Classical Mechanics, PHYB54
Problem Set 3

Professor Hanno Rein
TA Ari Silburt

Due: Monday, January 30th 2017, 4pm

Note: Assignments can be hand-written, but illegible answers will not be marked. Clearly indicate your final answers.

Problem 1.1

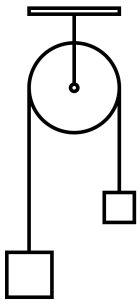
For this question, you may ignore air resistance. Two identical-twin circus performers, Alice and Betty, are facing each other. Alice, holding the handle of a knife, tosses the knife to Betty, who catches the handle after the knife makes $n + 0.5$ full rotations in the air. The knife is tossed such that at the moment of release it is horizontal, its centre of mass has an initial speed v_0 at angle θ, with an angular velocity of ω_0. What is ω_0 such that Betty safely catches the handle of the knife? Express your answer in terms of n, g (gravity), v_0 and θ.

Problem 1.2

A particle of mass m is moving on a frictionless horizontal table and is attached to a massless string, whose other end passes through a hole in the table, held by Prof. Rein. Initially the particle is moving in a circle of radius r_i with angular velocity ω_i.
If Prof. Rein pulls the string slowly through the hole, and stops when a length r_f of string remains between the hole and particle,
a) What is the particle's new angular velocity ω_f?
b) What is the work done by Prof. Rein?
c) What is the change in kinetic energy of the particle?
d) Is the final kinetic energy less, equal, or greater than the initial kinetic energy? Use math to support your answer.

Problem 1.3

An Atwood machine consists of a pulley (radius R, moment of inertia I, rotates with angular velocity ω), a massless string passing through the pulley, and two hanging blocks connected to each end of the string with mass m and M, respectively.



a) Write down the total energy of the system in terms of coordinate x (i.e. the only variables in your solution are x, $\dot{x}$, $\ddot{x}$, etc.).
b) Is this a conservative system? Explain why or why not.
c) Derive the equation of motion for the system from the time derivative of the total energy.