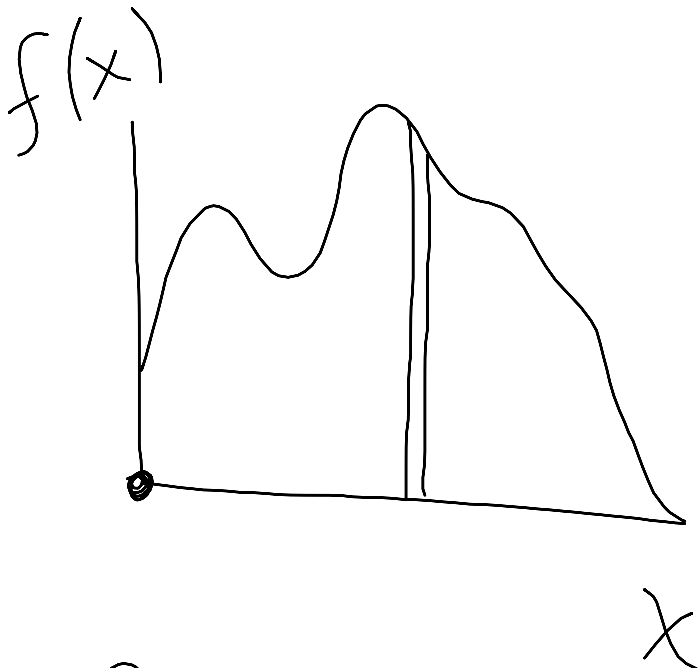
Ch 4 Moment of a Force



$f(x) = \frac{dF}{dx}$ force per unit length

$\int f(x)\,dx = F_R$ total force

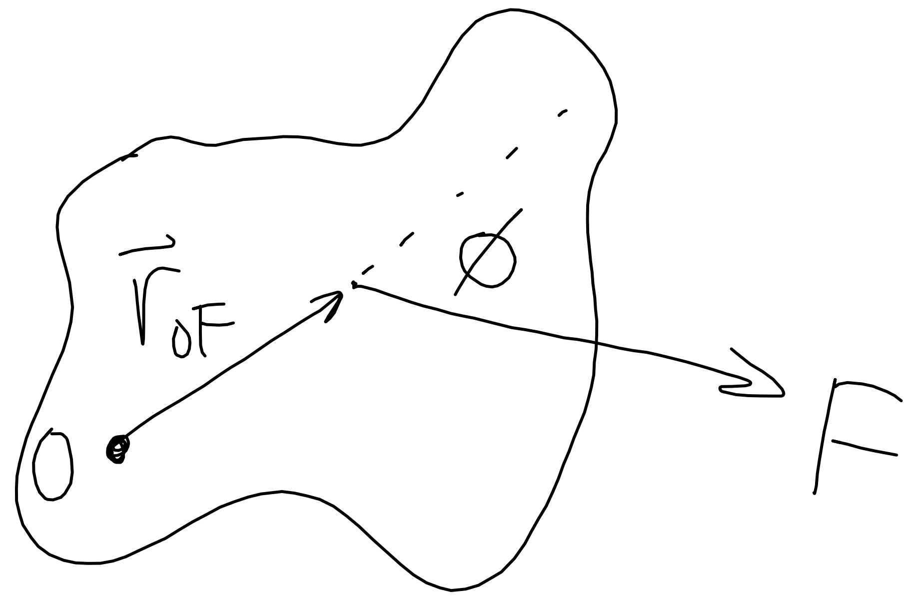
0^{th} moment of the distribution

$\int x^p f(x)\,dx$

$\int x^1 f(x)\,dx = 1^{st}$ moment $\overset{also}{=} F_R x_R$

So $$x_R = \frac{\int x f(x)\,dx}{F_R}$$

$$\int x f(x)\,dx = M_O$$



$$\vec{M}_O = \vec{r}_{OF} \times \vec{F}$$

