11. An object is placed at a distance of 10cm from a concave mirror of focal length 20cm.

(a) Draw a ray diagram for formation of image

(b) Calculate the image distance

(c) State two characteristics of the image formed.

(b) The object distance $u = -10cm$

focal length $f = -20cm$

image distance $v = ?$

Image distance =

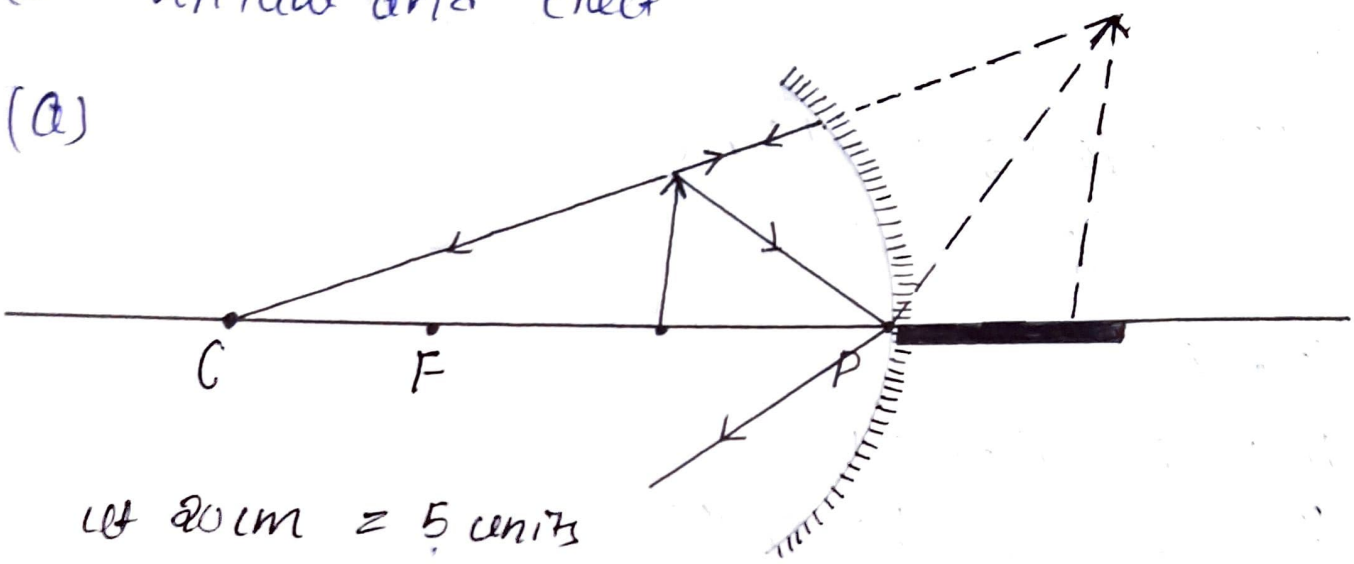
$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} + \frac{1}{-10} = \frac{1}{-20}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{-20} - \frac{1}{-10} \Rightarrow \frac{1}{v} = \frac{-1+2}{20} = \frac{1}{20}$$

$$v = 20cm$$

(c) Virtual and erect

(a)



let 20 cm = 5 units
10 cm = 2.5 units

12. If an object of 10cm height is placed at a distance of 36 cm from a concave mirror of focal length 12cm, Find the position, nature and height of the image.

(h) The height of the object = 10cm
(u) distance of the object = -36 cm
(f) focal length of the object = -12 cm

The image distance =

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \quad = \quad \frac{1}{v} + \frac{1}{-36} = \frac{1}{-12}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{-12} - \frac{1}{-36} \quad \Rightarrow \frac{1}{v} = \frac{-3+1}{36} = \frac{-2}{36}$$

$$v = -18$$

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

$$\Rightarrow \frac{-(-18)}{-36}$$

$$\Rightarrow \frac{-18}{36}$$

$$\Rightarrow \frac{-1}{2}$$

$$m = \frac{h'}{h} \quad \text{height of image / height of object}$$

$$m = \frac{h'}{10}$$

$$\frac{-1}{2} = \frac{h'}{10} \Rightarrow h' = -\frac{1}{2} \times 10$$

$$\Rightarrow h' = -5$$

13. At what distance from a concave mirror of focal length 10 cm should an object 2 cm long be placed in order to get an erect image 6 cm tall?

