EDUVISTA BOARD MASTER NOTES • CLASS 10 SCIENCE

CHAPTER 10: THE HUMAN EYE & THE COLOURFUL WORLD

Complete NCERT Textbook Coverage + Last 10 Years PYQs + Competency Questions + Memory Hacks

100% NCERT FAITHFUL | CBSE BOARD EXAM READY | PASTEL VISUAL DESIGN | TOPPER ANSWER WRITING TIPS | ZERO OMISSION STANDARD

CHAPTER EXAM ANALYSIS & WEIGHTAGE

- **CBSE Board Weightage:** 5 to 7 Marks (Physics Section)
- **Expected Question Types:** 1 MCQ/AR, 1 Numerical (Defect Power calculation), 1 Diagrammatic/Reasoning Question (Prism/ Scattering)
- **Highest Frequency Topics:** Myopia & Hypermetropia Correction Ray Diagrams, Twinkling of Stars, Advance Sunrise/Delayed Sunset, Rainbow Formation.

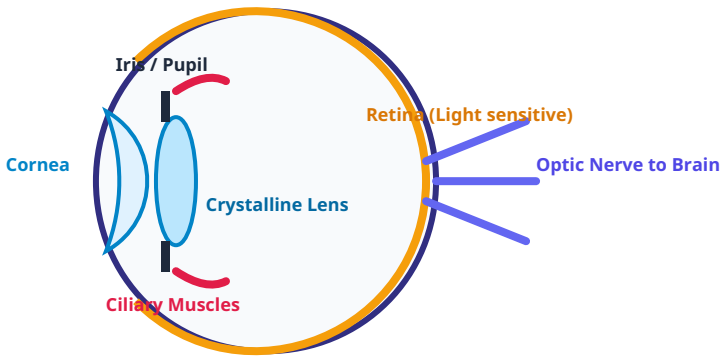
RAPID FORMULA & UNIT CHEAT SHEET

- **Power of Lens (P):** $P = \frac{1}{f(\text{in meters})} = \frac{100}{f(\text{in cm})}$ (Unit: Dioptre, D)
- **Myopia Correction Focal Length:** $f = -d$ (where d is far point distance)
- **Hypermetropia Correction Focal Length:** $f = \frac{d \cdot D'}{d - D'}$ (where $D'=25\text{ cm}$, $d=$ near point)
- **Rayleigh Scattering:** Scattering Intensity $I \propto \frac{1}{\lambda^4}$

1. THE HUMAN EYE (Structure & Function)

NCERT Section 10.1 • An Optical Instrument created by Nature

The human eye is one of the most valuable and sensitive sense organs. It works like a camera, forming a real, inverted image of objects on a light-sensitive screen called the **Retina**. The eyeball is approximately spherical with a diameter of about **2.3 cm**.



Eye Structure	Anatomical Description & Location	Key Functional Role
1. Cornea	Thin, transparent membrane forming the front bulge of the eyeball.	Refracts maximum light entering the eye (~80% of total refraction).
2. Iris	Dark muscular diaphragm situated behind the cornea. Gives eye its distinct color.	Controls the size of the pupil to adjust light entry.
3. Pupil	A central aperture/hole in the iris. Appears black because light does not reflect back out.	Regulates and controls the intensity of light entering the eye lens.
4. Crystalline Lens	Double convex, flexible lens composed of fibrous, jelly-like protein material.	Provides fine adjustment of focal length to focus image sharply on retina.
5. Ciliary Muscles	Muscular ring holding the eye lens in position.	Modifies lens curvature & focal length (Power of Accommodation).
6. Retina	Delicate inner back membrane containing millions of photoreceptor cells (Rods & Cones).	Acts as light-sensitive screen; converts light into electrical signals.
7. Optic Nerve	Nerve bundle connecting retina to the brain.	Transmits electrical signals from retina to brain for perception.

1.1 Power of Accommodation (NCERT Section 10.1.1)

DEFINITION: POWER OF ACCOMMODATION

The ability of the eye lens to adjust its focal length using ciliary muscles to see both distant and nearby objects clearly is called **Accommodation**.

A. Viewing Distant Objects (Far Vision)

- **Ciliary Muscles:** Relaxed
- **Eye Lens:** Becomes Thin
- **Focal Length (f):** Increases to Maximum
- **Far Point of Normal Eye: Infinity (∞)**

B. Viewing Nearby Objects (Near Vision)

- **Ciliary Muscles:** Contract
- **Eye Lens:** Becomes Thick & Curved
- **Focal Length (f):** Decreases
- **Near Point / Least Distance: 25 cm**

EXAM TRAP & MOST COMMON MISTAKE

WRONG
"When looking at nearby objects, ciliary muscles relax to make the lens thicker."

