UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

PH 105 LeClair | Summer 2015

Week 2 Homework

Instructions:

1. There are problems assigned for each day of class.
2. The following class, you will turn in the one problem the instructor requests.
3. Only the chosen problem for the day is graded.
4. Please follow the homework template provided.
5. You may collaborate, but everyone must turn in their own work.

Problems for 2 June (due 3 June)

1. A projectile is launched with initial velocity $\vec{\mathbf{v}}_i$ from the start of a ramp, with the ramp making an angle φ with respect to the horizontal. The projectile is launched with an angle $\theta > \varphi$ with respect to the horizontal. **(a)** At what position along the ramp does the projectile land? **(b)** What angle θ maximizes the distance the particle makes it along the ramp (your answer will be in terms of the angle φ? Note no numeric solution is required.

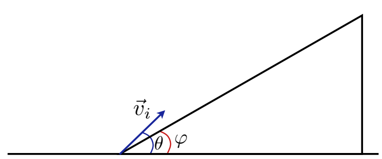


Figure 1: *A projectile is launched onto a ramp.*

2. In the figure below, a slab of mass $m_1 = 40\,\text{kg}$ rests on a frictionless floor, and a block of mass $m_2 = 10\,\text{kg}$ rests on top of the slab. Between block and slab, the coefficient of static friction is 0.60, and the coefficient of kinetic friction is 0.40. A horizontal force $\vec{\mathbf{F}}$ of magnitude 100 N begins to pull directly on the block, as shown. What are the resulting accelerations of **(a)** the block, and **(b)** the slab?

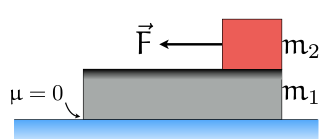


Figure 2: *Problem 2*

3. Three boxes are pushed with force F across a frictionless table as shown in the figure below. Let N_1 be the normal force between the left two boxes, and N_2 the normal force between the right two boxes. What are the relative sizes of F, N_1, and N_2? (I.e., set up an inequality relating the three, and justify your answer

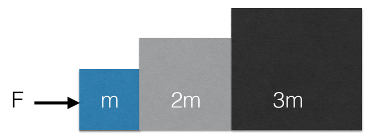
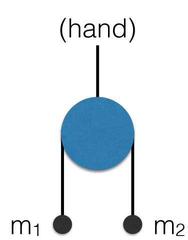


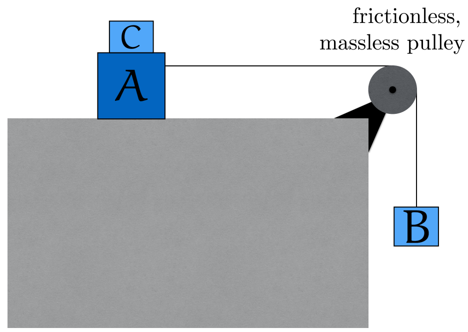
Figure 3: *Problem 3*

Problems for 3 June (due 4 June)

4. You have two masses m_1 and m_2 hanging from a pulley, which you support by holding a string connected to the pulley's axis. If you have your eyes closed and think that you are instead supporting a single mass M at rest, what is M in terms of m_1 and m_2? Is it simply equal to $m_1 + m_2$?



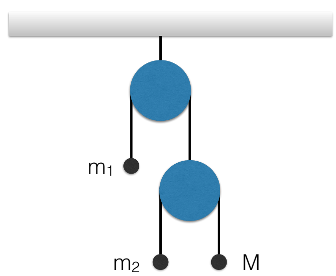
5. In the figure below, blocks A and B have **weights** of $44\,\mathrm{N}$ and $22\,\mathrm{N}$, respectively. **(a)** Determine the minimum weight of block C to keep A from sliding if μ_s between the table and A is 0.20. **(b)** Block C is suddenly lifted off A. What is the acceleration of block A if μ_k between A and the table is 0.15?



Problems for 4 June (due 5 June)

6. A circular rope with radius R and mass density λ (kg/m) lies on a frictionless table and rotates around its center, with all points moving at speed v. What is the tension in the rope? *Hint:* consider the net force on a small piece of rope that subtends an angle θ.

7. Consider the machine shown below. The masses are held at rest and then released. In terms of m_1 and m_2, what should M be so that m_1 doesn't move? What relationship must hold between m_1 and m_2 so that such an M exists?



Problems for 5 June (due 8 June)

8. In the figure below, a small block of mass $m = 0.032$ kg can slide along the frictionless loop-the-loop, with loop radius $R = 12$ cm. The block is released from rest at a point P, at height $h = 5.0R$ above the bottom of the loop. How much work does the gravitational force do on the block as the block travels from point P to **(a)** point Q and **(b)** the top of the loop? If the gravitational potential energy of the block-Earth system is taken to be zero at the bottom of the loop, what is that potential energy when the block is **(c)** at point P, **(d)** at point Q, and **(e)** at the top of the loop? **(f)** If, instead of merely being released, the block is given some initial speed downward along the track, do the answers to (a) through (e) increase, decrease, or remain the same?

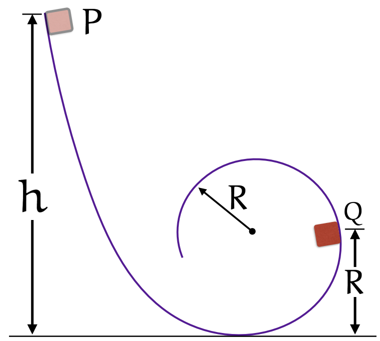


Figure 4: *A block slides along a loop-the-loop.*

9. A block with mass m starts from rest and slides down a plane inclined at angle θ. The coefficient of kinetic friction is μ. What is the block's speed after it has traveled a distance d down the plane, assuming that it does indeed start sliding down? (d is a distance here, so it is a positive quantity.)

10. A block with mass m is attached to a ceiling by a spring with spring constant k and relaxed length l. Initially, the spring is compressed to a length of $l/2$. If the block is released, at what distance below the ceiling will the block be brought to rest (instantaneously, at the lowest point) by the spring?

11. A block with mass m is located at position $x = 0$ on a horizontal table. A spring with spring constant k and relaxed length *zero* is connected to it and has its other end anchored at position $x = l$ (so that it is stretched from equilibrium by a distance l). The coefficient of both static and kinetic friction between the block and table depends on position according to $\mu = Ax$, where A is a positive constant. Assume that the block is small enough that it only touches the table at essentially one value of x. **(a)** The block is released from rest at $x = 0$. Where does it come to rest for the first time? **(b)** What is the condition on A for which the stopping point is beyond the anchor point, $x > l$?