The focal length of the object = -10cm
The height of the object = + 2cm
height of the image = 6cm

magnification $= \frac{h'}{h} = +\frac{6}{2}$

$= +3$ ∴

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

$\Rightarrow -3u = v$

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $\Rightarrow \frac{1}{-10} = \frac{1}{-3u} + \frac{1}{u}$

$\Rightarrow \frac{1}{-10} = \frac{3-1}{3u} = \frac{2}{3u}$

$\Rightarrow \frac{1}{-10} = \frac{2}{3u}$

$3u = -20$

$u = \frac{-20}{3}$ ∴

$u = -6.\overline{6}$

14. When an object is placed at a distance of 8 cm from a concave mirror, its image is formed at 6 cm in front of the mirror. find focal length

object distance (u) $= -15$ cm
image distance (v) $= -10$ cm
focal length (f) $= ?$

Mirror formula

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

$\Rightarrow \frac{1}{-10} + \frac{1}{-15} = \frac{1}{f}$

$\Rightarrow \frac{-3 + -2}{30} = \frac{1}{f}$

$\Rightarrow \frac{-5}{30} = \frac{1}{f}$ $= -\frac{1}{6} = \frac{1}{f}$

$f = -6$ cm

15. ~~An Object is placed at a distance of 15 cm~~
An Object 3cm high is place at a distance of 8cm from a concave mirror which produces a virtual image 4.5 cm high.

(i) What is the focal length of the mirror?

(ii) What is the position of image

height of the object $= 3$cm
distance of the object (u) $= -8$cm
height of the image $= 4.5$cm

magnification $= \frac{h'}{h} = \frac{4.5}{3} = \frac{45}{30} = \frac{3}{2}$

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

$$-\frac{v}{u} = \frac{3}{2} \quad \text{or} \quad -\frac{v}{u} = \frac{1.5}{1}$$

$\Rightarrow 3u = -2v$ $\Rightarrow 1.5u = -v$

$\Rightarrow v = -1.5u$

mirror formula

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

$$\Rightarrow \frac{1}{u} + \frac{1}{-1.5u} = \frac{1}{f} \quad \Rightarrow \frac{15-10}{15u} = \frac{1}{f}$$

$$\Rightarrow \frac{5}{15u} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{3u} = \frac{1}{f}$$

$\Rightarrow f = 3u$

$\Rightarrow f = (-8) \times 3$

$\Rightarrow f = -24$ cm

$v = -1.5u$

$v = \frac{15}{10} \times -8$

$= \frac{-15}{3} \times -8$

$= -3 \times -4$

$= 12$

$\therefore v = 12$cm, $f = -24$ cm

16. A converging mirror a real image of height 4cm of an object of height 1cm placed 20cm away from the mirror.

(i) calculate the image distance

(ii) what is the focal length.

Image height = 4cm (h')

Object height = 1cm (h)

Object distance $= -20$cm (u)

image distance $(v) =$

magnification $= \frac{h'}{h} = \frac{4}{1} = 4$cm

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

$\Rightarrow 4u = -v$

$\Rightarrow v = -4u$ (i)

mirror formula

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

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

$$\Rightarrow \frac{1 \times 4}{-20 \times 4} + \frac{1}{-80} = \frac{1}{f}$$

$$\Rightarrow \frac{-4 + (-1)}{80} = \frac{1}{f}$$

$$\Rightarrow \frac{-5}{80} = \frac{1}{f}$$

$f = -16$

$f = -16$ cm

$v = -80$ cm

17. An object of size 7.0 cm is placed at 27 cm in front of a concave mirror of focal length 18 cm. Find image distance and size and nature of image

height of the object = 7cm (h)
distance of the object = -27cm (u)
Focal length of the mirror = -18 cm (f)

image distance =

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

$$\Rightarrow \frac{1}{v} + \frac{1}{-27} = \frac{1}{-18}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{-18} - \frac{(-1)}{27}$$

