Class 10 Science · Chapter 9: Light: Reflection and Refraction

Answer key and marking scheme · 20 marks · about 40 minutes · based on NCERT

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1. Of the pole P, the principal focus F and the centre of curvature C of a concave mirror, the point that lies on the reflecting surface itself is [1]

(a) P only
(b) F only
(c) C only
(d) both F and C

Answer: (a) The pole is the centre of the reflecting surface and lies on the mirror. F and C lie on the principal axis in front of a concave mirror, not on its surface.

2. A beam of light parallel to the principal axis falls on the convex mirror of a shop's security mirror. After reflection the rays [1]

(a) meet at a point in front of the mirror
(b) remain parallel to the principal axis
(c) travel back along their own paths
(d) appear to diverge from a point on the principal axis behind the mirror

Answer: (d) A convex mirror reflects parallel rays so that they appear to come from a point on the principal axis behind the mirror; that point is its principal focus.

3. Kavya holds a concave mirror facing the Sun and finds the sharpest bright spot of sunlight on a card 14 cm in front of the mirror. The radius of curvature of the mirror is about [1]

(a) 7 cm
(b) 14 cm
(c) 42 cm
(d) 28 cm

Answer: (d) The bright spot is the real image of the distant Sun, formed at the principal focus, so $f \approx 14$ cm. For a mirror of small aperture $R = 2f = 28$ cm.

4. A ray of light strikes a plane mirror making an angle of 35° with the surface of the mirror. The angle of reflection is [1]

(a) 35°
(b) 55°
(c) 70°
(d) 110°

Answer: (b) Angles of incidence and reflection are measured from the normal. The ray makes $90° - 35° = 55°$ with the normal, so $i = 55°$ and, since the angle of incidence equals the angle of reflection, $r = 55°$.

5. A dentist holds a small concave mirror close to a patient's tooth, nearer to the tooth than the mirror's focal length. The mirror is used this way because the image of the tooth is then [1]

(a) real, inverted and enlarged
(b) real, inverted and the same size
(c) virtual, erect and diminished
(d) virtual, erect and enlarged

Answer: (d) With the object between the pole and the focus, a concave mirror forms an enlarged, virtual and erect image behind the mirror; that is why dentists use it to see large images of teeth.

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6. State the two laws of reflection of light. Do these laws hold for reflection from a spherical mirror? [2]

(i) The angle of incidence equals the angle of reflection. (ii) The incident ray, the normal to the mirror at the point of incidence and the reflected ray all lie in the same plane. Yes: the laws apply to all reflecting surfaces, including spherical mirrors.

- first law: angle of incidence equals angle of reflection (0.5)
- second law: incident ray, normal and reflected ray in one plane (1)
- states that the laws hold for spherical mirrors too (0.5)

7. A convex lens of power +5 D and a concave lens of power −3 D are placed in contact. Find the power and the focal length of the combination, and say whether it converges or diverges light. [2]

$P = P_1 + P_2 = +5 + (-3) = +2$ D. $f = 1/P = 1/2$ m $= 0.5$ m $= 50$ cm. The power is positive, so the combination converges light.

- net power +2 D by adding powers (1)
- f = 50 cm, converging (1)

8. Farhan finds that a shaving mirror shows his face upright and enlarged when held close, but shows it inverted when he holds it at arm's length. Name the mirror and explain both observations. [2]

It is a concave mirror. Held close, his face is between the pole and the focus, so the image is virtual, erect and enlarged. At arm's length his face is beyond the focus, where a concave mirror forms a real, inverted image.

- names concave mirror (0.5)
- close: object between P and F gives virtual, erect, enlarged image (1)
- far: object beyond F gives real, inverted image (0.5)

9. A ray of light in air enters a transparent block. For this ray, the sine of the angle of incidence is 0.6 and the sine of the angle of refraction is 0.375. Find the refractive index of the block and the speed of light in it (speed of light in air 3×10^8 m/s). Is the block optically denser than crown glass, whose refractive index is 1.52? [3]

By Snell's law $n = \sin i / \sin r = 0.6/0.375 = 1.6$. $v = c/n = (3 \times 10^8)/1.6 = 1.875 \times 10^8$ m/s. Since $1.6 > 1.52$, the block is optically denser than crown glass.

- $n = \sin i / \sin r = 1.6$ (1)
- $v = c/n = 1.875 \times 10^8$ m/s (1)
- denser, as $1.6 > 1.52$ (1)

10. A convex mirror of focal length 30 cm is fixed at a blind turn in a hostel corridor. Tenzin, who is 180 cm tall, sees his image in it only 30 cm tall. How far is he from the mirror, and where is his image? [3]

The image is virtual and erect, so $m = h'/h = +30/180 = +1/6$. Also $m = -v/u$, so $v = -u/6$. Then $1/v + 1/u = -6/u + 1/u = -5/u = 1/f = 1/30$, so $u = -150$ cm. $v = -u/6 = +25$ cm. Tenzin is 1.5 m in front of the mirror; his image is 25 cm behind it.

- $m = +1/6$ and $v = -u/6$ (1)
- mirror formula gives $u = -150$ cm (1)
- $v = +25$ cm, behind the mirror (1)

11. Harpreet moves a toy figure towards a convex lens, from well beyond $2F_1$ to $2F_1$ and then to a point between F_1 and $2F_1$, catching the image on a screen each time. State the position and size of the image in each of the three cases. What stays the same about its nature? [3]

Beyond $2F_1$: image between F_2 and $2F_2$, diminished. At $2F_1$: image at $2F_2$, the same size. Between F_1 and $2F_1$: image beyond $2F_2$, enlarged. In all three the image is real and inverted.

- beyond $2F_1$: between F_2 and $2F_2$, diminished (1)
- at $2F_1$: at $2F_2$, same size; between F_1 and $2F_1$: beyond $2F_2$, enlarged (1)
- real and inverted throughout (1)