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Class 10 · Science · Chapter 10

The Human Eye and the Colourful World

Complete notes — every lesson, figure, activity, revision sheet and summary

Bihar Board · NCERT · CBSE

In this PDF

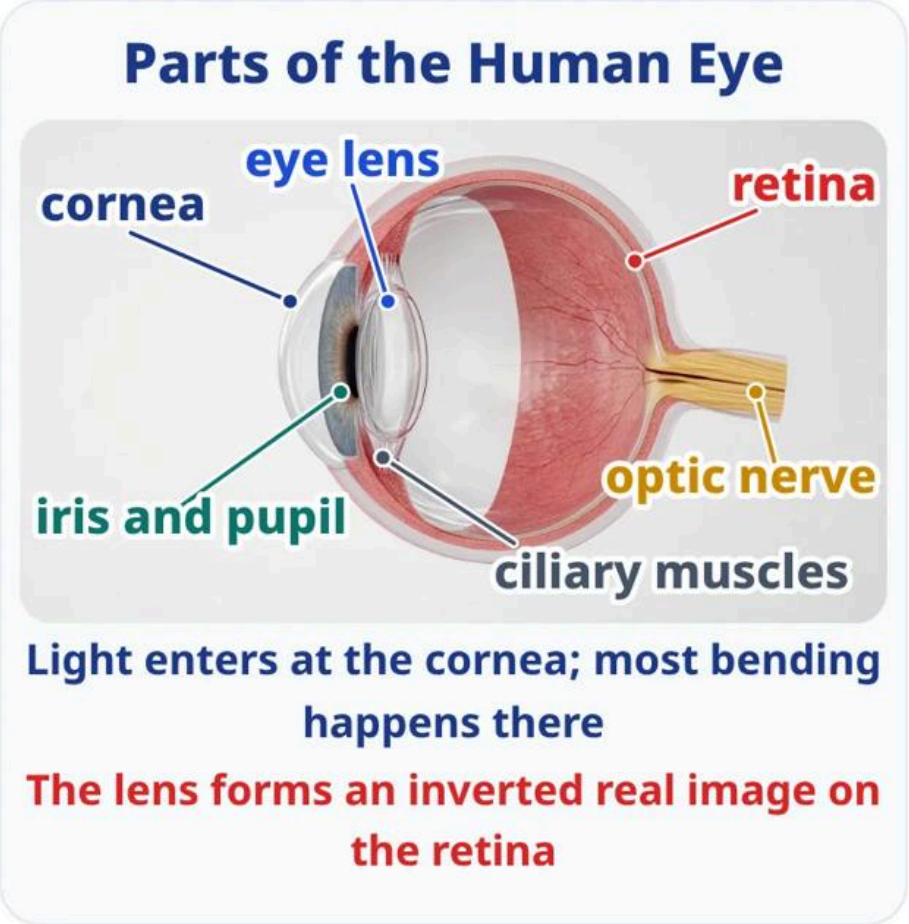
1. Parts of the eye and the power of accommodation
2. Myopia and hypermetropia — which lens
3. Presbyopia, bifocal lenses and eye donation
4. Refraction through a prism — Activity 10.1
5. Dispersion and recombination — Activity 10.2
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Questions and answers are in the separate «answer key» PDF.

1 Parts of the eye and the power of accommodation

Open

NCERT 10.1 · accommodation · near point 25 cm



Parts of the human eye: cornea, iris, pupil, eye lens, ciliary muscles, retina (10.1).



Power of accommodation: near point about 25 cm, far point at infinity.

📘 **The eye is like a camera, but the lens can change its focal length** Notes

The eyeball is roughly spherical and about **2.3 cm** across. Light enters through a thin membrane, the **cornea**. Most of the bending happens at the outer surface of the cornea. The crystalline lens only makes the fine adjustment of focal length.

Behind the cornea is the **iris**. This dark muscular diaphragm changes the size of the pupil and so controls how much light enters. The lens forms an **inverted, real image on the retina**. Light-sensitive cells of the retina make electrical signals. The signals travel to the brain along the **optic nerve**.

Part	Job
Cornea	Most of the refraction
Iris	Light amount through the pupil

Part	Job
Eye lens	Fine change of focal length
Retina	Inverted real image
Optic nerve	Signals to the brain

📘 Accommodation — near and far, on the same retina

Notes

The lens is a fibrous, jelly-like material. The **ciliary muscles** can change its curvature a little. When the muscles are relaxed the lens becomes thin, the focal length increases and a distant object is clear. For a nearby object the muscles contract, the lens thickens and the focal length decreases.

The focal length cannot be made shorter than a limit. The smallest distance for clear, comfortable vision is the **least distance of distinct vision**. It is also called the near point. For a young adult with normal vision it is about **25 cm**. The far point is infinity. A page held closer than this looks blurred and the eye feels strained.

📘 Cells of the retina and the blind spot

Notes

Cell / spot	Job
rods	respond to the intensity of dim light
cones	detect colour in bright light
blind spot	where the optic nerve leaves; no rods or cones, so no image is seen here

👉 The board model set has asked «Rod cells are sensitive to?» and «The blind spot has no?».

💡 Why do we have two eyes?

Do you know

- One eye sees a field of about **150°**; with two eyes it becomes about **180°**.
- Each eye sees a slightly different picture; the brain joins them and gives a sense of **depth**.
- Close one eye and try to thread a needle — it feels hard!

⚡ **10-second revision**

- Most refraction is at the cornea; the lens only fine-focuses
- The image on the retina is inverted and real
- Near point about 25 cm; far point infinity; accommodation means changing focal length

🎯 **Board tip** Board tip

In a BSEB definition write both words — ciliary muscle and focal length. “The eye shrinks” is incomplete.

🎯 **Board tip** Board tip

CBSE often asks where the image is formed. The answer is the retina, not the cornea or the pupil.

10-second revision

- Most refraction is at the cornea; the lens only fine-focuses
- The image on the retina is inverted and real
- Near point about 25 cm; far point infinity; accommodation means changing focal length

🧪 **Worked example** Example

Question: What is the power of accommodation? What is the range of a normal eye?

Answer: It is the ability of the eye to focus near and distant objects on the retina by changing the focal length of the lens. A normal young eye sees clearly from 25 cm out to infinity.

