PROB. 4.115

$W = 75^{LB}$, ASSUME $B_x = 0$, FIND T, $\vec{A}$, $\vec{B}$

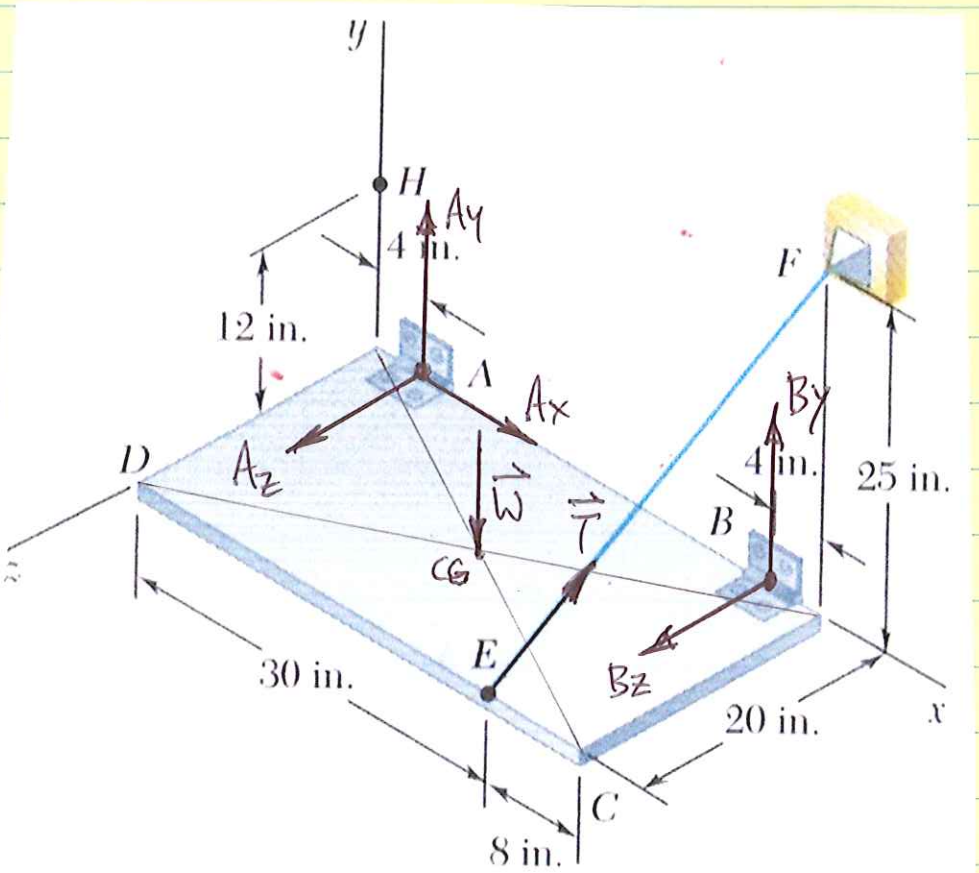

Fig. P4.115

LOCATE POINTS: $A(4,0,0)^{IN}$, $B(34,0,0)^{IN}$,

$E(30,0,20)^{IN}$, $F(38,25,0)^{IN}$, $CG(19,0,10)^{IN}$

DEFINE FORCE VECTORS:

$$\vec{A} = (A_x)\hat{i} + (A_y)\hat{j} + (A_z)\hat{k}^{LB}$$

$\vec{B} = (B_y)\hat{j} + (B_z)\hat{k}$ LB

$\vec{W} = (-75)\hat{j}$ LB

$\vec{T}$: $d_x = X_F - X_E = 38 - 30 = 8$ IN

$d_y = Y_F - Y_E = 25 - 0 = 25$ IN

$d_z = Z_F - Z_E = 0 - 20 = -20$ IN

$d = \sqrt{8^2 + 25^2 + 20^2} = 33$ IN

$T_x = T\frac{d_x}{d} = T\left(\frac{8}{33}\right) = 0.242T$

$T_y = T\frac{d_y}{d} = T\left(\frac{25}{33}\right) = 0.757T$

$T_z = T\frac{d_z}{d} = T\left(\frac{-20}{33}\right) = -0.606T$

$\vec{T} = (0.242T)\hat{i} + (0.757T)\hat{j} + (-0.606T)\hat{k}$ LB

SOLVE FOR $\vec{T}$ DIRECTLY BY SETTING $\vec{M}_o \cdot \hat{i} = 0$.

