Session - 27 - Optics
(Optical Instruments - Telescope)

→ Recap

→ Telescopes

Recap.

→ Visual angle

→ Microscope → (M.P.) (Simple)
- → D/f
- → $(1 + D/f)$

↓

Comp.

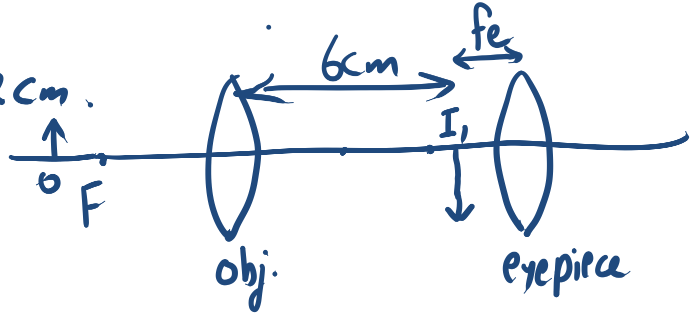
- $\dfrac{v_o}{u_o}\left(\dfrac{D}{f_e}\right)$ → $\dfrac{-LD}{f_o f_e}$
- $\dfrac{v_o}{u_o}\left(1 + \dfrac{D}{f_e}\right)$ → $-\dfrac{L}{f_o}\left(1 + \dfrac{D}{f_e}\right)$

Ex. 1. In a compound microscope,

$f_o = 1cm, \quad f_e = 2.5cm$

dist. of obj. from obj. lens = 1.2cm.

Find angular magnification & Length of tube.



$$M.P. = \frac{v_o}{u_o}\frac{D}{f_e}$$

$$\frac{1}{v} - \frac{1}{-1.2} = \frac{1}{f_o} = \frac{1}{1}$$

$v = 6\ cm$

$$M.P. = \frac{6}{-1.2} \times \frac{25}{2.5} = -50$$

$L = v_o + f_e = 6 + 2.5 = 8.5cm.$

$$\boxed{\frac{8.5 \times 25}{1 \times 2.5}}$$

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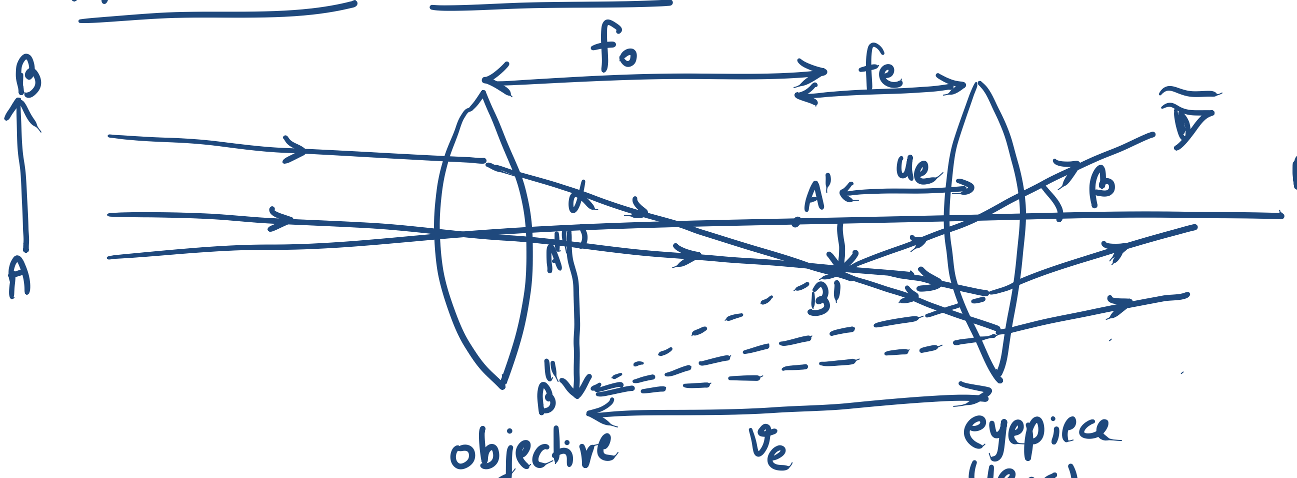
Telescopes → An optical instrument used to increase our visual angle to see magnified images of far away things.

