



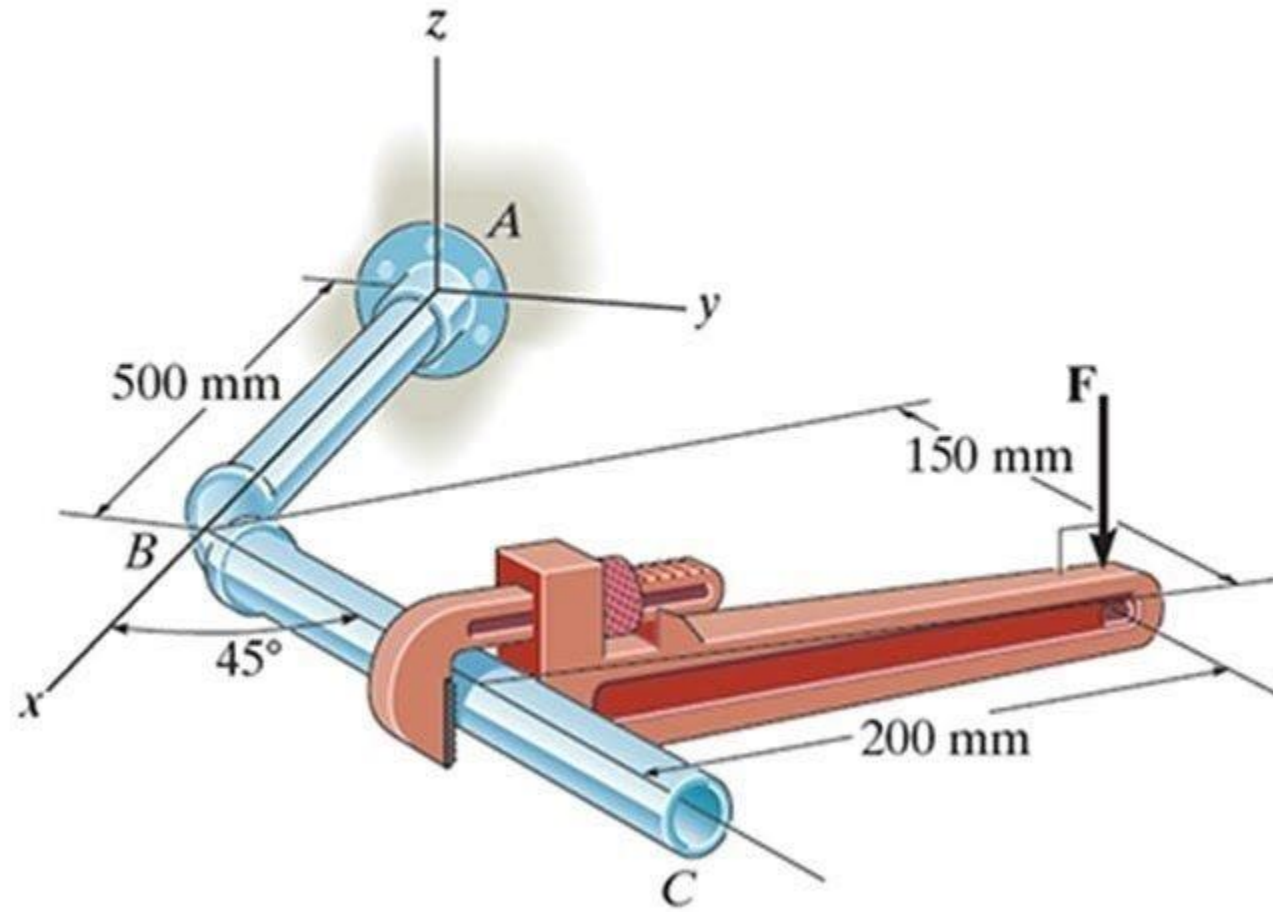
MECHANICS

Lecture No.2

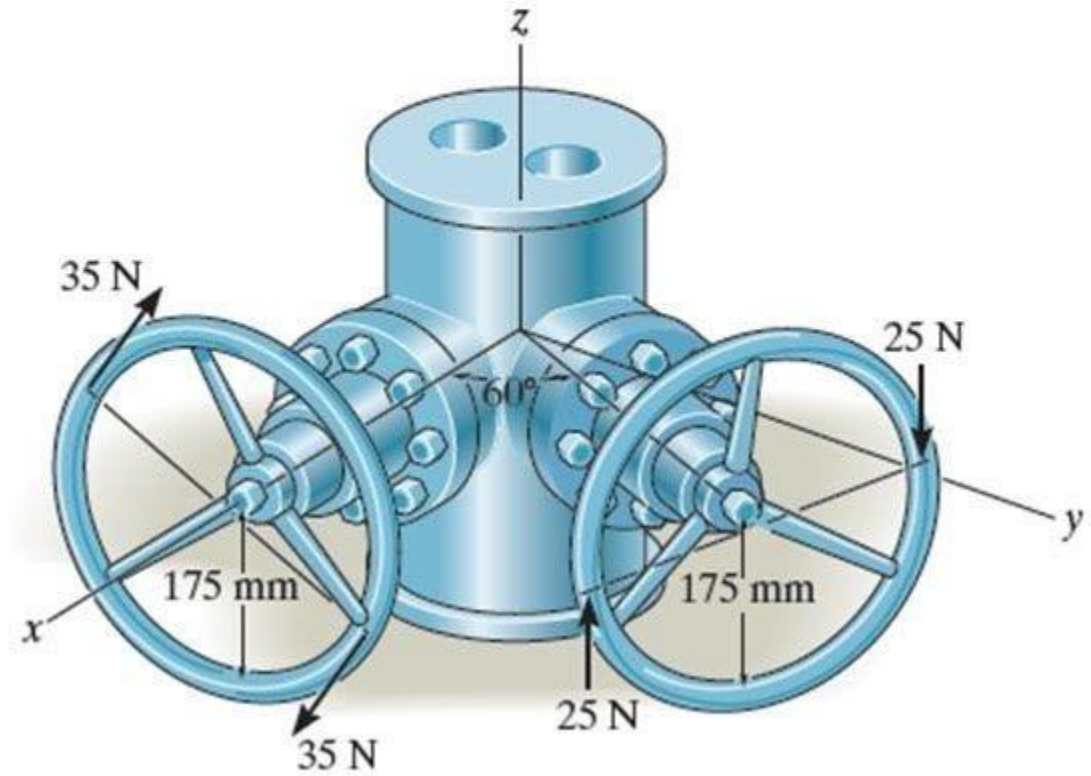
د. محمد سعد

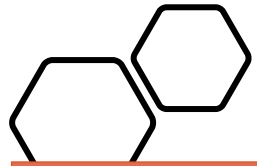


