**: What is the band of colours produced by the dispersion of white light through a prism called?
    - **Answer**: Spectrum.
5. **Question**: What causes the Sun to appear red during sunrise and sunset?
    - **Answer**: Rayleigh scattering, which disperses shorter wavelengths (like blue) and allows longer wavelengths (like red) to be more visible due to the longer atmospheric path.
6. **Question**: Which part of the eye is responsible for providing a clear focus by changing its curvature?
    - **Answer**: The lens.
7. **Question**: What happens to the eye's power of accommodation with age?
    - **Answer**: It decreases, resulting in presbyopia, a condition where the near point recedes, making it difficult to focus on nearby objects.
8. **Question**: What is the angle called when light passes through a prism and bends from its original path?
    - **Answer**: Angle of deviation.
9. **Question**: What is the role of the optic nerve in vision?
    - **Answer**: The optic nerve transmits visual information from the retina to the brain for processing.
10. **Question**: What is the condition where a person has both myopia and hypermetropia, often requiring bifocal lenses?
    - **Answer**: Mixed refractive defects.
11. **Question**: Which part of the eye is transparent and helps focus light onto the retina?
    - **Answer**: The cornea.
12. **Question**: What is the function of the vitreous humour in the eye?
    - **Answer**: It maintains the eye's shape and allows light to pass through to the retina.
13. **Question**: What is the term for the scattering of light by particles in the atmosphere, leading to phenomena like the blue sky?
    - **Answer**: Rayleigh scattering.
14. **Question**: What is the main cause of hypermetropia?

- **Answer**: A shorter-than-normal eyeball or insufficient curvature of the lens.

15. **Question**: Which condition involves excessive curvature of the eye lens or elongation of the eyeball, leading to near-sightedness?
    - **Answer**: Myopia.
16. **Question**: What does "least distance of distinct vision" mean?
    - **Answer**: The minimum distance at which objects can be seen clearly without eye strain, typically about 25 cm for a normal human eye.
17. **Question**: What is the function of the aqueous humour in the human eye?
    - **Answer**: It maintains eye pressure and provides nutrients to the lens and cornea.
18. **Question**: How can the refractive defects of vision be corrected surgically?
    - **Answer**: Through laser-assisted procedures like LASIK or PRK.
19. **Question**: What is the condition called when the eyeball becomes too long, causing the image to form in front of the retina?
    - **Answer**: Myopia, or near-sightedness.
20. **Question**: What are bifocal lenses, and why are they used?
    - **Answer**: Bifocal lenses have two distinct optical powers to correct both near-sightedness and far-sightedness in the same pair of glasses.
21. **Question**: Which condition causes difficulty in seeing distant objects, corrected with concave lenses?

- **Answer**: Myopia.

22. **Question**: What happens to light when it enters a prism, resulting in different colours?

- **Answer**: It is dispersed into a spectrum.

23. **Question**: What is the function of the pupil in the eye?

- **Answer**: It controls the amount of light entering the eye by adjusting its size.

24. **Question**: What causes stars to twinkle at night?

- **Answer**: Atmospheric refraction, where light is bent due to changes in air density, causing the star's light to fluctuate.

25. **Question**: What is the angle of refraction?

- **Answer**: The angle between the refracted ray and the normal.

26. **Question**: What causes a rainbow to form in the sky after rain?

- **Answer**: The dispersion and internal reflection of sunlight by water droplets, creating a spectrum of colours.

27. **Question**: What is the farthest point the eye can see clearly?

- **Answer**: Infinity.

28. **Question**: What is a common surgical correction method for cataracts?

- **Answer**: Cataract surgery, where the cloudy lens is replaced with an artificial one.

29. **Question**: What does the iris do?

- **Answer**: The iris controls the size of the pupil, regulating the amount of light entering the eye.

30. **Question**: Which colour of light bends the least when passing through a prism?

- **Answer**: Red.

Question: What is meant by power of accommodation of the eye? (NCERT)

Answer: The power of accommodation of the eye is its ability to adjust the focus by changing the shape of the lens to see objects clearly at different distances.

Question: **A person with a myopic eye cannot see objects beyond 1.2 m distinctly. What should be the type of the corrective lens used to restore proper vision. (NCERT)**

Answer: A person with a myopic eye (near-sightedness) sees nearby objects clearly but has difficulty seeing distant objects because the image is focused in front of the retina. To correct this, a concave lens (also known as a diverging lens) is used. This type of lens helps diverge light rays before they reach the eye, allowing them to be properly focused on the retina, thus restoring clear vision for distant objects.

