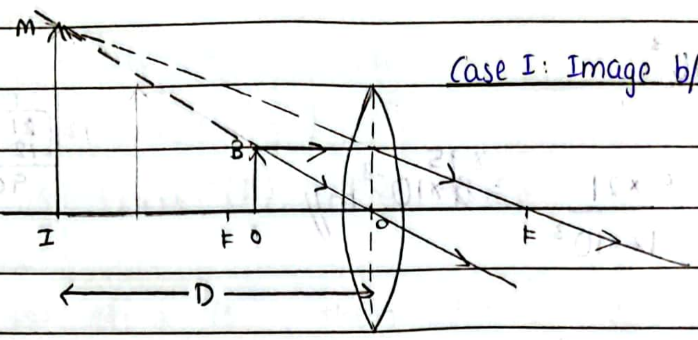
OPTICAL INSTRUMENTS

- SIMPLE MICROSCOPE

A magnifying lens is called a simple microscope



Case I: Image b/w F & O:-

we have magnification,

$$m = \frac{v}{u}$$

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

$$m = v \times \frac{1}{u}$$

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

$$m = v \times \left(\frac{1}{v} - \frac{1}{f}\right)$$

$$m = \left(1 - \frac{v}{f}\right)$$

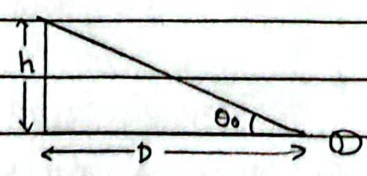
but $v = -D$

$$m = 1 - \left(\frac{-D}{f}\right)$$

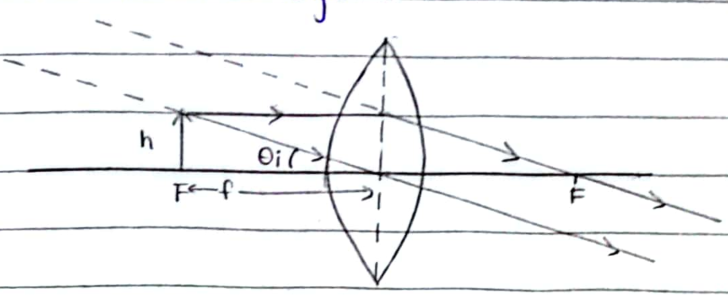
$$m = 1 + \frac{D}{f}$$

Case II : Image at infinity:-

Consider an object of height h, kept at a nearpoint of the eye. The object makes an angle θ_0 with the eye.



Let the same object be placed at the focus of a simple microscope. Then, the image will be formed at infinity and it makes an angle θ_i with the eye.



Angular magnification

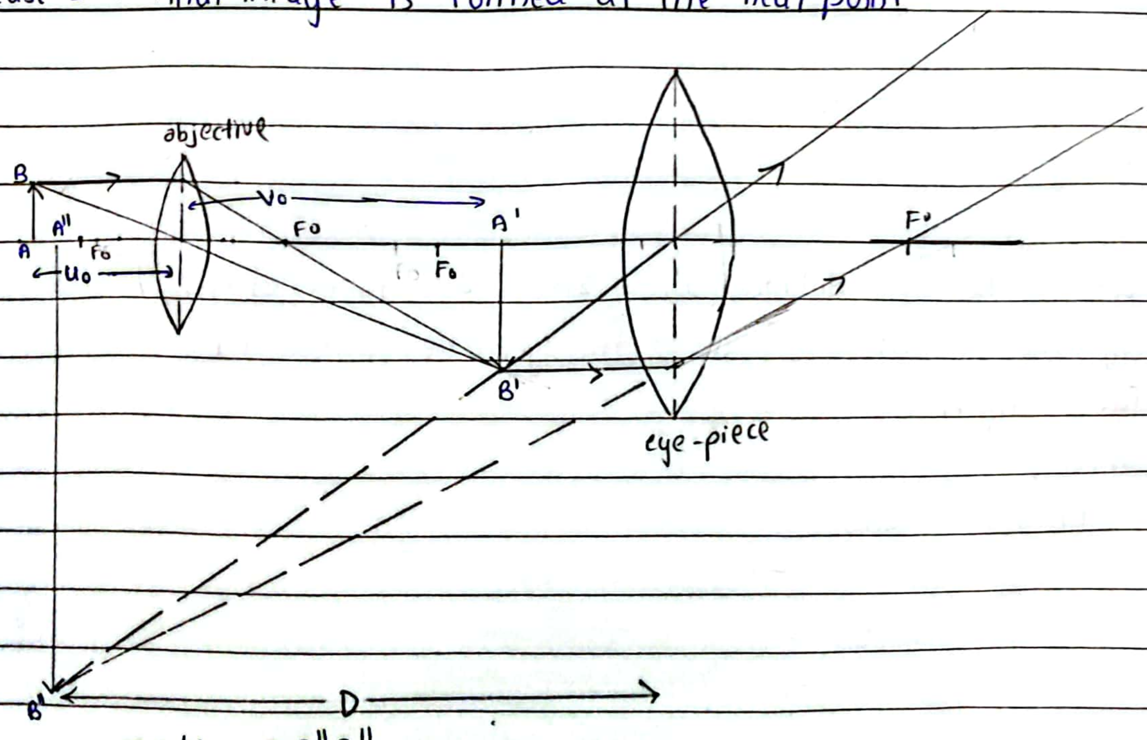
$$m = \frac{\theta_i}{\theta_o} = \frac{\tan\theta_i}{\tan\theta_o}$$