Moment



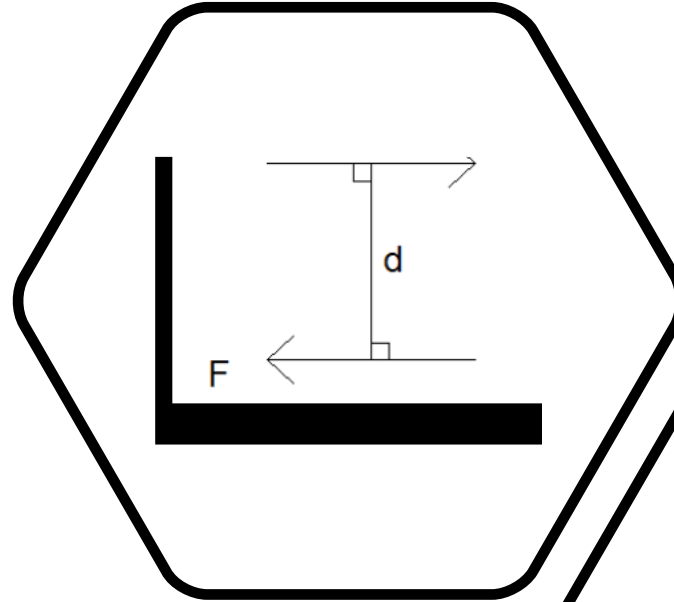
Couple

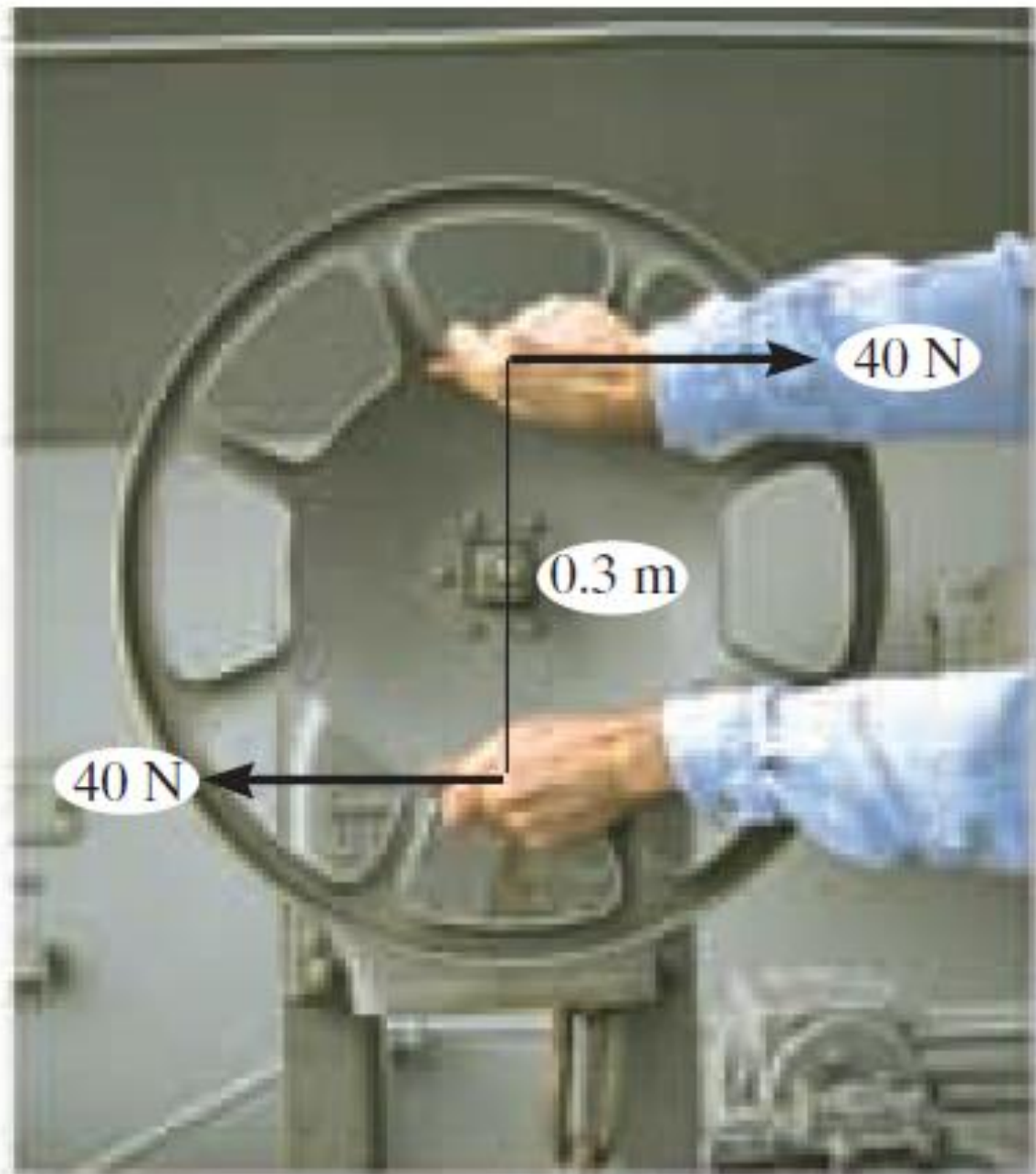
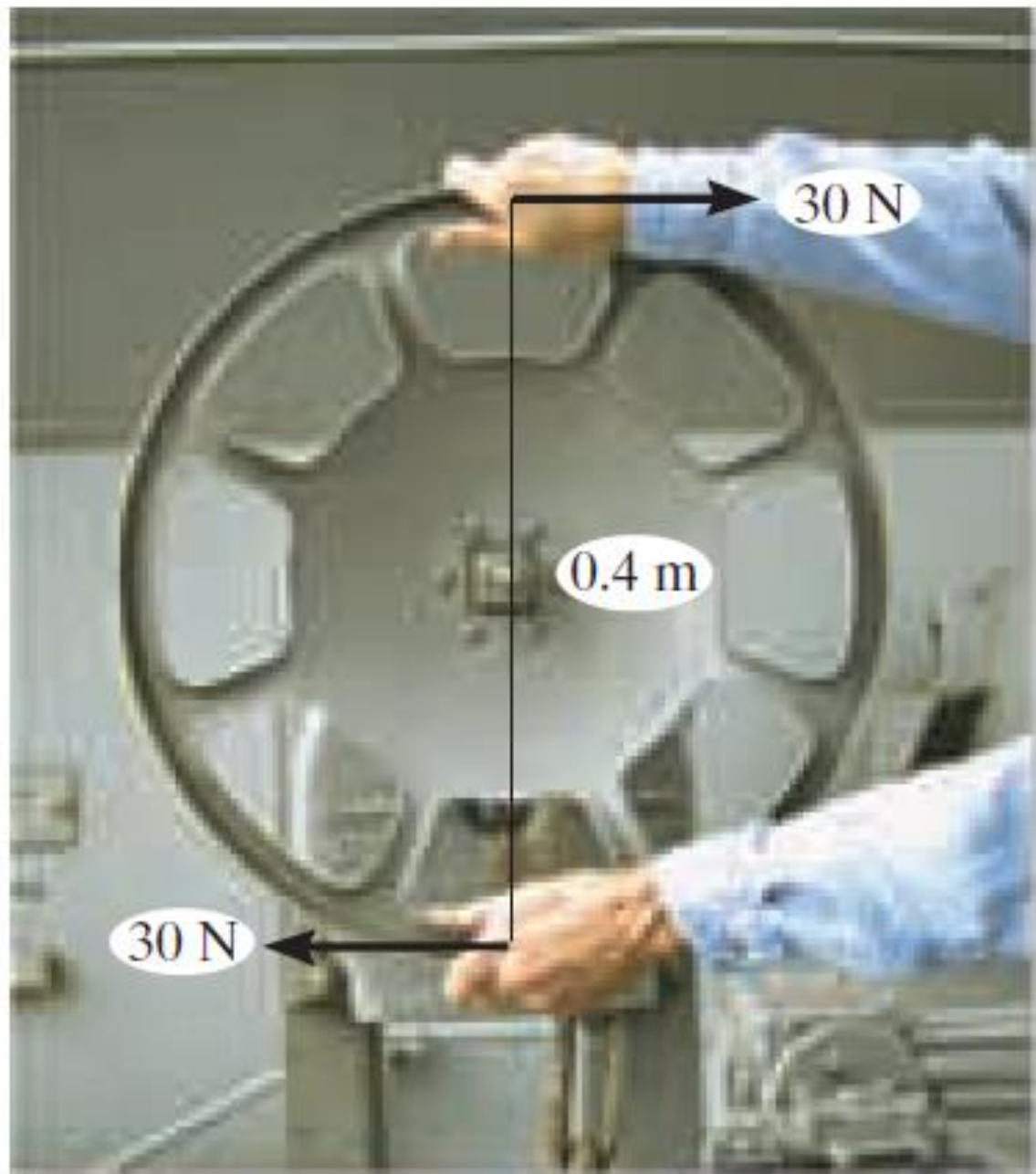




