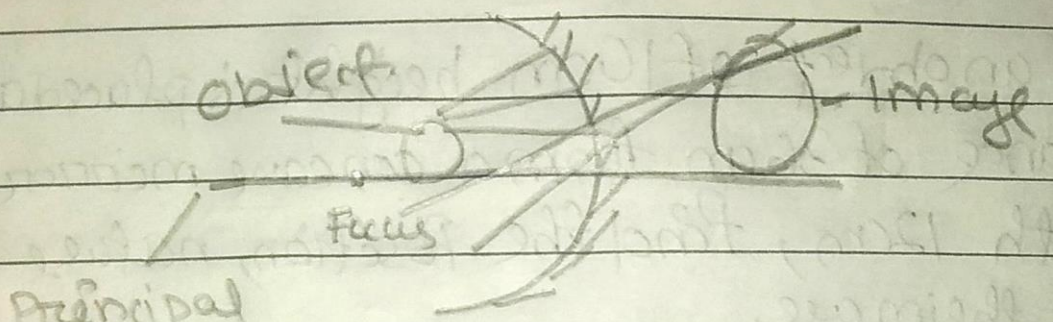
HW

Short Answer type questions

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

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) Given,

Distance of object = -10 cm = u

Focal length = -20 cm = f

We know, [Mirror Formula]

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

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

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

$\Rightarrow \frac{1}{v} \Rightarrow \frac{-1}{20} + \frac{1}{10} =$ ∴ The distance of image

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

$\Rightarrow \frac{1}{v} = \frac{1}{20}$ *The characteristics of formed image :

$\Rightarrow v = 20$ i) Virtual

ii) Erect.

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 of the image.

Ans - Given,

The height of object = 10cm = h_o

Distance of object = ~~36~~ 36cm = u

Focal length = -12cm

We know, By Mirror Formula,

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

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

$$\Rightarrow \frac{1}{v} = \frac{-1}{012} - \left(-\frac{1}{36}\right)$$

$$\Rightarrow \frac{1}{V} = \frac{-1}{12} + \frac{1}{36}$$

$$\Rightarrow \frac{1}{V} = \frac{-3+1}{36}$$

$$\Rightarrow \frac{1}{V} = \frac{-2}{36}$$

$$\Rightarrow V = \frac{-36}{2} = -18$$

$\Rightarrow V = -18$ ∴ The position of image is 18cm in front of mirror.

magnification, $m = \frac{h_i}{h_o} = -\left(\frac{V}{U}\right)$

$$\Rightarrow \frac{hi}{10} = -\left(\frac{-18}{-36}\right)$$

$$\Rightarrow \frac{hi}{10} = \frac{-18}{36}$$

$$\Rightarrow \frac{hi}{10} = \frac{-1}{2}$$

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

$$\Rightarrow h_i = -5$$

The image will be real and inverted.

13. At what distance from a concave mirror of focal length 10cm should an object 2cm

long be placed in orders to get an image 6cm tall?

Ans- Given,

Focal length = -10cm

height of object = 2cm

height of image = 6cm (erect)

By ~~Magnification~~ Formula,

Magnification = $m = \frac{h_i}{h_o}$

$= \frac{6cm}{2}$

$= 3cm$

So,

$-\left(\frac{v}{u}\right) = 3$

$\Rightarrow -v = 3u$

$\Rightarrow v = -3u$ ..... i)

we know,

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

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

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

$$\Rightarrow \frac{2}{30} = \frac{-1}{10}$$

$$\Rightarrow -30 = 20$$

$$\Rightarrow u = -6.67 \text{ cm}$$

∴ The object should be placed in a distance of 6.67 cm on the left side of mirror.

4. When an object is placed at a distance of 15cm from a concave mirror, it's image is formed at 10cm in front of the mirror. Calculate the focal length of the mirror.

Ans- Given,

Distance of object = -15cm = u

Distance of image = -10cm = v

Focal length = ?

We know,

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

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

∴ The focal length of the concave mirror is 6 cm.

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

(i) What is the Focal length?

(ii) Position of image?

(iii) Draw a ray diagram to show the formation of image?

Ans- Given,

Height of Object = 3cm = h_o

Distance of object = 8cm = u

Height of Image = 4.5cm = h_i

We know,

Magnification = $\frac{h_i}{h_o} = \frac{4.5}{3} = 1.5$ cm

$\Rightarrow \left(\frac{v}{u}\right) = 1.5$

$\Rightarrow \frac{-v}{-8} = 1.5$

$\Rightarrow v = 12$ cm

~~This term is de~~

∴ The image will be 12cm away from the mirror toward right.

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

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

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

$$\Rightarrow \frac{-1}{24} = \frac{1}{f}$$

$$\therefore \Rightarrow -24 = f$$

So, the focal length is 24cm.

