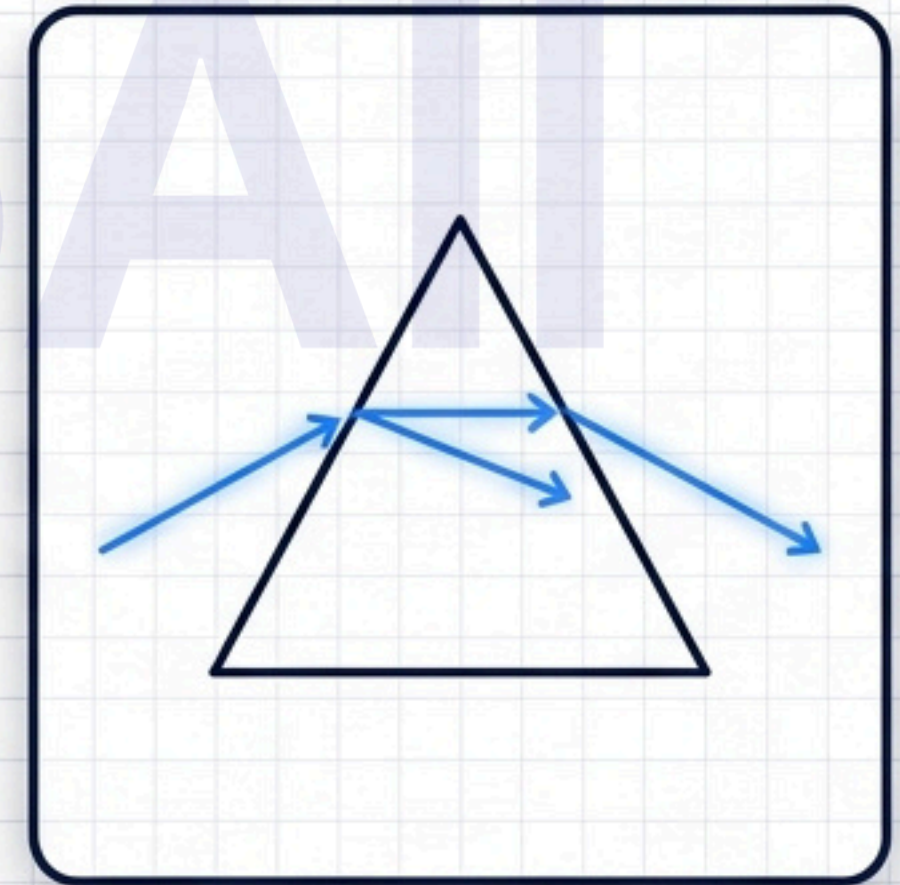
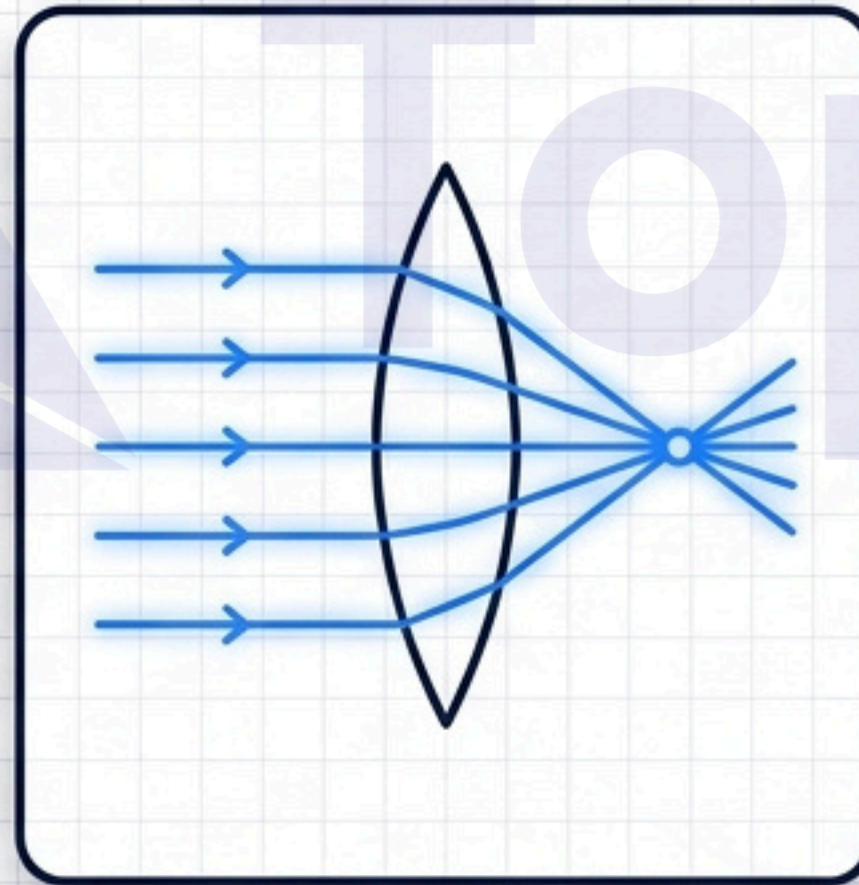
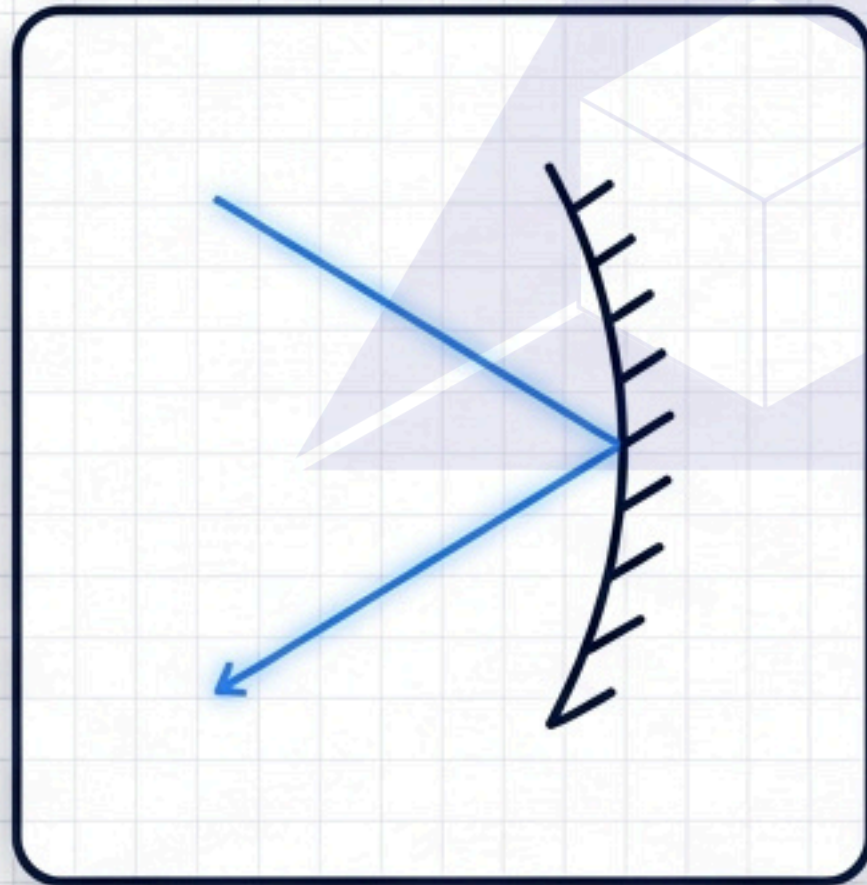


