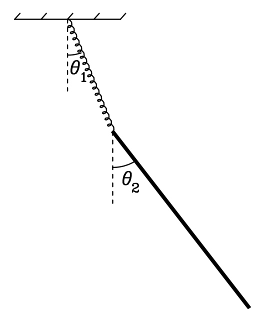
Physics 321 – Spring 2017

Homework #14, Due at beginning of class Friday April 28.

1. [5 pts] A particle of mass M moves in two dimensions under the influence of the potential $U(r) = A\, e^{B\,r}$ where A and B are positive constants. Find its angular momentum if the perigee and apogee (turning points in r) are given by R_1 and R_2, i.e., the motion obeys $R_1 \leq r \leq R_2$.

2. [5 pts] A uniform stick of length ℓ and mass M hangs from the ceiling by a massless spring that has spring constant k and unstretched length B. It moves only in the plane shown in the paper, so there are only three coordinates: θ_1, θ_2, and the length of the spring r. Write the Lagrangian and use it to obtain the equations of motion. You do not need to solve them.

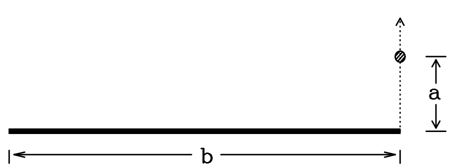


   The calculus needed to obtain the equations of motion can be considerably simplified using the trig identities

$$
\begin{aligned}
\sin(\theta_1 - \theta_2) &= \sin(\theta_1)\cos(\theta_2) - \cos(\theta_1)\sin(\theta_2) \\
\cos(\theta_1 - \theta_2) &= \cos(\theta_1)\cos(\theta_2) + \sin(\theta_1)\sin(\theta_2)
\end{aligned}
$$

   The essential part of this problem from the standpoint of grading is getting the correct Lagrangian. But carrying out accurate calculations like this is an important skill for a physicist, so the scoring will be 4 pts for the Lagrangian and 1 pt for all three equations of motion. You can also get full credit by doing the problem using Mathematica, since that would help develop an important skill.

3. [5 pts] A point mass m is located at a distance **a** from one end of a uniform wire of mass **M** and length **b** as shown. Find the gravitational potential energy of the mass m as a result of the mass M. (Hint: divide the mass **M** into infinitessimal segments of length ds, and integrate to add up all of the contributions to the potential energy.)



4. [5 pts] Taylor Problem 8.29

   (Taylor gives a hint involving the Virial Theorem; but you can ignore that hint—it isn't necessary to do the problem.)

(Last updated 4/26/2017)