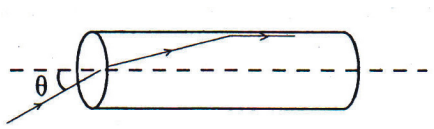
Ray Optics

1. A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the mid-point of one end of the rod as shown in the figure.



The incident angle θ for which the light ray grazes along the wall of the rod is **[AIEEE-2009]**

(1) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (2) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(3) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (4) $\sin^{-1}\left(\frac{1}{2}\right)$

2. In an optics experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance *u* and the image distance *v*, from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an angle of 45° with the *x*-axis meets the experimental curve at *P*. The coordinates of *P* will be **[AIEEE-2009]**

(1) $\left(\frac{f}{2}, \frac{f}{2}\right)$ (2) (f, f)

(3) $(4f, 4f)$ (4) $(2f, 2f)$

3. When monochromatic red light is used instead of blue light in a convex lens, its focal length will **[AIEEE-2011]**

(1) Remain same

(2) Does not depend on colour of light

(3) Increase

(4) Decrease

4. A beaker contains water up to a height h_1 and kerosene of height h_2 above water so that the total height of (water + kerosene) is $(h_1 + h_2)$. Refractive index of water is μ_1 and that of kerosene is μ_2. The apparent shift in the position of the bottom of the beaker when viewed from above is **[AIEEE-2011]**

(1) $\left(1+\frac{1}{\mu_1}\right)h_2 - \left(1+\frac{1}{\mu_2}\right)h_1$

(2) $\left(1-\frac{1}{\mu_1}\right)h_2 + \left(1-\frac{1}{\mu_2}\right)h_1$

(3) $\left(1+\frac{1}{\mu_1}\right)h_1 - \left(1+\frac{1}{\mu_2}\right)h_2$

(4) $\left(1-\frac{1}{\mu_1}\right)h_1 + \left(1-\frac{1}{\mu_2}\right)h_2$

5. An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film. At what distance (from lens) should object be shifted to be in sharp focus on film? **[AIEEE-2012]**

(1) 2.4 m (2) 3.2 m

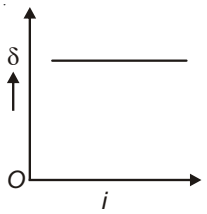
(3) 5.6 m (4) 7.2 m

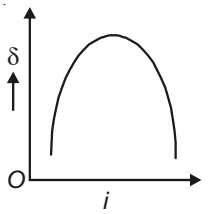
6. Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is [JEE (Main)-2013]

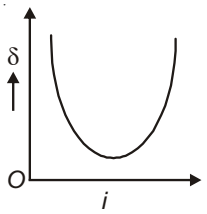
(1) 15 cm (2) 20 cm

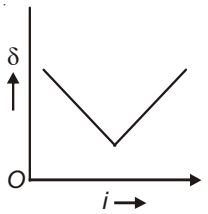
(3) 30 cm (4) 10 cm

7. The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by **[JEE (Main)-2013]**

(1) 

(2) 

(3) 

(4) 

8. A thin convex lens made from crown glass $\left(\mu = \frac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\frac{4}{3}$ and $\frac{5}{3}$, it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal lengths is **[JEE (Main)-2014]**

(1) $f_1 = f_2 < f$

(2) $f_1 > f$ and f_2 becomes negative

(3) $f_2 > f$ and f_1 becomes negative

(4) f_1 and f_2 both become negative

9. A green light is incident from the water to the air - water interface at the critical angle(θ). Select the correct statement **[JEE (Main)-2014]**

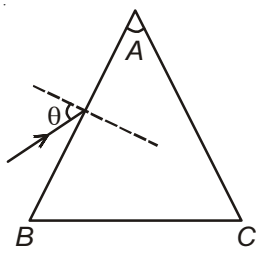
(1) The entire spectrum of visible light will come out of the water at an angle of 90° to the normal

(2) The spectrum of visible light whose frequency is less than that of green light will come out to the air medium

(3) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium

(4) The entire spectrum of visible light will come out of the water at various angles to the normal

10. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided. **[JEE (Main)-2015]**



(1) $\theta > \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(2) $\theta < \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(3) $\theta > \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(4) $\theta < \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

11. An observer looks at a distant tree of height 10 m with a telescope of magnifying power of 20. To the observer the tree appears **[JEE (Main)-2016]**

