DPP – 9 (Geometrical Optics)

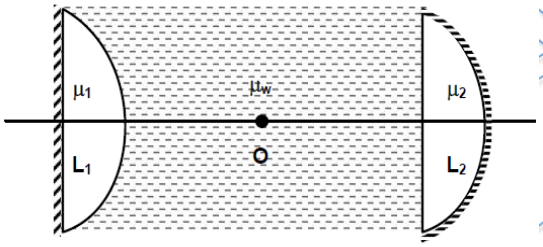
Video Solution on Website:- https://physicsaholics.com/home/courseDetails/67

Video Solution on YouTube:- https://youtu.be/yg5OBl6wRi8

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/68

Comprehension (Q1 to Q2)

A cylindrical tube filled with water ($\mu_w = 4/3$) is closed at its both ends by two thin silvered plano-convex lenses as shown in the figure. Refractive index of lenses L_1 and L_2 are 2.0 and 1.5 while their radii of curvature are 5 cm and 9 cm respectively. A point object is placed somewhere at a point O on the axis of cylindrical tube. It is found that the object and image coincide each other.



Q 1. The distance of object O from
(a) lens L_1 is 10 cm (b) lens L_2 is 10 cm
(c) lens L_1 is 8 cm (d) lens L_2 is 8 cm

Q 2. If $\mu_1 = \mu_2 = \mu_w$ then image after two reflections (once from each) will coincide with object if distance of O from
(a) L_1 is $9\sqrt{2}$ cm (b) L_2 is $9\sqrt{2}$ cm
(c) L_1 is 9 cm (d) L_2 is 9 cm

Q 3. The plane face of a plano-convex lens is silvered. If μ be the refractive index and R, the radius of curvature of curved surface, then the system will behave like a concave mirror of radius of curvature:
(a) m R (b) $\frac{R}{(\mu-1)}$ (c) $\frac{R^2}{\mu}$ (d) $\left[\frac{(\mu+1)}{(\mu-1)}\right] R$

Q 4. 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 center. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is:
(a) –25 cm (b) –50 cm (c) 50 cm (d) –20 cm

Comprehension (Q5 to Q6)

Magnification (by a lens) of an object at distance 10 cm from it is – 2. Now a second lens is placed exactly at the same position where first was kept and first lens is removed. The magnification by this lens is –3.

Q 5. Find magnification of image formed by combination of both lenses in contact. (Relative to combination):

(a) $-\frac{6}{11}$ (b) $\frac{6}{11}$ (c) $\frac{6}{13}$ (d) $-\frac{6}{13}$

Q 6. What is the focal length of the combination when both lenses are in contact?

(a) 60/17cm (b) 5/17cm (c) 12/7 (d) 13/9cm

Q 7. An object is placed in front of an equiconvex lens with refractive index 1.5 and radius of curvature 30 cm. Surface which is away from object is polished. Find the distance of object from lens so that object and image coincide:

(a)10 cm (b)20 cm (c)15 cm (d)40 cm

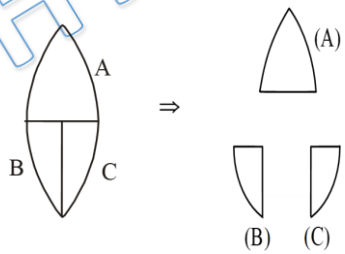
Q 8. Two planoconvex lenses each of focal length 10 cm & refractive index 3/2 are placed as shown. In the space left, water ($\mu = 4/3$) is filled. The whole arrangement is in air. The optical power of the system is (in diopters)

(a) 6.67 (b) – 6.67 (c) 33.3 (d) 20

Q 9. One of the curved surfaces of an equiconvex lens of radius of curvature 20 cm and power + 4 D is silvered. The power of the system is-

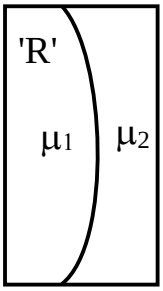
(a) + 8 D (b) -10 D (c) - 18 D (d) + 14 D

Q 10. A thin, symmetric double-convex lens of power P is cut into three parts A, B and C as shown. The power of –



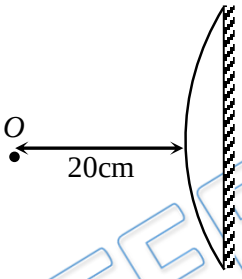
(a) A is P (b) A is 2P (c) B is P/2 (d) B is P/4

Q 11. A plane glass plate behaves as a lens when made as shown in the figure -



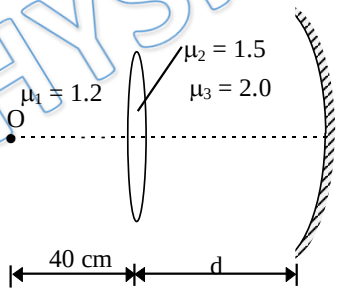
(a) For $\mu_1 = \mu_2$, it will behave as a glass slab
(b) For $\mu_2 > \mu_1$, it will behave as a divergent lens
(c) For $\mu_2 < \mu_1$, it will behave as a converging lens
(d) For any relations between μ_1 and μ_2 it is a lens

Q 12. A thin plano-convex lens of focal length 15 cm has its plane side silvered. An object is placed on the principal axis of the lens at a distance 20 cm from it as shown. The position of the image is



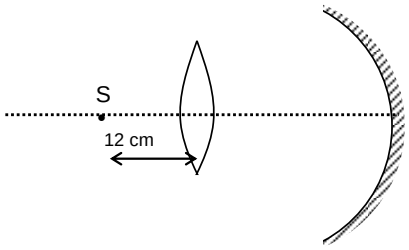
(a) 60 cm to the right of the lens (b) 60 cm to the left of the lens
(c) 30 cm to the left of the lens (d) 12 cm to the left of the lens

Q 13. The figure shows an arrangement of a equi-convex lens and a concave mirror. A point object O is placed on the principal axis at a distance 40 cm from the lens such that the final image is also formed at the position of the object. If the radius of curvature of the concave mirror is 80 cm, find the distance d. The focal length of the lens is 20 cm.



