AL- ESRAA COLLEGE UNIVERSITY

Building & Construction Technology Engineering

Engineering Mechanics

First year

Moment of a force

By

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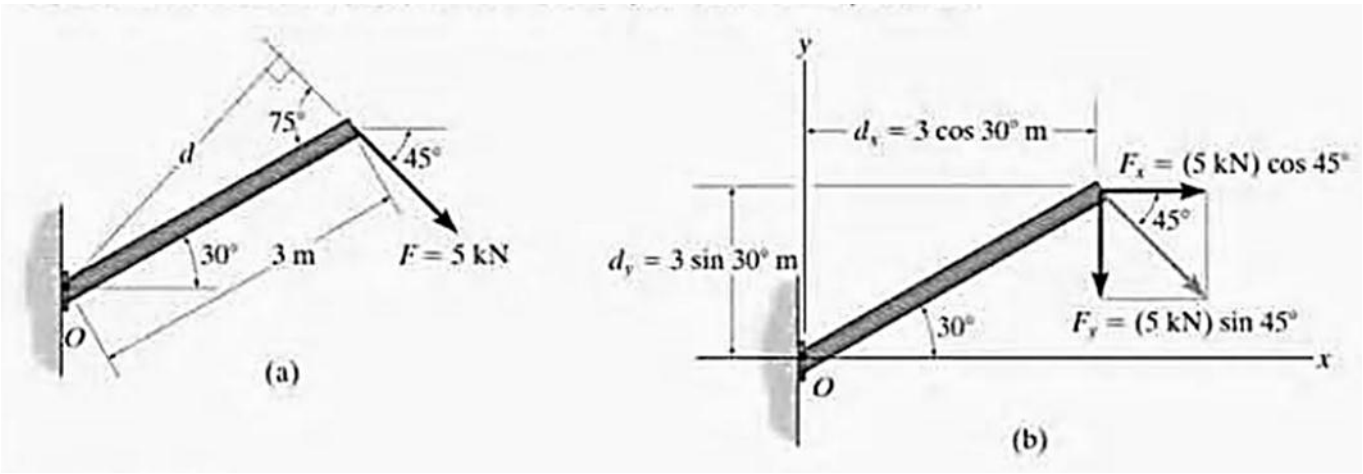
Example: Determine the moment of the force in Figure shown below about point O.



SOLUTION I: the moment arm *d* in Figure **a** can be found from trigonometry

$\sin 75° = \frac{d}{3} \rightarrow d = 3\ sin\, 75° = 2.898\, m$

Assume m+

Thus, $M_o = Fd = (5)(2.898) = 14.5\ kN.m\ +$

Since the force lends to rotate or orbit clockwise about point 0

SOLUTION II: The *x* and *y* components of the force are indicated in Figure **b**. considering counterclockwise moment as positive. m+

$F_x = (5)\cos 45° = 3.54\ kN\ \rightarrow$

$F_Y = (5)\ \sin 45° = 3.54\ kN\ \downarrow$

$\cos 30° = \frac{d_x}{3} \rightarrow d_x = (3)\cos 30° = 2.6\, m$

$\sin 30° = \frac{d_y}{3} \rightarrow d_y = (3)\ \sin 30° = 1.5\, m$

Assume m+

$M_o = F_x dy + F_y dx \rightarrow M_o = (3.54)(1.5) + (3.54)(2.6) = 14.5\ kN.m\ +$

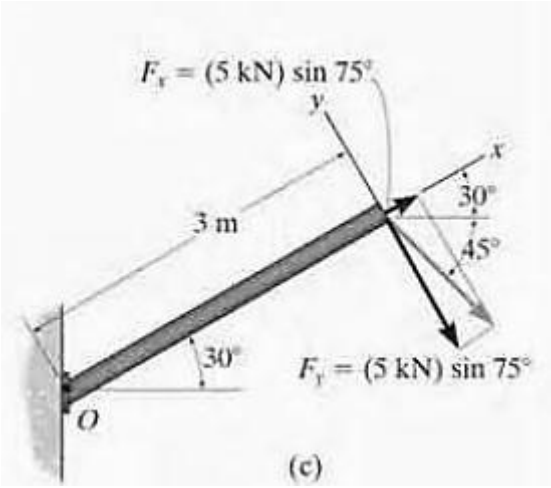
SOLUTION III: The *x* and *y* axes can be set parallel and perpendicular to the rod's axis as shown in Figure C here Fx produces no moment about point O since its line of action passes through this point. Therefore,

