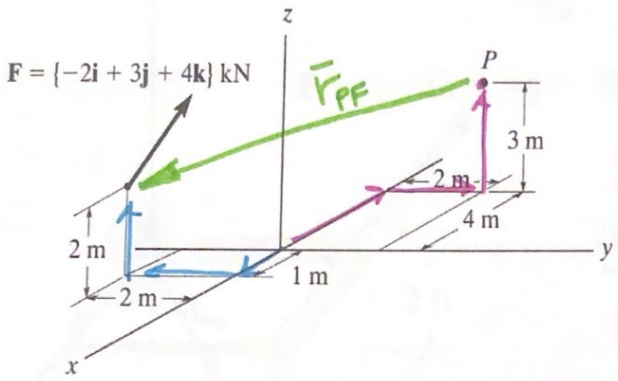
- Example: Determine the moment created by the force about point *P*.



$$\bar{M} = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ \text{MOMENT ARM} & & \\ \text{FORCE VECTOR} & & \end{vmatrix} \begin{matrix} m \\ kN \end{matrix}$$

MOMENT ARM = $\bar{r}_{PF}$

POSITION VECTOR FROM POINT → FORCE

$\bar{F} = F\bar{u}$

MOMENT ARM = distance from point P to Force → $\vec{r}_{PF}$

$P(-4, 2, 3)\,m \qquad F(1, -2, 2)\,m$

$\bar{r}_{PF} = \{(1-(-4))\bar{i} + (-2-2)\bar{j} + (2-3)\bar{k}\}\,m = \{5\bar{i} - 4\bar{j} - 1\bar{k}\}\,m$

FORCE VECTOR $\bar{F} = \{-2\bar{i} + 3\bar{j} + 4\bar{k}\}\,kN$

$$\bar{M} = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ 5 & -4 & -1 \\ -2 & 3 & 4 \end{vmatrix} \begin{matrix} m \\ kN \end{matrix}$$

$$= \{[(-4)(4) - (-1)(3)]\bar{i} - [(5)(4) - (-1)(-2)]\bar{j} + [(5)(3) - (-4)(-2)]\bar{k}\}\,kN\cdot m$$

$$= \{(-16 - (-3))\bar{i} - (20 - (2))\bar{j} + (15 - (8))\bar{k}\}\,kNm$$

$$= \{-13\bar{i} - 18\bar{j} + 7\bar{k}\}\,kNm$$

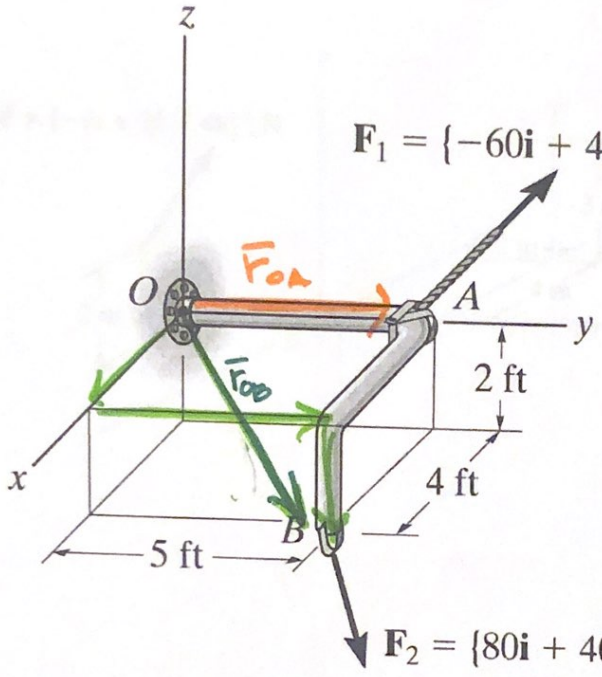
$$\boxed{\bar{M} = \{-13\bar{i} - 18\bar{j} + 7\bar{k}\}\,kNm}$$

$$M = \sqrt{(-13\,kNm)^2 + (-18\,kNm)^2 + (7\,kNm)^2}$$

$$\boxed{M = 23.3\,kNm}$$

- Example: Determine the resultant moment created by the forces about point *O*.

$$\bar{M} = \begin{vmatrix} i & j & k \\ \bar{r}_{OA} & & \\ \bar{F}_A & & \end{vmatrix} + \begin{vmatrix} \bar{i} & j & \bar{k} \\ \bar{r}_{OB} & & \\ \bar{F}_B & & \end{vmatrix}$$



COORDINATES

O (0, 0, 0) ft
A (0, 5, 0) ft
B (4, 5, −2) ft

F_1: POSITION VECTOR (MOMENT ARM) $\bar{r}_{OA}$ & FORCE VECTOR, $\bar{F}_1$

$$\bar{r}_{OA} = \{(0-0)\bar{i} + (5-0)\bar{j} + (0-0)\bar{k}\}\ \text{ft} = \{0\bar{i} + 5\bar{j} + 0\bar{k}\}\ \text{ft}$$

$$\bar{F}_1 = \{-60\bar{i} + 40\bar{j} + 20\bar{k}\}\ \text{lb}$$

F_2: POSITION VECTOR (MOMENT ARM) $\bar{r}_{OB}$ & FORCE VECTOR $\bar{F}_2$

$$\bar{r}_{OB} = \{(4-0)\bar{i} + (5-0)\bar{j} + (-2-0)\bar{k}\}\ \text{ft} = \{4\bar{i} + 5\bar{j} - 2\bar{k}\}\ \text{ft}$$

$$\bar{F}_2 = \{80\bar{i} + 40\bar{j} - 30\bar{k}\}\ \text{lb}$$

$$\bar{M}_o = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ 0 & 5 & 0 \\ -60 & 40 & 20 \end{vmatrix} + \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ 4 & 5 & -2 \\ 80 & 40 & -3 \end{vmatrix} \begin{matrix} \text{ft} \\ \text{lb} \end{matrix}$$

$$= \left[(5(20)-0)\bar{i} - [0-0]\bar{j} + [0-5(-60)]\bar{k}\right] + \left[(5(-3)-(-2)(40))\bar{i} - [4(-3)-(-2)(80)]\bar{j} + [4(40)-5(80)]\bar{k}\right] \text{lb ft}$$

$$= \{100\bar{i} - 0\bar{j} + 300\bar{k}\}\ \text{lb ft} + \{65\bar{i} - 148\bar{j} - 240\bar{k}\}\ \text{lb ft}$$

$$\bar{M} = \{165\bar{i} - 148\bar{j} + 60\bar{k}\}\ \text{lb ft}$$