(a) 20 cm (b) 30 cm (c) 40 cm (d) 10 cm

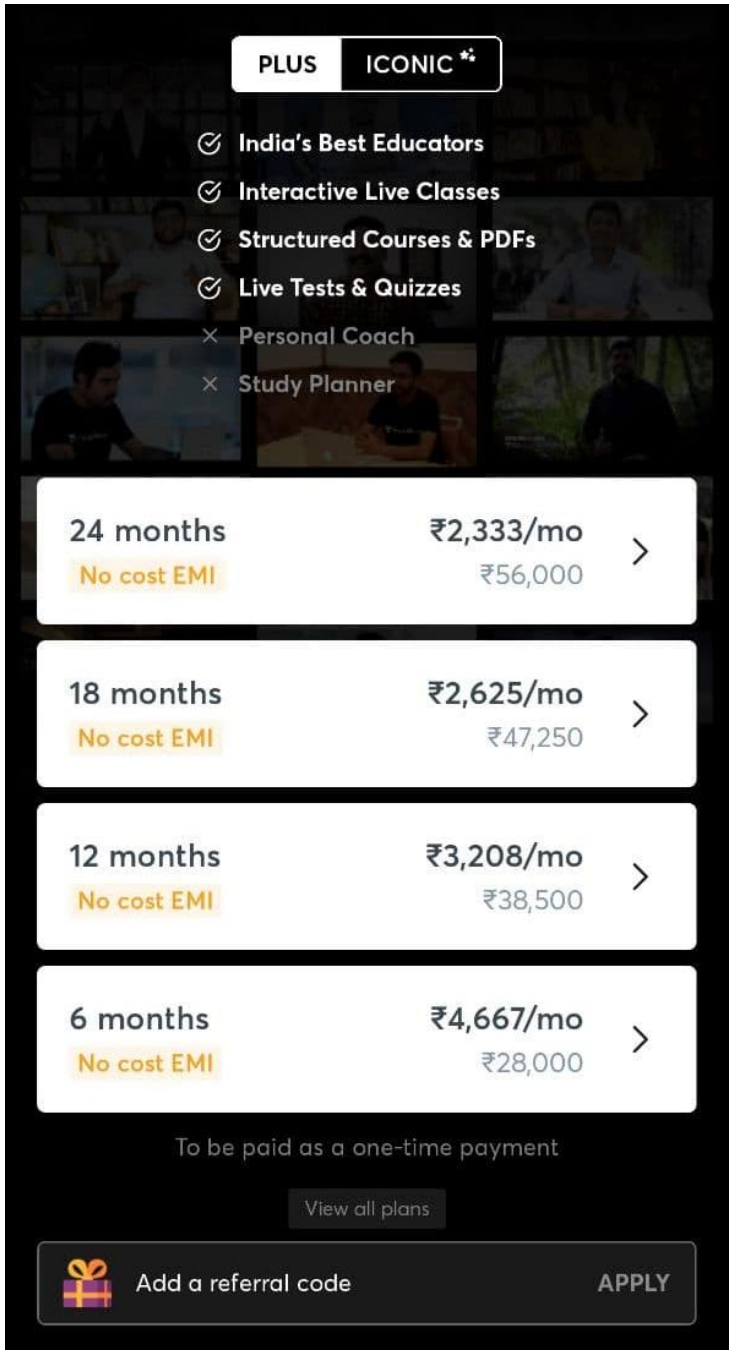
Q 14. A converging lens of focal length 15 cm and a converging mirror of focal length 20cm are placed with their principal axis coinciding. A point source S is placed on the principal axis at a distance of 12 cm from the lens as shown in the figure. It is found that the final beam comes out parallel to the principal axis. Find the separation between the mirror and the lens.



(a) 20 cm (b) 30 cm (c) 40 cm (d) 50 cm

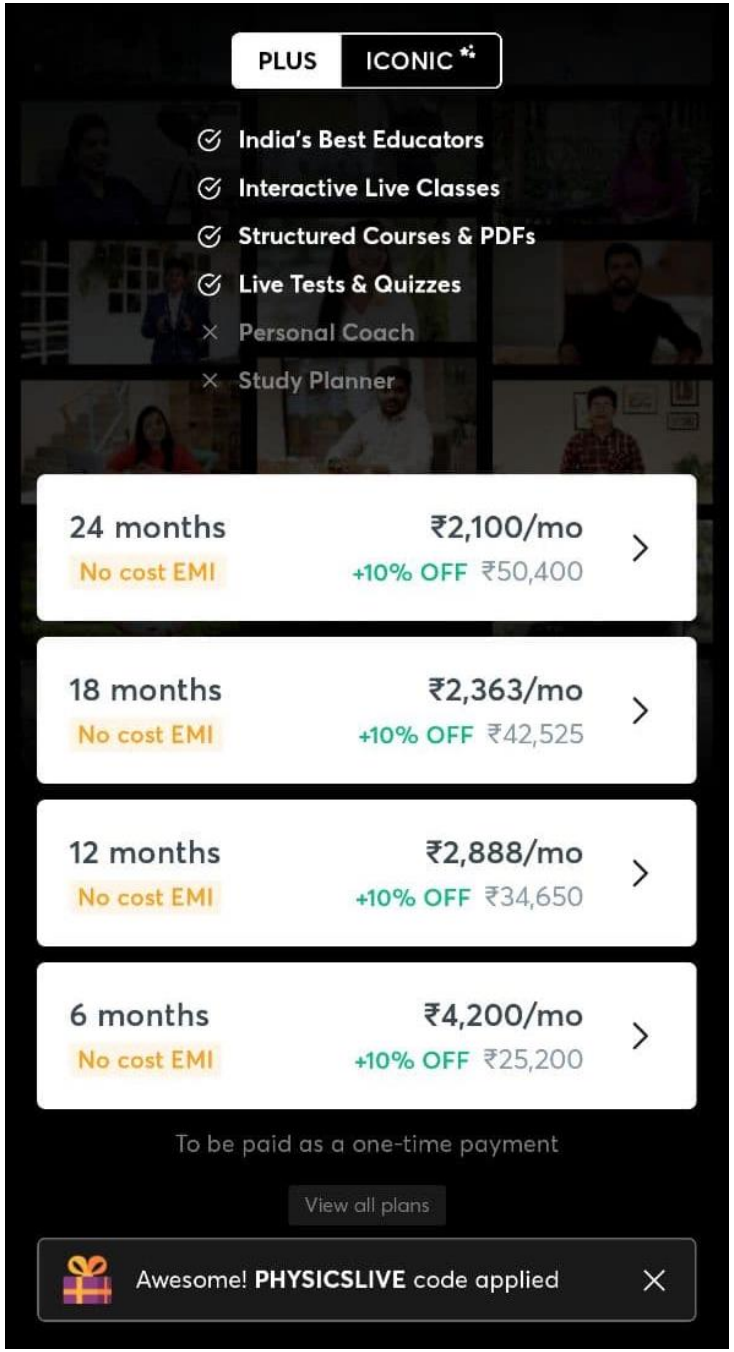
Answer Key

Q.1 a, d	**Q.2 a**	**Q.3 b**	**Q.4 b**	**Q.5 a**
Q.6 a	**Q.7 c**	**Q.8 a**	**Q.9 c**	**Q.10 a, c**
Q.11 a, b, c	**Q.12 d**	**Q.13 b**	**Q.14 c**	



PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS.

