Name____

University of Maryland
Department of Physics

Physics 121 **Dr. E. F. Redish**
Fall 2010 **Exam 1 (Makeup)** **14. October. 2010**

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 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. 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."):

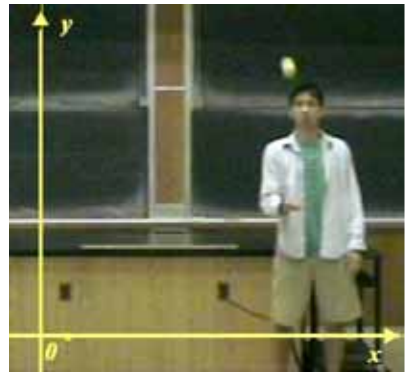
#1:	#2:	#3:	#4:	#5:	Total

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

NAME____ POINTS_______

Physics 121 **Dr. E. F. Redish**
Fall 2010 **Exam 1 (M.U.)**

1. (30 points) In the picture shown at the right (a single frame from a video), the TA shown is riding on a skateboard that is moving to the left with a constant velocity. Just before this frame, he threw the ball straight up. Imagine taking data from this video by placing a dot on the center of the ball from the time just after it left his hand until the ball crosses the y-axis.



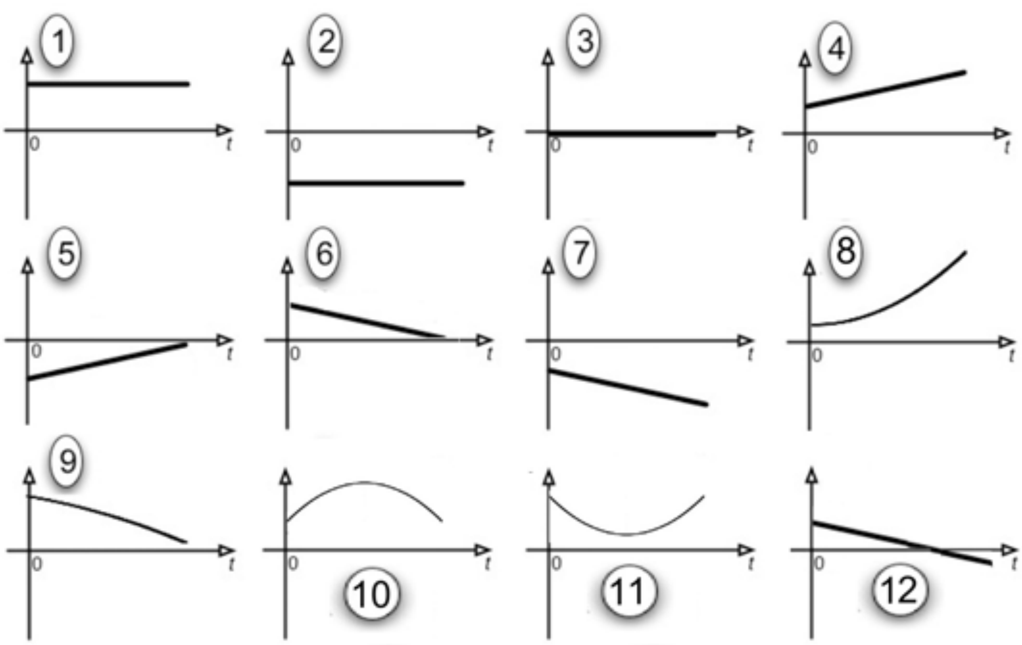
Suppose you made time graphs of the x and y position, velocity, and acceleration, and then fit each of your graphs with smooth curves. Which of the graphs in the figure below would look like each of your graphs if the vertical axis were given the right units and scale? Put the number of the graph in the box after the variable name. If none could work write N. (5 each)

A. For the x coordinate:

1. Position ☐ 2. Velocity ☐ 3. Acceleration ☐

B. For the y coordinate:

1. Position ☐ 2. Velocity ☐ 3. Acceleration ☐



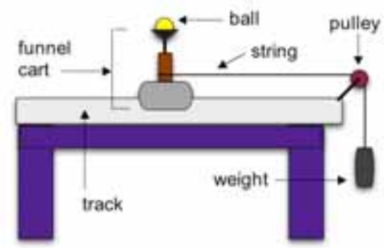
If you need more space, continue on the back and check here. ☐

