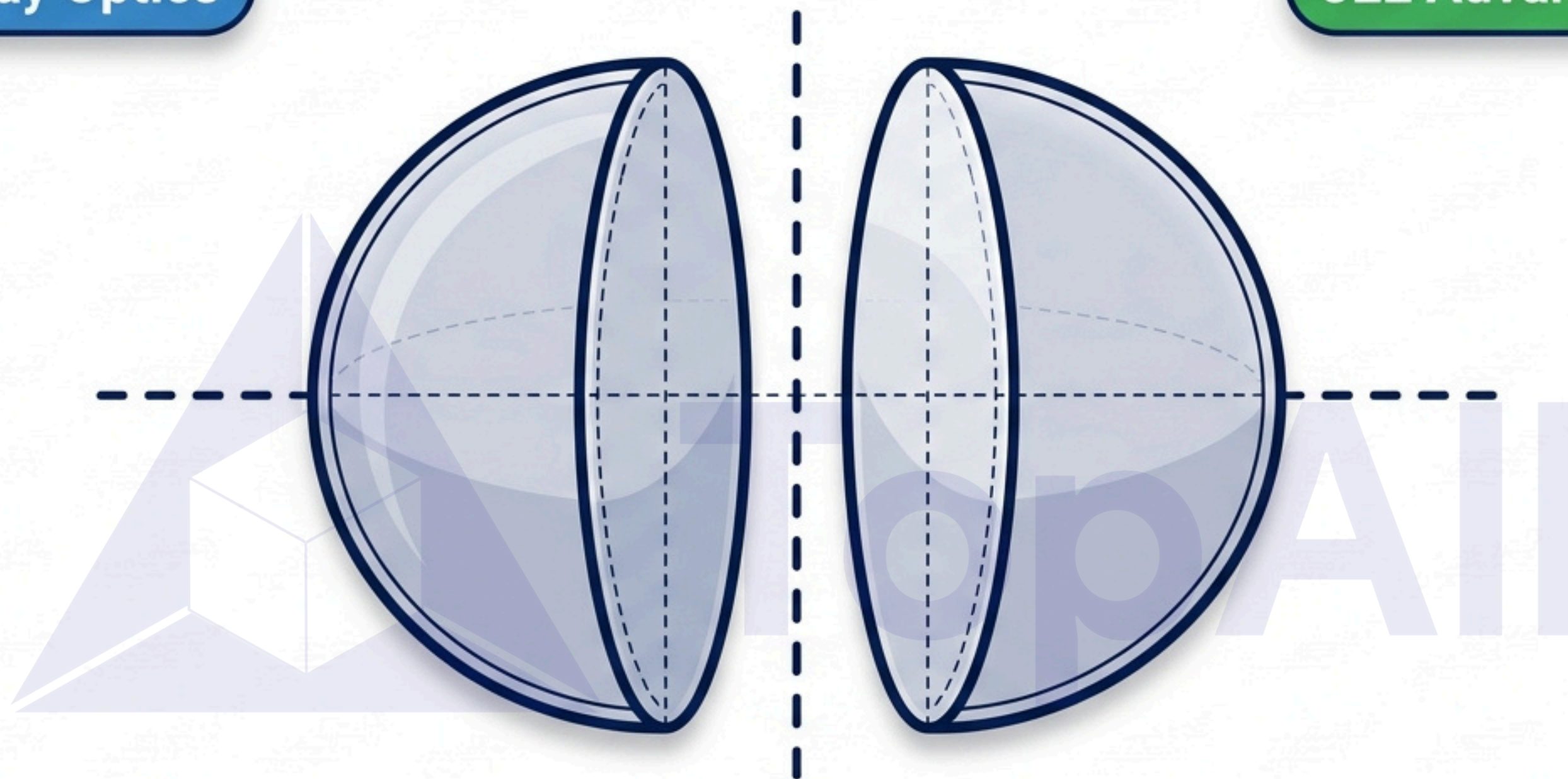




A Lens Is Two Refractions Back-to-Back

Deconstructing the geometry of spherical interfaces
to master the Lens Maker's Formula.

