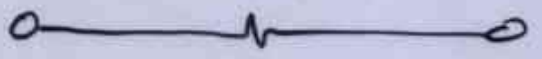
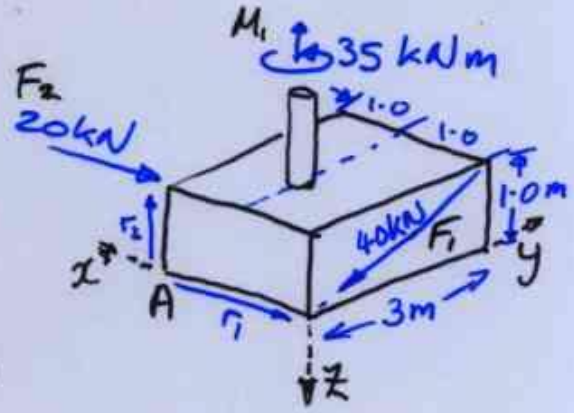
Problem 2/143 (b11)

REPLACE 2 forces + couple by a force-couple sys @ A.

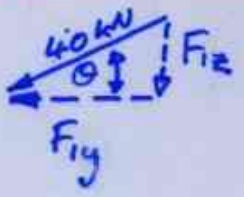




Step 1) Express forces in components. Label forces to aid clarity $\vec{F}_1$ $\vec{F}_2$

$\vec{F}_2$ is easy: $\vec{F}_2 = -20\,\text{kN}\,\hat{i}$ Note sign

$\vec{F}_1$ needs trig:



$\theta = \tan^{-1}\left(\frac{1.0}{3.0}\right) = 18.40°$

$F_{1y} = (40\,\text{kN})(\cos(18.4°)) = 37.95$

$F_{1z} = (40\,\text{kN})(\sin(18.4°)) = 12.65\,\text{kN}$

So $\vec{F}_1 = -37.95\,\hat{j} + 12.65\,\hat{k}$ kN

To get $\vec{R} = \vec{F}_1 + \vec{F}_2$ ... ADD $\Rightarrow$ $\vec{R} = -20\,\hat{i} - 37.95\,\hat{j} + 12.65\,\hat{k}$ kN

Now to get couple of resultant about A.

we have $\vec{M}_1$ already: $\vec{M}_1 = -35\,\hat{k}$ kNm sign

moments Due to $\vec{F}_1$ & $\vec{F}_2$ ...

$$\vec{r}_1 \times \vec{F}_1 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2 & 0 & 0 \\ 0 & -37.95 & +12.65 \end{vmatrix}$$

$$= -\hat{j}(-2)(12.65) + \hat{k}(-2)(-37.95)$$

$$\vec{r}_2 \times \vec{F}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -1 \\ -20 & 0 & 0 \end{vmatrix}$$

$$= +20\,\hat{j}$$

Sum 3 contributions (green)

$$\vec{M} = -35\,\hat{k} + 20\,\hat{j} + 25.3\,\hat{j} + 75.9\,\hat{k}$$

$$= 45.3\,\hat{j} + 40\,\hat{k} \quad \text{kN·m}$$