PH

Kepler's Laws

$$\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{R_A}{R_B}\right)^3$$

1) $R_A = 2.0 \times 10^{11}\ m$ $\quad T_A = ?$

$R_B = 5.79 \times 10^{10}\ m$ $\quad T_B = 7.60 \times 10^{6}\ s$

$$T_A = \sqrt{\frac{(R_A^3)(T_B^2)}{R_B^3}} = \sqrt{\frac{(2.0\times10^{11}\ m)^3 (7.60\times10^{6}\ s)^2}{(5.79\times10^{10}\ m)^3}}$$

$T_A = 4.9 \times 10^{7}\ s$

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2) $R_A = ?$ $\quad T_A = 6.32 \times 10^{7}\ s$ $\quad$ Earth in Mystery Planet

$R_B = 1.49 \times 10^{11}\ m$ $\quad T_B = 3.16 \times 10^{7}\ s$

$$R_A = \sqrt[3]{\frac{T_A^2 R_B^3}{T_B^2}} = \sqrt[3]{\frac{(6.32\times10^{7}\ s)^2 (1.49\times10^{11}\ m)^3}{(3.16\times10^{7}\ s)^2}} = \frac{2.37\times10^{11}\ m}{1.49\times10^{11}\ m} = 1.59$$

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3) $R_A = 4.8 \times 10^{11}\ m$ $\quad R_B = 5.79 \times 10^{10}\ m$

$T_A = ?$ $\quad T_B = 7.60 \times 10^{6}\ s$

$$T_A = \sqrt{\frac{R_A^3 T_B^2}{R_B^3}} = \sqrt{\frac{(4.8\times10^{11}\ m)^3 (7.60\times10^{6}\ s)^2}{(5.79\times10^{10}\ m)^3}} = 1.8\times10^{8}\ s$$

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4) Demos is B $\quad$ Phobos is A

$T_B = 30h\ 18s = 109080\ s$ $\quad T_A = 7h\ 39m = 27540\ s$

$R_B = 2.3\times10^{4}\ km = 2.3\times10^{7}\ m$ $\quad R_A = ?$

$$R_A = \sqrt[3]{\frac{T_A^2 R_B^3}{T_B^2}} = \sqrt[3]{\frac{(27540\ s)^2 (2.3\times10^{7}\ m)^3}{(109080\ s)^2}} = 9.2\times10^{6}\ m$$

5) A is Lander B is Phobos

$T_A = ?$ $\quad R_A = 100\,km + 3.43\times10^6\,m = 3.53\times10^6\,m$

$T_B = 27540\,s$ $\quad R_B = 9.2\times10^6\,m$

$$T_A = \sqrt{\frac{R_A^{\,3} T_B^{\,2}}{R_B^{\,3}}} = \sqrt{\frac{(3.53\times10^6\,m)^3 (27540\,s)^2}{(9.2\times10^6\,m)^3}} = 6.5\times10^3\,s$$

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6) A is Sat B is Moon

$T_A = 24\,hrs = 86400\,s$ $\quad T_B = 2.36\times10^6\,s$

$R_A = ?$ $\quad R_B = 3.8\times10^8\,m$

A)
$$R_A = \sqrt[3]{\frac{T_A^{\,2} R_B^{\,3}}{T_B^{\,2}}} = \sqrt[3]{\frac{(86400\,s)^2 (3.8\times10^8\,m)^3}{(2.36\times10^6\,s)^2}} = 4.2\times10^7\,m$$

B) Height above Earth $= 4.2\times10^7\,m - 6.38\times10^6\,m =$

$= 3.6\times10^7\,m$