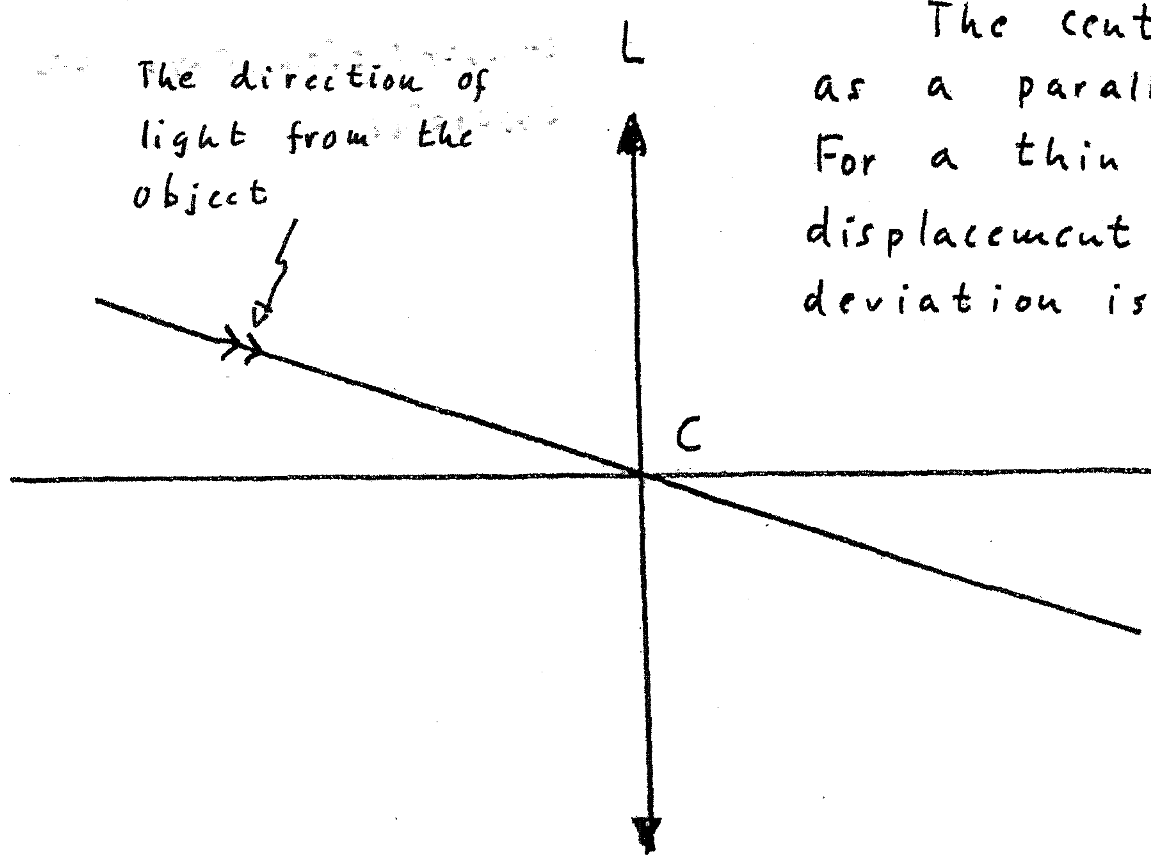
A

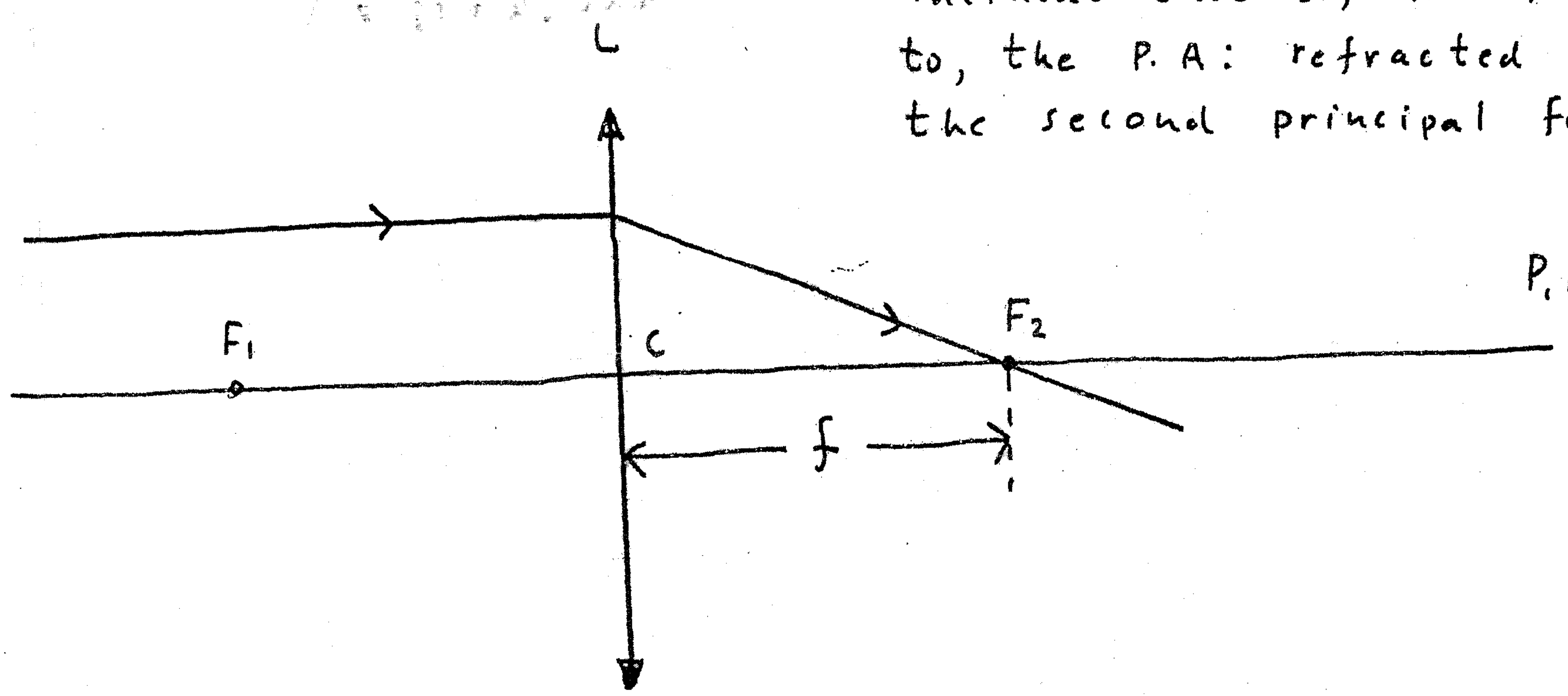
Principal construction rays for the different images formed by a convex lens

