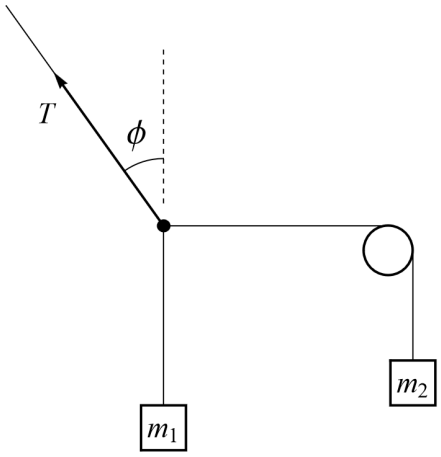
Physics 336
HW1

1. Two masses, $m_1 \pm \delta m_1$ and $m_2 \pm \delta m_2$, are connected to light threads. The thread connected to mass m_2 is threaded over a frictionless pulley, and the two threads are knotted together with a third thread whose other end is tied to a fixed point. The position of the pulley is adjusted so that the thread connected to m_2 is exactly horizontal,

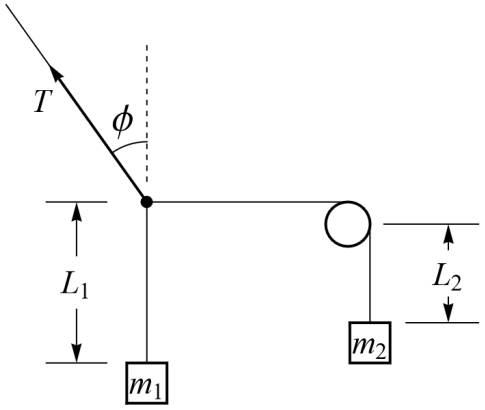


as shown. In terms of m_1 and m_2 (and their uncertainties) determine symbolic expressions for the tension in the third thread, T, and the angle ϕ with their uncertainties. Then, evaluate your expressions for $m_1 = 65.0 \pm 0.2$ g and $m_2 = 85.0 \pm 0.3$ g. Do this two ways:

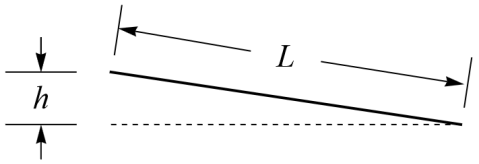
(a) Calculate all derivatives by hand.

(b) Set up a Mathematica notebook to do all of the calculations.

(c) Re-evaluate this system if the thread masses are not negligible. In particular, suppose the thread has linear mass density $\mu = 3.1 \pm 0.2$ g/m, with $L_1 = 25.0 \pm 0.5$ cm and $L_2 = 30.0 \pm 0.7$ cm.



2. An inclined plane of length $L = 1.250 \pm 0.002$ m has one end propped up a height $h = 3.7 \pm 0.1$ cm.



A round object (a sphere, cylinder or ring) is rolled (beginning at rest) a distance $x = 85.0 \pm 0.3$ cm down this incline. Calculate the elapsed time, with its uncertainty.

(a) Calculate all derivatives by hand.

(b) Set up a Python file to do all of the calculations.

For each of the following problems, construct either a Mathematica notebook or a Python file to do the calculations. Receive a 10% bonus for each problem if you do both.

3. A simple pendulum is made from a light string with a dense mass $m = 250 \pm 2$ g attached to it. Let $L = 85.0 \pm 0.3$ cm be the distance from the point (assumed fixed) where the string is anchored to the center of mass of the attached mass.

(a) Predict the period of the pendulum, including its uncertainty, assuming $g = 9.80$ m/s^2 (with minimal uncertainty).

(b) Assuming g is unknown, and the period is measured to be $T = 1.83 \pm 0.06$ s, calculate g with its uncertainty.

(c) Re-evaluate this system by including the string mass, and not treating the mass as a point mass. In particular, suppose the mass is a ball of radius $r = 2.81 \pm 0.02$ cm, and the string (which has length $d = L - r$) has mass 6.5 g.

P4. Consider an RC circuit, with $R = 810\ \Omega$ (assume this is a 1% tolerance resistor) and $C = 2500\ \mu$F (with a tolerance of 5%) connected in series with a DC source with $V = 2.00 \pm 0.03$ V. Predict the capacitor voltage at time $t = 3.0 \pm 0.1$ s.