

Name \_\_\_\_\_

**University of Maryland  
Department of Physics**

**Physics 121  
Fall 2010**

**Exam 2**

**Dr. E. F. Redish  
12. November. 2010**

**Instructions:**

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

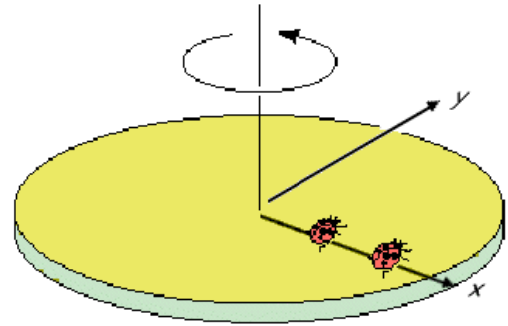
1. When the proctor tells you to begin, **write your full name at the top of every page.** This is essential since this exam booklet will be separated for grading.
2. Do your work for each problem on the page for that problem. You might find it convenient to either do your scratch work on the back of 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.
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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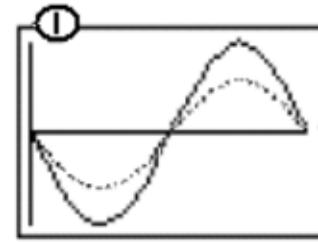
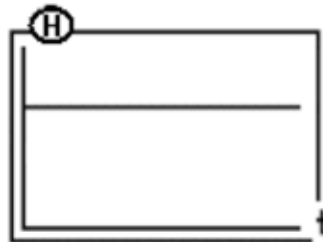
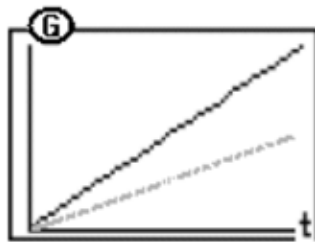
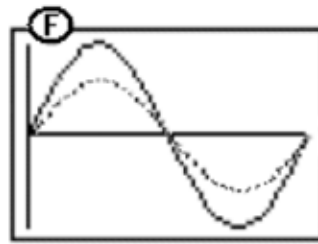
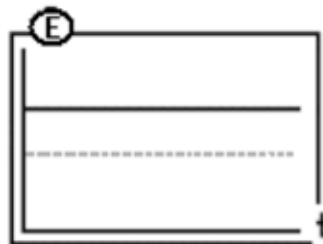
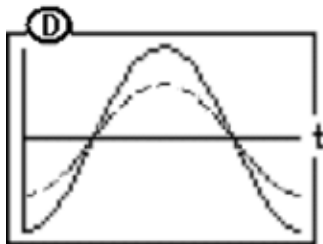
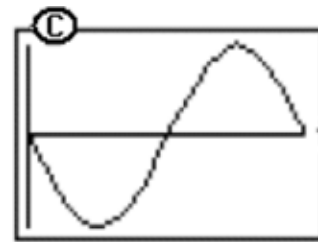
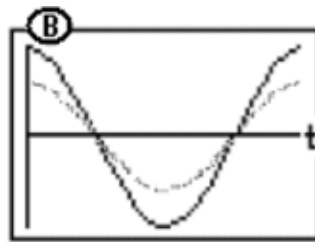
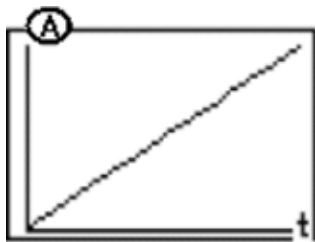
**\*\*\* Good Luck \*\*\***

Physics 121  
Fall 2010Dr. E. F. Redish  
Exam 2

1. (25 points) In the figure at the right is shown a disk at a uniform rate. On the disk are shown two ladybugs. The disk goes around slowly enough that the bugs are not thrown off. At time  $t = 0$  both bugs are along the x-axis of the fixed (i.e., not rotating) coordinate system. Below are shown a set of graphs. For each of the 5 variables below, select which of the graphs A-I (if it had the proper scale) could serve to display the variables for the two bugs. If only one curve is shown, it means both bugs have the same curve. If two curves are shown, the solid curve is for one of the bugs, the dotted curve for the other. If none of the graphs work, write N.



- \_\_\_\_\_ (1) their angular velocity  
 \_\_\_\_\_ (2) the y-component of their velocity  
 \_\_\_\_\_ (3) the x-component of the net force they feel  
 \_\_\_\_\_ (4) their speed  
 \_\_\_\_\_ (5) the angle their position makes with respect to the x-axis

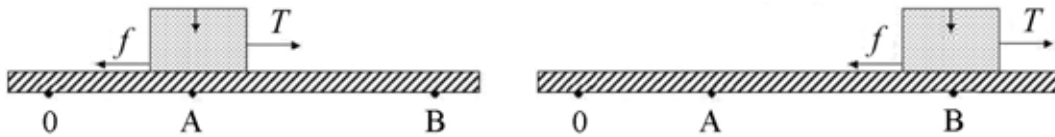


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Physics 121  
Fall 2010Dr. E. F. Redish  
Exam 2

2. (25 points) Using a rope of negligible mass, a box is pulled along a horizontal surface as shown in the figure below. Initially, the marker arrow on the box points to the position marked 0 and the box is at rest. At time  $t = 0$  a tension force  $T_0$  is exerted on the box and the box begins to move. The tension force stays constant until the arrow marker on the box reaches the point marked A at a time  $t = t_1$ . At that point the force changes to a new constant value of  $T$  and the box continues to move with a constant velocity until it passes position B at a time  $t = t_2$ . The force of friction  $f$  cannot be neglected. Use a horizontal coordinate system centered at 0 with the +x direction pointing to the right. If you need  $g$ , use the value of 10 N/kg.



