

19. $h_1 = 10 \text{ cm}$

$u = 36 \text{ cm}$

$f = 12 \text{ cm}$

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

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

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

$v = -18 \text{ cm}$

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

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

$h_2 = 5 \text{ cm}$

real & inverted

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

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

$3u = -v$

$v = -3u$

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

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

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

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

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

$$14. u = -15 \text{ cm}$$

$$v = 10 \text{ cm}$$

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

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

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

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

f of the concave mirror = 6

$$15. \Rightarrow m = \frac{h_2}{h_1} = \frac{4.5}{3} = 1.5$$

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

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

$$v = 15 \times 8 = 12 \text{ cm}$$

We have

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

$$\frac{1}{12} + \frac{1}{-8} = \frac{1}{f} \quad f = -24$$



ii) $v = 12 \text{ cm}$

16. $h_2 = 4 \text{ cm}$
 $h_1 = 1 \text{ cm}$
 $u_2 = 20 \text{ cm}$

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

$\Rightarrow \frac{-4}{1} = \frac{-v}{20}$
 $v = 80 \text{ cm}$

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

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

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

$f = -16 \text{ cm}$

17. $h_1 = 7$
 $u_1 = 27$
 $f = 18 \text{ cm}$

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

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

$v = -54 \text{ cm}$

$$h_2 = +4 \text{ cm}$$

$$18. \quad \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

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

$$v = 20$$

$$m = 6 \text{ cm}$$

$$h_2 = 6 \text{ cm}$$

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

$$u = 9 \text{ cm}$$

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

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

$$v = -7.2 \text{ cm}$$

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

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

20. a) We know that

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

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

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

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

$$\frac{1}{(-60)} + \frac{1}{(-20)} = \frac{1}{f} \quad f = -15 \text{ cm}$$

b) $m = \frac{v}{u}$

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

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

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

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

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

$$v = -600 \text{ cm}$$

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

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

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

height of image = 15 cm

24. $m = 3$

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

$R = ?$

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

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

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

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

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

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

Radius of curvature = $2(-15) = -30 \text{ cm}$

21. A dentist's mirror has a radius of curvature of 3 cm. How far must it be placed from a small mirror?

$$S:- R = -3 \text{ cm}$$

$$m = 5$$

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

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

We have

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

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

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

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

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

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

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

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

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

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

$$25. \quad \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

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

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

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

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

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

Image height will be 25 mm height.

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

$$u = 4v$$

$$u = 4(-25)$$

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

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

$$u = 4v$$

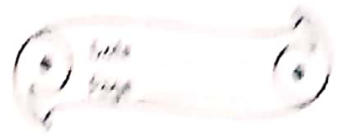
so

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

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

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

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



21. Case 1:

$$u = 50 \text{ cm}$$

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

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

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

$$v = 25$$

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

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

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

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

Case 2:

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

$$f = \frac{50}{2} \text{ cm}$$

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

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

Now

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

$$\frac{5}{u} + \frac{1}{u} = \frac{-3}{50}$$
$$\frac{6}{u} = \frac{-3}{50}$$

Qr.

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

$f = -12 \text{ cm}$

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

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

$v = -30 \text{ cm}$

b) $u = -4 \text{ cm}; f = -12 \text{ cm}$

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

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

$v = 6 \text{ cm}$

29.

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

$m = \frac{-10}{20}$

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

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

$v = -200 \text{ mm}$

$v = -20 \text{ cm}$

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

$$\frac{1}{f} = \frac{-20}{100}$$

$f = -4 \text{ cm}$

$$30. \quad \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

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

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

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

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

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

$$m = 2$$