RIGHT
"When looking at nearby objects, ciliary muscles **CONTRACT**, making the lens thicker and decreasing focal length."

2. DEFECTS OF VISION AND THEIR CORRECTION

NCERT Section 10.2 • Myopia, Hypermetropia, Presbyopia & Solved Numericals

Due to refractive errors, aging, or muscular weakness, the eye loses its power of accommodation. The image is no longer focused sharply on the retina. The three main refractive defects are **Myopia**, **Hypermetropia**, and **Presbyopia**.

1. MYOPIA (NEAR-SIGHTEDNESS) MOST REPEATED PYQ (LAST 10 YRS: 14 TIMES)

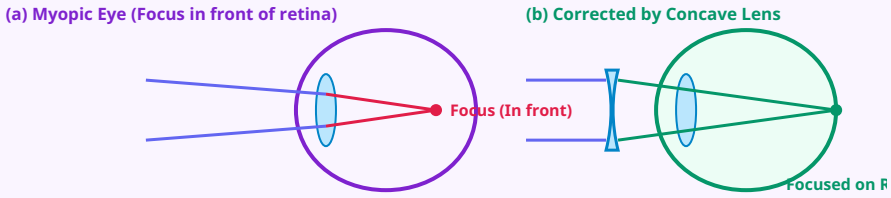
Symptom: A person can see nearby objects clearly but **cannot see distant objects distinctly**. The far point shifts from infinity to a distance less than infinity ($d < \infty$).

Causes:

- 1. Excessive curvature of the eye lens (lens becomes too thick).
- 2. Elongation of the eyeball (distance between lens and retina increases).

Image Formation: Image of a distant object is formed **in front of the retina** (not on the retina).

Correction: Using spectacles with a **Concave Lens** of suitable power/focal length ($f < 0$). The concave lens diverges incoming rays so they appear to come from the defective far point O.



2. HYPERMETROPIA (FAR-SIGHTEDNESS) CBSE BOARD FAVORITE

Symptom: A person can see distant objects clearly but **cannot see nearby objects distinctly**. The near point shifts beyond 25 cm (e.g. 50 cm, 1 m).

Causes:

- 1. Focal length of the eye lens is too long (lens too thin).
- 2. Eyeball has become too small (distance between lens and retina is shorter).

Image Formation: Image of a nearby object (at 25 cm) is formed **behind the retina**.

Correction: Using spectacles with a **Convex Lens** of suitable power ($P > 0, f > 0$). The convex lens converges incoming rays so they focus right on the retina.

3. PRESBYOPIA (OLD-AGE PRESBYOPIA)

- **Cause:** Gradual weakening of ciliary muscles and diminishing flexibility of crystalline lens due to aging.
- **Effect:** Near point recedes away; person finds it difficult to read comfortably.
- **Correction:** Bifocal lenses (Upper part: Concave for distant vision; Lower part: Convex for reading).

4. CATARACT & CORNEAL DONATION

- **Cataract:** Crystalline lens becomes cloudy/milky in old age, causing partial or total vision loss. Corrected via **Cataract Surgery**.
- **Corneal Blindness:** ~4.5 million people in India can be cured through corneal transplantation. 1 donor pair can cure 2 blind persons.

STEP-BY-STEP BOARD NUMERICAL MASTERCLASS

Example 1 (NCERT Intext Question): A person with a myopic eye cannot see objects beyond **1.2 m** distinctly. What should be the type and power of the lens used to restore proper vision?

Solution:

- For myopic eye correction, a distant object at infinity ($u = -\infty$) must form a virtual image at the person's far point ($v = -1.2 ext{ m} = -120 ext{ cm}$).
- By Lens Formula: $□rac{1}{f} = □rac{1}{v} - □rac{1}{u} \implies □rac{1}{f} = □rac{1}{-1.2} - □rac{1}{-\infty} = -□rac{1}{1.2} ext{ m}^{-1}$
- Focal Length $f = -1.2 ext{ m}$ (Negative sign indicates **Concave Lens**).
- Power $P = □rac{1}{f} = □rac{1}{-1.2} = \mathbf{-0.83 ext{ D}}$.

