Homework #9 PHY523 Fall 2017 Due 11/16/2017

Reading Assignment: Please read the rest of Chapter 11, and Sections 1-5 of Chapter 12

Problems marked with as asterisk are more challenging and/or calculationally involved. Do the other ones first, if you prefer. Come to me or talk to each other if you would like help/hints. I encourage discussion among you, but all submitted work must be your own.

Problem #1
Euler's Equations

I throw a thin uniform circular disc (essentially a frisbee) into the air so that it spins with angular velocity ω about an axis which makes an angle α with the axis of the disc.

(a) Show that the magnitude of ω is constant (look at Eq. 10.94).

(b) Show that as seen by an inertial observer (i.e. the one who threw the frisbee) that the disc's axis precesses around the fixed direction of the angular momentum with angular velocity $\Omega_s = \omega\sqrt{4 - 3\sin^2\alpha}$. The final results of Problems 10.23 and 10.46 in the textbook will be useful.

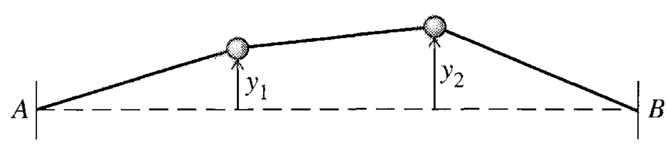
Problem #2
Double Pendulum

(a) Find the normal frequencies for small oscillations of the double pendulum of Figure 11.9 for arbitrary values of the masses and lengths.

(b) Check that your answers are correct for the special case that $m_1 = m_2$ and $L_1 = L_2$.

(c) Discuss the limit that $m_2 \to 0$.

Problem #3
Normal modes



Two equal masses m move on a frictionless horizontal table. They are held by three identical taut strings (each of length L, tension T), as shown in Figure 11.19, so that their equilibrium position is a straight line between the anchors at A and B. The two masses move in the transverse (y) direction, but not in the longitudinal (x) direction. Write down the Lagrangian for small displacements, and find and describe the motion in the corresponding normal modes. [Hint: "Small" displacements have y_1 and y_2 much less than L, which means that you can treat the tensions as constant. Therefore the PE of each string is just Td, where d is the amount by which its length has increased from equilibrium.]