AL- ESRAA COLLEGE UNIVERSITY

Building & Construction Technology Engineering

Engineering Mechanics

First year

Introduction to Mechanics

By

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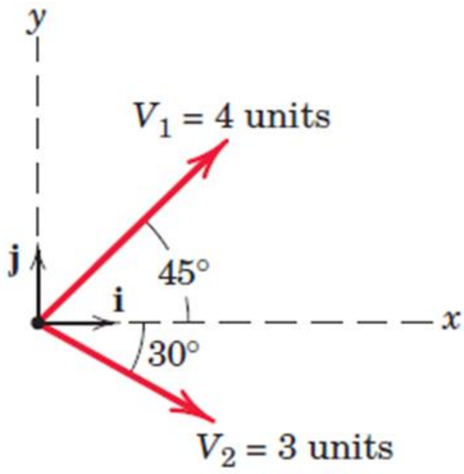
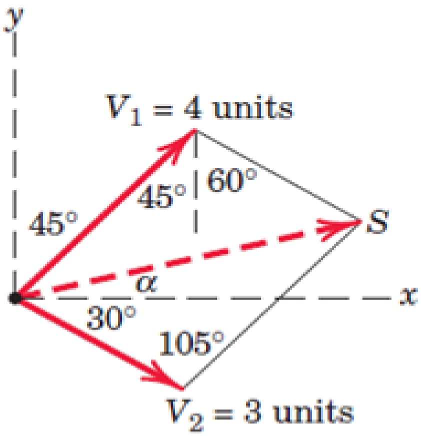
Example: For the vectors V_1 and V_2 shown in the figure, (*a*) Determine the magnitude *S* of their vector sum S= $V_1 + V_2$,(*b*) Determine the angle *α* between **S** and the positive *x*-axis.



(*a*) We construct to scale the parallelogram shown in Fig. *a* for adding V_1 and V_2. Using the law of cosines, we have



$$S = \sqrt{V_2^2 + V_1^2 - 2\,V_1 V_2 \cos s}$$

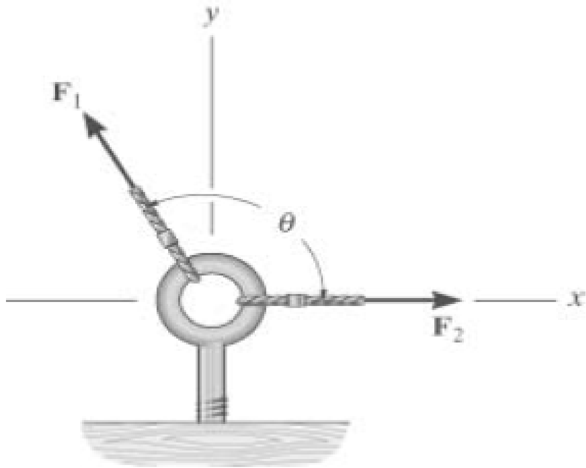
$$S = \sqrt{3^2 + 4^2 - 2\,(3)(4)\cos 105^{\circ}} = 5.59 \text{ units}$$

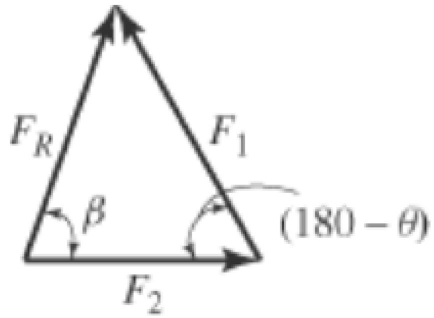
(b) Using the law of sines for the lower triangle, we have

$$\frac{S}{\text{sins}} = \frac{V_1}{\sin(\alpha + 30^{\circ})} \rightarrow \frac{5.59}{\sin 105^{\circ}} = \frac{4}{\sin(\alpha + 30^{\circ})} \rightarrow \sin(\alpha + 30^{\circ}) = 0.691$$

$$(\alpha + 30^{\circ}) = 43.7^{\circ} \rightarrow \alpha = 13.7^{\circ}$$

Example: Determine the magnitude of the resultant force and its direction measured counterclockwise from the positive *x* axis. Given: F_1=80lb, F_2= 60lb, and θ=120°





$$F_R = \sqrt{F_1^2 + F_2^2 + 2\,F_1F_2\cos(180-\theta)}$$

$$F_R = \sqrt{(80)^2 + (60)^2 - 2\,(80)(60)\cos(180-120)} = 72.1\text{ lb}$$

$$\frac{F_R}{\sin(180-\theta)} = \frac{F_1}{\sin\beta} \rightarrow \frac{72.1}{\sin(180-120)} = \frac{80}{\sin\beta}$$

$$\beta = 73.9\,^{\circ}$$

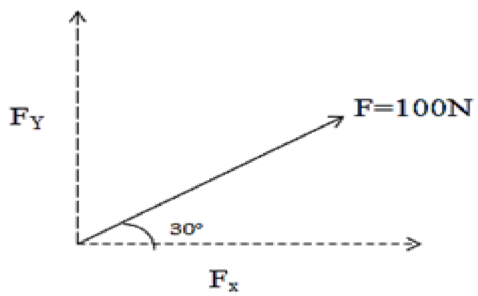
Example: Determine the component in the direction x&y for the (100N) force make angle θ=30° with the positive direction for x.