Example 2 (Board PYQ 3 Marks): The near point of a hypermetropic eye is **1 m (100 cm)**. Find the power of the lens required to read a book placed at **25 cm**.

Solution:

- Object distance $u = -25 ext{ cm} = -0.25 ext{ m}$ (Standard normal near point).
- Defective image distance $v = -100 ext{ cm} = -1.0 ext{ m}$ (Given defective near point).
- Lens Formula: $□rac{1}{f} = □rac{1}{v} - □rac{1}{u} = □rac{1}{-1.0} - □rac{1}{-0.25} = -1 + 4 = \mathbf{+3.0 ext{ m}^{-1}}$
- Focal Length $f = +□rac{1}{3} ext{ m} = +0.333 ext{ m} = \mathbf{+33.3 ext{ cm}}$.
- Power $P = □rac{1}{f} = \mathbf{+3.0 ext{ D}}$ (Positive sign indicates **Convex Lens**).

3. REFRACTION & DISPERSION OF LIGHT THROUGH A PRISM

NCERT Sections 10.3 & 10.4 • Prism Geometry, Spectrum (VIBGYOR) & Rainbow Formation

A. TRIANGULAR GLASS PRISM GEOMETRY

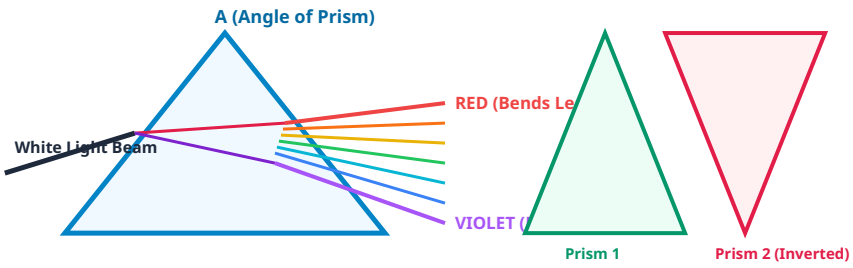
A glass prism has **two triangular bases** and **three rectangular lateral surfaces** inclined to each other. The angle between its two lateral faces is called the **Angle of Prism (A)**.

- **PE:** Incident Ray | **EF:** Refracted Ray | **FS:** Emergent Ray
- **$ngle i$:** Angle of Incidence | **$ngle r$:** Angle of Refraction | **$ngle e$:** Angle of Emergence
- **$ngle D$: Angle of Deviation** (Angle between produced incident ray & emergent ray).
- **Formula:** $\mathbf{ngle i + ngle e = ngle A + ngle D}$

B. DISPERSION & VIBGYOR SPECTRUM

The splitting of white light into its component colors upon passing through a transparent medium (prism) is called **Dispersion**.

- **Order of Spectrum: V-I-B-G-Y-O-R** (Violet, Indigo, Blue, Green, Yellow, Orange, Red).
- **Cause:** Different colors of light have different speeds in glass. Red light has longest wavelength (λ), travels fastest, and bends **LEAST**. Violet light has shortest wavelength, travels slowest, and bends **MOST**.



RECOMBINATION & RAINBOW FORMATION (NCERT ACTIVITY 10.2 & SECTION 10.4)

1. Recombination of Spectrum: Sir Isaac Newton showed that by placing a second identical glass prism in an **inverted position** relative to the first prism, all colors recombine to yield **White Light again**.

2. Rainbow Formation Steps: A rainbow is a natural spectrum caused by dispersion of sunlight by tiny water droplets in atmosphere after rain. The droplets act like small prisms.

- **Step I (Refraction + Dispersion):** Sunlight enters water droplet and refracts & splits into colors.
- **Step II (Internal Reflection):** Light hits inner back surface of droplet and undergoes **Internal Reflection**.
- **Step III (Refraction):** Light refracts again when coming out of the droplet into air, reaching observer's eye.

4. ATMOSPHERIC REFRACTION

NCERT Section 10.5 • Twinkling of Stars & Advance Sunrise/Delayed Sunset

Atmospheric Refraction is the refraction of light caused by Earth's atmosphere having air layers of varying optical densities (cooler dense air below, warmer rarer air above).

A. TWINKLING OF STARS VS. PLANETS

Why Stars Twinkle:

- Stars are very distant and act as **point sources of light**.
- Atmospheric mobility causes refractive index of air layers to continuously fluctuate.
- Apparent position and intensity of light from the star keeps changing rapidly, giving a **twinkling effect**.