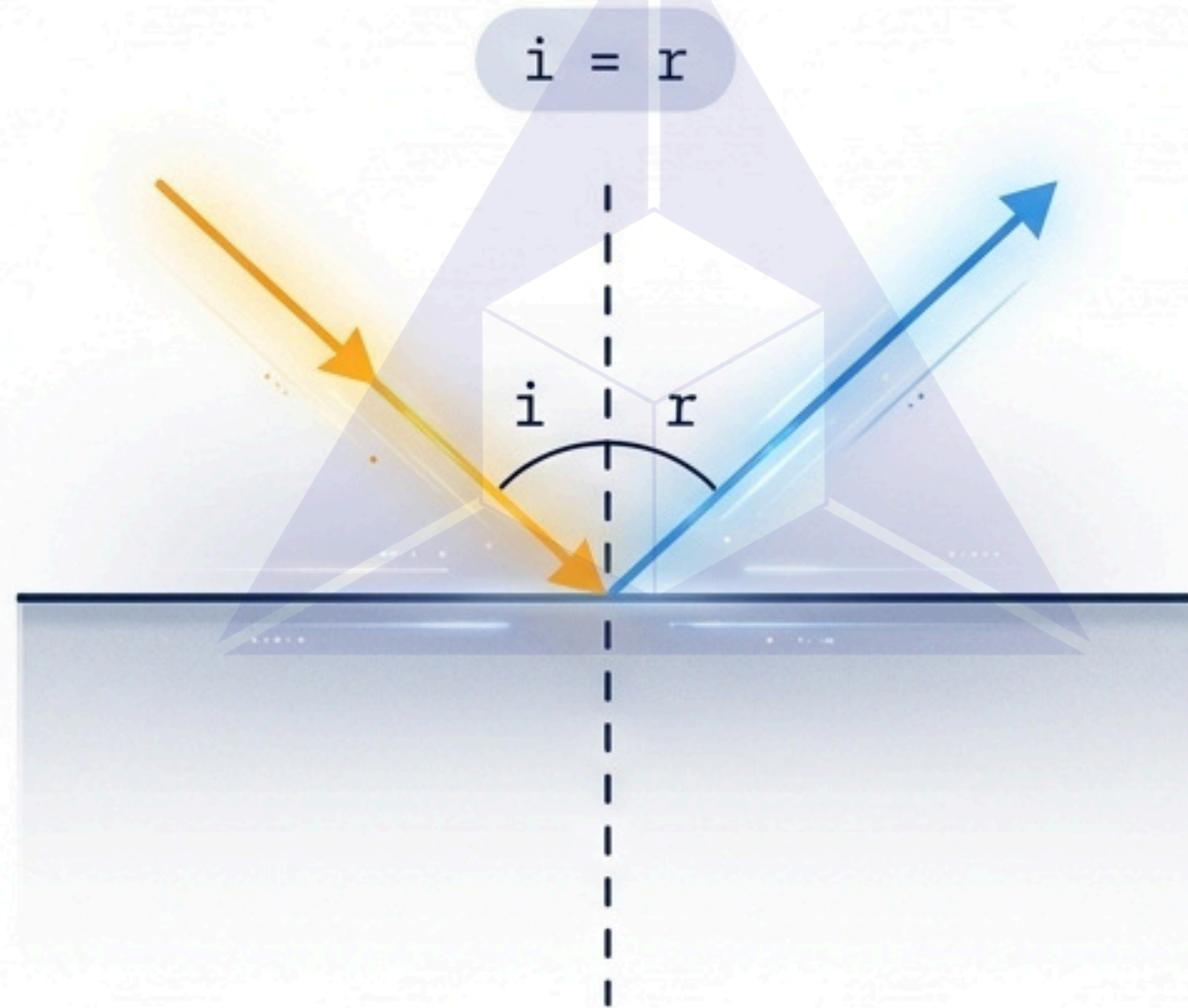
Optical Instruments: Controlling the Path of Light

