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The Human Eye and the Colourful World Class 10 Notes | CBSE

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The Human Eye and the Colourful World Class 10 Notes | CBSE Chapter 10 Science

The Human Eye and the Colourful World is Chapter 10 of CBSE Class 10 Science. This chapter explains how the human eye works as an optical device, common vision defects and their corrections, and fascinating optical phenomena like the formation of rainbows, the blue colour of the sky, and why the sun appears reddish at sunrise and sunset.

This chapter carries 3–5 marks in board exams. The structure of the eye, defects of vision (myopia and hypermetropia), and atmospheric refraction/scattering of light are the most frequently tested topics.

Key Concepts

1. The Human Eye

The human eye is a natural optical instrument that works like a camera. It uses a convex lens system to form a real, inverted image on the retina.

Structure of the Human Eye

Part	Function
Cornea	Transparent front surface; most of the refraction (bending) of light happens here
Iris	Coloured part of the eye; controls the size of the pupil
Pupil	Black opening in the iris; controls how much light enters the eye. Dilates in dim light, constricts in bright light
Crystalline lens	Transparent, flexible, convex lens behind the pupil; fine-focuses light onto the retina by changing its shape
Ciliary muscles	Hold the lens and change its shape (curvature) to focus on near or far objects
Retina	Light-sensitive screen at the back of the eye; contains rod cells (dim light) and cone cells (colour vision)
Optic nerve	Carries electrical signals from the retina to the brain for image interpretation
Aqueous humour	Clear fluid between cornea and lens
Vitreous humour	Jelly-like substance filling the space between lens and retina

How the Eye Forms an Image

1. Light enters through the cornea → most refraction occurs here
2. Passes through the pupil (controlled by iris)
3. The crystalline lens further refracts the light to form a sharp image on the retina
4. The retina converts the light into electrical nerve impulses
5. The optic nerve sends these impulses to the brain, which interprets them as the image we “see”

The image on the retina is **real and inverted** — the brain flips it to appear upright.

2. Power of Accommodation

The ability of the eye lens to adjust its focal length to focus on objects at different distances is called the **power of accommodation**.

- **Looking at distant objects:** Ciliary muscles relax → lens becomes thin → focal length increases → distant objects are focused on retina
- **Looking at nearby objects:** Ciliary muscles contract → lens becomes thick (more curved) → focal length decreases → nearby objects are focused on retina

Near Point and Far Point

Term	Definition	For a normal eye
Near point (least distance of distinct vision)	Closest distance at which the eye can see clearly	25 cm (denoted as D)
Far point	Farthest distance at which the eye can see clearly	Infinity (∞)

3. Defects of Vision and Their Correction

a) Myopia (Short-sightedness / Near-sightedness)

Problem: Can see nearby objects clearly, but distant objects appear blurry.

Cause:

- Eyeball is too long (elongated), OR
- Lens is too thick (too much curvature) → too much converging power

What happens: Image of distant objects forms **in front of the retina** instead of on it.

Correction: Use a **concave lens** (diverging lens) of appropriate power. The concave lens diverges the light slightly before it enters the eye, so the image shifts back onto the retina.

b) Hypermetropia (Long-sightedness / Far-sightedness)

Problem: Can see distant objects clearly, but nearby objects appear blurry.

Cause:

- Eyeball is too short, OR
- Lens is too thin → not enough converging power

What happens: Image of nearby objects forms **behind the retina**.

Correction: Use a **convex lens** (converging lens) of appropriate power. The convex lens adds extra converging power so the image forms on the retina.

c) Presbyopia

Problem: Difficulty focusing on both nearby and distant objects (common in old age).

Cause: Ciliary muscles weaken with age → lens loses flexibility → power of accommodation decreases.

Correction: **Bifocal lenses** — upper part is concave (for distant vision), lower part is convex (for near vision).

Comparison of Defects

Feature	Myopia	Hypermetropia
Can see clearly	Near objects	Far objects
Cannot see clearly	Far objects	Near objects
Image forms	In front of retina	Behind retina
Eyeball	Too long	Too short
Correction	Concave lens (–ve power)	Convex lens (+ve power)

4. Refraction of Light Through a Prism

When white light passes through a glass prism, it splits into its component colours. This is called **dispersion of light**.

