Universal Gravitation Practice Problems 35, 36, 38, 39

(35) Velocity can be found by equating $\frac{mv^2}{r}$ and $\frac{Gm_1m}{r^2}$

$$\frac{m_1v^2}{r} = \frac{Gm_1m_2}{r^2} \rightarrow m_1v^2 = \frac{Gm_1m_2r}{r^2} \rightarrow$$

$$m_1v^2 = \frac{Gm_1m_2}{r} \rightarrow v^2 = \frac{Gm_1m_2}{r \cdot m_1} \rightarrow$$

$$v^2 = \frac{Gm_2}{r} \rightarrow v = \sqrt{\frac{G \cdot M_2}{r}}$$

M_2 ← mass of Bigger Body being orbited

what is orbital velocity?

a) $v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.67\times10^{-11}\frac{N\cdot m^2}{kg^2} \cdot 5.0\times10^{24}kg}{8.5\times10^{9}m}} = 1980\frac{m}{s} =$

$v = 2.0\times10^{4}\frac{m}{s}$

b) what is orbital period?

$v = \frac{2\pi r}{T}$ so $T = \frac{2\pi r}{v} = \frac{2\cdot\pi\cdot 8.5\times10^{9}m}{2.0\times10^{4}\frac{m}{s}} =$

↑ Period

$T = 2.7\times10^{6}s$

(36) What is Velocity at 2 R_E above surface?

a) $\frac{mv^2}{r} = \frac{Gmm}{r^2}$ $\therefore v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.67\times10^{-11}\frac{N\cdot m^2}{kg^2}\cdot 5.97\times10^{24}\,kg}{3\cdot 6.371\times10^{6}\,m}}$ =

$v = 4564\ \frac{m}{s} = 4.6\times10^{3}\ \frac{m}{s}$

b) $v = \frac{2\pi r}{T}$, so $T = \frac{2\pi r}{v} = \frac{2\cdot\pi\cdot(3\cdot 6.371\times10^{6}\,m)}{4564\ \frac{m}{s}}$ =

$T = 2.63\times10^{4}\,s$

Does not agree with Key, which says answer is $5.09\times10^{3}\,s$???

(38) What is Velocity at 7.3×10^{8} m from a spherical object of mass 3.0×10^{27} kg?

a) $\frac{mv^2}{r} = \frac{Gmm}{r^2}$ $\therefore v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.67\times10^{-11}\frac{N\cdot m^2}{kg^2}\cdot 3.0\times10^{27}\,kg}{7.3\times10^{8}\,m}}$

$v = 16556\ \frac{m}{s} = 1.7\times10^{4}\ \frac{m}{s}$

b) $v = \frac{2\pi r}{T}$, so $T = \frac{2\pi r}{v} = \frac{2\cdot\pi\cdot 7.3\times10^{8}\,m}{16556\ \frac{m}{s}}$ =

$T = 277043.5 = 2.8\times10^{5}\,s$

39

a) $\frac{mv^2}{r} = \frac{GmM}{r^2}$, so $v = \sqrt{\frac{GM}{r}} =$

$$\sqrt{\frac{6.67\times10^{-11} \cdot 5.97\times10^{24}\,kg}{(6\times6.371\times10^{6}\,m)}} = 3228\,\frac{m}{s} = 3.23\times10^{3}\,\frac{m}{s}$$

b) $v = \frac{2\pi r}{T}$, so $T = \frac{2\pi r}{v} = \frac{2\cdot\pi\cdot(6\cdot6.371\times10^{6}\,m)}{3228\,\frac{m}{s}}$

$$T = 74406\,s = 7.44\times10^{4}\,s$$