CENTRIPETAL FORCE FROM GRAVITY

Units 14 & 8 Dr. John P. Cise, Professor of Physics, Austin Com. College, 1212 Rio Grande St., Austin Tx. 787011, jpcise@austincc.edu , & New York Times , October 19, 2016 , by Kenneth Chang

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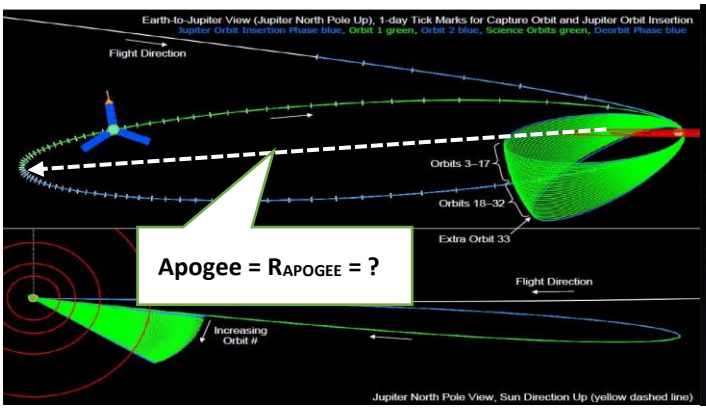
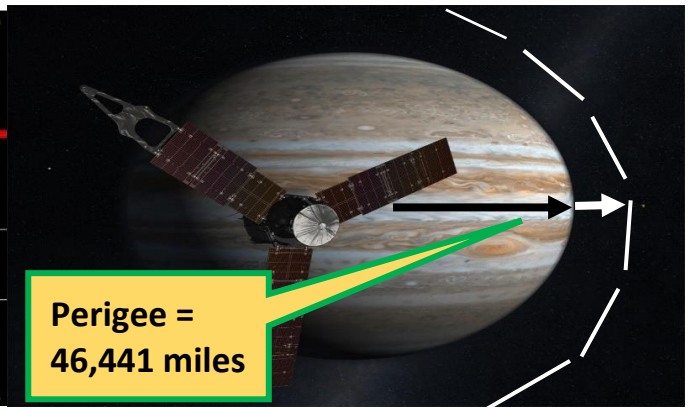
Juno Hobbled but Healthy After Glitch, NASA Says





Hours before a close flyby of Jupiter on Wednesday, NASA's Juno spacecraft experienced a malfunction that scrambled plans for peering deep into the planet. At 1:47 a.m. Eastern, the spacecraft put itself into "safe mode" and restarted its computer. **Juno's instruments shut down, scuttling observations** that were to take place **as it passed 3,000 miles above Jupiter's clouds.** The computer problem followed a glitch that led mission managers last week to put off one last firing of Juno's main engine in order to refine its orbit. **Occurring at closest approach, that engine burn would have shortened Juno's orbit, bringing it close to Jupiter every 14 days instead of every 53.** With each close pass, instruments on Juno are to peer beneath Jupiter's dense clouds. With enough passes, scientists should be able to piece together a picture of the planet's composition. The next opportunity to shorten the orbit will be during Juno's close approach on Dec. 11. Juno launched on Aug. 5, 2011, and entered orbit around Jupiter on July 4. On Aug. 27, the spacecraft made the first close swing by Jupiter with its instruments turned on. Even that one pass has revealed interesting hints about the solar system's largest planet. Meanwhile, Juno's camera provided the first clear pictures of Jupiter's polar regions. Dr. Bolton said that even if there turned out to be a serious failure with the engine and Juno needed to remain in its current orbit, the mission could achieve its scientific objectives, but it would take longer. "The worst-case scenario is I have to be patient," Dr. Bolton said.

INTRODUCTION: Purpose of this application is to find apogee (furthest from Jupiter) of juno spacecraft as it orbits with provided data: T(period) = 53 days, & from above perigee(closeness) = 3000 miles above surface. Radius of Jupiter is 43,441 miles. Thus, perigee = $R_{PERIGEE}$ = 3000 miles + 43,441 miles = 46,441 miles. R = semi major axis = $(R_{APOGEE} + R_{PERIGEE})/2$

Equating gravity to centripetal force:

$$G\, m\, M_S / R^2 = m\, v^2 / R \quad \text{where } v = 2\pi / T \text{ yields}$$

$$M_J = (4\pi^2/G)(R^3/T^2)$$

This is Kepler's 3rd law.

Where G = gravitational constant =

$$6.67 \times 10^{-11}\ N\ m^2/kg.^2$$

$$M_{JUPITER} = 1.9 \times 10^{27}\ kg.$$

QUESTIONS: (a) Convert 53-day period to seconds? (b) Find Perigee in meters from miles? (c) Find semi-major axis R from Kepler's 3rd law? (d Find apogee R_{APOGEE} (maximum distance from Jupiter) of Juno spacecraft from Jupiter during it's 53 day orbit of Jupiter?, (e) How does computed apogee compare with NASA know apogee of Juno 53 day orbit of Jupiter?

HINTS: 1609 meters/mile , 24 hrs./day, 3600 s./hr.,

ANSWERS: (a) T = 4.5792×10^6 seconds, (b) 7.4723×10^7 meters (c) R = 4.069×10^9 meters, (d) R_{APOGEE} = ~8.063×10^9 m. or 8.063×10^6 km., (e) NASA/Jet Propulsion Lab at Cal. Tech. states the Apogee of Juno on it's 53 day orbital period to be 8 million kilometers. Thus, the computed apogee is quite close.

Thanks to Kepler a German Mathematian/Astronomer who lived 1571 -1630.