Answer Key & Solutions

LIGHT

1 (b) In plane mirror, object distance = image distance

∴ Distance between object and image

$= 0.5 + 0.5 = 1$ m

2 (a) $n = \frac{360^\circ}{90^\circ} = 4$

so number of images is $(n - 1) \Rightarrow (4 - 1) = 3$

3 (b) Concave mirror is used as a shaving mirror

4 (c) For all spherical mirrors $f = R/2$

5 (c) given, $m = \frac{\text{Image height}}{\text{object height}} > 1$

$$\Rightarrow \text{Image height} > \text{Object height}$$

6 (b) Convex mirror always form virtual and erect image.

7 (b)

8 (c)

9 (a) Power $= \frac{1}{\text{focal length}}$

10 (a) Magnification, $m = \frac{\text{Image height}}{\text{Object height}}$

11 (b) Diminished, erect image is formed by convex mirror.

12 (b)

13 (b)

14 (a)

15 (c)

16 (d) For a spherical lens $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

For convex lens. $u = -f/2$ and f is + ve

$$\therefore \frac{1}{v} = \frac{1}{f} + \frac{1}{u} + \frac{1}{f} = +\frac{1}{f} - \frac{2}{f} \quad \therefore v = -f$$

17 (d)

18 (c)

19 (a)

20 (c)

21 (a)

22 (a)

23 (c)

24 (b)

25 (c)

26 (b)

27 (c)

28 (d)

29 (d)

30 (d)

31 (d)

32 (d)

33 (b)

34 (b)

35 (a)

36 (a)

37 (b)

38 (d)

39 (a)

40 (a)

41 (b)

42 (c)

43 (b)

44 (c)

45 (b)

46 (c)

47 (c)

48 (c)

49 (b)

50 (b)

51 (d)

52 (c)

53 (a)

54 (c)

55 (c)

56 (a)

57 (b) ${}_a\mu_g = \frac{\sin 60^\circ}{\sin 35^\circ}$ and ${}_a\mu_w = \frac{\sin 60^\circ}{\sin 41^\circ}$

$$\therefore\ {}_a\mu_g = \frac{{}_a\mu_g}{{}_a\mu_w} = \frac{\sin 41^\circ}{\sin \theta}$$
$$\text{or } \left(\frac{\sin 60^\circ}{\sin 35^\circ} \Big/ \frac{\sin 60^\circ}{\sin 41^\circ}\right) = \frac{\sin 41^\circ}{\sin \theta}$$
$$\therefore \theta = 35^\circ$$

58 (d)

59 (b)

60 (c)

61 (d)

62 (d)

63 (a)

64 (c)

65 (b)

66 (d)

67 (a)

68 (a)

69 (b)

70 (a)

71 (b)

72 (a)

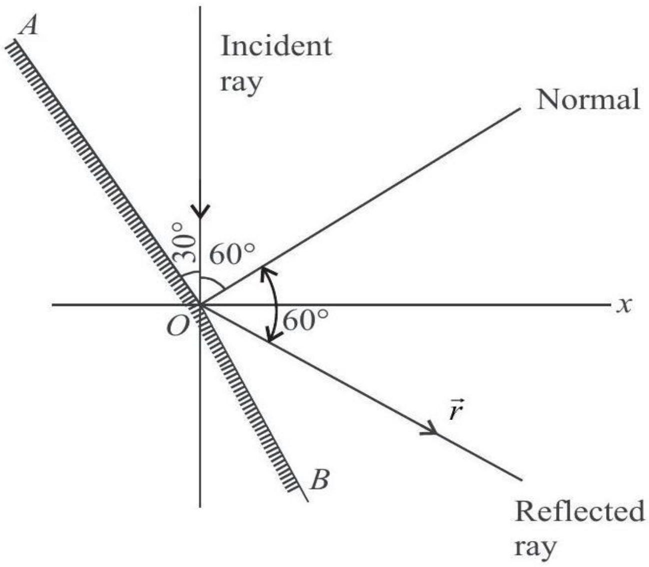
73 (a)

74 (c) Number of images formed $= \frac{360^\circ}{\theta} - 1 = 7$.

