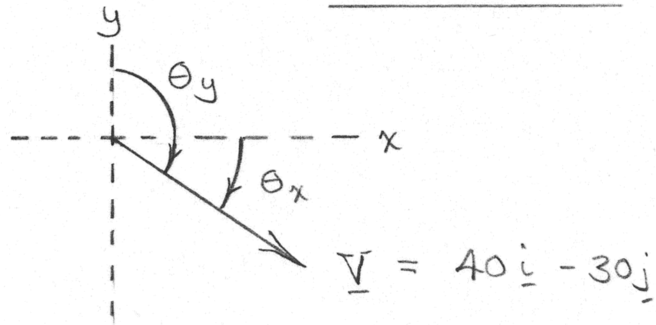
1/1

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

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

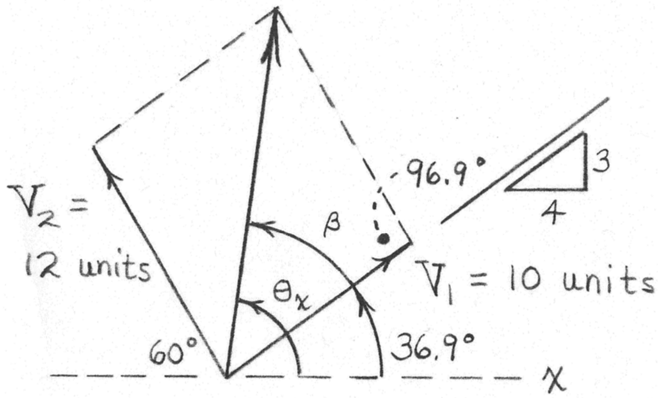
$\cos\theta_x = 0.8$, $\underline{\theta_x = 36.9°}$

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



1/2

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




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

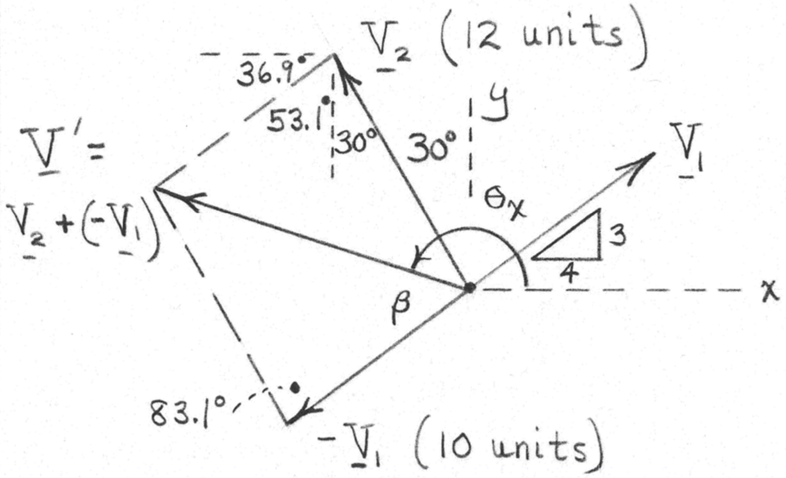
Algebraically, $V^2 = 10^2 + 12^2 - 2(10)(12)\cos 96.9°$

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

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

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

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

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

$$\cos\theta_x = \frac{F_x}{F} = \frac{120}{215} = 0.557, \quad \underline{\theta_x = 56.1^\circ}$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{-160}{215} = -0.743, \quad \underline{\theta_y = 138.0^\circ}$$

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

**1/5** $m = \dfrac{W}{g} = \dfrac{3000}{32.174} = \underline{93.2 \text{ slugs}}$

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

from inside textbook cover

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

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

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

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

**1/6** $F = W = \dfrac{Gm_1m_2}{r^2}$

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

$m_1 = 90\ kg$

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

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

Substitute these numbers & obtain $\underline{W = 819\ N}$

U.S. units : $W = 819\ N \left(\dfrac{1\ lb}{4.4482\ N}\right) = \underline{184.1\ lb}$

1/7

$$W = (130 \text{ lb})\left(\frac{4.4482 \text{ N}}{\text{lb}}\right) = \underline{578 \text{ N}}$$

$$m = \frac{W}{g} = \frac{130}{32.2} = \underline{4.04 \text{ slugs}}$$

$$m = \frac{W}{g} = \frac{578}{9.81} = \underline{58.9 \text{ kg}}$$

1/8

$A = 6.67$, $B = 1.726$

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

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

$(AB) = \underline{11.51}$

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

1/9

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

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

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

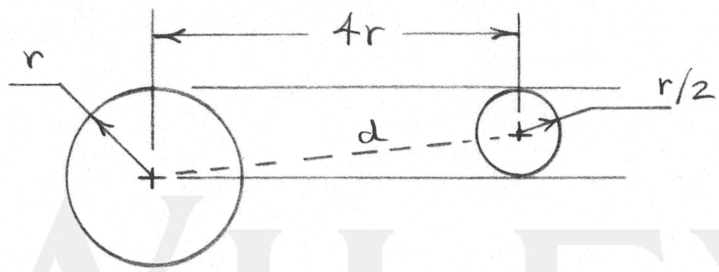
1/10

$$F = \frac{G m_s m_t}{d^2}$$

$$= \frac{G\left(\frac{4}{3}\pi r^3 \rho_s\right)\left(\frac{4}{3}\pi \left(\frac{r}{2}\right)^3 \rho_t\right)}{(4r)^2 + \left(\frac{r}{2}\right)^2}$$

With $\begin{cases} G = 6.673(10^{-11})\ m^3/(kg \cdot s^2) \\ r = 0.050\ m \\ \rho_s = 7830\ kg/m^3,\ \rho_t = 3080\ kg/m^3 \end{cases}$

$\underline{F = 1.358\ (10^{-9})\ N}$



1/11

| $\theta$ (deg) | $\theta$ (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 $\theta$ 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.