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CLASS X · SCIENCE (086) · PHYSICS · CBSE BOARD EXAMINATION 2027

CHAPTER 10

The Human Eye and the Colourful World

Answer Booklet · CBSE marking-scheme answers with marks for every point

Every question of the chapter booklet | Marks shown point by point | MCQ keys with reasons

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HOW TO USE THE ANSWERS

1. Answer the question in your notebook **first**. Open this booklet only to check.
2. Each answer is written the way the CBSE marking scheme sets it out: **value points**, with the **mark for each point** in orange beside it.
3. Give yourself marks point by point. Use the same **key words** in your own answers.
4. Equations must be balanced; diagrams must be labelled; numericals need formula, substitution and unit.
5. Copy every wrong answer to the My Mistakes page of your booklet.

READ THIS FIRST

Marking Guide

Model answers to every question in the chapter booklet, set out the way a CBSE examiner marks them.

HOW MARKS ARE GIVEN IN SCIENCE ANSWERS

1. **MCQ and assertion–reason (1 mark):** only the correct option scores. The reason given here is for your understanding.
2. **2 and 3 marks:** one mark (or ½) for each correct **value point**. The examiner looks for the key word – a long answer without it scores less than a short answer with it.
3. **Equations:** a correct balanced equation earns its full mark; an unbalanced one, or one with wrong formulae, usually earns ½ or nothing.
4. **Numericals:** formula, substitution and the final answer **with unit** are marked separately.
5. **Diagrams:** marks for a correct drawing and for the labels asked for. An unlabelled diagram earns little.
6. **Case study (4 marks):** 1 + 1 + 2. **Long answer (5 marks):** the split is shown beside each point.

PART A · ANSWERS

A NCERT Practice – Answers

Marking-scheme answers for every question in Part A of the chapter booklet.

The human eye

A1. What are the near point and the far point of a normal human eye? **[2]**

Near point – the nearest point at which an object is seen clearly without strain: about 25 cm. 1

Far point – the farthest point up to which the eye sees clearly: infinity. 1

A2. What is meant by the power of accommodation of the eye? What happens to the ciliary muscles and the eye lens when we look at (i) a distant object (ii) a near object? **[3]**

The ability of the eye lens to adjust its focal length to focus near and far objects on the retina. 1

(i) Ciliary muscles relax; lens becomes thinner; focal length increases. 1

(ii) Ciliary muscles contract; lens becomes thicker; focal length decreases. 1

A3. Name the part of the eye that (i) controls the size of the pupil (ii) changes the curvature of the eye lens (iii) acts as a screen on which the image forms (iv) carries signals to the brain. **[2]**

(i) Iris (ii) ciliary muscles 1

(iii) Retina (iv) optic nerve 1

A4. Where does most of the refraction of light entering the eye take place? What is the role of the eye lens? **[2]**

At the outer surface of the cornea. 1

The eye lens provides the finer adjustment of focal length to focus objects at different distances on the retina. 1

A5. Why is a normal eye unable to see clearly an object placed closer than 25 cm? [2]

To focus a very near object the eye lens must have a very short focal length. 1

The focal length of the eye lens cannot be decreased below a certain minimum, so the image is not formed on the retina and looks blurred. 1

A6. What happens to the image distance in the eye when an object is moved farther away from the eye? [1]

It stays the same (the distance from the lens to the retina); the eye lens changes its focal length instead. 1

A7. What is cataract? How is vision restored? [2]

In old age the eye lens becomes milky and cloudy, causing partial or complete loss of vision. 1

By cataract surgery. 1

Defects of vision

A8. A student in the last row cannot read the blackboard clearly but can read her book. Name the defect, give its two causes and the type of lens that corrects it. [3]

