1/1 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!

1/5 $r = 0.050$ 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 $d = 2m$)

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

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 $\underline{h = 0.414R}$

1/9

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

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

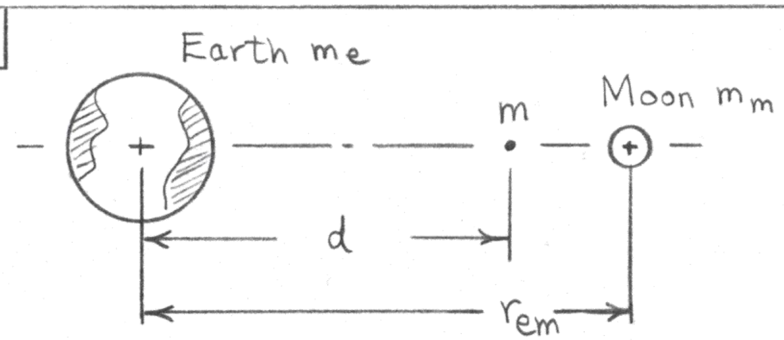
Mass of man : $m = \frac{W}{g} = \frac{200}{32.174} = 6.22$ slugs

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.

1/11



Newton's Law of Universal Gravitation:

$$\frac{G m_e m}{d^2} = \frac{G m_m m}{(r_{em}-d)^2} \Rightarrow m_m d^2 = m_e (r_{em}-d)^2$$

With $m_m = 0.0123\, m_e$ and $r_{em} = 384\,398$ km,

$$\begin{cases} d = 346\,022 \text{ km} & \text{(between earth \& moon)} \\ d = 432\,348 \text{ km} & \text{(to right of moon)} \end{cases}$$

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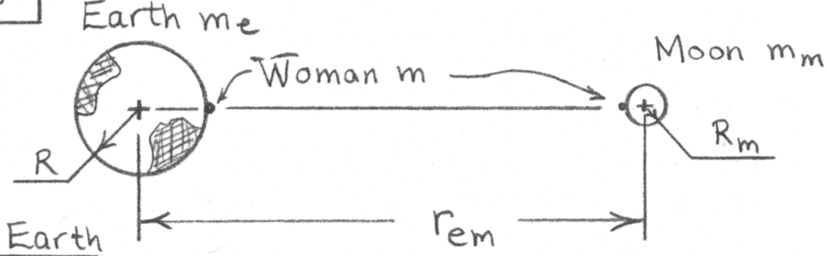

On Earth

$$F_e = \frac{G m_e m}{R^2} \qquad F_m = \frac{G m_m m}{(r_{em} - R)^2}$$

$$\text{Ratio } R_{em} = \frac{F_e}{F_m} = \frac{m_e (r_{em} - R)^2}{m_m R^2}$$

$$\text{or } R_{em} = \frac{1}{0.0123} \frac{[384\,398 - 6371]^2}{[6371]^2}$$

$$= \underline{286\,000}$$

On moon

$$F_e = \frac{G m_e m}{(r_{em} - R_m)^2} \qquad F_m = \frac{G m_m m}{R_m^2}$$

$$R_{em} = \frac{F_e}{F_m} = \frac{m_e R_m^2}{m_m (r_{em} - R)^2}$$

$$= \frac{1}{0.0123} \frac{[3476/2]^2}{[384\,398 - 3476/2]^2} = \underline{0.001677}$$

(Note: $R_{me} = F_m / F_e = 1/R_{em} = 596$)

1/15

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

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

$$[MLT^{-1}] = [MLT^{-1}] \checkmark$$