

Light: Reflection and Refraction

Class 10 - CBSE Science | Chapter 9 | Worksheet & Test Paper

14 MCQs | 8 board questions | 6 practice problems

Video lesson, notes and an interactive quiz: learn.ultimatetools.io

SECTION A - Multiple Choice Questions (1 mark each)

1. A ray of light strikes a plane mirror at an angle of incidence of 35° . What is the angle between the incident ray and the reflected ray?

- (a) 35°
- (b) 55°
- (c) 70°
- (d) 90°

2. The image formed by a convex mirror is always:

- (a) Real, inverted and magnified
- (b) Virtual, erect and diminished
- (c) Real, erect and same size
- (d) Virtual, inverted and diminished

3. The radius of curvature of a spherical mirror is 30 cm. Its focal length is:

- (a) 60 cm
- (b) 30 cm
- (c) 15 cm
- (d) 7.5 cm

4. Which mirror gives the driver of a vehicle the widest field of view of the traffic behind?

- (a) Plane mirror
- (b) Concave mirror
- (c) Convex mirror
- (d) All give the same field of view

5. A ray of light travels from air into glass. It bends:

- (a) Away from the normal
- (b) Towards the normal
- (c) Along the normal
- (d) It does not bend

6. The speed of light in a medium is 2×10^8 m/s. The refractive index of the medium is:

- (a) 0.67
- (b) 1.33
- (c) 1.5
- (d) 2.0

7. The refractive index of diamond is 2.42. This means the speed of light in diamond is:

- (a) 2.42 times the speed in vacuum
- (b) The same as in vacuum
- (c) $1/2.42$ of the speed in vacuum
- (d) 2.42×10^8 m/s

8. A concave mirror forms a real, inverted image of the same size as the object. The object is placed at:

- (a) Infinity
- (b) The centre of curvature C
- (c) The focus F
- (d) Between P and F

9. A lens has a power of +2.0 D. It is a:

- (a) Concave lens of focal length 50 cm
- (b) Convex lens of focal length 50 cm
- (c) Convex lens of focal length 2 m
- (d) Concave lens of focal length 2 m

10. A dentist uses a concave mirror to examine teeth because, when the tooth is between the pole and the focus, the mirror forms:

- (a) A real, inverted, magnified image
- (b) A virtual, erect, magnified image
- (c) A virtual, erect, diminished image
- (d) A real, erect image of the same size

11. Light passes through a rectangular glass slab. The emergent ray is:

- (a) Parallel to the incident ray but shifted sideways
- (b) Bent towards the incident ray
- (c) Perpendicular to the incident ray
- (d) Along the same line as the incident ray

12. A convex lens forms a real, inverted and magnified image. The object is placed:

- (a) Beyond $2F$
- (b) At $2F$
- (c) Between F and $2F$
- (d) Between the lens and F

13. In Snell's law, the constant $\sin i / \sin r$ for light going from medium 1 to medium 2 equals:

- (a) The refractive index of medium 1 with respect to medium 2
- (b) The refractive index of medium 2 with respect to medium 1
- (c) The speed of light in medium 2
- (d) Always 1.5

14. The magnification produced by a plane mirror is:

- (a) +1
- (b) -1
- (c) 0
- (d) Depends on the object distance

SECTION B - Board-style Questions

1. State the laws of reflection of light. [2 marks]

2. A pencil partly immersed in a glass of water appears bent at the water surface. Explain why. [2 marks]

3. 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. [3 marks]

4. The refractive index of glass is 1.5. If the speed of light in vacuum is 3×10^8 m/s, find the speed of light in glass. [2 marks]

5. Why is a convex mirror preferred as a rear-view mirror in vehicles? Give two reasons. [2 marks]

6. An object is placed 25 cm from a convex lens of focal length 10 cm. Find the position of the image and its magnification, and state its nature. [3 marks]

7. Define 1 dioptre of power of a lens. [1 mark]

8. Describe the image formed by a concave mirror when the object is placed (a) beyond C, (b) at C, (c) between P and F. [3 marks]

SECTION C - Practice Problems

1. A bus is 5 m away from a car's convex rear-view mirror (the bus is behind the car, in front of the mirror's reflecting surface). The mirror's radius of curvature is 3 m. Where does the driver see the bus's image, and what is its nature?

