CHAPTER 10

Light, Reflection and Refraction

1. OBJECTIVE QUESTIONS

1. Morning sun is not so hot as the mid day sun because
(a) Sun is cooler in the morning
(b) Heat rays travel slowly is the morning
(c) It is God gift
(d) The sun's rays travel a longer distance through atmosphere in the morning

Ans : (d) The sun's rays travel a longer distance through atmosphere in the morning

2. Where should an object be placed in front of a convex lens to get a real image of the size of the object?
(a) At the principal focus of the lens
(b) At twice the focal length
(c) At infinity
(d) Between the optical centre of the lens and its principal focus.

Ans : (b) At twice the focal length

3. An object is placed 60 cm in front of a concave mirror. The real image formed by the mirror is located 30 cm in front of the mirror. What is the object's magnification?
(a) $+2$ (b) -2
(c) $+0.5$ (d) -0.5

Ans : (d) -0.5

4. The image of an object placed in front of a convex mirror is formed at
(a) the object itself
(b) twice the distance of the object in front of the mirror
(c) half the distance of the object in front of the mirror
(d) behind the mirror

Ans : (d) behind the mirror

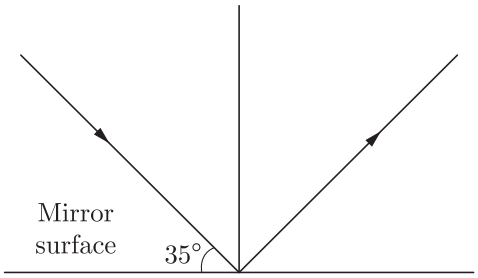
5. Light waves
(a) Require air or another gas to travel through
(b) Require an electric field to travel through
(c) Require a magnetic field to travel through
(d) Can travel through perfect vacuum

Ans : (d) Can travel through perfect vacuum

6. An object is placed 40.0 cm in front of a convex mirror. The image appears 15 cm behind the mirror. What is the focal length of the mirror?
(a) $+24$ cm (b) $+11$ cm
(c) -11 cm (d) -24 cm

Ans : (d) -24 cm

7. Find the angle of incidence and angle of reflection from the diagram.



(a) 45°, 40° (b) 55°, 55°
(c) 60°, 60° (d) 30°, 30°

Ans : (b) 55°, 55°

8. Velocity of light in air is 3×10^8 m/s. While its velocity in a medium is 1.5×10^8 m/s. Then, refractive index of this medium is
(a) 3 (b) 5
(c) 0.5 (d) 2

Ans : (d) 2

Refractive index of medium with respect to air,

$$ {}_a n_g = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}} $$

$$ {}_a n_g = \frac{3 \times 10^8}{1.5 \times 10^8} = 2 $$

9. Focal length of a plane mirror is
(a) zero (b) infinite

(c) 25 cm (d) -25

Ans : (b) infinite

Focal length of a plane mirror is infinite.

10. An object is placed at a distance of 10 cm in front of a plane mirror, then the distance of image from mirror will be

(a) 5 cm (b) 10 cm

(c) 20 cm (d) 0

Ans : (b) 10 cm

The distance of image is equal to the distance of object from mirror. Therefore, the distance of image from mirror is 10 cm.

11. The radius of curvature of concave mirror is 12 cm. Then, the focal length will be

(a) 12 cm (b) 6 cm

(c) -24 cm (d) -6 cm

Ans : (d) -6 cm

Given, radius of curvature, $R = 12$ cm

We know that the focal length of concave mirror has negative value.

Hence, focal length, $f = \frac{-R}{2} = \frac{-12}{2} = -6$ cm

12. A man is 6.0 ft tall. What is the smallest size plane mirror he can use to see his entire image

(a) 3.0 ft (b) 6.0 ft

(c) 12 ft (d) 24 ft

Ans : (a) 30 ft

13. A spherical mirror and a thin spherical lens have each a focal length of -15 cm. The mirror and the lens are likely to be

(a) both concave

(b) both convex

(c) the mirror is concave and the lens is convex.

(d) the mirror is convex, but the lens is concave.

Ans : (a) both concave

14. Which of the following lenses 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.

Ans : (c) A convex lens of focal length 5 cm.

15. One light wave is incident upon a plate of refracting index μ. Incident angle i, for which refractive & reflective waves are mutually perpendicular will be

(a) $i = 45^\circ$ (b) $i = \sin^{-1}(\mu)$

(c) $i = \text{cosec}^{-1}(\mu)$ (d) $i = \tan^{-1}(\mu)$

Ans : (d) $i = \tan^{-1}(\mu)$

$$\frac{\sin i}{\sin r} = \mu$$

Angle between refractive & reflective waves

$$180^\circ - (i + r) = 90^\circ$$

$$i + r = 90^\circ$$

$$r = 90^\circ - i$$

$$\mu = \frac{\sin i}{\sin(90 - i)} = \frac{\sin i}{\cos i} = \tan i$$

$$i = \tan^{-1}(\mu)$$

16. An object is situated at a distance of $f/2$ from a convex lens of focal length f. Distance of image will be

(a) $+(f/2)$ (b) $+(f/3)$

(c) $+(f/4)$ (d) $-f$

Ans : (d) $-f$

For a spherical lens $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

For convex lens, $u = -f/2$ and f is Positive

$$\frac{1}{v} = \frac{1}{(-f)} + \frac{1}{u} + \frac{1}{(-f)} = +\frac{1}{f} - \frac{2}{f}$$

$$v = -f$$

17. Two plane mirrors are set at right angle and a flower is placed in between the mirrors. The number of images of the flower which will be seen is

