PRAYAS

JEE 2025

Lecture-11 | **Physics**

[redacted] Ray optics

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Topics *to be covered*

1 # Optics Instruments

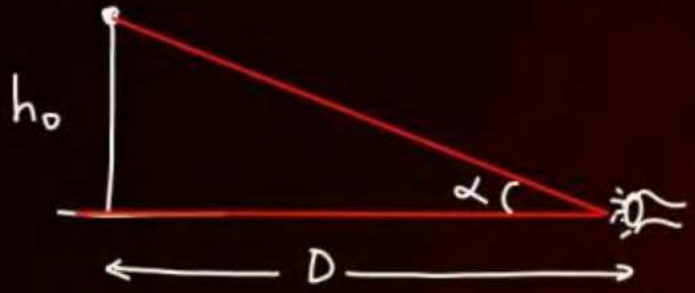
ATDB.uno

2 #

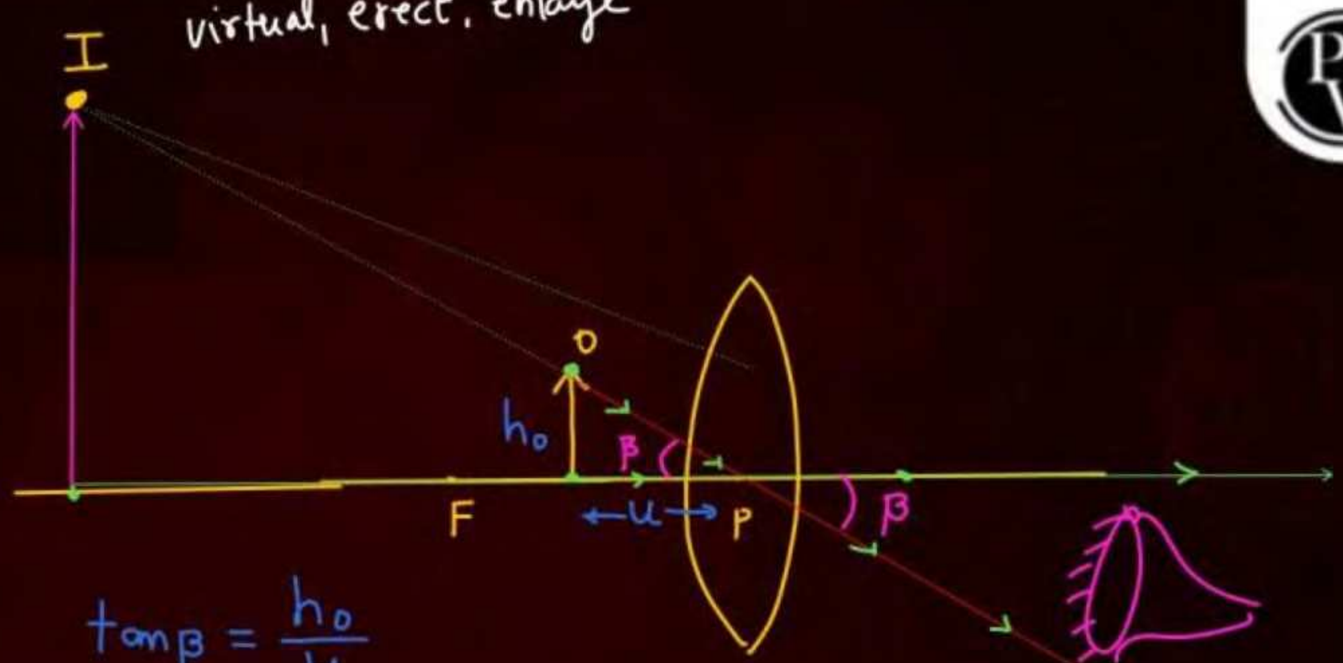
3 #

4 #

Simple microscope



$$\tan\alpha = \frac{h_o}{D}$$



$$\tan\beta = \frac{h_o}{u}$$

$$\text{magnifying power} = \text{M.P.} = \frac{\beta}{\alpha} \approx \frac{h_o|-u}{h_o|-D} = \frac{D}{u}$$

* The maximum distance, which a person can see things without help of चश्मा spectacles is known as FAR POINT. (for normal eye far point is ∞)

* The minimum distance which a person can see without help of चश्मा spectacles (without Strain) is known as NEAR POINT. For normal eye near point is taken as 25 cm.

Near point ⇛ Least distance of distinct Vision. ⇚

Simple Microscope

$$m.p = \frac{D}{u}$$

① final image at ∞

$u = f$ (magnitude)

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

$D = 25\ cm$

② final image at $v = -D$ (least distance of distinct vision)

