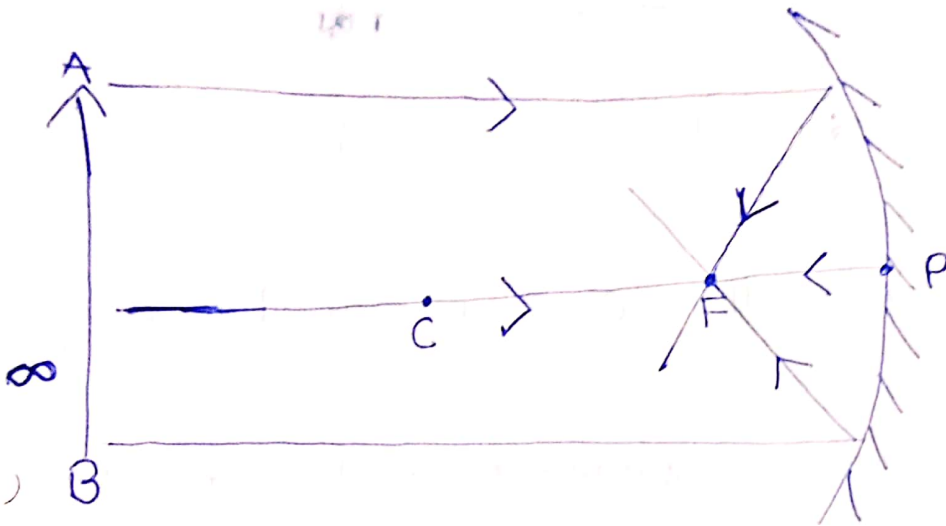
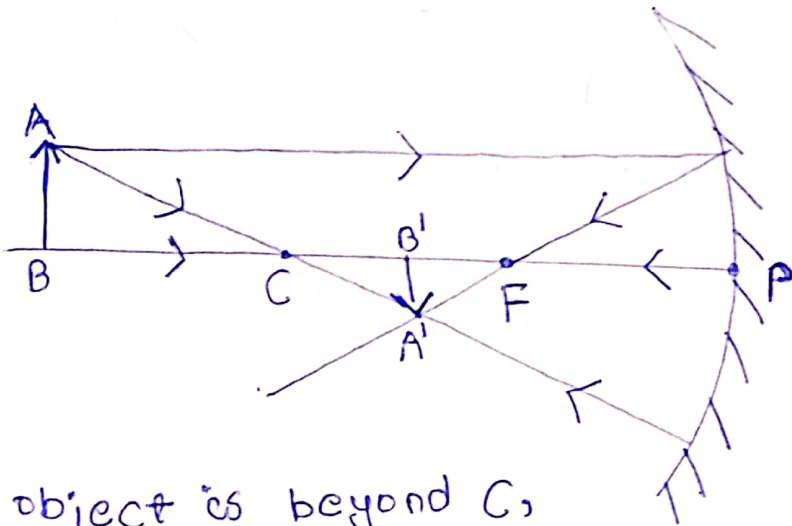