(1)



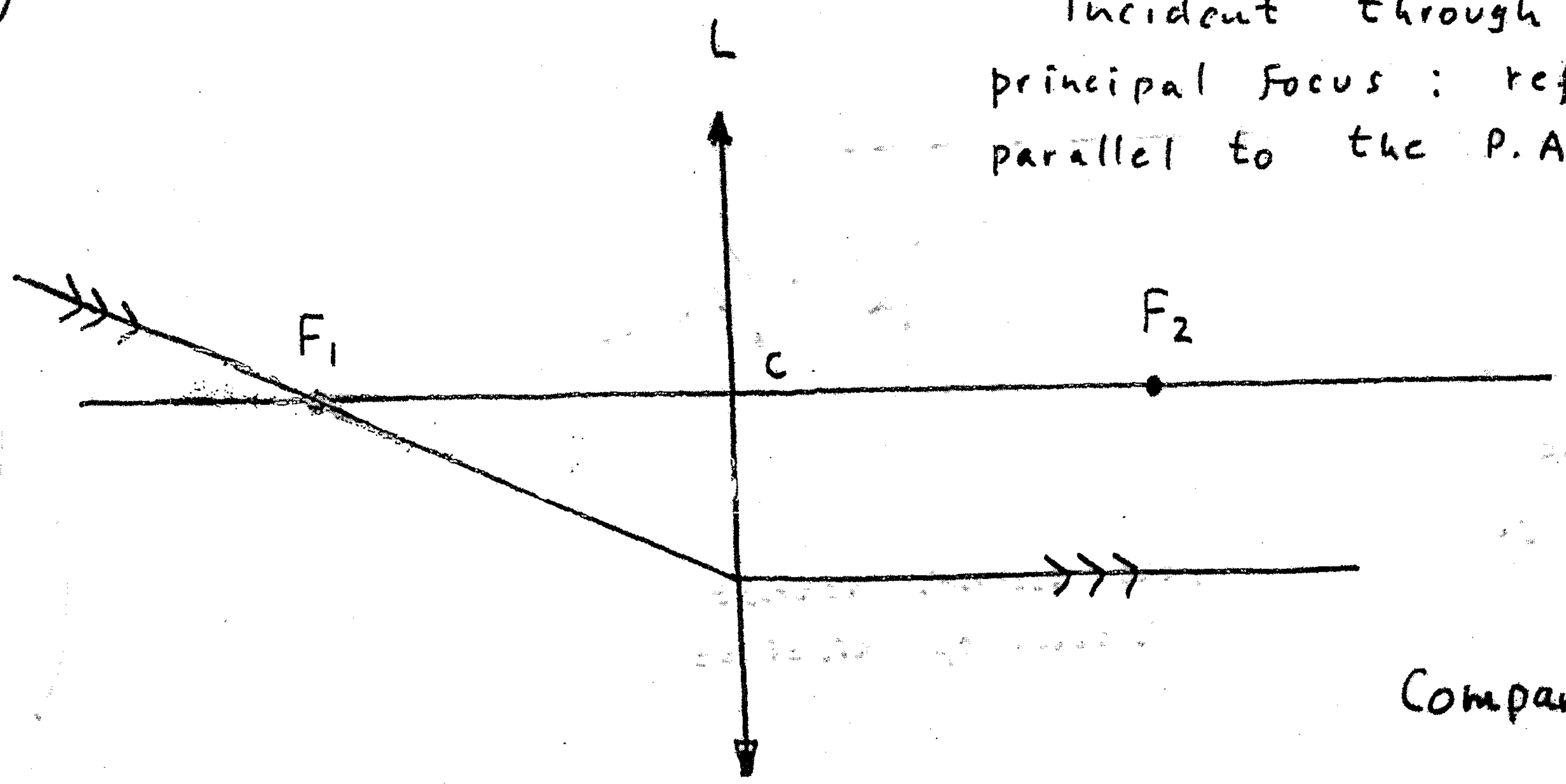
The centre of the lens functions as a parallel-sided glass block. For a thin lens, the lateral displacement is negligible and the deviation is zero.