(1) 10 times nearer (2) 20 times taller

(3) 20 times nearer (4) 10 times taller

12. In an experiment for determination of refractive index of glass of a prism by $i - \delta$, plot, it was found that a ray incident at angle 35°, suffers a deviation of 40° and that it emerges at angle 79°. In that case which of the following is closest to the maximum possible value of the refractive index? **[JEE (Main)-2016]**

(1) 1.6 (2) 1.7

(3) 1.8 (4) 1.5

13. A diverging lens with magnitude of focal length 25 cm is placed at a distance of 15 cm from a converging lens of magnitude of focal length 20 cm. A beam of parallel light falls on the diverging lens. The final image formed is **[JEE (Main)-2017]**

(1) Real and at a distance of 40 cm from convergent lens

(2) Virtual and at a distance of 40 cm from convergent lens

(3) Real and at a distance of 40 cm from the divergent lens

(4) Real and at a distance of 6 cm from the convergent lens

14. A convex lens is put 10 cm from a light source and it makes a sharp image on a screen, kept 10 cm from the lens. Now a glass block (refractive index 1.5) of 1.5 cm thickness is placed in contact with the light source. To get the sharp image again, the screen is shifted by a distance d. Then d is **[JEE (Main)-2019]**

(1) 1.1 cm away from the lens

(2) 0.55 cm towards the lens

(3) 0

(4) 0.55 cm away from the lens

15. Two plane mirrors are inclined to each other such that a ray of light incident on the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors willl be **[JEE (Main)-2019]**

(1) 75° (2) 45°

(3) 90° (4) 60°

16. A plano convex lens of refractive index μ_1 and focal length f_1 is kept in contact with another plano concave lens of refractive index μ_2 and focal length f_2. If the radius of curvature of their spherical faces is R each and $f_1 = 2f_2$, then μ_1 and μ_2 are related as **[JEE (Main)-2019]**

(1) $2\mu_1 - \mu_2 = 1$ (2) $3\mu_2 - 2\mu_1 = 1$

(3) $2\mu_2 - \mu_1 = 1$ (4) $\mu_1 + \mu_2 = 3$

17. 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. **[JEE (Main)-2019]**

(1) 4.0 cm (2) 1 cm

(3) 3.1 cm (4) 2 cm

18. An object is at a distance of 20 m from a convex lens of focal length 0.3 m. The lens forms an image of the object. If the object moves away from the lens at a speed of 5 m/s, the speed and direction of the image will be **[JEE (Main)-2019]**

(1) 0.92×10^{-3} m/s away from the lens

(2) 2.26×10^{-3} m/s away from the lens

(3) 1.16×10^{-3} m/s towards the lens

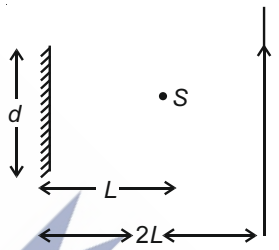
(4) 3.22×10^{-3} m/s towards the lens

19. A monochromatic light is incident at a certain angle on an equilateral triangular prism and suffers minimum deviation. If the refractive index of the material of the prism is $\sqrt{3}$, then the angle of incidence is **[JEE (Main)-2019]**

(1) 90° (2) 30°

(3) 45° (4) 60°

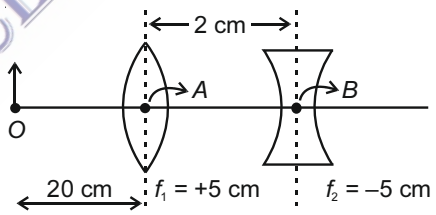
20. A point source of light, S is placed at a distance L in front of the centre of plane mirror of width d which is hanging vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror, at a distance $2L$ as shown below. The distance over which the man can see the image of the light source in the mirror is **[JEE (Main)-2019]**



(1) $\frac{d}{2}$ (2) $3d$

(3) $2d$ (4) d

21. What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths) **[JEE (Main)-2019]**



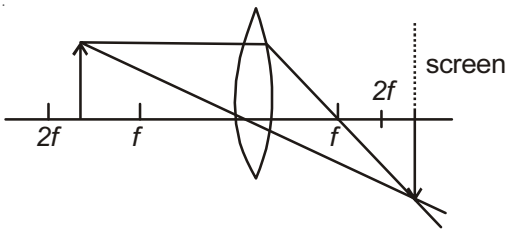
(1) $\frac{20}{3}$ cm from point B at right; real

(2) 70 cm from point B at right; real

(3) 40 cm from point B at right; real

(4) 70 cm from point B at left; virtual

22. Formation of real image using a biconvex lens is shown below: **[JEE (Main)-2019]**



If the whole set up is immersed in water without disturbing the object and the screen positions, what will one observe on the screen?