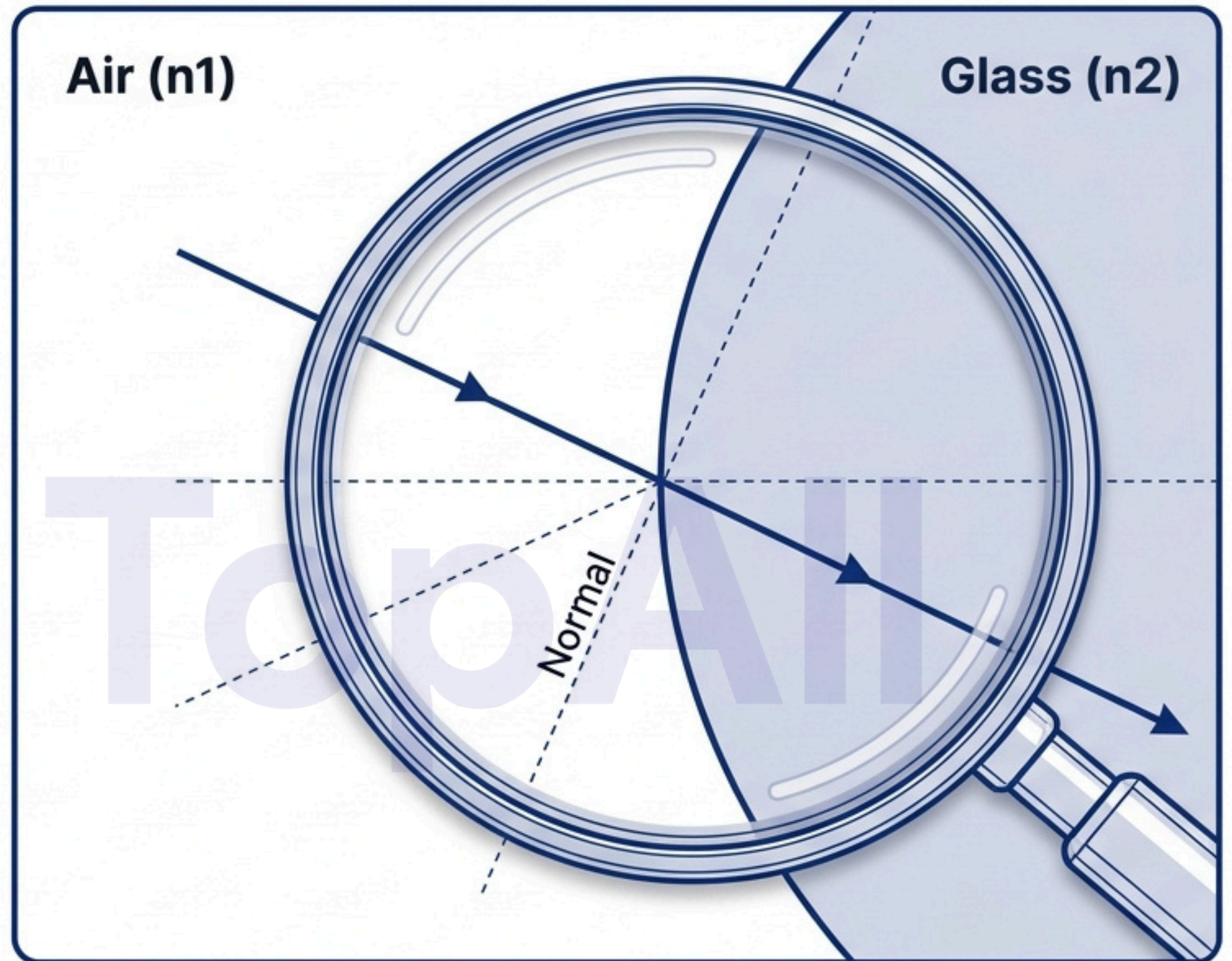
The Spherical Refracting Surface

A thin lens is bounded by two surfaces, at least one being spherical. To understand the lens, we must first master the single spherical interface.