Assume m+↻

$F_Y = (5)\ \sin 75° = 4.83\ \text{kN}\ \downarrow$

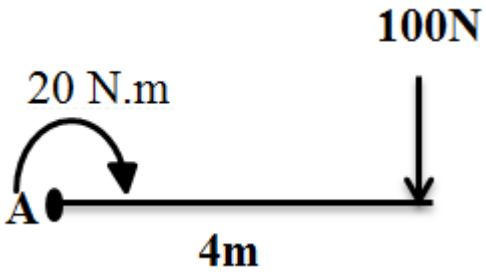
$M_o = F_y dx \rightarrow\ M_o = (4.83)(3) =$

14.5kN.m +↻



Example: Find the moment about A**.**

$M_a = 100(4) + 20.\text{m} = 420\ N.m$ +↻



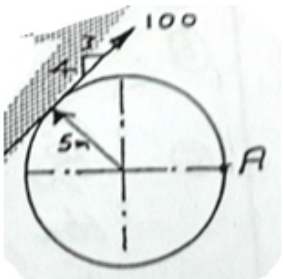
Example: Determine the moment of the force with respect to the point A.

$\frac{y}{5} = \frac{3}{5} \rightarrow y = 3$

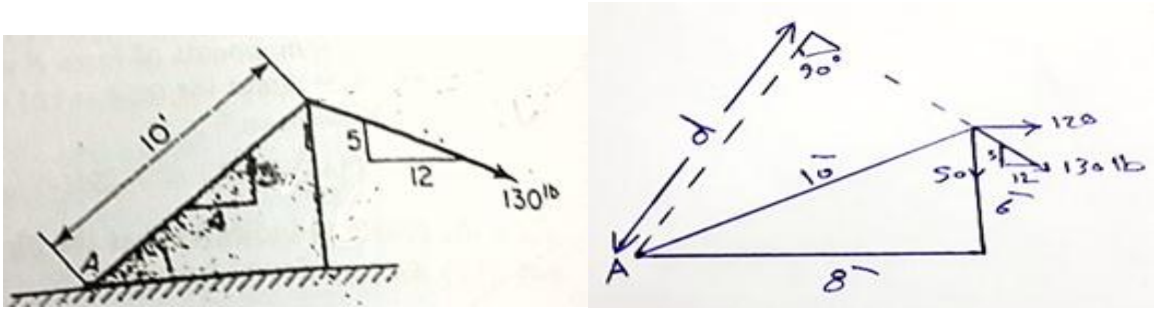
$\frac{x}{5} = \frac{4}{5} \rightarrow x = 4$

$\sum M_A =$ +↻

$M_A = (60).(3) + (80).(4+5) = 900N.m$ +↻



Example: Determine the moment of the force with respect to the point A. Find perpendicular distance (d).

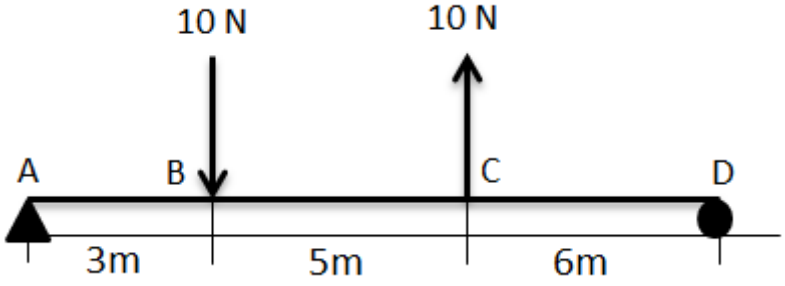


$$\sum M_A = +\circlearrowleft$$

$$M_A = (120)(6) + (50)(8) = 1120\ lb.ft\ +\circlearrowleft$$

$$\text{Distance } d = \frac{M}{F} = \frac{1120}{130} = 8.615\ ft$$

Example: Determine the moment of a couple with respect to: (1) point A, (2) point B, (3) point C. (4) point D.