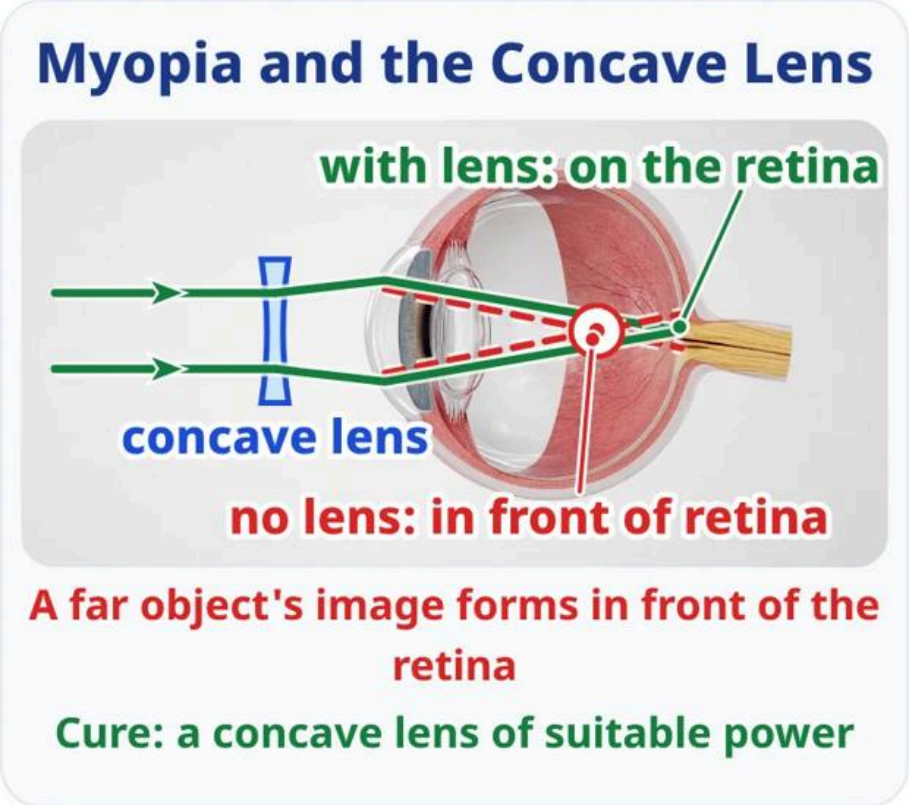
▼ ➕ More questions

More questions on this lesson are in the chapter **question bank** (final stop).

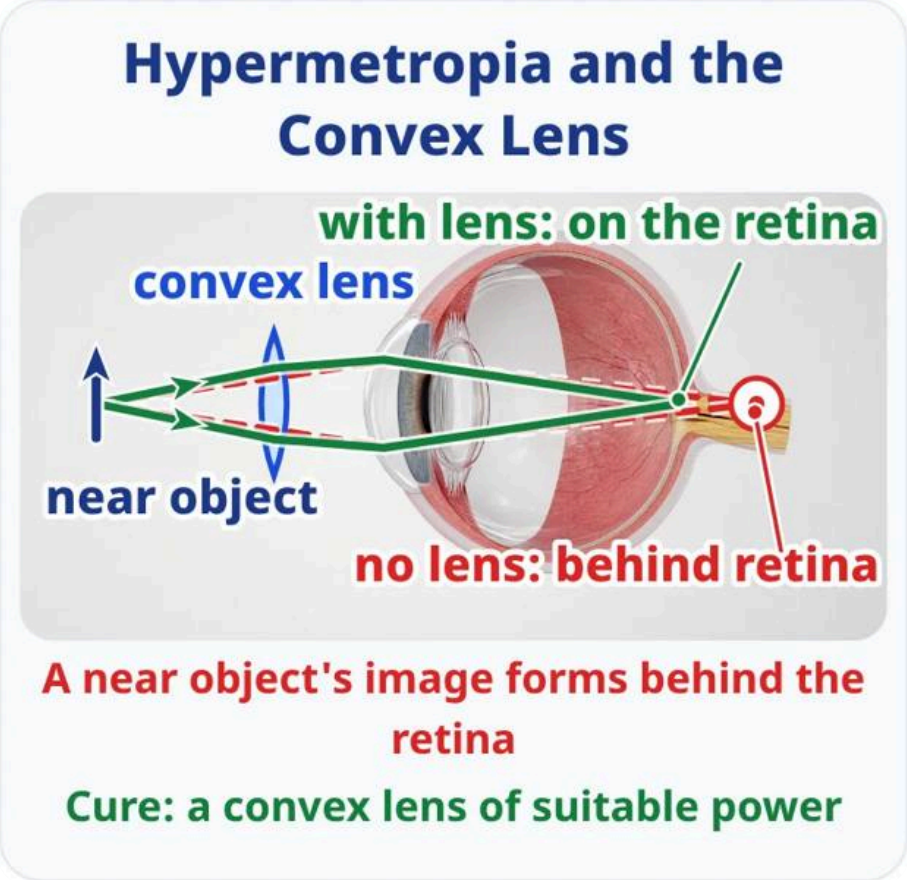
2 Myopia and hypermetropia — which lens

Open

NCERT 10.2 · myopia · hypermetropia



Myopia: the image forms in front of the retina; a concave lens corrects it.



Hypermetropia: the image forms behind the retina; a convex lens corrects it.

📘 **Two defects, two places where the image forms** Notes

In **myopia** nearby objects are clear and distant ones are not. The far point comes closer than infinity. The image of a distant object forms in front of the retina. Two causes are possible — the lens is too curved, or the eyeball has become too long. A **concave lens** of suitable power corrects it.

In **hypermetropia** distant objects are clear and nearby ones are not. The near point shifts farther than 25 cm. The image of a nearby object forms **behind the retina**. The cause is a focal length that is too long, or an eyeball that is too small. A **convex lens** of suitable power corrects it.

Defect	Image	Lens
Myopia	In front of the retina	Concave
Hypermetropia	Behind the retina	Convex

📘 Power of a lens — the numbers for corrective lenses

Notes

P = 1/f (f in metres) · unit dioptre (D)

Case	Lens	Example
myopia, far point 80 cm	concave, P negative	f = −0.8 m ⇒ P = −1.25 D
hypermetropia, near point 1 m	convex, P positive	u = −25 cm, v = −100 cm ⇒ f = +33.3 cm ⇒ P = +3 D
a −5.5 D lens	concave	f = 1/(−5.5) m = −18.2 cm

👉 Rule to remember: **concave → negative (–) power**, **convex → positive (+) power**.

⚡ 10-second revision

- Myopia: image in front of the retina; concave lens
- Hypermetropia: image behind the retina; convex lens
- If the far point is 40 cm, P = −2.5 D

🎯 Board tip

Board tip

In a BSEB answer write all three — the name of the defect, where the image forms, and the lens.

🎯 Board tip

Board tip

A CBSE calculation asks for the signs. Without u at infinity and a negative v you will not get −2.5 D.

