

Observational Astronomy - Spring 2014

Homework 5 - The Motion of the Earth and Moon

Time, Precession, Eclipses, Tides

1. You see the moon transiting at 6:00 PM. Approximately what phase is it in? On another day you see it transit at midnight. What phase is it in now?
 - If the moon is transiting at 6:00 PM, it is approximately 90° away from the sun, which transits at noon. So it is half illuminated, and since it is transiting in the evening, it is in the first quarter. If the moon is transiting at midnight, it is opposite the sun in the sky, so it is full.
2. The American Civil War began at Fort Sumter on April 12, 1861, and ended at Appomattox on May 10, 1865. Look up the Julian Day for each of these dates and calculate how many days the American Civil War lasted.
 - April 10, 1861 was $JD = 2,400,877$. May 10, 1865 was $JD = 2,402,366$. The difference is 1489, so the American Civil War lasted 1489 days.
3. Why don't we have a solar eclipse every new moon when the moon is between the Earth and the Sun?
 - Because the moon's orbit is inclined with respect to the ecliptic plane, most of the time the moon's shadow doesn't land on the Earth. It is only when the moon is near one of its orbital nodes that its shadow lands on the Earth and we have an eclipse.
4. As we discussed in class, geosynchronous satellites orbit the Earth with a period of one sidereal day, and have orbits with an orbital radius of about 42,200 km. It turns out the the GPS satellites, which you probably use every day, orbit the Earth on what are called semi-synchronous orbits, which have an orbital period of $1/2$ of a sidereal day. Using Kepler's third law, calculate the orbital radius of the GPS satellites.
 - Since $a^3 \propto T^2$, if we reduce T by $1/2$, we will reduce a by a factor of $2^{2/3}$. So the orbital radius of the GPS satellites is:

$$a = \frac{42200 \text{ km}}{2^{2/3}} = 26,600 \text{ km}$$