Physics 109: Homework #3 Solutions

3.1 The Ptolemaic model of the solar system required epicycles in order to account for the retrograde motion of the planets as well as their change in apparent brightness. Copernicus included epicycles just to account for the varying speeds of the planets as they move through the sky.

3.2 Yes, it is possible for a planet to have a synodic period exactly equal to one year. It would need to be an inferior planet with a sidereal period of exactly 1/2 year. A planet with a synodic period a little more than a year could be either (1) an inferior planet with a sidereal period of a little more than 1/2 year, or (2) a superior planet with a very long sidereal period (like Neptune or Pluto).

3.3 Kepler had already demonstrated that he was an accomplished mathematician and astronomer in his work *Mysterium Cosmographicum* (*The Mystery of the Universe*) which tried to explain the spacing of the planets using the geometry of the five regular solids (cube, tetrahedron, dodecahedron, icosahedron, and octahedron). However in this work he also revealed that he was a true believer in the Copernican or heliocentric model of the solar system, which would have been a considerable weakness in his qualifications from Tycho's point of view, who had his own model for how the solar system was arranged.

3.4 The numerical agreement between the P^2 and the a^3 columns in the table below for each of the nine planets demonstrates that $P^2 = a^3$ (Kepler's Third Law of Planetary Motion).

Planet	P (yr)	a (A.U.)	P^2	a^3
Mercury	0.2408	0.3871	0.05798	0.05801
Venus	0.6151	0.7233	0.3783	0.3784
Earth	1	1	1	1
Mars	1.881	1.523	3.538	3.533
Jupiter	11.86	5.202	140.7	140.8
Saturn	29.46	9.539	867.9	868.0
Uranus	84.01	19.19	7058	7067
Neptune	164.8	30.06	27160	27160
Pluto	248.5	39.53	61750	61770

3.5 The phases of Venus proved that Venus revolved around the Sun. The moons of Jupiter showed that other celestial bodies could have satellites and that the Earth was not the center of all motions in the Universe. Stars remained point-like when viewed through the telescope showing that they were much further away than Tycho and other previous astronomers have believed. Sunspots and the mountains on the Moon revealed that these bodies were not perfect but were likely to be worlds like our own. The motion of sunspots across the Sun's surface allowed Galileo to infer that the Sun was rotating, making it that much easier to believe that the Earth itself rotated as well.