Myopia (near-sightedness). 1

Causes: excessive curvature of the eye lens; elongation of the eyeball. 1

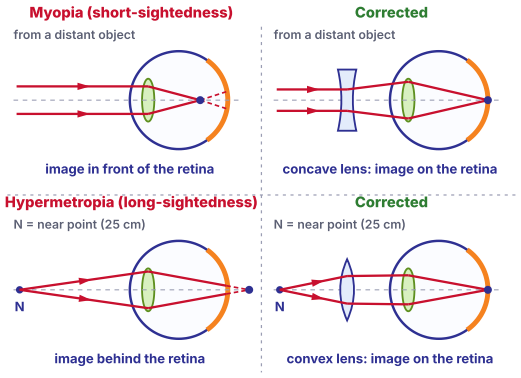
Corrected by a concave lens of suitable power. 1

A9. The near point of a hypermetropic eye is 1 m. What is the power of the lens needed to correct this defect? (Normal near point = 25 cm.) Draw a diagram to show how the defect is corrected. [4]

u = −25 cm, v = −100 cm; $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = -\frac{1}{100} + \frac{1}{25} = \frac{3}{100}$ 1

f = 33.3 cm = 0.333 m; P = 1/f = +3.0 D (convex lens). 1

Diagram: rays from N (25 cm) pass through a convex lens, then the eye lens, and meet on the retina. 2



A10. A myopic person cannot see objects beyond 80 cm clearly. What kind of lens, and of what power, will correct the defect? [2]

Concave lens with f = −(far point) = −80 cm = −0.8 m. 1

P = 1/f = 1/(−0.8) = −1.25 D. 1

A11. What is presbyopia? Give its causes. How is it corrected when a person has both near and far vision problems? **[3]**

The power of accommodation decreases with age, so the near point moves away and near objects are not seen clearly. 1

Causes: gradual weakening of the ciliary muscles and reduced flexibility of the eye lens. 1

Bifocal lenses: upper part concave (distant vision), lower part convex (near vision). 1

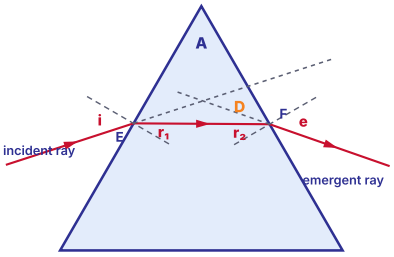
Prism, dispersion and the rainbow

A12. Draw a labelled ray diagram for the refraction of light through a glass prism. Mark the angles of incidence, emergence and deviation. **[3]**

Correct ray: bends towards the normal at the first face and away from it at the second, towards the base. 1

Normals drawn; i and e marked. 1

Incident ray produced and emergent ray produced backward; D marked. 1



A13. What is dispersion of white light? What is its cause? **[2]**

Splitting of white light into its seven component colours (VIBGYOR) is dispersion. 1

Different colours bend through different angles in the prism: red the least, violet the most. 1

A14. How did Newton show that sunlight is made of seven colours? **[2]**

He passed sunlight through a prism to get a spectrum, and placed a second identical prism upside down after it. 1

The colours recombined and white light came out, showing that white light is made of these colours. 1

A15. Explain how a rainbow is formed. In which direction should you look to see it? **[3]**

After rain, tiny water droplets act like small prisms; sunlight is refracted and dispersed on entering a drop. 1

It is internally reflected at the back of the drop and refracted again on coming out; the colours reach the eye. 1

Look in the direction opposite to the sun (sun behind you). 1

Atmospheric refraction and scattering

A16. Why do stars twinkle? **[3]**

Starlight is refracted continuously as it passes through air layers of changing density; it bends towards the normal, so the star appears slightly higher. 1

The air keeps changing, so the apparent position of the star keeps shifting. 1

A star is a point source; the light entering the eye flickers – sometimes brighter, sometimes fainter – so the star twinkles. 1

A17. Explain why the planets do not twinkle. **[2]**

Planets are much closer to the Earth and appear as extended sources – a collection of many point sources. 1

