DPP - Daily Practice Problems

Name : ________ Date : ________

Start Time : ________ End Time : ________

PHYSICS 51

SYLLABUS : RAY OPTICS - 3 (Refraction on curved surface lens, Optical instrument)

Max. Marks : 120 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 A small point object is placed at O, at a distance of 0.60 metre in air from a convex spherical surface of refractive index 1.5. If the radius of the curvature is 25 cm, then what is the position of the image on the principal axis ?

(a) 4.5 m (b) 2.5 m
(c) 1.5 m (d) 5.5 m

Q.2 The radius of a glass ball is 5 cm. There is an air bubble at 1cm from the centre of the ball and refractive index of glass is 1.5. The position of image viewed from surface near the bubble is.

(a) 3.63 cm (b) 4.63 cm
(c) 2.12 cm (d) 5.12 cm

Q.3 In case of thin lens of focal length f an object is placed at a distance x_1 from first focus and its image is formed at a distance x_2 from the second focus, find $x_1 x_2$

(a) f (b) f^3
(c) f^2 (d) 1/f

Q.4 What is the refractive index of material of a plano-convex lens , if the radius of curvature of the convex surface is 10 cm and focal length of the lens is 30 cm ?

(a) 1/3 (b) 4/3
(c) 2/3 (d) 1/4

Q.5 A convex lens of focal length 10.0 cm is placed in contact with a convex lens of 15.0 cm focal length. What is the focal length of the combination ?

(a) 6 cm (b) 12 cm
(c) 8 cm (d) 4 cm

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 A convex lens of focal length 20 cm is placed in contact with a diverging lens of unknown focal length. The lens combination acts as a converging lens and has a focal length of 30 cm. What is the focal length of the diverging lens ?

(a) – 10 cm (b) – 30 cm (c) – 60 cm (d) – 90 cm

Q.7 A pin is placed 10 cm in front of a convex lens of focal length 20 cm, made of material having refractive index 1.5. The surface of the lens farther away from the pin is silvered and has a radius of curvature 22 cm. Determine the position of the final image.

(a) 11 cm in front (b) 21 cm in front
(c) 15 cm in front (d) 31 cm in front

Q.8 An image is formed on the screen by a convex lens. When upper half part of lens is covered with black paper, then :

(a) half image is formed
(b) full image is formed
(c) intensity of image will be enhanced
(d) None of these

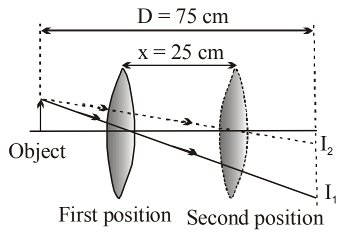
Q.9 A convex lens is made out of a substance of 1.2 refractive index. The two surfaces of lens are convex. If this lens is placed in water whose refractive index is 1.33, it will behave as :

(a) convergent lens (b) divergent lens
(c) plane glass plate (d) like a prism

Q.10 An equiconvex lens has a power of 5 diopter. If it is made of glass of refractive index 1.5 then the radius of the curvature of each surface will be

(a) 20 cm (b) 10 cm (c) 5 cm (d) zero

Q.11 A convex lens when placed in the first position forms a real image of an object on a fixed screen. The distance between the object and the screen is 75 cm. On displacing the lens from first position by 25 cm to the second position, again a real image is formed on the screen. Then the focal length of the lens is



(a) 25.0 cm (b) 16.7 cm (c) 50.3 cm (d) 33.3 cm

Q.12 A lens is placed between a source of light and a wall. It forms images of area A_1 and A_2 on the wall for its two different positions. The area of the source of light is

(a) $\dfrac{A_1+A_2}{2}$ (b) $\left[\dfrac{1}{A_1}+\dfrac{1}{A_2}\right]^{-1}$

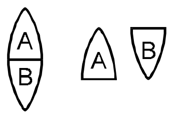
(c) $\sqrt{A_1A_2}$ (d) $\left[\dfrac{\sqrt{A_1}+\sqrt{A_2}}{2}\right]^2$

Q.13 A convex lens of power 4D is kept in contact with a concave lens of power 3D, the effective power of combination will be

(a) 7D (b) 4D/3
(c) 1D (d) 3D/4

Q.14 The power of a plano-convex lens is P. If this lens is cut longitudinally along its principal axis into two equal parts and then they are joined as given in the figure. The power of combination will be :

(a) P
(b) 2P
(c) P/2
(d) zero



Q.15 The plane surface of a planoconvex lens is silvered. If radius of curved surface is R and refractive index is μ, then the system behaves like a concave mirror whose radius will be

(a) $\dfrac{R}{\mu}$ (b) $R\mu$

(c) $\dfrac{R}{\mu-1}$ (d) $R(\mu-1)$

Q.16 A slide projector lens has a focal length 10 cm. It throws an image of a 2cm × 2 cm slide on a screen 5 m from the lens. Find the size of the picture on the screen.

