TWO BODY PROBLEM

Due Date: 1/30/2014 @ 8:00 am

First Kepler's law tells us that two massive bodies travel around the common center of mass along elliptical orbits, with the period P that can be determined from the third Kepler's law

$$\frac{a^3}{P^2} = \frac{GM}{4\pi^2},$$

where a is semi-major axis and $M = m_1 + m_2$ is the sum of both masses. Orbit equation can be calculated analytically but only as a function of angle. If we want to calculate the position of orbiting bodies as a function of time, we must numerically integrate the equation of motion. This can be done using variety of algorithms, from the simplest Euler method to more advanced and robust methods.

- Implement your own 4th order Runge-Kutta (RK4) method and simulate Earth's motion around the Sun in three dimensions. Make sure that one full orbit is completed in expected time.
- Compare the results of your method to the results you obtain with `odeint` method from `scipy.integrate` module (or equivalent, if you are using another programming language) for different values of time step h.
- Plot Earth's orbit and the orbit of comet Halley. You can find necessary orbital elements online.
- Verify that total energy per unit mass and total angular momentum per unit mass of an orbiting body are conserved.
- Test stability of your RK4 method on comet's orbit. How long does it take for an orbit to collapse or comet to escape?
- Discuss all results!