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Ray Optics and Optical Instruments — CBSE Class 12 Physics Chapter Test

FREE CHAPTER TEST · CLASS XII · PHYSICS (042) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	37	17 (A 8 · B 3 · C 3 · D 1 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 17 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. Section A (Q1–8) contains 6 multiple choice questions and 2 assertion-reason based questions of 1 mark each.
4. Section B (Q9–11) contains short answer questions of 2 marks each.
5. Section C (Q12–14) contains short answer questions of 3 marks each.
6. Section D (Q15) contains case study based questions of 4 marks each, with four sub-parts of 1 mark.
7. Section E (Q16–17) contains long answer questions of 5 marks each.
8. There is no overall choice. However, an internal choice has been provided in 1 question in Section B, 1 question in Section C, 2 questions in Section E. Attempt only one of the alternatives in such questions.
9. Use of calculators is not allowed. You may use: $c = 3 \times 10^8$ m s^{-1}. Use the Cartesian sign convention..
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Physics (042) Sample Question Paper 2026-27, at about half the length of the 70-mark board paper: 37 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Ray Optics and Optical Instruments · **Topics:** Reflection by spherical mirrors · Refraction and total internal reflection · Refraction at spherical surfaces and lenses · Lens maker's formula, power and combinations · Prism · Microscopes and telescope

SECTION A

This section comprises 8 questions of 1 mark each: 6 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. An object is placed 30 cm in front of a convex lens of focal length 20 cm. The image is formed at a distance of 1

(A) 12 cm (B) 30 cm

(C) 40 cm (D) 60 cm

2. The critical angle for light going from glass of refractive index 1.5 into air is about 1

(A) 30° (B) 41.8°

(C) 48.6° (D) 60°

3. A convex lens of focal length 20 cm is in contact with a concave lens of focal length 40 cm. The power of the combination is 1

(A) +7.5 D (B) −2.5 D

(C) +2.5 D (D) +0.40 D

4. A coin lies at the bottom of a beaker filled with water (refractive index 4/3) to a depth of 12 cm. Seen from directly above, the coin appears to be at a depth of 1

(A) 9.0 cm (B) 16 cm

(C) 3.0 cm (D) 12 cm

5. The refractive index of a glass is 1.5. The speed of light in it is 1

(A) 4.5×10^8 m s^{-1} (B) 3.0×10^8 m s^{-1}

(C) 2.0×10^8 m s^{-1} (D) 1.5×10^8 m s^{-1}

6. Optical fibres carry light over long distances on the principle of 1

(A) refraction (B) dispersion

(C) scattering (D) total internal reflection

7. **Assertion (A) :** A cut diamond sparkles more than a piece of glass cut to the same shape. 1
Reason (R) : Diamond has a much smaller critical angle (about 24°) than glass, so light entering it is totally reflected many times before it comes out.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

8. **Assertion (A) :** A convex lens has a slightly shorter focal length for violet light than for red light. 1
Reason (R) : The speed of light in vacuum is the same for all colours.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

SECTION B

This section comprises 3 short answer questions of 2 marks each.

9. A small bulb is placed at the bottom of a tank filled to a depth of 60 cm with a liquid of refractive index 5/4. Find the radius of the circle on the liquid surface through which light from the bulb can come out. 2

10. (a) A double convex lens of glass (refractive index 1.5) has both radii of curvature equal to 20 cm. Find its focal length in air and in water (refractive index 4/3). 2

OR

(b) An object is placed 10 cm in front of a concave mirror of focal length 15 cm. Find the position, nature and magnification of the image.

11. A convex lens of focal length 5.0 cm is used as a simple microscope. Find its magnifying power when the final image is at the near point (25 cm), and when it is at infinity. 2

SECTION C

This section comprises 3 short answer questions of 3 marks each.

