Physics Class Notes

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Mirror Equation and Focal length

Mirror equation is the relation between object distance (u), image distance (v), and focal length (f) of the mirror.

1/f = 1/u + 1/v is the mirror equation.

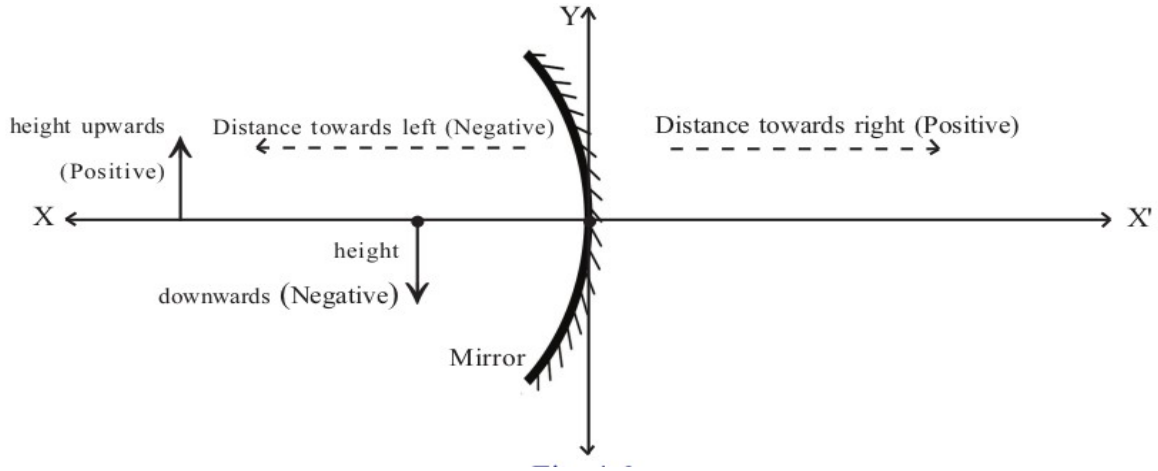
Or **f = uv/(u+v).**

New Cartesian Sign Convention.

While measuring distance in optical experiments the sign also is to be taken into account. For this the following rules are to be adopted.

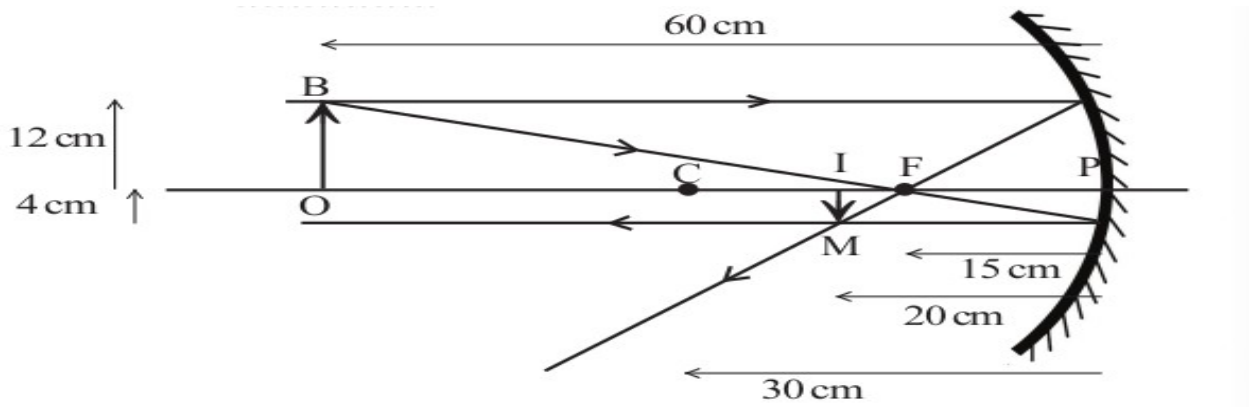
- **Distances are measured considering the pole of the mirror as the origin (O).**
- **Those measured to the right from O are positive and those in the opposite direction are negative.**
- **Distances measured upward from X axis are positive and those downwards are negative. The incident ray is to be considered as travelling left to right.**

Record the measurements shown in the figure using the New Cartesian Sign Convention.



Distance to the object from the mirror (u) = Negative
Distance to the image from the mirror (v) = Negative
Height of the object (OB) = Positive
Height of the image (IM) = Negative.

- **The given figure shows the image formation by a concave mirror. Analyse the figure and write down different measures using New Cartesian Sign Convention.**



Distance of the object from the mirror (u)	**- 60 cm**
Distance of image from the mirror (v)	**- 20 cm**
Focal length (f)	**- 15 cm**
Radius of curvature (R)	**- 30 cm**
Height of the object (OB)	**+ 12 cm**
Height of the image (IM)	**- 4 cm**

- **When an object is placed in front of a concave mirror at a distance 30 cm from an image is obtained on a screen at a distance of 20 cm from the mirror. Find the focal length of the mirror?**

  Ans: u = - 30 cm, v = - 20cm

  f = uv/(u+v)

  =(- 30 x - 20)/(-30 + -20)

  = 600/(-50) = - 12 cm.
- **An object is placed in front of a concave mirror 20 cm away from it. If its focal length is 40 cm, locate the position of the image and its nature.**

  Ans: u = - 20 cm, f = - 40 cm

  v= fu/ (u-f)

  = (-40 x – 20) / (-20 - (-40))

  = 800/ (-20+ 40)

  = 800/ 20

  = 40 cm

  Since 'v' is positive the image is virtual and erect.
- **When an object is placed in front of a concave mirror at a distance 15 cm an image is formed on a screen 10 cm away from the mirror. If the object is placed 30 cm away what is the distance to the image?**

  Ans: u = - 15 cm, v = - 10 cm

  f = uv/(u+v)

  = (-15 x - 10) / (-15 + -10)

  = 150/ -25

  = - 6 cm

  If the object is placed 30 cm away

  u = - 30 cm

  v = fu/ (u-f)

  = (-6 x – 30) / (-30 - (-6))

  = 180 / (-30 +6)

  = 180 / - 24

  = - 7.5 cm.

  Since 'v' is negative image is real and inverted.

Homework

1. **An image is placed in front of a concave mirror 40 cm away from it. If its focal length is 80 cm, locate the position of the image and find the nature of the image.**