Astr 2100 Descriptive Astronomy
Fall 2017 – Assignment 4
Answers

1. Let's start with a (fictitious) inner planet. Being closer to the Sun than the Earth it orbits the Sun in only 180 (Earth) days, and has a solar day (noon to noon) of 120 (Earth) hours.
   a. How long is the solar day in Earth days? 120 (Earth) hours / 24 hours per day = 5 Earth days
   b. Through what angle does it move in its orbit around the Sun in 1 Earth day? 360° / 180 days = 2 °/day
   c. Through what angle does it move in its orbit around the Sun in 1 of the planet's solar days? 2 °/day * 5 days = 10°
   d. What is its rotational speed in degrees per (Earth) hour? 360° / 120 hour = 3°/hour
   e. How long will it take to rotate through the angle from part c? 10° / 3° per hour = 3⅓ hour
   f. How long it the sidereal day on this planet? 120 hours – 3⅓ hour = 116⅔ hours (or 116 hour 40 minutes).

2. Now let's look at a (fictitious) outer planet. Being further from the Sun than the Earth it orbits the Sun in 3600 (Earth) days[1], and has a solar day (noon to noon) of 12 (Earth) hours.
   a. How long is the solar day in Earth days? 12 (Earth) hours / 24 hours per day = ½ Earth day
   b. Through what angle does it move in its orbit around the Sun in 1 Earth day? 360° / 3600 days = 0.1 °/day
   c. Through what angle does it move in its orbit around the Sun in 1 of the planet's solar days? 0.1 °/day * ½ day = 0.05°
   d. What is its rotational speed in degrees per (Earth) hour? 360° / 12 hour = 30°/hour
   e. How long will it take to rotate through the angle from part c? 0.05° / 30° per hour = 0.00167 hour = 6 seconds
   f. How long it the sidereal day on this planet? 12 hours – 6 seconds = 11 h 59 m 54 s

3. Now look up the length of both the sidereal and solar day, and calculate their difference for the real inner planets[2]
   a. Mercury
      i. Sidereal day 58.6467 days
      ii. Solar Day 175.940 days
      iii. Difference about 117 days
   b. Venus
      i. Sidereal day 243.02 days
      ii. Solar Day 116.75 days
      iii. Difference about 126 days

   Note that for the inner planets the difference between the solar and sidereal dates is very large

4. And do the same for a couple of the outer planets
   a. Jupiter
      i. Sidereal day 9 hr 55 min 30 sec
      ii. Solar Day 9 hr 55 min 33 sec
      iii. Difference 3 seconds
   b. Saturn
      i. Sidereal day 10 hr 32 min 35 sec
      ii. Solar Day 10 hr 32 min 36 sec
      iii. Difference 1 second

   Note that for the outer planets the difference between the solar and sidereal dates is vanishingly small

1 Approximately 10 years, and comparable to that of Jupiter (11.6 years)
2 http://cseligman.com/text/sky/rotationvsday.htm