75 (c)

76 (b) $P = P_1 + P_2 \Rightarrow P = \frac{1}{f_1} + \frac{1}{f_2} \Rightarrow P = \frac{f_1+f_2}{f_1 f_2}$

77 (c) According to laws of reflection, angle of incidence = angle of reflection



$\therefore$ if a vector $\vec{r}$ is along the reflected ray, then

$\vec{r} = \cos\ 30^\circ \hat{\imath} - \sin\ 30 \hat{\jmath}$

$\vec{r} = \frac{\sqrt{3}}{2}\hat{\imath} - \frac{1}{2}\hat{\jmath}$

$\vec{r} = \sqrt{3}\hat{\imath} - \hat{\jmath}$

Hence, the direction of the reflected ray vector is .

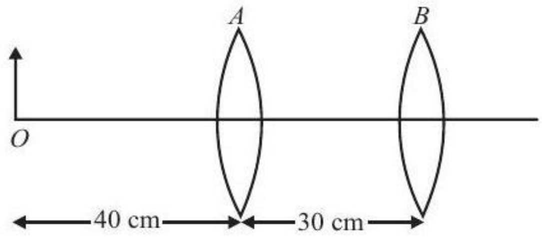
$\sqrt{3}\hat{\imath} - \hat{\jmath}$

78 (a) Angle of incidence, $i = 90^\circ - \theta$, decreases with increase in θ upto angle of incidence i = critical angle reflection takes place so x is positive and beyond the critical angle refraction takes place so x is negative.

Hence graph 'A' correctly depicts variation of x with the angle θ.

79 (c) For lens A, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\Rightarrow \frac{1}{30} = \frac{1}{v} - \left(-\frac{1}{40}\right) \uparrow$$
$$\Rightarrow \frac{1}{30} = \frac{1}{v} + \frac{1}{40}$$
$$= \frac{4-3}{120} = \frac{1}{120} \text{ or, } v = 120 \text{ cm.}$$



For lens B, $u = 90$ cm$[u = 120 - 30]$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{30} = \frac{1}{v} - \frac{1}{90}$$
$$\frac{1}{v} = \frac{1}{30} + \frac{1}{90} = \frac{3+1}{90}$$
$$\text{or, } v = 22.5 \text{ cm}$$

Which is positive so that it is 22.5 cm from lens B.

80 (d) Two mirrors are inclined at an angle, $\theta = ?$

According to question, emergent ray is parallel to incident ray

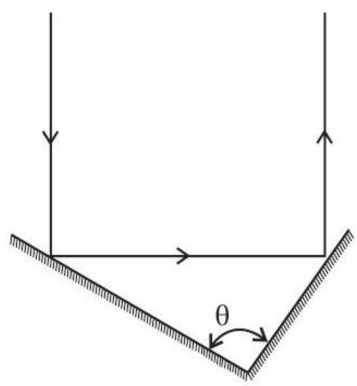
$\therefore$ deviation angle $\delta = 180°$

But $\delta = 360° - 2\theta$

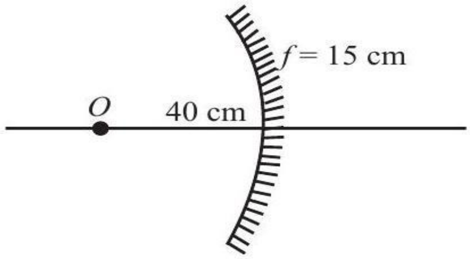
or, $360° - 2\theta = 180°$

or, $2\theta = 180°$

$$\therefore \theta = 90°$$



81 (b)



Using mirror formula, $\frac{1}{f}=\frac{1}{v_1}+\frac{1}{u}$

$$-\frac{1}{15}=\frac{1}{v_1}+\frac{1}{u}\Rightarrow\frac{1}{v_1}=\frac{1}{-15}+\frac{1}{40}$$

$\therefore\ v_1=-24$ cm

When object is displaced by 20 cm towards mirror Now, $u_2=-20$

So, $\frac{1}{f}=\frac{1}{v_2}+\frac{1}{u_2}$

$$\frac{1}{-15}=\frac{1}{v_2}-\frac{1}{20}\Rightarrow\frac{1}{v_2}=\frac{1}{20}-\frac{1}{15}$$

$$\therefore v_2=-60 \text{ cm}$$

Therefore, image shifts away from mirror by $=60-24=36$ cm

82 (c) For the end B, image distance of end B will be,

$$f = 10 \text{ cm}$$
$$u_B = -18 \text{ cm}$$
$$v_B = \text{ image distance of end } B$$

