Name_____

University of Maryland
Department of Physics

Physics 122 **Dr. E. F. Redish**
Spring 2010 **Exam 2** **16. April. 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."):

You may find some of the following numbers useful in this exam (or not):

3.141592	3.0×10^8 m/s	330 m/s	6×10^9
9×10^9 N-m^2/C^2	$\frac{2}{3} \times 10^{-10}$ N-m^2/kg^2	$2/\pi \times 10^7$ m	3×10^8

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

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

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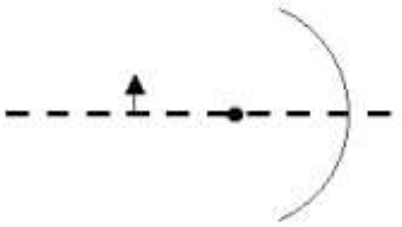
1. (25 points) For the following questions, place the letter corresponding to the answer that best answers the question in the boxes at the left. If more than one answer is correct give them all – but do not give extra answers as you will lose credit for wrong entries. If none are correct, write N.

1.1 An object (shown as an upright small arrow) is placed in front of a concave mirror. An image is created. The object is slid along the dotted line to the right until it is at the dot. This dot is the center of the sphere from which the mirror was cut. What happens to the image? (5 pts)



a) The image will disappear.
b) It will stay in the same place.
c) It will move farther away from the mirror.
d) It will move closer to the mirror.
e) It will move to the opposite side of the mirror

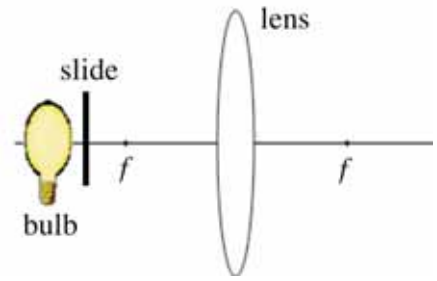
1.2 The object in 1.1 is now slid toward the mirror until it is past the dot and is closer to the mirror than to the dot. Now what happens to the image? (5 pts)

a) The image will disappear.
b) It will stay in the same place.
c) It will move farther away from the mirror.
d) It will move closer to the mirror.
e) It will move to the opposite side of the mirror

1.3 How are the images in cases 1.1 and 1.2 oriented? (5 pts)

a) Both point up, like the object.
b) Both point down, in the opposite direction from the object.
c) 1.1 points up and 1.2 points down.
d) 1.1 points down and 1.2 points up.
e) You can't tell from the information given.

In the figure at the right is shown the components of a slide projector: bulb, slide, and lens. When the bulb is on, the lens shows an image of the slide on a distant screen. The lens' focal points are indicated by dots and the letters "*f*".



1.4 If a piece of cardboard is slid in front of the bottom half of the lens on the right (right next to it) what will happen to the image of the slide on the screen? (5 pts)

a) The top half of the image will disappear.
b) The bottom half of the image will disappear.
c) The entire image will remain but get dimmer
d) The image will remain the same.

1.5 If a piece of cardboard is slid in front of the bottom half of the slide on the right (right next to it) what will happen to the image of the slide on the screen? (5 pts)

a) The top half of the image will disappear.
b) The bottom half of the image will disappear.
c) The image will all remain but get dimmer
d) The image will remain the same.

