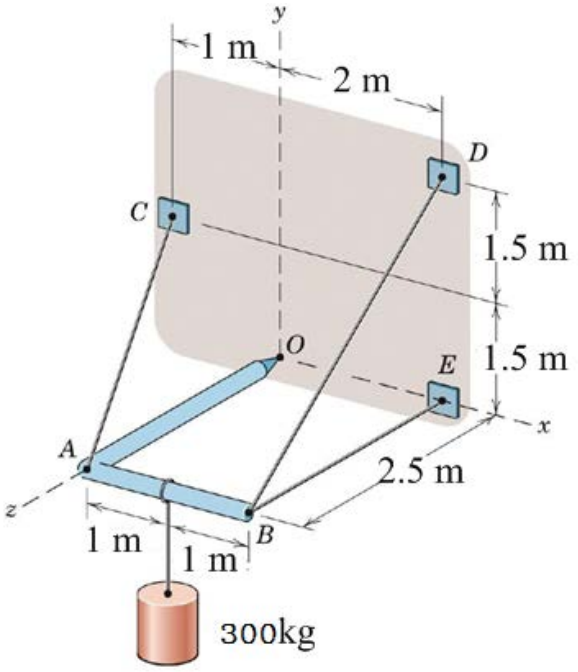
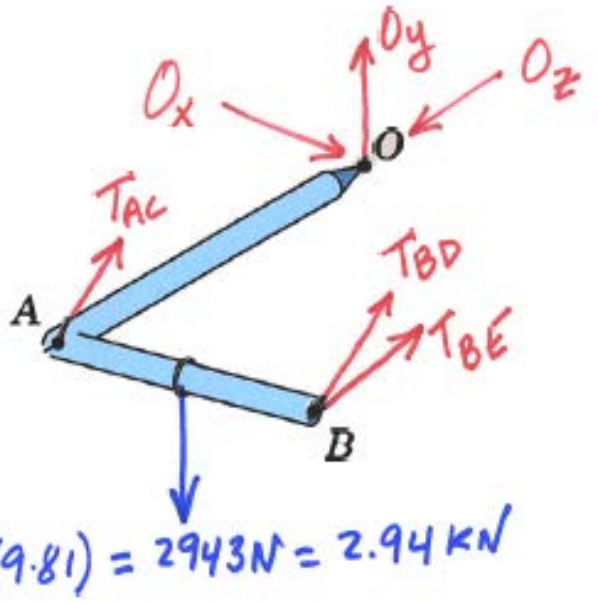
Problem 9

The right-angle boom, which carries the 300-kg cylinder, is supported by three cables and a ball-and-socket joint at *O* attached to the vertical *x-y* surface.

a. Draw the free body diagram of the boom on the body to the right, only need to show forces.



FBD



$300(9.81) = 2943N = 2.94kN$

Determine the tensions in three cables *AC*, *BD* and *BE* and the reactions at *O*.

$$\hat{u}_{AC} = \frac{[-1 \quad 1.5 \quad -2.5]m}{\sqrt{(-1)^2+(1.5)^2+(-2.5)^2}\,m} = [-0.324 \quad 0.487 \quad -0.811]$$

$$\hat{u}_{BD} = \frac{[0 \quad 3 \quad -2.5]\,m}{\sqrt{0^2+3^2+(-2.5)^2}\,m} = [0 \quad 0.768 \quad -0.640]$$

$$\hat{u}_{BE} = \frac{[0 \quad 0 \quad -2.5]\,m}{\sqrt{0^2+0^2+(-2.5)^2}\,m} = [0 \quad 0 \quad -1]$$

ANSWER:

$T_{AC} = 3.02kN;\ T_{BD} = 1.914kN;\ T_{BE} = \phi;\ \vec{O} = [0.978 \quad \phi \quad 3.67]\,kN$

Forces Reactions	$\vec{r}_{O\to Force}$ "m"	$\vec{F}$ "KN"	$\vec{M}_o = \vec{r} \times \vec{F}$ "KN.m"
Reactions @ $O \equiv \vec{O}$	[0 0 0]	[O_x O_y O_z]	[0 0 0]
2.94KN	[1 0 2.5]	[0 -2.94 0]	[7.35 0 -2.94]
T_{AC}	[0 0 2.5]	[-0.324 0.487 -0.811] T_{AC}	[-1.218 -0.81 0] T_{AC}
T_{BD}	[2 0 2.5]	[0 0.768 -0.640] T_{BD}	[-1.92 1.28 1.536] T_B
T_{BE}	[2 0 0]	[0 0 -1] T_{BE}	[0 2 0] T_{BE}

$\Sigma M_z = 0 = -2.94 + 1.536 T_{BD} \Rightarrow T_{BD} = 1.914\ kN$

$\Sigma M_x = 0 = 7.35 - 1.218 T_{AC} - 1.92 T_{BD} \Rightarrow T_{AC} = 3.02\ kN$ ($T_{BD} \to 1.914$)

$\Sigma M_y = 0 = -0.81 T_{AC} + 1.28 T_{BD} + 2 T_{BE} \Rightarrow T_{BE} = \phi$ ($T_{AC} \to 3.02$, $T_{BD} \to 1.914$)

$\Sigma F_x = 0 = O_x - 0.324 T_{AC} \Rightarrow O_x = 0.978\ kN$ ($T_{AC} \to 3.02$)

$\Sigma F_y = 0 = O_y - 2.94 + 0.487 T_{AC} + 0.768 T_{BD} \Rightarrow O_y = \phi$ ($T_{AC} \to 3.02$, $T_{BD} \to 1.914$)

$\Sigma F_z = 0 = O_z - 0.811 T_{AC} - 0.640 T_{BD} - T_{BE} \Rightarrow O_z = 3.67\ kN$ ($T_{AC} \to 3.02$, $T_{BD} \to 1.914$, $T_{BE} \to \phi$)

Note: $\Sigma M_{Line\ AB} = 0 \Rightarrow O_y = \phi$ O.K.