(a) One (b) Two

(c) Three (d) Four

Ans : (c) Three

18. An object is placed 20 cm from the concave mirror of focal length 10 cm, then image is formed at

(a) behind the mirror

(b) between the mirror and focus

(c) at focus

(d) centre of curvature of mirror

Ans : (d) centre of curvature of mirror

Given, focal length of concave mirror,

$$f = -10 \text{ cm}$$

Distance of object from concave mirror,

$$u = -20 \text{ cm}$$

From the mirror formula,

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

$$\frac{1}{-20} + \frac{1}{v} = \frac{1}{-10}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{10} = \frac{1-2}{20} = \frac{-1}{20}$$

$$v = -20 \text{ cm}$$

Hence, the image is formed at the centre of curvature of mirror.

19. The refractive index of dens flint glass is 1.65 and for alcohol, it is 1.36 with respect to air, then the refractive index of the dens flint glass with respect to alcohol is

(a) 1.31 (b) 1.21

(c) 1.11 (d) 1.01

Ans : (b) 1.21

Given,

Refractive index of flint glass with respect to air

$n_a = 1.36$

$$_fn_a = \frac{n_f}{n_a} = \frac{1.65}{1.36} = 1.21$$

Thus, the refractive index of flint glass with respect to alcohol is 1.21.

20. A virtual image three times the size of the object is obtained with a concave mirror of radius of curvature 36 cm. The distance of the object from the mirror is

(a) 20 cm (b) 10 cm

(c) 12 cm (d) 5 cm

Ans : (c) 12 cm

We know that, $f = \frac{R}{2}$

$$f = \frac{36}{2} = 18$$

Magnification, $m = 3$

$$m = \frac{f}{u - f}$$

$$-3 = \frac{18}{u - 18}$$

$$u = 12\,\text{cm}$$

21. A convex mirror of focal length of produces an image $\frac{1}{n^{th}}$ of the size of the object. The distance of the object from the mirror is

(a) $\frac{n+1}{n}f$ (b) $(n+1)f$

(c) $(n-1)f$ (d) $\frac{n-1}{n}f$

Ans : (c) $(n-1)f$

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

Take real +ve, virtual = − ve

Sign convention, $n = \frac{I}{O} = \frac{v}{u} = \frac{1}{\mu}$

$$v = \frac{u}{\mu}$$

$$\frac{1}{u} - \frac{n}{u} = \frac{1}{f}$$

$$f = \frac{u}{0 - n}$$

$$u = f(1 - n)$$

Required distance $= -u = (n-1)f$

22. An object is placed at the centre of curvature of a concave mirror. The distance between its image and the pole is

(a) equal to f (b) between f and $2f$

(c) equal to $2f$ (d) greater than $2f$

Ans : (c) equal to $2f$

An object is at c,

$$u = -c = -2f$$

Mirror formula, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

For concave mirror, f is negative

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

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

$$v = -2f$$

Distance of image from pole is $2f$.

23. A perfectly reflecting mirror has an area of $1\,\text{cm}^2$. Light energy is allowed to fall on it for an hour at the rate of $10\,\text{Wcm}^{-2}$. The force that acts on the mirror is

(a) $3.35 \times 10^{-7}\,\text{N}$ (b) $6.7 \times 10^{-7}\,\text{N}$

(c) $3.35 \times 10^{-8}\,\text{N}$ (d) $6.7 \times 10^{-8}\,\text{N}$

Ans : (d) $6.7 \times 10^{-8}\,\text{N}$

Let n photons fall on mirror each having frequency v_1 energy of all photons is 1 sec is $= 10\,\text{J} = nv$

Rate of change of momentum $= \frac{2nbv}{c}$ (after reflection)

$$= \frac{2}{c} \times 10 = \frac{20}{3 \times 10^8} = 6.7 \times 10^{-8}\,\text{N}$$

24. Refractive index of diamond with respect to glass is 1.6. If the absolute refractive index of glass is 1.5, then the absolute refractive index of diamond is

(a) 1.4 (b) 2.4

(c) 3.4 (d) 4.4

Ans : (b) 2.4

Given, $_d\mu_g = 1.6$ and $\mu_g = 1.5$

Refractive index of diamond with respect to glass

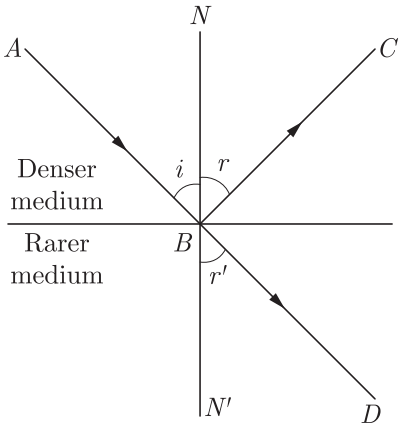
$$= \frac{\text{Absolute refractive index of diamond}}{\text{Absolute refractive index of glass } (\mu_g)}$$

