CBSE CLASS X

Science (086)

ANSWER KEY

AI-generated question paper

Code: EHEN6D	Questions: 36	Maximum Marks: 76	Generated: 2026-06-25 17:46

SELECTIONS USED

Subject	Science
Lessons	10 The Human Eye and the Colourful World
Level of understanding	Exam-ready
Question selection	CBSE board paper, whole lesson (~80 marks across Sections A-E)
Model	claude-sonnet-4-6

Composition — Difficulty: 15 straightforward · 14 medium · 7 deep | Types: 13 MCQ · 7 Short · 5 Assertion–reason · 5 Very short · 3 Long · 3 Case-based | Sections: A 18Q/18m · B 5Q/10m · C 7Q/21m · D 3Q/15m · E 3Q/12m

Q1. straightforward exam-ready **[1]**

A person can see nearby objects clearly but has difficulty seeing distant objects. Which type of lens is used to correct this defect?

A Convex lens
B Concave lens
C Bifocal lens
D Cylindrical lens

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Model Answer

Answer: B — Concave lens

This defect is **myopia (near-sightedness)**. It is corrected by using a **concave lens** of suitable power, which brings the image back onto the retina.

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

Explanation

- The key phrase "sees nearby clearly, difficulty with distant" = **myopia**.
- Myopia is corrected by a **concave (diverging) lens** — not convex.
- Convex lens corrects hypermetropia; bifocal corrects presbyopia; cylindrical corrects astigmatism (not in this syllabus).
- For MCQs, always link the symptom → defect name → corrective lens in your recall.

Q2. straightforward exam-ready **[1]**

The part of the human eye that is responsible for most of the refraction of incoming light is the:

A Eye lens
B Retina
C Cornea
D Ciliary muscles

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Model Answer

C — Cornea

The cornea is responsible for most of the refraction of incoming light. The eye lens only provides finer adjustment of focal length.

Source: Chapter 10, Section 10.1 – The Human Eye

Explanation

The textbook explicitly states: *"Most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea."* The eye lens only fine-tunes focus. Students often incorrectly choose "Eye lens" — remember, the lens handles **accommodation**, not the bulk of refraction. Cornea is the correct answer.

Q3. straightforward exam-ready **[1]**

When white light passes through a glass prism, the colour that deviates the LEAST is:

A Violet
B Blue
C Green
D Red

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Model Answer

D – Red

Red light bends the least while passing through a glass prism, as different colours bend through different angles; violet bends the most.

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

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Explanation

The textbook explicitly states: *"The red light bends the least while the violet the most."* In dispersion, VIBGYOR is the order from most deviated (Violet) to least deviated (Red). Examiners expect you to recall this directly — just state the colour and give a one-line reason.

Q4. straightforward exam-ready **[1]**

The correct sequence of colours in the spectrum of white light from the least deviated to the most deviated is:

A Violet, Indigo, Blue, Green, Yellow, Orange, Red
B Red, Orange, Yellow, Green, Blue, Indigo, Violet
C Red, Green, Violet, Yellow, Orange, Indigo, Blue
D Violet, Blue, Green, Red, Orange, Yellow, Indigo

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Model Answer

The correct answer is **(B) Red, Orange, Yellow, Green, Blue, Indigo, Violet**.

Red light bends the least and violet bends the most while passing through a prism, so the sequence from least to most deviated follows ROYGBIV.

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

Explanation

The textbook clearly states: *"The red light bends the least while the violet the most."* The acronym VIBGYOR gives the spectrum order from violet to red (most to least deviated), so reversing it gives the order from least to most deviated: Red, Orange, Yellow, Green, Blue, Indigo, Violet — option B. Don't confuse VIBGYOR (spectrum order on screen) with the order of deviation.

Q5. medium exam-ready **[1]**

Stars twinkle at night but planets do not. The most accurate reason for this difference is:

A Planets emit their own light while stars do not
B Planets are much closer to Earth and act as extended sources, so light variations average out
C Stars are hotter than planets and so their light fluctuates more
D Planets move faster across the sky, reducing the twinkling effect

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Model Answer

Answer: B

Planets are much closer to Earth and act as extended sources of light, so the fluctuations in light from individual point-sized sources average out to zero, nullifying the twinkling effect.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction

Explanation

The textbook explicitly states that planets, being closer, appear as **extended sources** (collection of many point-sized sources), and the total variation in light entering the eye averages out to zero. Stars, being very distant, act as **point sources**, so atmospheric refraction causes their light to flicker — producing twinkling. Option A is wrong (planets reflect light, not emit); C and D have no textual or scientific basis.

Q6. medium exam-ready **[1]**

A rainbow is always observed in the direction opposite to the Sun. Which set of optical phenomena is responsible for its formation?

A Refraction and scattering
B Dispersion, internal reflection and refraction
C Reflection and diffraction
D Scattering and total internal reflection

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Model Answer

Answer: B — Dispersion, internal reflection and refraction

A rainbow is formed when water droplets refract and disperse sunlight, reflect it internally, and refract it again as light exits, separating colours (VIBGYOR) in the direction opposite to the Sun.

