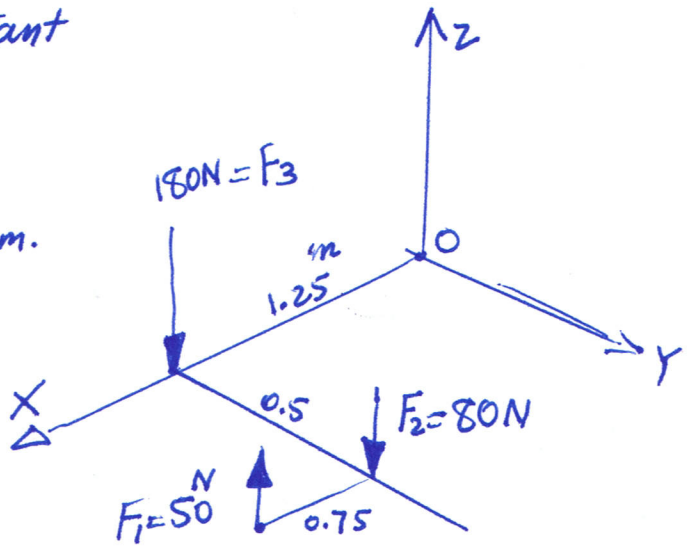
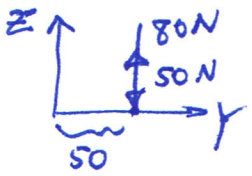
4-130 A force and couple act on the pipe assembly. If $F_1 = 50\,N$, and $F_2 = 80\,N$, replace this system by an equivalent resultant force and couple moment acting at O. Express the results in Cartesian vector form.



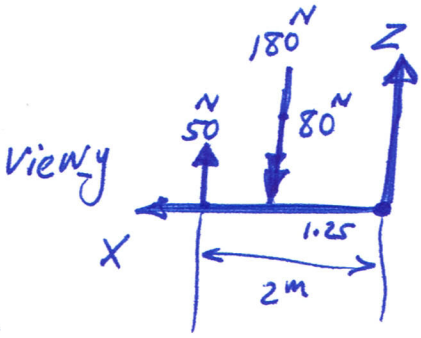
Scalar analysis:

View-X:



$$M_X = -80(0.5) + 50(0.5) = -15 \ N.m$$

View-Y



$$M_Y = +180(1.25) + 80(1.25) - 50(2) = 225 \ N.m$$

All forces are parallel to z, so they do not creat any moment about z.

$$\vec{M} = M_x\hat{i} + M_y\hat{j} = \boxed{-15\hat{i} + 225\hat{j}} \ N.m$$

OR

Vector analysis: $\vec{M}_O = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2 + \vec{r}_3 \times \vec{F}_3$

$$\vec{M}_O = \begin{vmatrix} i & j & k \\ 2 & 0.5 & 0 \\ 0 & 0 & 50 \end{vmatrix} + \begin{vmatrix} i & j & k \\ 1.25 & 0.5 & 0 \\ 0 & 0 & -80 \end{vmatrix} + \begin{vmatrix} i & j & k \\ 1.25 & 0 & 0 \\ 0 & 0 & -180 \end{vmatrix}$$

$$\vec{M}_O = 25\hat{i} - 100\hat{j} + -40\hat{i} + 100\hat{j} + 225\hat{j} \ N.m$$

$$\boxed{M_O = -15\hat{i} + 225\hat{j} \ N.m}$$