Topic : Geometrical optics and
Wave optics

1. The focal length f is related to the radius of curvature r of the spherical convex mirror by -

   A. $f = r$

   B. $f = -\frac{1}{2}r$

   C. $f = +\frac{1}{2}r$

   D. $f = -r$

2. A short straight object of height $100\ \mathrm{cm}$ lies before the central axis of a spherical mirror whose focal length has absolute value $|f| = 40\ \mathrm{cm}$. The image of the object produced by the mirror is of height $25\ \mathrm{cm}$ and has the same orientation as of the object. One may conclude from the information :

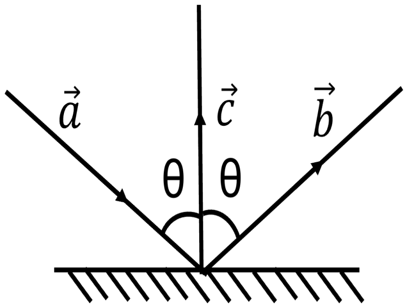
   A. Image is real, same side of the concave mirror.

   B. Image is virtual, opposite side of the convex mirror.

   C. Image is virtual, opposite side of the concave mirror.

   D. Image is real, same side of the convex mirror.

3. The incident ray, reflected ray and the outward drawn normal are denoted by the unit vectors, $\vec{a}$, $\vec{b}$ and $\vec{c}$ respectively. Then, choose the correct relation for these vectors.



A. $\vec{b} = \vec{2a} + \vec{c}$

B. $\vec{b} = \vec{a} - \vec{c}$

C. $\vec{b} = \vec{a} + 2\vec{c}$

D. $\vec{b} = \vec{a} - 2(\vec{a} \cdot \vec{c})\vec{c}$

4. The refractive index of a converging lens is 1.4. What will be the focal length of this lens if it is placed in a medium of same refractive index? Assume the radii of curvature of the faces of lens are R_1 and R_2 respectively.

A. Zero

B. $\dfrac{R_1R_2}{R_1 - R_2}$

C. Infinite

D. 1

5. The thickness at the centre of a planoconvex lens is $3\ \text{mm}$ and the diameter is $6\ \text{cm}$. If the speed of light in the material of the lens is $2 \times 10^8\ \text{ms}^{-1}$, the focal length of the lens kept in air is :

A. $0.30\ \text{cm}$

B. $1.5\ \text{cm}$

C. $15\ \text{cm}$

D. $30\ \text{cm}$

6. Your friend is having eye sight problem. She is not able to see clearly a distant uniform window mesh and it appears to her as non-uniform and distorted. The doctor diagnosed the problem as:

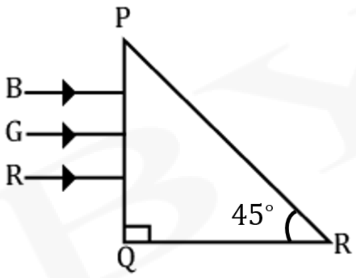
A. Myopia and hypermetropia

B. Astigmatism

C. Myopia with astigmatism

D. Presbyopia with astigmatism

7. Three rays of light, namely red (R), green (G) and blue (B) are incident on the face PQ of a right-angled prism PQR as shown in the figure. The refractive indices of the material of the prism for red, green and blue wavelengths are $1.27, 1.42 \text{ and } 1.49$ respectively. The colour of the ray(s) emerging out of the face PR will be :



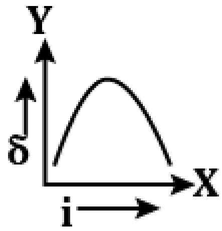
A. Blue

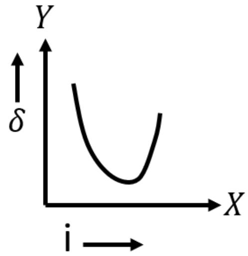
B. Green

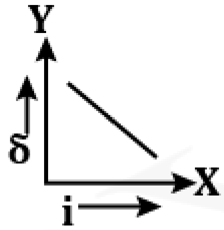
C. Red

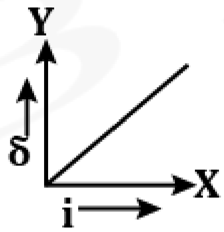
D. Blue and Green

8. The expected graphical representation of the variation of angle of deviation $'\delta'$ with angle of incidence $'i'$ in a prism is :

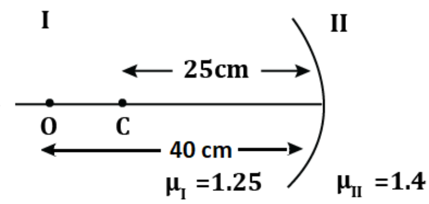
A. 

B. 

C. 

D. 

