HW

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VERY SHORT ANSWER TYPE.

(1) If the magnification of a body of size 1 m is 2, what is the size of the image?

ans. size of body (h) = 1 m

size of image (h') be x m

magnification = 2

So $m = \frac{x}{h} \Rightarrow 2 = \frac{x}{1} \Rightarrow x = 1 \times 2 = 2$ m

so the size of the image is 2m.

(2) What is the position of the image when an object is placed at a distance of 20 cm from a concave mirror of focal length 20 cm.?

ans the position of image is at infinity

(3) what is the nature of image formed by a concave mirror if the magnification is

(a) +4

(b) (-2)

ans- (a) The image formed with a magnification of +4 is virtual and erect.

(b) The image formed with a magnification of -2 is real and inverted.

(4) state the relation between object distance and focal length of spherical mirror (concave or convex mirror)

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

v = distance of image
u = object distance
f = focal length of the mirror

(5) write the mirror formula. Give the meaning of each symbol which occurs in it.

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

where v is the image distance
u is the object distance
and f is the focal length.

(6) What is the ratio of the height of an image to the height of an object known as ?

ans- Magnification.

(7) Define linear magnification Produced by a mirror

ans- The ratio of height of image to height of object is known as linear magnification.

(8) write down a formula for the magnification produced by a concave mirror.

(a) in terms of height of object and height of image.

(b) in terms of object distance and image distance.

ans - (a) $m = \frac{h_2}{h_1}$

(b) or $m = \frac{-v}{u}$

where h_2 is the height of image
h_1 is the height of object
v is the image distance
u is the object distance.

(9) Describe the nature of image formed when the object is placed at a distance of 20 cm from a concave mirror of focal length 10 cm

ans - $u = -20\,cm$

$f = -10\,cm$

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

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

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

$$\Rightarrow v = -20\,cm$$

hence the image is real and inverted.

(10) Fill in the following blanks

(a) if the magnification has a plus sign, then the image is virtual and erect.

(b) if the magnification has a minus sign, then the image is Real and inverted.

SHORT ANSWER TYPE QUESTION :-

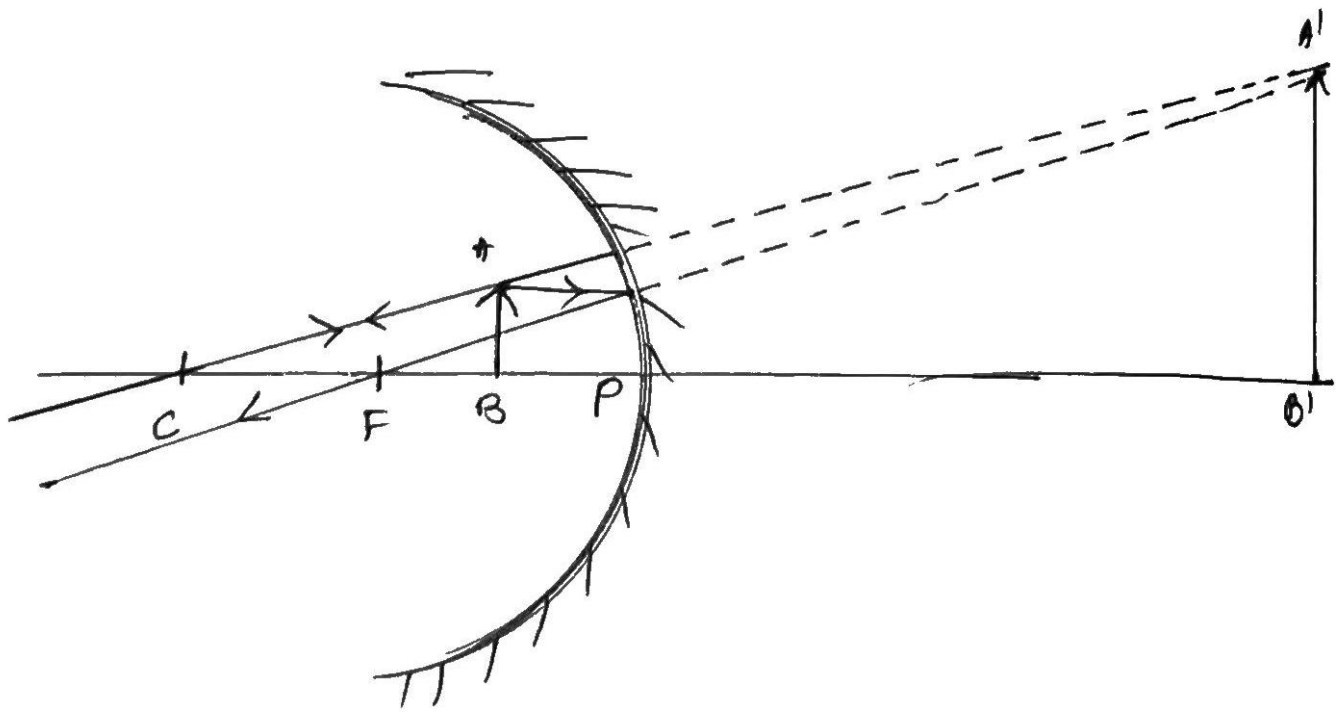
(11) An object is placed at a distance of 10 cm from a concave mirror of focal length 20 cm.