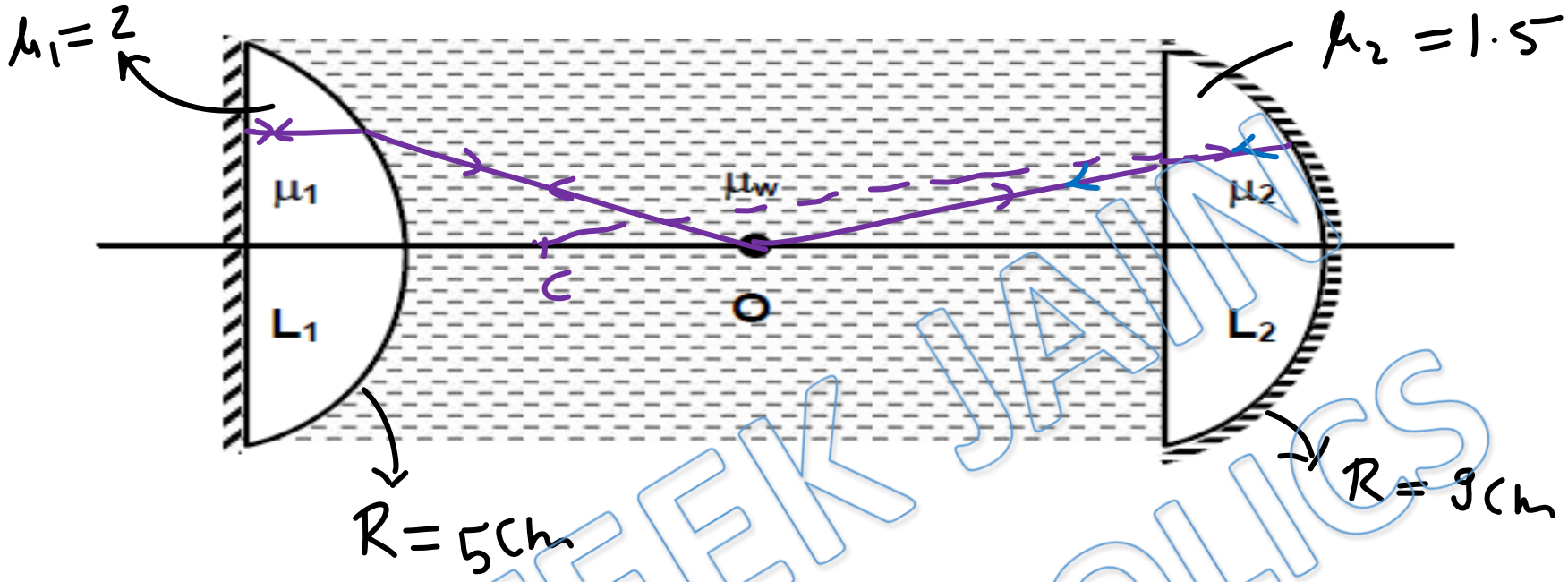


Written Solution

DPP 9 - Geometrical Optics- Power, Cutting, Silvering & Combination of lenses

By Physicsaholics Team

Solution: 1



To form image on object, incident ray on mirror must be perpendicular to mirror.

for first refraction by right surface of L_1

$$\frac{2}{\infty} - \frac{4}{3u_1} = \frac{2-4/3}{+5} \Rightarrow -\frac{4}{3u_1} = \frac{2}{15} \Rightarrow u_1 = -10\text{cm}$$

for first refraction by plane surface of $L_2 \rightarrow$

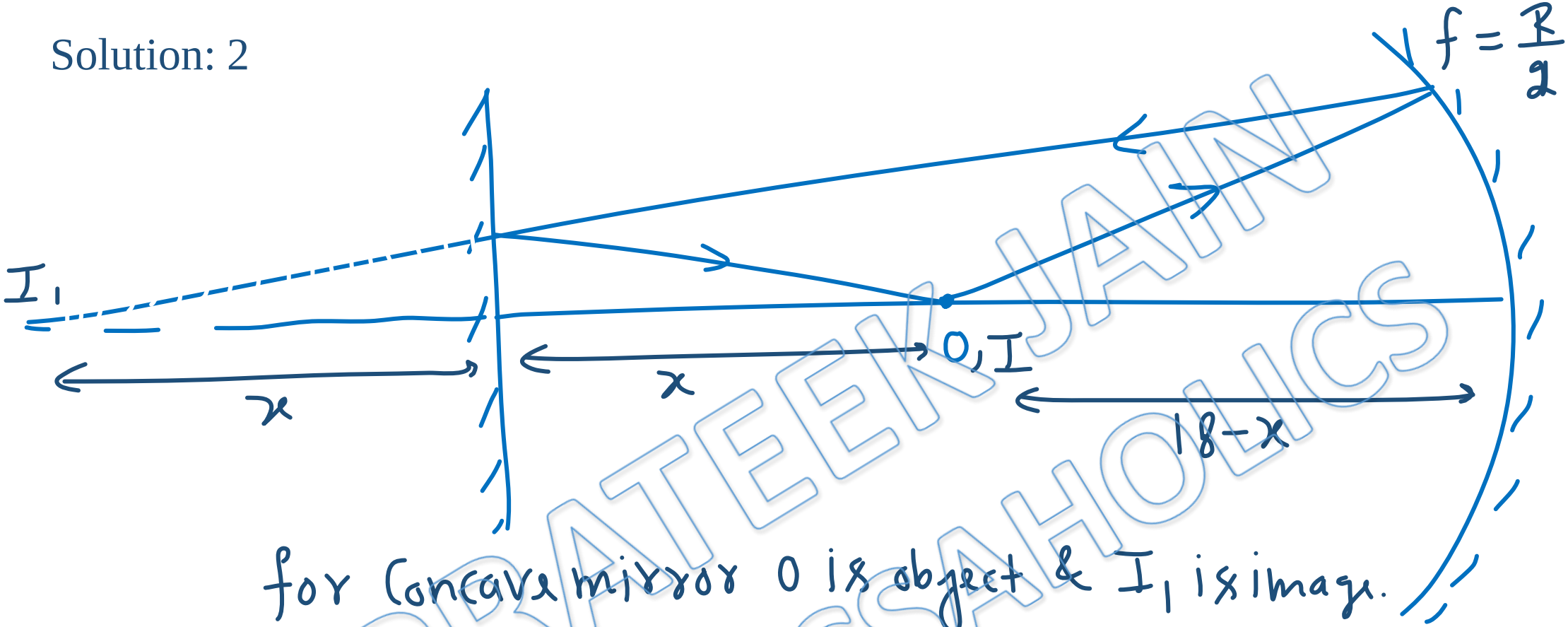
$$AI = t\left(\frac{\mu_2}{\mu_1}\right)$$

