Axial Magnification

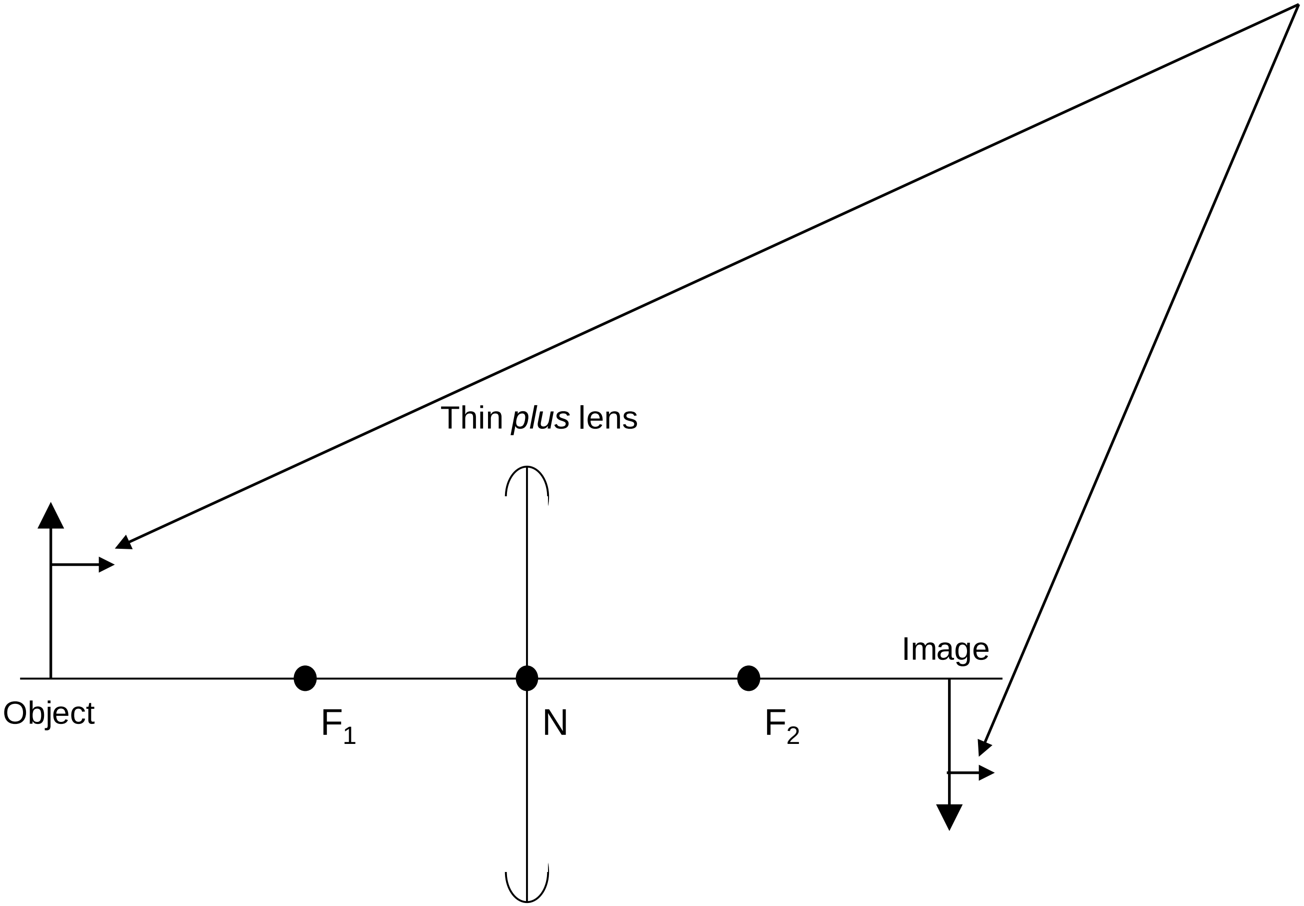
Basic Optics, Chapter 21

Axial Magnification

- We saw in Chapter 20 that *transverse mag* addresses the relative heights of an image and object
- But what about changes in the ‘fore and aft’ (i.e., along the lens axis) relative sizes?
- This is captured by *axial magnification*

