Solutions to Orbital Motion Problems

1.) $T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{3m}{9.8 m/s^2}} = 3.5_s$

2.) $2.5_s = 2\pi\sqrt{\frac{1.3m}{g}}$ $g = 8.2\ m/s^2$

3.) $4.2_s = 2\pi\sqrt{\frac{l}{9.8\ m/s}} = l = 4.4_m$

4.) $F_g = \frac{G m_1 m_2}{r^2}$ $\left(G = 6.67\times10^{-11}\frac{Nm^2}{kg^2}\right)$ a) $F_g = 5.33\times10^{-10}$

b) quadruples

c) 1/16 as great

5) 7.1 metres apart

6) 2.1×10^{-11}

7) a) $1.99\times10^{20}\ N$

b) $3.53\times10^{22}\ N$

c) $1.64\times10^{21}\ N$

8) a) 17,493.6 N

b) $V_o = \sqrt{\frac{G M_{earth}}{r}}$

$V_o = 6,462.7\ m/s$

c) $V = \frac{2\pi r}{T}$

$T = 9,284.77_s$

9) $V_0 = \sqrt{\frac{GM}{r}}$

radius of earth ↓ , altitude ↓

$r = 1.35 \times 10^7 - 6.37 \times 10^6_m = \boxed{7.16 \times 10^6_m}$

↑ total radius of orbit from earth's center

10) $V_0 = \sqrt{\frac{GM}{r}}$ $\quad r = \sqrt[3]{\frac{GMT^2}{4\pi^2}} = 4.19 \times 10^{22}$

$= 3.67 \times 10^7$

$\frac{2\pi r}{T} = \sqrt{\frac{GM}{r}}$ algebra

11)

$F_g = \frac{GM_1M_2}{r^2} = 3.69 \times 10^{22}_N$

$\left(\frac{T_{Earth}}{T_{saturn}}\right)^2 = \left(\frac{R_{Earth}}{R_{saturn}}\right)^3 = 9,307.45 \text{ days}$

12) $mg = \frac{GM_1M}{r^2}$

a) $g = \frac{GM}{r^2} = \frac{(6.67 \times 10^{-11})(6 \times 10^{23})}{(7000,000\ m)^2} = 10.05$

b) 700.35 N

B = bob M = mary T_B = 10ed (earth days)

15)

$R_B = 5\times10^6$ m

T_M = 18ed

$$\left(\frac{T_B}{T_M}\right)^2 = \left(\frac{R_B}{R_m}\right)^3$$

a) $R_m = 8.29\times10^6$ m

for Bob

b) $V_o = \sqrt{\frac{GM}{r}}$

$$\left(\frac{2\pi r}{T}\right)^2 = \sqrt{\frac{GM}{r}}^2$$ algebra

$$M = \frac{4\pi^2 r^3}{T^2 G}$$

$$M = \frac{4\pi^2(5\times10^6\text{ m})^3}{(\quad)(6.67\times10^{-11})}$$

10ed = 8.64×10^5 s

8.56×10^{25}

~~c)~~ ~~g~~

$$g = \frac{GM}{r^2} = \frac{(6.67\times10^{-11}\ \frac{N m^2}{kg^2})(\quad)}{(9\times10^5\text{ m})^2}$$

8.56×10^{25}

10ed = 8.64×10^5 s for bob

$$M = \frac{4\pi^2 r^3}{T^2 G} = \frac{4\pi^2(5\times10^6\text{ m})^3}{(8.64\times10^5)^2(6.67\times10^{-11})} = \frac{4.9348\times10^{21}}{49.79} = 9.911\times10^{19}$$

c) $$g = \frac{GM}{r^2} = \frac{(6.67\times10^{-11})(9.911\times10^{19})}{(9\times10^5)^2} =$$

13) $r = 1.5 \times 10^6 m$ $\quad g = 7.5 m/s^2$

a) $g = \frac{GM}{r^2}$

$M = \frac{gr^2}{G} = 2.53 \times 10^{23} kg$

b) $V_e = \sqrt{\frac{GM}{r}}$ $\leftarrow r = 1.5 \times 10^6 + 200{,}000 m$

$V_0 = \sqrt{\frac{(6.67 \times 10^{-11})(2.53 \times 10^{23})}{1.7 \times 10^6}}$

$V_0 = 3150.6 m/s$

14) $T_H = 2 ey$ $\quad H = huey \quad D = dewey \quad L = Louie$

$R_H = 4.5 \times 10^5 m$

a) $\left(\frac{T_H}{T_D}\right)^2 = \left(\frac{R_H}{R_D}\right)^3$ $\quad T_D = 9.71$ earth years

b) $\left(\frac{T_H}{T_L}\right)^2 = \left(\frac{R_H}{R_L}\right)^3$ $\quad R_L = 2.42 \times 10^6$

(R_L goes in the denominator)

c) don't worry about C-g

16) $r = 7.5 \times 10^6 m$

$M = 5.98 \times 10^{24} kg$

a) $V_0 = \sqrt{\frac{GM}{r}}$

$V_0 = 7292.6 m/s$

b) $V_0 = \frac{2\pi r}{T}$

$T = \frac{2\pi r}{V_0} = \frac{2\pi (7.5 \times 10^6 m)}{7292.6 m/s} = 6461.9 s$

c) $F_g = \frac{Gm_1 m_2}{r^2} = \frac{(6.67 \times 10^{-11} \frac{Nm^2}{kg^2})(5.98 \times 10^{24} kg)(500 kg)}{(7.5 \times 10^6)^2}$

$F_g = 3545.48 N$

17) A = asteroid E = earth ey = earth year au = distance of earth to sun

$\left(\frac{5.6 au}{1 au}\right)^3 = \left(\frac{T_A}{1 ey}\right)^2$

$175.616 = \frac{T_A^2}{1 ey^2}$

$T_A = 13.25$ earth years

18) $T_{sat} = 34 ey$

compare to earth

$$\left(\frac{34 ey}{1 ey}\right)^2 = \left(\frac{R_{sat}}{1.5 \times 10^{11}}\right)^3$$

$$1156 = \frac{R_{sat}^3}{3.375 \times 10^3}$$

$$R_{sat} = 1.57 \times 10^{12} m$$