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

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

$$m.p = 1 + D/f$$

$$-\frac{1}{D} + \frac{1}{u} = \frac{1}{f}$$

$$mp = \frac{D}{u} = \frac{D}{f} + \frac{D}{D}$$

Simple microscope

$$mp = \frac{D}{u}$$

① find image at ∞, $v = -\infty$

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

② $v = -D$, $mp = 1 + \frac{D}{f}$

Compound u-scope

$$mp = \frac{v_0}{u_0}\frac{D}{u_e} \quad \text{(magnitude)}$$

① find image at ∞, $v = -\infty$

$$mp = \frac{v_0}{u_0}\frac{D}{f_e} \quad \text{(magnitude)}$$

② $v = -D$,

$$mp = \frac{V_0}{u_0}\left(1 + \frac{D}{f_e}\right) \quad (\text{''})$$

Astronomical Telescope

$$mp = \frac{f_0}{u_e}$$

① find image at ∞, $v = -\infty$

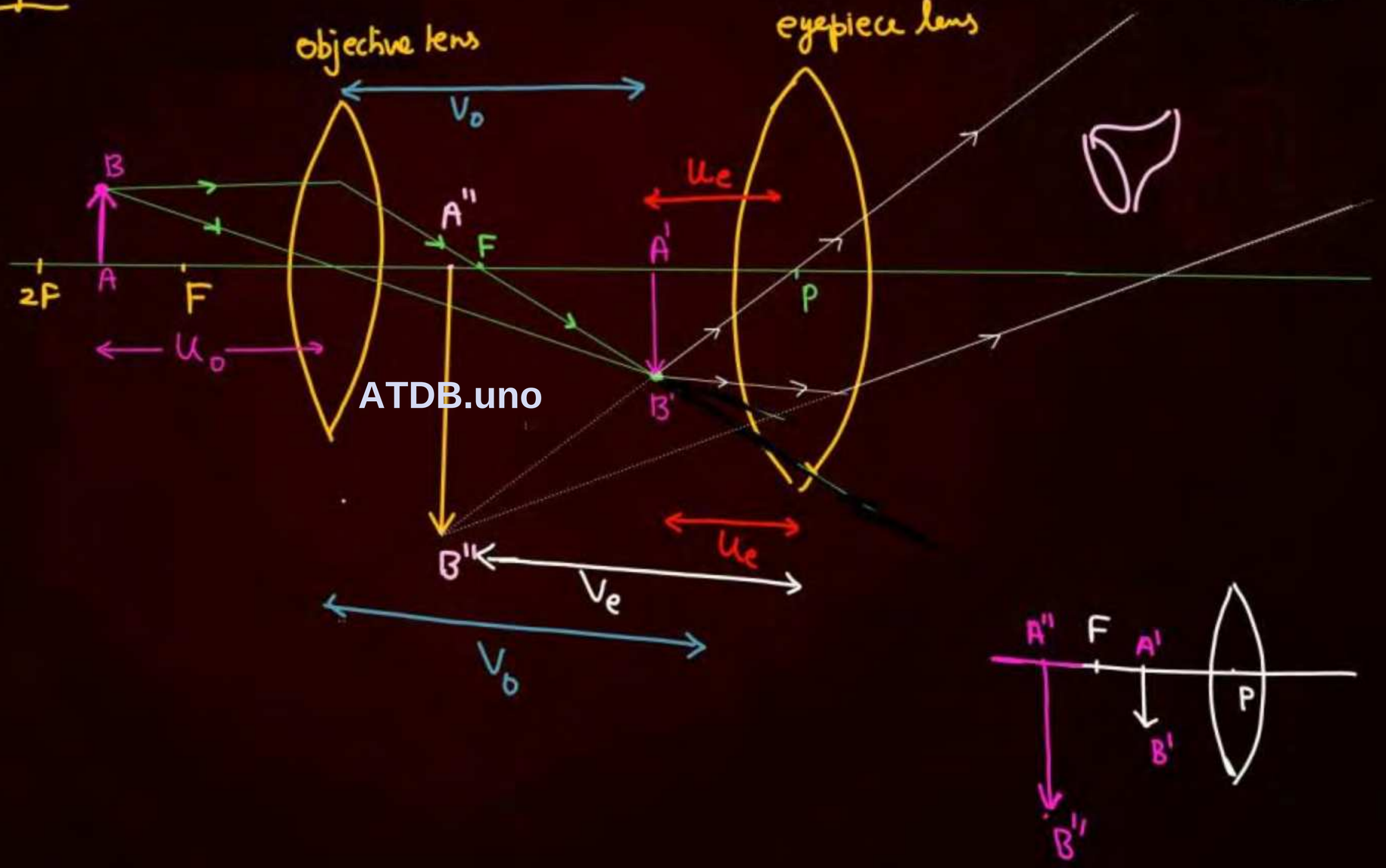
$$mp = \frac{f_0}{f_e} \text{ (magnitude)}$$

