PAGE 255

Q1.
(a) Convex lens (since image is real, inverted and diminished).
(b) Concave lens (since image is virtual, erect and diminished).
Q2.
When an object is placed at a very large distance from a diverging lens, then image is formed at the focus of the lens.
Therefore, the focal length of the lens is 20 cm.

PAGE 256
Q3.

$u = -4\,cm$

$f = -12\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

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

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

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

$v = -3\,cm$

Image is formed 3 cm infront of the concave lens.

Image is virtual and erect.

Q4.

$f = -15\,cm$

$v = -10\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

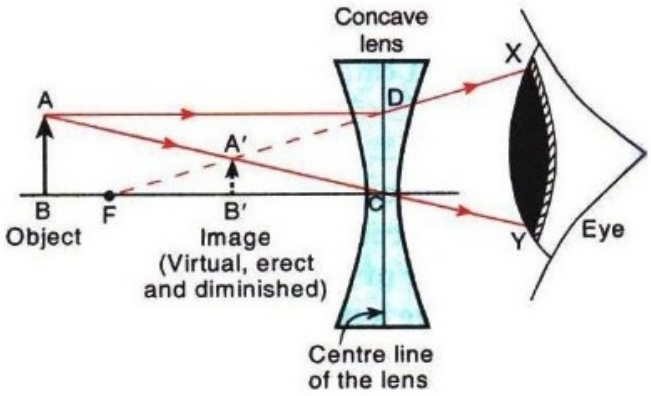
$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-15}$

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

$\frac{1}{u} = \frac{-2}{60}$

$u = -30\,cm$

Object is at 30 cm from the concave lens (on left side).



Here, OB=30cm
OF=15cm
OB'=10cm

Q5.

$u = -60\,cm$

$v = -20\,cm$ (Virtual image)

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

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

$= \frac{-2}{60}$

$f = -30\,cm$

The lens is diverging because the focal length is negative.

Q6.

$f = -20\,cm$

$v = -15\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

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

$\frac{1}{u} = -\frac{1}{15} + \frac{1}{20}$

$\frac{1}{u} = \frac{-1}{60}$

$u = -60\,cm$

Object distance is 60 cm towards the left of the lens.

Q7.

$f = -15\,cm$

$v = -10\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

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

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

$\frac{1}{u} = \frac{-1}{30}$

$u = -30\,cm$

Object should be placed at a distance of 60 cm on the left side of the lens.

$m = \frac{v}{u} = \frac{-10}{-30} = +0.33$

Q8.

$v = ?$

$h_1 = 12\,mm = 0.012\,m$

$u = -0.20\,m$

$f = -0.30\,m$

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

$\frac{1}{v} - \frac{1}{-0.20} = \frac{1}{-0.30}$

$\frac{1}{v} = \frac{-1}{0.30} - \frac{1}{0.20}$

$v = -0.12\,m$

Image is virtual and erect.

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

$\frac{h_2}{0.012} = \frac{-0.12}{-0.20}$

$h_2 = 0.0072\,m = 7.2\,mm$

Image is 7.2 mm high.

Q9.

$f = -20\,cm$

$h_1 = 5\,cm$

$v = -15\,cm$ (Concave lens forms virtual image)

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

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

$\frac{1}{u} = -\frac{1}{15} + \frac{1}{20}$

$\frac{1}{u} = \frac{-1}{60}$

$u = -60\,cm$

Object should be placed 60 cm to the left of the lens.

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

$\frac{-15}{-60} = \frac{h_2}{5}$

$h_2 = 1.25\,cm$

Image formed is 1.25 cm high.

Q10.

$u = -20\,cm$

(a) f=15 cm (for converging lens)

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

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

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

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

$$v = 60\,cm$$

$$m = \frac{v}{u} = \frac{60}{-20} = -3$$

(b) f=-15 cm (for diverging lens)

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

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

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

$$\frac{1}{v} = \frac{-7}{60}$$

$$v = -8.57\,cm$$

$$m = \frac{-v}{u} = \frac{-8.57}{-20} = +0.42$$

Q11.

$$h_1 = 2\,cm$$

$$u = -40\,cm$$

$$f = -15\,cm$$

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

$$\frac{1}{v} - \frac{1}{-40} = \frac{1}{-15}$$

$$\frac{1}{v} = -\frac{1}{15} - \frac{1}{40}$$

$$\frac{1}{v} = \frac{-11}{120}$$

$$v = -10.90\,cm$$

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

$$\frac{-10.90}{-40} = \frac{h_2}{2}$$

$$h_2 = 0.54\,cm$$

Q12.