So, absolute refractive index of diamond

= Refractive index of diamond glass $(_d\mu_g) \times$ Absolute refractive index of glass (μ_g)

$$\mu_d = 1.6 \times 1.5 = 2.4$$

25. A ray of light from a denser medium strikes a rarer medium at an angle of incidence as shown in figure. The reflected and refracted rays make an angle of 90° with each other. The angles of reflection and refraction are r and r'. The critical angle is



(a) $\sin^{-1}(\tan r)$ (b) $\sin^{-1}(\tan i)$

(c) $\sin^{-1}(\tan r')$ (d) $\tan^{-1}(\tan i)$

Ans : (a) $\sin^{-1}(\tan r)$

From figure, $i = r$ and $r' = 90° - r$

Now, $n = \frac{\sin i}{\sin r} = \frac{\sin r'}{\sin r} = \frac{\sin(90^\circ - r)}{\sin r}$

$n = \frac{\cos r}{\sin r} = \frac{1}{\tan r}$

We know that, $n = \frac{1}{\sin C}$

where, C = critical angle

$\frac{1}{\sin C} = \frac{1}{\tan r}$

$C = \sin^{-1}(\tan r)$

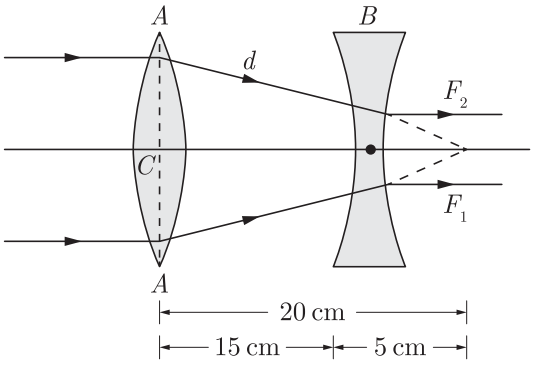
26. A convex lens A of focal length 20 cm and a concave lens B of focal length 5 cm are kept along the same axis with a distance d between them. If a parallel beam of light falling on A leaves B as a parallel beam, then the distance d in cm will be

(a) 25 (b) 15

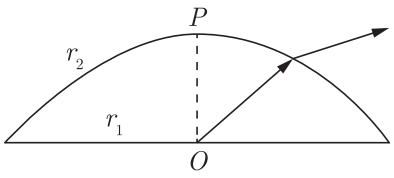
(c) 30 (d) 50

Ans : (b) 15

The situation is shown in figure. In the absence of concave lens, the parallel beam will be focussed at f_2 i.e. at a distance 20 cm from the lens A. The focal length of concave lens is 5 cm. i.e. if this lens is placed at 5 cm from f_2, then the beam will become parallel. So, $d = 15\,\text{cm}$.



27. A thick plane convex lens made of crown glass (refractive index 1.5) has thickness of 3 cm at its centre.



An ink mark made at the centre of its plane face, when viewed normal through the curved face, appears to be a distance x from the curved face. Then, x is equal to

(a) 2 cm (b) 2.1 cm

(c) 2.3 cm (d) 2.5 cm

Ans : (d) 2.5 cm

The ray of light from the object O gets refracted at the interface between lens and air and therefore appears to start from the point I in figure. So, I is the refracted image of the object O. The object distance u is PO and the image distance V is PI. [P is the pole of the spherical surface].

We have, $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{(\mu_2 - \mu_1)}{R}$

So that $\frac{1}{v} - \frac{1.5}{(-3)} = \frac{(1-1.5)}{(-5)}$

rearranging the above equation, we obtain.

$\frac{1}{v} = \frac{0.5}{5} - \frac{1.5}{3} = \frac{-6}{15}$

$v = -2.5\,\text{cm}$

28. If the refractive indices for water and diamond relative to air are 1.33 and 2.4 respectively, then the refractive index of diamond relative to water is-

(a) .55 (b) 1.80

(c) 3.19 (d) None of these

Ans : (b) 1.80

29. There is an equiconvex lens of focal length of 20cm. If the lens is cut into two equal parts perpendicular to the principle axis, the focal lengths of each part will be

(a) 20 cm (b) 10 cm

(c) 40 cm (d) 15 cm

Ans : (c) 40 cm

30. An object is placed in front of a screen and a convex lens is placed at a position such that the size of the image formed is 9 cm. When the lens is shifted through a distance of 20 cm. the size of the image becomes 1 cm. The focal length of the lens and the size of the object are respectively.

(a) 7.5 cm and 3.5 cm (b) 7.5 cm and 4.5 cm

(c) 6 cm and 3 cm (d) 7.5 cm and 3 cm

Ans : (d) 7.5 cm and 3 cm

If h_1 and h_2 are the size of the image in the two conjugate positions, the size of the object is given by

$h = \sqrt{(h_1 h_2)} = \sqrt{(9 \times 1)} = 3\,\text{cm}$

Considering the formations of the image in the first case, we have $\frac{v}{u} = \frac{9}{3}$. So that $v = 3u$.