JEE Physics Module: From Ray Optics to Complex Instrumentation



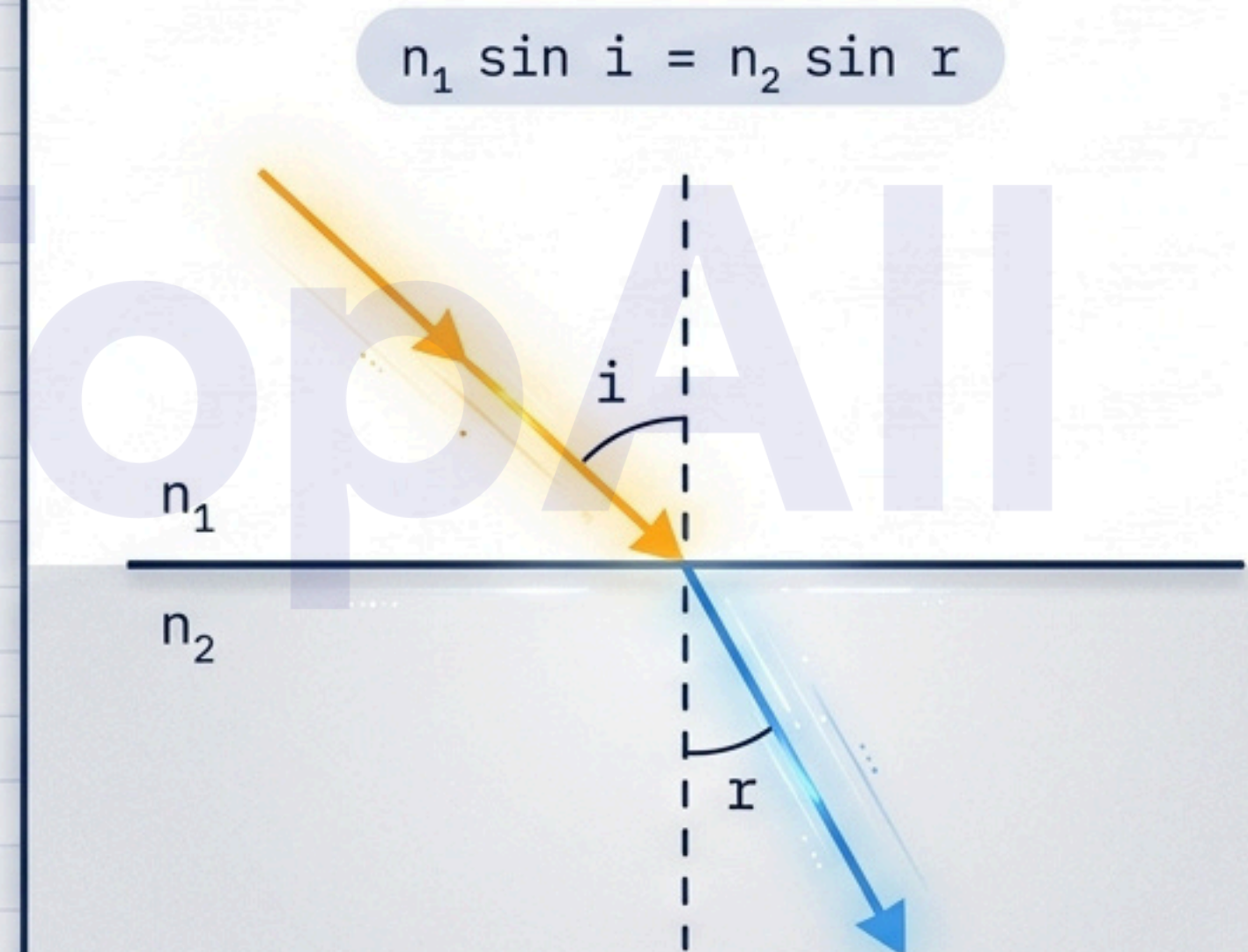
Law of Reflection

Light bounces off a boundary, remaining in the original medium.



Law of Refraction

Light bends as it crosses into a medium with a different optical density.

