CBSE CLASS X

Science (086)

ANSWER KEY

AI-generated question paper

Code: UASCAF	Questions: 36	Maximum Marks: 93	Generated: 2026-06-25 17:48

SELECTIONS USED

Subject	Science
Lessons	10 The Human Eye and the Colourful World
Level of understanding	Thorough understanding
Question selection	Curated chapter coverage (~5 questions per section + 8 synthesis)
Model	claude-sonnet-4-6

Composition — Difficulty: 2 straightforward · 20 medium · 14 deep | Types: 27 Short · 3 Long · 3 MCQ · 2 Very short · 1 Assertion–reason

Q1. medium | thorough-understanding | § Chapter Introduction **[3]**

The cornea performs most of the refraction of light entering the eye, yet we still need the crystalline lens. What specific function does the crystalline lens serve that the cornea cannot, and what structure in the eye controls the lens's ability to perform this function?

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Model Answer

The cornea performs most of the refraction, but it has a **fixed focal length** and cannot change it. The crystalline lens provides the **finer adjustment of focal length** needed to focus objects at different distances (near or far) on the retina. This ability is called **accommodation**.

The structure that controls this function is the **ciliary muscles**. When they contract, the lens becomes thicker (shorter focal length) to focus nearby objects; when they relax, the lens becomes thin (longer focal length) to focus distant objects.

Source: Chapter 10, Section 10.1 and 10.1.1

Explanation

- The key distinction: cornea = fixed refraction; lens = variable/adjustable focal length.
- The term **accommodation** must be mentioned — examiners specifically look for it.
- **Ciliary muscles** is the required structure (not iris, not pupil — a common error).
- Three marks: one for the cornea's limitation/lens's role, one for accommodation, one for ciliary muscles.

Q2. medium | thorough-understanding | § 10.1 THE HUMAN EYE **[3]**

When you shift your gaze from a distant tree to a book held 25 cm away, describe what happens inside your eye to keep the image focused sharply on the retina. In your answer, name the structure responsible and explain the physical change it undergoes.

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Model Answer

When we shift our gaze from a distant tree to a book held 25 cm away, the **ciliary muscles** (which control the eye lens) contract. This increases the curvature of the **crystalline (eye) lens**, making it thicker. As a result, the focal length of the eye lens decreases, converging the light from the nearby book sharply onto the retina. This ability of the eye lens to adjust its focal length is called **accommodation**.

(For a distant object, the ciliary muscles are relaxed, the lens becomes thin, and focal length increases.)

Source: Chapter 10, Section 10.1.1 — Power of Accommodation

Explanation

- **3 marks** are typically split as: (1) naming the structure — ciliary muscles / eye lens; (1) describing the physical change — muscles contract → lens becomes thicker / curvature increases; (1) effect — focal length decreases → image focused on retina.
- Always use the term **accommodation** — examiners expect it.
- Mention both what changes (curvature/thickness) and the consequence (focal length decreases) to secure full marks.
- Don't just say "lens changes shape" — be specific: *curvature increases, lens becomes thicker, focal length decreases.*

Q3. deep | thorough-understanding | § 10.1 THE HUMAN EYE **[3]**

Most of the refraction of light entering the eye occurs at the cornea, yet it is the lens that allows us to see objects at varying distances clearly. Why can the cornea not perform this focusing adjustment on its own?

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Model Answer

The cornea has a **fixed curvature** and therefore a fixed focal length — it cannot change its shape. While it performs most of the refraction, it is unable to adjust focus for objects at different distances.

The **eye lens**, made of fibrous jelly-like material, can change its curvature using the **ciliary muscles**. When viewing distant objects, the muscles relax and the lens becomes thin (larger focal length). When viewing nearby objects, the muscles contract, the lens becomes thicker (shorter focal length). This adjustment of focal length, called **accommodation**, allows clear vision at varying distances — something the cornea cannot do alone.

Source: Chapter 10, Section 10.1 and 10.1.1

Explanation

- The key distinction examiners want: **cornea = fixed refractor; lens = variable focuser**.
- Name the mechanism: **ciliary muscles** change lens curvature → focal length changes → **accommodation**.
- Mention both cases (distant and near) to earn full marks.
- The word **accommodation** is a must-use term here.

Q4. medium | thorough-understanding | § 10.1.1 Power of Accommodation **[3]**

When you shift your gaze from a distant tree to a book held 25 cm away, describe what happens to your ciliary muscles and eye lens. How do these changes together bring the image of the nearby text onto the retina?

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Model Answer

When shifting focus from a distant tree to a book 25 cm away, the **ciliary muscles contract**. This increases the curvature of the eye lens, making it **thicker**. As a result, the **focal length of the eye lens decreases**.

A shorter focal length provides greater converging power, which is needed to focus light from the nearby book. The lens bends the incoming light rays more sharply so that they converge exactly **on the retina**, forming a clear image of the text. This adjustment is called **accommodation**.

Source: Chapter 10, Section 10.1.1 – Power of Accommodation

Explanation

- Examiners expect **three linked steps**: ciliary muscles contract → lens becomes thicker/more curved → focal length decreases → image focuses on retina.
- The keyword **accommodation** must appear for full marks.
- Do not say focal length *increases* for nearby objects — that is the opposite (relaxed lens for distant vision).
- 25 cm is the near point; mentioning it shows awareness of context but is not compulsory here.

Q5. deep | thorough-understanding | § 10.1.1 Power of Accommodation **[3]**

A person can read a billboard 50 m away with perfect clarity, but finds the text on her phone blurred when held 15 cm from her eyes. Identify the likely reason for this blurring and explain it in terms of the eye's power of accommodation and the near point of vision.

