Chapter 1 Reserve Problem Solutions

Question Title: Chapter 1, Reserve Problem 1/001

Determine the angles made by the vector **V** = -36**i** + 15**j** with the positive *x*- and *y*-axes. Write the unit vector **n** in the direction of **V**.

SOLUTION

$$V = \sqrt{V_x^2 + V_y^2} = \sqrt{36^2 + 15^2} = 39$$

$$\cos\theta_x = \frac{V_x}{V} = \frac{-36}{39}, \quad \theta_x = 157.4^\circ$$

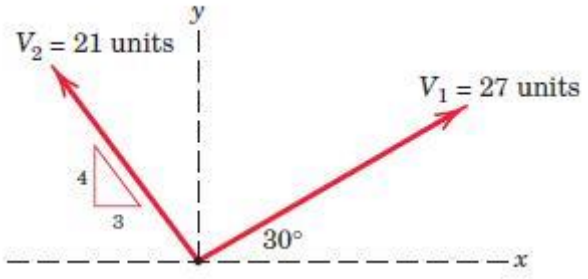
$$\cos\theta_y = \frac{V_y}{V} = \frac{15}{39}, \quad \theta_y = 67.4^\circ$$

$$\underline{n} = \frac{\underline{V}}{V} = \frac{-36\underline{i} + 15\underline{j}}{39} = -0.923\underline{i} + 0.385\underline{j}$$

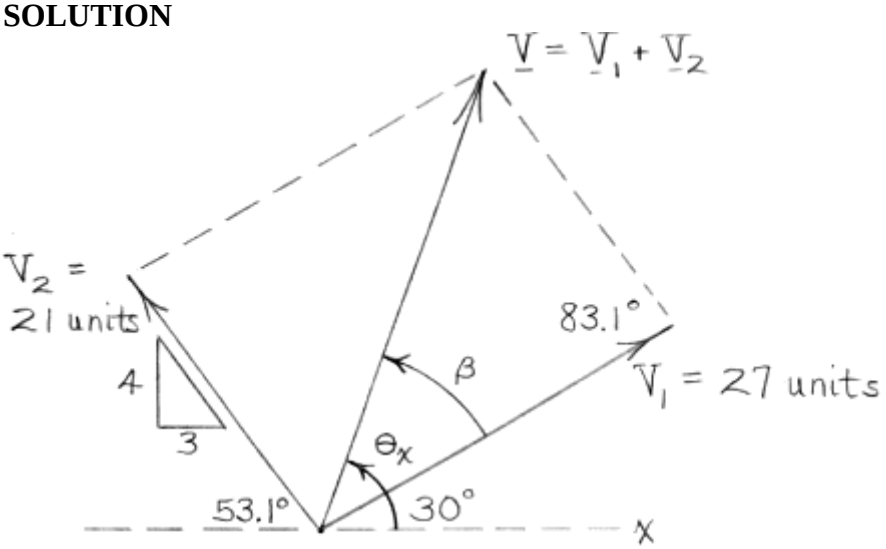
Engineering Mechanics: Statics, 9th Edition

Question Title: Chapter 1, Reserve Problem 1/002

Determine the magnitude of the vector sum $\mathbf{V} = \mathbf{V}_1 + \mathbf{V}_2$ and the angle θ_x which $\mathbf{V}$ makes counterclockwise with the positive x-axis. Complete both graphical and algebraic solutions. You will have to draw an accurate figure for the graphical solution.



SOLUTION



Graphically, $V = 32$ units, $\theta_x = 70°$

Algebraically, $V^2 = 27^2 + 21^2 - 2(27)(21)\cos 83.1°$

$V = 32.2$ units

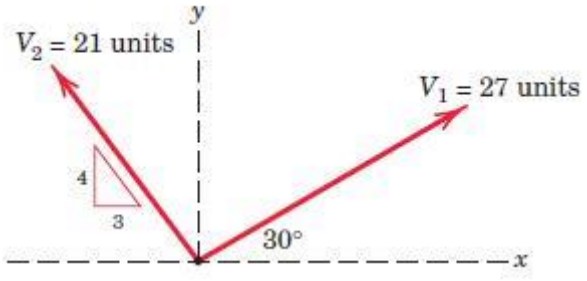
$\frac{\sin\beta}{21} = \frac{\sin 83.1°}{32.2}$, $\beta = 40.4°$