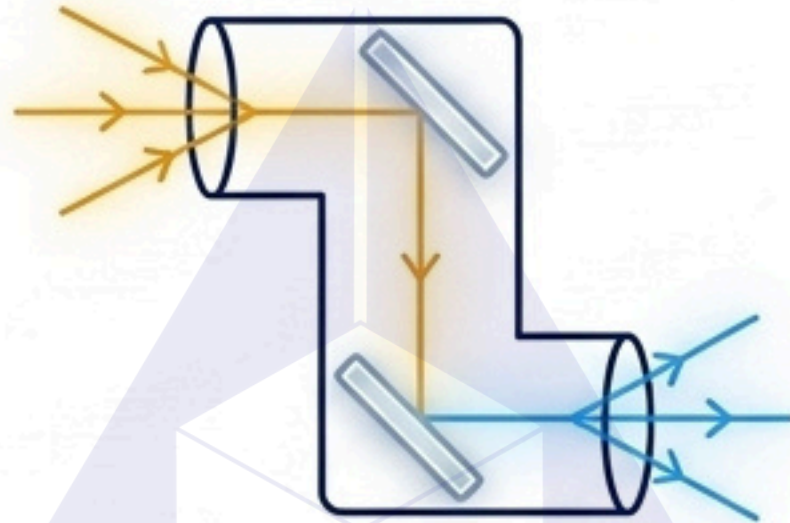


The Device Map: Harnessing Physics for Application

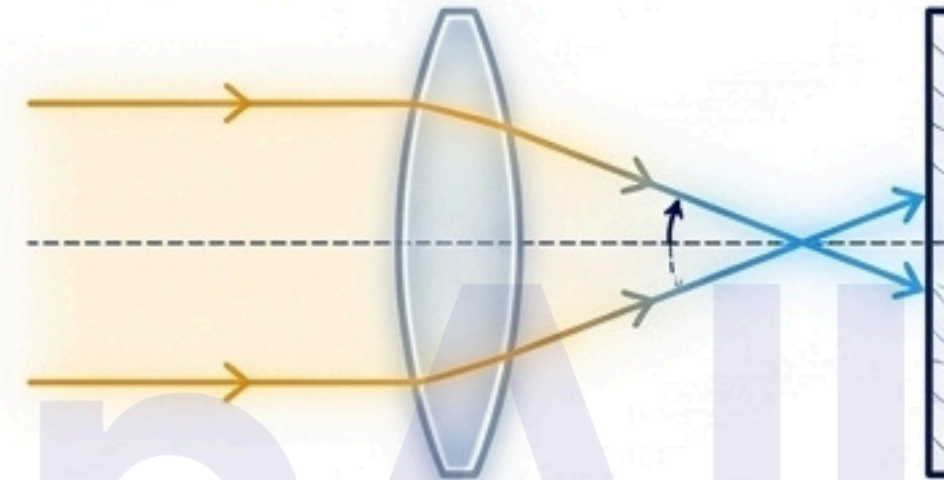
Primary Mechanism: Reflection vs. Refraction