10-second revision

- Myopia: image in front of the retina; concave lens
- Hypermetropia: image behind the retina; convex lens
- If the far point is 40 cm, P = −2.5 D

🧪 **Worked example — far point 40 cm** Example

Question: A person cannot see objects clearly beyond 40 cm. Find the nature and the power of the lens.

Formula: $1/f = 1/v - 1/u$ and $P = 1/f$, with f in metres.

Signs: For a distant object $u = -\infty$. The image must lie at the far point, so $v = -40$ cm $= -0.40$ m.

Substitution: $1/f = 1/(-0.40) - 0 = -2.5\ m^{-1}$. So $f = -0.40$ m and $P = -2.5$ D.

A negative power means a **concave lens**.

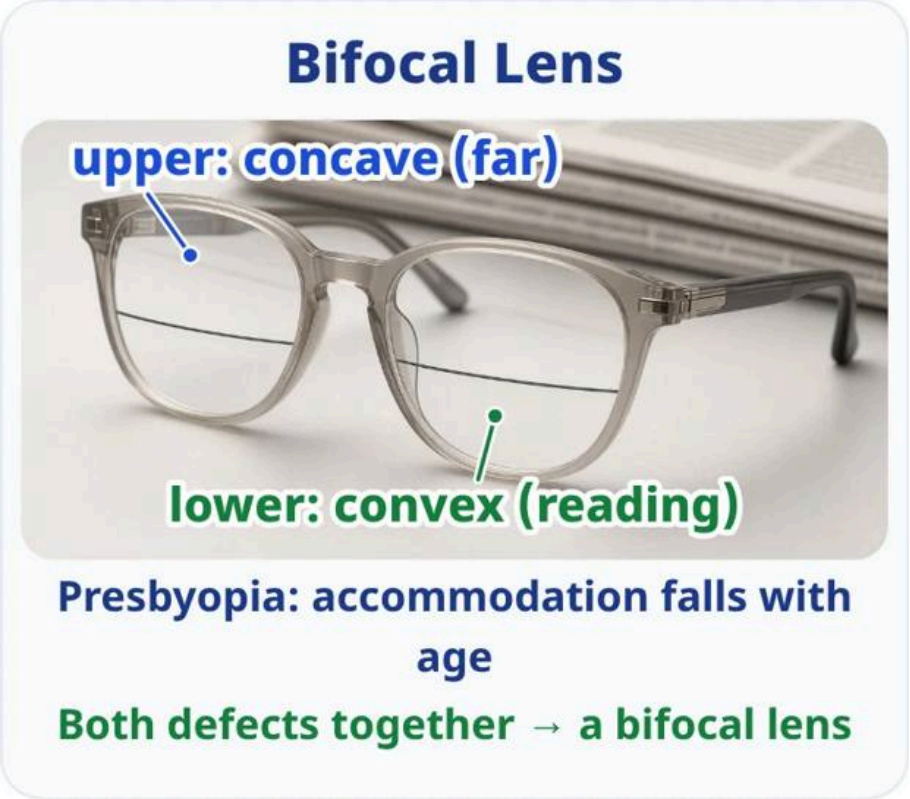
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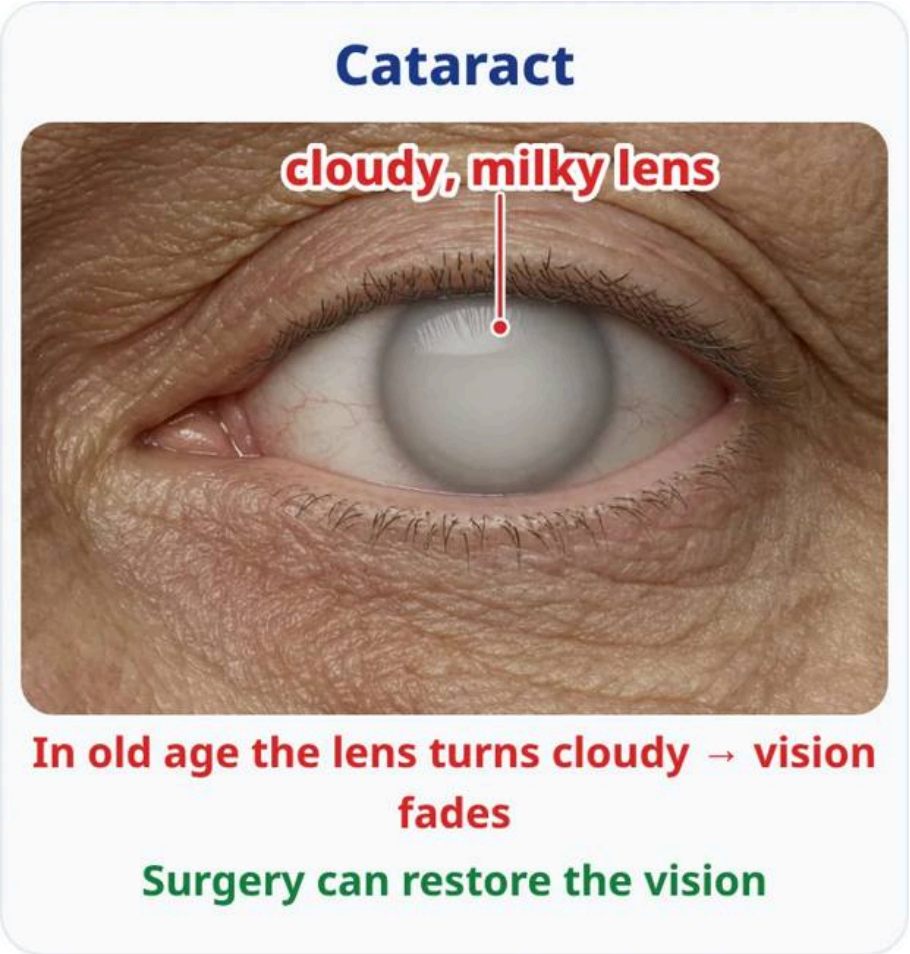
3 Presbyopia, bifocal lenses and eye donation

Open

NCERT 10.2 · presbyopia · cataract · eye donation



Bifocal lens: concave above (for far), convex below (for reading).



Cataract: the eye lens turns cloudy; surgery restores the vision.

📘 Accommodation falls with age

Notes

For most people the near point slowly recedes with age. Nearby objects are no longer comfortable without glasses. This defect is **presbyopia**. The ciliary muscles gradually weaken and the lens loses flexibility.

Sometimes one person has both myopia and hypermetropia. Then a bifocal lens is used. The upper part is concave, for distant vision. The lower part is convex, for reading. These defects can also be corrected with contact lenses or by surgery.

In old age the lens sometimes becomes milky and cloudy. This is **cataract**. Vision may be lost in part or fully. Surgery can restore it.

