

Ray Optics and Optical Instruments — NEET Physics PYQ (2006-2021)

Class 12 Physics · 41 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

1. 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) 50
- (D) 30

NEET 2020 · Q140

2. A ray is incident at an angle of incidence i on one surface of a small angle prism (with angle of prism A) and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ , then the angle of incidence is nearly equal to :

- (A) $A/2\mu$
- (B) $2A/\mu$
- (C) μA
- (D) $\mu A/2$

NEET 2019 · Q11

3. Two similar thin equi-convex lenses, of focal length f each, are kept coaxially in contact with each other such that the focal length of the combination is F_1 . When the space between the two lenses is filled with glycerin (which has the same refractive index ($\mu = 1.5$) as that of glass) then the equivalent focal length is F_2 . The ratio $F_1 : F_2$ will be:

- (A) 2 : 1
- (B) 1 : 2
- (C) 2 : 3
- (D) 3 : 4

NEET 2019 · Q28

4. In total internal reflection when the angle of incidence is equal to the critical angle for the pair of media in contact, what will be angle of refraction?

- (A) 180°
- (B) 0°
- (C) equal to angle of incidence
- (D) 90°

NEET 2018 · Q10

5. An astronomical refracting telescope will have large angular magnification and high angular resolution, when it has an objective lens of

- (A) large focal length and large diameter
- (B) large focal length and small diameter
- (C) small focal length and large diameter
- (D) small focal length and small diameter

NEET 2018 · Q19

6. The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30° . One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is

- (A) 30°
- (B) 45°
- (C) 60°
- (D) zero

NEET 2018 · Q20

7. An object is placed at a distance of 40 cm from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, the displacement of the image will be

- (A) 30 cm towards the mirror
- (B) 36 cm away from the mirror
- (C) 30 cm away from the mirror
- (D) 36 cm towards the mirror

NEET 2017 · Q138

8. The ratio of resolving powers of an optical microscope for two wavelengths $\lambda_1 = 4000 \text{ \AA}$ and $\lambda_2 = 6000 \text{ \AA}$ is:

- (A) 8 : 27
- (B) 9 : 4
- (C) 3 : 2
- (D) 16 : 81

NEET 2017 · Q144

9. A beam of light from a source L is incident normally on a plane mirror fixed at a certain distance x from the source. The beam is reflected back as a spot on a scale placed just above the source L. When the mirror is rotated through a small angle θ , the spot of the light is found to move through a distance y on the scale. The angle θ is given by:

- (A) $y/2x$
- (B) y/x
- (C) $x/2y$
- (D) x/y

NEET 2017 · Q160

10. A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be:

- (A) 4°
- (B) 6°
- (C) 8°
- (D) 10°

NEET 2017 (Gujarati paper) · Q137

11. If the angle of a prism is 60° and angle of minimum deviation is 40° , then the angle of refraction will be:

- (A) 30°
- (B) 20°
- (C) 3°
- (D) 4°

NEET 2017 (Gujarati paper) · Q149

12. A light beam is incident on a denser medium whose refractive index is 1.414 at an angle of incidence 45° . Find the ratio of width of refracted beam in a medium to the width of the incident beam in air.

- (A) $1 : \sqrt{2}$
- (B) $\sqrt{2} : 1$
- (C) $\sqrt{2} : \sqrt{3}$
- (D) $\sqrt{3} : \sqrt{2}$

NEET 2016 Phase 2 · Q34

13. Two identical glass ($\mu_g = 3/2$) equiconvex lenses of focal length f each are kept in contact. The space between the two lenses is filled with water ($\mu_w = 4/3$). The focal length of the combination is

- (A) $f/3$
- (B) f
- (C) $4f/3$
- (D) $3f/4$

NEET 2016 Phase 2 · Q35

14. An air bubble in a glass slab with refractive index 1.5 (near normal incidence) is 5 cm deep when viewed from one surface and 3 cm deep when viewed from the opposite face. The thickness (in cm) of the slab is

