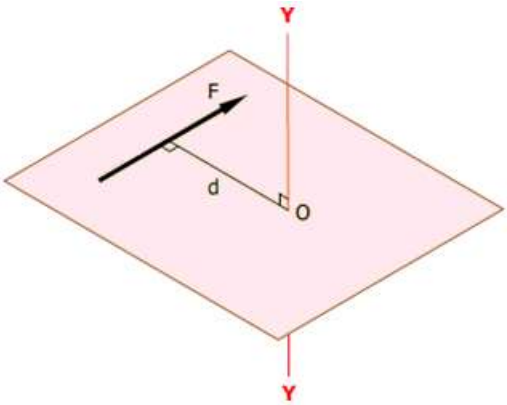
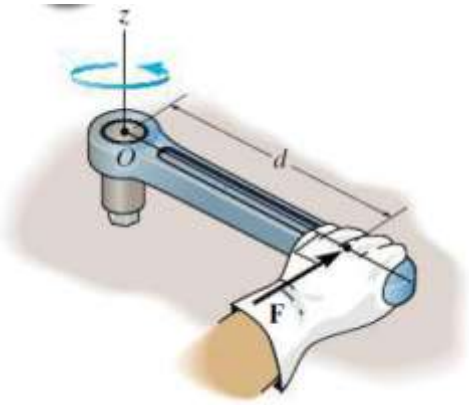
1.3 Moment of a Force

Moment is ability of the force to produce twisting or turning a body about an axis.





$$\boldsymbol{M = F \cdot d}$$

where:

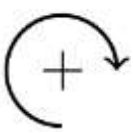
M: The moment of the force (N.m).

F: Applied force (N).

d: is the perpendicular distance from the axis moment to the line of action of the force.

Units: kN.m, N.m, N.mm (1 kN = 1000 N)

Sign Convention:

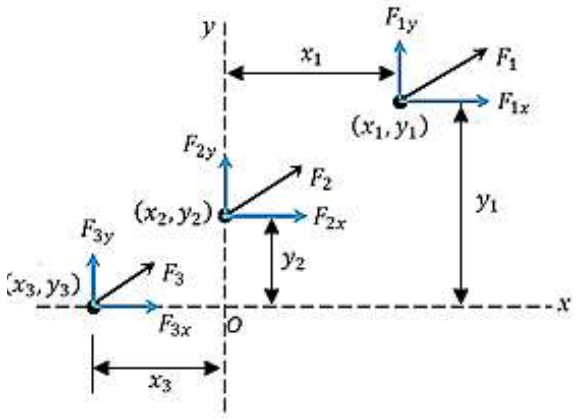


we will be taking clockwise as positive moment

Principle of moments:

The moment of a force with respect to any axis (or point) is equal to the algebraic sum of the moments of its components with respect to the same axis.

$$\boldsymbol{M = \sum F \cdot d}$$

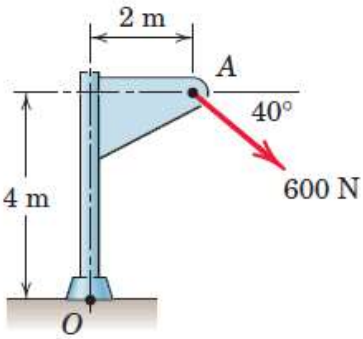


For Example: moment about point O

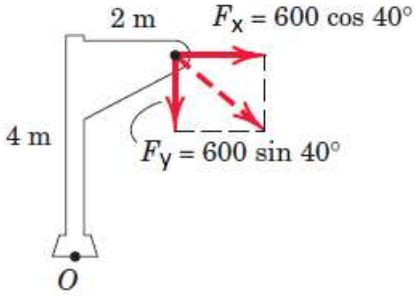
$$\circlearrowleft M_O = \sum F \cdot d$$

$$M_O = F_{1x} \cdot y_1 - F_{1y} \cdot x_1 + F_{2x} \cdot y_2 + F_{3y} \cdot x_3$$

Example No. 1: Calculate the magnitude of the moment about the base point O of the 600-N force.



