

Answers

Module 1: Reflection from Plane and Spherical Surfaces

A.9.1.1 (A)

$$\therefore \frac{v}{u} = \frac{1}{n}$$

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

Substituting in mirror equation and using sign conventions, we have,

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

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

$$\therefore u = (n - 1)f$$

A.9.1.2 (C) $R = 20$ cm,

$$f = \frac{R}{2} = -10 \text{ cm}, u = -1 \text{ m},$$

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

$$\therefore \frac{1}{v} = -\frac{1}{10} + \frac{1}{100} = -\frac{9}{100} \Rightarrow v = -\frac{100}{9} \text{ cm}$$

$$h' = m \times h = -\frac{v}{u} \times h$$

$$h = \frac{\frac{100}{9}}{100} \times 5 = \frac{5}{9} = 0.55 \text{ cm}$$

Negative sign indicates image is formed below the principal axis.

A.9.1.3 (C) A convex mirror always forms a virtual and diminished image irrespective of object distance. Therefore it can cover the maximum field of view in front of the mirror.

A.9.1.4 (B) $u = -(f + d_1)$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = -\frac{1}{f} + \frac{1}{f+d_1} = \frac{-d_1}{f(f+d_1)}$$

$$\therefore v = -\frac{f^2}{d_1} - f$$

$$\therefore d_2 = v + f = -\frac{f^2}{d_1}$$

$$\text{Numerically, } f^2 = d_1 d_2$$

$$\therefore f = \sqrt{d_1 d_2}$$

A.9.1.5 (D) The light rays from the full object will reach the concave mirror and hence the image of the full object will be seen. Since the lower half of the concave mirror is covered, the intensity of the image will be reduced.

A.9.1.6 (B) Calculate the image distance (v_1) for object distance of 10 cm and (v_2) for object distance 8 cm.

$$v_1 = \frac{20}{3} \text{ cm and}$$

$$v_2 = \frac{40}{7} \text{ cm}$$

$$\text{Longitudinal magnification} = \frac{\text{length of image along the axis}}{\text{length of object along the axis}}$$

$$\therefore v_1 - v_2 = \frac{20}{21}$$

A.9.1.7 (B) Calculate the image distance (v_1) for an object distance of 39 cm and v_2 for object distance 41 cm.

$$v_1 = \text{distance of one end of object from F} = -\frac{780}{19}$$

$$v_2 = \text{distance of other end of object from F} = -\frac{820}{21}$$

$$m = \frac{v_2 - v_1}{h} = \frac{\frac{-820}{21} + \frac{780}{19}}{2} = -1.05$$

A.9.1.8 (A) on rotating the mirror, the tangent at the point of incidence doesn't change. So, the reflected ray is not rotated at all. Hence, x is zero.

A.9.1.9 (C)

$$u = -25\text{cm}, f = 12\text{cm}$$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{12} + \frac{1}{25} = \frac{37}{300}$$

$$I = o \times \frac{v}{u} = 2 \times \frac{300}{37 \times 25} = \frac{24}{37}$$

$$= 0.65 \text{ cm}$$

A.9.1.10 (A) field of view is large for a convex mirror and the size of the image formed by the convex mirror is very small as compared to actual size of the object, so the image appears to be at distance in overall view in context of other dimensions.

Module 2 : Refraction at Plane and Spherical Surfaces

A.9.2.1 (D)

$$v = \frac{c}{n}.$$

And n is least for red. So, the velocity is highest for red.

A.9.2.2 (C) Since water is rarer compared to kerosene, at the kerosene water interface, the ray would bend
Away from the normal.

A.9.2.3 (D) Here r is on the other side of the normal, negative r would give a negative refractive index.

A.9.2.4 (B) For the mark not to be visible, the grazing incidence on bottom face must satisfy condition for grazing emergence from side face (Fig.A.9.2.1)

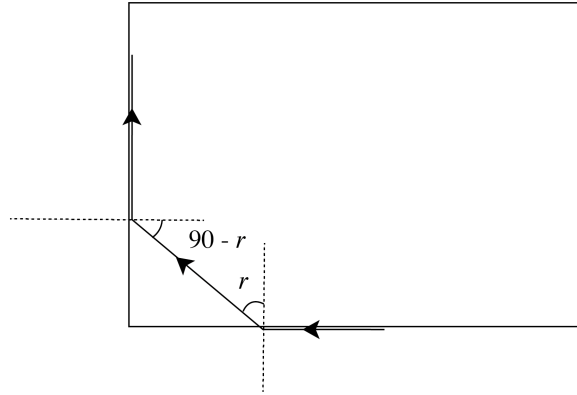


Fig.A.9.2.1

$$\mu > \frac{1}{\sin(90^\circ - r)} = \frac{1}{\cos r}$$

$$\therefore r = 45^\circ \text{ and } \mu > \sqrt{2}$$

A.9.2.5 (B) refer Fig.A.9.2.2 :

