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Class: 12
Subject: Physics
Topic: Ray Optics
No. of Questions: 30

1. Why a diamond glitters in a brightly lit room, but not in a dark room?

2. Explain why a crack in a window pane appears silvery.

3. Explain why the bubbles of air rising up in a water tank appear silvery when viewed from top.

4. A lens shown in Fig. is made of two different materials. A point object is placed on the principal axis of the lens. How many images will be obtained?

5. Why does a diamond shine?

6. A thin lens has focal length f and its aperture has diameter d. It forms an image of intensity I. Now the central part of the aperture up to diameter d/2 is blocked by an opaque paper. What will be the focal length and image intensity now?

7. Why is there no dispersion of light refracted through a rectangular glass slab?

8. What colour do you observe when white light passes through a blue and yellow filter?

9. List some advantages of a reflecting telescope, especially for high resolution astronomy.

10. A reflecting type telescope has a large mirror for its objective with radius of curvature equal to 80 cm. What is the magnifying power of telescope, especially for high resolution astronomy?

11. A thin prism P_1 with angle 4° is made from a glass of refractive index 1.54 combined with another thin prism P_2 made from a glass of refractive index 1.72 to produce dispersion without deviation. The angle of prism P_2 is

    a. 5.33°
    b. 4°
    c. 3°
    d. 2.6°

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12. When a ray of light enters a glass slab from air,

    a. its wavelength decreases
    b. its wavelength increases
    c. its frequency increases
    d. neither wavelength nor frequency changes

13. Spherical aberration in a thin lens can be reduced by

    a. using a monochromatic light
    b. using a doublet combination
    c. using a circular annular mask over the lens
    d. increasing the size of the lens

14. A real image of a distant object is formed by a plano-convex lens on its principal axis. The spherical aberration

    a. is absent
    b. is smaller if the curved surfaces of the lens faces the object
    c. is smaller if the plane surface of the lens faces the object
    d. is the same whichever side of the lens faces the object

15. A concave mirror is placed on a horizontal table, with its axis directed vertically upwards. Let O be the pole of the mirror and C its centre of curvature. A point object is placed at C. It has a real image, also located at C. If the mirror is now filled with water, the image will be

    a. real and will remain at C
    b. real and located at a point between C and infinity
    c. virtual and located at a point between C and O
    d. real and located at a point between C and O

16. A concave lens of refractive index 1.5 has both surfaces of the same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a

    a. convergent lens of focal length 3.5R
    b. convergent lens of focal length 3R
    c. divergent lens of focal length 3.5R
    d. divergent lens of focal length 3R

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17. In a compound microscope, the intermediate image is

a. real, inverted and magnified
b. real, erect and magnified
c. virtual, erect and magnified
d. virtual, erect and reduced

18. A hollow double concave lens is made of a very thin transparent material. It can be filled with air or either of the two liquids L_1 or L_2 having refractive indices n_1 and n_2 respectively ($n_2 > n_1 > 1$). The lens will diverge a parallel beam of light if it is filled with

a. air and placed in air
b. air and immersed in L_1
c. L_1 and immersed in L_2
d. L_2 and immersed in L_1

19. When a glass prism of refracting angle 60° is immersed in a liquid, its angle of minimum deviation is 30°. The critical angle of glass with respect to the liquid medium is

a. 42°
b. 45°
c. 50°
d. 52°

20. A prism is made of a material of refractive index $\sqrt{3}$. The angle of the prism is A. If the angle of minimum deviation is equal to the angle of the prism, then the value of A is

a. 30°
b. 45°
c. 60°
d. 75°

21. Light is incident at an angle α on one planar end of a transparent cylindrical rod of refractive index **n**. The least value of **n** so that the light entering the rod does not emerge from the curved suface of the rod for any value of α is

a. $\frac{4}{3}$
b. $\sqrt{2}$
c. 1.5
d. $\sqrt{3}$

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22. A square wire of side 3.0 m is placed 25 cm from a concave mirror of focal length 10 cm. The area enclosed by the image of the wire is

    a. 1 cm^2
    b. 4 cm^2
    c. 16 cm^2
    d. 25 cm^2

23. A convex lens and a concave lens are placed in contact. The ratio of the magnitude of the power of the convex lens to that of the concave lens is 4 : 3. If the focal length of the convex lens is 12 cm, the focal length of the combination will be

