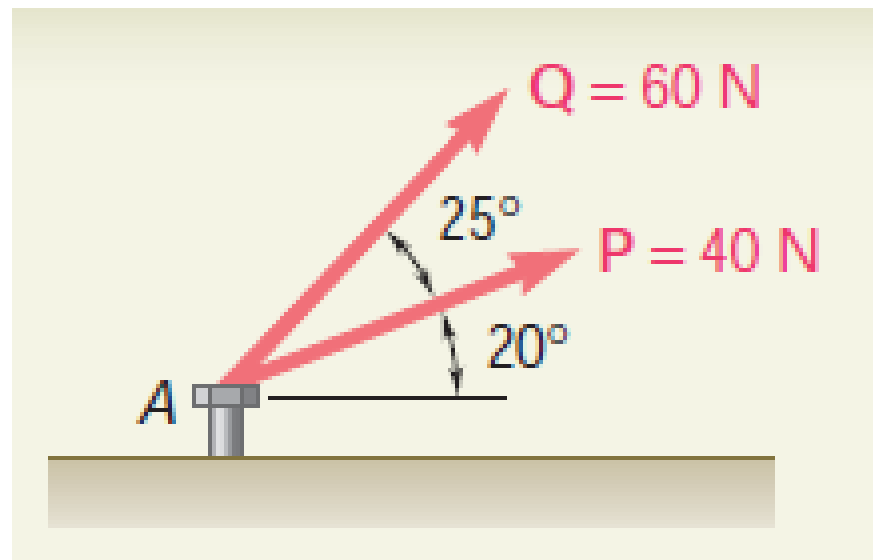
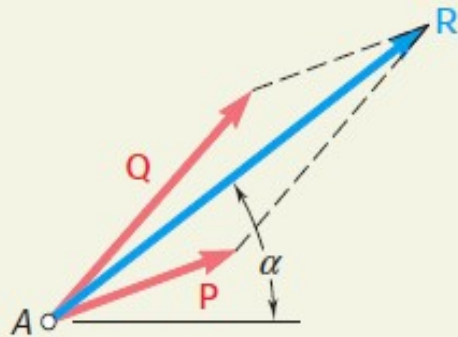


Contoh 4

The two forces P and Q act on a bolt A . Determine their resultant.



SOLUTION

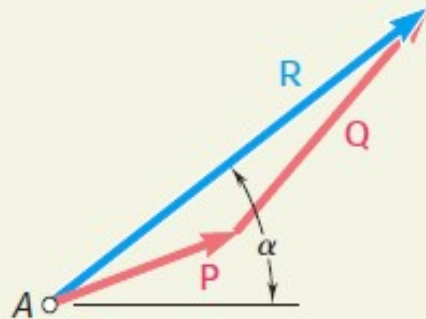


Graphical Solution. A parallelogram with sides equal to **P** and **Q** is drawn to scale. The magnitude and direction of the resultant are measured and found to be

$$R = 98 \text{ N} \quad \alpha = 35^\circ \quad \mathbf{R} = 98 \text{ N } \alpha 35^\circ \quad \blacktriangleleft$$

The triangle rule may also be used. Forces **P** and **Q** are drawn in tip-to-tail fashion. Again the magnitude and direction of the resultant are measured.

$$R = 98 \text{ N} \quad \alpha = 35^\circ \quad \mathbf{R} = 98 \text{ N } \alpha 35^\circ \quad \blacktriangleleft$$



Trigonometric Solution. The triangle rule is again used; two sides and the included angle are known. We apply the law of cosines.

$$R^2 = P^2 + Q^2 - 2PQ \cos B$$

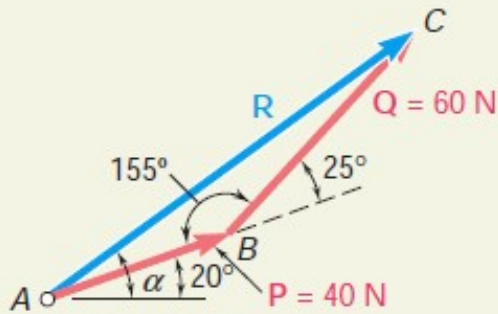
$$R^2 = (40 \text{ N})^2 + (60 \text{ N})^2 - 2(40 \text{ N})(60 \text{ N}) \cos 155^\circ$$

$$R = 97.73 \text{ N}$$

Now, applying the law of sines, we write

$$\frac{\sin A}{Q} = \frac{\sin B}{R} \quad \frac{\sin A}{60 \text{ N}} = \frac{\sin 155^\circ}{97.73 \text{ N}} \quad (1)$$

