Name_____

University of Maryland
Department of Physics

Physics 121 **Dr. E. F. Redish**
Fall 2009 **Exam 1 (Make Up)** **15. 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."):

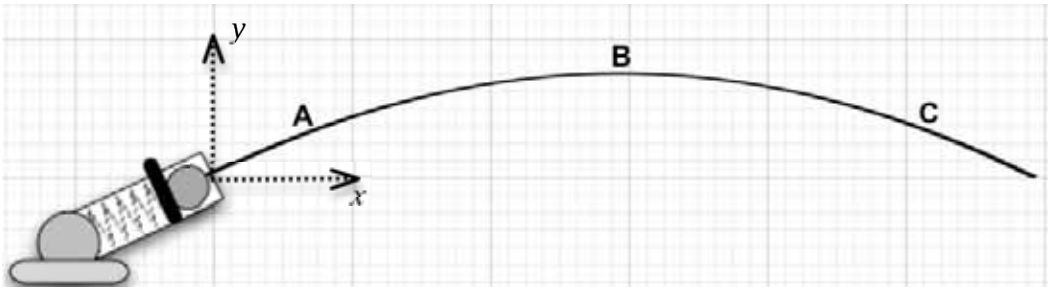
#1:	#2:	#3:	#4:	#5:	Total

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

NAME_____ **POINTS**_____

Physics 121 **Dr. E. F. Redish**
Fall 2009 **Exam 1 (M.U.)**

1. (30 points) A child's tilted spring-loaded ball launcher shoots a golf ball with a mass of 45 grams at an angle of 25° at a speed of 4 m/s. Its path looks something like shown in the figure at the right. With these parameters, the force due to the resistance of the air can be neglected while the ball is in the air.



Three points are labeled along the path: A, just after it leaves the gun but before it gets to the top, B, at the highest point, and C, while it's on its way down but before it hits the ground. The points A and C occur at the same height. In describing the object's motion, we will use the coordinate system indicated by the dotted lines.

For each of the quantities below, rank the quantities at these three points using greater than (>) or equal (=) signs and indicate if any are equal to 0. Thus, your answer should look something like U > V = W = 0 if the value at point U was greater than that at V, which is equal and W and to 0. Do NOT use less than (<) signs. [Grading is by neighboring relations only. Thus, if you write U > V > W and the actual rank is V > U > W, you only get credit for V > W not for U > W.]

A. Rank the magnitude of the speed of the ball at the three points A, B, and C. (10 pts)

B. Rank the magnitude of the net force acting on the ball at the three points, A, B, and C. (10 pts)

C. Rank the magnitude of the x-component of the acceleration of the ball at the three points A, B, and C. (10 pts)

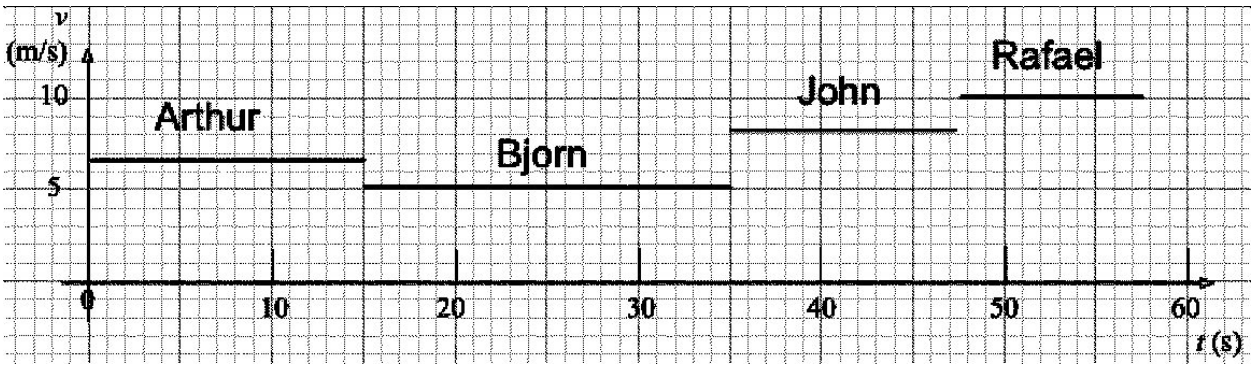
If you need more space, continue on the back and check here. ☐

NAME_____ **POINTS**_____

Physics 121 **Dr. E. F. Redish**
Fall 2009 **Exam 1 (M.U.)**

2. (20 points) In a 4x100 m relay race, each of four runners take turns running a 100 m course, trading places by passing a baton as shown in the figure at the right. In one specific example of a relay race between two teams, the speeds of the runners in the two teams are graphed below. (To simplify the problem in order to make it do-able during an exam, we are ignoring the short amounts of time it takes the runners to get up to speed and the small variations in their speed during their 100 m lap.)

A. Team T had the speeds as a function of time in the graph shown below.



Find the speeds of the individual runners and the team's average speed. (12 pts)

v_A =

v_B =

v_J =

v_R =

$\langle v_{team} \rangle$

B. The team competing against it, team G, had speeds as a function of time as shown in the graph below. Which team won? Explain how you know. (8 pts)

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

NAME_____ **POINTS**_____

3. (15 points) Estimate the number of people in the world that have the same birthday that you do and the number of babies in the world who were born yesterday (on October 14th, 2009). *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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NAME_____ **POINTS**_____

Physics 121 **Dr. E. F. Redish**
Fall 2009 **Exam 1 (M.U.)**

4. (10 points) A mother and her young daughter are both wearing roller blades. Mom stands behind her daughter, puts her hands against her daughter's back and gives her daughter a push. As a result, the daughter ends up rolling forward (leftward), and mom ends up rolling backward (rightward). The mother's mass is twice the daughter's.

Is the force exerted by the mother on the daughter greater than the force exerted by daughter on mother, or are those two forces equal? As part of your answer, be sure to briefly state your answer and the reason you think it's true, briefly explain why a smart student might give the opposite answer, and reconcile those two lines of reasoning. (A *reconciliation* not only identifies what's wrong with the incorrect reasoning; it also shows how to refine those intuitions into something 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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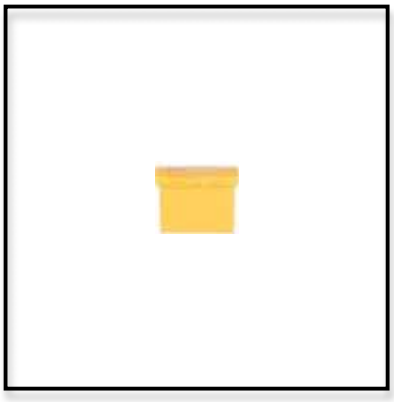
NAME_____ **POINTS**_____

Physics 121 **Dr. E. F. Redish**
Fall 2009 **Exam 1 (M.U.)**

5. (25 points) A worker is pushing a heavy box across a concrete floor. At first, he has to push as hard as he can to get it moving. Once it is moving with a reasonable speed, he still has to push on it but not as hard.

A. Draw free-body diagrams for the box for the two situations, labeling your forces in a way that specifies the type of force and the actors involved in each interaction. (8 pts)



Box is speeding up

Box is moving with constant speed

B. Identify which forces are equal to each other and your reason for thinking so. (Note: You may compare forces within or across your diagrams.) (8 pts)

C. While speeding up the box from rest, he manages to maintain a uniform acceleration of 0.5 m/s^2 for a distance of 4 m, after which he maintains the box at the velocity he has reached at that instant. How fast will the box then be going? Explain your reasoning. (9 pts)

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