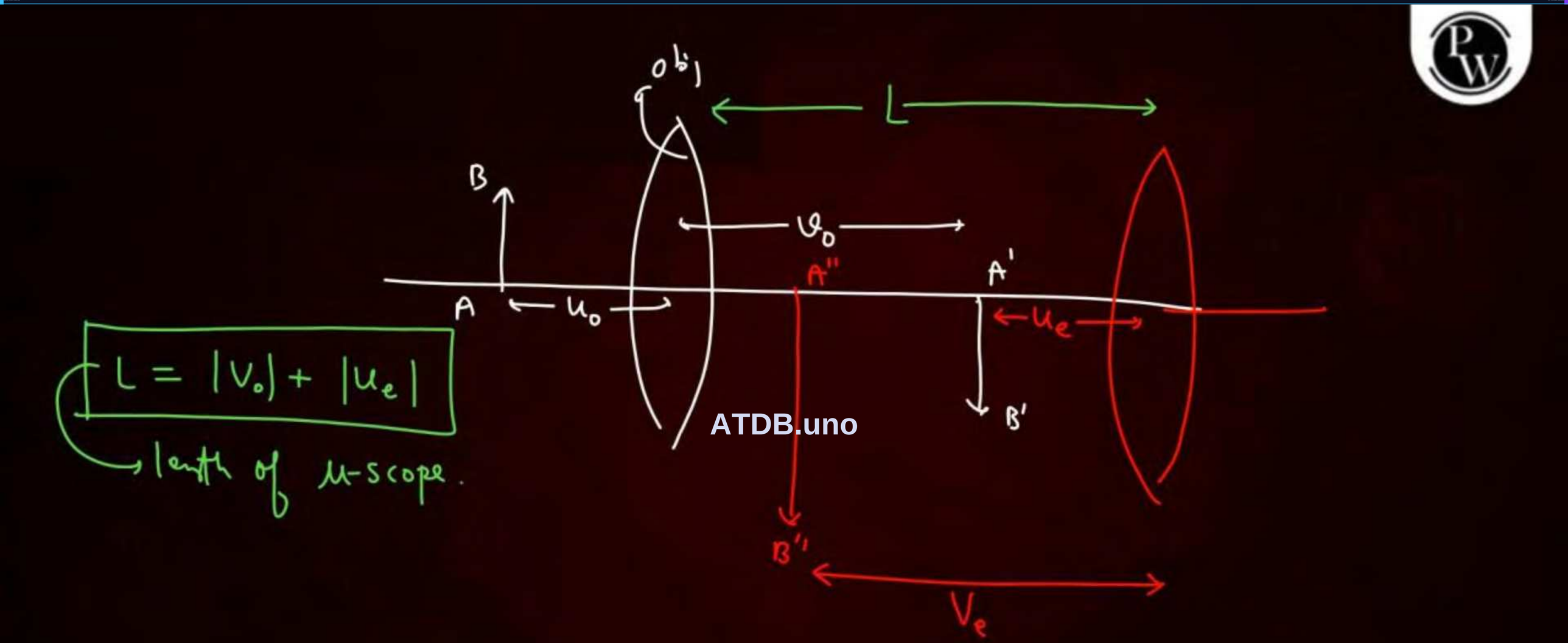
$$mp = -\frac{f_0}{f_e}$$

② $v = -D$

$$mp = -\frac{f_0}{f_e}\left(1 + \frac{f_e}{D}\right)$$

Compound minoscope



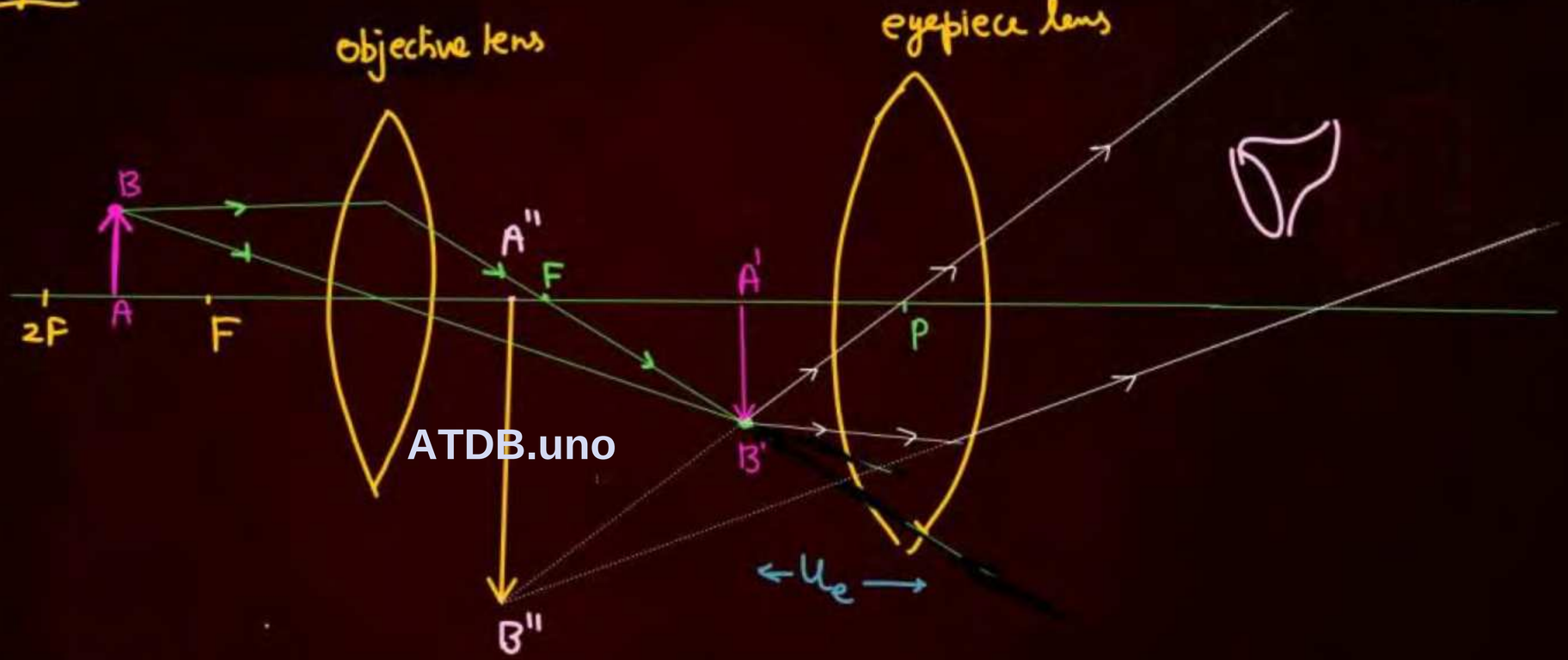


$$L = |v_o| + |u_e|$$

↳ length of μ-scope.

Compound Microscope

$$m \cdot p = \frac{\beta}{\alpha} = \frac{v_0}{u_0} \frac{D}{u_e}$$



① final image at '∞'

$u_e = f$ (magnitude)

$$m_p = \frac{v_0}{u_0} \frac{D}{f} \quad (\text{''})$$

② final image at least dist - of distinct vision

$V = -D$

(2)

$$v_e = -D$$

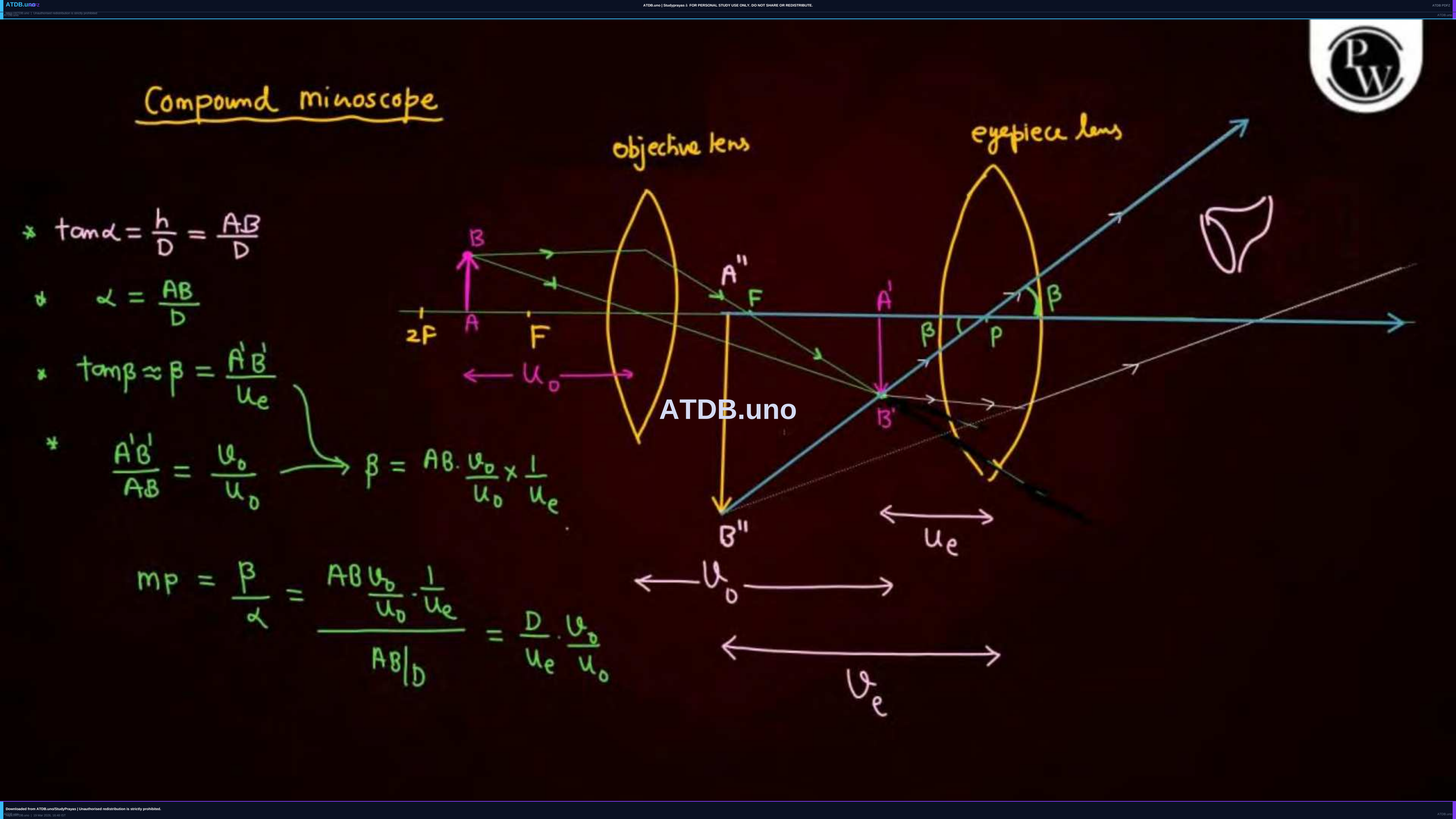
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