$$|\vec{M}_O| = |\vec{r}_{OF} \times \vec{F}| = rF\sin\phi$$

$$= r_\perp F \text{ or } r F_\perp$$

So Statics =

$$\sum \vec{F} = 0 \quad \sum \vec{M}_{\text{any pt}} = 0$$

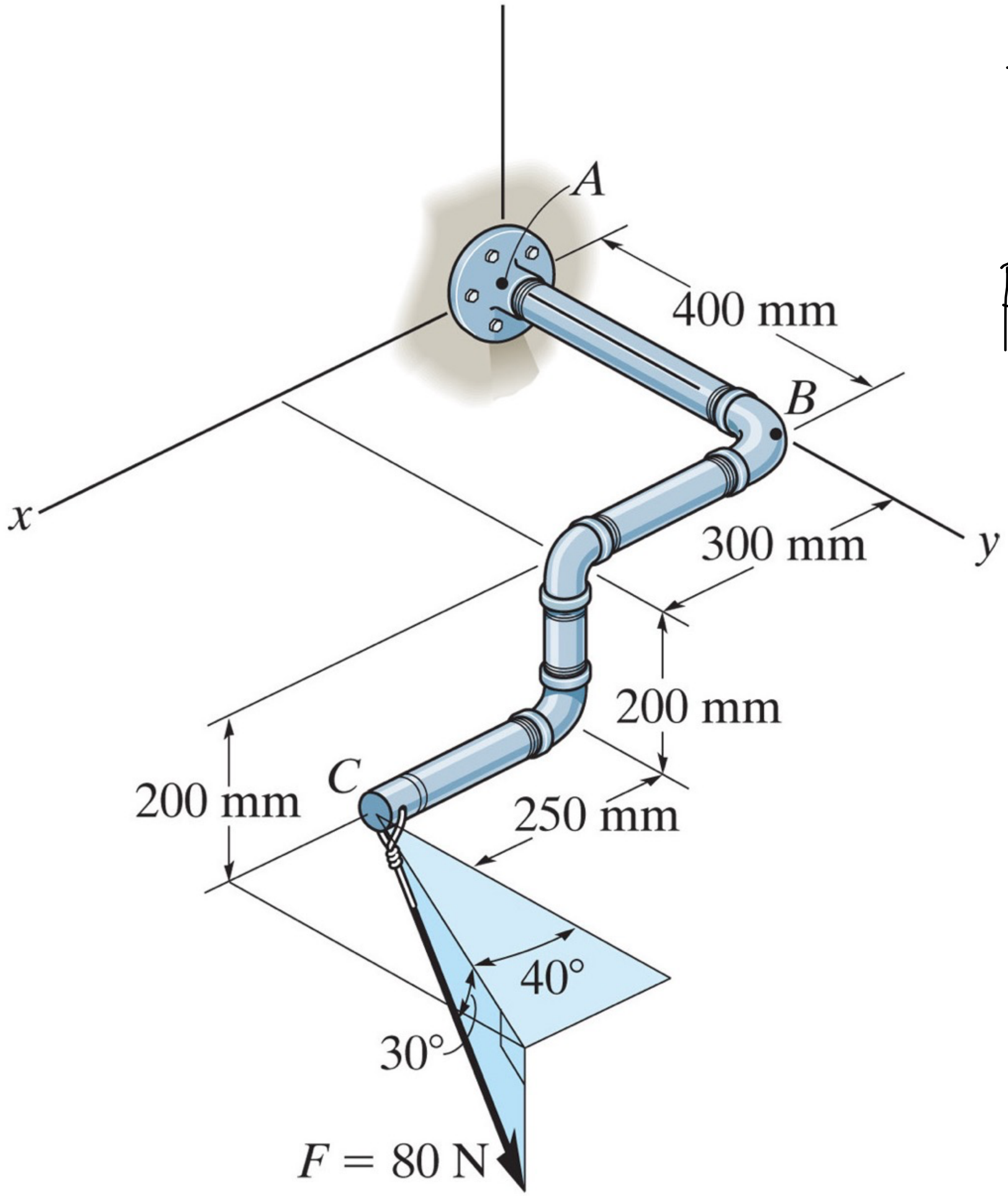
$$\vec{r} = \hat{i} + 2\hat{j} - 3\hat{k}$$

$$\vec{F} = 10\hat{i} - 4\hat{k}$$

$$\vec{M} = \vec{r} \times \vec{F}$$

$$\vec{M} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & -3 \\ 10 & 0 & -4 \end{vmatrix} = \hat{i}(-8) - \hat{j}(-4+30) + \hat{k}(0-20)$$

