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Q1.

$$\text{Size of object, } h_1 = 1 \text{ m}$$
$$\text{Magnification, } m = 2$$
$$\text{Size of image, } h_2 = ?$$
$$m = \frac{h_2}{h_1}$$
$$2 = \frac{h_2}{1}$$
$$h_2 = 2m$$

Q2.

Object distance, u = -20 cm
Focal length, f = -20 cm (concave mirror)
Image distance, v =?
We know that

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$
$$\Rightarrow \quad \frac{1}{v} + \frac{1}{(-20)} = \frac{1}{(-20)}$$
$$\Rightarrow \quad \frac{1}{v} = 0$$
$$\therefore \quad v = \text{infinity}$$

Q3.

(a) If m = + 4, then the image is virtual and erect.
(b) If m = - 2, then the image is real and inverted.

Q4.

$$\frac{1}{\text{image distance}} + \frac{1}{\text{object distance}} = \frac{1}{\text{focal length}}$$

Or

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

v=distance of image from mirror

u=distance of object from mirror

f=focal length of mirror.

Q5.

Mirror formula is given below

$$\frac{1}{\text{image distance}} + \frac{1}{\text{object distance}} = \frac{1}{\text{focal length}}$$

Or

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

v=distance of image from mirror

u=distance of object from mirror

f=focal length of mirror.

Q6.

The ratio of height of an image to the height of an object is known as magnification.

Q7.

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

Q8.

Here, u = - 20 cm ; f = -10 cm

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

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

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

$$\therefore \quad v = -20 \text{ cm}$$

So, image will be real and inverted

Q9.

Here, u = - 20 cm ; f = -10 cm

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

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

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

$$\therefore \quad v = -20 \text{ cm}$$

So, image will be real and inverted

Q10.

(a) virtual; erect
(b) real; inverted

Q11.

(a)

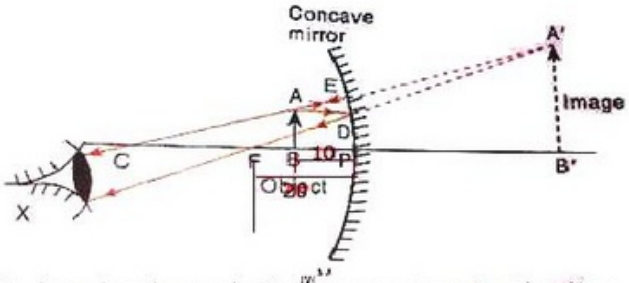

fig. formation of image by the concave mirror when the object is palced between its pole and focus.

(b) f=-20cm, u=-10cm, v=?
We know that

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

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

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

$$\therefore \quad v = 20 \text{ cm}$$

(c) Characteristics of image formed
(i) Image is virtual.
(ii) Image is erect.

Q12.

h_1=10cm, u=-36cm, f=-12cm
We know that

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

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

$$\Rightarrow \quad \frac{1}{v}=\frac{1}{36}-\frac{1}{12}=\frac{1-3}{36}=-\frac{2}{36}=-\frac{1}{18}$$

$$v = -18\,\text{cm}$$

$\therefore$ The position of the image is 18 cm in front of the mirror.

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

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

$$\Rightarrow h_2=-5\text{cm}$$

The image formed is real and inverted.

Q13.

f=-10cm, h_1=2cm, h_2=6cm (erect image)
u =?
We know that:

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

and

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

$$\Rightarrow 3u = -v$$

$$\Rightarrow v = -3u \qquad ----(A)$$

We have,

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

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

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

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

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

The object should be placed at a distance of 6.66 cm on the left side of the mirror.