12. (a) Derive the relation $n_2/v - n_1/u = (n_2 - n_1)/R$ for refraction at a convex spherical surface separating media of refractive indices n_1 and n_2 (light going from n_1 to n_2). 3

OR

(b) A solid glass sphere of radius 10 cm (refractive index 1.5) has a small air bubble 4.0 cm from its centre. Find where the bubble appears to be when it is viewed from the nearest side, along the line through the centre.

13. A convex lens of focal length 10 cm and a concave lens of focal length 15 cm are placed in contact. An object is placed 45 cm in front of the combination. Find (i) the focal length of the combination and (ii) the position, nature and size of the image if the object is 2.0 cm tall. 3

14. Using a ray diagram for a concave mirror forming a real image, derive the mirror equation $1/v + 1/u = 1/f$. 3

SECTION D

This section comprises 1 case study based question of 4 marks, with four sub-parts of 1 mark each.

15. An optical fibre has a thin core of glass of refractive index 1.60 surrounded by a cladding of refractive index 1.50. Light sent into one end is trapped in the core and comes out at the other end, even when the fibre is bent gently. Such fibres carry telephone and internet signals and are used in endoscopes.

(I) The critical angle at the core-cladding boundary is about
(A) 20° (B) 42° (C) 70° (D) 90° [1]

(II) Light stays inside the core when its angle of incidence on the core-cladding boundary is
(A) greater than the critical angle (B) less than the critical angle (C) zero (D) exactly 45° [1]

(III) For the fibre to work, the refractive index of the cladding must be
(A) equal to that of the core (B) greater than that of the core (C) zero (D) less than that of the core [1]

(IV) The speed of light in the core is about
(A) 1.6×10^8 m s^{-1} (B) 1.9×10^8 m s^{-1} (C) 2.0×10^8 m s^{-1} (D) 4.8×10^8 m s^{-1} [1]

SECTION E

This section comprises 2 long answer questions of 5 marks each.

16. (a) (i) Derive the lens maker's formula for a thin double convex lens. 5
(ii) A double convex lens with equal radii of curvature is made of glass of refractive index 1.6 and has a focal length of 25 cm. Find the radius of curvature. What would its focal length be in a liquid of refractive index 1.6?

OR

(b) (i) Derive the relation between the refractive index of the material of a prism, its angle A and the angle of minimum deviation δ_m.
(ii) A prism of angle 60° gives a minimum deviation of 40°. Find the refractive index of its material and the angle of incidence at minimum deviation.

17. (a) (i) With the help of a labelled ray diagram (described in words), explain how a compound microscope forms the final image at the near point, and write the expression for its magnifying power. 5
(ii) A compound microscope has an objective of focal length 1.0 cm and an eyepiece of focal length 5.0 cm. An object is placed 1.1 cm from the objective, and the final image is formed at 25 cm from the eye (close to the eyepiece). Find the magnifying power and the distance between the two lenses.

OR

(b) (i) Explain the working of an astronomical telescope in normal adjustment and derive its magnifying power. Why should its objective have a large aperture?
(ii) An astronomical telescope has an objective of focal length 120 cm and an eyepiece of focal length 4.0 cm. Find its magnifying power and length in normal adjustment, and its magnifying power when the final image is at the near point (25 cm).

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
(D)	(B)	(C)	(A)	(C)	(D)	(A)	(B)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (D). $1/v - 1/u = 1/f$: $1/v = 1/20 + 1/(-30) = 1/60$, $v = +60$ cm (real, on the other side).

Q2. Answer (B). $\sin c = 1/n = 2/3$, $c \approx 41.8°$.

Q3. Answer (C). $P = 1/0.20 - 1/0.40 = 5.0 - 2.5 = +2.5$ D.

Q4. Answer (A). Apparent depth = real depth/n = $12/(4/3) = 9.0$ cm.

Q5. Answer (C). $v = c/n = 3.0 \times 10^8/1.5 = 2.0 \times 10^8$ m s^{-1}.

