ANSWERS

OBJECTIVE TYPE QUESTIONS

1. **(b) :** Using, $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

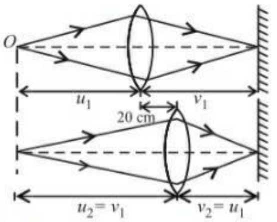
Here, $\mu_1 = 1$, $\mu_2 = 1.5$, $u = -50$ cm, $R = 10$ cm

$\therefore \quad \frac{1.5}{v} - \frac{1}{(-50)} = \frac{(1.5-1)}{10}$

or $\quad \frac{1.5}{v} = 0.05 - 0.02 = 0.03 \Rightarrow v = 50$ cm

2. **(b) :** The image of the object can be located on the screen for two positions of convex lens such that u and v are exchanged.

The separation between two positions of the lens is $d = 20$ cm



From the figure,
$u_1 + v_1 = 90$ cm
$v_1 - u_1 = 20$ cm
On solving,
$v_1 = 55$ cm, $u_1 = 35$ cm
From lens formula,

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

$\frac{1}{55} - \frac{1}{-35} = \frac{1}{f}$ or $\frac{1}{55} + \frac{1}{35} = \frac{1}{f}$

$\Rightarrow f = \frac{55 \times 35}{90} = 21.4$ cm

3. **(a) :** Here, $f = -0.2$ m, $v = +0.3$ m

The lens formula,

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad \therefore \quad \frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{0.3} + \frac{1}{0.2} = \frac{0.5}{0.06}$

$\therefore \quad u = \frac{0.06}{0.5} = 0.12$ m

4. **(d) :** Here, $f_o = 50$ cm, $f_e = 5$ cm, $D = 25$ cm

The length of the telescope when the image is formed at the least distance of distinct vision is

$L = f_o + \frac{f_e D}{f_e + D} = 50 + \frac{5 \times 25}{5 + 25} = 50 + \frac{25}{6} = \frac{325}{6}$ cm

5. **(d) :** Here, $P_1 = 10$ D and $P_2 = -5$ D

Therefore, power of the combined lens is

$P = P_1 + P_2 = +10 + (-5) = +5$ D

Now, magnification, $m = \frac{f}{u+f}$

Here, $m = 2$ and $f = \frac{1}{P} = \frac{1}{5} = 0.2 \text{ m} = 20$ cm

$\therefore \quad 2 = \frac{20}{u+20} \Rightarrow u + 20 = 10$

$\Rightarrow \quad u = -10$ cm

6. **(b) :** Mirage is phenomenon due to total internal reflection of light.

7. **(a) :** $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Here, $f = \frac{2}{3}R$, $R_1 = +R$, $R_2 = -R$

$\therefore \quad \frac{1}{(2/3)R} = (\mu - 1)\left(\frac{1}{R} + \frac{1}{R}\right) = \frac{(\mu - 1) \times 2}{R}$

$\mu - 1 = \frac{3}{4} = 0.75 \Rightarrow \mu = 1.75$

8. **(c) :** When an object moving towards a convergent lens from the left of the lens with a uniform speed of 5 m s^{-1}, the image moves away from the lens with a non uniform acceleration.

Now, $\frac{1}{f_w} = \left({}^{w}\mu_g - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (1.128 - 1) \times 10 = 1.28$

or $\quad f_w = \frac{1}{1.28} = 0.78$

Hence, change in focal length of the lens,

$f_w - f_a$

$= 0.78 - 0.2 = 0.58$ m

10. **(d) :** The separation between the objective and the eye piece = Length of the telescope tube *i.e.* $f = f_o + f_e$

Here, $f_o = 144$ cm $= 1.44$ m

$f_e = 6.0$ cm $= 0.06$ m

$\therefore \quad f = 1.44 + 0.06 = 1.5$ m

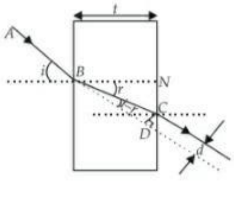
11. **(d) :** The far point of 6.0 m tell us that the focal length of the lens is $f = -6.0$ m, $u = -18$ m and $h = 2$ m

Using, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-6.0} - \frac{1}{18.0}$

$\Rightarrow \quad v = -4.5$ m

$\therefore \quad$ The image size, $h' = h\left(\frac{-v}{u}\right) = 2 \times \left(-\frac{-4.5}{18.0}\right) = 0.50$ m

12. **(c) :** From figure, in right angled ΔCDB, $\angle CBD = (i - r)$



$\therefore \quad \sin(i - r) = \frac{CD}{BC} = \frac{d}{BC}$

or $\quad d = BC \sin(i - r) \quad$ ...(i)

Also, in right angled ΔCNB

$\cos r = \frac{BN}{BC} = \frac{t}{BC}$

or $\quad BC = \frac{t}{\cos r} \quad$ ...(ii)

Substitute equation (ii) in equation (i), we get

$d = \frac{t}{\cos r} \sin(i - r)$

For small angles $\sin(i - r) \approx i - r$, $\cos r \approx 1$

9. **(c) :** Using $\frac{1}{f_a}=({}^a\mu_g)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Here, $f_a = 0.2$ m, ${}^a\mu_g = 1.50$

$\therefore \quad \frac{1}{0.2}=(1.50-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)=0.50\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$\Rightarrow \quad \frac{1}{R_1}-\frac{1}{R_2}=10$

Consider f_w be the focal length of the lens, when immersed in water. If ${}^w\mu_g$ be refractive index of glass w.r.t. water, then

${}^w\mu_g=\frac{{}^a\mu_g}{{}^a\mu_w}=\frac{1.50}{1.33}=1.128$

$\therefore \quad d = t(i-r),\ d = it\left[1-\frac{r}{i}\right]$

13. **(c) :** Image formed is complete but has decreased intensity.