- (A) 8
- (B) 10
- (C) 12
- (D) 16

NEET 2016 Phase 2 · Q37

15. A person can see clearly objects only when they lie between 50 cm and 400 cm from his eyes. In order to increase the maximum distance of distinct vision to infinity, the type and power of the correcting lens, the person has to use, will be

- (A) convex, +2.25 diopter
- (B) concave, -0.25 diopter
- (C) concave, -0.2 diopter
- (D) convex, +0.15 diopter

NEET 2016 Phase 1 · Q22

16. The angle of incidence for a ray of light at a refracting surface of a prism is 45° . The angle of prism is 60° . If the ray suffers minimum deviation through the prism, the angle of minimum deviation and refractive index of the material of the prism respectively, are:

- (A) 45° ; $1/\sqrt{2}$
- (B) 30° ; $\sqrt{2}$
- (C) 45° ; $\sqrt{2}$
- (D) 30° ; $1/\sqrt{2}$

NEET 2016 Phase 1 · Q32

17. A astronomical telescope has objective and eyepiece of focal lengths 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, the lenses must be separated by a distance:

- (A) 37.3 cm
- (B) 46.0 cm
- (C) 50.0 cm
- (D) 54.0 cm

18. Match the corresponding entries of column 1 with column 2. [Where m is the magnification produced by the mirror]

Column 1: (A) $m = -2$, (B) $m = -1/2$, (C) $m = +2$, (D) $m = +1/2$

Column 2: (a) Convex mirror, (b) Concave mirror, (c) Real image, (d) Virtual image

(A) $m = -2$: concave mirror, real image; $m = -1/2$: concave mirror, real image; $m = +2$: concave mirror, virtual image; $m = +1/2$: convex mirror, virtual image

(B) $m = -2$: convex mirror, real image; $m = -1/2$: convex mirror, virtual image; $m = +2$: convex mirror, concave mirror; $m = +1/2$: real image, virtual image

(C) $m = -2$: convex mirror, virtual image; $m = -1/2$: concave mirror, real image; $m = +2$: concave mirror, virtual image; $m = +1/2$: concave mirror, real image

(D) $m = -2$: real image, virtual image; $m = -1/2$: concave mirror, virtual image; $m = +2$: concave mirror, real image; $m = +1/2$: convex mirror, virtual image

AIPMT 2015

19. The refracting angle of a prism is A , and refractive index of the material of the prism is $\cot(A/2)$. The angle of minimum deviation is:

- (A) $180^\circ + 2A$
- (B) $180^\circ - 3A$
- (C) $180^\circ - 2A$
- (D) $90^\circ - A$

AIPMT 2015

20. Two identical thin plano-convex glass lenses (refractive index 1.5) each having radius of curvature of 20 cm are placed with their convex surfaces in contact at the centre. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is:

- (A) 50 cm
- (B) -20 cm
- (C) -25 cm
- (D) -50 cm

AIPMT 2014

21. If the focal length of objective lens is increased then magnifying power of:

- (A) microscope and telescope both will increase
- (B) microscope and telescope both will decrease
- (C) microscope will decrease but that of telescope will increase
- (D) microscope will increase but that of telescope will decrease

AIPMT 2014

22. The angle of a prism is ' A '. One of its refracting surfaces is silvered. Light rays falling at an angle of incidence $2A$ on the first surface returns back through the same path after suffering reflection at the silvered surface. The refractive index μ , of the prism is:

- (A) $2 \cos A$
- (B) $(1/2) \cos A$
- (C) $\tan A$
- (D) $2 \sin A$

NEET 2013

23. A plano convex lens fits exactly into a plano concave lens. Their plane surfaces are parallel to each other. If lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of the curved surface of the lenses, then the focal length of the combination is

- (A) $R/(2(\mu_1 + \mu_2))$
- (B) $R/(2(\mu_1 - \mu_2))$
- (C) $R/(\mu_1 - \mu_2)$
- (D) $2R/(\mu_2 - \mu_1)$