As we know,

$$\frac{1}{f}=\frac{1}{v_B}-\frac{1}{u_B}$$

$$\frac{1}{v_B}=\frac{1}{f}+\frac{1}{u_B}$$

$$\frac{1}{v_B}=\frac{1}{10}-\frac{1}{18}=\frac{8}{180}$$

$v_B=\frac{180}{8}\Rightarrow 22.5$ cm

Similarly, for the end A, image distance of end A will be,

$f = 10$ cm

$u_A = -20$ cm

$v_A =$ image distance of end A

$$\frac{1}{f} = \frac{1}{v_A} - \frac{1}{u_A}$$

$$\frac{1}{v_A} = \frac{1}{f} + \frac{1}{u_A}$$

$$\frac{1}{v_A} = \frac{1}{10} - \frac{1}{20} = \frac{1}{20}$$

$v_A = 20$ cm

So, length of image $A'B' = (v_B - v_A)$

$= 22.5 - 20 = 2.5$ cm

So, magnification, $m = \frac{A'B'}{AB} \Rightarrow \frac{2.5}{2} = 1.25$

83 (c) $+5 = -\frac{v}{u} \Rightarrow v = -5u$

Using $\Rightarrow \frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{-5u} + \frac{1}{u} = \frac{-1}{0.4}$

$\therefore u = -0.32$ m.

84 (a) Given,

Object distance, $u = 30$ cm

when a lens is cut along the principle axis into two equal parts focal length remains same for each part.

$\therefore$ Focal length, $f = 20$ cm using lens formula

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

$$\text{p}\ \frac{1}{v} = \frac{1}{20} - \frac{1}{30} = \frac{1}{60}$$

$$\Rightarrow v = 60 \text{ cm}$$

85 (c) Focal length of a lens, $F = 25$ cm

$$f = 0.25 \text{ m}$$

$$\text{P} = \frac{1}{f} = \frac{1}{0.25} = 4\text{D}$$

86 (a)

87 (b)

88 (a)

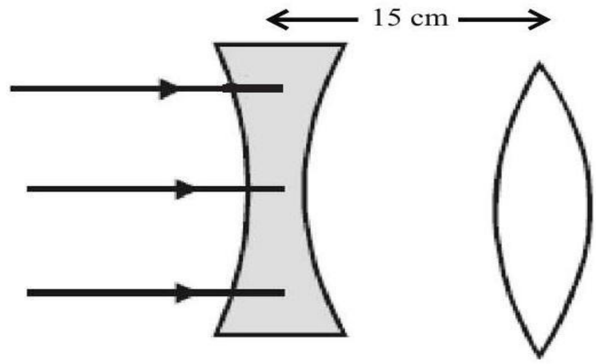
89 (a)

90 (d) Here $\underset{(1.6)}{\mu_{cs_2}} > \underset{(1.33)}{\mu_{\text{water}}} > \underset{(1.0)}{\mu_{\text{air}}}$ i.e., CS_2 is denser than water and water is denser than air. When medium outside a lens is denser than medium of lens, then a concave lens will acts like a convex lens and vice-versa.

Hence, lens here acts as a diverging lens when filled with CS_2 and immersed in water.

91 (c) As parallel beam incident on diverging lens will form image at focus.

$\therefore v = -25$ cm



$f = -25$ cm $f = 20$ cm

The image formed by diverging lens is used as an object for converging lens,

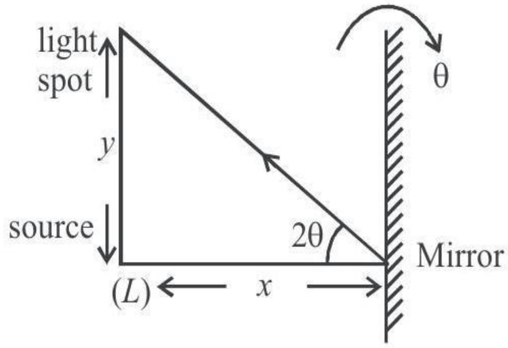
So, for converging lens $u = -25 - 15 = -40$ cm, $f = 20$ cm

$\therefore$ Final image formed by converging lens

$$\frac{1}{V} - \frac{1}{-40} = \frac{1}{20}$$

or, $V = 40$ cm from converging lens real and inverted.