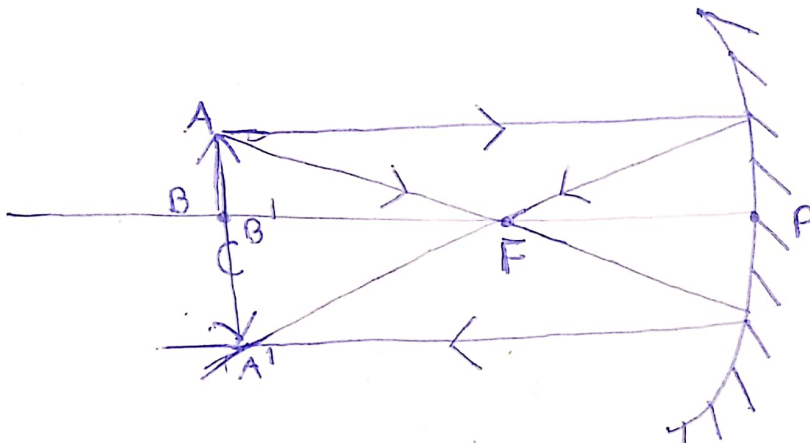
Ray diagrams



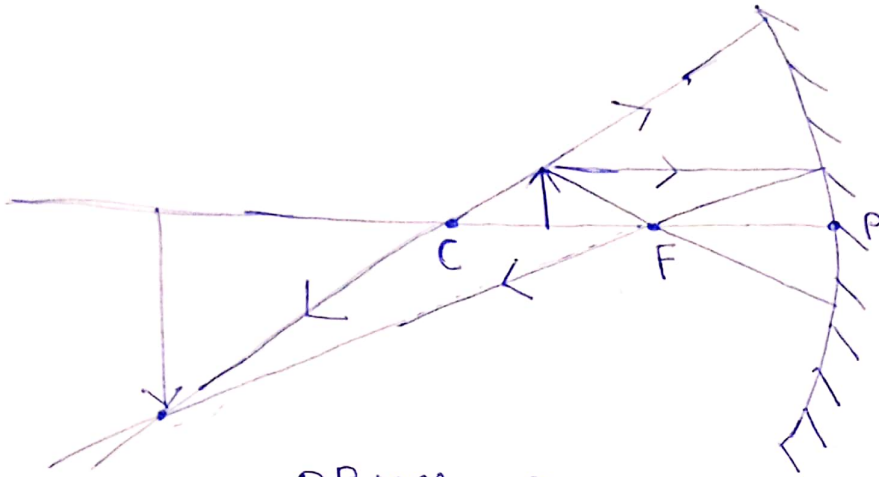
When object is at ∞ , image formed at F.
Real & inverted



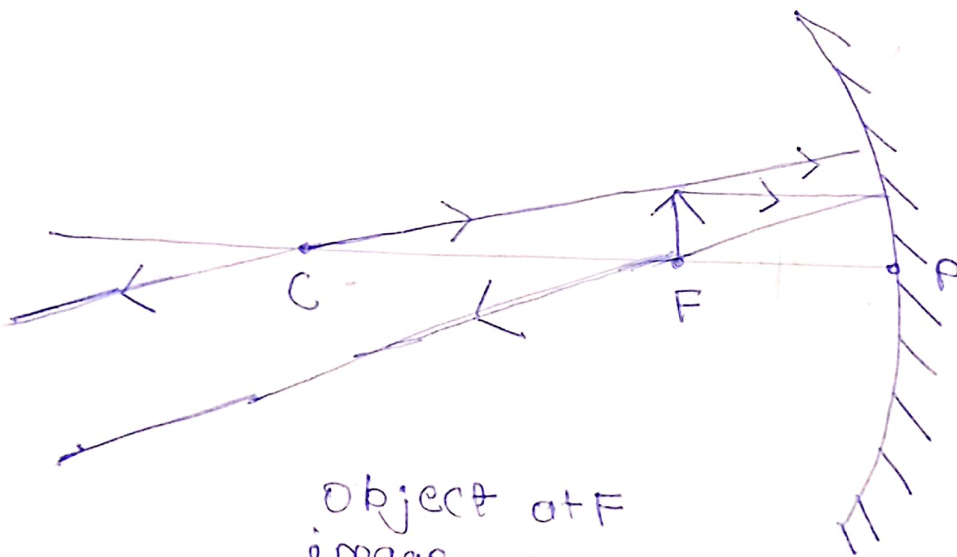
When object is beyond C,
image formed between C and F. (Real & inverted)



