↖ your staple goes up there,
alongside the original one

Full name (neatly printed) _____

General Physics 122 – Exam 3 – May 10, 2019

Time started _____ Time ended _____

Place taken _____

PLEASE READ ALL THE INSTRUCTIONS THROUGH FIRST!!!!

- To receive full credit for a problem, your work must convincingly demonstrate that you understand the physics involved behind the problem. That means not only providing the correct answer but showing how you obtained your answer.
- Questions represent a mix of conceptual and quantitative issues. Questions are scored according the rubric on the next page
- You may not consult the textbook, your notes, or any source of information other than the equations below.
- You may choose any continuous, uninterrupted 3-hour period in which to take this exam, and the times you record to document compliance are covered by the BSC Honor Code.
- You may use a calculator provided it is not programmed with course-specific information.
- It is important that your answers be neat and clear. Legible handwriting and clear exposition are required, not optional
- Include raw algebraic equations and identify variables. Include units (m, s, m/s, etc.) in calculations and carry them through.
- Box your final answers to help me locate and identify them quickly
- Use only one side of each page of paper.
- Use your own, lined paper. Nothing written on this exam will be graded.
- Do not use paper ripped from a spiral-bound notebook with jagged edges.
- **Do not write your name on any of the pages other than this cover sheet.**
- Start each answer on a new sheet of paper.
- When finished, place this entire exam atop your responses arranged in sequential order, straighten all the edges neatly, and staple them together before handing them in.
- You must turn in the exam to Dr. Pontius unless other arrangements have been made.
- **I reserve the right to assign additional penalties for violating these instructions.**

Honor code:

Don't Panic!

Reminder: Show all your work. Explain thoroughly and justify everything.

Grading rubric:

Level of demonstrated understanding	Example	Score
Complete	Correct, fully justified reasoning and answer	10
	Correct reasoning; minor computational mistakes or omissions; reasonable answer	9
Partial	Some physics errors or a correct setup but no or incomplete execution; substantial omissions	7
	Major physics errors or partial justification provided even if answer is correct; major omissions	5
Little to none	Little of relevance or no justification provided even if answer is correct	3
	Very little of relevance; moderately interesting B. S.	1
	Blank or just a restatement of the question	0

Data that may or may not be of value to you:

$e = 1.60 \times 10^{-19}$ C

$R_E = 6370$ km

$k_e = 8.99 \times 10^9$ N·m^2/C^2

$G = 6.673 \times 10^{11}$ N·m^2/kg^2

$\mu_o = 4\pi \times 10^{-7}$ T· m/A

$\varepsilon_o = 8.85 \times 10^{-12}$ C^2/N·m^2

$\mu T = 10^{-6}$ T

$nT = 10^{-9}$ T

$m_p = 1.67 \times 10^{-27}$ kg

$m_e = 9.11 \times 10^{-31}$ kg

1 amu $= 1.67 \times 10^{-27}$ kg

$n_{glass} = 1.50$ $n_{water} = 1.333$

1. When diving deep in the water or scuba diving, one must be very careful when returning to the surface to avoid rising up into another swimmer or a boat. Hence, it is important to look upward and look about for hazards. When you do this, you will notice some interesting optical effects. For simplicity, assume that the surface of the water is perfectly flat, that the sky is perfectly blue, and that there are no pesky islands or boats around anywhere between you and the horizon. Also, to avoid additional optical complications, assume you do not have on a mask but assume your eyes can still focus the incoming rays as needed.

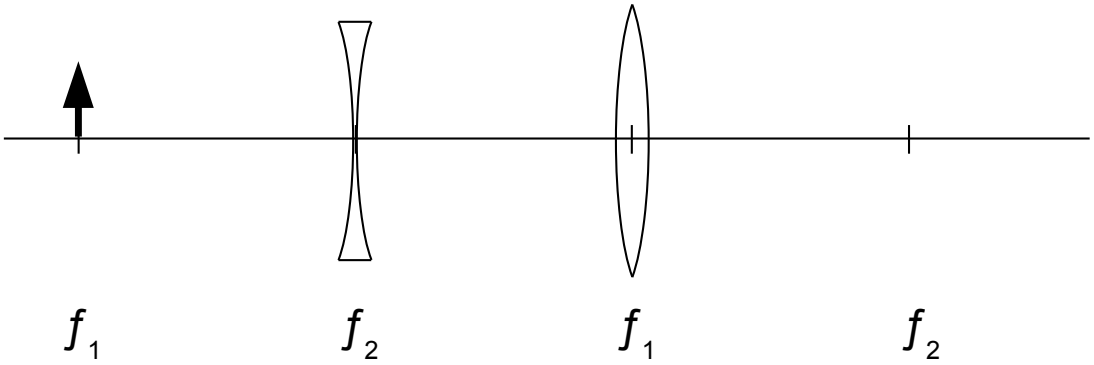
a. Consider a large brown pelican that happens to be flying directly above you. Compare his altitude above the water to where you perceive his image to be. Explain how the light rays behave to produce this perception and include a sketch as illustration.

b. Around the pelican, you see the blue sky. However, the blue you see is limited to a circular disk centered directly above you, no matter how you turn your head. Explain what produces this disk, and relate its apparent size on the surface to your depth. Hint: consider the light rays that reach your eye and trace them backwards to their source.