(2)



Incident close to, and parallel to, the P.A: refracted through the second principal focus.

(3)

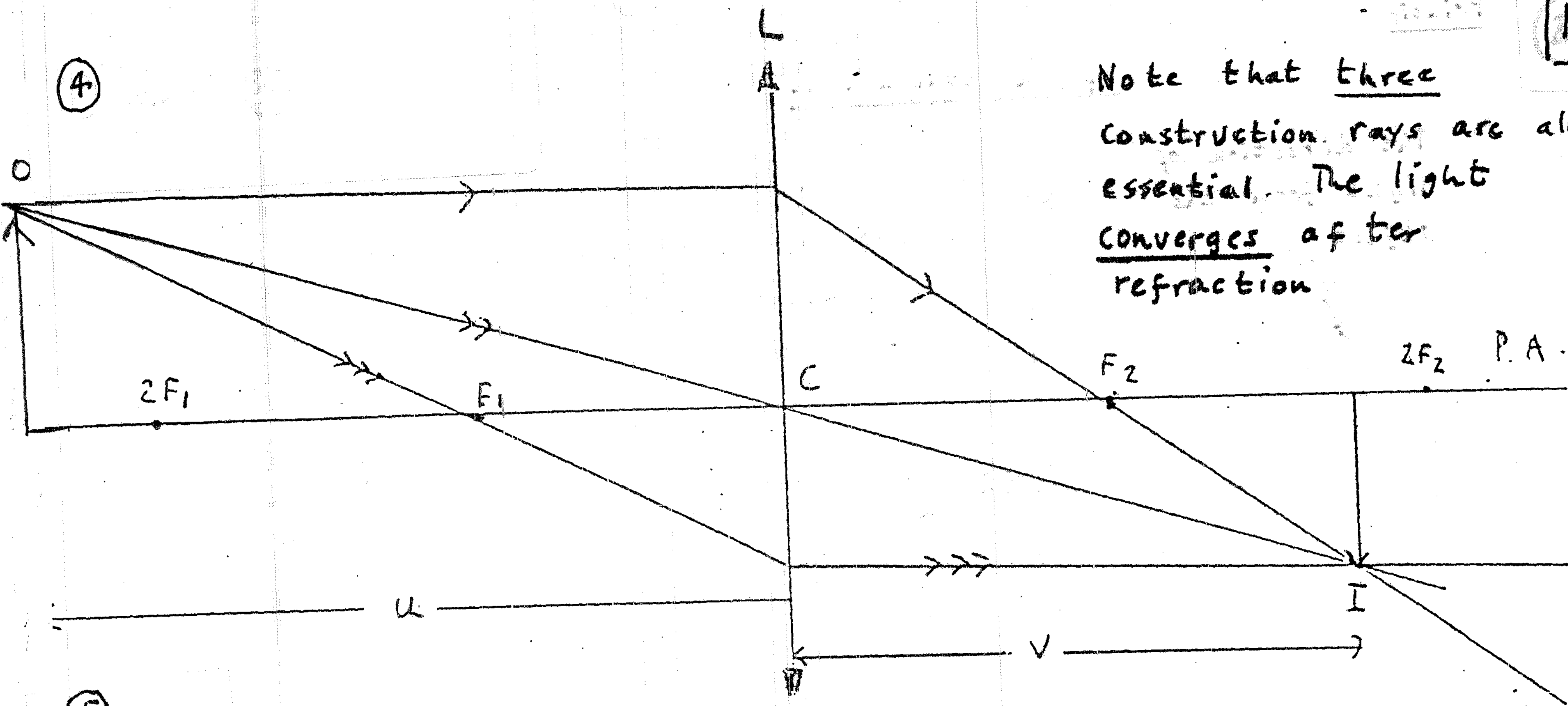


Incident through the first principal focus: refracted parallel to the P.A.

Compare (3) with (2)

