

Q1) The image of a needle placed at 45 cm from a lens is formed on a screen placed 90 cm from 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.

$$u_1 = -45 \text{ cm}$$

$$v_1 = 90 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{v_1} + \frac{1}{u_1}$$

$$\Rightarrow \frac{1}{f} = \frac{1}{90 \text{ cm}} - \frac{1}{45 \text{ cm}} = \frac{1 + 2}{90 \text{ cm}} =$$

$$= \frac{3}{90} \text{ cm}^{-1} = \frac{1}{30} \text{ cm}^{-1}$$

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

$$u_2 = (-45 - 5) \text{ cm} = -50 \text{ cm}$$

$$\frac{1}{v_2} = \frac{1}{f} + \frac{1}{u_2}$$

$$\frac{1}{v_2} = \frac{1}{30} - \frac{1}{-50} \text{ cm} = \frac{-5+9}{150} =$$

$$\frac{1}{v_2} = \frac{1}{30} + \frac{1}{-50} \text{ cm} = \frac{5-3}{150} \text{ cm} = \frac{2}{150} \text{ cm} = \frac{1}{75} \text{ cm}$$

$$\Rightarrow v_2 = 75 \text{ cm}$$

Displacement of image from the lens (v_2) = 75 cm

Power of the lens.

$$P = \frac{1}{f} = \frac{1}{30 \text{ cm}} = \frac{100 \text{ m}}{30} = \frac{10 \text{ m}}{3} = +3.3 \text{ D}$$

(Q8) 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.

Power of lens₁ = +3D

$$\Rightarrow f_1 = \frac{1}{3} \text{ m}$$

Power of lens₂ = -1.5D

$$\Rightarrow f_2 = \frac{100-15}{10} \text{ m} = -\frac{10 \text{ m}}{15} = -\frac{2}{3}$$

$$F = \frac{f_1 f_2}{f_1 + f_2} = \frac{\frac{1}{3} \text{ m} \times -\frac{2}{3} \text{ m}}{\frac{1}{3} \text{ m} + -\frac{2}{3} \text{ m}} = \frac{-\frac{2}{9} \text{ m}^2}{-\frac{1}{3} \text{ m}} = 2 \times -\frac{2}{3}$$

$$= \frac{2}{3} \text{ m.}$$

∴ Power of the combination = $\frac{1}{F}$
 $= \frac{3}{2} \text{ m} = \frac{3}{2} \text{ D.}$

∴ $f_1 > f_2$

∴ convergence will be less. or we can say that ~~it~~ it will be a ~~div~~ divergent combination.

Q3) Find the nature and focal length of a lens which must be placed in contact with a concave ~~lens~~ 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. Let the f_1 be the focal length of lens and f_2 be the focal length of the concave lens.

$$f_2 = 0.25 \text{ m}$$

$$u = 0.2 \text{ m}$$

$$m = -5$$

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

$$\Rightarrow v = -0.2 \text{ m} \times 5 = 1 \text{ m.}$$

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

$$\Rightarrow 1 - \left(-\frac{10}{2}\right) = \frac{1}{F} \Rightarrow F = \frac{1}{6} \text{ m}$$

We know that,

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

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

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

$$\Rightarrow P_1 = \frac{1}{10} \text{ m} = 0.1 \text{ m}$$

∴ 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. 20/3cm.

(i) Total power $P = P_1 + P_2$

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

$$\text{Let } P_1 = 10\text{D} \text{ \& } P_2 = 5\text{D}$$

$$P = P_1 + P_2 = 10\text{D} - 5\text{D} = 5\text{D}$$

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

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

$$P = 10D - 20D$$

$$= -10D$$

$$\text{focal length} = \frac{100}{-10} = -10 \text{ cm}$$

(iii) when lenses of +5D and -10D

$$P = -5D$$

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

$$F = -20 \text{ cm.}$$

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

$$P = 15D$$

$$F = \frac{100}{15} = \frac{20}{3} \text{ cm}$$