

①

Given distance of object $u = -10 \text{ cm}$

Focal length $f = 20 \text{ cm}$

∴ From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{20} = \frac{1}{v} - \frac{1}{10}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{20} + \frac{1}{10}$$

$$\Rightarrow \frac{1}{v} = \frac{1+2}{20}$$

$$\Rightarrow \frac{1}{v} = \frac{3}{20}$$

Image distance $\Rightarrow v = \frac{20}{3} \text{ cm}$

②

Given size of image = 4.5 size of object. → ①

Distance of object $u = -20 \text{ cm}$

From ① $h_I = -4.5 h_o$ [Image is real]

∴ magnification $m = +\frac{h_I}{h_o}$ also $m = -\frac{v}{u}$

$$\therefore -\frac{v}{u} = \frac{h_I}{h_o}$$

$$\Rightarrow \frac{+v}{+20} = -\frac{4.5 h_o}{h_o}$$

$$\Rightarrow \frac{v}{20} = -4.5 \Rightarrow v = -4.5 \times 20 = -90 \text{ cm}$$

2nd continuation

we know that

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

$$\Rightarrow \frac{1}{f} = \frac{-1}{90} - \frac{1}{20}$$

$$\Rightarrow \frac{1}{f} = \frac{-2-9}{180}$$

$$\Rightarrow \frac{1}{f} = \frac{-11}{180}$$

$$\Rightarrow f = -\frac{180}{11} \text{ cm}$$

(3)

Given size of image $h_I = \frac{1}{n} h_o$

Here object distance is $u = -u$.

$$\therefore \text{From Magnification } m = \frac{-v}{u} = \frac{h_I}{h_o}$$

$$\Rightarrow \frac{-v}{-u} = \frac{\frac{1}{n} h_o}{h_o}$$

$$\Rightarrow \frac{v}{u} = \frac{1}{n} \Rightarrow v = \frac{u}{n}$$

$$\therefore \text{From mirror formula } \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{f} = \frac{1}{\frac{u}{n}} + \frac{1}{(-u)}$$

$$\Rightarrow \frac{1}{f} = \frac{n}{u} - \frac{1}{u}$$

$$\Rightarrow \frac{1}{f} = \frac{(n-1)}{u}$$

$$\Rightarrow u = (n-1)f$$

(4)

Given $R = -60 \text{ cm}$

$$\therefore f = \frac{R}{2} = -\frac{60}{2} = -30 \text{ cm} \quad [\text{For concave mirror } f \text{ is -ve}]$$

$$v = -90 \text{ cm}$$

By using mirror formula

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

$$\Rightarrow -\frac{1}{30} = -\frac{1}{90} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{u} = -\frac{1}{30} + \frac{1}{90}$$

$$\Rightarrow \frac{1}{u} = \frac{-3+1}{90}$$

$$\Rightarrow \frac{1}{u} = -\frac{2}{90} \Rightarrow u = -\frac{90}{2} = -45 \text{ cm}$$

object distance is always Negative.

(5)

Given distance of object $u = 0.2 \text{ m} = -20 \text{ cm}$

Distance of image $v = 30 \text{ cm}$

From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{f} = \frac{1}{30} - \frac{1}{20}$$

$$\Rightarrow \frac{1}{f} = \frac{2-3}{60} = -\frac{1}{60}$$

$$\Rightarrow f = -60 \text{ cm} \quad \text{Here focal length is}$$

Negative, so the nature of lens is concave.

6

If object distance is $u_1 = -25\text{cm}$

$\therefore$ magnification is $m_1 = -\frac{v_1}{u_1}$

As the object is moved 15cm away from earlier position (i.e) the distance of object is $u_2 = -40\text{cm}$

magnification is $m_2 = -\frac{v_2}{u_2}$

Given

$$\frac{m_1}{m_2} = 4 \Rightarrow \frac{-\frac{v_1}{u_1}}{-\frac{v_2}{u_2}} = 4$$

$$\Rightarrow \frac{v_1}{v_2} \times \frac{u_2}{u_1} = 4$$

$$\Rightarrow \frac{v_1}{v_2} \left(\frac{-40}{-25} \right) = 4$$

$$\Rightarrow \frac{v_1}{v_2} = \left[\frac{25}{40} \right] \times 4 = \frac{5}{2}$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{5}{2}$$

