# **Light Reflection and Refraction**

**1.** Observe the given figure.



**2.** An object O is placed in front of a plane mirror as shown below.



**3.** A ray of light travels from water to air as shown below.



Given that the refractive index of air is 1.0 and the refractive index of water is 1.3, what is the angle of incidence?

(a) 22.6°	(b) 23.1°
(c) 39.0°	(d) 40.5°

The radius of curvature of a spherical mirror is 30 cm. What is its focal length?
(a) 10cm
(b) 15cm

(c) 20 cm	(d) 25 cm

**5.** A ray of light travels from air to glass as shown below.



Given that the refractive index of air is 1.0 and the refractive index of glass is 1.5, what is the angle of refraction?

(a)  $22.6^{\circ}$  (b)  $30.8^{\circ}$  (c)  $35.3^{\circ}$  (d)  $40.0^{\circ}$ 

6.

Which of the following correctly represents the incident ray, the refracted ray and the emergent ray in the given glass slab?



	Incident	Refracted	Emergent
	ray	ray	ray
(a)	PQ	QR	RS
(b)	PQ	RS	QR
(c)	RS	QR	PQ
(d)	RS	PQ	QR

**7.** A ray of light travels from water to air as shown below.





Given that the refractive index of air is 1.0, what is the refractive index of glass?

(a) 1.2	(b) 1.3
(c) 1.4	(d) 1.5

**8.** A light ray travels through three media as shown below.



Which of the following shows the ascending order of their refractive indices?

(a) Medium 1, medium 2, medium 3

- (b) Medium 2, medium 3, medium 1
- (c) Medium 3, medium 1, medium 2
- (d) Medium 1, medium 3, medium 2
- **9.** Which of the following correctly shows how a light ray travels through a thick converging lens?



**10.** Which of the emergent rays shown in the figure is the correct-one, when an incident ray strikes a diverging lens?



**11.** What is focal length?

(a) The distance from the light source to the image

(b) The distance from the object to the centre of the lens

(c) The distance from the image to the centre of the lens

(d) The distance from the focal point to the centre of the lens  $% \left( {{{\bf{n}}_{\rm{c}}}} \right)$ 

**12.** Which of the following statements are

(i) The principal focus of a converging lens is real.(ii) The principal focus of a diverging lens is virtual.

(iii)	The	principal	focus	of a	lens	always	lies	on
1	the p	rincipal ax	kis.					

(a) Only (i) and (ii)	(b) Only (ii) and (iii)
(c) Only (i) and (iii)	(d) (i), (ii) and (iii)
Which of the following	statements are correct?

13. Which of the following statements are correct?(a) The image distance obtained from a far away object is the focal length of the convex lens.(b) The images obtained from a convex lens always lie on the focal point.

(c) The images obtained by a convex lens are always real.

(d) The images obtained by a convex lens are always inverted.

**14.** An object O is placed at the position shown in the given figure.

### Converging lens



What are the characteristics of the image formed?

- (a) Real, inverted and diminished
- (b) Real, inverted and enlarged

(c) Virtual, inverted and diminished

- (d) Virtual, upright and enlarged
- **15.** An object O is placed at the position shown in the given figure.

### Converging lens



What are the characteristics of the image formed?

- (a) Real, inverted and diminished
- (b) Real, inverted and enlarged
- (c) Virtual, upright and enlarged
- (d) No image is formed

**16.** A converging lens has a focal length of 15 cm. Given that an object is placed 10 cm from the optical centre of the lens, what are the characteristics of the image formed?

(a) Real, inverted and diminished

- (b) Real, inverted and of the same size as the object
- (c) Real, inverted and enlarged
- (d) Virtual, upright and enlarged

An object 0 and its image I drawn to scale are 17. shown below.



Identify the correct position of the converging lens. / \ **F** 

(a) P	(b) Q
(c) R	(d) S

18. A light ray is parallel to the principal axis of a converging lens as shown below. **Converging lens** 



Identify the correct position of the emergent ray. (b) R (a) Q (c) P (d) S

19. An object 0 is placed at the position shown in the given figure.



What are the characteristics of the image formed?

(a) Real, inverted and diminished

2F

(b) Real, inverted and of the same size as the object

- (c) Real, inverted and enlarged
- (d) Virtual, upright and enlarged
- 20. Find the position, nature and size of the image formed when an object of size 1 cm is placed at a distance of 15 cm from a concave mirror of focal length 10 cm.

(a) On the left side, 30 cm, real, inverted and magnified

(b) On the left side, 20 cm, virtual, upright and diminished

(c) On the right side, 30 cm, real, inverted and magnified

(d) On the right side, 20 cm, virtual, up- right and diminished

- 21. A camera uses a converging lens to produce an image on the film. If the focal length of the lens is 10 cm, where can an object be placed from the camera for taking a photograph? (b) 15cm (a) 10cm (c) 25cm (d) None of the above
- 22. When is refraction of light NOT possible?

