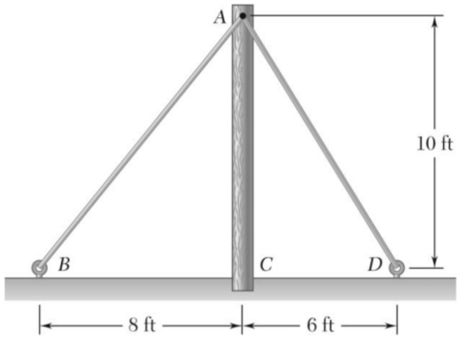
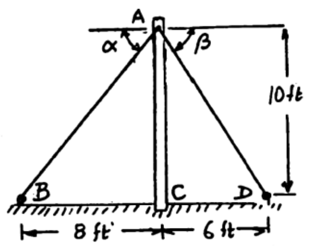


PROBLEM 2.2

The cable stays *AB* and *AD* help support pole *AC*. Knowing that the tension is 120 lb in *AB* and 40 lb in *AD*, determine graphically the magnitude and direction of the resultant of the forces exerted by the stays at *A* using (*a*) the parallelogram law, (*b*) the triangle rule.

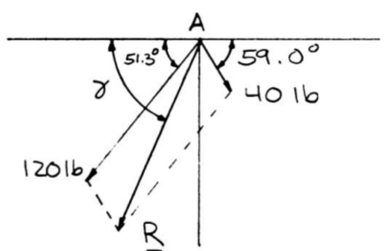
SOLUTION



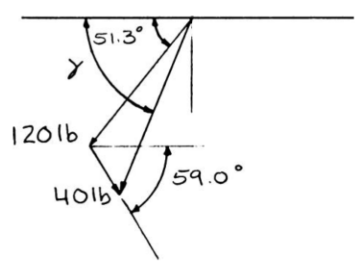
We measure: $\alpha = 51.3°$

$\beta = 59.0°$

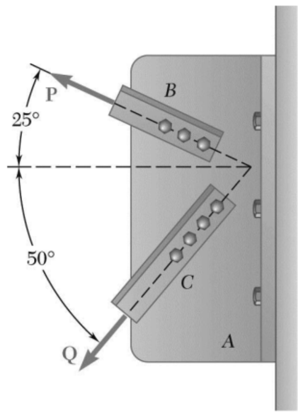
(*a*) Parallelogram law:



(*b*) Triangle rule:



We measure: $R = 139.1$ lb, $\gamma = 67.0°$ $\qquad R = 139.1 \text{ lb} \measuredangle 67.0°$ ◀

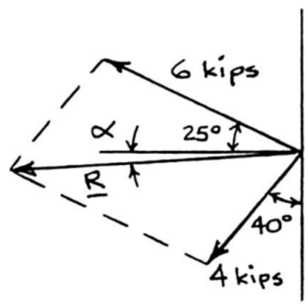


PROBLEM 2.4

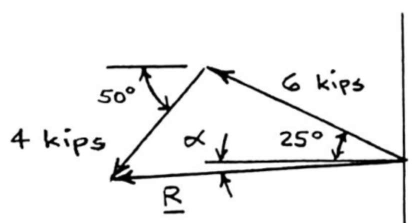
Two structural members B and C are bolted to bracket A. Knowing that both members are in tension and that $P = 6$ kips and $Q = 4$ kips, determine graphically the magnitude and direction of the resultant force exerted on the bracket using (*a*) the parallelogram law, (*b*) the triangle rule.

SOLUTION

(*a*) Parallelogram law:

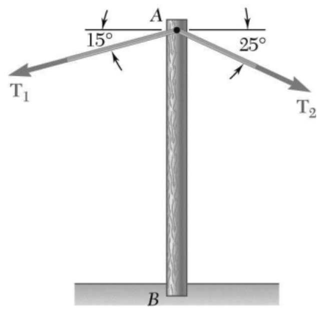


(*b*) Triangle rule:



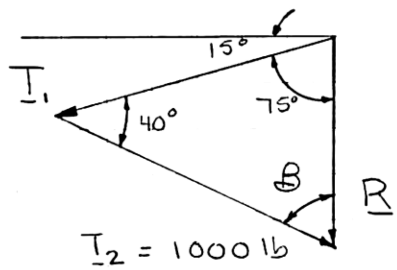
We measure: $R = 8.03$ kips, $\alpha = 3.8°$ **R** $= 8.03$ kips ⦣ $3.8°$ ◀

PROBLEM 2.9



A telephone cable is clamped at A to the pole AB. Knowing that the tension in the right-hand portion of the cable is $T_2 = 1000$ lb, determine by trigonometry (*a*) the required tension T_1 in the left-hand portion if the resultant **R** of the forces exerted by the cable at A is to be vertical, (*b*) the corresponding magnitude of **R**.

