

Ray Optics

Question1

When an object is placed in front of a convex mirror at a distance ' u ' from the pole of the mirror such that the size of the image is ' n ' times that of the object. Then, the object distance ' u =

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Options:

A.

$$\frac{f}{n^2} - nf$$

B.

$$nf - \frac{f}{n}$$

C.

$$f - \frac{f}{n}$$

D.

$$f + \frac{f}{n^2}$$

Answer: C

Solution:

$$h_i = nh_o$$

$$n = \frac{h_i}{h_o}$$

$$n = -\frac{v}{u}$$

$$\Rightarrow v = -nu$$



Using mirror formula,

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

$$\frac{1}{f} = \frac{1}{-nu} + \frac{1}{u}$$

$$\Rightarrow u = \frac{f(n-1)}{n} = f - \frac{f}{n}$$

Question2

The ratio of the focal lengths of a convex lens when kept in air and when it is immersed in a liquid is 1 : 2. If the refractive index of the material of the lens is 1.5 , then the refractive index of the liquid is

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Options:

A.

1.20

B.

1.30

C.

1.25

D.

1.35

Answer: A

Solution:

By Lens maker's formula, For a equiconvex lens,

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1 \right) \left(\frac{2}{R} \right)$$

In air, $n_1 = 1, n_2 = \frac{3}{2}$

$$\therefore \frac{1}{f_{\text{air}}} = \left(\frac{3}{2} - 1\right) \left(\frac{2}{R}\right)$$

$$\frac{1}{f_{\text{air}}} = \frac{1}{R} \quad \dots (i)$$

In liquid, $n_1 = x, n_2 = \frac{3}{2}$

$$\frac{1}{f_l} = \left(\frac{3}{2x} - 1\right) \left(\frac{2}{R}\right) \quad \dots (ii)$$

Given, $\frac{f_{\text{air}}}{f_{\text{liquid}}} = \frac{1}{2}$

So, from Eq. (i) and (ii)

$$\frac{f_{\text{air}}}{f_{\text{liquid}}} = \frac{R \times 2 \left(\frac{3}{2x} - 1\right)}{R \times 1} = \frac{1}{2}$$

$$\Rightarrow 2 \left(\frac{3}{2x} - 1\right) = \frac{1}{2}$$

$$\Rightarrow \frac{3}{2x} - 1 = \frac{1}{4}$$

$$\Rightarrow \frac{3}{2x} = \frac{5}{4} \text{ or } x = \frac{6}{5} = 1 : 20$$

Question3

If the least distance of distinct vision for a boy is 35 cm , then the lens to be used by the boy for correcting the defect of his eye is

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Options:

A.

convex lens of focal length 35 cm

B.

concave lens of focal length 35 cm

C.

convex lens of focal length 87.5 cm

D.

concave lens of focal length 87.5 cm

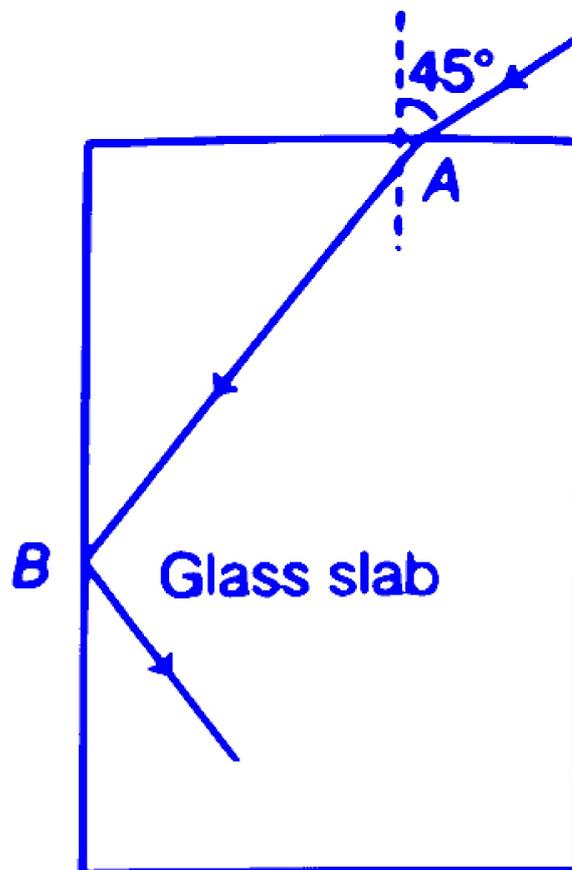
Answer: C

Solution:

$$\begin{aligned}\frac{1}{f} &= \frac{1}{v} - \frac{1}{u} \\ &= \frac{1}{-35} - \frac{1}{-25} = \frac{10}{875} \\ \therefore f &= \frac{875}{10} = 87.5 \text{ cm}\end{aligned}$$

Question4

A light ray falls on a rectangular glass slab as shown in the figure. If total internal reflection occurs at the vertical face of the slab at point *B*, the refractive index of glass is



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Options:

A.