9. Regions I and II are separated by a spherical surface of radius $25 \mathrm{~cm}$. An object is kept in region I at a distance of $40 \mathrm{~cm}$ from the surface. The distance of the image from the surface is :



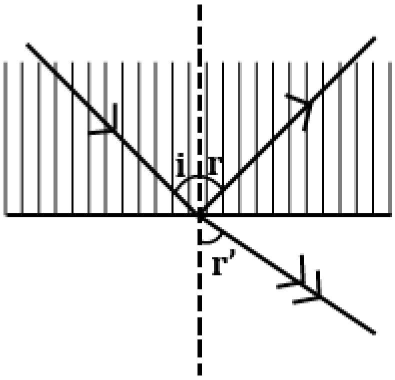
A. $55.44 \mathrm{~cm}$

B. $9.52 \mathrm{~cm}$

C. $18.23 \mathrm{~cm}$

D. $37.58 \mathrm{~cm}$

10. A ray of light passes from a denser medium to a rarer medium at an angle of incidence i. The reflected and refracted rays make an angle of 90° with each other. The angle of reflection and refraction are respectively r and r'. The critical angle is given by :



A. $\sin^{-1}(\cot r)$

B. $\tan^{-1}(\sin i)$

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

D. $\sin^{-1}(\tan r)$

11. A ray of laser of a wavelength $630\ \mathrm{nm}$ is incident at an angle of 30° at the diamond-air interface. It is going from diamond to air. The refractive index of diamond is 2.42 and that of air is 1. Choose the correct option.

A. angle of refraction is 24.41°

B. angle of refraction is 30°

C. refraction is not possible

D. angle of refraction is 53.4°

12. A prism of refractive index μ and angle of prism A is placed in the position of minimum angle of deviation. If minimum angle of deviation is also A, then A in terms of refractive index is

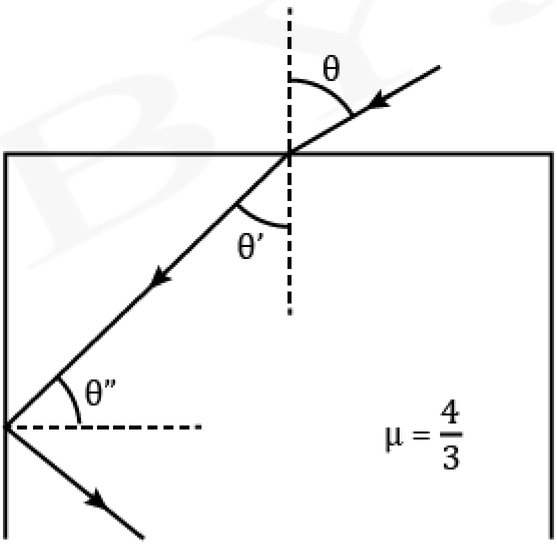
A. $2\cos^{-1}\left(\frac{\mu}{2}\right)$

B. $\sin^{-1}\left(\frac{\mu}{2}\right)$

C. $\sin^{-1}\left(\sqrt{\frac{\mu-1}{2}}\right)$

D. $\cos^{-1}\left(\frac{\mu}{2}\right)$

13. A ray of light entering from air into a denser medium of refractive index $\frac{4}{3}$, as shown in figure. The light ray suffers total internal reflection at the adjacent surface as shown. The maximum value of angle θ should be equal to



A. $\sin^{-1}\frac{\sqrt{7}}{3}$

B. $\sin^{-1}\frac{\sqrt{5}}{4}$

C. $\sin^{-1}\frac{\sqrt{7}}{4}$

D. $\sin^{-1}\frac{\sqrt{5}}{3}$

14. Car B overtakes another car A at a relative speed of $40\ \mathrm{ms^{-1}}$. How fast will the image of car B appear to move, in the mirror of focal length $10\ \mathrm{cm}$, fitted in car A, when the car B is $1.9\ \mathrm{m}$ away from the car A?

A. $0.1\ \mathrm{ms^{-1}}$

B. $0.2\ \mathrm{ms^{-1}}$

C. $40\ \mathrm{ms^{-1}}$

D. $4\ \mathrm{ms^{-1}}$

15. An object is placed beyond the center of curvature C of the given concave mirror. If the distance of the object is d_1 from C and the distance of the image formed is d_2 from C, the radius of curvature of this mirror is :

A. $\dfrac{d_1 d_2}{d_1 - d_2}$

B. $\dfrac{d_1 d_2}{d_1 + d_2}$

C. $\dfrac{2d_1 d_2}{d_1 - d_2}$

D. $\dfrac{2d_1 d_2}{d_1 + d_2}$

16. If we need a magnification of 375 from a compound microscope of tube length 150 mm and an objective of focal length 5 mm, the focal length of the eye-piece should be close to:

A. 22 mm

B. 2 mm

C. 12 mm

D. 33 mm

17. Given below are two statements : One is labelled as Assertion A and the other is labelled as reason R.

A : For a simple microscope, the angular size of the object equals the angular size of the image.

R : Magnification is achieved as the small object can be kept much closer to the eye than $25 \mathrm{~cm}$ and hence it subtends a large angle.

