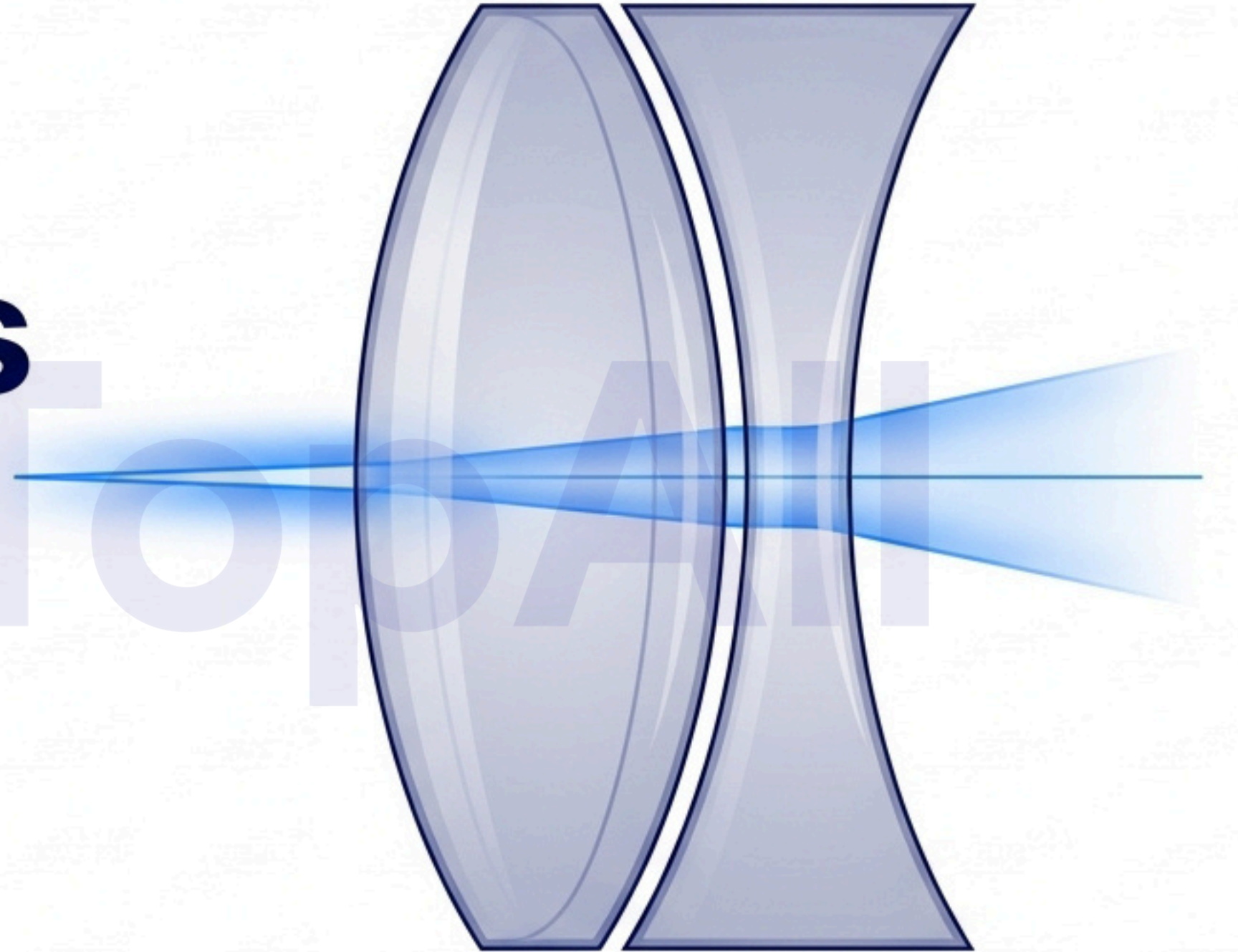


Combination of Thin Lenses in Contact

Image formation, equivalent focal length, and magnifying power.



