1/1

$W = mg = (1500\text{ kg})(9.81\ \frac{\text{m}}{\text{s}^2}) = \underline{14\ 720\text{ N}}$

$m = (1500\text{ kg})\left(\frac{1\text{ slug}}{14.594\text{ kg}}\right) = \underline{102.8\text{ slugs}}$

$W = mg = (102.8\text{ slugs})(32.2\ \frac{\text{ft}}{\text{sec}^2})$

$= \underline{3310\text{ lb}}$

1/2 For a 180-lb person:

$$W = mg: \quad 180 \text{ lb} = m(32.2 \text{ ft/sec}^2)$$

$$m = \underline{5.59 \text{ slugs}}$$

$$180 \text{ lb}\left(\frac{4.4482 \text{ N}}{\text{lb}}\right) = \underline{801 \text{ N}}$$

$$W = mg: \quad 801 \text{ N} = m(9.81 \text{ m/s}^2)$$

$$m = \underline{81.6 \text{ kg}}$$

1/3 The weight of an average apple is

$$W = \frac{5 \text{ lb}}{12 \text{ apples}} = 0.417 \text{ lb}$$

Mass in slugs is $m = \frac{W}{g} = \frac{0.417}{32.2} = \underline{0.01294 \text{ slugs}}$

Mass in kg is $m = 0.01294 \text{ slugs} \left(\frac{14.594 \text{ kg}}{1 \text{ slug}}\right)$

$$= \underline{0.1888 \text{ kg}}$$

Weight in N is $W = mg = 0.1888(9.81) = \underline{1.853 \text{ N}}$

These apples weigh closer to 2 N each than to the rule of 1 N each!

1/4 $\underline{V}_1 = 12(\cos 30° \underline{i} + \sin 30° \underline{j})$

$= 10.39\underline{i} + 6\underline{j}$

$\underline{V}_2 = 15\left(-\frac{3}{5}\underline{i} + \frac{4}{5}\underline{j}\right) = -9\underline{i} + 12\underline{j}$

$V_1 + V_2 = 12 + 15 = \underline{27}$

$\underline{V}_1 + \underline{V}_2 = (10.39 - 9)\underline{i} + (6 + 12)\underline{j} = \underline{1.392\underline{i} + 18\underline{j}}$

$\underline{V}_1 - \underline{V}_2 = (10.39 - (-9))\underline{i} + (6 - 12)\underline{j} = \underline{19.39\underline{i} - 6\underline{j}}$

$\underline{V}_1 \times \underline{V}_2 = (10.39\underline{i} + 6\underline{j}) \times (-9\underline{i} + 12\underline{j})$

$= [10.39(12) - 6(-9)]\underline{k} = \underline{178.7\underline{k}}$

$\underline{V}_1 \cdot \underline{V}_2 = 10.39(-9) + 6(12) = \underline{-21.5}$

1/5 $r = 0.050$ m for both spheres

$$F = \frac{G m_c m_t}{d^2} = \frac{G\left(\rho_c \frac{4}{3}\pi r^3\right)\left(\rho_t \frac{4}{3}\pi r^3\right)}{d^2}$$

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

With
$$\begin{cases} G = 6.673(10^{-11}) \frac{m^3}{kg \cdot s^2} \\ \rho_c = 8910 \ kg/m^3 \\ \rho_t = 3080 \ kg/m^3, \end{cases}$$

We obtain, as vectors:

(a) $\underline{\underline{F}} = -1.255(10^{-10})\underline{i}$ N (for $d = 2$m)

(b) $\underline{\underline{F}} = -3.14(10^{-11})\underline{i}$ N (for $d = 4$m)

1/6

$$g_h = \frac{Gm_e}{(R+h)^2}$$

$$= \frac{(3.439 \times 10^{-8})(4.095 \times 10^{23})}{[(3959)(5280) + (150)(5280)]^2} = \underline{29.9 \text{ ft/sec}^2}$$

Mass of man : $m = \frac{W}{g} = \frac{200}{32.174} = 6.22$ slugs

Absolute weight at $h = 150$ miles :

$$W_h = mg_h = (6.22)(29.9) = \underline{186.0 \text{ lb}}$$

The terms "zero-g" and "weightless" are definitely misnomers in this instance.