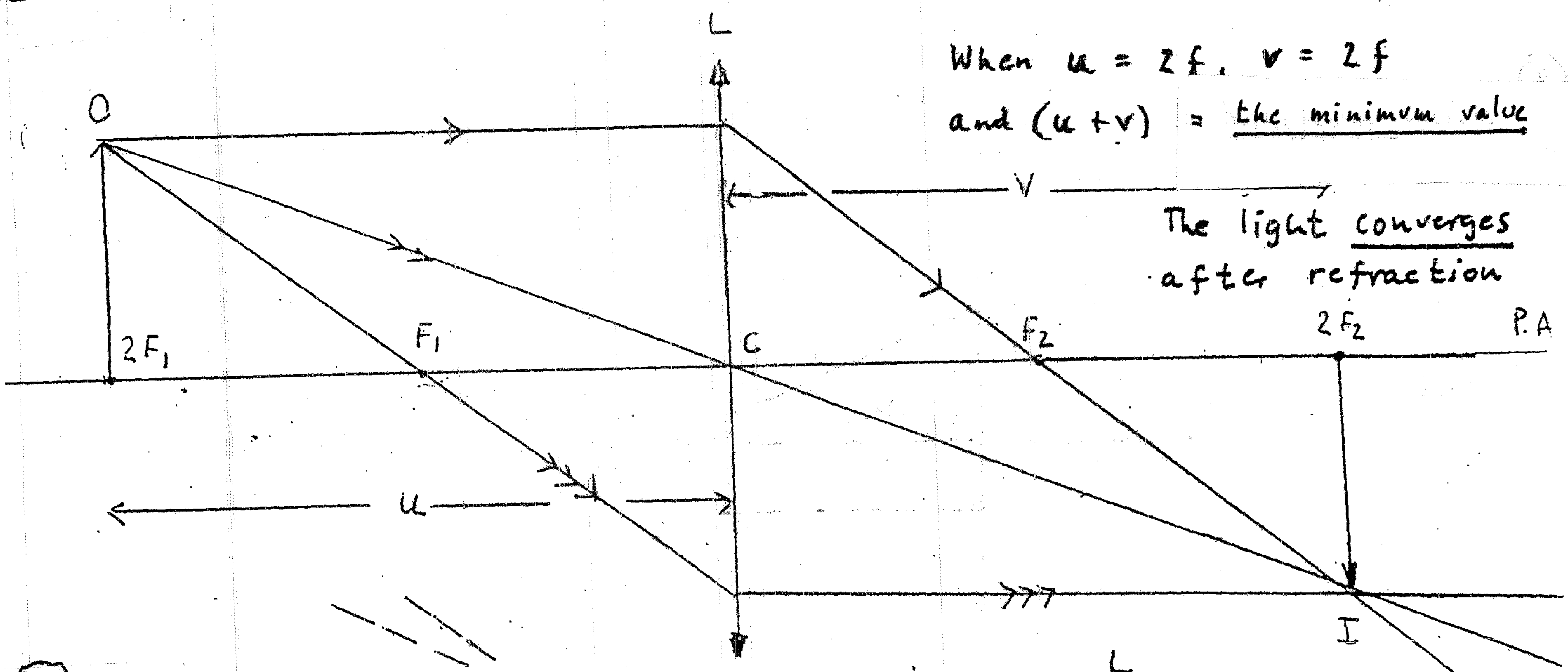
B

(4)



Note that three construction rays are always essential. The light converges after refraction

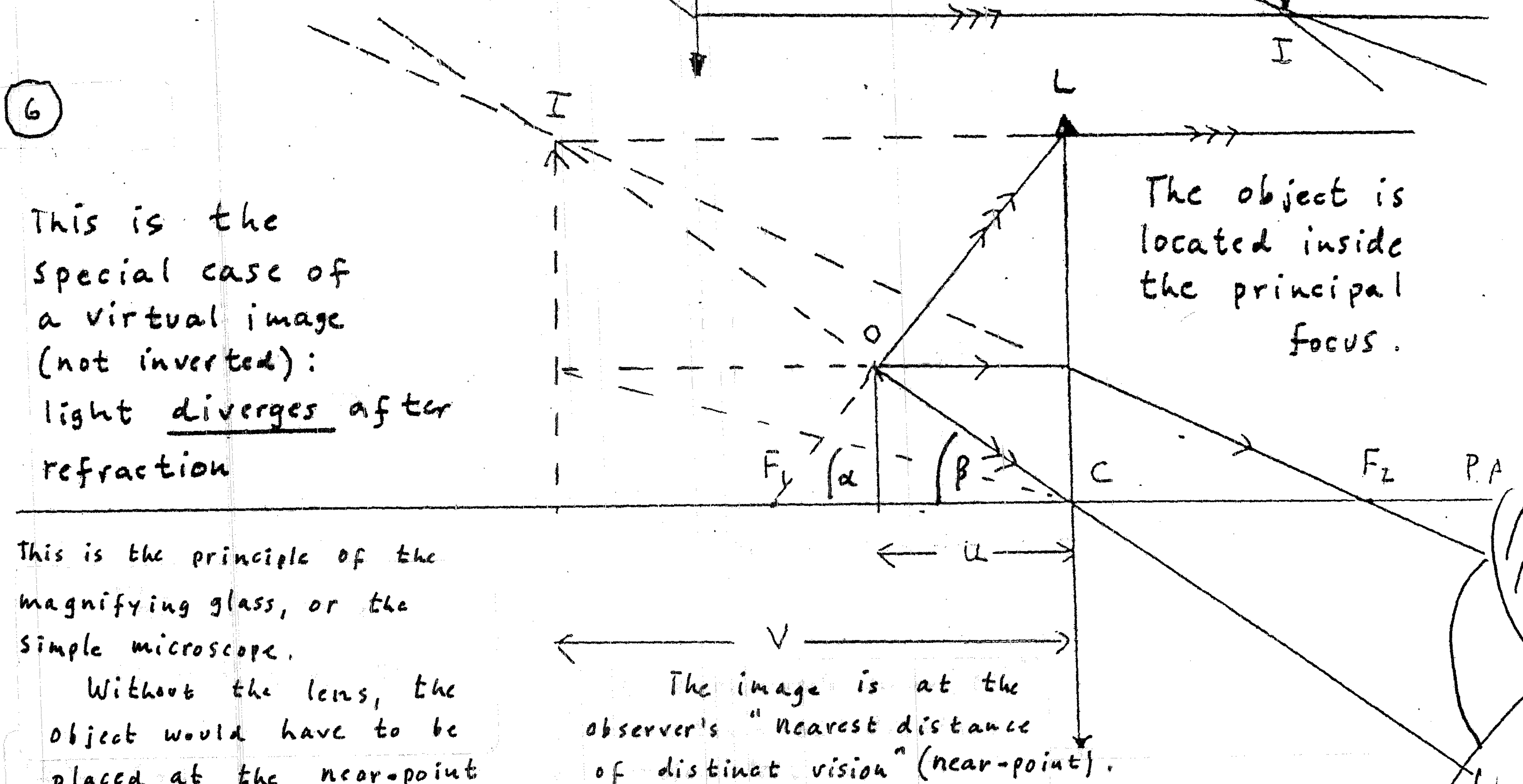
(5)