The Two-Step Image Formation

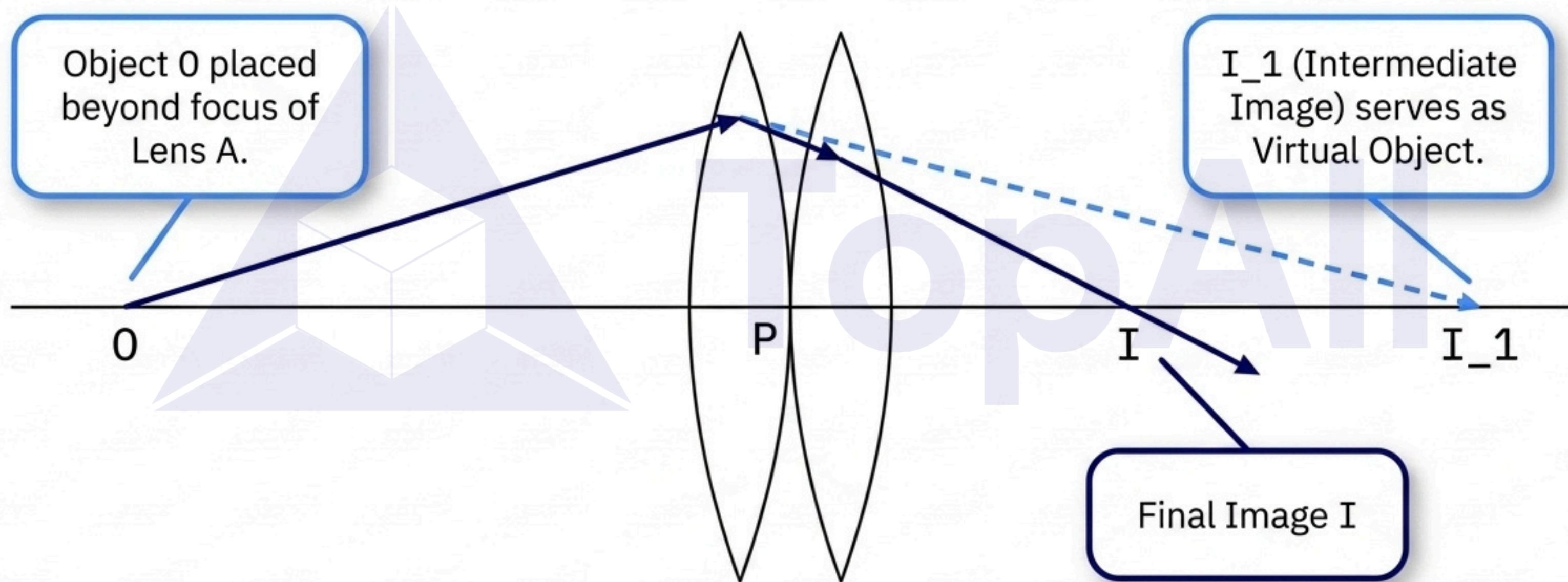
Lens A forms an intermediate image (I_1) of the object (O).

Acts as a **virtual object** for...

Lens B takes I_1 as its object to form the **final image (I)**.

The output of the first lens becomes the input for the second lens.
For thin lenses, their optical centres are assumed to coincide.

Geometry of the Dual-Lens System





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$$E=mc^2$$



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The Master Equations

Equivalent Focal Length

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \dots$$

(Valid for any number of thin lenses in contact)

Net Power

$$P = P_1 + P_2 + P_3 + \dots$$

Total Magnification

$$m = m_1 * m_2 * m_3 \dots$$

 JEE Trap Alert

Adding focal lengths directly:

$$f = f_1 + f_2$$

Adding magnifications:

$$m = m_1 + m_2$$

Ignoring signs:

$$P = 5 + 2 \text{ (when one lens is concave!)}$$



Add reciprocals of focal lengths:

$$1/f = \text{sum}(1/f_i)$$

Multiply magnifications:

$$m = \text{product}(m_i)$$

Powers add algebraically:
Always use sign convention
(Convex = +, Concave = -).

Concept Check: Mixed Combination

A convex lens ($f_1 = +10$ cm) and a concave lens ($f_2 = -20$ cm) are in contact. Find the nature and focal length of the combination.

$$1/f = 1/f_1 + 1/f_2$$

$$1/f = 1/10 + 1/-20$$

$$1/f = (2 - 1) / 20 = 1/20$$

$$f = +20 \text{ cm}$$

Net focal length is +20 cm.
The combination acts as a
Converging (Convex) Lens.

Quick Revision: Lenses in Contact

Power Add algebraically $\rightarrow P = P_1 + P_2$

Magnification Multiply $\rightarrow m = m_1 * m_2$

Sign Convention Convex ($f > 0, P > 0$) | Concave ($f < 0, P < 0$)

Why combine lenses? Combining lenses enhances image sharpness and allows optical engineers to design systems (like microscopes and cameras) with precise, custom magnification and power while minimizing defects.



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