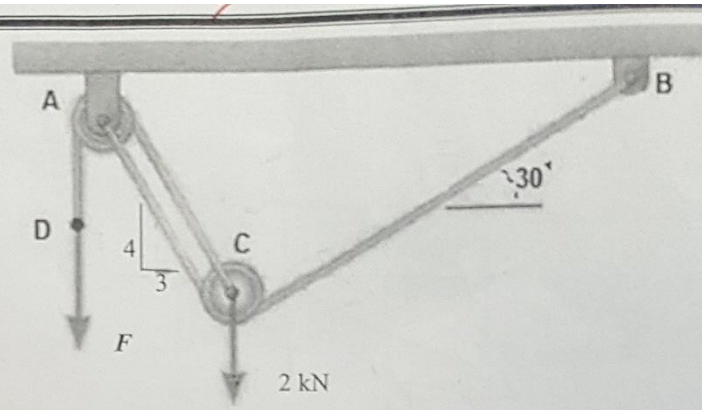
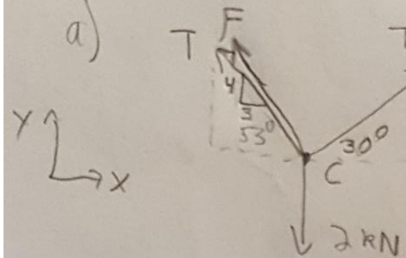
1. (a) Draw a free-body diagram of pulley *C* or point *C*.
(b) Determine the downward force F required for equilibrium and the corresponding tension in the cable *ACB*. The pulleys are ideal pulleys.

Solutions without free-body diagrams will receive zero credit.



a)



ok

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b) $\Sigma F_y = 0 = \frac{4}{5}T + \frac{4}{5}F + \sin 30^\circ T - 2 = T\left(\frac{4}{5} + \sin 30^\circ\right) + \frac{4}{5}F - 2$

$\Sigma F_x = 0 = -\frac{3}{5}T - \frac{3}{5}F + \cos 30^\circ T = T\left(-\frac{3}{5} + \cos 30^\circ\right) - \frac{3}{5}F$

$2 = 1.3T + .8F$

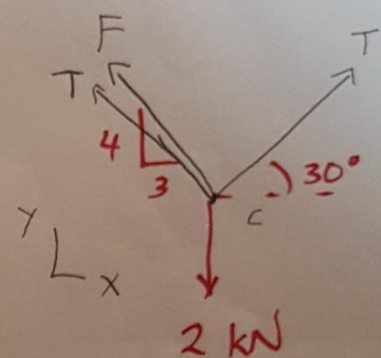
$0 = 0.266T - .6F$

[calc]

$T = 1.209$ kN

$F = 0.536$ kN

(a) Free-body diagram:

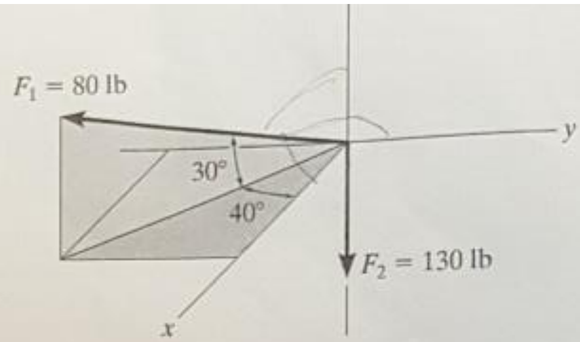


(b)

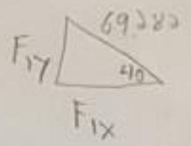
F = 0.536 kN

T = 1.21 kN

2. For $\overrightarrow{F_R} = \overrightarrow{F_1} + \overrightarrow{F_2}$, determine the magnitude and direction angles of $\overrightarrow{F_R}$.



$F_1' = 80 \cos 30^\circ$
$= 69.282$ lb



$F_{1x} = 69.282 \cos 40^\circ$
$= 53.073$ lb

$F_{1y} = 69.282 \sin 40^\circ$
$= 44.534$ lb

$F_{1z} = 80 \sin 30^\circ$
$= 40$ lb

$\theta_{Rx} = \cos^{-1} \frac{F_{Rx}}{F_R} = \cos^{-1}\left(\frac{53.073}{113.583}\right) = 62.1^\circ$

$\theta_{Ry} = \cos^{-1} \frac{F_{Ry}}{F_R} = \cos^{-1}\left(\frac{-44.534}{113.583}\right) = 113.1^\circ$

$\theta_{Rz} = \cos^{-1} \frac{F_{Rz}}{F_R} = \cos^{-1}\left(\frac{-90}{113.583}\right) = 142.4^\circ$

$\vec{F_1} = 53.073\,\hat{i} - 44.534\,\hat{j} + 40\,\hat{k}$ lb

$\vec{F_2} = -130\,\hat{k}$ lb

$\vec{F_R} = \vec{F_1} + \vec{F_2}$
$= 53.073\,\hat{i} - 44.534\,\hat{j} - 90\,\hat{k}$ lb