    a. 16 cm
    b. 24 cm
    c. 32 cm
    d. 48 cm

24. A plano-convex lens has thickness 4 cm. When placed on a horizontal table with the curved face in contact with it, the apparent depth of the bottom-most point of the lens is found to be 3 cm. If the lens is inverted such that the plane face is in contact with the table, the apparent depth of the centre of the plane face of the lens is found to be $\frac{25}{8}$ cm. The focal length of the lens is

    a. 25 cm
    b. 50 cm
    c. 75 cm
    d. 100 cm

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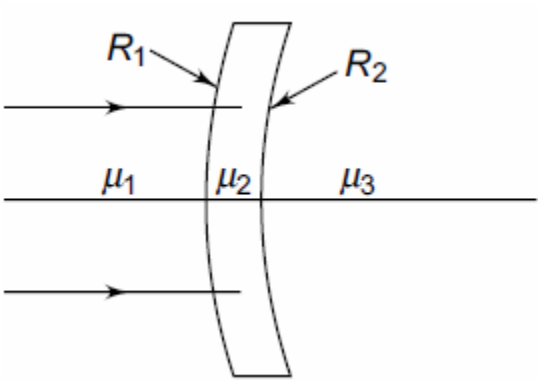
25. The figure below shows a lens having radii of curvature R_1 and R_2 and $\mu_1 < \mu_2 < \mu_3$. If the thickness of the lens is negligible and $R_1 = R_2 = R$, the focal length of the lens will be



a. $f = \frac{\mu_3 R}{(\mu_3 - \mu_1)}$

b. $f = \frac{\mu_2 R}{(\mu_3 - \mu_1)}$

c. $f = \frac{\mu_1 R}{(\mu_3 - \mu_2)}$

d. $f = \frac{(\mu_2 - \mu_1) R}{(\mu_3 - \mu_1)}$

or $$\frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R_1} \quad \text{(i)}$$

Refraction at the second surface: $u = v - t = v$ ($\because$ t is negligible),

$v = +v_1$ and $R = +R_2$. We have

$$\frac{\mu_3}{v_1} - \frac{\mu_2}{v} = \frac{\mu_3 - \mu_2}{R_2} \quad \text{(ii)}$$

Since the incident ray is parallel to the principal axis, $v_1 = f$, the focal length of the lens and using $v_1 = f$ (i) in (ii), we get

$$\frac{\mu_3}{f} - \frac{\mu_2 - \mu_1}{R_1} = \frac{\mu_3 - \mu_2}{R_2}$$

or $$\frac{1}{f} = \left(\frac{\mu_2 - \mu_1}{\mu_3}\right)\cdot\frac{1}{R_1} + \left(\frac{\mu_3 - \mu_2}{\mu_3}\right)\cdot\frac{1}{R_2} \quad \text{(iii)}$$

This is the expression for the focal length. If $R_1 = R_2$ we get [put $R_1 = R_2 = R$ in (iii)]

$$\frac{1}{f} = \left(\frac{\mu_3 - \mu_1}{\mu_3}\right)\frac{1}{R}$$

So the correct choice is (1).

26. A spherical surface of radius of curvature R separates air (refractive index 1.0) from glass (refractive index 1.5). The centre of curvature is in the glass. A point object P placed in air is found to have a real image Q in the glass. The line PQ cuts the surface at point O and PO = OQ. The distance PO is equal to

5 R
3 R
2 R
1.5 R

Right Answer Explanation:

Using the formula for a spherical surface

$$\frac{\mu_a}{u}+\frac{\mu_g}{v}=\frac{\mu_g-\mu_a}{R}$$

we have $\frac{1.0}{u}+\frac{1.5}{u}=\frac{1.5-1.0}{R}$ (since $v=u$)

which gives $u = 5R$. Hence the correct choice is (1).

27. An eye specialist prescribes spectacles having a combination of a convex lens of focal length 40 cm in contact with a concave lens of local length 25 cm. The power of this lens combination is

+ 1.5 D
– 1.5 D
+ 6.67 D
– 6.67 D

Right Answer Explanation:
Power of the lens combination is

$$P = P_1 + P_2 = \frac{1}{f_1(\text{in m})}+\frac{1}{f_2(\text{in m})}$$

$$= \frac{1}{+0.40\text{ m}}+\frac{1}{-0.25\text{ m}}$$

$$= -1.5\text{ m}^{-1} = -1.5\text{ D},$$

which is choice (2).

