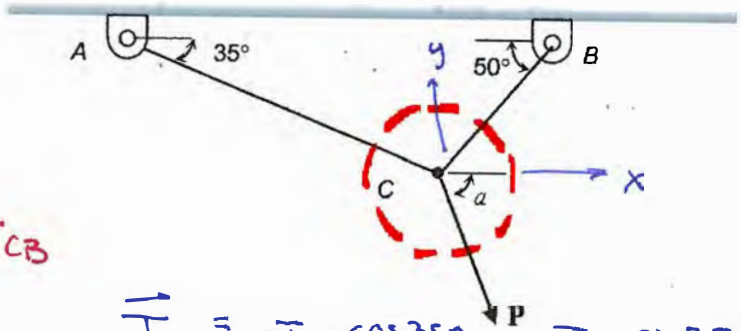
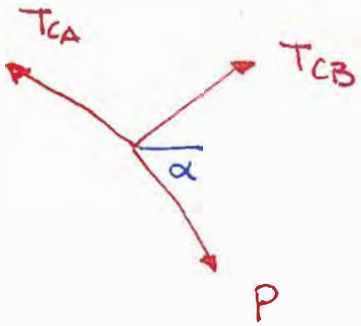
Example

Two cables are tied together as shown. If the largest allowable tension in either cable is 800 N,

a) what is the largest force P that can be applied at C?
b) What is the corresponding angle α?



a)



$\vec{T}_{CA} = -T_{CA}\cos 35\,\hat{i} + T_{CA}\sin 35\,\hat{j}$

$\vec{T}_{CB} = T_{CB}\cos 50\,\hat{i} + T_{CB}\sin 50\,\hat{j}$

$\vec{P} = P\cos\alpha\,\hat{i} - P\sin\alpha\,\hat{j}$

EQUILIBRIUM IN x

$\Sigma F_x = 0 \quad -T_{CA}\cos 35^\circ + T_{CB}\cos 50^\circ + P\cos\alpha = 0 \qquad (1)$

$\Sigma F_y = 0 \quad T_{CA}\sin 35^\circ + T_{CB}\sin 50^\circ - P\sin\alpha = 0 \qquad (2)$

EQNS	UNK.
(1)	T_{CB}
(2)	T_{CA}
(3) $T_{CA} = 800N$	P
(4) $T_{CB} = 800N$	α

NEED TWO MORE EQNS.

FROM (2)

$$P = \frac{T_{CA}\sin 35^\circ + T_{CB}\sin 50^\circ}{\sin\alpha}$$

FOR ANY $\alpha > 0$ P IS LARGER IF BOTH T_{CA} & T_{CB} = 800 N. (LOOKING FOR MAX P)

$\therefore$

$$P = \frac{800\sin 35^\circ + 800\sin 50^\circ}{\sin\alpha}$$

SUB INTO (1)

$$-800\cos 35^\circ + 800\cos 50^\circ + \left[\frac{800\sin 35^\circ + 800\sin 50^\circ}{\sin\alpha}\right]\cos\alpha = 0$$

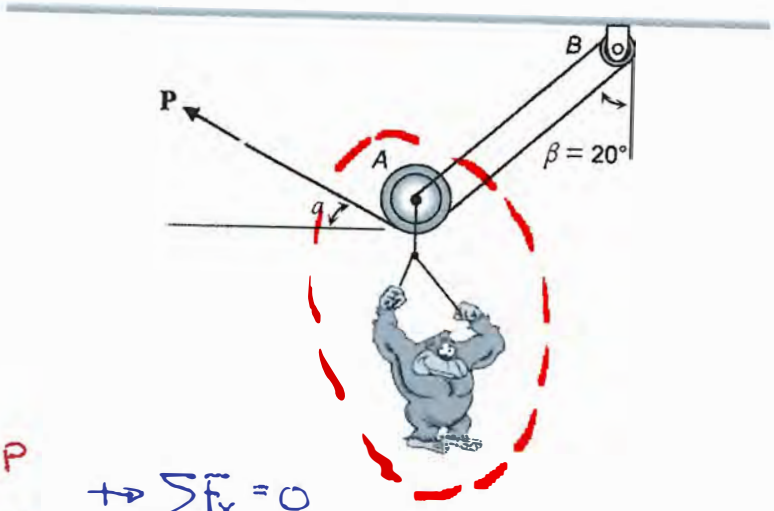
$$\tan\alpha = \frac{800\sin 35^\circ + 800\sin 50^\circ}{800\cos 35^\circ - 800\cos 50^\circ} = 7.596 \qquad \boxed{\alpha = 82.5^\circ}$$

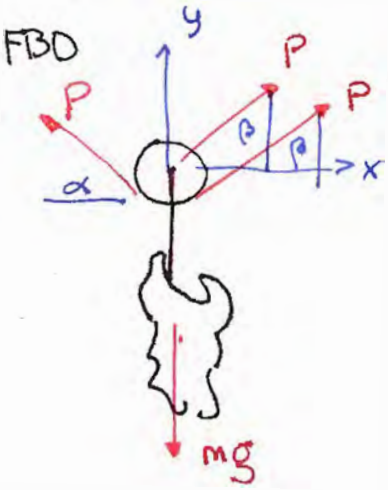
FROM (2)

$$P = \frac{800\sin 35^\circ + 800\sin 50^\circ}{\sin(82.5^\circ)} = \boxed{1081\ \text{N}}$$

Example

A gorilla of mass 160 kg is suspended from a light, inextensible cable making use of two massless, frictionless pulleys as shown in the figure. Find the magnitude of the force **P** that must be applied to keep the gorilla stationary as well as the angle *a*.





$\rightarrow \sum F_x = 0$

$P\sin\beta + P\sin\beta - P\cos\alpha = 0$ (1)

$\uparrow \sum F_y = 0$

$P\sin\alpha + P\cos\beta + P\cos\beta - mg = 0$ (2)

FROM (1)

$2\sin\beta = \cos\alpha \qquad \alpha = \cos^{-1}[2\sin\beta]$

$= \cos^{-1}[2\cdot\sin(20)] = \boxed{46.8°}$

FROM (2)

$P = \dfrac{mg}{\sin\alpha + 2\cos\beta} = \dfrac{160\,kg \cdot 9.81\,\frac{kg}{m\cdot s^2}\left\langle\frac{N\cdot s^2}{kg\cdot m}\right\rangle}{\sin 46.8° + 2\cos 20°}$

$\boxed{602\ N}$