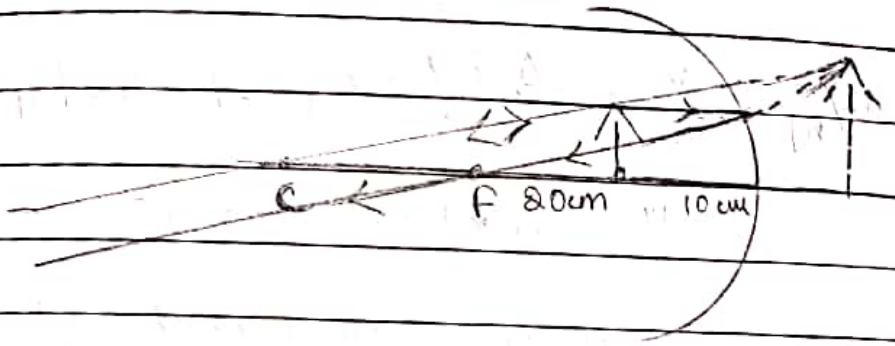
HW

4) An object is placed at a distance of 10cm from a concave mirror of focallength of 20cm
(a) Draw a draw ray diagram
(b) calculate image distance
(c) State 2 characteristics of image formed.

Ans (a)



(b) $f = 15cm \quad u = -10\,cm \quad v = ?$

By mirror formular

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{v} + \frac{1}{(-10)} = \frac{1}{-15}$$

$$\frac{1}{v} = \frac{-1}{15} + \frac{1}{10} = \frac{1}{30}$$

$\therefore v = 30$

(c) The characteristics of the image are
It is virtual and erect
Magnified

12) If an object of 10cm height is placed at a distance of 36cm from a concave mirror

of focal length 12cm find the position nature and height.

$h_1 = 10cm$ $u = -24cm$ (12cm)

By mirror formulae

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} = \frac{1}{v} + \frac{1}{(-24)} = \frac{1}{-12}$

$\frac{1}{v} = \frac{-1}{+24} \Rightarrow v = -24\,cm$

$m = h_2/h_1 = \frac{-v}{u} = -(24)/-24 = -1 = h_2/h_1$

$= -1 \times h_1 \Rightarrow h_2 = -10$

The image will be of same height and inverted

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

$f = (-10)\,cm$ $h_1 = 2cm$ $h_2 = 6cm$ (erect) $u = ?$

We know

$m = \frac{h_2}{h_1} = \frac{6}{2} = 3$ $m = -\frac{v}{u} = 3$

$3u = -v$

$v = (-3u)$

By mirror formulae

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

$\frac{1}{-3u} + \frac{1}{u} = \frac{1}{(-10)} \Rightarrow \frac{1}{u}\left(1 - \frac{1}{3}\right) = \frac{1}{(-10)}$

$\frac{2}{3u} = \frac{1}{(-10)}$ (By cross multiplication)

$u = -6.66cm$ on left side of mirror

14. When an object is placed at a distance of 15cm from a concave mirror its image is formed at 10cm in front of the mirror calculate radius of curvature

$u = -15cm$ $v = -10cm$

$\frac{1}{v} + \frac{1}{u} = \frac{1}{-1} \Rightarrow \frac{1}{(-10)} + \frac{1}{(-15)} = \frac{1}{f}$

$\frac{1}{f} = \frac{-1}{10} - \frac{1}{15} = \frac{-3-2}{30} = \frac{-5}{30} = -\frac{1}{6}$

$\therefore$ focal length = 6cm Radius of curvature = 12cm

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

(i) What is the focal length

(ii) Position of image?

(iii) Draw a ray diagram to show formation

(i) $m = \frac{h_2}{h_1} = \frac{4.5}{3} = 1.5$

$m = -\frac{v}{u}$ $\quad 1.5 = -\frac{v}{-8}$

$v = 1.5 \times 8 = 12\ cm$

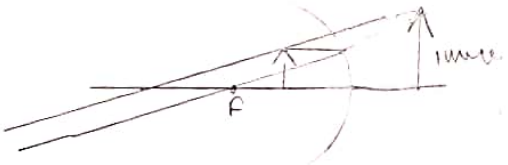
We have $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$f = -24\ cm$

(ii) $v = 12cm$

So the image is 12cm behind the mirror

(iii)



(16) A converging mirror forms a real image of magnification of an object of height 2cm placed 20cm away from mirror.

(i) Calculate image distance

(ii) What is focal length

$h_2 = -4cm$ (real image)

$h_1 = 2cm$

$u = -20cm$

$m = \frac{h_2}{h_1} = -\frac{v}{u} \Rightarrow -\frac{4}{2} = -\frac{v}{-20} \Rightarrow v = -40cm$

Image is in front of the mirror

(ii) $f = ?$

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{-40} + \frac{1}{-20} = \frac{1}{f} \Rightarrow -\frac{3}{80} = -26.6\ cm$

17. An object of size 9cm is placed at 27cm in front of concave mirror of focal length 18cm. At what distance from mirror should a screen be placed so that a sharp focused image can be obtained. Find the size and nature of image.