Moment of a couple

- **A couple** is defined as two parallel force that have the same magnitude and opposite directions and separated by perpendicular distance d , the moment of the couple is the algebraic sum of the moment of its forces about any axis.





$$M = F * d$$

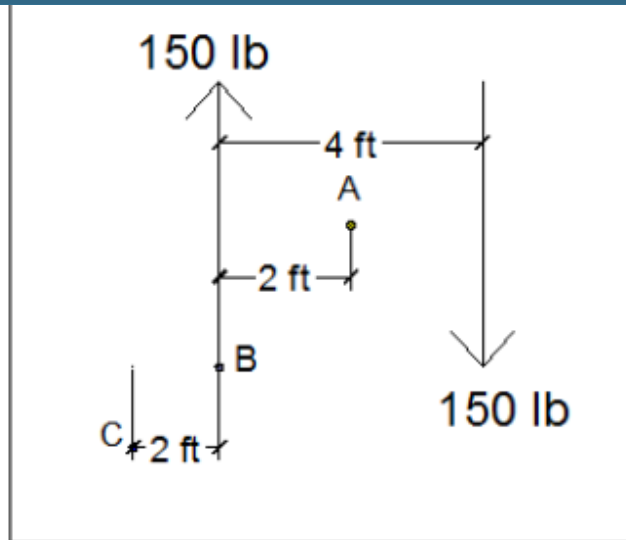
M: couple moment

F: magnitude of the force

d :the perpendicular distance between the forces.

The couple moment have the same magnitude for all axis perpendicular to the plan.

Example (1):Determine the moment of the couple in the fig. 1 with respect to a point, b point and c point.



