Name_____

University of Maryland
Department of Physics

Physics 122 **Dr. E. F. Redish**
Spring 2009 **Exam 1** **6. March. 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.
6. All calculations should be done to the appropriate number of significant figures. You may lose credit for too many. Use scientific notation for large or small numbers.
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 ******

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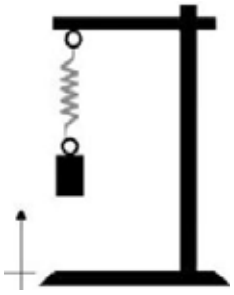
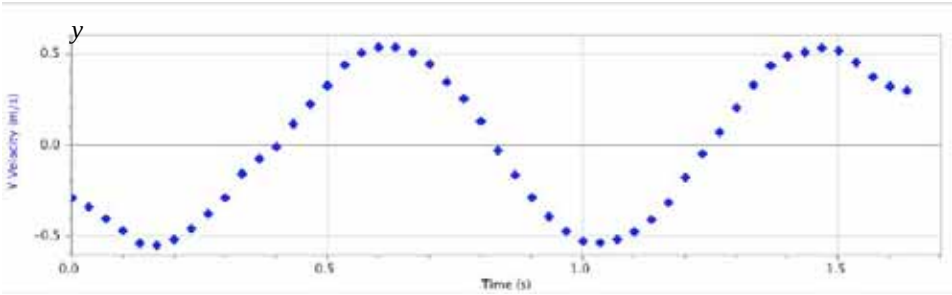
1. (25 points) A video clip of a mass hanging on a spring (like shown in the sketch at the right) produces a graph of the y-velocity of the mass as a function of time shown below. The y-axis is shown in the figure with the positive direction indicated by the arrowhead. The graph starts in the second frame of the video. For this problem, ignore friction and air drag.





Answer the questions below by choosing all the correct answers and putting them in the boxes at the right of the questions. If none of the answers listed are correct, write N and write a brief indication of what you think the correct answer is next to the box. (5 pts each)

a) At ~0.15 s when the velocity is at a negative maximum, the position of the mass is
- A. At its lowest point.
- B. At its highest point
- C. You can't tell from the information given.
- D. At equilibrium going up
- E. At equilibrium going down

b) At ~0.4 s when the velocity is zero, the position of the mass is
- A. At its lowest point.
- B. At its highest point
- C. You can't tell from the information given.
- D At equilibrium going up.
- E. At equilibrium going down

c) At ~0.8 s when the velocity is zero, the net force on the mass is
- A. Pointing up
- B. Pointing down
- C. Zero
- D. You can't tell from the information given.

d) At ~0.4 s when the velocity is zero, the force of the spring on the mass is
- A. Pointing up
- B. Pointing down
- C. Zero
- D. You can't tell from the information given.

e) At ~0.8 s when the velocity is zero, the force of the spring on the mass is
- A. Pointing up
- B. Pointing down
- C. Zero
- D. You can't tell from the information given.

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

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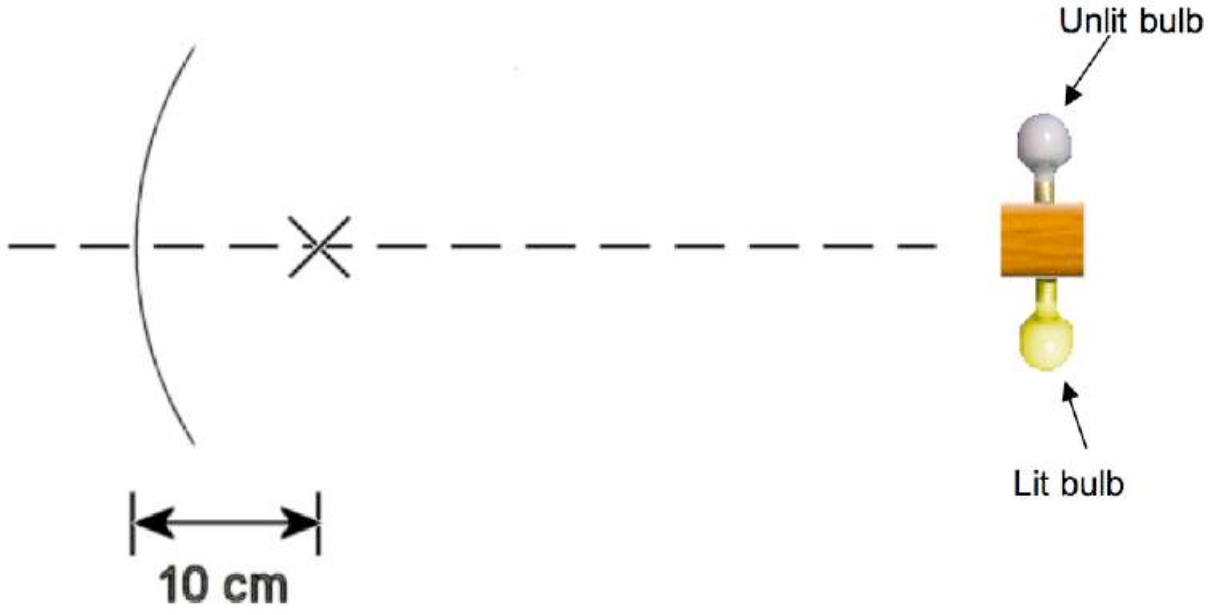
2. (25 points) In lecture, we did a demonstration in which a curved mirror was used to project a real image of a lit bulb (upside down and hidden from class view by a box) on top of a lit bulb (rightside up and on top of the box).

