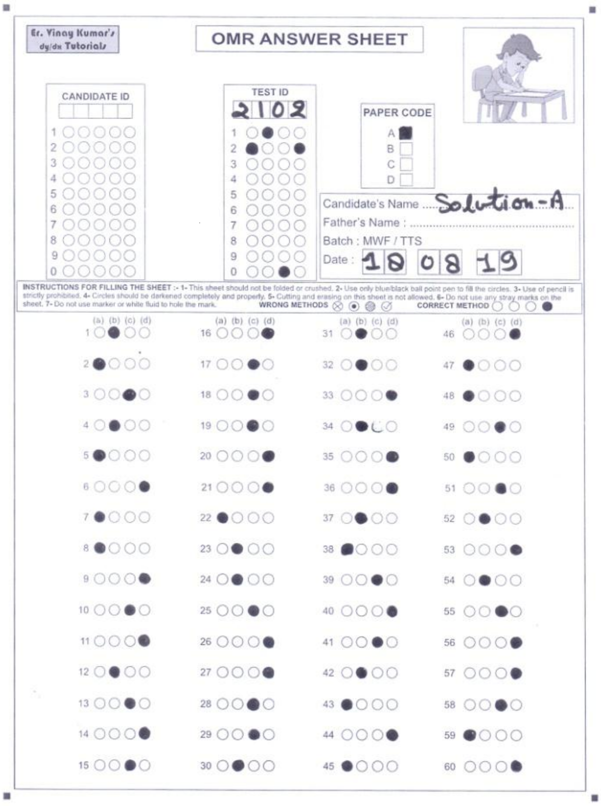
SET-A



Q1. M = – 100, L = 101 cm

In normal adjustment,

$$M = -\frac{f_o}{f_e} \Rightarrow -100 = -\frac{f_o}{f_e}$$

$$\Rightarrow f_o = 100\, f_e \;\ldots\ldots\ldots\ldots\ldots\; (1)$$

$$L = f_o + f_e \Rightarrow 101 = f_o + f_e \;\ldots\ldots\ldots\ldots\ldots\; (2)$$

From (1) & (2) : $101 = 100\, f_e + f_e \Rightarrow f_e = 1\,\text{cm}$

From (1) : $f_o = 100\, f_e = 100 \times 1 \Rightarrow f_o = 100\,\text{cm}$

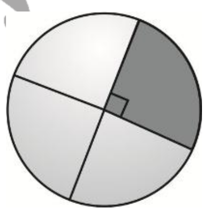
Q2. $f_1 = -\dfrac{R}{\mu_1 - 1}$, $f_2 = \dfrac{R}{\mu_2 - 1}$

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} \Rightarrow \frac{1}{F} = -\frac{\mu_1 - 1}{R} + \frac{\mu_2 - 1}{R}$$

$$\Rightarrow \frac{1}{F} = \frac{1}{R}[-\mu_1 + 1 + \mu_2 - 1]$$

$$\Rightarrow \frac{1}{F} = \frac{1}{R}[\mu_2 - \mu_1] \Rightarrow F = \frac{R}{\mu_2 - \mu_1}$$

Q3. The stop covers $\frac{1}{4}th$ area of the aperture hence the intensity which passes is $\left(I - \frac{I}{4}\right)$



$$= \frac{3I}{4}$$

Q4. $P = \dfrac{1}{f} \Rightarrow +10 = \dfrac{1}{f_1} \times 100$

$$\Rightarrow f_1 = +10\, cm$$

$$+12.5 = \frac{1}{f_2} \times 100 \Rightarrow f_2 = \frac{100}{12.5} = +8cm$$

for achromatic combination :

$$d = \frac{f_1 + f_2}{2} = \frac{10 + 8}{2} \Rightarrow d = 9cm$$

$$P = P_1 + P_2 - dP_1P_2$$

$$= 10 + 12.5 - \frac{9}{100} \times 10 \times 12.5$$

$$\Rightarrow P = 11.25\, D$$

Q5. u = –200, v = –40

$$P = \frac{1}{v} - \frac{1}{u} \Rightarrow P = \frac{1}{-40} - \frac{1}{-200} = \frac{1}{200} - \frac{1}{40}$$

$$= \frac{1-5}{200} = \frac{-4}{200} \Rightarrow P = -\frac{4}{200} \times 100 = -2D$$

Q7.

