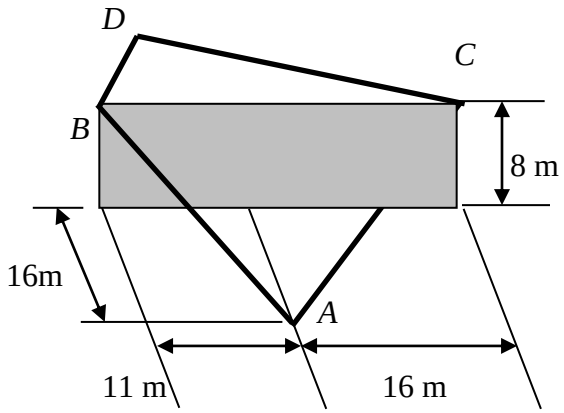
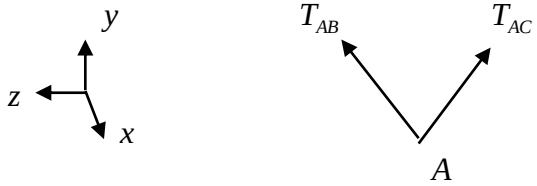
TUTORIAL-1 ENGINEERING MECHANICS SOLUTION

1. Given: A precast-concrete wall section is temporarily held by the cable shown. The tension in cable *AB* is 840 N and the tension in cable *AC* is 1200 N.



Find: The magnitude and direction of the resultant of the forces exerted by cables *AB* and *AC* on stake *A*.

Put coordinate system in lower, left corner of wall.



A (16, 0, -11), *B* (0, 8, 0), *C* (0, 8, -27)

$$\vec{R} = \vec{T}_{AB} + \vec{T}_{AC}$$

$$\vec{T}_{AB} = T_{AB}\vec{u}_{AB} = 840\frac{(0-16)\hat{i} + (8-0)\hat{j} + (0-(-11))\hat{k}}{\sqrt{16^2 + 8^2 + 11^2}}$$

$$\vec{T}_{AB} = -640\hat{i} + 320\hat{j} + 440\hat{k}$$

$$\vec{T}_{AC} = T_{AC}\vec{u}_{AC} = 1200\left[\frac{(0-16)\hat{i} + (8-0)\hat{j} + (-27-(-11)\hat{k}}{\sqrt{16^2 + 8^2 + 16^2}}\right]$$

$$\vec{T}_{AC} = -800\hat{i} + 400\hat{j} - 800\hat{k}$$

$$\vec{R} = -(-640\hat{i} + 320\hat{j} + 440\hat{k}) + (-800\hat{i} + 400\hat{j} - 800\hat{k})$$

$$\vec{R} = -1440\hat{i} + 720\hat{j} - 360\hat{k}$$

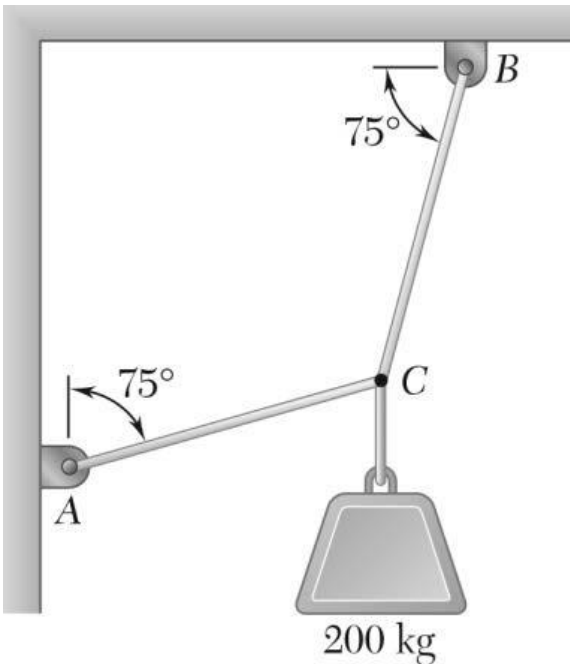
$R = 1649.73$ N

$$\vec{u}_R = -0.873\hat{i} + 0.436\hat{j} - 0.218\hat{k}$$

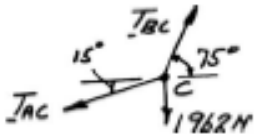
or

$$\theta_x = 150.8^\circ \quad \theta_y = 64.2^\circ \quad \theta_z = 102.6^\circ$$

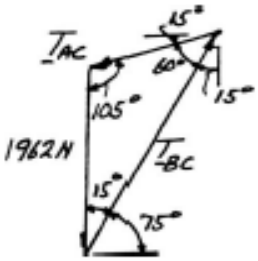
2. Two cables are tied together at C and are loaded as shown. Determine the tension (a) in cable AC, (b) in cable BC.