⚠️ Eye donation — the time limit, and who cannot donate

Caution

The eyes must be removed within **4 to 6 hours** of death. Inform the eye bank at once. Removal takes 10–15 minutes and does not disfigure the face. A donor may be of any age or sex. People who wear spectacles, and those who have had cataract surgery, can still donate.

A person infected with, or dead from, AIDS, hepatitis B or C, rabies, acute leukaemia, tetanus, cholera, meningitis or encephalitis cannot donate eyes. One pair of eyes can give vision to as many as four people with corneal blindness.

💡 Eye donation — one pair of eyes, sight for four people

Do you know

- Eyes must be removed **within 4–6 hours** of death; inform the nearest **eye bank** at once.
- People of any age or sex can donate — including those who wear glasses, had cataract surgery, or have diabetes or high blood pressure.
- Removing the eyes takes only 10–15 minutes and leaves no disfigurement.
- One pair of eyes can give vision to up to four people with **corneal blindness**.

⚡ 10-second revision

- Presbyopia: weak ciliary muscles and a less flexible lens
- Bifocal: concave on top (far), convex below (near)
- Eyes must be removed within 4–6 hours of death

🎯 Board tip

Board tip

In a BSEB answer the bifocal sentence must not swap the upper and lower parts.

🎯 Board tip

Board tip

In the CBSE relation f = 1/P the sign of P stays with the focal length. The focal length for −4.0 D is negative.

10-second revision

- Presbyopia: weak ciliary muscles and a less flexible lens
- Bifocal: concave on top (far), convex below (near)
- Eyes must be removed within 4–6 hours of death

🧪 Worked example — two powers, two focal lengths

Example

Question: The power of the lens for distant vision is −4.0 D and for near vision it is +2.5 D. Find both focal lengths.

Formula: f = 1/P, and f is in metres when P is in dioptres.

Substitution: Distant vision, f = 1/(−4.0) = −0.25 m = −25 cm. This is a concave lens.

Near vision, f = 1/(+2.5) = 0.40 m = 40 cm. This is a convex lens. In a bifocal the upper part is concave and the lower part is convex.

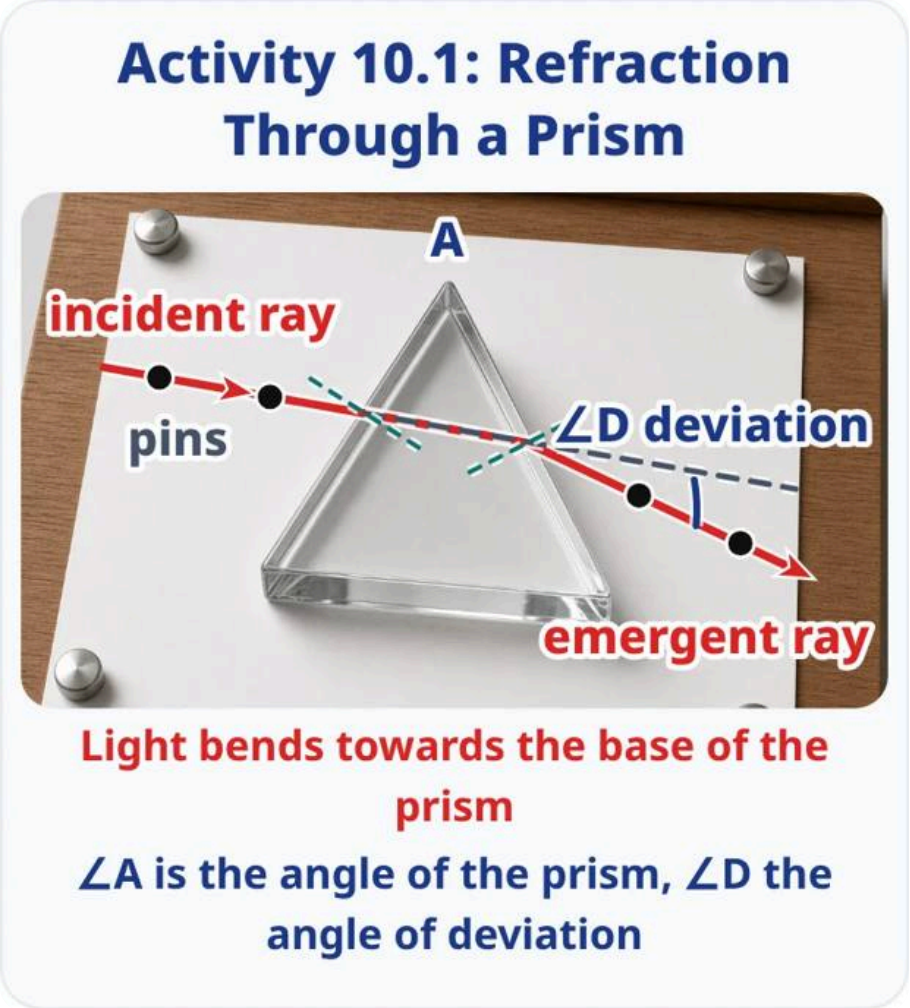
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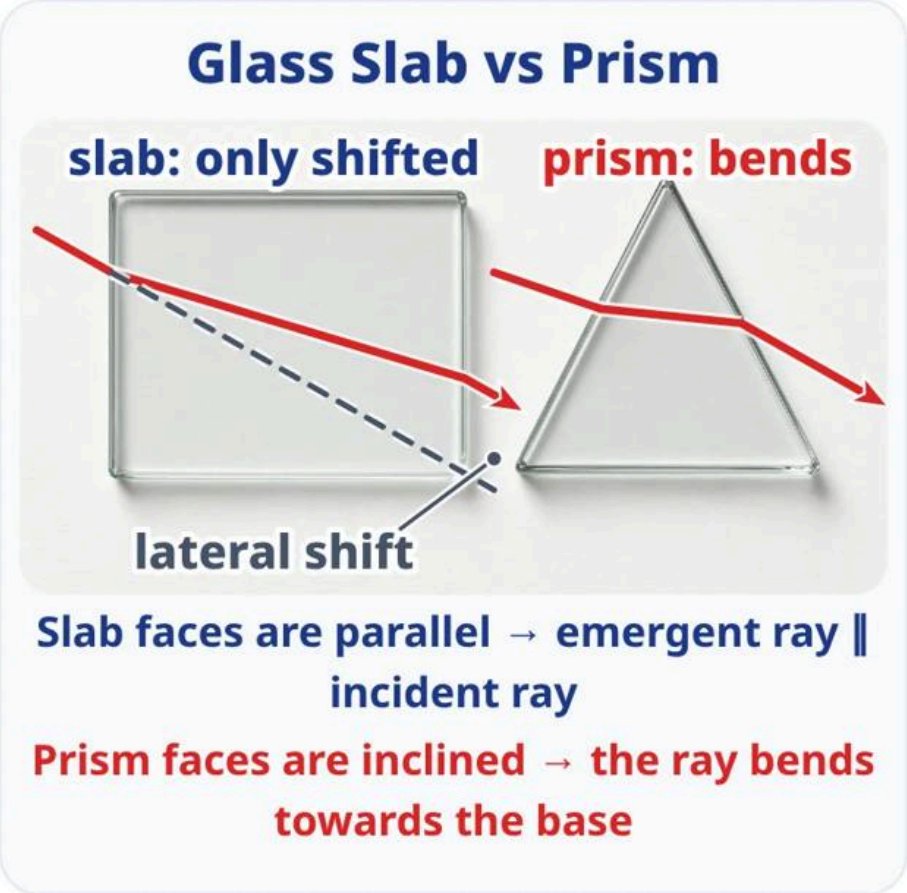
4 Refraction through a prism — Activity 10.1