16. A converging mirror forms 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 of the mirror?

Ans Given,

height of image = 4cm

height of object = 1cm

Object distance = 20cm

We know,

$$M = \frac{h_i}{h_o} = -\left(\frac{V}{U}\right)$$

$$\Rightarrow \frac{4}{1} = \frac{-V}{20} \Rightarrow -80 = V$$

So, the distance of image from mirror = 80cm

By mirror Formula,

$$\frac{1}{V} + \frac{1}{U} = \frac{1}{F}$$

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

$$\Rightarrow \frac{-1-4}{80} \Rightarrow \frac{-5}{80} \Rightarrow -16\text{cm}$$

So, the focal length is 16cm

17 An object of size 7cm is placed at 27cm in front of concave mirror of focal length 18cm At what distance from the mirror should a screen be placed so that a sharp focused image can be obtained? Find the size and nature of ima

Ans: Given,

height of Object = 7cm ≡ h_o

Distance of Object = 27cm = U

Focal length = 18cm

By Mirror Formula,

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

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

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

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

$$\Rightarrow \frac{1}{v} = \frac{-1}{54}$$

$$\Rightarrow v = -54$$

So, the distance of image from mirror is 54cm

$$m = \frac{h_i}{h_o} = \left(\frac{v}{u}\right)$$

$$\Rightarrow \frac{h_i}{7} = -\left(\frac{-54}{-27}\right)$$

$$\Rightarrow \frac{h_i}{7} = \frac{-54}{27} \times 2$$

$$\Rightarrow h_i = -14$$

So, the image is Real and inverted and 14cm in height.

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 image formed

Ans- Given,

height of object = 3cm = h_o

Distance of object = -10cm = u

Focal length = -20cm

By Mirror Formula,

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

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

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

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

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

∴ The image formed is 20cm behind the mirror.

$$m = -\left(\frac{v}{u}\right) = \frac{h_i}{h_o}$$

$$\Rightarrow -\frac{20}{-10} = \frac{h_i}{3}$$

$$\Rightarrow 6 = h_i$$

∴ The image is 6cm inverted and virtual, erect.

19. A concave mirror has ~~reduced~~ 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.

Ans- Given,

Focal length = ~~4cm~~ 4cm

height of object = 2cm

Distance of object = -9cm

By mirror formula,

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

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

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

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

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

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

The image is formed 7.2cm infront of the mirror.

$$M = \frac{h_i}{h_o} = -\left(\frac{v}{u}\right)$$

$$\Rightarrow \frac{h_i}{2} = -\left(\frac{-7.2}{-9}\right)$$

$$\Rightarrow \frac{h_i}{2} = -\frac{7.2}{9}$$

$$\Rightarrow -1.6 = h_i$$

So, the image is 1.6cm in size which is real and inverted

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

a) The focal length of the mirror

b) Where must the object be placed to give a virtual image 3 times the height of object?

Ans- Given,

Distance of object = -20cm = u

$m_e = -3$ for real image.

We know

$$m = -\left(\frac{v}{u}\right) = \frac{h_i}{h_o}$$

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

$\Rightarrow v = -60$

By Mirror Formula,

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

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

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

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

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

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

$\Rightarrow f = -15$

b) For virtual image ($m = 13$ and $f = -15$ cm)

We know,

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

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

$\Rightarrow \frac{1}{-3u} + \frac{1}{u} = \frac{1}{-15}$

$\Rightarrow \frac{-1+3}{3u} = \frac{-1}{15}$

$\Rightarrow \frac{2}{3u} = \frac{-1}{15}$

$\Rightarrow -3u = 30$

$\Rightarrow u = -10$

So, the object should be placed infront of the mirror by 10 cm.

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 5 times?

Ans Given,

Radius of concave mirror = -3cm

~~Image~~ magnification = 5cm

focal length = $\frac{R}{2}$

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

$= -1.5$ cm

$m \Rightarrow 5 = -\left(\frac{v}{u}\right) \Rightarrow v = -5u$

By Mirror Formula,

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

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

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

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

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

$$\Rightarrow -1.2cm=u$$

The mirror is placed 1.2cm away from the dental cavity.

22. A large concave mirror has a radius of curvature of 1.5m. A person stands 1m in front of the mirror. Where is the person's image.

Ans- Given,

Radius of curvature $= -1.5m$

distance of object $= -1m$

So, $F=\frac{R}{2}=\frac{-1.5}{2}=-0.75m$

By mirror Formula,

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

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

$$\Rightarrow \frac{1}{v} = \frac{1}{10} - \frac{1}{0.75}$$ [transmultip by hundred in $\frac{1}{0.75}$]

$$\Rightarrow \frac{1}{v} = \frac{1}{10} - \frac{100}{75}$$

$$\Rightarrow \frac{1}{v} = \frac{15 - 200}{150}$$

$$\Rightarrow \frac{1}{v} = \frac{-185}{150}$$

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

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

$$\Rightarrow v = -0.81 m$$

So, The person's image would be at 0.81m infront of the mirror.

