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.

$u_1 = -45\,cm$

$v_1 = 90\,cm$

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

$\Rightarrow \frac{1}{f} = \frac{1}{90\,cm} - \frac{1}{-45\,cm} = \frac{1+2}{90\,cm} = \frac{3}{90}\,cm^{-1} = \frac{1}{30}\,cm^{-1}$

$\Rightarrow f = 30\,cm$

$u_2 = (-45-5)\,cm = -50\,cm$

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

$$\frac{1}{v_2} = \frac{1}{30} - \frac{1}{-50} \text{ cm} = \frac{-5+9}{150} = \frac{4}{150}$$

$$\frac{1}{v_2} = \frac{1}{20} + \frac{1}{-50} \text{ cm} = \frac{5-3}{150} \text{ cm} = \frac{2}{150} \text{ cm} = \frac{1}{76} \text{ cm}$$

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

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

Power of the lens.

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

(Q8) A lens of power +3D 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.

Power of $\text{lens}_1 = +3\text{D}$

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

Power of $\text{lens}_2 = -1.5\text{D}$

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

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

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

Power of the combination $= \frac{1}{f}$

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

$\because f_1 > f_2$

$\therefore$ convergence will be less. or we can say that it will be a divergent combination.

Q3) 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 may produce a real image 5 times the size of the object 0.2 m from the combination. Let the f_1 be the focal length of lens and f_2 be the focal length of the concave lens.

$f_2 = 0.25$ m

$u = 0.2$ m

$m = -5$

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

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

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

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

We know that.

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

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

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

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

∴ 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:
a. 20cm b. -10cm c. -20cm d. 20/3cm.

(a) $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$ where $f = 20\,cm = \frac{20}{100}\,m = \frac{1}{5}\,m$

let $f_1 = 10\,m$

$\Rightarrow$ 6 cm =

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

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

Let $P_1 = 10D$ & $P_2 = 5D$

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

Hence, 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 +5D and -10D

$P = -5D$

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

$F = -20\,cm.$

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

$P = 15D$

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