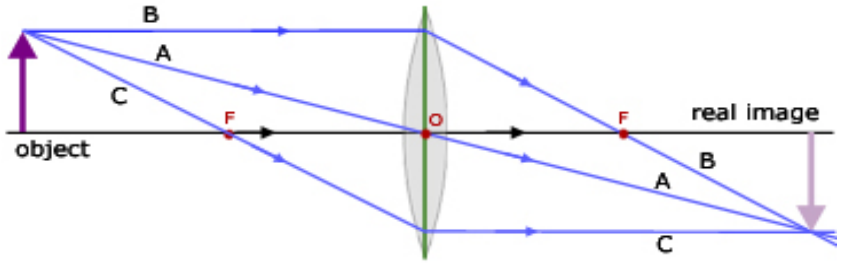
4-4 The diagrams and the formation of an image

To understand ray diagrams it is important to know something about images. Images come in two categories :
real images - are produced from actual rays of light coming to a focus (eg a film projected onto a screen)
virtual images - are produced from where rays of light appear to be coming from (eg a magnifying glass image)

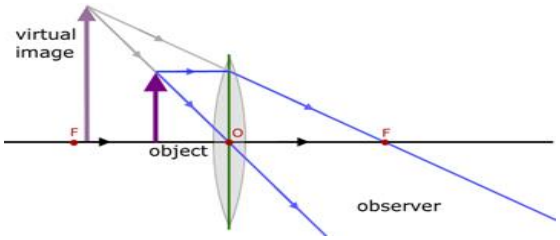


A) a ray passing through the optical centre of the lens
B) a ray parallel to the principal axis, which refracts through the lens, passing through the principal focus
C) a ray passing through the principal focus(on the same side as the object) and being refracted through the lens, emerging parallel to the principal axis

The diagrams represent the formation of an image from an object positioned between *f* and the lens, at *f*, between f and 2f and at 2*f* from the lens

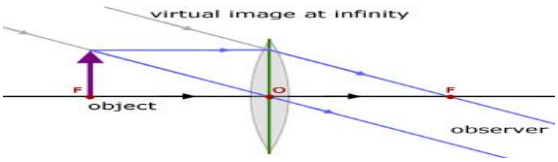
4-4.1 Object between *f* and the lens (magnifying glass)

The image is the same side of the lens as the object and is upright, virtual and magnified.



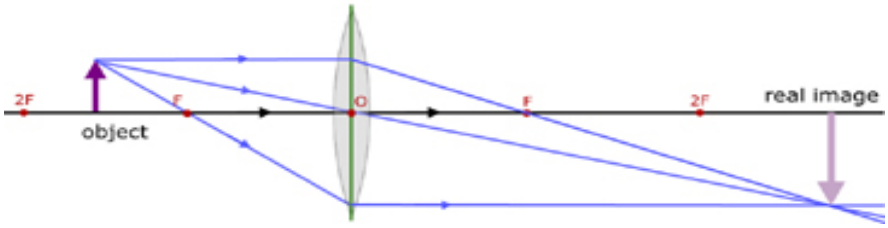
4-4.2object at *f*

The image is formed at infinity from parallel rays that do not converge. Therefore no image is formed



4-4.3 object between f and 2f (projector)

The image is on the opposite side of the lens than the object. It is real, inverted and magnified



4-4.4 object at 2*f*

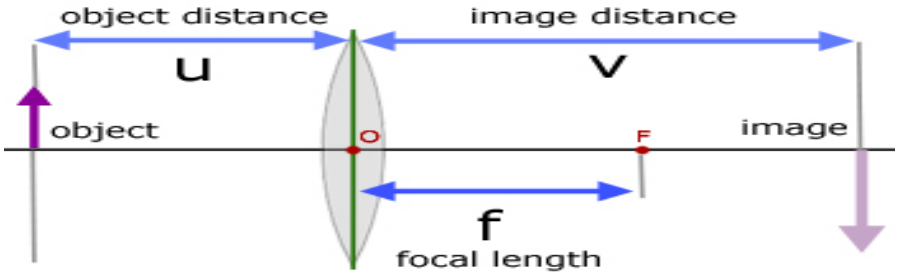
The diagram is very similar to the one showing the three construction rays.
The image is the same distance behind the lens as the object is infront.
The image is inverted, real and the same size as the object.

4-4.5 object at infinity

The image is formed at the focal point of the lens. It is real, inverted and diminished in size.

4-5 The Lens Formula

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

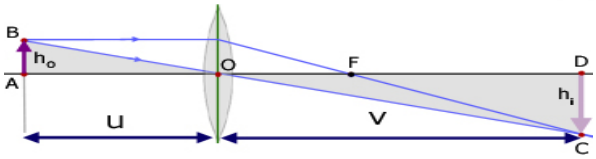


-When using this equation a sign convention must be obeyed:
Distances from lenses to real objects & real images are positive
Distances from lenses to imaginary objects and imaginary images are negative.
Focal lengths of convex lenses are positive.
Focal lengths of concave lenses are negative

4-6 Magnification

Magnification (***m***) is simply the image height divided by the object height

$$m = \frac{h_i}{h_o}$$



To obtain a relation involving object distance (***u***) and image distance (***v***), consider the image formed by two rays from a point on the object.
Triangles **AOB** and **COD** are similar.
Therefore,

$$\frac{CD}{AB} = \frac{DO}{AO}$$

$$\frac{h_i}{h_o} = \frac{v}{u}$$

$$\underline{m = \frac{v}{u}}$$