From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \rightarrow (1)$

For $u_1 = -25\text{cm} \rightarrow \frac{1}{f} = \frac{1}{v_1} - \frac{1}{25} \rightarrow (2)$

For $u_2 = -40\text{cm} \rightarrow \frac{1}{f} = \frac{1}{v_2} - \frac{1}{40} \rightarrow (3)$

From (2) and (3) $\frac{1}{v_1} - \frac{1}{25} = \frac{1}{v_2} - \frac{1}{40}$

$$\Rightarrow \frac{1}{40} - \frac{1}{25} = \frac{1}{v_2} - \frac{1}{v_1}$$

6th continuation

(3)

$$\Rightarrow \frac{5-8}{200} = \frac{1}{v_1} \left[\frac{v_1}{v_2} - 1 \right]$$

$$\Rightarrow -\frac{3}{200} = \frac{1}{v_1} \left[\frac{5}{2} - 1 \right]$$

$$\Rightarrow -\frac{3}{\cancel{200}_{100}} = \frac{1}{v_1} \times \frac{3}{2}$$

$$\Rightarrow \frac{1}{v_1} = -\frac{1}{100} \Rightarrow v_1 = -100 \text{ cm.}$$

$$\therefore \text{From (2)} \quad \frac{1}{f} = \frac{1}{v_1} - \frac{1}{25}$$

$$\Rightarrow \frac{1}{f} = -\frac{1}{100} - \frac{1}{25}$$

$$\Rightarrow \frac{1}{f} = \frac{-1-4}{100}$$

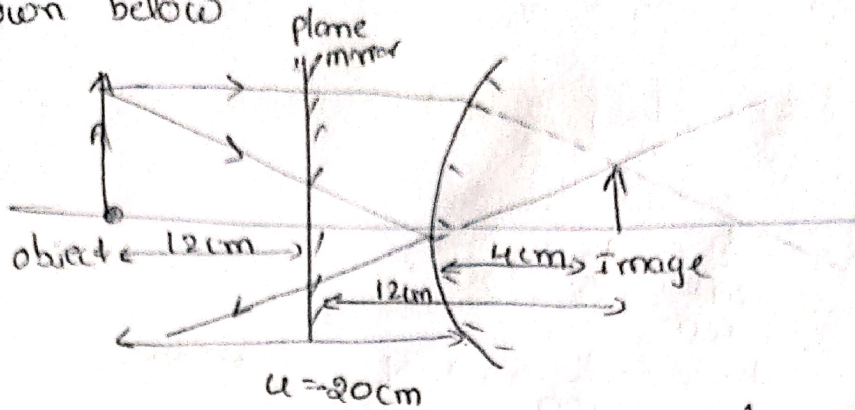
$$\Rightarrow \frac{1}{f} = -\frac{5}{100} \Rightarrow f = -\frac{100}{5} = -20 \text{ cm}$$

'-ve' sign shows the mirror is concave mirror

Distance of object $u = -20 \text{ cm}$

⑦

According to given data the ray diagram is shown below



For a plane mirror object distance = image distance

∴ From convex mirror image is at a distance
 $v = 4 \text{ cm}$

∴ From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{f} = \frac{1}{4} - \frac{1}{20}$$

$$\Rightarrow \frac{1}{f} = \frac{5-1}{20}$$

$$\Rightarrow \frac{1}{f} = \frac{4}{20} = \frac{1}{5}$$

$$\therefore f = 5 \text{ cm}$$

⑧

Given that size of image $h_I = 2$ size of object
 $h_I = 2h_o$

∴ magnification = $\frac{h_I}{h_o}$; From mirror formula

$$\Rightarrow -\frac{v}{u} = \frac{2h_o}{h_o}$$

$$\Rightarrow \boxed{v = -2u}$$

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

$$\Rightarrow -\frac{1}{15} = -\frac{1}{2u} + \frac{1}{u}$$

$$\Rightarrow -\frac{1}{15} = \frac{1}{2u} \Rightarrow 2u = -15$$

$$\Rightarrow u = -7.5 \text{ cm}$$

9

Given distance of object $u = -2f$

Focal length of the mirror $F = f$

$\therefore$ From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{f} = \frac{1}{v} - \frac{1}{2f}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{f} + \frac{1}{2f} = \frac{3}{2f}$$

