Phy 4A 12/2

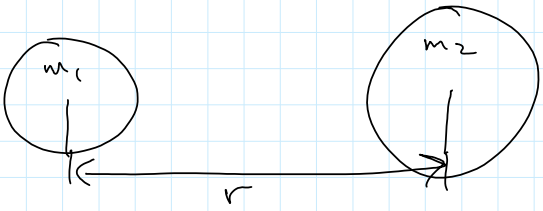
Friday, December 2, 2016 9:58 AM

Goals for the Lecture:

1) Know how to calculate gravitational forces between any two objects with mass
2) Know how to calculate the acceleration due to gravity far away from the earth's surface or on other planets
3) Understand geosynchronous orbit and how to calculate it
4) Know how to calculate the gravitational potential energy far away from the earth's surface or between any two objects with mass

$F_g = mg$ only on surface of earth

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



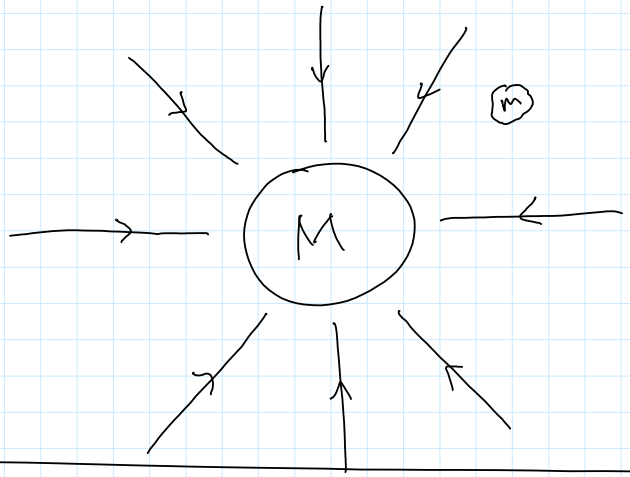
on Earth:

$$F_g = \frac{G m M_{Earth}}{R_{Earth}^2} = mg$$

$$\frac{G M_E}{R_E^2} = g$$

$G = 6.67 \times 10^{-11} \frac{N m^2}{kg^2}$

Fields

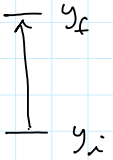


Potential Energy:

Potential Energy:

on Earth's Surface:

$F_g = mg$



$$W = \int F \cdot dy$$

$$= -mgy \Big|_{y_i}^{y_f}$$

$$= -\underbrace{mgy_f} + mgy_i$$

$$= -\Delta U$$

$$\boxed{U_g = mgy}$$

when F_g is constant → on surface of earth

In general:

$$F_g = \frac{G m_1 M_2}{r^2}$$

$$W = \int_{r_i}^{r_f} \frac{G m_1 M_2}{r^2} dr$$

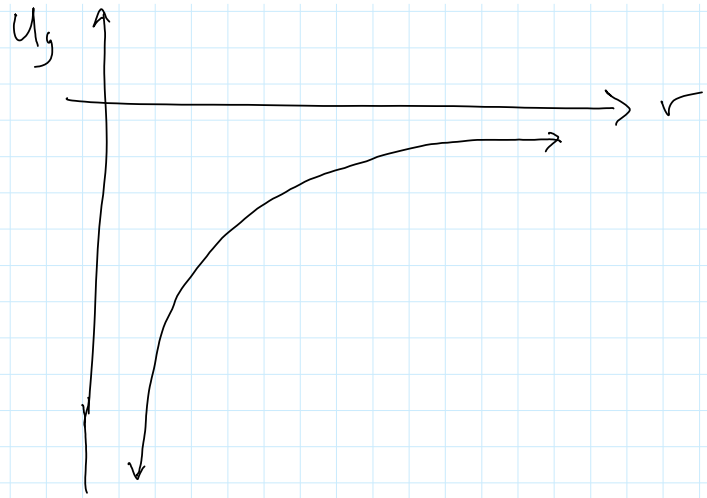
$$= \frac{G m_1 m_2}{r} \Big|_{r_i}^{r_f}$$

