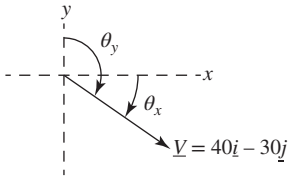
Solution 1.1

$$V = \sqrt{V_{x^2} + V_{y^2}} = \sqrt{40^2 + 30^2} = 50$$

$$\underline{n} = \frac{\underline{V}}{V} = \frac{40\underline{i} - 30\underline{j}}{50} = \underline{0.8\underline{i} - 0.6\underline{j}}$$

$$\cos\theta_x = 0.8, \qquad \underline{\theta_x = 36.9^\circ}$$

$$\cos\theta_y = -0.6, \qquad \underline{\theta_y = 126.9^\circ}$$



Solution 1.2

$$\underline{V} = \underline{V}_1 + \underline{V}_2 \left(\text{But } V \neq V_1 + V_2 !\right)$$

Graphically, $\underline{V = 16.4 \text{ units}, \quad \theta_x = 83^\circ}$

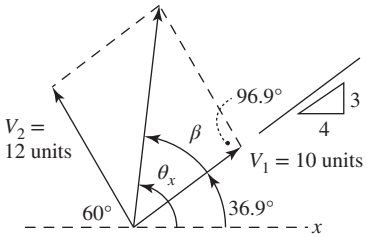
Algebraically,

$$V^2 = 10^2 + 12^2 - 2(10)(12)\cos 96.9^\circ$$

$$\underline{V = 16.51 \text{ units}}$$

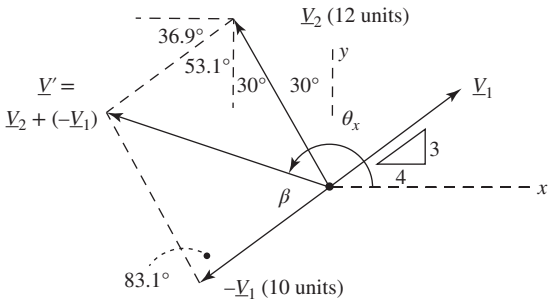
$$\frac{\sin\beta}{12} = \frac{\sin 96.9^\circ}{16.51}, \qquad \beta = 46.2^\circ$$

$$\theta_x = \beta + 36.9^\circ = 46.2^\circ + 36.9^\circ = \underline{83.0^\circ}$$



Solution 1.3

Graphically, $\underline{V' = 14.7 \text{ units}, \theta_x = 163^\circ}$



Algebraically, $V'^2 = 10^2 + 12^2 - 2(10)(12)\cos 83.1^\circ$

$\underline{V' = 14.67 \text{ units}}$

$$\frac{\sin\beta}{12} = \frac{\sin 83.1^\circ}{14.67}, \quad \beta = 54.3^\circ$$

$$\theta_x = (180^\circ + 36.9^\circ) - \beta = 180^\circ + 36.9^\circ - 54.3^\circ$$

$$= \underline{162.6^\circ}$$

Solution 1.4

$$F = \sqrt{160^2 + 80^2 + 120^2} = 215N$$

$$\cos\theta_x = \frac{F_x}{F} = \frac{160}{215} = 0.743, \qquad \underline{\theta_x = 42.0^\circ}$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{80}{215} = 0.371, \qquad \underline{\theta_y = 68.2^\circ}$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{-120}{215} = -0.557, \qquad \underline{\theta_z = 123.9^\circ}$$

Solution 1.5

$$m = \frac{W}{g} = \frac{3000}{32.174} = \underline{93.2 \text{ slugs}}$$

$$m = 93.2 \text{ slugs}\left(\frac{14.594 \text{ kg}}{\text{slug}}\right) = \underline{1361 \text{ kg}}$$

↑ from Table D/5

To illustrate the sensitivity of such calculations to significant-figure issues, we now use $g = 32.2 \text{ ft/sec}^2$:

$$m = \frac{W}{g} = \frac{3000}{32.2} = 93.2 \text{ slugs}$$

$$m = 93.2(14.594) = 1360 \text{ kg!}$$

The value of $g = 32.2 \text{ ft/sec}^2$ will normally, but not always, suffice.