(a) Draw a ray diagram for the formation of image.

(b) calculate the image distance

(c) State two characteristics of the image formed

ans-(a)



(b) $f = -20\,cm$

$u = -10\,cm$

let image distance be v

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

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

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

$$\Rightarrow v = 20\,cm$$

(c) So the characteristics of the image formed is virtual and erect.

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

ans- $h_1 = 10\,cm$

$u = 36\,cm$

$f = -12\,cm$

we know

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

$\Rightarrow \quad \frac{1}{v} + \frac{1}{(-36)} = \frac{1}{(-12)}$

$\Rightarrow \quad \frac{1}{v} = \frac{1}{36} - \frac{1}{12} = \frac{1-3}{36} = -\frac{2}{36} = -\frac{1}{8}$

hence $v = -18\,cm$

so the position of image is 18 cm in front of the mirror

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

$$= \frac{h_2}{10} = -\frac{(+18)}{(+36)}$$

$$\Rightarrow \quad h_2 = -5cm$$

so the image is real and inverted.

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

ans $f = 10cm$

$h_1 = 2cm$

$h_2 = 6cm$

object distance be u

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

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

$\Rightarrow v = -3u$

we also know that

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

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

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

$$\Rightarrow u = \frac{-20}{3} = -6.66\,cm$$

so the object should be placed at a distance of 6.66 cm on the left of the 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 the focal length of the mirror

ans: $u = -15\,cm$

$v = -10\,cm$

Let the focal length be f

so we know that

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

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

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

$\Rightarrow f = -6\,cm$

so the focal length is 6cm.

(15) An object 3cm high is placed 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) Draw a ray diagram to show the formation of image.

(iii) What is the position of image?

ans: (i) $h_1 = 3\,cm$

$u = -8\,cm$

$h_2 = 4.5$

$\Rightarrow$ so $m = \frac{h_2}{h_1} = \frac{4.5}{3} = 1.5$

$m = \frac{-v}{u} = 1.5 = \frac{-v}{(-8)} \Rightarrow v = 1.5 \times 8 = 12\,cm$

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

$\Rightarrow \frac{1}{12} + \frac{1}{(-8)} = \frac{1}{f}$

$\Rightarrow \frac{1}{f} = \frac{1}{12} - \frac{1}{8} = \frac{2-3}{24} = \frac{-1}{24}$

$\Rightarrow f = -24\,cm$

(ii) $v = 12\,cm$ and so the image will be formed 12 cm behind the mirror.

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

(i) calculate the image distance.