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Model Answer

The person is likely suffering from **hypermetropia (far-sightedness)**. She can see distant objects (50 m) clearly, but nearby objects (15 cm) appear blurred.

In a normal eye, the near point is **25 cm**. At 15 cm, the ciliary muscles must contract further to increase the eye lens curvature and raise its power. In a hypermetropic eye, the focal length of the lens is too long (or the eyeball is too small), so the image of a nearby object forms **behind the retina** instead of on it. The eye's power of accommodation is insufficient to bring the image forward onto the retina, causing blurring. This defect is corrected using a **convex (converging) lens** of appropriate power.

Source: Chapter 10, Section 10.2 – Defects of Vision and Their Correction; Section 10.1.1 – Power of Accommodation

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Explanation

- Examiners want you to **name the defect** (hypermetropia), state **why it causes near-blurring** (image forms behind retina), and link it to **accommodation** (ciliary muscles can't increase curvature enough) and the **near point** (normal = 25 cm; phone at 15 cm is closer than near point).
- Do not confuse with myopia — myopes can see *near* clearly but not far. Here it is the reverse.
- Mentioning the correction (convex lens) is a good finishing point and may earn the third mark.

Q6. medium | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[3]**

A myopic person can see objects clearly only up to 2 m. Which type of lens is used to correct this defect, and how does it restore normal vision?

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Model Answer

Lens used: A **concave lens** (diverging lens) is used to correct myopia.

How it restores normal vision: The myopic person's far point is 2 m (not infinity), meaning the image of distant objects forms in front of the retina. A concave lens of suitable power diverges the incoming light rays before they enter the eye. This shifts the image of the distant object back onto the retina, restoring clear distant vision.

Power of the lens required:

$$P = \frac{1}{f} = \frac{1}{-2} = -0.5\ \text{D}$$

Source: Chapter 10, Section 10.2 – Defects of Vision and Their Correction

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Explanation

- Examiners expect you to name the lens type, explain *why* it is used (image forms in front of retina), and state *how* it corrects the defect (diverges rays so image shifts back to retina).
- For 3 marks, mentioning the power calculation using the far point (f = −2 m) earns the third mark.
- Always use a negative sign for the concave lens focal length/power — this is a common error students make.

Q7. medium | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[1]**

Both myopia and hypermetropia involve the image not forming on the retina. How does the position of the image differ between the two defects?

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Model Answer

In myopia, the image of a distant object is formed **in front of** (before) the retina, whereas in hypermetropia, the image of a nearby object is formed **behind** the retina.

Explanation

The key contrast examiners look for is "in front of / before the retina" for myopia and "behind the retina" for hypermetropia. Both phrases must appear for full marks. Avoid vague terms like "not on the retina" alone.

Q8. medium | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[3]**

A student can read the school notice board from across the room but struggles to read his textbook unless he holds it at arm's length. (a) Identify the defect of vision he has. (b) State TWO possible structural reasons for this defect. (c) What kind of corrective lens should he use?

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Model Answer

(a) Defect of Vision:

The student has **Hypermetropia (far-sightedness)**. He can see distant objects (notice board) clearly but cannot see nearby objects (textbook) without holding them far away.

(b) Two Structural Reasons:

1. The focal length of the eye lens is too long.
2. The eyeball has become too small.

(c) Corrective Lens:

A **convex lens (converging lens)** of appropriate power should be used. It provides the additional focusing power needed to form the image on the retina.

Source: Chapter 10, Section 10.2 – Hypermetropia

Explanation

- The key clue is that the student struggles with **near vision** (textbook) but not **distant vision** (notice board) — this is the classic sign of **hypermetropia**, not myopia.
- Examiners expect you to name both the defect and its common name.
- The two structural causes must be stated as given in the textbook — focal length too long OR eyeball too small.
- Always specify **convex** (not just "a lens") for hypermetropia; **concave** is for myopia. Getting this reversed is a common mistake.

Q9. deep | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[2]**

A person is unable to see distant objects clearly. State TWO possible structural reasons for this defect of vision. What common optical consequence, in terms of image formation, leads to blurred distant vision in both cases?

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Model Answer

The defect described is **myopia (near-sightedness)**. Two possible structural reasons are:

1. **Excessive curvature of the eye lens** (lens becomes too curved, increasing its converging power).
2. **Elongation of the eyeball** (eyeball becomes too long).

Common optical consequence: In both cases, the image of a distant object is formed **in front of the retina** instead of on it, causing blurred distant vision.

Source: Chapter 10, Section 10.2 – Defects of Vision and Their Correction

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Explanation

- The question asks for **two structural causes** and **one optical consequence** — examiners expect all three points for full marks.
- The structural reasons must be specific (curvature/elongation), not just "weak eye."
- The optical consequence ("image formed in front of the retina") is the key phrase from the textbook — use it verbatim.
- Do not mix up myopia with hypermetropia; the question is about **distant** objects being blurred.

Q10. medium | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[2]**

An elderly person finds it difficult to read a newspaper but can see distant objects clearly without glasses. Which defect of vision is this, and what is its underlying physiological cause?

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Model Answer

The defect is **Presbyopia**. It occurs in old age due to the **gradual weakening of the ciliary muscles** and **diminishing flexibility of the eye lens**. As a result, the eye loses its power of accommodation and cannot focus on nearby objects like a newspaper, though distant vision remains clear.

