Assignments

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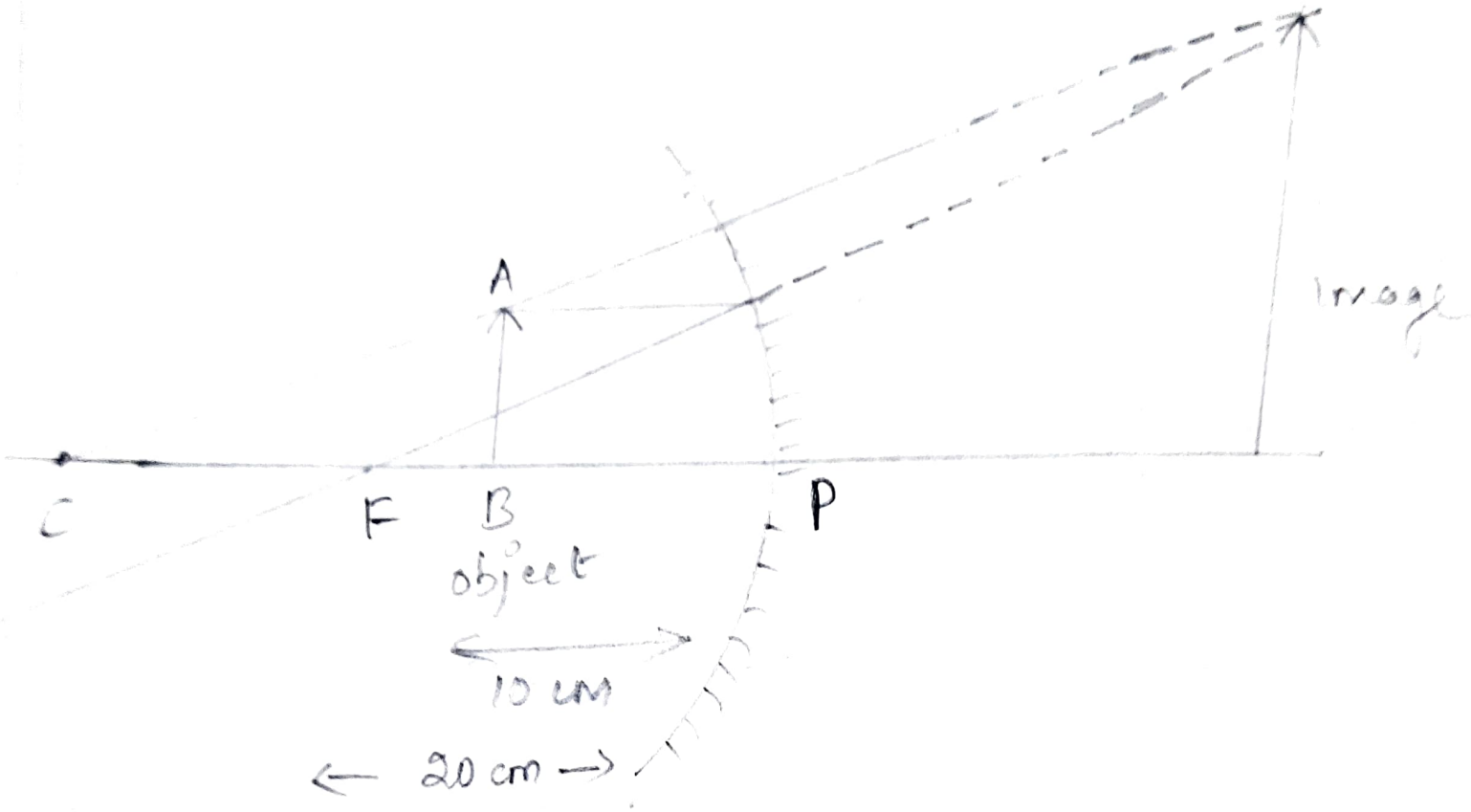
1) An object is placed at a distance of 10cm from a concave mirror of focal length 20cm.

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

(b) Calculate the image distance

(c) State two characteristics of image formed.

(a)



(b) Distance of object (u) = −10 cm

$f = -20$ cm

$v = ?$

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

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

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

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

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

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

(C) the Image 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 image.

