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**University of Maryland
Department of Physics**

**Physics 121
Fall 2009**

Exam 2 (Makeup)

**Dr. E. F. Redish
18. November. 2009**

Instructions:

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

1. When the proctor tells you to begin, **write your full name at the top of every page.** 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. **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!**
3. On all the problems *except the multiple choice questions in problem 1 or where it says not to explain*, your answers will be evaluated at least in part on how you got them. More than half the credit of the problem may be given for the explanation. **YOU MAY EARN LITTLE OR NO CREDIT FOR YOUR ANSWERS IF YOU DO NOT SHOW HOW YOU GOT THEM.** Partial credit will be granted for correct steps shown, even if the final answer is wrong. Explanations don't need to be long, but they need to show what physics you are using and assumptions you are making.
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 calculations should be done to the appropriate number of significant figures.
7. At the end of the exam, write and 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 exam.”):

#1:	#2:	#3:	#4:	#5:	Total
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***** Good Luck *****

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1. (20 points) For the following five items, place the letter or letters corresponding to the correct items in the box to the right of the item. If none are correct, put N. (5 pts each)

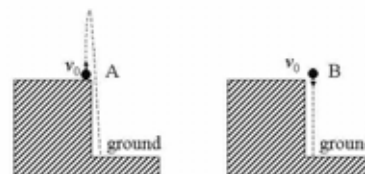
1.1 The brakes of your bicycle have failed, and you must choose between slamming into either a haystack or a concrete wall. Which of the following statements justifies why hitting a haystack is the wiser choice?

- (a) The haystack gives you a smaller impulse than the concrete wall.
- (b) The haystack changes your momentum over a longer time.
- (c) Your change in kinetic energy is smaller if you hit the haystack than if you hit the concrete wall.
- (d) Your change in momentum is smaller if you hit the haystack than if you hit the concrete wall.
- (e) More potential energy is stored in the wall, which is released upon the impact and results in a greater force on you.

1.2 You drop a ball from a high tower and it falls freely under the influence of the gravitational force. All other forces can be neglected. Which of the following statements is true?

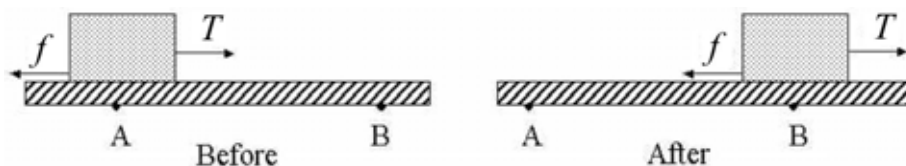
- (a) The kinetic energy of the ball increases by equal amounts in equal times.
- (b) The kinetic energy of the ball increases by equal amounts over equal distances.
- (c) There is zero work done on the ball by the gravitational force as it falls.
- (d) The work done on the ball by the gravitational force is negative as it falls.
- (e) The total mechanical energy of the ball decreases as it falls.

1.3 Two identical stones, A and B, are shot from a cliff from the same height and with identical initial speeds v_0 . Stone A is shot vertically up, and stone B is shot vertically down (see Figure). Which one of the following statements best describes which stone has a larger speed right before it hits the ground?



- (a) Both stones have the same speed.
- (b) A, because it travels a longer path.
- (c) A, because it takes a longer time.
- (d) A, because it travels a longer path and takes a longer time.
- (e) B, because no work is done against the gravitational force.
- (f) Another answer (give the letter and briefly state a reason)

1.4 Using a rope of negligible mass, you pull a box along a horizontal surface with a constant horizontal force T . The box moves to the right at a constant velocity from A to B. The force of friction f cannot be neglected. Which of the following statements concerning the motion of the box from A to B are true?



- (a) The impulse given to the box by the gravitational force is non-zero.
- (b) The impulse given to the box by f points to the right.
- (c) The net impulse on the box created by the net force is non-zero.
- (d) The magnitude of the impulse given to the box by T is equal to the magnitude of the impulse given to the box by f .
- (e) The magnitude of T is greater than the magnitude of f .