- Astronomical telescope
  M.P. → −ve
  (2 convex lenses)
- Terrestrial telescope
  (M.P. → +ve)
  - (3 convex lenses)
  - (1 convex lens + 1 concave lens)
    (Galilean telescope)
- Cassegrain's telescope
  (using parabolic & convex mirror)

Astronomical Telescope



objective lens (large focal length & aperture)

eyepiece (lens) (small focal length & aperture)

$A''B'' \rightarrow v_e$ → $-\infty$ (normal cond^n) ; → $-D$ (LDDV)

$$M.P. = -\left|\frac{\beta}{\alpha}\right|$$

$$= -\frac{|A'B'/u_e|}{|A'B'/f_o|}$$

$$= -\frac{f_o}{|u_e|}$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad \text{(for eyepiece)}$$

$v = -\infty$:

$$\frac{1}{-\infty} - \frac{1}{-|u_e|} = \frac{1}{f_e}$$

$$\frac{1}{|u_e|} = \frac{1}{f_e}$$

$v = -D$:

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

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

Astronomical Telescope

when v @ -∞

$$M.P. = -\frac{f_o}{|u_e|}$$

$$\boxed{M.P. = -\frac{f_o}{f_e}}$$

$$\boxed{L = f_o + f_e}$$

when v @ -D

$$M.P. = -\frac{f_o}{|u_e|}$$

$$\left(\frac{1}{|u_e|} = \frac{1}{D} + \frac{1}{f_e}\right)$$

$$M.P. = -f_o\left(\frac{1}{D} + \frac{1}{f_e}\right)$$

$$\boxed{M.P. = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)}$$

$$L = f_o + |u_e|$$

$$\boxed{L = f_o + \frac{f_e D}{f_e + D}}$$

Ex. 1 **Astronomical Telescope**

↳ M.P. = 10

$f_e = 20cm$.

Find f_o.

Normal cond^n → Assume

$V \to -\infty$.

$M.P = -\frac{f_o}{f_e}$

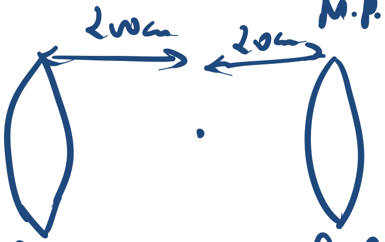
$-10 = -\frac{f_o}{20}$

$\Rightarrow \boxed{f_o = 200cm}$

$-\infty$.

$-\infty$

Ex. 2. If obj & eye piece are interchanged find ratio of $\frac{M.P_f}{M.P_i}$

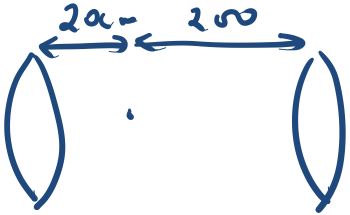


$f_o = 200cm$ $f_e = 20cm$

$M.P_i = -f_o/f_e$

$= -\frac{200}{20}$

$= -10$



$f_o = 20cm$ $f_e = 200cm$

$M.P_f = -f_o/f_e$

$= -\frac{20}{200}$

$= 1/10$

$\boxed{\frac{M.P_f}{M.P_i} = \frac{1}{100}}$

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Ex 3. Astronomical telescope

M.P. = 8

lenses are 45 cm apart

Find f_o & f_e.