$u = -36\ cm$

$h = 10\ cm$

$f = -12\ cm$

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

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

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

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

$$\frac{1}{v} = \frac{-3 + 1}{36}$$

$$\frac{1}{v} = -\frac{2}{36} = -\frac{1}{18}$$

$v = -18\ cm$

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

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

$$\Rightarrow \frac{h_2}{10} = \frac{-18}{36} = -\frac{1}{2}$$

$$\Rightarrow h_2 = \frac{-1}{2} \times 10$$

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

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

height of object (h_1) = 2cm

$f = -10cm$

$h_2 = 6\,cm$

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

$$\Rightarrow \frac{6}{2} = -\frac{v}{u}$$

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

$$\Rightarrow v = -3u$$

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

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

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

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

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

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

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

$$\Rightarrow 3u = -20$$

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

14 When an object is placed at a distance of 15 cm from a concave mirror, its image is formed at 10 cm in front of mirror. Calculate focal length.

$u = -15$ cm

$v = -10$ cm

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

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

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

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

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

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

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

$u = -8\text{cm}$

$h_1 = 3\text{cm}$

$h_2 = 4.5\text{cm}$

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

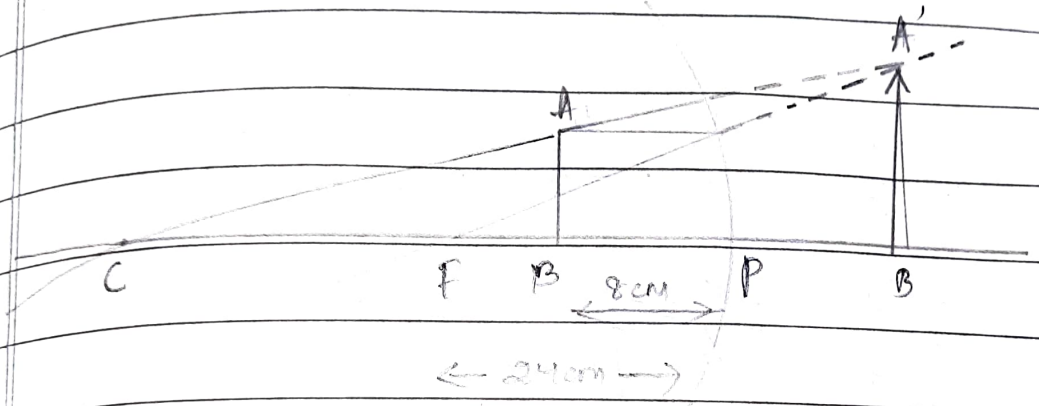
$$= \frac{4.5}{3} = \frac{-v}{8}$$

$$-v = \frac{4.5 \times 8}{3} = 12\text{cm}$$

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{12} + \frac{1}{-8}$$

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

$$f = -24\,cm$$



6. A converging mirror ~~has a~~ 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 mirror.

$u = -20\,cm$

$h_1 = 1\,cm$

$h_2 = -4\,cm$

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

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

$$\Rightarrow -v = 80$$

$$v = -80 \text{ cm}$$

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

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

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

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

$$\Rightarrow f = -16 \text{ cm}$$

17. An object of size 7 cm is placed at 27 cm in front of a concave mirror of focal length 18 cm. 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?

$u = -27\,cm$

$h_1 = 7\,cm$

$f = -18\,cm$

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

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

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

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

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

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

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

$$m = \frac{h_2}{h_1} = -\left(\frac{+54}{-27}\right) = -\frac{2}{1}$$

$$h_2 = -2 \times 7 = -14\,cm$$

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

$u = -10\,cm$

$h_1 = 3cm$

$f = -20cm$

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

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

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

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

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

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

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

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

$$\Rightarrow h_2 = -6\,cm$$

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 image formed.

$u = -9cm$

$h_1 = 2cm$

$f = -4cm$

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

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

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

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

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

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

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

$$\Rightarrow \frac{8h_2}{2} = +\frac{4}{5}\frac{36}{1} \times \frac{1}{9}$$

$$\Rightarrow h_2 = 8/5$$

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

(i) the focal length of the mirror.