Open

NCERT 10.3 · Activity 10.1 · angle of deviation



Activity 10.1: refraction through a glass prism, angle of deviation D.



A slab only shifts the ray; a prism bends it towards the base.

📘 A slab and a prism are not the same

Notes

The two faces of a glass slab are parallel, so the emergent ray stays parallel to the incident ray and only shifts sideways. The refracting faces of a prism are inclined to each other. The angle between the two lateral faces is the **angle of the prism (∠A)**.

Because of the shape of the prism, the emergent ray bends at an angle to the direction of the incident ray. That angle is the angle of deviation (∠D).

📘 Glass slab vs prism

Notes

	Slab	Prism
faces	parallel	inclined to each other (∠A)
emergent ray	parallel to the incident ray, only shifted	bent towards the base
deviation	zero (only a lateral shift)	angle of deviation ∠D
colours	do not split	white light splits

⚡ **10-second revision**

- First face: air to glass, towards the normal
- Second face: glass to air, away from the normal
- ∠D is the angle of deviation; in a slab it stays zero

🎯 **Board tip** Board tip

In a BSEB ray diagram name PE, EF, FS and the angles ∠i, ∠r, ∠e, ∠D. A diagram without names is counted incomplete.

🎯 **Board tip** Board tip

CBSE asks how the emergent ray differs for a slab and a prism. Write parallel versus deviation in one sentence.

10-second revision

- First face: air to glass, towards the normal
- Second face: glass to air, away from the normal
- ∠D is the angle of deviation; in a slab it stays zero

🔬 Activity 10.1 — the path of the ray with four pins

Activity

Fix a sheet of white paper on a drawing board with drawing pins. Place a glass prism on its triangular base and trace the outline. Draw a straight line PE inclined to one refracting face, AB. Fix two pins, P and Q, on the line.

Look through the other face AC for the images of P and Q. Fix two more pins, R and S, so that R, S and the images of P and Q lie on one straight line. Remove the pins and the prism. PE meets the boundary at E. Join R and S and produce the line to meet the boundary at F. Join E and F.

Draw the normals at E and F. Mark the angle of incidence ∠i, the angle of refraction ∠r and the angle of emergence ∠e. PE is the incident ray, EF the refracted ray and FS the emergent ray. At the first face the ray goes from air into glass and bends **towards the normal**. At the second face it goes from glass into air and bends **away from the normal**.

🧪 Worked example

Example

Question: Why is the ray that leaves a prism not parallel to the incident ray?

Answer: The two refracting faces of a prism are not parallel. At the first face the ray bends towards the normal and at the second face it bends away from the normal. The two bends do not cancel. The angle left between the incident and emergent rays is the angle of deviation.

▼ ➕ More questions

More questions on this lesson are in the chapter **question bank** (final stop).

5 Dispersion and recombination — Activity 10.2

Open

NCERT 10.4 · Activity 10.2 · the rainbow

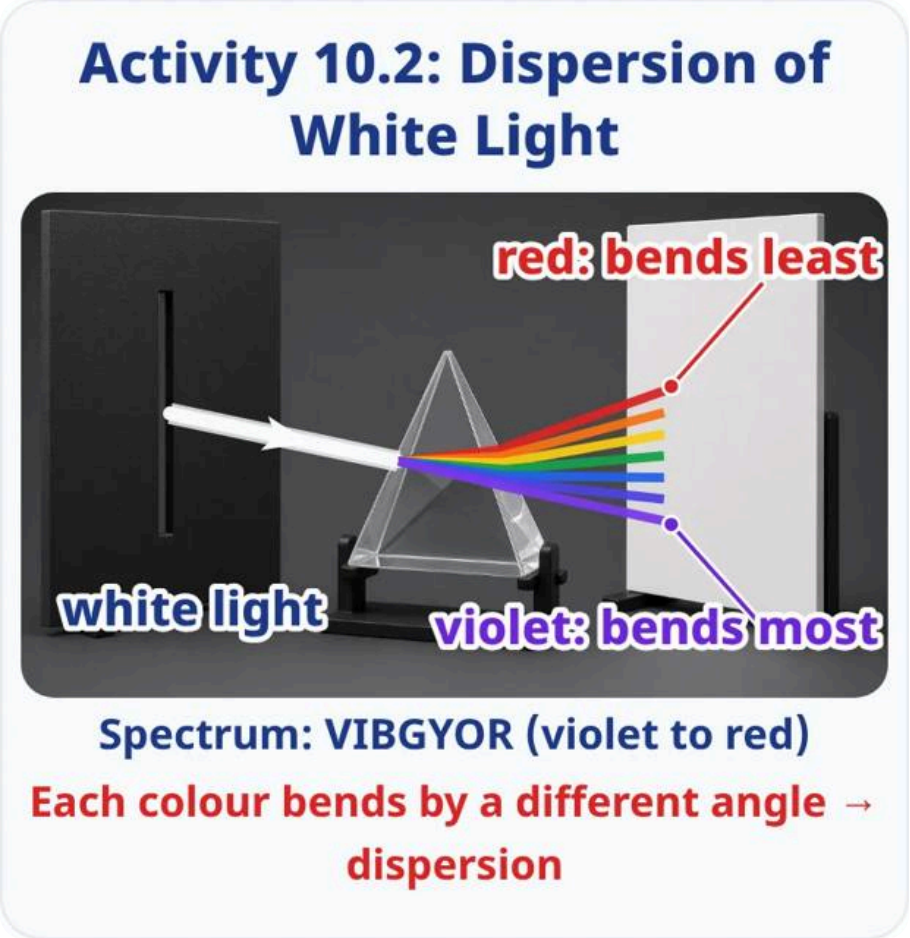
📘 Violet bends more, and a second prism joins the colours

Notes

Each colour bends through a different angle from the incident ray. **Red bends the least** and **violet bends the most**. So each colour leaves along its own path and stands apart on the screen.