In the light of the above statements, choose the most appropriate answer from the options given below.

A. Both A and R are true, but R is **NOT** the correct explanation of A.

B. Both A and R are true, and R is the correct explanation of A.

C. A is true, but R is false.

D. A is false, but R is true.

18. The magnifying power of a telescope at normal adjustment with tube length $60 \mathrm{~cm}$ is 5. What is the focal length of its eye piece?

A. $20 \mathrm{~cm}$

B. $40 \mathrm{~cm}$

C. $30 \mathrm{~cm}$

D. $10 \mathrm{~cm}$

19. The eye can be regarded as a single refracting surface. The radius of curvature of this surface is equal to that of cornea 7.8 mm. This surface separates two media of refractive indices 1 and 1.34. Calculate the distance from the refracting surface at which a parallel beam of light will come to focus.

A. 1 cm

B. 2 cm

C. 4.0 cm

D. 3.1 cm

20. The diameter of the objective lens of a telescope is 250 cm. For light of wavelength 600 nm. Coming from a distant object, the limit of resolution of the telescope is close to-

A. $2.7 \times 10^{-7} \text{ rad}$

B. $1.5 \times 10^{-7} \text{ rad}$

C. $2.9 \times 10^{-7} \text{ rad}$

D. $4.5 \times 10^{-7} \text{ rad}$

21. Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter $0.1 \ \mu\text{m}$. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such that:

A. its size decreases, but intensity increases

B. its size increases, but intensity decreases

C. its size increases and intensity increases

D. its size decreases and intensity decreases

22. If the source of light used in a Young’s double slit experiment is changed from red to violet:

A. the fringes will become brighter.

B. consecutive fringe lines will come closer.

C. the central bright fringe will become a dark fringe.

D. the intensity of minima will increase.

23. In a Young's double slit experiment, the width of one of the slit is three times the other slit. The amplitude of the light coming from a slit is proportional to the slit-width. Find the ratio of the maximum to the minimum intensity in the interference pattern.

A. $4:1$

B. $2:1$

C. $3:1$

D. $1:4$

24. Two coherent light sources having intensities in the ratio $2x$ produces an interference pattern. The ratio $\frac{I_{\text{max}} - I_{\text{min}}}{I_{\text{max}} + I_{\text{min}}}$ will be :

A. $\frac{2\sqrt{2x}}{x+1}$

B. $\frac{\sqrt{2x}}{2x+1}$

C. $\frac{2\sqrt{2x}}{2x+1}$

D. $\frac{\sqrt{2x}}{x+1}$

25. In a Young's double slit experiment two slits are separated by $2 \mathrm{~mm}$ and the screen is placed one meter away. When a light of wavelength $500 \mathrm{~nm}$ is used, the fringe separation will be:

A. $0.75 \mathrm{~mm}$

B. $0.50 \mathrm{~mm}$

C. $1 \mathrm{~mm}$

D. $0.25 \mathrm{~mm}$

26. Red light differs from blue light as they have:

A. Same frequencies and same wavelengths

B. Different frequencies and different wavelengths

C. Different frequencies and same wavelengths

D. Same frequencies and different wavelengths

27. In Young's double slit arrangement, slits are separated by a gap of $0.5 \mathrm{~mm}$, and the screen is placed at a distance of $0.5 \mathrm{~m}$ from them. The distance between the first and the third bright fringe formed when the slits are illuminated by a monochromatic light of 5890 Å is:

A. $1178 \times 10^{-6} \mathrm{~m}$

B. $1178 \times 10^{-9} \mathrm{~m}$

C. $5890 \times 10^{-7} \mathrm{~m}$

D. $1178 \times 10^{-12} \mathrm{~m}$

28. With what speed should a galaxy move outward with respect to earth so that the sodium$-\mathrm{D}$ line at wavelength $5890\ \mathrm{\dot{A}}$ is observed at $5896\ \mathrm{\dot{A}}$?

A. $306\ \mathrm{km/sec}$

B. $322\ \mathrm{km/sec}$

C. $296\ \mathrm{km/sec}$

D. $336\ \mathrm{km/sec}$

29. In the Young's double slit experiment, the distance between the slits varies in time as $d(t) = d_0 + a_0\ \sin\omega t$; where d_0, ω and a_0 are constants. The difference between the largest fringe width and the smallest fringe width, obtained over time, is given as :

A. $\dfrac{2\lambda D(d_0)}{(d_0^2 - a_0^2)}$

B. $\dfrac{2\lambda D a_0}{(d_0^2 - a_0^2)}$

C. $\dfrac{\lambda D}{d_0^2} a_0$

D. $\dfrac{\lambda D}{d_0 + a_0}$

30. In Young's double slit experiment, if the source of light changes from orange to blue then :

A. the central bright fringe will become a dark fringe.

B. the distance between consecutive fringes will decrease.

C. the distance between consecutive fringes will increase.

D. the intensity of the minima will increase.