28. The size of the image of an object, which is at infinity, as formed by a convex lens of focal length 30 cm is 1.6 cm. If a concave lens of focal length 20 cm is placed between the convex lens and the image at a distance of 26 cm from the convex lens, the size of the final image will be

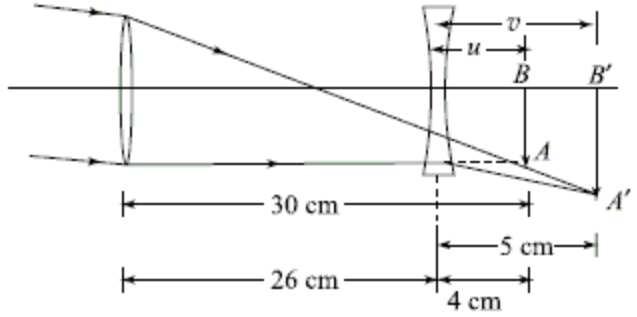
0.8 cm
1.2 cm
2.0 cm
2.4 cm

Right Answer Explanation:

Refer to the Fig. AB is the image of size 1.6 cm formed by the convex lens at its focal plane. It serves as the virtual object for the concave lens. $A'B'$ is the final image.

For concave lens, $f = -20$ cm, $u = +4$ cm; $v = ?$.

Now



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

or $$\frac{1}{v} - \frac{1}{4} = -\frac{1}{20}$$

which gives $v = 5$ cm. Thus the final image at a distance of 5 cm from the concave lens. Now

$$\frac{A'B'}{AB} = \frac{v}{u}$$

or $$\frac{A'B'}{1.6\text{ cm}} = \frac{5\text{ cm}}{4\text{ cm}}$$

or $A'B' = 2.0$ cm. Hence the correct choice is (3).

29. In the visible region, the dispersive powers and the mean angular deviations for crown and flint glass prisms are ω and $\omega\Gamma$ and d and d' respectively. When the two prisms are combined, the condition of zero dispersion by the combination is

$\sqrt{\omega}d + \sqrt{\omega'}d' = 0$

$\omega' d + \omega d' = 0$

$\omega d - \omega d' = 0$

$(\omega d)^2 + (\omega' d')^2 = 0$

Right Answer Explanation:

Mean angular deviations produced by crown and flint glass prisms respectively are

$$d = (\mu - 1)\,A \text{ and } d' = (\mu' - 1)\,A'$$

Their dispersive powers are

$$\omega = \frac{(\mu_v - \mu_r)}{(\mu - 1)} \text{ and } \omega' = \frac{(\mu'_v - \mu'_r)}{(\mu' - 1)}$$

Their angular dispersions respectively are

$$D = (\mu_v - \mu_r)\,A \text{ and } D' = (\mu'_v - \mu'_r)\,A'$$

When the prisms are combined, the dispersion by the combination will be zero if

$$D + D' = 0$$

or $$(\mu_v - \mu_r)\,A + (\mu'_v - \mu'_r)\,A' = 0$$

or $$\frac{(\mu_v - \mu_r)}{(\mu - 1)}(\mu - 1)\,A + \frac{(\mu'_v - \mu'_r)}{(\mu' - 1)}(\mu' - 1)\,A' = 0$$

or $$\omega d + \omega' d' = 0,$$ which is choice (3).

30. One face of a glass prism is silver polished. A light ray falls at an angle of 45° on the other face. After refraction, it is subsequently reflected from the silvered face and then it retraces its path. The refracting angle of the prism is 30°. The refractive index of the material of the prism is

$\frac{3}{2}$

$\sqrt{2}$

$\frac{\sqrt{3}}{2}$

$\sqrt{3}$

Right Answer Explanation:

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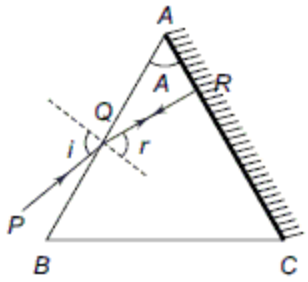
The refracted ray QR will retrace its path if it falls normally on the silvered face AB (see adjoining figure). It follows from Fig. that



$$r = A = 30^\circ \text{ (given)}$$

Also $i = 45^\circ$ (given). Hence

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin 45^\circ}{\sin 30^\circ} = \sqrt{2}$$

which is choice (2).