SOLUTION



Using the triangle rule and the law of sines:

(*a*)

$$75° + 40° + \beta = 180°$$

$$\beta = 180° - 75° - 40°$$

$$= 65°$$

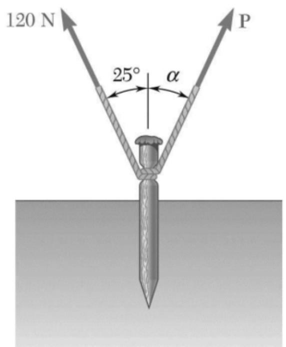
$$\frac{1000 \text{ lb}}{\sin 75°} = \frac{T_1}{\sin 65°}$$

$T_1 = 938$ lb ◀

(*b*)

$$\frac{1000 \text{ lb}}{\sin 75°} = \frac{R}{\sin 40°}$$

$R = 665$ lb ◀

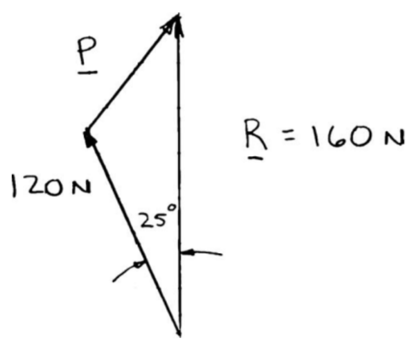


PROBLEM 2.17

For the stake of Prob. 2.5, knowing that the tension in one rope is 120 N, determine by trigonometry the magnitude and direction of the force **P** so that the resultant is a vertical force of 160 N.

PROBLEM 2.5 A stake is being pulled out of the ground by means of two ropes as shown. Knowing that $\alpha = 30°$, determine by trigonometry (*a*) the magnitude of the force **P** so that the resultant force exerted on the stake is vertical, (*b*) the corresponding magnitude of the resultant.

SOLUTION



Using the laws of cosines and sines:

$$P^2 = (120\text{ N})^2 + (160\text{ N})^2 - 2(120\text{ N})(160\text{ N})\cos 25°$$

$$P = 72.096\text{ N}$$

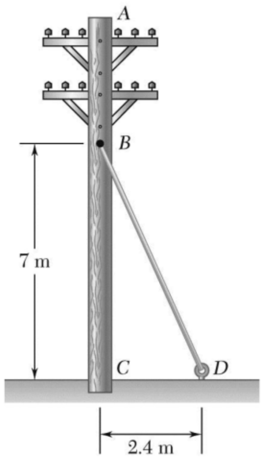
And

$$\frac{\sin\alpha}{120\text{ N}} = \frac{\sin 25°}{72.096\text{ N}}$$

$$\sin\alpha = 0.70343$$

$$\alpha = 44.703°$$

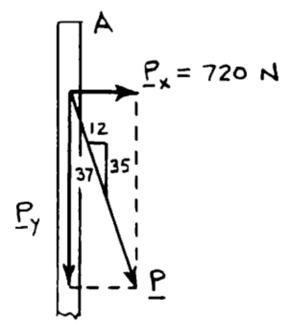
P = 72.1 N ⦪ 44.7° ◀



PROBLEM 2.29

The guy wire *BD* exerts on the telephone pole *AC* a force **P** directed along *BD*. Knowing that **P** must have a 720-N component perpendicular to the pole *AC*, determine (*a*) the magnitude of the force **P**, (*b*) its component along line *AC*.

