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.”

** *** Good Luck *** **
1. (25 points) Consider two long parallel current carrying wires shown in cross section in the figure in the box below. They each might either carry a fixed amount of current I or no current at all. For each of the three cases described below, indicate in which direction you would measure a magnetic field at the point marked with an X using the compass rose at the right. If none of the directions work, put N.

1.1 Wire A is carrying a current in direction J
Wire B is carrying no current.

1.2 Wire A is carrying a current in direction J
Wire B is carrying a current in direction J.

1.3 Wire A is carrying a current in direction J
Wire B is carrying a current in direction K.

Red blood cells often carry an electrical charge. If it carries, say, a positive charge, it will attract negative ions (e.g., Cl^- or OH^- in the blood) to itself. Consider two models of what happens.

- In the first case, in a capillary, the capillary is narrow — only about the width of a blood cell. As a result, the negative ions “get stuck” along the walls. The blood cells will move with the blood, but the negative ions (enough to keep the overall blood neutral) stick along the walls and are mostly stationary.

- In the second case, in an artery, there is plenty of room for the negative ions. In this case, they travel along with the red cells at the same speed.

Assume that the electric and magnetic effects being asked about are only due to the charges described. Assume also that we are far enough away that we can treat the system as uniform and smooth. When comparing the two cases, assume we are comparing a bundle of capillaries, all with the blood moving in the same direction, so the total amount of flow of red cells/second is the same in the two cases.

In the statements below, select which of the statements are correct and write them in the box to the right of the questions. If more than one are correct, put them all. If none are correct, put N.

1.4 If you measure the magnetic field just outside and above the two cases, you would find
a) No magnetic field in either case.
b) A magnetic field in case 1 only.
c) A magnetic field in case 2 only.
d) Magnetic fields in both cases.

1.5 If you measure the electric field just outside and above the two cases, you would find
a) No electric field in either case.
b) An electric field in case 1 only.
c) An electric field in case 2 only.
d) Electric fields in both cases.
2. (25 points)
A. The two top view diagrams shown were drawn by a student who is studying image formation by a plane mirror. Each diagram shows the location of an object and two lines of sight to the image of that object in the mirror. For each diagram, determine whether or not the situation illustrated is possible. If a situation is possible, draw the location and orientation of the mirror. Explain briefly how you reached your conclusions. (15 pts)

![Diagram 1](image1)
![Diagram 2](image2)

Possible ____ Not Possible ______  Possible ____ Not Possible ______

Explanation:

B. In the figure at the right is shown an arrangement of three small light bulbs, a cardboard mask with a v-shaped hole in it, and a reflecting screen. The three bulbs form a triangle and lie in a plane parallel to the planes of the mask and screen.

In the box below, sketch what the pattern of light on the screen would look like. (10 pts)

![Sketch](image3)

If you need more space, continue on the back and check here.
3. (10 points) It’s spring and the cherry trees are in bloom in Washington, DC! Estimate the number of blossoms on a typical blooming cherry tree. (For the tree shown in the picture, an individual blossom is about 2 inches across.) 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 building the ray model of light, we started with a number of common sense ideas, followed their implications, and came up with some surprises — all of which turned out to work as the model predicted. Pick one result that surprised you, describe it, and sketch briefly how it followed from carefully working out the implication of some common sense foothold ideas. (If you weren’t surprised by anything, pick something that might surprise your English major roommate.)
5. (30 points) A magnifying glass is a converging lens used so that the object observed is closer to the lens than the focal point. An example is shown in the figure below.

e) On the figure, draw a ray diagram that will help you identify where the image is located. (10 pts)
f) Is the image real or virtual? Explain why you say so. (5 pts)

c) The focal length is a distance of 16 cm from the lens, the object is a distance of 8 cm from the lens, and the object is 8 cm high. Calculate the location and the size of the image using the lens equation. Does your calculation agree with your drawing? If not, explain why not. (15 pts)