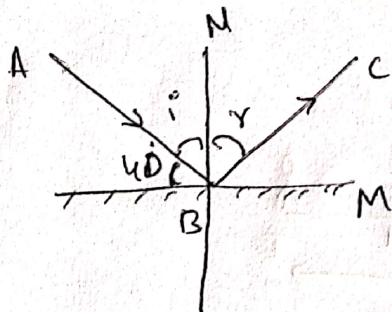
$$\Rightarrow v = \frac{2f}{3}$$

$\therefore$ magnification $m = -\frac{v}{u}$

$$= \frac{\frac{2f}{3}}{2f}$$

$$m = \frac{1}{3}$$

14



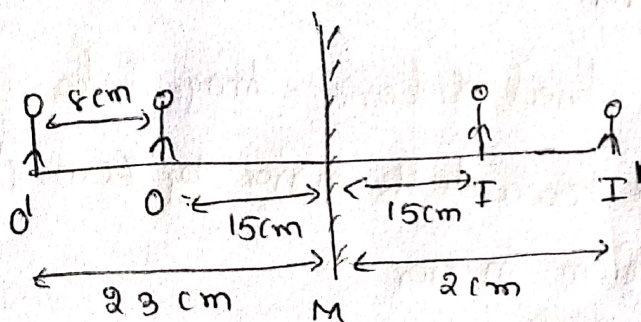
N is Normal makes an angle 90° with mirror.

$$\text{Clearly } Li = 90 - 40 = 60^\circ$$

According to laws of reflection $Li = Lr$

$$\therefore \text{Angle of reflection } Lr = 60^\circ$$

12



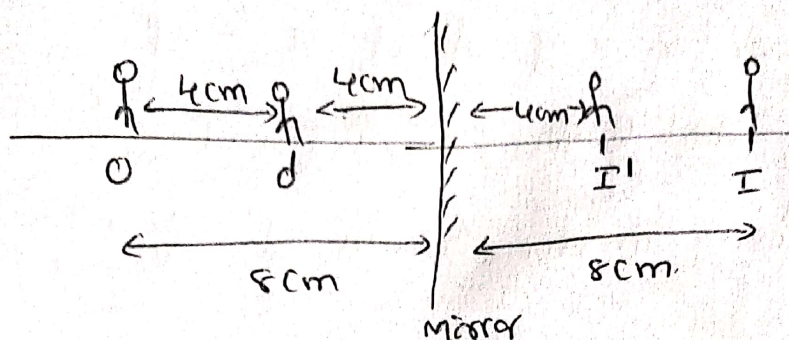
O, I are original positions of object and image. For plane mirror object & image distances are equal.

As the object is moved 8 cm away, its new position is $O' = 23 \text{ cm}$

$\therefore$ The new position of image is $I' = 23 \text{ cm}$

$$\text{Distance b/w } O' \text{ \& } I' = 23 \text{ cm} + 23 \text{ cm} = 46 \text{ cm}$$

(13)



For a plane mirror object distance = image distance

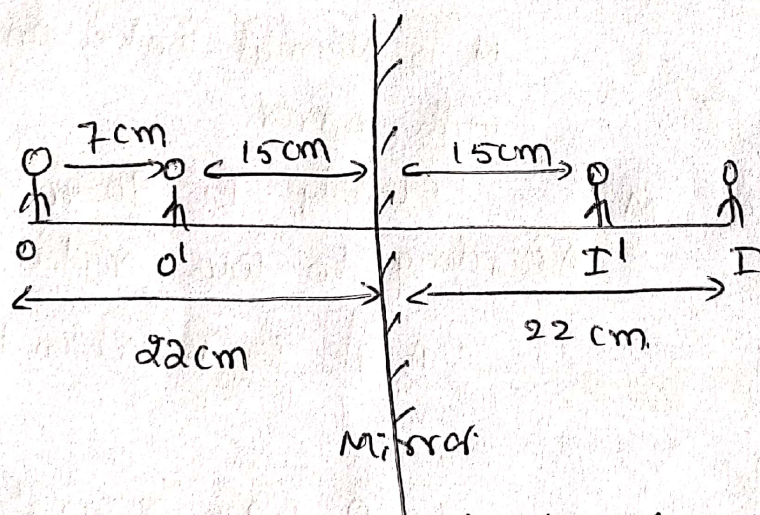
As the object is moved from $O \rightarrow O'$ by 4cm, its new distance from mirror is 4cm.