Source: Chapter 10, Section 10.2(c) — Presbyopia

Explanation

- The key symptom — difficulty with near vision but clear distant vision in old age — directly points to **Presbyopia**, not Hypermetropia (which can occur at any age).
- Examiners expect **both** parts of the physiological cause: weakening of ciliary muscles **and** reduced flexibility of the eye lens. Mentioning only one may cost half a mark.
- Do not confuse Presbyopia with Hypermetropia; the distinguishing factor here is **age-related gradual loss** of accommodation.

Q11. deep | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[3]**

How is presbyopia similar to hypermetropia in its symptoms, and yet different in its cause?

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Model Answer

Similarity in symptoms: Both presbyopia and hypermetropia cause difficulty in seeing nearby objects clearly. In both conditions, the near point recedes beyond 25 cm, and a convex (converging) lens is used for correction.

Difference in cause:

- **Hypermetropia** is caused by the focal length of the eye lens being too long, or the eyeball being too small, so light from nearby objects focuses behind the retina.
- **Presbyopia** is caused by the gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens due to ageing, leading to loss of power of accommodation.

Source: Human Eye and Colourful World, Section 10.2

Explanation

Examiners expect you to clearly separate the two parts — similarity (symptom: can't see nearby objects) and difference (cause). For full marks, name the specific causes of each defect. Don't just say "old age" for presbyopia — mention ciliary muscles and flexibility of the lens. The correction (convex lens) can be mentioned as part of the similarity to strengthen the answer.

Q12. medium | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[2]**

A person suffers from both myopia and hypermetropia simultaneously. What type of spectacle lenses would be prescribed for such a person, and how are the two corrective components arranged in these lenses?

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Model Answer

A person suffering from both myopia and hypermetropia is prescribed **bi-focal lenses**.

These lenses have two components arranged as follows:

- **Upper portion** — a **concave lens**, which corrects myopia and facilitates **distant vision**.
- **Lower portion** — a **convex lens**, which corrects hypermetropia and facilitates **near vision**.

Source: Light – Reflection and Refraction / Human Eye and Colourful World, Section 10.2(c)

Explanation

The examiner expects you to name the lens type (bi-focal) and correctly describe the arrangement of both components with their functions. Many students forget to specify *which part* holds which lens — that detail carries marks. The concave (upper/distance) and convex (lower/near) arrangement must both be stated.

Q13. deep | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[5]**

The near point of a normal young adult is 25 cm, but for a hypermetropic person it is much farther. Explain why the hypermetropic eye fails to see nearby objects clearly, even when the eye lens is fully accommodated.

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Model Answer

Hypermetropia (far-sightedness) is a defect in which the near point of the eye is farther than the normal 25 cm. The person cannot see nearby objects clearly.

Cause: In a hypermetropic eye, either the focal length of the eye lens is too long or the eyeball is too small. As a result, light rays from a nearby object are focused at a point **behind the retina** instead of on it, forming a blurred image.

Role of accommodation: When the ciliary muscles contract fully, the eye lens becomes maximally thick, giving its shortest possible focal length. However, even at maximum accommodation, the focal length of a hypermetropic lens is still **not short enough** to focus nearby objects (within 25 cm) onto the retina. The minimum focal length limit is never crossed, so nearby objects always appear blurred.

Correction: A convex (converging) lens of appropriate power is used to provide the extra converging power, bringing the image onto the retina.

Source: Chapter 10 — Defects of Vision and Their Correction, Section 10.2(b); Section 10.1.1

Explanation

- Examiners expect: definition of hypermetropia, the structural cause (long focal length / small eyeball), explanation of image forming behind retina, and why full accommodation still fails.
- Mentioning the **minimum focal length limit** of the eye lens is the key conceptual point that directly answers "even when fully accommodated."
- Always end with the correction method — it is usually part of the expected answer even if not explicitly asked.
- Avoid lengthy diagrams unless asked; a brief description suffices for 5 marks.

Q14. medium | thorough-understanding | § 10.2 DEFECTS OF VISION AND THEIR CORRECTION **[1]**

Which of the following correctly describes the cause of myopia?
(A) The eyeball is too short, causing the image to form behind the retina.
(B) The ciliary muscles become permanently relaxed, reducing the lens curvature.
(C) The focal length of the eye lens is too long, so the image of nearby objects falls behind the retina.
(D) The eyeball is elongated or the eye lens is too curved, causing the image of distant objects to form in front of the retina.

A The eyeball is too short, causing the image to form behind the retina.
B The ciliary muscles become permanently relaxed, reducing the lens curvature.
C The focal length of the eye lens is too long, so the image of nearby objects falls behind the retina.
D The eyeball is elongated or the eye lens is too curved, causing the image of distant objects to form in front of the retina.

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Model Answer

(D) The eyeball is elongated or the eye lens is too curved, causing the image of distant objects to form in front of the retina.

Explanation

The passage clearly states myopia arises due to (i) excessive curvature of the eye lens or (ii) elongation of the eyeball, and the image of a distant object forms **in front of** the retina. Option A and C describe hypermetropia; Option B describes presbyopia. Only D matches the textbook definition exactly.

Q15. medium | thorough-understanding | § 10.3 REFRACTION OF LIGHT THROUGH A PRISM **[3]**

A ray of white light enters a triangular glass prism through one refracting surface and exits through the other. Explain why the ray bends at each surface and why the bending is in opposite directions at the two surfaces. How is this behaviour different from what happens when light passes through a rectangular glass slab?

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Model Answer

When a ray enters the prism at surface AB, it travels from air (rarer) to glass (denser), so it **bends towards the normal**. At surface AC, it travels from glass (denser) to air (rarer), so it **bends away from the normal**. Because the two refracting surfaces of the prism are **inclined** (not parallel) to each other, the bending at each surface is in the same overall direction (towards the base), and the ray emerges at an angle to the incident ray called the **angle of deviation**.