1/7

$$\cancel{m}g = \frac{1}{2}\cancel{m}g_{h=0}$$

$$\frac{R^2}{(R+h)^2}g_0 = \frac{1}{2}g_0$$

Solve for h to obtain $\underline{h = (\sqrt{2} - 1)R}$

or $\underline{h = 0.414R}$

1/8

$$g_{rel} = 9.780327(1 + 0.005279 \sin^2 \gamma + 0.000023 \sin^4 \gamma + \cdots)$$

At $\gamma = 40°$, $g_{rel} = 9.801698 \text{ m/s}^2$

$$g_{abs} = g_{rel} + 0.03382 \cos^2 \gamma$$
$$= 9.801698 + 0.03382 \cos^2 40°$$
$$= 9.821544 \text{ m/s}^2$$

$$W_{abs} = m g_{abs} = 90\,(9.821544) = \underline{883.9 \text{ N}}$$

$$W_{rel} = m g_{rel} = 90\,(9.801698) = \underline{882.2 \text{ N}}$$

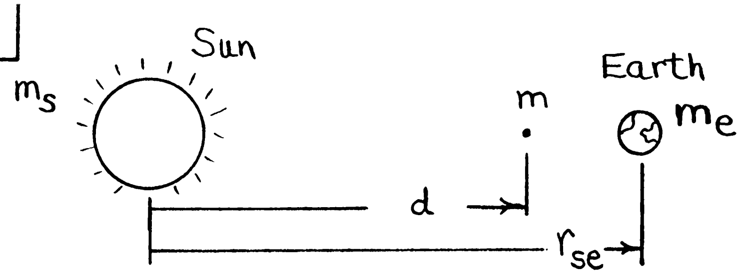
1/9 | Use $r_{ms} = 149.6(10^6)$ km as the moon-sun distance.

$$F_s = \frac{G m_s m}{r_{ms}^2} = \frac{[6.673(10^{-11})][5.976(10^{24})(333{,}000)]90}{[149.6(10^9)]^2}$$

$$= \underline{0.534 \text{ N}}$$

$$F_m = m g_m = 90(1.62) = \underline{146 \text{ N}}$$

1/10



Newton's Universal Gravitational Law:

$$\frac{G m m_s}{d^2} = \frac{G m m_e}{(r_{se} - d)^2}$$

$$d^2 [m_s - m_e] - d[2 m_s r_{se}] + m_s r_{se}^2 = 0$$

Substitute $m_e = 5.976\,(10^{24})$ kg,

$m_s = 333\,000\,[5.976\,(10^{24})]$ kg,

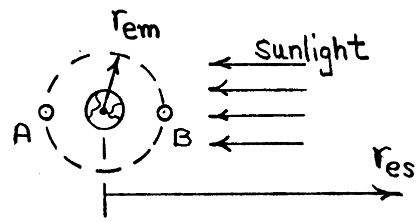
and $r_{se} = 149.6\,(10^9)$ m,

then solve the quadratic to obtain

$d = 149.3\,(10^9)$ m

or $d = 149.9\,(10^9)$ m

1/11



Force exerted by earth on moon:

$$F_e = \frac{G m_e m_m}{r_{em}^2} = \frac{(6.673\times10^{-11})(5.976\times10^{24})^2(1)(0.0123)}{(3.84398\times10^{8})^2}$$

$$= 1.984\times10^{20}\ \text{N}$$

Forces exerted by sun on moon:

$$F_{s_A} = \frac{G m_s m_m}{(r_{es}+r_{em})^2} = \frac{(6.673\times10^{-11})(5.976\times10^{24})^2(333{,}000)(0.0123)}{(1.496\times10^{11}+3.84398\times10^{8})^2}$$

$$= 4.34\times10^{20}\ \text{N}$$

$$F_{s_B} = \frac{G m_s m_m}{(r_{es}-r_{em})^2} = 4.38\times10^{20}\ \text{N}$$

Ratios:

$R_A = 2.19$

$R_B = 2.21$

1/12

$$mv = \int_{t_1}^{t_2} (F\cos\theta)\,dt$$

$$[M][LT^{-1}] = [MLT^{-2}][T]$$

$$[MLT^{-1}] = [MLT^{-1}] \quad ✓$$