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DPP – 8 (Geometrical Optics & Dispersion)

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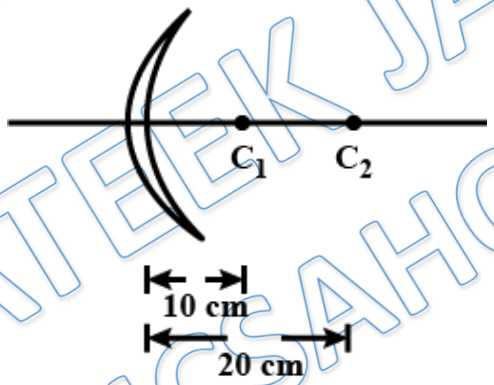
Q 1. A biconvex lens has a focal length 2/3 times the radius of curvature of either surface. The refractive index of the lens material is :

(a) 1.57 (b) 1.23

(c) 1.75 (d) 2.13

Q 2. In figure the points C_1 and C_2 denote the centers of curvatures then the focal length of the thin lens (μ=1.5) is



(a) 40 cm (b) 10 cm

(c) 20 cm (d) 30 cm

Q 3. A tree is 18.0 m away and 2.0 m high from a concave lens. How high is the image formed by the given lens of focal length 6 m ?

(a) 1 m (b) 0.5 m

(c) 2 m (d) 1.5 m

Q 4. The focal length of a symmetric bi-convex lens is 20cm. If the refractive index of the material of the prism is 1.5, the radius of curvature of one of two surfaces is

(a) 10 cm (b) 20 cm

(c) 30 cm (d) 40 cm

Q 5. A biconvex lens behaves as a converging lens in air and a diverging lens in water (μ=1.33). The refractive index (μ_0) of the material is

(a) $\mu_0 = 1$ (b) $\mu_0 = 1.33$

(c) $1 < \mu_0 < 1.33$ (d) $\mu_0 > 1.33$

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Q 6. A convex lens is immersed in a liquid of refractive index greater than that of glass. It will behave as a
(a) Converging lens (b) diverging lens
(c) Plane glass (d) homogeneous liquid

Q 7. A thin lens made of glass of refractive index μ = 1.5 has a focal length equal to 12 cm in air. It is now immersed in water (μ = $\frac{4}{3}$). Its new focal
(a) 26 cm (b) 12 cm
(c) 56 cm (d) 48 cm

Q 8. The radius of curvature for a convex lens is 40 cm, for each surface. Its refractive index is 1.5. The focal length will be
(a) 10 cm (b) 40 cm
(c) 15 cm (d) 25 cm

Q 9. A concavo-convex lens is made of glass of refractive index 1.5. The radii of curvature of its two surfaces are 30cm and 50cm. Its magnitude focal length when placed in a liquid of refractive index 1.4 is
(a) 1150 cm (b) 85 cm
(c) 150 cm (d) 1050 cm

Q 10. When an object is at a distance u_1 and u_2 from a lens, real image and a virtual image formed by the same lens are real and virtual, respectively, and of same size. Then, the focal length of the lens is:
(a) $\frac{\sqrt{u_1 u_2}}{2}$ (b) $\frac{1}{2}(u_1 + u_2)$
(c) $\sqrt{u_1 u_2}$ (d) $2(u_1 + u_2)$

Q 11. An object is placed at a distance of 20 cm from a convex lens of focal length 10 cm. The image is formed on the other side of the lens at a distance
(a) 5 cm (b) 15 cm
(c) 20 cm (d) 35 cm

Q 12. A diverging meniscus lens has a focal length of -20 cm. If the lens is held 10 cm from the object, the magnification is :
(a) $+0.67$ (b) -0.67
(c) -2 (d) $+2$

Q 13. The magnification of an object placed in front of a convex lens is +2. The focal length of the lens is 2.0 meters. Find the distance by which object has to be moved to obtain a magnification of -2 (in meters)
(a) 1 (b) 2
(c) 3 (d) 4

Q 14. An object is placed at a distance of 4 cm from a concave lens of focal length 12 cm. Find the position and nature of the image.
(a) real, 3cm , smaller then object

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(b) virtual, 3cm, Larger then object
(c) real, 1cm , smaller then object
(d) virtual, 3cm, Smaller then object