$$\Rightarrow \quad 9 = t\left(\frac{1.5}{4/3}\right)$$

$$\Rightarrow \quad t = \frac{9 \times 4}{1.5 \times 3} = 8\ cm$$

Ans. a, d

Solution: 2



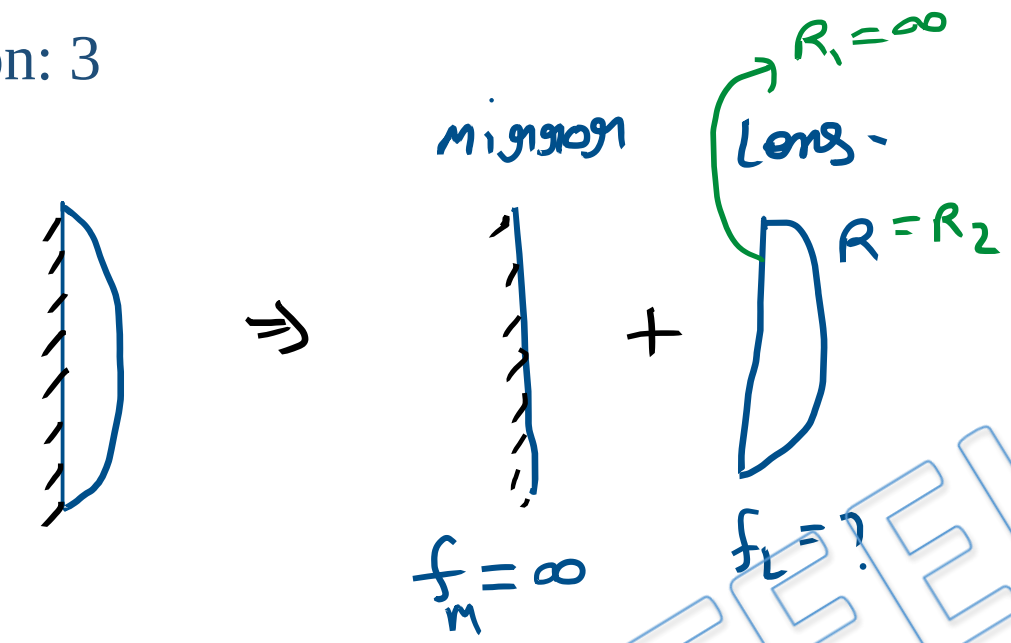
for Concave mirror O is object & I_1 is image.

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{2}{-9} = \frac{1}{-(18+x)} + \frac{1}{-(18-x)} \Rightarrow \frac{2}{9} = \frac{18-x+18+x}{18^2 - x^2}$$

$$\Rightarrow 18^2 - x^2 = 18 \times 9 = \frac{18^2}{2} \Rightarrow x^2 = \frac{18^2}{2} \Rightarrow x = \frac{18}{\sqrt{2}} = 9\sqrt{2}\ \text{cm}$$

Ans: (a)

Solution: 3



$$\frac{1}{f_{eq}} = \frac{1}{f_m} - \frac{2}{f_L}$$

$$\frac{1}{f_{eq}} = \frac{1}{\infty} - \frac{2}{R/\mu - 1}$$

$$\frac{1}{f_{eq}} = 0 - \frac{2(\mu-1)}{R}$$

$$\boxed{f = \frac{-R}{2(\mu-1)}}$$

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

$$\frac{1}{f_L} = (\mu-1)\left(\frac{1}{\infty} - \frac{1}{R}\right)$$

$$\frac{1}{f_L} = \frac{(\mu-1)}{R} \Rightarrow \boxed{f_L = \frac{R}{\mu-1}}$$

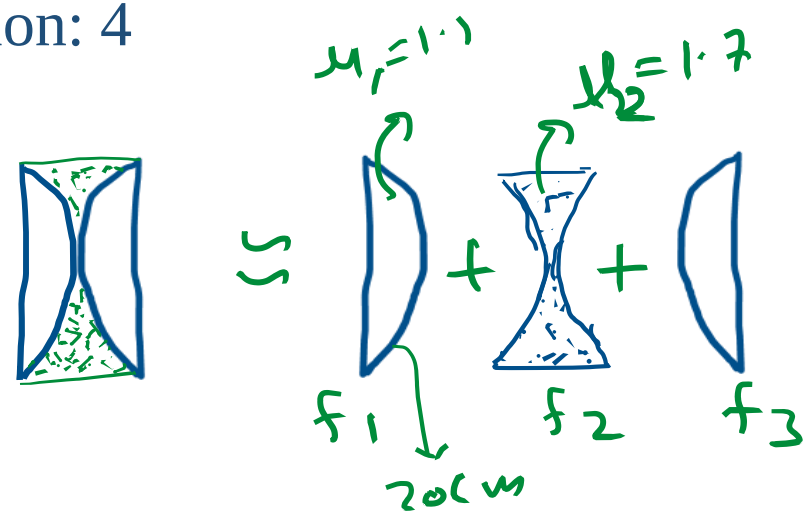
$R_{eq} = 2 f_{eq}$ [∵ equivalent combination is behaving as mirror]

magnitude of $R_{eq} = 2|f_{eq}|$

$$\boxed{R_{eq} = \frac{R}{\mu-1}}$$

Ans : (b)

