2/1

$$\begin{cases} F_x = -800 \sin 35° = \underline{-459 \text{ N}} \\ F_y = 800 \cos 35° = \underline{655 \text{ N}} \end{cases}$$

$$\underline{\underline{F} = -459\underline{i} + 655\underline{j} \text{ N}}$$

2/2

$$\mathbf{F} = 7(-\sin 25^\circ\,\mathbf{i} + \cos 25^\circ\,\mathbf{j})$$

$$\underline{\mathbf{F} = -2.96\,\mathbf{i} + 6.34\,\mathbf{j}\ \text{kN}}$$

• SCALAR COMPONENTS

$$\underline{F_x = -2.96\ \text{kN}}$$

$$\underline{F_y = 6.34\ \text{kN}}$$

2/3

$$\underline{F} = 6.5\left(-\frac{12}{13}\underline{i} - \frac{5}{13}\underline{j}\right)$$

$$= \overline{-6\underline{i} - 2.5\underline{j} \text{ kN}}$$

(Note: Writing 6, rather than 6.00, indicates an exact result.)

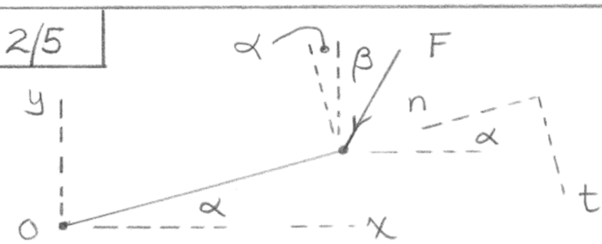
2/4

$$\underline{n} = \frac{13\underline{i} - 15\underline{j}}{\sqrt{13^2 + 15^2}} \longrightarrow \underline{\underline{n} = 0.655\underline{i} - 0.756\underline{j}}$$

• Scalar Components:

$$\begin{cases} F_x = F n_x = 6(0.655) \longrightarrow \underline{F_x = 3.93 \text{ kN}} \\ F_y = F n_y = 6(-0.756) \longrightarrow \underline{F_y = -4.53 \text{ kN}} \end{cases}$$

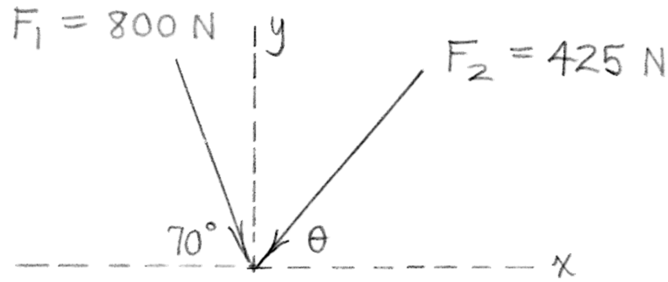
2/5



$$\begin{cases} F_x = -F\sin\beta \\ F_y = -F\cos\beta \end{cases}$$

$$\begin{cases} F_n = F\sin(\alpha+\beta) \\ F_t = F\cos(\alpha+\beta) \end{cases}$$

2/6



$$R_x = \Sigma F_x = 800 \cos 70° - 425 \cos\theta = 0$$

$$\underline{\theta = 49.9°}$$

$$R_y = \Sigma F_y = -800 \sin 70° - 425 \sin 49.9°$$

$$= -1077 \text{ N}$$

So $\underline{R = 1077 \text{ N}}$

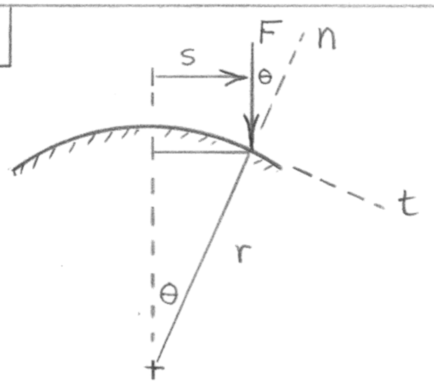
2/7

$$\begin{cases} \underline{R} = (500 + 350\cos 60^\circ)\,\underline{i} + 350\sin 60^\circ\,\underline{j} \\ \underline{\underline{R} = 675\,\underline{i} + 303\,\underline{j}\ \text{N}} \end{cases}$$

$$R = \sqrt{675^2 + 303^2} \longrightarrow \underline{R = 740\ \text{N}}$$

$$\theta_x = \cos^{-1}\left(\frac{R_x}{R}\right) = \cos^{-1}\left(\frac{675}{740}\right) \longrightarrow \underline{\theta_x = 24.2^\circ \ \text{ABOVE } +x \text{ AXIS}}$$