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

B.

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

C.

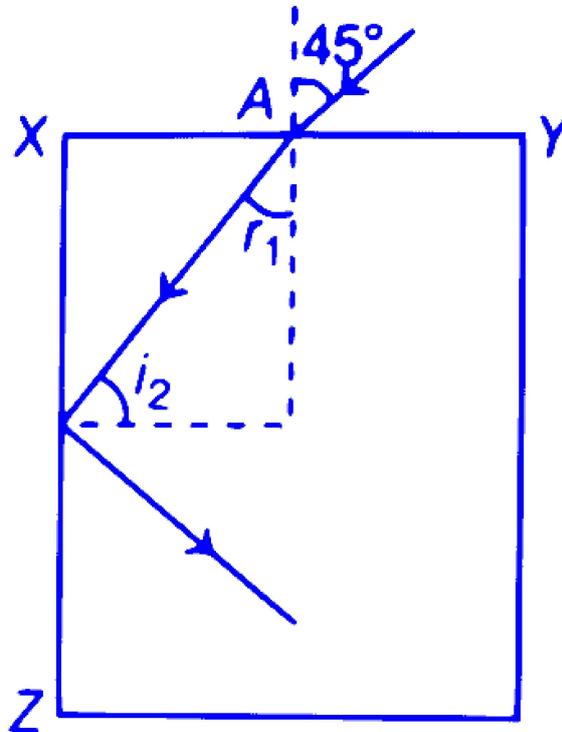
$$\frac{(\sqrt{2+1})}{2}$$

D.

$$\frac{\sqrt{5}}{2}$$

Answer: A

Solution:



For surface XY ,

$$\mu_a \sin 45^\circ = \mu_g \sin r_1$$

$$\mu_g \sin r_1 = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \sin r_1 = \frac{1}{\mu_g \sqrt{2}} \quad \dots (i)$$

\therefore From figure, $i_2 = 90 - r_1$

For total internal reflection

$$\sin i_2 = \frac{1}{\mu_g}$$

$$\Rightarrow \sin (90 - r_1) = \frac{1}{\mu_g}$$

$$\Rightarrow \cos r_1 = \frac{1}{\mu_g} \quad \dots (ii)$$

From eqn. (i) and (ii),

$$\sin^2 r_1 + \cos^2 r_1 = 1$$

$$\Rightarrow \frac{1}{2\mu_g^2} + \frac{1}{\mu_g^2} = 1 \Rightarrow \frac{3}{2\mu_g^2} = 1$$

$$\Rightarrow \mu_g^2 = \frac{3}{2}; \therefore \mu_g = \sqrt{\frac{3}{2}}$$

Question5

Images of same size are formed by a convex lens when an object is placed either at 20 cm or 10 cm distance from the lens. The focal length of the lens is

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Options:

A.

12 cm

B.

40 cm

C.

18 cm

D.

15 cm

Answer: D

Solution:

Magnification of a lens is given as

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

from lens formula

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

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

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

$$\text{and } m = \frac{v}{u} = \frac{f}{f+u}$$

Now, magnification in both case is equal.

$$\text{So, } m_1 = -m_2$$

$$\frac{f}{f-20} = \frac{-f}{f-10}$$

$$f-20 = -f+10$$

$$2f = 30 \Rightarrow f = 15 \text{ cm}$$

Question6

A light ray incidents on an equilateral prism made of material of refractive index $\sqrt{3}$. Inside the prism, if the light ray moves parallel to the base of the prism, then the angle of incidence of the light ray is

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Options:

A.

30°

B.

45°

C.

75°

D.

