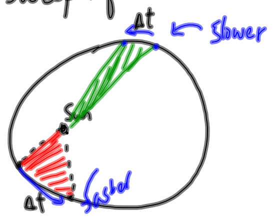
Chapter 12 - Universal Gravitation

§12-1 Newton's Law of Universal Gravitation

Tycho Brahe → Kepler (read p575)

Kepler's Laws (p575)

1. Planets travel in elliptical orbits
2. Planets sweep equal areas in equal time intervals.



3. $K = \frac{r^3}{T^2}$ (same for all planets orbiting the sun)

(Kepler's constant) * K is unique for any central body

$K = 3.35 \times 10^{18}\ m^3/s^2$ (sun)

Example

If a small planet were discovered whose obital period was twice that of Earth, how many times farther from the sun would that planet be?

$$K = \frac{r_e^3}{T_e^2} \qquad K = \frac{r_p^3}{T_p^2}$$

$$\frac{r_e^3}{T_e^2} = \frac{r_p^3}{T_p^2}$$

$$r_p^3 = \frac{r_e^3 T_p^2}{T_e^2}$$

$$r_p^3 = \frac{r_e^3 (2T_e)^2}{T_e^2}$$

$$r_p^3 = \frac{r_e^3\, 4 T_e^2}{T_e^2}$$

$$r_p^3 = 4 r_e^3$$

$$r_p = \sqrt[3]{4}\ r_e$$

$$\boxed{r_p = 1.6\ r_e}$$

The orbital radius for the small planet will be 1.6 times that of the Earth

Newton's Law of Universal Gravitation

The simple way to find F_g is using $F_g = mg$

Newton said that $F_g \propto m_1$, $F_g \propto m_2$, $F_g \propto \frac{1}{r^2}$ } $F_g \propto \frac{m_1 m_2}{r^2}$

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

$$F_g = mg$$

Where F_g is the force of gravity (N)

m_1 and m_2 are masses (kg)

r is the separation between the two masses. (m) (centre to centre)

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

MP|579

$m_1 = 65.0 kg$

$m_2 = 7.35 \times 10^{22} kg$

$r = 1.74 \times 10^3 km$ → m

$F_g = ?$

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

$$F_g = \frac{\left(6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}\right)(65.0 kg)(7.35 \times 10^{22} kg)}{(1.74 \times 10^6 m)^2}$$

$$F_g = 105 N$$

$F_g = mg$??

To Do: ① FOP SP + PP|272

② PP|580