Assignment 4 Solutions

1a) Kepler's Law $\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$

Orbit about Moon 1: $\frac{r_1^3}{T_1^2} = \frac{GM_1}{4\pi^2}$ (1)

" " 2: $\frac{r_2^3}{T_2^2} = \frac{GM_2}{4\pi^2}$ (2)

$(1) \div (2) \Rightarrow \frac{r_1^3/T_1^2}{r_2^3/T_2^2} = \frac{M_1}{M_2}$

$T_1 = T_2,\ r_2 = 2r_1 \Rightarrow \frac{1}{8} = \frac{M_1}{M_2}$

or $M_2 = 8M_1$

b) If volumes are the same, then density of M_2 is 8 times density of M_1 and the two moons have very different composition $\Rightarrow$ different origins.

2a) Kepler's Law $\frac{r^3}{T^2} = \frac{GM_{Earth}}{4\pi^2}$

$T = 1\,\text{day} \Rightarrow r = \left\{\frac{6.67\times10^{-11} \times 6\times10^{24} \times 24^2 \times 3600^2}{4\pi^2}\right\}^{1/3}$

$= 4.23\times10^{7}$ m

$= 42{,}300$ km.

b) This is a nice spot for telecommunications satellite.

3. Newton's 2nd Law $ma = \frac{GmM}{r^2}$.

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

$$\frac{a_{Mars}}{a_{Earth}} = \frac{M_{mars}/r_{mars}^2}{M_{Earth}/r_{Earth}^2}$$

$$= \frac{M_m}{M_E}\left(\frac{r_{Earth}}{r_{mars}}\right)^2$$

$$= \frac{1}{8}(2)^2$$

$$= \frac{1}{2}$$

$\therefore a_{Mars} = \frac{1}{2} \times 9.8 = 4.9\ m/sec^2$.

4. At Earth's surface $mg = \frac{GmM}{R_E^2}$ (1)

Find r such that $0.9mg = \frac{GmM}{r^2}$

$$0.9 = \left(\frac{R_E}{r}\right)^2 \text{ using (1).}$$

$$r = 1.05\ R_E$$

$\therefore$ height of object is $.05 R_E = 320$ km.

5. $F_{grav} = \frac{6.67\times10^{-11} \times 1.67\times10^{-27} \times 9.11\times10^{-31}}{(5\times10^{-11})^2} = 4.06\times10^{-47}$ Nt.