2/8



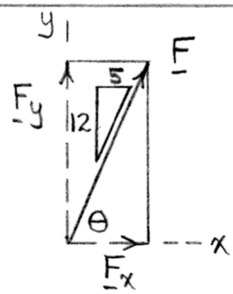
$$\theta = \sin^{-1}\left(\frac{s}{r}\right)$$

$$F_t = F\sin\theta = F\sin\left[\sin^{-1}\left(\frac{s}{r}\right)\right] = \underline{\frac{Fs}{r}}$$

$$F_n = -F\cos\theta = -F\cos\left[\sin^{-1}\left(\frac{s}{r}\right)\right]$$

$$= \underline{-\frac{F\sqrt{r^2-s^2}}{r}}$$

2/9



$\cos\theta = \frac{5}{13}$, $\sin\theta = \frac{12}{13}$

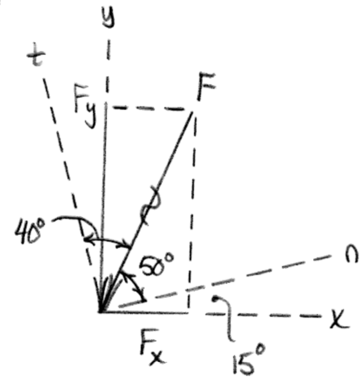
$F_y = F\sin\theta = F\frac{12}{13} = 320 \text{ N}$

$\underline{F = 347 \text{ N}}$

$F_x = F\cos\theta = 347\left(\frac{5}{13}\right) = \underline{133.3 \text{ N}}$

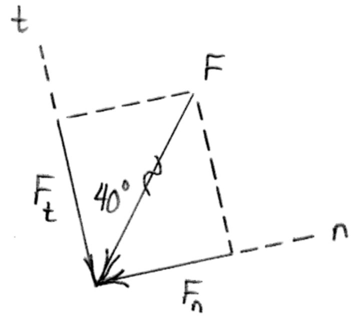
2/10

$F = 65\ \text{kN}$



$$\begin{cases} F_x = -F\cos 65^\circ = -65\cos 65^\circ \\ \underline{F_x = -27.5\ \text{kN}} \end{cases}$$

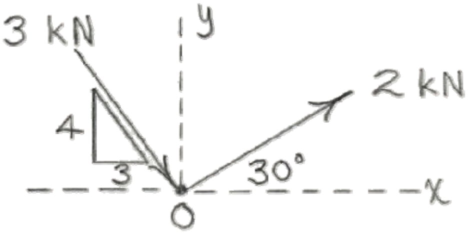
$$\begin{cases} F_y = -F\sin 65^\circ = -65\sin 65^\circ \\ \underline{F_y = -58.9\ \text{kN}} \end{cases}$$



$$\begin{cases} F_n = -F\sin 40^\circ = -65\sin 40^\circ \\ \underline{F_n = -41.8\ \text{kN}} \end{cases}$$

$$\begin{cases} F_t = -F\cos 40^\circ = -65\cos 40^\circ \\ \underline{F_t = -49.8\ \text{kN}} \end{cases}$$

2/11



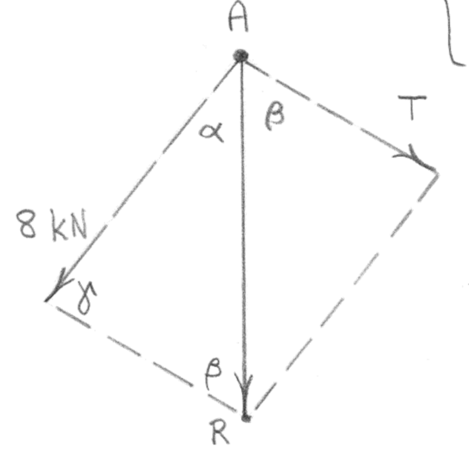
$$\begin{cases} R_x = \Sigma F_x = +3\left(\frac{3}{5}\right) + 2\cos 30° = 3.53 \text{ kN} \\ R_y = \Sigma F_y = -3\left(\frac{4}{5}\right) + 2\sin 30° = -1.4 \text{ kN} \end{cases}$$

