Universal Gravitation

Chapter Eight

Physics

Key

$m_e = 5.98 \times 10^{24}$ kg
$r_e = 6.38 \times 10^{6}$ m
$r_{oe} = 1.5 \times 10^{11}$ m (orbital)

$m_s = 1.99 \times 10^{30}$ kg
$r_s = 6.96 \times 10^{8}$ m
$m_v = 4.87 \times 10^{24}$ kg
$r_{ov} = 1.08 \times 10^{11}$ m

$m_m = 7.22 \times 10^{22}$ kg
$r_m = 1.785 \times 10^{6}$ m
$r_m = 3.9 \times 10^{8}$ m (from earth)
$T_m = 27.3$ days

1. Find the period of a planet that is 1.89×10^{11} m from the sun using Newton's Variation of Kepler's 3rd Law?

$\frac{r^3}{T^2} = \frac{Gm_s}{4\pi^2}$ $\quad T = \sqrt{\frac{4\pi^2 r^3}{Gm_s}} = \sqrt{\frac{4\pi^2 (1.89\times10^{11}m)^3}{G(1.99\times10^{30}kg)}} = 4.48\times10^{7}s$

518 days
1.42 yrs

2. What would "g" be on the surface of the sun if it imploded and became ¼ its present size?...still has same mass....

$g = \frac{Gm}{r^2} = \frac{G(1.99\times10^{30}kg)}{(\frac{1}{4}\times6.96\times10^{8}m)^2} = 4380\ m/s^2$

3. What is the velocity of the planet in #1 as it circles the sun?

$v = \sqrt{\frac{Gm}{r}} = \sqrt{\frac{G\,1.99\times10^{30}kg}{1.89\times10^{11}m}} = 26500\ m/s$

4. State Kepler's Three Laws of Planetary Motion:

1) ellipses
2) equal areas
3) $\frac{r^3}{T^2} = k$

5. Mr. G (90.0 kg) stands 25 cm away from his 925 kg Corvette. What gravitational force of attraction is present? (note the distance is in centimeters)

$F = \frac{Gm_1m_2}{r^2} = \frac{G(90kg)\,925kg}{(.25m)^2} = 8.88\times10^{-5}N$

6. Neptune is 30 times further from the sun than the earth is. What is its period?

$\frac{r^3}{T^2} = \frac{r^3}{T^2}$ $\quad \frac{(1\,roe)^3}{(1\,yr)^2} = \frac{(30\,roe)^3}{T_N^2}$

$T_N = 164\ yr$

59901 days
4.2410^8 s