SOLUTION



(*a*)

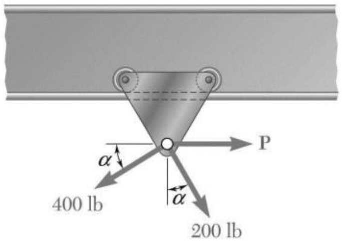
$$P = \frac{37}{12} P_x$$
$$= \frac{37}{12}(720 \text{ N})$$
$$= 2220 \text{ N}$$

$P = 2.22$ kN ◀

(*b*)

$$P_y = \frac{35}{12} P_x$$
$$= \frac{35}{12}(720 \text{ N})$$
$$= 2100 \text{ N}$$

$P_y = 2.10$ kN ◀



PROBLEM 2.42

A hoist trolley is subjected to the three forces shown. Knowing that P = 250 lb, determine (*a*) the required value of α if the resultant of the three forces is to be vertical, (*b*) the corresponding magnitude of the resultant.

SOLUTION

$$R_x = \xrightarrow{+} \Sigma F_x = 250 \text{ lb} + (200 \text{ lb})\sin\alpha - (400 \text{ lb})\cos\alpha$$

$$R_x = 250 \text{ lb} + (200 \text{ lb})\sin\alpha - (400 \text{ lb})\cos\alpha \qquad (1)$$

$$R_y = +\!\downarrow \Sigma F_y = (200 \text{ lb})\cos\alpha + (400 \text{ lb})\sin\alpha$$

(*a*) For **R** to be vertical, we must have $R_x = 0$.

Set $R_x = 0$ in Eq. (1)

$$0 = 250 \text{ lb} + (200 \text{ lb})\sin\alpha - (400 \text{ lb})\cos\alpha$$

$$(400 \text{ lb})\cos\alpha = (200 \text{ lb})\sin\alpha + 250 \text{ lb}$$

$$2\cos\alpha = \sin\alpha + 1.25$$

$$4\cos^2\alpha = \sin^2\alpha + 2.5\sin\alpha + 1.5625$$

$$4(1-\sin^2\alpha) = \sin^2\alpha + 2.5\sin\alpha + 1.5625$$

$$0 = 5\sin^2\alpha + 2.5\sin\alpha - 2.4375$$

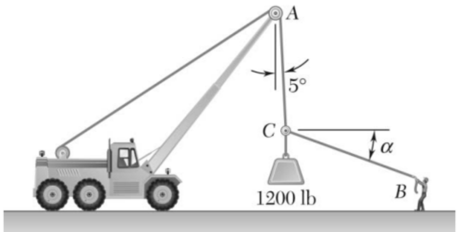
Using the quadratic formula to solve for the roots gives

$$\sin\alpha = 0.49162$$

or $\alpha = 29.447°$ $\qquad \alpha = 29.4°$ ◀

(*b*) Since **R** is to be vertical:

$R = R_y = (200 \text{ lb})\cos 29.447° + (400 \text{ lb})\sin 29.447°$ $\qquad$ **R** $= 371$ lb ◀

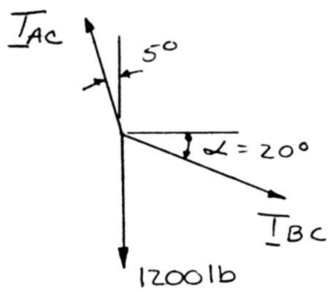


PROBLEM 2.45

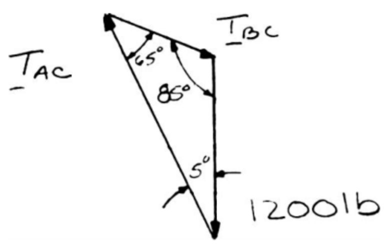
Knowing that $\alpha = 20°$, determine the tension (*a*) in cable *AC*, (*b*) in rope *BC*.

SOLUTION

Free-Body Diagram



Force Triangle



Law of sines:
$$\frac{T_{AC}}{\sin 110°} = \frac{T_{BC}}{\sin 5°} = \frac{1200 \text{ lb}}{\sin 65°}$$

(*a*)
$$T_{AC} = \frac{1200 \text{ lb}}{\sin 65°} \sin 110°$$
$T_{AC} = 1244$ lb ◀

(*b*)
$$T_{BC} = \frac{1200 \text{ lb}}{\sin 65°} \sin 5°$$
$T_{BC} = 115.4$ lb ◀