Why Planets Do NOT Twinkle:

- Planets are much closer to Earth and act as **extended sources** (collection of point sources).
- Total variation in light entering our eye from all point sources averages to zero, nullifying twinkling.

B. ADVANCE SUNRISE & DELAYED SUNSET

Mechanism:

- Sun is visible to us about **2 minutes before actual sunrise** and **2 minutes after actual sunset**.
- **Total Time Gain: 4 Minutes per day**.
- **Cause:** Sunlight entering Earth's atmosphere refracts downwards towards the normal because optical density increases towards Earth's surface.
- The Sun appears slightly raised above the horizon when it is actually below the horizon.

5. SCATTERING OF LIGHT

NCERT Section 10.6 • Tyndall Effect, Blue Sky & Red Sunrise/Sunset

RAYLEIGH SCATTERING RULE & TYNDALL EFFECT

1. Tyndall Effect: The phenomenon of scattering of light beam by colloidal particles in its path, making the path of light visible. Examples: Sunlight passing through dense forest canopy, smoke-filled room.

2. Rayleigh Scattering Rule: Intensity of scattered light is inversely proportional to fourth power of wavelength ($I \propto \frac{1}{\lambda^4}$). Shorter wavelengths (Blue/Violet) are scattered much more strongly than longer wavelengths (Red).

Phenomenon	Scientific Explanation	Key Exam Trigger Words
Clear Sky appears BLUE	Air molecules (N_2, O_2) have sizes smaller than wavelength of visible light. They scatter shorter wavelength blue light much more strongly than red light.	Fine molecules, Selective scattering, Shorter wavelength $\lambda_{blue} < \lambda_{red}$.
Sun appears RED at Sunrise & Sunset	Sunlight travels a **longer distance** through thick atmospheric layers. Most blue/short wavelengths are scattered away. Only longest red wavelength reaches our eyes.	Thicker atmosphere, Longer distance, Blue scattered away, Red reaches eye.
Sky appears DARK to Astronauts	At high altitudes, there is no atmosphere and no particles to cause light scattering.	No atmosphere, No scattering, Dark outer space.
DANGER Signals are RED	Red color has the longest wavelength among visible colors, so it is **scattered least** by fog/smoke and is visible from maximum distance.	Longest wavelength, Least scattering, Maximum visibility through fog.

6. SOLVED CBSE BOARD QUESTION BANK & PYQs

NCERT In-text, Exercise Solutions, Assertion-Reason & Competency Questions

PART A: MULTIPLE CHOICE & ASSERTION-REASON QUESTIONS

Q1 (NCERT Exercise): The human eye forms the image of an object at its:
(a) cornea (b) iris (c) pupil **(d) retina**
Answer: (d) Retina. Retinal cells convert light into electrical signals.

Q2 (NCERT Exercise): The least distance of distinct vision for a young adult with normal vision is about:
(a) 25 m (b) 2.5 cm **(c) 25 cm** (d) 2.5 m
Answer: (c) 25 cm. Called the Near Point of normal eye.

Q3 (NCERT Exercise): The change in focal length of an eye lens is caused by the action of the:
(a) pupil (b) retina **(c) ciliary muscles** (d) iris
Answer: (c) Ciliary muscles. They alter lens curvature for accommodation.

Q4 (Assertion-Reasoning Board Pattern):
Assertion (A): Danger signals installed at top of tall buildings are red in color.
Reason (R): Red light is scattered the most by smoke or fog.
(a) Both A and R are true and R is correct explanation.
(b) Both A and R are true but R is NOT correct explanation.
(c) A is true but R is false.
(d) A is false but R is true.
Answer: (c) A is true but R is false. Red light has longest wavelength and is scattered the **LEAST** (not most) by fog.

PART B: SHORT & LONG ANSWER TOPPER SOLUTIONS

Q5 (NCERT Ex Q5): 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**. Calculate the focal length of the lens required for correcting (i) distant vision, and (ii) near vision.

Topper Solution:

- **(i) Distant Vision Correction:**
  Given Power $P_1 = -5.5 ext{ D}$
  Focal Length $f_1 = rac{1}{P_1} = rac{1}{-5.5} ext{ m} = -rac{10}{55} ext{ m} = \mathbf{-0.1818 ext{ m}} = \mathbf{-18.18 ext{ cm}}$. (Concave Lens)
- **(ii) Near Vision Correction:**
  Given Power $P_2 = +1.5 ext{ D}$
  Focal Length $f_2 = rac{1}{P_2} = rac{1}{+1.5} ext{ m} = rac{10}{15} ext{ m} = \mathbf{+0.667 ext{ m}} = \mathbf{+66.67 ext{ cm}}$. (Convex Lens)

Q6 (NCERT Ex Q10): Why does the Sun appear reddish early in the morning?

