Dr. Bob

1. a) (1) $m_1 = 0.150\,kg$ $m_2 = 6.37 \times 10^{23}\,kg$

$r = 3.4 \times 10^6\,m$ $G = 6.67 \times 10^{-11}\,\frac{N \cdot m^2}{kg^2}$

$$F = G\frac{m_1 m_2}{r^2}$$

$$= \left(6.67 \times 10^{-11}\,\frac{N \cdot m^2}{kg^2}\right)\frac{(0.150\,kg)(6.37 \times 10^{23}\,kg)}{(3.4 \times 10^6\,m)^2}$$

$$\boxed{F = 0.551\,N}$$

b) $m_1 = 100\,kg$ $m_2 = 70{,}000\,kg$ $r = 15\,m$

$$F = \left(6.67 \times 10^{-11}\,\frac{N \cdot m^2}{kg^2}\right)\frac{(70{,}000\,kg)(100\,kg)}{(15\,m)^2}$$

$$\boxed{F = 2.08 \times 10^{-6}\,N}$$

c) $m_1 = 77\,kg$ $m_2 = 56\,kg$ $r = 1.5\,m$

$$F = \left(6.67 \times 10^{-11}\,\frac{N \cdot m^2}{kg^2}\right)\left(\frac{(77\,kg)(56\,kg)}{(1.5\,m)^2}\right)$$

$$\boxed{F = 1.28 \times 10^{-7}\,N}$$

2. a) Weight is the force due to gravitational attraction

Mass is the amount of matter in an object.

b) A balance is calculated to measure mass on earth

A dynamometer measure acceleration.

3. $a = 9.8\ m/s^2 \quad m = 79kg$

$$F = ma = (79kg)(9.8\ m/s^2)$$

$$\boxed{F = 774N}$$

4. Total mass, $m = 72kg + 84kg + 81kg = 237kg$

$a = 9.8\ m/s^2$

$$F = ma = (237kg)(9.8\ m/s^2)$$

$$F = 2{,}323\ N = 2.3kN$$

Yes. The force of gravity is less than the breaking force in the weakest side (9kN).

5. $a = \frac{F}{m_1} = \frac{G\ m_2}{r^2}$ $\quad m_2 = 4.83 \times 10^{24} kg$, $r = 6.05 \times 10^6 m$

$$a = \left(6.67 \times 10^{-11} \frac{(kg\ m/s^2)m^2}{kg^2}\right) \frac{(4.83 \times 10^{24} kg)}{(6.05 \times 10^6\ m)^2}$$

$$\boxed{a = 8.80\ m/s^2}$$

6. If the air resistance on earth is negligible, the acceleration in free fall on earth is $\boxed{a = g = 9.8\ m/s^2}$ for all 3 objects

7. $W = 650N \quad m_2 = 3.28 \times 10^{23} kg \quad r = 2.44 \times 10^6 m$

$m_1 = ?$

$$F = G \frac{m_1 m_2}{r^2}$$

$$m_1 = \frac{F \cdot r^2}{G\ m_2} = \frac{(650N)(2.44 \times 10^6 m)^2}{(6.67 \times 10^{-11}(N \cdot m^2/kg^2))(3.28 \times 10^{23} kg)}$$

$$\boxed{m_1 = 177kg}$$

p.272 7. (Cont'd) $W = ?$ on Pluto.

$m_2 = 1.31 \times 10^{22}$ kg $r = 1.15 \times 10^6$ m

The mass of Pluto given in the book is 10 times too big.

$$F = G\frac{m_1 m_2}{r^2} = 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2} \frac{(177 kg)(1.31 \times 10^{22} kg)}{(1.15 \times 10^6 m)^2}$$

Weight $\boxed{F = 117 N}$

Extra The radius decreases by $\frac{1.15 \times 10^6 m}{2.44 \times 10^6 m} = \frac{1.15}{2.44}$

So r^2 decreases by $\left(\frac{1.15}{2.44}\right)^2$

So Force actually increases by $\left(\frac{0.131}{3.28}\right)\left(\frac{2.44}{1.15}\right)^2$

$$F = 650 N \left(\frac{0.131}{3.28}\right)\left(\frac{2.44}{1.15}\right)^2 = 117 N$$

8. $m = 750$ tonnes $= 750,000$ kg 1 tonne = 1000kg

Force must exceed gravity

$$F = mg = (7.5 \times 10^5 kg)(9.8 m/s^2)$$

$$\boxed{F_g = 7.35 \times 10^6 N}$$

Force must exceed 7.35×10^6 N