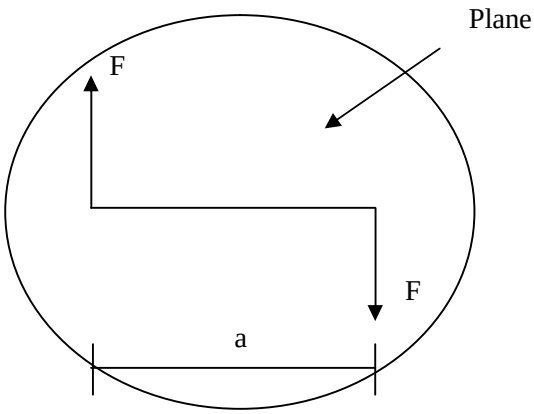
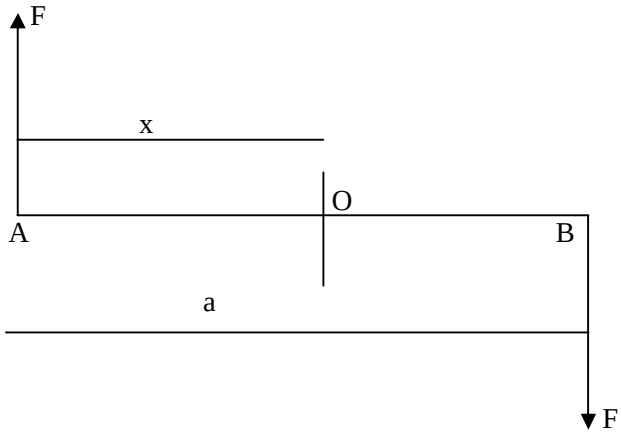
Couple:



Two forces F and –F having the same magnitude , parallel lines of action and opposite sense one said to form a couple.

-Couple has a tendency to rotate the body

-The perpendicular distance between the parallel forces is called arm of the couple.



Here OA = x; OB = (a-x)

Sum of moments at A

$\sum m_A$=F× $a()$

Sum of moments at B

$\sum m_B$=F× a

Sum of moments at o

$\sum m_o = (F \times x) + (F \times (a - x))$

$= F \times x + F \times a - F \times x$

$\sum m_o = Fa$ ()

The sum of the moments of couple forces about any point is same magnitude and nature.

Moment of a couple = Force × Arm of the couple

m=F×a

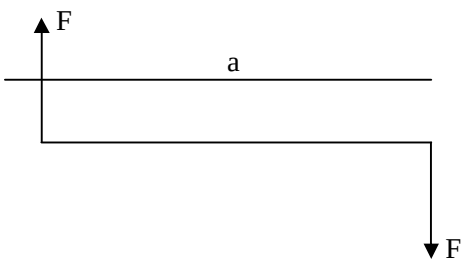
Difference between moment and couple

The couple is a pure turning effect which may be moved anywhere in its own plane or into a parallel plane without change of its effect of the body, but the moment of a force must include a description of the reference axis about which the moment is taken.

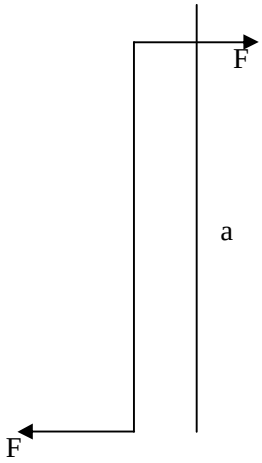
Types of Couple:

Based on its nature

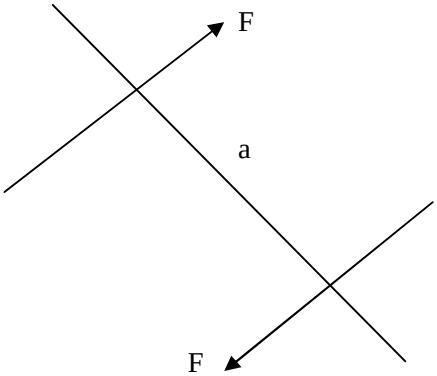
(i) Clockwise couple
(ii) Anticlockwise couple



