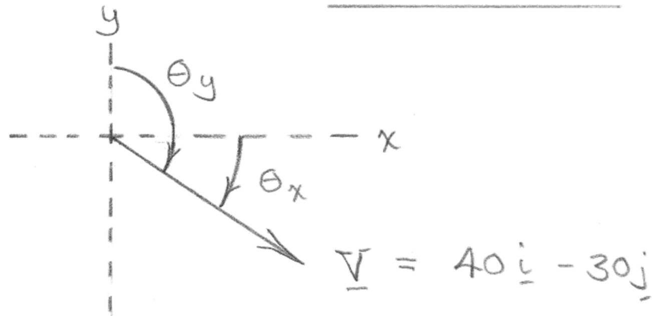
1/1

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

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

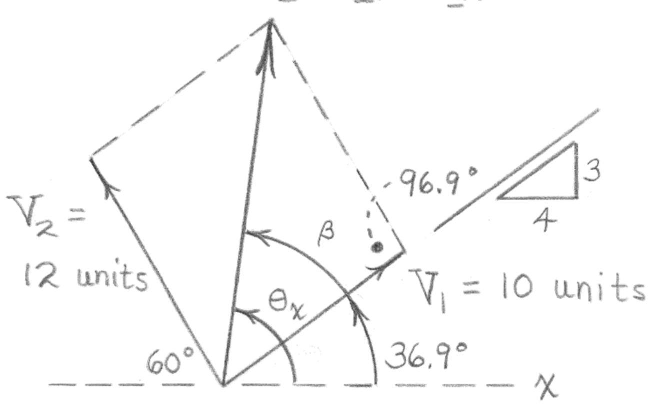
$$\cos\theta_x = 0.8, \qquad \underline{\theta_x = 36.9°}$$

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



1/2

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



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

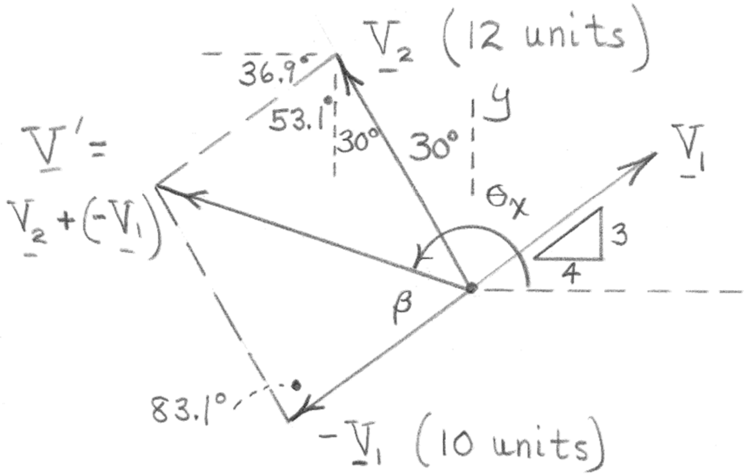
Algebraically, $V^2 = 10^2 + 12^2 - 2(10)(12)\cos 96.9°$

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

$\frac{\sin\beta}{12} = \frac{\sin 96.9°}{16.51}$, $\beta = 46.2°$

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

1/3



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

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

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

$\dfrac{\sin\beta}{12} = \dfrac{\sin 83.1°}{14.67}$, $\beta = 54.3°$

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

$= \underline{162.6°}$

1/4

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

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

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

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

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 $g = 32.2$ 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 $g = 32.2$ ft/sec^2 will normally, but not always, suffice.

1/6 $F = W = \dfrac{Gm_1 m_2}{r^2}$,

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

$m_1 = 85\ kg$

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

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

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

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

1/7

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

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

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

1/8

$A = 8.67, \quad B = 1.429$

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

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

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

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

1/9

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

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

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

1/10

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

where

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

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

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

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

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

Then

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

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

1/11 $\quad E = 3\sin^2\theta \tan\theta \cos\theta$

Exact: $\quad E = 3\sin^2 2^\circ \tan 2^\circ \cos 2^\circ$

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

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

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

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

1/12 SI: $[Q] = (1)(kg)(m^2)/s^2$

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

U.S.: $[Q] = (1)(slug)(ft^2)/sec^2$

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

Note: The SI units reduce to $(kg \cdot m/s^2)\,m = N \cdot m$, but N is not a base unit.