Hint: $f = R/2 = +1.5$ m for a convex mirror; $u = -5$ m. Use $1/v + 1/u = 1/f$.

2. The refractive index of water is 1.33. Calculate the speed of light in water. ($c = 3 \times 10^8$ m/s)

Hint: $n = c/v$, so $v = c/n$.

3. A concave mirror produces a real image magnified 3 times of an object placed 10 cm in front of it. Find the image position and the focal length of the mirror.

Hint: Real image $\rightarrow m = -3$. Use $m = -v/u$ first, then the mirror formula.

4. An object is placed 30 cm from a convex lens of focal length 20 cm. Find the image position and magnification.

Hint: $u = -30$ cm, $f = +20$ cm. Lens formula: $1/v - 1/u = 1/f$.

5. Light travelling in air strikes a transparent medium at 45° and refracts at 30° . Find the refractive index of the medium with respect to air.

Hint: Snell's law: $n = \sin i / \sin r$. $\sin 45^\circ = 0.707$, $\sin 30^\circ = 0.5$.

6. Two thin lenses of powers +4 D and -1.5 D are placed in contact. Find the power and focal length of the combination, and state whether it converges or diverges light.

Hint: Powers in contact add: $P = P_1 + P_2$. Then $f = 1/P$.

ANSWER KEY

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Section A - MCQ answers

1. (c) 70°

Angle of reflection = angle of incidence = 35°. Both angles are measured from the normal, so the angle between the two rays is 35° + 35° = 70°.

2. (b) Virtual, erect and diminished

A convex mirror diverges light, so the reflected rays never actually meet - the image is always virtual, erect and smaller than the object, whatever the object's position.

3. (c) 15 cm

$R = 2f$, so $f = R/2 = 30/2 = 15$ cm.

4. (c) Convex mirror

A convex mirror's diverging reflection compresses a wide region into a small, erect image - that is exactly why it is used as a rear-view mirror.

5. (b) Towards the normal

Glass is optically denser than air, so light slows down and bends towards the normal.

6. (c) 1.5

$n = c/v = (3 \times 10^8)/(2 \times 10^8) = 1.5$.

7. (c) 1/2.42 of the speed in vacuum

$n = c/v$, so $v = c/n$ - light travels at 1/2.42 of its vacuum speed inside diamond. High n = slower light.

8. (b) The centre of curvature C

At C, the image also forms at C: real, inverted, and exactly the same size ($m = -1$).

9. (b) Convex lens of focal length 50 cm

$P = 1/f \rightarrow f = 1/2.0 = 0.5$ m = 50 cm. Positive power means a converging (convex) lens.

10. (b) A virtual, erect, magnified image

For an object between P and F, a concave mirror acts as a magnifying mirror: the image is virtual, erect and enlarged.

11. (a) Parallel to the incident ray but shifted sideways

The two refractions at the parallel faces are equal and opposite, so the emergent ray is parallel to the incident ray but laterally displaced.

12. (c) Between F and 2F

Between F and 2F, a convex lens forms a real, inverted, magnified image beyond 2F on the other side - the projector arrangement.

13. (b) The refractive index of medium 2 with respect to medium 1

$\sin i / \sin r = n_{21}$, the refractive index of the second medium (where the refracted ray travels) with respect to the first (where the incident ray travels).

14. (a) +1

A plane mirror's image is virtual, erect and the same size as the object, so $m = +1$ (positive = erect, 1 = same size).

Section B - Model answers

1. State the laws of reflection of light.

(1) The angle of incidence is equal to the angle of reflection. (2) The incident ray, the reflected ray and the normal to the reflecting surface at the point of incidence all lie in the same plane.

2. A pencil partly immersed in a glass of water appears bent at the water surface. Explain why.

Light rays coming from the immersed part of the pencil travel from water (denser) to air (rarer) and bend away from the normal at the surface. The rays appear to come from a raised position, so the immersed part looks bent upwards at the surface - an effect of refraction.

3. 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.