60°

Answer: D

Solution:



$$\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\frac{A}{2}}$$

$$\Rightarrow \sqrt{3} = \frac{\sin\left(\frac{60+\delta m}{2}\right)}{\sin\frac{60}{2}}$$

$$\Rightarrow \sqrt{3} \sin 30^\circ = \sin\left(\frac{60+\delta m}{2}\right)$$

$$\Rightarrow \frac{\sqrt{3}}{2} = \sin\left(\frac{60+\delta m}{2}\right)$$

$$\Rightarrow 60^\circ = \frac{60+\delta m}{2} \Rightarrow \delta m = 60^\circ$$

\therefore Angle of incidence

$$i = \frac{A+\delta m}{2} = \frac{60+60}{2} = 60^\circ$$

Question 7

Two thin convex lenses are kept in contact coaxially. If the focal length of the combination of the lenses is 4 cm and sum of the focal lengths of the two lenses is 18 cm, then the focal length of the lens of low power is

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Options:

A.

8 cm

B.

10 cm

C.

6 cm

D.

12 cm

Answer: D

Solution:

$$f_1 + f_2 = 18 \text{ cm}$$

$$f = 4 \text{ cm}$$

$$\therefore \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\Rightarrow \frac{1}{4} = \frac{f_2 + f_1}{f_1 f_2}$$

$$\Rightarrow \frac{1}{4} = \frac{18}{f_1 f_2}$$

$$\Rightarrow f_1 f_2 = 72$$

$$\Rightarrow f_1 (18 - f_1) = 72$$

$$\Rightarrow 18f_1 - f_1^2 = 72$$

$$\Rightarrow f_1^2 - 18f_1 + 72 = 0$$

$$\Rightarrow f_1^2 - 12f_1 - 6f_1 + 72 = 0$$

$$\Rightarrow (f_1 - 12)(f_1 - 6) = 0$$

$$\therefore f_1 = 6 \text{ cm}, 12 \text{ cm}$$

When, $f_1 = 6 \text{ cm}$, then,

$$f_2 = 18 - 6 = 12 \text{ cm}$$

When $f_1 = 12 \text{ cm}$, then

$$f_2 = 18 - 12 = 6 \text{ cm}$$

Since, $P \propto \frac{1}{f}$

\therefore Focal length of low power = 12 cm

Question8

If the far point of a short sighted person is 400 cm , then the power of the lens required to enable him to see very distant objects clearly is

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Options:

A.

-0.5 D

B.



+0.5 D

C.

+025 D

D.

-025 D

Answer: D

Solution:

The far point of a short-sighted person is 400 cm . To correct this, a lens is needed to bring objects at infinity into focus at the person's far point.

$$\therefore P = \frac{1}{f} = \frac{1}{-4} = -0.250$$

Question9

When a convex lens is immersed in two different liquids of refractive indices 1.25 and 1.5 , the ratio of the focal lengths of the lens is 5 : 16 . The refractive index of the material of the lens is

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Options:

A. 1.55

B. 1.5

C. 1.65

D. 1.6

Answer: C

Solution:

Given, two different liquids of refractive indices 1.25 and 1.5 .

$$\text{Focal length, } \frac{f_1}{f_2} = \frac{5}{16}$$

Using len's Maker's formula,



$$\frac{1}{f_1} = \frac{(n_{\text{Lens}} - 1.25)}{1.25} \left(\frac{1}{R_1} - \frac{1}{R_2'} \right) \dots$$

$$\frac{1}{f_2} = \frac{(n_{\text{Lens}} - 1.5)}{1.5} \left(\frac{1}{R_1} - \frac{1}{R_2} \right) \dots$$

From Eqs. (i) and (ii),

$$\frac{\left(\frac{1}{f_1}\right)}{\left(\frac{1}{f_2}\right)} = \frac{(n_{\text{Lens}} - 1.25) \times 1.5}{(n_{\text{Lens}} - 1.5) \times 1.25}$$

$$\Rightarrow \frac{16}{5} = \frac{(n_{\text{Lens}} - 1.25)}{(n_{\text{Lens}} - 1.5)} \times \frac{6}{5}$$

$$\Rightarrow 16n_{\text{Lens}} - 24 = 6n_{\text{Lens}} - 7.5$$

$$\Rightarrow 10n_{\text{Lens}} = 16.5$$

$$\Rightarrow n_{\text{Lens}} = 1.65$$

Therefore, the refractive index of material of the lens is approximately 1.65.