Solution 1.6

$$F = W = \frac{Gm_1m_2}{r^2},$$

where $G = 6.673\left(10^{-11}\right) \text{m}^3/\left(\text{kg} \cdot \text{s}^2\right)$

$$m_1 = 85 \text{ kg}$$

$$m_2 = 5.976\left(10^{24}\right) \text{kg}$$

and $r = (6371 + 250)\left(10^3\right) \text{m}$

Substitute these numbers and obtain $\underline{W = 773 \text{ N}}$

U.S. units: $W = 773 \text{ N}\left(\frac{1 \text{ lb}}{4.4482 \text{ N}}\right) = \underline{173.8 \text{ lb}}$

Solution 1.7

$$W = (125 \text{ lb})\left(\frac{4.4482 \text{ N}}{\text{lb}}\right) = \underline{556 \text{ N}}$$

$$m = \frac{W}{g} = \frac{125}{32.2} = \underline{3.88 \text{ slugs}}$$

$$m = \frac{W}{g} = \frac{556}{9.81} = \underline{56.7 \text{ kg}}$$

Solution 1.8

$$A = 8.67, \qquad B = 1.429$$

$$(A + B) = 8.67 + 1.429 = \underline{10.10}$$

$$(A - B) = 8.67 - 1.429 = \underline{7.24}$$

$$(AB) = (8.67)(1.429) = \underline{12.39}$$

$$(A/B) = 8.67/1.429 = \underline{6.07}$$

Solution 1.9

$$F = \frac{Gm_e m_m}{d^2} = \frac{6.673(10^{-11})(5.976 \bullet 10^{24})^2 (1)(0.0123)}{(384\,398 \bullet 10^3)^2}$$

$$= \underline{1.984(10^{20}) \text{ N}}$$

$$F = 1.984(10^{20}) \text{ N}\left(\frac{1 \text{ lb}}{4.4482 \text{ N}}\right) = \underline{4.46(10^{19}) \text{ lb}}$$

Solution 1.10

$$\underline{F} = F\underline{n} = F\left(\frac{-4\underline{i} - 2\underline{j}}{\sqrt{4^2 + 2^2}}\right),$$

where $F = \dfrac{Gm_{cu}\, mst}{d^2}$

$$= \frac{G\left(\rho_{cu}\dfrac{4}{3}\pi r^3\right)\left(\rho_{st}\dfrac{4}{3}\pi\left(\dfrac{r}{2}\right)^3\right)}{(4r)^2 + (2r)^2}$$

$$= \frac{1}{90}G\rho_{cu}\rho_{st}\pi^2 r^4$$

$$= \frac{1}{90}\left(6.673 \bullet 10^{-11}\right)(8910)(7830)\pi^2(0.050^4)$$

$$= 3.19\left(10^{-9}\right)\text{ N}$$

Then $\underline{F} = 3.19\left(10^{-9}\right)\left[\dfrac{-4\underline{i} - 2\underline{j}}{\sqrt{20}}\right]$

$$= \underline{\left(-2.85\underline{i} - 1.427\underline{j}\right)10^{-9}\text{ N}}$$

Solution 1.11

$$E = 3\sin^2\theta\tan\theta\cos\theta$$

Exact: $E = 3\sin^2 2°\tan 2°\cos 2°$

$$= \underline{1.275\left(10^{-4}\right)}$$

Approx: $E_{ap} = 3\left(\theta^2\right)(\theta)(1)$

$$= 3\theta^3\ (\theta \text{ in rad})$$

$$E_{ap} = 3\left[2\frac{\pi}{180}\right]^3 = \underline{1.276\left(10^{-4}\right)}$$

Solution 1.12

$$\text{SI: } [Q] = (1)(\text{kg})\left(\text{m}^2\right)/\text{s}^2$$

$$= \underline{\text{kg} \cdot \text{m}^2/\text{s}^2}$$

$$\text{U.S.: } [Q] = (1)(\text{slug})\left(\text{ft}^2\right)/\text{sec}^2$$

$$= \left(\frac{\text{lb} - \text{sec}^2}{\text{ft}}\right)(\text{ft})^2/\text{sec}^2 = \underline{\text{lb} - \text{ft}}$$

Note: The SI units reduce to $\left(\text{kg} \bullet \text{m/s}^2\right)\text{m} = \text{N} \bullet \text{m}$, but N is not a base unit.