Name__________________________________ Section ___________

University of Maryland
Department of Physics

Physics 122   Dr. E. F. Redish
Spring 2004   Exam 2 (Make Up)  29. April, 2004

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 and section number 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. If explanations are requested, more than half the credit of the problem will be given for the explanation. LITTLE OR NO CREDIT MAY BE EARNED FOR ANSWERS THAT DO NOT SHOW HOW YOU GOT THEM. Partial credit will be granted for correct steps shown, even if the final answer is wrong.

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. All estimations should be done to the appropriate number of significant figures.

6. 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 examination.”

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

*** Good Luck ***
1. (30 points) Each of the problems in this part has a description of an object and an optical device (lens or mirror). A sketch is shown below. For each case, specify whether

- the image is real (R), virtual (V), or no image is formed (N);
- the image is on the same side of the device as the object (S) or the opposite side (O). If there is no image put a null mark (φ);
- if an image is formed, on which side of the system must the observer be in order to see it, left (-) or right (+)?

For each problem you should therefore give three answers (for example: V O +). For the mirrors the center is shown. For the lenses, the focal points are shown. The radius of curvature of the mirrors is $R$, the focal length of the lenses is $f$.

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- a. Concave spherical mirror, object on right a distance $s > R$ from mirror.
- b. Convex spherical mirror, object on right a distance $s < R/2$ from mirror.
- c. Concave spherical mirror, object on left a distance $R > s > R/2$ from mirror.
- d. Convex lens, object on right a distance $s > f$ from lens.
- e. Convex lens, object on left a distance $s < f$ from lens.
2. (20 points) The figure at the left below shows a cross section of four long parallel wires (labeled A through D) taken in a plane perpendicular to the wires. One or more of the wires may be carrying a current. If a wire carries a current it is in the direction indicated and has magnitude $I_0$.

For each of the four vector quantities (i) through (iv) give the direction of the quantity. To indicate the direction, use one of the letters associated with a directional arrow on the "compass" figure at the right below. If the magnitude of the quantity is zero, write "0". If it is non-zero, but in none of the indicated directions, write "N".

i. Only wires A and C are carrying current. What is the direction of the force on wire D?

ii. Only wires B and D are carrying current. What is the direction of the force on wire D?

iii. Only wire B is carrying current. What is the direction of the force felt by an electron at point E traveling in the A direction (on the compass)?

iv. Only wires B and D are carrying current. What is the direction of the force felt by an electron at point E traveling in the C direction (on the compass)?
3. (10 points) In the picture shown at the right is shown the women’s march held in Washington DC last Sunday. Estimate the number of people visible in the picture. 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.
4. (10 points) In our tutorial working with mirrors, two students, Ethelred and Guinivere, answered the question, “Where does the image [in the mirror] appear to be located?” by saying “On the mirror.” Do you agree with them or not? If you disagree, where would you say the image is and how would you justify your answer to them? If you agree, propose different plausible position for the image in the mirror and explain why you prefer Ethelred and Guinivere’s answer.
5. **(30 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 (right side up and on top of the box).

(a) Where do you have to place the box in order to have the image 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? (10 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)