Free-Body Diagram



Force Triangle



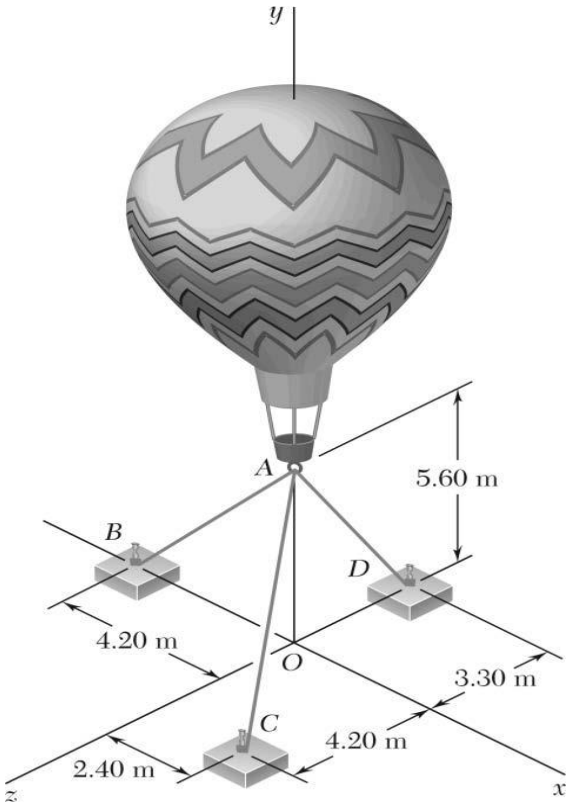
$$W = mg$$
$$= (200\text{ kg})(9.81\text{ m/s}^2)$$
$$= 1962\text{ N}$$

Law of sines:
$$\frac{T_{AC}}{\sin 15^\circ} = \frac{T_{BC}}{\sin 105^\circ} = \frac{1962\text{ N}}{\sin 60^\circ}$$

(*a*)
$$T_{AC} = \frac{(1962\text{ N})\sin 15^\circ}{\sin 60^\circ} \qquad T_{AC} = 586\text{ N} \blacktriangleleft$$

(*b*)
$$T_{BC} = \frac{(1962\text{ N})\sin 105^\circ}{\sin 60^\circ} \qquad T_{BC} = 2190\text{ N} \blacktriangleleft$$

3. Three cables are used to tether a balloon as shown. Determine the vertical force P exerted by the balloon at A knowing that the tension in cable AC is 44 N.



$$-0.6T_{AB} + 0.32432T_{AC} = 0 \tag{1}$$

$$-0.8T_{AB} - 0.75676T_{AC} - 0.86154T_{AD} + P = 0 \tag{2}$$

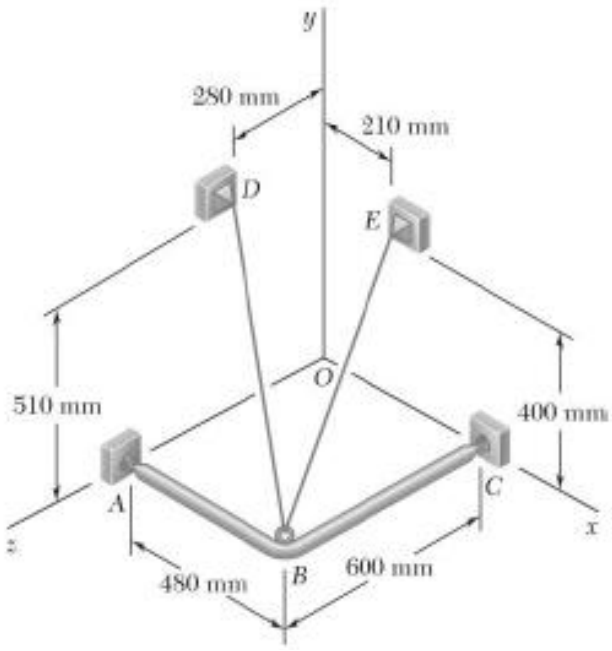
$$0.56757T_{AC} - 0.50769T_{AD} = 0 \tag{3}$$

Substituting $T_{AC} = 444$ N in Equations (1), (2), and (3) above, and solving the resulting set of equations using conventional algorithms gives

$$T_{AB} = 240 \text{ N}$$
$$T_{AD} = 496.36 \text{ N}$$

$$\mathbf{P} = 956 \text{ N} \uparrow \blacktriangleleft$$

4. A frame ABC is supported in part by cable DBE that passes through a frictionless ring at B. Knowing that the tension in the cable is 385 N, determine the components of the force exerted by the cable on the support at D.



$$\overrightarrow{DB} = (480\text{ mm})\mathbf{i} - (510\text{ mm})\mathbf{j} + (320\text{ mm})\mathbf{k}$$

$$DB = \sqrt{(480\text{ mm})^2 + (510\text{ mm}^2) + (320\text{ mm})^2}$$

$$= 770\text{ mm}$$

$$\mathbf{F} = F\boldsymbol{\lambda}_{DB}$$

$$= F\frac{\overrightarrow{DB}}{DB}$$

$$= \frac{385\text{ N}}{770\text{ mm}}[(480\text{ mm})\mathbf{i} - (510\text{ mm})\mathbf{j} + (320\text{ mm})\mathbf{k}]$$

$$= (240\text{ N})\mathbf{i} - (255\text{ N})\mathbf{j} + (160\text{ N})\mathbf{k}$$

$$F_x = +240\text{ N}, \quad F_y = -255\text{ N}, \quad F_z = +160.0\text{ N} \blacktriangleleft$$