$$M_{couple} = Fd$$

(1) $+\circlearrowleft M_A = -(10)(3) + (10)(3+5) = 50\ N.m\ \circlearrowright$

(2) $+\circlearrowleft M_B = (10)(5) = 50\ N.m\ \circlearrowright$

(3) $+\circlearrowleft M_C = (10)(5) = 50\ N.m\ \circlearrowright$

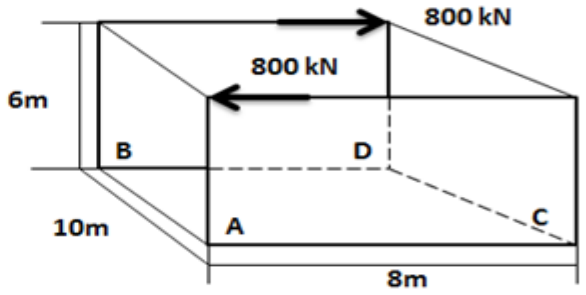
(4) $+\circlearrowleft M_D = (10)(5+6) - (10)(6) = 50\ N.m\ \circlearrowright$

The moment of a couple does not depend on the point one takes the moment about. In other words, a moment of a couple is the same about all points in space.

Example: By means of transformation of a couple, replace the couple shown in figure into an equivalent couple consisting of horizontal forces which act along AB and CD.

$M_{couple} = Fd$

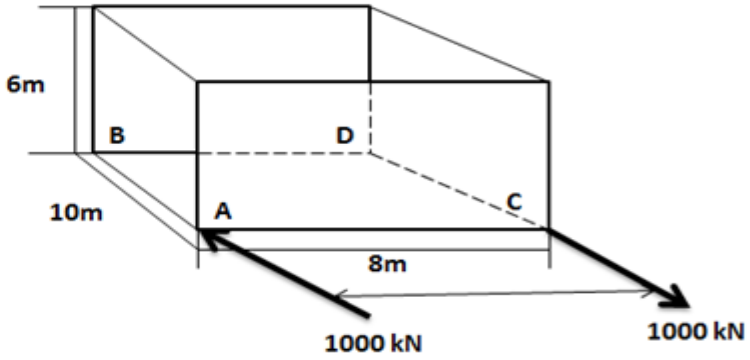
$M = (800)(10) = 8000\ kN.m$ ↺



$M_{couple} = Fd$

$8000 = F\ (8)$

$F = 1000\ kN$



Example: By using the transformation of a couple, replace the three couples shown in figure by one couple with the forces acting horizontally at A and B.