Vertical

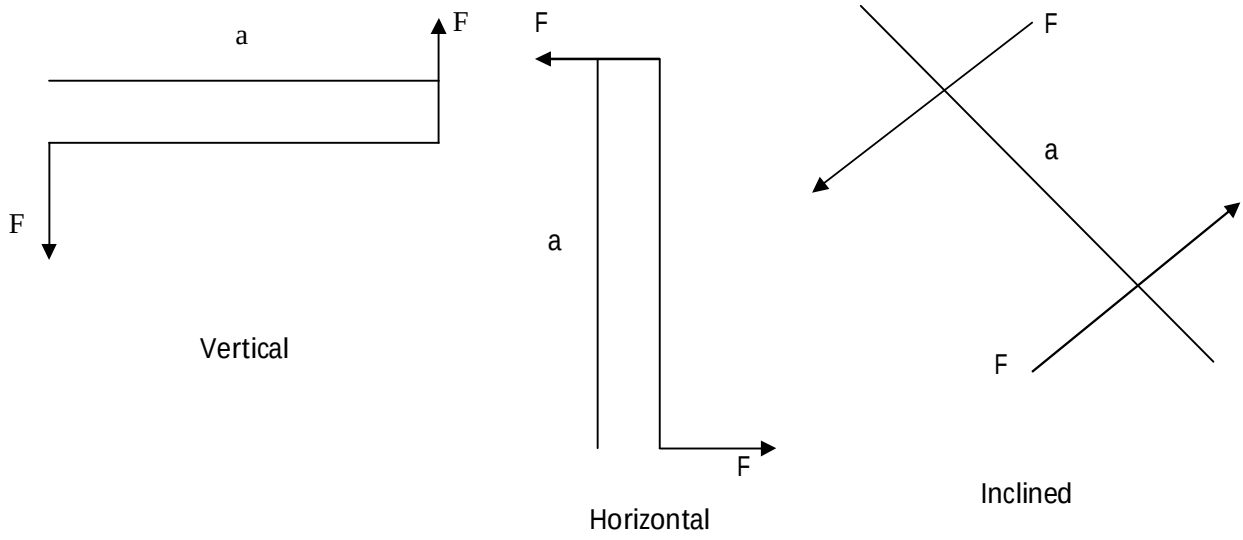


Horizontal



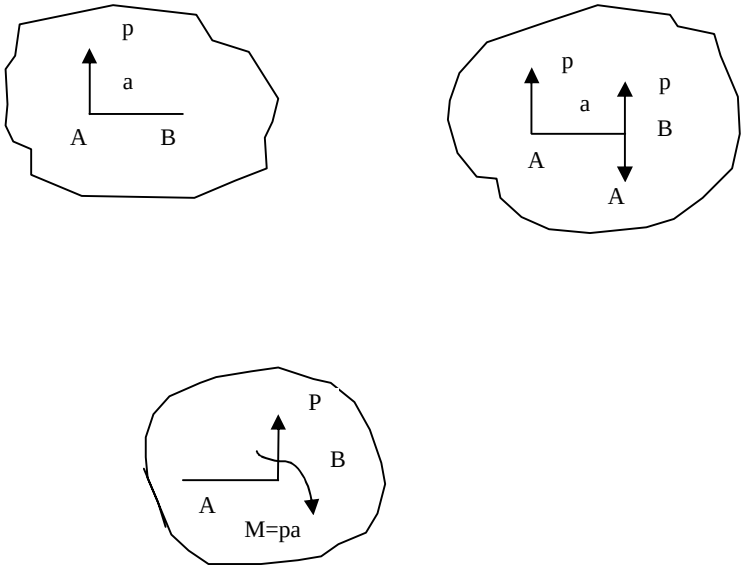
Inclined

Clockwise couple



Anticlockwise couple

Resolution of a force into a force and a couple at a point



Principle of transmissibility of forces

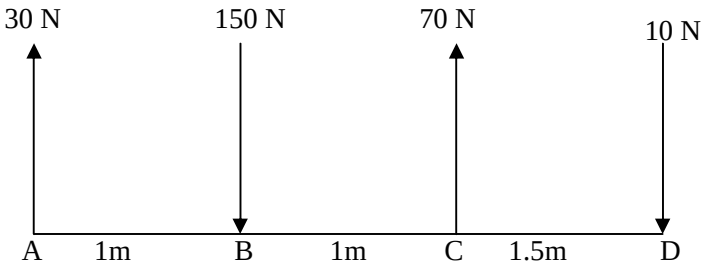
If a force acts at any point on a rigid body it may also be considered to act at any other point on its line of action.

Problem 6:

A system of parallel forces are acting on rigid bar as shown in fig. Reduce the system to

(i) A single force
(ii) A single force and a couple at A

(iii) A single force and a couple at B.



Solution:

(i) Single force system

The single force system will consist only resultant force.

Magnitude of resultant force R = 30-150+70-10

R=-60N

Direction of Resultant: Vertical & Downwards (as R in negative)

Location of Resultant force

Sum of all moments about A $\sum m_A = R \times x$

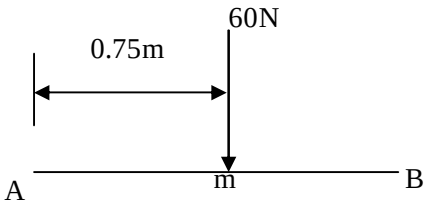
$$\sum m_A = (30 \times 0) + (150 \times 1) - (70 \times 2) + (10 \times 3.5)$$