Question: What is the far point and near point of the human eye with normal vision. (NCERT)

Answer: The far point of the human eye with normal vision is the farthest distance at which the eye can see objects clearly. For a normal eye, the far point is at infinity, allowing it to focus on distant objects.

The near point is the closest distance at which the eye can see objects clearly without strain. For a young adult with normal vision, the near point is about 25 centimetres from the eye.

Question: **A 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? (NCERT)**

Answer: If a student has difficulty reading the blackboard while sitting in the last row, the likely defect is myopia, also known as near-sightedness. In myopia, the far point is shorter than it should be, causing distant objects to appear blurred.

To correct this defect, **concave lenses** are used. These lenses help diverge the light rays so that they focus correctly on the retina, allowing the student to see distant objects, like a blackboard, more clearly.

Question: 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 (i) distant vision, and (ii) near vision? (NCERT)

Step 1: Given data.

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

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

Step 2: Formula used.

The focal length of the lens =$\frac{1}{p}$

Step 3: Focal length of the lens required for correcting distant vision=1/p

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

The focal length of the lens = 1/-5.5 = -0.181m

Step 4: Focal length of the lens required for correcting near vision=1/p

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

The focal length of the lens =1/P

=1/+1.5D=+0.667m

Hence, the focal length of lens for correcting distant and near vision are -0.181$m and$+0.667m respectively**.**

Question: 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? (NCERT)

Answer: A myopic person has a far point shorter than infinity, resulting in a difficulty focusing on distant objects. To correct this, a concave (diverging) lens is used to move the far point to infinity, allowing the person to focus on distant objects.

To find the power of the lens required, you can use the following relationship:

$$P=1/f$$

where f is the focal length of the lens in meters, and P is the lens's power in dioptres.

For a myopic person with a far point of 80 cm (0.8 meters):

$$P=1/-0.8\approx-1.25 \text{ dioptres}$$

Since the lens power is negative, it confirms that a concave lens is required. The magnitude of the power gives the strength of the correction.

Thus, the nature of the lens required to correct this problem is a concave lens with a power of approximately -**1.25 dioptres.**

Question: Make a diagram to show how hypermetropia is corrected. The near point of a hypermetropic eye is 1 m. What is the power of the lens required to correct this defect? Assume that the near point of the normal eye is 25 cm.

Answer: To correct hypermetropia (farsightedness), a convex lens is used. The convex lens creates a virtual image of a nearby object at the near point of vision of a person suffering from hypermetropia, allowing the light to focus properly on the retina.

Given:

- Object distance (u): −25 cm.

- Image distance (v): −100 cm (the near point for a hypermetropic person)
- Near point for a normal eye: 25 cm
- Near point for the person with hypermetropia: 1 meter

Using the lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Substitute u= -25cm and v=−100 cm

$$\frac{1}{f} = \frac{1}{-100} - \frac{1}{-25} = \frac{-1+4}{100} = \frac{3}{100}. v = \frac{100}{3} = +0.33cm$$

To get the power of the lens, we use:

$$P = \frac{1}{f} = \frac{1}{0.33} = +3D$$

Thus, a convex lens of power +3.0 dioptres is required to correct hypermetropia for this case.

Queston: Why is a normal eye not able to see clearly the objects placed closer than 25 cm? (NCERT)

Answer: A normal eye can't see clearly objects placed closer than 25 cm because this distance is the limit of the eye's accommodation, known as the "near point." Beyond this point, the lens can't curve enough to focus light onto the retina, resulting in blurred vision.

Question: **What happens to the image distance in the eye when we increase the distance of an object from the eye?**

Answer: We increase the distance of an object from the eye, the image distance in the eye remains the same. This is because the eye’s power of accommodation adjusts the focal length of the eye lens to compensate for the change in object distance, ensuring that the image continues to form on the retina.

Question: Why does the sky appear dark instead of blue to an astronaut? (NCERT)

Answer: The sky appears dark instead of blue to an astronaut because space lacks Earth’s atmosphere. On Earth, the blue colour of the sky results from Rayleigh scattering, were atmospheric molecules scatter sunlight, especially the shorter blue wavelengths. However, in space, there is no atmosphere to scatter light, which is why the sky appears dark to astronauts when they travel beyond our planet.

Question: Why does the Sun appear reddish early in the morning? (NCERT)

Answer: In the early morning, the Sun appears reddish due to a phenomenon called atmospheric scattering. When sunlight travels through the Earth’s atmosphere, most of the blue light (which has a shorter wavelength) gets scattered by dust particles. As a result, only red light (with a longer wavelength) reaches our eyes during sunrise. The Sun and the sky around it appear red early in the morning because of this effect. Interestingly, an astronaut on the Moon wouldn’t observe this phenomenon since there is no atmosphere on the Moon to scatter.