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

$$\frac{D}{u_e} = \frac{D}{f} + \frac{D}{D}$$

$$\boxed{m_p = \frac{v_0}{u_0}\left(1 + \frac{D}{f}\right)} \text{ magnitude.}$$

Compound minoscope



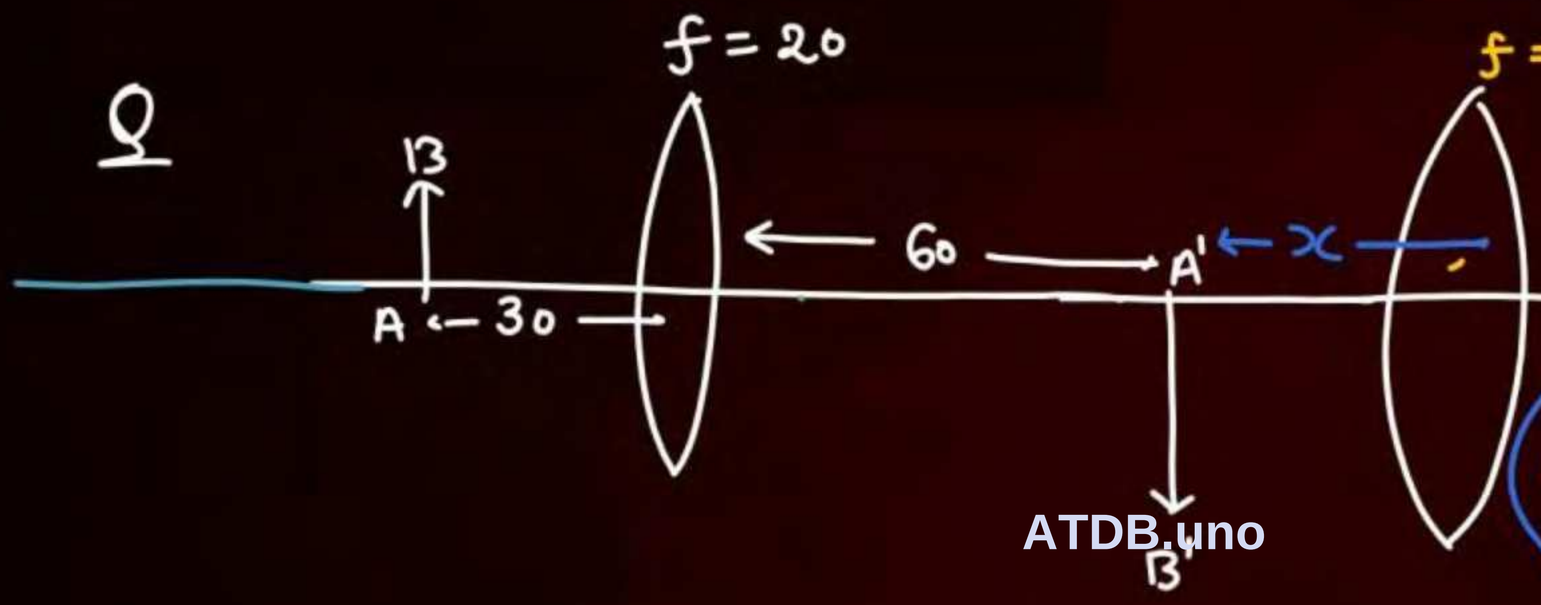
* $\tan\alpha = \frac{h}{D} = \frac{AB}{D}$

* $\alpha = \frac{AB}{D}$

* $\tan\beta \approx \beta = \frac{A'B'}{u_e}$

* $\frac{A'B'}{AB} = \frac{v_0}{u_0} \longrightarrow \beta = AB \cdot \frac{v_0}{u_0} \times \frac{1}{u_e}$

$$mp = \frac{\beta}{\alpha} = \frac{AB\frac{v_0}{u_0}\cdot\frac{1}{u_e}}{AB/D} = \frac{D}{u_e}\cdot\frac{v_0}{u_0}$$



final image ∞ पर

$$m_p = \frac{v_o}{u_o}\frac{D}{f_e} = \frac{60}{30} \times \frac{25}{40}$$

$$m_p = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right)$$

Ex. A thin convex lens of focal length 5 cm is used as a simple microscope by a person with normal near point (25 cm). What is the magnifying power of the microscope ?

