HW

Home Assignment

Q1. The image of a needle placed at 4cm 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- Given, object distance, $u = 4cm$

Image distance, $V = 90cm$

Using lens formula,

$$\frac{1}{f} = \frac{1}{V} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{90} + \frac{1}{4} = \frac{2+45}{180}$$

$$\Rightarrow \frac{1}{f} = \frac{47}{180} = 0.26\ cm.$$

When the needle is move 5cm away from the lens, $u = -(4+5) = -9cm.$

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

$$= \frac{47-20}{180} \Rightarrow V' = \frac{20}{3} = 6.66cm.$$

so, the displacement of image $= V - V'$

$= 90 - 6.666$

$= 83.34cm$

towards the lens.

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

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

Ans- Power of the first lens (P_1) = +3D

Power of the second lens (P_2) = -1.5 D

Power of the combination of lens,

$P = P_1 + P_2 = 3 - 1.5 = +1.5$ D

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

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

3. Find the nature and 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- $F_2 = -0.25$ & $m = -25$ cm

Given, $m = -5$ & $u = -20$ cm

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

Using lens formula,

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

$$= \frac{1+5}{100} = \frac{6}{100}$$

$$\Rightarrow f' = \frac{100}{6} \text{ m.}$$

combination of lens,

$$\frac{1}{f'} = \frac{1}{f_1} + \frac{1}{f_2} \Rightarrow \frac{6}{100} = \frac{1}{f_1} + \frac{1}{-25}$$

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

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

$$\Rightarrow f_1 = 10 \text{ cm.}$$

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

Q4. You are provided with lenses of power +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 two lenses ~~are~~ are kept in contact in each case 1. 20 cm, 2. −10 cm, 3. −20 cm, 4. $\frac{20}{3}$ cm.

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

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

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

Power $P = P_1 + P_2 = 10D - 5D = 5D$

Focal length $= \frac{100}{6} = 20\,cm.$

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

$P = 10D - 20D = -10D$

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

(iii) When lenses of ~~power~~ of +6D and -10D are taken.

$P = -5D$, $f = \frac{100}{-5} = -20\,cm.$

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

$P = 15D$

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