Solution: 4



$\therefore f_1 = f_3$ [f remains same on inverting the lens]

$$\frac{1}{f_1} = (1.5-1)\left(\frac{1}{\infty} - \frac{1}{-20}\right) = (0.5)\left(\frac{1}{20}\right)$$

$$\boxed{f_1 = 40\,cm = f_3}$$

$$\frac{1}{f_2} = (1.7-1)\left(\frac{1}{-20} - \frac{1}{20}\right) = (0.7)\left(\frac{-2}{20}\right)$$

$$\frac{1}{f_2} = -\frac{0.7}{10}$$

$$f_2 = -\frac{10}{0.7} = -\frac{100}{7}\,cm.$$

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

$$= \frac{1}{40} + \frac{1}{-100/7} + \frac{1}{40}$$

$$\frac{1}{f_{eq}} = \frac{2}{40} - \frac{7}{100} = \frac{20-28}{400}$$

$$f_{eq} = \frac{50}{-8}$$

$$\boxed{f_{eq} = -50\,cm}$$

Ans: (b)

Solution: 5

$$m = \frac{f}{f+u}$$

$u = -10\,cm$

$m_1 = -2$

$$-2 = \frac{f_1}{f_1 - 10}$$

$$-2f_1 + 20 = f_1$$

$$\boxed{f_1 = \frac{20}{3}\,cm}$$

$m_2 = -3$

$$-3 = \frac{f_2}{f_2 - 10}$$

$$-3f_2 + 30 = f_2$$

$$f_2 = \frac{30}{4}\,cm$$

$$\boxed{f_2 = \frac{15}{2}\,cm}$$

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{3}{20} + \frac{2}{15} = \frac{9+8}{60}$$

$$\boxed{f_{eq} = \frac{60}{17}}$$

$$m = \frac{f_{eq}}{f_{eq} + u} = \frac{60/17}{60/17 - 10}$$

$$m = \frac{60/17}{-110/17} = \frac{-60}{110}$$

$$\boxed{m = -\frac{6}{11}}$$

Ans: (a)

Solution: 6

$$m = \frac{f}{f+u}$$

$u = -10\,cm$

$m_1 = -2$

$$-2 = \frac{f_1}{f_1 - 10}$$

$$-2f_1 + 20 = f_1$$

$$\boxed{f_1 = \frac{20}{3}\,cm}$$

$m_2 = -3$

$$-3 = \frac{f_2}{f_2 - 10}$$

$$-3f_2 + 30 = f_2$$

$$f_2 = \frac{30}{4}\,cm$$

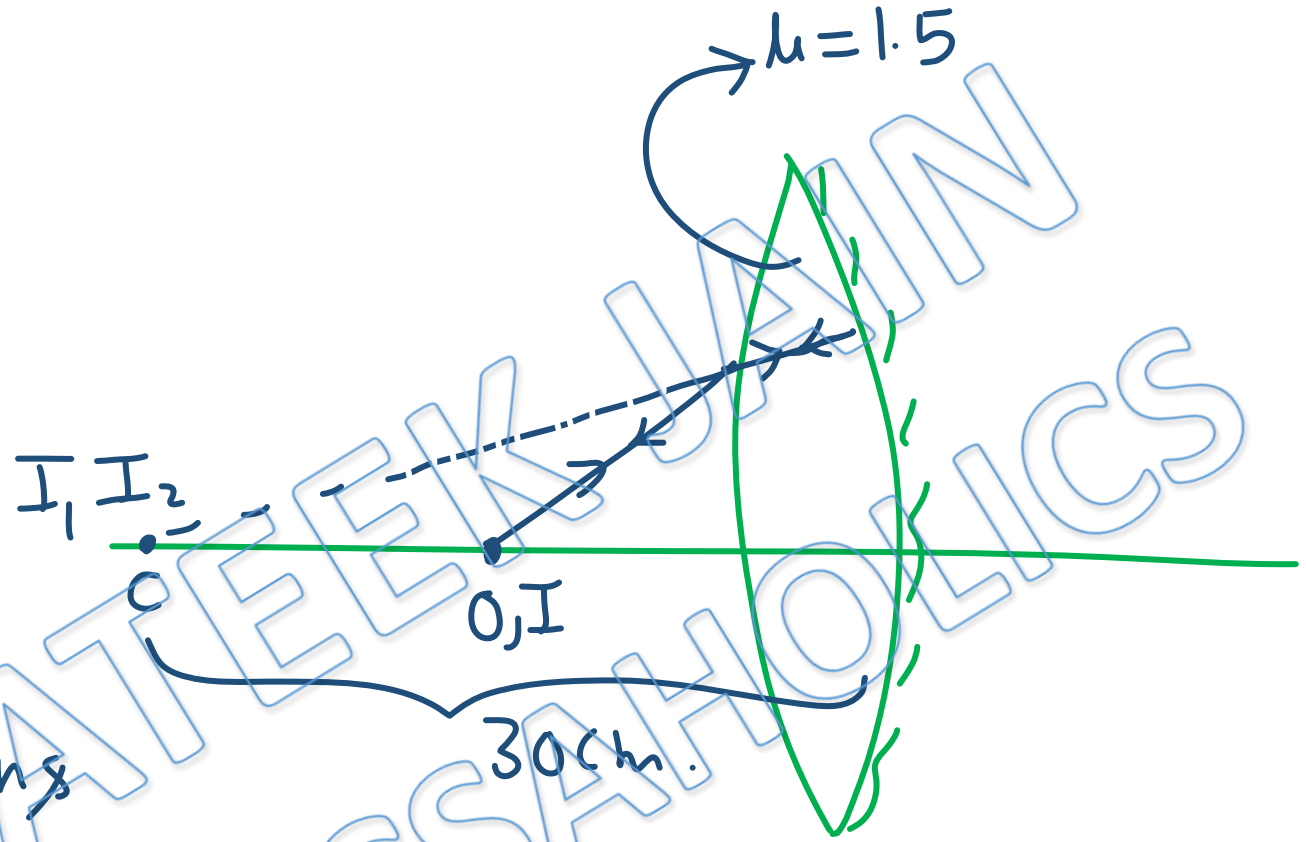
$$\boxed{f_2 = \frac{15}{2}\,cm}$$

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{3}{20} + \frac{2}{15} = \frac{9+8}{60}$$

$$\boxed{f_{eq} = \frac{60}{17}\,cm}$$

Ans : (a)