Also, $v = 20 + u$ (since, v and u interchange in the conjugate position)

Therefore, $3u = 20 + u$ from which $u = 10\,\text{cm}$

$v = 20 + u = 30\,\text{cm}$

Focal length, $f = \frac{uv}{u+v}$

Since v is positive and u is negative in the equation,

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

Therefore, $f = \frac{10 \times 30}{(10+30)} = 7.5\,\text{cm}$

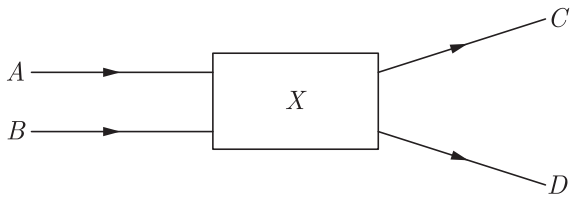
31. An object is placed 60 cm in front of a convex mirror. The virtual image formed by the mirror is located 30 cm behind the mirror. What is the object's magnification

(a) +2 (b) −2

(c) $+0.5$ (d) -0.5

Ans : (c) $+0.5$

32. Light rays A and B fall on optical component X and come out as C and D.



The optical component is a
(a) concave lens (b) convex lens
(c) convex mirror (d) prism

Ans : (a) concave lens

33. An object is placed 20.0 cm in front of a concave mirror whose focal length is 25.0 cm. What is the magnification of the object?
(a) $+5.0$ (b) -5.0
(c) $+0.20$ (d) -0.20

Ans : (a) $+5.0$

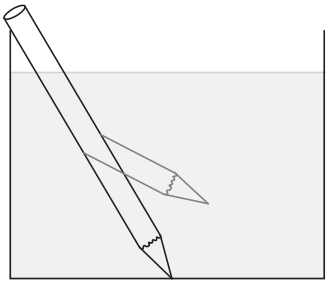
34. An object is placed at the radius of curvature of a concave spherical mirror. The image formed by the mirror is
(a) located at the focal point of the mirror.
(b) located between the focal point and the radius of curvature of the mirror.
(c) located at the center of curvature of the mirror.
(d) located out beyond the center of curvature of the mirror.

Ans : (c) located at the center of curvature of the mirror.

35. An object is placed 20.0 cm in front of a concave mirror whose focal length is 25.0 cm. Where is the image located?
(a) 1.0×10^2 cm in front of the mirror
(b) 1.0×10^2 cm behind the mirror
(c) 5.0×10^1 cm in front of the mirror
(d) 5.0×10^1 cm behind the mirror

Ans : (b) 1.0×10^2 cm behind the mirror

36. Which statement best describes the property of light waves illustrated in the diagram below?



(a) some materials absorb light waves.
(b) Some materials refracted by some materials.
(c) Light waves are refracted by some materials.
(d) Light waves are emitted by some materials.

Ans : (c) Light waves are refracted by some materials.

2. FILL IN THE BLANK

DIRECTION : Complete the following statements with an appropriate word/term to be filled in the blank space(s).

1. Two immiscible transparent liquids A and B have 1.2 and 1.4 as their refractive indices (with respect to air). The refractive index of B with respect to A is.....
Ans : 5/4

2. The power of a convex lens is ..... and that of a concave lens is .....
Ans : Positive, negative

3. Light seems to travel in .....
Ans : Straight lines

4. Power of a lens is the reciprocal of its .....
Ans : Focal length

5. The SI unit of power of a lens is .....
Ans : Dioptre

6. The centre of the reflecting surface of a spherical mirror is a point called the .....
Ans : Pole

7. The mirror used in the construction of shaving glass is ..... mirror.
Ans : Concave

8. An object is placed in front of a spherical mirror. The image is found to be virtual for all positions of the object. The spherical mirror is .....
Ans : Convex

9. The angle of incidence is ..... to the angle of reflection.
Ans : Equal

10. The reflecting surface of a spherical mirror may be curved ..... or .....
Ans : Inwards, outwards

11. The surface of the spoon can be approximated to a ..... mirror.
Ans : Concave

12. Line passing through the pole and the centre of curvature of a spherical mirror is called the .....
Ans : Principal axis

13. Parallel rays of light are reflected by a concave mirror to a point called the ..... . The focal length is the distance from the ..... to the pole of mirror.
Ans : Focus point, focus

14. Light is a form of ..... and it travels in a .....
Ans : energy, straight line

15. A ray of light passes ..... after refraction through the optical centre of a thin lens.
Ans : straight

16. A ray parallel to the principal axis, after reflection, will pass through the .....
Ans : Principal focus

17. $\frac{\sin i}{\sin r} = \mu$ is called ..... law.
Ans : Snell's

18. A light ray travelling obliquely from a denser medium to a rarer medium bends ..... the normal when it travels obliquely from a rarer to a denser medium.
Ans : Away from, towards