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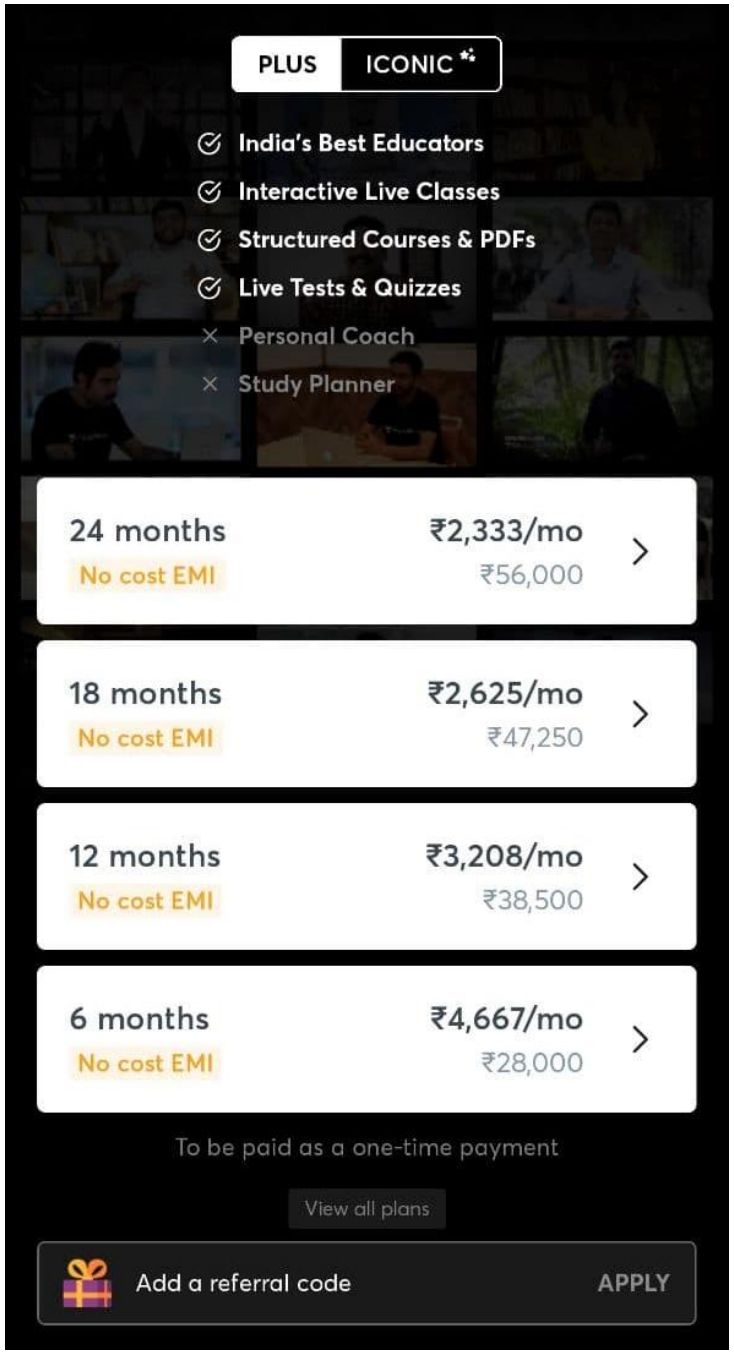
Answer Key