The spectrum of white light: VIBGYOR

- **V**iolet, **I**ndigo, **B**lue, **G**reen, **Y**ellow, **O**range, **R**ed

Why does dispersion happen? White light is made up of 7 colours. Each colour has a different wavelength, and therefore each colour bends by a different amount when passing through the prism:

- **Violet** has the shortest wavelength → bends the **most**
- **Red** has the longest wavelength → bends the **least**

Recombination: If a second inverted prism is placed after the first, the 7 colours recombine to form white light again. (Newton's experiment)

5. Atmospheric Refraction

The atmosphere has layers of air at different temperatures and densities. Light bends as it passes through these layers — this is **atmospheric refraction**.

Phenomena Caused by Atmospheric Refraction

- **Stars twinkling:** Starlight passes through many layers of atmosphere with varying densities. The continuous bending makes the star appear to shift position slightly — causing it to twinkle. Planets don't twinkle because they are much closer and appear as extended sources (not point sources).
 - **Early sunrise and delayed sunset:** The sun is visible about 2 minutes before actual sunrise and 2 minutes after actual sunset. Light from the sun below the horizon gets refracted downward by the atmosphere, making the sun appear above the horizon when it is actually below it. This adds about 4 minutes of daylight each day.
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6. Scattering of Light

When light hits tiny particles (smaller than the wavelength of light), it gets scattered in different directions. This is called **Rayleigh scattering**.

Key rule: Shorter wavelengths (blue, violet) are scattered much more than longer wavelengths (red, orange).

Why is the Sky Blue?

Sunlight contains all colours. When it enters the atmosphere, the tiny air molecules (N_2 , O_2) scatter shorter wavelengths (blue and violet) much more than longer wavelengths (red). Although violet is scattered even more than blue, our eyes are more sensitive to blue, and some violet is absorbed by the upper atmosphere. So we see a **blue sky**.

At higher altitudes (e.g., from space), the sky appears dark/black because there are no molecules to scatter light.

Why Does the Sun Appear Reddish at Sunrise and Sunset?

At sunrise and sunset, sunlight has to travel through a much longer path through the atmosphere (compared to noon). Most of the blue and shorter wavelengths get scattered away during this long journey. Only red and orange light (longer wavelengths) reach our eyes — so the sun and sky near the horizon appear reddish.

Why Does the Sun Appear White at Noon?

At noon, sunlight travels through a shorter path through the atmosphere. Very little scattering occurs — all colours reach our eyes almost equally, making the sun appear white (or slightly yellowish).

Tyndall Effect

The **Tyndall effect** is the scattering of light by colloidal particles (larger than molecules but smaller than visible).

Examples:

- Beam of light visible in a dusty room
 - Headlights visible in fog
 - Blue colour of smoke from a mosquito coil (tiny particles scatter blue light)
-

7. Rainbow Formation

A **rainbow** is formed by the dispersion of sunlight by tiny water droplets in the atmosphere.

Process: Sunlight enters a water droplet → refracts (bends) → disperses into 7 colours → reflects internally off the back of the droplet → refracts again as it exits → reaches the observer's eyes.

A rainbow is always seen:

- Opposite to the sun (sun behind you, rainbow in front)
 - After rain or near a waterfall/fountain
 - In a semicircular arc
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Important Definitions

Term	Definition
Power of accommodation	Ability of the eye lens to change its focal length to focus on objects at different distances
Near point	Closest distance at which the eye can focus clearly (25 cm for a normal eye)
Far point	Farthest point the eye can see clearly (infinity for a normal eye)
Myopia	Defect where distant objects are blurry; image forms in front of retina
Hypermetropia	Defect where nearby objects are blurry; image forms behind retina
Presbyopia	Age-related loss of accommodation; difficulty seeing both near and far
Dispersion	Splitting of white light into its component colours by a prism
Spectrum	Band of seven colours obtained by dispersion of white light (VIBGYOR)
Scattering of light	Deflection of light by tiny particles in all directions
Tyndall effect	Scattering of light by colloidal particles, making a beam of light visible

Solved Examples (NCERT-Based)

Example 1

A person cannot see objects clearly beyond 50 cm. What type of defect does the person have? What lens is needed, and what will be its power?

