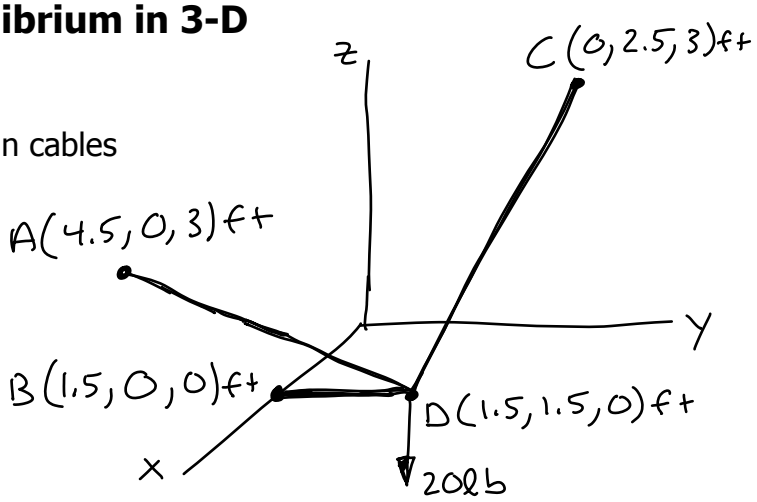
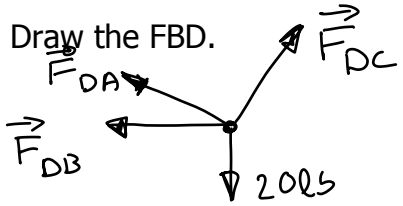
Equilibrium in 3-D

Problem Statement: Determine the force in cables DA, DB, and DC to support the 20 lb weight.



1.) Draw the FBD.



2.) Resolve each force into x, y, and z components.

$\vec{r}_{DA} = \{3\hat{\imath} - 1.5\hat{\jmath} + 3\hat{k}\}$ ft $\quad r_{DA} = 4.5$ ft

$\vec{u}_{DA} = \frac{\vec{r}_{DA}}{r_{DA}} = \{0.667\hat{\imath} - 0.333\hat{\imath} + 0.667\hat{k}\}$

$\vec{F}_{DA} = \{0.667F_{DA}\hat{\imath} - 0.333F_{DA}\hat{\jmath} + 0.667F_{DA}\hat{k}\}$

$\vec{u}_{DB} = -1\hat{\jmath}$

$\vec{F}_{DB} = \{-F_{DB}\hat{\jmath}\}$

$\vec{r}_{DC} = \{-1.5\hat{\imath} + 1\hat{\jmath} + 3\hat{k}\}$ ft $\quad r_{DC} = 3.5$ ft

$\vec{u}_{DC} = \frac{\vec{r}_{DC}}{r_{DC}} = \{-0.4286\hat{\imath} + 0.2857\hat{\jmath} + 0.8571\hat{k}\}$

$\vec{F}_{DC} = \{-0.4286F_{DC}\hat{\imath} + 0.2857F_{DC}\hat{\jmath} + 0.8571F_{DC}\hat{k}\}$

$F_{20} = \{-20\hat{k}\}$ lb

3.) Enforce equilibrium and solve for the unknowns.

$\Sigma F_x = 0 \Rightarrow 0.667F_{DA} - 0.4286F_{DC} = 0$

$\Sigma F_y = 0 \Rightarrow -0.333F_{DA} - F_{DB} + 0.2857F_{DC} = 0$

$\Sigma F_z = 0 \Rightarrow 0.667F_{DA} + 0.8571F_{DC} - 20\text{lb} = 0$

3 Equations, 3 Unknowns

$F_{DA} = 10\text{lb}, \; F_{DB} = 1.11\text{lb}, \; F_{DC} = 15.6\text{lb}$