$$R = \sqrt{R_x^2 + R_y^2} = \underline{3.80 \text{ kN}}$$

$$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) = \tan^{-1}\left(\frac{-1.4}{3.53}\right) = 338°$$

$$\underline{(\text{or } -21.6°)}$$

2/12



$$\begin{cases} \alpha = \tan^{-1}\frac{40}{50} = 38.7^\circ \\ \beta = \tan^{-1}\frac{50}{30} = 59.0^\circ \end{cases}$$

$$\gamma = 180^\circ - \alpha - \beta$$

$$= 82.3^\circ$$

$$\frac{\sin\beta}{8} = \frac{\sin\alpha}{T}$$

$$\underline{T = 5.83 \text{ kN}}$$

$$\frac{\sin\beta}{8} = \frac{\sin\gamma}{R}, \qquad \underline{R = 9.25 \text{ kN}}$$

2/13

$$R_x = \Sigma F_x = 400 + 400 \cos 60^\circ = 600 \text{ N}$$

$$R_y = \Sigma F_y = 400 \sin 60^\circ = 346 \text{ N}$$

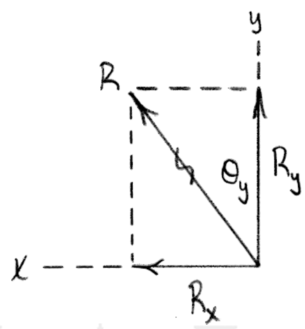
$$\Rightarrow \underline{R} = \underline{600\underline{i} + 346\underline{j} \text{ N}}$$

$$R = \sqrt{600^2 + 346^2} = \underline{693 \text{ N}}$$

2/14

$$\underline{R} = (175\cos 40^\circ + 125\sin 15^\circ)\,\underline{i} + (175\sin 40^\circ + 125\cos 15^\circ)\,\underline{j}$$

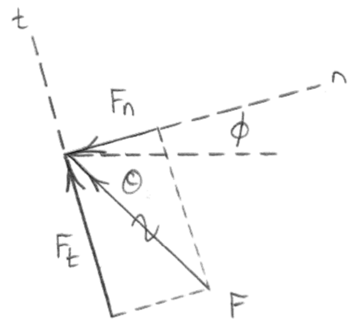
$$\underline{R} = 166.4\,\underline{i} + 233\,\underline{j} \text{ N}$$



$$\theta_y = \tan^{-1}\left(\frac{R_x}{R_y}\right) = \tan^{-1}\left(\frac{166.4}{233}\right)$$

$$\theta_y = 35.5^\circ \text{ CCW OFF } +y\text{-AXIS}$$

2/15



$$\begin{cases} \underline{F_n = -F\cos(\theta+\phi)} \\ \underline{F_t = F\sin(\theta+\phi)} \end{cases}$$

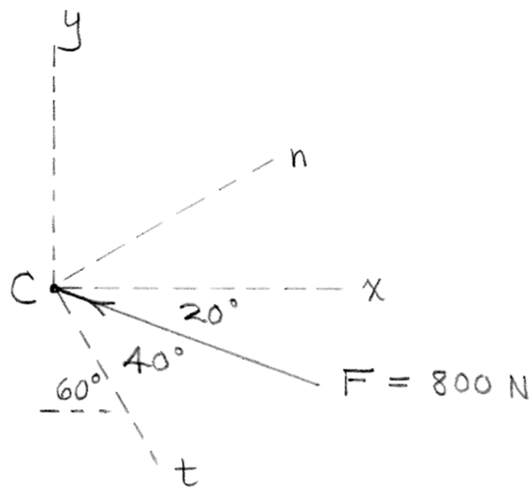
a) $F = 500\text{ N}$, $\theta = 60°$, $\phi = 20°$

$$\begin{cases} F_n = -500\cos(60° + 20°) \longrightarrow \underline{F_n = -86.8\text{ N}} \\ F_t = 500\sin(60° + 20°) \longrightarrow \underline{F_t = 492\text{ N}} \end{cases}$$

b) $F = 800\text{ N}$, $\theta = 45°$, $\phi = 150°$

$$\begin{cases} F_n = -800\cos(45° + 150°) \longrightarrow \underline{F_n = 773\text{ N}} \\ F_t = 800\sin(45° + 150°) \longrightarrow \underline{F_t = -207\text{ N}} \end{cases}$$