$\therefore$ Now the position of image I' is also 4cm from mirror.

$\therefore$ The distance between object and image is

$$\begin{aligned} O'I' &= 4\text{cm} + 4\text{cm} \\ &= 8\text{cm} \end{aligned}$$

(14)



For a plane mirror, object distance = image distance = 22cm

As object is moved towards the mirror by 7cm, its new position is 15cm from mirror

So the image is at a distance of 15cm from mirror.

(10)

focal length $f = -12 \text{ cm}$

let 'u' be the object distance, v be the image distance

using mirror formula

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

$$\Rightarrow -\frac{1}{12} = \frac{1}{u} + \frac{1}{v} \rightarrow (1)$$

Given image is 10cm more left than the object.

$$\text{image distance } v = u - 10 \rightarrow (2)$$

$$\therefore -\frac{1}{12} = \frac{1}{u} + \frac{1}{u-10}$$

$$\Rightarrow -\frac{1}{12} = \frac{u-10+u}{u(u-10)}$$

$$\Rightarrow -\frac{1}{12} = \frac{2u-10}{u^2-10u} \Rightarrow -(u^2-10u) = 12(2u-10)$$

$$\Rightarrow -u^2 + 10u = 24u - 120$$

$$\Rightarrow -u^2 - 14u + 120 = 0$$

$$\Rightarrow u^2 + 14u - 120 = 0$$

$$\Rightarrow u^2 + 20u - 6u - 120 = 0$$

$$\Rightarrow u(u+20) - 6(u+20) = 0$$

$$\Rightarrow (u+20)(u-6) = 0$$

$$\therefore u+20=0 \text{ (or) } u-6=0$$

$$\Rightarrow u = -20 \text{ cm} \quad u = 6 \text{ cm}$$

10th continuation

object distance can not be positive

$$U = -20 \text{ cm}$$

$$\text{image distance } V = U - 10$$

$$= -20 - 10$$

$$V = -30 \text{ cm}$$

$$\therefore \text{magnification is given by } m = \frac{-V}{-U}$$

$$\Rightarrow m = \frac{-(-30)}{-20} = -1.5$$

For concave mirror magnification is negative.

(16)

$$\text{Focal length } f = -7.5 \text{ cm (For concave mirror)}$$

$$\text{object distance } U = -15 \text{ cm.}$$

$$\therefore \text{From mirror formula } \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{-1}{7.5} + \frac{1}{15}$$

$$\Rightarrow \frac{1}{v} = \frac{-2 + 1}{15} = \frac{-1}{15}$$

$$\Rightarrow v = -15 \text{ cm}$$

image is real, it can be caught on screen.

-ve value of 'v' indicates that image is formed in front of the mirror.

(6)

(21)

Given size of image = $\frac{1}{3}$ size of object

$$h_I = \frac{1}{3} h_o$$

Focal length of concave mirror $f = -40$ cm

(22)

Given size of image = size of object

$$h_I = h_o$$

and image is real so magnification = -ve

$$m = -\frac{v}{u} \quad \left[m = \frac{h_I}{h_o} \Rightarrow 1 \right]$$

$$\Rightarrow -1 = -\frac{v}{u} \Rightarrow v = u$$

Focal length $f = -40$ cm

$$\text{From mirror } \frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow (1)$$

$$\Rightarrow -\frac{1}{40} = \frac{1}{u} + \frac{1}{u} \Rightarrow -\frac{1}{40} = \frac{2}{u} \Rightarrow u = -80 \text{ cm}$$

v also -80 cm

As the object moved towards mirror by 10 cm, then its

Position $u' = 70$ cm

From (1)

$$-\frac{1}{40} = \frac{1}{v'} - \frac{1}{70} \Rightarrow \frac{1}{v'} = -\frac{1}{40} + \frac{1}{70} = \frac{-7+4}{280}$$

$$\Rightarrow \frac{1}{v'} = \frac{-3}{280} \Rightarrow v' = -\frac{280}{3}$$

$$= -93.33 \text{ cm}$$

$\therefore$ The image is moving from -80 cm to -93.33 cm

$\therefore$ It moves 13.33 cm away from the mirror.



