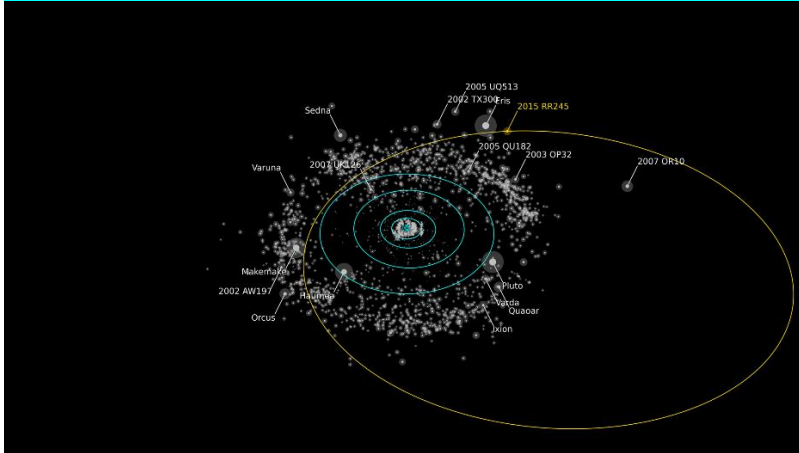


CENTRIPETAL FORCE & GRAVITY

Units 14 & 8 Dr. John P. Cise, Professor of Physics, Austin Com. College, Northridge Campus, Austin Texas, jpcise@austincc.edu , & NY Times, July 15, 2016 by Kenneth Chang

Astronomers Discover New Likely Dwarf Planet, the Latest of Many



INTRODUCTION: This new dwarf planet is held in orbit by the centripetal force of gravity. $G Mm/R^2 = m V^2 / R$ Since $V = R \omega = R 2\pi f = 2\pi R / T$, thus

$$R^3/T^2 [4 \pi^2 / G] = M$$

This is called Kepler's 3rd Law. It's closest approach (perigee) to sun is 33.9 AU (astronomical units = 1.5×10^{11} meters) and farthest orbit point (apogee) from sun is 129.82 AU. See graphic at left.

A rendering of the orbit, shown in orange, of **2015 RR2245**, the latest likely dwarf planet to be discovered in the solar system's Kuiper Belt. Its path around the sun takes about 700 years. (((((Actually 730 years by NASA measures)))))) The blue circles show the orbits of the major planets. The neighborhood beyond Neptune is becoming ever more crowded, with astronomers announcing this week the discovery of another likely dwarf planet. A survey at the Canada-France-Hawaii Telescope in Hawaii has been tracking more than 600 bodies in a ring of icy debris known as the Kuiper belt. One of them turned out to be the likely dwarf planet. "This is a big fish among a whole lot of small ones we're working with," said Michele Bannister, a postdoctoral fellow at the University of Victoria in British Columbia who is working on the survey. In the year since NASA's New Horizons spacecraft flew past Pluto, planetary astronomers continue to make new discoveries in the Kuiper belt and what it might reveal about the earliest days of the solar system. The study of these objects also offers hints about the formation and migration of the gas giant planets: Jupiter, Saturn, Uranus and Neptune. Even if the newly found world is a dwarf planet, however, it will probably be years before it might earn official designation — part of the confusion of definitions that followed the International Astronomical Union's decision in 2006 to demote Pluto and reduce the solar system to eight planets from nine. More than 100 bodies in the solar system, all but one located along the ring of icy debris beyond Neptune, appear to meet the definition of a dwarf planet, a category that the astronomical union created to describe Pluto as well as Ceres, the largest asteroid, and Eris, a Kuiper belt object slightly smaller than Pluto. (A full-statured planet has an additional requirement: It must have "cleared the neighborhood" of smaller debris.)

QUESTIONS: (a) $R = \text{semi major axis} = (\text{apogee} + \text{perigee})/2$, Find R in AU units?, (b) Convert R in AU units to meters?, (c) Convert period T in years (730 years) to seconds?, (d) Find mass of sun (M) ?, (e) How well does computed mass of sun compare to NASA/Wiki data on sun mass?

HINTS: $G = \text{Gravitational constant} = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$, 24 hrs./day , 365 days/yr./ 3600 seconds/hour
 $1.5 \times 10^{11} \text{ m./AU}$

ANSWERS: (a) $R = 81 \text{ AU}$, (b) $R = 121.5 \times 10^{11} \text{ m.}$, (c) $T = 2.3 \times 10^{10} \text{ seconds}$, (d) $M = 2.0 \times 10^{30} \text{ kg.}$
(e) NASA/Wiki states mass of sun is close to $2.0 \times 10^{30} \text{ kg.}$ Thus, your computation is quite close.