19. In case of a rectangular glass slab, the refraction takes place at both ..... interface and ..... interface. The emergent ray is ..... to the direction of incident ray.
Ans : Air-glass, glass-air, parallel

20. The centre of curvature of a concave mirror lies in ..... of it.
Ans : Front

21. According to the new cartesian sign convention, the focal length of a convex lens is ..... and focal length of a concave lens is .....
Ans : Positive, negative

22. A concave mirror ..... rays of light, whereas a convex mirror ..... rays of light.
Ans : converges, diverges

23. The dentists use ..... mirrors to see large images of the teeth of patients.
Ans : Concave

24. A transparent material bound by two surfaces, of which one or both surfaces are spherical, forms a .....
Ans : Lens

25. The degree of ..... of light rays achieved by a lens is expressed in terms of its power.
Ans : Convergence or divergence

3. TRUE/FALSE

DIRECTION : Read the following statements and write your answer as true of false.

1. A lens of power 1 dioptre must have a focal length of 1 cm.
Ans : False

2. Convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.
Ans : True

3. A convex lens always forms a real image for a real object.
Ans : False

4. A concave lens will always give a virtual, erect and diminished image.
Ans : True

5. A glass slab can produce lateral displacement which occurs in the direction of the light.
Ans : True

6. A ray of light passing through the optical centre of a lens will emerge without any deviation.
Ans : True

7. All the distances measured in a direction opposite to that of incident rays are taken as negative.
Ans : True

8. A plane mirror can form virtual images.
Ans : True

9. An object is placed in front of a mirror and an image of it is formed at the object itself. The mirror mentioned in question is a convex mirror.
Ans : True

10. A concave mirror can produce both real and virtual images.
Ans : True

11. Light travels faster in glass than in air.
Ans : False

12. A lens that is thicker at the middle than at the edge is a diverging lens.
Ans : False

13. The refractive index of a transparent medium is the ratio of the speed of light in vacuum to that in the medium.
Ans : True

14. A concave mirror always produces inverted image.
Ans : False

15. The reflecting surfaces, of all types, obey the laws of reflection.
Ans : True

16. Light travels in vacuum with an enormous speed of $3 \times 10^8\ ms^{-1}$.
Ans : True

17. The speed of light is different in different media.
Ans : True

18. Light has transverse wave nature.
Ans : True

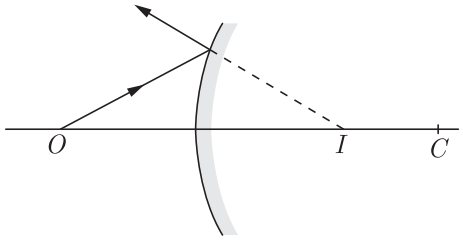
19. The laws of reflection are valid for plane mirrors and not for spherical mirrors.
Ans : False

20. The mirror formula is valid only if the aperture of the mirror is small.
Ans : True

21. When a ray of light travels from air to water, its speeds up.
Ans : False

22. The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.
Ans : True

23. Image formed by a plane mirror is always virtual and erect.
Ans : False
Plane mirror can form real image as shown.



24. The principal focus of a spherical mirror lies midway between the pole and centre of curvature.
Ans : True

4. MATCHING QUESTIONS

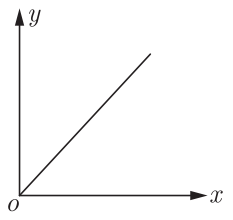
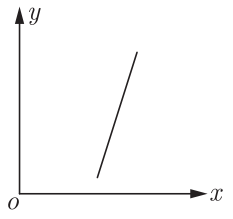
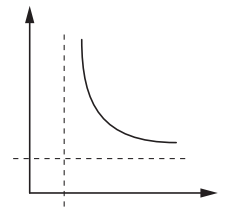
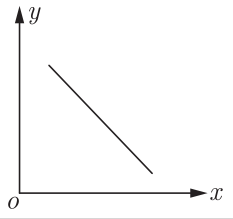
DIRECTION : Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column-I have to be matched with statements (p, q, r, s) in column II.

1. Match the Following

Column I		Column II	
(A)	Power of convex mirror	(p)	Positive power
(B)	Power of concave mirror	(q)	Negative power
(C)	Power of plane mirror	(r)	Zero power
(D)	Power of convex lens	(s)	Infinite power

Ans : A-q, B-p, C-r, D-p

2. The graphs given apply to convex lens of focal length f, producing a real at a distance v from the optical centre when self luminous object is at distance u from the optical centre. The magnitude of magnification is m. Identify the following graphs with the first named quantity being plotted along y-axis.

Column I		Column II	
(A)	ν against u	(p)	
(B)	$\frac{1}{\nu}$ against $\frac{1}{u}$	(q)	
(C)	m against ν	(r)	
(D)	$(m+1)$ against $\frac{\nu}{f}$	(s)	

Ans : A-r, B-s, C-q, D-p

3. A convex lens (f) forms an images on a screen Considering the object to be at the zero mark in a scale, match the following.

Column I		Column II	
(A)	Image	(p)	Moves the image of infinite object further away
(B)	Additional lens in contact	(q)	Not unique as lens is moved between object and source.
(C)	Reduction in refractive index	(r)	Virtual for screen position at a distance $< 4f$ from the object.