[JEE (Main)-2019]

(1) Erect real image (2) No change

(3) Image disappears (4) Magnified image

23. A plano-convex lens (focal length f_2, refractive index μ_2, radius of curvature R) fits exactly into a plano-concave lens(focal length f_1, refractive index μ_1, radius of curvature R). Their plane surfaces are parallel to each other. Then, the focal length of the combination will be **[JEE (Main)-2019]**

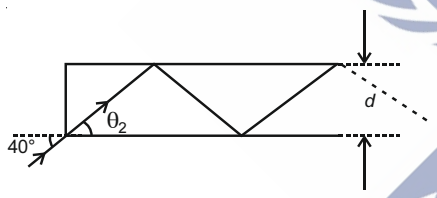
(1) $f_1 - f_2$ (2) $\frac{R}{\mu_2 - \mu_1}$

(3) $\frac{2f_1 f_2}{f_1 + f_2}$ (4) $f_1 + f_2$

24. In figure, the optical fiber is l = 2 m long and has a diameter of d = 20 μm. If a ray of light is incident on one end of the fiber at angle $\theta_1 = 40°$, the number of reflections it makes before emerging from the other end is close to

(Refractive index of fiber is 1.31 and sin 40° = 0.64)

[JEE (Main)-2019]



(1) 66000 (2) 55000

(3) 45000 (4) 57000

25. An upright object is placed at a distance of 40 cm in front of a convergent lens of focal length 20 cm. A convergent mirror of focal length 10 cm is placed at a distance of 60 cm on the other side of the lens. The position and size of the image formed due to mirror will be **[JEE (Main)-2019]**

(1) 20 cm from the convergent mirror, twice the size of the object

(2) 20 cm from the convergent mirror, same size as the object

(3) 40 cm from the convergent lens, twice the size of the object

(4) 40 cm from the convergent mirror, same size as the object

26. Calculate the limit of resolution of a telescope objective having a diameter of 200 cm, if it has to detect light of wavelength 500 nm coming from a star. **[JEE (Main)-2019]**

(1) 457.5×10^{-9} radian (2) 305×10^{-9} radian

(3) 152.5×10^{-9} radian (4) 610×10^{-9} radian

27. A convex lens (of focal length 20 cm) and a concave mirror, having their principal axes along the same lines, are kept 80 cm apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of 30 cm to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance of the object for which this concave mirror, by itself would produce a virtual image would be :

[JEE (Main)-2019]

(1) 30 cm (2) 25 cm

(3) 20 cm (4) 10 cm

28. A concave mirror for face viewing has focal length of 0.4 m. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is

[JEE (Main)-2019]

(1) 0.32 m (2) 0.24 m

(3) 1.60 m (4) 0.16 m

29. A convex lens of focal length 20 cm produces images of the same magnification 2 when an object is kept at two distances x_1 and x_2 ($x_1 > x_2$) from the lens. The ratio of x_1 and x_2 is

[JEE (Main)-2019]

(1) 3 : 1 (2) 2 : 1

(3) 4 : 3 (4) 5 : 3

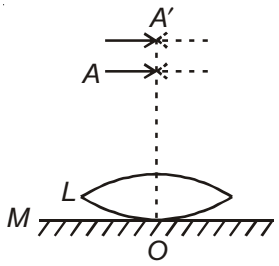
30. Diameter of the objective lens of a telescope is 250 cm. For light of wavelength 600 nm coming from a distant object, the limit of resolution of the telescope is close to **[JEE (Main)-2019]**

(1) 1.5×10^{-7} rad (2) 3.0×10^{-7} rad

(3) 2.0×10^{-7} rad (4) 4.5×10^{-7} rad

31. A thin convex lens *L* (refractive index = 1.5) is placed on a plane mirror *M*. When a pin is placed at *A*, such that *OA* = 18 cm, its real inverted image is formed at *A* itself, as shown in figure. When a liquid of refractive index μ_l is put between the lens and the mirror, the pin has to be moved to *A′*, such that *OA′* = 27 cm, to get its inverted real image at *A′* itself. The value of μ_l will be