Question10

When a convex lens is immersed in a liquid of refractive index equal to 80% of the refractive index of the material of the lens. The focal length of the lens increases by 100%. The refractive index of the liquid is

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Options:

A. 1.27

B. 1.2

C. 1.33

D. 1.4

Answer: B

Solution:

Given:

Let the refractive index of the lens be μ_L .

The refractive index of the liquid is given by $0.8\mu_L$.

Let's assign:

The focal length of the lens in air as f .

The focal length in the liquid as $f_{\text{liquid}} = 2f$.

Using the Lens Maker's formula in air:

$$\frac{1}{f} = (\mu_L - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

For the lens immersed in the liquid, the formula modifies to:

$$\frac{1}{f_{\text{liquid}}} = \left(\frac{\mu_L}{\mu_{\text{liquid}}} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

Substituting the given values:

$$\frac{1}{2f} = \left(\frac{\mu_L}{0.8\mu_L} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

This simplifies to:

$$\frac{1}{2f} = 0.25 \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

Therefore:

$$\Rightarrow \frac{1}{f} = 0.5 \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

From equations (i) and (ii), we derive:

$$\mu_L - 1 = 0.5 \quad \Rightarrow \quad \mu_L = 1.5$$

Thus, the refractive index of the liquid:

$$= 0.8 \times \mu_L = 0.8 \times 1.5 = 1.2$$

Therefore, the refractive index of the liquid is 1.2.

Question11

A person can see objects clearly when they lie between 40 cm and 400 cm from his eye. In order to increase the maximum distance of distant vision to infinity the type of lens and power of correction lens required respectively, are

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Options:

- A. convex, 0.25 D
- B. concave, -0.25 D
- C. concave, -0.5 D
- D. concave, 0.5 D

Answer: B

Solution:

A person can see objects clearly when they are between 40 cm and 400 cm from their eyes. The goal is to increase the maximum distance of distinct vision to infinity.

The maximum distance at which the person can see clearly is 400 cm. To achieve clear vision at infinity, an object's image at infinity needs to be formed at 400 cm, or 4 meters.

Using the lens formula:

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

For this situation:

$$P = \frac{1}{-4} - \frac{1}{\infty} = \frac{1}{f}$$

$$P = \frac{1}{f} = -0.25 \text{ D}$$

The negative sign indicates that a concave lens is required.

Question12

The focal length of the objective lens of a telescope is 30 cm and that of its eye lens is 3 cm . It is focussed on a scale at a distance 2 m from it. The distance of objective lens from eye lens to see the clear image is

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Options:

- A. 38.3 cm
- B. 48.3 cm
- C. 58.3 cm



D. 22.5 cm

Answer: A

Solution:

Given:

Focal length of the objective lens, $f_0 = 30$ cm

Focal length of the eye lens, $f_e = 3$ cm

Distance to the object being focused on, $u_0 = -200$ cm (since the object is 2 m away and the convention is to take the object distance as negative)

Let's use the lens formula to find the image distance (v_0) formed by the objective lens:

$$\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$$

Substitute the known values into the formula:

$$\frac{1}{30} = \frac{1}{v_0} + \frac{1}{200}$$

Solving for $\frac{1}{v_0}$:

$$\frac{1}{v_0} = \frac{1}{30} - \frac{1}{200} = \frac{20-3}{600} = \frac{17}{600}$$

Thus, v_0 is:

$$v_0 = \frac{600}{17} \approx 35.3 \text{ cm}$$

The distance from the objective lens to the eye lens (d) is the sum of v_0 and the focal length of the eye lens (f_e):

$$d = v_0 + f_e = 35.3 + 3 = 38.3 \text{ cm}$$

Therefore, to see a clear image, the distance between the objective lens and the eye lens should be approximately 38.3 cm.

Question13

A ray of light travels from an optically denser to rare medium. The critical angle for the media is C . The maximum possible deviation of the ray will be

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Options:

A. $\frac{\pi}{2} - C$

B. $2C$

C. $\pi - 2C$

D. $\pi^\circ - C$

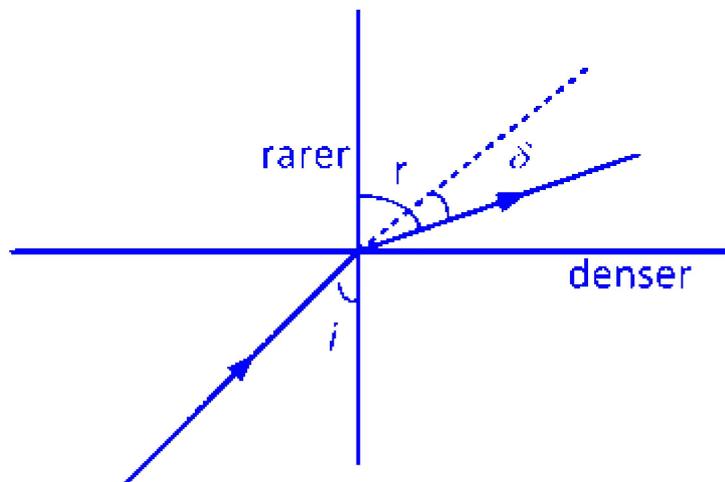
Answer: C

Solution:

When a ray of light passes from an optically denser to rarer medium, the deviation is, $\delta = r - i$, where $i =$ angle of incidence $r =$ angle of refraction This can have a maximum value of $(\frac{\pi}{2} - C)$ for $i = C$ and $r = \frac{\pi}{2}$.

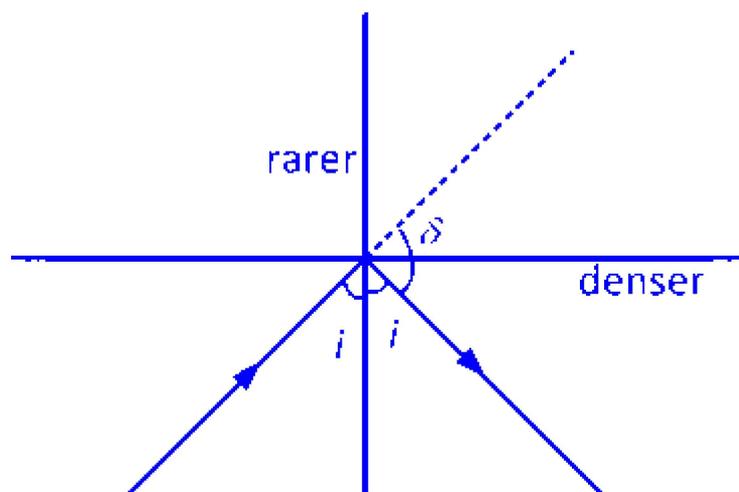
When total internal reflection occurs, the deviation is

$$\delta = \pi - 2i$$



the minimum value of i being C , then maximum value of

$$\delta_{\max} = \pi - 2C$$



Question14

The angle of polarisation for a medium with respect to air is 60° .
The critical angle of this medium with respect to air is

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Options:

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

B. $\tan^{-1} \sqrt{3}$

C. $\cos^{-1} \sqrt{3}$

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

Answer: D

Solution:

Given:

The angle of polarization for a medium is $\theta_p = 60^\circ$.

We know that:

$$\mu = \tan(\theta_p) \Rightarrow \mu = \tan 60^\circ = \sqrt{3}$$

Furthermore, since the refractive index μ is also related to the critical angle by:

$$\mu = \frac{1}{\sin C} \quad (\text{where } C \text{ is the critical angle})$$

We can substitute for μ :

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

Therefore, the critical angle C is:

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

Question15

An object is placed at a distance of 18 cm in front of a mirror. If the image is formed at a distance of 4 cm on the other side, then focal length, nature of the mirror and nature of image are respectively

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Options:

- A. 3.14 cm , concave mirror and real image
- B. 3.14 cm , convex mirror and real image
- C. 5.14 cm , convex mirror and virtual image
- D. 5.14 cm , concave mirror and virtual image

Answer: C

Solution:

Given the object distance $u = -18$ cm and the image distance $v = 4$ cm, we need to find the focal length f , the type of mirror, and the nature of the image.

Using the mirror formula:

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

Substitute the given values:

$$\frac{1}{f} = \frac{1}{-18} + \frac{1}{4}$$

Solving for f :

$$f = \frac{36}{7}$$

$$f = 5.14 \text{ cm}$$

Since the focal length is positive ($f > 0$), the mirror is a convex mirror. Therefore, the image formed is virtual.

Question16

An object lying 100 cm inside water is viewed normally from air. If the refractive index of water is $\frac{4}{3}$, then the apparent depth of the object is



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Options:

A. 100 cm

B. 50 cm

C. 25 cm

D. 75 cm

Answer: D

Solution:

To determine the apparent depth of an object submerged in water and viewed from the air, we can use the concept of refractive index.