Axial Magnification

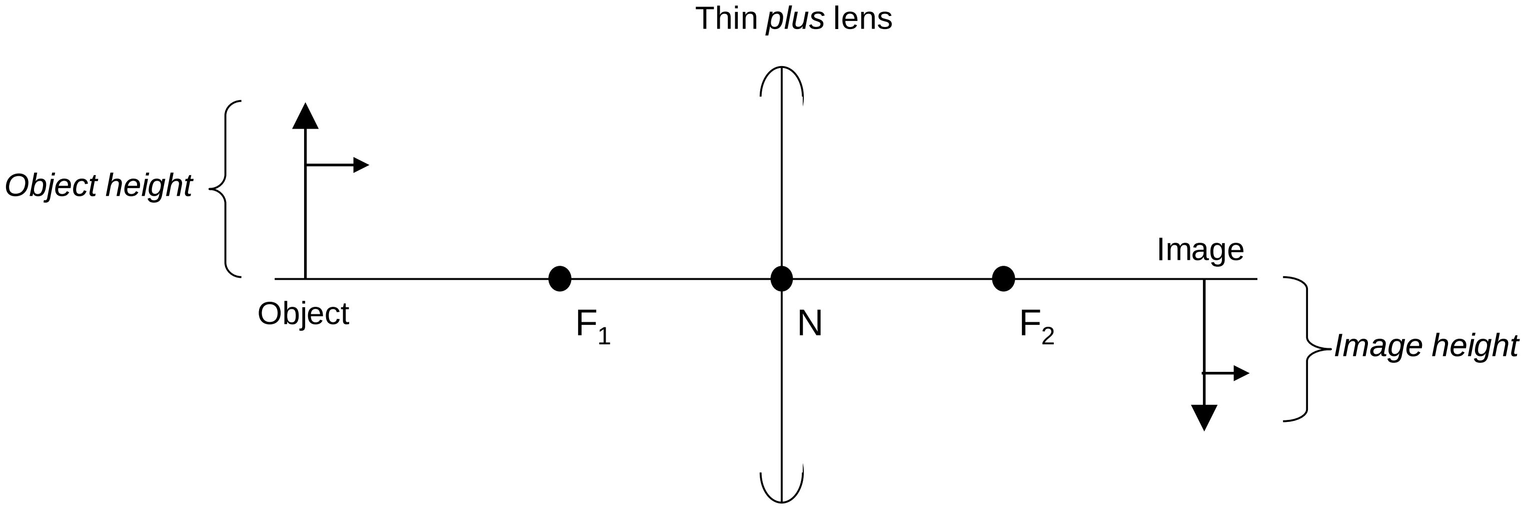
Note the addition of an ***axial component*** *to the object (and therefore image)*



Axial Magnification

You will recall that ***transverse*** mag is defined as:

$$\frac{\textit{Image height}}{\textit{Object height}}$$



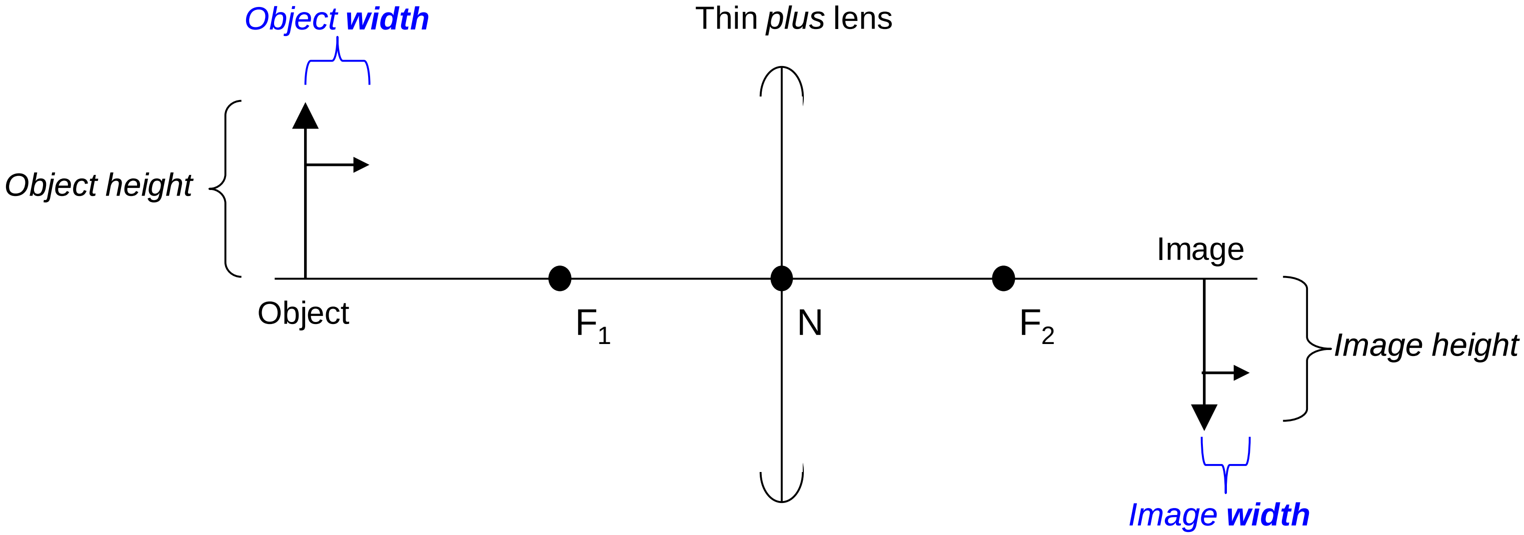
Axial Magnification

You will recall that ***transverse*** mag is defined as:

$$\frac{\textit{Image height}}{\textit{Object height}}$$

Likewise, ***axial* magnification** is defined as:

$$\frac{\textit{Image width}}{\textit{Object width}}$$



Axial Magnification

- Axial magnification can be approximated by the square of the transverse magnification

$$\text{Axial mag} \approx (\text{Transverse mag})^2$$

Axial Magnification

Axial ~~Transverse~~ magnification is defined as:

$$\boxed{\frac{\underline{\text{Image height}}}{\text{Object height}}}^{2}$$

Axial ~~Transverse~~ magnification is equal to:

(By the Vergence Law)

$$\boxed{\frac{\underline{\text{Vergence of incoming light (U)}}}{\text{Vergence of light leaving lens (V)}}}^{2}$$

(By similar triangles)

$$\boxed{\frac{\underline{\text{Image distance (v)}}}{\text{Object distance (u)}}}^{2}$$

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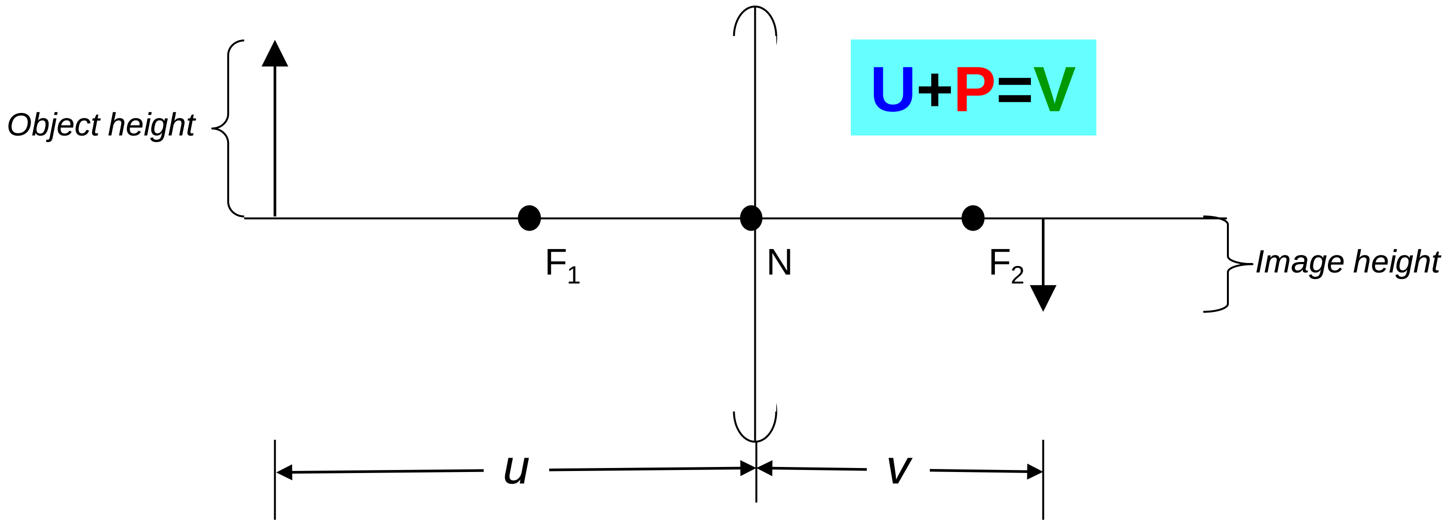
U+P=V