$\theta_x = \beta + 30° = 40.4° + 30° = 70.4°$

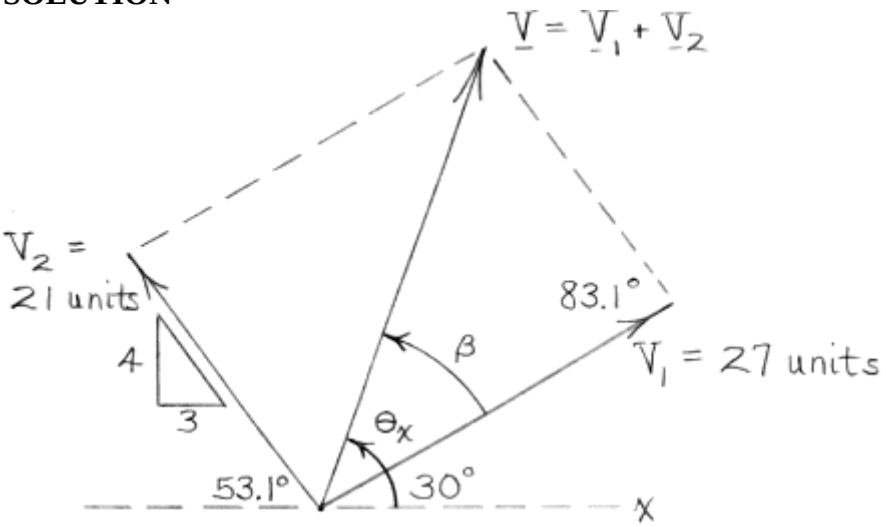
Engineering Mechanics: Statics, 9th Edition

Question Title: Chapter 1, Reserve Problem 1/002 (GO Tutorial version available)

Determine the magnitude of the vector sum $\mathbf{V} = \mathbf{V}_1 + \mathbf{V}_2$ and the angle θ_x which $\mathbf{V}$ makes with the positive x-axis. Complete both graphical and algebraic solutions. You will have to draw an accurate figure for the graphical solution.



SOLUTION



Graphically, $V = 32$ units, $\theta_x = 70°$

Algebraically, $V^2 = 27^2 + 21^2 - 2(27)(21)\cos 83.1°$

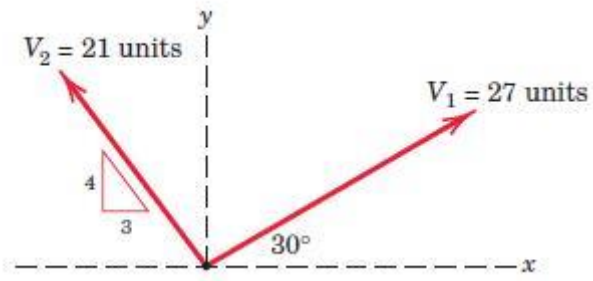
$V = 32.2$ units

$\frac{\sin\beta}{21} = \frac{\sin 83.1°}{32.2}$, $\beta = 40.4°$

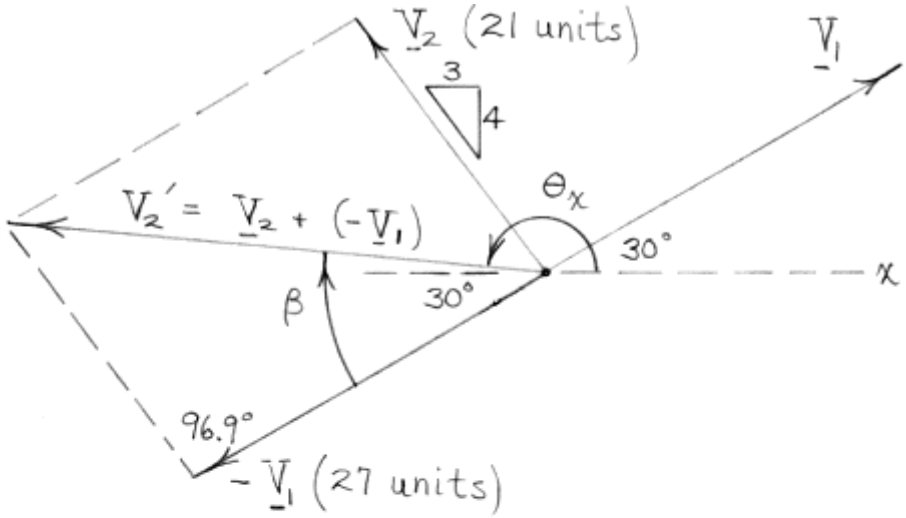
$\theta_x = \beta + 30° = 40.4° + 30° = 70.4°$

Question Title: Chapter 1, Reserve Problem 1/003 (Multistep version available)

Determine the magnitude of the vector difference $\mathbf{V}' = \mathbf{V}_2 - \mathbf{V}_1$ and the angle θ_x which $\mathbf{V}'$ makes counterclockwise with the positive x-axis. The angle ϑ_x will be a positive number between 0 and 360°. Complete both graphical and algebraic solutions. You will have to draw an accurate figure for the graphical solution.