(a) $(98 \times 98)\ cm^2$ (b) $(88 \times 88)\ cm^2$
(c) $(64 \times 64)\ cm^2$ (d) $(78 \times 78)\ cm^2$

Q.17 If the focal length of a magnifier is 5 cm calculate the power of the lens.

(a) 20D (b) 10D
(c) 5D (d) 15D

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ			

Space for Rough Work

Q.18 In the above question, find the magnifying power of the lens for relaxed and strained eye.
(a) 2×, 3× (b) 5×, 6×
(c) 4×, 2× (d) 1×, 2×

Q.19 A 35 mm film is to be projected on a 20 m wide screen situated at a distance of 40 m from the film-projector. Calculate the focal length of projection lens.
(a) 70 mm (b) 35 mm
(c) 40 mm (d) 20 mm

Q.20 In a compound microscope the objective and the eye- piece have focal lengths of 0.95 cm and 5 cm respectively, and are kept at a distance of 20 cm. The last image is formed at a distance of 25 cm from the eye- piece. Calculate the total magnification.
(a) 94 (b) 84
(c) 75 (d) 88

Q.21 A Galilean telescope consists of an objective of focal length 12 cm and eye- piece of focal length 4 cm. What should be the separation of the two lenses when the virtual image of a distant object is formed at a distance of 24 cm from the eye- piece?
(a) 7.2 cm (b) 8.2 cm.
(c) 12.4 cm. (d) 2.8cm.

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

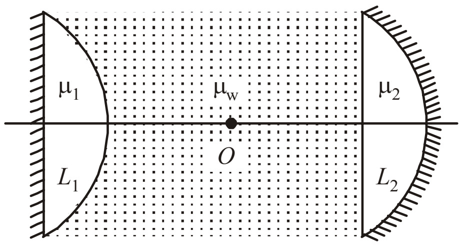
Codes :
(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and eye- piece is 36 cm and the final image is formed at infinity.
(1) the focal length of objective is 30 cm
(2) the focal length of objective is 25 cm
(3) the focal length of eye piece is 6 cm
(4) the focal length of eye piece is 12 cm

Q.23 Resolving power of a microscope doesn't depend upon
(1) Velocity of light used
(2) Frequency of light used
(3) Focal length of objective
(4) Wavelength of light used

Q.24 The light gathering power of a camera lens doesn't depend on
(1) Ratio of focal length and diameter
(2) Product of focal length and diameter
(3) Wavelength of light used
(4) Its diameter

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :



A cylindrical tube filled with water ($\mu_w = 4/3$) is closed at its both ends by two 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.25 The position of object w.r.t lens L_1 is
(a) 8 cm (b) 10 cm
(c) 12 cm (d) 14 cm

Q.26 The position of object w.r.t lens L_2 is
(a) 8 cm (b) 10 cm
(c) 12 cm (d) 14 cm

Q.27 The length of the cylindrical tube is
(a) 16 cm (b) 18 cm
(c) 20 cm (d) 22 cm

RESPONSE GRID					
	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ
	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ

Space for Rough Work

DIRECTIONS (Q. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.28 Statement-1: A double convex lens (μ = 1.5) has focal length 10 cm. When the lens is immersed in water ($\mu = 4/3$) its focal length becomes 40 cm.

Statement-2: $\frac{1}{f} = \frac{\mu_\ell - \mu_m}{\mu_m}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Q.29 Statement-1: The focal length of lens changes when red light is replaced by blue light.

Statement-2: The focal length of lens does not depend on colour of light used.

Q.30 Statement-1: By increasing the diameter of the objective of telescope, we can increase its range.

Statement-2: The range of a telescope tells us how far away a star of some standard brightness can be spotted by telescope.