In a rectangular glass slab, the two surfaces are **parallel**, so the bending towards the normal at the first surface is exactly equal and opposite to the bending away from the normal at the second surface. Thus the emergent ray is **parallel to the incident ray** (only laterally displaced), and there is no net deviation.

Source: Chapter 10, Section 10.3; Chapter 9, Section 9.3.1

Explanation

- The examiner wants three clear points: (1) why bending occurs at surface 1, (2) why bending occurs (opposite sense) at surface 2, and (3) contrast with slab.
- Key terms to use: rarer/denser medium, towards/away from normal, angle of deviation, parallel surfaces, lateral displacement.
- Do **not** confuse "opposite directions at two surfaces" (towards normal vs. away from normal) with "opposite net effect" — in a prism, both bendings add up (inclined surfaces), while in a slab they cancel (parallel surfaces).

Q16. medium | thorough-understanding | § 10.3 REFRACTION OF LIGHT THROUGH A PRISM **[2]**

When light passes through a rectangular glass slab, the emergent ray is parallel to the incident ray. When light passes through a triangular glass prism, the emergent ray is NOT parallel to the incident ray. What feature of the prism is responsible for this difference?

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Model Answer

In a rectangular glass slab, the two refracting surfaces are **parallel** to each other. The bending at the two surfaces is equal and opposite, so the emergent ray comes out parallel to the incident ray.

In a triangular glass prism, the two refracting surfaces are **inclined** to each other (at the angle of the prism). Because of this inclination, the bending at the two surfaces does not cancel out, and the emergent ray is deviated from the direction of the incident ray (angle of deviation ∠D is produced).

Source: Chapter 10, Section 10.3; Chapter 9, Section 9.3.1

Explanation

- Examiners want you to explicitly contrast **parallel surfaces** (slab) with **inclined surfaces** (prism).
- Key phrase from the textbook: *"The peculiar shape of the prism makes the emergent ray bend at an angle to the direction of the incident ray."*
- Mention **angle of deviation** for full marks — it shows you understand the consequence of the inclined surfaces.
- Do not write vague answers like "the prism has a different shape" — always state *how* the shape (inclination of surfaces) causes the deviation.

Q17. straightforward | thorough-understanding | § 10.3 REFRACTION OF LIGHT THROUGH A PRISM **[1]**

In the refraction of light through a triangular glass prism, which of the following correctly describes the angle of deviation?
(A) The angle between the incident ray and the refracted ray inside the prism
(B) The angle between the emergent ray and the direction of the original incident ray
(C) The angle between the two refracting surfaces of the prism
(D) The angle at which the emergent ray meets the base of the prism

A The angle between the incident ray and the refracted ray inside the prism
B The angle between the emergent ray and the direction of the original incident ray
C The angle between the two refracting surfaces of the prism
D The angle at which the emergent ray meets the base of the prism

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Model Answer

(B) The angle between the emergent ray and the direction of the original incident ray

Explanation

The textbook (Section 10.3) explicitly states: "The peculiar shape of the prism makes the emergent ray bend at an angle to the direction of the incident ray. This angle is called the angle of deviation (∠D)." Option C describes the angle of the prism, not deviation. Always distinguish between angle of deviation (∠D) and angle of the prism (∠A).

Source: Chapter 10, Section 10.3 – Refraction of Light through a Prism

Q18. straightforward | thorough-understanding | § 10.4 DISPERSION OF WHITE LIGHT BY A GLASS PRISM **[2]**

When white light passes through a glass prism, different colours deviate by different amounts. Using this observation, explain how a prism is able to separate white light into its constituent colours, and state which colour undergoes the maximum and minimum deviation.

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Model Answer

When white light enters a prism, different colours (wavelengths) travel at different speeds in glass and hence refract by different amounts. Since red light bends the least and violet bends the most, each colour emerges along a different path, separating white light into its constituent colours (VIBGYOR) — a process called **dispersion**.

- **Maximum deviation:** Violet
- **Minimum deviation:** Red

Source: Chapter 10, Section 10.4 – Dispersion of White Light by a Glass Prism

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Explanation

Examiners look for two key ideas: (1) different colours bend by different amounts on refraction, and (2) this causes them to emerge along different paths. You must name violet (maximum) and red (minimum) deviation explicitly — these two facts together usually carry 1 mark each or split across the two marks. The word "dispersion" is good to include. Avoid lengthy derivations; a tight 2–3 sentence explanation plus the two named colours is sufficient.

Q19. medium | thorough-understanding | § 10.4 DISPERSION OF WHITE LIGHT BY A GLASS PRISM **[3]**

A student passes white light through a prism and sees a spectrum on a screen. She then passes just the red band from this spectrum through a second identical prism. What will she observe, and why?

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Model Answer

Observation: The red light will pass through the second prism but will **not** split further into more colours. It will emerge as red light only, possibly deviating in direction but remaining red.

Reason: White light is a mixture of seven colours (VIBGYOR). When the first prism disperses it, each colour is already separated. The red band is a single, pure component of the spectrum. Since it is not a mixture of different colours, the second prism has nothing further to disperse — it can only refract (bend) the red light, not split it. This was demonstrated by Newton, who showed that individual colours from a spectrum cannot be dispersed further by a second prism.

