Windows User at 1/5/2014 4:02 PM

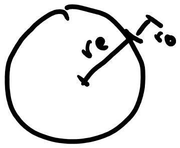
Universal Gravitation Wrap Up

Sunday, January 5, 2014   4:02 PM

Orbit and Constant Velocity Problem

$$V_T = \frac{2\pi r}{T}$$

A satellite is in orbit 500 km above the surface of the Earth. What is its velocity?



m_1 = mass earth = 5.98×10^{24} kg m_2 = mass of satellite

$$F = \frac{Gm_1 m_2}{r^2}$$

$$r = r_e + r_o = 6.38 \times 10^6 + 5 \times 10^5 = 6.88 \times 10^6 \text{ m}$$

What is happening?

→ centripetal acceleration

$$F_c = \frac{mv^2}{r} \qquad F = \frac{Gm_1 m_2}{r^2}$$

m of object → $\frac{m_2 v^2}{r} = \frac{Gm_1 m_2}{r^2}$

$$v^2 = \frac{Gm_1}{r}$$

$$v = \sqrt{\frac{Gm_1}{r}} = \sqrt{\frac{6.67 \times 10^{-11} \cdot 5.98 \times 10^{24}}{(6.88 \cdot 10^6)}} = 7610 \text{ m/s}$$

Masses cancel

This is a good thing - imagine velocity depending on the mass of the object orbiting

- Space walks would be a big problem

Time for 1 orbit (T)

$$V_T = \frac{2\pi r}{T}$$

$$T = \frac{2\pi r}{V_T} = \frac{2 \cdot \pi \cdot 6.88 \times 10^6}{7610} = 5680 \text{ s}$$

Potential energy of the satellite

$$PE = -\frac{Gm_1 m_2}{r}$$

satellite has mass of 11,000 kg

$$= -\frac{6.67 \times 10^{-11} \cdot 5.98 \times 10^{24} \cdot 11000 \text{ kg}}{6.88 \times 10^6}$$

$$= -6.38 \times 10^{11} \text{ J}$$

Find a there

$$F = \cancel{m}g = \frac{G m_p \cancel{m_o}}{r^2}$$

$$g = \frac{G m_p}{r^2} = \frac{6.67 \times 10^{-11} \cdot 5.98 \times 10^{24}}{(6.88 \times 10^6)^2} = 8.43 \text{ m/s}^2$$