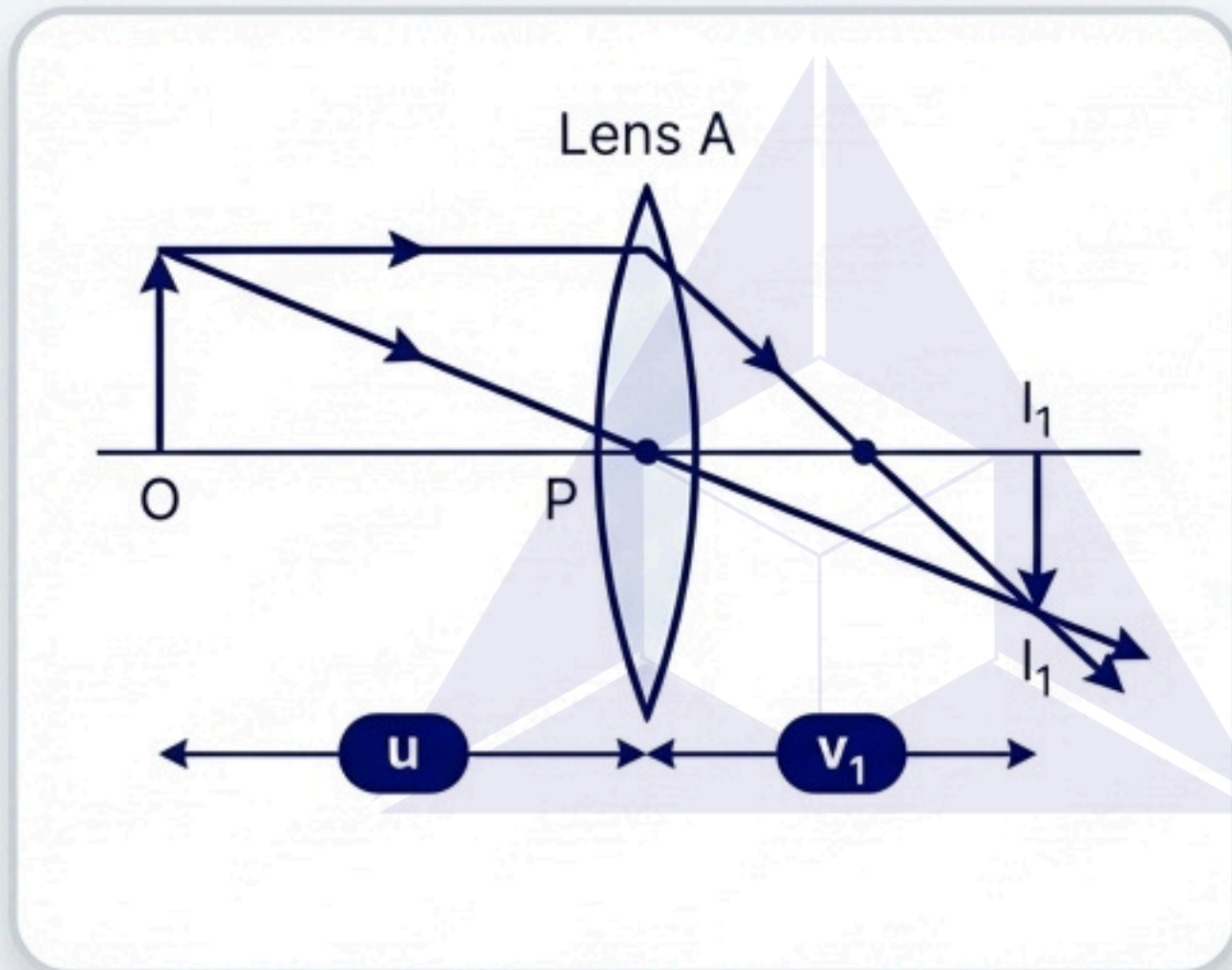


Combination of Thin Lenses in Contact

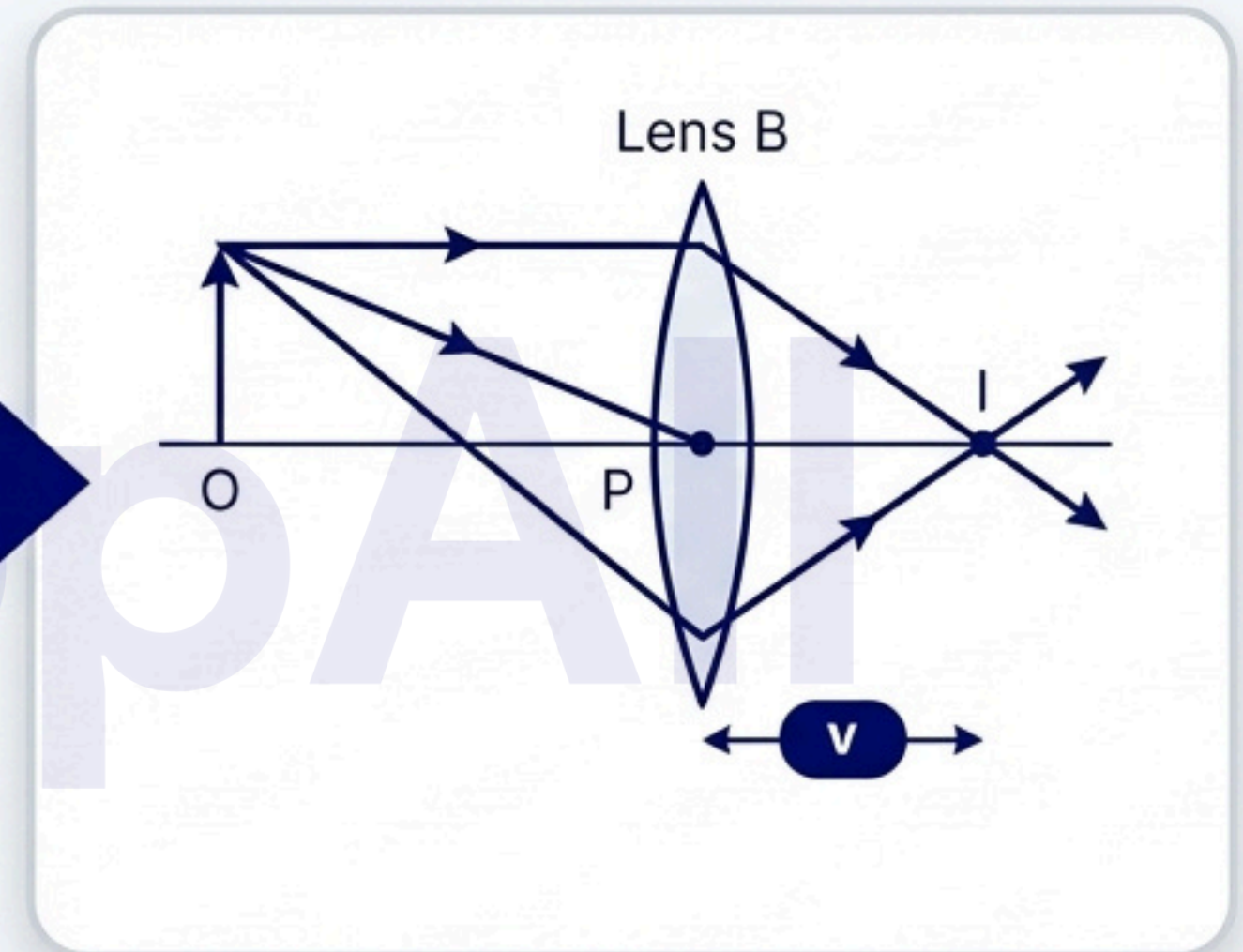
Mastering effective focal length, power addition, and system magnification (Section 9.5.4).