Solution: 7



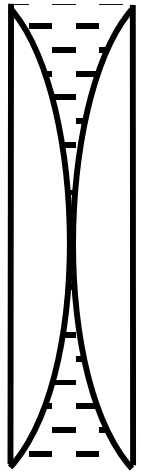
for first refraction by left surface of lens

$$\frac{1.5}{-30} - \frac{1}{u} = \frac{1.5-1}{+30} \Rightarrow \frac{1}{20} + \frac{1}{u} = \frac{1}{-60} \Rightarrow \frac{1}{u} = -\frac{1}{60} - \frac{1}{20} = \frac{-1-3}{60}$$

$$\Rightarrow u = -15\,cm$$

Ans(c)

Solution: 8



by using lens maker's formula for plano

Convex Lens →

$$\frac{1}{+10} = \left(\frac{3}{2}-1\right)\left(\frac{1}{R}-\frac{1}{\infty}\right) \Rightarrow R = 5\,cm$$

focal length of water lens

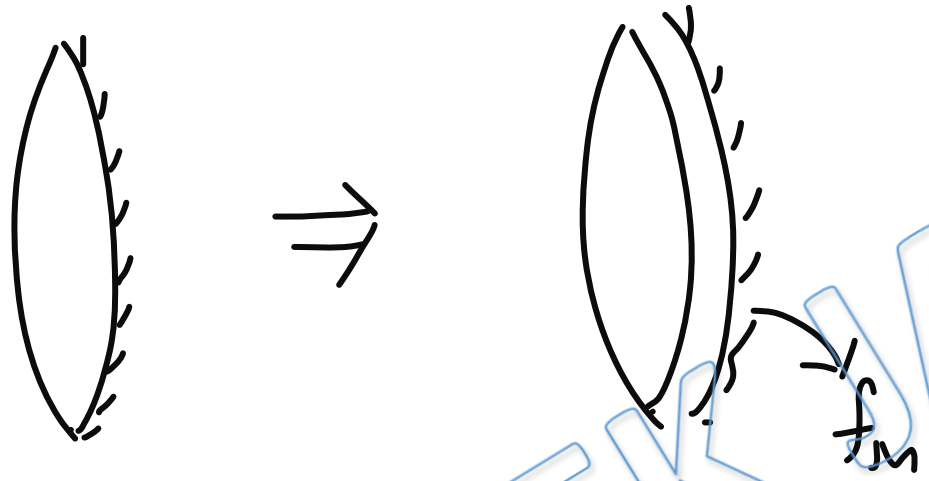
$$\frac{1}{f_w} = \left(\frac{4}{3}-1\right)\left(\frac{1}{-5}-\frac{1}{+5}\right) = \frac{1}{3}\times\left(-\frac{2}{5}\right) = -\frac{2}{15}$$

Effective power of Combination

$$P = \frac{1}{f} = \frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3} = \frac{100}{10}-\frac{200}{15}+\frac{100}{10} = \frac{100}{5}-\frac{200}{15} = \frac{100}{15} = \frac{20}{3} = +6.67D$$

Ans(a)

Solution: 9



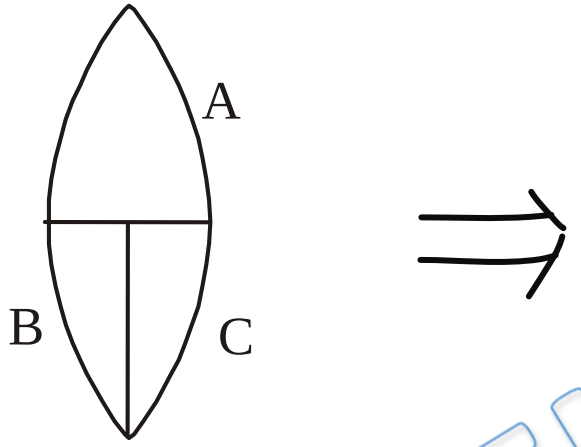
$f_M = -\frac{20}{2} = -10 \Rightarrow$ Power of Mirror $= \frac{1}{f_M} = -\frac{1}{10cm} = -10D$

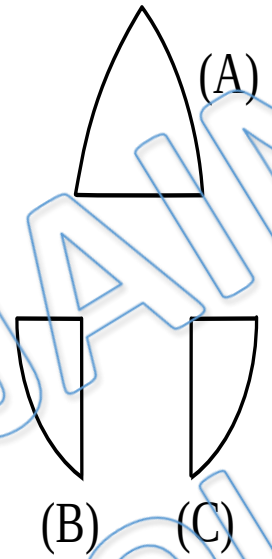
$P_L = +4D$

for Combination $P = P_M - 2P_L = -10D - 2(4D) = -18D$

Ans(c)

Solution: 10





Let Power of B is $P_1 \Rightarrow$ Power of C $= P_1$ (both are identical)

A is Combination of B & C $\Rightarrow$ Power of A $= 2P_1$

but power of A = Power of original lens $\Rightarrow 2P_1 = P \Rightarrow P_1 = P/2$

Ans (a, c)

Solution: 11

for plano-Convex lens

$$P_1 = \frac{1}{f_1} = (\mu_1 - 1)\left(\frac{1}{\infty} - \frac{1}{-R}\right)$$

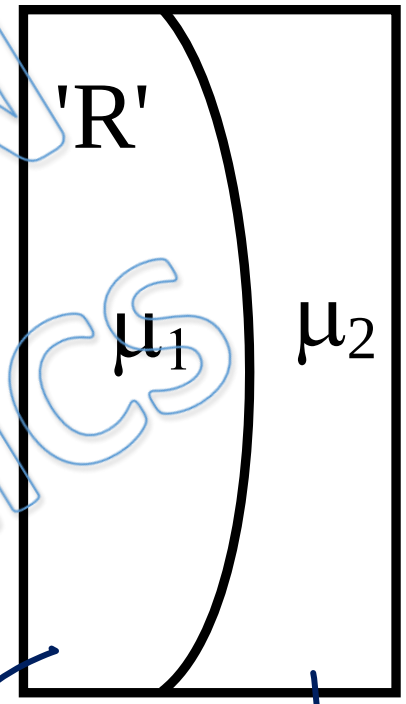
$$\Rightarrow P_1 = \frac{(\mu_1 - 1)}{R}$$

for plano concave lens

$$P_2 = \frac{1}{f_2} = (\mu_2 - 1)\left(\frac{1}{-R} - \frac{1}{\infty}\right) = -\frac{(\mu_2 - 1)}{R}$$

