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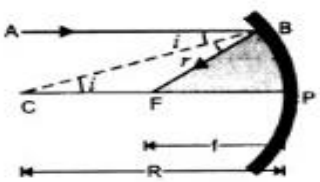
Class 12Sc   Sub Physics(Unit 06)   Date 01 09 XX

In fig. P, C and F is pole, centre of curvature and principal focus of the concave mirror. AB is ray incident parallel to the principal axis where BF is reflected ray.



$\therefore$ $\angle ABC = i$, angle of incidence

$\angle CBF = r$, angle of reflection

Now $\angle BCF = \angle ABC = i$ (alternate angles)

In ΔCBF, as $i = r$ (law of reflection)

$\therefore$ $CF = FB$

But $FB = FP$ ($\because$ aperture is small)

$\therefore$ $CF = FP$

i.e., F is the centre of PC

$\therefore$ $PF = \frac{1}{2}PC$, Using sign conventions,

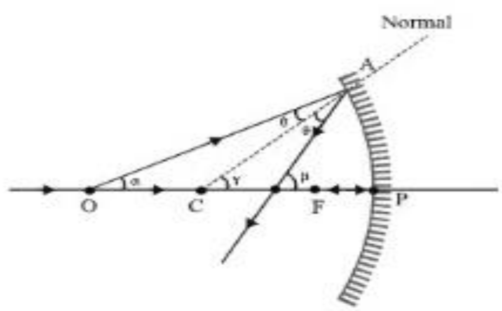
$PF = -f$ and $PC = -R$.

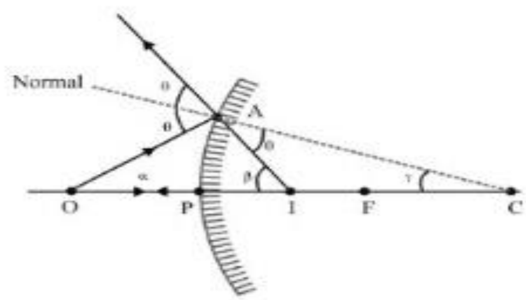
Therefore, $-f = -R/2$ or $f = R/2$

i.e., focal length of a concave mirror is equal to half the radius of curvature of the mirror.

4.3 Deriving the Mirror Formula

Mirror formula can be derived for any of the cases of image formation shown before. When we derive a formula, we keep in mind the sign conventions and substitute each value with sign. This makes a formula suitable to be applied in any case. Here, we shall derive the formula for two cases.

<table>
<tr><th>Real object and real image
(concave mirror)</th><th>Real object and virtual image
(convex mirror)</th></tr>
<tr><td>


$PO = -u$ (distance of object)
$PC = -R$ (radius of curvature)
$PI = -v$ (distance of image)
In ΔOAC, $\gamma = \alpha + \theta$ ...(i)
In ΔOAI, $\beta = \alpha + 2\theta$ ...(ii)
From (i) and (ii)
$2(\gamma - \alpha) = \beta - \alpha$
$\Rightarrow \beta + \alpha = 2\gamma$
$\beta = \frac{AP}{PI}, \alpha = \frac{AP}{PO}, \gamma = \frac{AP}{PC}$
$\frac{AP}{PI} + \frac{AP}{PO} = \frac{2AP}{PC}$
$\frac{1}{-v} + \frac{1}{-u} = \frac{}{-R} \Rightarrow \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$
</td><td>


$PO = -u$ (distance of object)
$PI = +v$ (distance of image)
$PC = +R$ (radius of curvature)
In ΔOAC, $\theta = \alpha + \gamma$ ...(i)
In ΔOAI, $2\theta = \alpha + \beta$ ...(ii)
From (i) and (ii)
$2(\alpha + \gamma) = \alpha + \beta$
$\Rightarrow \beta - \alpha = 2\gamma$
$\beta = \frac{AP}{PI}, \alpha = \frac{AP}{PO}, \gamma = \frac{AP}{PC}$
$\frac{AP}{PI} - \frac{AP}{PO} = \frac{2AP}{PC}$
$\frac{1}{v} - \frac{1}{-u} = \frac{2}{R} \Rightarrow \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$
</td></tr>
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