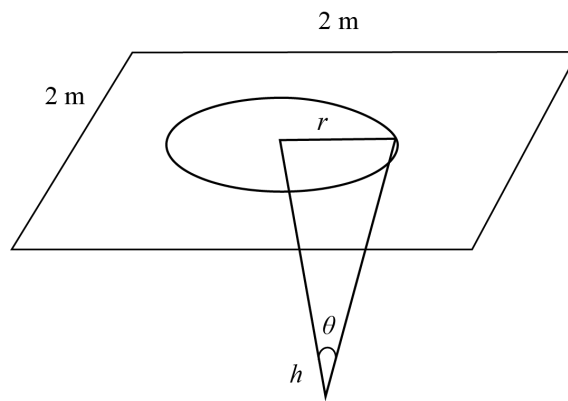


Fig.A.9.2.2

$$\tan \theta = \frac{n}{h}$$

$$\frac{\sin 90^\circ}{\sin \theta} = \mu = \frac{4}{3}$$

$$\therefore \sin \theta = \frac{3}{4}, \tan \theta = \frac{3}{\sqrt{7}}$$

$$\therefore r = h \tan \theta = (0.8) \frac{3}{\sqrt{7}} \text{ m}$$

$$\therefore \text{Reqd p.c} = \frac{\pi \left\{ (0.8) \frac{3}{\sqrt{7}} \right\}^2}{2 \times 2} \times 100$$

$$= 64.64$$

A.9.2.6 (B)

Object distance = 2 cm

radius of curvature = 1 cm

$$n_1 = 1.5 \text{ and } n_2 = 1 \text{ and } m = v/u$$

$$\text{So, } \frac{1}{v} - \frac{1.5}{2} = \frac{n_2 - n_1}{r} = \frac{-0.5}{1};$$

$$\frac{1}{v} = \frac{3}{4} - \frac{1}{2} = \frac{1}{4};$$

$$v = 4; m = \frac{4}{2} = 2$$

So, size of image = $2 \times 0.5 \text{ cm} = 1 \text{ cm}$.

A.9.2.7 (C)

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R} \quad R = 0.5 \text{ cm}, u = -1.5 \text{ cm}$$

$$n_1 = 1.5, n_2 = 1.$$

$$\frac{1}{v} + \frac{1.5}{1.5} = \frac{-0.5}{1.5};$$

$$\frac{1}{v} = -2,$$

$$v = -\frac{1}{2} = -0.5 \text{ cm}$$

Hence, 0.5 cm behind the groove.

A.9.2.8 (C)

Image formed by the first surface to be used as the object for the second surface.

A.9.2.9 (D)

Image formed by the first surface to be used as the object for the second surface.

For the first surface $n_1 = 1.5, n_2 = 1$.

For second surface $n_1 = 1, n_2 = 1.5$

$$\text{For the first surface, } \frac{1.5}{v_1} - \frac{1.5}{\infty} = \frac{0.5}{2} = \frac{1}{4}, v_1 = 6$$

For the second surface, $\frac{1}{v} = \frac{1.5}{6-4} = \frac{-0.5}{-2} = \frac{1}{4}$

$$\frac{1}{v} = \frac{3}{4} + \frac{1}{4} = 1,$$

$$v = 1.$$

A.9.2.10 (A)

$$\text{As, } n = \frac{\text{real depth}}{\text{apparent depth}}$$

$$\text{apparent depth} = h / n.$$

Module 3 : Image Formation Due to Lenses

$$\text{A.9.3.1 (A)} \quad \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{dv}{dt} = \left(\frac{v^2}{u^2} \right) \frac{dx}{dt}$$

and $v = 2f$ when $u = 2f \Rightarrow \frac{dv}{dt} = \frac{du}{dt}$ same speed and as u decreases, v would increase on the other side giving motion in the same direction.

A.9.3.2 (A) As long as ($d \neq 0$), the resultant will always be converging.

A.9.3.3 (A)

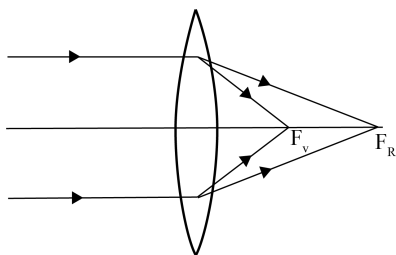
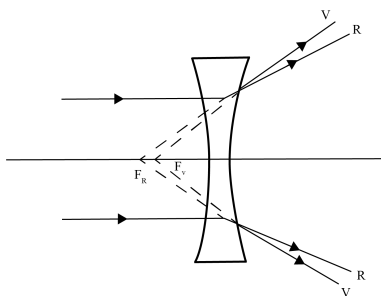


Fig.A.9.3.1

$F_v < F_R$ because $\mu_v > \mu_R$, violet bends more than red (**Fig.A.9.3.1**).

For concave lenses, violet also bent more than red. So, the diagram looks as below(**Fig.A.9.3.2**)

**Fig.A.9.3.2**

Giving $F_V < F_R$, hence option (A) is correct.

