# Examples

## Moment of a Couple

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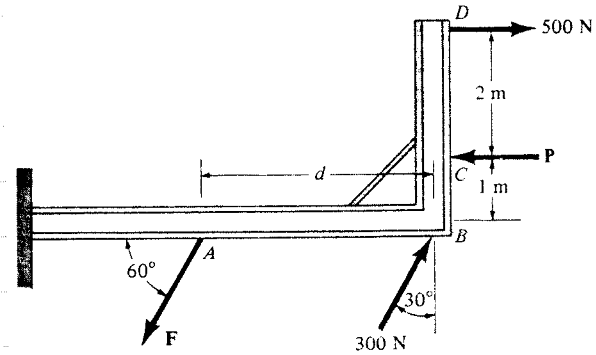
### Example 1:




Given :

The two couples which act on the beam shown. The resultant couple is zero.

Req.d. :

a) The forces P and F

b) The distance d

Soln. :

a) Since the two are couples, then, the forces have to be equal and opposite. ⇒

$\boxed{P = 500 \text{ N}}$ in the direction shown

$\boxed{F = 300 \text{ N}}$ " " " "

b) To have the resultant couple equal to zero, then

$$M_P + M_F = 0$$

$$M_P = -500(2) = -1000 \text{ N.m} = 1000 \text{ N.m} \circlearrowright$$

$$M_F = F_x y + F_y x$$
$$= 300 \sin 30^\circ (0) + 300 \cos 30^\circ (d)$$
$$= 259.8\, d \circlearrowleft$$

$$\Sigma M = 0 \Rightarrow -1000 + 259.8\, d = 0$$

$$\Rightarrow \boxed{d = 3.85 \text{ m}}$$

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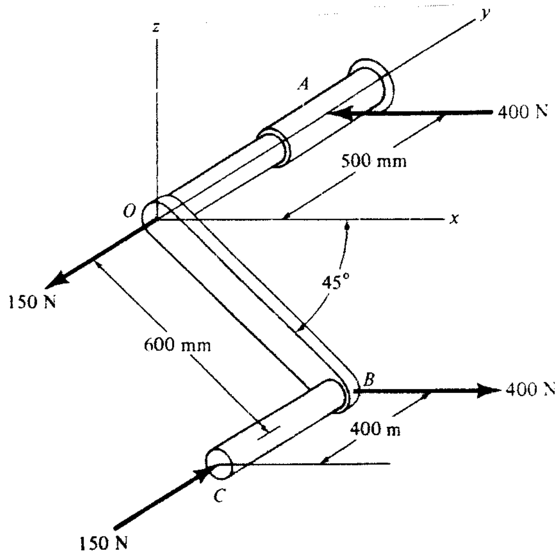
## Example 2 :

Given :

The two couples that act on the assembly shown

Member OB lies in the x-z plane




Req'd. :

The resultant couple

Sol'n. :

Vector analysis :

$F = 400$ N

$\vec{F}_B = 400\,\vec{i}$ (N)

$\vec{r}_{AB} = (B - A) = (600 \cos 45^\circ - 0)\vec{i} + (0 - 500)\vec{j} + (-600 \sin 45^\circ - 0)\vec{k}$

$= 423.3\,\vec{i} - 500\,\vec{j} - 423.3\,\vec{k}$

$$\vec{M}_A = \vec{r}_{AB} \times \vec{F}_B = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 424.3 & -500 & -424.3 \\ 400 & 0 & 0 \end{vmatrix} = 0\vec{i} - 169.7\,\vec{j} + 200\,\vec{k}$$

Note : You may choose $\vec{F}_A = -400\,\vec{i}$ and $\vec{r}_{BA} = -\vec{r}_{AB}$ ⇒ get the same answer.

$P = 150$ N

$\vec{P}_c = 150\,\vec{j}$ (N)

$\vec{r}_{OB} = 424.3\,\vec{i} + 0\,\vec{j} - 424.3\,\vec{k}$

$$\vec{M}_o = \vec{r}_{OB} \times \vec{P}_c = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 424.3 & 0 & -424.3 \\ 0 & 150 & 0 \end{vmatrix} = 63.645\,\vec{i} - 0\,\vec{j} + 63.645\,\vec{k}$$

Note : Try $\vec{M}_o$ with $\vec{r}_{OC}$ and $\vec{P}_c$ , or $\vec{r}_{BO}$ , $\vec{r}_{CO}$ with $\vec{P}_o = -150\,\vec{j}$ ⇒ the same result

$\vec{M}_R = \vec{M}_A + \vec{M}_o$

$= (0 + 63.645)\vec{i} + (-169.7 + 0)\vec{j} + (200 + 63.645)\vec{k}$ ⇒ $\boxed{\vec{M}_R = 63.6\,\vec{i} - 170\,\vec{j} + 264\,\vec{k} \text{ (N.m)}}$

Scalar analysis :

$M_P = Pd = 150(600) = 90000$ N.mm $= 90$ N.m $= M_o$

$M_{ox} = 90 \cos 45^\circ = 63.64$ N.m

$M_{oz} = 90 \sin 45^\circ = 63.64$ N.m

$M_{oy} = 0$

Note that $M_F$ is not as easy to get it as $M_P$ by scalar analysis → try! → which method is easier ?!