SOLUTION



Graphically, $V' = 36$ units, $\theta_x = 175°$

Algebraically, $V'^2 = 27^2 + 21^2 - 2(27)(21)\cos 96.9°$

$V' = 36.1$ units

$\frac{\sin\beta}{21} = \frac{\sin 96.9°}{36.1}$, $\beta = 35.2°$

$\theta_x + \beta = 210°$, $\theta_x = 210 - 35.2° = 174.8°$

Engineering Mechanics: Statics, 9th Edition

Question Title: Chapter 1, Reserve Problem 1/004

What is the mass in both slugs and kilograms of a 1000-lb beam?

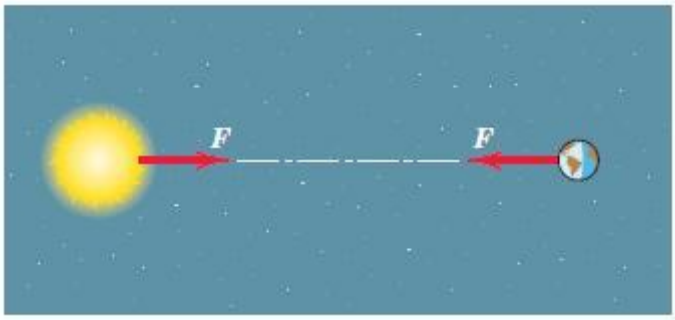
SOLUTION

$$m = \frac{W}{g} = \frac{1000}{32.174} = \underline{31.1 \text{ slugs}}$$

$$m = 31.1 \text{ slugs} \left(\frac{14.594 \text{ kg}}{\text{slug}} \right) = \underline{454 \text{ kg}}$$

Question Title: Chapter 1, Reserve Problem 1/005

Compute the magnitude F of the force which the sun exerts on the earth. Perform the calculation first in pounds and then convert your result to newtons. Refer to Table D/2 for necessary physical quantities.



SOLUTION

$$F = \frac{Gm_e m_s}{d^2} = \frac{3.439(10^{-8})(1)(333{,}000)(4.095 \cdot 10^{23})^2}{(92.96 \cdot 10^6 \cdot 5280)^2}$$

$$= 7.97(10^{21})\ \text{lb}$$

$$F = 7.97(10^{21})\ \text{lb}\left(\frac{4.4482\ \text{N}}{1\ \text{lb}}\right) = 3.55(10^{22})\ \text{N}$$

Engineering Mechanics: Statics, 9th Edition

Question Title: Chapter 1, Reserve Problem 1/006

Suppose that two nondimensional quantities are exactly $A = 6.67$ and $B = 1.726$. Using the rules for significant figures as stated in this chapter, express the four quantities $(A+B)$, $(A-B)$, (AB), and (A/B).

SOLUTION

$A = 6.67, \quad B = 1.726$

$(A+B) = \underline{8.40}$

$(A-B) = \underline{4.94}$

$(AB) = \underline{11.51}$

$(A/B) = \underline{3.86}$

Engineering Mechanics: Statics, 9th Edition

Question Title: Chapter 1, Reserve Problem 1/007

Determine the percent error *n* in replacing the sine and tangent of an angle by the value of the angle in radians for angle values of 5°, 10°, and 20°. Explain the qualitative difference between the sine and tangent results.

SOLUTION

θ (deg)	θ (rad)	$\sin\theta$	n_s (%)	$\tan\theta$	n_t (%)
5	0.0873	0.0872	+0.1270	0.0875	-0.254
10	0.1745	0.1736	+0.510	0.1763	-1.017
20	0.3491	0.3420	+2.06	0.3640	-4.09

$$\text{Error } n_s = \frac{\theta - \sin\theta}{\sin\theta}(100\%)$$

$$\text{Error } n_t = \frac{\theta - \tan\theta}{\tan\theta}(100\%)$$

The magnitude of both errors increases as θ increases. The approximation $\sin\theta \cong \theta$ is better than the approximation $\tan\theta \cong \theta$, because the former involves the approximation that $s = \theta$ is the vertical side of the triangle, whereas the latter, in addition, involves the approximation that 1 is the horizontal side of the triangle.