When $u = 2f$, $v = 2f$ and $(u + v)$ = the minimum value

The light converges after refraction

(6)



This is the special case of a virtual image (not inverted): light diverges after refraction

The object is located inside the principal focus.

This is the principle of the magnifying glass, or the simple microscope.

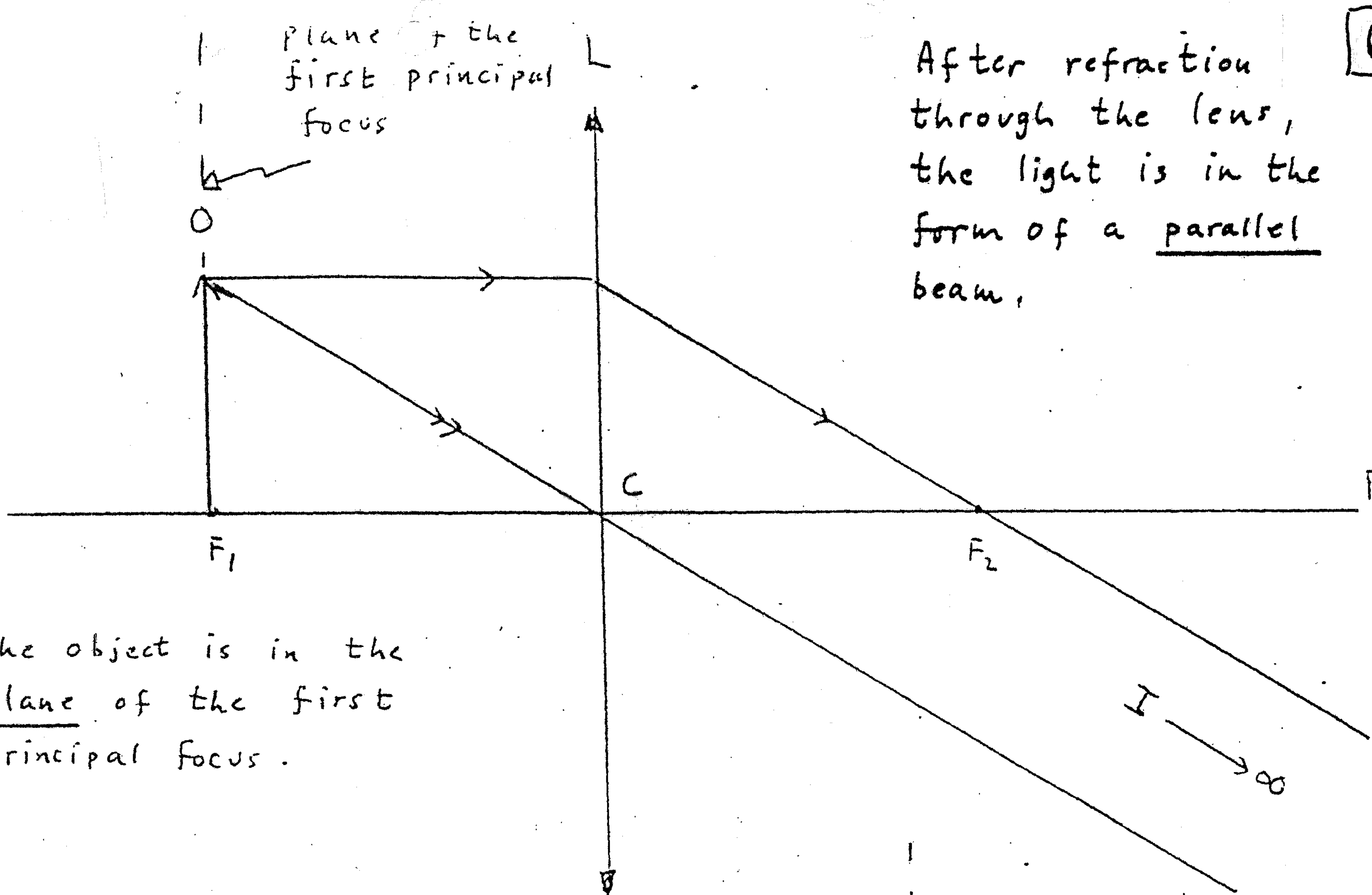
Without the lens, the object would have to be placed at the near-point and the angle subtended at the observer's eye then becomes α

$$M.P. = \frac{\beta}{\alpha}$$

The image is at the observer's "nearest distance of distinct vision" (near-point). This is achieved by adjusting the distance from the lens of the object. This image subtends angle of β