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



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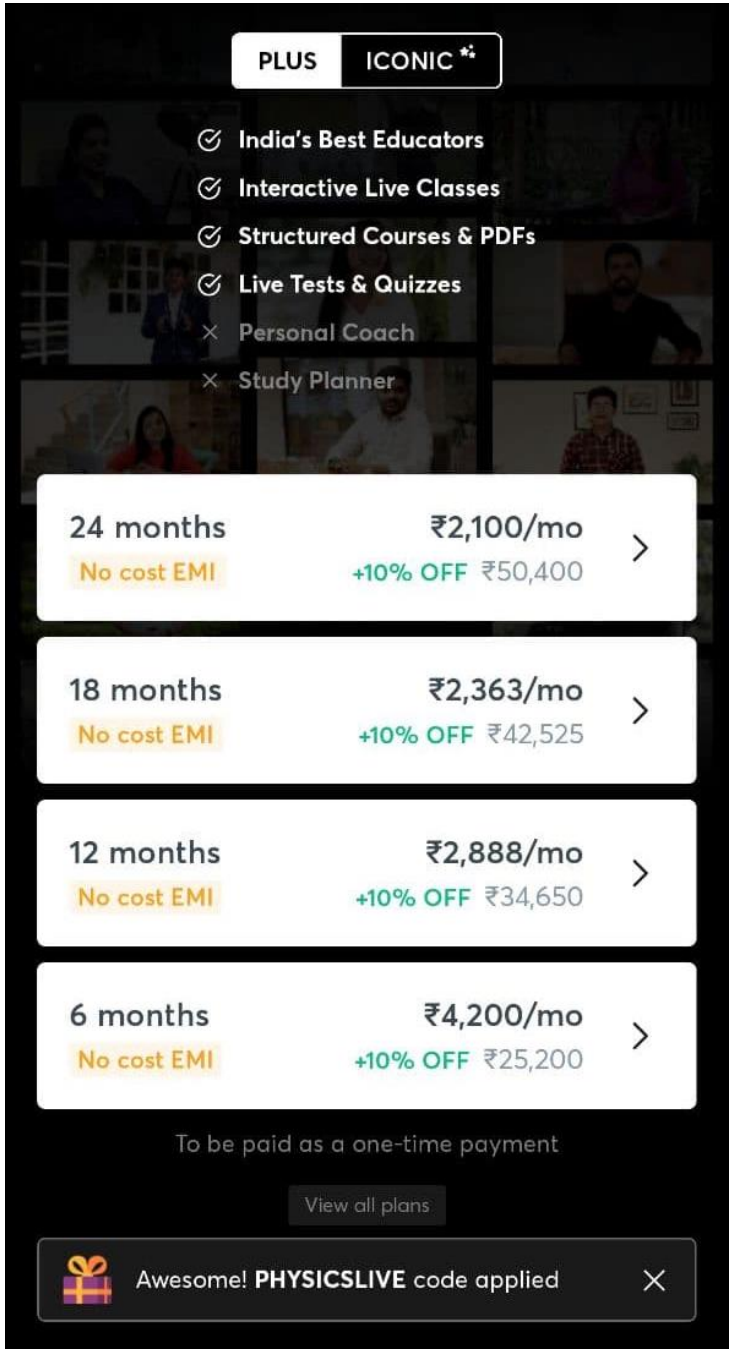


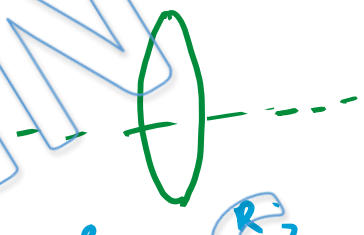
Written Solution

DPP-8 Geometrical Optics: Lens, Lens Maker Formula & Magnification

By Physicsaholics Team

Solution: 1

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$



$R_1 = R$, $R_2 = -R$

$$f = \frac{2}{3}R$$

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

$$\frac{3}{2R} = (\mu - 1)\left(\frac{2}{R}\right) \Rightarrow 3 = 4\mu - 4$$

$$\Rightarrow 4\mu = 7 \Rightarrow \boxed{\mu = \frac{7}{4}} \text{ Ans.}$$

or $\boxed{\mu = 1.75}$ Ans.

Ans. c

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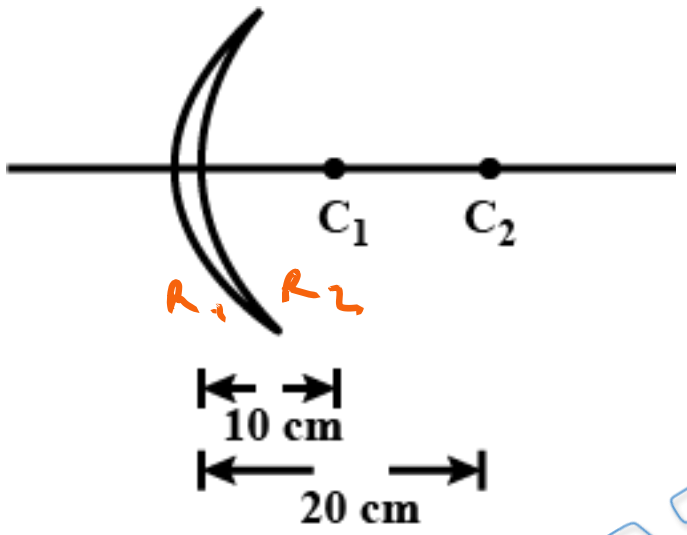
Solution: 2