RESPONSE GRID			
	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 51 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	30	Qualifying Score	48
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

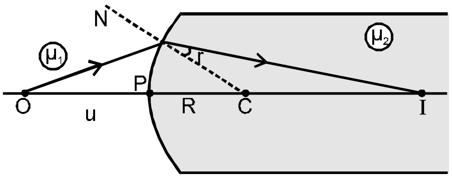
DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

51

1. **(a).** According to sign convention, it is given that

$u = -0.6$ m, $R = 0.25$ m, $\mu_1 = 1$ (air), $\mu_2 = 1.5$



Therefore, using

$$-\frac{\mu_1}{u}+\frac{\mu_2}{v}=\frac{\mu_2-\mu_1}{R}, \text{ we get}$$

$$\frac{1.5}{v}=\frac{1}{(-0.6)}+\frac{1.5-1}{0.25}=-\frac{1}{0.6}+\frac{0.5}{0.25}$$

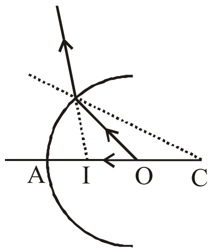
$$=-\frac{5}{3}+2=\frac{1}{3}$$

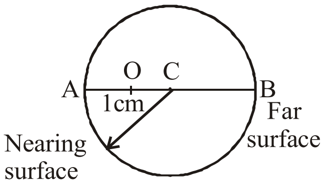
$\Rightarrow v = 4.5$ m

The image is formed on the other side of the object (i.e. inside the refracting surface).

2. **(a).** On viewing from the closer surface A (near to object) :

The final image is formed at I.





From sign convention

$u = OA = -4$ cm, $v = ?$

$R = AC = -5$cm

$$\mu=\frac{\mu_2}{\mu_1}=\frac{2}{3}$$

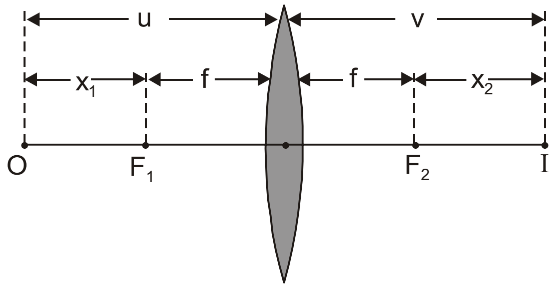
$$\frac{\mu}{v}-\frac{1}{u}=\frac{\mu-1}{R} \Rightarrow \frac{2/3}{v}+\frac{1}{4}=\frac{2/3-1}{-5}$$

$$\Rightarrow \frac{2}{3v}=\frac{1}{15}-\frac{1}{4}=\frac{4-15}{60}=\frac{-11}{60}$$

$$v=\frac{2}{3}\times\frac{-60}{11}=-\frac{40}{11}=-3.63 \text{ cm}$$

$\therefore$ AI = 3.63 cm

3. **(c).**



As in case of thin lens the distance of either foci from the optical centre is f ,

$|u| = (f + x_1)$ and $|v| = (f + x_2)$

Substituting thses values of u and v in lens formula with proper sign

$$\frac{1}{(f+x_2)}-\frac{1}{-(f+x_1)}=\frac{1}{f}$$

$$\text{or} \quad \frac{x_1+x_2+2f}{(f+x_1)(f+x_2)}=\frac{1}{f}$$

i.e., $fx_1 + fx_2 + 2f^2 = f^2 + fx_1 + fx_2 + x_1 x_2$

or, $x_1 x_2 = f^2$

4. **(b).** According to Lens-maker's formula :

$$\frac{1}{f}=(\mu-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right] \text{ with } \mu=\frac{\mu_L}{\mu_M}$$

Here f = 30 cm and R_1 = 10 cm and $R_2 = \infty$

$$\text{So, } \frac{1}{30}=(\mu-1)\left[\frac{1}{10}-\frac{1}{\infty}\right]$$

$3\mu - 3 = 1$ or, $\mu = (4/3)$

5. **(a).** For combination of lenses

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{10}+\frac{1}{15}=\frac{25}{150}=\frac{1}{6}$$

Therefore, f = 6 cm.

6. (c). Let f_2 is the focal length of the diverging lens. Then ,

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

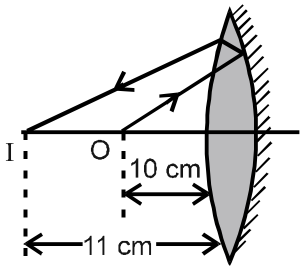
It is given that $f_1 = +20$ cm, f = 30 cm

$$\frac{1}{30}=\frac{1}{20}+\frac{1}{f_2}$$

or $\frac{1}{f_2}=\frac{1}{30}-\frac{1}{20}=\frac{2-3}{60}=-\frac{1}{60}$

Thus $f_2 = -60$ cm

7. (a). As radius of curvature of silvered surface is 22 cm, so,



$$f_M=\frac{R}{2}=\frac{-22}{2}=-11 \text{ cm} = -0.11 \text{ m}$$

and hence, $P_M=-\frac{1}{f_M}=\frac{1}{-0.11}=\frac{1}{0.11}D$

Further as the focal length of lens is 20 cm, i.e. 0.20 m, its power will be given by :

