Homework

Q1. The image of a needle placed at 45cm from a lens is formed on a screen placed 90cm on the other side of the lens. Find the displacement of the image if the object is moved 5cm away from the lens. Also, find the power of the lens.

ans- Initially, $u = -45\text{cm}$

$v = 90\text{cm}$

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

$\Rightarrow \frac{1}{90} + \frac{1}{45} = \frac{1}{f}$

$\Rightarrow \frac{1}{f} = \frac{3}{90} = \frac{1}{30}$

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

New, $u = -45 - 5 = -50\text{cm}$

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{30} - \frac{1}{50} = \frac{5-3}{150} = \frac{2}{150} = \frac{1}{75}$

$\Rightarrow v = 75\text{cm}$

$\therefore$ displacement of image = $90 - 75 = 15\text{cm}$ towards lens

$P = \frac{100}{30} = \frac{10}{3}\,D = 3.33\,D$

Q2. A lens of power +3D and another of power −1.5D are placed in contact. Will the combination be convergent or divergent? Also find the focal length and power of the combination.

ans- $P = P_1 + P_2$

$\Rightarrow P = 3D - 1.5D$

$= +1.5D$

$\therefore P = \frac{1}{f}$

$\Rightarrow f = \frac{1}{P} = \frac{1}{1.5} = \frac{10}{15} = \frac{2}{3}m = \frac{200}{3}$

$= +66.66cm$

since, focal length is positive, the combination will be convergent.

Q3. Find the nature and focal length of a lens which must be placed in contact with a concave lens of focal length 0.25m in order that the lens combination may produce a real image 5 times the size of the object 0.2m from the combination.

ans- Let, f_1 be the focal length of the lens.

f_2 be the focal length of the concave lens

F = Combined focal length

$u = -0.2m$

$m = -5$

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

$\Rightarrow v = (-5) \times (-0.2) = 1m$

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

$$\Rightarrow 1 - \left(\frac{-10}{2}\right) = \frac{1}{F}$$

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

$$\Rightarrow F = \frac{1}{6}m$$

We know,

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\Rightarrow \frac{1}{1/6} = \frac{1}{f_1} - \frac{1}{25/100} \Rightarrow \frac{1}{f_1} = \frac{100}{25} = \frac{1}{f_1} = 4$$

$$\Rightarrow \frac{1}{f_1} = 6 + 4 = 10$$

$$\Rightarrow f_1 = \frac{1}{10} = 0.1m$$

Since, f_1 is (+ve), nature of lens is convex

Q4. You are provided with lenses of powers +10 D, +5 D, −5 D, −20 D, and −10 D. Taking a pair of lenses at a time, which two lenses would you select to have a combination of total focal length when the two lenses are kept in contact. In each case: 1. 20cm, 2. − 10cm, 3. − 20cm, 4. ∞ 20/3 cm

ans − case-1 → 20cm

$f = 20\text{cm}$

$\Rightarrow f = \frac{20}{100} = \frac{1}{5}\text{ m}$

$P = \frac{1}{f} = 5\text{ D}$

∴ To obtain a combined power of 5D, we can select lenses having powers +10D and −5D.

case-2 → −10cm

$f = -10\text{cm} = \left(\frac{10}{100}\right)\text{m} = -\frac{1}{10}\text{ m}$

$P = \frac{1}{f} = -10\text{ D}$

∴ To obtain a combined power of −10D, we can select lenses having powers (−20D) and (+10D).

case-3 → −20cm

$f = -20\text{cm} = -\left(\frac{20}{100}\right)\text{m} = -\frac{1}{5}\text{ m}$

$P = \frac{1}{f} = -5\text{ D}$

∴ To obtain a combined power of (−5D), we can select lenses having powers, (−10D) and (+5D)

Case-4 → 20/3 cm

$$f = \frac{20}{3}\text{cm} = \left(\frac{20}{300}\right)\text{m} = \frac{1}{15}\text{m}$$

$$P = \frac{1}{f} = 15\text{D}$$

∴ To obtain a combined power of 15D, we can select lenses having powers (+10D) and (+5D).