(i) The angle of incide	nce is $0^{\circ}$ .
index. (iii) The refractive inde	ex is higher than 3.0.
(a) Only (i) and (ii)	(b) Only (ii) and (iii)

- (b) Only (i) and (iii) (d) (i), (ii) and (iii) 23. Which of the following does NOT affect the focal length of a convex lens? (a) Refractive index of the material for making
  - the lens
  - (b) Material of the lens
  - (c) Object distance
  - (d) Thickness of the lens
- 24. In an experiment to determine the focal length of a converging lens, the object distance and the image distance recorded were 20 cm and 30 cm respectively. What is the focal length of the converging lens? (a) 10 cm (b) 12 cm
  - (c) 15 cm (d) 18cm
- 25. During the refraction of light, which of the following quantities remains constant? (a) Wavelength (b) Speed (c) Frequency (d) Both (a) and (b)
- 26. A converging lens magnifies a real image to four times its original size. Given that the focal length of the converging lens is 20 cm. what is the object distance? (b) 25 cm
  - (a) 5 cm (d) 100cm (c) 40cm
- 27. A converging lens magnifies a virtual image to four times its original size. Given that the focal length of the converging lens is 20 cm, what is the object distance? (a) 5cm (b) 10cm (c) 15cm (d) 25cm
- 28. A concave mirror is made by cutting a portion of a hollow glass sphere of radius 24 cm. Find the focal length of the mirror.
  - (a) 24cm (b) 12cm (c) 6cm
    - (d) 18cm

- 29. At which of the following positions do the given mirrors form a virtual image?(a) In convex mirror at infinity
  - (b) In concave mirror between F and P
  - (c) In plane mirror at all positions
  - (d) All the above
- **30.** An object is placed at the centre of the curvature of a concave mirror. What is the distance between its image and the pole?
  - (a) Equal to f (b) Between f and 2 f (c) Equal to f (b) f (c) f
  - (c) Equal to 2 f (d) Greater than 2 f
- **31.** A ray of light is incident on a concave mirror. If it is parallel to the principal axis, what happens to the reflected ray?
  - (a) t will pass through the pole.
  - (b) It will pass through the centre of curvature.
  - (c) It will pass through the focus.
  - (d) It will retrace its path.
- **32.** What is the distance between a real object and its real image in the case of a concave mirror, when the object is placed at the centre of curvature?
  - (a) f (b) 2f (c) 4f (d) Zero
- **33.** Which of the given mirrors can be used to get an image larger than the object?
  - (a) A convex mirror
  - (b) A concave mirror
  - (c) Either a convex or a concave mirror
  - (d) A plane mirror
- **34.** If an incident ray passes through the centre of curvature of a concave mirror, what happens to the reflected ray?
  - (a) It will pass through the pole of the mirror.
  - (b) It will pass through the focus of the mirror.
  - (c) It will retrace its path.
  - (d) It will be parallel to the principal axis.

- 35. Identify a mirror which neither converges or diverges a parallel beam of light rays falling on it.(a) Plane mirror
  - (b) Convex mirror
  - (c) Concave mirror
  - (d) Convexo-Concave mirror
- 36. Where should an object be placed so that a real and inverted image of the same size is formed by a convex lens?(a) At infinity
  - (a) At infinity
  - (b) At the focus of the lens
  - (c) At twice its focal length
  - (d) Between f and the lens
- 37. If a real object is placed in front of a convex lens of focal length 'f at its principal focus, where is the image formed?(a) At zero(b) At infinity
  - (c) At a distance of 2f (d) At a distance f/2
- 38. Which of the following always produces a diminished image of an object?
  (a) A convex mirror
  (b) A concave mirror
  (c) A convex lens
  (d) Bi-convex lens
- **39.** A monochromatic beam of light passes from a denser medium into a rarer medium. What is the result?(a) Its velocity increases.
  - (b) Its velocity decreases.
  - (c) Its frequency decreases.
  - (d) Its wavelength increases.
- **40.** In which mirror does one find the image long and thin?
  - (a) Concave mirror(c) Cylindrical mirror
- (b) Convex mirror
  - (d) Parabolic mirror

### **Previous contest Questions**

8.

**1.** By using which of the following mirrors can you burn a piece of paper using the reflected rays of the sun?

(a) A plane mirror	(b) A concave mirror
(c) A convex mirror	(d) All of the above

- **2.** When sun rays are focussed with a convex lens, a sharp, bright spot is observed at its focus. What does this spot indicate?
  - (a) The real image of the sun
  - (b) The virtual image of the sun
  - (c) An optical illusion produced by the convex  $\ensuremath{\mathsf{lens}}$

(d) The magnified image of the sun

**3.** Which of the following statements is NOT correct?

(a) A medium with larger refractive index is optically denser than a medium with smaller refractive index.