Newton first obtained the spectrum of sunlight with a glass prism. A second prism used the same way did not split the colours any further. When a second identical prism was placed inverted relative to the first, all the colours passed through it and **white light** came out on the other side. Light that gives a spectrum like sunlight is called white light.

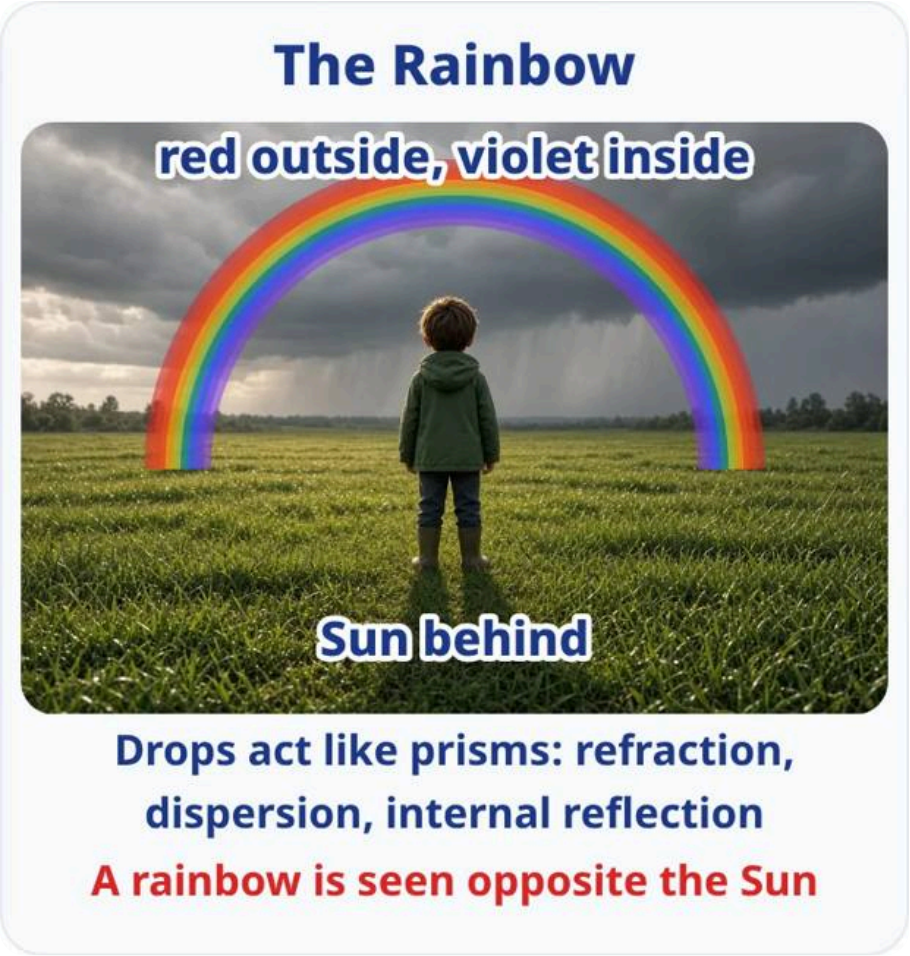
A rainbow forms in the sky after rain, in the direction opposite the sun. Tiny water drops act as prisms. They refract and disperse the sunlight, then reflect it inside the drop, and refract it again as it comes out. With the sun behind you, a rainbow can also be seen in a waterfall or a fountain.



Activity 10.2: dispersion of white light into seven colours.



Newton: an inverted second prism makes the colours white again.



A rainbow is opposite the Sun; red outside, violet inside.

📘 How a rainbow forms — four steps

Notes

- **1. Refraction:** sunlight bends as it enters the drop.
- **2. Dispersion:** the drop splits the colours like a tiny prism.
- **3. Internal reflection:** light turns back from the far side of the drop.
- **4. Refraction again:** the colours spread further as they leave.

👉 A rainbow is always **opposite the Sun** — you see it with the Sun behind you. On a sunny day you can see one near a fountain or waterfall.

⚡ 10-second revision

- Dispersion is white light splitting into colours; the band is the spectrum
- Violet bends the most, red the least
- An inverted second prism recombines the colours into white light

🎯 Board tip

Board tip

When you write VIBGYOR for BSEB, put violet first. Do not give red the larger deviation.

🎯 Board tip

Board tip

CBSE asks three steps for a rainbow — refraction, internal reflection, then refraction. “The drop is a prism” is only half the

10-second revision

- Dispersion is white light splitting into colours; the band is the spectrum
- Violet bends the most, red the least
- An inverted second prism recombines the colours into white light

🔬 Activity 10.2 — sunlight through a slit onto a prism

Activity

Make a small hole or a narrow slit in the middle of a thick sheet of cardboard. Let sunlight fall on the slit so that you get a narrow beam of white light. Do not look straight at the sun; let the beam fall on the slit.

Take a glass prism and let this beam fall on one face. Turn the prism slowly until the light that comes out appears on a nearby screen. A beautiful band of colours appears. The order is violet, indigo, blue, green, yellow, orange and red — VIBGYOR. This band is called the **spectrum**. The splitting of white light into its component colours is **dispersion**.

🧪 **Worked example** Example

Question: Which colours lie at the two ends of the spectrum, and what does a second inverted prism do?

Answer: Violet is at one end and bends the most. Red is at the other end and bends the least. A second prism placed inverted joins these colours into one beam, and white light comes out.

▼ ➕ More questions

More questions on this lesson are in the chapter **question bank** (final stop).

6 Atmospheric refraction — twinkling and advanced sunrise

Open

NCERT 10.5 · stars · planets · sunrise by 2 minutes



Twinkling of stars: a star looks a little higher than it is (10.5).



Atmospheric refraction shows the Sun about 2 minutes early.



Hot air above a fire makes objects seem to waver.

📘 Hot air wavers, and a star twinkles

Notes

The hot air above a fire is lighter than the cooler air and has a slightly smaller refractive index. The medium does not stay still, so the apparent position of an object keeps wavering. That is atmospheric refraction on a small scale.

Starlight bends continuously in the atmosphere. Near the horizon a star appears slightly higher than its real position. The state of the atmosphere keeps changing, so the apparent position changes too. Stars are so far away that they behave as point sources. The light entering the eye is sometimes more and sometimes less — that is the twinkling.

Planets do not twinkle. They are nearer the earth and look like extended sources. The variations from a large number of point sources average out to zero.