$$= \frac{h/f}{h/D}$$

$$m = \frac{D}{f}$$

- compound microscope

Case I : Final image is formed at the near point



$$m = \frac{h_i}{h_o} = \frac{A''B''}{AB}$$

$$= \left(\frac{A''B''}{A'B'}\right)\left(\frac{A'B'}{AB}\right)$$

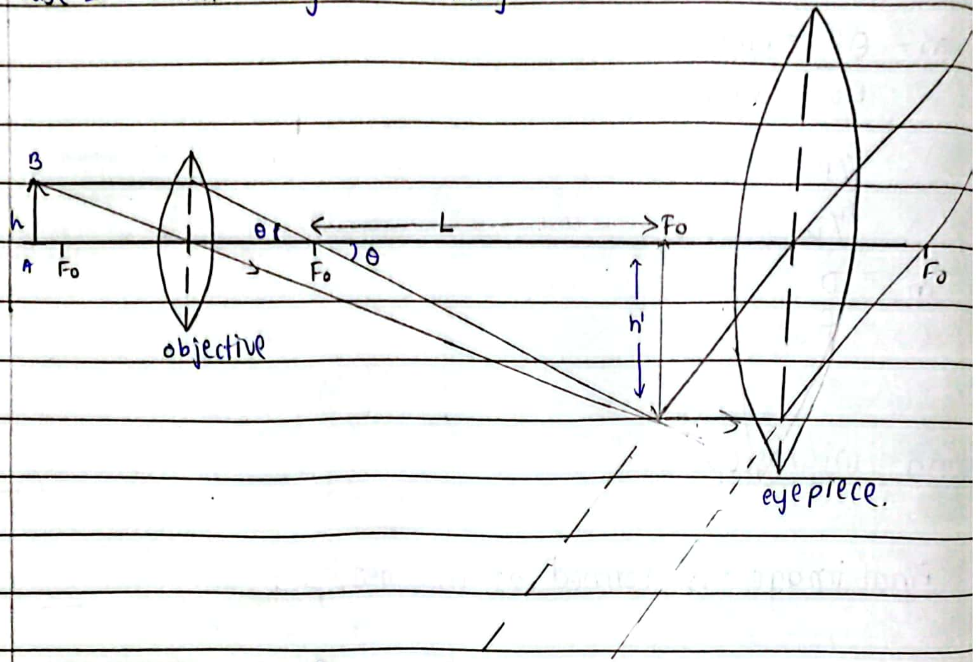
$$m = m_e \times m_o$$

$m = m_o \times m_e$

$m_o \rightarrow$ magnification of objective
$m_e \rightarrow$ magnification of eyepiece

$$m = \frac{V_o}{\mu_o}\left(1 + \frac{D}{f_e}\right)$$

Case II: Final image at infinity



$m = m_o \times m_e \longrightarrow (1)$

$$m = \frac{V_o}{u_o} \times \frac{D}{f_e}$$

Let L be the distance b/w the 2nd focus of the objective & the 1st focus of the eyepiece called the **Tube Length**

Then ;

