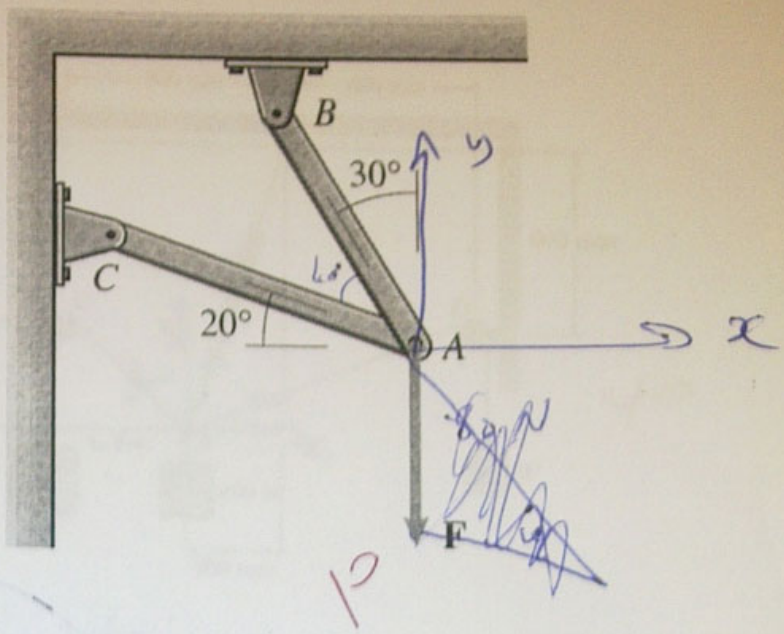
PROBLEM 1: **(30 points)**

The magnitude of the vertical force **F** is 80 N. If you resolve it into components $\mathbf{F}_{AB}$ and $\mathbf{F}_{AC}$ that are parallel to the bars *AB* and *AC*, what are the magnitudes of the components?

N.B.:
This is not an equilibrium problem.



$u_{AB} = \sin 30\, i + \cos 30\, j$

$u_{AC} = -\cos 20\, i + \sin 20\, j$

$F_{\parallel} = F_{AB\parallel} + F_{AC\parallel}$

$F_{\parallel} = F_{AB}\cos 30 + F_{AC}\sin 20 = 80\ N$

$F_{\perp} = F_{AB\perp} + F_{AC\perp} = 0$

$F_{AB\perp} = -F_{AC\perp}$

$-F_{AB}\sin 30 = +F_{AC}\cos 20$

$F_{AC} = -F_{AB}(0.53)$

$0.867 F_{AB} + 0.342 F_{AC} = 80$

$\Rightarrow 0.867 F_{AB} - 0.342 \times 0.53 F_{AB} = 80$

$0.867 F_{AB} - 0.18 F_{AB} = 80$

$F_{AB} = 116.4\ N$

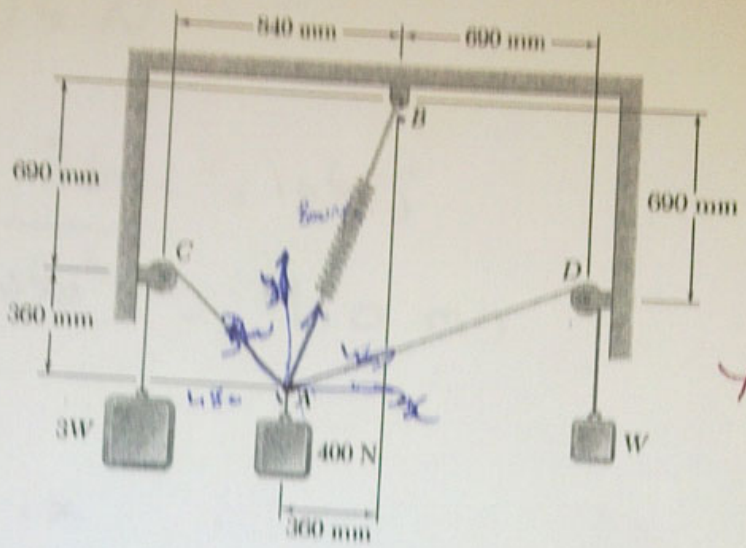
$F_{AC} = 62\ N$

PROBLEM 2: **(40 points)**

A load of weight 400 N is suspended from a spring and two cords which are attached to blocks of weights $3W$ and W as shown.