Solving Eq. (1) for $\sin A$, we have



Solving Eq. (1) for $\sin A$, we have

$$\sin A = \frac{(60 \text{ N}) \sin 155^\circ}{97.73 \text{ N}}$$

Using a calculator, we first compute the quotient, then its arc sine, and obtain

$$A = 15.04^\circ \quad a = 20^\circ + A = 35.04^\circ$$

We use 3 significant figures to record the answer (cf. Sec. 1.6):

$$\mathbf{R} = 97.7 \text{ N } a 35.0^\circ \quad \blacktriangleleft$$

Alternative Trigonometric Solution. We construct the right triangle BCD and compute

$$CD = (60 \text{ N}) \sin 25^\circ = 25.36 \text{ N}$$

$$BD = (60 \text{ N}) \cos 25^\circ = 54.38 \text{ N}$$

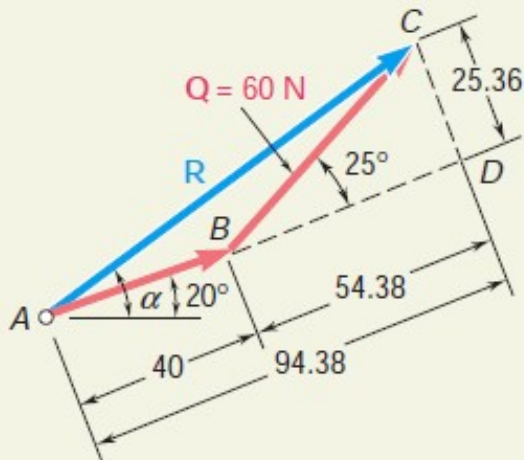
Then, using triangle ACD , we obtain

$$\tan A = \frac{25.36 \text{ N}}{94.38 \text{ N}} \quad A = 15.04^\circ$$

$$R = \frac{25.36}{\sin A} \quad R = 97.73 \text{ N}$$

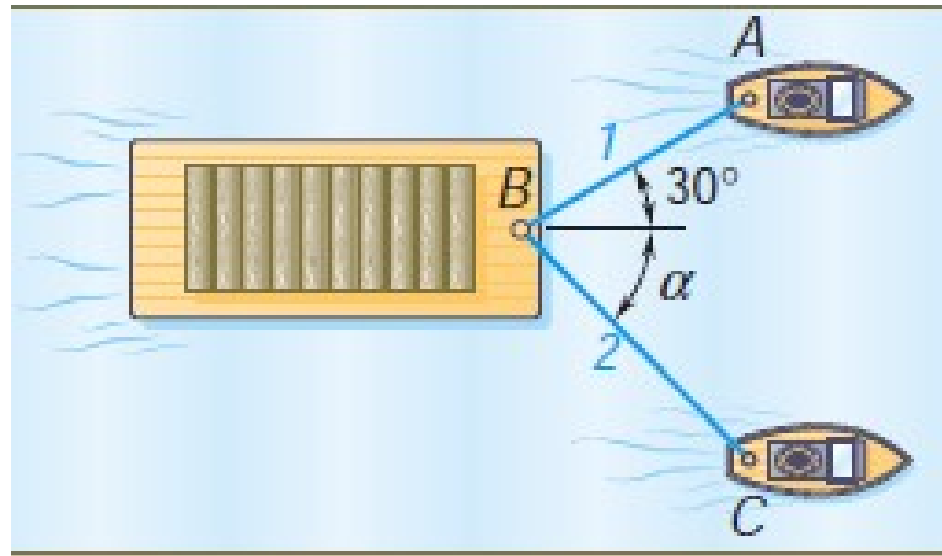
Again,

$$a = 20^\circ + A = 35.04^\circ \quad \mathbf{R} = 97.7 \text{ N } a 35.0^\circ \quad \blacktriangleleft$$

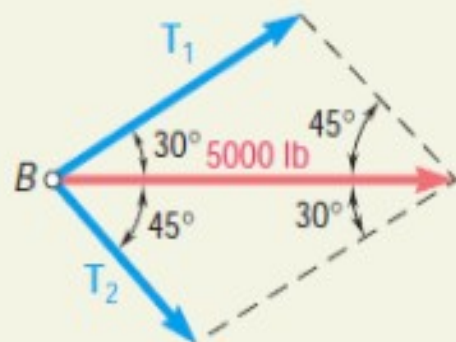


Contoh 5

A barge is pulled by two tugboats. If the resultant of the forces exerted by the tugboats is a 5000-lb force directed along the axis of the barge, determine (a) the tension in each of the ropes knowing that $\alpha = 45^\circ$, (b) the value of α for which the tension in rope 2 is minimum.