NEET 2013

24. For a normal eye, the cornea of eye provides a converging power of 40 D and the least converging power of the eye lens behind the cornea is 20 D. Using this information, the distance between the retina and the cornea-eye lens can be estimated to be

- (A) 5 cm
- (B) 2.5 cm
- (C) 1.67 cm
- (D) 1.5 cm

AIPMT 2012 Mains

25. For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index :

- (A) lies between $\sqrt{2}$ and 1
- (B) lies between 2 and $\sqrt{2}$
- (C) is less than 1
- (D) is greater than 2

AIPMT 2012 Mains

26. A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is :

- (A) 10 cm
- (B) 15 cm
- (C) 2.5 cm
- (D) 5 cm

AIPMT 2012 Prelims

27. When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index

- (A) less than that of glass
- (B) equal to that of glass
- (C) less than one
- (D) greater than that of glass

AIPMT 2012 Prelims

28. The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are

- (A) 11 cm, 9 cm
- (B) 10 cm, 10 cm
- (C) 15 cm, 5 cm
- (D) 18 cm, 2 cm

AIPMT 2012 Prelims

29. A ray of light is incident at an angle of incidence i on one face of a prism of angle A (assumed to be small) and emerges normally from the opposite face. If the refractive index of the prism is μ , the angle of incidence i is nearly equal to

- (A) $A/(2\mu)$
- (B) μA
- (C) $\mu A/2$
- (D) A/μ

AIPMT 2011 Mains

30. A converging beam of rays is incident on a diverging lens. Having passed through the lens the rays intersect at a point 15 cm from the lens on the opposite side. If the lens is removed the point where the rays meet will move 5 cm closer to the lens. The focal length of the lens is

- (A) -30 cm
- (B) 5 cm
- (C) -10 cm
- (D) 20 cm

AIPMT 2011 Mains

31. A thin prism of angle 15° made of glass of refractive index $\mu_1 = 1.5$ is combined with another prism of glass of refractive index $\mu_2 = 1.75$. The combination of the prisms produces dispersion without deviation. The angle of the second prism should be

- (A) 12°
- (B) 5°
- (C) 7°
- (D) 10°

AIPMT 2011 Prelims

32. Which of the following is not due to total internal reflection?

- (A) Brilliance of diamond
- (B) Working of optical fibre
- (C) Difference between apparent and real depth of a pond
- (D) Mirage on hot summer days

AIPMT 2010 Mains · Q68

33. The speed of light in media M_1 and M_2 is 1.5×10^8 m/s and 2.0×10^8 m/s respectively. A ray of light enters from medium M_1 to M_2 at an incidence angle i . If the ray suffers total internal reflection, the value of i is

- (A) Equal to $\sin^{-1}(2/3)$
- (B) Equal to or less than $\sin^{-1}(3/5)$
- (C) Equal to or greater than $\sin^{-1}(3/4)$
- (D) Less than $\sin^{-1}(2/3)$

AIPMT 2010 Mains · Q69

34. A ray of light is incident on a 60° prism at the minimum deviation position. The angle of refraction at the first face (i.e., incident face) of the prism is

- (A) Zero
- (B) 30°
- (C) 45°
- (D) 60°

AIPMT 2010 Prelims · Q23

35. A lens having focal length f and aperture of diameter d forms an image of intensity I . Aperture of diameter $d/2$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively

- (A) $f/2$ and $I/2$
- (B) f and $I/4$
- (C) $3f/4$ and $I/2$
- (D) f and $3I/4$

36. A ray of light travelling in a transparent medium of refractive index μ , falls on a surface separating the medium from air at an angle of incidence of 45° . For which of the following value of μ the ray can undergo total internal reflection?