The variations in light from the individual point sources cancel out, so there is no twinkling. 1

A18. Why does the sun appear to us about two minutes before actual sunrise and stay visible about two minutes after actual sunset? **[2]**

Because of atmospheric refraction, light from the sun below the horizon bends towards us. 1

So the sun is seen above the horizon before it actually rises and after it actually sets. 1

A19. Why does the clear sky look blue? **[3]**

Air molecules and fine particles are smaller than the wavelength of visible light. 1

They scatter light of shorter wavelength (blue) much more than light of longer wavelength (red). 1

This scattered blue light enters our eyes, so the sky looks blue. 1

A20. Why does the sky appear dark instead of blue to an astronaut in space? **[2]**

There is no atmosphere in space to scatter sunlight. 1

With no scattered light reaching the eye, the sky looks dark. 1

A21. What is the Tyndall effect? Give two examples. **[2]**

Scattering of light by colloidal particles, which makes the path of a beam visible. 1

A beam of sunlight through a small hole in a smoky room; sunlight through the canopy of a dense forest. 1

A22. Why are danger signals red? **[2]**

Red light has the longest wavelength of visible light and is scattered the least by fog or smoke. 1

So it can be seen in the same colour from a large distance. 1

A23. Objects seen through the hot air above a fire appear to waver. Why? [2]

The hot air just above the fire is optically rarer than the cooler air above it, and its density keeps changing. 1

So light from the objects is refracted by different amounts all the time; the apparent position keeps changing. 1

PART B · ANSWERS

B Exemplar Practice – Answers

Marking-scheme answers for every question in Part B of the chapter booklet.

Multiple choice

Q	Answer	Working / reason
B1	**(d)** retina	The retina is the light-sensitive screen.
B2	**(c)** ciliary muscles	They change the curvature of the lens.
B3	**(c)** 25 cm	Near point = 25 cm.
B4	**(b)** concave, −0.5 D	f = −2 m, so P = 1/(−2) = −0.5 D.
B5	**(d)** Violet	Violet bends the most.
B6	**(b)** is scattered least by fog and smoke	It travels far without much scattering.
B7	**(c)** atmospheric refraction	Changing air layers refract starlight.
B8	**(b)** different colours bend through different angles	Each colour is refracted by a different amount.
B9	**(a)** elongation of the eyeball	A long eyeball puts the image in front of the retina.
B10	**(b)** fine particles in air scatter blue light more than red	Shorter wavelengths are scattered more.

Short answer

B11. On entering a dark cinema hall from bright sunlight, we cannot see the seats for a short while, but slowly we can. Explain. [2]

In bright light the pupil is small; in the dark little light enters, so we cannot see. 1

The iris slowly widens the pupil to let in more light; this takes some time, after which we can see. 1

B12. A person needs a lens of power –4.5 D for distant vision and +3.5 D for near vision. Find the focal lengths of the two lenses. Name the defect. [3]

Distant vision: f = 1/P = 1/(–4.5) m = –0.222 m = –22.2 cm (concave). 1

Near vision: f = 1/3.5 m = 0.286 m = +28.6 cm (convex). 1

The person needs both corrections – presbyopia; bifocal lenses are used. 1

B13. In the spectrum formed by a prism kept with its base down, name the colours at the top and at the bottom. Which colour travels fastest in glass? [2]

Top – red (bends least); bottom – violet (bends most). 1

Red travels fastest in glass (it is refracted the least). 1

B14. Is the position of a star as seen by us its true position? Justify your answer. [2]

No. 1

Starlight bends towards the normal as it passes into denser air layers, so the star appears slightly higher than its true position. 1

B15. Why do clouds look white while the clear sky looks blue? [2]

Clouds have large water droplets that scatter all colours almost equally, so the scattered light looks white. 1

Fine air particles scatter mainly blue light, so the sky looks blue. 1

B16. The near point of a hypermetropic person is 50 cm. Find the power of the lens needed so that the person can read a book at 25 cm. [3]

u = –25 cm, v = –50 cm. 1

$\frac{1}{f} = \frac{1}{-50} - \frac{1}{-25} = \frac{1}{50}$, so f = +50 cm = 0.5 m. 1

P = 1/0.5 = +2.0 D (convex lens). 1

PART C · ANSWERS

C Board Pattern Practice – Answers

Marking-scheme answers for every question in Part C of the chapter booklet.

