The mirror equation

If rays emanating from a point actually meet at another point after reflection and/or refraction, that point is called the image of the first point. The image is real if the rays actually converge to the point; it is virtual if the rays do not actually meet but appear to diverge from the point when produced backwards

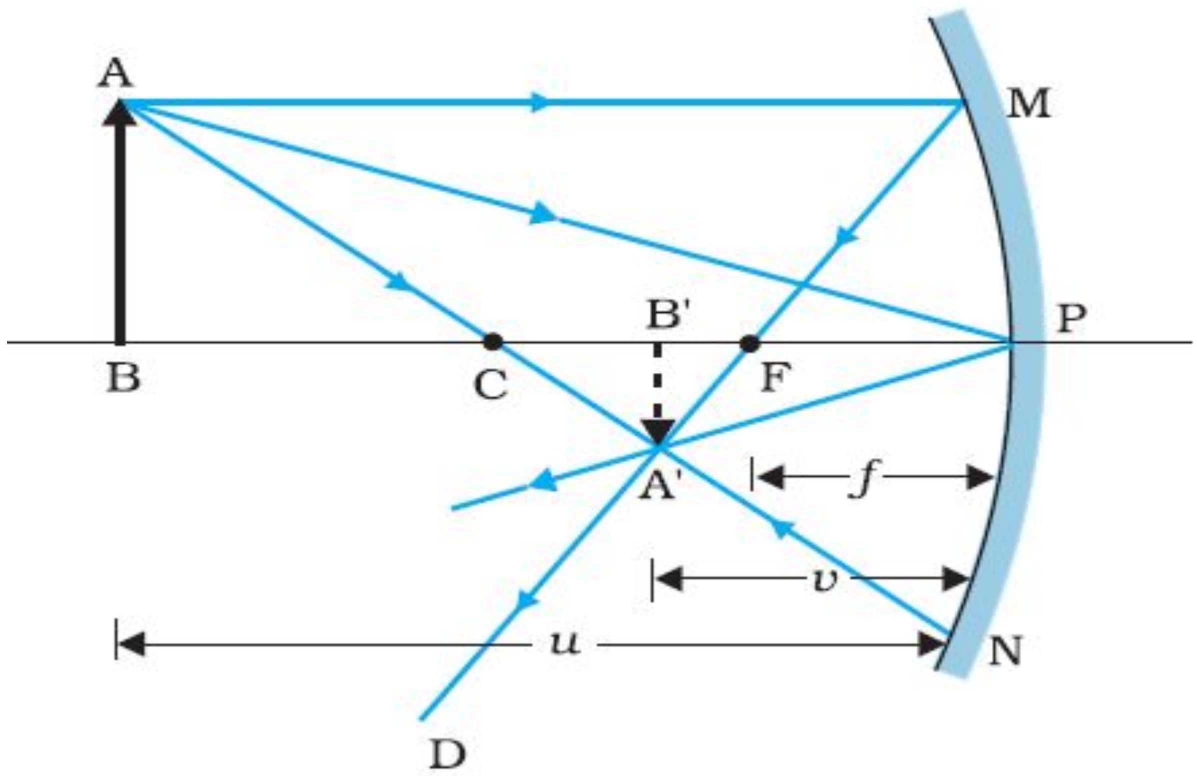
(i) The ray from the point which is parallel to the principal axis. The reflected ray goes through the focus of the mirror.

(ii) The ray passing through the centre of curvature of a concave mirror or appearing to pass through it for a convex mirror. The reflected ray simply retraces the path.

(iii) The ray passing through (or directed towards) the focus of the concave

mirror or appearing to pass through (or directed towards) the focus of a convex mirror. The reflected ray is parallel to the principal axis.

(iv) The ray incident at any angle at the pole. The reflected ray follows laws of reflection.


A
M
B'
P
B
C
F
f
A'
v
u
N
D

the two right-angled triangles

A□’B□’F and MPF are similar.

$$\frac{BA}{PM} = \frac{BF}{FP}$$

$$\text{or } \frac{BA}{BA} = \frac{BF}{FP} \quad (\because PM = AB)$$

Since triangles A□’B□’P and ABP are

also similar. Therefore,

$$\frac{BA}{BA} = \frac{BP}{BP}$$

Comparing Eqs

$$\frac{B\,F}{FP} = \frac{B\,P - FP}{FP} = \frac{B\,P}{BP}$$

When applying sign convension, all the three will have negative signs.

B□’P = -v,   FP = -f,   BP = -u

then applying

$$\frac{-v \quad f}{-f} = \frac{-v}{-u}$$

$$\text{or} \quad \frac{v-f}{f} = \frac{v}{u}$$

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

This relation is known as the **mirror equation**

We define **linear magnification** (m) as the ratio of the height of the image (h′) to the height of the object (h):

$$m = \frac{h'}{h}$$

h and h’ will be taken positive or negative in accordance with the accepted sign convention.

In triangles A□’B□’P and ABP, we have $$\frac{B\ A}{BA} = \frac{B\ P}{BP}$$

With the sign convention, this becomes

$$\frac{-h}{h} = \frac{-v}{-u}$$

so that

$$m = \frac{h}{h} = -\frac{v}{u}$$