LTASK CUQ'n

⑩

focal length of concave mirror $f = -15\text{cm}$

$$h_I = 2h_o$$

$$\therefore \text{magnification } m = \frac{h_I}{h_o} = 2$$

$$\Rightarrow -\frac{v}{u} = 2 \Rightarrow v = -2u$$

$$\text{From mirror formula } \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\Rightarrow -\frac{1}{15} = -\frac{1}{2u} + \frac{1}{u}$$

$$\Rightarrow -\frac{1}{15} = \frac{-1+2}{2u} = \frac{1}{2u}$$

$$\Rightarrow 2u = -15 \Rightarrow u = -\frac{15}{2} = -7.5\text{cm.}$$

LTASK Jee main level

⑪

focal length of convex mirror $f = 20\text{cm}$

Size of image = $\frac{1}{2}$ Size of the object.

$$h_I = \frac{1}{2} h_o$$

$$\therefore \text{magnification } m = \frac{h_I}{h_o} = \frac{1}{2}$$

$$\Rightarrow -\frac{v}{u} = \frac{1}{2} \Rightarrow v = -\frac{u}{2}$$

$$\text{From mirror formula } \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{20} = -\frac{2}{u} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{20} = -\frac{1}{u}$$

$$\Rightarrow u = -20\text{cm}$$

object distance is always negative.

(12)

focal length $f = -20 \text{ cm}$

Size of image = 2 size of object

Image is real means magnification is -ve

$$\therefore \text{magnification} = -\frac{h_i}{h_o} = -\frac{2h_o}{h_o} \quad [\text{Also } m = -\frac{v}{u}]$$

$$+\frac{v}{u} = +2 \Rightarrow \frac{v}{u} = 2 \Rightarrow v = 2u$$

From mirror formula

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

$$\Rightarrow -\frac{1}{20} = \frac{1}{2u} + \frac{1}{u}$$

$$\Rightarrow -\frac{1}{20} = \frac{3}{2u} \Rightarrow u = -30 \text{ cm}$$

object distance is always negative.

(13)

Focal length of mirror $f = -16 \text{ mm}$

Distance of cavity = Distance of object $u = -8 \text{ mm}$

To see real images a dentist use concave mirror.

$$\therefore \text{From mirror formula } \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\Rightarrow -\frac{1}{16} = \frac{1}{v} - \frac{1}{8} \text{ m}$$

$$\Rightarrow \frac{1}{v} = -\frac{1}{16} + \frac{1}{8} = \frac{-1+2}{16}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{16} \Rightarrow v = 16 \text{ mm}$$

$$\therefore \text{magnification } m = \frac{v}{u} = \frac{16}{8} = 2.$$

(14)

magnification $m = \frac{1}{3}$; focal length $f = 18\text{cm}$

$$\Rightarrow -\frac{v}{u} = \frac{1}{3}$$

$$\Rightarrow v = -\frac{u}{3}$$

From mirror formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$$= \frac{1}{18} = -\frac{3}{u} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{18} = \frac{-3+1}{u} = -\frac{2}{u}$$

$$\Rightarrow u = -36\text{ cm}$$
 object distance is always

Negative.

(15)

Focal length of convex lens $f = 30\text{cm}$

size of image $h_I = \frac{1}{4}$ size of object (h_o)

$\therefore$ magnification $m = \frac{h_I}{h_o}$

$$\Rightarrow -\frac{v}{u} = \frac{1}{4} \frac{h_o}{h_o} = \frac{1}{4} \Rightarrow v = -\frac{u}{4}$$

$\therefore$ From lens formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{30} = -\frac{4}{u} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{30} = \frac{-4+1}{u}$$

$$\Rightarrow \frac{1}{30} = \frac{-3}{u}$$

$$\Rightarrow u = -30 \times 3 = -90\text{ cm}$$

object distance is always -ve.