The human eye

Q	Answer	Working / reason
C1	**(b)** contract; thicker	A thicker lens has a shorter focal length.
C2	**(b)** iris	The pupil then regulates the light entering.
C3	**(a)**	Both true; accommodation explains the range.
C4	**(a)**	Both true; R explains A.

C5. State the function of (a) the iris (b) the pupil. How does the pupil change in dim light? [2]

(a) Iris controls the size of the pupil. (b) Pupil regulates the amount of light entering the eye. 1

In dim light the pupil becomes larger to let in more light. 1

C6. What is the range of vision of a normal eye? What is cataract and how is it treated? [3]

From 25 cm (near point) to infinity (far point). 1

Cataract: the eye lens becomes milky and cloudy, causing partial or total loss of vision. 1

Treated by cataract surgery. 1

Defects of vision

Q	Answer	Working / reason
C7	**(b)** hypermetropia; convex	The near point has moved beyond 25 cm.
C8	**(a)** convex, f = +50 cm	f = 1/P = 0.5 m.
C9	**(a)**	Both true; R explains A.
C10	**(a)**	Both true; R explains A.

C11. Give two differences between myopia and hypermetropia. [2]

Myopia: distant objects are not seen clearly; hypermetropia: near objects are not seen clearly. 1

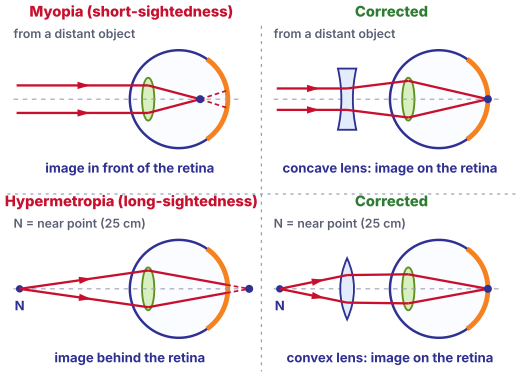
Myopia: image in front of the retina, corrected by a concave lens; hypermetropia: image behind the retina, corrected by a convex lens. 1

C12. A student can read a far-off board but finds it hard to read a book. Name the defect. Give its two causes and draw ray diagrams of the defect and its correction. [3]

Hypermetropia (far-sightedness). ½

Causes: focal length of the eye lens too long; eyeball too small. 1

Diagrams: (a) rays from N meet behind the retina; (b) with a convex lens they meet on the retina. 1½



C13. A person cannot see clearly beyond 2.5 m. Name the defect, and find the nature and power of the lens needed. [3]

Myopia. 1

A concave lens with f = –2.5 m. 1

P = 1/f = 1/(–2.5) = –0.4 D. 1

C14. The near point of a person is 75 cm. Find the power of the lens that will let the person read at 25 cm. [3]

u = –25 cm, v = –75 cm. 1

$\frac{1}{f} = \frac{1}{-75} + \frac{1}{25} = \frac{2}{75}$, so f = 37.5 cm = 0.375 m. 1

P = 1/0.375 = +2.67 D (convex). 1

Prism, dispersion and the rainbow

Q	Answer	Working / reason
C15	**(d)** red	Red bends least.
C16	**(b)** R O Y G B I V	Red first, violet last.
C17	**(a)**	Both true; R explains A.
C18	**(a)**	Both true; R explains A.