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

Ans- Given,

Height of object = ~~5.0cm~~ 5.0cm

Distance of object = -20cm

Focal length = -15cm

By Mirror Formula,

$$\frac{1}{V} + \frac{1}{U} = \frac{1}{f}$$

$$\Rightarrow \frac{-1}{20} + \frac{1}{V} = \frac{-1}{15}$$

$$\Rightarrow \frac{1}{V} = \frac{-1}{15} + \frac{1}{20}$$

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

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

$$\Rightarrow v = -60cm$$

So, the screen should be placed 60cm in front of the mirror.

$$M = \frac{h_i^\circ}{h_o} = -\left(\frac{v}{u}\right)$$

$$\Rightarrow \frac{h_i}{5} = -\left(\frac{-60}{-20}\right)$$

$$\Rightarrow \frac{h_i}{5} = -3$$

$h_i = 29.15\ cm$

∴ The height of image is 15cm.

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

Ans- Given,

$m = 3$ (virtual)

Distance of object $= -10\ cm$

We know,

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

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

$\Rightarrow 30\ cm = v$

By mirror formula,

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

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

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

$\Rightarrow \frac{-2}{30} = \frac{1}{f} \Rightarrow \frac{-1}{15} = \frac{1}{f} \Rightarrow f = -15$

Radius = 2f
= -30cm

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

Ans Given,

Height of a bright object = 50mm
Focal length = -100mm
Distance of object = -300m
Height of image = ?

By mirror formula,

$$\frac{1}{V} + \frac{1}{U} = \frac{1}{f}$$

$$\Rightarrow \frac{-1}{300} + \frac{1}{V} = \frac{-1}{100}$$

$$\Rightarrow \frac{1}{V} = \frac{-1}{100} + \frac{1}{300}$$

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

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

$$M = -\left(\frac{v}{u}\right) = \frac{h_i}{h_o}$$

$$\Rightarrow -\left(\frac{-150}{300}\right) = \frac{h_i}{50}$$

$$\Rightarrow \frac{1}{2} = \frac{h_i}{50}$$

$$\Rightarrow 25\,cm = h_i$$

So, the height of image = 25cm.

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

Ans- Focal length = -20cm

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

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

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

$$\Rightarrow 4v = u$$

By Mirror Formula,

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

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

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

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

$$\Rightarrow -4v = 100$$

$$\Rightarrow v = -25cm$$

$\because u = 4v$

so, $u = 4 \times (-25)$

$= -100cm$

$\therefore$ the object must be placed 100cm left of mirror.

27. When an object is placed at a distance of -50cm from a concave spherical mirror, the magnification produced is, $-\frac{1}{2}$. Where should the object be placed to get a magnification of, $-\frac{1}{5}$?

Ans Given,

Distance of object $= -50cm$

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

We know,

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

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

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

$$\Rightarrow 2v = -50$$

$$\Rightarrow v = -25cm$$

By Mirror formula,

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

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

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

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

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

A/q,

$$m = \left(\frac{1}{5}\right) \text{ and } f = \frac{-50}{3} cm$$

$$m = -\left(\frac{1}{5}\right) = -\left(\frac{v}{u}\right)$$

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

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

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

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

$$\Rightarrow -3v = 300$$

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

So, the distance of object is 100cm.

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

Ans- Case (a)

Object distance = -20cm = u

Focal length = -12cm

By mirror Formula,

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

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

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

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

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

$$\Rightarrow -2v = 60$$

$$\Rightarrow v = -30\text{cm}$$

Nature: R

∴ The ima

30cm

mirr

Case (b)

Object distance = -4cm

Focal length = -12cm

By Mirror formula,

$$\frac{1}{V} + \frac{1}{U} = \frac{1}{F}$$

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

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

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

$$\Rightarrow \frac{1}{V} = \frac{2}{12}$$

$$\Rightarrow \frac{1}{V} = \frac{1}{6}$$

$$\Rightarrow v = 6\,cm$$

So, the image is 6cm behind the mirror and it is virtual and Erect.

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

Ans- Given,

height of image = 1cm = h_i = 10mm

height of object = 2.5mm = h_o

Object distance = 5cm = 50mm

$$M = \frac{h_i}{h_o}$$

$$= -\left(\frac{10}{2.5}\right)$$

$$= -4mm$$

We know,

$$M = \frac{h_i}{h_o} = -\left(\frac{v}{u}\right)$$

$$-4mm = -\left(\frac{v}{-u}\right)$$

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

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

$$-200mm = v$$

$v = -20\,cm$

The image is formed 20 cm in front of the mirror.

By mirror formula,

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

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

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

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

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

$$\Rightarrow -4\,cm = f$$

∴ The focal length is 4 cm

30. Aman 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- Given,

Radius of curvature = -60cm

Focal length = -30cm

Object distance = -15cm

By Mirror formula,

$$\frac{1}{V} + \frac{1}{U} = \frac{1}{F}$$

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

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

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

$$\Rightarrow \frac{1}{V} = \frac{1}{30}$$

$$\Rightarrow v = 30$$

So, the image is 30cm behind the mirror.

$$M = -\left(\frac{V}{U}\right) = \frac{hi}{ho}$$

$$M = -\left(\frac{30}{-15}\right) =$$

$$M = 2$$

So, the image is magnified by +2.