Gravitation + Satellites

1) $F_g = \frac{GM_1M_2}{r^2}$

$r = \sqrt{\frac{GM_1M_2}{F_g}}$

$r = \sqrt{\frac{6.67\times10^{-11}\frac{Nm^2}{kg^2}(5kg)(5.98\times10^{24}kg)}{3.5N}}$

a) $\boxed{r = 2.39\times10^7 m}$

$r = r_e + h$

$h = r - r_e$

$= 2.39\times10^7 m - 6.37\times10^6 m$

b) $\boxed{h = 1.75\times10^7 m}$

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

$r = \sqrt{\frac{GM}{g}}$

$r = \sqrt{\frac{6.67\times10^{-11}\frac{Nm^2}{kg^2}(5.98\times10^{24}kg)}{1\frac{m}{s^2}}}$

$r = 2.00\times10^7 m$

$h = r - r_e$

$= 2.00\times10^7 m - 6.37\times10^6 m$

$\boxed{h = 1.36\times10^7 m}$

3) $\frac{T_U^2}{r_U^3} = \frac{T_e^2}{r_e^2}$

$T_U = \sqrt{\frac{T_e^2 r_U^3}{r_e^3}}$

$T_U = \sqrt{\frac{(1yr)^2(19.182AU)^3}{(1AU)^3}}$

a) $\boxed{T_U = 84.0\,yr}$

$v_{esc} = \sqrt{\frac{2GM}{r}}$

$= \sqrt{\frac{2(6.67\times10^{-11}\frac{Nm^2}{kg^2})(14.5)(5.98\times10^{24}kg)}{2.59\times10^7 m}}$

b) $\boxed{v_{esc} = 2.11\times10^4\frac{m}{s}}$

4) $\frac{r_T^3}{T_T^2} = \frac{r_N^3}{T_N^2}$

$r_T = \sqrt[3]{\frac{(5.56\times10^6 km)^3(5,877d)^2}{(359.9d)^2}}$

$\boxed{r_T = 3.57\times10^5 km}$

5) $F_g = \frac{GM_1M_2}{r^2}$

$= \frac{6.67\times10^{-11}\frac{Nm^2}{kg^2}(1.991\times10^{30}kg)(3.71\times10^{23}kg)}{(39.439AU)^2(1.496\times10^{11}\frac{m}{AU})^2}$

$\boxed{F_g = 1.42\times10^{18}N}$

6) $r = r_e + h$

$= 6.37\times10^6 m + 4\times10^5 m$

$r = 6.77\times10^6 m$

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

$T = \sqrt{\frac{4\pi^2(6.77\times10^6 m)^3}{6.67\times10^{-11}\frac{Nm^2}{kg^2}(5.98\times10^{24}kg)}}$

a) $\boxed{T = 5540s}$

$v_{esc} = \sqrt{\frac{2GM}{r}}$

$= \sqrt{\frac{2(6.67\times10^{-11}\frac{Nm^2}{kg^2})(5.98\times10^{24}kg)}{6.77\times10^6 m}}$

b) $\boxed{v_{esc} = 1.09\times10^4\frac{m}{s}}$

7) $v_{orb} = \sqrt{\frac{GM}{r}}$

$= \sqrt{\frac{6.67\times10^{-11}\frac{Nm^2}{kg^2}(5.98\times10^{24}kg)}{6.77\times10^6 m}}$

$\boxed{v_{orb} = 7680\frac{m}{s}}$

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

$= \frac{6.67\times10^{-11}\frac{Nm^2}{kg^2}(5.98\times10^{24}kg)}{(6.77\times10^6 m)^2}$

$\boxed{g = 8.70\frac{m}{s^2}}$

9) $\frac{r_x^3}{T_x^2} = \frac{r_e^3}{T_e^2}$ $\quad r_x = \sqrt[3]{\frac{(1.496\times10^{11}\,m)^3 (1077\,d)^2 \left(86400\frac{s}{d}\right)^2}{(3.15\times10^7\,s)^2}}$

$r_x = \sqrt[3]{\frac{r_e^3 T_x^2}{T_e^2}}$ b) $\boxed{r_x = 3.08\times10^{11}\,m}$

$V_{orb} = \sqrt{\frac{G M_{SUN}}{r}}$ a) $\boxed{V_{orb} = 2.08\times10^4\,\frac{m}{s}}$

$= \sqrt{\frac{6.67\times10^{-11}\frac{Nm^2}{kg^2}\,(1.991\times10^{30}\,kg)}{3.08\times10^{11}\,m}}$

10) $r_{MARS} = 0.53 r_e$ $\quad V_{esc} = \sqrt{\frac{2GM}{r}}$

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

$= \frac{6.67\times10^{-11}\frac{Nm^2}{kg^2}\,(0.11)(5.98\times10^{24}\,kg)}{(0.53)^2 (6.37\times10^6\,m)^2}$ $\quad = \sqrt{\frac{2(6.67\times10^{-11}\frac{Nm^2}{kg^2})(0.11)(5.98\times10^{24}\,kg)}{0.53(6.37\times10^6\,m)}}$

a) $\boxed{g = 3.85\,\frac{m}{s^2}}$ b) $\boxed{V_{esc} = 5100\,\frac{m}{s}}$