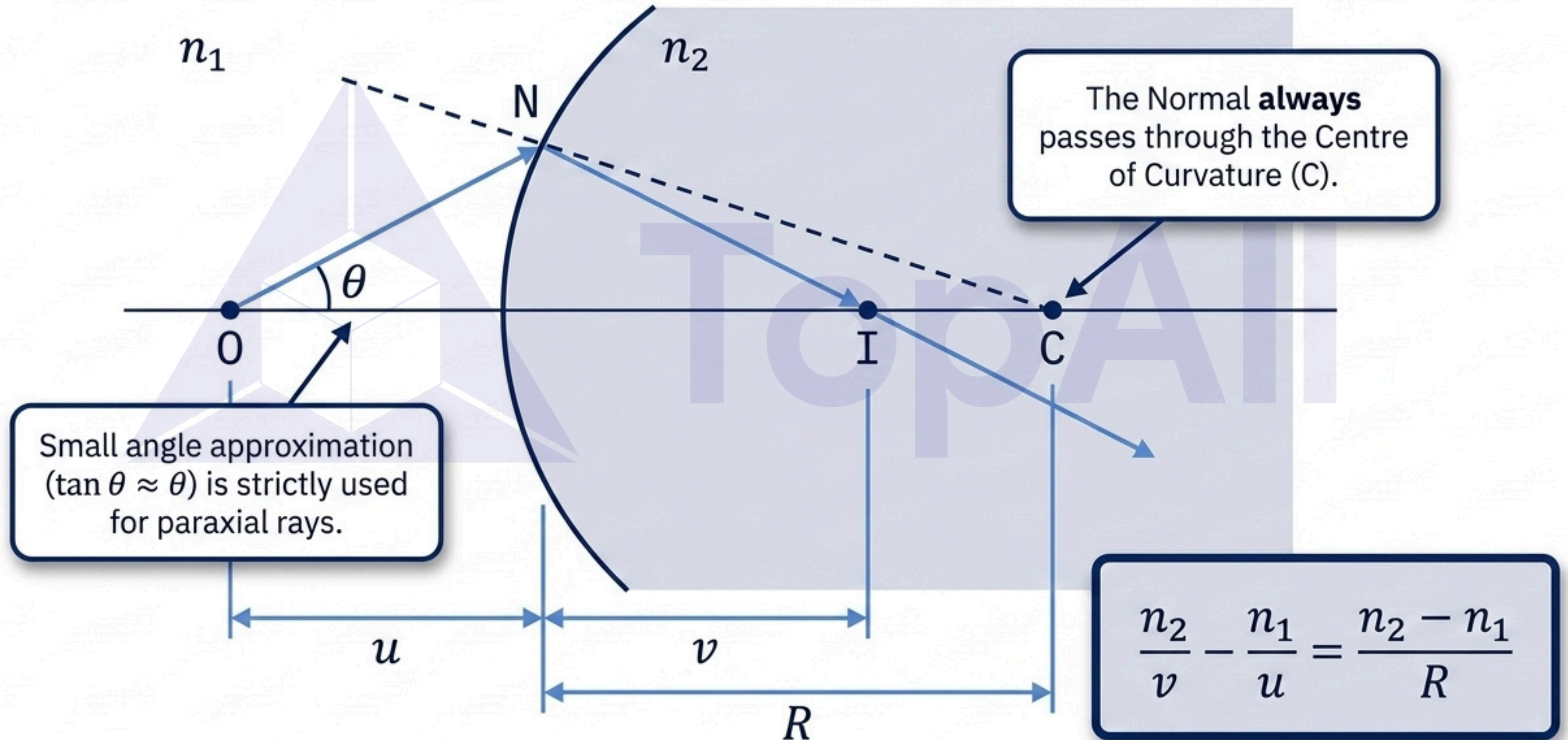
The Tangent Plane: An infinitesimal part of a spherical surface acts as a perfectly flat plane.

Applying Snell's Law: Because it acts as a plane locally, standard laws of refraction apply at every single microscopic point.

Just like a spherical mirror, the normal to the point of incidence on a spherical refracting surface is perpendicular to its tangent plane.



