Physics 7A (Prof. Hallatschek)

First Midterm, Fall 2017, Berkeley, CA

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one-half sheet of 8.5" x 11" of paper on which you can whatever note you wish.* ***You are not allowed to use scientific calculators.*** *Cell phones must be turned off during the exam, and placed in your backpacks.* ***In particular, cell-phone-based calculators cannot be used.***

Please make sure that you do the following during the midterm:

- *Write your name, discussion number, ID number on all documents you hand in.*
- *Make sure that the grader knows what s/he should grade by circling your final answer.*
- *Answer all questions that require a numerical answer to three significant figures.*

We will give partial credit on this midterm*, so if you are not altogether sure how to do a problem, or if you do not have time to complete a problem, be sure to write down as much information as you can on the problem. This includes any or all of the following: Drawing a clear diagram of the problem, telling us how you would do the problem if you had the time, telling us why you believe (in terms of physics) the answer you got to a problem is incorrect, and telling us how you would mathematically solve an equation or set of equations once the physics is given and the equations have been derived. Don't get too bogged down in the mathematics; we are looking to see how much physics you know, not how well you can solve math problems.*

If at any point in the exam you have any problems, just raise your hand, and we will see if we are able to answer it.

Name: ______________________________ *Disc Sec Number:* ________________________

Signature: ___________________________ *Disc Sec GSI:* ___________________________

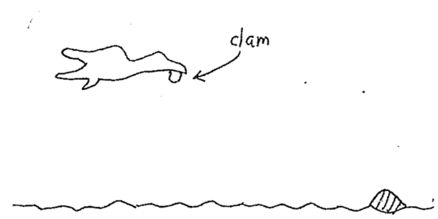
Student ID Number: ___________________

Problem	***Possible***	***Score***
1	15	
2	20	
3	20	
4	20	
5	25	
Total	100	

NOTE: Unless otherwise stated, your answers may contain any symbols defined in the problem statement and any physical constants such as the acceleration due to gravity g.

Problem 1 (15 pts)

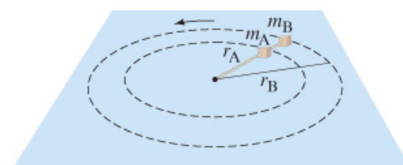
A seagull holding a clam in its beak is flying at a constant altitude *h* over the ocean, traveling at a steady velocity *v*. It wants to drop the clam so that it smashes against a small rock straight ahead, just sticking out of the water.



(a) At what distance ahead of the rock must the seagull let go of the clam? You may ignore air resistance (5 pts)
(b) What is the speed of the clam just before hitting the rock? (5 pts)
(c) Where is the seagull when the clam hits the rock? Why? (5 pts)

Problem 2 (20 pts)

Two blocks, with masses m_A and m_B, are connected to each other and to a central post by massless cords as shown in the figure. They rotate about the post at frequency f (revolutions per second) on a frictionless horizontal surface at distances r_A and r_B from the post.

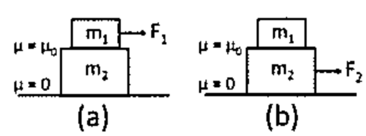


(a) Determine the tension in the segment of the cord between block A and block B. (6 pts)
(b) Determine the tension in the segment of the cord between the post and block A. (6 pts)
(c) Consider the case where the two blocks stand freely (no cords) on a rotating surface with friction. For a given static friction coefficient μ_S between the blocks and the surface, what is the maximal rotation frequency of the rotating surface for which none of the two blocks slides? (8 pts)

Problem 3 (20 pts)

Consider a small box of mass m_1 sitting on top of a larger mass m_2 which in turn sits on a table. Between the two blocks, the coefficient of static friction is equal to the coefficient of kinetic friction which are both equal to μ_0. There is no friction between the lower block and the table.

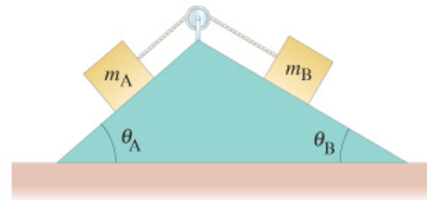
(a) Draw a free-body diagram for each of the boxes. How much force can be applied to the *top* block in the horizontal direction before slipping between the blocks occurs? (6 pts)
(b) Draw a free-body diagram for each of the boxes. How much force can be applied to the *bottom* block in the horizontal direction before slipping between the blocks occurs? (6 pts)



(c) How does your answer to (b) change when there is friction between the lower block and the table? Assume that the coefficients of static and kinetic friction are identical and equal to μ_0. (8 pts)

Problem 4 (20 pts)

The masses m_A and m_B slide on the smooth inclines fixed as shown in the figure. Pulley and ropes are massless. There is no friction.



(a) Determine a formula for the acceleration of the system in terms of m_A, m_B, θ_A ,θ_B, and g. (10 pts)

(b) What ratio, m_A/m_B would allow the masses to move at constant speed along their ramps in either direction? (5 pts)

(c) Now consider the case where the supporting triangular block of mass m_C is allowed to slide without friction across the horizontal surface: Determine its acceleration in terms of m_A, m_B, m_C, θ_A, θ_B, and g. (5 pts)

Problem 5 (25 pts)

The masses of blocks *A* and *B* in the below figure are m_A and m_B, respectively. Assume that $m_A > m_B$. The blocks are initially at rest on the floor and are connected by a massless, inextensible string passing over a massless and frictionless pulley. An upward force ***F*** is applied to the pulley such that Block B begins to accelerate but block A stays at rest on the ground:

(a) What can you say about the magnitude of the force applied to the pulley? (2 pts)

(b) Draw free-body diagrams for both blocks and the pulley. (2 pts)

(c) Find the acceleration of block B in terms of *F*, m_B and *g.* (3 pts)

(d) Find the acceleration a_P of the pulley. (5 pts)

(e) Now, consider the case where *both* blocks begin to accelerate as soon as the upward force acts on the pulley. Find the acceleration a_P of the pulley. (10 pts)