Kepler’s Laws Challenge Problem

In early history, scientists regarded Earth as the center of the Universe. This geocentric model was formalized by the Greek astronomer Ptolemy in the second century. Copernicus originated the heliocentric (Sun-centered) model in the early 16th century, with planets traveling in circular orbits. German astronomer Johannes Kepler was a 17th century astronomer who was the first person to realize that planetary paths are ellipses with the Sun at one focus of the ellipse. This became his first law of planetary motion. His second law: The radius vector describes equal areas in equal times, meaning that when the planet is closer to the sun, it has to go faster. His third law states that the square of the period is proportional to the cube of the mean radius of the orbit. It has to be the mean radius since planets have elliptical orbits. Kepler’s 3rd law led directly to Newton’s development of his Law of Universal Gravitation. Kepler’s Third Law is embodied in the equation:

 where M is m2, the mass of the primary object.

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| Task # | Description |
| 1 | Look up Kepler’s Laws. Draw pictures to represent the first 2 laws. State Kepler’s 3rd Law. |
| 2 | Write a net force equation for a satellite orbiting a central object using Newton’s equation for gravitational force as the centripetal force. |
| 3 | Starting with the net force equation from step 2, show how Kepler’s Third Law (in the form shown above the table) can be derived. |
| 4 | Find the distance from Earth to the sun at perihelion (closest approach) and aphelion (furthest approach). Determine the period of the Earth and the speed of Earth at each of those distances. |