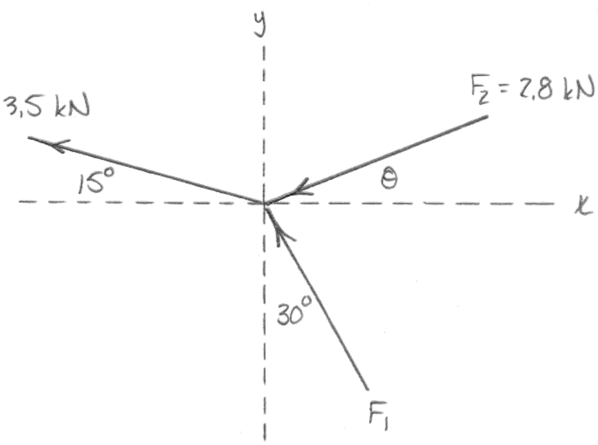
2/16



$$\begin{cases} F_x = -800 \cos 20° = \underline{-752 \text{ N}} \\ F_y = 800 \sin 20° = \underline{274 \text{ N}} \end{cases}$$

$$\begin{cases} F_n = -800 \sin 40° = \underline{-514 \text{ N}} \\ F_t = -800 \cos 40° = \underline{-613 \text{ N}} \end{cases}$$

2/17



$$\begin{cases} R_x = \Sigma F_x: & -3.5\cos 15^\circ = -F_1 \sin 30^\circ - 2.8\cos\theta \quad (1) \\ R_y = \Sigma F_y: & 3.5 \sin 15^\circ = F_1 \cos 30^\circ - 2.8 \sin\theta \quad (2) \end{cases}$$

Solving (1) and (2)...

$$\begin{cases} F_1 = 1.165 \text{ kN} \\ \theta = 2.11^\circ \end{cases} \quad \text{OR} \quad \begin{cases} F_1 = 3.78 \text{ kN} \\ \theta = 57.9^\circ \end{cases}$$

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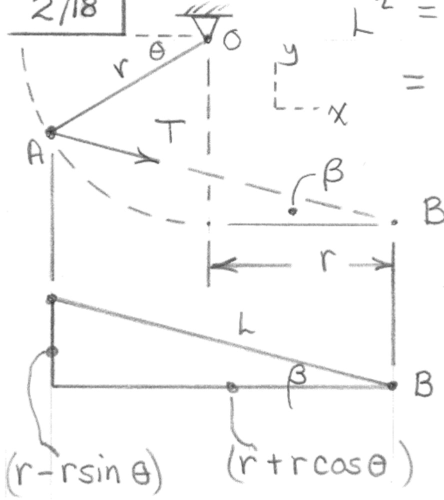

$$L^2 = (r - r\sin\theta)^2 + (r + r\cos\theta)^2$$

$$= r^2 - 2r^2\sin\theta + r^2\sin^2\theta$$

$$+ r^2 + 2r^2\cos\theta + r^2\cos^2\theta$$

$$= r^2(3 + 2\cos\theta - 2\sin\theta)$$

So $\cos\beta = \dfrac{r(1+\cos\theta)}{r\sqrt{3+2\cos\theta-2\sin\theta}}$

$$= \frac{1+\cos\theta}{\sqrt{3+2\cos\theta-2\sin\theta}}$$

$$\sin\beta = \frac{1-\sin\theta}{\sqrt{3+2\cos\theta-2\sin\theta}}$$

$$T_x = T\cos\beta = \underline{\frac{T(1+\cos\theta)}{\sqrt{3+2\cos\theta-2\sin\theta}}}$$

$$T_y = -T\sin\beta = \underline{\frac{T(\sin\theta-1)}{\sqrt{3+2\cos\theta-2\sin\theta}}}$$

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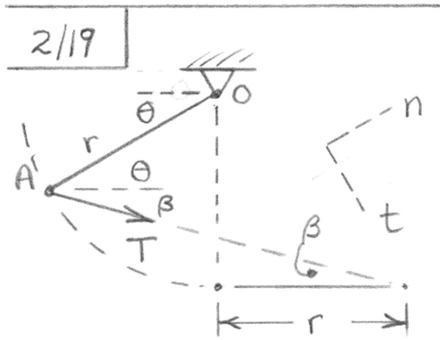