C

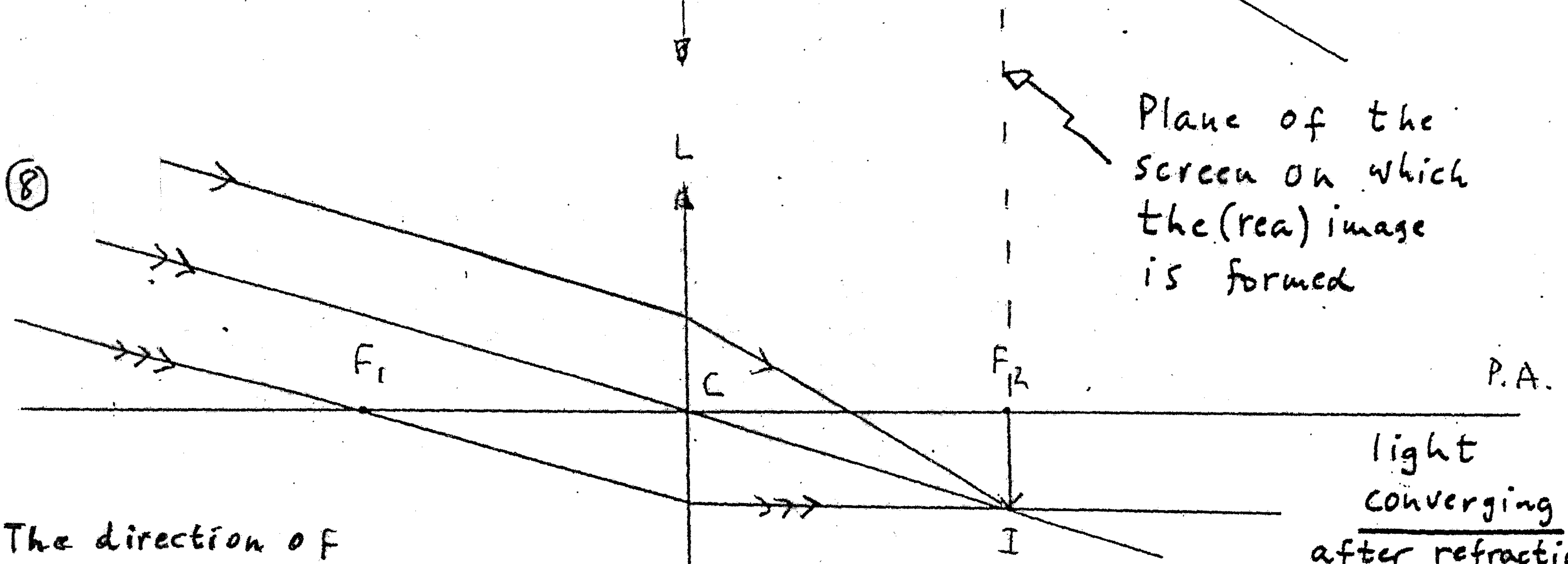
(7)



After refraction through the lens, the light is in the form of a parallel beam.