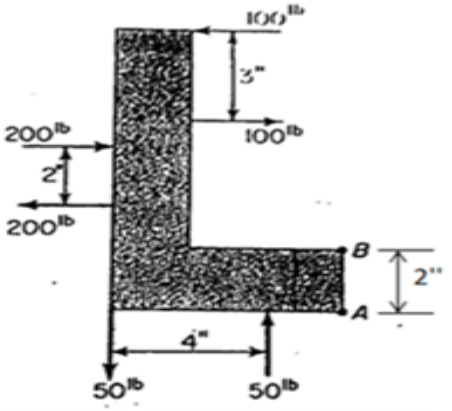
$M_{couple} = Fd$

Assume Σ M +↺

$M = (200)(2) - (100)(3) - (50)(4)$

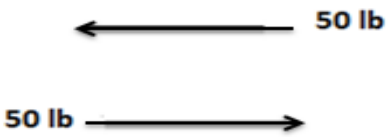
$M = -100\ lb.in$

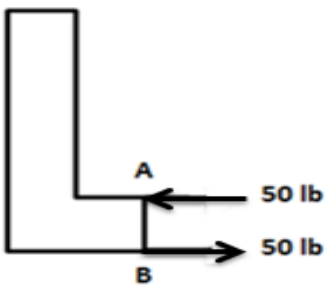
$M = 100\ lb.in$ ↻



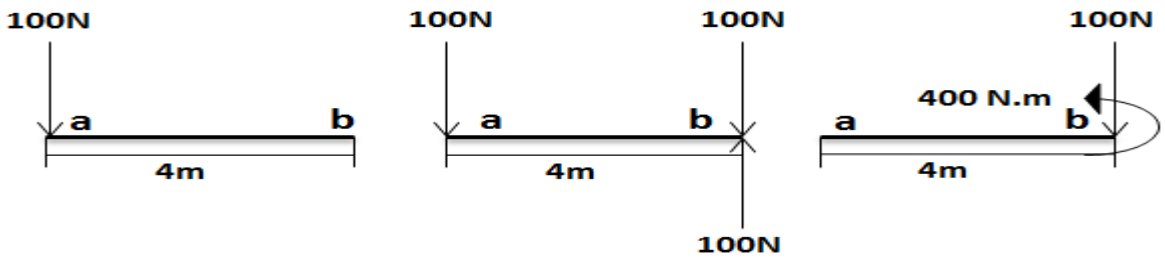
$M_{couple} = Fd$

$100 = F\ (2) \rightarrow F = 50\ lb$





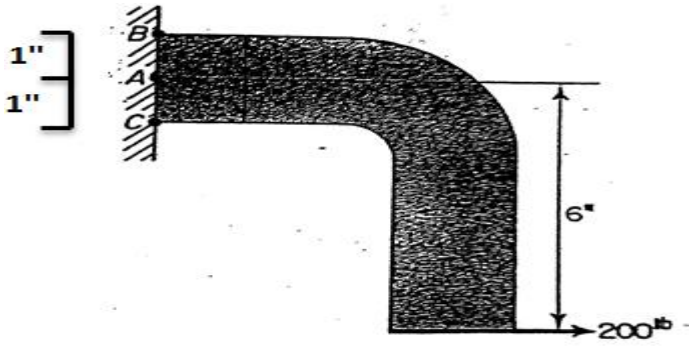
Example: Replace the force 100N by an equivalent force –couple system at point B.



$$M_{couple} = Fd$$

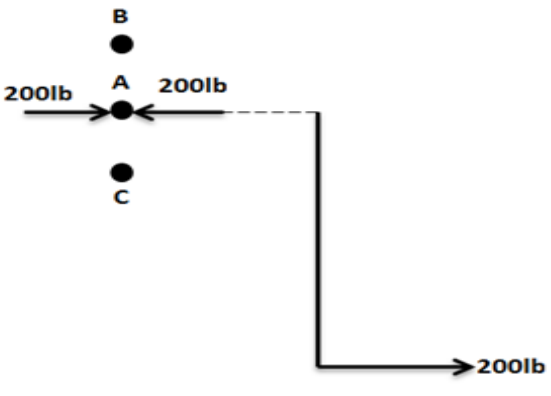
$$M_B = (100)(4) = 400\ N.m$$

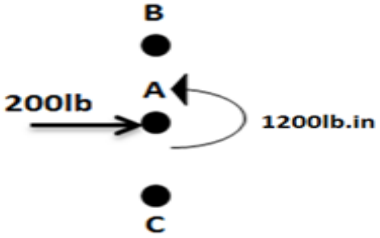
Example: Replace the 600-lb force of figure shown below by a force through A and a couple whose forces act vertically through points B and C.



