Unit : 6 Ray optics

Q.No 1. Given: $h = 4cm$ $u = -6cm$ $R = +24cm$

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

$$\frac{1}{-12} = \frac{1}{v} + \frac{1}{(-6)}$$

$$\frac{-1}{12} + \frac{1}{6} = v \; ; \quad \boxed{v = 12cm} \quad (1)$$

$$m = \frac{h'}{h} = \frac{-v}{u} \; ; \quad h' = h \times \frac{-v}{u}$$

$$= 4 \times \frac{-12}{-6}$$

$$\boxed{h' = 8cm} \quad (2)$$

$$\boxed{m = 2} \quad (3)$$

Q.No 2. Given, $f = -20cm$ $h' = 3h$

$$\boxed{m = \frac{h'}{h} = \frac{-3}{1}}$$

$$\boxed{v = 3u}$$

may be 'm' is positive

$$\boxed{m = 3/1}$$

$$\frac{1}{-20} = \frac{1}{-3u} + \frac{1}{u}$$

$$\boxed{u = \frac{40}{3} cm}$$

$$\frac{1}{-20} = \frac{1}{3u} + \frac{1}{u}$$

$$\boxed{u = -80/3 \; cm}$$

Q.No 3. Given

$i = 90^\circ$, $\mu_R = 1.39$ $\mu_g = 1.44$, $\mu_b = 1.47$

$$\mu = \frac{\sin i}{\sin r}$$

Red. $1.39 = \frac{\sin 90^\circ}{\sin r}$; $\sin r = \frac{1}{1.39}$

$r = \sin^{-1}(0.526) = 31.7^\circ$

Green: $r = \sin^{-1}(0.694) = 43.98^\circ$

Blue : $r = \sin^{-1}(0.680) = 42.84^\circ$

Critical angle of glass 42°. But our case green and blue above the critical angle so suffer the total internal Reflection.

Q.NO:4 Given,

$f = +20\,cm$; $m = 4$

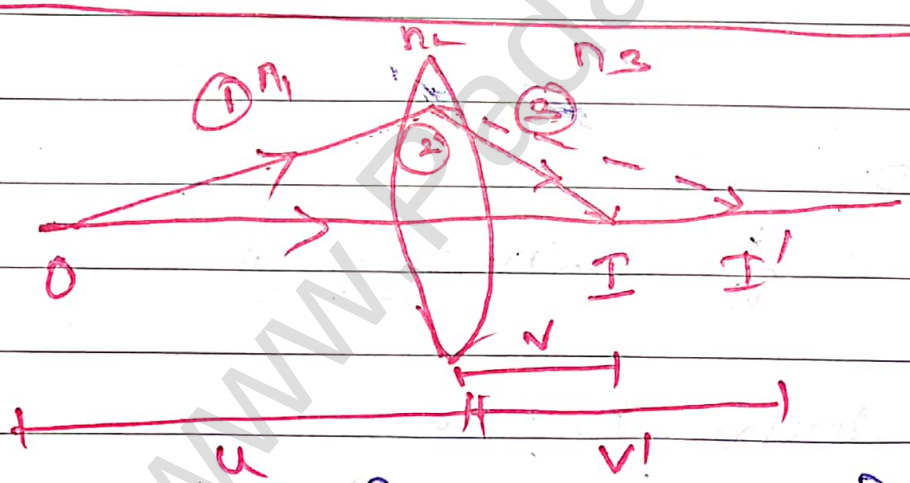
$m = \frac{h'}{h} = \frac{v}{u}$ $\quad 4 = \frac{v}{u}$ $\quad \boxed{4u = v}$

$\frac{1}{20} = \frac{1}{v} - \frac{1}{u}$; $\frac{1}{20} = \frac{1}{4u} - \frac{1}{u}$