$u = -10$ cm, $f = -15$ cm. Mirror formula: $1/v + 1/u = 1/f \rightarrow 1/v = 1/f - 1/u = (-1/15) - (-1/10) = (-2 + 3)/30 = 1/30 \rightarrow v = +30$ cm. The image is 30 cm behind the mirror: virtual and erect. Magnification $m = -v/u = -(30)/(-10) = +3$ - enlarged three times.

4. The refractive index of glass is 1.5. If the speed of light in vacuum is 3×10^8 m/s, find the speed of light in glass.

$$n = c/v \rightarrow v = c/n = (3 \times 10^8)/1.5 = 2 \times 10^8 \text{ m/s.}$$

5. Why is a convex mirror preferred as a rear-view mirror in vehicles? Give two reasons.

(1) It always forms an erect image, whatever the distance of the vehicle behind. (2) Because the image is diminished, it covers a much wider field of view than a plane mirror of the same size.

6. An object is placed 25 cm from a convex lens of focal length 10 cm. Find the position of the image and its magnification, and state its nature.

$u = -25 \text{ cm}$, $f = +10 \text{ cm}$. Lens formula: $1/v - 1/u = 1/f \rightarrow 1/v = 1/10 + (-1/25) = (5 - 2)/50 = 3/50 \rightarrow v = +16.7 \text{ cm}$ (approximately). $m = v/u = 16.7/(-25) \sim -0.67$. The image is real, inverted and diminished, formed about 16.7 cm on the other side of the lens.

7. Define 1 dioptre of power of a lens.

1 dioptre is the power of a lens whose focal length is 1 metre. ($P = 1/f$ with f in metres; $1 \text{ D} = 1 \text{ m}^{-1}$.)

8. Describe the image formed by a concave mirror when the object is placed (a) beyond C, (b) at C, (c) between P and F.

(a) Beyond C: image between F and C - real, inverted, diminished. (b) At C: image at C - real, inverted, same size. (c) Between P and F: image behind the mirror - virtual, erect, magnified.

Section C - Solutions

1. A bus is 5 m away from a car's convex rear-view mirror (the bus is behind the car, in front of the mirror's reflecting surface). The mirror's radius of curvature is 3 m. Where does the driver see the bus's image, and what is its nature?

$1/v = 1/f - 1/u = 1/1.5 + 1/5 = 0.667 + 0.2 = 0.867 \rightarrow v \sim +1.15 \text{ m}$. The image is about 1.15 m behind the mirror - virtual, erect and diminished ($m = -v/u \sim +0.23$).

2. The refractive index of water is 1.33. Calculate the speed of light in water. ($c = 3 \times 10^8 \text{ m/s}$)

$$v = (3 \times 10^8)/1.33 \sim 2.26 \times 10^8 \text{ m/s.}$$

3. A concave mirror produces a real image magnified 3 times of an object placed 10 cm in front of it. Find the image position and the focal length of the mirror.

$m = -v/u \rightarrow -3 = -v/(-10) \rightarrow v = -30 \text{ cm}$ (30 cm in front of the mirror, real). $1/f = 1/v + 1/u = (-1/30) + (-1/10) = -4/30 \rightarrow f = -7.5 \text{ cm}$. Focal length = 7.5 cm (concave).

4. An object is placed 30 cm from a convex lens of focal length 20 cm. Find the image position and magnification.

$1/v = 1/20 + (-1/30) = (3 - 2)/60 = 1/60 \rightarrow v = +60 \text{ cm}$. $m = v/u = 60/(-30) = -2$. Real, inverted, magnified twice, 60 cm beyond the lens.

5. Light travelling in air strikes a transparent medium at 45° and refracts at 30° . Find the refractive index of the medium with respect to air.

$$n = \sin 45^\circ / \sin 30^\circ = 0.707/0.5 \sim 1.41.$$

6. Two thin lenses of powers +4 D and -1.5 D are placed in contact. Find the power and focal length of the combination, and state whether it converges or diverges light.

$P = +4 - 1.5 = +2.5 \text{ D}$. $f = 1/2.5 = 0.4 \text{ m} = 40 \text{ cm}$. Positive power $\rightarrow$ the combination behaves as a converging (convex) lens.

