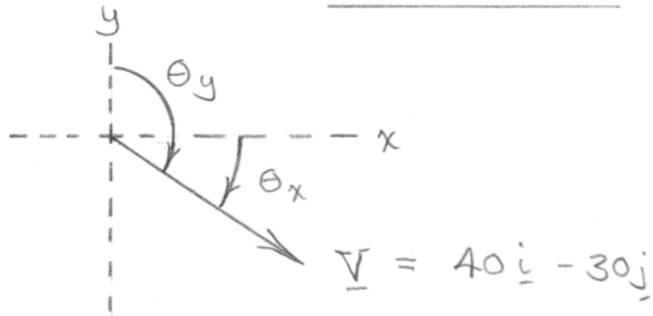
1/1

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

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

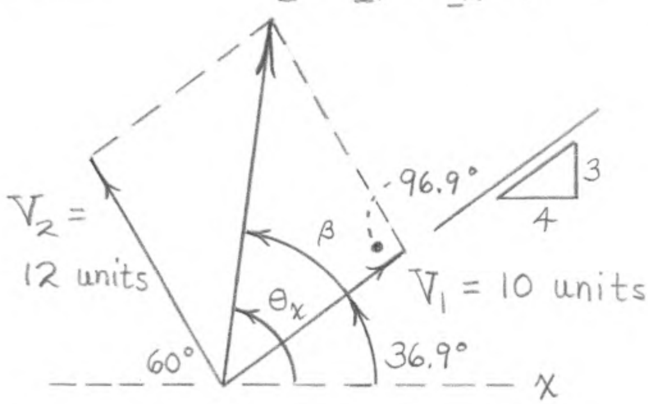
$\cos\theta_x = 0.8$, $\quad \underline{\theta_x = 36.9°}$

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



1/2

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



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

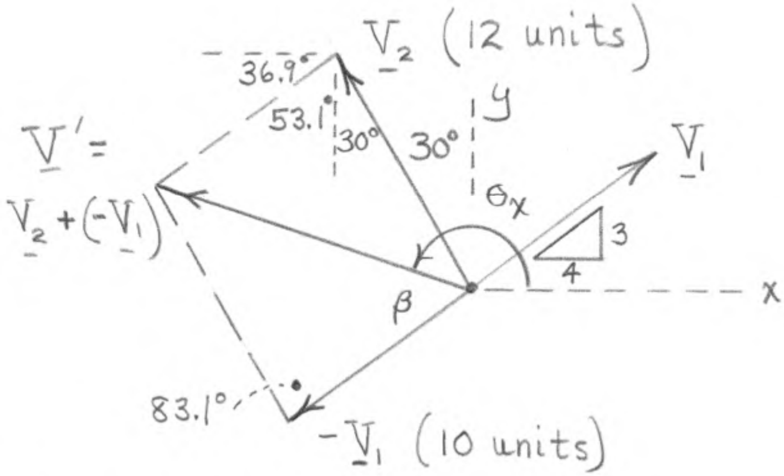
Algebraically, $V^2 = 10^2 + 12^2 - 2(10)(12)\cos 96.9°$

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

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

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

1/3



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

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

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

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

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

$$= \underline{162.6°}$$

1/4

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

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

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

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

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:

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

$m = 93.2\,(14.594) = 1360$ kg !

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

1/6 $\quad F = W = \dfrac{G m_1 m_2}{r^2}$,

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 $\underline{W = 773 \text{ N}}$

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

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

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

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

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

1/10

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1/12

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

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

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

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

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