Solution:



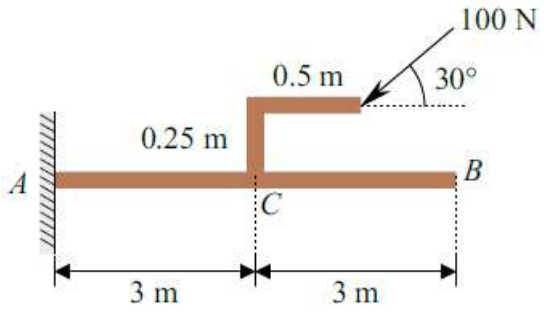
$$F_x = 600 \cos 40 = 460\ N \quad \rightarrow$$

$$F_y = 600 \sin 40 = 386\ N \quad \downarrow$$

$$\circlearrowleft M_o = \sum F \cdot d$$

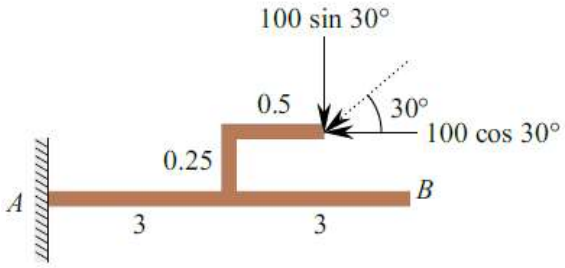
$$M_o = 460 \times 4 + 386 \times 2 = 2610\ N.m \quad \circlearrowleft$$

Example No. 2: Compute the moment of a 100 N force applied on a cantilever beam about the fixed end A as shown in Figure.



Solution:

Resolving the force along x and y directions.

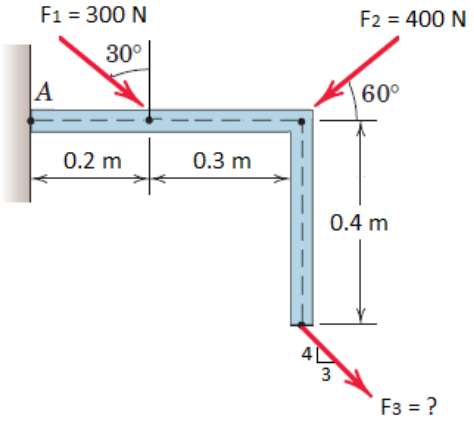


$$\circlearrowleft M_A = \sum F \cdot d$$

$$M_A = 100 \sin 30 \times (3 + 0.5) - 100 \cos 30 \times 0.25$$

$$M_A = 153.35\ N.m \circlearrowleft$$

Example No. 3: If the resultant moment about point A is (480 N.m) clockwise. Determine the magnitude of F_3?



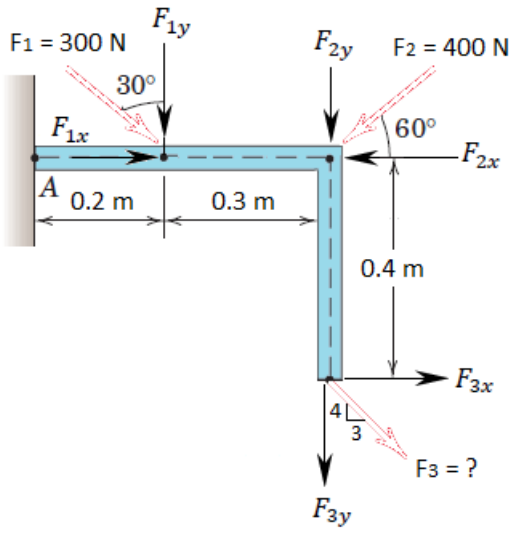
Solution:

$$F_{1x} = 300 \sin 30 = 150\ N \ \rightarrow$$

$$F_{1y} = 300 \cos 30 = 259.88\ N \ \downarrow$$

$F_{2x} = 400 \times \cos 60 = 200\ N \quad \leftarrow$

$F_{2y} = 400 \times \sin 60 = 346.41\ N \quad \downarrow$



$c = \sqrt{3^2 + 4^2} = 5$

$F_{3x} = F_3 \times \frac{3}{5} = 0.6\ F_3\ N \quad \rightarrow$

$F_{3y} = F_3 \times \frac{4}{5} = 0.8\ F_3\ N \quad \downarrow$

$\circlearrowleft M_A = \sum F \cdot d$

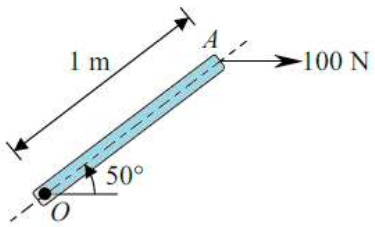
$480 = F_{1y} \times 0.2 + F_{2y} \times 0.5 - F_{3x} \times 0.4 + F_{3y} \times 0.5$

$480 = 259.88 \times 0.2 + 346.41 \times 0.5 - 0.6\ F_3 \times 0.4 + 0.8\ F_3 \times 0.5$

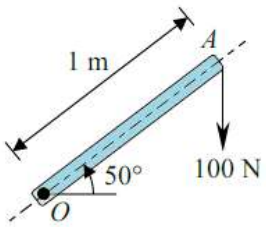
$F_3 = \frac{480 - 225.167}{0.16} = 159.27\ N \quad \searrow$

Problems:

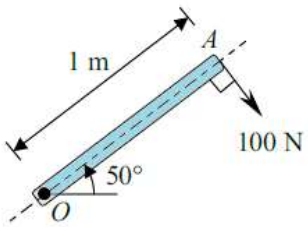
1. Determine the moment of the force about O in each case.



(a)



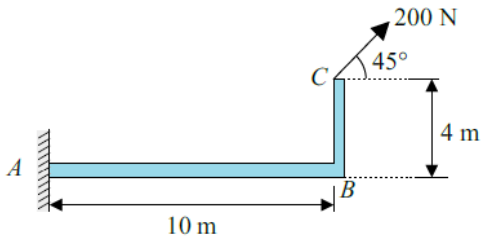
(b)



(c)

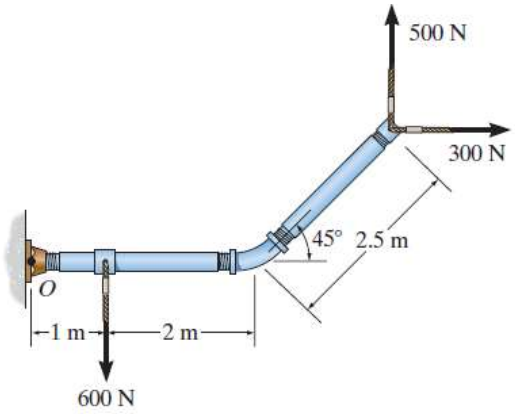
Answer: $(a)\ M_O = 76.6\ N.m \circlearrowright$, $(b)\ M_O = 64.3\ N.m \circlearrowright$, $(c)\ M_O = 100\ N.m \circlearrowright$

2. Compute the moment of a 200 N force applied as shown in Figure, about points A and B.



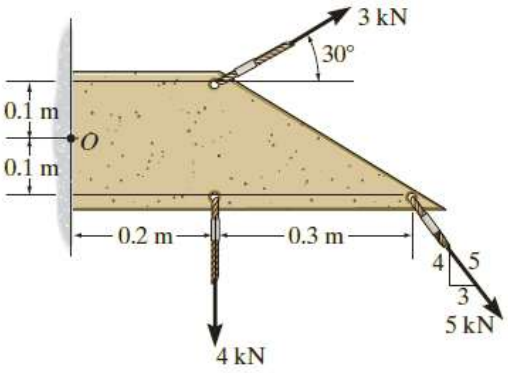
Answer: $M_A = 848.528\ N.m$ ↺ , $M_B = 565.685\ N.m$ ↻

3. Determine the resultant moment produced by the forces about point O.



Answer: $M_O = 1253.55\ N.m$ ↺

4. Determine the moment of the forces about O.



Answer: $M_O = 2.460\ kN.m$ ↺