Complexity: Single-Element vs. Compound

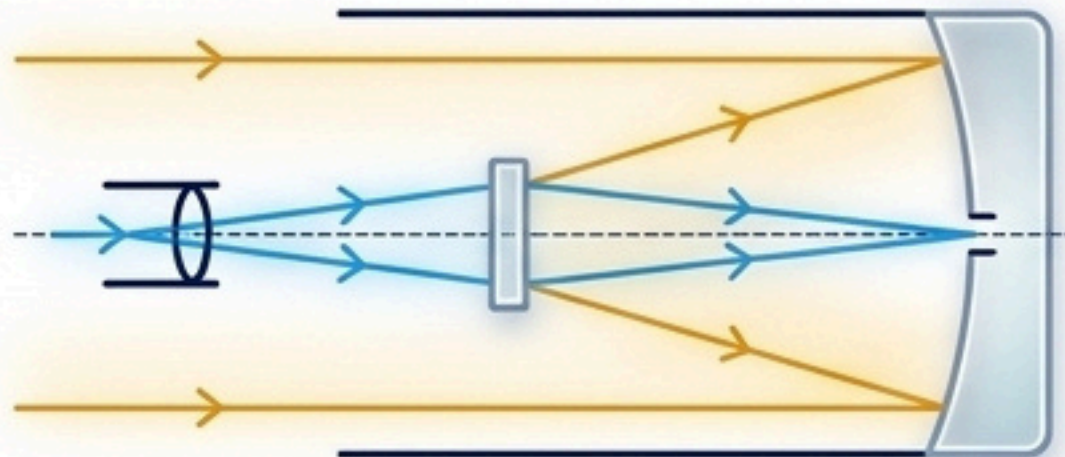
Periscope & Kaleidoscope



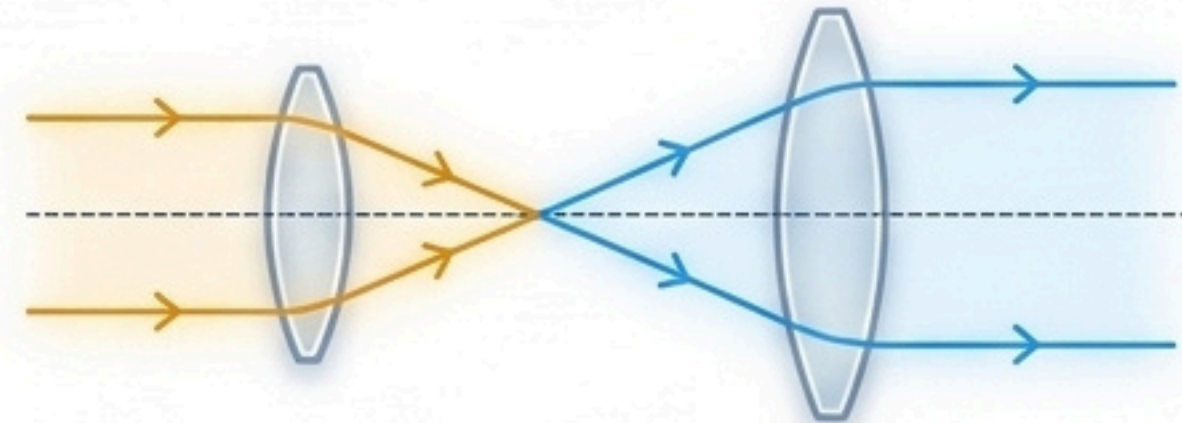
Human Eye & Simple Magnifier



Reflecting Telescopes



Microscope & Binoculars





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$$E=mc^2$$



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Key Highlights

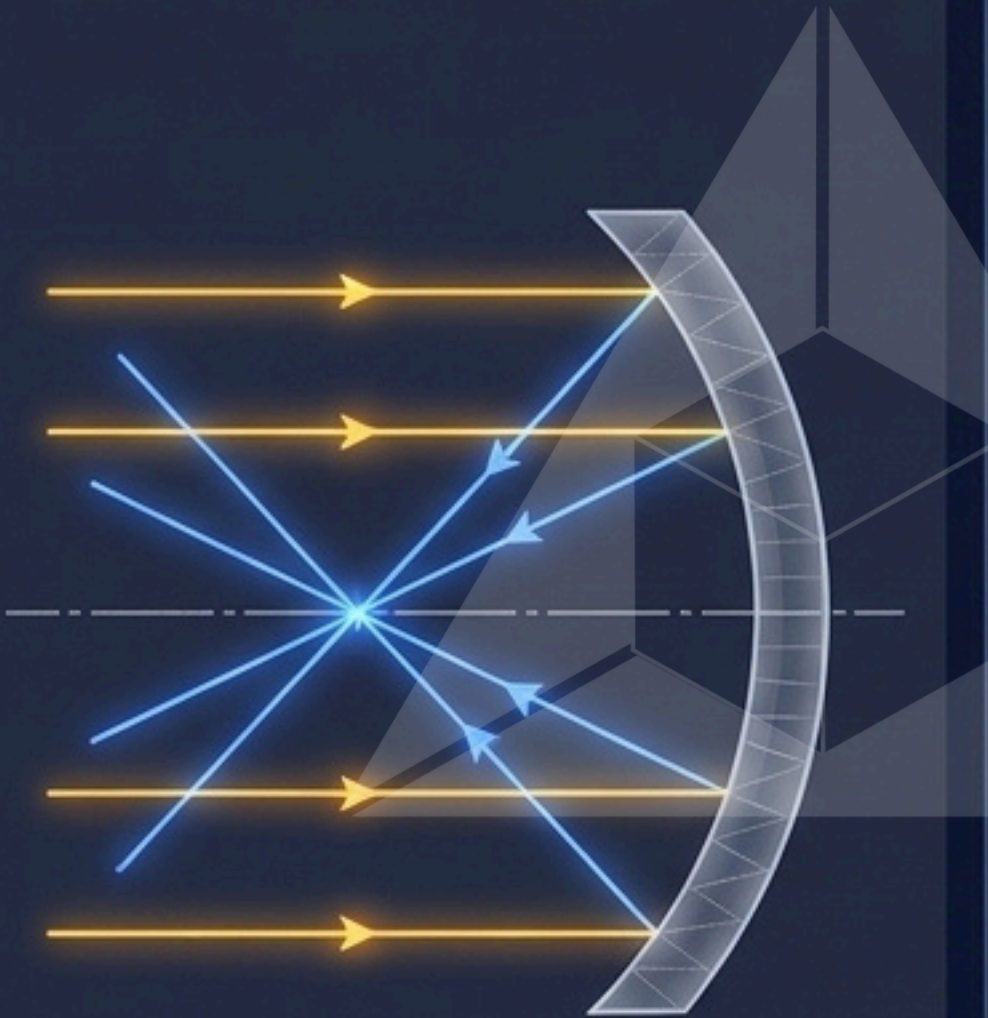
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The Mirror