$$M.P. = -\frac{f_o}{f_e} = -8$$

$$f_o + f_e = 45\text{ cm}.$$

$$9f_e = 45$$

$$f_e = 5\text{ cm}$$

$$f_o = 40\text{ cm}$$

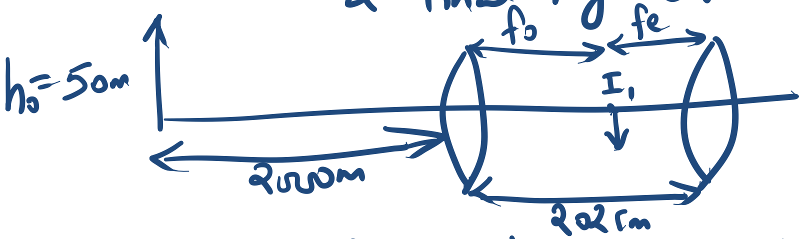
Ex 4 Astronomical telescope

↳ $f_o = 200\text{ cm}$

$f_e = 2\text{ cm}.$

50 m tall building @ 2 km from telescope.

Find height of img of building thru obj. lens & find img also.

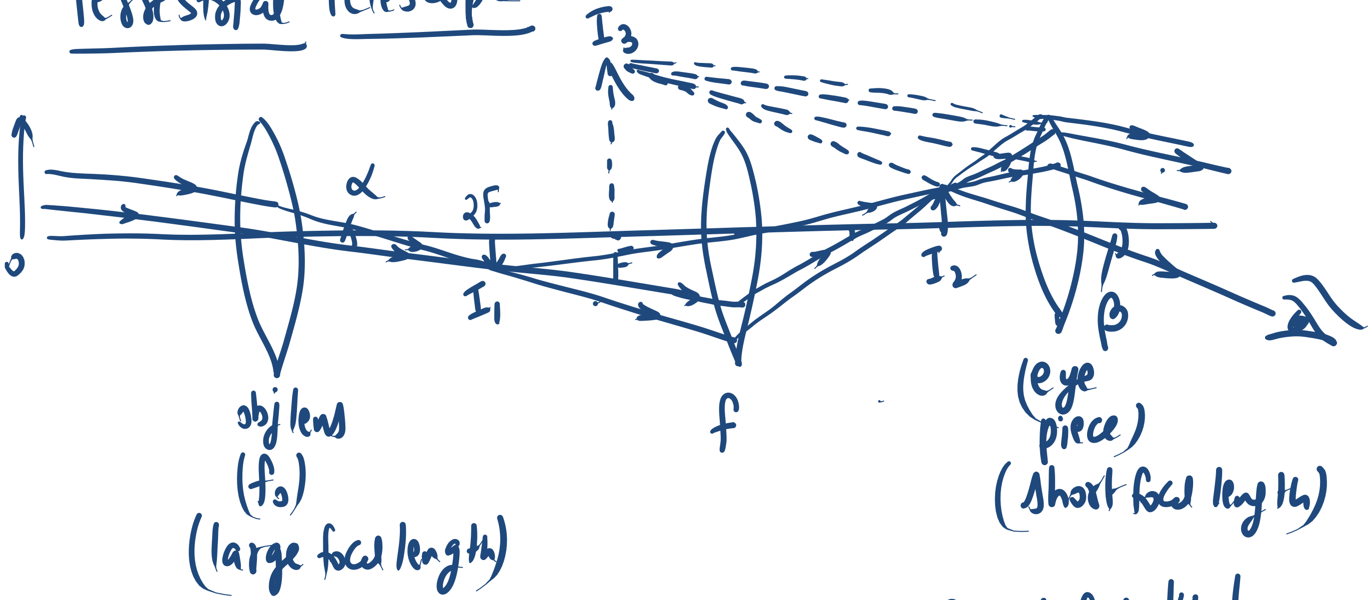


$$m = \frac{v}{u} = \frac{2m}{-2000} = \frac{-h_{I_1}}{50}$$

$$h_{I_1} = \frac{2\times 50}{2000}\text{ m} = 5\text{ cm}$$

$h_{I_2} \to \infty.$

Terrestrial Telescope



$$L = f_o + 4f + f_e$$

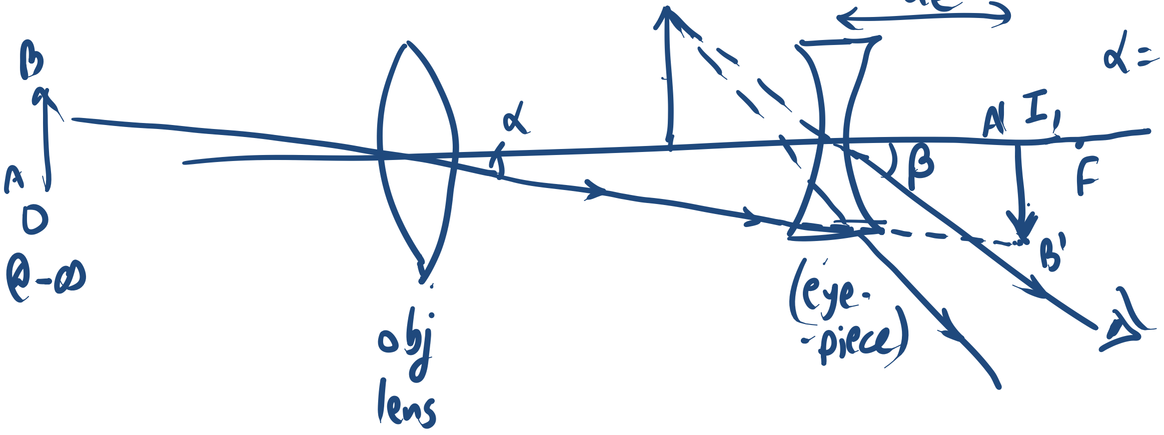
$$M.P. = \frac{f_o}{f_e}$$