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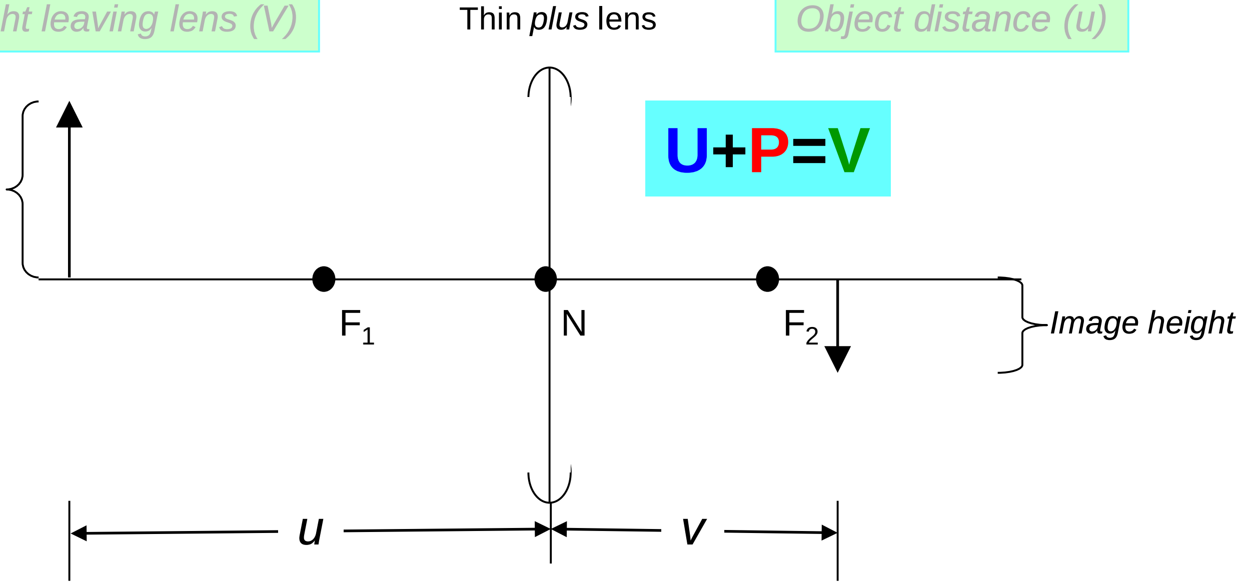

$U+P=V$

If *u* = -100cm, and **P** = +3, then *v* = ?

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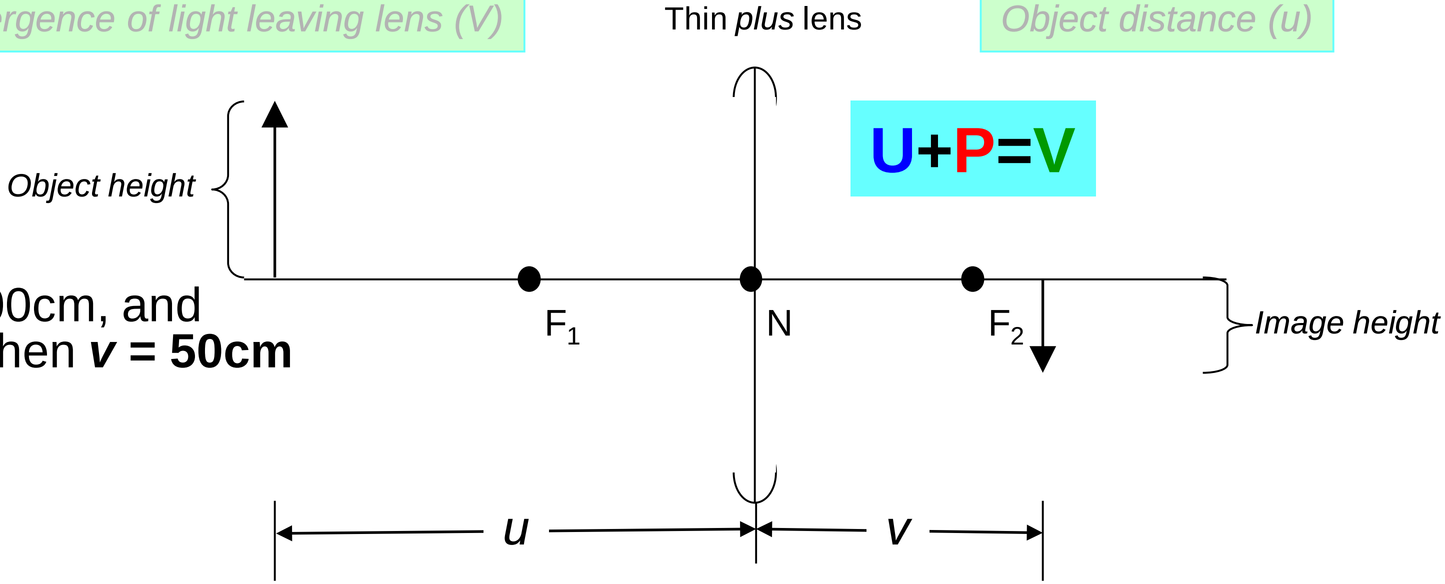