(ii) what is the focal length of the mirror

ans. (i) $h_2 = -4\,cm$

$h_1 = 1\,cm$

$u = -20\,cm$

let the image distance be v

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

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

$$\Rightarrow v = -80\,cm$$

so image distance is $-80\,cm$

(ii) let the focal length be f

$$\text{So, } \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

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

$$\Rightarrow \frac{1}{f} = -\frac{1}{80} - \frac{1}{20} = \frac{-1-4}{80} = \frac{-5}{80} = \frac{-1}{16}$$

$$\Rightarrow f = -16\,cm$$

(17) An object of size 7.0cm is placed at 27 cm in front of a concave mirror of focal length 18cm. At what distance from the mirror should a screen be placed so that a sharp focussed image can be obtained ? find the size and nature of image.

ans $h_1 = 7\,cm \qquad f = -18\,cm$

$u = 27\,cm$

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

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

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

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

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

$$\Rightarrow \frac{-(54)}{-(27)} = \frac{h_2}{7}$$

$$\Rightarrow h_2 = -14\,cm$$

So image is 14cm in size, real and inverted.

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

ans. Given- $h_1 = 3cm$

$u = -10cm$

$f = -20cm$ $\left(\frac{1}{v} + \frac{1}{u} = \frac{1}{f}\right)$

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

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

$$\Rightarrow v = 20\ cm$$

So the image is formed at a distance of 20cm.

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

$$\Rightarrow \frac{-(20)}{(-10)} = \frac{h_2}{3}$$

$$\Rightarrow h_2 = 6cm$$

image is 6cm in size, virtual and erect.

(19) A concave mirror has a focal length of 4cm and an object 2cm tall is placed 9cm away from it. find the nature, position and size of the image formed.

ans- $h_1 = 2cm$

$u = 9cm$

$f = -4cm$

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

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

$= \frac{1}{-4} - \frac{1}{-9}$

$= \frac{-1}{4} + \frac{1}{9} = \frac{-9+4}{36} = \frac{-5}{36}$ 7.2

$\Rightarrow v = -7.2$

so $m = \frac{-v}{u} = -\frac{(-7.2)}{9} = -0.8$

$m = \frac{h_2}{h_1} \Rightarrow -0.8 = \frac{h_2}{2}$

$\Rightarrow h_2 = -1.6$ cm

so image is 1.6 cm in size and real and inverted.

20) when an object is placed 20 cm from a concave mirror, a real image magnified, three time is formed. find

(a) the focal length of the mirror

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

ans. $u = -20\ cm$

$m = -3$

(a) $m = \frac{-v}{u}$

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

$\Rightarrow v = -60\ cm$

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

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

$\Rightarrow \frac{1}{f} = \frac{-1}{60} - \frac{1}{20} = \frac{-1-3}{60} = \frac{-4}{15}$

$\Rightarrow f = -15\ cm$

(b) $m = 3$

$f = -15\ cm$

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

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

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{(3u)} + \frac{1}{u} = \frac{1}{-15} \Rightarrow u = \frac{-2 \times 15}{3} = -10$

so the object be placed 10 cm from the mirr

(21) 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 is magnified five times.

ans- $R = -3$

$f = \frac{R}{2} = \frac{-3}{2} = -1.5\,cm$

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

$\Rightarrow v = -5u$

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

$\Rightarrow \left(\frac{1}{-5u}\right) + \frac{1}{u} = \left(\frac{1}{-1.5}\right)$

$\Rightarrow \frac{4}{5u} = -\left(\frac{1}{1.5}\right)$

$\Rightarrow u = \frac{4 \times 1.5}{5} = 0.3 = -1.2\,cm$

the mirror should be place 1.2cm away from the dental cavity.

(22) A large concave mirror has a radius of curvature of 1.5m. A person stands 10m in front of the mirror where is the person image?

ans- $R = 1.5\,m$

$u = -10m$

$f = \frac{R}{2} = \frac{-1.5}{2} = -0.75m$

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

$\Rightarrow \frac{1}{v} + \frac{1}{(-10)} = \frac{1}{(-0.75)}$

$\Rightarrow \frac{1}{v} = \frac{1}{10} - \frac{1}{0.75} = \frac{.37}{30} \qquad v = -\frac{30}{37} = -0.81\,m$

The person's image will be 0.81 m in front of the mirror.