Power of Combination $P = P_1 + P_2$

$$P = \frac{\mu_1 - \mu_2}{R}$$



Plano Convex Lens

Plano Concave lens

Ans(c)

$$P = \frac{\mu_1 - \mu_2}{R}$$

If $\mu_1 = \mu_2 \Rightarrow P = 0 \Rightarrow$ Combination behaves as glass slab

If $\mu_2 > \mu_1 \Rightarrow P = -Ve \Rightarrow$ " " " divergent lens

If $\mu_2 < \mu_1 \Rightarrow P = +Ve \Rightarrow$ " " " converging "

Ans (a, b, c)

Solution: 12

$f_L = 15\,cm$, $f_M = \infty$

$$\Rightarrow \frac{1}{f} = \frac{1}{f_M} - 2\left(\frac{1}{f_L}\right) = -\frac{2}{15\,cm}$$

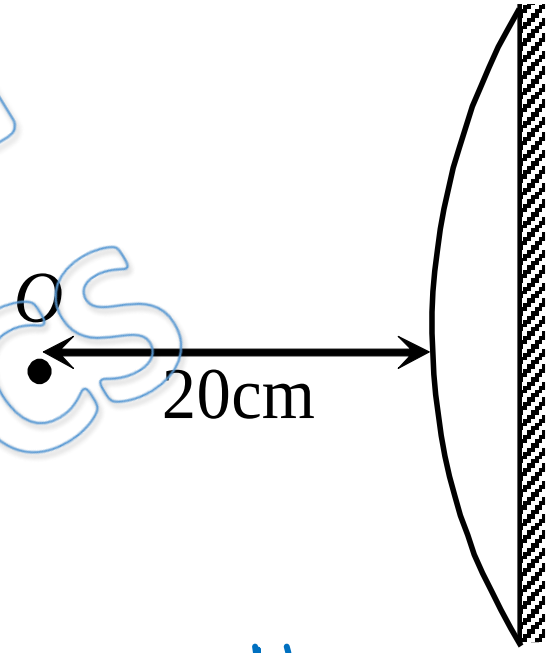
Using Mirror formula for effective mirror

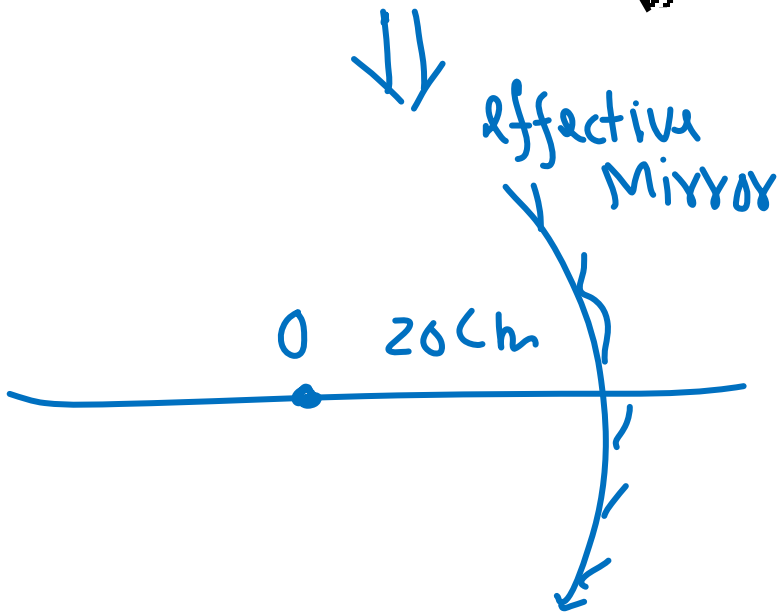
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow -\frac{2}{15} = \frac{1}{v} + \frac{1}{-20}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{20} - \frac{2}{15} = \frac{3-8}{60} = -\frac{5}{60}$$

$$\Rightarrow v = -12\,cm$$

Ans(d)





Solution: 13

To form image on object incident ray on mirror shoul be perpendicular to mirror ⇒ image formed by lens should be at centre of curvature of mirror.

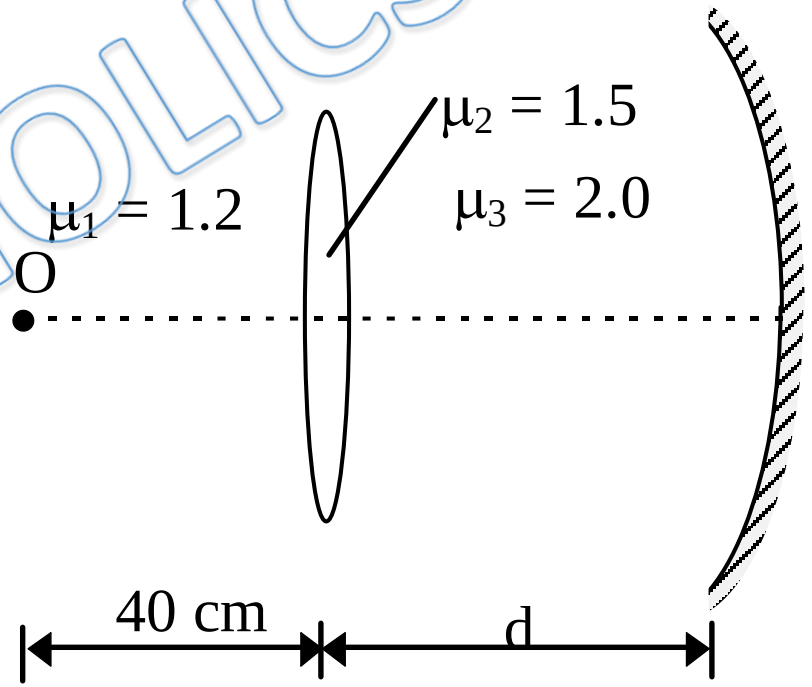
by Using lens maker's formula for given lens