Source: Chapter 10, Section 10.4 — Dispersion of White Light by a Glass Prism

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Explanation

- The key idea examiners want: **dispersion requires a mixture of colours**; a single colour cannot be dispersed.
- Mention Newton's experiment — it directly supports this conclusion and is explicitly in the textbook.
- Avoid confusing **refraction** (bending, which still happens) with **dispersion** (splitting into colours, which does NOT happen here).
- 3 marks = observation (1) + reason with reference to dispersion/single colour (1) + Newton's link (1).

Q20. medium | thorough-understanding | § 10.4 DISPERSION OF WHITE LIGHT BY A GLASS PRISM **[3]**

Explain with a labelled ray diagram how a rainbow is formed in the sky after a rain shower. Name all the optical phenomena that occur inside a water droplet and describe the role each plays in producing the coloured arc.

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Model Answer

Rainbow Formation:

A rainbow is formed after rain by dispersion of sunlight through tiny water droplets suspended in the atmosphere. It is always formed opposite to the Sun.

Ray Diagram:

```
Sunlight → [Water Droplet]
/ Refraction (entry)
↓
Internal Reflection
↓
\ Refraction (exit)
→ Dispersed colours (Violet to Red) → Observer's eye
```

(Labelled diagram should show: incident white light, refraction at entry, internal reflection at back surface, refraction at exit, with violet bending most and red least.)

Optical Phenomena and their roles:

1. **Refraction (at entry):** Disperses white sunlight into its seven component colours (VIBGYOR).
2. **Internal Reflection:** Reflects the dispersed light back inside the droplet toward the observer.
3. **Refraction (at exit):** Further separates the colours, making the coloured arc visible to the observer.

Source: Chapter 10, Section 10.4

Explanation

- Examiners expect **all three phenomena** named: refraction (twice) and internal reflection — missing any costs marks.
- The diagram must be **labelled** (incident ray, refraction, internal reflection, emergent colours).
- Note violet deviates most, red least — this is why colours appear as a band/arc.
- Keep diagram simple; a neat single-droplet diagram is sufficient for 3 marks.

Q21. deep thorough-understanding § 10.4 DISPERSION OF WHITE LIGHT BY A GLASS PRISM **[1]**

A rainbow is always seen in the part of the sky that is opposite to the Sun. Which one of the following correctly explains this?

(A) Sunlight must enter the water droplets from behind the observer so that internal reflection sends dispersed light back towards the observer's eyes.
(B) The atmosphere refracts sunlight downward, and only the region opposite the Sun is free of atmospheric interference.
(C) Water droplets on the side facing the Sun absorb light rather than dispersing it.
(D) Dispersion only occurs when light travels from a denser medium to a rarer medium, which happens only on the far side of the droplets.

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Model Answer

(A) Sunlight must enter the water droplets from behind the observer so that internal reflection sends dispersed light back towards the observer's eyes.

Source: Chapter 10, Section 10.4 Dispersion of White Light by a Glass Prism

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Explanation

The textbook explicitly states: "A rainbow is always formed in a direction opposite to that of the Sun. The water droplets act like small prisms. They refract and disperse the incident sunlight, **then reflect it internally**, and finally refract it again when it comes out of the raindrop." This means the Sun must be **behind the observer** for internally reflected, dispersed light to travel back toward the observer's eyes — exactly what option (A) says. Options B, C, and D are scientifically incorrect and not supported by the passage.

Q22. deep thorough-understanding § 10.4 DISPERSION OF WHITE LIGHT BY A GLASS PRISM **[5]**

Dispersion of white light occurs when it passes through a prism but NOT when it passes through a rectangular glass slab (where the emergent beam is white). Using your understanding of refraction at the two surfaces of each, explain why a prism disperses white light while a glass slab does not.

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Model Answer

In a Glass Slab (no dispersion):

A rectangular glass slab has two refracting surfaces that are parallel to each other. When white light enters the first surface (air → glass), different colours bend by different amounts (violet bends most, red least). However, at the second surface (glass → air), the bending is equal and opposite for each colour, because the surfaces are parallel. All colours emerge parallel to each other and parallel to the incident ray. The colours recombine, and the emergent beam remains white. There is lateral displacement but no dispersion.

In a Prism (dispersion occurs):

A prism has two refracting surfaces inclined at an angle (the angle of the prism). When white light enters the first surface, violet bends most and red bends least. At the second inclined surface, instead of cancelling, the bending adds to the original separation. Since the surfaces are not parallel, the deviation of each colour is different and cumulative. The colours therefore emerge along different paths, forming a spectrum — VIBGYOR — on the screen. This splitting of white light into its component colours is called **dispersion**.

Key reason: Parallel surfaces (slab) cancel colour separation; inclined surfaces (prism) compound it.

Source: Chapter 9, Section 9.3.1; Chapter 10, Sections 10.3 and 10.4

Explanation

- The examiner wants you to contrast the **geometry** of the two surfaces — parallel vs. inclined — and link it to whether the colour-wise bending cancels or accumulates.
- Mention VIBGYOR and the fact that violet deviates most, red least (from Section 10.4).
- Use the textbook's own language: "equal and opposite bending at parallel faces," "angle of deviation," "dispersion," "spectrum."
- A common mistake is writing only about the prism; always explain the slab too, since the question specifically asks for both.
- The concluding one-line summary ("parallel → cancel; inclined → compound") is a good examiner-pleasing wrap-up.

Q23. deep | thorough-understanding | § 10.5 ATMOSPHERIC REFRACTION **[3]**

A star near the horizon appears to twinkle more vigorously than a star directly overhead. Using your knowledge of atmospheric refraction, explain why this is so.