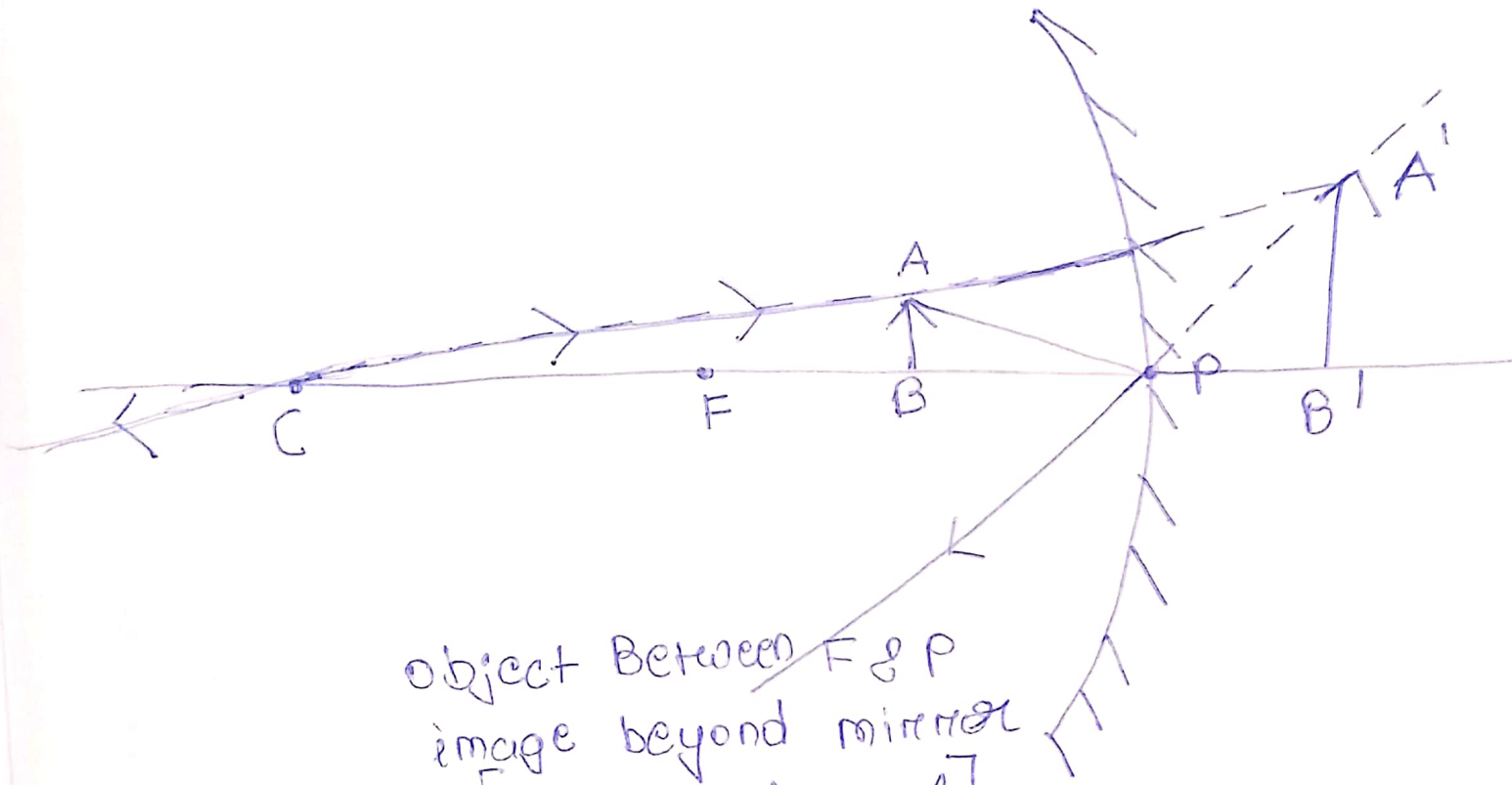
When object is at C, image will be formed at C.
(Real & inverted).



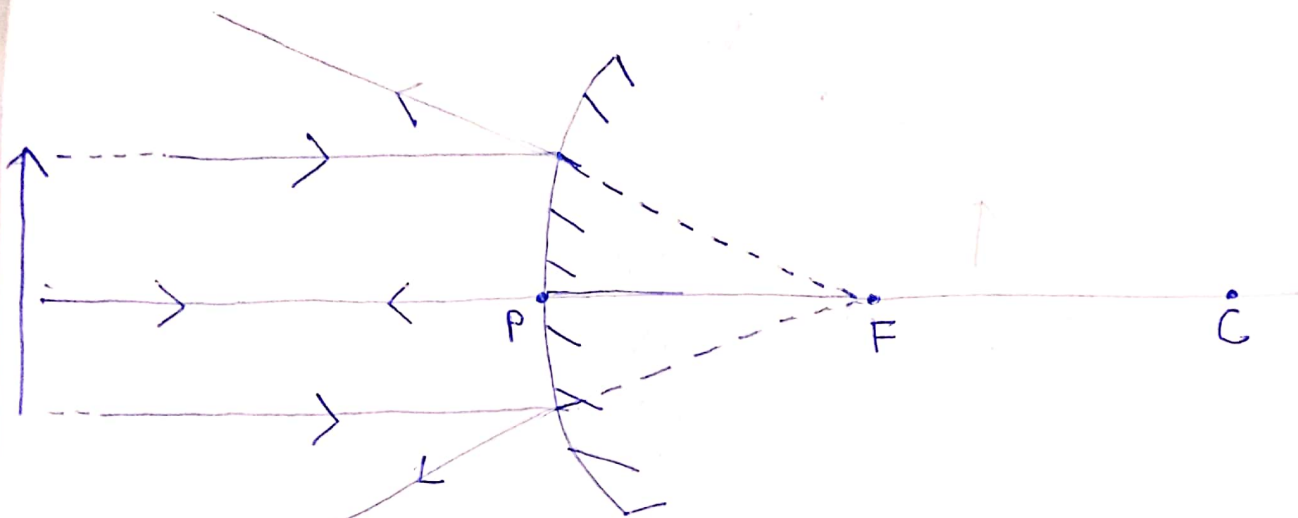
Object - Between C & F
 Image - Beyond C (Real & inverted)