Source: Chapter 10, Section 10.4

Explanation

The textbook explicitly states: "The water droplets act like small prisms. They **refract and disperse** the incident sunlight, then **reflect it internally**, and finally **refract it again**." This makes Option B the only correct combination. Scattering and diffraction are **not** involved in rainbow formation — don't confuse rainbow with sky colour (scattering) or shadow phenomena (diffraction).

Q7. medium exam-ready **[1]**

The sky appears dark to astronauts flying at very high altitudes because:

A Sunlight does not reach very high altitudes
B At such altitudes, the atmosphere is too cold to scatter light
C Scattering of sunlight by air particles is not prominent at such heights
D The Sun's rays are parallel at great heights and do not spread

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Model Answer

Correct Option: C — Scattering of sunlight by air particles is not prominent at such heights.

At very high altitudes, the atmosphere is very thin, so scattering of sunlight by air particles is negligible, making the sky appear dark.

Explanation

The textbook (Section 10.6.2) explicitly states: *"The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights."* The blue colour of the sky is caused by scattering of sunlight by fine atmospheric particles. At very high altitudes, the atmosphere is too thin for significant scattering to occur, so no scattered blue light reaches the eye — the sky looks dark. Options A, B, and D are incorrect explanations not supported by the textbook.

Q8. straightforward exam-ready **[1]**

In hypermetropia, the image of a nearby object is formed:

A In front of the retina
B On the retina
C Behind the retina
D On the cornea

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Model Answer

Option C: Behind the retina

In hypermetropia (far-sightedness), the eyeball is too short, so the image of a nearby object is focused **behind the retina** instead of on it. It is corrected using a convex lens.

Explanation

The "What you have learnt" section of Chapter 10 directly states: *"Hypermetropia (far-sightedness – the image of nearby objects is focussed beyond the retina)."* "Beyond the retina" and "behind the retina" mean the same thing here. Examiners expect you to recall this one-line definition precisely. Myopia is "in front of" the retina; hypermetropia is "behind" — keep these two contrasted clearly.

Q9. straightforward exam-ready **[1]**

Bifocal lenses are commonly prescribed for people suffering from:

A Myopia only
B Hypermetropia only
C Both myopia and hypermetropia simultaneously
D Cataract

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Model Answer

Answer: C — Both myopia and hypermetropia simultaneously

Bifocal lenses contain both concave (upper part) and convex (lower part) lenses. They are prescribed when a person suffers from both myopia and hypermetropia at the same time.

Explanation

The textbook (Chapter 10, Section 10.2) explicitly states: *"Sometimes, a person may suffer from both myopia and hypermetropia. Such people often require bi-focal lenses."* The upper concave portion corrects distant vision (myopia) and the lower convex portion corrects near vision (hypermetropia). Cataract is not a refractive error and is not corrected by bifocal lenses.

Q10. straightforward exam-ready **[1]**

Which colour of light is scattered the MOST by fine particles in the earth's atmosphere?

A Red
B Green
C Yellow
D Blue

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Model Answer

Answer: D — Blue

Blue light has the shortest wavelength in visible light, so fine atmospheric particles scatter it most strongly. This is why the clear sky appears blue.

Source: Chapter 10, Section 10.6.2

Explanation

- The key principle: **shorter wavelength = more scattering** by fine particles.
- Blue has the shortest wavelength among the options; red has the longest and is scattered the least (hence used for danger signals).
- For a 1-mark MCQ, just state the correct option and one supporting reason — no need for elaboration.

Q11. medium exam-ready **[1]**

The Sun is visible to us about 2 minutes before actual sunrise. This is due to:

A Scattering of sunlight
B Atmospheric refraction
C Dispersion of sunlight
D Reflection from the ionosphere

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Model Answer

Answer: B — Atmospheric Refraction

The Sun is visible ~2 minutes before actual sunrise due to atmospheric refraction. The Earth's atmosphere bends sunlight towards the normal, making the Sun appear above the horizon before it actually crosses it.

Explanation

The source passage (Chapter 10, Section 10.5 – Atmospheric Refraction) explicitly states: *"The Sun is visible to us about 2 minutes before the actual sunrise...because of atmospheric refraction."* Scattering causes the blue sky/red sunset colours, not early visibility — don't confuse the two.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction

Q12. straightforward exam-ready **[1]**

The angle between the emergent ray and the direction of the incident ray when light passes through a prism is called the:

A Angle of prism
B Angle of refraction
C Angle of deviation
D Critical angle

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Model Answer

C — Angle of deviation

The angle between the emergent ray and the direction of the incident ray when light passes through a prism is called the **angle of deviation** (∠D).

Explanation

The passage from Chapter 10 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."* Angle of prism (A) is between the two lateral faces; angle of refraction is at the surface; critical angle relates to total internal reflection — all distractors here.