The refractive index (μ) is defined by the equation:

$$\mu = \frac{\text{Real depth}}{\text{Apparent depth}}$$

Given:

$$\text{Refractive index of water, } \mu = \frac{4}{3}$$

$$\text{Real depth} = 100 \text{ cm} = 100 \times 10^{-2} \text{ m}$$

We need to find the apparent depth. Plug the values into the formula:

$$\frac{4}{3} = \frac{100 \times 10^{-2}}{\text{Apparent depth}}$$

Solve for the apparent depth:

$$\text{Apparent depth} = \frac{3 \times 100 \times 10^{-2}}{4} = 75.0 \times 10^{-2} \text{ m}$$

Thus, the apparent depth is 75 cm.

Question 17

The minimum deviation produced by a hollow prism filled with a certain liquid is found to be 30° . The light ray is also, found to be refracted at an angle of 30° . Then, the refractive index of the liquid is



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Options:

A. $\sqrt{2}$

B. $\sqrt{3}$

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

D. $\frac{3}{2}$

Answer: A

Solution:

To find the refractive index of the liquid in the hollow prism, we consider the scenario of minimum deviation. Here's how we can calculate it:

Angular Relations:

At minimum deviation, the angle of the prism A is related to the angle of refraction r by:

$$A = 2r = 2 \times 30^\circ = 60^\circ$$

Given: Minimum deviation $\delta_m = 30^\circ$.

Refractive Index Calculation:

The refractive index μ of the liquid is given by the formula:

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$$

Substitute the known values:

$$\mu = \frac{\sin\left(\frac{60^\circ+30^\circ}{2}\right)}{\sin\frac{60^\circ}{2}}$$

Simplify the expression:

$$\mu = \frac{\sin 45^\circ}{\sin 30^\circ}$$

Trigonometric Values:

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

$$\sin 30^\circ = \frac{1}{2}$$

Final Calculation:

Hence, the refractive index is:



$$\mu = \frac{1/\sqrt{2}}{1/2} = \sqrt{2}$$

Therefore, the refractive index of the liquid is $\sqrt{2}$.

Question18

The focal length of a thin converging lens in air is 20 cm . When the lens is immersed in a liquid, it behaves like a concave lens of power 1 D . If the refractive index of the material of the lens is 1.5 . The refractive index of the liquid is

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Options:

A. $5/3$

B. $4/3$

C. $5/4$

D. $7/4$

Answer: A

Solution:

Given:

Refractive index of the lens, $\mu_l = 1.5$

Refractive index of air, $\mu_a = 1$

Focal length of the lens in air, $f = 20$ cm

Using the lens maker's formula:

$$\frac{1}{f} = \left(\frac{\mu_l}{\mu_a} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

Substituting the known values:

$$\frac{1}{20} = (1.5 - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{10} = \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

Now, when the lens is immersed in a liquid with refractive index μ_{liquid} , it behaves as a concave lens:

Power of the lens in the liquid, $P = -1$ D

Calculating focal length in the liquid:

$$f = \frac{100}{P} = \frac{100}{-1} = -100 \text{ cm}$$

Applying the lens maker's formula for the lens immersed in the liquid:

$$\frac{-1}{100} = \left(\frac{1.5 - \mu_{\text{liquid}}}{\mu_{\text{liquid}}} \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

Using the earlier result:

$$\frac{-1}{100} = \left(\frac{1.5}{\mu_{\text{liquid}}} - 1 \right) \times \frac{1}{10}$$

Solving for μ_{liquid} :

$$\frac{1.5}{\mu_{\text{liquid}}} = 1 - \frac{1}{10}$$

$$\mu_{\text{liquid}} = \frac{1.5 \times 10}{9}$$

$$\mu_{\text{liquid}} = \frac{5}{3}$$

Question19

A needle is lying at the bottom of a water tank of height 12 cm. The apparent depth of the needle measured by a microscope is 9 cm . If the water is replaced by a liquid of refractive index of 1.5 of same height, the distance through which the microscope has to be moved to focus the needle again is

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Options:

- A. 1.2 cm
- B. 1.1 cm
- C. 1 cm
- D. 1.33 cm

Answer: C



Solution:

For water, real depth = 12 cm

Apparent depth = 9 cm

Since, refractive index, $\mu_w = \frac{\text{Real depth}}{\text{Apparent depth}}$

$$\Rightarrow \mu_w = \frac{12}{9}$$

when water is replaced by liquid of refractive index $\mu = 1.5$, we have

$$\text{New apparent depth} = \frac{\text{real depth}}{\mu_l} = \frac{12}{1.5} = 8 \text{ cm}$$

Hence, required shifted distance = $9 - 8 = 1 \text{ cm}$

Question20

The radii of curvature of a double convex lens are 4 cm and 8 cm . If the refractive index of the material of the lens is 1.5 , the focal length of the lens is nearly.