NAME____ POINTS_______

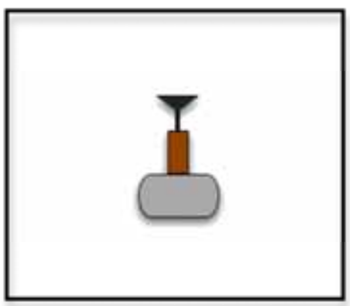
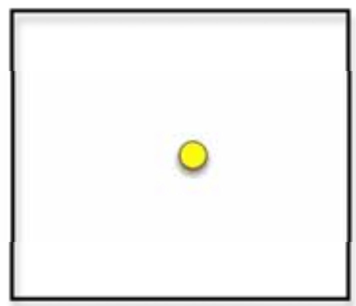
Physics 121 **Dr. E. F. Redish**
Fall 2010 **Exam 1 (M.U.)**

2. (20 points) In lecture, we considered a demonstration in which a "funnel cart" rolls freely along a track without slowing down significantly. It carried a ball that it was able to pop straight up into the air when a trigger was released. When the cart was rolling freely and crossed a bar that pulled the trigger, the ball flew up in the air and the cart caught it.

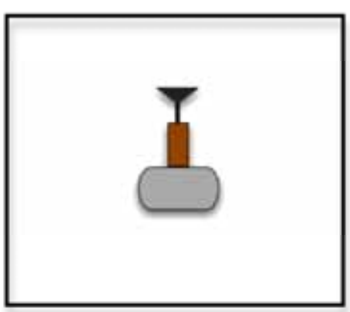
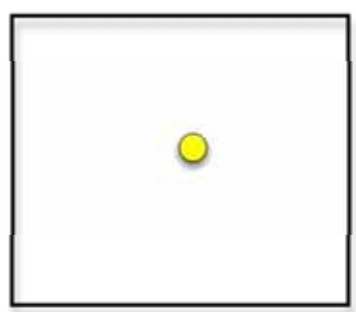
Consider a second experiment. We loop a noose of string around the cart and hang the other end of the string to a pulley where the string is attached to a weight. When the cart is released, it speeds up. Partway down the track it hits the trigger and the ball is thrown into the air. A drawing of this is shown at the right. Assume that the funnel cart has been released for both of the problems below.



A. In the boxes below, draw free body diagrams for the funnel cart and the ball for an instant <u>after</u> the ball has been released. Assume the ball is in the air and the cart is speeding up. Label all forces to show the type of force, who is feeling it and who is causing it. (5 pts)

B. In the boxes below, draw free body diagrams for the funnel cart and for the ball for an instant <u>before</u> the ball has been released. Assume the ball is in the cart's cup and the cart is speeding up. Label all forces to show the type of force, who is feeling it and who is causing it. (10 pts)

C. Identify which of the forces in the diagrams for part B are equal and give the reasons why you think so. (5 pts)

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

NAME____ **POINTS**_______

3. (15 points) The average number of miles driven by a personal car in the US is about 1000 miles/month. Use this to estimate the total number of gallons of gasoline used by all US drivers in one year. *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.*

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

NAME____ **POINTS**_______

4. (10 points) Your roommate peeks over your shoulder while you are reading a physics text and notices the following sentence: "In free-fall the acceleration is always g and always straight downward regardless of the motion." Your roommate finds this peculiar and makes two objections:

(1) Not everything falls straight down; if I throw a ball it can go sideways.
(2) If I hold a wooden ball in one hand and a steel ball in the other, I can tell that the steel ball is being pulled down much more strongly than the wooden one. It will probably fall faster.

How would you respond to these statements? Discuss the extent to which these invalidate the quoted statement. If they don't, explain why. *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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NAME____ **POINTS**_______

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5. (25 points) Small rockets have been used to probe the atmosphere for 40 years. Scientific packages in the nose cone of the rocket detect chemicals in the atmosphere and return to earth by parachute. One early such rocket (the Canadian Black Brant VI) is shown in the figure at the right. It was quite small, being only about 9 ft long and weighing about 100 kg. Yet it could climb quite high. Let's see if it could probe the stratosphere (10-50 km up), which contains the environmentally important ozone layer. Be sure to explain your reasoning for all parts of this problem (except the last).

A. When launched, the Black Brant VI could accelerate upward with an acceleration of 5g for 20 seconds. (For simplicity, take g for this problem to be 10 m/s^2.) At the end of this acceleration phase, it what was its velocity? (5 pts)

v_1 =

B. At the end of the acceleration phase, how high up would it be? (5 pts)

h_1 =

C. At the end of the acceleration phase, the rocket just turned off. For how long will it continue to rise? Calculate the total height to which it will rise. (10 pts)

Δt_2 =

h_{tot} =

D. For this calculation we made many assumptions in order to simplify what we could do in the short time available for this exam. Identify two assumptions that we made that, if treated correctly, might significantly affect the results we obtained. (5 pts)

1.

2.

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