$F_X = F \times \text{Cos}\,30$

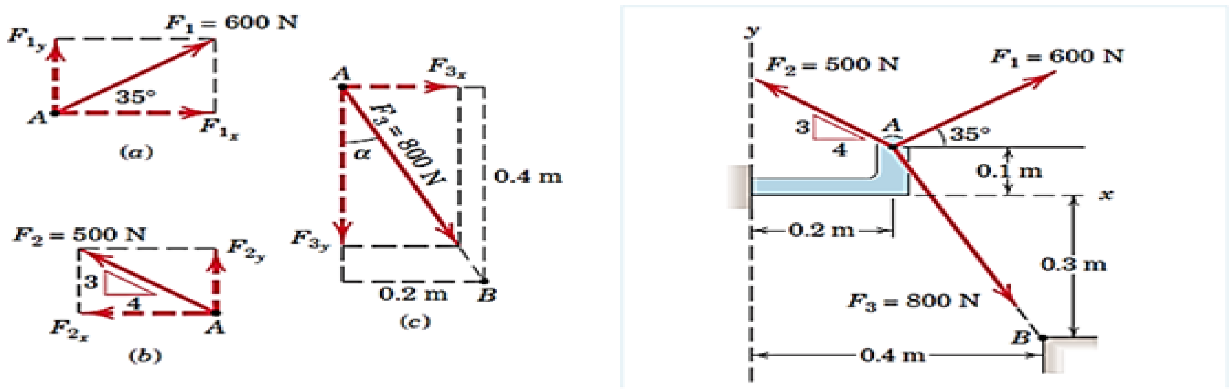
$F_X = 100 \times \text{Cos}\,30 = 86.6\text{N} \longrightarrow$

$F_y = F \times \text{Sin}\,30$

$F_y = 100 \times \text{Sin}\,30 = 50\text{N} \uparrow$



<u>Example:</u> The forces F1, F2, and F3, all of which act on point *A* of the bracket, are specified in three different ways. Determine the *x* and *y* scalar components of each of the three forces.



The components of **F1**, from Fig. *a*, are

$$F_{1x} = 600 \times \text{Cos } 35 = 491\text{N} \longrightarrow$$

$$F_{1y} = 600 \times \text{Sin } 35 = 344\text{N} \uparrow$$

The components of **F2**, from Fig. *b*, are

$$F_{2x} = 500 \times \frac{4}{5} = 400 \text{ N} \longleftarrow$$

$$F_{2y} = 500 \times \frac{3}{5} = 300 \ N \uparrow$$

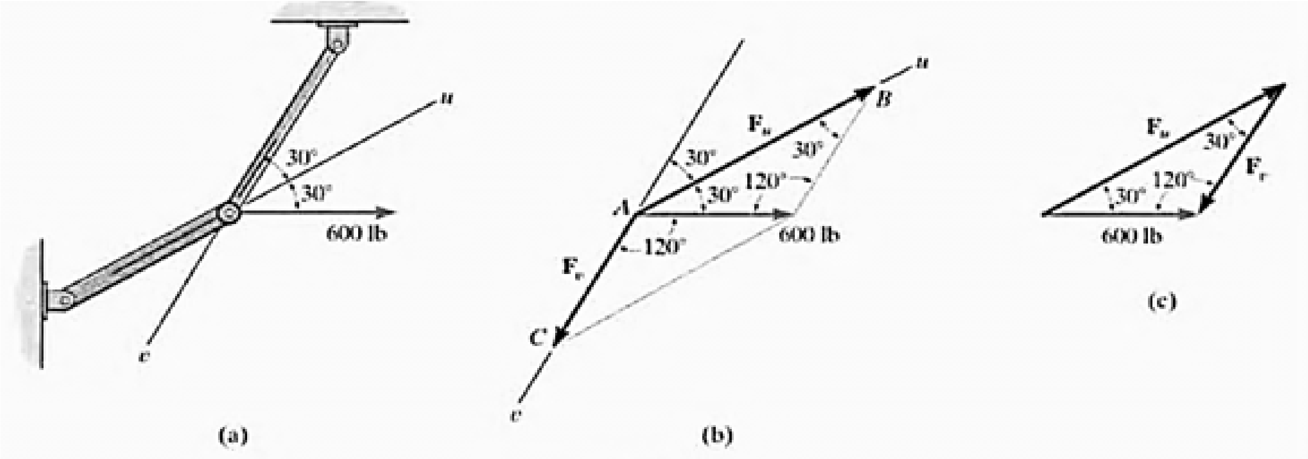
The components of **F3** can be obtained by first computing the angle *α* of Fig. *c*.

$$\alpha = \tan^{-1}\left[\frac{0.2}{0.4}\right] = 26.6^{\circ}$$

$$F_{3x} = 800 \times \sin 26.6^{\circ} = 358\text{N} \longrightarrow$$

$$F_{3y} = 800 \times \cos 26.6^{\circ} = 716\text{N} \downarrow$$

Example: Resolve the horizontal 600-lb force in figure below into components action along the u and v axes and determine the magnitudes of these components.



$$\frac{F_u}{\sin 120^{\circ}} = \frac{600\text{lb}}{\sin 30^{\circ}} \rightarrow F_u = 1039\text{ lb}$$

$$\frac{F_v}{\sin 30^{\circ}} = \frac{600\text{lb}}{\sin 30^{\circ}} \rightarrow F_v = 600\text{lb}$$