$$P_L=\frac{1}{f_L}=\frac{1}{0.20}D$$

Now as in image formation, light after passing through the lens will be reflected back by the curved mirror the lens again $P = P_L + P_M + P_L = 2P_L + P_M$

i.e. $P=\frac{2}{0.20}+\frac{1}{0.11}=\frac{210}{11}D$

So the focal length of equivalent mirror

$$F=-\frac{1}{P}=-\frac{11}{210}m=-\frac{110}{21}cm$$

i.e. the silvered lens behaves as a concave mirror of focal length (110/21) cm. So for object at a distance 10 cm in front of it,

$$\frac{1}{v}+\frac{1}{-10}=-\frac{21}{110} \text{ i.e. } v=-11 \text{ cm}$$

i.e. image will be 11 cm in front of the silvered lens

8. (b). On covering the lens half by a black paper will reduce the intensity of image and not the part of image. So full image is formed.

9. (b). The focal length of lens in water is given by

$$f_\ell=\frac{{}_a\mu_g-1}{\frac{{}_a\mu_g}{{}_a\mu_\ell}-1}f_a=\frac{1.2-1}{\frac{1.2}{1.33}-1}f_a$$

$$f_\ell=-\frac{0.2\times 1.33}{0.13}f_a$$

Hence f is negative and as such it behaves as a divergent lens.

10. (a). The focal length of an equiconvex lens is given by

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

It is given that $\frac{1}{f}=+5$ and $\mu = 1.5$

Therefore, $5=\frac{2(1.5-1)}{R}$

or $R=\frac{1}{5}$ metre = 20 cm

11. (b). The question is based on the conventional method of measurement of focal length by displacement method. According to this method where D is the distance between object and the image, and x is the displacement given to the object.

From the data x = 25 cm and D = 75 cm .

Thus

$$f=\frac{(75)^2-(25)^2}{4\times 75}=\frac{(75-25)(75+25)}{4\times 75}$$

$$=\frac{50\times 100}{4\times 75}=\frac{50}{3}=16.7 \text{ cm}$$

12. (c). $m_1=\frac{A_1}{O}$ and $m_2\ \frac{A_2}{O}$

$$\Rightarrow m_1m_2=\frac{A_1A_2}{O^2}$$

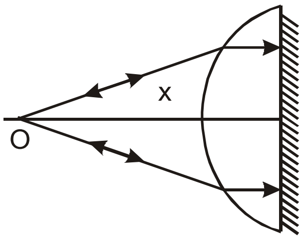
Also it can be proved that $m_1m_2 = 1$

So $O=\sqrt{A_1A_2}$

13. (c). Effective power $P = P_1 + P_2 = 4 - 3 = 1D$

14. (d). One part of combination will behave as converging lens and the other as diverging lens of same focal length. As such total power will be zero.

15. (c). Let the image of an object at O is formed at the same point as shown in figure. The distance of O from the plane surface is x. The rays suffer refraction at first surface (curved) as they reach lens. After wards become parallel and gets reflected form plane surface and so retrace the path and image is formed at O itself.



$$\frac{\mu}{v}-\frac{1}{u}=\frac{\mu-1}{R}$$

$u=-x,\ v=\infty$

$$\frac{\mu}{\infty}+\frac{1}{x}=\frac{\mu-1}{R}$$

$$x=\frac{R}{\mu-1}$$

As such O behaves as equivalent to centre of curvature of equivalent concave mirror.

$$\therefore\ \text{Radius}=x=\frac{R}{\mu-1}$$

16. **(a).** As here f = 10 cm and v = 5m = 500 cm

So from lens formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$, we have

$$\frac{1}{500}-\frac{1}{u}=\frac{1}{10}\quad \text{i.e.,}\quad u=-\left[\frac{500}{49}\right]\text{cm}$$

So that $m=\frac{v}{u}=\frac{500}{-500/49}=-49$

Here negative sign means the image is inverted with respect to object. Now as here object is (2 cm × 2cm) so the size of picture on the screen

A_i = (2 × 49 cm) × (2 × 49cm) = (98 × 98) cm^2

17. **(a).** As power of a lens is reciprocal of focal length in m,

$$P=\frac{1}{5\times10^{-2}\,m}=\frac{1}{0.05}\ \text{diopter}=20\ D$$

18. **(b).** For relaxed eye, MP is minimum and will be

$$MP=\frac{D}{f}=\frac{25}{5}=5\times$$

While for strained eye, MP is maximum and will be

$$MP=1+\frac{D}{f}=1+5=6\times$$

19. **(a).** As in case of projector, $m=\frac{I}{O}=\frac{v}{u}$

So $-\frac{20\times100\ cm}{3.5\,cm}=\frac{40\times100}{u}$

i.e., u = – 7 cm

i.e., film is at a distance of 7 cm in front of projection lens.

