1) The image of a needle placed at 45 cm 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.

$u = -45\ cm$

$v = 90\ cm$

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

$$= \frac{1}{90} + \frac{1}{45} = \frac{1}{30}$$

$f = 30\ cm$

When needle is moved away from 5 cm

$u = -(45 + 5)$

$= -50\ cm$

$$\frac{1}{v'} = \frac{1}{f} + \frac{1}{u'} = \frac{1}{30} + \frac{1}{-50}$$

$$\frac{2}{150} = \frac{1}{75cm}$$

$v' = 75cm$

Displacement $= v - v'$

$90 - 75 = 15cm$, towards lens

Power of the lens :-

2) A lens of power $+3D$ & 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 the first lens $= +3D$

Power of the second lens $= -1.5D$

Power of the combination of lens,

$P = P_1 + P_2$

$= 3 - 1.5$

$= +1.5D$

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

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

$$= 66.6\,cm$$

3) 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

Let the focal length of 1st lens $= f_1$

focal length of 2nd lens $= f_2$

ATQ $f_2 = -0.25 = -2.5\,cm$

Given,

$m = -5$

$u = -20$

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

$\frac{v}{-20} = -5 \Rightarrow v = 100\,cm$

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

$$= \frac{1}{100} - \frac{1}{-20} = \frac{1-(-5)}{100} = \frac{6}{100}$$

Combination of lens

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

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

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

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

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

4) You are provided with lenses of power +10 D, +5 D, −5 D, −20 D & −10 D. 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 kept in contact. In each case, P.

i) 20 cm

ii) −10 cm

iii) −20 cm

iv) $\frac{20}{3}$ cm

Total power = $P = P_1 + P_2$

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

i) when lenses of 10 D & −5 D are taken,

Power = $P = P_1 + P_2$

$= 10D - 5D$

$= 5D$

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

ii) when lenses of 10D & −20 D are taken

$P = 10D - 20D$

$= -10D$

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

iii) When lenses of power +6D & −10D are taken

P = 10D − 20D
= −10D

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

iv) when lenses of

P = −5D

f = $\frac{100}{-5}$ = −20 cm

iv) When lenses of 10D & 5D are taken

P = 15 D

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