From fig $\tan\theta = \frac{h'}{L}$

& $\tan\theta = \frac{h}{f_o}$

$$\frac{h'}{L} = \frac{h}{f_o}$$

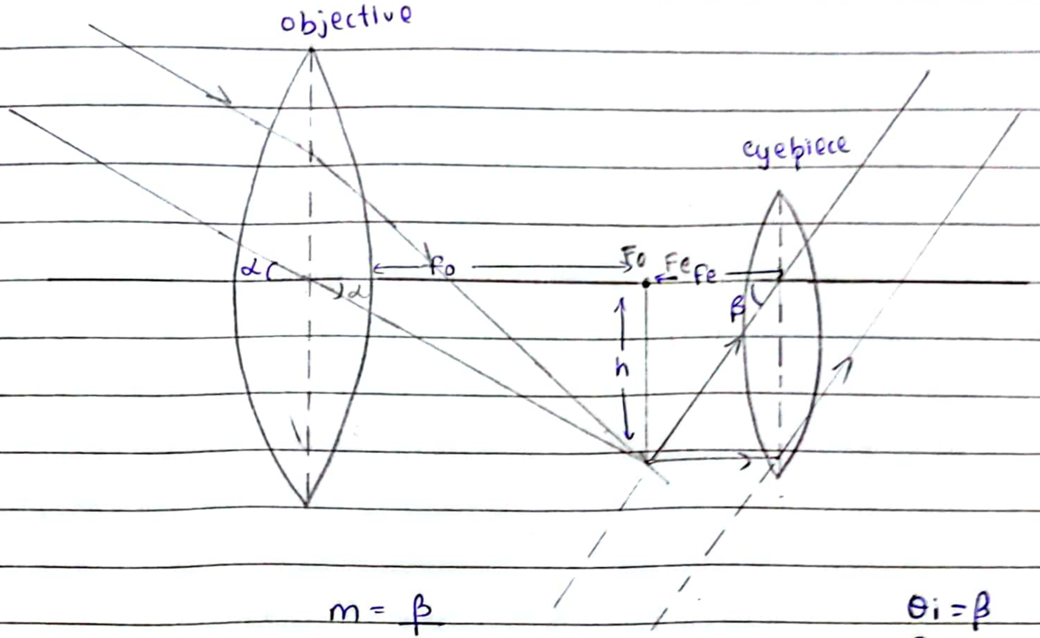
$$\frac{h'}{h} = \frac{L}{f_o}$$

$$m_o = \frac{L}{f_o}$$

$$m = \frac{L}{f_o} \times \frac{D}{f_e}$$

Telescope

case : ~~III~~ I : Final image at infinity



$$m = \frac{\beta}{\alpha}$$

$\theta_i = \beta$
$\theta_o = \alpha$

$$= \frac{\tan\beta}{\tan\alpha}$$

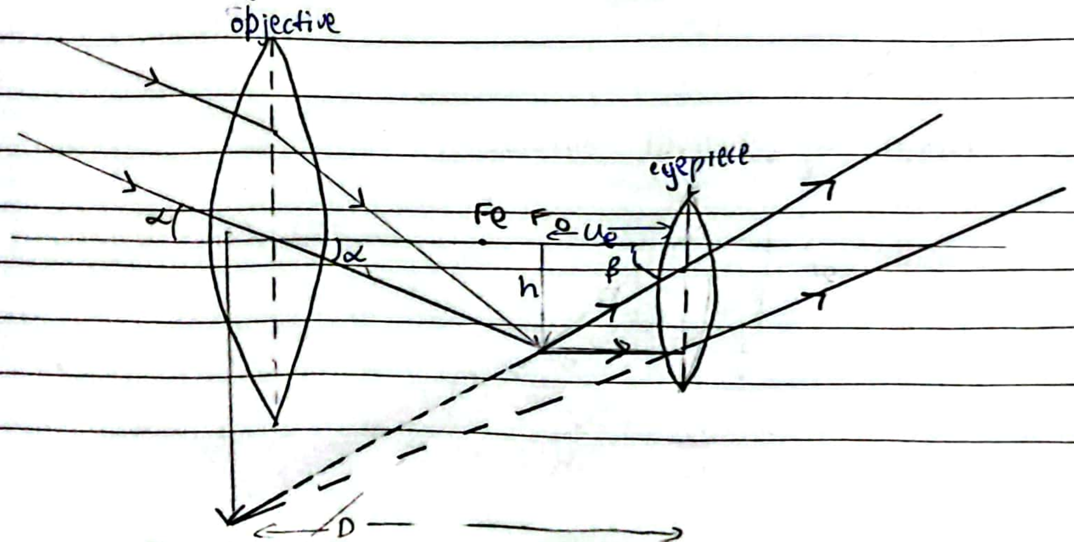
$$= \frac{h/f_e}{h/f_o}$$

$$m = \frac{f_o}{f_e}$$

Length of telescope $= f_o + f_e$

∴ Final image is formed at eyepiece

Case II Final image is formed at nearpoint.



$$m = \frac{\beta}{\alpha}$$

$$= \frac{\tan\beta}{\tan\alpha}$$

$$= \frac{h/u_e}{h/f_o}$$

$$m = \frac{f_o}{u_e} \longrightarrow (1)$$

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

$$\frac{1}{f_e} = \frac{1}{-D} - \frac{1}{-u_e}$$

$$\frac{1}{u_e} = \frac{1}{f_e} + \frac{1}{D}$$

$$\therefore (1) = m = f_o\left(\frac{1}{f_e} + \frac{1}{D}\right)$$

$$m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$$