(a) Where do you have to place the box in order to have the image of the lit bulb appear right on top of the unlit bulb? The focal length of the mirror is 10 cm. The box with the bulbs is shown at the right in the figure below, ready to be slid to the left to the appropriate position. (10 pts)

(b) How big will the image of the lit bulb be compared to the size of the lit bulb? That is, how big should we make the unlit bulb so that it is the same size as the image of the lit bulb? (5 pts)

(c) On the figure below, sketch the correct position of the lit bulb and draw a ray diagram to confirm your calculation. (10 pts)



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3. (15 points) When traveling through an airport a few weeks ago, I passed a billboard opposing government borrowing to revive the economy. The billboard stated something like, "If you took a trillion dollars in $10 bills and passed out one every second, it would take you nearly 2000 years to get rid of them all." Given that a trillion is 10^{12}, is this correct? On the other hand, there are a lot of people in the US. If you had 2000 years to meet them one at a time, how much time would you have with each person? Are either of these numbers relevant in evaluating how big $1 trillion is? Can you come up with a more relevant number?
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) In our discussions of waves on a taut spring and of ray optics, we have focused not just on what happens, but on what is the *mechanism* – that is, on how our observations can be interpreted as a result of the behavior and interactions of what we assume to be the component parts (e.g., beads and massless springs, light particles or rays, etc.). Give one example of mechanism that we have used in class and discuss whether you found it useful in "making sense of the physics" or not. Explain why or why not. *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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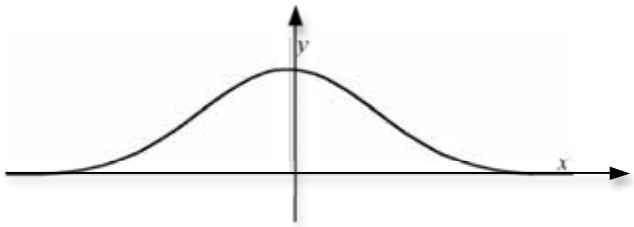
5. (25 points)

A. The curve $y = f(x)$ is shown in the figure at the right.



A1. A pulse with this shape is started on a long stretched spring; that is, at time $t = 0$, the spring has the shape $y(x,0) = f(x)$. What is the function, $y(x,t)$, that describes the shape of the spring at a time t if this pulse moving to the right with the speed v_0? (5 pts)

A2. A demonstrator holds a long stretched spring at one end and generates a pulse moving down the string by moving his hand up and back to its starting point quickly. The speed of pulses moving on the spring is 250 cm/s and he moves his hand up and down in 0.5 s. Is it possible to predict the width of the pulse that moves along the spring? If so, find it. If not, explain why not. (5 pts)

B. The curve $y(x,t) = A \sin(kx - \omega t)$ describes a sinusoidal wave shape moving on a (different) long spring. The parameters have the following values: $A = 0.5$ cm, $k = 0.125$ cm^{-1}, and $\omega = 25$ s^{-1}.

B1. Is the wave shape described by this function moving to the left (in the direction of the negative x axis) or to the right (in the direction of the positive x axis)? (5 pts)

B2. How fast is the shape traveling down the spring? (5 pts)

B3. How long does it take for a bit of the spring to oscillate one full oscillation as the wave passes it? (5 pts)

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