From solution to previous problem:

$$\beta = \tan^{-1}\left[\frac{1-\sin\theta}{1+\cos\theta}\right]$$

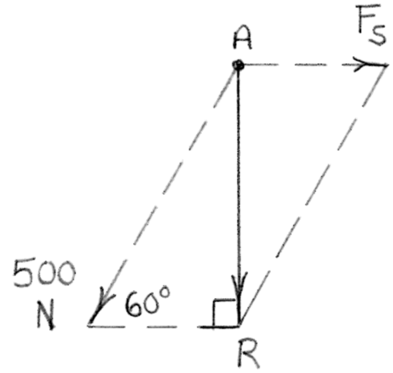
$$\begin{cases} T_n = T\cos(\theta+\beta) \\ T_t = T\sin(\theta+\beta) \end{cases}$$

For $T = 100$ N and $\theta = 35°$:

$\beta = 13.19°$

$$\begin{cases} T_n = 66.7 \text{ N} \\ T_t = 74.5 \text{ N} \end{cases}$$

2/20



$$\cos 60° = \frac{F_s}{500}$$

$$F_s = 250 \text{ N}$$

$$\sin 60° = \frac{R}{500}$$

$$R = 433 \text{ N}$$

2/21 Using the coordinates of the problem figure:

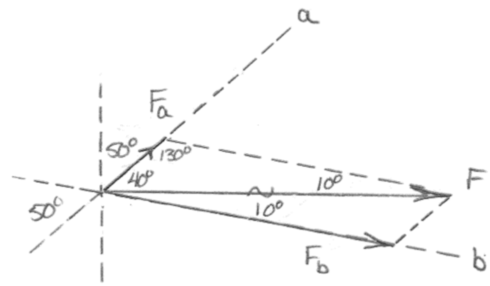
$$R_x = \Sigma F_x = 200 \cos 35° - 150 \sin 30°$$
$$= 88.8 \text{ N}$$

$$R_y = \Sigma F_y = 200 \sin 35° + 150 \cos 30°$$
$$= 245 \text{ N}$$

$$\therefore \underline{R} = 88.8\underline{i} + 245\underline{j} \text{ N}$$

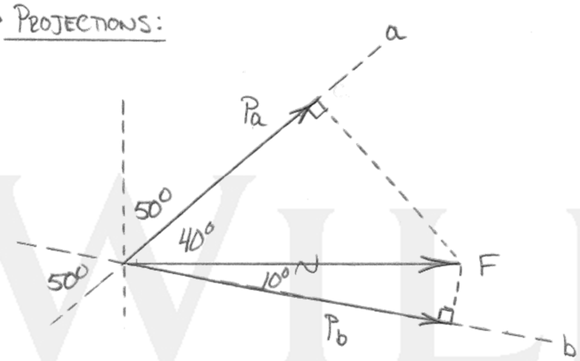
2/22 $F = 2.5$ kN

• COMPONENTS:



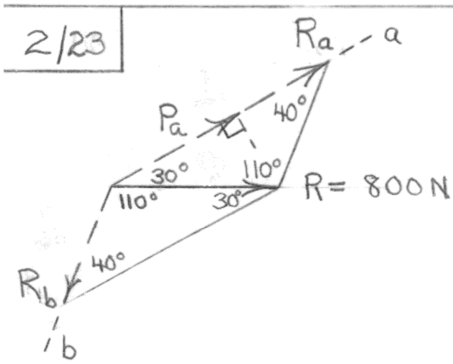
$$\frac{F}{\sin 130^\circ} = \frac{F_a}{\sin 10^\circ} = \frac{F_b}{\sin 40^\circ} \longrightarrow \begin{cases} F_a = 0.567 \text{ kN} \\ F_b = 2.10 \text{ kN} \end{cases}$$

• PROJECTIONS:



$$\begin{cases} P_a = F\cos 40^\circ = 2.5\cos 40^\circ \longrightarrow P_a = 1.915 \text{ kN} \\ P_b = F\cos 10^\circ = 2.5\cos 10^\circ \longrightarrow P_b = 2.46 \text{ kN} \end{cases}$$

2/23



Law of sines:

$$\frac{800}{\sin 40^\circ} = \frac{R_a}{\sin 110^\circ} = \frac{R_b}{\sin 30^\circ}$$