A.9.3.4 (B)

If the focal length of the first converging lens is the same as the focal length of the second converging lens, the first lens will bring parallel light to its focus and the second lens will convert the light coming from its focus to parallel light. Therefore $d = f_1 + f_2$

A.9.3.5

(A) If the focal length of first converging lens is the same as the focal length of second diverging lens, the first lens will bring parallel light to its focus and the light will appear to come from the focus of diverging lens then the second diverging lens will convert the light coming from its focus to parallel light. Therefore $d = f_1 - f_2$

A.9.3.6**(D)**

Using the property of diverging lenses as in the case of question 5.

A.9.3.7 (C)

$$\frac{1}{f_1} = \left(\frac{4}{3} - 1 \right) \left(\frac{1}{100} - \frac{1}{20} \right) = \frac{1}{60}, f_1 = -60 \text{ cm}$$

For 1st lens (Fig.A.9.3.3)

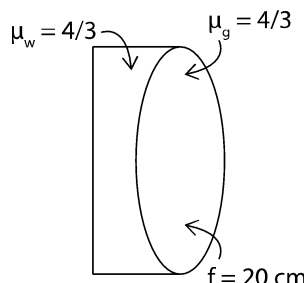


Fig.A.9.3.3

$$2^{nd} \text{ lens } f_2 = R = 20 \text{ cm}$$

$$f_1 = \frac{f_1 f_2}{f_1 + f_2} = \frac{-60 \times 20}{-60 + 20} = 30 \text{ cm}$$

A.9.3.8 (C)

As $u = +40 \text{ cm}$,

then for object parallel to the principal axis with end points at 39 cm and 41 cm. Gives image on other side at 41.052 cm and 39.047 cm. This gives the size of the image 2.005 cm. Whereas an object at 40 cm perpendicular to principal axis gives an image at 40 cm perpendicular to principal axis gives image at 40 cm with magnification of 1 gives size of image 2.000 cm. Thus, the ratio of the image size is 1.0025. Hence, option (C) is correct.

A.9.3.9 (D)

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

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

$$v = f(m + 1)$$

A.9.3.10 (C)

$$m_{axis} > m_{lateral}$$

Module 4 : Prism and Optical Instruments

A.9.4.1 (C) For prism $i + e = A + \delta$

$$\Rightarrow e = A + \delta \text{ (since } i = 0\text{)}$$

$$= 15^\circ$$

A.9.4.2: (A)

The image formed by the objective is formed beyond the focus of the eyepiece. So, the real image is formed by the eye piece as the image formed by the objective serves as an object for the eyepiece.

A.9.4.3 : (D)

For microscope $m \propto \frac{1}{f_o}$ and telescope $m \propto f_o$.

A.9.4.4: (A)

$$r' = A \text{ since } r = 0$$

$$= 30^\circ$$

$$\sin e = n \sin r' = \frac{n}{2} = \frac{\sqrt{3}}{2}$$

$$\therefore e = 60^\circ$$

$$\delta = i + e - A = 30^\circ$$

A.9.4.5 (B)

$$r' = A = 45^\circ \text{ since } r = 0$$

and $n \geq \frac{1}{\sin r'} = \sqrt{2}$ for total internal reflection

A.9.4.6 (A) and (C)

Refer Fig.A.9.4.1

$$L = f_0 - f_e = 19.96 \text{ m}$$

$$m = \frac{f_0}{f_e} = \frac{20}{0.04} = 500$$

and image is erect

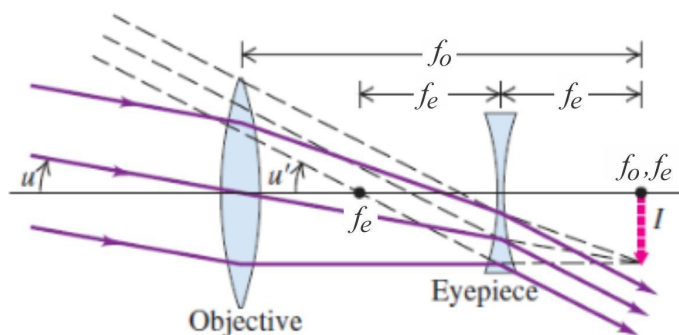


Fig.A.9.4.1

A. 9.4.7 (C) Since $i = 0$, $\delta = e - A = A(n - 1)$

therefore $e = nA$

A. 9.4.8 (B) and (C)

Microscope $f_0 = 1 \text{ cm}$

$$f_e = 2.5 \text{ cm.}$$

$$u = -1.2 \text{ cm}$$

$$\therefore L > f_0 + f_e$$

$$L = 8.25 \text{ cm}$$

$$m = \frac{L}{f_0} \left(1 + \frac{D}{f_e} \right) = \frac{8.25}{1} \left(1 + \frac{25}{2.5} \right) = 8.25 \times 11$$

$$= 90.75$$

A.9.4.9 (D) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ and $\frac{I}{o} = \frac{1}{u} = \frac{v}{u} \Rightarrow v = \frac{u}{n}$

$$\therefore \frac{n+1}{u} = \frac{1}{f} \text{ or } u = (n + 1)f$$

A.9.4.10 (C) By convention diverging lens focal length is negative .this given effective length $|f_o| - |f_e|$ and

magnification $\frac{|f_o|}{|f_e|}$



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