Q6. Answer (D). Light inside the core strikes the core-cladding boundary at more than the critical angle and is totally reflected again and again.

Q7. Answer (A). Multiple total internal reflections, due to the small critical angle, make the diamond sparkle. R explains A. Answer (A).

Q8. Answer (B). A is true: glass has a larger refractive index for violet, and $1/f \propto (n - 1)$. R is true but does not explain A (A depends on the speed in glass, not in vacuum). Answer (B).

Q9. (2 marks) Answer: 80 cm.
Light comes out only where the angle of incidence is less than c, with $\sin c = 4/5$, so $\cos c = 3/5$ and $\tan c = 4/3$. [1]
$r = h \tan c = 60 \times 4/3 = 80$ cm. [1]

Q10. (2 marks) Answer: (a) 20 cm; 80 cm; (b) 30 cm behind the mirror; virtual, erect, ×3.
(a) In air: $1/f = (1.5 - 1)(1/20 + 1/20) = 0.05$, $f = 20$ cm. [1]
In water: $1/f = (1.5/(4/3) - 1)(1/10) = 0.125 \times 0.1 = 0.0125$, $f = 80$ cm. [1]
OR (b) $u = -10$ cm, $f = -15$ cm: $1/v = 1/f - 1/u = -1/15 + 1/10 = 1/30$, $v = +30$ cm, i.e. 30 cm behind the mirror. [1]
$m = -v/u = -30/(-10) = +3$: virtual, erect and three times the size of the object. [1]

Q11. (2 marks) Answer: 6; 5.
Image at the near point: $m = 1 + D/f = 1 + 25/5 = 6$. [1]
Image at infinity: $m = D/f = 5$. [1]

Q12. (3 marks) Answer: (a) $n_2/v - n_1/u = (n_2 - n_1)/R$; (b) 5.0 cm from the surface.
(a) Object O on the axis, ray meets the surface at N (height h) and is refracted towards the image I; C is the centre. For small angles: $\angle NOM = h/OM$, $\angle NCM = h/MC$, $\angle NIM = h/MI$. [1]
$i = \angle NOM + \angle NCM$ and $r = \angle NCM - \angle NIM$; Snell's law for small angles $n_1 i = n_2 r$ gives $n_1/OM + n_2/MI = (n_2 - n_1)/MC$. [1]
With the sign convention $OM = -u$, $MI = +v$, $MC = +R$: $n_2/v - n_1/u = (n_2 - n_1)/R$. [1]
OR (b) Light goes from the bubble (in glass, $n_1 = 1.5$) to air ($n_2 = 1$). Along this light, $u = -(10 - 4) = -6$ cm and the centre is on the incident side, $R = -10$ cm. [1]
$1/v - 1.5/(-6) = (1 - 1.5)/(-10)$: $1/v = 0.05 - 0.25 = -0.20$, $v = -5.0$ cm. [1]
The bubble appears 5.0 cm inside the glass from the near surface (not 6 cm). [1]

Q13. (3 marks) Answer: (i) +30 cm; (ii) 90 cm, real, inverted, 4.0 cm.
(i) $1/F = 1/10 - 1/15 = 1/30$, F = +30 cm (converging). [1]
(ii) $1/v = 1/F + 1/u = 1/30 - 1/45 = 1/90$, v = +90 cm: real, on the other side. [1]
$m = v/u = 90/(-45) = -2$: inverted, 4.0 cm tall. [1]

Q14. (3 marks) Answer: $1/v + 1/u = 1/f$.
Object AB, image A′B′; ray from B parallel to the axis reflects through F; ray through F reflects parallel. Triangles A′B′F and MDF (D on the mirror, M the pole) are similar: B′A′/BA = B′A′/MD = FA′/FM (paraxial: MD ≈ BA). [1]
Triangles A′B′P and ABP are similar: B′A′/BA = PA′/PA. [1]
So FA′/FM = PA′/PA, i.e. (PA′ − PF)/PF = PA′/PA. With PA′ = −v, PA = −u, PF = −f: (−v + f)/(−f) = v/u, giving $1/v + 1/u = 1/f$. [1]

