Due: Tue 18 Sep 2007, at the start of class.

Reading: Please read Sections 4.3–4.6 in Taylor for Thursday and 4.7–4.8 for Tuesday.

Problems (note Problems 6 and 7 on other side):

1. Numerical integration of equations of motion. Taylor Problem 1.51. This is the same Mathematica problem as last week, repeated for a different amplitude of oscillation. Last week, you saw that for $\phi_0 = 20^\circ$, the approximate solution obtained using the small angle approximation $\sin \phi \simeq \phi$ was very close to the exact solution obtained numerically. This week, you are asked to repeat the problem using $\phi_0 = 90^\circ$ instead of $20^\circ$. Based on your plots of the approximate and exact solutions, please comment on whether the small angle approximation is still a good approximation. Is this expected? Express $20^\circ$ and $90^\circ$ as radians rather than degrees, and compare $\phi_0$ to $\sin \phi_0$ for the two cases.

2. Center of mass of a compound system. Taylor Problem 3.20. In this problem you are asked to express the center of mass of a system of particles in terms of the mass and center of mass of two subsystems.

3. Moment of inertia of a uniform solid sphere. Taylor Problem 3.32. Despite what the problem says, please feel free to use any coordinate system you like to compute the moment of inertia. In particular, cylindrical coordinates work well; in this case, the computation is similar to that of the center of mass of a cone in Sec. 3.3.


5. Angular second law in CM frame. Taylor Problem 3.37. In class and in the previous problem of this problem set, we made use of the result that

$$\frac{d}{dt} L(\text{about CM}) = \Gamma^\text{ext}(\text{about CM})$$
even when the CM frame is accelerating. You will now have the opportunity to prove this result.

6. Particle on string through hole in table. Taylor Problem 4.4. Part (a) uses angular momentum conservation. Parts (b) and (c) show that the same result can also be obtained from the Work-K.E. theorem.

7. Gravitational potential energy of a system of particles. Taylor Problem 4.6. We saw in Chapter 3 that the equation of motion for the center of mass $\mathbf{R}$ as a function of time is just like that of a point particle. This problem explores an analogous result for the gravitational potential energy.