Knowing that the constant of the spring is 800 N/m, determine:

1. The value of W.
2. The unstretched length of the spring.



40

$\Sigma f = 0$; $r_{AB} = 360i + 1050j$

$u_{AB} = \frac{360i + 1050j}{\sqrt{360^2 + 1050^2}} = \frac{360i}{1110} + \frac{1050}{1110}j = 0.324i + 0.95j$

$r_{AC} = -480i + 360j$

$u_{AC} = \frac{-480i + 360j}{\sqrt{480^2 + 360^2}} = \frac{-480i + 360j}{600} = -0.8i + 0.6j$

$r_{AD} = 1050i + 360j$

$u_{AD} = \frac{1050i + 360j}{\sqrt{1050^2 + 360^2}} = \frac{1050i + 360j}{1110} = 0.95i + 0.324j$

$u_{AB} = 0.324i + 0.95j$

$u_{AD} = 0.95i + 0.324j$

$u_{AC} = -0.8i + 0.6j$

$\Sigma F_x = 3W(-0.8) + W(0.95) + 0.324T_{AB} = 0$

$\Sigma F_y = 3W(0.6) + W(0.324) + 0.95T_{AB} = 400$

$-1.45W + 0.324T_{AB} = 0$

$2.13W + 0.95T_{AB} = 400$

$\Rightarrow T_{AB} = \frac{1.45}{0.324}W = 4.5W \Rightarrow 2.13W + 0.95(4.5W) = 400$

$$W = 62.5\ N$$

2) $T_{AB} = 281.25\ N$

$\vec{r}_{AB} = 360\,i + 1050\,j$

$\|\vec{r}_{AB}\| = \sqrt{360^2 + 1050^2} = 1110\ mm$

$T_{AB} = k\,x$

$281.25\ N = 800\ N/m \cdot x$

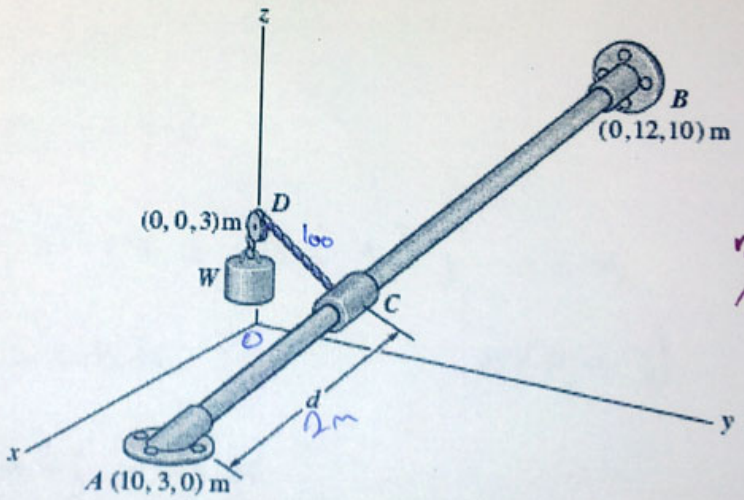
$x = 0.35\ m = 350\ mm$ length of streted spring.

the length of unstretched spring $= 1110 - 350 = 760\ mm$

PROBLEM 3: **(30 points)**

The weight W causes a tension of 100 N in cable CD. If $d = 2$ m, what is the moment about the x axis due to the force exerted by the cable CD at point C?

Express the result in Cartesian Vector form.



30°

$r_{AB} = -10i + 9j + 10k$

$u_{AB} = \frac{-10i + 9j + 10k}{\sqrt{10^2 + 9^2 + 10^2}} = \frac{-10i + 9j + 10k}{16.76} = -0.59i + 0.54j + 0.5$

$C = 2(-0.59i + 0.54j + 0.59k) = -1.18i + 1.08j + 1.18k$

$\vec{CD} = 1.18i - 1.08j + 1.8k$

$r_{AC} = 2\,u_{AB}$

$r_{AC} = 2(-0.59\,i + 0.54\,j + 0.59\,k) = -1.2i + 1.08j + 1.2k$

$A(10, 3, 0)\,m$

$C - A = -1.2i + 1.08j + 1.2k$

$C = -1.2i + 1.08j + 1.2k + 10i + 3j + 0k$

$C = 8.8i + 4.08j + 1.2k$ $\qquad D(0, 0, 3)$

$\vec{r_{CD}} = -8.8i + 4.08j + 1.8k$

$\vec{f_{CD}} = u_{CD} \cdot F = 100\left(\dfrac{-8.8i - 4.8j + 1.8k}{\sqrt{8.8^2 + 4.08^2 + 1.8^2}}\right) = 100\left(\dfrac{-8.8i - 4.08j + 1.8k}{9.8}\right)$

$\vec{f_{CD}} = 100(-0.9i - 0.42j + 0.18k)$

$\vec{f_{CD}} = \{-90i - 42j + 18k\}\,N$

$\vec{u_a} = 1i$

$\vec{r_{OD}} = 3k$

$\vec{M} = u_x \cdot (\vec{r_{OD}} \times \vec{f_{CD}})$

$$M = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 0 & 3 \\ -90 & -42 & 18 \end{vmatrix} = 126\ N.m$$

$\vec{M}_{x_{axis}} \cong \{+126\,i\}\ N.m$