2. Okay, a traditional question. An object 2 cm high is placed 1.0 m to the left of a **diverging** lens. One meter to the right of that lens is another lens, which is **converging**. The magnitude of the focal length for each individual lens is1.0 m. Yes, these suckers are all on top of one another, which is what this question needed to make it moderately interesting.

    a. Find the final image algebraically and specify its location, size, and other characteristics. As you go, interpret the signs of the various quantities.

    b. Draw ray diagram(s) showing all three principal rays for both lenses. Explain the rationale for each ray you draw

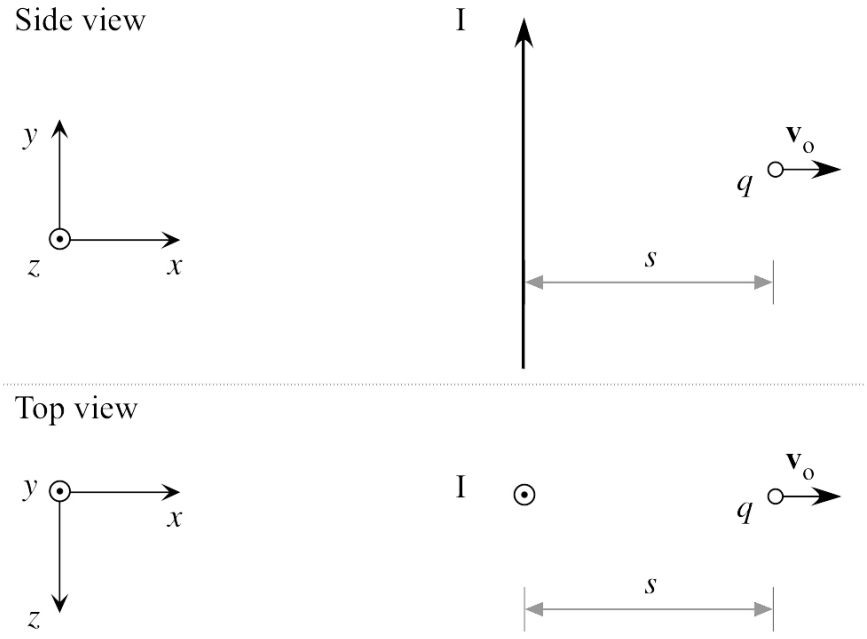


3. Positrons are antimatter particles with the same mass and magnitude of charge as an electron, except that their electrical sign is positive. At some instant designated $t = 0$, a particular positron is moving in the x direction at initial speed $v_o = 8.34 \times 10^6$ m/s at a distance $s = 0.42$ m away from an infinitely long line current of magnitude $I = 253$ A in the y direction, as illustrated below. (Do not try this yourself at home.) Answer the following and explain your reasoning throughout, showing all intermediate calculations.

a. Determine the magnitude and direction of the force acting on the positron at $t = 0$.

b. Find its speed at time $t = 41.999 \times 10^{-9}$ s.

c. *Qualitatively* describe the path the particle follows and provide a plausible sketch. Be specific about which planes you're describing.

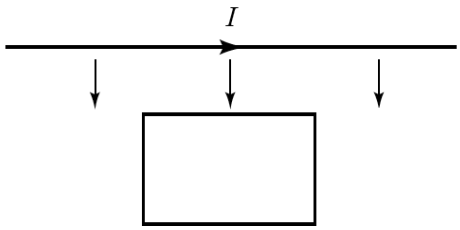


4. Holding onto Naomi for dear life while riding behind her on her Vespa scooter at some high speed (she's a speed demon), I distract myself from fear of imminent death by studying the rear view mirrors on either side, both of which say "Objects are closer than they appear." Discuss the type of mirror used and fully characterize the images seen in them relative to the object that produces them, such as that of the Hummer right behind us. Demonstrate your claims **with both diagrams and equations**. Then address the question, why do the mirrors say what they do, which is actually equivalent to "Images appear farther away than the actual object"?

5. A very long straight wire carries current to the right, as shown below. The loop is gradually moved toward the bottom of the page toward a stationary rectangular wire loop. To emphasize "stationary" means it doesn't move. It does not imply anything about paper, envelopes, writing implements, general office supplies, or the postal service*.

a. Explain very carefully what happens in the rectangular loop and why. Be specific about all directions involved. In, out, up, down, left, right are all useful words for you.

b. Repeat if the wire is now moved away from the loop.

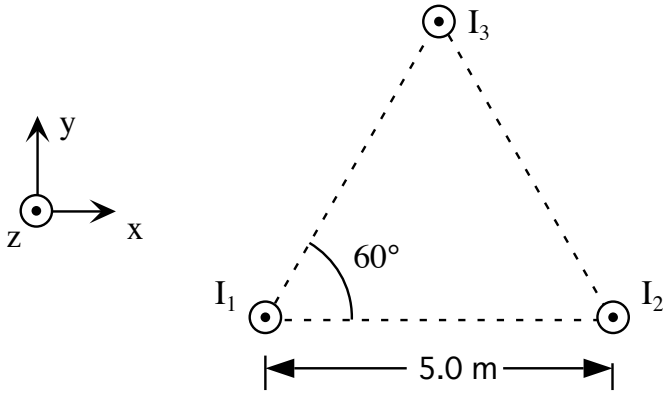


*That's "stationery", and originally the term stationery referred to all products sold by a stationer, whose name indicated that his book shop was on a fixed spot, usually near a university, and permanent, while medieval trading was mainly carried on by itinerant peddlers (including chapmen, who sold books) and others (such as farmers and craftsmen) at markets and fairs.

6. A trio of infinitely long, parallel line currents is arranged on the corners of an equilateral triangle, as shown below. The lower wires each carry the same current $I_1 = I_2 = 4$ A, while $I_3 = 2$ A, all directed out of the page, and the edge length is 5 m. Explain your work as you go.

a. Find the magnetic field at the position of the top wire (magnitude and direction!)

b. Find the force per length on the top wire (ditto!)



Extra credit opportunity (the three words most favored by students, even above "I love you"!):

Repeat the last question if $I_1 = 3$ A and $I_2 = 7$ A. Your answer should be precise.