14. **(c) :** Actual depth of the needle in water, $h_1 = 12.5$ cm

Apparent depth of needle in water, $h_2 = 9.4$ cm

$\therefore \quad \mu_{\text{water}}=\frac{h_1}{h_2}=\frac{12.5}{9.4}=1.33$

Hence, $\mu_{\text{water}} = 1.33$

When water is replaced by a liquid of refractive index $\mu' = 1.63$, the actual depth remains the same, but its apparent depth changes.

Let H be the new apparent depth of the needle.

$\therefore \quad \mu'=\frac{h_1}{H}$ or $H=\frac{h_1}{\mu'}=\frac{12.5}{1.63}=7.67$ cm

Here, H is less than h_2. Thus to focus the needle again, the microscope should be moved up. Distance by which the microscope should be moved up

$= 9.4 - 7.67 = 1.73$ cm

15. **(a) :** As refraction occurs from denser to rarer medium

$\therefore \quad \frac{\mu_2}{-u}+\frac{\mu_1}{v}=\frac{\mu_1-\mu_2}{R}$

Here, $\mu_1 = 1$, $\mu_2 = 1.5$, $R = 5$ cm, $u = -10$ cm

$\frac{1.5}{10}+\frac{1}{v}=\frac{1-1.5}{-5}=\frac{1}{10}$ or $\frac{1}{v}=\frac{1}{10}-\frac{3}{20}=\frac{-1}{20}$ or $v = -20$ cm

16. **(c) :** Equivalent focal length, $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$

Here, $f_1 = 20$ cm and $f_2 = -40$ cm

$\frac{1}{f}=\frac{1}{20}-\frac{1}{40}=\frac{2-1}{40}$, $f = 40$ cm

From lens formulas, $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

Here, $f = 40$ cm, $u = \infty$

$\therefore \quad \frac{1}{f}=\frac{1}{v}-\frac{1}{\infty} \Rightarrow v = f = 40$ cm

17. **(d) :** The final image in an astronomical telescope with respect an object is virtual and inverted.

18. **(c) :** Here, $m=\frac{v}{u}=-4$ or $u=\frac{-v}{4}$

Also, $|u| + |v| = 1.5$

$\frac{v}{4}+v=1.5$ or $v = 1.2$ m and $u=\frac{-1.2}{4}=-0.3$ m

$\therefore \quad f=\frac{uv}{u-v}=\frac{-0.3\times1.2}{-0.3-1.2}=0.24$ m

19. **(c) :** Here, $u = -45$ cm, $v = 90$ cm

$\therefore \quad \frac{1}{f}=\frac{1}{v}-\frac{1}{u}=\frac{1}{90}+\frac{1}{45}=\frac{1}{30} \Rightarrow f = 30$ cm

When the needle is moved 5 cm away from the lens,

$u = -(45 + 5) = -50$ cm

$\therefore \quad \frac{1}{v'}=\frac{1}{f}+\frac{1}{u'}=\frac{1}{30}+\frac{1}{-50}=\frac{2}{150}$

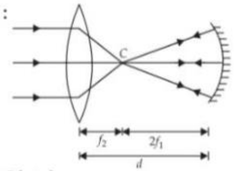
or $\quad v' = 75$ cm

$\therefore$ Displacement of image $= v - v' = 90 - 75 = 15$ cm, towards the lens.

20. **(b) :** When the curved surface of the lens faces the object, the spherical aberration is smaller. The total deviation is shared between the curved and the plane surfaces.

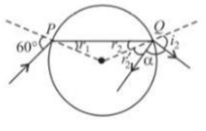
21. **(b) :** When refractive index of lens is equal to the refractive index of liquid, the lens behave like a plane surface with focal length infinity.

22. **(c) :**



$\therefore \quad d = 2f_1 + f_2$

23. **(c) :** Refraction at P,



$\frac{\sin 60°}{\sin r_1}=\sqrt{3}$

$\sin r_1=\frac{1}{2}$

or $\quad r_1 = 30°$

Since, $r_2 = r_1$

$\therefore \quad r_2 = 30°$

Refraction at Q, $\frac{\sin r_2}{\sin i_2}=\frac{1}{\sqrt{3}}$ or $\frac{\sin 30°}{\sin i_2}=\frac{1}{\sqrt{3}}$ or $i_2 = 60°$

At point Q, $r_2' = r_2 = 30°$

$\therefore \quad \alpha = 180° - (r_2' + i_2) = 180° - (30° + 60°) = 90°$