- (A) $\mu = 1.25$
- (B) $\mu = 1.33$
- (C) $\mu = 1.40$
- (D) $\mu = 1.50$

37. Two thin lenses of focal lengths f_1 and f_2 are in contact and coaxial. The power of the combination is

- (A) $(f_1 + f_2)/(f_1 f_2)$
- (B) $\sqrt{(f_1/f_2)}$
- (C) $\sqrt{(f_2/f_1)}$
- (D) $(f_1 + f_2)/2$

38. A boy is trying to start a fire by focusing sunlight on a piece of paper using an equiconvex lens of focal length 10 cm. The diameter of the Sun is 1.39×10^9 m and its mean distance from the earth is 1.5×10^{11} m. What is the diameter of the Sun's image on the paper?

- (A) 12.4×10^{-4} m
- (B) 9.2×10^{-4} m
- (C) 6.5×10^{-4} m
- (D) 6.5×10^{-5} m

39. The frequency of a light wave in a material is 2×10^{14} Hz and wavelength is 5000 Å. The refractive index of material will be

- (A) 1.50
- (B) 3.00
- (C) 1.33
- (D) 1.40

40. A microscope is focussed on a mark on a piece of paper and then a slab of glass of thickness 3 cm and refractive index 1.5 is placed over the mark. How should the microscope be moved to get the mark in focus again ?

- (A) 1 cm upward
- (B) 0.5 cm downward
- (C) 1 cm downward
- (D) 0.5 cm upward

41. A convex lens and a concave lens, each having same focal length of 25 cm, are put in contact to form a combination of lenses. The power in diopters of the combination is :

- (A) 25
- (B) 50
- (C) infinite
- (D) zero

Answer key and explanations

1. Answer: (B) 15

For the beam to emerge parallel, the second focal point of the convex lens must coincide with the focal point of the concave lens on the far side. Since the concave lens's focus lies on the incoming side at 5 cm, $d = 20 - 5 = 15$ cm. Adding the focal lengths (25 cm) would be right only for two convex lenses.

2. Answer: (C) μA

Emerging normally means $r_2 = 0$, so $r_1 = A - r_2 = A$. For small angles Snell's law $\sin i = \mu \sin r_1$ becomes $i \approx \mu A$. Dividing by μ instead of multiplying confuses the direction of refraction.

3. Answer: (B) 1 : 2

For an equiconvex glass lens ($\mu = 1.5$) $f = R$, so $F_1 = f/2$. The glycerin film is a concave lens with $1/f = 0.5(-2/R) = -1/f$. Then $1/F_2 = 1/f + 1/f - 1/f = 1/f$, so $F_2 = f$ and $F_1 : F_2 = 1 : 2$. The ratio 2 : 1 inverts this.

4. Answer: (D) 90°

The critical angle is defined as the angle of incidence for which the refracted ray grazes the interface, i.e. the angle of refraction is 90° . Beyond it, total internal reflection occurs.

5. Answer: (A) large focal length and large diameter

Magnification $m = f_o/f_e$ grows with the objective's focal length, and resolving power $\propto D/\lambda$ grows with its aperture. So the objective should have both a large focal length and a large diameter; a small aperture would worsen resolution.

6. Answer: (B) 45°

To retrace its path the ray must hit the silvered face normally, so $r_2 = 0$ and $r_1 = A = 30^\circ$. By Snell's law $\sin i = \sqrt{2} \sin 30^\circ = 1/\sqrt{2}$, so $i = 45^\circ$. Zero incidence would make the ray strike the silvered face at 30° , not normally.

7. Answer: (B) 36 cm away from the mirror

With $u = -40$ cm, $f = -15$ cm: $1/v = -1/15 + 1/40$ gives $v = -24$ cm. With $u = -20$ cm: $1/v = -1/15 + 1/20$ gives $v = -60$ cm. The image moves from 24 cm to 60 cm, i.e. 36 cm away from the mirror.

8. Answer: (C) 3 : 2

Resolving power of a microscope is $2n \sin \theta/\lambda$, i.e. inversely proportional to wavelength. $RP_1 : RP_2 = \lambda_2 : \lambda_1 = 6000 : 4000 = 3 : 2$. Squaring or cubing the ratio (9 : 4, 8 : 27) has no basis.