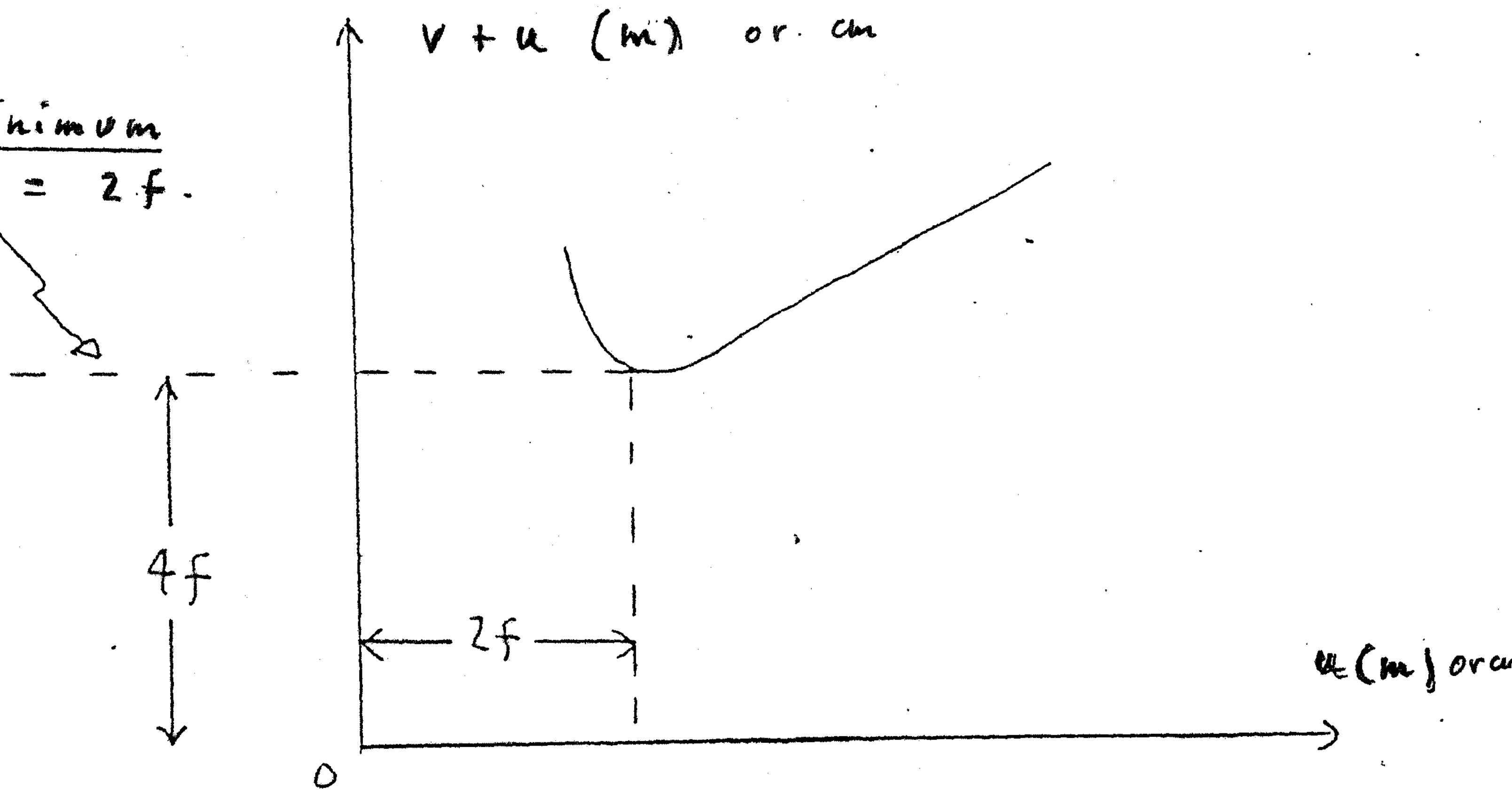
The object is in the plane of the first principal focus.

(8)



The direction of light from an extended and infinitely-distant object

The image is formed in the plane of the second principal focus.



(v + u) is a minimum value when u = 2f.

⇒ the linear magnification, M,

$= 1 \left(= \frac{v}{u} \right)$

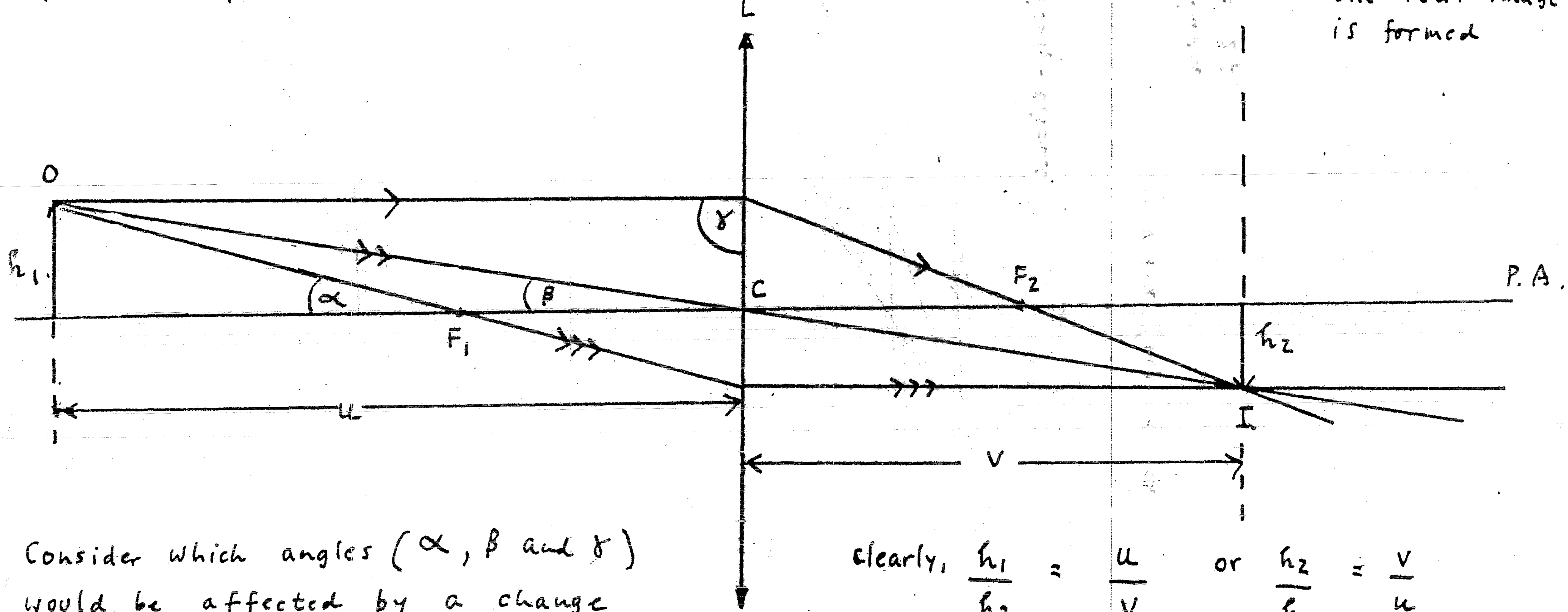
D

General ray diagram for the image formed by a convex lens.