$\frac{1}{20} = \frac{1-3}{4u} = \frac{-3}{4u}$

$\frac{1}{20} = \frac{-3}{4u}$ $\quad \boxed{u = -15\,cm}$

Q.NO.5



For the refracting surface ①, the light goes from n_1 to n_2

$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1}$ $\quad$ — ①

For the refracting surface (3), the light goes from media n_2 to n_3

$$\frac{n_3}{v} - \frac{n_2}{v'} = \frac{(n_3 - n_2)}{R_2} \quad \text{---(2)}$$

Adding eq (1) + (2)

$$\frac{n_2}{v'} - \frac{n_1}{v} + \frac{n_3}{v} - \frac{n_2}{v'} = \frac{n_2 - n_1}{R_1} + \frac{n_3 - n_2}{R_2}$$

$$\left[\frac{n_3}{v} - \frac{n_1}{v}\right] = \left[\frac{n_2 - n_1}{R_1}\right] + \left[\frac{n_3 - n_2}{R_2}\right]$$

Qno. 6. Given $P = 5D$

$$f = \frac{1}{P} = \frac{1}{5} = 0.2m = 20cm$$

I. $f = 20cm \quad n_2 = 1.5$

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

$$\frac{1}{20} = (1.5 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{10} \quad \text{---(1)}$$

II. $f = -100\,cm$ $n_2 = 1.5$ $n_1 = n$

$$\frac{-100}{100} = \left[\frac{1.5}{n} - 1\right]\left(\frac{1}{10}\right)$$

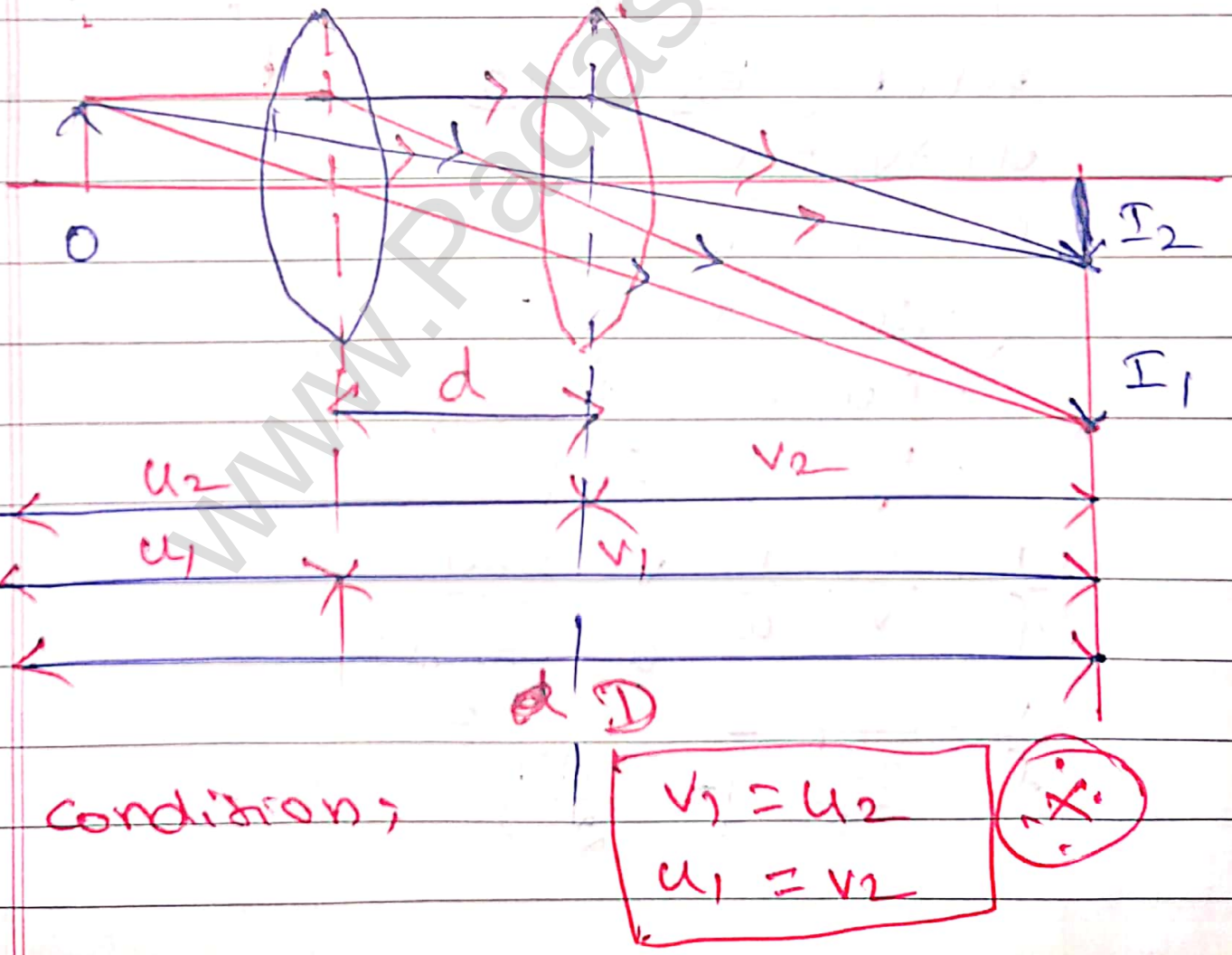
$$\frac{-1}{10} = \left[\frac{1.5}{n} - 1\right]$$