9. Answer: (A) $y/2x$

Rotating a mirror by θ turns the reflected ray by 2θ . For a small angle the spot moves $y = x \cdot 2\theta$ on the scale at distance x , so $\theta = y/2x$. Writing $\theta = y/x$ forgets the doubling of the reflected beam's rotation.

10. Answer: (B) 6°

For zero net deviation $(\mu_1 - 1)A_1 = (\mu_2 - 1)A_2$, so $0.42 \times 10^\circ = 0.7 \times A_2$ and $A_2 = 6^\circ$. A smaller-angle prism of higher index cancels the deviation of the first.

11. Answer: (A) 30°

At minimum deviation the ray passes symmetrically, so $r_1 = r_2$ and $r_1 + r_2 = A$. Hence $r = A/2 = 60^\circ/2 = 30^\circ$, whatever the deviation. 40° belongs to the angle of incidence calculation, $i = (A + \delta)/2 = 50^\circ$, not to r .

12. Answer: (D) $\sqrt{3} : \sqrt{2}$

$\sin r = \sin 45^\circ/1.414 = 0.5$, so $r = 30^\circ$. A beam crossing a boundary strip of length x has width $x \cos i$ in air and $x \cos r$ in the medium, so the ratio is $\cos 30^\circ/\cos 45^\circ = (\sqrt{3}/2)/(1/\sqrt{2}) = \sqrt{3} : \sqrt{2}$. The inverse ratio $\sqrt{2} : \sqrt{3}$ comes from swapping the two angles.

13. Answer: (D) $3f/4$

For each glass lens $1/f = (0.5)(2/R)$, so $R = f$. The water forms a concave lens with $1/f_w = (1/3)(-2/R) = -2/(3f)$. Combined: $1/F = 2/f - 2/(3f) = 4/(3f)$, so $F = 3f/4$. Ignoring the water lens gives $f/2$, and treating it as converging gives a shorter focal length.

14. Answer: (C) 12

Real depth = $\mu \times$ apparent depth, so the bubble is $1.5 \times 5 = 7.5$ cm from one face and $1.5 \times 3 = 4.5$ cm from the other. Thickness = $7.5 + 4.5 = 12$ cm. Just adding the apparent depths gives 8 cm.

15. Answer: (B) concave, -0.25 diopter

To see distant objects the lens must form the image of an object at infinity at the far point, 400 cm, so $f = -400$ cm = -4 m. Power $P = 1/f = -0.25$ D, a concave lens. A convex lens would correct the near point, not the far point.

16. Answer: (B) $30^\circ; \sqrt{2}$

At minimum deviation $i = e$, so $\delta = 2i - A = 90^\circ - 60^\circ = 30^\circ$, and $r = A/2 = 30^\circ$. $\mu = \sin 45^\circ/\sin 30^\circ = \sqrt{2}$. A refractive index of $1/\sqrt{2}$ (less than 1) is impossible for a prism in air.

17. Answer: (D) 54.0 cm

Objective: $1/v - 1/(-200) = 1/40$ gives $v = 50$ cm. For normal adjustment the image must be at the focus of the eyepiece, so separation = $50 + 4 = 54$ cm. 44 cm ($f_o + f_e$) applies only to an object at infinity, and 50 cm ignores the eyepiece.

18. Answer: (A) $m = -2$: concave mirror, real image; $m = -1/2$: concave mirror, real image; $m = +2$: concave mirror, virtual image; $m = +1/2$: convex mirror, virtual image

A negative magnification means an inverted real image, which only a concave mirror forms, so $m = -2$ and $m = -1/2$ are both concave mirror with real image. $m = +2$ is an enlarged erect virtual image, possible only with a concave mirror, while $m = +1/2$ is a diminished erect virtual image, typical of a convex mirror. The matching that pairs a convex mirror with a real image is impossible.

