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**University of Maryland
Department of Physics**

**Physics 121
Fall 2010**

Exam 1

**Dr. E. F. Redish
8. October. 2010**

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. (This means words.)
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.”):

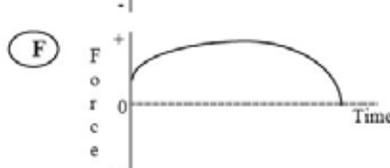
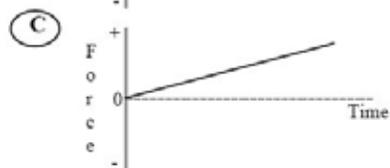
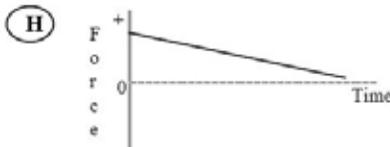
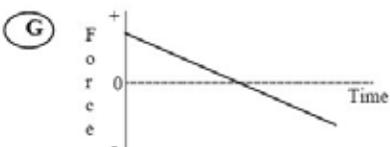
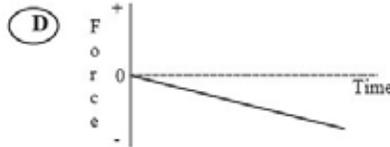
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***** Good Luck *****

1. (25 points) A toy car can move to the right or left along a horizontal line (the positive part of the distance axis) and is being pulled or pushed by a small child. Assume that friction is so small that it can be ignored. Choose the force graph (or graphs) for each statement below that the child could exert to allow the described motion of the car to take place. You may use a choice more than once or not at all. If you think that none is correct, answer choice N. Put your answers in the boxes at the right. (5 pts each)



- a. The car moves toward the right and is slowing down at a steady rate (constant acceleration).
- b. The car moves toward the right and is speeding up at a steady rate (constant acceleration).
- c. The car moves to the right first speeding up and then slowing down.
- d. The car moves toward the right with a steady (constant) velocity.
- e. The car moves toward the left (toward the origin) with a steady (constant) velocity.



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

2. (25 points) The pronghorn antelope in the Western Great Plains of the US is one of the fastest animals on the planet. But it has outlived all its predators and now runs where none pursues. Let's imagine a cheetah-like predator in the period tens of thousands of years ago when the pronghorn evolved its speed.

A cheetah is one of the fastest animals, but it can only maintain its high speed for a short time. The pronghorn can continue to run at a steady pace of 80 km/hr for a long time. Here are some of the parameters of the cheetah's motion.



- Max speed 120 km/hr
- Can accelerate from 0 to 120 km/hr in 3 seconds
- Can maintain max speed (sprint) for about 30 seconds.
- After its initial high-speed sprint, it quickly drops to a steady pace of ~70 km/hr.



A. During the time it is accelerating, what is the cheetah's average acceleration, $\langle a \rangle$, and its average speed, $\langle v \rangle$? Show your work in the space below and put your answers in the box at the right. (10 pts)

$\langle a \rangle =$
$\langle v \rangle =$

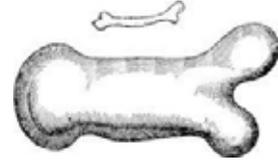
B. Suppose the cheetah comes across a herd of antelope running at a steady pace of 80 km/hr. As soon as they see the cheetah, they wheel and run directly away from the cheetah. How far from the cheetah do the pronghorns have to be if they are to be safe? Explain your reasoning. (15 pts)

$\Delta x =$

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



3. (15 points) In his book *Dialog Concerning Two New Sciences* (1638), Galileo showed the picture on the right and explained that larger animals had to have thicker bones. (“Thus a small dog could probably carry on his back two or three dogs of his own size, but I believe that a horse could not carry even one of this own size.”)



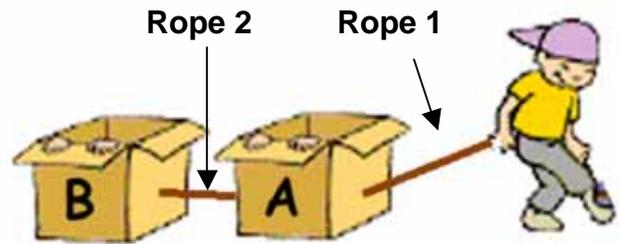
If the small bone in the figure is from a medium-sized dog and the large bone is 3 times the length and 8 times the diameter of the small one, estimate the weight of the animal from which the large bone was taken. *Be sure to clearly state your assumptions and how you came to the numbers you estimated, since grading on this problem will be mostly based on your reasoning, not on your answer.*

A large rectangular box with a diagonal cross from the top-left to the bottom-right and another diagonal cross from the top-right to the bottom-left. A zig-zag line is drawn in the center, starting from the top edge, going down to the left, then up to the right, then down to the left, and finally up to the right, ending at the bottom edge. This box is intended for the student to write their answer and reasoning.

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



5. (25 points) Little Nathan's dad has hooked together two boxes with ropes to make a train for him as shown in the picture. Nathan has put one of his twin sisters in each box and is pulling them along the rug as shown.



(a) If Nathan is pulling on the rope with a constant force T , draw free body diagrams for each of the boxes, identify all the forces on it, being sure to specify the kind of force each one is and what object is exerting it. (10 pts)

(b) Draw a free-body diagram for rope 2 (the one connecting the two boxes). Assume the rope is very light so that you can ignore its weight. (5 pts)

(c) Nathan is pulling his train so it is moving at a constant speed. If any of the forces in your three diagrams are equal, identify them and say how you know. (10 pts)