$$M_{couple} = Fd$$

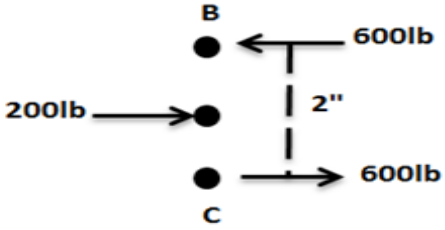
$$M_{couple} = (200)(6) = 1200\ lb.in$$



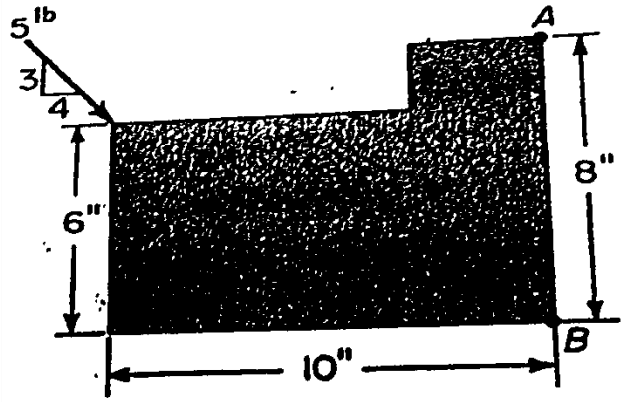


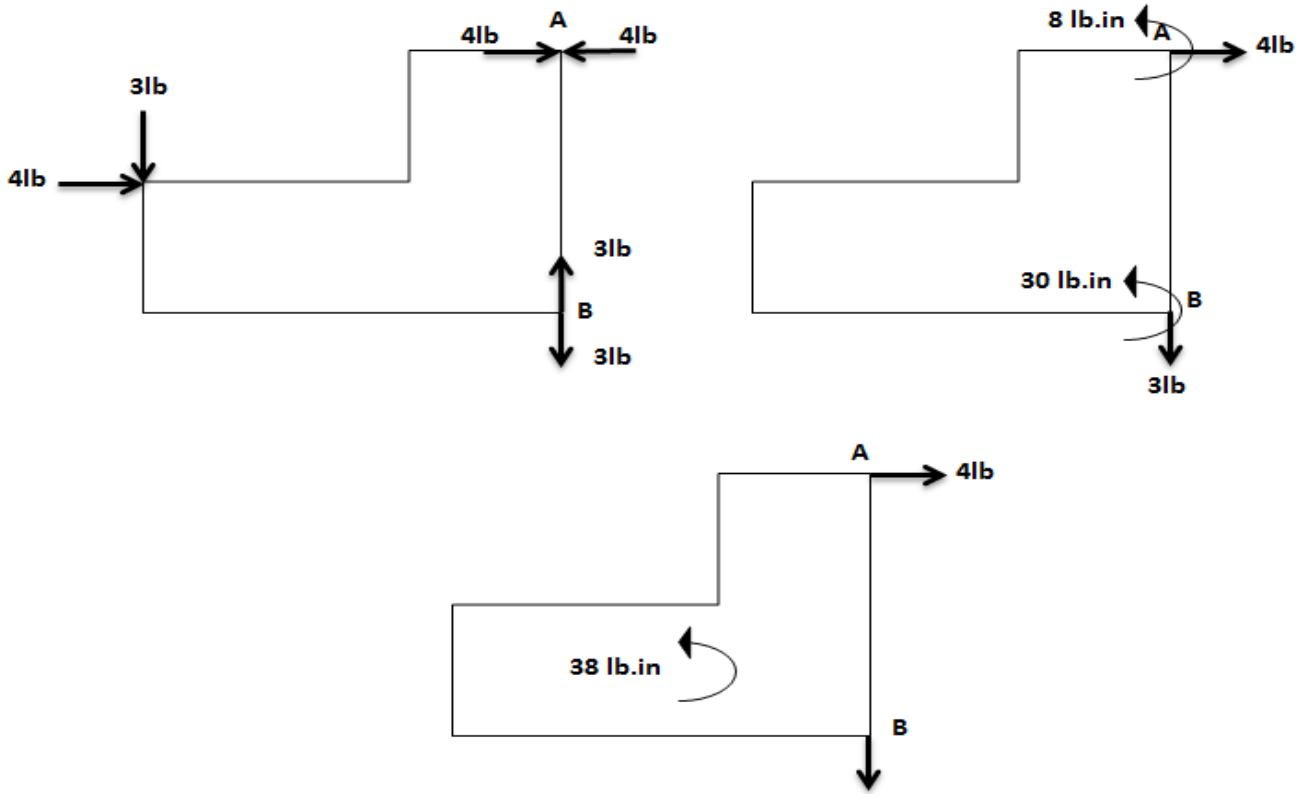
$$M_{couple} = Fd$$

$$1200 = F\ (2) \rightarrow F = 600lb$$



Example: Replace the single force of figure shown below by a horizontal force through A, a vertical force through B, and a couple.





$M_{couple} = Fd$

$M_{couple}@\ A = (4)(2) = 8\ lb.in$

$M_{couple}@\ B = (3)(10) = 30\ lb.in$

$M_{couple}Total = 8 + 30 = 38\ lb.in$