$|F_R| = \sqrt{53.073^2 + (-44.534)^2 + (-90)^2}$
$= 113.582$ lb

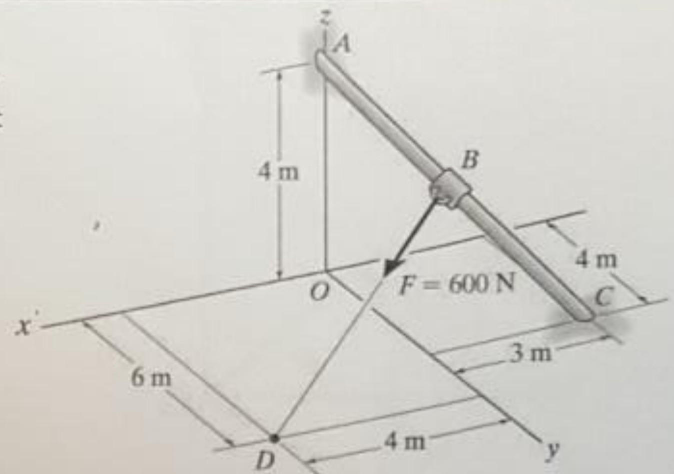
$F_R =$ 113.6 lb

$\theta_{Rx} =$ 62.1°

$\theta_{Ry} =$ 113°

$\theta_{Rz} =$ 142°

3. Point *B* has coordinates (-1.5, 2, 2) m. The tension force in cable *BD* is 600 N. Determine the components of that tension force acting along bar *AC* and perpendicular to bar *AC*. Report the magnitude of each component.



$\vec{F} = F\,\hat{n}_{BD} \qquad F = 600\ N$

$\hat{n}_{BD} = \dfrac{5.5\hat{i} + 4\hat{j} - 2\hat{k}}{\sqrt{5.5^2 + 4^2 + (-2)^2}}$

$= 0.776\hat{i} + 0.564\hat{j} - 0.282\hat{k}$

$\vec{F} = 600\,\hat{n}_{BD}$

$= 465.528\hat{i} + 338.566\hat{j} - 169.283\hat{k}$

$F_{\parallel AC} = \vec{F} \cdot \hat{n}_{AC}$

$\hat{n}_{AC} = \dfrac{-3\hat{i} + 4\hat{j} - 4\hat{k}}{\sqrt{9 + 16 + 16}}$

$= -0.469\hat{i} + 0.625\hat{j} - 0.625\hat{k}$

$= -218.333 + 211.604 + 105.802$

$= 99.073\ N$

$F^2 = F_{\parallel AC}^2 + F_{\perp AC}^2$

$F_{\perp AC} = \sqrt{F^2 - F_{\parallel AC}^2}$

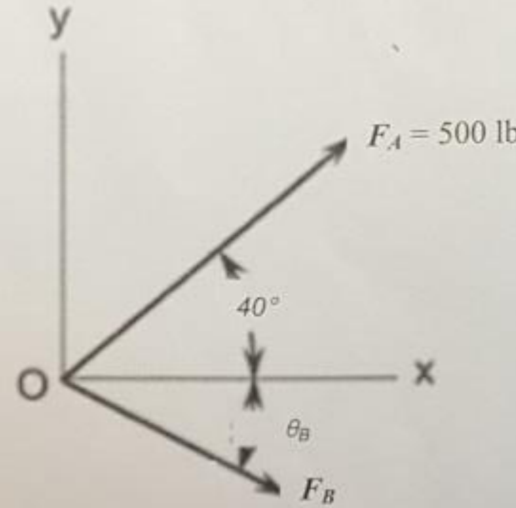
$= \sqrt{600^2 - 99.073^2}$

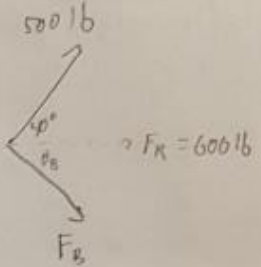
$= 591.764\ N$

$F_{\parallel AC} =$ 99.1 N

$F_{\perp AC} =$ 592 N

4. Two forces F_A and F_B act at a point. The resultant force F_R has magnitude 600 lb and acts along the positive x-axis. Determine the magnitude of F_B and the angle it forms with the x-axis θ_B.





$$\Sigma F_x = 600 = 500\cos 40^\circ + F_B \cos\theta_B$$

$$\Sigma F_y = 0 = 500\sin 40^\circ - F_B \sin\theta_B$$

$$F_B = \frac{500\sin 40^\circ}{\sin\theta_B}$$

$$600 = 500\cos 40^\circ + 500\sin 40^\circ \cot\theta_B$$

$$\cot\theta_B = \frac{600 - 500\cos 40^\circ}{500\sin 40^\circ}$$

$$\theta_B = \cot^{-1}\left(\frac{600 - 500\cos 40^\circ}{500\sin 40^\circ}\right)$$

$$= 55.976^\circ$$

$$F_B = \frac{500\sin 40^\circ}{\sin(55.976^\circ)}$$

$$= 387.781 \text{ lb}$$

F_B = 388 lb

θ_B = 56.0°