$$\sum m_A = 45\ Nm\ (Clockwise)$$

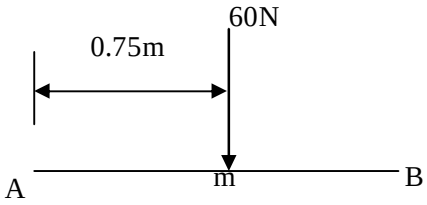
$$\sum m_A = R \times x$$

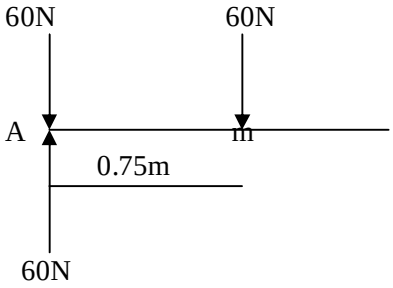
$$45 = 60 \times x$$

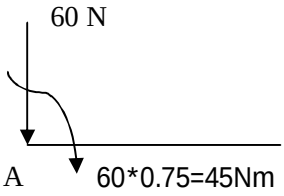
$$x = 0.75m$$



(ii) A Single force and a couple at A

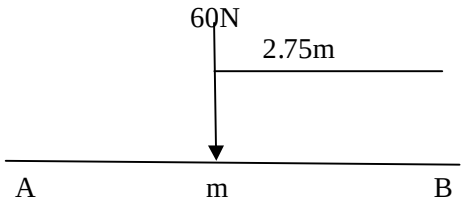


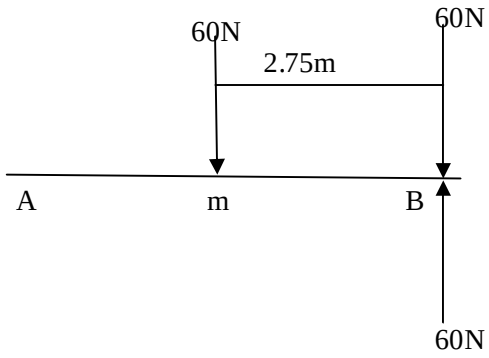


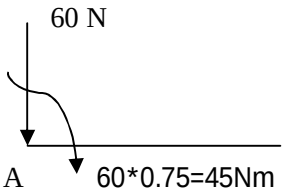


Clockwise couple

(iii) <u>A single force and a couple at B</u>





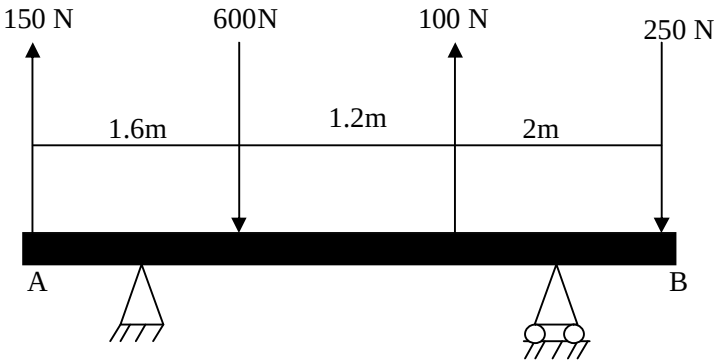


Anticlockwise couple

Problem 7:

A 4.8m beam is subjected to the forces shown in fig. Reduce the given system of forces to

(i) A single force
(ii) An equivalent force –couple system at A
(iii) Force couple system at B.



Solution:

(i) A single force (or Resultant force)