REDIRECT

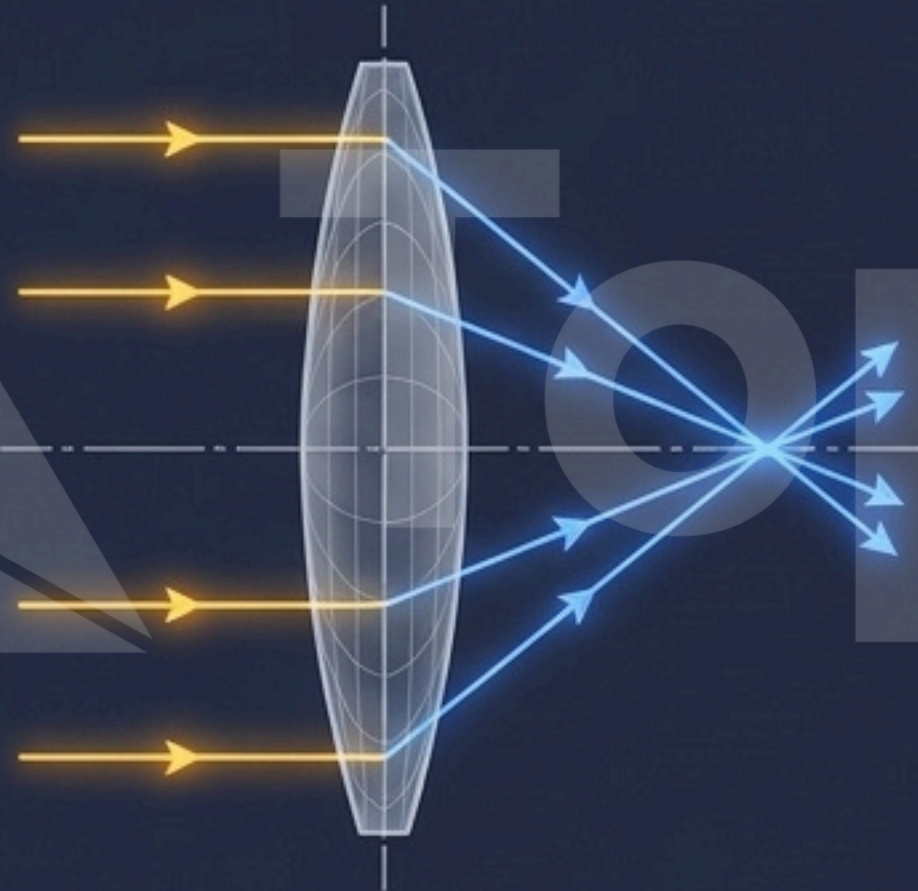
$$1/v + 1/u = 1/f$$



The Lens

FOCUS

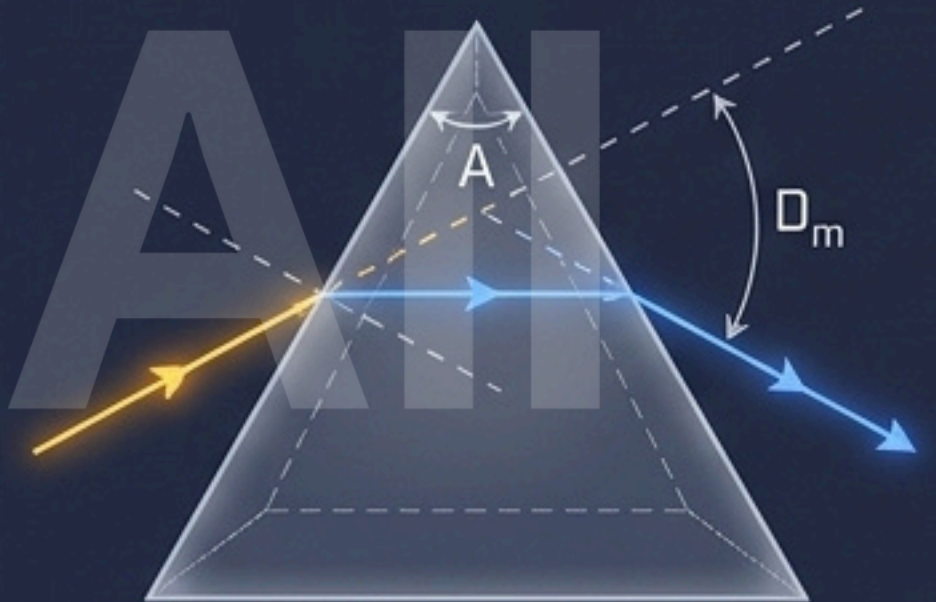
$$1/v - 1/u = 1/f$$



The Prism

DISPERSE / T.I.R.

