

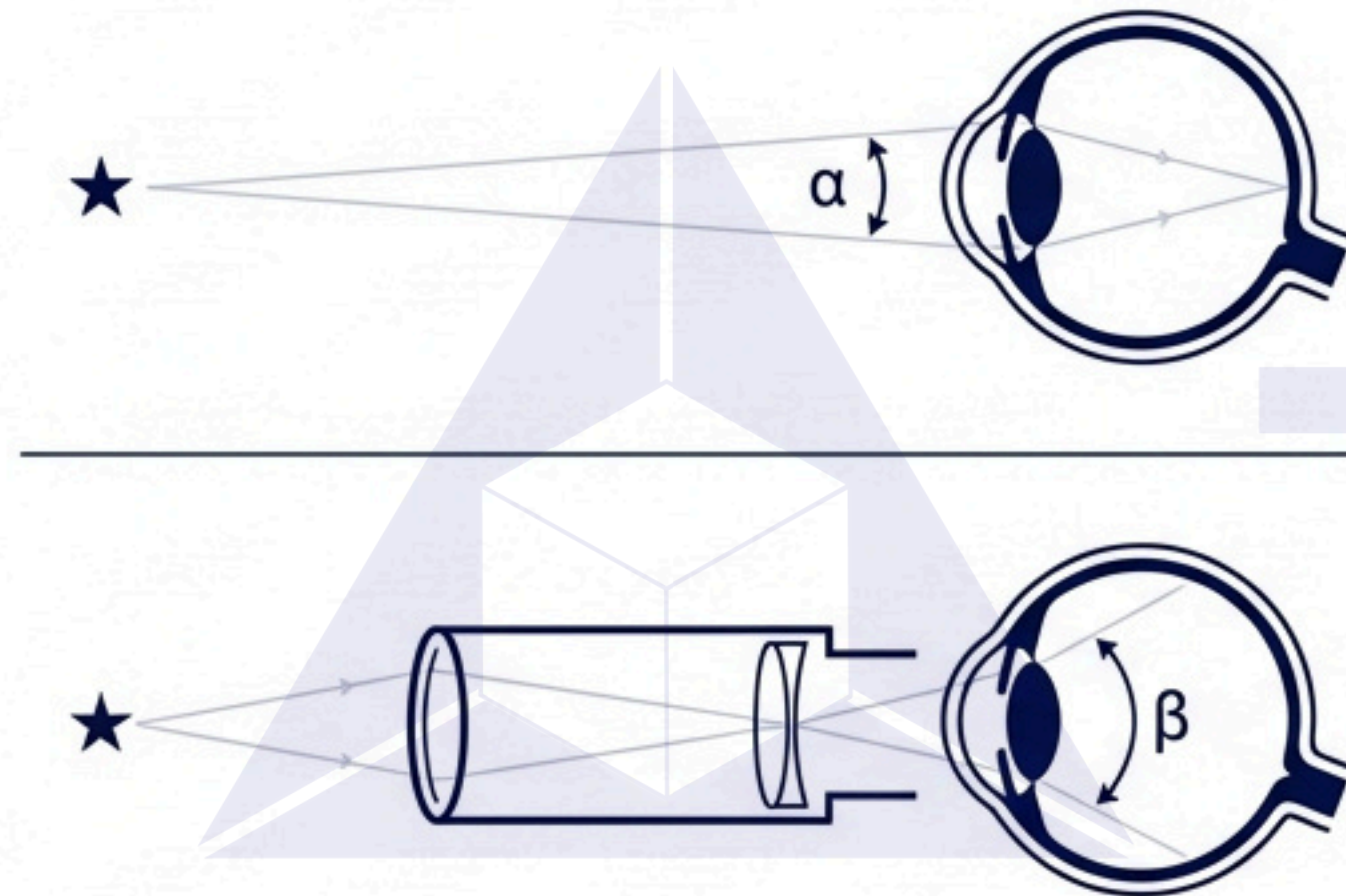
NEET Physics Concept

9.7.2 The Telescope

Ray Optics & Optical Instruments

Class 12 Physics

The Purpose of the Telescope



Angular Magnification

Telescopes do not physically move objects closer; they provide angular magnification to increase the visual angle subtended at the eye.

Light Gathering

Larger objectives collect faint light from distant objects, increasing visibility.

Resolving Power

Increases the ability to observe two distinct objects that are in very nearly the same direction.

The core metric of a telescope's power is its ability to magnify the visual angle of a distant target and gather enough light to make it visible.

The Objective Lens



Properties

Large focal length (f_o), much larger aperture.

Role

Light from a distant object enters here. Collects maximum light and forms a real, inverted intermediate image at its second focal point.

The Eyepiece Lens



Properties

Smaller focal length (f_e), smaller aperture.

Role

Acts as a simple magnifier. It magnifies the intermediate image to produce the final, inverted virtual image for the observer.

Total Tube Length = distance between the two lenses.