(16)

Focal length of convex mirror $F = f$

object distance $u = -\frac{f}{2}$

∴ From mirror formula $\frac{1}{F} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{f} = \frac{1}{v} - \frac{2}{f}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{f} + \frac{2}{f} = \frac{3}{f}$$

$$\Rightarrow v = \frac{f}{3}$$

(17)

object distance $u = -40 \text{ cm}$

Radius of curvature $R = 20 \text{ cm}$

∴ focal length $f = \frac{R}{2} = 10 \text{ cm}$

From mirror formula $\frac{1}{F} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{10} = \frac{1}{v} - \frac{1}{40}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{10} + \frac{1}{40}$$

$$\Rightarrow \frac{1}{v} = \frac{4+1}{40} = \frac{5}{40}$$

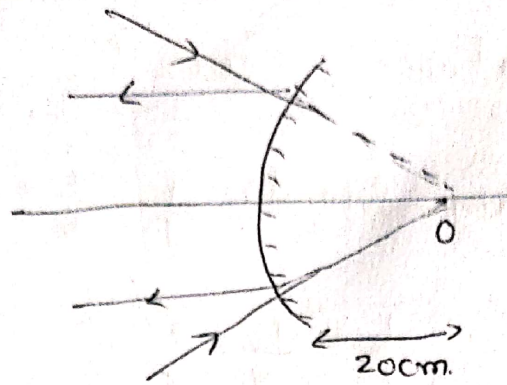
$$\Rightarrow \frac{1}{v} = \frac{1}{8}$$

$$\Rightarrow v = 8 \text{ cm} \text{ virtual}$$

v is positive means image is real and is formed behind the mirror

(18)

Given focal length $f = 20 \text{ cm}$



Here we have virtual object so u is positive
 $u = 20 \text{ cm}$

From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{20} - \frac{1}{20} = 0$$

$$\Rightarrow v = \frac{1}{0} = \infty = \text{infinity}$$

(19)

Focal length $f = -20 \text{ cm}$

Size of image (h_i) = 2 Size of object (h_o)

$$\therefore \text{magnification } m = \frac{h_i}{h_o} = \frac{2h_o}{h_o} = 2$$

For virtual image formed by a concave mirror m is +ve

$$\therefore m = -\frac{v}{u} \Rightarrow 2 = -\frac{v}{u} \Rightarrow v = -2u$$

From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow -\frac{1}{20} = -\frac{1}{2u} + \frac{1}{u}$$

$$\Rightarrow -\frac{1}{20} = \frac{-1+2}{2u}$$

$$\Rightarrow -\frac{1}{20} = \frac{1}{2u} \Rightarrow 2u = -20$$

$$\Rightarrow u = -10 \text{ cm}$$

object distance is always negative



(20)

Given magnification $m = 3$

If it is concave mirror focal length $f = -24 \text{ cm}$

For real image $m = -3$

$$\Rightarrow -\frac{v}{u} = -3$$

$$\Rightarrow v = 3u$$

From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow -\frac{1}{24} = \frac{1}{3u} + \frac{1}{u}$$

$$\Rightarrow -\frac{1}{24} = \frac{4}{3u}$$

$$\Rightarrow u = -8 \times 4 = -32 \text{ cm}$$

(or)

For virtual image $m = 3$

$$\Rightarrow -\frac{v}{u} = 3$$

$$\Rightarrow v = -3u$$

$\therefore$ From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow -\frac{1}{24} = -\frac{1}{3u} + \frac{1}{u}$$

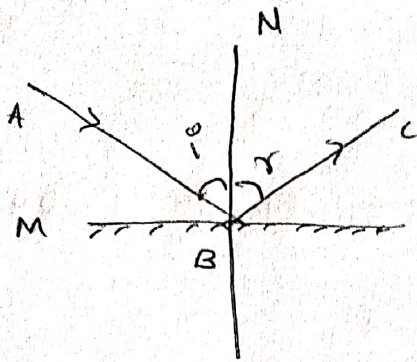
$$\Rightarrow -\frac{1}{24} = \frac{-1+3}{3u}$$

$$\Rightarrow -\frac{1}{24} = \frac{2}{3u}$$

$$\Rightarrow u = -8 \times 2 = -16 \text{ cm}$$

Object distance is always '-ve'

(21)