$h_1 = 9cm$ $\quad u = -24cm$ $\quad f = 18cm$

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

$\frac{1}{v} = \frac{1}{18} + \frac{1}{27} = \frac{-3+2}{54} = \frac{1}{54}$

$V = 54$ cm

18) An object 3cm high is placed at a distance of 10cm in front of a converging mirror of focal length 20cm. Find the position nature and size of the image

$u = 10$cm $\quad f = 20$cm $\quad h_1 = 3$ cm

By mirror formula

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

$$\frac{1}{v} + \frac{1}{10} = \frac{1}{20} \qquad v = +20\text{ cm}$$

The image is formed behind virtual 6cm high

A concave mirror has focal length of 4cm and an object 2cm tall is placed 9cm away from it. Find the nature position and size

$f = 4$cm) $\quad u = -9$cm $\quad v = ?$

By mirror formula

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

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

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

$$v = \frac{-36}{5} \Rightarrow -7.2\text{cm}.$$

$$m = \frac{h_1}{h_2} = \frac{-v}{u} = \frac{-(-7.2)}{-9}$$

$$\frac{h_1}{2} = \frac{(-7.2)}{(-9)} \Rightarrow h_1 = \frac{2\times(-7.2)}{9} \Rightarrow -1.6\text{cm}. \quad h_1 = 1.6\text{cm}$$

$$m = \frac{-v}{u} = \frac{-7.2}{-9} \Rightarrow 0.8.$$

The image is real inverted and small image

When object is placed 20cm from a concave a real image magnified 2 times is formed. Find focal length of the mirror. Where must the object be placed to virtual image three times the height of the object

$u = -20cm \quad m = 3$

$m = \frac{-v}{u} \Rightarrow 3 = \frac{-v}{(-20)}$

$\Rightarrow v = -60cm$

By mirror formula

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

$\frac{-1-3}{60} = \frac{-4}{60}$

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

b) $f = -15cm \quad m = 3$

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

$v = -3u$ (By mirror formula)

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

$u = \frac{2 \times (-15)}{3} \Rightarrow -10cm$

the object should be placed at a distance of 10cm

A dentist 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 is magnified five times?

Radius of curvature = 3cm $f = \frac{-3}{2} = -1.5$

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

$V = -5u$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{-1.5} = \frac{1}{u} + \frac{1}{-5}$

$\Rightarrow \frac{-1}{1.5} = \frac{1}{-5u} + \frac{5}{5u} = \frac{4}{5u} \Rightarrow u = \frac{(-1.5) \times 4}{5} = \frac{-6}{5}$

$u = -1.2cm$

It should be placed 1.2cm from mirror

$f = 1.5cm$

A large mirror has a radius of curvature of 1.05m. A person stands 10m in front of the mirror where is the person's image

Radius of curvature = 1.05m $f = \frac{1.05}{2} = 0.75m$

$u = -10m$

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{0.75} = \frac{1}{v} + \frac{1}{-10}$

$\frac{1}{v} = \frac{1}{10} - \frac{4}{3} \Rightarrow \frac{1}{v} = -\frac{37}{30}$

$v = -\frac{30}{37} = 0.81m$

Thus image will be formed at distance of 0.8m

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

$u = (20.0\text{ cm})$ $f = (-15\text{ cm})$ $h_1 = 5\text{cm}$

By mirror formulae

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{-15} = \frac{1}{v} + \frac{1}{(-20)}, \quad \frac{1}{v} = \frac{1}{20}$$

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

The image is at a distance of 60cm in front

By mirror formulae

$$m = \frac{-v}{u} = \frac{h_1}{h_0}$$

$$\frac{h_1}{5} = \frac{-60}{-20} \quad (\text{or}) \quad h_1/5 = -3$$

or $h_2 = -15\text{cm}$

∴ the height of image will be 15cm it is formed below principal axis

A concave mirror produces three times enlarged virtual image of an image of an object placed at 10cm in front of it calculate the radius of curvature

$m = 3$ $u = -10\text{cm}$

$$m = \frac{-v}{u} \Rightarrow 3 = \frac{-v}{-10} \Rightarrow v = 30\text{ cm}$$

The distance of is 30cm behind the mirror

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{30} + \frac{1}{-10} \Rightarrow \frac{1}{f} = \frac{-1}{15}$$

$f = -15\text{cm}$

The Radius of curvature $= 2 \times (-15) = -30\text{cm}$

A bright object 50mm high stands on the axis of a concave mirror of focal length 100mm and at a distance of 300mm from the concave mirror. How big will the image be.

$u = -300\text{mm}$ $h_1 = 50\text{mm}$ $f = -100\text{mm}$

By mirror formulae

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

$$\frac{1}{v} = \frac{-2}{300} \qquad v = -150\text{ cm}$$

$$m = \frac{h_2}{h_1} = \frac{-v}{u} = \frac{-(-150)}{-300} = \frac{-1}{2} \qquad h_2 = -25\text{m}$$

The size is 25mm

How far should an object be placed from the pole of a converging mirror of focal length 20 cm to form a real image of the size nearly $\frac{1}{4}$th of the size of the object

$f = -20\,cm$ $\quad m = -1/4$ (real image)

$m = -\frac{v}{u} \Rightarrow -(1/4) = -\frac{v}{u} \Rightarrow u = 4v$

By mirror formula

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

$\frac{1}{v} + \frac{1}{4v} = \frac{1}{(-20)}$

$v = -25\,cm$

$\therefore u = 4v$

$u = 4 \times (-25)$

$= -100\,cm$

$\therefore$ the object should be placed 100 m

(29) $h_2 = 1\,cm = 10\,mm$ (real) $\quad h_1 = 2.5\,mm$

$u = -5\,cm = -50\,mm$

$m = -h_2/h_1 = -(10/2.5) = -4$

$m = -v/u \Rightarrow -4 = (v/(-50))$

$v = -200\,cm$

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{f} = -2/100 \quad f = -4\,cm$

When an object is placed at a distance of 50 cm from a concave spherical mirror the magnification produced is $-1/2$. Where should be object to get magnification of $-1/5$

$m = -1/2 \qquad u = -50\,cm$

$m = -\frac{v}{u} \Rightarrow v = mu \Rightarrow v = -25$ (solved in rough copy)

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

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

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

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

$u = 100\,cm$