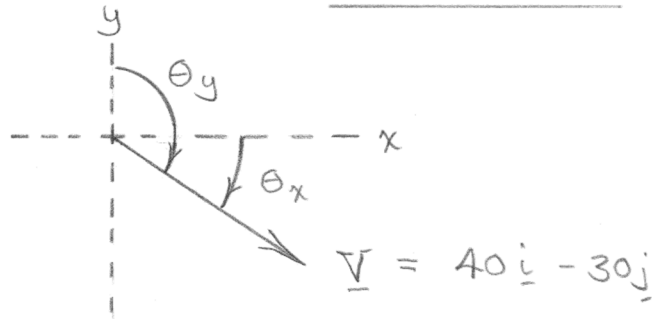


$$|V| \quad V = \sqrt{V_x^2 + V_y^2} = \sqrt{40^2 + 30^2} = 50$$

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

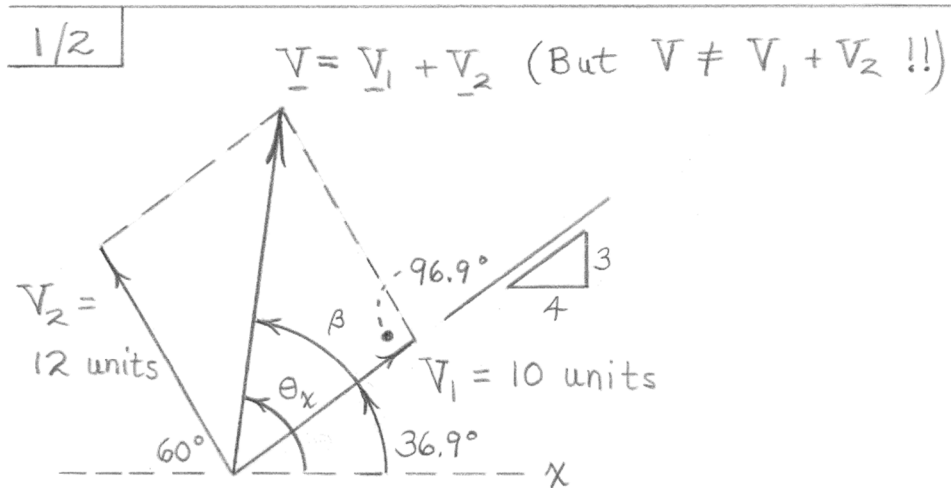
$$\cos \theta_x = 0.8, \quad \underline{\theta_x = 36.9^\circ}$$

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



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WhatsApp: <https://wa.me/message/2H3BV2L5TTSUF1> Telegram: <https://t.me/solutionmanual>

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Graphically, $V = 16.4$ units, $\theta_x = 83^\circ$

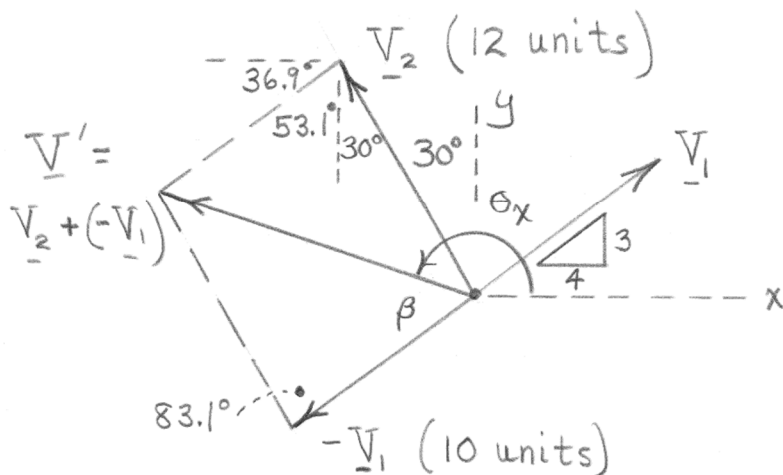
Algebraically, $V^2 = 10^2 + 12^2 - 2(10)(12)\cos 96.9^\circ$

$V = 16.51$ units

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

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

1/3



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

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

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

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

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

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

$$\frac{1}{4} \quad F = \sqrt{160^2 + 80^2 + 120^2} = 215 \text{ N}$$

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

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

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

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$$\boxed{1/5} \quad m = \frac{W}{g} = \frac{3000}{32.174} = \underline{93.2 \text{ slugs}}$$

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

↑ from Table D/5

To illustrate the sensitivity of such calculations to significant-figure issues,

we now use $g = 32.2 \text{ ft/sec}^2$:

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

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

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

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1/6

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

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

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

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

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

Substitute these numbers $\frac{1}{1}$ obtain $\underline{W = 773 \text{ N}}$

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

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$$\frac{1}{7} \quad W = (125 \text{ lb}) \left(\frac{4.4482 \text{ N}}{\text{lb}} \right) = \underline{556 \text{ N}}$$

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

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

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$$\frac{1}{8} \quad A = 8.67, \quad B = 1.429$$

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

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

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

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

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$$\begin{aligned} & \boxed{1/9} \\ F &= \frac{G m_e m_m}{d^2} = \frac{6.673(10^{-11})(5.976 \cdot 10^{24})^2(1)(0.0123)}{(384\,398 \cdot 10^3)^2} \\ &= \underline{1.984(10^{20}) \text{ N}} \\ F &= 1.984(10^{20}) \text{ N} \left(\frac{1 \text{ lb}}{4.4482 \text{ N}} \right) = \underline{4.46(10^{19}) \text{ lb}} \end{aligned}$$

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$$\frac{1}{10} \quad \underline{F} = \underline{F}_n = F \left(\frac{-4\hat{i} - 2\hat{j}}{\sqrt{4^2 + 2^2}} \right),$$

$$\text{where } F = \frac{G m_{cu} m_{st}}{d^2}$$

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

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

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

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

$$\text{Then } \underline{F} = 3.19 (10^{-9}) \left[\frac{-4\hat{i} - 2\hat{j}}{\sqrt{20}} \right]$$
$$= (-2.85\hat{i} - 1.427\hat{j}) 10^{-9} \text{ N}$$

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$$\frac{1}{11} \quad E = 3 \sin^2 \theta \tan \theta \cos \theta$$

$$\text{Exact: } E = 3 \sin^2 2^\circ \tan 2^\circ \cos 2^\circ \\ = \underline{1.275 (10^{-4})}$$

$$\text{Approx: } E_{ap} = 3(\theta^2)(\theta)(1) \\ = 3\theta^3 \quad (\theta \text{ in rad})$$

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

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$$\begin{aligned} \boxed{1/12} \quad \text{SI: } [\varphi] &= (1)(\text{kg})(\text{m}^2)/\text{s}^2 \\ &= \text{kg} \cdot \text{m}^2/\text{s}^2 \\ \text{U.S.: } [\varphi] &= (1)(\text{slug})(\text{ft}^2)/\text{sec}^2 \\ &= \left(\frac{\text{lb} \cdot \text{sec}^2}{\text{ft}}\right)(\text{ft})^2/\text{sec}^2 = \underline{\text{lb} \cdot \text{ft}} \end{aligned}$$

Note: The SI units reduce to

$(\text{kg} \cdot \text{m}/\text{s}^2) \text{m} = \text{N} \cdot \text{m}$, but N is not a base unit.

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