Simple uscope

$$MP = 1 + \frac{D}{f_e} = 1 + \frac{25}{5} = 6$$

(for least distance of distinct vision)

final image at ∞

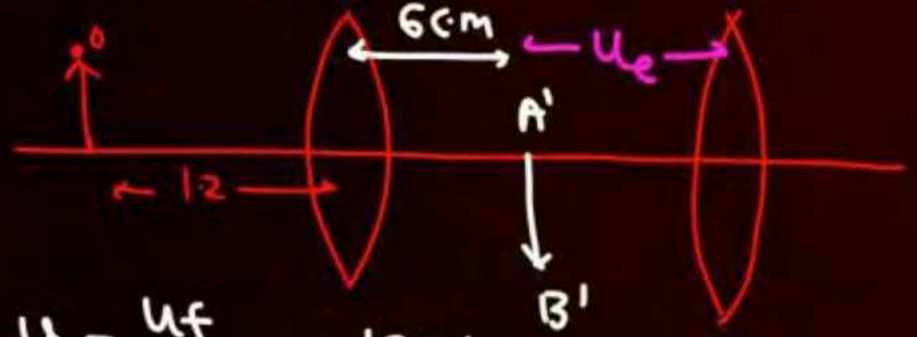
$$mp = \frac{D}{f} = \frac{25}{5} = 5$$

A compound microscope has an objective of focal length 1 cm and an eyepiece of focal length 2·5 cm. An object has to be placed at a distance of 1·2 cm away from the objective for normal adjustment. (a) Find the angular magnification. (b) Find the length of the microscope tube.

(mf)

① final image at ∞ $u_e = f_e = 2.5$

$f_o = 1$ $f = 2.5$



$$v = \frac{u_f}{u_f} = \frac{-1.2 \times 1}{-1.2+1} = 6$$

$$mP = \frac{v_o}{u_o}\frac{D}{f_e} = \frac{6}{1.2} \times \frac{25}{2.5} = 5 \times 10 = 50$$

(Magnitude)

$L = 6 + 2.5 = 8.5$

$mP = -50$

4. A compound microscope consists of an objective of focal length 1·0 cm and an eyepiece of focal length 5·0 cm separated by 12·2 cm. (a) At what distance from the objective should an object be placed to focus it properly so that the final image is formed at the least distance of clear vision (25 cm)? (b) Calculate the angular magnification in this case.

(b) If final image at least distance of dist vision. $MP = \frac{v_0}{u_0}\left(1+\frac{D}{f_e}\right)$

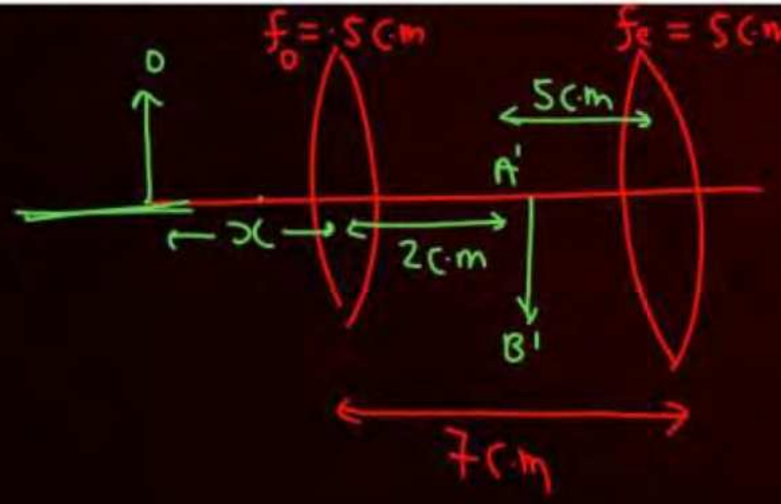
(next page sol^n)

copy

5. *The separation L between the objective (f = 0·5 cm) and the eyepiece (f = 5 cm) of a compound microscope is 7 cm. Where should a small object be placed so that the eye is least strained to see the image? Find the angular magnification produced by the microscope.*

$v_f = \infty$

$MP = \frac{v_0}{u_0}\frac{D}{f_e} = \frac{2}{2/3} \times \frac{25}{5}$



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

$$\frac{1}{2} - \frac{1}{-x} = \frac{1}{\cdot 5}$$

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

$u_e = u_e = 2/3$

$= 3 \times 5$

$= 15$

$MP = -15$

(b) $v_e = -25$ (for L_2)

$f_e = 5$

$u_e = ?$ solve करो

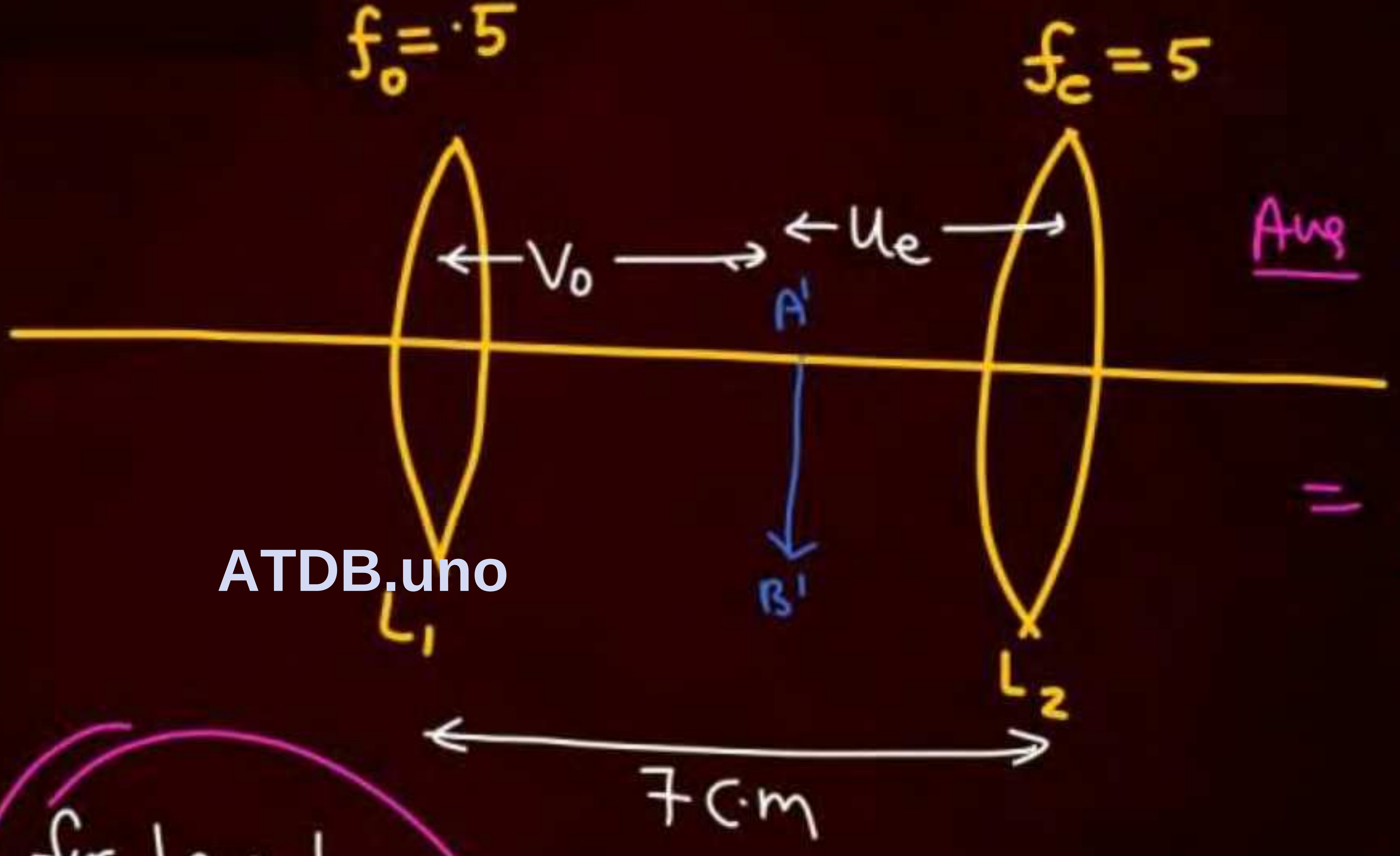
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{-25} - \frac{1}{-u_e} = \frac{1}{5}$$