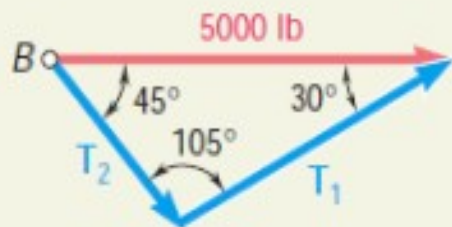


SOLUTION



a. Tension for $\alpha = 45^\circ$. *Graphical Solution.* The parallelogram law is used; the diagonal (resultant) is known to be equal to 5000 lb and to be directed to the right. The sides are drawn parallel to the ropes. If the drawing is done to scale, we measure

$$T_1 = 3700 \text{ lb} \quad T_2 = 2600 \text{ lb} \quad \blacktriangleleft$$

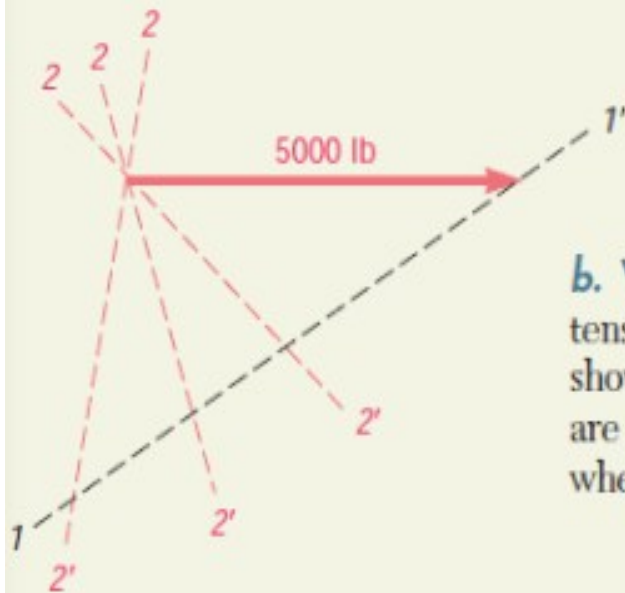


Trigonometric Solution. The triangle rule can be used. We note that the triangle shown represents half of the parallelogram shown above. Using the law of sines, we write

$$\frac{T_1}{\sin 45^\circ} = \frac{T_2}{\sin 30^\circ} = \frac{5000 \text{ lb}}{\sin 105^\circ}$$

With a calculator, we first compute and store the value of the last quotient. Multiplying this value successively by $\sin 45^\circ$ and $\sin 30^\circ$, we obtain

$$T_1 = 3660 \text{ lb} \quad T_2 = 2590 \text{ lb} \quad \blacktriangleleft$$



b. Value of α for Minimum T_2 . To determine the value of α for which the tension in rope 2 is minimum, the triangle rule is again used. In the sketch shown, line $1-1'$ is the known direction of T_1 . Several possible directions of T_2 are shown by the lines $2-2'$. We note that the minimum value of T_2 occurs when T_1 and T_2 are perpendicular. The minimum value of T_2 is

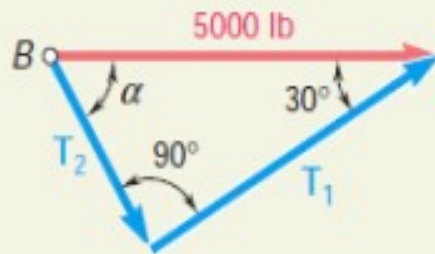
$$T_2 = (5000 \text{ lb}) \sin 30^\circ = 2500 \text{ lb}$$

Corresponding values of T_1 and α are

$$T_1 = (5000 \text{ lb}) \cos 30^\circ = 4330 \text{ lb}$$

$$\alpha = 90^\circ - 30^\circ$$

$$\alpha = 60^\circ \quad \blacktriangleleft$$



Komponen Tegak Lurus Suatu Gaya

Dalam banyak soal akan didapati keinginan untuk memecahkan suatu gaya menjadi dua komponen yang saling tegak lurus. Pada Gambar 2.18, gaya F telah diselesaikan menjadi komponen F_x sepanjang sumbu x dan komponen F_y sepanjang sumbu y . Jajaran genjang yang ditarik untuk mendapatkan dua komponen adalah persegi panjang, dan F_x dan F_y disebut komponen persegi panjang.