$$\Rightarrow \frac{1}{v} = \frac{-3+2}{54}$$

$$\Rightarrow v = -54\ cm$$

magnification =

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

$$\frac{-v}{u} = \frac{-(-54)}{-27}$$

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

$$\frac{h'}{h} = \frac{-2}{1}$$

$$\Rightarrow \frac{h'}{7} = \frac{-2}{1}$$

$$\Rightarrow h' = -14$$

v = -54cm Real
h' = -14cm inverted

The nature of the image is real and inverted

18. A Object 3cm high is placed at a distance of 60cm in front of a converging mirror of focal length 20cm. Find position, nature, size of the image

The height of the object = 3cm (h)
The Object distance = -60cm (u)
The focal length of the mirror = -20 cm (f)

mirror formula

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

$$\Rightarrow \frac{1}{v} = \frac{1}{-20} - \frac{1}{-60}$$

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

$$\Rightarrow v = 30\ cm$$

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

$$\Rightarrow \frac{-v}{u} = \frac{-30}{-60} = \frac{1}{2}$$

$$\Rightarrow \frac{h'}{h} = \frac{1}{2}$$

$$\Rightarrow h' = \frac{1}{2} \times 3 \times 2$$

$$\Rightarrow h' = 3\ cm$$

image is virtual and erect

19. A Concave mirror has a focal length of 4 cm and an object 2cm tall is placed 6 cm away from it. Find the nature, position, size of image.

Object distance = -9cm (u)
focal length of the mirror = -4 (f)
height of the object = 2cm. (h)

mirror formula

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

$$\Rightarrow \frac{1}{v} = \frac{1}{-4} + \frac{1}{-9}$$

$$\Rightarrow \frac{1}{v} = \frac{-9+-4}{36}$$

$$\Rightarrow \frac{1}{v} = \frac{-5}{36}$$

$$\Rightarrow v = -\frac{36}{5}$$

Magnification

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

$$\frac{-v}{u} = -\frac{36}{5} \times \frac{1}{-9}$$

$$\frac{-v}{u} = -\frac{4}{5}$$

$$\Rightarrow \frac{h'}{h} = -\frac{4}{5}$$

$$\Rightarrow \frac{h'}{2} = -\frac{4}{5}$$

$$\Rightarrow h' = -\frac{8}{5}$$

Image is real and inverted

Q0. When an object is placed 20cm from a concave mirror, a real image magnified three times is formed. Find

(a) focal length

(b) where must the object be placed to give a virtual image three times the height of the object

Ans Object distance = -20cm (u)

magnification = -3 (real image)

$$\text{magnification} = -\frac{v}{u}$$

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

$$\Rightarrow v = -3 \times 20$$

$$\Rightarrow \boxed{v = -60\ cm}$$

(a) mirror formula

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

$$\Rightarrow \frac{1}{-60} + \frac{1}{-20} = \frac{1}{f}$$

$$\Rightarrow \frac{-1+(-3)}{60} = \frac{1}{f}$$

$$\Rightarrow \frac{-4}{60} \times -1 = \frac{1}{f}$$

$$\Rightarrow \frac{1}{15} = \frac{1}{f}$$

$$\boxed{f = -15\ cm}$$

The object should be placed between the focus and Principal axis on 10cm

(b) $\frac{h'}{h} = 3$

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

Concave

Q). A dentist's mirror has a radius of curvature of 1.5 m. A person stands 10cm in front of the mirror. Where is the person's image?

Radius of curvature = 1.5 m

object distance = −10m (u)

focal length $= \frac{R}{2} = \frac{1.5}{10} \times \frac{1}{2}$

$= \frac{15}{20} \times \frac{3}{4} = -\frac{3}{4}$ m (f)

image distance (v) =

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

$$\Rightarrow \frac{1}{v} = -\frac{4}{3} - \left(\frac{-1}{10}\right)$$

$$\Rightarrow \frac{1}{v} = \frac{-40 + 3}{30}$$

$$\Rightarrow \frac{1}{v} = -\frac{37}{30}$$

$$v = -\frac{30}{37} \text{ m}$$

Q3. A dentist's mirror has a radius of curvature of 3cm. How far must it be placed from a small dental cavity to give a virtual image of the cavity that magnifies five time?

