KUMAR ONLINE CLASS
CBSE(NCERT): CLASS X SCIENCE
CASE STUDY
QUESTION 45

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Mirror formula is a relation between object distance \( u \), image distance \( v \) and focal length \( f \) of a spherical mirror. It can be written as \( \frac{1}{u} + \frac{1}{v} = \frac{1}{f} = \frac{2}{R} \) where \( R \) is the radius of curvature of the mirror. This formula is valid in all situations for all spherical mirrors for all positions of the object. Consider the case, in which a mirror forms a real image of height 4 cm of an object of height 1 cm placed 20 cm away from the mirror.
(i) The distance from the object to its image is
(a) 20 cm (b) 80 cm (c) 60 cm (d) 70 cm

Here $h_1 = 1 \text{ cm}$, $h_2 = -4 \text{ cm}$, $u = -20 \text{ cm}$

We have, $m = \frac{h_2}{h_1} = -\frac{v}{u}$ i.e., $\frac{-4}{1} = -\frac{v}{-20}$

or $v = -80 \text{ cm}$

So, $|v - u| = |(-80) - (-20)| = 60 \text{ cm}$

(ii) The focal length of mirror is
(a) -16 cm (b) 12 cm (c) -15 cm (d) 10 cm

Here, we have $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ i.e., $\frac{1}{f} = \frac{1}{-20} + \frac{1}{-80} = \frac{-4 - 1}{80} = \frac{-5}{80}$

$\therefore f = \frac{-80}{5} = -16 \text{ cm}$

Consider the case, in which a mirror forms a real image of height 4 cm of an object of height 1 cm placed 20 cm away from the mirror.
(iii) The radius of curvature of the mirror is
(a) -16 cm (b) -14 cm (c) -30 cm (d) -32 cm

\[
R = 2f = -2(16) = -32 \text{ cm.}
\]

(iv) The magnification of the image is
(a) 3 (b) -6 (c) -4 (d) 8

\[
m = \frac{-v}{u} = -\frac{-80}{-20} = -4
\]

Consider the case, in which a mirror forms a real image of height 4 cm of an object of height 1 cm placed 20 cm away from the mirror.
(v) At what distance must an object be placed from mirror in order that a real image double its size may be obtained?
(a) -24 cm (b) 32 cm (c) -40 cm (d) 45 cm

\[ m = -\frac{v}{u} = -2 \quad \Rightarrow \quad v = 2u \]

So, \[ \frac{1}{v} + \frac{1}{u} = \frac{1}{f} \quad \Rightarrow \quad \frac{1}{u} + \frac{1}{2u} = \frac{1}{f} \]

\[ \Rightarrow \quad u = \frac{3}{2} f = \frac{3}{2} (-16) = -24 \text{ cm} \]