19. Answer: (C) $180^\circ - 2A$

$\mu = \sin((A + \delta m)/2)/\sin(A/2) = \cot(A/2) = \cos(A/2)/\sin(A/2)$. So $\sin((A + \delta m)/2) = \cos(A/2) = \sin(90^\circ - A/2)$, giving $(A + \delta m)/2 = 90^\circ - A/2$ and $\delta m = 180^\circ - 2A$.

20. Answer: (D) -50 cm

Each plano-convex glass lens: $1/f = (1.5 - 1)/20 = 1/40 \text{ cm}^{-1}$. The oil forms a biconcave lens: $1/f = (1.7 - 1)(-1/20 - 1/20) = -0.07 \text{ cm}^{-1}$. Total $1/F = 2/40 - 0.07 = -0.02 \text{ cm}^{-1}$, so $F = -50$ cm.

21. Answer: (C) microscope will decrease but that of telescope will increase

For a compound microscope $M \approx (L/f_o)(D/f_e)$, so a larger objective focal length lowers M . For a telescope $M = f_o/f_e$, so it rises; the two instruments respond oppositely.

22. Answer: (A) $2 \cos A$

To return along its path the ray must strike the silvered face normally, so the refraction angle at the first face equals the prism angle, $r = A$. Then $\mu = \sin 2A/\sin A = 2 \cos A$.

23. Answer: (C) $R/(\mu_1 - \mu_2)$

Plano-convex: $1/f_1 = (\mu_1 - 1)/R$; plano-concave of the same curvature: $1/f_2 = -(\mu_2 - 1)/R$. In contact: $1/f = (\mu_1 - \mu_2)/R$, so $f = R/(\mu_1 - \mu_2)$. A factor of 2 would appear only for double-curved lenses.

24. Answer: (C) 1.67 cm

For a relaxed normal eye viewing a distant object, the total power $40 + 20 = 60$ D must focus the image on the retina. $f = 1/60 \text{ m} = 100/60 \text{ cm} \approx 1.67 \text{ cm}$, which is the cornea-retina distance. Using only the cornea power (40 D) gives 2.5 cm.

25. Answer: (B) lies between 2 and $\sqrt{2}$

$\mu = \sin((A + \delta m)/2)/\sin(A/2)$; with $\delta m = A$ this becomes $\mu = \sin A/\sin(A/2) = 2\cos(A/2)$. For a real emergent ray $A/2$ ranges between 0 and 45° , so μ lies between $\sqrt{2}$ and 2 .

26. Answer: (D) 5 cm

The near end at $20 \text{ cm} = 2f$ images at 20 cm . For the far end, $u = -30 \text{ cm}$: $1/v = 1/f - 1/u = -1/10 + 1/30$, so $v = -15 \text{ cm}$. The image extends from 15 cm to 20 cm , a length of 5 cm .

27. Answer: (B) equal to that of glass

By the lens maker's formula $1/f = (\mu_g/\mu_l - 1)(1/R_1 - 1/R_2)$. The lens behaves like a plane sheet (no power) only when $\mu_g/\mu_l = 1$, i.e. the liquid has the same refractive index as glass, 1.47. A liquid of smaller index would leave it a converging lens.

28. Answer: (D) 18 cm, 2 cm

For normal adjustment, magnifying power $= f_o/f_e = 9$ and tube length $= f_o + f_e = 20 \text{ cm}$. Solving, $f_e = 2 \text{ cm}$ and $f_o = 18 \text{ cm}$. 15 cm and 5 cm add to 20 cm but give a magnification of only 3.

29. Answer: (B) μA

Normal emergence means $r_2 = 0$, so $r_1 = A - r_2 = A$. Snell's law at the first face: $\sin i = \mu \sin A$. For small angles, $i \approx \mu A$. A/μ would come from inverting Snell's law.

30. Answer: (A) -30 cm

Without the lens the rays meet 10 cm behind the lens position, so that point is a virtual object at $u = +10 \text{ cm}$; with the lens the image is at $v = +15 \text{ cm}$. $1/f = 1/v - 1/u = 1/15 - 1/10 = -1/30$, so $f = -30 \text{ cm}$. The negative sign confirms a diverging lens, ruling out the positive values.