92 (d) When mirror is rotated by angle θ reflected ray will be rotated by 2θ.



$$\frac{y}{x} = 2\theta \Rightarrow \theta = \frac{y}{2x}$$

93 (b) Given: $d_1 = 5$ cm, $\mu_1 = 1.33$

$$d_2 = 2 \text{ cm}, \mu_2 = 1.5$$

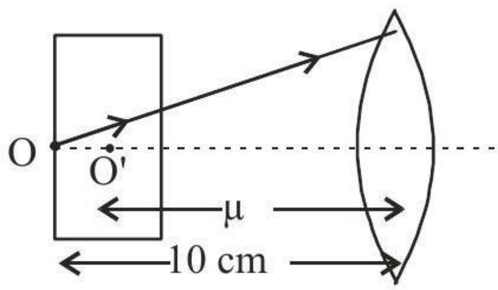
d_1 and d_2 are the thickness of slabs of medium with refractive index μ_1 and μ_2, respectively.

$$\text{using formula, } d = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \cdots.$$

$$\text{Apparent depth, } d = \frac{5}{1.33} + \frac{2}{1.5}$$

$$= 5.088 \text{ cm} = 5.1 \text{ cm}$$

94 (d)



As the object and image distance is same, object is placed at $2f$. Therefore $2f = 10$ or $f = 5$ cm.

Shift due to slab, $d = t\left(1 - \frac{1}{\mu}\right)$

in the direction of incident ray

$$\Rightarrow d = 1.5\left(1 - \frac{2}{3}\right) = 0.5 \text{ cm}$$

Now, $u = -9.5$ cm

Again using lens formulas $\frac{1}{v} - \frac{1}{-9.5} = \frac{1}{5}$

$\Rightarrow v = 10.55$ cm

Thus, screen is shifted by a distance $d = 10.55 - 10$

$= 0.55$ cm away from the lens.

95 (a) Object size $h_0 = 5.0$ cm, $f = 20$ cm,

Object distance $u = -30$ cm

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

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

Then $\frac{1}{v} = \frac{1}{20} + \frac{1}{-30} = \frac{1}{60}$

$\therefore v = +60$ cm

Positive sign of v shows that image is formed at a distance of 60 cm from the pole to the right of the lens.

Therefore image is real and inverted.

96 (a) Power $= \frac{1}{f} = \frac{1}{0.2\text{ m}} = +5\text{D}$

97 (a) From figure, angle of incidence, $i = 60°$ and angle of refraction, $r = 45°$

Refractive index of the medium B relative to medium A, (from Snell's law)

$$\mu_{BA} = \frac{\sin\ i}{\sin\ r} = \frac{\sin\ 60°}{\sin\ 45°} = \frac{\left(\frac{\sqrt{3}}{2}\right)}{\left(\frac{1}{\sqrt{2}}\right)} = \frac{\sqrt{3}}{2}$$

98 (a) Since light rays in the medium B goes towards normal (figure), so it has greater refractive index i.e., denser w.r.t. medium A. Hence, refractive index of medium B relative to medium A is greater than unity.

99 (b) In a rectangular glass slab, the emergent rays are parallel to the direction of the incident ray, as the extent of bending of the ray of light at the opposite parallel faces air-glass and glass-air interface of the rectangular glass slab is equal and opposite.

This is why the ray emerges are parallel to the incident ray. 100. (d) Among the given material kerosene refractive index, $\mu = 1.44$, water $\mu = 1.33$, mustard oil $\mu = 1.46$ and glycerine $\mu = 1.74$. Glycerine is most optically denser. Therefore, ray of light bend most in glycerine.

101 (a) $\frac{\sin\ i}{\sin\ r} = n_{21} = \frac{v_1}{v_2}$

102(a)

103 (c)

104 (b)

105(d) Any size of lens, can form full image, only intensity of image decreases with decrease in size.

106(c) The rays from centre of hemisphere cut at the centre after refraction - Snell's law is valid in each case of refraction.

107(d)

108 (d)

109 (a)

110 (b)

111 (b)

112 (c)

113 (c) Virtual image is formed when the rays of light after reflection or refraction appear to meet at a point.

114 (a)

115 (a)

116 (c)

117 (c)