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

(i) $u = -20$ cm

$M = -3$ cm

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

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

$$\Rightarrow -v = 60$$

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

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

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

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

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

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

$f = -15cm$

(b) If the image is virtual 3 times magnified, then we have to find the position of the object.

$f = -15cm$

$m = 3$

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

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

$v = -3u$

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

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

$\frac{1}{f} = \frac{3u}{2}$

$u = \frac{2f}{3} = \frac{2 \times (-15)}{3}$

$u = -10cm$

21. A dentist mirror has a radius of curvature of 3 cm. 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- $R = -3\,cm$

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

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

$$-5u = v$$

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

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

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

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

$$\Rightarrow 5u = 1.5 \times 4$$

$$\Rightarrow u = \frac{1.5 \times 4}{5} = -\frac{6}{5}$$

$$\Rightarrow u = -1.2\,cm$$

$f = \frac{R}{2} = \frac{3}{2} = 1.5m$

22. A large concave mirror has a radius of curvature of 1.5 m. A person stands 10m in front of the mirror. Where is the persons image.

$R = -1.5M$

$f = \frac{1}{R} = \frac{1}{1.5} = 0.75m$

$u = -10m$

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

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

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

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

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

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

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

29. An object of 5 cm size is placed at a distance of 20 cm from a converging mirror of focal length 15 cm. At what distance from the mirror should a screen be placed to get the sharp image? Also calculate the size of image?

$u = -20\ cm$

$h_1 = 5\ cm$

$f = -15\ cm$

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

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

$$\Rightarrow \frac{1}{v} = \frac{-1}{15} - \left(\frac{-1}{20}\right)$$

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

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

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

$$\Rightarrow v = -60\ cm$$

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

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

$$\Rightarrow h_2 = -3 \times 5 = -15\ cm$$

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

$u = -10\ cm$

$m = 3$

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

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

or $v = 3 \times 10$

or $v = 30\ cm$

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

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

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

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

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

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

Thus, $f = -15\text{cm}$

$R = 2x - 15$

$= -30 \text{ cm}$

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

$u = -300\text{mm}$

$h_1 = 50\text{mm}$

$f = -100\text{MM}$

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

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

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

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

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

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

$$\frac{\phi}{v} = -150\text{mm}$$

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

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

$$h_2 = -25\text{mm}$$

26. 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 size exactly $\frac{1}{4}$ th the size of the object?

$$f = 20\text{ cm}$$

$$M = -1/4$$

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

$$-1/4 = -v/u$$

$$-4v = -u$$

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

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

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

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

$$-u = 100$$

or $u = -100\ cm$

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

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

$$u = -50\ cm$$

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

$$v = -mu$$

$$v = -\left(-\frac{1}{2} \times -\frac{25}{50}\right)$$

$$v = -25\ cm$$

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

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

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

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

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

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

$$\frac{1}{f} = \frac{1}{-mu} + \frac{1}{u}$$

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

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

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

$$\Rightarrow u = -50 \times \frac{1}{3} = -100\,cm$$

$\therefore$ The object should be placed in front of mirror at a distance of 100cm to get magnification of $-1/5$.

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

Case (a)

$u = -20\ cm$

$(f) = -12\ cm$

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

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

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

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

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

$$\Rightarrow v = -30\ cm$$

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

$$m = \frac{-30}{-20} = 3/2 \text{ or } 1.5\ cm$$

Thus the image is real and inverted & enlarged.

Case (b)

$u = -4\,cm$

$f = -12\,cm$

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

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

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

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

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

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

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

$$m = \frac{+6}{+4} = \frac{3}{2} \text{ or } 1.5\,cm$$

Thus, the image 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 focal length of the mirror.

$u = -5\,cm$

$h_2 = -1\,cm$

$h_1 = 2.5\,mm = 0.25\,cm$

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

$$\Rightarrow \frac{-1}{0.25} = \frac{+v}{+5}$$

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

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

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

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

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

$$\frac{1}{f} = \frac{-3}{20}\ 1/4$$

$$f = -4\,cm$$

30. A man holds a spherical ~~mirror~~ 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.

$u = -15\,cm$

$f = -30\,cm$

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

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

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

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

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

$$\Rightarrow v = 30\,cm$$

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

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