$$= \frac{G m_1 m_2}{r_f} - \frac{G m_1 m_2}{r_i}$$

$$= -\Delta U$$

$$\boxed{U_g = -\frac{G m_1 m_2}{r}}$$

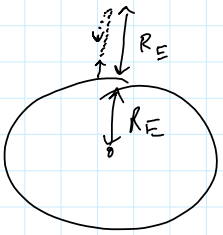
in general



Example: how fast does a projectile need to be launched from Earth's surface to reach a max. height of one Earth radius? ignor air resistance

$$E_i = E_f$$

$$K_i + (U_g)_i = \cancel{K_f}^{\,0} + (U_g)_f$$



$$\frac{1}{2}\cancel{m}v_i^2 - \frac{G\cancel{m}M_E}{R_E} = 0 - \frac{G\cancel{m}M_E}{2R_E}$$

$$v_i = \sqrt{\frac{\cancel{2}GM_E}{\cancel{2}R_E}}$$

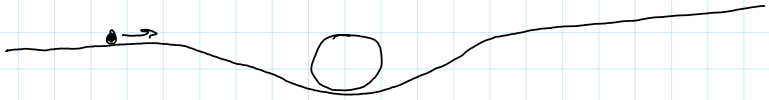
Find the escape speed : want v_f to be zero at $r = \infty$

$$K_i + (U_g)_i = K_f + (U_g)_f$$

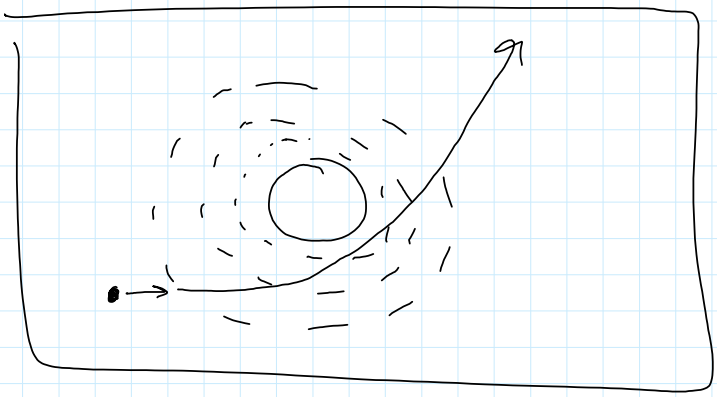
$$\frac{1}{2}\cancel{m}v_i^2 - \frac{G\cancel{m}M_E}{R_E} = 0 - 0$$

$$v_i = \sqrt{\frac{2GM_E}{R_E}}$$

Side view:



Top view:

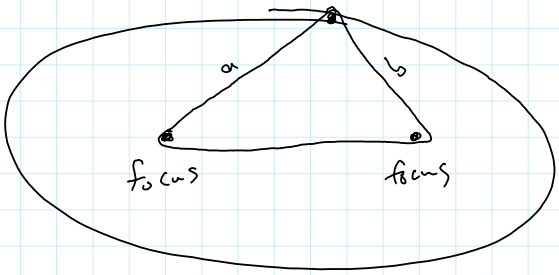


Kepler's Laws

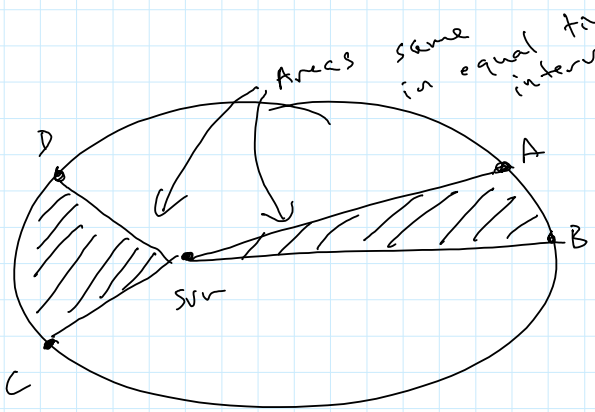
1) planets move in ellipses w/ sun at one focus

Ellipse:

a + b = constant



2)



planets go faster.

when close to sun

3) $T^2 \propto a^3$

Period
Time for 1 cycle