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Model Answer

A star near the horizon appears to twinkle more vigorously because its light has to travel through a **greater thickness of the earth's atmosphere** compared to a star overhead. As starlight passes through the atmosphere, it undergoes continuous refraction through layers of varying refractive index. Since atmospheric conditions (temperature, density) keep changing, the path of light varies continuously, causing fluctuations in the amount of light entering the eye. Near the horizon, the longer atmospheric path means greater and more frequent variations, resulting in more vigorous twinkling.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction (Twinkling of Stars)

Explanation

- The key idea is **path length through the atmosphere**: near the horizon = longer path = more layers of varying refractive index = more refraction variation = more twinkling.
- Examiners look for: (1) mention of continuous/variable refraction, (2) the reason why the horizon star is affected more (thicker atmosphere), and (3) the link between fluctuating light and twinkling effect.
- Don't confuse twinkling with scattering — twinkling is purely an **atmospheric refraction** phenomenon.

Q24. medium | thorough-understanding | § 10.5 ATMOSPHERIC REFRACTION **[2]**

Why does the Sun appear to rise about 2 minutes before it actually crosses the horizon?

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Model Answer

The Sun appears to rise about 2 minutes before it actually crosses the horizon due to **atmospheric refraction**. As sunlight enters the Earth's atmosphere, it bends (refracts) towards the normal, making the Sun appear slightly higher than its actual position. Thus, we see the Sun before it has actually crossed the horizon.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction (Advance sunrise and delayed sunset)

Explanation

- The key concept is **atmospheric refraction** — light bends as it passes through layers of air of gradually changing density/refractive index.
- Examiners expect you to clearly state: (1) the cause (atmospheric refraction), and (2) the effect (Sun appears higher/visible before actual crossing of horizon).
- Mentioning "actual sunrise = actual crossing of the horizon" adds precision and shows you've read the definition carefully.
- Do **not** confuse this with scattering of light — that explains colours at sunrise/sunset, not the time difference.

Q25. medium thorough-understanding § 10.5 ATMOSPHERIC REFRACTION **[2]**

Planets, unlike stars, do not appear to twinkle even though they are also very far away. Give a scientific reason for this difference in behaviour.

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Model Answer

Stars appear as **point-sized sources** of light because they are very far away. Due to atmospheric refraction, the amount of starlight entering the eye fluctuates, causing twinkling.

Planets, being much closer, appear as **extended sources** (a collection of many point-sized sources). The variations in light from all these individual points average out to zero, nullifying the twinkling effect. Hence, planets do not twinkle.

Source: Chapter 10, Section 10.5 – Twinkling of Stars

Explanation

- The key contrast is **point source (stars) vs. extended source (planets)** — examiners specifically look for this distinction.
- Mention "averaging out to zero" for planets — this phrase from the textbook scores well.
- Don't just say "planets are closer" without explaining *why* closeness matters (extended source → averaging effect).

Q26. deep | thorough-understanding | § 10.5 ATMOSPHERIC REFRACTION **[3]**

A star near the horizon appears to be at a position slightly higher than its actual position in the sky. Using the concept of atmospheric refraction, explain why this happens.

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Model Answer

When starlight travels from outer space into Earth's atmosphere, it passes through layers of air with gradually increasing density (and refractive index). As the atmosphere bends light towards the normal (from rarer to denser layers), the light rays curve continuously. For a star near the horizon, this bending is more pronounced because light travels through a thicker layer of atmosphere. As a result, the apparent position of the star — where the refracted ray seems to come from — appears slightly higher than its actual position in the sky.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction

Explanation

- **Key concept to state:** Atmospheric refraction occurs because air density (and refractive index) increases gradually from top to bottom.
- **Direction of bending:** Light bends towards the normal as it enters denser layers → overall path curves upward → apparent position shifts higher.
- **Why near horizon:** Light travels through a greater thickness of atmosphere, so the effect is stronger near the horizon.
- Examiners look for: mention of gradually changing refractive index, bending towards normal, and the conclusion that apparent position is higher than actual. Three clear points = 3 marks.

Q27. medium | thorough-understanding | § 10.6 SCATTERING OF LIGHT **[3]**

Why does the sky appear blue during the day, but an astronaut at very high altitude sees a dark sky instead?

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Model Answer

The sky appears blue due to **scattering of light**. The atmosphere contains fine particles (air molecules, dust, etc.) whose size is smaller than the wavelength of visible light. These particles scatter shorter wavelengths (blue light) much more strongly than longer wavelengths (red light). This scattered blue light reaches our eyes from all directions, making the sky appear blue.

At very high altitudes, the atmosphere is extremely thin and there are very few scattering particles. Since scattering is not prominent at such heights, the sky appears dark to astronauts.

Source: Chapter 10, Section 10.6.2 — Why is the colour of the clear Sky Blue?

Explanation

- **Two parts needed (split marks ~2+1):** Explain scattering causing blue sky, then explain why it's dark at high altitude.
- Key phrase to use: *"scattering of blue light (shorter wavelength) is more than red light (longer wavelength)."*
- The astronaut answer is direct from the textbook: *"The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights."* Quote or paraphrase this line — examiners look for it specifically.
- Avoid over-explaining Tyndall effect here; it's not directly asked.

Q28. deep | thorough-understanding | § 10.6 SCATTERING OF LIGHT **[3]**

A beam of white light passes through a colloidal suspension containing very fine particles. A second colloidal suspension contains much larger particles. How would the colour of the scattered light differ between the two suspensions, and why?

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Model Answer

Suspension 1 (very fine particles): The scattered light appears **blue**. Fine particles preferentially scatter shorter wavelengths (blue light), similar to how air molecules scatter blue light to make the sky appear blue.