Q13. straightforward exam-ready **[1]**

The condition in which the crystalline lens of the eye becomes milky and cloudy, causing partial or complete loss of vision, is known as:

A Myopia
B Presbyopia
C Astigmatism
D Cataract

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Model Answer

D. Cataract — The condition in which the crystalline lens becomes milky and cloudy, causing partial or complete loss of vision, is called **cataract**.

Source: Chapter 10, Section 10.1 (The Human Eye)

Explanation

The passage explicitly states: *"Sometimes, the crystalline lens of people at old age becomes milky and cloudy. This condition is called cataract."* Myopia, Hypermetropia, and Presbyopia are refractive defects — they do not involve the lens turning cloudy. Always link cataract to the key phrase "milky and cloudy crystalline lens."

Q14. medium exam-ready **[1]**

Assertion (A): Red light is used for danger signals at airports and on tall buildings.
Reason (R): Red light has the longest wavelength among visible colours and is scattered the least by fog or smoke.

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.

Red light has the longest wavelength among visible colours and is therefore scattered the least by fog or smoke, making danger signals visible from a distance.

Source: Chapter 10, Section 10.6 – Scattering of Light

Explanation

The textbook explicitly states: *"The red is least scattered by fog or smoke. Therefore, it can be seen in the same colour at a distance."* This directly links the use of red for danger signals (A) to its least scattering due to longest wavelength (R), making R the correct and complete explanation of A. Choose **A**.

Q15. medium exam-ready **[1]**

Assertion (A): When the ciliary muscles of the eye relax, the eye lens becomes thin and its focal length increases.
Reason (R): A thinner lens has less curvature, which decreases its converging power and allows the eye to focus on distant objects.

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

Answer: A

Both A and R are true, and R is the correct explanation of A. When ciliary muscles relax, the lens becomes thin (less curvature), reducing converging power, increasing focal length, enabling clear vision of distant objects.

Source: Chapter 10, Section 10.1.1 Power of Accommodation

Explanation

- The textbook directly states: "When the muscles are relaxed, the lens becomes thin. Thus, its focal length increases. This enables us to see distant objects clearly."
- R correctly explains *why* A happens: a thinner lens → less curvature → less converging power → greater focal length → distant object focus. This is a direct cause-effect chain, so R is the correct explanation of A.
- Choose **Option A** when both statements are true AND the Reason logically and correctly explains the Assertion.

Q16. deep exam-ready **[1]**

Assertion (A): The apparent position of a star near the horizon is slightly higher than its actual position.
Reason (R): The earth's atmosphere refracts starlight, bending it towards the normal as it passes through layers of increasing density.

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.

Atmospheric refraction bends starlight towards the normal as it travels through increasingly dense layers, making the star appear slightly higher than its actual position near the horizon.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction

Explanation

- **A is true**: The textbook explicitly states "The star appears slightly higher (above) than its actual position when viewed near the horizon."
- **R is true**: The atmosphere bends starlight towards the normal as density increases — this is standard refraction behaviour.
- **R correctly explains A**: The upward apparent shift is a direct result of this refraction — so R is the correct explanation, making Option A the right choice.
- Key phrase to remember: *"Since the atmosphere bends starlight towards the normal, the apparent position of the star is slightly different from its actual position."*

Q17. medium exam-ready **[1]**

Assertion (A): White light passing through a second prism placed in an inverted position relative to the first prism emerges as white light again.
Reason (R): The second prism recombines the dispersed colours back into white light.

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 is correct. Both A and R are true, and R is the correct explanation of A. Newton placed a second prism inverted relative to the first; it recombined the dispersed colours, and white light emerged from the other side.

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

Explanation

The passage explicitly states that Newton placed a second identical prism in an inverted position, and white light emerged from the other side. The reason — that the second prism recombines the dispersed colours — directly and correctly explains why white light re-emerges. So both statements are true and causally linked, making Option A the right choice.

Q18. deep exam-ready **[1]**

Assertion (A): Objects seen through a column of hot air rising above a fire appear to waver.
Reason (R): The hot air above a fire is less dense than the surrounding cooler air, creating continuously changing refractive index layers that cause light to bend irregularly, making the objects appear to shimmer.

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.

Hot air above fire is less dense, has a lower refractive index, and its continuously changing physical conditions cause irregular bending of light, making objects appear to waver.

Source: Chapter 10, Section 10.5 — Atmospheric Refraction

Explanation

The textbook explicitly states that hotter air is lighter (less dense) with a slightly lower refractive index, and since physical conditions are not stationary, the apparent position of objects fluctuates — exactly what R describes. Both A and R are correct, and R directly and fully explains A, so option A is the right choice. Examiners expect you to link "less dense → lower refractive index → changing conditions → irregular bending → wavering" as one connected chain of reasoning.

Q19. straightforward exam-ready **[2]**

State two causes that can lead to the development of myopia in a human eye.