And from lens formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$, here we have

$$\frac{1}{4000}-\frac{1}{-7}=\frac{1}{f}\ \text{or}\ f\cong 7\ cm=70\ mm$$

[as (1/4000) << (1/7)]

i.e., focal length of projection lens is 70 mm.

20. **(a).** As final image is at 25 cm in front of eye piece

$$\frac{1}{-25}-\frac{1}{u_e}=\frac{1}{5}\ \text{i.e., } u_e=-\frac{25}{6}$$

And so, $m_e=\frac{v_e}{u_e}=\frac{-25}{(-25/6)}=6$ ...(1)

Now for objective,

$v=L-u_e=20-(25/6)=(95/6)$

So if object is at a distance u from the objective,

$$\frac{6}{95}-\frac{1}{u}=\frac{1}{0.95}\ \text{i.e., } u=-\frac{95}{94}\ \text{cm}$$

i.e. object is at a distance (95/94) cm in front of field lens.

Also, $m=\frac{v}{u}=\frac{(95/6)}{(-95/94)}=-\left[\frac{94}{6}\right]$ ...(2)

So total magnification,

$$M=m\times m_e=-\left[\frac{94}{6}\right]\times(6)=-94$$

i.e., final image is inverted, virtual and 94 times that of object.

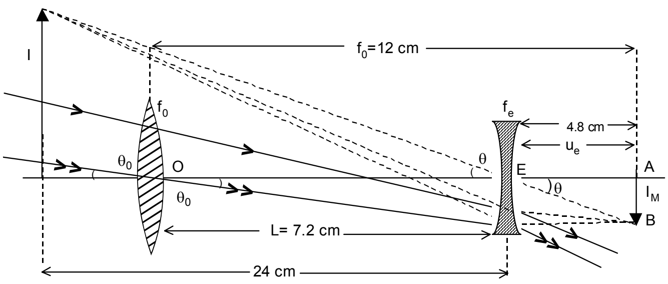
21. **(a).** As object is distant, i.e., u = – ∞ , so

$$\frac{1}{v}-\frac{1}{-\infty}=\frac{1}{f_0}\ \text{i.e. } v=f_0=12\ cm$$

i.e. objective will form the image I_M at its focus which is at a distance of 12 cm from O. Now as eye- piece of focal length – 4 cm forms image I at a distance of 24 cm from it,

$$\frac{1}{-24}-\frac{1}{u_e}=\frac{1}{-4}\Rightarrow u_e=\frac{24}{5}=4.8\ cm.$$

i.e, the distance of I_M from eye lens EA is 4.8 cm. So the length of tube L = OA – EA = 12 – 4.8 = 7.2 cm.



22. **(d)** In case of astronomical telescope if object and final image both are at infinity.

$MP = -(f_0/f_e)$ and $L = f_0 + f_e$

So here $-(f_0/f_e) = -5$ and $f_0 + f_e = 36$

Solving these for f_0 and f_e, we get

$f_0 = 30$ cm and $f_e = 6$ cm

23. **(a)** Resolving power of microscope $\propto \frac{1}{\lambda}$

24. **(a)** Light gathering power $\propto$ Area of lens aperture or d^2

25. **(b)** For lens L_1, ray must move parallel to the axis after refraction

$$\frac{\mu_1}{\infty} + \frac{\mu_\omega}{x} = \frac{\mu_1 - \mu_\omega}{R_1} \Rightarrow x = 10cm$$

26. **(a)** For lens L_2, image must form at centre of curvature of the curved surface after refraction through plane part

$$\frac{\mu_2}{-R_2} + \frac{\mu_\omega}{x'} = 0$$

$\Rightarrow x' = 8$ cm

27. **(b)** Length of tube $= x + x' = 18$ cm

28. **(a)** Focal length of lens immersed in water is four times the focal length of lens in air. It means

$f_w = 4f_a = 4 \times 10 = 40$ cm

29. **(d)** Focal length of the lens depends upon its refractive index as $\frac{1}{f} \propto (\mu - 1)$.

Since $\mu_b > \mu_r$ so $f_b < f_r$

Therefore, the focal length of a lens decreases when red light is replaced by blue light.

30. **(b)** The light gathering power (or brightness) of a telescope $\propto$ (diameter)^2. So by increasing the objective diameter even far off stars may produce images of optimum brightness.