Assignment: Objects in Orbit **Name:** KEY.

1. If a satellite orbits the earth with an orbital radius of 9.25×10^6 m, what is the time (in hours) to go around the earth once? **(T=2.46 hr)**

$r = 9.25 \times 10^6 m$ (radius of Earth included)

$T = ?$

$m_e = 5.97 \times 10^{24} kg$.

$F_c = F_g$

$$\frac{4\pi^2 r}{T^2} = \frac{G m_1 m_2}{r^2}$$

$$\sqrt{\frac{4\pi^2 r^3}{G m_2}} = \sqrt{T^2}$$

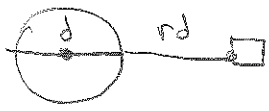
$$T = \sqrt{\frac{4\pi^2 (9.25 \times 10^6 m)^3}{6.67 \times 10^{-11} \cdot 5.97 \times 10^{24} kg}}$$

$T = 8858.136 s \times \frac{1 hr}{3600 s}$

$T = 2.46059 hr$

$\boxed{T = 2.46 hr}$

2. A 450kg satellite orbits a planet from a height of 34000 km. The diameter of the planet is 38197 km. If the satellite requires 8.9 hours to complete one orbit, what is the mass of the planet? **($m_2 = 8.6 \times 10^{25} kg$)**



$r_T = \frac{d}{2} + rd$

$r_T = \frac{38197 km}{2} + 34000 km$

$r_T = 53098.5 km \times 1000 = 5.3098 \times 10^7$

$T = 8.9 hr \times \frac{3600 s}{1 hr}$

$T = 32040 sec.$

$m_1 = 450 kg$

$m_2 = ?$

$F_c = F_g$

$$\frac{4\pi^2 r}{T^2} = \frac{G m_1 m_2}{r^2}$$

$$\frac{4\pi^2 r^3}{G T^2} = m_2$$

$$m_2 = \frac{4\pi^2 (5.3098 \times 10^7 m)^3}{6.67 \times 10^{-11} \cdot (32040 s)^2}$$

$m_2 = 8.63 \times 10^{25} kg$.

$\boxed{m_2 = 8.6 \times 10^{25} kg}$

3. In order to reduce the drag due to air resistance, most satellites are placed in orbits greater than 320km. Calculate the speed a satellite must maintain in order to remain in an orbit 400km above the earth's surface. **(v=7.67 x 10^3m/s)**

$F_c = F_g$

$m a_c = \frac{G m_1 m_2}{r^2}$

$r_T = 6.37\times10^6 m + 4.0\times10^5 m$

$r_T = 6.77\times10^6 m.$

$m_e = 5.97\times10^{24} kg.$

$v = ?$

$\frac{v^2}{r} = \frac{G m_2}{r^2}$

$v^2 = \sqrt{\frac{G m_2}{r}}$

$v = \sqrt{\frac{G m_2}{r}}$

$v = \sqrt{\frac{6.67\times10^{-11} \times 5.97\times10^{24} kg}{6.77\times10^6 m.}}$

$v = 7669.3 m/s$

$v = 7.67\times10^3 m/s$

4. A 625kg satellite is orbiting a planet at with an orbital radius of 3.43×10^6m. If the mass of the planet is 3.18×10^{23} kg, what is the orbital speed of the satellite? **[2.49×10^3 m/s]**

$m_1 = 625 kg.$

$r = 3.43\times10^6 m$

$m_2 = 3.18\times10^{23} kg$

$v = ?$

$v = \sqrt{\frac{G m^2}{r}}$

$v = \sqrt{\frac{6.67\times10^{-11} \times 3.18\times10^{23} kg}{3.43\times10^6 m}}$

$v = 2486.7 m/s$

$v = 2.49\times10^3 m/s$

5. A piece of space junk has a weight of 6250N when it is has an orbital radius of 6.84×10^5m around an unknown mass. If the space junk can make 7 complete orbits in 24.0 hours, what is the mass of the unknown mass? **[3.53×10^4kg]**

$m_1 = 6250N$

$r = 6.84 \times 10^5 m$

$T = \frac{24 hr}{7 cycles}$

$T = 3.4285 hr \times \frac{3600 s}{1 hr}$

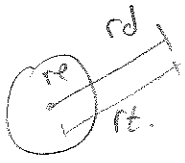
$T = 1.2342 \times 10^4 s$

$m_2 = ?$

above

6. An artificial satellite with a mass of 572kg is put into a circular orbit ~~about~~ the earth. If the satellite is 5.63×10^3km above the surface of the earth, how long (in hours) will it take the satellite to make one full revolution around the earth? **[3.64 hours]**

$m_1 = 572 kg$



$r_t = 6.37 \times 10^6 m + (5.63 \times 10^3 km \times 1000)$

$r_t = 1.2 \times 10^7 m$

$m_2 = 5.97 \times 10^{24} kg$

$T = ?$

$F_c = F_g$

$\frac{m_1 a_c}{} = \frac{G m_1 m_2}{r^2}$

$\frac{4\pi^2 r}{T^2} = \frac{G m_2}{r^2}$

$T = \sqrt{\frac{4\pi^2 (1.2 \times 10^7 m)^3}{6.67 \times 10^{-11} \times 5.97 \times 10^{24} kg}}$

$\sqrt{\frac{4\pi^2 r^3}{G m_2}} = \sqrt{T^2}$

$T = 13088.85 sec. \times \frac{1 hr}{3600 sec}$

$T = 3.6357 hr$

$T = 3.64 hr$

7. An asteroid is orbiting around Jupiter with a speed of 3.12×10^4 m/s. If the mass and radius of Jupiter, respectively, are 1.90×10^{27} kg and 6.99×10^7 m, how far above Jupiter's surface is the asteroid? **[6.03×10^7 m]**

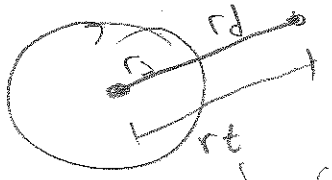
$v = 3.12 \times 10^4$ m/s

$M_2 = 1.90 \times 10^{27}$ kg

$r_T = r_J + r_d$

$r_d = ?$

$r_J = 6.99 \times 10^7$ m.



↳ from formula.

$F_c = F_g$

$m a_c = \frac{G m_1 m_2}{r^2}$

$\frac{v^2}{r} = \frac{G m_2}{r^2}$

$v^2 r^2 = G m_2$

$r_T = \frac{G m_2}{v^2}$

$r_T = \frac{6.67 \times 10^{-11} (1.9 \times 10^{27} kg)}{(3.12 \times 10^4 m/s)^2}$

$r_T = 1.30187 \times 10^8$ m

$r_d = r_T - r_J$

$r_d = 1.3 \times 10^8 m - 6.99 \times 10^7 m$

$r_d = 60287787$

$r_d = 6.03 \times 10^7$ m