$$\boxed{u_e = \frac{25}{6}}$$

$$V_0 = L - |u_e|$$

$$V_0 = 7 - \frac{25}{6} = \frac{17}{6}$$



for Lens L_1

$f_0 = \cdot 5$

$v_0 = +17/6$

$u_0 = ?$

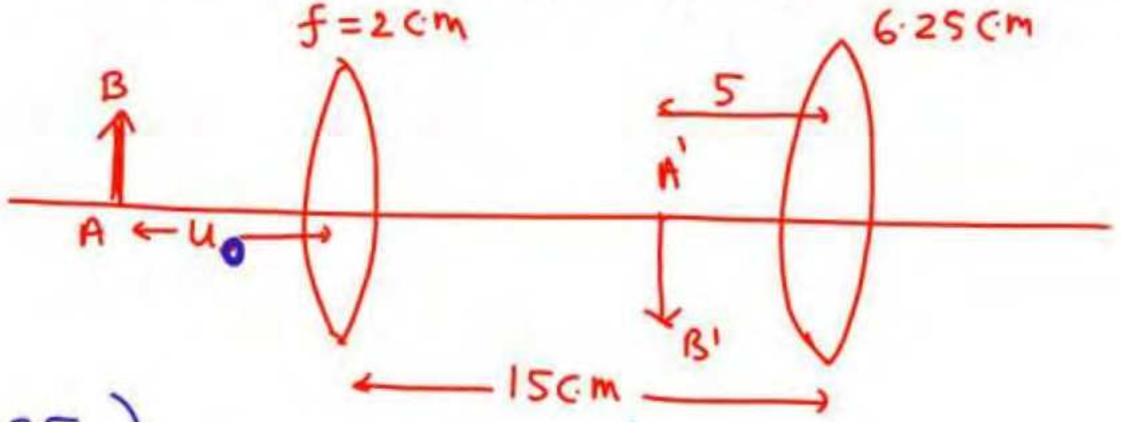
$\equiv u_0 = ✓$

Ans $\frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$

$$= \frac{\frac{17}{6}}{u_0}\left(1 + \frac{25}{5}\right)$$

EX. A compound microscope consists of an objective lens of focal length 2.0 cm and an eye piece of focal length 6.25 cm, separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at (a) the least distance of distinct vision (25 cm) (b) infinity?

Must



Ans (a) 20 ✓
(b) 13.51

(a) $v_e = -25$, $f_e = 6.25$ } $u_e = -5$ cm Solve करके

$L = |v_0| + |u_e|$

$V_0 = L - |u_e|$

$V_0 = 15 - 5 = 10$

for Lens L_1

$\frac{1}{10} - \frac{1}{-u_0} = \frac{1}{2}$

$u_0 = 2.5$

$m_p = \frac{V_0}{u_0}\left(1 + \frac{D}{f_e}\right) = \frac{10}{2.5}\left(1 + \frac{25}{6.25}\right) = 4(1+4) = 20$

Ex. A compound microscope consists of an objective lens of focal length 2.0 cm and an eye piece of focal length 6.25 cm, separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at (a) the least distance of distinct vision (25 cm) (b) infinity?

Must

Ans (a) 20

(b) 13.51

47. A simple microscope has a focal length of 5 cm. The magnification at the least distance of distinct vision is

(a) 1 (b) 5

(c) 4 (d) 6

$1+\frac{D}{f_e}=1+\frac{25}{5}=6$

48. In a compound microscope, the intermediate image is

(a) Virtual, erect and magnified

(b) Real, erect and magnified

(c) Real, inverted and magnified

(d) Virtual, erect and reduced

$f_e=5$

$mP=10=\frac{f_o}{f_e}$

$f_o=50$

Ans $\frac{f_o}{f_e}\left(1+\frac{f_e}{D}\right)=\frac{50}{5}\left(1+\frac{5}{25}\right)=10\left(1+\frac{1}{5}\right)$

∞ पर $=12$

49. An astronomical telescope has an eyepiece of focal length 5 cm. If the angular magnification in normal adjustment is 10 when final image is at least distance of distinct vision (25 cm) from eye piece, then angular magnification will be:

(a) 10 (b) 12

(c) 50 (d) 60

51. If the focal length of objective and eye lens are 1.2 cm and 3 cm respectively and the object is put 1.25 cm away from the objective lens and the final image is formed at infinity. The magnifying power of the microscope is:

(*a*) 150 (*b*) 200

(*c*) 250 (*d*) 400

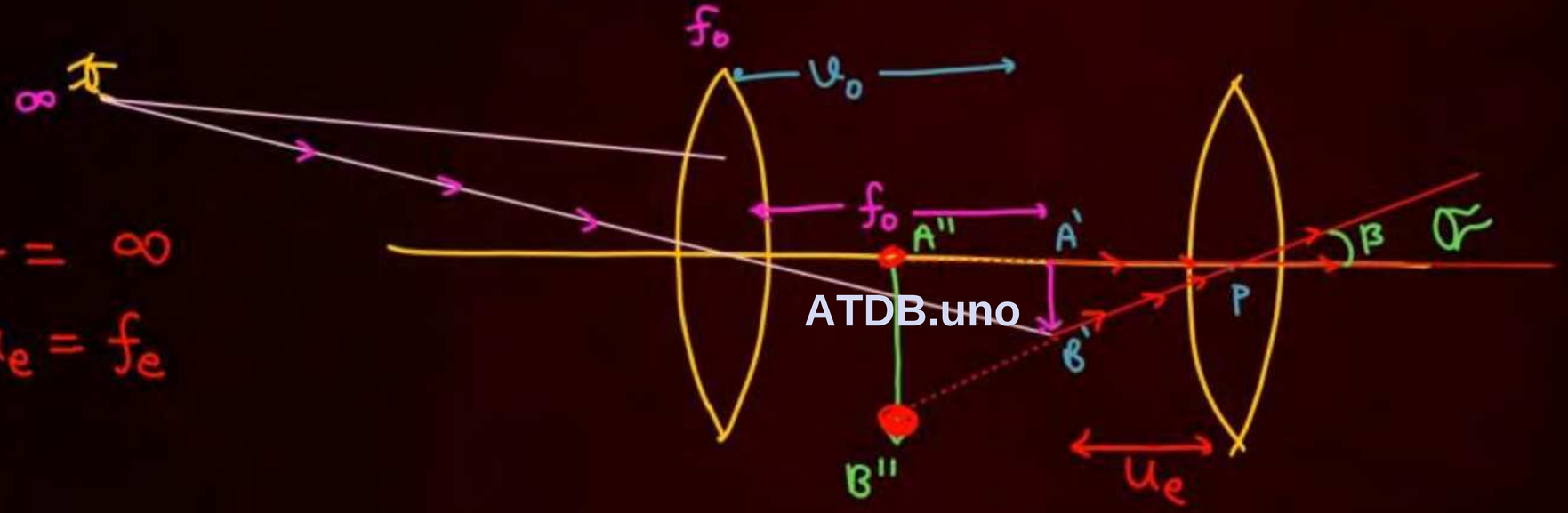
52. An astronomical telescope has a magnifying power 10. The focal length of the eye piece is 20 cm. The focal length of the objective is

$m_p = \frac{f_o}{f_e}$ $10 = \frac{f_o}{20}$

(*a*) 2 cm (*b*) 200 cm

(*c*) (1/2) cm (*d*) (1/200) cm

Telescope

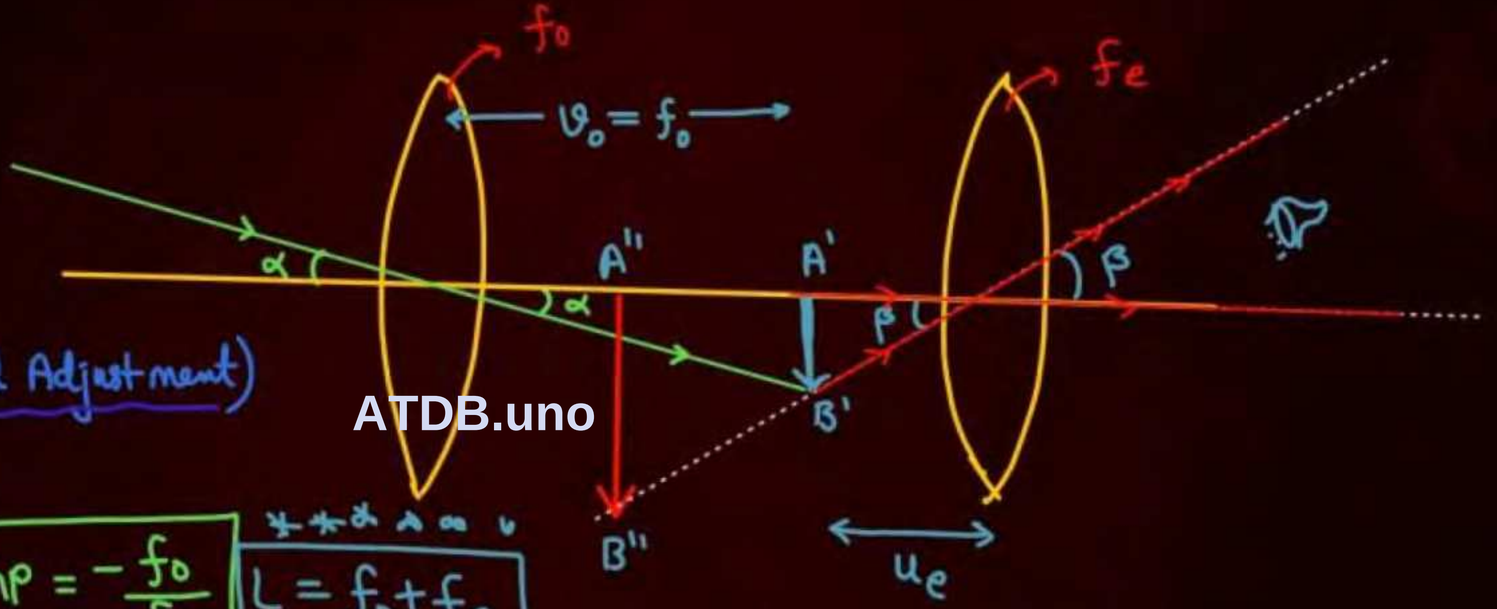


① $v = \infty$

$u_e = f_e$

Astronomical Telescope

$$M.P. = \frac{\beta}{\alpha} = \frac{A'B'/u_e}{A'B'/f_o} = \frac{f_o}{u_e}$$



① final image at ∞, (Normal Adjustment)

$v_e = \infty$, $u_e = -f_o$

$m_p = \frac{f_o}{f_e}$ (magnitude), $\boxed{m_p = -\frac{f_o}{f_e}}$ $\boxed{L = f_o + f_e}$