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Model Answer

Two causes of myopia are:

1. **Excessive curvature of the eye lens** — the lens becomes too curved, causing the image of a distant object to form in front of the retina instead of on it.
2. **Elongation of the eyeball** — the eyeball becomes too long, so the retina lies beyond the focal point of the lens.

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

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Explanation

The question asks specifically for **causes**, not symptoms or correction. Both points must be stated for full 2 marks (1 mark each). Examiners expect the exact textbook phrasing: "excessive curvature of the eye lens" and "elongation of the eyeball." Simply writing "weak eye lens" or "long eye" without the correct terminology may lose marks. No diagram is needed for a very short answer.

Q20. straightforward exam-ready **[2]**

What is the Tyndall effect? Give one example from nature where this phenomenon can be observed.

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Model Answer

Tyndall Effect: When a beam of light passes through a colloidal solution or a heterogeneous mixture, the path of light becomes visible due to scattering of light by the fine particles suspended in the medium. This phenomenon is called the Tyndall effect.

Example from nature: When sunlight passes through the canopy of a dense forest, tiny water droplets in the mist scatter the light, making the beam of sunlight visible. This is the Tyndall effect.

Source: Chapter 10, Section 10.6.1

Explanation

- **Mark 1** is for the correct definition — scattering of light by colloidal/fine particles making the beam visible.
- **Mark 2** is for a valid natural example. Both "sunlight through forest canopy" and "sunlight through a smoke-filled room" are acceptable. Examiners want the example to name the scattering particles (water droplets/smoke particles).
- Avoid confusing Tyndall effect with refraction or reflection — it is specifically **scattering** by colloidal/fine particles.

Q21. medium exam-ready **[2]**

Explain why the Sun appears reddish at sunrise and sunset but appears white or yellow-white at noon.

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Model Answer

At sunrise and sunset, sunlight travels a **longer path** through the atmosphere. Most of the shorter wavelengths (blue, violet) are scattered away, leaving mainly red and orange light to reach our eyes, making the Sun appear **reddish**.

At noon, sunlight travels the **shortest path** through the atmosphere, so very little scattering occurs and the Sun appears **white or yellow-white**.

Source: Chapter 10, Section 10.6.2 – Scattering of Light

Explanation

- The key concept is **differential scattering**: shorter wavelengths (blue/violet) scatter more than longer wavelengths (red/orange).
- At sunrise/sunset → longer atmospheric path → more blue scattered away → red dominates.
- At noon → shortest path → least scattering → nearly all colours reach us → white/yellow-white.
- Examiners expect you to explicitly mention **path length** and **scattering of shorter wavelengths** for both marks.

Q22. straightforward exam-ready **[2]**

What is the far point of a normal human eye? How does this differ in a person with myopia?

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Model Answer

The far point of a normal human eye is **infinity**, meaning a normal eye can see objects clearly up to an infinite distance.

In a person with **myopia (near-sightedness)**, the far point is nearer than infinity — only a few metres away. This is because the image of a distant object is formed in front of the retina instead of on it.

Source: Chapter 10, Section 10.1.1 & 10.2(a)

Explanation

- **Far point of normal eye = infinity** — this is a direct, frequently asked fact; must be stated clearly.
- For myopia, the key phrase is **"nearer than infinity"** — examiners expect this specific contrast.
- Mentioning that the image forms **in front of the retina** (not on it) strengthens the answer and may fetch the second mark.
- Avoid writing lengthy descriptions of causes or corrections — this is a 2-mark question; keep it tight.

Q23. straightforward exam-ready **[2]**

The power of accommodation of a person's eye gradually decreases as they grow older. Name this condition and state TWO reasons for its occurrence.

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Model Answer

Presbyopia is the condition in which the power of accommodation of the eye decreases with age.

Two reasons:

1. Gradual weakening of the ciliary muscles.
2. Diminishing flexibility (reduced elasticity) of the eye lens.

Source: Defects of Vision and Their Correction, Chapter 10

Explanation

The question asks for the name (1 mark) and two reasons (1 mark). Examiners expect the exact term **presbyopia —** not just a description. The two reasons must come directly from the textbook: ciliary muscle weakening and reduced lens flexibility. Do not confuse presbyopia with hypermetropia (far-sightedness), which is a separate defect. No diagram or correction method is needed here.

Q24. medium exam-ready **[3]**

Draw a labelled ray diagram showing how a concave lens corrects myopia in a person whose far point is closer than infinity. Your diagram must show the position of the image before and after correction.

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Model Answer

Labelled Ray Diagram – Correction of Myopia using Concave Lens:

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Without correction (myopic eye):
Distant object → Eye lens → Image formed IN FRONT of retina ✗

With correction:
Distant object → Concave lens → Diverged rays → Eye lens → Image ON retina ✓
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Description of Diagram:

- A distant object (at infinity) sends parallel rays towards the eye.
- **Before correction:** The myopic eye converges these rays to a point **in front of the retina** (not on it), since the far point is closer than infinity.
- A **concave (diverging) lens** of suitable power is placed in front of the eye.
- **After correction:** The concave lens diverges the parallel rays such that they appear to come from the person's far point. The eye lens then focuses them **exactly on the retina**, forming a clear image.