C19. A ray of light passes through a glass prism. What is the angle of deviation? On what side of the incident ray does the emergent ray bend, and why? [2]

Angle of deviation: the angle between the incident ray produced forward and the emergent ray. 1

The emergent ray bends towards the base of the prism, because the two refracting faces are inclined and the ray bends the same way at both faces. 1

C20. Describe Newton's experiment with two prisms. What does it show? [3]

A narrow beam of sunlight passes through a prism and forms a spectrum. 1

A second identical prism is placed upside down next to the first; the colours recombine. 1

White light emerges: sunlight is made of seven colours. 1

C21. Why does a glass prism give a spectrum, while a rectangular glass slab does not? [2]

In a slab the faces are parallel; all colours come out parallel to the incident ray and overlap, so the light looks white. 1

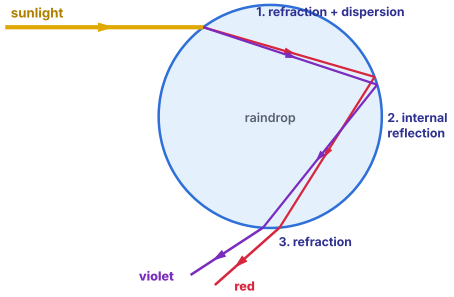
In a prism the faces are inclined; the second face bends the colours further apart, so they separate. 1

C22. What is a rainbow? Explain its formation with a labelled diagram. **[3]**

A natural spectrum seen in the sky after rain, in the direction opposite to the sun. 1

Raindrops act as prisms: refraction and dispersion on entry, internal reflection, refraction on leaving. 1

Diagram of a raindrop with the three steps marked. 1



Atmospheric refraction and scattering

Q	Answer	Working / reason
C23	**(a)** there is no atmosphere to scatter light	No scattering, no blue sky.
C24	**(a)** are extended sources close to us	Variations from many points average out.
C25	**(a)**	Both true; R explains A.
C26	**(a)**	Both true; R explains A.

C27. Explain: (a) the clear sky is blue; (b) the sky looks dark at very high altitudes; (c) danger signals are red. **[3]**

(a) Fine air particles scatter blue light (shorter wavelength) much more than red. 1

(b) Very little air at that height, so hardly any scattering takes place. 1

(c) Red is scattered least by fog and smoke, so it is seen from far away. 1

C28. Explain why stars twinkle but planets do not. How does atmospheric refraction change the time of sunrise? **[3]**

Stars: point sources; changing air layers keep shifting the apparent position and the light reaching the eye flickers. 1

Planets: nearer, extended sources; variations from many point sources cancel out. 1

The sun is seen about 2 minutes before actual sunrise (and 2 minutes after actual sunset). 1

Long answer

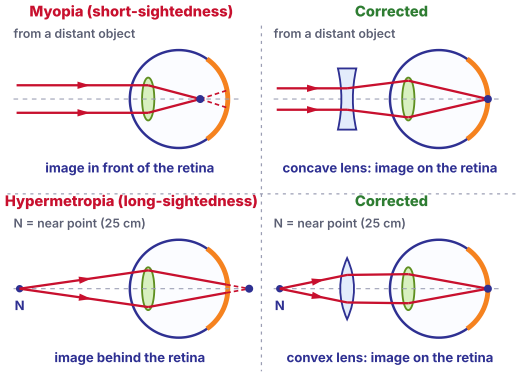
C29. (a) What is the power of accommodation? (b) A student can see near objects clearly but not distant ones. Name the defect, give two causes and draw ray diagrams of the defect and its correction. (c) The student's far point is 1.5 m. Find the power of the lens needed. **[5]**

(a) The ability of the eye lens to adjust its focal length to focus near and far objects. **1**