Q14.

u=-15cm, v=-10cm
f=?
We know that

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

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

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

$$\therefore \quad f = -6 \text{ cm}$$

∴ The focal length of the concave mirror is 6 cm

Q15.

h_1=3cm, u=-8cm, h_2=4.5 (virtual image)

(i) We know that

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

and

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

$$\Rightarrow \quad 1.5 = -\frac{v}{(-8)}$$

$$\Rightarrow \quad v = 1.5 \times 8 = 12 \text{ cm}$$

We have

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

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

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

$$\therefore \quad f = -24 \text{ cm}$$

(ii) v = 12 cm
So, the image is formed 12 cm behind the concave mirror.

Q16.

$h_2 = -4\,cm$ (real image)

$h_1 = 1\,cm$

$u = -20\,cm$

(i) v=?

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

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

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

Image forms in front of the concave mirror.

(ii)f=?

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

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

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

$$f = -16\,cm$$

Q17.

Given : h_1=7cm, u=-27cm, f=-18cm,

We know that

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

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

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

$\therefore$ v=-54 cm

The screen should be placed at a distance of 54 cm in front of the concave mirror.

And

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

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

$\Rightarrow$ h_2 = – 14 cm

Image is 14 cm in size, real and inverted.

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18.

Given : h_1=3cm, u=-10cm, f=-20cm,

We know that

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

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

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

$\therefore$ v=20 cm

The image is formed at a distance of 20 cm behind the mirror.

And

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

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

$\Rightarrow$ h_2 = 6 cm

Image is 6 cm in size, virtual and erect.

Q19.

h_1=2cm, u=-9cm, f=-4cm
We know that

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

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{(-4)}-\frac{1}{(-9)}$$

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

$v = -7.2$ cm

The image is formed at a distance 7.2 cm in front of the mirror

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

$$m=\frac{h_2}{h_1} \quad \Rightarrow \quad -0.8=\frac{h_2}{2} \quad \Rightarrow \quad h_2=-1.6 \text{ cm}$$

So, image is 1.6 cm in size, real and inverted.

Q20.

Given:-
u =-20cm, m=- 3 , for the real image

(a) We know that

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

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

$$\Rightarrow \quad v=-60 \text{ cm}$$

We have

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

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

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

$$\therefore \quad f=-15 \text{ cm}$$

(b) For virtual image m=3, and f=-15cm
We know that

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

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

We have,

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

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

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

$$\Rightarrow \quad u=-\frac{2\times 15}{3}=-10 \text{ cm}$$

So object should be placed 10cm from the concave mirror.

Q21.

R=-3cm (concave mirror)
m=5 (virtual image)

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

and

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

We have,

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

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

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

$$\Rightarrow \quad u=-\frac{4 \times 1.5}{5}=-1.2 \text{ cm}$$

The mirror should be placed 1.2cm away from the dental cavity.

Lakhmir Singh Physics Class 10 Solutions Chapter 4 Q22.

R=-1.5m (concave mirror)
u=-10m

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

We know,

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

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

$$\Rightarrow \quad \frac{1}{v}=\frac{1}{10}-\frac{1}{0.75}=\frac{1}{10}-\frac{100}{75}$$

$$=\frac{1}{10}-\frac{4}{3}=\frac{3-40}{30}=-\frac{37}{30}$$

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

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

Q23.

h_1=5.0cm, u=-20cm, f=-15cm, v=?, h_2=?
We know that

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

$$\frac{1}{v}+\frac{1}{(-20)}=\frac{1}{(-15)}$$

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

$$\frac{1}{v}=\frac{-5}{300}$$

$$v=-60\text{cm}$$

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

And

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

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

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

height of image = 15cm

Q24.

m=3 (virtual image)
u=-10cm
R=?
We know that

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

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

$$v = 30cm$$

and

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

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

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

$$f = -15cm$$

Radius of curvature = R = 2f

$$= 2x(-15) = -30cm$$

Q25.

h_1=50mm, f=-100mm, u=-300mm, h_1=?
We have:

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

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

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

$$\frac{1}{v} = \frac{-200}{30000}$$

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

$$v = -150\,mm$$

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

$$-\frac{-150}{-300} = \frac{h_2}{50}$$

The image will be 25 mm high.

