**Kepler’s Third Law of Planetary Motion**

Johannes Kepler used Tycho Brahe’s observations of the planets along with Nicholas Copernicus’ formula for **Synodic and Sidereal Periods of Planets** to determine the sidereal periods of the planets expressed in years. By using his own calculations of the average distances of the planets from the sun expressed in astronomical units (A.U.), he was able to find the relationship between sidereal periods of planets expressed in years (yr.) and average distances of the planets from the sun. It took Kepler 10 years to identify this relationship. You can do so in about 10 minutes using modern graphing processes and the data below.

**Planet Sidereal Period (yr.) Average Distance (A.U.)**

Mercury 0.241 0.387

Venus 0.615 0.722

Earth 1.00 1.00

Mars 1.88 1.52

Jupiter 11.8 5.20

Saturn 29.6 9.58

1. Using Excel or a dedicated graphing program, make a graph of sidereal period (on the y-axis) versus average distance (on the x-axis). The graph that results is not linear.
2. Linearize the graph by re-plotting period squared versus average distance cubed. The data will now appear as a straight line.
3. Determine the best-fit line passing through the data and relate to y=mx+b. Round off the m value, and if b is approximately 0, you may simply delete this number.\*

What approximate relationship did you find between period square (P2) and average distance cubed (r3) when period is expressed in years and average distance is expressed in astronomical units?

In 1801 the first asteroid, Ceres, was discovered orbiting the Sun with an average distance of about 2.765 A.U. What is Ceres’ expected orbital period in years?

Halley’s Comet takes about 75 years to orbit the Sun. What is its average distance from the Sun?

\* This approach is not really correct. If a physical model requires that the best-fit line pass through the origin, then one should use a proportional fit, y=mx, rather than linear fit.