📌 Sunrise two minutes early, sunset two minutes late

Actual sunrise means the sun really crossing the horizon. Because of atmospheric refraction we see the sun about **2 minutes before** the actual sunrise and about **2 minutes after** the actual sunset. The apparent flattening of the sun disc at sunrise and sunset has the same cause.

💡 Why does the Sun look flattened at the horizon?

Do you know

- Light from the lower edge of the Sun crosses **more air** than light from the upper edge, so it bends more.
- The lower edge looks raised more than the upper edge — the disc of the Sun looks **flattened**.
- The same refraction shows sunrise about **2 minutes early** and sunset about **2 minutes late**.

⚡ 10-second revision

- Twinkling is atmospheric refraction; a star is a point source
- Planets are extended sources, so they do not twinkle
- The sun appears about 2 minutes early at sunrise and 2 minutes late at sunset

🎯 Board tip

Board tip

For BSEB write both facts — the star appears higher, and the light flickers. The single word refraction is not enough.

🎯 Board tip

Board tip

The CBSE question on planets asks for a comparison. Write point source and extended source together.

10-second revision

- Twinkling is atmospheric refraction; a star is a point source
- Planets are extended sources, so they do not twinkle
- The sun appears about 2 minutes early at sunrise and 2 minutes late at sunset

🧪 Worked example

Example

Question: Stars twinkle and planets do not. Write one reason.

Answer: Atmospheric refraction acts on both. A star is a point source, so the flicker in its light reaches the eye. A planet is an extended source, so the flickers from different points average out.

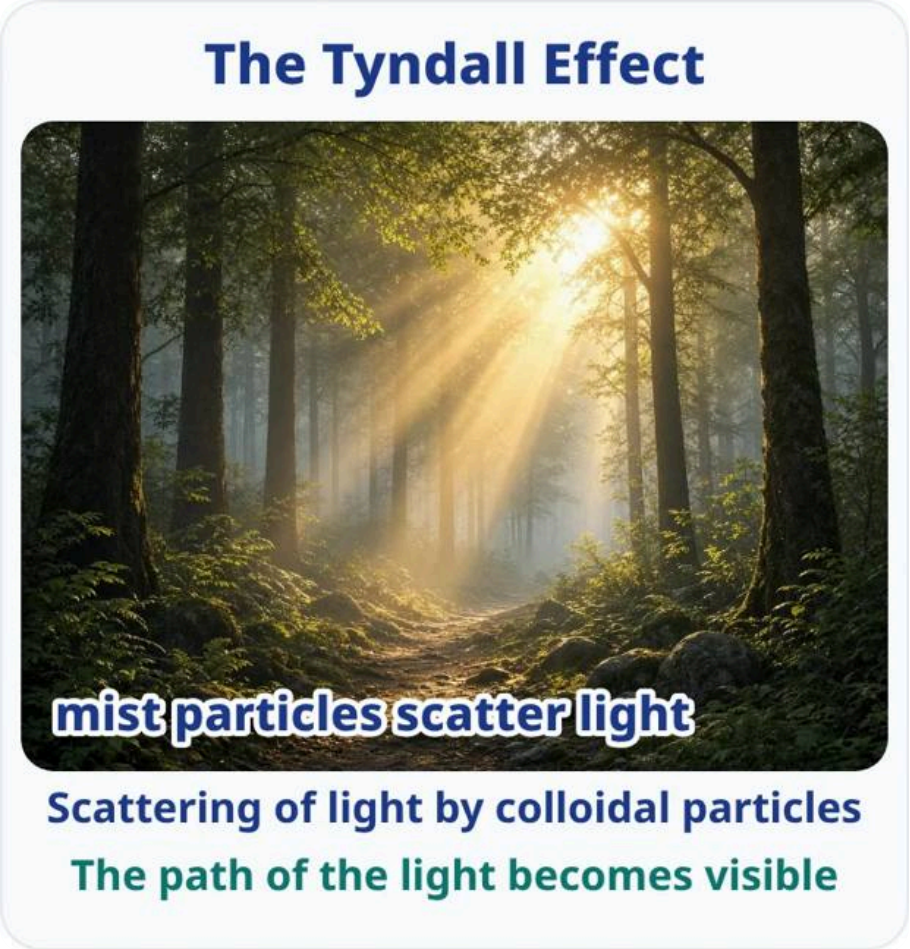
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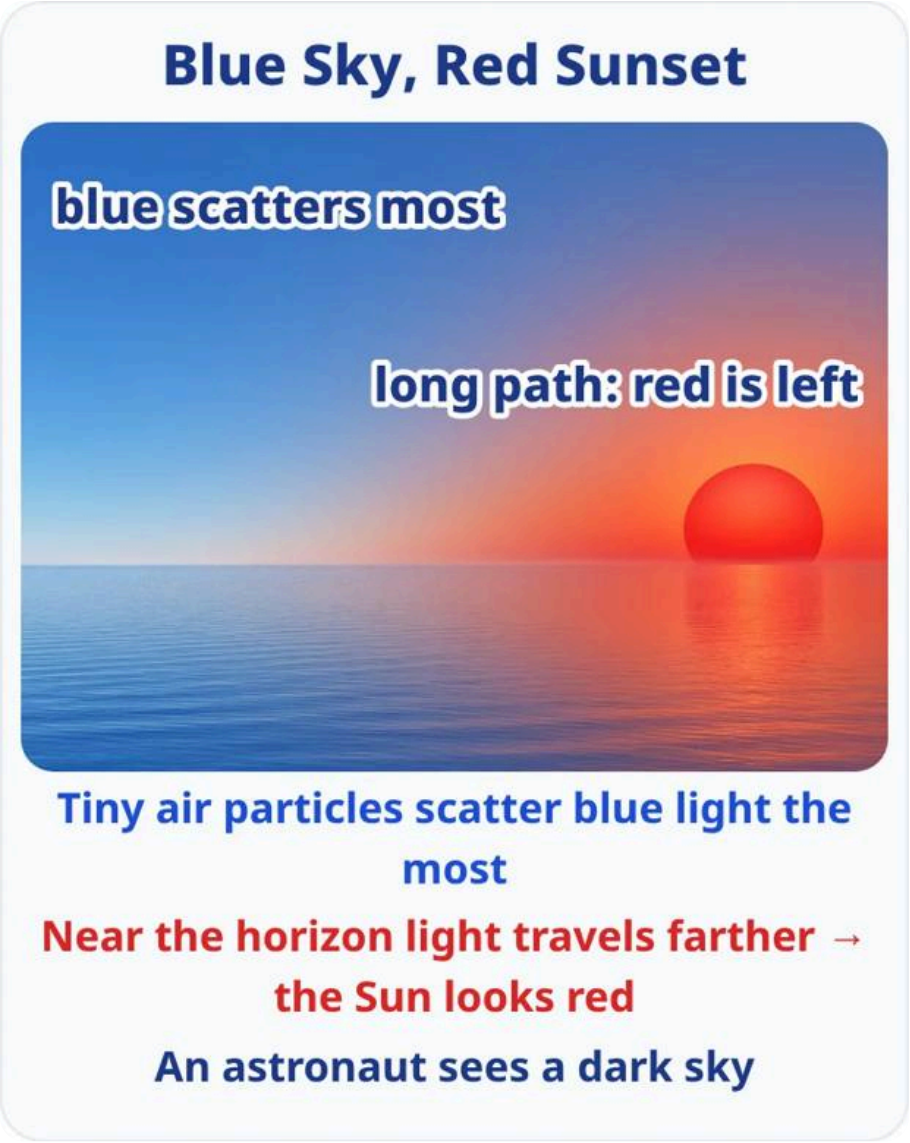
7 Scattering — blue sky, red sunset and the Tyndall effect