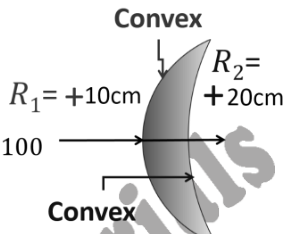
$$P = \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow P = \left(\frac{3}{2} - 1\right)\left(\frac{1}{+10} - \frac{1}{+20}\right) \times 100$$

$$\Rightarrow P = \frac{1}{2} \times \left(\frac{1}{10} - \frac{1}{20}\right) \times 100$$

$$\Rightarrow P = \frac{1}{2} \times \left(\frac{1}{20}\right) \times 100$$

$$\Rightarrow P = +2.5D$$

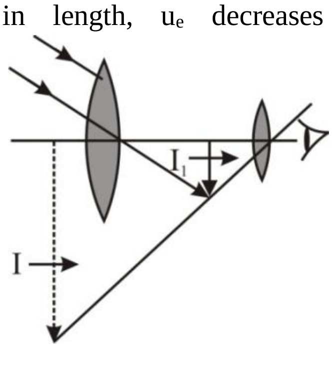


$$P = \frac{100}{f(cm)} \Rightarrow 2.5 = \frac{100}{f(cm)}$$

$$\Rightarrow f = \frac{100}{2.5} \Rightarrow f = +40cm$$

Q8. Range is from $1 + \dfrac{D}{f}$ to $\dfrac{D}{f} \Rightarrow$ depending on f only.

Q9. Due to decrease in length, u_e decreases $[L = f_o + u_e]$ i.e. I_1 (object of eyepiece) moves towards the eyepiece and therefore I (image of eye piece) also moves towards the eyepiece hence its size decreases



Q11. $\frac{Me_{min}}{Me_{max}} = \frac{D/f}{1+D/f} \Rightarrow \frac{D}{f+D} = \frac{2}{3} \Rightarrow 3D = 2f + 2D$

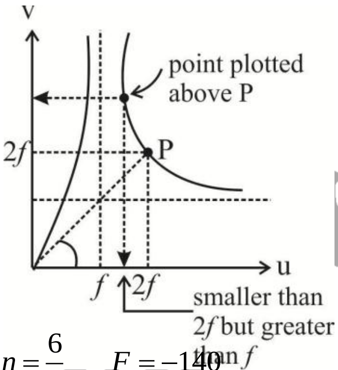
$\Rightarrow D = 2f$ .... (1)

$P = \frac{100}{f} \Rightarrow f = \frac{100}{10} = 10$ cm .... (2)

From (1) & (2) : $D = 2\times 10 = 20$ cm

$M = \frac{D}{u} = \frac{20}{2.5} = 8$

Q12.



Q13. $n = \frac{6}{7} \quad F = -140$

$$fc = \left(1 - \frac{6}{7}\right)(-140) = -20cm$$

$$f_F = \left(1 - \frac{7}{6}\right)(-140) = +23.3\,cm$$

Q14. $\frac{1}{f\text{v}} = (\mu_\text{v} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right), \frac{1}{f_R} = (\mu_R - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$\Rightarrow \frac{f_R}{f_\text{v}} = \frac{(\mu_\text{v} - 1)}{(\mu_R - 1)} \Rightarrow \frac{f_R}{20} = \frac{(1.66-1)}{(1.55-1)} = \frac{0.66}{0.55}$$

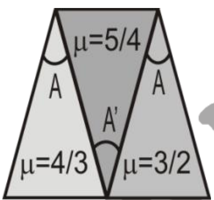
$$\frac{f_R}{20} = \frac{6}{5} \Rightarrow f_R = 24\,cm$$

Q15. $\theta = 0 \Rightarrow 4\theta_C - 3\theta_F = 0 \Rightarrow 4\theta_C = 3\theta_F$

$$\Rightarrow 4\omega_C(\mu_C - 1)A_C = 3\omega_F(\mu_F - 1)A_F$$

$$\Rightarrow A_C = \frac{3\omega_F(\mu_F - 1)A_F}{4\omega_C(\mu_C - 1)} = \frac{3\times 0.04\times(1.6-1)\,2^o}{4\times 0.03\times(1.5-1)} = 2^o.4$$

Q16.



