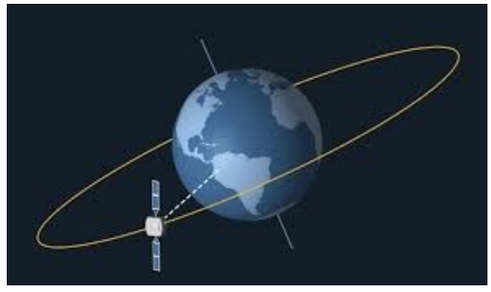
Examples

Ex. 1: Calculate the speed and period of the space shuttle's orbit around the Earth if it maintains an altitude of 295 km above the Earth's surface?

Ex. 2: What speed does Mercury orbit the Sun? What is the mass of the Sun?

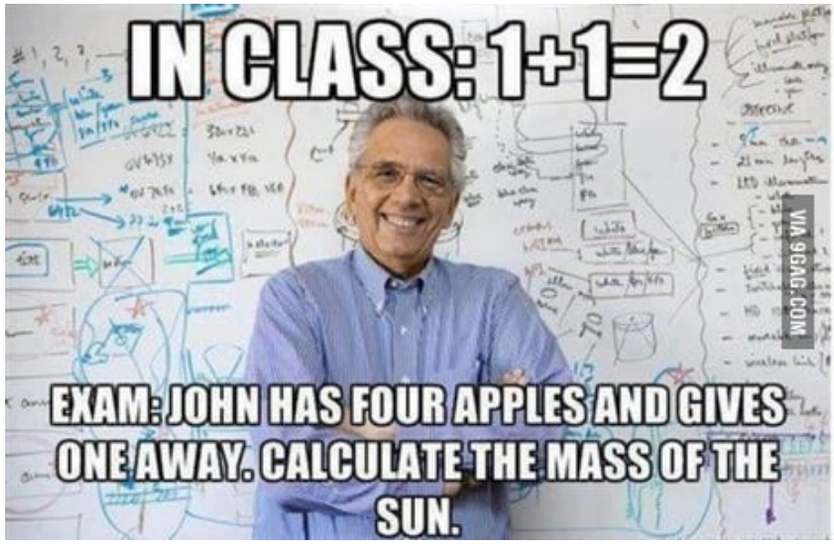
Ex. 3: Many communication satellites are placed in what is called a Geostationary Orbit. This means that their location above above the Earth never changes, i.e. it doesn't move in the sky? This means the period of these satellites is the same as the rotation of the Earth.



Using the mass of the Earth, what distance above the surface do these satellites orbit?

Practice Problems

9-14 on Page 586 & 15-17 on Page 591



Ex 1

h=295 km

R_E=6.38x10^6m

M_E=5.98x10^{24}kg

$$\begin{aligned} F_C &= F_g \\ \frac{mv^2}{R_E+h} &= \frac{GM_Em}{(R_E+h)^2} \\ \therefore v &= \sqrt{\frac{GM_E}{R_E+h}} \\ &= \sqrt{\frac{(6.673x10^{-11}Mm^2/kg^2)(5.98x10^{24}kg)}{(6.38x10^6m+295x10^3m)}} \\ &= 7.73km/s \end{aligned}$$

$$\begin{aligned} v &= \frac{2\pi r}{T} \longrightarrow T = \frac{2\pi(R_E+h)}{v} \\ T &= \frac{2\pi(6.38x10^6m+295x10^3m)}{7731.89m/s} \\ &= 5420s \approx 1.51h \end{aligned}$$

Ex 2

r_M=5.80x10^{10}m

T_M=87.77 d

M_M=3.2x10^{23}kg

$$87.77d \times \frac{24h}{1d} \times \frac{3600s}{1h} = 7583328s$$

$$\begin{aligned} v &= \frac{2\pi r_M}{T_M} = \frac{2\pi(5.80x10^{10}m)}{(7583328s)} \\ &= 48.1km/s \end{aligned}$$

$$\begin{aligned} K &= \frac{r_M^2}{T_M^2} = \frac{GM_S}{4\pi^2} \longrightarrow M_S = \frac{4\pi^2 r_M^3}{GT_M^2} \\ M_S &= \frac{4\pi^2(5.80x10^{10}m)^3}{(6.673x10^{-11}Nm^2/kg^2)(7583328s)^2} \\ &= 2.01x10^{30}kg \end{aligned}$$

Ex 3

$M_E=5.98x10^{24}kg$

$R_E=6.38x10^{6}m$

$T_S=23h56m4s$

$$K = \frac{r_S^2}{T_S^2} = \frac{GM_E}{4\pi^2} \longrightarrow r_S = \sqrt[3]{\frac{GM_E T_S^2}{4\pi^2}} = R_E + h$$

$$h = \sqrt[3]{\frac{GM_E T_S^2}{4\pi^2}} - R_E$$

$$h = \sqrt[3]{\frac{(6.673x10^{-11}Nm^2/kg^2)(5.98x10^{24}kg)(86164s)^2}{4\pi^2}} - 6.38x10^6 m$$

$$= 35,800km$$