Suspension 2 (larger particles): The scattered light appears **white** (or a mixture of longer wavelengths). Larger particles scatter light of longer wavelengths as well, and if the particles are large enough, all visible wavelengths are scattered, making the scattered light appear white.

Reason: The colour of scattered light depends on the size of the scattering particles. Very fine particles scatter mainly blue light (shorter wavelengths), while larger particles scatter light of longer wavelengths too, eventually appearing white.

Source: Chapter 10, Section 10.6.1 – Tyndall Effect

Explanation

- The key textbook line is: *"Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelengths. If the size of the scattering particles is large enough, then, the scattered light may even appear white."*
- Examiners expect you to clearly name the colour for each suspension and give the reason linked to particle size vs. wavelength.
- Don't just say "blue light is scattered more" — connect it to **particle size** being the deciding factor.

Q29. medium | thorough-understanding | § 10.6 SCATTERING OF LIGHT **[1]**

When sunlight filters through a dense forest canopy containing mist, bright shafts of light become visible. Explain the optical phenomenon responsible for this observation and state what the visibility of these shafts tells us about the size of the particles present in the mist.

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Model Answer

This is the **Tyndall Effect** — mist particles (tiny water droplets) scatter sunlight, making the beam's path visible. The visibility of white/bright shafts indicates the scattering particles are **large enough** (colloidal/larger size) to scatter all wavelengths.

Source: Chapter 10, Section 10.6.1 – Tyndall Effect

Explanation

- Examiners expect the term **Tyndall Effect** to be named explicitly — that alone can fetch the mark.
- The second part (particle size) is the key inference: large particles scatter longer wavelengths too, so light appears white/bright rather than blue. Mention this briefly.
- Do not confuse with refraction or dispersion — the phenomenon here is **scattering by colloidal particles**.

Q30. deep | thorough-understanding | § (whole-chapter synthesis) **[3]**

A glass prism disperses white light into a spectrum of colours, but the eye's lens system does not produce rainbow-coloured vision even though both involve refraction. Explain why the eye's lens does not disperse light into colours the way a glass prism does.

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Model Answer

A glass prism disperses white light because its two refracting surfaces are **inclined** to each other. Different colours (wavelengths) of light bend by different amounts — violet bends the most, red the least — causing them to emerge along separate paths, producing a spectrum.

The eye's lens has **curved, symmetrical surfaces** (not inclined like a prism). Although the lens refracts light, the refracting surfaces are arranged so that all colours are converged to (approximately) the same focal point on the retina, rather than being spread apart. Additionally, the lens forms a focused image, so colours do not separate into distinct bands. Thus, no dispersion is perceived.

Source: Chapter 10, Section 10.3 and 10.4

Explanation

- The key distinction examiners look for: **prism = inclined surfaces → colours emerge at different angles = dispersion**; **eye lens = curved converging surfaces → colours focused together = no dispersion visible**.
- You don't need to know the biological term "chromatic aberration" for Class 10, but the physics reasoning (different angles of deviation for different colours in a prism vs. convergence by a lens) is what earns marks.
- The passage explicitly states that "different colours of light bend through different angles" in a prism and that the inclined faces cause deviation — use this language in your answer.

Q31. medium | thorough-understanding | § (whole-chapter synthesis) **[1]**

Assertion (A): A person with presbyopia may need bi-focal lenses that combine both a concave and a convex portion.
Reason (R): Presbyopia can involve simultaneous difficulty in seeing both distant and nearby objects clearly.

A Both A and R are true, and R is the correct explanation of A.
B Both A and R are true, but R is not the correct explanation of A.
C A is true but R is false.
D A is false but R is true.

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Model Answer

Option A — Both A and R are true, and R is the correct explanation of A.

A presbyopic person may suffer from both myopia and hypermetropia simultaneously, requiring bi-focal lenses with a concave portion (for distant vision) and a convex portion (for near vision). R correctly explains why A is true.

Source: Chapter 10, Section 10.2(c) – Presbyopia

Explanation

The textbook explicitly states that a person suffering from both myopia and hypermetropia (which can occur with presbyopia) often requires bi-focal lenses consisting of **concave** (upper, for distant vision) and **convex** (lower, for near vision) portions. The Reason directly and correctly explains *why* bi-focal lenses are needed — hence Option A is correct, not B. Students often confuse presbyopia with only one defect; remember it can involve both.

Q32. medium | thorough-understanding | § (whole-chapter synthesis) **[2]**

Stars twinkle when observed from Earth, but the Sun does not appear to twinkle even though it is also a star. Explain why the Sun does not produce a twinkling effect, referring to the relevant physical property that distinguishes it from distant stars as seen from Earth.

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Model Answer

Stars twinkle because they are very far away and appear as **point-sized sources** of light. As starlight passes through the ever-changing layers of the atmosphere, continuous refraction causes the amount of light reaching the eye to flicker, producing the twinkling effect.

The Sun, though also a star, is much closer to Earth and therefore appears as an **extended source** (not a point source). When light from a large number of point-sized regions of the Sun's disc is considered, the fluctuations in light from all these points average out to zero, nullifying any twinkling effect.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction

Explanation

- The key distinction examiners look for is **point source vs. extended source**.
- Mention that stars are distant → point-sized; Sun is close → extended source.
- State clearly that for an extended source, individual fluctuations cancel out → no twinkling.
- Do not just say "Sun is closer" — you must link it to the *extended source* concept to earn both marks.