$\delta_1 - \delta_2 + \delta_3 = 0$

$$\left(\frac{4}{3} - 1\right)A - \left(\frac{5}{4} - 1\right)A' + \left(\frac{3}{2} - 1\right)A = 0$$

$$\Rightarrow \frac{A}{3} - \frac{A'}{4} + \frac{A}{2} = 0$$

$$\frac{5}{6}A = \frac{A'}{4} \Rightarrow \frac{A}{A'} = \frac{3}{10}$$

Q17. $\frac{1}{f} = 0.4 \Rightarrow f = \frac{1}{0.4} = \frac{10}{4} = 2.5$ cm

$R = 2f = 2\times 2.5 = 5\,cm$

Q19. Refraction on first surface :

$u = -2R, \ \mu_o = 1, \ \mu_i = \frac{3}{2}$

$R \Rightarrow +R$

$$\frac{\mu_i}{v} - \frac{\mu_o}{u} = \frac{\mu_i - \mu_o}{R} \Rightarrow \frac{3}{2v} - \frac{1}{-2R} = \frac{\frac{3}{2} - 1}{+R}$$

$$\Rightarrow \frac{3}{2v} + \frac{1}{2R} = \frac{1}{2R} \Rightarrow \frac{3}{2v} = 0 \Rightarrow v = \infty$$

Refraction on second surface :

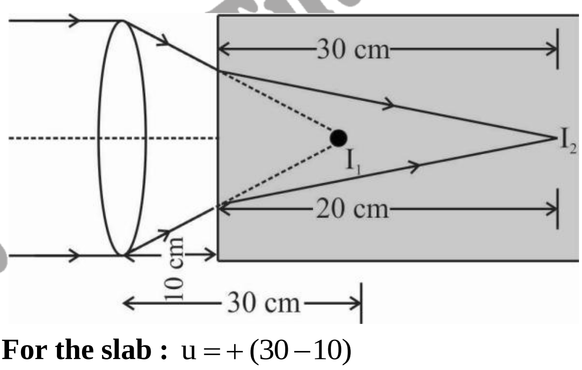
$u = \infty, \ \mu_o = \frac{3}{2}, \ \mu_i = 1, \ R \Rightarrow -R$

$$\frac{\mu_i}{v} - \frac{\mu_o}{u} = \frac{\mu_i - \mu_o}{R} \Rightarrow \frac{1}{v} - \frac{3}{2(\infty)} = \frac{1 - \frac{3}{2}}{-R}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{2R} \Rightarrow v = 2R$$

Q20. First image I_1 is formed at a distance of 30 cm from the lens (at the focus of the lens).

Image formed by the lens I_1 acts as virtual object for the slab.



For the slab : $u = +(30 - 10)$

$= +20$ cm

$\mu_0 = 1 \quad \mu_i = 3/2$

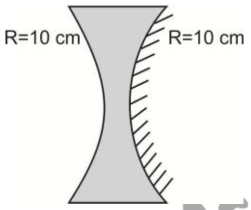
$$\frac{\text{v}}{\text{u}} = \frac{\mu_i}{\mu_0} \Rightarrow \frac{\text{v}}{+20} = \frac{\frac{3}{2}}{1} \Rightarrow \text{v} = +30 \text{ cm}$$

Distance of final image I_2 from the lens = 10 + 30 = 40 cm

Q22. $\frac{1}{F}=\frac{1}{f_m}-\frac{2}{f_l}$

Where $f_m=+\frac{10}{2}=+5\,cm$ (convex mirror)

$f_l=-\frac{R}{2(\mu-1)}=-\frac{R}{2(1.5-1)}$

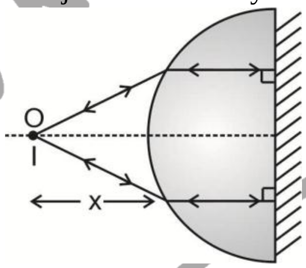


$\Rightarrow f_l=-R=-10\,cm$

$\frac{1}{F}=\frac{1}{+5}-\frac{2}{-10}=\frac{1}{5}+\frac{1}{5}$

$=\frac{2}{5}\Rightarrow F=\frac{5}{2}=+2.5\,cm$

Q23. For image to be formed on object itself the rays should retrace their path after reflection from the silvered surface. Since the silvered surface is a plane mirror the rays falling on the mirror should be parallel and perpendicular it.



