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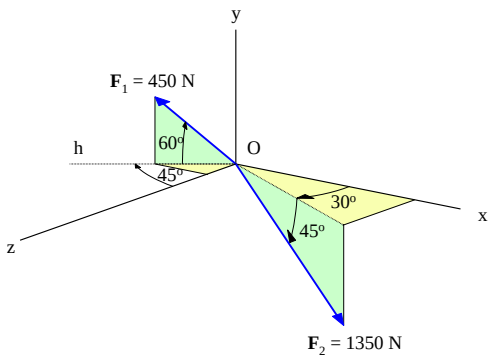
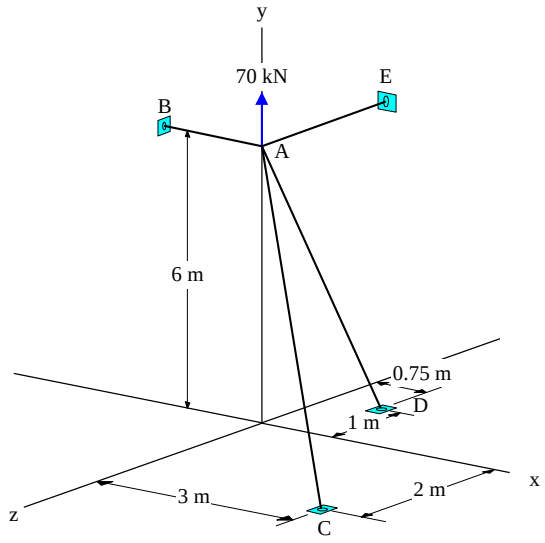
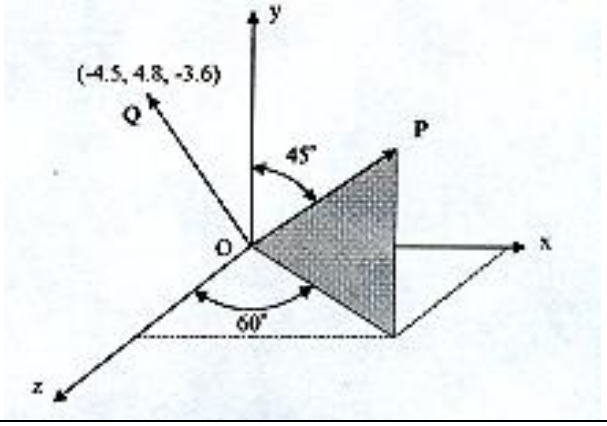
NAME:_____Student #_____ GROUP:_____

ENG 1440 Assignment #6 solution

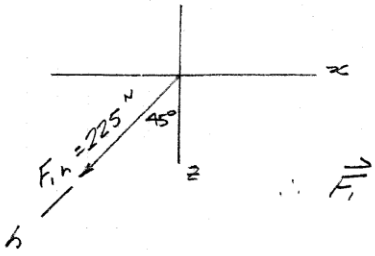
1. Determine the resultant of the two forces shown. Line Oh lies in the xz-plane.	
2. Four cables are connected at A, where an upward force of 70 kN is applied. Determine the tension in each cable if the tension in cable AB is 20 kN.	
3) Find the magnitude and direction of the resultant, R, of the two forces shown, knowing, P=6000N and Q=7500 All dimensions are in metres	

1)

For $\vec{F}_1$: $F_1 = 450^N$

$F_{1y} = 450\cos 30° = 389.71^N$

$F_{1h} = 450\cos 60° = 225^N$



$F_z = 225\cos 45° = 159.1^N$

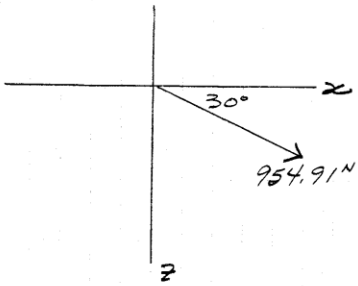
$F_x = -225\sin 45° = -159.1^N$

$\therefore \vec{F}_1 = -159.1\hat{i} + 389.71\hat{j} + 159.1\hat{k}$ N

For $\vec{F}_2$: $F_2 = 1350^N$

$F_{2y} = -1350\sin 45° = -954.59^N$

$F_{2h} = 1350\cos 45° = 954.59^N$



$F_{2x} = 954.91\cos 30° = 826.98^N$

$F_{2z} = 954.91\sin 30° \quad 477.46^N$

$\therefore \vec{F}_2 = 826.98\hat{i} - 954.59\hat{j} + 477.46\hat{k}$ N

$\vec{R} = \vec{F}_1 + \vec{F}_2 = (-159.1 + 826.98)\hat{i} + (389.71 - 954.59)\hat{j} + (159.1 + 477.46)\hat{k}$ N

$\vec{R} = 667.88\hat{i} - 564.88\hat{j} + 636.56\hat{k}$ N

$R = \sqrt{667.88^2 + (-564.88)^2 + (636.56^2} = 1081.83$ N

$\theta_x = \cos^{-1}\frac{R_x}{R} = \cos^{-1}\frac{667.88}{1081.83} \qquad \theta_x = 51.88°$

$\theta_y = \cos^{-1}\frac{R_y}{R} = \cos^{-1}\frac{-564.88}{1081.83} \qquad \theta_y = 121.48°$