The Story of a Ray: Handing Off the Image



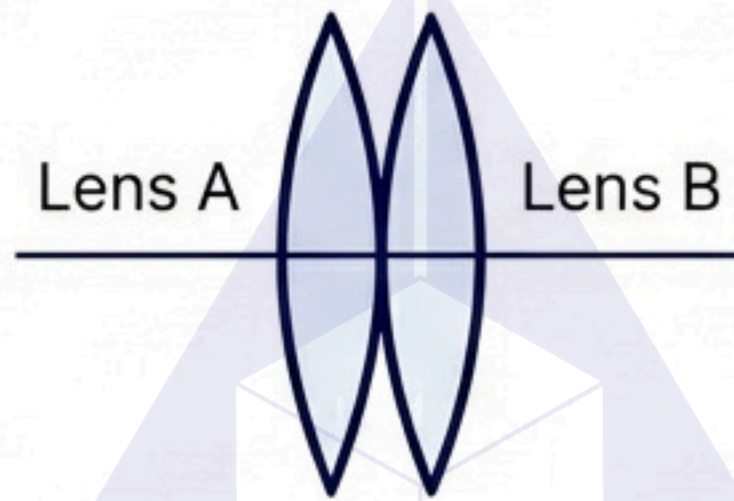
Lens A forms a real image (I_1) of the object.



Lens B produces the final image (I) from the virtual object.

Deriving the Effective Focal Length

The Physical Combination

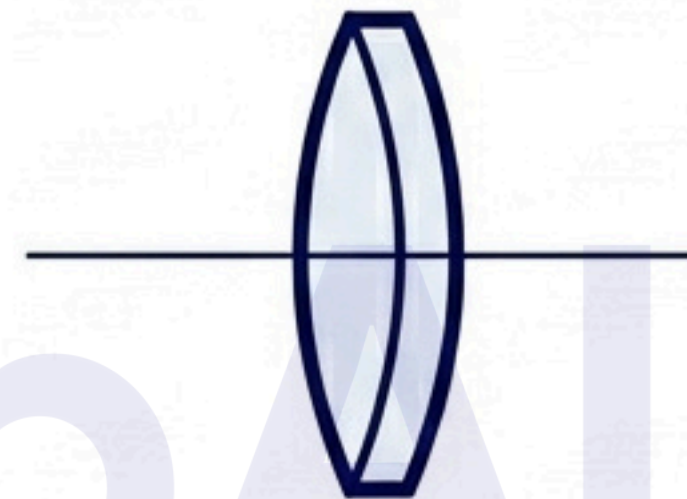


$$\frac{1}{v_1} - \cancel{\frac{1}{u}} = \frac{1}{f_1}$$

$$\frac{1}{v} - \cancel{\frac{1}{v_1}} = \frac{1}{f_2}$$

=

The Effective Lens



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

For an n-lens system: $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \dots$



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$$E=mc^2$$



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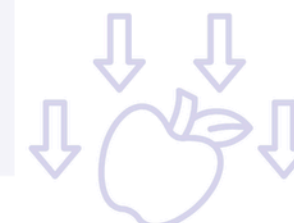
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Net Power and Total Magnification



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

The net power of a lens combination is the algebraic sum of individual powers.

$P = 1/f$ (Note: Convex is positive, Concave is negative)



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

The total magnification is the product of the magnifications of the individual lenses.

Because the image formed by the first lens becomes the object for the second, the magnification effect multiplies.

Why Combine Lenses?

To obtain desired magnification, enhance image sharpness, and minimize optical defects (aberrations).



Microscopes

Uses a multi-lens objective and eyepiece system to achieve massive exponential magnification ($m_o \times m_e$).



Telescopes

Combines a large-aperture objective (for gathering light) with an eyepiece (for angular magnification of distant objects).



Cameras

Utilizes precise systems of converging and diverging lenses in contact to enhance image sharpness and eliminate optical distortions.

System Summary

The Golden Rule:

The image formed by the first lens acts exactly as the (virtual) object for the second lens.

Effective Focal Length:

Reciprocals add up.

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

Net Power:

Algebraic sum (mind the signs).

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

Total Magnification:

Product of individual magnifications.

$$m = m_1 \times m_2 \times \dots$$



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