U+P=V

If *u* = -100cm, and
P = +3, then ***v* = 50cm**

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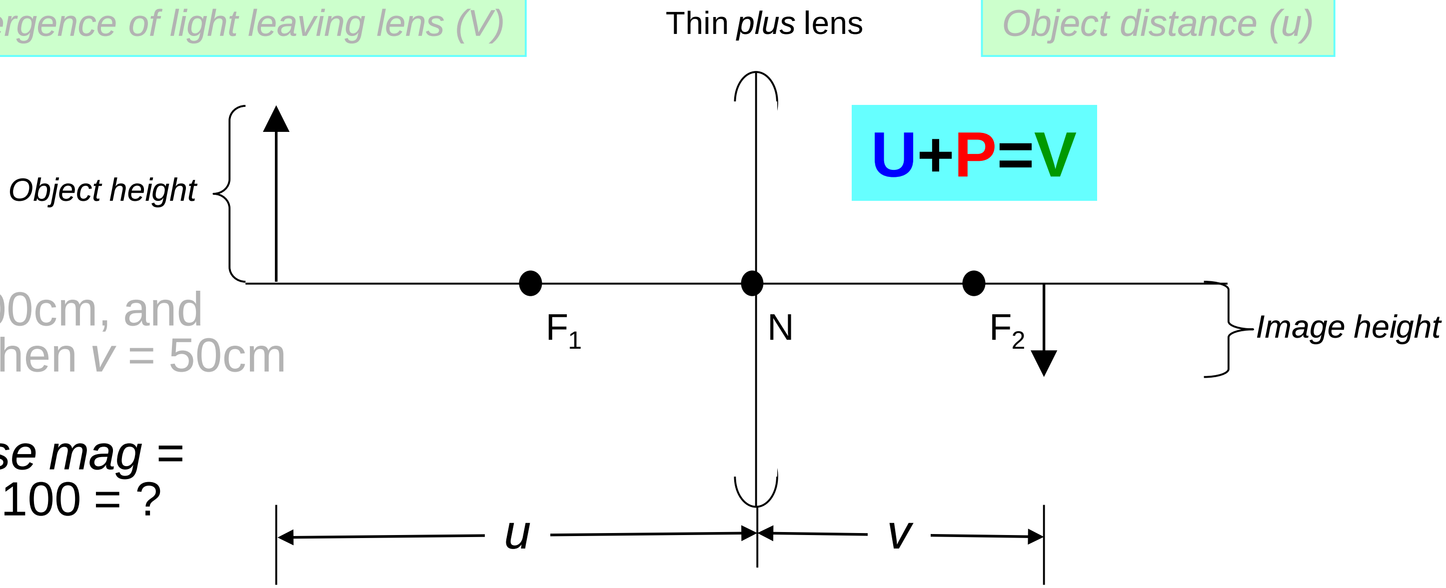

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Transverse mag =
v/u = 50/-100 = ?