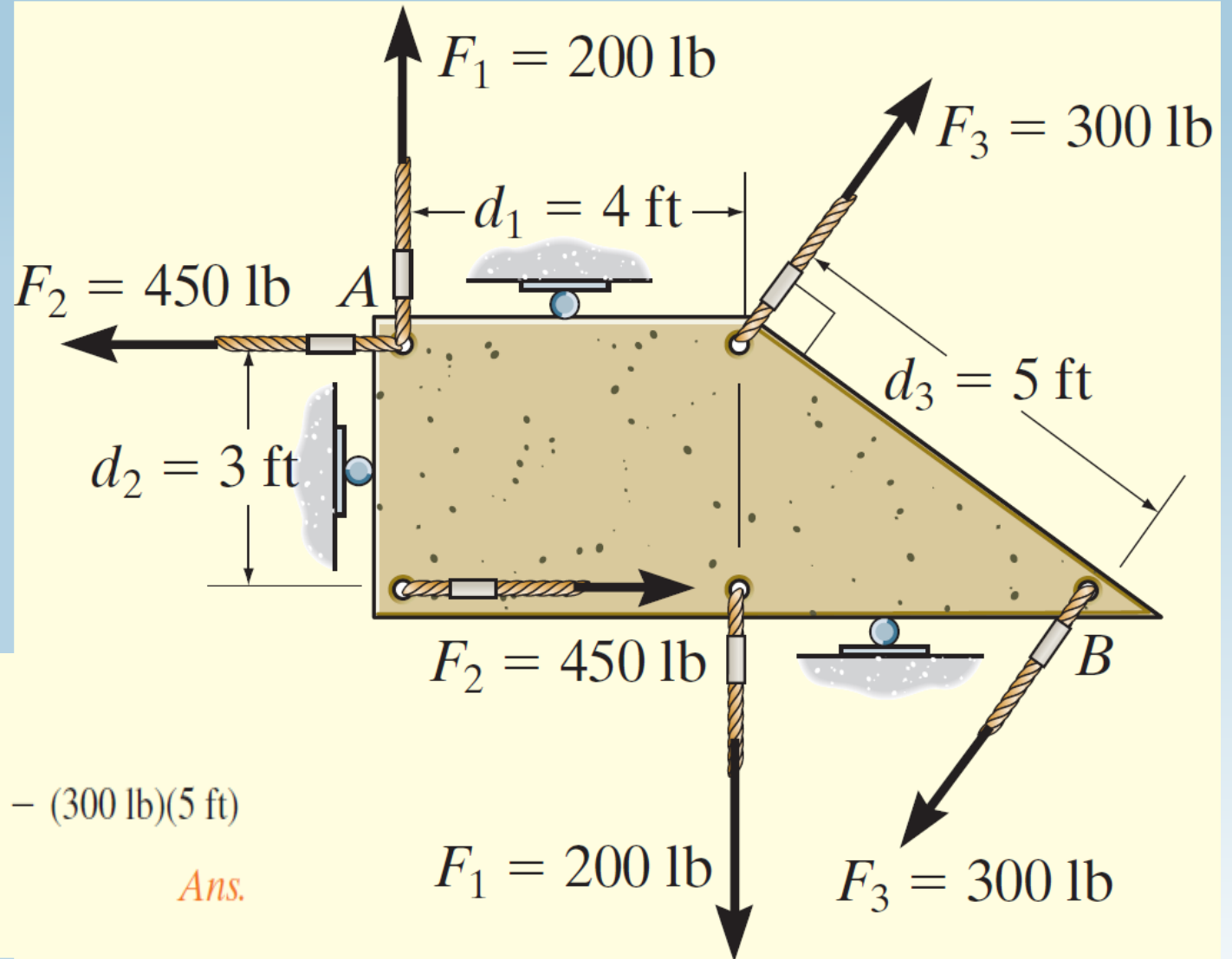
SOL.

$$M_a = 150 * 2 + 150 * 2 = 600 \text{ Ib. ft}$$

$$M_b = 150 * 4 = 600 \text{ Ib. ft}$$

$$M_c = 150 * 6 - 150 * 2 = 600 \text{ Ib. ft}$$

Example (2): Determine the resultant couple moment of the three couples acting on the plate in the fig. 2.



$$\zeta + M_R = \Sigma M; M_R = -F_1 d_1 + F_2 d_2 - F_3 d_3$$

$$= -(200 \text{ lb})(4 \text{ ft}) + (450 \text{ lb})(3 \text{ ft}) - (300 \text{ lb})(5 \text{ ft})$$

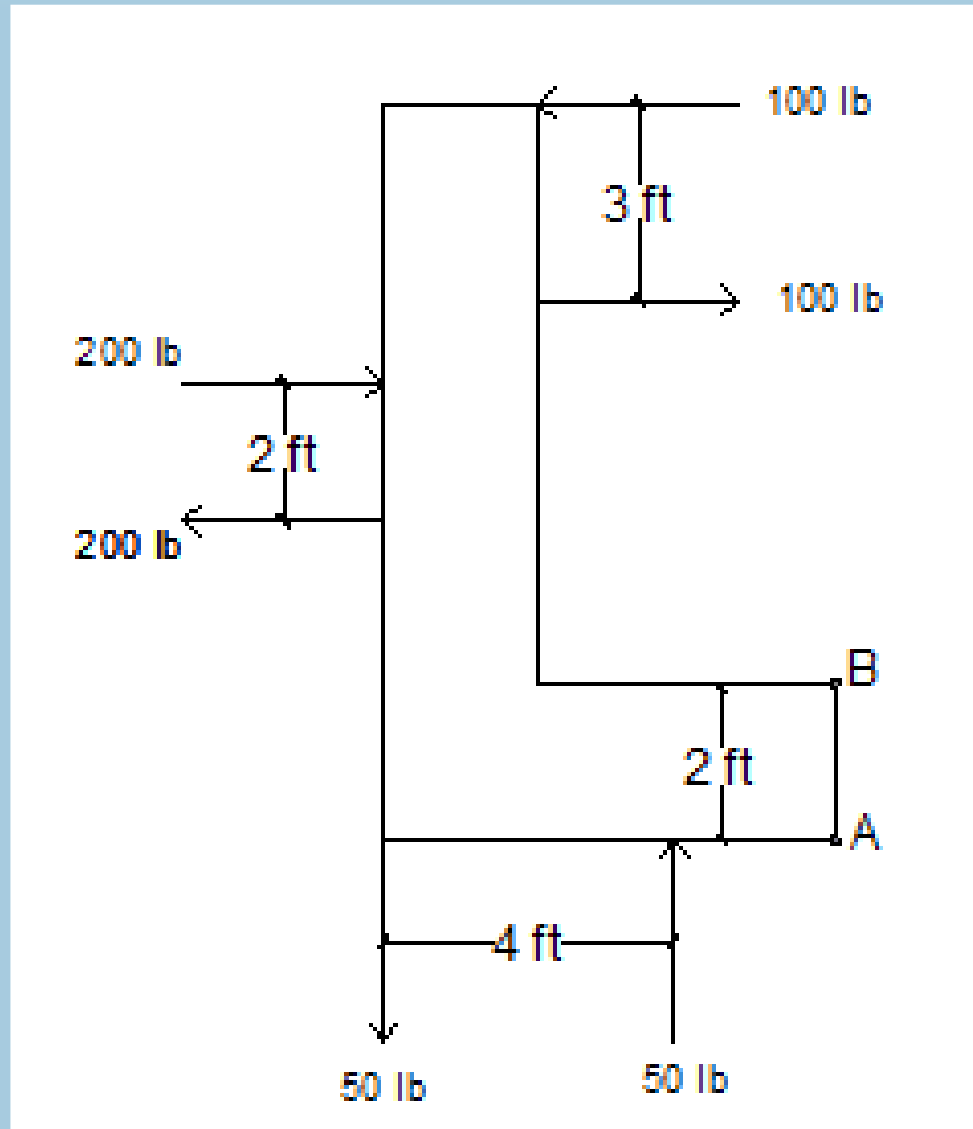
$$= -950 \text{ lb} \cdot \text{ft} = 950 \text{ lb} \cdot \text{ft} \zeta$$

Ans.