Sumbu x dan y biasanya dipilih masing-masing horizontal dan vertikal, seperti pada Gambar 2.18. Kedua sumbu dipilih dalam dua arah tegak lurus, seperti yang ditunjukkan pada Gambar. 2.19. Dalam menentukan komponen persegi panjang dari sebuah gaya, maka harus memikirkan garis konstruksi yang ditunjukkan pada Gambar. 2.18 dan 2.19 sebagai sejajar dengan sumbu x dan y , bukannya tegak lurus terhadap sumbu.

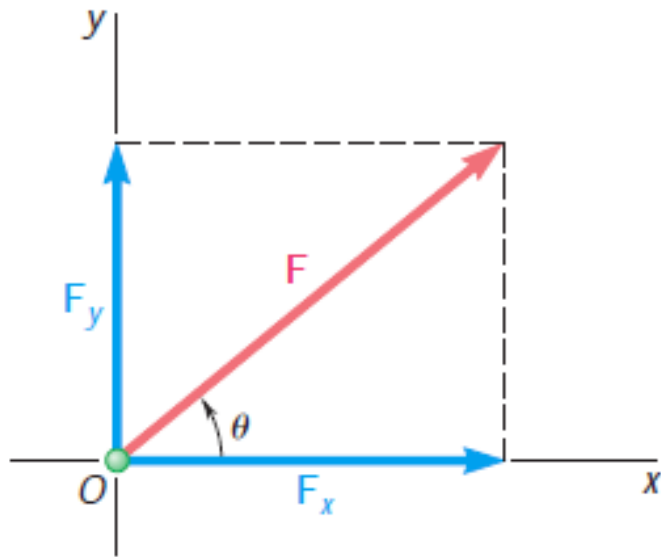


Fig. 2.18

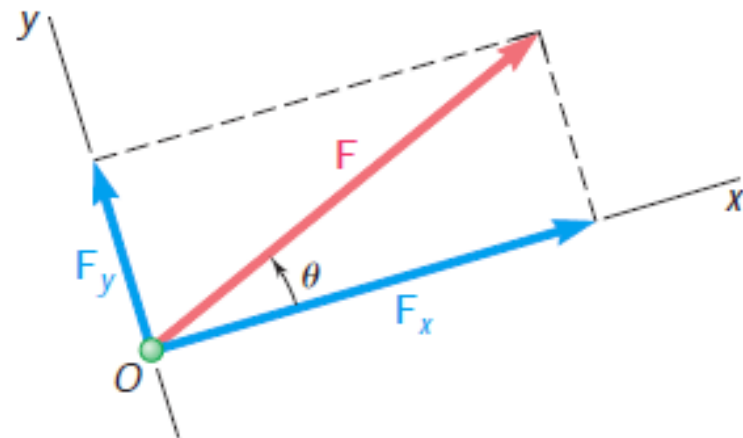


Fig. 2.19

Dilambangkan dengan F sebagai besarnya gaya F , ϑ sudut antara F dan sumbu x , dan F_x serta F_y menyatakan harga komponen F_x dan F_y , maka dapat menyatakan komponen skalar dari F sebagai berikut:

Penambahan Gaya dengan Menjumlahkan Komponen X dan Y

Ketika tiga atau lebih gaya harus ditambahkan, tidak ada solusi trigonometri praktis yang dapat diperoleh dari poligon gaya yang menentukan resultan gaya. Dalam hal ini, solusi analitik dari masalah dapat diperoleh dengan menyelesaikan setiap gaya menjadi dua komponen persegi panjang. Perhatikan, misalnya, tiga gaya P , Q , dan S yang bekerja pada sebuah partikel A (Gambar 2.25a). R resultannya ditentukan oleh relasi.