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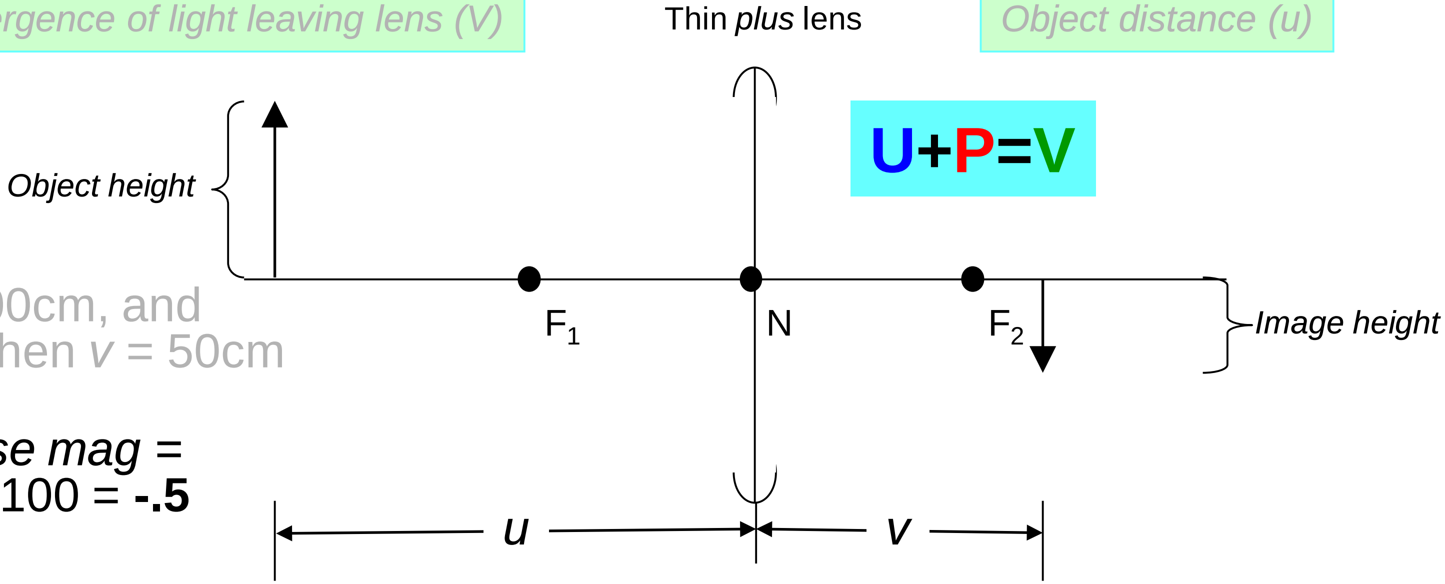

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If *u* = -100cm, and
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Transverse mag =
v/*u* = 50/-100 = **-.5**

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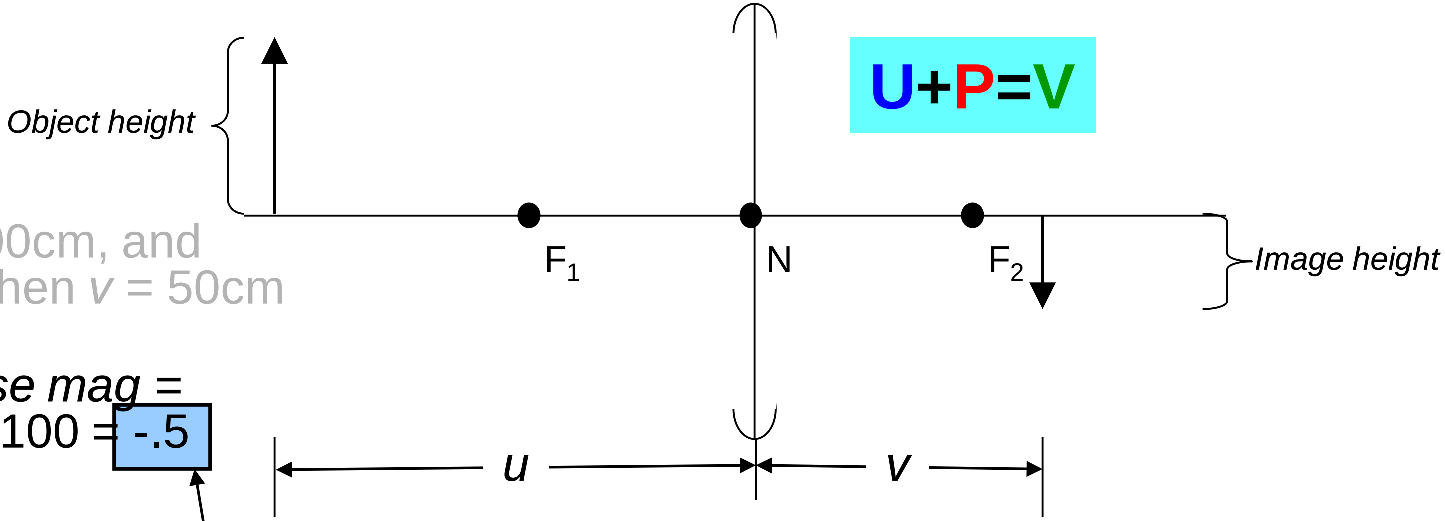

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If *u* = -100cm, and
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Transverse mag =
v/*u* = 50/-100 = $\boxed{-.5}$

(The **.5** *tells us the image is ½ the size of the object; the* **minus sign** *indicates the image is* **inverted***)*