Radius of curvature = 3cm

magnification = +5 cm

focal length = $R/2 = -\frac{3}{2}$ cm

magnification = $\frac{-v}{u} = \frac{f}{f} m$ $\quad v = -mu$

$\Rightarrow +v = -5u$

$\Rightarrow v = 5u$

mirror formula

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

$$\Rightarrow \frac{1}{-5u} + \frac{1}{u} = \frac{-3}{2}$$

$$\Rightarrow \frac{4}{5u} = \frac{-1}{1.5}$$

$$\Rightarrow u = \frac{-1.5 \times 4}{5}$$

$$= \frac{-6}{5} \text{ cm}$$

23. An object of 5.0 cm size is placed at a distance of 20.0 cm from a converging mirror of focal length 15.0 cm. At what distance from the mirror should a screen be placed to get the sharp image

height of the object = 5 cm
distance of the object = -20 cm (u)
focal length of the mirror = -15 cm (f)

Image distance =

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

$$\Rightarrow \frac{1}{v} = \frac{1}{-15} - \frac{1}{-20}$$

$$\Rightarrow \frac{1}{v} = \frac{-4+3}{60}$$

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

$$v = -60$$

The height of the image equals to

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

$$\Rightarrow -\frac{(-60)}{-20} = \frac{-v}{u}$$

$$\Rightarrow -3$$

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

$$\frac{h'}{h} = -3$$

$$\Rightarrow \frac{h'}{5} = \frac{-3}{1}$$

$$\Rightarrow h' = -3 \times 5$$

$$h' = -15 \text{ cm}$$

24. A concave mirror produces three times enlarged virtual image of an object placed at 10cm in front of it. Find R

$$m = +3$$

Object distance = -10 cm (u)

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

$\Rightarrow \frac{-v}{-10} = \frac{3}{1}$

$\Rightarrow v = 3 \times 10$

$\Rightarrow v = 30\ cm$

mirror formula

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

$\Rightarrow \frac{1}{30} + \frac{1}{-10} = \frac{1}{f}$ $\Rightarrow \frac{1-3}{30} = \frac{1}{f}$

$\Rightarrow \frac{-2}{30} = \frac{1}{f}$

$\Rightarrow f = -15$

$f = R/2$

$\Rightarrow R = 2f$

$\Rightarrow R = 2 \times -15$

$\Rightarrow R = -30$

25. A bright object 50 mm height stands on axis of a concave mirror of focal length 100 mm and distance 300 mm. Find height of image?

height of an object = 50 mm

Focal length of the mirror = −100 mm (f)

Distance of the object = −300 mm (u)

image distance = ?

image height = ?

image distance =

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

$\Rightarrow \frac{1}{v} = \frac{1}{-100} - \frac{1}{-300}$

$\Rightarrow \frac{1}{v} = \frac{-3+1}{300}$

$\Rightarrow \frac{1}{v} = \frac{-2}{300}$

$\Rightarrow v = -150$

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

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

$\Rightarrow \frac{-v}{u} = \frac{-(-150)}{-300}$

$\Rightarrow -\frac{1}{2}$

$\frac{h'}{h} = \frac{-1}{2}$

$\frac{h'}{50} = \frac{-1}{2}$

$\Rightarrow 2h' = -50$

$\Rightarrow h' = -50$

$\Rightarrow h' = -25\ mm$

26. How far should an object be placed from a pole of a concave mirror of focal length 20 mm and a distance of 300 mm from it. Real image of size $\frac{1}{4}$th size of object

27. Object distance = 50 cm Case I

magnification = $\frac{-1}{2}$

Case II

magnification = $\frac{-1}{5}$

Object distance = ?