(b) The speed of light is less in a rarer medium than a denser medium.

(c) Refraction is due to the change in speed of light as it enters from one medium to another.

(d) The absolute refractive index of a medium is simply called its refractive index.

A ray of light is incident on a plane mirror at an angle of incidence 30° to the normal. With what angle is the ray deviated, after reflection?
(a) 30°
(b) 60°

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(c)	90°	(d)	120°

- **5.** Only one of the following applies to a concave lens. Identify it.
  - (a) The focal length is positive.

(b) The object distance can be positive or negative.

(c) The height of the image can be positive or negative.

(d) Image distance is always negative.

**6.** In which of the following is the focal length always positive?

(a) Plane mirror	(b) Concave lens
(c) Convex lens	(d) All of the above

**7.** Which of the following lens would you prefer to use while reading small letters found in a dictionary?

(a) A convex lens of focal length 50 cm.

- (b) A concave lens of focal length 50 cm.
- (c) A convex lens of focal length 5 cm.
- (d) A concave lens of focal length 5 cm.
- A ray of light travels from water to glass as shown below. The refractive index of water is 1.3 and the refractive index of glass is 1.5.





**9.** Two light rays travelling parallel to the principal axis strike a converging lens and meet at a point as shown.



Which point is called the focal point? (a) R (b) P (c) Q (d) S

**10.** An incident ray strikes a rectangular glass block as shown below.



Which of the given emergent rays is the correct one?

- (a)  $E_1$  (b)  $E_2$
- (c)  $E_3$  (d)  $E_4$

## **Answers with Solutions**

### **Multiple Choice Questions**

- 1. (a) The angle of reflection is the angle between the normal and the reflected ray.  $90 - 70^\circ = 20^\circ$ .
- **2.** (c) At point R, the image of object 'O' is formed.



3. (a) As per the given figure on page 11,  $n_i \sin i = n_r (1.3) \sin(i) = (1) \sin 30^\circ$  $\frac{13}{10} \sin i = \frac{1}{2} = 0.3846, i = 22.6^\circ$ 

4. (b)  $f = \frac{R}{2} = \frac{30}{2} = 15 cm$ 

5. (c) As per the given figure on page 11,  $n_i \sin i = n_r \sin r$ , (1)  $\sin(i) = 60^\circ = (1.5) \sin(r)$ 

$$=1 \times \frac{\sqrt{3}}{2} = 1.5 \times sin(r),$$
  
sin r = 0.577, r = 35.3°

- **6.** (a) Option (a) correctly represents the respective rays in the given glass slab.
- 7. (d) As per the given figure on page 12,  $n_1 \sin i = n_r \sin r, (n_i) \sin 40^\circ = (1) \sin 74.6^\circ$  $\sin 74.6^\circ$  0.9617 ... 1.5

$$n_1 = \frac{\sin 74.0}{\sin 40^\circ} = \frac{0.9017}{0.6727} n_1 = 1.5$$

- **8.** (c) When a light ray travels from one medium to another medium, the more the light ray is refracted away from the normal, the lesser is the refractive index of that medium.
- **9.** (a) As per the given figure on page 12, Converging lens P correctly shows the incident ray refracting towards the normal when it travels from air to glass. It also refracts away from the normal when it travels from glass to air.
- **10.** (a) As per the given figure on page 12, Emergent ray P is the correct one when an incident ray strikes a diverging lens.

- **11.** (d) Focal length is the distance from the focal point to the centre of the lens.
- **12.** (d) All the three statements are true.
- **13.** (a) Statement (a) is correct.
- (d) When u < f, the image formed is always virtual, upright and enlarged (magnified) as per the given figure on pg. 13.</li>
- 15. (d) When u = f, there is no image formed as the light rays do not get converged or diverged as per the given figure on pg. 13.
- (d) Focal length f is 15 cm. As u < f, the image formed will be virtual, upright and magnified.</li>
- (b) Q is the correct position of the lens as per the given figure on pg. 13.
- **18.** (d)As per the given figure on pg. 14, the correct position of the emergent rays is S.
- **19.** (b) When u = 2f, the image formed is always real, inverted and of the same size as the object as per the given figure on pg. 13
- 20. (a)  $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ , we get:  $\frac{1}{v} + \frac{1}{-15} = \frac{1}{-10}$  $\frac{1}{v} = \frac{+2-3}{30}, \frac{1}{v} = \frac{-1}{30}$ So, image distance, v = -30 cm on the left side
- **21.** (c) The image obtained from a camera is real, inverted and diminished. To get such an image, it must be a case of u > 2f. This implies that u > 20 cm. The object can placed at 25 cm from the camera for taking a photograph.

of the mirror. It is real, inverted and magnified.