$$L = f_o + 4f + |u_e|$$

$$= f_o + 4f + \frac{f_e D}{f_e + D}$$

$$M.P. = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$$

Galilean's Telescope



$\beta = \frac{A'B'}{u_e}$

$\alpha = \frac{A'B'}{f_o}$

R V

R V

$M.P. = \left|\beta/\alpha\right| = \frac{f_o}{|u_e|}$

$= +\frac{f_o}{|f_e|}$

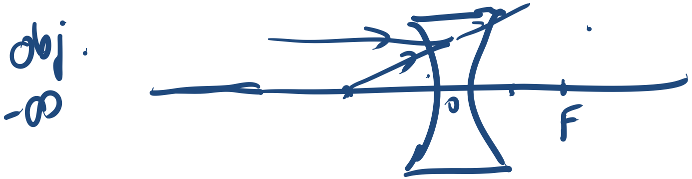
$L = f_o - |f_e|$

$v = -\infty$

v @ $-D$

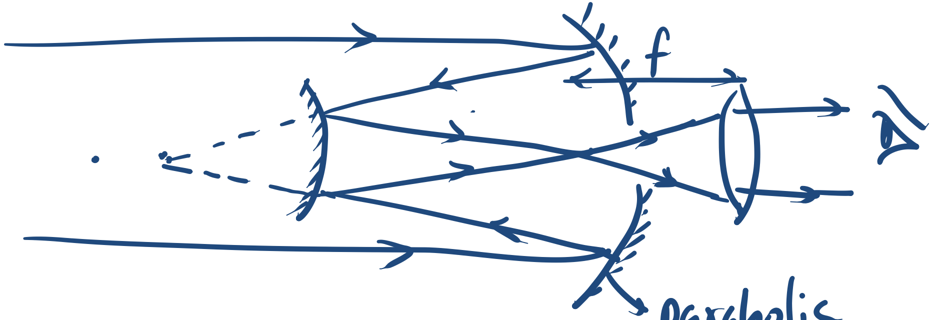
$M.P. = \frac{f_o}{|f_e|}\left(1 + \frac{f_e}{D}\right)$

$$L = f_o - |u_e|$$



Cassegrain's Telescope

uses (parabolic Mirror & a convex mirror)



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

$v = \infty$