For the incident rays on spherical surface :

u = - x v = ∞

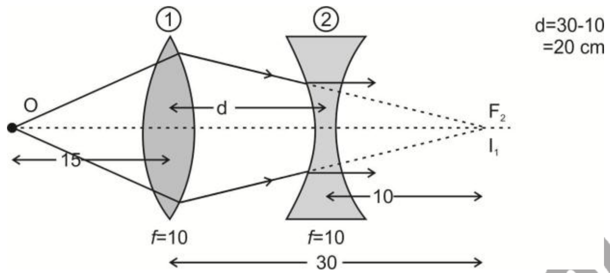
$R \Rightarrow +R$

$\frac{\mu_i}{v}-\frac{\mu_o}{u}=\frac{\mu_i-\mu_o}{R}$

$\Rightarrow x=2R$

Q24. For convex lens

u = - 15 f = + 10



$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{+10}=\frac{1}{v}-\frac{1}{-15}\Rightarrow\frac{1}{v}=\frac{1}{10}-\frac{1}{15}$

$\Rightarrow\frac{1}{v}=\frac{3-2}{30}=\frac{1}{30}\Rightarrow v=+30$

The first image I_1 formed by the convex lens should act as object for the concave lens and it should be placed on the focus of the concave lens F_2 to make the finally refracted rays parallel.

d = 30 – 10 = 20

Q25. $\frac{\mu_i}{v}-\frac{\mu_0}{u}=\frac{\mu-\mu_0}{R_1}-\frac{\mu-\mu_i}{R_2}$

$\Rightarrow\frac{4}{3v}-\frac{1}{-30}=\frac{\frac{3}{2}-1}{+10}-\frac{\frac{3}{2}-\frac{4}{3}}{-10}$

$\Rightarrow\frac{4}{3v}+\frac{1}{30}=\frac{1}{20}+\frac{1}{60}\Rightarrow\frac{4}{3v}=\frac{1}{20}+\frac{1}{60}-\frac{1}{30}$

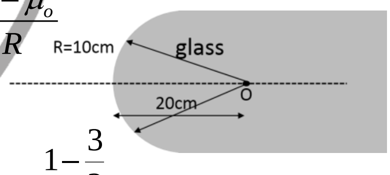
$\Rightarrow\frac{4}{3v}=\frac{3+1-2}{60}\Rightarrow\frac{4}{3v}=\frac{2}{60}\Rightarrow\frac{4}{3v}=\frac{1}{30}$

$\Rightarrow v=+40\,cm$ (image is formed 40 cm away from the lens in water)

Image is real because its medium is water and formed in the water itself.

Q26. $\mu_0=\frac{3}{2}\quad\mu_i=1,\quad u=-20cm,\quad R=-10cm$

$\frac{\mu_i}{v}-\frac{\mu_o}{u}=\frac{\mu_i-\mu_o}{R}$



$\Rightarrow\frac{1}{v}-\frac{3}{2(-20)}=\frac{1-\frac{3}{2}}{-10}$

$\Rightarrow\frac{1}{v}+\frac{3}{40}=\frac{1}{20}\Rightarrow\frac{1}{v}=-\frac{3}{40}+\frac{1}{20}$

$\Rightarrow\frac{1}{v}=\frac{-3+2}{40}\Rightarrow\frac{1}{v}=\frac{-1}{40}$

$\Rightarrow v=-40cm$

The image appears to be in glass but actually it is in air, therefore it is virtual.

Q27. $x=\frac{R}{\mu-1}\Rightarrow 5x=\frac{x}{\mu-1}$

$\Rightarrow\mu-1=\frac{1}{5}\Rightarrow\mu=6/5=1.2$

Q28. $t'=\frac{Rt}{\mu R-(\mu-1)t}$

$=\frac{10\times15}{1.5\times10-(1.5-1)\times15}=\frac{150}{15-7.5}$

$=\frac{150}{7.5}=20\,cm$

Q30. $x=\frac{(\mu+1)}{(\mu-1)}R \Rightarrow 5R=\left(\frac{\mu+1}{\mu-1}\right)R$