(a) $h_1 = 2cm$

$u = -20cm$

(i) f=-40cm (Diverging lens)

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

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{-40}$$

$$\frac{1}{v} = -\frac{1}{40} - \frac{1}{20}$$

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

$$v = -13.33cm$$

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

$$\frac{-13.33}{-20} = \frac{h_2}{2}$$

$$h_2 = 1.33cm$$

(ii) f=40 cm (Diverging lens)

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

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{40}$$

$$\frac{1}{v} = \frac{1}{40} - \frac{1}{20}$$

$$\frac{1}{v} = \frac{-1}{40}$$

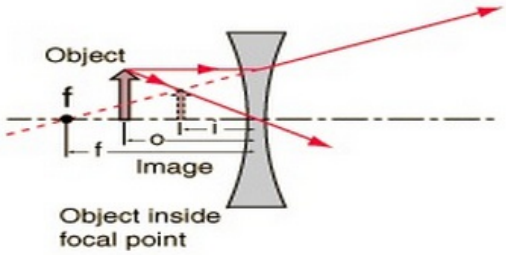
$$v = -40cm$$

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

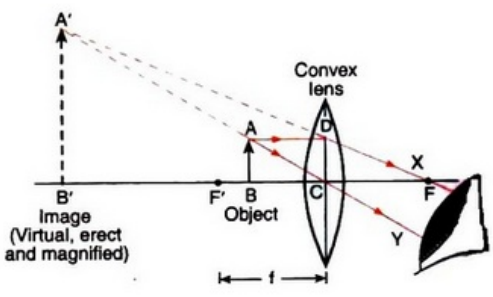
$$\frac{-40}{-20} = \frac{h_2}{2}$$

$$h_2 = 4cm$$

(b) Formation of image in case (i):

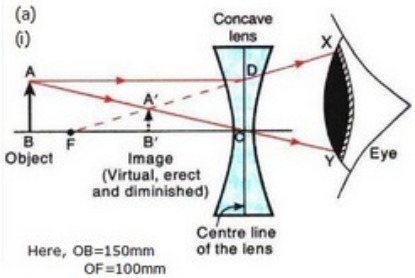


Formation of image in case (ii):



Q13.

(a)
(i)



Here, OB=150mm
OF=100mm

(ii) u=-150mm
f=-100mm

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

$$\frac{1}{v}-\frac{1}{-150}=\frac{1}{-100}$$

$$\frac{1}{v}=-\frac{1}{100}-\frac{1}{150}$$

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

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

(b) u=-150mm
f=100mm

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

$$\frac{1}{v}-\frac{1}{-150}=\frac{1}{100}$$

$$\frac{1}{v}=\frac{1}{100}-\frac{1}{150}$$

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

$$v=+300\text{mm}$$

The image formed by converging lens is real, inverted and magnified (2 times). It is formed behind the converging lens. On the other hand, the image formed by diverging lens is virtual, erect and diminished. It is formed in front of the diverging lens.

PAGE 257

Q18.

(a) u=-20 cm=-200 mm
f=50 mm

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

$$\frac{1}{v}-\frac{1}{-200}=\frac{1}{50}$$

$$\frac{1}{v}=\frac{1}{50}-\frac{1}{200}$$

$$\frac{1}{v}=\frac{3}{200}$$

$$v=66.6\text{ mm}=6.66\text{ cm}$$

The film should be at a distance of 6.66 cm behind the camera lens.

(b) $d_1=5\text{cm}=50\text{ mm}$

$$m=\frac{v}{u}=\frac{d_2}{d_1}$$

$$\frac{66.6}{-200}=\frac{d_2}{50}$$

$$d_2=16.65\text{mm}=1.66\text{ cm}$$

(c) It is a convex lens.

Q19.

$$u = -2\,m$$

$$m = +\frac{1}{4}\ (\text{Erect image})$$

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

$$\frac{1}{4} = \frac{v}{-2}$$

$$v = -0.5\,m$$

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

$$\frac{1}{-0.5} - \frac{1}{-2} = \frac{1}{f}$$

$$f = -0.666\,m = -66.6\,cm$$

It is a concave lens.

Q20.

(a) Since the image is formed on a screen, it must be a real image.
Hence, the lens should be a convex lens.
(b) m=-3 (Real and inverted image)
-u+v=80cm

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

$$-3 = \frac{80+u}{u}$$

$$-3u = 80+u$$

$$u = -20\,cm$$

$$v = 80+u = 80+(-20) = 60\,cm$$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

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

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

$$f = +15\,cm$$

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