Transformation of a couple

When a force is replaced by a force and a couple, the new force has the same action. The couple will be either in the plane determined by the original force, and it has a parallel line of final position of the force or in a parallel.

Example (1): Replace the three couple in the fig.1 by one couple with the force acting horizontally at A and B.



SOL.

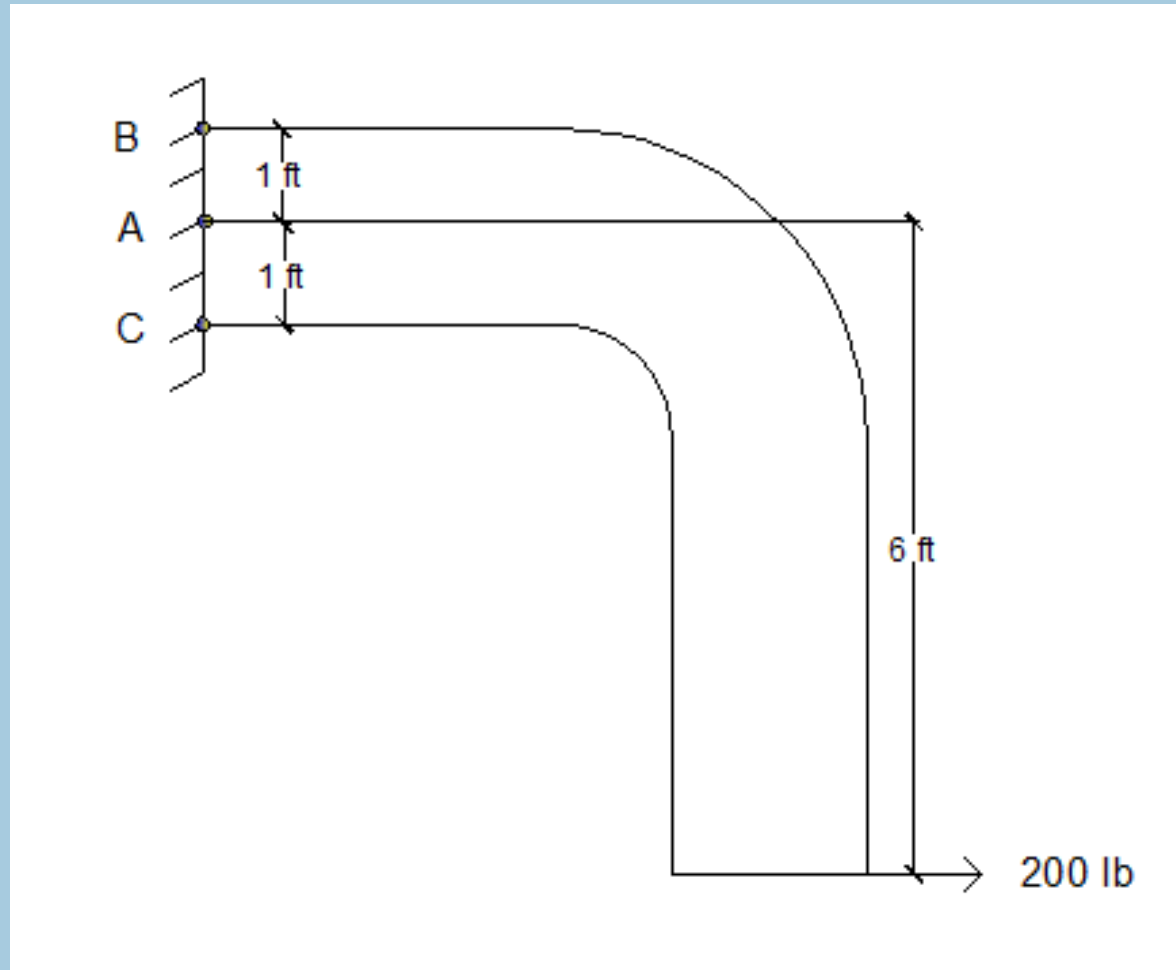
$$\sum M = 200 * 2 - 100 * 3 - 50 * 4 = -100 \text{ Ib. ft}$$

$$M = F * d$$

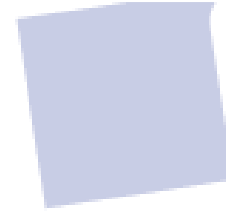
$$100 = F * 2$$

$$F = 50 \text{ Ib}$$

Example (2): Replace the 200 lb force in the fig. 2 by a couple whose forces are horizontal and pass through C and B.



SOL.