$\Rightarrow \frac{\mu+1}{\mu-1}=5 \Rightarrow \mu+1=5\mu-5$

$\Rightarrow 4\mu=6 \Rightarrow \mu=\frac{6}{4}=1.5$

Q31. For refraction on second surface

$\mu_o=\mu,\quad \mu_i=1,\quad u=-2R,\quad v=-6R\quad R\Rightarrow -R$

$\frac{\mu_i}{v}-\frac{\mu_o}{u}=\frac{\mu_i-\mu_o}{R} \Rightarrow \frac{1}{-6R}-\frac{\mu}{-2R}=\frac{1-\mu}{-R}$

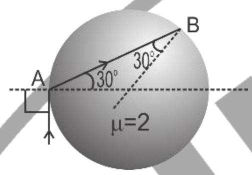
$\Rightarrow -\frac{1}{6}+\frac{\mu}{2}=\mu-1$

$\Rightarrow \frac{\mu}{2}=1-\frac{1}{6} \Rightarrow \frac{\mu}{2}=\frac{5}{6}$

$\Rightarrow \mu=\frac{10}{6}=\frac{5}{3}=1.67$

Q32. Since ray grazes on the surface it enters at critical angle.

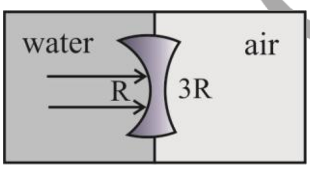
$\sin c=\frac{1}{\mu} \Rightarrow \sin c=\frac{1}{2}$



$\Rightarrow c=30^o$

$\delta=2\,(i\sim r)=2\,(90^o-30^o)$
$=2\times 60^o=120^o$

Q34. $P=\frac{\mu-\mu_o}{R_1}-\frac{\mu-\mu_i}{R_2}=\frac{\frac{3}{2}-\frac{4}{3}}{-R}-\frac{\frac{3}{2}-1}{+3R}$



$\Rightarrow P=-\frac{1}{6R}-\frac{1}{6R}=-\frac{2}{6R}=-\frac{1}{3R}$

Q35. $\frac{f_s}{f}=\frac{\mu-1}{\frac{\mu}{\mu_s}-1} \Rightarrow \frac{f_s}{12}=\frac{\frac{3}{2}-1}{\frac{3/2}{5/3}-1}$

$\Rightarrow \frac{f_s}{12}=\frac{1/2}{\frac{9}{10}-1}=\frac{f_s}{12}=\frac{1/2}{-1/10}$

$\Rightarrow f_s=12\times(-5)=-60\text{ cm}$

Q36. Nature of the device does not change on silvering.

Q38. $u=-30,\ v=-60 \Rightarrow P=\frac{1}{v}-\frac{1}{u}$

$\Rightarrow P=\frac{1}{-60}-\frac{1}{-30}$

$\Rightarrow P=\frac{1}{30}-\frac{1}{60}=\frac{2-1}{60}=\frac{1}{60}$

$\Rightarrow P=\frac{1}{60}\times 100 \Rightarrow P=+1.67D$

Q41. *fe* = 4*fo* = 2

$Me=1+\frac{D}{fe}=1+\frac{24}{4}=1+6=7$

$M=mo\times Me$

$M=\frac{fo}{fo+uo}\times Me$

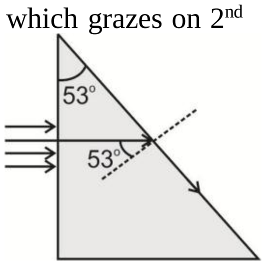
$=\frac{2}{2+(-6)}\times 7=\frac{2}{-4}\times 7=-\frac{14}{4}=-3.5$

Q42. Convergence of the eye lens has increased in the given defect therefore diverging lens is required.

Q43. Eye piece of the astronomical telescope is converging hence convex lens should be more powerful than concave lens. Therefore the convex lens should be of less dispersive power ie of crown and the concave of flint.

Q45. Refractive index for the ray which grazes on 2nd surface

$\sin 53^o=\frac{1}{\mu} \Rightarrow \frac{4}{5}=\frac{1}{\mu}$



$\Rightarrow \mu=\frac{5}{4}=1.25$

Only red has refractive index less than 1.25 hence only red will emerge and rest of the rays will face T.I.R.