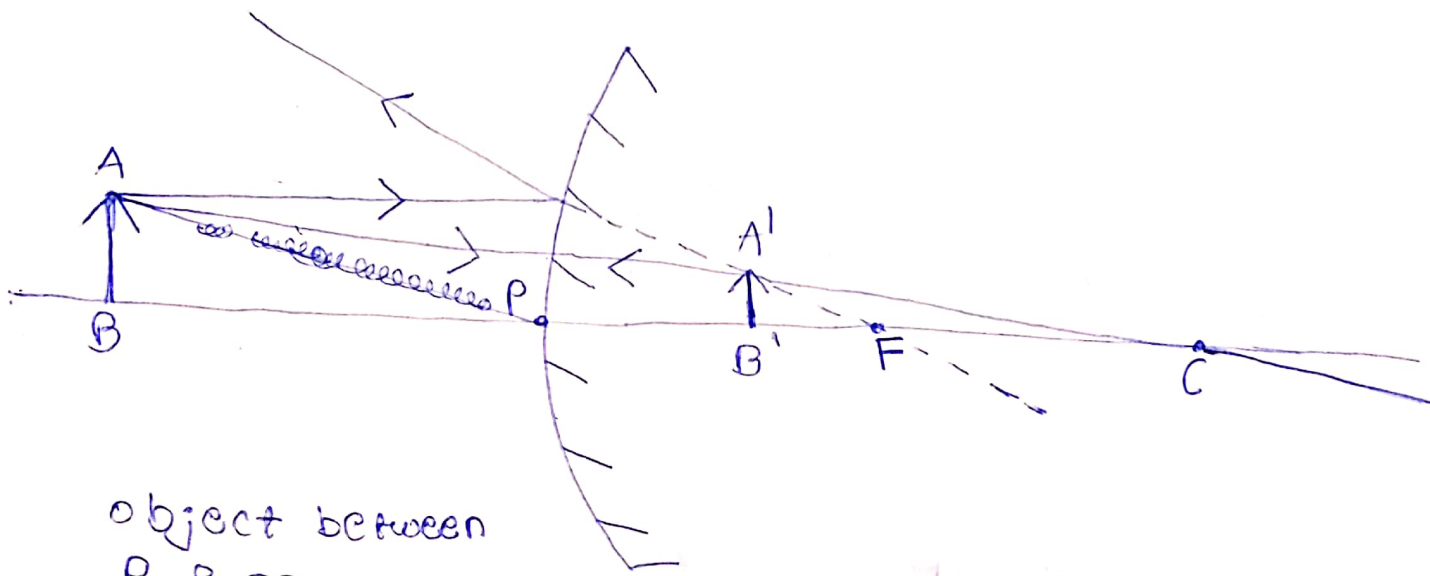
Object at F
 Image at ∞ (Real & inverted)



object Between F & P
 image beyond mirror
 [Erect & virtual]



object at ∞
 image at F (virtual & erect)



object between
 P & ∞
 image between P & F (virtual & erect)

Assignment

11. b) $f = -20$

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

ATQ,

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

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

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

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

c) Characteristics of image are -

i) Image is virtual and erect.