The Geometry of a Single Interface





**You've Learned the Theory.
Let's Test Them Now.**

$$E=mc^2$$



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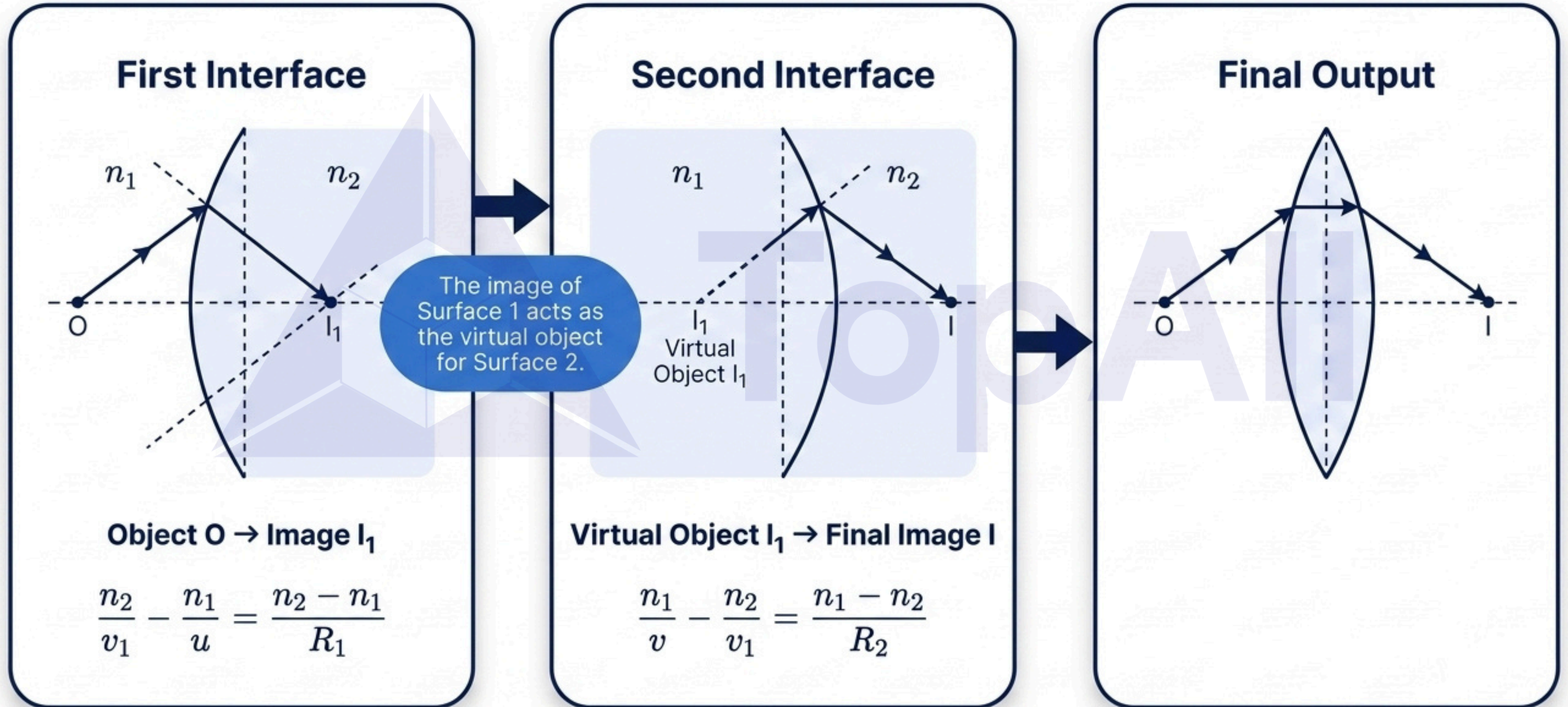
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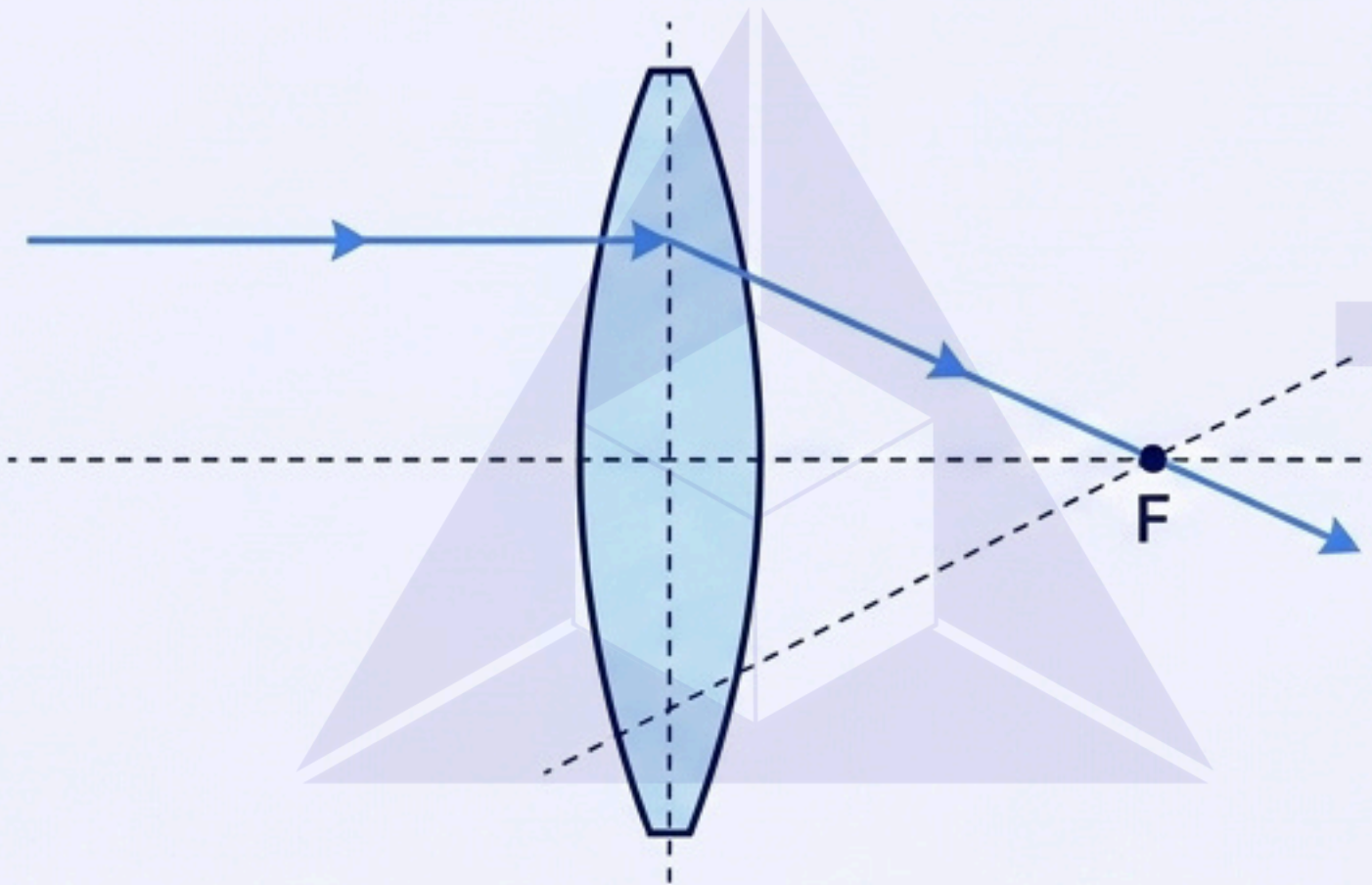


