Universal Gravitation

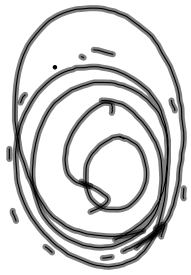
$$F_g = -\frac{G m m}{r^2}$$

Earth/Sun

$$F_g = -\frac{G M_s M_e}{r_{es}^2}$$

$$m_e a_c = -\frac{G M_s M_e}{r_{es}^2}$$

$$\frac{v_e^2}{r_s} = \frac{G M_s}{r_{es}^2}$$



$$v_e = \sqrt{\frac{G M_s}{r_{es}}}$$

$$\frac{2\pi r_{es}}{T} = \sqrt{\frac{G M_s}{r_{es}}}$$

$$T = 2\pi r_{es}\sqrt{\frac{r_{es}}{G M_s}}$$

Ex 11.3 → ISS

$$3.85 \times 10^5 \text{ m}$$

$$+ \; r_e + 6.38 \times 10^6$$

$$= r_0 = 6.765 \times 10^6$$

$$M_e = 5.98 \times 10^{24} \text{ kg}$$

$$T = 2\pi\sqrt{\frac{(6.765\times10^6)^3}{(6.67\times10^{-11})(5.98\times10^{24})}} \; \frac{\text{m}^3}{\frac{\text{N}\cdot\text{m}^2}{\text{kg}^2}\cdot\text{kg}} = \text{s}$$

$$= 5535.64 \text{ s}$$

$$\frac{5535.64}{3600} = 1.538 \text{ hr.}$$

Gravitational Potential Energy

$$F = -\frac{dU}{dl}$$

$$U = -\int F dx$$

$$dU = -F\,dl$$

$$dU = -\left(-\frac{GM_pM_s}{r^2}\right)dr$$

$$U = \int \frac{GM_pM_s}{r^2} dr$$

$$U = GM_pM_s \int r^{-2} dr$$

$$U = -\frac{GM_pM_s}{r} + \cancel{C}^{\,0}$$

Escape Velocity

$$U_i + K_i = U_f + K_f$$

$$0 + 0 = -\frac{GM_pM_e}{r} + \tfrac{1}{2}M_r v^2$$

$$\tfrac{1}{2}m_r v^2 = \frac{Gm_r m_e}{r}$$

$$v_{esc} = \sqrt{\frac{2GM_e}{r_e}}$$

Gravitational Fields

$$\vec{g} = \frac{\vec{F}_g}{m}$$

$$\vec{F}_g = m\vec{g}$$

points towards center of Earth, Sun, etc.

$$\vec{g} = \int d\vec{g}$$