Column I		Column II	
(D)	Slicing the lens to have one plane and another	(s)	Object at d forms real image further convex surface nearer plano-convex lens.

	A	B	C	D
(a)	p, q	q	r	q,r
(b)	r	q	q, r, s	r, s
(c)	p, r	s	p	p, r
(d)	p	q, r	r	s

Ans : (c) A-p,r, B-s, C-p, D-p, r

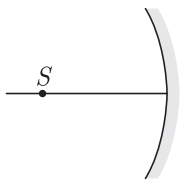
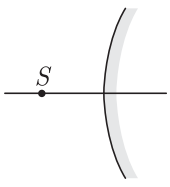
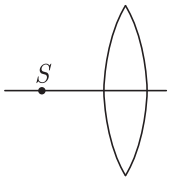
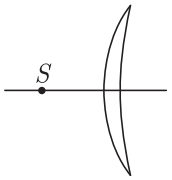
4. In the following columns, the position of an object is given is column I and the nature of image formed in a concave mirror is given in column II.

Column I (Position of object)		Column II (Nature of image)	
(A)	At infinity	(p)	Real
(B)	Between infinity and centre of curvature	(q)	Inverted
(C)	At centre of curvature	(r)	Diminished
(D)	At focus	(s)	Enlarged
		(t)	Same size

	A	B	C	D
(a)	p, q	q	r, s	q,r
(b)	r, s	q, r	s, t	p, q, r, s
(c)	p, s	q	r, s, t	r
(d)	p, q, r	p, q, r	p, q, t	p, q

Ans : (d) A-p, q, r, B-p, q, r, C-p, q, t, D-p, q

5. An optical component and an object S placed along its optic axis are given in **Column I.** The distance between the object and the component can be visaed. The properties of images are given in **Column II.** Match all the properties of images from **Column II** with the appropriate components given in **Column I.**

Column I		Column II	
(A)		(p)	Real image
(B)		(q)	Virtual image
(C)		(r)	Magnified image
(D)		(s)	Image at infinity

	A	B	C	D
(a)	p, q	q	r, s	q,r
(b)	p q, r, s	q	p, q, r, s	p, q, r, s
(c)	p, s	q	r, s, t	r
(d)	p	q, r	r	s

Ans : (b) A-p, q, r, s, B-q, C-p, q, r, s, D-p, q, r, s

6.

	Column I		Column II
1.	Reflection	(a)	The radius of that sphere of which the mirror is a part.
2.	Refraction	(b)	The bouncing back of light from a smooth surface.
3.	Incident ray	(c)	A mirror whose reflecting surface is the part of a hollow sphere.
4.	Spherical mirror	(d)	The bending of light, when it passes from one medium to another.
5.	Rarer medium	(e)	A ray of light that strikes the reflecting surface.
6.	Denser medium	(f)	It is the degree of convergence or divergence of light rays achieved by a lens.
7.	Radius of curvature	(g)	A medium in which the speed of light is less.
8.	Focal length	(h)	The centres of spheres which form the part of the surface of the lens.
9.	Optic centre	(i)	The distance of the principal focus from the pole of the mirror.
10.	Power of lens	(j)	A medium in which the speed of light is more.

Ans : 1-(b), 2-(d), 3-(e), 4-(c), 5-(j), 6-(g), 7-(a), 8-(i), 9-(h), 10-(f)

5. ASSERTION AND REASON

DIRECTION : In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(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 but reason (R) is true.

(e) Both Assertion and Reason are false.

1. **Assertion :** A point object is placed at a distance of 26 cm from a convex mirror of focal length 26 cm. The image will not form at infinity.
Reason : For above given system the equation $\frac{1}{u}+\frac{1}{\nu}=\frac{1}{f}$ gives $\nu=\infty$.
Ans : (c) Assertion (A) is true but reason (R) is false.

2. **Assertion :** Keeping a point object fixed, if a plane mirror is moved, the image will also move.
Reason : In case of a plane mirror, distance of object and Its image is equal from any point on the mirror.
Ans : (d) Assertion (A) is false but reason (R) is true.

3. **Assertion :** If both plane mirror and object are moved through a distance x, then the image moves through a distance $2x$.
Reason : When the object is fixed and plane mirror is moved through a distance x. Then the image is also moves through the distance $2x$.
Ans : (c) Assertion (A) is true but reason (R) is false.

4. **Assertion :** If a spherical mirror is dipped in water, its focal length remains unchanged.
Reason : A laser light is focused by a converging lens. There will be a significant chromatic aberration.
Ans : (c) Assertion (A) is true but reason (R) is false.

5. **Assertion :** Large concave mirrors are used to concentrate sunlight to produce heat in solar cookers.
Reason : Concave mirror converges the light rays falling on it to a point.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

Concave mirror converges the light rays falling on it to a point. So large concave mirrors are used to concentrate sunlight to produce heat in solar cookers.

6. **Assertion :** Plane mirror may form real image.
Reason : Plane mirror forms virtual image, if objects is real.
Ans : (b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

Plane mirror forms virtual image of real object and real image of virtual object.

