

Name _____

**University of Maryland
Department of Physics**

**Physics 121
Fall 2009**

Exam 1

**Dr. E. F. Redish
9. October. 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. (30 points) A small radio-controlled toy car can move to the right or left along a horizontal track. Its position is being measured by a sonic ranger attached to a computer as shown in the figure at the right.



For each of the two situations described as A and B, select the number of the graph (or graphs) that could provide a correct graph of the position, velocity, and acceleration of the car as it would be shown on the computer screen and put it in the box at the right of the variable name. If none of the graphs could work write N. (5 each)

- A. When the motion detector is turned on ($t = 0$ on the graph), the car is moving towards the left and is slowing down at a uniform rate.

1. Position

2. Velocity

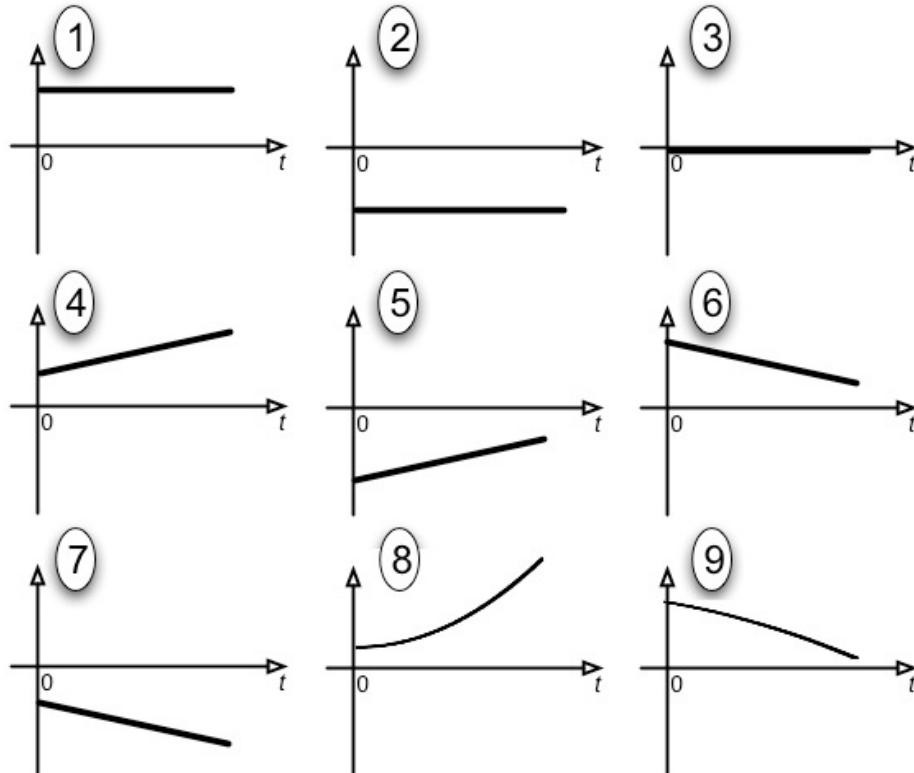
3. Acceleration

- B. When the motion detector is turned on ($t = 0$ on the graph), the car is moving towards the right and is speeding up at a uniform rate.

1. Position

2. Velocity

3. Acceleration



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2. (20 points)

- A. In a video, a juggler is pictured throwing a tennis ball straight up (ball A shown at the right). If the ball rises to a height h above his hand from the point just after he released it, find the initial velocity, v_i , with which it left his hand. Take the gravitational field strength to be g (in N/kg). Express your answer in terms of h and g . Put your answer in the box and show your reasoning in the space below. (10 pts)



$$v_i =$$

- B. In a second video, a TA is also shown throwing a tennis ball straight up, but in this video the TA is sliding to the left on a skateboard at a constant velocity v_0 while he is doing it. The ball rises to the same height above his release point as does the ball from the juggler.

1. How did the speed he threw the ball with compare to the speed the juggler threw the ball with, faster, slower, or the same? Put your answer in the box and explain your reasoning in the space at the side. (5 pts)



2. If you measured the initial speed of the ball from the videos in the two cases by taking the first two frames after the hand released the ball, how would the speeds you measure compare? Is the Juggler's ball faster, is the TA's ball faster, or would both be the same? Put your answer in the box and explain your reasoning in the space at the side. (5 pts)

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3. (15 points) One of your relatives lives on a farm and drives two cars – an off the road vehicle that gets 10 miles/gallon and a highway driving vehicle that gets 30 miles/gallon. She drives each of them approximately the same amount (as measured by distance). She can afford to upgrade one of them – the off-road vehicle to one that gets 15 miles/gallon, or the highway vehicle to a hybrid that gets 50 miles/gallon. If each upgrade costs about the same but she can only afford to do one of them, which vehicle would you recommend she upgrade to save more money on gas?
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)** Two 121 students were discussing a problem in which the class was asked to find the acceleration of a cart rolling up and down an incline when the cart was at the very top of its path. Malia says, “At the top the velocity has to be zero so the acceleration has to be zero too.” Sasha disagrees saying, “No, the velocity is changing at the top so the acceleration can’t be zero.” Who do you agree with? Discuss the reason for your answer and explain why the one who is wrong might legitimately be confused about which answer is correct. *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. (25 points) A cannonball (C) of solid iron that has a mass m_C is rolling on a flat concrete floor and runs into a soccer ball (S) that has a mass m_S as shown in the figure at the right. ($m_C \gg m_S$)

A. In the boxes below, draw diagrams showing the forces acting on each ball at an instant when they are in contact. For each force you include, be sure to indicate the type of force and the objects causing and feeling each force. (10 pts.)



B. If any of the forces you have drawn in your answer for A are equal to each other, specify the equalities and explain why they are equal. (6 pts.)

C. As a result of the collision, the cannonball loses an amount of its velocity, Δv_C , and the soccer ball gains some velocity, Δv_S . How do these changes in velocities compare? (Only a qualitative answer is needed, e.g., they are equal, one change is a little bit greater than the other, one change is a lot greater than the other [which?], they are in the same or opposite directions, etc.) Explain why you say so. (9 pts.)

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