$$\frac{-1}{10} + 1 = \frac{1.5}{n}$$

$$\frac{9}{10} = \frac{1.5}{n}$$

$$n = \frac{15}{9} = \frac{5}{3}$$

(7)



condition;

$v_1 = u_2$

$u_1 = v_2$

$u_1 + v_1 = D$ — (1)

$u_1 - v_2 = d$ $\quad \because v_2 = u_1$

$u_1 - u_1 = d$ — (2)

Adding (1) & (2)

$u_1 + v_1 = D$

$-u_1 + v_1 = d$

$2v_1 = D + d$

$$\boxed{v_1 = \frac{D+d}{2}} \quad (3)$$

Subtracting eq (1) & (2)

$u_1 + v_1 = D$

$u_1 - v_1 = -d$

$-2u_1 = D - d$

$$\boxed{u_1 = \frac{D-d}{2}} \quad (4)$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \qquad v = \frac{D+d}{2}$$

$$u = -\left(\frac{D-d}{2}\right)$$

$$\frac{1}{f} = \frac{1}{\frac{D+d}{2}} - \frac{1}{\left[-\frac{D-d}{2}\right]}$$

$$\frac{1}{f} = \frac{2}{D+d} + \frac{2}{D-d}$$

$$\frac{1}{f} = \frac{2(D-d)+2(D+d)}{(D+d)(D-d)}$$

$$\frac{1}{f} = \frac{2D-2d+2D+2d}{D^2-d^2}$$

$$\frac{1}{f} = \frac{4D}{D^2-d^2}$$

$$\boxed{f = \frac{D^2-d^2}{4D}}$$

Q.No: 9

Given $f_l = 15\,cm$ $u = -20\,cm$

$$\frac{1}{-f} = \frac{1}{f_l} + \frac{1}{(+f_m)} + \frac{1}{f_1}$$

$$\left(\frac{1}{-f}\right) = \frac{2}{f_l} + \left(\frac{-1}{f_m}\right)$$

$f_l = 15\,cm$; $f_m = \infty$

$$\frac{-1}{f} = \frac{2}{15}$$

$$\boxed{f = \frac{-15}{2}\,cm}$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$ Because Silvered lens = mirror.

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

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

$$\frac{-8}{60} + \frac{3}{60} = \frac{1}{v}$$

$$\frac{1}{v} = \frac{-5}{60}$$

$$\boxed{v = -12\,cm}$$

Ans

Q No: 10. $\lambda_1 = 500nm$ $\lambda_2 = 300nm$

Rayleigh $I \propto \frac{1}{\lambda^4}$

$I_1 = \frac{1}{(500nm)^4}$ $I_2 = \frac{1}{(300nm)^4}$

$\frac{I_1}{I_2} = \frac{(300nm)^4}{(500nm)^4} = \left(\frac{3}{5}\right)^4 = \frac{81}{625}$

$I_1 : I_2 = 81 : 625$

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