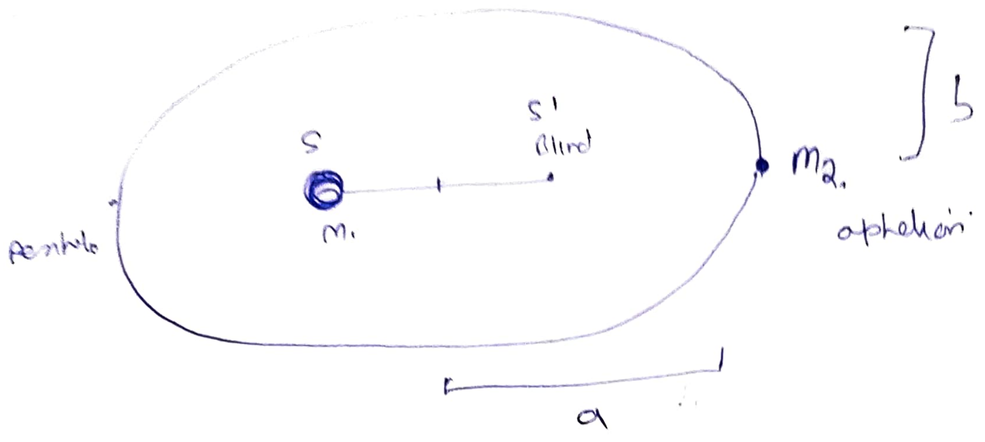
Module I

Rabbi
Indian

Keplers Laws

1) orbit law   ellipse.



2) Angular momentum conserved,
Equal areas in equal intervals of time

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

a = semimajor axis.
T = period of revolution in elliptical orbit.

$$P^2 = \frac{4\pi^2}{G(m_1+m_2)} \times a^3$$

Data given

Mass of Earth = 5.97×10^{24} kg

Mass of Satellite = 1.02×10^{-1} kg

$G = 6.67 \times 10^{-11}$

$R = 6.37 \times 10^{6}$ m

So period of sattellite

$$\rightarrow \quad P^2 = \frac{4\pi^2 \times (6.37 \times 10^{6})^3}{6.67 \times 10^{-11} \times (5.97 \times 10^{24})}$$

$P^2 = 256.258 \times 10^{18+11-24}$

$P = 5062.19$ s ≈ 84 minutes

or 1 hour, 24 minutes.

velocity = $v = \sqrt{\frac{GM_E}{R}} = \sqrt{6.25 \times 10^{-11+24-6}}$

$V = 7906.4$ m/s

Q3. Force characteristic

$$F = \frac{G m_1 m_2}{R^2} = \frac{6.67\times10^{-11} \times 5.97\times10^{24} \times 1.02\times10^{-1}}{6.37\times6.37\times10^{12}}$$