AB $\rightarrow$ incident ray

$\angle ABN = \angle i = \text{Angle of incidence} = 30^\circ$

BC $\rightarrow$ Reflected ray

$\angle NBC = \angle r = \text{Angle of reflection}$

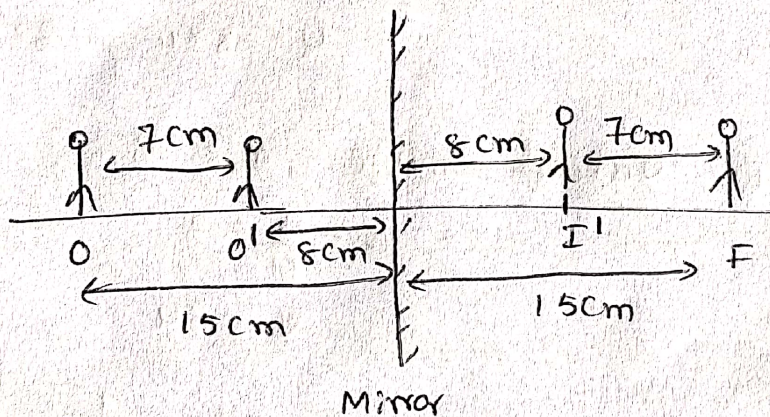
According to laws of reflection $\angle i = \angle r$

$$\therefore \angle r = 30^\circ$$

From fig angle between incident ray and reflected

$$\text{ray} = \angle i + \angle r = 30^\circ + 30^\circ = 60^\circ$$

(22)



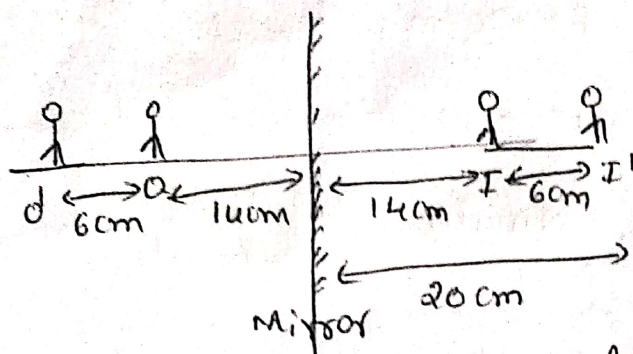
For a plane mirror object distance = image distance

As the object moved towards mirror by 7 cm, its new distance from mirror becomes $15 \text{ cm} - 7 \text{ cm} = 8 \text{ cm}$

$\therefore$ the image will be formed at a distance

8 cm from mirror

(23)



For a plane mirror.

object distance = image distance

Given image is at a distance 14 cm from mirror means

object is at a distance 14 cm from mirror.

If the object is moved 6 cm away from mirror.

So its position from mirror is $14 \text{ cm} + 6 \text{ cm} = 20 \text{ cm}$

$\therefore$ The distance of image from mirror = 20 cm

Advanced level

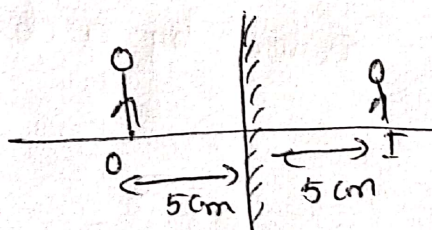
(7th)

Take solution from 20th & jee main level

(9)

For a plane mirror

Distance of object (face) = distance of image



As the person moves 5 cm away from the mirror

so the image also moves 5 cm. Thus the distance between the image formed by the mirror and object is 10 cm

② Given focal length $f = -20\text{cm}$

object distance $u = -30\text{cm}$

From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\Rightarrow -\frac{1}{20} = \frac{1}{v} - \frac{1}{30}$$

$$\Rightarrow \frac{1}{v} = -\frac{1}{20} + \frac{1}{30} = \frac{-3+2}{60}$$

$$\Rightarrow \frac{1}{v} = -\frac{1}{60} \Rightarrow v = -60\text{cm}$$

As the object moved 5cm towards mirror

then the object distance $u' = -25\text{cm}$

$\therefore$ From

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

$$\Rightarrow -\frac{1}{20} = \frac{1}{v'} + \frac{1}{25}$$

$$\Rightarrow \frac{1}{v'} = -\frac{1}{20} + \frac{1}{25} = \frac{-5+4}{100}$$

$$\Rightarrow v' = -100\text{cm}$$

$\therefore$ The image moved by a distance $= v' - v$
 $= -100 - (-60)$
 $= -40\text{cm.}$