↖ staple goes up there, near the corner Name (printed) _____

General Physics 122 - Exam 1 – March 10, 2017

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.
- 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.**

Signing the honor code also affirms that you are taking the exam during a time period that does not conflict with any other academic obligations.

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

$$\vec{F}_{12} = k_e \frac{Q_1 Q_2}{r^2} \hat{\mathbf{r}} \qquad k_e = \frac{1}{4\pi\varepsilon_o} \qquad \vec{F}_E = q\vec{E} \qquad E = \frac{\sigma}{\varepsilon_o}$$

$$\vec{E} = \sum_i k_e \frac{Q_i}{r_i^2} \hat{\mathbf{r}} \qquad \Delta V = I R \qquad Q = C \Delta V \qquad R = \rho \frac{L}{A}$$

$$\Delta V = -\int \vec{E} \cdot d\vec{s} \qquad \Delta V = k_e Q \left[\frac{1}{r_A} - \frac{1}{r_B} \right] \qquad U = 1/2\, Q \Delta V \qquad C = \kappa C_o$$

$$I = \frac{dQ}{dt} \qquad \Delta V = E \Delta x \qquad \Delta U = q\Delta V \qquad P = I \Delta V$$

$$V_\infty = \sum_i k_e \frac{Q_i}{r_i} \qquad R = \sum_i R_i \qquad \frac{1}{R} = \sum_i \frac{1}{R_i} \qquad \Delta V = I R$$

$$C = \sum_i C_i \qquad \frac{1}{C} = \sum_i \frac{1}{C_i} \qquad C = \frac{1}{2k_e \ln(b/a)} \qquad C = \frac{\varepsilon_o A}{d}$$

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

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

$k_e = 8.99 \times 10^9$ N·m^2/C^2

$\mu_o = 4\pi \times 10^{-7}$ T·m/A

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

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

$R_E = 6370$ km

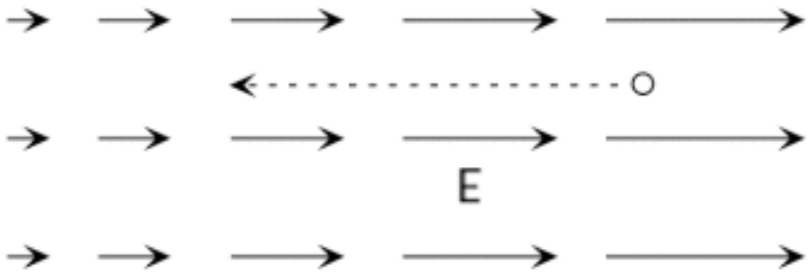
$G = 6.673 \times 10^{11}$ N·m^2/kg^2

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

$nT = 10^{-9}$ T

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

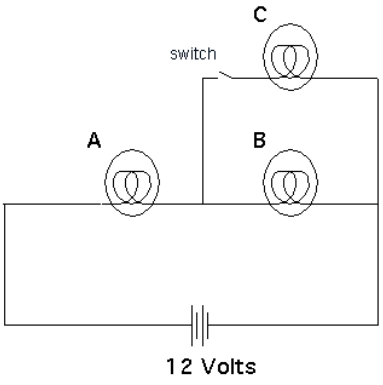
1. In the region shown below, the electric field points directly rightward and increases in strength toward the right. Discuss how the electric potential varies for a test charge that moves leftward along the dashed path shown and how that variation changes. Does your answer depend on the sign of the test charge? Explain why or why not thoroughly.



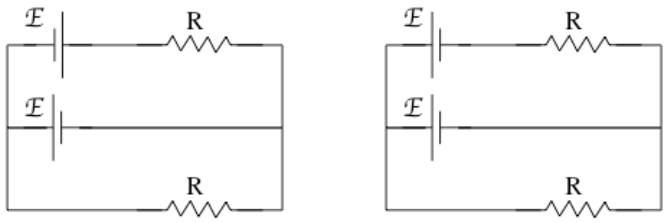
2. A pair of identical charges are situated along the x axis at positions $x = \pm 0.75$ m. Each has a positive charge $q = 0.32$ μC.
   i. At the origin $x = 0$, $y = 0$, find the electric field and the electric potential relative to infinity.
   ii. At position $x = 0$, $y = 0.50$ m, find the electric field and the electric potential relative to infinity.
   iii. Finally, calculate the work done by the total electric field when a third particle also of charge $q = 0.32$ μC is moved from the position in (b) to the position in (a) and give a clear physical interpretation of the sign.
   iv. Now answer those same questions if the charge at $x = -0.75$ is given a negative sign.

   Explain your reasoning throughout and give physical interpretations of your results, including the implications of their signs.

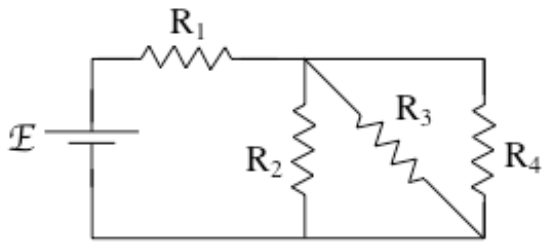
3. The illustrated circuit consists of two identical light bulbs A and B and a single 12 V battery. A third identical bulb C is added as shown by closing the indicated switch. Thoroughly explain how and why the brightness of bulbs A and B compare to each other at first, then explain how and why they change.



4. Two ideal batteries with identical emf's $\mathcal{E}$ = 12 V are connected with two resistors of identical resistance R = 3 Ω, initially as show in the left frame below. Calculate the potential drop, current, and power dissipated in each resistor. Then both resistors and the top battery are reversed as shown in the right frame. Repeat your calculations, and explain your logic.



5. Four resistors and a battery of negligible internal resistance are assembled to make the circuit in the figure below. The resistor values are R_1 = 3.50 Ω, R_2 = 8.00 Ω, R_3 = 2.20 Ω, and R_4 = 4.80 Ω. The current through R_3 is 0.968 A. Find the EMF of the battery, showing all your work clearly, as always, and explain your reasoning.



6. Consider a parallel-plate capacitor, as shown in the figure below, that is originally attached to a battery (not shown) at the terminals (small circles). The capacitor is originally charged while its plates are separated only by air, but during the experiment a dielectric material is inserted between the plates. Consider what happens when the dielectric is inserted under each of the following conditions.
   i. The charged capacitor remains attached to the battery while the dielectric is inserted
   ii. The charged capacitor is detached from the battery before the dielectric is inserted
   For both situations, explain whether the follow quantity increases, decreases, or remains the same: capacitance, charge, potential drop, and energy. Explain the logic underlying those conclusions.