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

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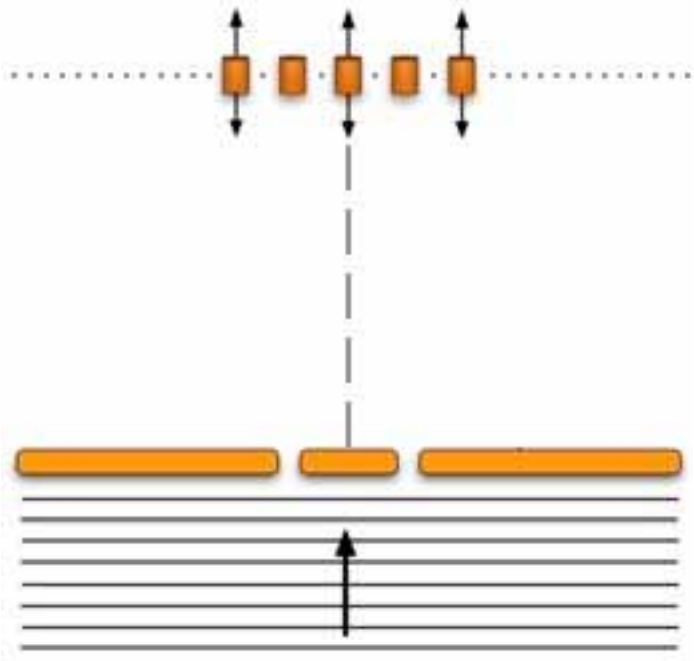
2. (25 points) You are studying the pattern of oscillations produced in a large ripple tank by having a bar tap the water to produce long straight waves. You have placed a barrier in the way of these waves parallel to the wave fronts and having two narrow slits in it as shown. To test what happens, you have put 5 small corks in the water on the other side of the barrier.



After the ripples have passed through the slits for a while, three of your corks are bobbing up and down regularly, while two of them are moving hardly at all. (The corks bob perpendicular to this page.) As you move the corks back and forth along the dotted line, you learn that there is no place closer to the dashed centerline where the corks do not bob.

A. From this information alone, indicate on the figure all other places where you can confidently predict that the corks will NOT bob if you placed them there. Explain your reasoning in the space below. (15 pts)

B. If you wanted to "spread out" the pattern of bobbing shown above so that the non-bobbing points occurred twice as far from the dashed centerline (where the outside bobbing corks now are), should you make the slits closer together? Farther apart? Narrower? Wider? Explain why you think your proposed change would have the desired result. (10 pts)

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3. (15 points) The charming little college town of Boulder, Colorado, where I spent my last sabbatical, sits at the foot of the Rocky Mountains. A few years ago, a candidate for the city council ran on a platform that said the town should aim to grow at a rate of 3% per year for the foreseeable future. Boulder had a population of about 100,000 in the 2000 census. If it were to grow at the rate of 3% each year without stopping, how long would it take to double its population? Estimate how many years it would take for the population of Boulder to become greater than the current population of the entire US.
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 this class I have often claimed that we use equations not just as ways to calculate but as ways to organize our thinking about a subject and to represent relationships among physical measurements. Give one equation from this segment of the class (ray optics, wave optics, or electrostatics) and discuss the extent to which my claim is true or 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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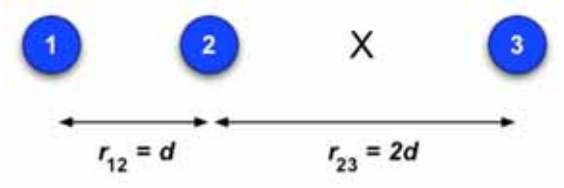
5. (25 points) In the figure at the right are shown three charges along a line. The distance between charges 2 and 3 is twice the distance between charges 1 and 2.



A. Find the magnitude of the force exerted on charge 1 by charge 2 if charge 1 has a magnitude of 0.05 μC, charge 2 has a magnitude of 0.2 μC, and the distance *d* between them is 3 cm. Put your answer in the box at the right and show your reasoning. (10 pts)

$F_{1\to 2} =$

B. Find the magnitude of the force exerted on charge 2 by charge 1 for the values given in part A. (5 pts)

$F_{2\to 1} =$

C. For this part, all three charges have magnitudes equal to 0.1 μC. If a test charge were to be placed at the "x" halfway between charges 2 and 3, in which case would it feel the biggest force?

a. 1 and 2 are positive and 3 is negative
b. 1 and 3 are positive and 2 is negative
c. 2 and 3 are positive and 1 is negative.

Put your answer in the box at the right and explain your reasoning below. (5 pts)

D. I place a test charge of 0.01 μC at the "x" to measure the electric field produced at that point by the three blue charges. If instead I had used a test charge of 0.02 μC as my test charge, how would the E field I measure have differed from the result I got with the first test charge? Explain. (5 pts)

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