Q26.

f=-20cm, m=-1/4 (real image)
We know that

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

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

$$u = 4v$$

so

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

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

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

$$v = -\frac{100}{4} = -25 \text{ cm}$$

$\therefore$

$$u = 4v$$

$$u = 4x(-25)$$

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

The object should be placed 100 cm to the left of the mirror.

Q27.

Case 1:

u=-50cm

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

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

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

$v=-25\text{cm}$

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

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

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

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

Case 2:

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

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

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

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

Now,

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

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

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

$u=\frac{600}{-3}=-100\,\text{cm}$

Q28.

(a) u=-20cm, f=-12cm

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

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

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

$v = -30\,cm$

The image is formed at a distance of 30 cm in front of the mirror.

The image is real and inverted.

?

(b) u=-4cm, f=-12cm

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

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

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

$v = 6\,cm$

The image is formed at a distance of 6 cm behind the mirror.

The image is virtual and erect.

Q29.

h_2=1cm=10mm (real image), h_1=2.5mm, u=-5cm=-50mm

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

$$m=-\frac{10}{2.5}$$

$m = -4$

and we know that

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

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

$v = -200mm$

$v = -20cm$

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

And,

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

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

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

$f = -4cm$

Q30.

Radius of curvature, R=-60cm (concave mirror)
f=-30cm, u=-15cm
We have

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

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

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

$$\frac{1}{v}=\frac{1}{30}$$

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

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

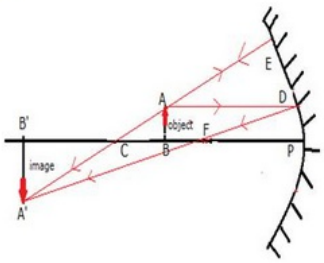
$$m=-\frac{30}{-15}$$

$$m=2$$

So, the the image is formed 30 cm behind the mirror and the magnification is +2.

Q31.

(a)



The image is real, inverted and magnified. It is formed beyond the centre of curvature of the mirror.

(b) If the object is moved further away from the mirror, the image is formed nearer to the mirror and its size goes on decreasing.

(c) u=-24cm

v=-16cm

f=?, R=?, m=?

we know that

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

$$\frac{1}{-16}+\frac{1}{-24}=\frac{1}{f}$$

$$\frac{-5}{48}=\frac{1}{f}$$

$$f=-9.6\text{cm}$$

$$R=2f$$

$$=2\times-9.6=-19.2\text{cm}$$

we know that

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

$$m=-\frac{-16}{-24}$$

$$m=-0.666$$

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Q42.
(a) Between focus and centre of curvature.
(b) Between pole and focus.
(c) Beyond the centre of curvature
Q43.

(a) f=-10 cm

v=-20cm (real image)

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

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

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

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

(b) f=-10 cm

v=20 cm (virtual image)

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

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

$$\frac{1}{u}=\frac{-1}{10}+\frac{-1}{20}=\frac{-3}{20}$$

$$u=-\frac{20}{3}\text{cm}$$

Q44.

$$f=-10\text{cm}$$

Case 1: m=2 (Image is virtual and erect)

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

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

$$\Rightarrow v=-2u$$

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

$$\frac{1}{-2u}+\frac{1}{u}=\frac{1}{-10}$$

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

$$u=-5\text{cm}$$

Case 2:m=-2 (Image is real and inverted)

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

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

$$v=2u$$

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

$$\frac{1}{2u}+\frac{1}{u}=\frac{1}{-10}$$

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

$$u=-15\text{cm}$$

Q45.

Let the image formed is virtual and erect.

$v - u = 30\,cm$

$m = 2$

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

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

$v = -2u$

$-2u - u = 30cm$

$u = -10\,cm$

(b) $v=-2u=20\,cm$

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

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

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

$f = -20\,cm$

$R = 2f = -40\,cm$

(c) Concave mirror

********** END **********