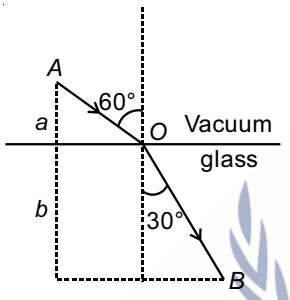
[JEE (Main)-2019]



(1) $\sqrt{2}$ (2) $\frac{4}{3}$

(3) $\sqrt{3}$ (4) $\frac{3}{2}$

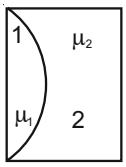
32. A ray of light *AO* in vacuum is incident on a glass slab at angle 60° and refracted at angle 30° along *OB* as shown in the figure. The optical path length of light ray from *A* to *B* is : **[JEE (Main)-2019]**



(1) $\frac{2\sqrt{3}}{a} + 2b$ (2) $2a + \frac{2b}{\sqrt{3}}$

(3) $2a + \frac{2b}{3}$ (4) $2a + 2b$

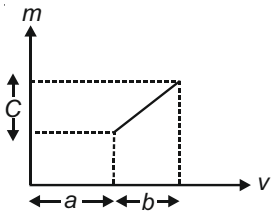
33. One plano-convex and one plano-concave lens of same radius of curvature '*R*' but of different materials are joined side by side as shown in the figure. If the refractive index of the material of 1 is μ_1 and that of 2 is μ_2, then the focal length of the combination is : **[JEE (Main)-2019]**



(1) $\frac{R}{2(\mu_1 - \mu_2)}$ (2) $\frac{R}{2-(\mu_1 - \mu_2)}$

(3) $\frac{R}{\mu_1 - \mu_2}$ (4) $\frac{2R}{\mu_1 - \mu_2}$

34. The graph shows how the magnification *m* produced by a thin lens varies with image distance *v*. What is the focal length of the lens used? **[JEE (Main)-2019]**



(1) $\frac{b^2}{ac}$ (2) $\frac{b^2c}{a}$

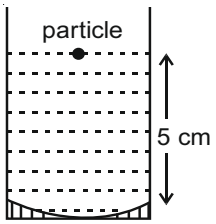
(3) $\frac{a}{c}$ (4) $\frac{b}{c}$

35. The value of numerical aperture of the objective lens of a microscope is 1.25. If light of wavelength 5000 Å is used, the minimum separation between two points, to be seen as distinct, will be : **[JEE (Main)-2019]**

(1) 0.24 μm (2) 0.38 μm

(3) 0.48 μm (4) 0.12 μm

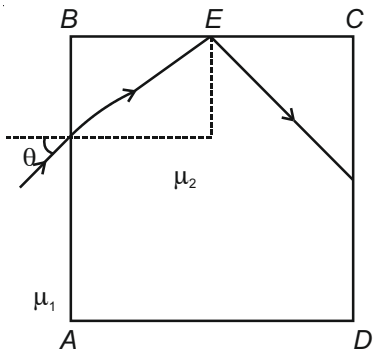
36. A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to (Refractive index of water = 1.33) **[JEE (Main)-2019]**



(1) 11.7 cm (2) 6.7 cm

(3) 13.4 cm (4) 8.8 cm

37. A transparent cube of side *d*, made of a material of refractive index μ_2, is immersed in a liquid of refractive index μ_1 ($\mu_1 < \mu_2$). A ray is incident on the face *AB* at an angle θ(shown in the figure). Total internal reflection takes place at point *E* on the face *BC*.



Then θ must satisfy: **[JEE (Main)-2019]**

(1) $\theta > \sin^{-1}\frac{\mu_1}{\mu_2}$ (2) $\theta < \sin^{-1}\frac{\mu_1}{\mu_2}$

(3) $\theta > \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2}-1}$ (4) $\theta < \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2}-1}$

38. 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 **[JEE (Main)-2020]**

(1) 2 mm (2) 33 mm

(3) 22 mm (4) 12 mm

39. A thin lens made of glass (refractive index = 1.5) of focal length f = 16 cm is immersed in a liquid of refractive index 1.42. If its focal length in liquid is f_l, then the ratio $\frac{f_l}{f}$ is closest to the integer **[JEE (Main)-2020]**