$$M_a = -200 * 6$$

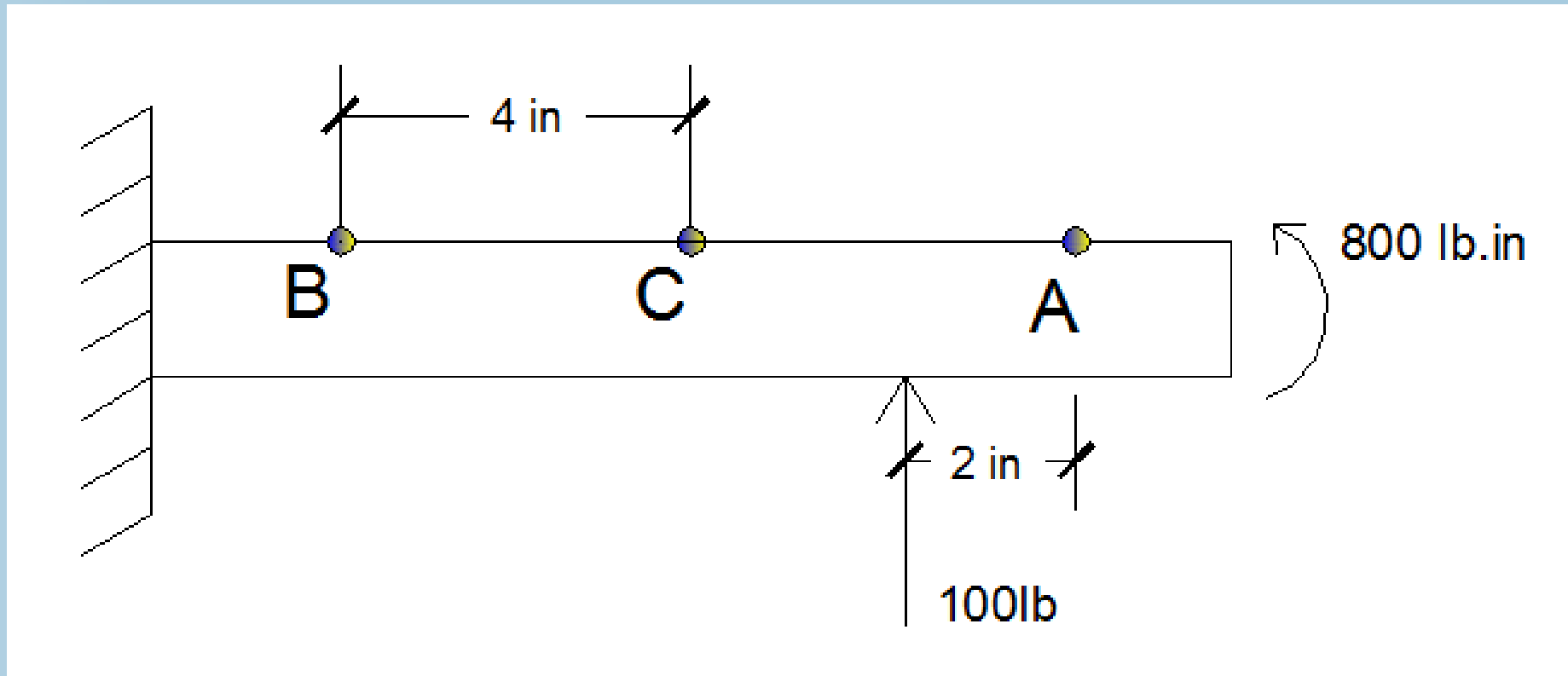
$$M_a = -1200 \text{ lb. ft}$$

$$M_{BC} = F * d$$

$$1200 = F * 2$$

$$F = 600 \text{ lb}$$

Example (3): Replace the force and couple in the fig. 3 by a vertical force which passes through A and a couple whose forces are vertically at C and B.



