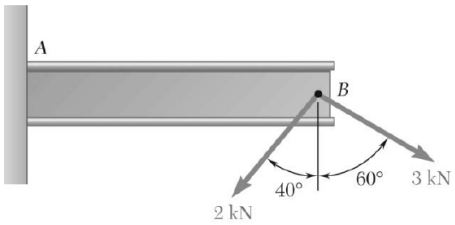
Homework 1: 2.1, 2.2, 2.5, 2.9, 2.17, 2.20

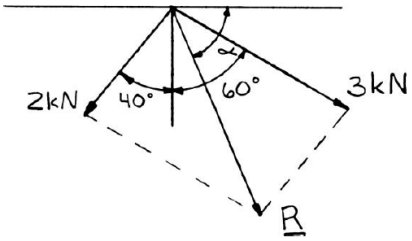


PROBLEM 2.1

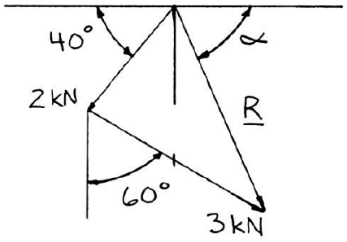
Two forces are applied at point B of beam AB. Determine graphically the magnitude and direction of their resultant using (a) the parallelogram law, (b) the triangle rule.

SOLUTION

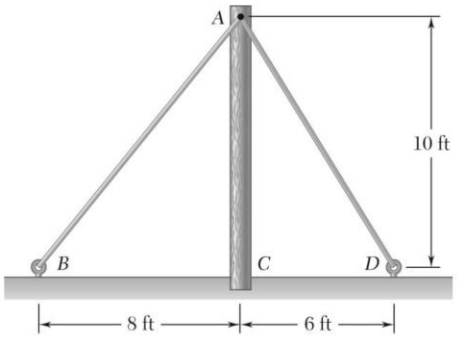
(a) Parallelogram law:



(b) Triangle rule:



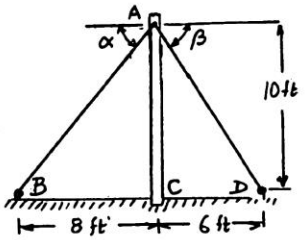
We measure: $R = 3.30$ kN, $\alpha = 66.6°$ **R** = 3.30 kN ∠ 66.6° ◀



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.

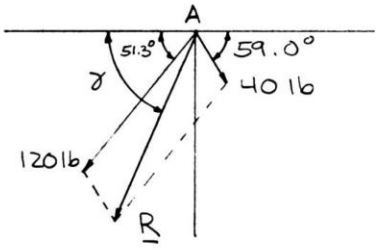
SOLUTION



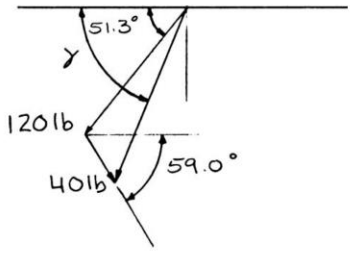
We measure: $\alpha = 51.3°$

$\beta = 59.0°$

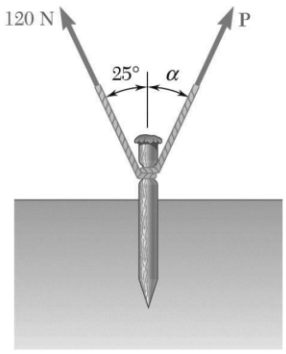
(*a*) Parallelogram law:



(*b*) Triangle rule:



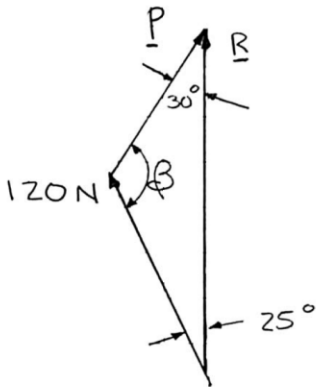
We measure: $R = 139.1$ lb, $\gamma = 67.0°$ $R = 139.1$ lb $\measuredangle$ $67.0°$ ◀



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.