12. $h = 10 \text{ cm}$, $u = -36 \text{ cm}$, $f = -12 \text{ cm}$,

ATQ,

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

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

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

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

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

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

$$\Rightarrow h' = -50 \text{ m.}$$

The image is real and inverted.

$$14. \rightarrow u = -150 \text{ m}, v = -100 \text{ m},$$

ATQ,

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

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

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

$$\Rightarrow f = -60 \text{ m}$$

So the focal length of concave mirror is 60m.

15. H_1 (height of the ~~image~~ ^{object}) = 3cm

$$U = -8 \text{ cm}$$

$$H = 4.5 \text{ cm}$$

$\frac{4.5}{3}$ i) magnification (m), $\frac{H}{H_1} = \frac{4.5}{3} = 1.5 \text{ cm}$

ii) Now, $m = \frac{-v}{u} = \frac{-v}{-8}$

$$\Rightarrow 1.5 = -v / -8$$

$$\Rightarrow +v = 1.5 \times -8 = +12$$

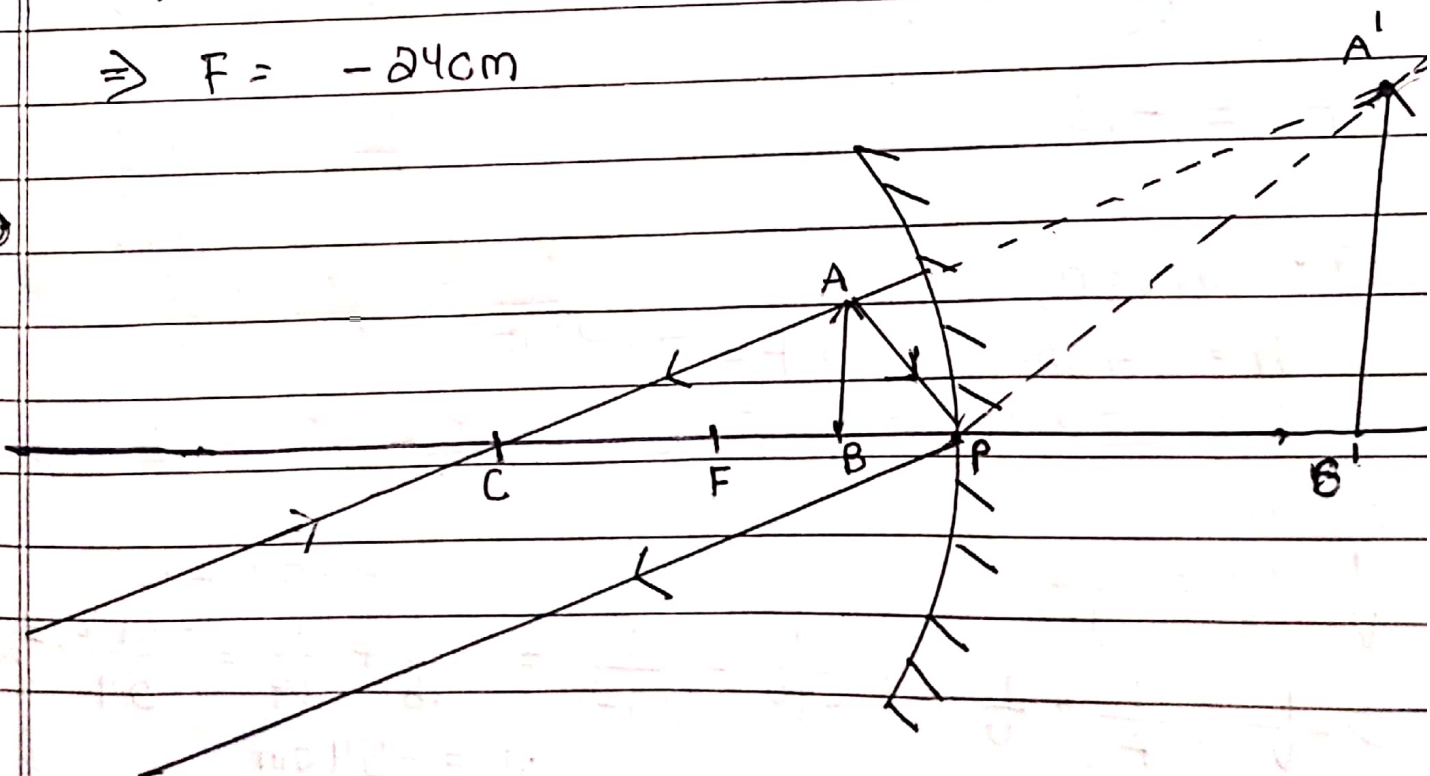
$$\Rightarrow v = 12 \text{ cm}$$

So the image formed is 12cm.