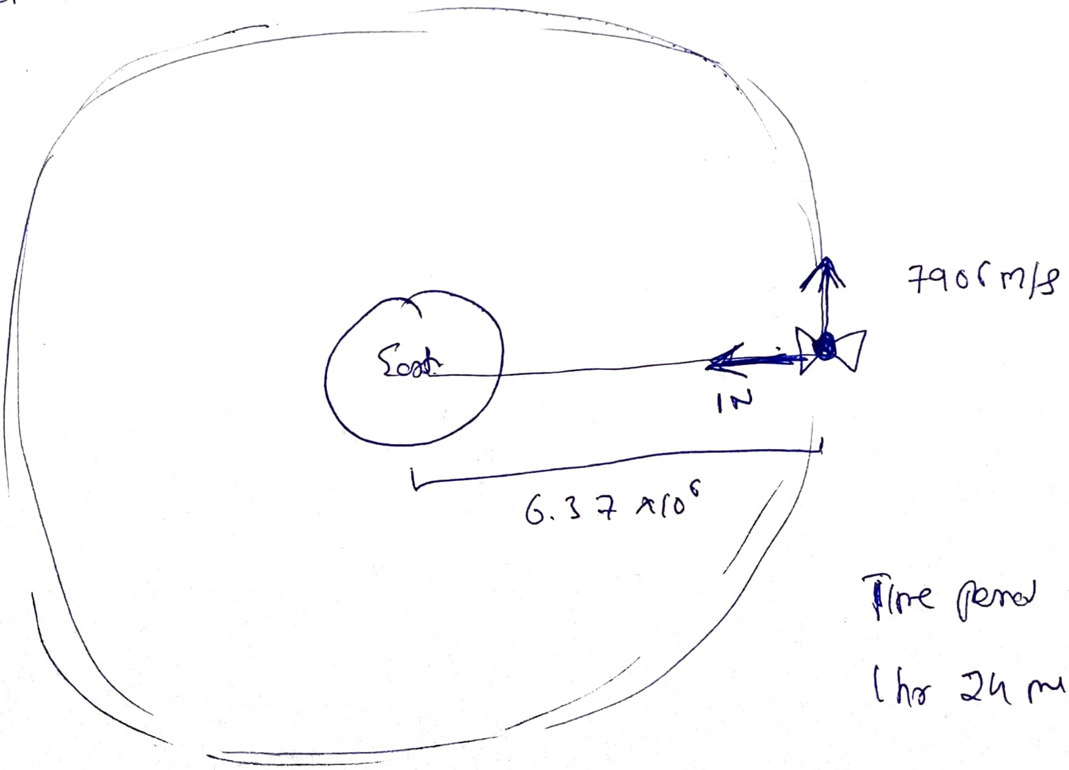
$=$ ~~Newton~~ 1 newton force

This force should be equal to the centripetal force

$$F_E = F_S = \frac{mv^2}{R} =$$

$$\frac{mv^2}{R} = \frac{1.02\times10^{-1} \times 7906\times7906}{6.37\times10^{6}} = 1 \text{ newton}$$

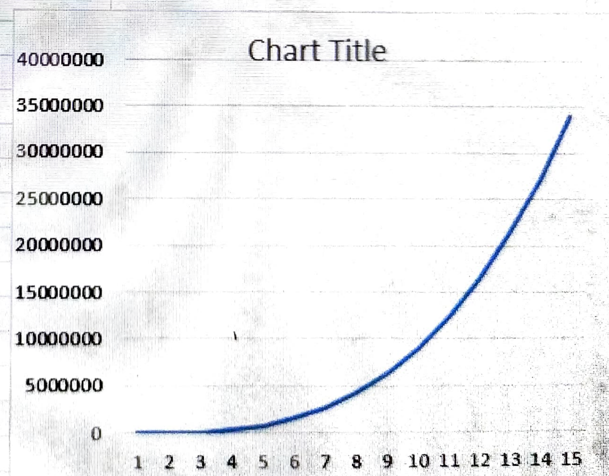
The satellite is in a stable orbit.



Time period

1 hr 24 minutes

A	B	C	D	E	F	G	H	I	J	K
Radius Values in m		Radius Cube(		K		Time Period S	Time Period			
0		0				0		0		
500000		#				##		111.2429773		
1000000		#				##		314.6426545		
1500000		#				##		578.035466		
2000000		#				##		889.9438185		
2500000		#				##		1243.734296		
3000000		#				##		1634.931191		
3500000		#				##		2060.248771		
4000000		#				##		2517.141236		
4500000		#				##		3003.560387		
5000000		#				##		3517.81182		
5500000		#				##		4058.463379		
6000000		#				##		4624.283728		
6500000		#				##		5214.199363		
7000000		#				##		5827.263509		



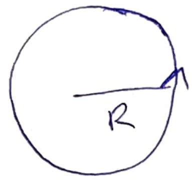
Conclusion:

Period given by. $P^2 = K R^3$

$K = 9.9 \times 10^{-14}$

$$\frac{\cancel{m_2} v^2}{\cancel{R}} = \frac{G m_1 \cancel{m_2}}{R^2}$$

$$V = \sqrt{\frac{Gm_1}{R}}$$



$$V = \frac{2\pi R}{T} \qquad T = \frac{2\pi R}{V}$$

$$T = \frac{2\pi R \sqrt{R}}{\sqrt{Gm_1}}$$ Square both sides.

$$T^2 = \left(\frac{4\pi^2}{Gm_1}\right) R^3$$

We observe that as we increase the radius then the time taken for the satellite to complete its revolution also increase

Period square $\propto$ Radius cubed

$$P^2 \propto R^3$$

$\cancel{P \propto R}$ $\quad P = K^{1/2} R^{1.5}$

$R = 0,\ 637000000$ m

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