Key labels required: Distant object, concave lens, eye lens, retina, image before correction (in front of retina), image after correction (on retina), far point.

Source: Chapter 10, Section 10.2(a) – Myopia

Explanation

- Examiners expect an **actual drawn diagram** with all labels; describe it fully if drawing isn't possible in text.
- The three must-show elements for full marks: (1) image in front of retina without lens, (2) concave lens placed before the eye, (3) image shifted onto the retina after correction.
- Mention that the concave lens makes rays appear to diverge from the person's own far point — this is the key optical principle examiners reward.
- Do **not** use a convex lens; that corrects hypermetropia.

Q25. straightforward exam-ready **[3]**

The human eye has several specialised parts that work together to form a clear image. Explain the specific function of each of the following, stating what would happen if each part were absent or damaged: (i) Cornea, (ii) Iris, (iii) Retina.

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Model Answer

(i) Cornea: The cornea is the transparent membrane on the front of the eyeball where most refraction of light occurs. If absent or damaged, light cannot be properly refracted into the eye, causing severely blurred or complete loss of vision.

(ii) Iris: The iris is a dark muscular diaphragm that controls the size of the pupil, regulating the amount of light entering the eye. If damaged, the eye cannot adjust to varying light intensities, causing discomfort or poor vision in bright/dim conditions.

(iii) Retina: The retina is a delicate membrane containing light-sensitive cells that generate electrical signals sent to the brain via optic nerves. If damaged, images cannot be detected or transmitted to the brain, leading to loss of vision.

Source: Chapter 10, Section 10.1 – The Human Eye

Explanation

- Each part requires a **function + consequence of damage** — examiners award marks for both parts together.
- Use textbook terminology: "muscular diaphragm" (iris), "transparent membrane / most refraction" (cornea), "light-sensitive cells / electrical signals" (retina).
- Do not confuse pupil (opening) with iris (the muscle controlling it) — a common error.
- Keep each point to 2–3 lines; one mark per part.

Q26. straightforward exam-ready **[3]**

When white light is passed through a glass prism, a band of colours is observed on a screen placed on the other side. (i) Name this band and the phenomenon responsible for its formation. (ii) Explain why different colours emerge at different angles from the prism, and identify which colour undergoes the maximum and minimum deviation.

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Model Answer

(i) The band of colours formed on the screen is called the **spectrum**. The phenomenon responsible for its formation is **dispersion of light**.

(ii) White light is made up of seven colours, each having a different wavelength. When light enters the prism, different colours bend (refract) by different amounts because each colour travels at a different speed in glass. **Violet light undergoes maximum deviation** (bends the most), while **red light undergoes minimum deviation** (bends the least). Thus, each colour emerges at a different angle, forming the spectrum — VIBGYOR.

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

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Explanation

- **Key terms to use:** spectrum, dispersion, deviation — examiners look for these exact words.
- The reason for different bending is that different colours have different speeds (and hence different refractive indices) in glass — mention this for full marks.
- Always state both: **violet = maximum deviation**, **red = minimum deviation**. Forgetting one costs a mark.
- VIBGYOR is a helpful sequence to mention briefly; it shows you know the order of colours.

Q27. medium exam-ready **[3]**

Explain why stars twinkle on a clear night. Your answer must include the role of the earth's atmosphere and the nature of stars as light sources.

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Model Answer

Stars twinkle because of **atmospheric refraction** of starlight. As starlight enters the earth's atmosphere, it passes through layers of air with continuously changing refractive indices (due to varying temperature and density). This causes the path of light to keep shifting slightly.

Since stars are extremely distant, they act as **point-sized sources** of light. Even a tiny shift in the light path causes the amount of starlight reaching our eye to fluctuate — making the star appear sometimes brighter and sometimes fainter. This flickering is perceived as twinkling.

Source: Chapter 10, Section 10.5 — Atmospheric Refraction

Explanation

Examiners look for **three specific points** (one per mark):

1. **Cause** — atmospheric refraction through layers of varying refractive index/density.
2. **Effect** — continuously changing path of starlight → fluctuating amount of light reaching the eye.
3. **Nature of stars** — point-sized (very distant) sources, so no averaging-out occurs (unlike planets).

Avoid writing too much about planets unless specifically asked — it wastes time. The phrase "point-sized sources" is key terminology the examiner expects.

Q28. deep exam-ready **[3]**

A hypermetropic person has a near point of 1.5 m. Calculate the power of the corrective lens needed so that she can read a book placed at 25 cm from her eyes.