Open

NCERT 10.6 · Tyndall · blue sky · red signal



The Tyndall effect: scattering of light by colloidal particles (10.6).



Blue sky and red sunset — scattering of light.



Danger signals are red — red light scatters the least.

📘 Tyndall — the path shows only when the particles are colloidal

Notes

The path of a beam through a true solution is not visible. In a colloidal solution the particles are larger, so the path of the beam becomes visible. Scattering of light by those particles produces this effect. It is called the **Tyndall effect**.

The atmosphere is a mixture of smoke, tiny water droplets, dust and molecules of air. A sunbeam entering a smoke-filled room through a small hole, or sunlight filtering through the mist of a dense forest, are examples. Very fine particles scatter mainly blue light. Larger particles scatter longer wavelengths. If the particles are large enough, the scattered light can even look white.

📘 Blue scatters more, and red travels on

Notes

Molecules of air and other fine particles are smaller than the wavelength of visible light. They scatter the shorter waves at the blue end more than the longer waves at the red end. The wavelength of red light is about **1.8 times** that of blue light. The scattered blue light enters our eyes, so the clear sky looks blue.

With no atmosphere there would be no scattering and the sky would look dark. Passengers flying very high see a dark sky. At sunrise and sunset the light travels a long path through the atmosphere. Blue is scattered away on the way, and the less-scattered red light reaches the eye. Danger signals are red for the same reason — fog or smoke scatters red the least, so the colour stays the same at a distance.

📘 The particle size decides the colour

Notes

Particles	Scattered light	Example
very fine (air molecules)	mainly blue	clear blue sky
larger	longer wavelengths too (towards red)	hazy sky
very large (cloud droplets)	all colours equally — white	white clouds
none (great heights)	no scattering	dark sky for an astronaut

⚡ 10-second revision

- The Tyndall effect is scattering by colloidal particles
- Blue is scattered more; the wavelength of red is about 1.8 times that of blue
- A danger signal is red because red is scattered the least

🎯 Board tip

Board tip

For BSEB join the blue sky and the red sunset with one rule — a shorter wavelength scatters more.

🎯 Board tip

Board tip

CBSE keeps Tyndall and dispersion apart. Tyndall is scattering by particles. Dispersion is the splitting of colours in a prism.

10-second revision

- The Tyndall effect is scattering by colloidal particles
- Blue is scattered more; the wavelength of red is about 1.8 times that of blue
- A danger signal is red because red is scattered the least

🧪 Worked example

Example

Question: Why does the sky look dark, not blue, to an astronaut?

Answer: The blue colour comes from scattering by fine particles in air. At a very great height that scattering is no longer effective. Without scattering the sky looks dark.

▼ ➕ More questions

More questions on this lesson are in the chapter **question bank** (final stop).

📋 One-page revision sheet

5 minutes before the exam: these six cards.

⚡ 👁️ Eye

10-second revision

- cornea: most refraction
- iris → size of the pupil
- real, inverted image on the retina

⚡ 🔎 Accommodation

10-second revision

- ciliary muscles change the lens
- near point 25 cm · far point infinity
- near: lens thick · far: thin

⚡ 👓 Defects

10-second revision

- myopia → concave (−)
- hypermetropia → convex (+)
- presbyopia → bifocal · P = 1/f

⚡ 🔺 Prism

10-second revision

- ray bends towards the base
- ∠A angle of prism · ∠D angle of deviation
- slab: only a shift

⚡ 🌈 Dispersion

10-second revision

- VIBGYOR · red bends least, violet most
- inverted prism → white again (Newton)
- rainbow: opposite the Sun

⚡ ✨ Refraction and scattering

10-second revision

- stars twinkle, planets don't
- sunrise 2 minutes early
- blue sky · red signals · Tyndall effect

🧠 What you learned + equation sheet

What you learned

- Most of the bending in the eye happens at the cornea. The lens only fine-tunes the focal length. The image on the retina is real and inverted.
- Power of accommodation is the ability of the lens to change its focal length. For a normal young eye the near point is about 25 cm and the far point is infinity.
- Myopia is corrected by a concave lens. Hypermetropia is corrected by a convex lens. Presbyopia uses a bifocal lens, concave on top and convex below.
- In Activity 10.1 the ray leaving a prism is not parallel to the incident ray. The angle between them is the angle of deviation.
- In Activity 10.2 the spectrum of white light is VIBGYOR. Violet bends the most and red the least. A second, inverted prism joins the colours again.
- Twinkling of stars and sunrise about 2 minutes early are atmospheric refraction. The blue sky and the red sunset are scattering. A danger signal is red for the same reason.
- Rod cells sense dim light and cone cells sense colour; the blind spot has neither.
- Power of a lens P = 1/f (dioptre); a concave lens has negative power, a convex lens positive.
- A rainbow always forms opposite the Sun.
- Red light is scattered the least, so danger signals are red.

What	Keep this
Least distance of distinct vision	लगभग 25 cm (युवा सामान्य नेत्र)
Myopia	अवतल लेंस; प्रतिबिंब रेटिना से पहले
Hypermetropia	उत्तल लेंस; प्रतिबिंब रेटिना के पीछे
Dispersion	बैंगनी सबसे अधिक, लाल सबसे कम
Atmospheric refraction	सूर्योदय लगभग 2 मिनट पहले
Scattering	नीला आकाश; खतरे का संकेत लाल

Source: NCERT Science Class 10, Chapter 10 «The Human Eye and the Colourful World» (Hindi and English) — the same book used in Bihar. Notes are in our own words. Board questions are from official BSEB papers, with year and page.

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