A. In the space below, draw a free-body diagram showing all the forces acting on the box at a time between the times  $t = t_1$  and  $t = t_2$ . Be sure to identify the type of force and what object is causing it. (5 pts)

B. The box has a mass of 2 kg, and the coefficient of sliding friction between the block and the table is 0.25. The box has attained a speed of 0.3 m/s when it reaches point A. Find the tension force,  $T$ , if you can, and explain how you know what it is. If you cannot find it, explain what additional information you would need to find it. (5 pts)

 $T =$ 

C. If the distance between A and B is 0.7 m, find the work done by the tension and friction forces as the box moves between points A and B. Show your reasoning. (7 pts)

 $W_T =$  $W_f =$ 

D. Find the impulse delivered to the box by the tension and friction forces as the box moves between points A and B. Show your reasoning. (8 pts)

 $I_T =$  $I_f =$ 

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NAME \_\_\_\_\_ POINTS \_\_\_\_\_

Physics 121  
Fall 2010

Dr. E. F. Redish  
Exam 2

**3. (15 points)** The water company that provides water to houses in the DC area (WSSC) charges both for providing water and for carrying waste water away. The combined rate is about 1 cent per gallon. My niece, the environmentalist, chides me not to run water when I am brushing my teeth.



Estimate the cost to me in one year if I let the water in the sink run while I brush my teeth.

*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**  
**Fall 2010**

**Dr. E. F. Redish**  
**Exam 2**

**4. (10 points)** Three physics students had different answers to the following quiz problem:

*A spring-loaded toy dart gun is used to shoot a dart straight up in the air, and the dart reaches a maximum height of 24 m. The same dart is shot straight up a second time from the same gun, but this time the spring is compressed only half as far before firing. How far up does the dart go this time, neglecting friction and air resistance and assuming an ideal spring?*

Fred said, “I don’t think it will make any difference.” Ethel said, “No, Fred. It will go half as high.” Lucy said, “I think it will only go  $\frac{1}{4}$  as high.” Who is right and suggest how the one who is correct might convince the other two? (Just giving the answer in the louder voice is not good enough.) The one with the correct answer has to have a good physics reason. Explain that reasoning in a way that should be convincing to the others. *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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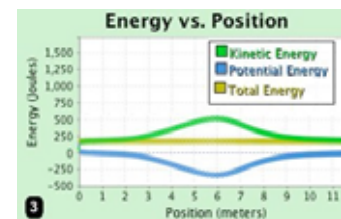
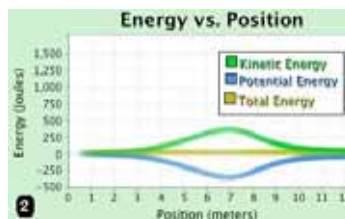
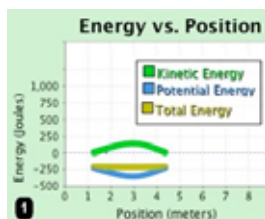
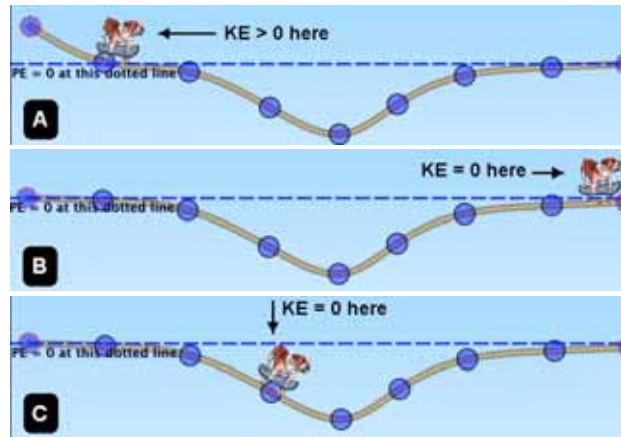
**Physics 121**  
**Fall 2010**

**Dr. E. F. Redish**  
**Exam 2**

**5. (25 points)** In the three figures labeled A, B, and C at the right are shown three situations in which a bulldog on a skateboard traverses a dip in the ground. (The dips are all the same.)

In A, the bulldog enters the dip traveling at a non-0 kinetic energy (KE). In B, when he leaves the dip, he has 0 KE. In C, he begins in the dip (at the position indicated) at a KE of 0. Since he is riding a skateboard, friction may be ignored.

A. In the figures below are shown graphs of the KE, gravitational PE, and total energy as a function of position. In situation 1, the total energy is negative; in situation 2, the total energy is 0; and in situation 3, the total energy is positive. Match which situation goes with which graph and put the letter of the situation to the left of the corresponding graph. (6 pts)



B. The bulldog and skateboard have a combined mass of 20 kg. In case B (the middle of the three pictures of the bulldog and the well), the bulldog and skateboard have a KE of 380 J when they roll past the bottom of the well. How deep is the well? (8 pts)

Depth =

C. In case 1 (the left one of the three graphs) it says the KE is positive but the total energy is negative. How is this possible? Explain what it means for the total energy to be negative. (5 pts)

D. In case 3, the total energy is 200 J. How fast is the bulldog when he passes the bottom of the well? (6 pts)

$v =$

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