Answer: The person has **myopia** (short-sightedness) — the far point is 50 cm instead of infinity. A concave lens is needed. The lens should form a virtual image at 50 cm (the person's far point) for objects at infinity.

Using lens formula: $1/v - 1/u = 1/f$

For object at infinity: $u = -\infty$, $v = -50$ cm (virtual image, same side as object)

$$1/(-50) - 1/(-\infty) = 1/f \rightarrow 1/f = -1/50$$

$$f = -50 \text{ cm} = -0.5 \text{ m}$$

$$\text{Power} = 1/f = 1/(-0.5) = \mathbf{-2 \text{ D}}$$

Example 2

Why do stars twinkle but planets do not?

Answer: Stars are extremely far away and appear as point sources of light. As their light passes through the atmosphere (which has layers of varying density and temperature), the light is continuously refracted, causing the apparent position and brightness to change rapidly — we see this as twinkling. Planets, being much closer, appear as extended sources (not point sources). The variations in refraction from different parts of the planet's disc average out, so planets appear steady and do not twinkle.

Example 3

Why is the colour of the clear sky blue?

Answer: The molecules of air (N_2 , O_2) are very small compared to the wavelength of visible light. According to Rayleigh's law of scattering, the amount of scattering is inversely proportional to the fourth power of wavelength ($1/\lambda^4$). Since blue light has a shorter wavelength than red, it is scattered about 10 times more than red light. This scattered blue light reaches our eyes from all directions in the sky, making the sky appear blue.

Example 4

A person needs a lens of power +2.5 D for correction. What defect does the person have?

Answer: The person has **hypermetropia** (far-sightedness). A positive power indicates a convex lens, which is used to correct hypermetropia. Focal length: $f = 1/P = 1/2.5 = 0.4 \text{ m} = 40 \text{ cm}$.

Important Questions for Board Exams

1-Mark Questions

1. What is the near point of a normal human eye?
2. What type of lens is used to correct myopia?
3. Why does the sun appear reddish at sunrise?
4. What is the function of the iris in the human eye?
5. Name the phenomenon responsible for the blue colour of the sky.

2-Mark Questions

1. What is the power of accommodation? Explain briefly.
2. Distinguish between myopia and hypermetropia.
3. What is dispersion of light? Name the colours in the spectrum of white light.
4. Why do stars twinkle?
5. What is the Tyndall effect? Give one example.

3-Mark Questions

1. With the help of ray diagrams, explain myopia and how it is corrected.
2. Draw a labelled diagram of the human eye. Explain how the eye adjusts to see nearby and distant objects.
3. Explain why the sun appears reddish at sunrise and sunset but white at noon.
4. What is atmospheric refraction? Explain how it causes the early sunrise and delayed sunset.
5. Explain the formation of a rainbow with a diagram.

5-Mark Questions

1. What are the common defects of vision? Explain each defect, its cause, and correction with ray diagrams.
 2. Explain the phenomenon of dispersion of light through a prism. Why does the sky appear blue? Why does the sun appear red at sunset?
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Quick Revision Points

- Eye: cornea (max refraction) → pupil (light control) → lens (fine focus) → retina (image) → optic nerve → brain
 - Power of accommodation: lens changes shape to focus near/far objects
 - Near point: 25 cm; Far point: infinity (for normal eye)
 - Myopia: can't see far; image in front of retina; corrected by concave lens
 - Hypermetropia: can't see near; image behind retina; corrected by convex lens
 - Presbyopia: old age; both near and far affected; corrected by bifocal lens
 - Dispersion: white light → VIBGYOR through prism; violet bends most, red bends least
 - Blue sky: short wavelengths (blue) scattered more by air molecules (Rayleigh scattering)
 - Red sun at sunrise/sunset: long path through atmosphere → blue scattered away → red reaches us
 - White sun at noon: short atmospheric path → little scattering → all colours reach us
 - Stars twinkle (point source, atmospheric refraction); planets don't (extended source)
 - Tyndall effect: scattering by colloidal particles (dust, fog)
 - Rainbow: sunlight + water droplets → refraction + dispersion + internal reflection
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Previous Chapter: Chapter 9 — Light: Reflection and Refraction

Next Chapter: Chapter 11 — Electricity



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