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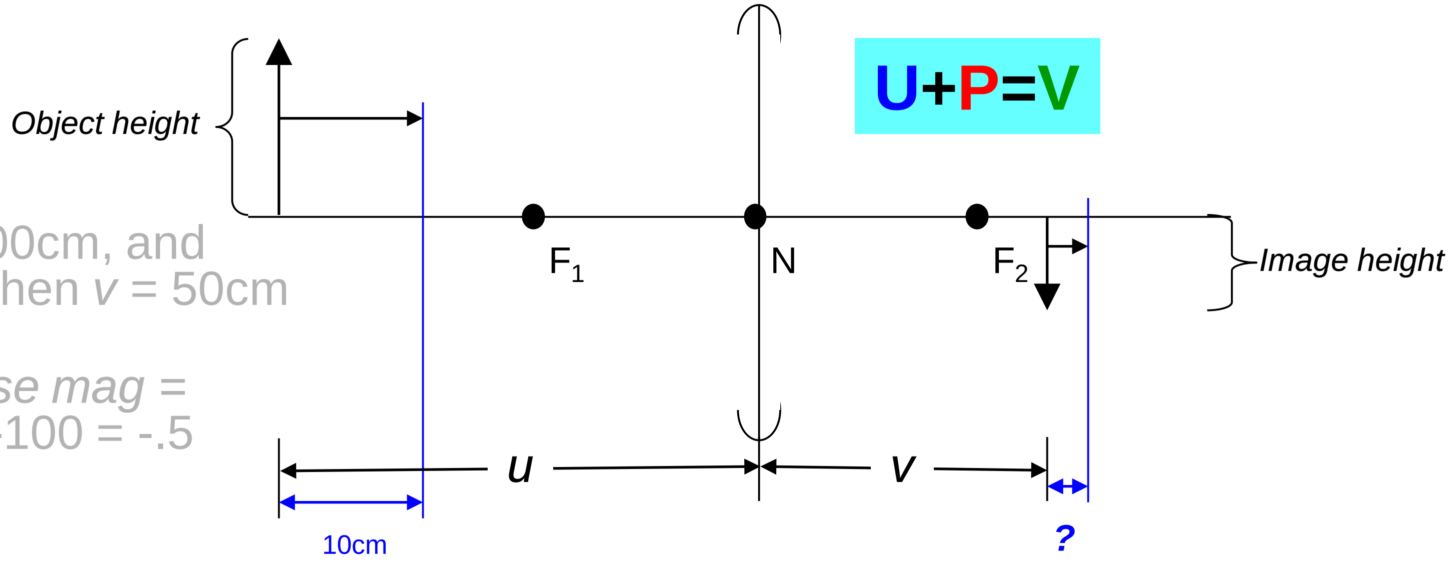

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If our arrow has a 10cm ‘nose,’
how big will the image nose be?

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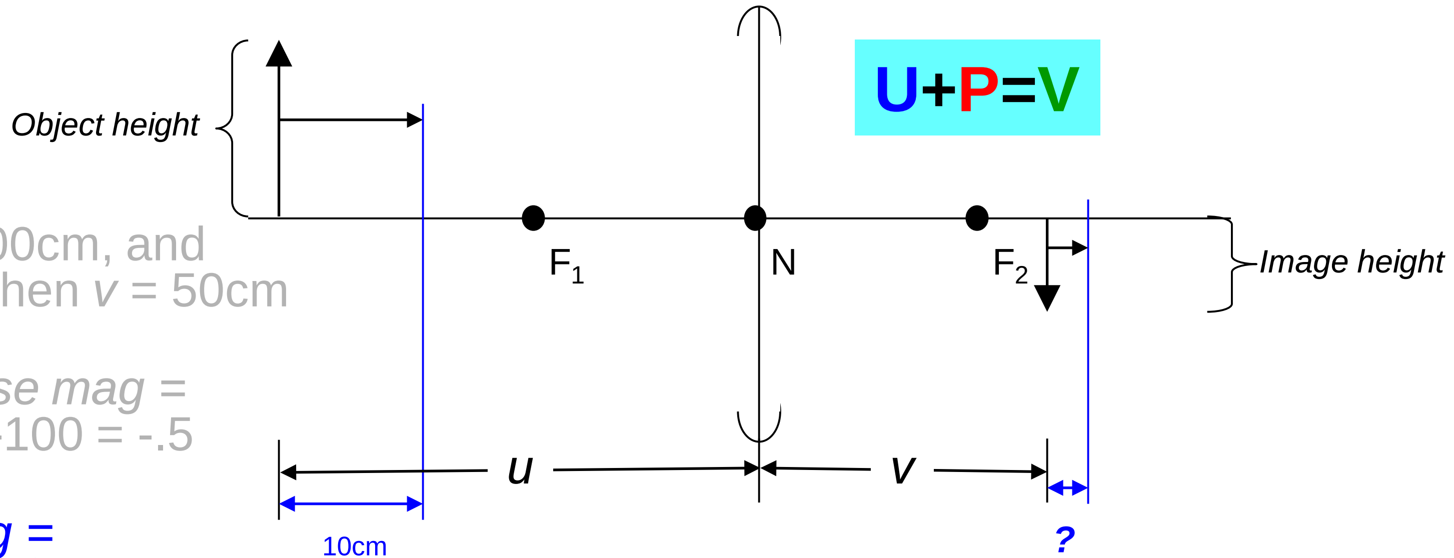
Thin *plus* lens