$\underline{R_a = 1170 \text{ N}}$

$\underline{R_b = 622 \text{ N}}$

Projection $P_a = R\cos 30^\circ = 800\cos 30^\circ = \underline{693 \text{ N}}$

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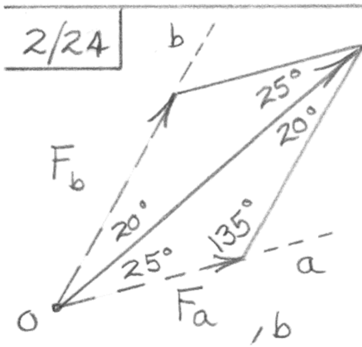
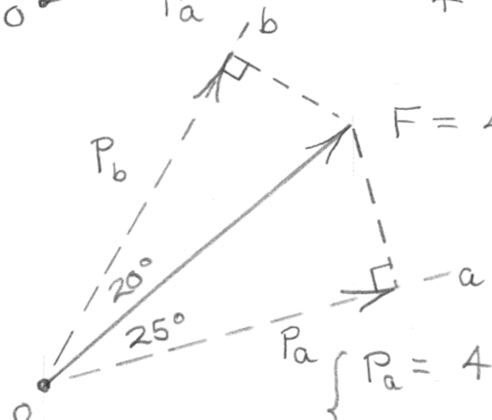


Components:

$\dfrac{\sin 135°}{4} = \dfrac{\sin 20°}{F_a}$, $\underline{F_a = 1.935 \text{ kN}}$

$\dfrac{\sin 135°}{4} = \dfrac{\sin 25°}{F_b}$, $\underline{F_b = 2.39 \text{ kN}}$



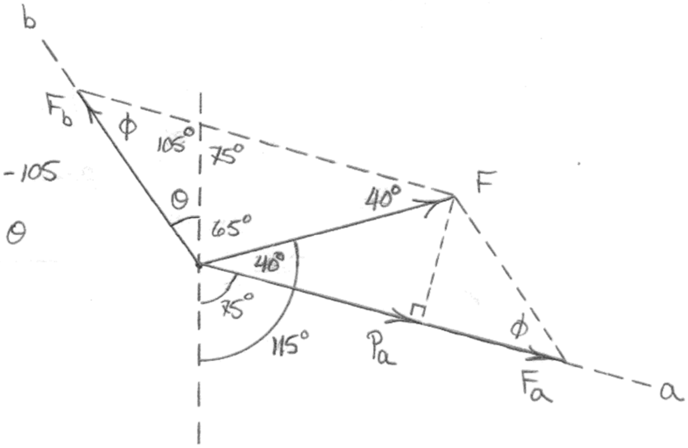
Projections:

$$\begin{cases} P_a = 4 \cos 25° = \underline{3.63 \text{ kN}} \\ P_b = 4 \cos 20° = \underline{3.76 \text{ kN}} \end{cases}$$

2/25

$\phi = 180 - \theta - 105$

$\phi = 75° - \theta$



$P_a = F\cos 40° \longrightarrow 325 = F\cos 40° \longrightarrow \underline{F = 424 \text{ N}}$

$$\frac{F}{\sin\phi} = \frac{F_b}{\sin 40°} \longrightarrow \frac{424}{\sin(75°-\theta)} = \frac{325}{\sin 40°}$$

SOLVING THIS YIELDS... $\underline{\theta = 17.95° \text{ OR } -48.0°}$

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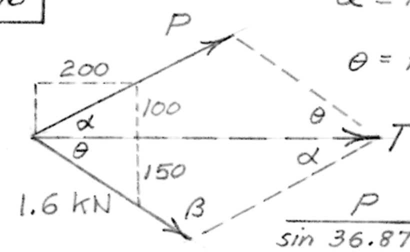

$$\alpha = \tan^{-1}\frac{100}{200} = 26.57°$$

$$\theta = \tan^{-1}\frac{150}{200} = 36.87°$$

$$\beta = 180 - (\alpha + \theta) = 116.57°$$

$$\frac{P}{\sin 36.87°} = \frac{1.6}{\sin 26.57}$$

$$P = 1.6\,\frac{0.6}{0.4472} = \underline{2.15\text{ kN}}$$

$$\frac{T}{\sin 116.57°} = \frac{1.6}{\sin 26.57°}, \quad T = 1.6\,\frac{0.8944}{0.4472} = \underline{3.20\text{ kN}}$$