(1) 17 (2) 1

(3) 5 (4) 9

40. The critical angle of medium for a specific wavelength, if the medium has relative permittivity 3 and relative permeability $\frac{4}{3}$ for this wavelength, will be **[JEE (Main)-2020]**

(1) 60° (2) 45°

(3) 15° (4) 30°

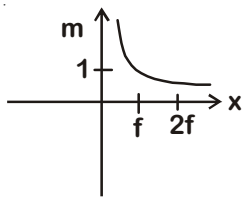
41. The magnifying power of a telescope with tube length 60 cm is 5. What is the focal length of its eye piece? **[JEE (Main)-2020]**

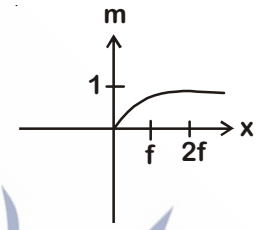
(1) 30 cm (2) 10 cm

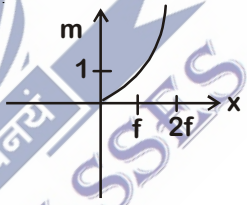
(3) 20 cm (4) 40 cm

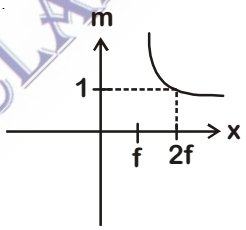
42. An object is gradually moving away from the focal point of a concave mirror along the axis of the mirror. The graphical representation of the magnitude of linear magnification (m) versus distance of the object from the mirror (x) is correctly given by

(Graphs are drawn schematically and are not to scale) **[JEE (Main)-2020]**

(1) 

(2) 

(3) 

(4) 

43. The aperture diameter of a telescope is 5 m. The separation between the moon and the earth is 4×10^5 km. With light of wavelength of 5500 Å, the minimum separation between objects on the surface of moon, so that they are just resolved, is close to **[JEE (Main)-2020]**

(1) 20 m (2) 200 m

(3) 600 m (4) 60 m

44. A vessel of depth $2h$ is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$. The liquids are immiscible. The apparent depth of the inner surface of the bottom of vessel will be **[JEE (Main)-2020]**

(1) $\frac{h}{\sqrt{2}}$ (2) $\frac{h}{2\left(\sqrt{2}+1\right)}$

(3) $\frac{h}{3\sqrt{2}}$ (4) $\frac{3}{4}h\sqrt{2}$

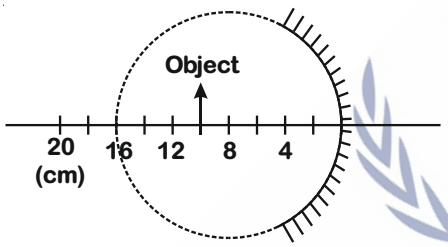
45. There is a small source of light at some depth below the surface of water (refractive index = $\frac{4}{3}$) in a tank of large cross-sectional surface area. Neglecting any reflection from the bottom and absorption by water, percentage of light that emerges out of surface is (nearly)

[Use the fact that surface area of a spherical cap of height h and radius of curvature r is $2\pi rh$]

[JEE (Main)-2020]

(1) 34% (2) 21%

(3) 50% (4) 17%

46. 

A spherical mirror is obtained as shown in the figure from a hollow glass sphere. If an object is positioned in front of the mirror, what will be the nature and magnification of the image of the object? (Figure drawn as schematic and not to scale) **[JEE (Main)-2020]**

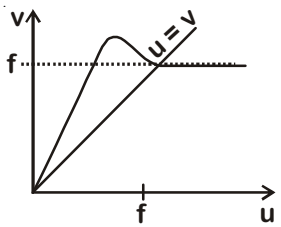
(1) Inverted, real and unmagnified

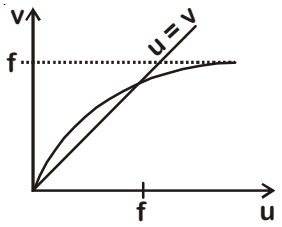
(2) Inverted, real and magnified

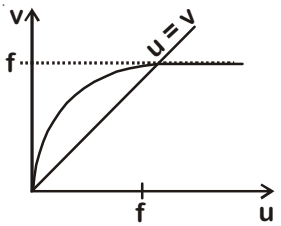
(3) Erect, virtual and magnified

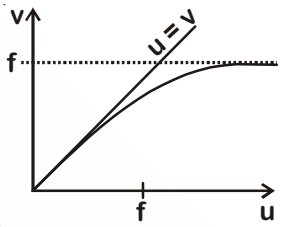
(4) Erect, virtual and unmagnified

47. For a concave lens of focal length f, the relation between object and image distances u and v, respectively, from its pole can best be represented by ($u = v$ is the reference line) **[JEE (Main)-2020]**