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

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

$$\Rightarrow f = -24 \text{ cm}$$



$$Q 13) \quad f = -10 \text{ cm}$$

$$h = 2 \text{ cm}$$

$$h' = 6 \text{ cm}$$

ATA,

$$m = \frac{h'}{h} = 6/2 = 3$$

and,

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

$$\Rightarrow 3u = -v$$

$$\Rightarrow v = -3u \quad \text{--- (A)}$$

we have

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

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

$$\Rightarrow \frac{1}{u} - \frac{1}{3u} = \frac{-1}{10} \Rightarrow \frac{2}{3u} = \frac{-1}{10} \Rightarrow u = 6.66 \text{ cm}$$

\Rightarrow The object should be placed at a distance of 6.66 cm.

$$16. \quad h_2 = -4 \text{ cm} \quad (\text{real image})$$

$$h_1 = 1 \text{ cm}$$

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

$$i) \quad v = ?$$

$$\text{now, magnification (m)} = \frac{h_2}{h_1} = -\frac{v}{u}$$

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

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

So image formed in front of the concave mirror.

$$ii) \quad \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

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

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

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

$$\Rightarrow f = -16$$

17. Given,

$$h = 7 \text{ cm}, \quad f = -18 \text{ cm}$$

$$u = -27 \text{ cm}$$

ATQ,

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

$$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-18} - \frac{1}{(-27)} = -\frac{1}{18} + \frac{1}{27} = \frac{-3+2}{54} = \frac{-1}{54}$$
$$v = -54 \text{ cm}$$

So the screen should be placed at a distance of 54cm in front of the Concave mirror.

And,

$$\text{magnification (m)} = \frac{-v}{u} = \frac{h'}{h} = \frac{-(-54)}{(-27)} = \frac{h'}{7}$$

$$\Rightarrow h' = -14\text{cm}$$

So image is 14cm in size real & inverted.

18. Given

$$h = 3\text{cm}$$

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

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

now,

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

$$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{(-20)} - \frac{1}{(-10)} = \frac{1}{20} + \frac{1}{10} = \frac{-1+2}{20} = \frac{1}{20}$$

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

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

now,

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

$$\Rightarrow \frac{-(20)}{(-10)} = \frac{h'}{3} \Rightarrow h' = 6\text{cm}$$

Image is 6cm, virtual and erect.

$$19. \quad h_1 = 2 \text{ cm}$$

$$U = -9 \text{ cm}$$

$$f = -4 \text{ cm}$$

Now,

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

$$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-4} - \frac{1}{(-9)} = -\frac{1}{4} + \frac{1}{9} = \frac{-9+4}{36} = -\frac{5}{36}$$

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

So the image is formed at a distance of 7.2 cm in front of concave mirror.

now,

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

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

$$\Rightarrow h_2 = -1.6 \text{ cm}$$

Image is 1.6 cm, real and inverted.

$$20. \quad U = -20 \text{ cm}$$

$$m = -3$$

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

$$\Rightarrow -3 = \frac{-v}{-20} \Rightarrow -v = -20 \times -3 = 60$$

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

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

~~$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{15}$$~~

$$\Rightarrow \frac{1}{-60} + \frac{1}{(-20)} = \frac{1}{-60} - \frac{1}{20} = \frac{-1-3}{60} = -\frac{1}{15}$$

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

b) for virtual image $m = 3$, $f = -15 \text{ cm}$

now,

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

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

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

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

$$\Rightarrow \frac{1}{-30} + \frac{1}{u} = \frac{1}{-15} \Rightarrow \frac{-1+3}{30} = -\frac{1}{15}$$

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

$$21. R = -3 \text{ cm}$$

$$m = 5.$$

$$F = R/2 = -3/2 = -1.5 \text{ cm}$$

now,

$$m = -\frac{v}{u} \Rightarrow v = \textcircled{2} -5u$$

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

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

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

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

⊙ The mirror should be placed 1.2 cm away from the teeth.