case I

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

$$\Rightarrow v = -mu$$

$$\Rightarrow v = -\left(-\frac{1}{2} \times -50\right)$$

$$\Rightarrow v = -25\,cm$$

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

$$\Rightarrow \frac{1}{-25} + \frac{1}{-50} = \frac{1}{f}$$

$$\Rightarrow \frac{-2-1}{50} = \frac{1}{f}$$

$$\Rightarrow \frac{-3}{50} = \frac{1}{f}$$

$$\Rightarrow f = \frac{-50}{3}\,cm$$

Case II

$m = \frac{-1}{5}$

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

$\Rightarrow \frac{-3}{50} = -\frac{1}{mu} + \frac{1}{u}$

$\Rightarrow \frac{-3}{50} = \frac{1}{\frac{-1}{5}\times u} + \frac{1}{u}$

$\Rightarrow \frac{-3}{50} = \frac{+5}{u} + \frac{1}{u}$

$\Rightarrow \frac{-3}{50} = \frac{6}{u}$

$\Rightarrow u = -\frac{50\times 6}{3} = -100\,cm$

26. $m = \frac{-v}{u}$

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

$v = \frac{u}{4}$

mirror formula

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

$\Rightarrow \frac{1}{-20} = \frac{4}{u} + \frac{1}{u}$

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

$\Rightarrow u = 5\times -20$

$u = 100\,cm$

28. An object is placed (a) 20cm, (b) 4cm, in front of a concave mirror of focal length 12cm. Find the nature and position of the image formed in each case.

(a) Object distance = -20cm (u)

Focal length of the mirror = -12m (f)

image distance = ? (v)

Case I mirror formula

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

$\Rightarrow \frac{1}{v} + \frac{1}{-20} = \frac{1}{-12}$

$\Rightarrow \frac{1}{v} = \frac{1}{-12} - \frac{1}{-20}$

$\Rightarrow \frac{1}{v} = \frac{-5+3}{60}$

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

$v = -30$

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

$= \frac{-(-30)}{-20}$

$= -\frac{3}{2} = \frac{h'}{h}$

nature:- image is real and inverted

(b) Case II mirror formula

$u = -4\,cm$

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

$\Rightarrow \frac{1}{v} = \frac{1}{-12} - \frac{1}{-4}$

$\Rightarrow \frac{1}{v} = \frac{-1+3}{12}$

$\Rightarrow v = +6$

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

$= \frac{-(+6)}{-4}$

$\Rightarrow +\frac{3}{2} = \frac{h'}{h}$

nature :- image is virtual and erect.

29. Image height = $-1\,cm$ = 10 mm
Object height = $2.5\,mm = 0.25\,cm$
object distance = $-5\,cm$ = $-50\,mm$
image distance = ?
focal length = ?

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

$\frac{h'}{h} = \frac{10}{25} = \frac{2}{1} \times \frac{10}{25} = \frac{4}{1}$

$\frac{h'}{h} = \frac{-v}{u} = \frac{4}{1}$

$\Rightarrow \frac{v}{+50} = \frac{4}{1}$

$\Rightarrow v = \frac{4}{1} \times 50$

$\Rightarrow v = 200\,mm$

Mirror formula

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

$\Rightarrow \frac{1}{200} + \frac{1}{-50} = \frac{1}{f}$

$\Rightarrow \frac{1-4}{200} = \frac{1}{f}$

$\Rightarrow \frac{-3}{200} = \frac{1}{f}$

$\Rightarrow f = -\frac{200}{3}$

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

$\frac{h'}{h} = \frac{-1}{0.25} = \frac{-v}{u}$

$v = \frac{-5}{0.25} = -20\ cm$

mirror formula

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

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

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

$\Rightarrow f = \frac{20}{3} = -\frac{20}{5} = -4$

30. A man holds a spherical shaving mirror of radius of 60 cm, focal length = 30cm at a distance of 15 cm. Find the position of image magnification.

Radius of the mirror = −60 cm (R)
focal length of the mirror = −30cm (f)
distance of object = −15cm (u)
image distance = ?

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

$$\Rightarrow \frac{1}{v} = \frac{1}{-30} - \frac{1}{-15}$$

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

$$\Rightarrow v = +30\ cm$$

$$\text{magnification} = \frac{-v}{u}$$

$$\Rightarrow \frac{-(+30)}{-15}$$

$$\Rightarrow +2$$