(23) An object of 5.0 cm size is placed at a distance of 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 a sharp image ? Also calculate the size of image.

ans. $h_1 = 5.0\ cm$ $\quad f = -15\ cm$

$u = -20\ cm$ $\quad h_2$ and v we have to find

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

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

$\Rightarrow \frac{1}{v} = \frac{-5}{300} \Rightarrow v = -60\ cm$

So scree should be placed 60 cm in front of mirror

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

$\Rightarrow \frac{h_2}{5} = \frac{-(-60)}{(-20)}$

$\Rightarrow h_2 = -15\ cm$

height of image = 15 cm

(24) A concave mirror produces 3 times enlarged virtual image of an object placed at 10cm in front of it. Calculate the radius of curvature of the mirror.

ans - $m = 3$

$u = 10\ cm$

let the radius of curvature be R

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

$$3 = \frac{-v}{(-10)} \Rightarrow v = 30\ cm$$

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

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

$$\Rightarrow \frac{-20}{300} = \frac{1}{f}$$

$$\Rightarrow f = -15\ cm$$

Radius of curvature $= 2f \Rightarrow 2 \times (-15) = -30\ cm$

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

ans - $h_1 = 50\ mm$, $f = -100\ mm$ and $u = -300\ mm$

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

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

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

$\Rightarrow \frac{1}{v} = \frac{-2}{300} \Rightarrow v = -150\,mm$

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

$= \frac{-150}{-300} = \frac{h_2}{60}$

$\Rightarrow h_2 = 25\,mm$

So image size will be 25 mm.

(26) How far should an object be placed from the pole of a converging mirror of focal length 20cm to form a real and inverted image of size exactly 1/4th size of the object.

Ans: $f = -20cm$, $m = \frac{-1}{4}$

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

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

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

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

$\Rightarrow \frac{5}{4v} = \frac{-1}{20}$

$\Rightarrow v = -100/4 = -25cm$

$u = 4v = 4 \times (25) = -100\,cm$

So the object should be placed 100 cm to the left of mirror

(27) When an object is placed at a distance of 50 cm from a concave mirror, the magnification is $-1/2$ where it should be placed to get a magnification of $-1/5$?

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

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

$$\frac{1}{2} = -\frac{v}{-50} \quad \cdot v = -25\,cm$$

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

$$\Rightarrow \frac{1}{-25} + \frac{1}{-50} = \frac{1}{f} \Rightarrow \frac{-3}{50} = \frac{1}{f}$$

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

in second question,

$$m = -1/5$$

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

$$m = \frac{-1}{5} = -\frac{v}{u} \Rightarrow v = \frac{u}{5}$$

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

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

$$\Rightarrow \frac{6}{u} = \frac{-3}{50} \Rightarrow u = \frac{600}{-3} = -200\,cm$$

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

ans- (a) $u = -20\,cm$, $f = -12\,cm$

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

$$\Rightarrow \frac{1}{v} + \frac{1}{-20} = \frac{1}{-12} \Rightarrow \frac{1}{v} = \frac{1}{12} + \frac{1}{20} = \frac{-20+12}{240} = \frac{-8}{240}$$

$V = -30$ cm

so the image is at a distance of 30 cm

(b) $v = -4$cm, $f = -12$cm

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

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

$$\Rightarrow \frac{1}{v} = \frac{-1}{12} + \frac{1}{4} = \frac{-1+3}{12} = \frac{2}{12}$$

$$\Rightarrow v = 6\text{cm}$$

(29) A concave mirror produces a real image 1cm tall of an object 2.5 mm tall placed 5 cm from the mirror. find the position of the image and the focal length of the mirror

ans- $h_2 = 1\text{cm} = 10\text{mm}$, $h_1 = 2.5$ mm ; $u = -5\text{cm} = -50$ mm

$$m = \frac{h_1}{h_2} = \frac{-10}{2.5} = -4$$

and we know that $m = \frac{-v}{u}$

$$-4 = \frac{-v}{(-50)}$$

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

so image is formed 20 cm in front of mirror

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\Rightarrow \frac{1}{f} = -\frac{25}{100} - \frac{1}{4}$ $\Rightarrow f = -4cm$