$$22. R = -1.5 \text{ m}$$

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

$$F = R/2 = \frac{-1.5}{2} = \textcircled{2} -0.75 \text{ m}$$

~~ATQ,~~ ATQ,

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

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

$$\frac{1}{v} = \frac{1}{10} - \frac{100}{75} = \frac{1}{10} - \frac{4}{3}$$

$$\Rightarrow \frac{1}{v} = \frac{3 - 40}{30} = -\frac{37}{30}$$

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

23. $h_1 = 5 \text{ cm}$

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

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

ATQ,

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

$$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-15} - \frac{1}{(-20)} = \frac{1}{-15} + \frac{1}{20} = \frac{-4+3}{60}$$

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

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

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

Now,

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

$$m = \frac{h_2}{5} = -\frac{(-60)}{(-20)} \Rightarrow \frac{h_2}{5} = -3 \Rightarrow h_2 = -3 \times 5 = -15$$

height of image = 15 cm

24) Given,

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

$$m = 3$$

Now,

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

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

$$\Rightarrow -v = 3 \times -10 = -30$$

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

Then,

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

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

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

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

Radius of Curvature (R) = 2f

$$\Rightarrow R = 2 \times (-15) = 30 \text{ cm}$$

25. $h = 50 \text{ mm}$

$f = -100 \text{ m}$

$U = -300 \text{ m}$

ATQ,

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

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

$$\Rightarrow \frac{1}{v} = \frac{-1}{100} + \frac{1}{300} = \frac{-3+1}{300} = \frac{-2}{300} \text{ a}$$

$$\Rightarrow v = -150 \text{ mm}$$

now,

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

$$\Rightarrow \frac{h'}{50} = \frac{-(-150)}{(-300)} = -\frac{1}{2}$$

$$\Rightarrow h' = \frac{-1}{2} \times 50 = -25 \text{ mm}$$

The image will 25mm high.

26. Given,

$f = -20 \text{ cm}$

$m = -1/4$

ATQ,

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

So,

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

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

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

$$\Rightarrow -100 = 4v$$

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

$$\therefore u = 4v$$

$$\Rightarrow u = 4 \times (-25) = -100 \text{ cm}$$

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

Case 1,

$$27. \quad v = -50 \text{ cm}$$

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

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

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

$$\Rightarrow u = -25 \text{ cm}$$

Now,

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

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

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

$$\Rightarrow \frac{-2-1}{50} = -\frac{3}{50} = \frac{1}{f}$$

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

Case 2,

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

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

~~no other~~

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

$$\Rightarrow f \frac{1}{5} = \frac{fv}{u}$$

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

$$5v = u$$

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

now,

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

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

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

$$\Rightarrow -3u = \text{~~600~~ } 300$$

$$\Rightarrow u = 300 / -3 = -100 \text{ cm}$$

Q 28) Given,

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

$$f = -12 \text{ cm}$$

ATQ,

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

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

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

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

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

$$\Rightarrow \frac{1}{v} = \frac{-5+3}{60} = \frac{-2}{60}$$

$$\Rightarrow v = \frac{\cancel{60}}{-2} = -30 \text{ cm}$$

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

b) $u = -4 \text{ cm}$

$$f = -12 \text{ cm}$$

ATQ,

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

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

$$\Rightarrow \frac{1}{v} = -\frac{1}{12} + \frac{1}{4} = \frac{-1+3}{12} = \frac{2}{12} = \frac{1}{6}$$

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

So the image will be formed 60cm behind the mirror.

The nature is virtual and erect.

29. Given,

$$h' = -10\text{cm} = -10\text{mm}$$

$$h = 2.5\text{m}$$

$$u = -5\text{cm} = -50\text{mm}$$

ATQ,

$$m = \frac{h'}{h}$$

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

now,

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

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

$$\Rightarrow 200\text{mm} = -v$$

$$\Rightarrow v = -200\text{m}$$

$$\Rightarrow v = 200\text{m}$$

And,

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

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

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

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

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

30) $R = -60 \text{ cm}$

$$f = -30 \text{ cm}$$

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

ATA,

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

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

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

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

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

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

now,

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

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

$$\Rightarrow m = 2$$

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