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

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2. (30 points) Two carts can move freely without friction on an air track. The cart on the right (cart 1) has a mass of 1 kg and the one on the left (cart 2) has a mass of 2 kg. At $t = 0$, the 1 kg cart is moving to the left with a speed of 10 cm/s as shown. Use the indicated coordinate system to specify your results.



(a) The carts have Velcro™ bumpers and stick together when they meet. Calculate the velocity of the combined carts after the collision and put your answer in the box. Explain your reasoning. (8 pts)

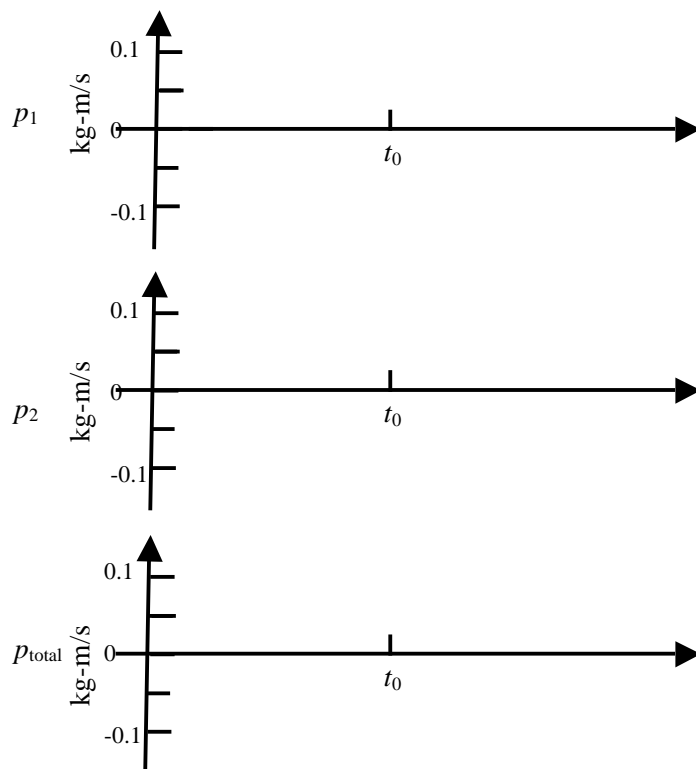
$V =$

(b) Calculate the Impulse that the each cart experiences. (7 pts)

$I_1 =$

$I_2 =$

(c) On the graphs at the right, draw graphs showing the momentum of each of the carts and the total momentum of the system as a function of time. You may assume that the time it takes the carts to merge is short compared to the total time you are graphing. The time of the collision is marked as t_0 . Note that a momentum scale is given so you are expected to be quantitative. (15 pts)