$R_1 = 10$ cm

$R_2 = 20$ cm

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

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{10} - \frac{1}{20}\right)$$

$$\frac{1}{f} = \left(\frac{1}{2}\right)\left(\frac{1}{20}\right)$$

$$\boxed{f = 40 \text{ cm}}$$ Ans.

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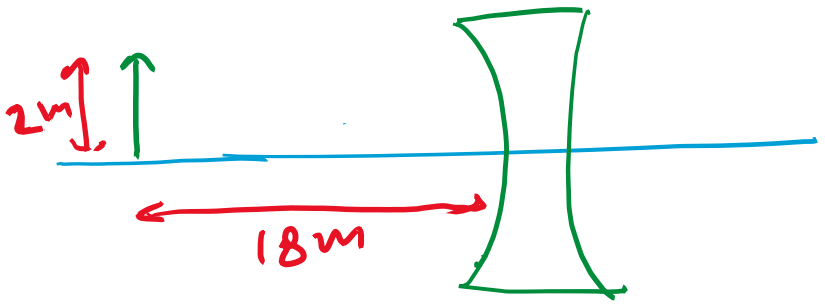
Ans. a

Solution: 3



$f = -6\ m$

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

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

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

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

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

$m = \frac{-6}{-6-18} = \frac{-6}{-24}$

$m = \frac{1}{4}$

$h_I = \frac{1}{4} h_O$

$h_I = \frac{1}{4} \times 2$

$\boxed{h_I = 0.5\ m}$ Ans

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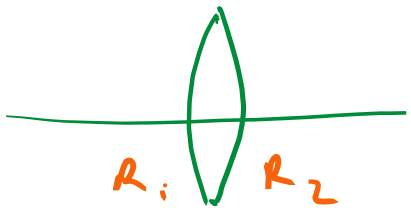
Ans. b

Solution: 4



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

$$\therefore |R_1| = |R_2| = R$$

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

$$\frac{1}{20} = \left(\frac{1}{2}\right)\left(\frac{2}{R}\right)$$

$$R = 20\ \text{cm}$$

Ans. b

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Solution: 5

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

μ_L = R.I. of lens
μ_m = R.I. of medium

when $\frac{\mu_L}{\mu_m} > 1$ or $\mu_L > \mu_m \Rightarrow$ Converging

& $\frac{\mu_L}{\mu_m} < 1$ or $\mu_L < \mu_m \Rightarrow$ Diversing

Case-1 in air $\Rightarrow$ converging

$\Rightarrow \mu_L > \mu_{air} \Rightarrow \mu_L > 1$

Case-2 in water $\Rightarrow$ diverging

$\Rightarrow \mu_L < \mu_{water} \Rightarrow \mu_L < 1.33$

$\Rightarrow$ $\boxed{1 < \mu_L < 1.33}$

Ans. c

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Solution: 6

$$\frac{1}{f} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$; μ_L = R.I. of lens, μ_m = R.I. of medium

when $\frac{\mu_L}{\mu_m} > 1$ or $\mu_L > \mu_m \Rightarrow$ Converging

& $\frac{\mu_L}{\mu_m} < 1$ or $\mu_L < \mu_m \Rightarrow$ Diverging

So, if $\mu_m > \mu_L$

$\Rightarrow$ it will behave as a Diverging lens.