7. **Assertion :** The focal length of a convex mirror of radius R is equal to, $f=\left(\mu_g=\frac{3}{2}\right)$.
Reason : The focal length of convex lens in water becomes $4f$.
Ans : (d) Assertion (A) is false but reason (R) is true.

$$f_w = f\frac{{}_a\mu_g - 1}{\left(\frac{{}_a\mu_g}{{}_a\mu_g} - 1\right)} = f\frac{\left(\frac{3}{2}-1\right)}{\left(\frac{\frac{3}{2}}{\frac{4}{3}}-1\right)} = 4f$$

8. **Assertion :** The speed of light in glass depends on colour of light.
Reason : The speed of light in glass $v_g=\frac{c}{n_g}$ the refractive index (n_g) of glass is different for different colours.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

9. **Assertion :** If the rays are diverging after emerging from a lens; the lens must be concave.
Reason : The convex lens can give diverging rays.
Ans : (d) Assertion (A) is false but reason (R) is true

If the rays cross focal point of convex lens, they become diverging.

10. **Assertion :** Light travels faster in glass than in air.
Reason : Glass is denser than air.
Ans : (d) Assertion (A) is false but reason (R) is true.

11. **Assertion :** A ray of light incident along the normal to the plane mirror retraces its path after reflection from the mirror.
Reason : A ray of light along the normal has angle of incidence as $\pi/2$ and hence, it retraces its own path after reflection from mirror.
Ans : (c) Assertion (A) is true but reason (R) is false.

Angle of incidence = Angle between incident ray normal to the mirror $= 0^\circ$

12. **Assertion :** The height of an object is always considered positive.
Reason : An object is always placed above the principal axis in this upward direction.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

13. **Assertion :** Refractive index has no units.
Reason : The refractive index is a ratio of two similar quantities.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

14. **Assertion :** When a concave mirror is held under water, its focal length will increase.
Reason : The focal length of a concave mirror is independent of the medium in which it is placed.
Ans : (d) Assertion (A) is false but reason (R) is true.

15. **Assertion :** A ray incident along normal to the mirror retraces its path.
Reason : In reflection, angle of incidence is always equal to angle of reflection.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

When light ray incident along normal to the mirror, angle of incidence $\angle i = 0^\circ$. According to law of reflection $\angle i = \angle r$, therefore angle of reflection $\angle r = 0^\circ$, i.e. the incident ray retraces its path.

16. **Assertion :** A convex mirror is used as a driver's mirror.
Reason : Because convex mirror's field of view is large and images formed are virtual, erect and diminsed.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

17. **Assertion :** When a concave mirror is held under water, its focal length will increase.
Reason : The focal length of a concave mirror is independent of the medium in which it is placed.
Ans : (d) Assertion (A) is false but reason (R) is true.

Focal length is the property of mirror and is independent of the medium in which it is placed.

18. **Assertion :** A virtual image cannot be photographed.
Reason : Only real objects are photographed.
Ans : (c) Assertion (A) is true but reason (R) is false.

An image is a plane mirror is virtual and it can be photographed.

19. **Assertion :** If both object and plane mirror are moved through a distance x, then the image moves through a distance $2x$.
Reason : If object is fixed and plane mirror is moved through a distance x then the image also moves through a distance $2x$.
Ans : (c) Assertion (A) is true but reason (R) is false.

20. **Assertion :** Higher is the refractive index of a medium or denser the medium, lesser if the velocity of light in that medium.
Reason : Refractive index is inversely proportional to velocity.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

According to Snell's law,

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = \frac{c/v_2}{c/v_1} = \frac{v_1}{v_2}$$

$$n_1 v_1 = n_2 v_2$$

This shows that higher is the refractive index of a medium or denser the medium, lesser is the velocity of light in that medium.

21. **Assertion :** Mirror formula can be applied to a plane mirror.
Reason : A plane mirror is a spherical mirror of infinite focal length.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

22. **Assertion :** Red light travels faster in glass than green light.
Reason : The refractive index of glass is less for red light than for green light.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

23. **Assertion :** For observing traffic at back, the driver mirror is convex mirror.
Reason : A convex mirror has much larger field of view than a plane mirror.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

24. **Assertion :** The image formed by a concave mirror is certainly real if the object is virtual.
Reason : The image formed by a concave mirror is certainly virtual if the object is real.
Ans : (c) Assertion (A) is true but reason (R) is false

The image of real object may be real in case of concave mirror.

25. **Assertion :** When the object moves with a velocity $\vec{v}$, its image in the plane mirror moves with a velocity of $-2\vec{v}$.
Reason : The minimum height of the mirror to be required to see the full image of man of height h is $\frac{h}{2}$.
Ans : (b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

26. **Assertion :** When the object moves with a velocity 2 m/s, its image in the plane mirror moves with a velocity of 4 m/s.
Reason : The image formed by a plane mirror is as far behind the mirror as the object is in front of it.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

27. **Assertion :** A convex mirror is used as a driver's mirror.
Reason : Convex mirrors have a wider field of view as they are curved outwards. They also give an erect, though diminished image.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

28. **Assertion :** The small object, to be seen in a microscope, is kept within the two foci of its objective.
Reason : In this case, the image formed by the objective is nearer to the eyepiece.
Ans : (c) Assertion (A) is true but reason (R) is false.

