H.W

Home Assignment

Q1. The image of a needle placed at 4cm from a lens is formed on a screen placed 90 cm on the other side of the lens. Find the displacement of the image, if the object is moved 5 cm away from the lens. Also, find the power of the lens.

Ans Given; Object distance, $u = -4$ cm

Image distance, $v = 90$ cm

Using lens formula

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

$$\Rightarrow \frac{1}{f} = \frac{1}{90} + \frac{1}{4}$$

$$\Rightarrow \frac{1}{f} = \frac{2+45}{180} \quad \Rightarrow \frac{1}{f} = \frac{47}{180} = 0.26 \text{ cm}$$

When the needle is move 5 cm away from the lens,

$$u = -(4+5) = -9 \text{ cm}$$

$$\therefore \frac{1}{v'} = \frac{1}{f} + \frac{1}{u'} = \frac{47}{180} + \frac{1}{(-9)}$$

$$= \frac{47}{180} - \frac{1}{9} = \frac{47-20}{180} = \frac{27}{180} = \frac{3}{20}$$

$$v' = \frac{20}{3} = 6.66 \text{ cm}$$

∴ So, the displacement of image = $v - v'$

$= 90 - 6.66$

$= 83.34$ cm

towards the lens.

Power (D) $= \frac{100}{0.26} = \frac{10000}{26} = 384.61$.

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

Ans Power of the first lens = +3 D

Power of the second lens = −1.5 D

Power of the combination of lens,

$P = P_1 + P_2$

$= 3 - 1.5$

$= +1.5$ D

Focal length, $f = \frac{1}{P}$

$f = \frac{1}{1.5} = \frac{10}{15} = 0.66$ m $= 66.66$ cm

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

Ans Let the focal length of 1st Lens $= f_1$
focal length of 2nd lens be $= f_2$

ATQ $f_2 = -0.25\ m = -25\ cm$

Given, $m = -5$ and $u = -20\ cm$

$\Rightarrow \frac{V}{u} = -5 \Rightarrow \frac{V}{-20} = -5 \Rightarrow V = 100\ cm$

Using Lens Formula

$$\frac{1}{f'} = \frac{1}{V} - \frac{1}{u} = \frac{1}{100} - \frac{1}{-20} = \frac{1}{100} + \frac{1}{20} = \frac{1+5}{100}$$

$$= \frac{6}{100}$$

$\Rightarrow f' = \frac{100}{6}\ cm$

Combination of lens

$$\frac{1}{f'} = \frac{1}{f_1} + \frac{1}{f_2}$$

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

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

$\Rightarrow \frac{1}{f_1} = \frac{6+4}{100} = \frac{10}{100} = \frac{1}{10}$

$\Rightarrow f_1 = 10\ cm$

The focal length = 10 cm and it is a convex lens.

Q4. You are provided with lenses of powers +10D, +5D, -5D, -20D, and -10D. Taking a pair of lenses at a time, which two lenses will 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. $\frac{20}{3}$ cm.

Ans Total power, $P = P_1 + P_2$.

Focal length $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

(i) When lenses of 10D and -5D are taken,

Power $P = P_1 + P_2$

$= 10D - 5D = 5D$

focal length $= \frac{100}{5} = 20\ cm$

(ii) When lenses of 10D and -20D are taken

$P = 10D - 20D$

$= -10D$

Focal length $= \frac{100}{-10} = -10\ cm$

(iii) When lenses of powers +6D and -10D are taken

$P = -5D$

$f = \frac{100}{-5}$

$f = -20\ cm$

(iv) When lenses of 10D and 5D are taken

$P = 15D$

$f = \frac{100}{15} = \frac{20}{3}\ cm.$