U+P=V



If u = -100cm, and
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Axial mag =
$(v/u)^2 = -.5^2 = .25$

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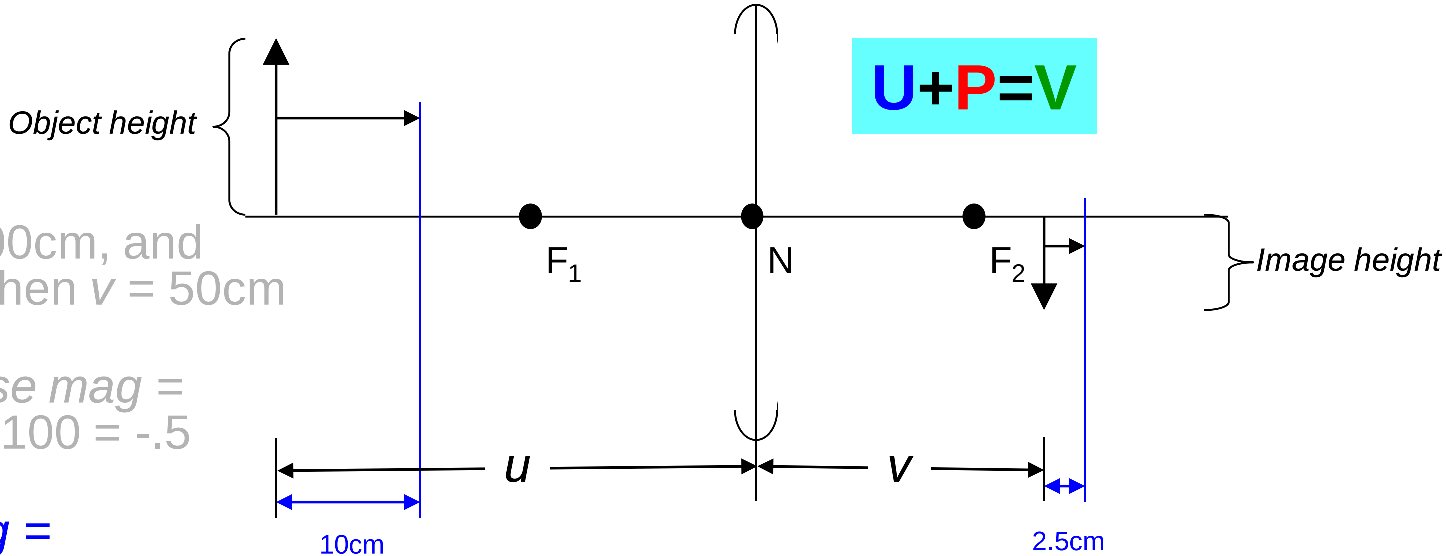

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If our arrow has a 10cm ‘nose,’
how big will the image nose be? **.25 x 10 cm = 2.5 cm** (approx)

Axial Magnification

- Axial magnification is important in the context of *indirect ophthalmoscopy*
- The condensing lens power and the pupillary distance (PD) on the indirect ophthalmoscope determine the perceived height of elevated posterior pole lesions

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$$\text{Image lesion height} = \frac{\text{PD in millimeters}}{\text{Condensing lens power (D)}}$$

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- Axial magnification is important in the context of *indirect ophthalmoscopy*
- The condensing lens power and the pupillary distance (PD) on the indirect ophthalmoscope determine the perceived height of elevated posterior pole lesions

$$\text{Image lesion height} = \frac{\text{PD in millimeters}}{\text{Condensing lens power (D)}}$$

Mathematically convenient PD (it’s a little low)

$$\text{Image lesion height} = \frac{60}{20D} = \mathbf{3x}$$

Typical condensing lens power