Time allowed: 1 hr. 15 min.

Print Name _____

ID Number _____

Your lecture section time _____

Physics 241E, Test No. 1
September 28, 1999

First do the problems you find easiest, then do the harder ones. It is best to do them first on scratch paper and then to copy the solutions on to the test paper. Show your complete solution, including diagrams, reasoning, and algebra. Scratch out anything you do not want the grader to consider. Undeleted, incorrect jottings will lower your grade; so will answers without an indication of where you got them. Your grade for each problem will be based on the grader's impression of your understanding of the problem, as well as on the correct answer. You may use one half of an 8.5" x 11" sheet of paper on which you have written anything you want. No other notes or books are allowed during the exam.

Numerical answers must include units and must be written with the correct number of significant figures.

Write out the authorized form of the pledge here and sign it.

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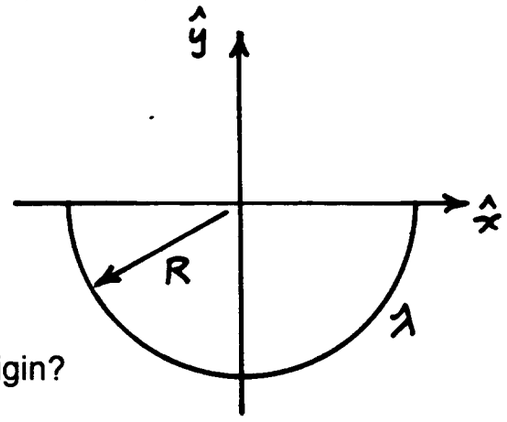
Signed _____

1) A thin wire on which there is a linear charge density λ describes a semicircle of radius R centered on the origin and lying in the lower half of the x-y plane as shown.



a) [15] What is the electric field at the origin?

b) [10] A point charge is placed in the upper half of the x-y plane at a distance R from the origin such that the field at the origin is now zero. What are the magnitude and sign of the point charge and where is it located?

2) The National Board of Fire Underwriters has fixed safe current-carrying capacities for various sizes and types of wires. For 10-gauge (diameter = 0.10 in), rubber coated copper ($\rho = 1.72 \times 10^{-8}\ \Omega\cdot m$) wire the maximum safe current is 25 A. At this current find

a) [5] the current density,

b) [5] the resistance of 1000 ft of this wire,

c) [5] the voltage difference across 1000 ft of wire,

d) [5] the rate at which thermal energy will be developed in this wire,

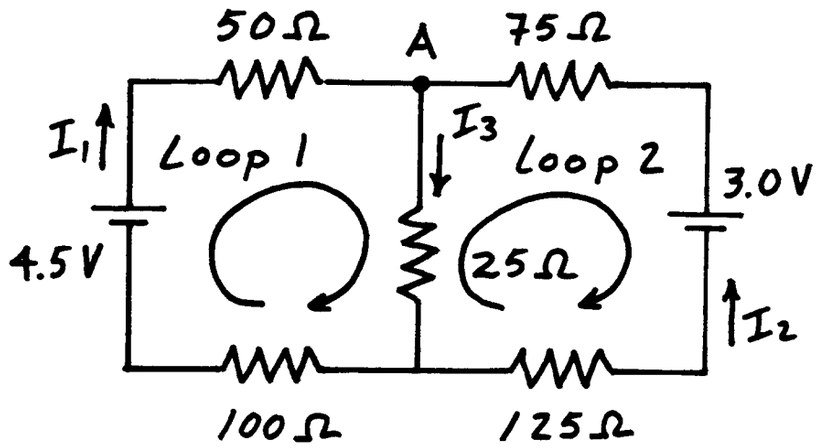
e) [5] the time required for 2 kW·hr of energy to be dissipated.

3) Two identical small metal spheres (treat as points) initially carrying charges of $q_1<0$ and $q_2>0$ experience an attractive force of 2.0 N when 1.0 meter apart. They are brought together so that the charges get equalized ($q_1'=q_2'$) and when separated again to 1.0 meter experience a repulsive force of 2.0 N.

a) [15] What were the original charges q_1 and q_2 on the two metal spheres?

b) [10] You are now required to place a third charge q_3 precisely at the midpoint between the two spheres. What is the sign and the magnitude of q_3 such that neither of the spheres experiences any force?

4) Consider the circuit shown:



a) [10] Give equations expressing Kirchoff's loop rules around *loop 1* and *loop 2.*

b) [5] Give an equation expressing Kirchoff's junction rule at *point A.*

c) [10] Find a numerical value for I_3.