Only three rays have been considered to represent the light being emitted. These particular rays have been demonstrated experimentally.

N.B. Three construction rays are needed. The third one is used to confirm the accuracy of the other two (or their inaccuracy!)

Plane of the screen on which the real image is formed



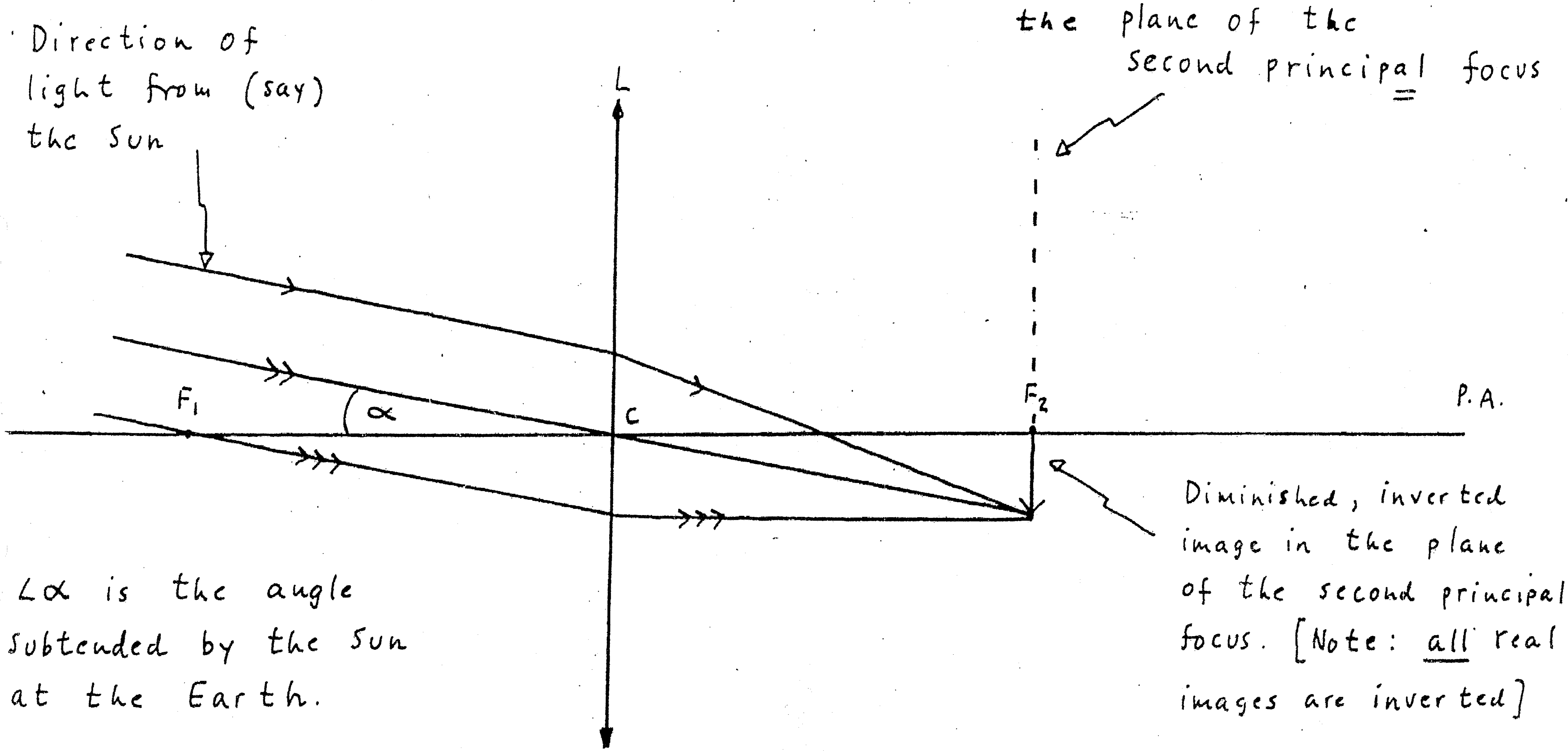
Consider which angles (α, β and γ) would be affected by a change in the object position and how this change would affect the properties of the image (size, distance, linear magnification, etc.)

Clearly, $\frac{h_1}{h_2} = \frac{u}{v}$ or $\frac{h_2}{h_1} = \frac{v}{u}$

i.e., $M = \frac{v}{u}$ M = linear magnification

Formation of the image of a distant extended object

E



∠α is the angle subtended by the Sun at the Earth.

N.B. Only if the object was a point object, situated on the P.A., would the image be formed at the second principal focus. } Assumed to be aberration-free *

* Aberration: the phenomenon of a point object not giving rise to a point image.

DF
2017, January 2