Q33. deep thorough-understanding § (whole-chapter synthesis) **[3]**

Both the twinkling of stars and the advance sunrise are caused by atmospheric refraction, yet they are observed as very different phenomena. Compare the two, explaining what specific property of the atmosphere is responsible in each case and why the effects differ.

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Model Answer

Both phenomena involve atmospheric refraction, but they differ in which property of the atmosphere is responsible:

Twinkling of stars: Caused by the **continuously changing physical conditions** (density/refractive index) of the atmosphere. Since stars are point-sized sources, even slight fluctuations in the refractive index alter the path of light, making the amount of light entering the eye flicker — appearing alternately brighter and fainter.

Advance sunrise: Caused by the **gradual increase in refractive index** of the atmosphere from top to bottom (denser air near Earth's surface). Sunlight bends continuously toward the normal, making the Sun appear above the horizon about 2 minutes before it actually crosses it. Here conditions are stable, so no flickering occurs — only a steady shift in apparent position.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction

Explanation

- The key distinction examiners look for: twinkling = **changing** refractive index (unstable atmosphere) → flickering; advance sunrise = **density gradient** of atmosphere (stable, layered) → steady positional shift.
- Mention that stars are point sources (which is why planets don't twinkle) — this supports why even tiny fluctuations cause a visible effect.
- Avoid confusing the two effects; they share the same cause (atmospheric refraction) but different *aspects* of it.

Q34. deep | thorough-understanding | § (whole-chapter synthesis) **[3]**

White light entering a glass prism emerges as a spectrum of colours. Using your knowledge of how different colours of light behave when passing through a medium, predict which colour of light would be most scattered by fine atmospheric particles, and explain how this determines the colour of the sky we see during the day.

◆ **The Human Eye and the Colourful World**

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Model Answer

From dispersion, we know that violet and blue light (shorter wavelengths) bend the most through a prism, while red light bends the least. This indicates that shorter wavelengths interact more strongly with matter.

When sunlight enters the atmosphere, fine particles (smaller than the wavelength of visible light) scatter **blue light** most strongly, as it has a shorter wavelength. Red light, having the longest wavelength, is scattered the least.

The scattered blue light reaches our eyes from all directions across the sky, making the sky appear **blue** during the day.

Source: Chapter 10, Section 10.6.2 – Why is the colour of the clear Sky Blue?

Explanation

- The examiner expects you to **link dispersion** (violet/blue bends most → shorter wavelength) to scattering behaviour — this earns the first mark.
- Explicitly stating **blue is most scattered** due to shorter wavelength = second mark.
- Explaining that this scattered blue light **enters our eyes**, making the sky look blue = third mark.
- Avoid mentioning Rayleigh scattering by name — it is not in the CBSE Class 10 syllabus. Stick to "shorter wavelengths are scattered more."
- The danger-signal point (red least scattered) is a useful supporting fact but not required here.

Q35. medium | thorough-understanding | § (whole-chapter synthesis) **[2]**

At sunset, the Sun appears red, yet the sky around it may still appear slightly bluish. Briefly explain why these two colours appear simultaneously in the sky at that moment.

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Model Answer

At sunset, sunlight travels a longer path through the atmosphere. Most of the blue light (shorter wavelength) is scattered away by fine particles, leaving mainly red and orange light to reach our eyes — making the Sun appear red.

However, some blue light scattered sideways from other parts of the atmosphere still reaches our eyes, making the surrounding sky appear slightly bluish.

Source: Chapter 10, Section 10.6.2 — Scattering of Light

Explanation

- The key concept is **scattering of light**: shorter wavelengths (blue) scatter more, longer wavelengths (red) scatter least.
- At sunset, the longer atmospheric path means nearly all blue is scattered out of the direct line of sight → red Sun.
- Blue light scattered at angles from other overhead/surrounding air still enters the eye → slightly blue sky.
- Examiners expect both effects to be linked explicitly to scattering and wavelength. One mark for each colour's explanation.

Q36. deep thorough-understanding § (whole-chapter synthesis) **[5]**

A student makes the following argument: 'The defects of vision — myopia, hypermetropia, and presbyopia — are all essentially the same problem: the image does not fall on the retina. So they should all be correctable with the same type of lens.' Evaluate this argument. Identify what is correct in it and where the reasoning breaks down, referring to the causes and corrections of each defect.

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Model Answer

What is correct: The student is right that in all three defects, the image does not fall on the retina, causing blurred vision. It is also true that all three are correctable using spherical lenses.

Where the reasoning breaks down: The three defects differ in cause and direction of image shift, so they require *different* types of lenses:

- **Myopia:** Image forms *in front of* the retina due to excessive curvature of the eye lens or elongation of the eyeball. Corrected by a **concave (diverging) lens**.
- **Hypermetropia:** Image forms *behind* the retina because the focal length of the eye lens is too long or the eyeball is too small. Corrected by a **convex (converging) lens**.
- **Presbyopia:** Caused by weakening of ciliary muscles and reduced flexibility of the eye lens with age, reducing the power of accommodation. Often requires **bi-focal lenses** (concave portion for distant vision, convex for near vision).

Since the image displacement and underlying causes differ, one lens type cannot correct all three defects.

Source: Chapter 10, Section 10.2 – Defects of Vision and their Correction

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Explanation

- Examiners expect you to **acknowledge the valid part** of the argument first — it shows analytical thinking.
- The key error to expose is that image displacement direction differs (in front vs. behind retina), demanding opposite lens types.
- Presbyopia is distinct — it's about *loss of accommodation*, not just image position — so it gets special mention (bifocals).
- Name each defect, its cause, image position, and correction lens. That covers all 5 marks.

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