Topper Solution:

1. At sunrise, the Sun is near the horizon, so sunlight travels a longer distance through Earth's atmospheric layers.
2. Shorter wavelengths of light (blue and violet) are scattered away by air particles in all directions.
3. Light of longer wavelengths (red) suffers minimal scattering and reaches our eyes directly, making the Sun appear reddish.

Q7 (NCERT Ex Q11): Why does the sky appear dark instead of blue to an astronaut in space?

Topper Solution:

1. Outer space has no atmosphere and no atmospheric gas molecules or dust particles.
2. As a result, no scattering of light takes place in outer space.
3. Since no scattered light reaches the astronaut's eyes, the sky appears completely dark/black.

PART C: CBSE COMPETENCY / CASE-BASED QUESTION (4 MARKS)

Case Scenario: Rohan, a Class 10 student, finds it difficult to read the blackboard while sitting on the last bench in his classroom. However, he can comfortably read his textbook kept at 25 cm.

Questions:

1. Name the eye defect Rohan is suffering from.
2. List two potential anatomical causes of this defect.
3. Draw a ray diagram showing how a lens can correct Rohan's vision.
4. If Rohan's far point is 2 meters, calculate the power of the spectacle lens he requires.

Topper Answers:

- **1. Defect: Myopia** (Near-sightedness).
- **2. Causes:** (i) Excessive curvature of the eye lens, or (ii) Elongation of the eyeball.
- **3. Ray Diagram:** Concave lens placed in front of eye diverging rays to retina.
- **4. Power Calculation:** $u = -\infty$, $v = -2 ext{ m}$. Lens formula gives $f = -2 ext{ m}$. Power $P = rac{1}{-2} = \mathbf{-0.5 ext{ D}}$ (Concave Lens).

7. EDUVISTA 5-MINUTE MASTER REVISION & CHECKLIST

Top 30 Facts, Top 10 Traps & Official Board Readiness Certificate

TOP 10 HIGH-YIELD EXAM FACTS

1. Diameter of normal human eye = **2.3 cm**.
2. Near point of normal eye = **25 cm**; Far point = **Infinity**.
3. Myopia is corrected by **Concave Lens** ($P < 0$).
4. Hypermetropia is corrected by **Convex Lens** ($P > 0$).
5. Presbyopia is corrected by **Bifocal Lenses**.
6. Refraction angle relation in prism: $i + e = A + D$.
7. In spectrum, **Red light bends LEAST**, **Violet bends MOST**.
8. Rainbow involves: Refraction $ ightarrow$ Internal Reflection $ ightarrow$ Refraction.
9. Atmospheric time gain at sunrise/sunset = **4 minutes total**.
10. Rayleigh scattering intensity: $I \propto rac{1}{\lambda^4}$.

TOP 5 EXAM TRAPS TO AVOID

1. **Trap 1:** Do NOT write "Total Internal Reflection" for Rainbow unless specified; NCERT specifically terms it "Internal Reflection".
2. **Trap 2:** Never forget negative sign for concave lens focal length ($f < 0$).
3. **Trap 3:** Always convert focal length to **meters** before calculating Power ($P = 1/f$).
4. **Trap 4:** Do NOT confuse Ciliary muscle relaxation (far vision) with contraction (near vision).
5. **Trap 5:** Planets don't twinkle because they are *extended sources*, not because they have their own light.

NIGHT BEFORE EXAM 15-MINUTE CHECKLIST

- **Human Eye Labelled Diagram Memory Practice**
- **Myopia & Hypermetropia Correction Ray Diagrams**
- **Prism Refraction Angle Labeling (i, r, e, A, D)**
- **Power of Defect Correction Numericals Practice**

EDUVISTA BOARD READY CERTIFICATE

CLASS 10 SCIENCE • CHAPTER 10: THE HUMAN EYE & THE COLOURFUL WORLD

This certifies that the student has completed the full NCERT chapter review, visual diagrams, step-by-step numerical practice, last 10 years PYQs, and competency board exam questions.

100% NCERT Covered **10 Years PYQs Solved** **Competency Ready** **Board Revision Complete**

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