# Final Exam 1

August $14^{th}$, 2013
*80minutes ◇ 100points*

Physics 7A Summer 2013
University of California at Berkeley

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

- ◇ Write your name, discussion number, and ID number on all documents you hand in.
- ◇ Make sure that the grader knows what s/he should grade by circling your final answer.
- ◇ Cross out any parts of the your solutions that you do not want the grader to grade.

We will give partial credit on this exam, 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 questions, just raise your hand, and we will see if we are able to answer them.

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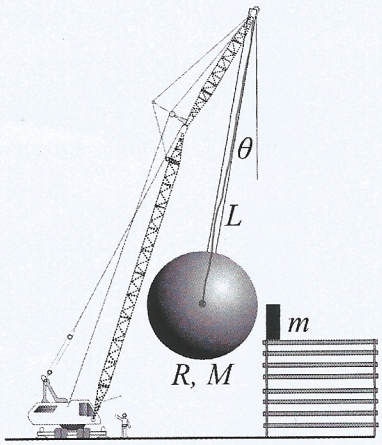
PROBLEM 1 ◇ BOUNCY WRECKING BALL ◇ *50points*

A large rubber ball of mass $M$ and radius $R$ is hung from a crane by a light steel cable of length $L$ measured to the center of the ball. The ball is connected to the cable rigidly and the length of cable is comparable to the radius of the wrecking ball (you cannot assume $L \gg R$). The moment of inertia of the ball about its center is given by $\frac{2}{5}MR^2$.




- ◇ **A** Find the period of small oscillations of this wrecking ball.
- ◇ **B** If the wrecking ball is released from rest when the steel cable forms (not necessarily small) angle $\theta_I$ with the vertical what is its speed $v_L$ at the lowest point of the swing.
- ◇ **C** At the bottom of the swing the wrecking ball collides elastically with a much smaller heavy box of mass $m > M$ and bounces back. You can treat this box as a point particle and assume that it is placed exactly distance $L$ directly under the tip of the crane. What is $v_B$, the speed of the box after the collision? You can write this speed in terms of $v_L$ and other quantities given in this problem.
- ◇ **D** What is the angle $\theta_F$ that the cable forms with the vertical at the top of the next swing. Express this final angle in terms of initial angle $\theta_I$ and other quantities.

PROBLEM 2 ◇ SUPPORTING A POOL ◇ *30points*

You are making a pool using a board of length $L$, width $W$ and negligible thickness by placing it on a frictionless wet tile floor so its width $W$ is on the ground like in Figure 1.

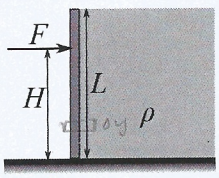



Figure 1: A force for supporting a pool.

You realize you have to push on the board so it can support the pool water which has uniform density $\rho$ but you can do this with a single force. If you fill the pool all the way to the top of the board (pool water height $L$) what is the exact horizontal push you will be needing to support it?

- ◇ **A** What is the magnitude of the force $F$ you have to apply to the board?
- ◇ **B** At what height $H$ should that force be applied?

PROBLEM 3 ◇ FALLING STREAM OF WATER ◇ *20points*

Derive the equation for the radius of the stream of water falling from a horizontal hose as a function of distance $y$ below the tip of the hose. Assume that the stream has circular cross-section everywhere and that the hose has radius $R$ where the water leaves it with speed $v_0$.

# Final Exam 2

August $15^{th}$, 2013
*80minutes ◇ 100points*

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