$$D_m = (n_{21} - 1)A$$

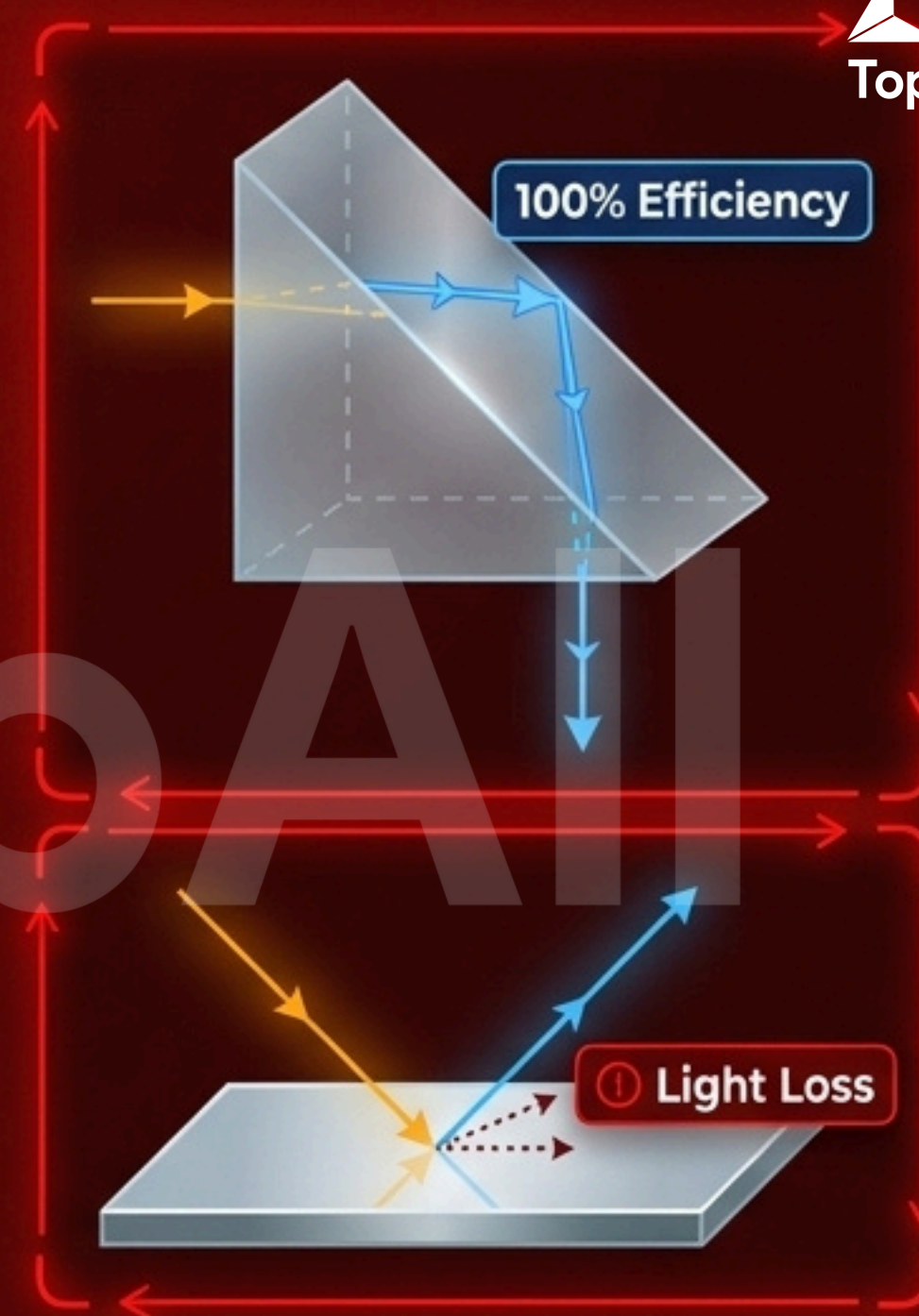


JEE Trap Alert

~~Advanced optical instruments rely exclusively on complex lens systems.~~

Reality: Prisms and mirrors are critical to high-end instrumentation.

- Total Internal Reflection (TIR) in prisms is used in binoculars and periscopes because it reflects 100% of light, unlike silvered mirrors which absorb some light.
- Reflecting Telescopes use parabolic mirrors to entirely eliminate chromatic aberration (color fringing) inherent in thick lenses.



Compound Microscope

Goal

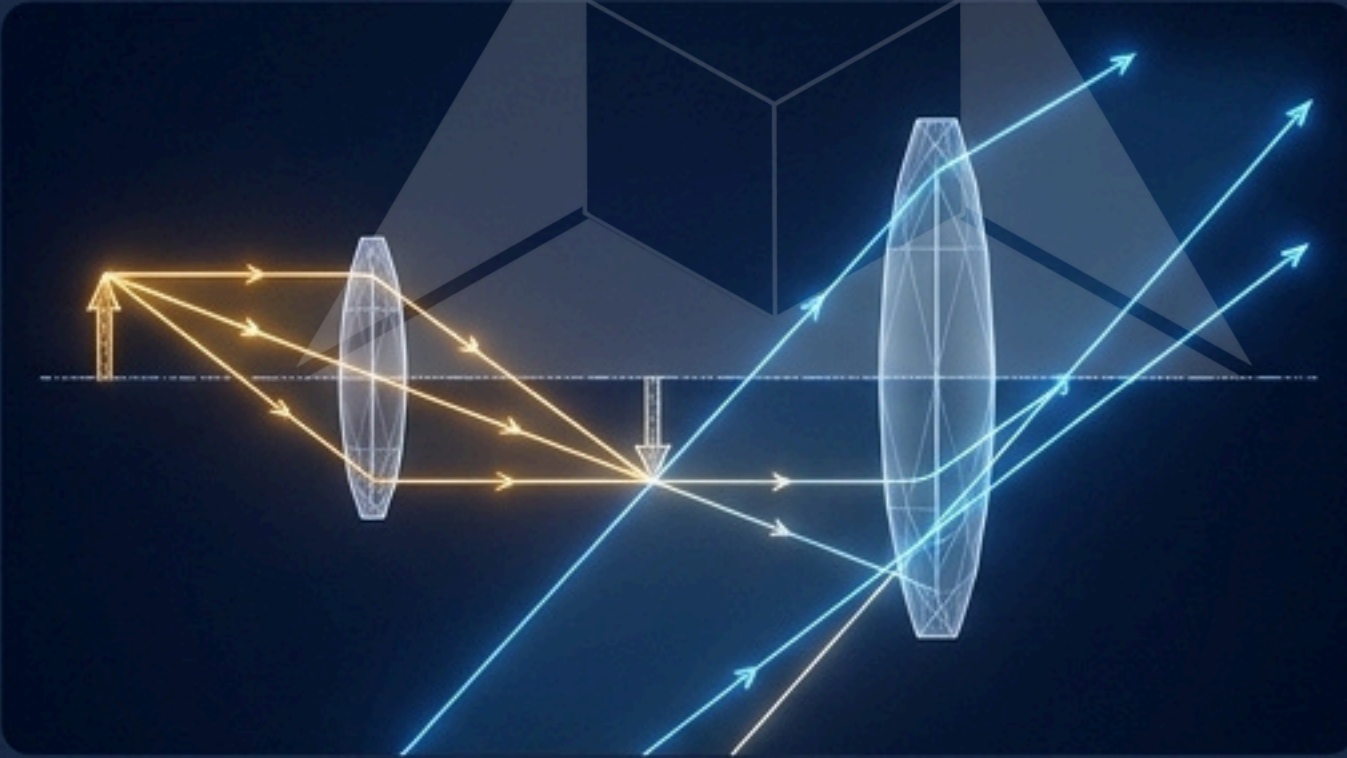
Magnify tiny, nearby objects.