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

$$\frac{1}{20} = \frac{1}{2} \times \frac{2}{R} \Rightarrow R = 20\,cm$$

for refraction by left surface of lens

$$\frac{1.5}{V_1} - \frac{1.2}{-40} = \frac{1.5-1.2}{+20}$$



$$\frac{1.5^-}{V_1} + \frac{1.2}{40} = \frac{.3}{20} \Rightarrow \frac{5}{V_1} + \frac{4}{40} = \frac{1}{20}$$

$$\Rightarrow \frac{5}{V_1} = \frac{1}{20} - \frac{1}{10} = \frac{-1}{20} \Rightarrow V_1 = -100\,cm$$

for refraction by right surface of lens

$$\Rightarrow \frac{2}{V_2} - \frac{1.5^-}{-100} = \frac{2-1.5^-}{-20} \Rightarrow \frac{2}{V_2} + \frac{1.5^-}{100} = \frac{.5^-}{-20}$$

$$\Rightarrow \frac{4}{V_2} + \frac{3}{100} = -\frac{1}{20} \Rightarrow \frac{4}{V_2} = -\left(\frac{1}{20} + \frac{3}{100}\right) = -\left(\frac{5^- + 3}{100}\right)$$

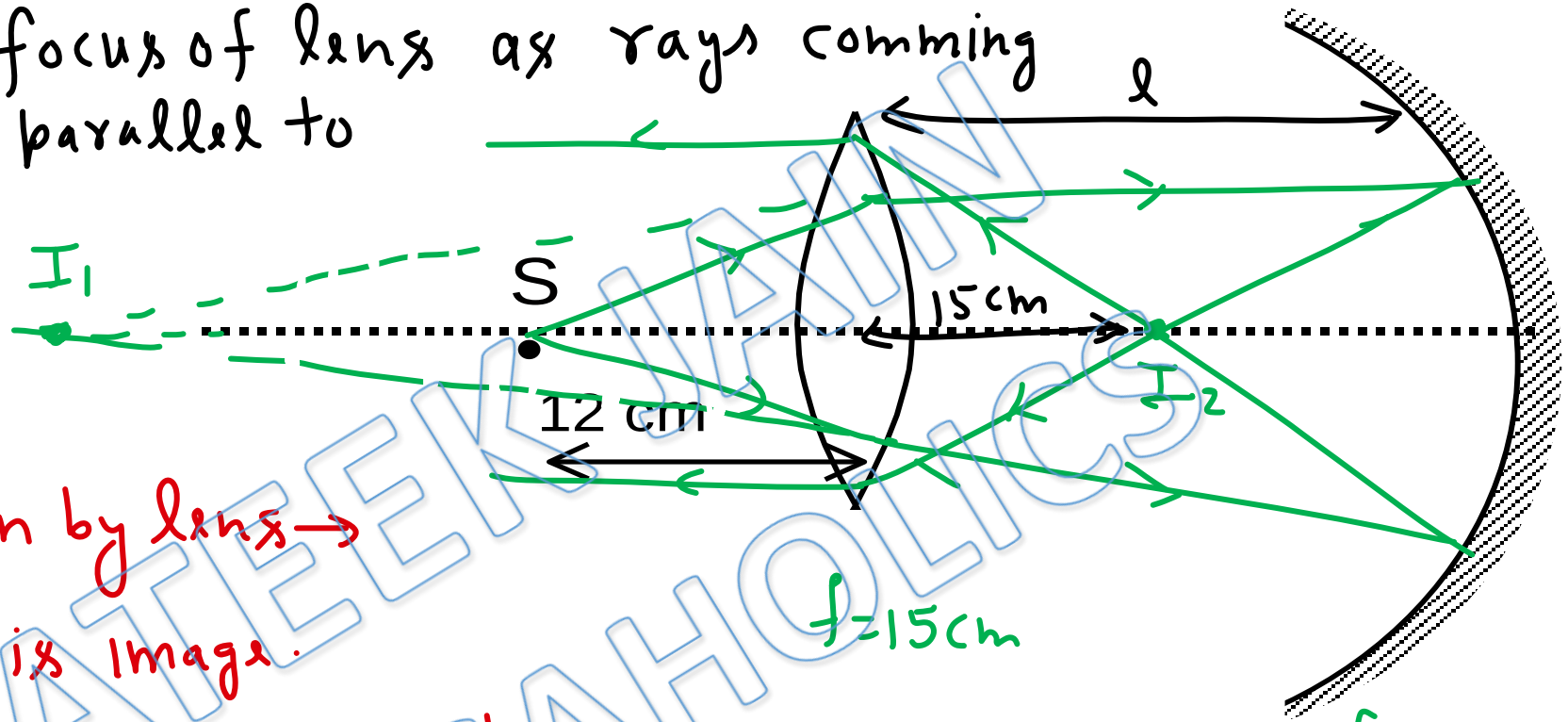
$$\Rightarrow V_2 = -50$$

$$\Rightarrow d + 50 = 80 \Rightarrow d = 30\,cm$$

Ans(b)

Solution: 14

I_2 is at focus of lens as rays comming from I_2 are moving parallel to Principal axis after refraction by lens.



for first refraction by lens →

S is object & I_1 is image.

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u} \Rightarrow \frac{1}{+15}=\frac{1}{v}-\frac{1}{-12} \Rightarrow \frac{1}{v}=\frac{1}{15}-\frac{1}{12}=\frac{4-5}{60}$$

$f = 20cm$

$V = -60cm$

for reflection by mirror I_1 is object & I_2 is image →

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \Rightarrow \frac{1}{-20}=\frac{1}{-(l-15)}+\frac{1}{-(l+60)} \Rightarrow \frac{1}{20}=\frac{1}{l-15}+\frac{1}{l+60}$$

$$(l-15)(l+60) = 20(l+60+l-15)$$

$$\Rightarrow \quad l^2 - 15l + 60l - 900 = 40l + 900$$

$$\Rightarrow \quad l^2 + 5l - 1800 = 0$$

$$\Rightarrow \quad (l+45)(l-40) = 0$$

$$\Rightarrow \quad l = 40, \cancel{-45}$$

Ans (c)

For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/67

Video Solution on YouTube:- https://youtu.be/yg5OBl6wRi8

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/68

SUBSCRIBE

@Physicsaholics

@Physicsaholics_prateek

@NEET_Physics
@IITJEE_Physics

physicsaholics.com

Unacademy

CLICK

Chalo Niklo