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

(30) A man holds a spherical shaving mirror of radius of curvature 60 cm and focal length 30 cm, at a distance of 15 cm, from his nose. Find the position of image, and calculate the magnification

ans $R = -60\ cm$

$f = 30\ cm$

$u = -15\ cm$

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

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

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

So $\frac{1}{v} = \frac{1}{30} \Rightarrow v = 30cm$

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

$m = + \frac{30}{-15} 2$

$m = 2$

So magnification is +2

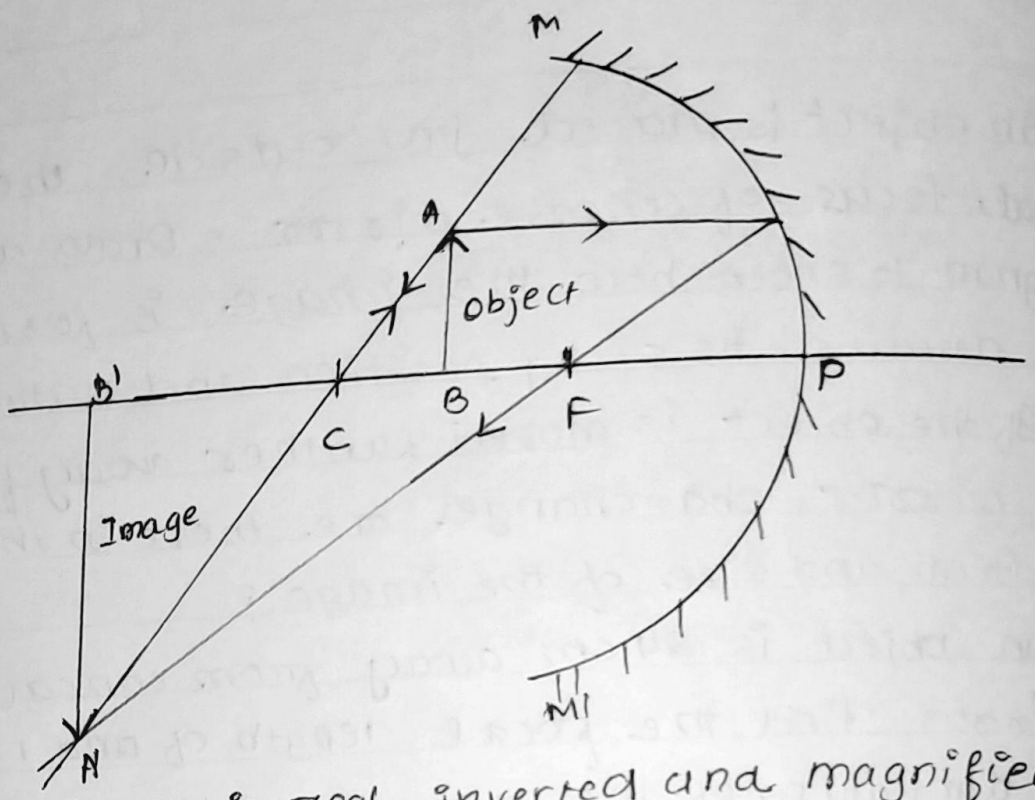
Long answer type -

(31) (a) An object is placed just outside the principal focus of concave mirror. Draw a ray diagram to show how the image is formed and describe its size, position and nature.

(b) If the object is moved further away from the mirror, what changes are there in the position and size of the image?

(c) an object is 24 cm away from concave mirror. find the focal length of and radius of curvature of the mirror and the magnification of image

(a)



the image is real, inverted and magnified and is formed beyond C.

(b) the image formed nearer to the mirror, the image is formed nearer to the mirror and its size goes on decreasing.

(c) $u = -24\ cm$, $v = -16\ cm$

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

$\Rightarrow \frac{1}{-16} + \frac{1}{-24} = \frac{1}{f} \Rightarrow \frac{-5}{48} = \frac{1}{f} \Rightarrow f = -9.6\ cm$

$R = 2f$ so $2 \times -9.6 = 19.2$

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

$= -\frac{(-16)}{-24} = -0.666.$

MCQs

(32) (c) less than 1; more than 1 or equal to 1

(33) (b) less than 1

(34) (d) equal to one

(35) (b) between focus and centre of curvature

(36) (c) between focus and pole

(37) (b) at centre of curvature

(38) (d) beyond centre of curvature

(39) (a) 20 cm

(40) (b) between 32 cm and 16 cm

(41) (b) is less than one.