$L = f_o + |u_e|$

② final image at $v_e = -D$

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

$L = f_o + |u_e|$

$$m_P = \frac{f_o}{u_e}$$

Case 2

$$u_e = -D$$

eyepiece for L_2

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

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

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

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

$$m_P = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) \text{ (magnitude)}$$

Q focal length of objective & eyepiece lens of astronomical telescope is 60 cm & 5 cm. find m.p. & length of telescope if final image is at ① ∞ ② Least distance of Distinct Vision

Sol^n (a) $f_o = 60$ $f_e = 5$

final image at ∞

$$mp = -\frac{f_o}{f_e} = -\frac{60}{5} = -12$$

$$L = f_o + f_e = 60 + 5 = 65$$

(b)

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

$$= -\frac{60}{5}\left(1 + \frac{5}{25}\right) = -12 \times \frac{6}{5}$$

$$L = f_o + |u_e|$$

for L_2

$u_e = -25$
$f_e = 5$

$u_e = \checkmark$

telescope $\equiv$ $m_p = \frac{f_o}{f_e}$

$L = f_o + f_e$

} $v = \infty$ Normal adjust.

102. In a compound microscope, the intermediate image, in normal use is

(A) Virtual, erect and magnified

(B) Real, erect and magnified

(C) Real, inverted and magnified

(D) Virtual, inverted and magnified

संयुक्त सूक्ष्मदर्शी में, मध्यस्थ प्रतिबिम्ब होता है-

(A) आभासी, सीधा तथा आवर्धित

(B) वास्तविक, सीधा तथा आवर्धित

(C) वास्तविक, उल्टा तथा आवर्धित

(D) आभासी, उल्टा तथा आवर्धित

Ans. (C)

103. If tube length of astronomical telescope is 105 cm and magnifying power is 20 for normal setting. Calculate the focal length of objective :–

यदि खगोलीय दूरदर्शी के नली की लम्बाई 105 सेमी एवं आवर्धन 20 है तो सामान्य समायोजन के लिये अभिदृश्यक की फोकस दूरी होगी–

(A) 100 cm (B) 10 cm (C) 20 cm (D) 25 cm

Ans. (A)

100,5

$f_o + f_e = 105$

$\frac{f_o}{f_e} = 20$

106. When the length of an astronomical telescope tube increases its magnifying power

(A) Decreases

(B) Increases

(C) Does not change

(D) May increase of decrease

$l \uparrow \Rightarrow u_e \uparrow$

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

जब खगोलिय दूरदर्शी की लम्बाई बढ़ाई जाती है, तो उसकी आवर्धन क्षमता

(A) घटती है

(B) बढ़ती है

(C) परिवर्तित नहीं होती

(D) बढ़ती अथवा घट सकती है

Ans. (A)

44 cm. The focal length of the objective is :–

किसी खगोलीय दूरदर्शी का कोणीय आवर्धन 10 गुना है जब अंतिम प्रतिबिम्ब अनन्त पर है एवं इसकी लम्बाई 44 सेमी है। अभिदृश्यक की फोकस दूरी होगी–

(A) 4 cm (B) 40 cm (C) 44 cm (D) 440 cm

Ans. (B)

40, 4

Q68. An astronomical telescope has an angular magnification of magnitude 5 for distance objects. The separation between the objective and the eye-piece is 36 cm and the final image is formed at infinity. The focal length f_0 of the objective and f_e of the eye-piece are

आकाशीय दूरदर्शी की कोणीय आवर्धन का परिमाण दूरस्थ वस्तुओं के लिए 5 हैं। अभिदृश्यक तथा नैत्रिका के बीच दूरी 36cm है और अन्तिम प्रतिबिम्ब अनन्त पर प्राप्त होता है। अभिदृश्यक की फोकस दूरी f_0 तथा नेत्रिका की फोकस दूरी f_e हैं

(A) $f_0 = 45$ cm and $f_e = -9$ cm

(B) $f_0 = 50$ cm and $f_e = 10$ cm

(C) $f_0 = 7.2$ cm and $f_e = 5$ cm

(D) $f_0 = 30$ cm and $f_e = 6$ cm

Ans. (D)

focal lengths of component lenses

दूरदर्शी की आवर्धन क्षमता 9 है और दोनों लैन्सों के मध्य दूरी 20 सेमी है तो घटक लैन्सों की फोकस दूरियाँ क्या हैं।

(A) 18cm, 2cm (B) 4cm, 16cm (C) 10cm, 10cm (D) 12cm, 8cm

Ans. (A)

18 + 2

Paragraph for Question 110 to 113

110. If an astronomical telescope has objective and eye-pieces of focal lengths 200 cm and 4 cm respectively, then the magnifying power of the telescope for the normal vision is
खगोलीय दूरदर्शी के अभिदृश्यक तथा नेत्रिका की फोकस दूरिया क्रमश: 200 cm तथा 4 cm हैं, तो सामान्य दृष्टि के लिए दूरदर्शी की आवर्धन क्षमता होगी-

(A) 42 (B) 50 (C) 58 (D) 204

Ans. (B)

111. In the above question the length of the telescope for normal vision, is
उपरोक्त प्रश्न में सामान्य दृष्टि के लिए दूरदर्शी की लम्बाई होगी -

(A) 204 cm (B) 200 cm (C) 196 cm (D) 203.45 cm

Ans. (A)

112. In the above question magnifying power of the telescope for distinct vision is
उपरोक्त प्रश्न में स्पष्ट दृष्टि के लिए दूरदर्शी का आवर्धन होगा

(A) 42 (B) 50 (C) 58 (D) 204

Ans. (C)

113. In the above question the length of the telescope for distinct vision is
उपरोक्त प्रश्न में स्पष्ट दृष्टि के लिए दूरदर्शी की लम्बाई होगी

(A) 204 cm (B) 200 cm (C) 196 cm (D) 203.45 cm

Ans. (D)

104. When length of a compound microscope tube increase, its magnifying power

(A) decreases (B) increases

(C) does not change (D) may increase or decrease

जब किसी संयुक्त सूक्ष्मदर्शी के नलिका की लम्बाई बढ़ायी जाती है, तो आवर्धन क्षमता

(A) घटती है (B) बढ़ती है (C) अपरिवर्तित रहती है (D) कम व अधिक हो सकती है

Ans. (A)

Home Work

— Chill. . . . करो आज

ATDB.uno