(b) Myopia. **½**

Causes: excessive curvature of the eye lens; elongation of the eyeball. **1**

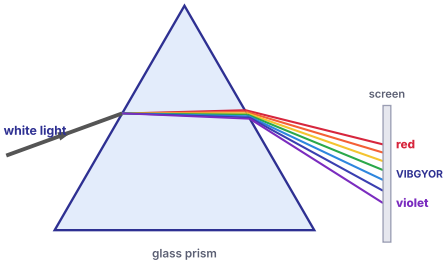
Diagrams: image in front of the retina; with a concave lens the image is on the retina. **1½**



(c) f = −1.5 m; P = 1/(−1.5) = −0.67 D (concave). **1**

C30. (a) Draw a diagram to show the dispersion of white light by a glass prism and label the spectrum. (b) Why do the colours separate? (c) Explain how a rainbow is formed. (d) What did Newton's second prism show? **[5]**

(a) Labelled diagram: white light, prism, spectrum with red at the top and violet at the bottom. **1½**



(b) Different colours bend through different angles – red least, violet most. **1**

(c) Water drops refract and disperse sunlight, reflect it internally and refract it again; the sun is behind the observer. **1½**

(d) The colours recombine into white light – sunlight is made of seven colours. **1**

C31. (a) What is the Tyndall effect? Give one example. (b) Why is the sky blue? (c) Why do stars twinkle? (d) Why do planets not twinkle? (e) Why are danger signals red? **[5]**

(a) Scattering of light by colloidal particles; e.g. a sunbeam in a smoky room. 1

(b) Fine air particles scatter blue light much more than red. 1

(c) Atmospheric refraction keeps changing the apparent position and brightness of a point source. 1

(d) Planets are extended sources; the variations average out. 1

(e) Red is scattered least by fog and smoke. 1

PART D · ANSWERS

D Case-Based Questions – Answers

Marking-scheme answers for every question in Part D of the chapter booklet.

D1. Case Study · The Eye Camp [4]

(i) Name Rohan's defect of vision. **[1]**

Myopia. 1

(ii) Find the focal length of Rohan's lens. **[1]**

f = 1/P = 1/(−2.0) = −0.5 m = −50 cm. 1

(iii) Name the grandfather's defect and give its causes. How do his glasses help? **[2]**

Presbyopia: weakening of the ciliary muscles and less flexible eye lens. 1

Bifocal lenses: upper concave part for distant vision, lower convex part for reading. 1

OR

(iii) What is Rohan's far point without glasses? Explain how his concave lens helps him see the chart. **[2]**

Far point = 50 cm (f = −far point). 1

The concave lens makes light from the distant chart appear to come from 50 cm, so the eye can focus it on the retina. 1

D2. Case Study · The Prism Lab [4]

(i) Name the phenomenon that produced the band of colours. **[1]**

Dispersion of white light. 1

(ii) Which colour was deviated the most? **[1]**

Violet. 1

(iii) Why did the colours separate in the first prism, and what does the second prism show? **[2]**

Different colours bend through different angles (red least, violet most). 1

The second prism recombines the colours into white light: sunlight is made of seven colours. 1

OR

(iii) Explain how nature produces the same band of colours in the sky after rain. **[2]**

Raindrops act as tiny prisms: they refract and disperse sunlight, reflect it internally and refract it again. 1

A rainbow is seen opposite the sun, with the sun behind the observer. 1

D3. Case Study · Sky Watch [4]

(i) Name the phenomenon that makes the sky blue. **[1]**

Scattering of light. 1

(ii) Why did the sky look darker at the high pass? **[1]**

There is less air high up, so less light is scattered. 1

(iii) Why do stars twinkle? **[2]**

Starlight is refracted by air layers of changing density; the apparent position keeps shifting. 1

Stars are point sources, so the light reaching the eye flickers – the star twinkles. 1

OR

(iii) Why did Jupiter not twinkle, and why are warning lights red? **[2]**

Jupiter is a planet – an extended source near us; the variations average out. 1

Red light is scattered least by fog, so it is seen from far away. 1