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Model Answer

Given:

- Near point of hypermetropic person, v = −1.5 m (image must form at her near point)
- Object distance, u = −25 cm = −0.25 m

Using the lens formula:

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

$$\frac{1}{f} = \frac{1}{-1.5} - \frac{1}{-0.25} = -\frac{1}{1.5} + \frac{1}{0.25}$$

$$\frac{1}{f} = -0.667 + 4 = 3.33 \text{ m}^{-1}$$

$$\therefore P = +3.33 \text{ D}$$

The corrective lens is a **convex lens** of power **+3.33 D**.

Source: Light – Reflection and Refraction, Chapter 9 (Lens Formula); The Human Eye and the Colourful World, Chapter 10 (Hypermetropia)

Explanation

- Hypermetropia is corrected by a **convex (converging) lens**.
- The lens must form a virtual image at the person's own near point (−1.5 m) when the object is at 25 cm — so $v = -1.5$ m and $u = -0.25$ m (both negative by sign convention for real object, virtual image on same side).
- Power = $\frac{1}{f(\text{in metres})}$; a positive power confirms a convex lens.
- Examiners award marks for: correct sign convention, correct substitution in lens formula, and the final answer with unit (D) and nature of lens.

Q29. medium exam-ready **[3]**

What is atmospheric refraction? How does it cause the apparent shift in the position of stars near the horizon? Why is this effect more pronounced near the horizon than overhead?

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Model Answer

Atmospheric refraction is the refraction of light by the Earth's atmosphere, which has layers of gradually changing refractive index.

Apparent shift near the horizon: As starlight enters the atmosphere, it is continuously refracted (bent towards the normal) through layers of increasing density. This makes the star appear slightly higher than its actual position, especially when viewed near the horizon.

More pronounced near the horizon: Near the horizon, starlight travels a longer path through the atmosphere at a more oblique angle, undergoing greater refraction. Overhead, light travels a shorter, nearly perpendicular path, so refraction is minimal.

Source: Chapter 10, Section 10.5 – Atmospheric Refraction

Explanation

- Examiners expect three clear points matching the three parts of the question: definition, mechanism of apparent shift, and reason for horizon effect.
- Key phrase: "gradually changing refractive index" — use it.
- The textbook specifically states the star appears **higher** than actual when near the horizon — mention this directly.
- Do **not** mix twinkling with apparent shift; they are different effects in the same section.

Q30. deep exam-ready **[3]**

Differentiate between dispersion and scattering of light. How does the size of particles determine the colour of scattered light?

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Model Answer

Dispersion vs Scattering:

Dispersion	Scattering
Splitting of white light into its component colours by a prism	Redirection of light in all directions by fine particles in a medium
Due to different refractive indices for different wavelengths	Due to interaction of light with suspended particles

Effect of particle size on colour of scattered light:

- **Very fine particles** (smaller than the wavelength of visible light) scatter mainly **blue light** (shorter wavelength) — this is why the sky appears blue.
- **Larger particles** scatter light of **longer wavelengths** (yellow, red).
- If particles are **very large**, the scattered light may appear **white**.

Source: Chapter 10, Section 10.6 / 10.6.1

Explanation

- Examiners expect a clear distinction between the two phenomena (1 mark) and then 2 marks for the particle-size effect with at least three levels: fine → blue, larger → longer wavelengths, very large → white.
- Use the sky example to illustrate fine-particle scattering — it shows you understand application.
- Do **not** confuse dispersion (prism/refraction-based) with scattering (particle-based); this is the core distinction the question tests.

Q31. medium exam-ready **[5]**

(a) With the help of a labelled ray diagram, explain the defect of hypermetropia, showing where the image is formed in a hypermetropic eye.
(b) Show how the defect is corrected using an appropriate lens.
(c) State TWO possible structural reasons why this defect develops.

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Model Answer

(a) Defect of Hypermetropia:

Hypermetropia (far-sightedness) is a defect in which a person can see distant objects clearly but **cannot see nearby objects distinctly**. The near point shifts beyond 25 cm. This happens because light rays from a nearby object are focused **behind the retina** instead of on it.

Ray Diagram — Hypermetropic Eye:

```
Object → Eye Lens → [Retina] → (Image forms behind retina)
```

(Draw: nearby object, eye with lens, rays converging to a point behind the retina, label: Object, Eye Lens, Retina, Image behind retina)

(b) Correction:

A **convex (converging) lens** of appropriate power is used. It converges the incoming rays before they enter the eye, so the image is now brought forward onto the retina.

Ray Diagram — Corrected Eye:

(Draw: nearby object → convex lens → eye lens → rays converge exactly on retina)

(c) Two structural reasons:

1. The **focal length of the eye lens is too long** (eye lens is too less curved / less converging).
2. The **eyeball has become too small** (shortened eyeball), so the retina is closer to the lens than normal.

Source: Chapter 10, Section 10.2 — Hypermetropia

Explanation

- The examiner expects a **labelled ray diagram** for both the defect and the correction — even a neat sketch with labels (Object, Eye Lens, Retina, Image) earns full diagram marks.
- Key phrase for (a): image forms **behind** the retina.
- Key phrase for (b): **convex/converging lens** — never say concave here.
- For (c), both reasons must come directly from the textbook: *focal length too long* OR *eyeball too small*. These are the only two accepted structural reasons. Writing "weak ciliary muscles" is incorrect here (that applies to presbyopia).