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Options:

- A. 16 cm
- B. 12.11 cm
- C. 7.33 cm
- D. 5.33 cm

Answer: D

Solution:

For double convex lens,

$$R_1 = 4 \text{ cm}, R_2 = -8 \text{ cm}$$

Refractive index, $\mu = 1.5$



By lens maker's formula, focal length is given by

$$\begin{aligned}\frac{1}{f} &= (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right) \\ &= (1.5 - 1) \left(\frac{1}{4} - \frac{1}{-8} \right) = 0.5 \left(\frac{1}{4} + \frac{1}{8} \right) \\ &= 0.5 \left(\frac{3}{8} \right) = \frac{3}{16} \\ \Rightarrow f &= \frac{16}{3} \text{ cm} \\ &= 5.33 \text{ cm}\end{aligned}$$

Question21

A ray is incident from a medium of refractive index 2 into a medium of refractive index 1. The critical angle is

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Options:

- A. 30°
- B. 60°
- C. 45°
- D. 90°

Answer: A

Solution:

From the given situation absolute refractive index of denser medium, ${}^a\mu_d = 2$

Absolute refractive index of rarer medium, ${}^a\mu_r = 1$

\therefore Refractive index of denser medium with respect to rarer medium

$${}^r\mu_d = \frac{{}^a\mu_d}{{}^a\mu_r} = \frac{2}{1} = 2 \Rightarrow {}^r\mu_d = 2$$

If i_c be the critical angle, then

$$\sin i_c = \frac{1}{r\mu_d} = \frac{1}{2} = \sin 30^\circ$$
$$\Rightarrow i_c = 30^\circ$$

Question22

Assertion (A) The focal length of lens doesnot change when red light is replaced by bluelight.

Reason (R) The focal length of lens does notdepend on colour of light used.

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Options:

- A. Both A and R are true and R is a correct explanation for A .
- B. Both A and R are true but R is not a correct explanation for A .
- C. A is true, R is false.
- D. Both A and R are false.

Answer: D

Solution:

By using lens Maker formula,

$$\frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

where,

f = focal length,

μ = refractive index,

R_1 and R_2 = radii of curvature.

If light changes from red to blue, refractive index of light also changes. Hence, focal length will also change.

Hence, Assertion and Reason both are false.



Question23

Light of wavelength 300 nm in medium A enters into medium B through a plane surface. If the frequency of light is 5×10^{14} Hz and the ratio of speed in medium A to that in medium B is $4/5$, the absolute refractive index of medium B is

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Options:

A. 1.6

B. 1.5

C. 1.3

D. 1.45

Answer: A

Solution:

Given, wavelength of light A , $\lambda_A = 300$ nm

$$= 300 \times 10^{-9} \text{ m}$$

Frequency of light in A , $f_A = 5 \times 10^{14}$ Hz

$$\text{Ratio of speed of light } \frac{v_A}{v_B} = \frac{4}{5}$$

Let μ_A , μ_{air} and μ_B are refractive indexes of medium A , air and B respectively.

$$\begin{aligned} \therefore \text{Absolute refractive index} &= \frac{\mu_A}{\mu_{\text{air}}} \\ &= \frac{\text{Speed of light in air } (c)}{\text{Speed of light in medium } A (v_A)} \\ \Rightarrow \mu_A &= \frac{3 \times 10^8}{f_A \lambda_A} \\ \Rightarrow \mu_A &= \frac{3 \times 10^8}{5 \times 10^{14} \times 300 \times 10^{-9}} = 0.2 \times 10^1 = 2 \end{aligned}$$

$$\text{Now, } \frac{\mu_B}{\mu_A} = \frac{v_A}{v_B}$$

$$\Rightarrow \mu_B = \mu_A \left(\frac{v_A}{v_B} \right) = 2 \left(\frac{4}{5} \right) = \frac{8}{5} = 1.6$$