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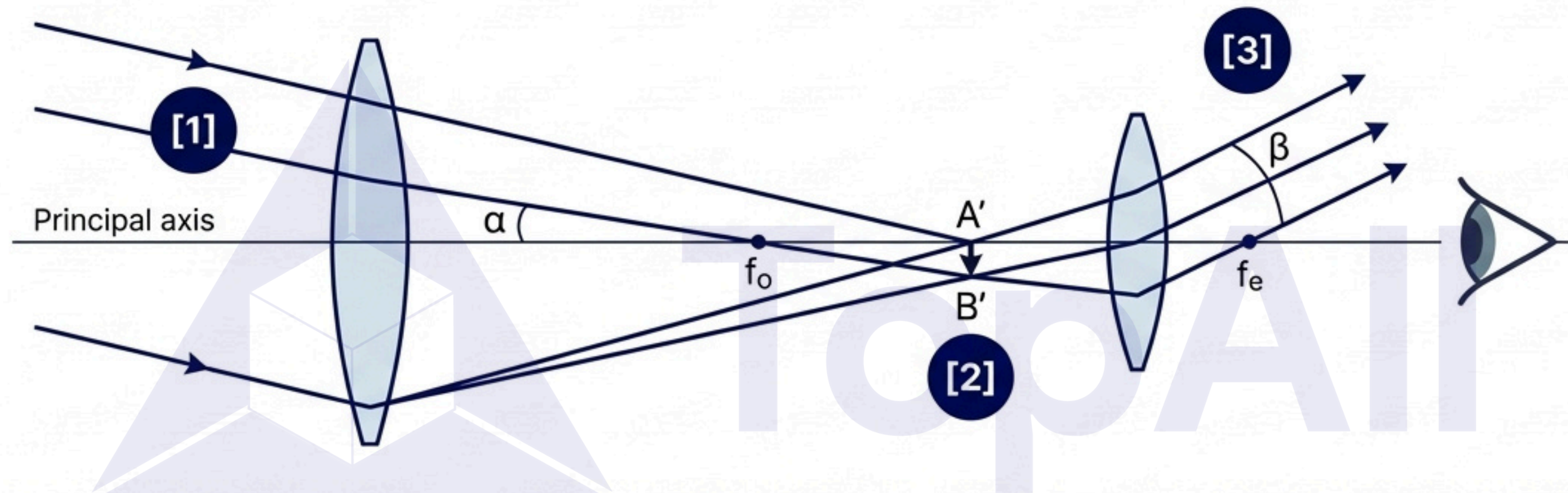


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Image Formation in Normal Adjustment



[1] Light Entry: Parallel rays from a distant object enter the large objective lens.

[2] Intermediate Image: A real, inverted image forms exactly at the second focal point of the objective (f_o).

[3] Normal Adjustment: The eyepiece is positioned so its focal point (f_e) exactly coincides with the objective's focal point.

In Normal Adjustment, the final magnified image forms at infinity. The exact tube length becomes $f_o + f_e$.

Calculating Magnifying Power (m)

$$m \approx f_o / f_e$$

m = Ratio of the angle β (subtended at eye by image) to angle α (subtended at lens/eye by object).

f_o = Focal length of the objective.

f_e = Focal length of the eyepiece.

Textbook Application

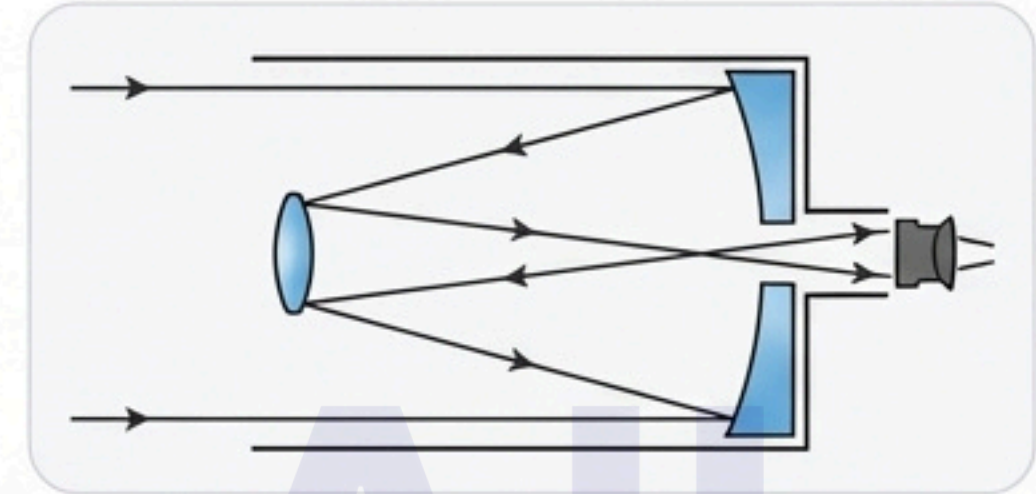
Setup: Objective $f_o = 100$ cm | Eyepiece $f_e = 1$ cm

Result: Magnifying Power $m = 100$

Real-world effect: A pair of stars with an actual separation of 1' (minute of arc) will appear separated by 100' (1.67°).

The Shift to Reflecting Telescopes

Dimension	Refracting (Lenses)	Reflecting (Mirrors)
Chromatic Aberration	Present, degrades image	Zero, mirrors do not disperse light
Mechanical Support	Difficult, supported only by rim	Easy, supported over entire back surface
Weight & Cost	Extremely heavy, expensive to cast	Much lighter, easier to manufacture



The Cassegrain Solution

Mirrors block light inside the tube. The Cassegrain design solves this using a convex secondary mirror to focus light through a hole in the primary mirror.

To maximize light-gathering and resolving power without the heavy, distortion-prone limitations of giant lenses, modern large telescopes (like the 10m Keck or 2.34m Kavalur) use mirror-based objectives.



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