SOL. M

Move force 100 lb to point A

$$Ma = 100 * 2$$

$$Ma = 200 \text{ lb}\cdot\text{IN}$$

Find resultant of moment

$$\sum M = 200 - 800 = -600 \text{ lb}\cdot\text{IN}$$

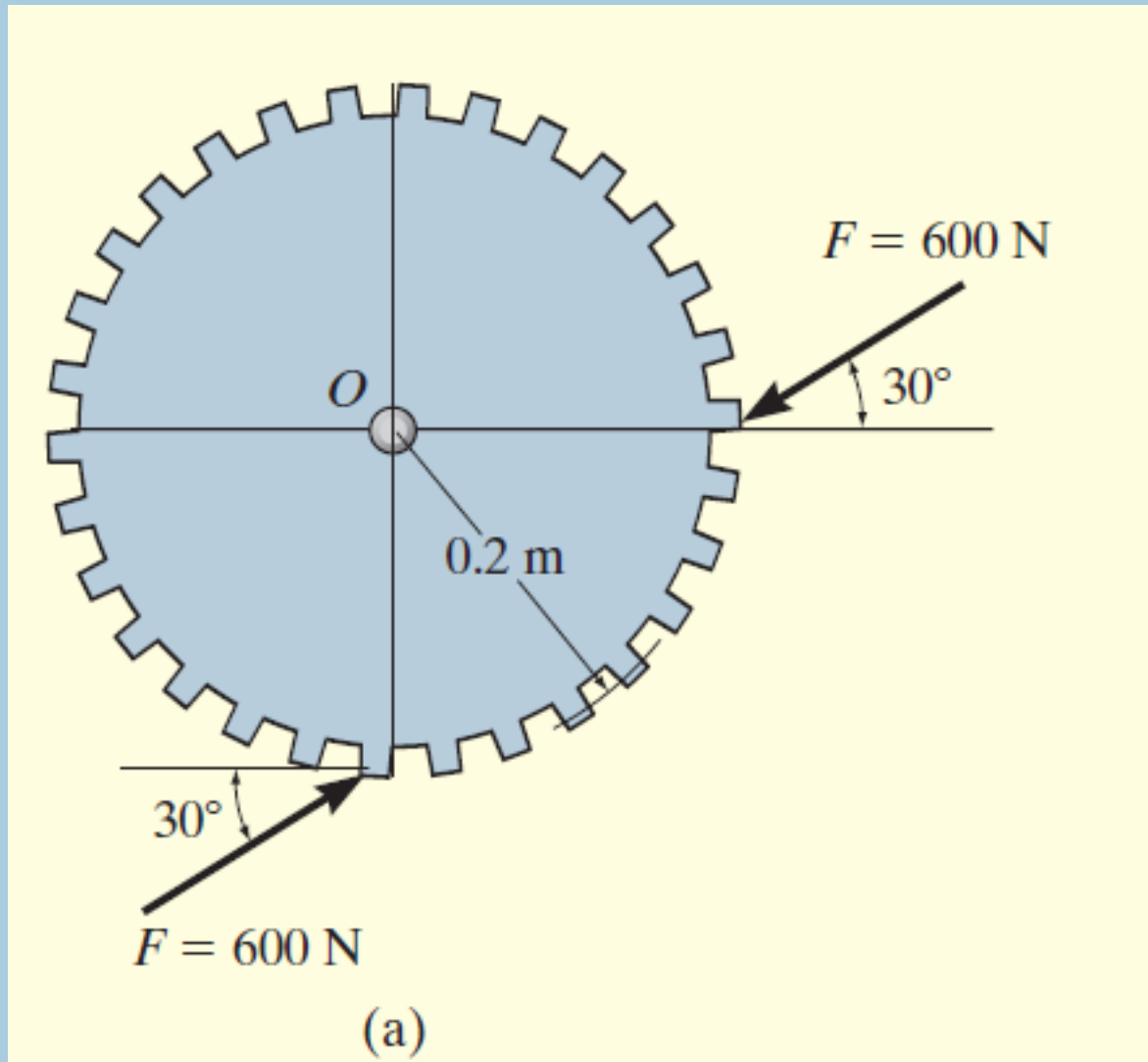
Find the couple forces

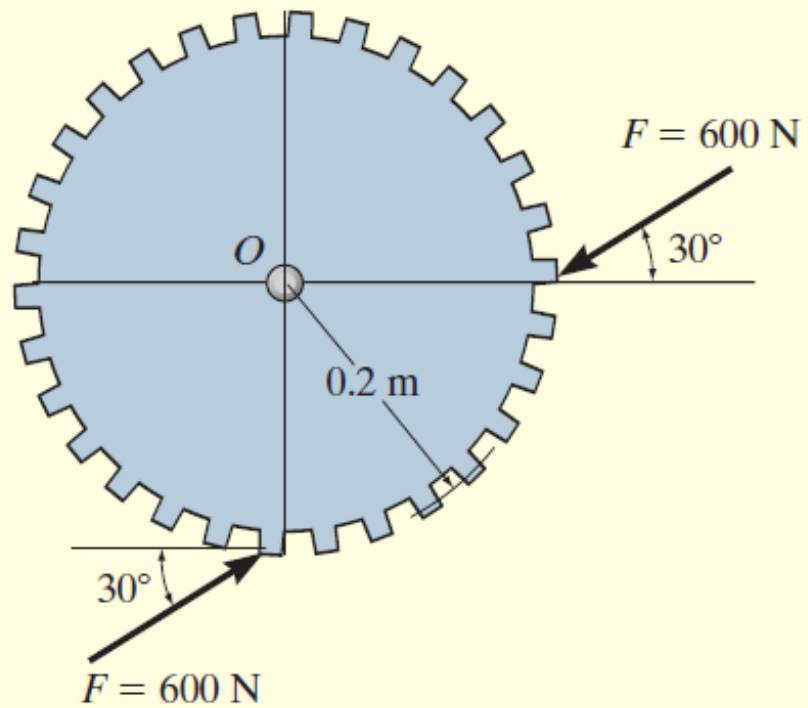
$$M_{BC} = F * d$$

$$600 = F * 4$$

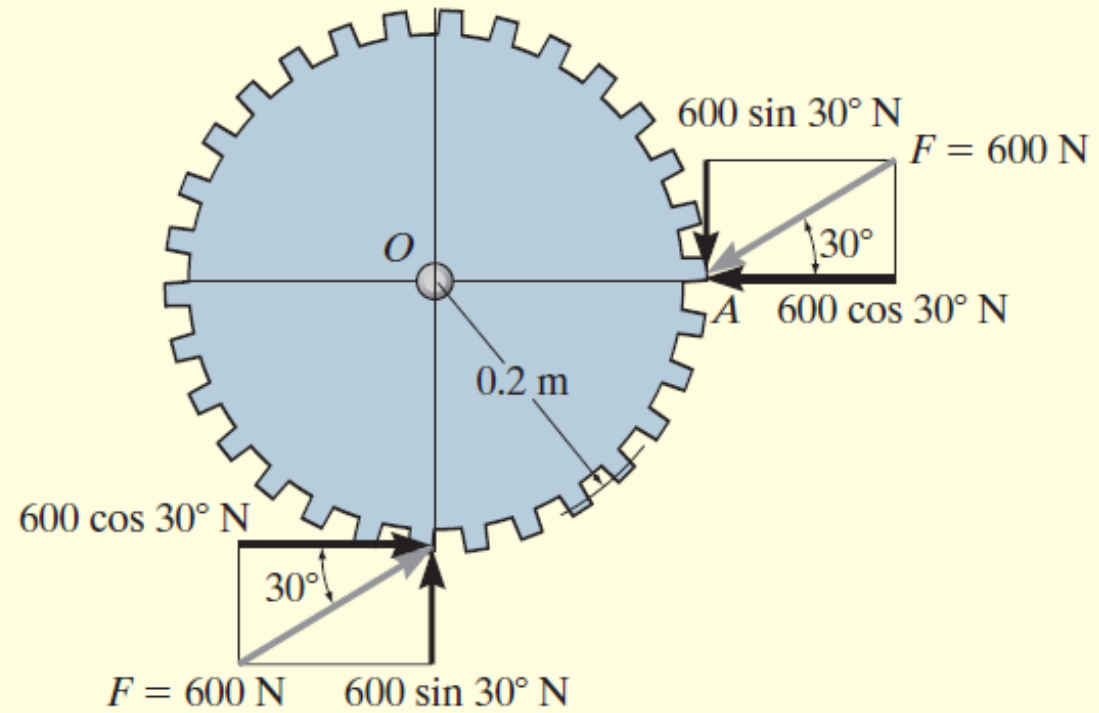
$$F = 150 \text{ lb}$$

Determine the magnitude and direction of the couple moment acting on the gear in Fig. below





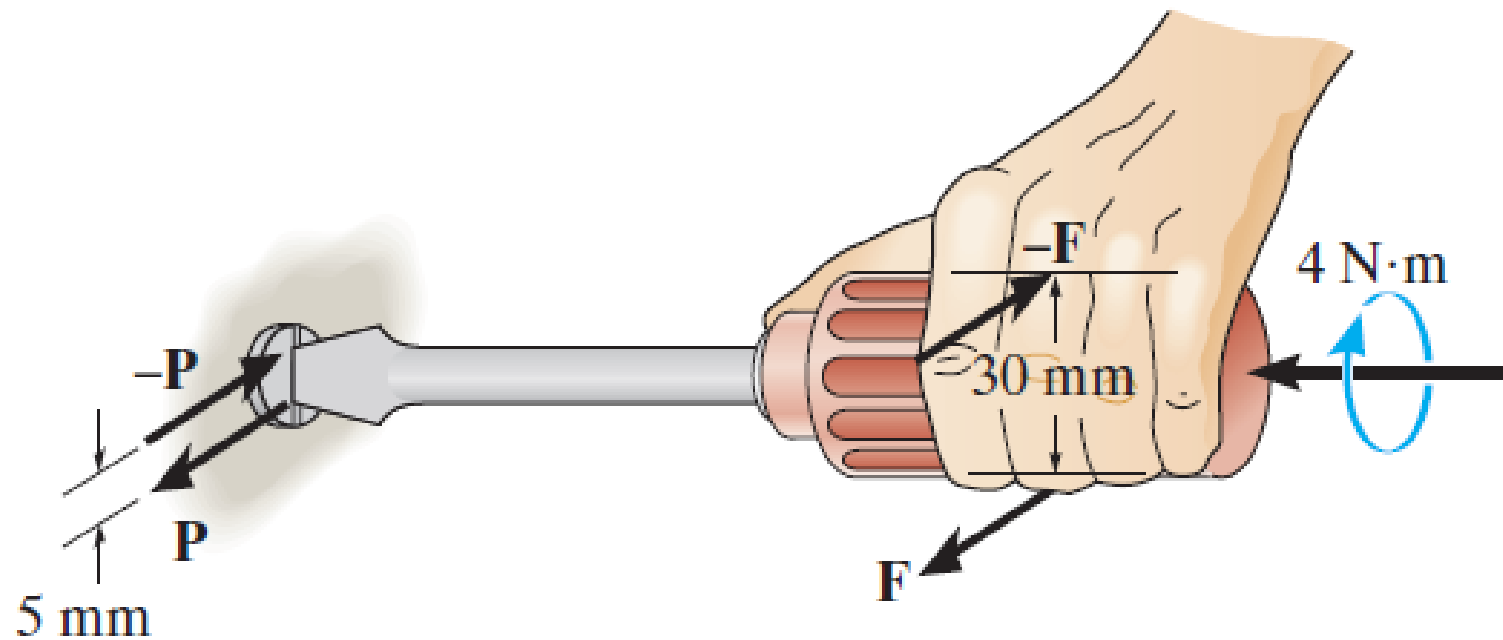
(a)