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Ans. b

Solution: 7

$\mu = 1.5$

$f = 12\ cm.$

$\frac{1}{f} = \left(\frac{\mu_2}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} \propto \left(\frac{\mu_2}{\mu_m} - 1\right)$

$\rightarrow \frac{\frac{1}{f_1}}{\frac{1}{f_2}} = \frac{\left(\frac{1.5}{1} - 1\right)}{\left(\frac{1.2}{4/3} - 1\right)}$

$\frac{f_2}{12} = \frac{0.5}{\frac{4.5}{4} - 1}$

$\frac{f_2}{12} = \frac{0.5}{0.125} \times 4$

$f_2 = 48\ cm$ Ans.

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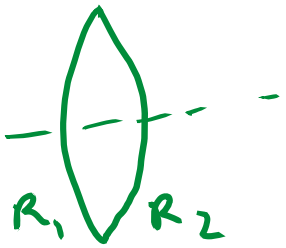
Ans. d

Solution: 8

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$



$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{40} - \frac{1}{-40}\right)$$

$$\frac{1}{f} = \left(\frac{1}{2}\right)\left(\frac{2}{40}\right)$$

$$\boxed{f = 40\ \text{cm}}\ \text{Ans.}$$

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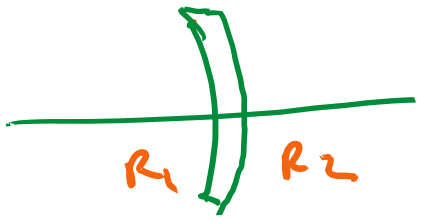
Ans. b

Solution: 9



$R_1 = -50\,cm$

$R_2 = -30\,cm$

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{1.5}{1.4} - 1\right)\left(\frac{1}{-30} - \frac{1}{-50}\right)$$

$$\frac{1}{f} = \left(\frac{1}{14}\right)\left(-\frac{1}{30} + \frac{1}{50}\right)$$

$$\frac{1}{f} = \left(\frac{1}{14}\right)\left(\frac{-20}{50\times 30}\right)$$

$$\frac{1}{f} = \frac{-10}{7\times 50\times 30}$$

$$f = -1050\,cm$$

$$\boxed{f = 1050\,cm}$$ Ans

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Ans. d

Solution: 10

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

when $u = -u_1$

$$m = m$$

$$m = \frac{f}{f-u_1} \quad \text{—①}$$

& when $u = -u_2$

$$m = -m$$

$$-m = \frac{f}{f-u_2} \quad \text{—②}$$

① = ② ⇒

$$\frac{f}{f-u_1} = \frac{-f}{f-u_2}$$

$$f - u_2 = -f + u_1$$

$$2f = u_1 + u_2$$

$$\boxed{f = \frac{(u_1+u_2)}{2}} \text{ Ans.}$$

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Ans. b

Solution: 11

$f = 10\ cm$

$u = -20\ cm$

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

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

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

$v = 20\ cm$ is

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Ans. c

Solution: 12

$f = -20\ cm$

$u = -10\ cm$

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

$$m = \frac{-20}{-20-10} = \frac{-20}{-30}$$

$$m = \frac{2}{3}$$ Ans.

or

$$m = 0.67$$ Ans

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Ans. a

Solution: 13

$m = +2$

$f = 2m$

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

when; $u = -u_1$

$m = 2 = \frac{v_1}{-u_1}$

$v_1 = -2u_1$

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

$\frac{1}{-2u_1} - \frac{1}{-u_1} = \frac{1}{2}$

$\frac{1}{2u_1} = \frac{1}{2}$

$\boxed{u_1 = 1m}$

when, $u = -u_2$

$m = -2 = \frac{v_2}{-u_2}$

$v_2 = 2u_2$

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

$\frac{1}{2u_2} - \frac{1}{-u_2} = \frac{1}{2}$

$\frac{3}{2u_2} = \frac{1}{2}$

$\boxed{u_2 = 3m}$

$d = u_2 - u_1 = 3 - 1$

$\boxed{d = 2m}$ Ans

Ans. b

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Solution: 14

$f = -12\ cm$

$u = -4\ cm$

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

$m = \frac{-12}{-12-4} = \frac{-12}{-16} = \frac{3}{4}$

$m = \frac{3}{4} < 1$, Small

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

$\frac{3}{4} = \frac{v}{-4}$

$v = -3\ cm$

$\Rightarrow v = -ve$

$\Rightarrow$ virtual

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Ans. d

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