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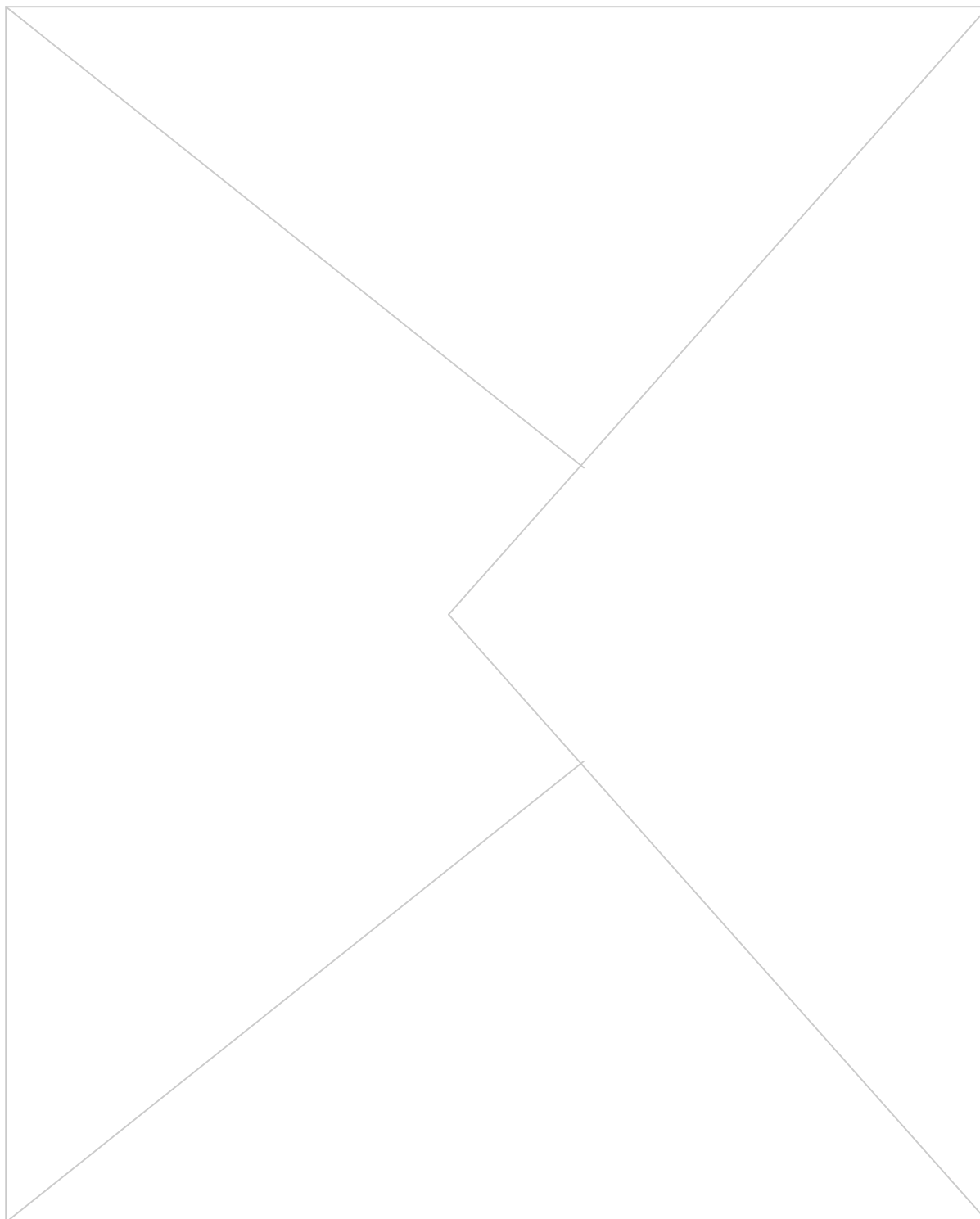


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3. (10 points) Estimate the total number of hairs growing on your head. *Be sure to clearly state your assumptions and how you came to the numbers you estimated, since grading on this problem will be mostly based on your reasoning, not on your answer.*



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4. (15 points) Two of the concepts that students in this class often find difficult are Work and Mechanical Energy. Explain these concepts and discuss why we define them and how they are related. *Note: This is an essay question. Your answer will be judged not solely on its correctness, but for its depth, coherence, and clarity.*

[illegible]

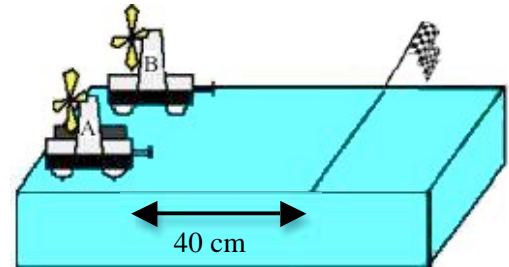
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5. (25 points) Two fan carts labeled A and B are placed on opposite sides of a table with their fans pointed in the same direction as shown in the figure at the right. Cart A is weighted with iron bars so it has a mass of 2 kg, twice as much as cart B, which has a mass of 1 kg.

When the fans are turned on, they result in the air pushing on the cart with a constant force of 5 Newtons independent of the cart's mass. Assume that friction is small enough to be neglected.

The fans are controlled by a detector that turns the fans off when the carts cross the finish line (shown by the checkered flag) 40 cm from the starting point. Put your answers in the boxes at the right and your explanations in the space provided.



(a) Which cart reaches the finish line first? (5 pts)

(b) Calculate the kinetic energy that each cart has when it crosses the finish line. (10 pts)

 $KE_A =$ $KE_B =$

(c) Calculate the momentum that each cart has when it crosses the finish line. (10 pts)

 $p_A =$ $p_B =$

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