$\theta_z = \cos^{-1}\frac{R_z}{R} = \cos^{-1}\frac{636.56}{1081.83} \qquad \theta_z = 53.96°$

2)

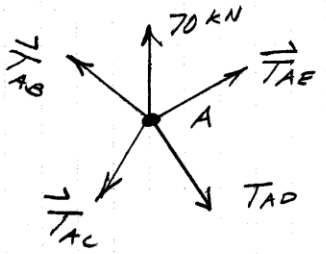
$A(0, 6, 0)$ $D(0.75, 0, -1)$

$B(?, 6, 0)$

$C(3, 0, 2)$

$E(0, 6, ?)$

Tension in AB = 20 kN



FBD of Point A

$\vec{T}_{AB} = -20\,\hat{i}$

$\vec{T}_{AE} = -T_{AE}\,\hat{k}$

$\vec{T}_{AC} = T_{AC}\,\vec{\lambda}_{AC}$ $\quad \vec{\lambda}_{AC} = \dfrac{\vec{AC}}{AC}$ $\quad \vec{AC} = 3\hat{i} - 6\hat{j} + 2\hat{k}$

$AC = \sqrt{3^2 + (-6)^2 + 2^2} = 7$

$\vec{T}_{AC} = T_{AC}\left(\frac{3}{7}\hat{i} - \frac{6}{7}\hat{j} + \frac{2}{7}\hat{k}\right)$

$= \frac{3}{7}T_{AC}\,\hat{i} - \frac{6}{7}T_{AC}\,\hat{j} + \frac{2}{7}T_{AC}\,\hat{k}$

$\vec{T}_{AD} = T_{AD}\,\vec{\lambda}_{AD}$ $\quad \vec{\lambda}_{AD} = \dfrac{\vec{AD}}{AD}$ $\quad \vec{AD} = 0.75\hat{i} - 6\hat{j} - 1\hat{k}$

$AD = \sqrt{(0.75)^2 + (-6)^2 + (-1)^2} = \sqrt{37.5625}$

$\vec{\lambda}_{AD} = \dfrac{0.75\hat{i} - 6\hat{j} - 1\hat{k}}{\sqrt{37.5625}}$

$\vec{T}_{AD} = 0.1224\,T_{AD}\,\hat{i} - 0.979\,T_{AD}\,\hat{j} - 0.1632\,T_{AD}\,\hat{k}$

5.18

$\Sigma F_x = 0$

$$-20 + \frac{3}{7} T_{AC} + 0.1224 T_{AD} = 0 \quad (1)$$

$\Sigma F_y = 0$

$$70 - \frac{6}{7} T_{AC} - 0.979 T_{AD} = 0 \quad (2)$$

$\Sigma F_z = 0$

$$-T_{AE} + \frac{2}{7} T_{AC} - 0.1632 T_{AD} = 0 \quad (3)$$

$$-40 + \frac{6}{7} T_{AC} + 0.2448 T_{AD} = 0$$

$$70 - \frac{6}{7} T_{AC} - 0.979 T_{AD} = 0$$

$$30 - 0.7342 T_{AD} = 0$$

$$T_{AD} = \frac{30}{0.7342} = 40.86 \text{ kN}$$

$$70 - \frac{6}{7} T_{AC} - 0.979(40.86) = 0$$

$$\frac{6}{7} T_{AC} = 30 \qquad T_{AC} = 35 \text{ kN}$$

$$T_{AE} = \frac{2}{7}(35) - 0.1632(40.86)$$

$$T_{AE} = 3.33 \text{ kN}$$

3)

$$\bar{Q} = Q\,\bar{\lambda}_{OQ} \qquad \bar{\lambda}_{OQ} = \frac{\bar{OQ}}{OQ}$$

$$= \frac{-4.5\bar{i} + 4.8\bar{j} - 3.6\bar{k}}{\sqrt{(-4.5)^2 + (4.8)^2 + (-3.6)^2}}$$

$$= -0.6\,\bar{i} + 0.64\,\bar{j} - 0.48\,\bar{k}$$

$$Q = 7500\,\bar{\lambda}_{OQ}$$

$$= -4500\,\bar{i} + 4800\,\bar{j} - 3600\,\bar{k}$$

$$\bar{P} = P_x\,\bar{i} + P_y\,\bar{j} + P_z\,\bar{k}$$

$$= (P\cos 45^\circ)\cos 30^\circ\,\bar{i} + (P\cos 45^\circ)\,\bar{j} + (P\cos 45^\circ)\cos 60^\circ\,\bar{k}$$

$$= 3674.2\,\bar{i} + 4242.6\,\bar{j} + 2121.3\,\bar{k}$$

$$\bar{R} = \bar{P} + \bar{Q} = -825.8\,\bar{i} + 9042.6\,\bar{j} - 1478.7\,\bar{k}$$

$$R = 9199.8\ \text{N} \quad \blacktriangleleft$$

$$\lambda_R = -0.0898\,\bar{i} + 0.9829\,\bar{j} - 0.1607\,\bar{k}$$

$$\cos\theta_x = -0.0898 \qquad \theta_x = 95.1^\circ \quad \blacktriangleleft$$

$$\cos\theta_y = 0.9829 \qquad \theta_y = 10.6^\circ \quad \blacktriangleleft$$

$$\cos\theta_z = -0.1607 \qquad \theta_z = 99.2^\circ \quad \blacktriangleleft$$