Homework 4
Physics 5A
Due Fr 9 / 27 / 24 @ 5:00PM

The clearer your presentation is, the easier it is for us to give you points! "K.K." refers to the 2nd edition of the textbook "An Introduction to Mechanics" authored by Kleppner & Kolenkow. Remember, you are encouraged to work together, but please make sure the work you turn in is your own.

Problem 1. (5 pts) K.K. 3.5

Problem 2. (10 pts) K.K. 3.6

Problem 3. (5 pts) K.K. 3.7. NB: The coefficients of friction that are given are for kinetic friction, and the rope referred to in part c) is the one tied to mass M_C .

Problem 4. (10 pts) K.K. 3.13. NB: The coefficients of friction that are given are for static friction.

Problem 5. (15 pts) K.K. 3.15 (Be sure to read KK 3.3.1 before you start this one)

Problem 6. (15 pts) K.K. 3.26

Problem 7. (15 pts)

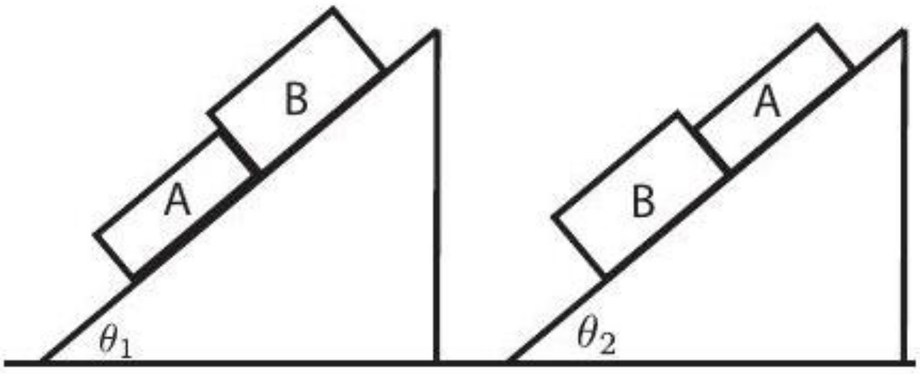
K.K. 3.12 (μ is the coefficient of static friction between the drum and the rope). In addition, plug in some numbers: if $\mu = 0.25$, the rope is wound for four turns around the drum, and a sailor holds the rope A with tension $T_A = 200\ \mathrm{N}$, how much mass (in kg) could she hang vertically from segment B ?

Hint: Because of friction, the tension in the rope will vary as it winds around, $T(\theta)$. By modifying KK Example 3.7 to include the effect of friction, you should be able to derive a simple differential equation for $T(\theta)$.

Problem 8. (15 pts)

Two blocks, of mass $m_{A/B}$ and coefficients of static friction $\mu_{A/B}$, are stacked side by side on an incline, as in the figure. Assume $\mu_A < \mu_B$.

a) Suppose they are stacked as on the left, with A below B. What is the critical angle θ_1 where one or both of the blocks begin sliding?



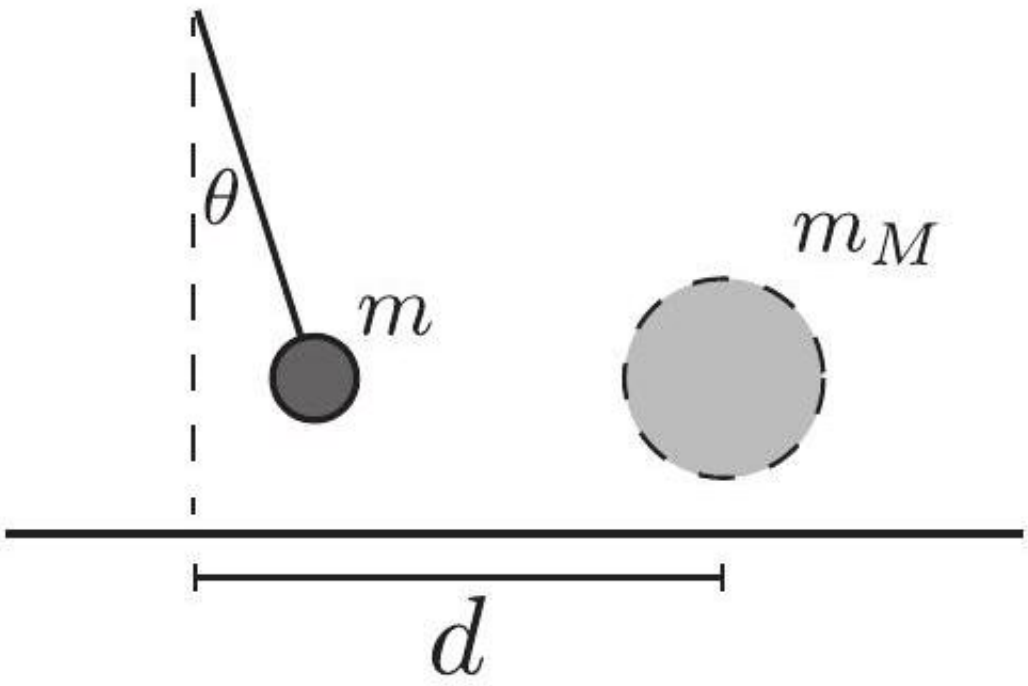
b) Suppose they are stacked as on the right, with A above B. What is the critical angle θ_2 where one or both of the blocks begin sliding?

c) Suppose the two blocks are glued together. Do your answers to part (a) or (b) change? What is the effective coefficient of static friction μ_{AB} of the two blocks glued together?

Problem 9. (10 pts)

A mass m hangs from a massless plumb line under the influence of the Earth's gravity as well as a nearby (remarkably spherical!) mountain of mass m_M. The distance from the center of the mountain to the mass is d, while the distance to the center of the Earth is r_E. We measure the deflection angle from the Earth's normal θ (in radians). What is the mass m_E of the Earth in terms of θ, m_M, d, r_E ? Your answer need only be correct to first-order in θ, i.e., you can drop factors of θ^2 and higher. Given in addition the acceleration due to surface gravity g, what is the gravitational constant G ?

Given the known values of m_E, G, it's "fun" to compute θ for $d = 1$ m, $m_M = 1$ kg.



θ
m
m_M
d