Architecture Formula

$f_o < f_e$ (Objective focal length is very small)

Magnification

$$m = (L/f_o) \times (D/f_e)$$



Refracting Telescope



Goal

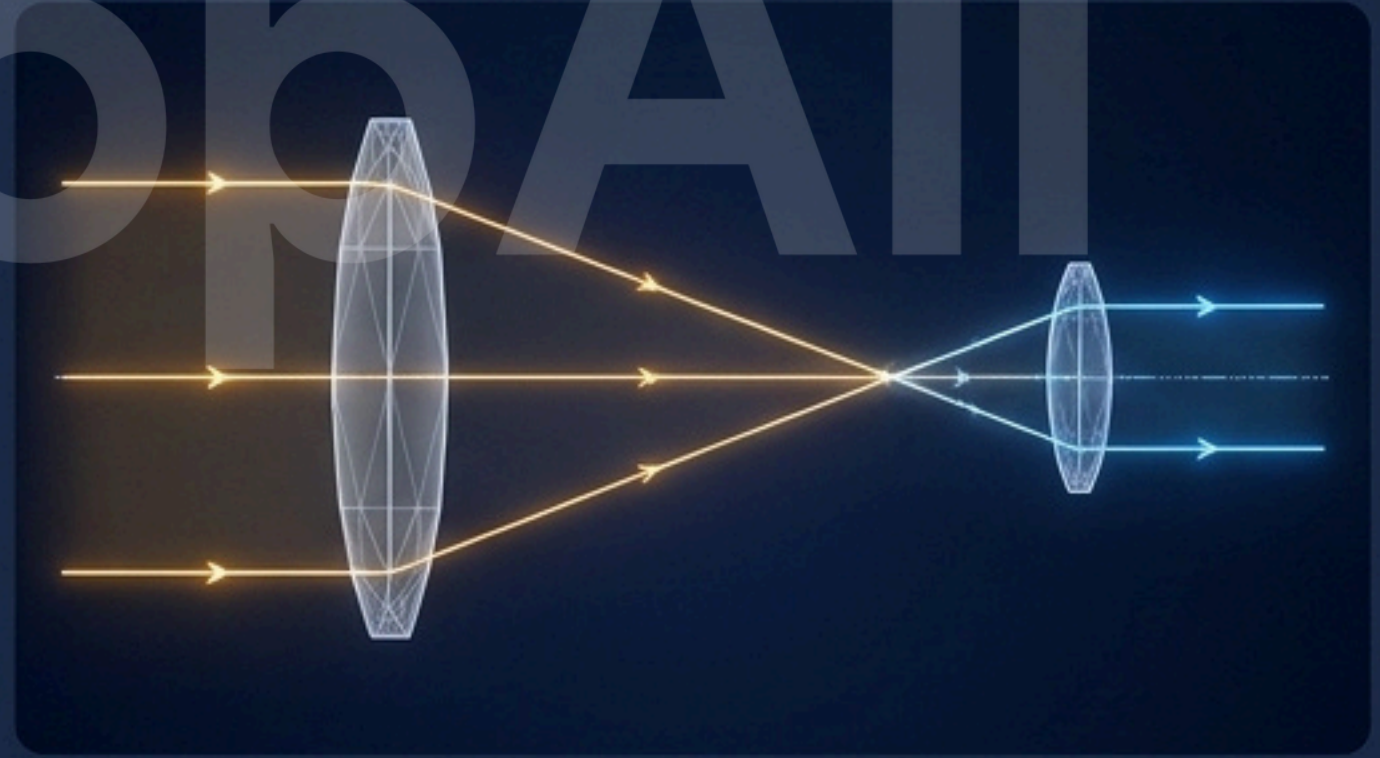
Magnify massive, distant objects.

Architecture Formula

$f_o \gg f_e$ (Objective focal length is very large)

Magnification

$$m = f_o / f_e$$



The Optical Algorithm

[Raw Light Rays]

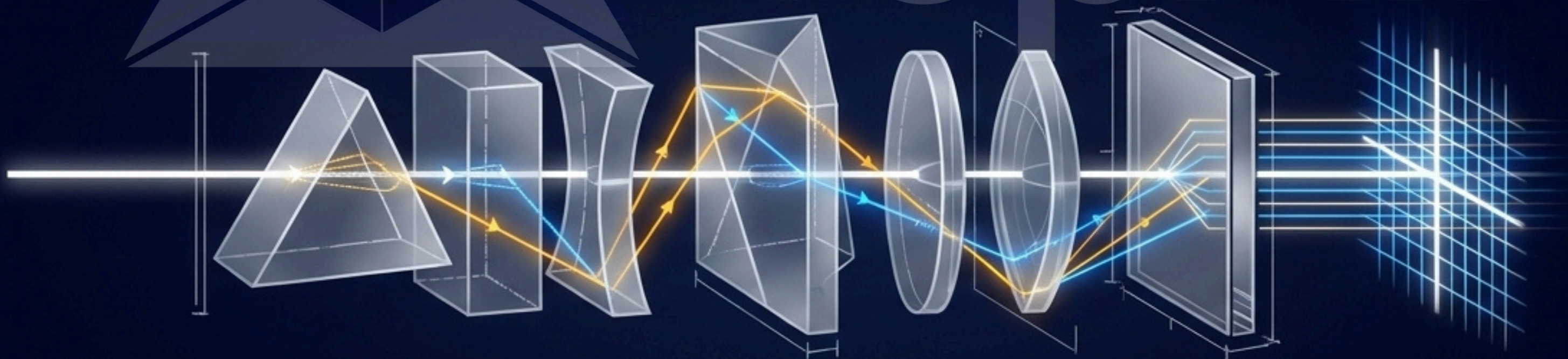


[Sequenced Reflection & Refraction]



[Controlled Image]

- Optical instruments do not “create” images; they geometrically intercept and redirect naturally expanding wavefronts.
- Whether shifting an image via a periscope, or magnifying a cell via a microscope, the math always reduces to sequential applications of Snell’s Law and the Law of Reflection.





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