$\vec{M}_o = \vec{r}_{CG} \times \vec{W} + \vec{r}_E \times \vec{T}$

$\vec{r}_{CG} = (19)\hat{i} + (10)\hat{k}$ IN, $\vec{r}_E = (30)\hat{i} + (20)\hat{k}$ IN

$$\vec{r}_{CG} \times \vec{W} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 19 & 0 & 10 \\ 0 & -75 & 0 \end{vmatrix}$$

$$= [0 - (10)(-75)]\hat{i} - [0]\hat{j} + [(19)(-75) - 0]\hat{k}$$

$$= (750)\hat{i} + (-1425)\hat{k} \text{ IN.LB}$$

$$\vec{r}_E \times \vec{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 30 & 0 & 20 \\ 0.242T & 0.757T & -0.606T \end{vmatrix}$$

$$= [0 - (20)(0.757T)]\hat{i} - [(30)(-0.606T) - (20)(0.242T)]\hat{j}$$

$$+ [(30)(0.757T) - 0]\hat{k}$$

$$= (-15.1T)\hat{i} + (-23T)\hat{j} + (22.7T)\hat{k} \text{ IN.LB}$$

$$\vec{M}_O = (750 - 15.1T)\hat{i} + (-23T)\hat{j}$$

$$+ (-1425 + 22.7T)\hat{k}$$

$$\vec{M}_O \cdot \hat{i} = 750 - 15.1T = 0 \Rightarrow \underline{T = 49.7 \text{ LB}}$$

$$\vec{T} = [0.242(49.7)]\hat{i} + [0.757(49.7)]\hat{j}$$

$$+ [-0.606(49.7)]\hat{k}$$

$\vec{T} = (12)\hat{i} + (37.6)\hat{j} + (-30.1)\hat{k}$ LB

$\Sigma F_x = 0: \quad A_x + 12 = 0 \Rightarrow \underline{A_x = -12}$ LB

$\Sigma F_y = 0: \quad A_y + B_y + 37.6 - 75 = 0$

$A_y = -B_y + 37.4$ (1)

$\Sigma F_z = 0: \quad A_z + B_z - 30.1 = 0$

$A_z = -B_z + 30.1$ (2)

$\Sigma \vec{M}_A = \vec{r}_{ACG} \times \vec{W} + \vec{r}_{AE} \times \vec{T} + \vec{r}_{AB} \times \vec{B} = 0:$

POSITION VECTORS:

$\vec{r}_{ACG}: \quad dx = X_{CG} - X_A = 19 - 4 = 15$ IN

$dy = Y_{CG} - Y_A = 0$

$dz = Z_{CG} - Z_A = 10 - 0 = 10$ IN

$\vec{r}_{ACG} = (15)\hat{i} + (10)\hat{k}$ IN

$\vec{r}_{AE}: \quad dx = X_E - X_A = 30 - 4 = 26$ IN

$$dy = Y_E - Y_A = 0$$

$$dz = Z_E - Z_A = 20 - 0 = 20^{IN}$$

$$\vec{r}_{AE} = (26)\hat{i} + (20)\hat{k}^{IN}$$

$$\vec{r}_{AB}: dx = X_B - X_A = 34 - 4 = 30^{IN},\ dy = 0,\ dz = 0$$

$$\vec{r}_{AB} = (30)\hat{i}^{IN}$$

$$\vec{r}_{ACG} \times \vec{W} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 15 & 0 & 10 \\ 0 & -75 & 0 \end{vmatrix}$$

$$= [0 - (10)(-75)]\hat{i} - [0]\hat{j} + [(15)(-75) - 0]\hat{k}$$

$$= (750)\hat{i} + (-1125)\hat{k}^{IN\cdot LB}$$

$$\vec{r}_{AE} \times \vec{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 26 & 0 & 20 \\ 12 & 37.6 & -30.1 \end{vmatrix}$$

$$= [0 - (20)(37.6)]\hat{i} - [(26)(-30.1) - (20)(12)]\hat{j}$$

$$+ [(26)(37.6) - 0]\hat{k}$$

PROB. 4.115 CONT.

$$\vec{r}_{AE} \times \vec{T} = (-752)\hat{i} + (1023)\hat{j} + (978)\hat{k} \text{ IN.LB}$$

$$\vec{r}_{AB} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 30 & 0 & 0 \\ 0 & B_y & B_z \end{vmatrix}$$

$$= [0]\hat{i} - [(30)B_z - 0]\hat{j} + [(30)B_y - 0]\hat{k}$$

$$= (-30B_z)\hat{j} + (30B_y)\hat{k} \text{ IN.LB}$$

$$\Sigma \vec{M}_A = (750 - 752)\hat{i} + (1023 - 30B_z)\hat{j}$$

$$+ (-1125 + 978 + 30B_y)\hat{k} = 0$$

$$\underline{B_z = \left(\frac{1023}{30}\right) = 34.1 \text{ LB}}$$

$$\underline{B_y = \frac{1}{30}(1125 - 978) = 4.9 \text{ LB}}$$

$$\text{①}: \underline{A_y = -(4.9) + 37.4 = 32.5 \text{ LB}}$$

$$\text{②}: \underline{A_z = -(34.1) + 30.1 = -4.0 \text{ LB}}$$

$$\underline{\vec{A} = (-12)\hat{i} + (32.5)\hat{j} + (-4.0)\hat{k} \text{ LB}}$$

$$\underline{\vec{B} = (4.9)\hat{j} + (34.1)\hat{k} \text{ LB}}$$