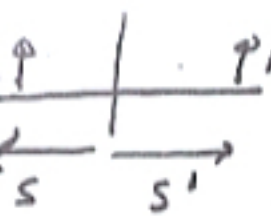
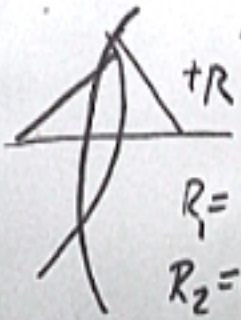
250

$M = \frac{h'}{h} = -\frac{s'}{s}$



M + upright

M - inverted



R_1 = Light side

R_2 = other side

$n = \frac{c}{v}$

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

Converging

○ $f > 0$ (+)

‖ $f < 0$ (−) diverging

Upright / inverted

- Enlarged ($|M| > 1$)
- Unmagnified ($|M| = 1$)
- Reduced ($|M| < 1$)

Real / Virtual

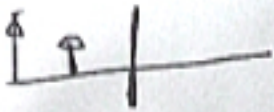
$s, s_i > 0$ $s, s_i < 0$

$M+$: upright $M-$: inverted

$f = 10\,cm$

$h = 1\,cm$ $\qquad f = +10\,cm$

$s = 5\,cm$



$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

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

$$s' = -10$$

$$M = -\frac{s'}{s} = -\frac{-10}{5} = +2$$

$s' < 0 \Rightarrow$ virtual

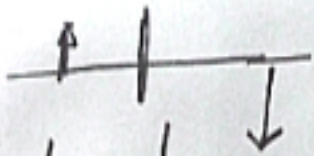
$|M| > 1$ ENLarged

$M > 0$ upright

conv $f=10$ $f=+10\,cm$

$h=1\,cm$ $s=15\,cm$

$$\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}$$



$$\frac{1}{s'}=\frac{1}{f}-\frac{1}{s}=\frac{1}{+10}-\frac{1}{15}$$

$$=\frac{3}{30}-\frac{2}{30}=\frac{1}{30}$$

$$s'=+30$$

$$M=-\frac{s'}{s}=-\frac{30}{15}=-2$$

inverted : $M<0$ (-)

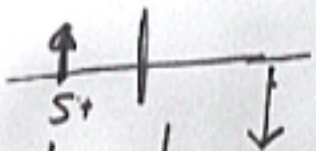
Enlarged : $|M|>1$

Real : $s'>0$

conv $f=10$ $f=+10\,cm$

$h=1\,cm$ $s=15\,cm$

$$\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}$$



$$\frac{1}{s'}=\frac{1}{f}-\frac{1}{s}=\frac{1}{+10}-\frac{1}{15}$$

$$=\frac{3}{30}-\frac{2}{30}=\frac{1}{30}$$

$$s'=+30$$

$$M=-\frac{s'}{s}=-\frac{30}{15}=-2$$

inverted : $M<0$ (-)

Enlarged : $|M|>1$

Real : $s'>0$

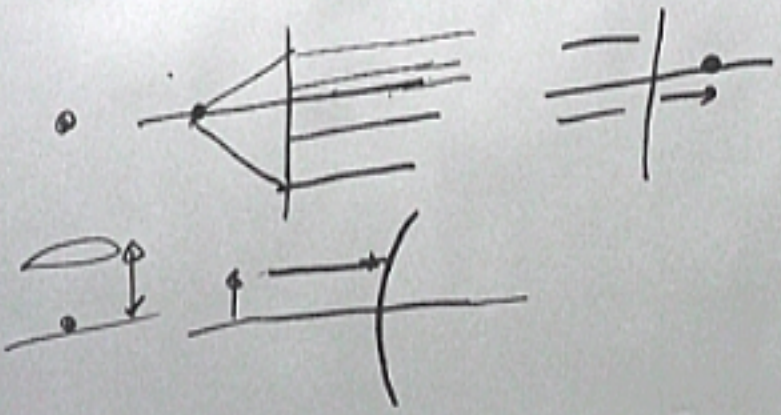
$f = 10\,cm \quad (f+)$

$R = 1\,cm$

$s = 10\,cm$

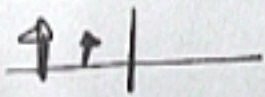
$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \Rightarrow \frac{1}{s'} = \frac{1}{+10} - \frac{1}{+10} = 0$

$s' = \infty$ No image forms



$f<0$
diverg

$f>0$
conv



Virtual
$s'<0$
upright
$M>0$
Reduced
$|M|<1$

$f = -10\text{cm}$

$h = 1\text{ cm}$ $\quad s = +10\text{cm}$

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \Rightarrow \frac{1}{s'} = \frac{1}{f} - \frac{1}{s}$$

$$\frac{1}{s'} = \frac{1}{-10} - \frac{1}{+10} = -\frac{2}{10} \therefore s' = -5$$

$$M = -\frac{s'}{s} = -\frac{-5}{10} = +\frac{1}{2}$$