Magnitude of Resultant, R = 150-600+100-250

= -600N

Direction of Resultant force: Vertically downwards (R is (-))

Location of Resultant force

Algebric sum of moments of all forces $\sum m_A = (150 \times 0) + (600 \times 1.6) - (100 \times 2.8) + 250(1.6 + 1.2 + 2)$

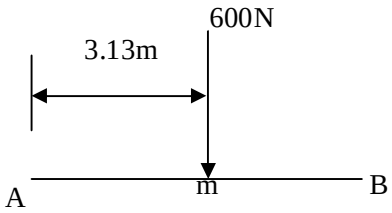
$= 1880$ Nm (Clockwise)

Sum of moments about A = moment of Resultant force about A

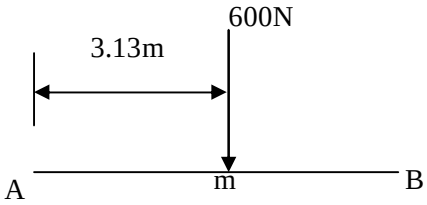
$1880 = R \times x$

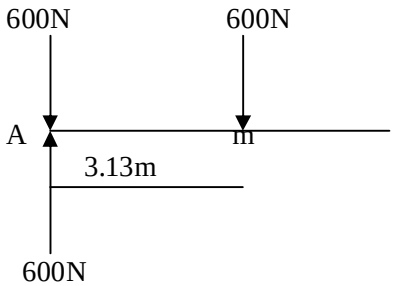
$1880 = 600 \times x$

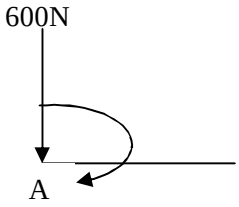
$x = 3.13m$



(ii) Force -Couple system at A

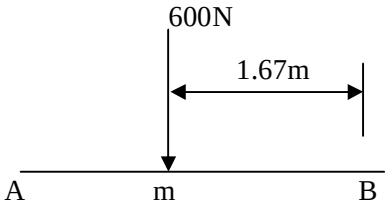


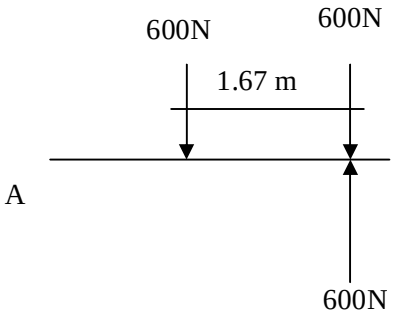


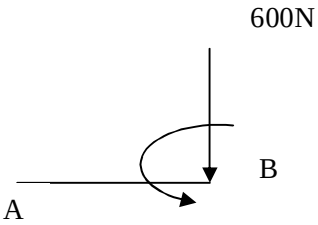


60X3.13=1878Nm

(iii) Force – Couple system at B







600X1.67=*1002Nm*