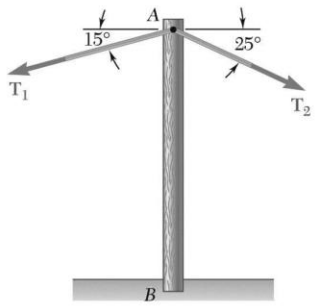
SOLUTION



Using the triangle rule and the law of sines:

(*a*)
$$\frac{120\text{ N}}{\sin 30°} = \frac{P}{\sin 25°}$$
$$P = 101.4\text{ N} \blacktriangleleft$$

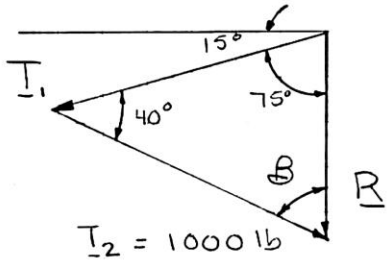
(*b*)
$$30° + \beta + 25° = 180°$$
$$\beta = 180° - 25° - 30°$$
$$= 125°$$
$$\frac{120\text{ N}}{\sin 30°} = \frac{R}{\sin 125°}$$
$$R = 196.6\text{ N} \blacktriangleleft$$



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:

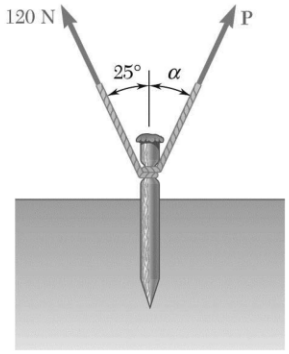
(*a*)
$$75° + 40° + \beta = 180°$$
$$\beta = 180° - 75° - 40°$$
$$= 65°$$

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

$$T_1 = 938 \text{ lb} \blacktriangleleft$$

(*b*)
$$\frac{1000 \text{ lb}}{\sin 75°} = \frac{R}{\sin 40°}$$

$$R = 665 \text{ lb} \blacktriangleleft$$

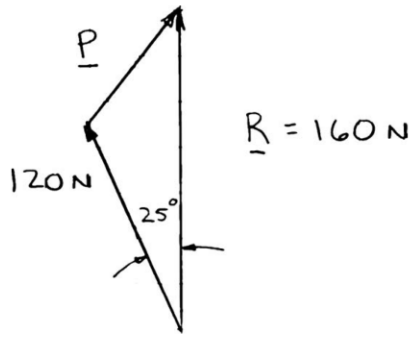


PROBLEM 2.17

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:

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

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

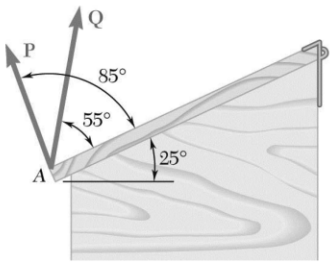
And

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

$$\sin\alpha = 0.70343$$

$$\alpha = 44.703°$$

$$\mathbf{P} = 72.1\text{ N} \measuredangle 44.7° \blacktriangleleft$$



PROBLEM 2.20

Two forces **P** and **Q** are applied to the lid of a storage bin as shown. Knowing that $P = 60$ N and $Q = 48$ N, determine by trigonometry the magnitude and direction of the resultant of the two forces.

SOLUTION

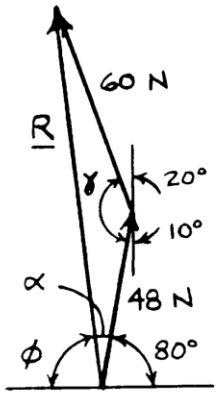
Using the force triangle and the laws of cosines and sines:

We have
$$\gamma = 180° - (20° + 10°)$$
$$= 150°$$

Then
$$R^2 = (60\text{ N})^2 + (48\text{ N})^2 - 2(60\text{ N})(48\text{ N})\cos 150°$$
$$R = 104.366\text{ N}$$

and
$$\frac{60\text{ N}}{\sin\alpha} = \frac{104.366\text{ N}}{\sin 150°}$$
$$\sin\alpha = 0.28745$$
$$\alpha = 16.7054°$$

Hence:
$$\phi = 180° - \alpha - 180°$$
$$= 180° - 16.7054° - 80°$$
$$= 83.295°$$



R = 104.4 N ⦤ 83.3° ◀