Reassembling the Lens: The 2-Step Process

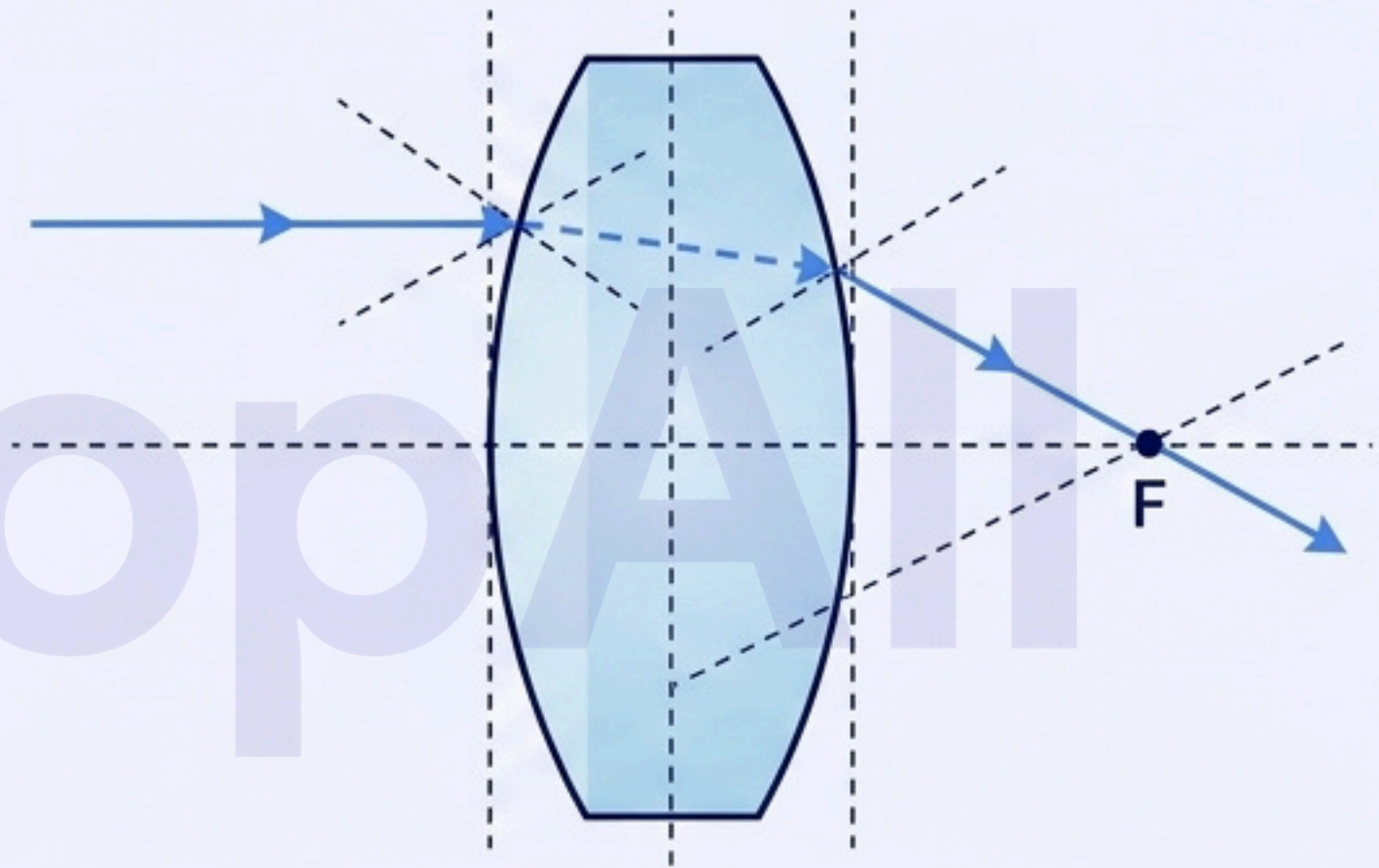


Beware the Single Bend Illusion

✗ Novice View



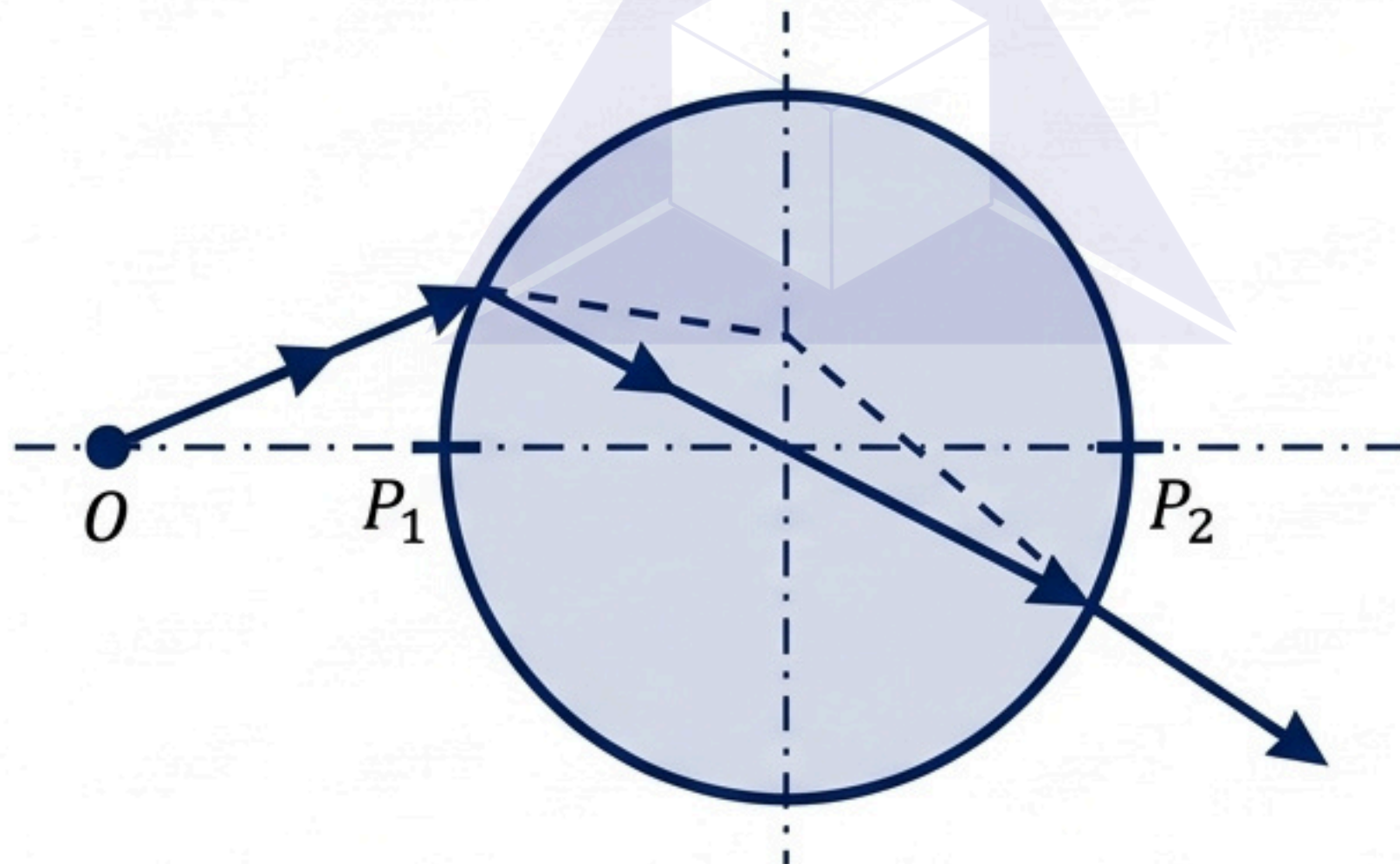
✓ Topper View



JEE TRAP ALERT: Do not assume a lens bends light precisely at its optical centre. The Lens Formula is an approximation. If a problem involves a thick lens or a lens split with a liquid medium inside, the $1/f$ formula breaks. You must solve it surface-by-surface using the spherical refraction equation.

Test Your Optics Vision

A point object is placed in air in front of a thick solid glass sphere ($n=1.5$, $R=20$ cm). Identify the variables for the first surface and the intermediate image.



Step 1 Isolate Surface 1. Identify media:

$n_1 = 1$ (air), $n_2 = 1.5$ (glass).

Step 2 Apply Cartesian Sign Convention to the first pole. (u is negative,

R_1 is positive).

Step 3 Calculate v_1 to locate the

Intermediate Image (I_1).



Stop! Before applying the math to Surface 2, remember that the new object distance must be measured from the second pole. Distance = $v_1 - \text{Diameter}$.

The Ultimate Equation Synthesis

The Addition

$$\begin{array}{c} \text{Surface 1} \\ \cancel{\frac{n_2}{v_1}} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R_1} \end{array} + \begin{array}{c} \text{Surface 2} \\ \frac{n_1}{v} - \cancel{\frac{-n_2}{v_1}} = \frac{(n_1 - n_2)}{R_2} \end{array}$$

=

The Result

$$\text{Lens Maker's Formula} \\ \frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1 \right) \left[\frac{1}{R_1} - \frac{1}{R_2} \right]$$

Remember: The final thin lens formula is just a mathematical shortcut. True mastery of optics lies in understanding the two sequential refractions that create it.



You've Learned the Theory.

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