- **22.** (a) The refractive index in higher than 3.0 is incorrect. As long as the  $\angle i$  is not 0° and there is a difference between the refractive indices of the two media involved, refraction will take place.
- **23.** (c) The object distance does not affect the focal length which is a property of the lens.
- **24.** (b) By using the lens equation,  $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$$\frac{1}{20} + \frac{1}{30} = \frac{1}{f} \Longrightarrow \frac{1}{f} = \frac{1}{20} + \frac{1}{30}$$
$$\Longrightarrow \frac{1}{f} = \frac{3+2}{60} = \frac{5}{60} \Longrightarrow f = 12 \, cm$$

**25.** (c) During the refraction of light the quantities wavelength and speed change. Frequency is always a constant quantity in the case of light.

26. (b) By using the lens equation, 
$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$
  
 $\frac{1}{u} + \frac{1}{4u} = \frac{1}{20}, \frac{5}{4u} = \frac{1}{20}, u = 25 \, cm$ 

**27.** (c) By using the lens equation,  $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ 

$$\frac{1}{u} + \frac{1}{-4u} = \frac{1}{20} \to \frac{3}{4u} = \frac{1}{20}, u = 15 \, cm$$

Take note that a negative sign must be added to the image distance if the image is a virtual image.

**28.** (b) 
$$f = \frac{\text{Radius of curvature}}{2} = \frac{24}{2} = 12 \, cm$$

- **29.** (d) All the given mirrors form a virtual image of a real object according to the giver positions.
- **30.** (c) An object is placed at C,  $\therefore u = -C = -2f$ Mirror formula,  $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ For concave mirror, f = negative $-\frac{1}{f} = \frac{-1}{2f} + \frac{1}{v}, \frac{1}{v} = -\frac{1}{f} + \frac{1}{2f}$

$$\frac{1}{v} = \frac{-1}{2f} \Longrightarrow v = -2f$$

**31.** (c) When a ray of light is incident and parallel to the principal axis, after reflection it will pass through the focus of the mirror.

- **32.** (d) When the object is placed at C of a concave mirror, the distance between a real object and its real image is zero.
- **33.** (b) To get an image larger than the object i.e., a magnified image, one can use a concave mirror because it forms a magnified, real and inverted image when the object is placed at F of the mirror.
- **34.** (c) The reflected ray retraces its path in the same direction because it strikes the mirror at right angles  $(90^{\circ})$  to its surface due to which the angle of incidence and reflection are  $0^{\circ}$ .
- **35.** (a) When a parallel beam of light rays fall on a plane mirror, it neither converges or diverges as its focal length is said to be infinite or at infinity. It means that it is limitless.
- **36.** (c) To obtain a real, inverted image of the same size, the object must be placed at 2for twice the focal length of the convex lens.
- (b) When a real object is placed infront of a convex lens of focal length 'f at its principal focus, then the image is formed at infinity.

$$\therefore -\frac{1}{f} = \frac{1}{v} - \frac{1}{f}, \frac{1}{v} = 0 \text{ (or) } v = \infty$$

- **38.** (a) A convex mirror always produces only virtual and diminished images of objects.
- 39. (a) When a monochromatic beam of light passes from a denser medium to a rarer medium, its velocity increases and wavelength decreases, but frequency remains constant.
- **40.** (c) In a cylindrical mirror, one finds his image long and thin.

# **Previous Contest Questions**

- (b) A concave mirror can be used to burn a piece of a paper by focusing reflected rays of the sun.
- (a) A parallel beam of sun rays get converged by a convex lens as a sharp, bright spot. This is the real image of the sun.
- (b) The speed of light is higher in a rarer medium than in a denser medium.
- **4.** (a) Given  $\angle i = 30^\circ$ , As  $\angle i = \angle r, \angle r = 30^\circ$
- **5.** (d) For a concave lens, the image distance is always negative.
- (c) Focal length is always positive for a convex lens.
- **7.** (c) A convex lens of focal length 5 cm.
- 8. (d) As per the given figure on pg. 16,  $n_i \sin i = n_r \sin r$ , (1.3)  $\sin 60^\circ = (1.5) \sin(r)$ 
  - $\frac{13}{10} \times \frac{\sqrt{3}}{2} = \frac{3}{2} = \sin r, \sin r = 0.577, r = 48.6^{\circ}$
- 9. (d) As per the given figure on pg. 16, Point S is called the focal point on the principal axis where the light rays converge.
- **10.** (b) The correct emergent ray is  $E_2$