Q15. (4 marks) Answer: (I) C; (II) A; (III) D; (IV) B.
(I) (C) sin c = 1.50/1.60 = 0.9375, c ≈ 70°. [1]
(II) (A) Total internal reflection needs i > c. [1]
(III) (D) Total internal reflection is possible only going from a denser to a rarer medium. [1]
(IV) (B) $v = c/n = 3 \times 10^8/1.60 \approx 1.9 \times 10^8$ m s^{-1}. [1]

Q16. (5 marks) Answer: (a) $1/f = (n_{21} - 1)(1/R_1 - 1/R_2)$; 30 cm; infinite; (b) $n = \sin((A + \delta_m)/2)/\sin(A/2)$; ≈ 1.53; 50°.
(a) (i) First surface (radius R_1), light from medium n_1 into glass n_2, gives an image at v_1: $n_2/v_1 - n_1/u = (n_2 - n_1)/R_1$. [1] This image is the object for the second surface (radius R_2): $n_1/v - n_2/v_1 = (n_1 - n_2)/R_2$. [1] Adding: $n_1(1/v - 1/u) = (n_2 - n_1)(1/R_1 - 1/R_2)$; for an object at infinity v = f: $1/f = (n_{21} - 1)(1/R_1 - 1/R_2)$. [1]
(ii) $1/25 = (1.6 - 1)(2/R)$, R = 2 × 0.6 × 25 = 30 cm. [1] In a liquid of the same refractive index $n_{21} = 1$, so 1/f = 0: the focal length is infinite — the lens has no effect (like a plane glass sheet). [1]
OR (b) (i) At minimum deviation the ray passes symmetrically: $r_1 = r_2 = r$ and i = e. Since $r_1 + r_2 = A$, r = A/2; and $\delta = i + e - A$ gives $i = (A + \delta_m)/2$. [2] $n = \sin i/\sin r = \sin((A + \delta_m)/2)/\sin(A/2)$. [1]
(ii) $n = \sin 50°/\sin 30° \approx 0.766/0.5 \approx 1.53$. [1] Angle of incidence i = (60° + 40°)/2 = 50°. [1]

Q17. (5 marks) Answer: (a) m = 60; ≈ 15.2 cm; (b) $m = f_o/f_e$; 30; 124 cm; 34.8.
(a) (i) The object is placed just beyond F of the objective, which forms a real, inverted, magnified image A′B′ just inside F of the eyepiece. [1] The eyepiece acts as a simple microscope and forms a virtual, magnified final image at the near point. [1] $m = m_o \times m_e = (v_o/u_o)(1 + D/f_e)$. [1]
(ii) Objective: $1/v_o = 1/1.0 - 1/1.1$, v_o = 11 cm, $|m_o| = 11/1.1 = 10$; $|m_e| = 1 + 25/5 = 6$; m = 60. [1] Eyepiece object distance: $1/u_e = 1/(-25) - 1/5$, $|u_e| \approx 4.2$ cm; separation ≈ 11 + 4.2 ≈ 15.2 cm. [1]
OR (b) (i) Parallel rays from a distant object form a real, inverted image at the focus of the objective, which is also the focus of the eyepiece; the eyepiece then sends out parallel rays, giving the final image at infinity. [1] $m = \beta/\alpha = (h/f_e)/(h/f_o) = f_o/f_e$. [1] A large aperture collects more light (fainter objects seen) and gives better resolution. [1]
(ii) m = 120/4.0 = 30; length $= f_o + f_e$ = 124 cm. [1] Final image at the near point: $m = (f_o/f_e)(1 + f_e/D) = 30 \times 1.16 = 34.8$. [1]

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