$$= -8\hat{i} - 26\hat{j} - 20\hat{k}$$



$F_z = -80 \sin 30 = -40$

$F_{xy} = 80 \cos 30$

$F_y = 80 \cos 30 \cos 40$

$= 53.1$

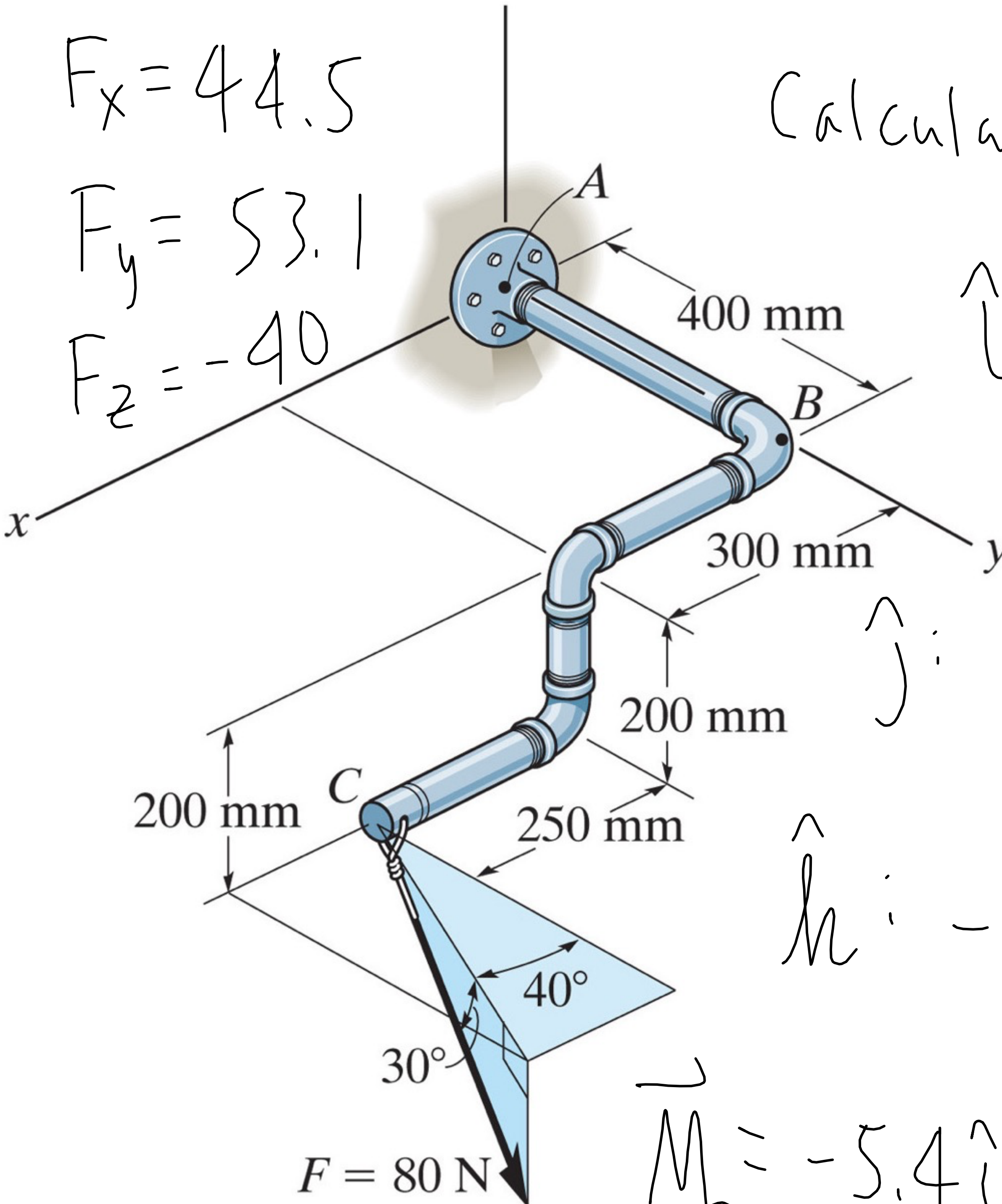
$F_x = 80 \cos 30 \sin 40$

$= 44.5$

$F_x = 44.5$

$F_y = 53.1$

$F_z = -40$



Calculate $\vec{M}_A$ components

$\hat{i}: 53.1(.2) - 40(.4)$

$\hat{j}: 44.5(.2) + 40(.55)$

$\hat{k}: -44.5(.4) + 53.1(.55)$

$\vec{M}_O = -5.4\hat{i} + 13.1\hat{j} + 11.4\hat{k}$

or use $\vec{r}_{AC} = .55\hat{i} + .4\hat{j} - .2\hat{k}$

Now we know $M_O = r_\perp F$ or $F_\perp r$

So $d_\perp$ or dist of closest approach for line of $\vec{F}$ to O

$$d = \frac{M_O}{F} = \frac{\sqrt{5.4^2 + 13.1^2 + 11.4^2}}{80} = .23\text{ m}$$