Name__________________________________ Section ___________

University of Maryland
Department of Physics

Physics 121 | | **Dr. E. F. Redish**

Fall 2007 **Exam 2** **16. November, 2007**

Instructions:

Do not open this examination until the proctor tells you to begin.

1. When the proctor tells you to begin, **<u>write your full name and section number at the top of every page.</u>** This is essential since this exam booklet will be separated for grading.
2. Do your work for each problem on the page for that problem. You might find it convenient to either do your scratch work on the back of the page before starting to write out your answer or to continue your answer on the back. **<u>If part of your answer is on the back, be sure to check the box on the bottom of the page so the grader knows to look on the back!</u>**
3. On all the problems *except the multiple choice questions in problem 1 or where it says <u>not</u> to explain*, your answers will be evaluated at least in part on how you got them. If explanations are requested, more than half the credit of the problem will be given for the explanation. LITTLE OR NO CREDIT MAY BE EARNED FOR ANSWERS THAT DO NOT SHOW HOW YOU GOT THEM. Partial credit will be granted for correct steps shown, even if the final answer is wrong.
4. Write clearly and logically so we can understand what you are doing and can give you as much partial credit as you deserve. We cannot give credit for what you are thinking — only for what you show on your paper.
5. If you try one approach and then decide on another, cross out the one you have decided is wrong. If your paper contains both correct and incorrect approaches the grader will not choose between the two. You will not receive any credit when contradictory statements are present, even if one is correct.
6. All estimations should be done to the appropriate number of significant figures.
7. At the end of the exam, sign the honor pledge in the space below:

I pledge on my honor that I have not given or received any unauthorized assistance on this examination.

#1:	#2:	#3:	#4:	#5:	Total

****** Good Luck ******

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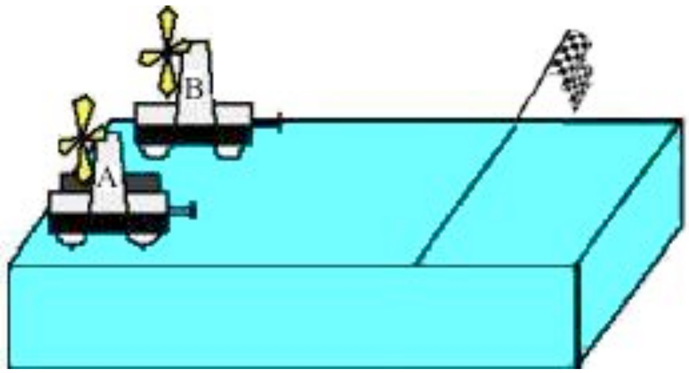
1. (20 points) Two fan carts labeled A and B are placed on opposite sides of a table with their fans pointed in the same direction as shown in the figure at the right. Cart A is weighted with iron bars so it is twice as heavy as cart B. When the fans are turned on, they provide a constant force on the cart independent of its mass. Assume that friction is small enough to be neglected. The fans are rigged so that they go off when the carts cross the finish line (shown by the checkered flag). Put your answers to items a-d in the boxes at the right. (Explanations are not required for this problem.)



a. Which cart will reach the finish line first? (5 pts)

(1) Cart A.

(2) Cart B

(3) They will reach at the same time.

b. After both fans have gone off, which of the following statements are true about the kinetic energies of the two carts? (5 pts)

(1) $K_A > K_B$

(2) $K_A = K_B$

(3) $K_A < K_B$

c. After both fans have gone off, which of the following statements are true about the momenta of the two carts? (5 pts)

(1) $\mathbf{p}_A > \mathbf{p}_B$

(2) $\mathbf{p}_A = \mathbf{p}_B$

(3) $\mathbf{p}_A < \mathbf{p}_B$

d. Which of the following statements are true? You may choose as many as you like, or none. If you choose none, write N. (5 pts)

(1) After the fans are turned on, each cart moves at a constant velocity, but the two velocities are different from each other.

(2) During the entire race the kinetic energy of each cart is conserved.

(3) During the entire race the momentum of each cart is conserved.

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2. (25 points) On a visit to New Zealand, I watched a woman bungee jumping from a high bridge. In this activity, an operator attaches an elastic rope to the jumper. The jumper then jumps off the bridge. She falls freely until she reaches the unstretched length of the rope. Then, the rope begins to stretch and slow her to a stop. It yanks her back up and she oscillates up and down for a while. When she is nearly stopped, the operator of the jump pulls on the elastic rope and hauls her back up to the bridge.