Object is placed between F and $2F$ of objective lens.

29. **Assertion :** As light travels from one medium to another, the frequency of light does not change.
Reason : Because frequency is the characteristic of source.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

30. **Assertion :** Light rays retrace their path when their direction is reversed (Law of reversibility of light rays)
Reason : For the refraction light, water is denser than air, but for the refraction of sound, water is rarer than air.
Ans : (b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

31. **Assertion :** Speed of light in glass of

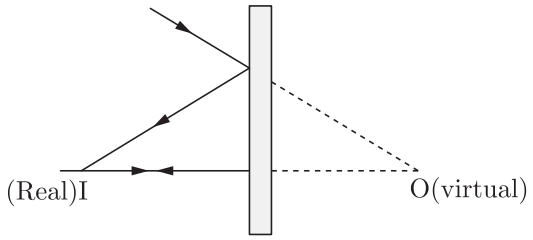
$$\mu = 1.5 \text{ is} 2 \times 10^8 \text{ m/sec}$$

Reason : According to dual theory, light has particle nature and wave nature simultaneously.
Ans : (c) Assertion (A) is true but reason (R) is false.

32. **Assertion :** It is not possible to see a virtual image by eye.
Reason : The rays that seem to emanate from a virtual image do not in fact emanates from the image.
Ans : (d) Assertion (A) is false but reason (R) is true.

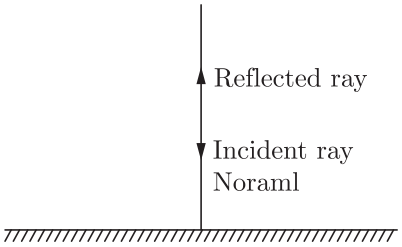
33. **Assertion :** Plane mirror may form real image.
Reason : Plane mirror forms virtual image, if objects is real.
Ans : (b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

Plane mirror may form real image, if object is virtual.



34. **Assertion :** An object is placed at a distance of f from a convex mirror of focal length f, its image will form at infinity.
Reason : The distance of image in convex mirror can never be infinity.
Ans : (d) Assertion (A) is false but reason (R) is true

The distance of image in convex mirror is always finite.



Angle of reflection $= 0^\circ$ (from laws of reflection) Hence, the reflected ray retraces its path along the normal at an angle 0° with normal.

35. **Assertion :** The mirror used in search lights are concave spherical.
Reason : In concave spherical mirror the image formed is always virtual.
Ans : (c) Assertion (A) is true but reason (R) is false.

36. **Assertion :** Refractive index of glass with respect to air is different for red light and violet light.
Reason : Refractive index of a pair of media depends on the wavelength of light used.
Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

Refractive index of any pair of media is inversely proportional to wavelength of light.

Hence, $\gamma_v < \gamma_r$

$\mu_r < \mu_v$

where, γ_v and γ_r are the wavelengths of violet and red light. μ_v and μ_v are refractive index of violet and red light.

37. **Assertion :** The focal length of the convex mirror will increase, if the mirror is placed in water.
Reason : The focal length of a convex mirror of radius R is equal to, $f = \frac{R}{2}$
Ans : (d) Assertion (A) is false but reason (R) is true.

Focal length of the spherical mirror does not depend on the medium which it placed.

38. **Assertion :** As the temperature of a medium increases the refractive index decreases.
Reason : When a ray travels from vacuum to a medium, then μ is known as absolute refractive index of the medium. ($\mu_{\text{vacuum}} = 1$).
Ans : (b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

39. **Assertion :** Concave mirrors are used as make-up mirrors.
Reason : When the face is held within the focus of a concave mirror, then a diminished image of the face is seen in the concave mirror.
Ans : (c) Assertion (A) is true but reason (R) is false.

40. **Assertion :** Propagation of light through an optical fibre is due to total internal reflection taking palce at the core-clade interface.
Reason : Refractive index of the material of the core

of the optical fibre is greater than of air.

Ans : (b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

Optical fibre communication is based on the phenomenon of total internal reflection at core-clade interface. The refractive index of the material of the cladding, hence, light sinking at core-cladding interface gets totally internal reflected. The light undergoes and reaches the other end of the fibre.

41. **Assertion :** The refractive index of diamond is $\sqrt{6}$ and refractive index of liquid is $\sqrt{3}$. If the light travels from diamond to the liquid, it will initially reflected when the angle of incidence is 30°.

Reason : $\mu = \dfrac{1}{\sin C}$, where μ is the refractive index of diamond with respect to liquid.

Ans : (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

Refractive index of diamond *w.r.t.* liquid

$$^{l}\mu_{b} = \frac{1}{\sin C} = \frac{\mu_d}{\mu_1}$$

$$\frac{\sqrt{6}}{\sqrt{3}} = \frac{1}{\sin C}$$

$$\sin C = \frac{1}{\sqrt{2}} = \sin 45^\circ$$

$$C = 45^\circ$$