Q32. deep exam-ready **[5]**

(a) What is meant by the dispersion of white light? With the help of a labelled diagram, show how a glass prism disperses white light into its constituent colours.
(b) Describe the experiment that proved sunlight is composed of seven colours, including the role of a second inverted prism placed in the path of the dispersed light.
(c) Using the concept of dispersion, explain in detail how a rainbow is formed in the sky after a rain shower. Draw a labelled diagram showing the path of light through a single water droplet.

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Model Answer

(a) Dispersion of White Light:
The splitting of white light into its seven constituent colours on passing through a prism is called **dispersion**. The colours formed are Violet, Indigo, Blue, Green, Yellow, Orange, Red (VIBGYOR). Different colours bend by different angles — violet bends the most, red the least — so they separate and form a spectrum.

Diagram: [Labelled diagram showing white light entering prism face, splitting into VIBGYOR band on screen, with violet closest to base and red farthest]

(b) Newton's Experiment:
Newton placed a second identical prism in an **inverted position** with respect to the first. All seven colours of the spectrum passed through the second prism and recombined to give a beam of **white light** on the other side. This proved that sunlight is composed of seven colours.

(c) Rainbow Formation:
A rainbow forms after a rain shower when sunlight falls on tiny water droplets in the atmosphere. Each droplet acts like a small prism. Light is **refracted** as it enters the droplet, undergoes **total internal reflection** inside, and is **refracted again** as it exits. This causes dispersion into seven colours. The rainbow always appears in the direction **opposite to the Sun**.

Diagram: [Labelled diagram of a single water droplet showing — incident sunlight → refraction at entry → internal reflection → refraction at exit → dispersed colours emerging]

Source: Chapter 10, Section 10.4

Explanation

- **(a):** Examiners expect the definition of dispersion, mention of VIBGYOR, and the reason (different bending for different colours). A labelled diagram of Fig. 10.5 is compulsory.
- **(b):** The key fact is the **inverted second prism** recombining colours into white light — this is Newton's proof. Keep it brief.
- **(c):** Three key steps — refraction (entry), internal reflection, refraction (exit) — must all be named. Mention that the rainbow is always opposite to the Sun. The diagram of a single droplet (Fig. 10.8 in textbook) is expected. Do not omit "internal reflection" — it is a common exam error.

Q33. deep exam-ready **[5]**

(a) Define the power of accommodation of the human eye. How do the ciliary muscles bring about this accommodation when viewing a nearby object versus a distant object?

(b) A myopic person's far point is 2 m. Calculate the power of the lens he needs to see distant objects clearly.

(c) With increasing age, a person finds that the range of clear vision becomes very restricted — she cannot see near objects or far objects without glasses. Name the defect and describe the type of lens used to correct it.

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Model Answer

(a) The ability of the eye lens to adjust its focal length to see objects at different distances is called the **power of accommodation**.

- **Distant object:** Ciliary muscles **relax** → lens becomes **thin** → focal length **increases** → distant object seen clearly.
- **Nearby object:** Ciliary muscles **contract** → lens becomes **thicker** → focal length **decreases** → nearby object seen clearly.

(b) Far point of myopic person = 2 m. The concave lens must form the image of a distant object (at infinity) at the far point (2 m).

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

The person needs a **concave lens of power −0.5 D**.

(c) The defect is **Presbyopia**. It occurs due to gradual weakening of ciliary muscles and reduced flexibility of the eye lens with age. Since the person cannot see both near and distant objects, **bi-focal lenses** are used — the upper part has a **concave lens** (for distant vision) and the lower part has a **convex lens** (for near vision).

Source: Chapter 10, Sections 10.1.1 and 10.2

Explanation

- **(a)** Examiners expect the definition plus **both** cases (near and far) with the muscle action and lens shape change clearly stated — don't skip either case.
- **(b)** Use $P = 1/f$; since the far point is 2 m, $f = -2$ m (concave lens). Show the formula and substitution for full marks.
- **(c)** The keyword "restricted range — neither near nor far" is the clue for **presbyopia** (not just myopia or hypermetropia). Always name the specific lens for each part of the bi-focal — examiners look for this detail.

Q34. medium exam-ready **[4]**

Read the following and answer the questions that follow:

Rahul, a Class 10 student, notices that when sunlight enters his room through a small gap in the curtains, he can clearly see dust particles floating in the air along the beam. During a science fair, he sets up a glass tank filled with a colloidal suspension of dilute milk in water and shines a torch through it — the beam is clearly visible from the side. He recalls that a similar effect is seen when sunlight filters through the canopy of a dense forest on a misty morning.