31. Answer: (D) 10°

For no net deviation with thin prisms, $(\mu_1 - 1)A_1 = (\mu_2 - 1)A_2$, so $0.5 \times 15^\circ = 0.75 \times A_2$ and $A_2 = 10^\circ$. Using the ratio of refractive indices directly instead of $(\mu - 1)$ leads to wrong angles.

32. Answer: (C) Difference between apparent and real depth of a pond

The pond looking shallower than it is comes from ordinary refraction at the water surface, not total internal reflection. Sparkle of diamond, light guidance in optical fibres and mirages all rely on total internal reflection.

33. Answer: (C) Equal to or greater than $\sin^{-1}(3/4)$

Refractive indices are $\mu_1 = c/v_1 = 2$ and $\mu_2 = c/v_2 = 1.5$. The critical angle satisfies $\sin C = \mu_2/\mu_1 = 3/4$, so total internal reflection needs i equal to or greater than $\sin^{-1}(3/4)$. The value $\sin^{-1}(2/3)$ is obtained by wrongly using $1/\mu_1$ ratios; TIR never occurs for angles smaller than the critical angle.

34. Answer: (B) 30°

At minimum deviation the ray passes symmetrically, so $r_1 = r_2$ and $r_1 + r_2 = A$. Hence $r_1 = A/2 = 60^\circ/2 = 30^\circ$. Taking 60° confuses the refraction angle with the prism angle itself.

35. Answer: (D) f and $3I/4$

Covering part of a lens does not change its focal length, which depends only on curvature and refractive index. The light gathered is $\propto$ area: the covered central part has diameter $d/2$, i.e. $1/4$ of the area, so intensity becomes $I - I/4 = 3I/4$. $I/4$ would be the share of the covered part, not what remains.

36. Answer: (D) $\mu = 1.50$

TIR needs the incidence angle to exceed the critical angle: $\sin 45^\circ > 1/\mu$, so $\mu > \sqrt{2} \approx 1.414$. Only $\mu = 1.50$ exceeds this; 1.40 is just below.

37. Answer: (A) $(f_1 + f_2)/(f_1 f_2)$

For thin lenses in contact, powers add: $P = 1/f_1 + 1/f_2 = (f_1 + f_2)/(f_1 f_2)$. $(f_1 + f_2)/2$ has dimensions of length, so it cannot be a power.

38. Answer: (B) $9.2 \times 10^{-4} \text{ m}$

The image forms in the focal plane, and the Sun and its image subtend the same angle at the lens: $d = f \times D/u = 0.10 \times 1.39 \times 10^9 / 1.5 \times 10^{11} \approx 9.3 \times 10^{-4} \text{ m}$, closest to $9.2 \times 10^{-4} \text{ m}$. $6.5 \times 10^{-4} \text{ m}$ would come from wrongly halving or mis-scaling the angular size.

39. Answer: (B) 3.00

Speed in the material $v = f\lambda = 2 \times 10^{14} \times 5 \times 10^{-7} = 1 \times 10^8 \text{ m/s}$, so $n = c/v = 3 \times 10^8 / 1 \times 10^8 = 3.00$. 1.50 comes from a slip in the power of ten.

40. Answer: (A) 1 cm upward

A slab of thickness t and refractive index μ makes the mark appear raised by $t(1 - 1/\mu) = 3(1 - 1/1.5) = 1 \text{ cm}$. Since the image of the mark is now 1 cm higher, the microscope must be raised by 1 cm.

Moving it down would take it further out of focus.

41. Answer: (D) zero

The powers are $+1/0.25 = +4 \text{ D}$ for the convex lens and -4 D for the concave lens. In contact the total power is $4 - 4 = 0$, so the combination acts like a plane glass plate. Zero power means infinite focal length, not infinite power.

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