In order to use common symbols, let's call the jumper's mass, m, the unstretched length of the rope, L_0, the height of the bridge above the water, H, the elastic constant of the rope, k, and the gravitational field strength, g. The approximate values of these symbols for this case are: m = 50 kg, L_0 = 8 m, H = 150 m, and g = 10 N/kg.

a) Write an expression for the energy of the jumper-rope system in terms of symbols that can be used to describe her descent. (10 pts)

b) How fast is she falling when she reaches the length of the unstretched rope? (5 pts)

c) If the elastic rope stretches an extra 4 m to bring her to a stop, what is its spring constant, k? (10 pts)

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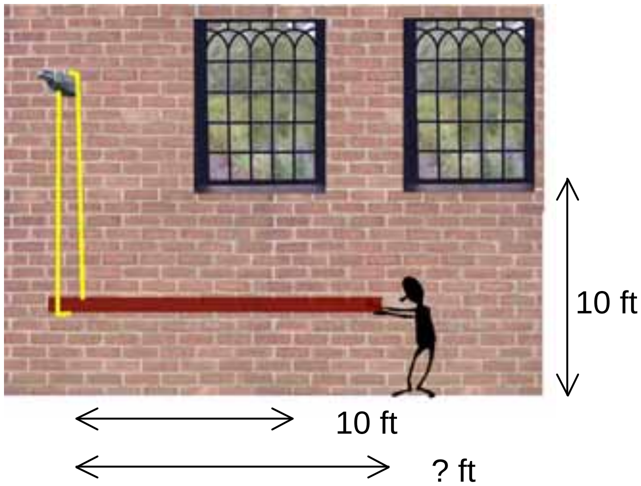
3. (15 points) While walking by your friend's dorm, she calls to you saying her door is stuck and she's locked in but she needs to get out and get to class for her physics exam. You suggest she climb out the window, but the bottom of the window is 10 feet up from the ground and she is afraid to jump. You note that there is a work site nearby with some rope and boards. You suggest that you can hook a loop of rope off a convenient gargoyle on one side of her window, put one end of a board in the loop, and hold the other end up for her. You could hold it about 5 feet up so she could lower herself down in two steps safely. This arrangement is sketched at the right.



She is heavier than you and you know you can't hold up her weight by yourself. Estimate how long a board you need in order to be able to hold her up without dropping her. (The picture is drawn only to show the arrangement. The length of the board shown has not been adjusted to be appropriate. **In order to save time for this exam, ignore the weight of the board.**) *Be sure to clearly state your assumptions and how you came to the numbers you estimated, since grading on this problem will be mostly based on your reasoning, not on your answer.*

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4. (10 points) In class we considered a demonstration in which we let a superball and a clay ball (of equal masses) swing down to hit a wooden block. To the surprise of almost half the class, the superball knocked the block over but the clay ball did not. Tell whether you were surprised by this result or not and explain how you might help someone who finds the result strange make sense of it. *Note: This is an essay question. Your answer will be judged not solely on its correctness, but for its depth, coherence, and clarity.*

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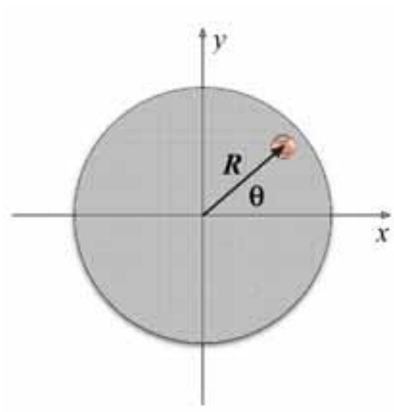
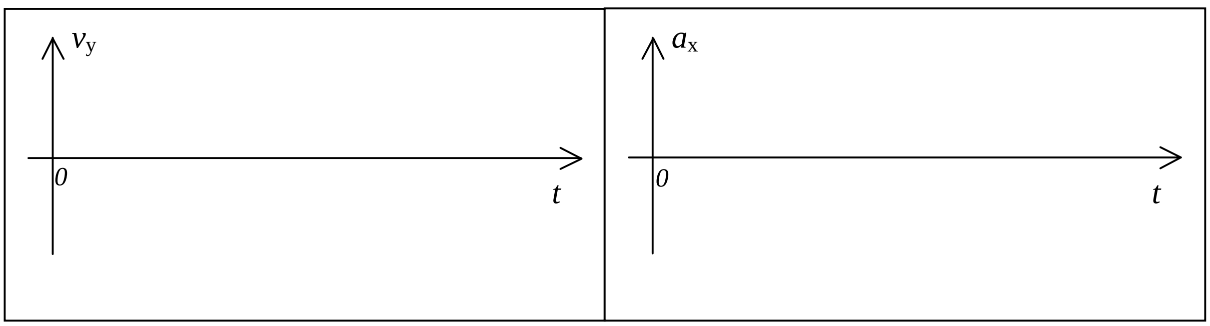
5. (30 points) A penny of mass m sits on a turntable (a disk that spins in a horizontal plane) at a radius R from the center. (Shown in a top view at the right.) The turntable spins at an angular velocity of ω radians per second, which means the penny moves with a speed of $v = \omega R$. The coefficient of friction μ between the penny and the turntable is large enough that the penny doesn't slide off.



a) If the penny starts along the x-axis at time $t = 0$, sketch in the boxes below, graphs of the <u>y-component of the penny's velocity</u> and the <u>x-component of the penny's acceleration</u> as a function of time for one full rotation of the turntable. (10 pts)



b) Explain what forces act on the penny. Be clear with your list, and be sure to explain the magnitude and direction of each force. (10 pts)

c) Solve for the maximum angular velocity (ω) the turntable can have before the penny slides off. Express your answer in terms of m, R and μ. (10 pts)

If you need more space, continue on the back and check here. ☐