(i) Name the phenomenon Rahul observes in all three situations. [1]
(ii) Why is the path of light visible through the colloidal suspension but not through a true (clear) solution? [1]
(iii) How does the size of scattering particles determine the colour of scattered light? [2]

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Model Answer

(i) The phenomenon Rahul observes in all three situations is the **Tyndall Effect** — the scattering of light by colloidal particles, making the path of the beam visible.

(ii) In a true (clear) solution, the particles are too small to scatter light, so the beam's path is invisible. In a colloidal suspension (dilute milk in water), the particles are relatively larger and scatter light, making the beam visible from the side.

(iii) The colour of scattered light depends on the size of the scattering particles. **Very fine particles** scatter mainly **blue light** (shorter wavelengths). Particles of **larger size** scatter light of **longer wavelengths**. If particles are large enough, the scattered light may even appear **white**.

Source: Chapter 10, Section 10.6 — Scattering of Light / Tyndall Effect

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Explanation

- **(i)** Directly name "Tyndall Effect" — do not just say "scattering."
- **(ii)** The key contrast is particle size: true solution particles are too small; colloidal particles are large enough to scatter. One mark — keep it to one-two lines.
- **(iii)** This is 2 marks, so mention all three size ranges: very fine → blue; larger → longer wavelengths (red/orange); very large → white. The passage states this explicitly — quote it closely.

Q35. medium exam-ready **[4]**

Read the following and answer the questions that follow:

Dr. Sharma, an ophthalmologist, examines three patients in one morning. Patient A, aged 14, complains that she cannot read the whiteboard at school from the back rows. Patient B, aged 45, says he has to hold his newspaper at arm's length to read it comfortably. Patient C, aged 65, tells the doctor that she struggles to see both nearby and distant objects clearly and has been prescribed special glasses with two different lens types.

(i) Identify the vision defect each patient is suffering from. [1]
(ii) For Patient A, state the position of the image formed on the eye relative to the retina and the type of corrective lens prescribed. [1]
(iii) For Patient B, explain why the light from a nearby object is not focused on the retina. What type of lens corrects this? [2]

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Model Answer

(i) Defects:

- Patient A (14 yrs): **Myopia** (short-sightedness)
- Patient B (45 yrs): **Hypermetropia** (far-sightedness)
- Patient C (65 yrs): **Presbyopia**

(ii) In Patient A's myopic eye, the image of a distant object is formed **in front of (before) the retina**. A **concave lens** (diverging lens) of suitable power is prescribed to correct this defect.

(iii) In Patient B's hypermetropic eye, 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. A **convex lens** (converging lens) provides the additional focusing power needed to bring the image onto the retina, correcting the defect.

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

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Explanation

- **(i)** Each patient maps to a textbook defect: difficulty seeing the board = myopia; holding things far to read = hypermetropia; trouble with both near and distant + bifocals = presbyopia.
- **(ii)** For myopia, the key phrase examiners look for is "image formed in front of/before the retina" + "concave lens." Both parts needed for the 1 mark.
- **(iii)** This is 2 marks, so you need **reason** (focal length too long OR eyeball too small → image behind retina) AND **correction** (convex/converging lens). Missing either costs a mark.

Q36. deep exam-ready **[4]**

Read the following and answer the questions that follow:

Priya and her friends are on a stargazing trip on a clear night. Priya notices that stars near the horizon seem to twinkle more vigorously than those directly overhead. Her friend Arun points out that a bright object he identified as the planet Jupiter does not twinkle at all. Later that evening, they notice the full Moon also does not twinkle.

(i) Why do stars twinkle? Name the phenomenon responsible. [1]
(ii) Why do planets like Jupiter not twinkle even though they are also observed through the earth's atmosphere? [1]
(iii) Priya wonders why stars near the horizon twinkle more than those directly overhead. Provide a scientific explanation. [2]

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Model Answer

(i) Stars twinkle due to **atmospheric refraction** of starlight. Since stars are very distant point-sized sources, the continuously changing physical conditions of the atmosphere cause the path of light to vary, making the star appear to flicker (sometimes brighter, sometimes fainter).

(ii) Planets are much closer to Earth and appear as **extended sources** (not point-sized). A planet can be considered a collection of many point-sized sources; the variations in light from all these individual sources average out to zero, nullifying the twinkling effect.

(iii) When a star is near the horizon, its light passes through a **thicker, denser layer** of the atmosphere compared to stars overhead. More atmospheric layers mean greater and more variable refraction, causing stronger fluctuations in the apparent position and brightness — hence more vigorous twinkling.

Source: Chapter 10, Section 10.5 — Atmospheric Refraction

Explanation

- **(i)** Always name the phenomenon (atmospheric refraction) and explain the point-source nature of stars — both are needed.
- **(ii)** The key word examiners look for is "extended source" and the idea that individual variations cancel/average out.
- **(iii)** This is 2 marks — you need TWO logical steps: (a) thicker atmosphere near horizon, and (b) more refraction/variation = more twinkling. One line alone won't fetch full marks.
- The Moon/Jupiter comparison in the passage is the same extended-source argument — always link back to point-source vs extended-source distinction.

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