(1) 

(2) 

(3) 

(4) 

48. A point like object is placed at a distance of 1 m in front of a convex lens of focal length 0.5 m. A plane mirror is placed at a distance of 2 m behind the lens. The position and nature of the final image formed by the system is **[JEE (Main)-2020]**

(1) 2.6 m from the mirror, real

(2) 1 m from the mirror, real

(3) 2.6 m from the mirror, virtual

(4) 1 m from the mirror, virtual

49. A double convex lens has power P and same radii of curvature R of both the surfaces. The radius of curvature of a surface of a plano-convex lens made of the same material with power 1.5 P is

[JEE (Main)-2020]

(1) $\frac{3R}{2}$ (2) $2R$

(3) $\frac{R}{3}$ (4) $\frac{R}{2}$

50. A point object in air is in front of the curved surface of a plano-convex lens. The radius of curvature of the curved surface is 30 cm and the refractive index of the lens material is 1.5, then the focal length of the lens (in cm) is _____.

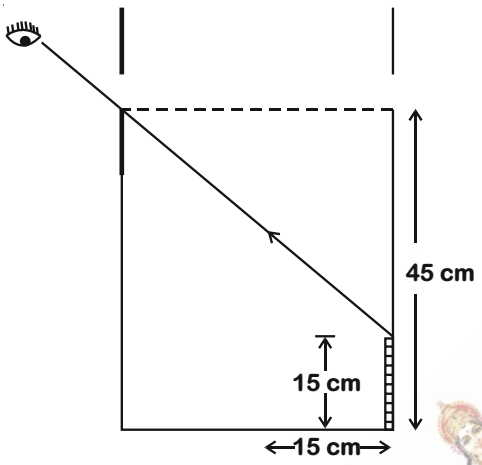
[JEE (Main)-2020]

51. A light ray enters a solid glass sphere of refractive index $\mu = \sqrt{3}$ at an angle of incidence 60°. The ray is both reflected and refracted at the farther surface of the sphere. The angle (in degrees) between the reflected and refracted rays at this surface is _____.

[JEE (Main)-2020]

52. An observer can see through a small hole on the side of a jar (radius 15 cm) at a point at height of 15 cm from the bottom (see figure). The hole is at a height of 45 cm. When the jar is filled with a liquid up to a height of 30 cm the same observer can see the edge at the bottom of the jar. If the refractive index of the liquid is $N/100$, where N is an integer, the value of N is _____.

[JEE (Main)-2020]



53. When an object is kept at a distance of 30 cm from a concave mirror, the image is formed at a distance of 10 cm from the mirror. If the object is moved with a speed of 9 cms^{-1}, the speed (in cms^{-1}) with which image moves at that instant is _____.

[JEE (Main)-2020]

54. In a compound microscope, the magnified virtual image is formed at a distance of 25 cm from the eye-piece. The focal length of its objective lens is 1 cm. If the magnification is 100 and the tube length of the microscope is 20 cm, then the focal length of the eye-piece lens (in cm) is _____.

[JEE (Main)-2020]

55. The distance between an object and a screen is 100 cm. A lens can produce real image of the object on the screen for two different positions between the screen and the object. The distance between these two positions is 40 cm. If the power of the lens is close to $\left(\frac{N}{100}\right)D$ where N is an integer, the value of N is _____.

[JEE (Main)-2020]

56. A compound microscope consists of an objective lens of focal length 1 cm and an eyepiece of focal length 5 cm with a separation of 10 cm.

The distance between an object and the objective lens, at which the strain on the eye is minimum is $\frac{n}{40}$ cm. The value of n is _____.

[JEE (Main)-2020]

57. A prism of angle $A = 1°$ has a refractive index $\mu = 1.5$. A good estimate for the minimum angle of deviation (in degrees) is close to $\frac{N}{10}$. Value of N is _____.

[JEE (Main)-2020]

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