(b)

$$\zeta + M = \sum M_O; M = (600 \cos 30^\circ \text{ N})(0.2 \text{ m}) - (600 \sin 30^\circ \text{ N})(0.2 \text{ m})$$
$$= 43.9 \text{ N} \cdot \text{m} \zeta \quad \textit{Ans.}$$

A twist of $4 \text{ N} \cdot \text{m}$ is applied to the handle of the screwdriver. Resolve this couple moment into a pair of couple forces F exerted on the handle and P exerted on the blade.



For the handle

$$M_C = \Sigma M_x; \quad F(0.03) = 4$$

$$F = 133 \text{ N}$$

Ans

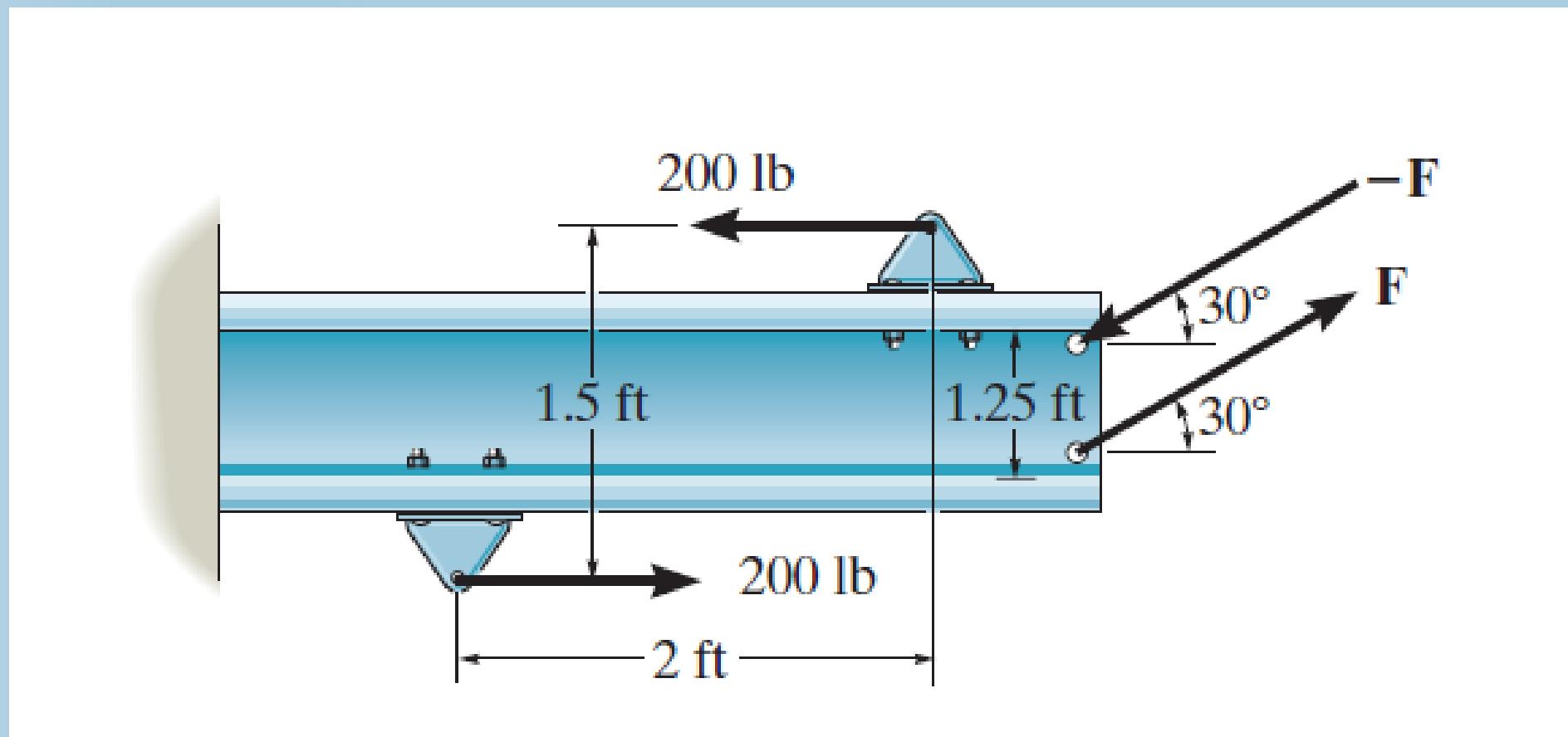
For the blade,

$$M_C = \Sigma M_x; \quad P(0.005) = 4$$

$$P = 800 \text{ N}$$

Ans

Two couples act on the beam. Determine the magnitude of F so that the resultant couple moment is $450 \text{ lb} \cdot \text{ft}$, counterclockwise. Where on the beam does the resultant couple moment act?



$$\zeta + M_R = \Sigma M; \quad 450 = 200(1.5) + F \cos 30^\circ(1.25)$$

$$F = 139 \text{ lb}$$

Ans

The resultant couple moment is a free vector. It can act at any point on the beam.

Thank you for listening

