PHYSICS 208 Final Exam

Spring, 2013

Do not fill out the information below until instructed to do so!

Name:_____
Signature:_____
E-mail:_____
Section Number: _____

- No calculators are allowed in the test.
- Be sure to put a box around your final answers and clearly indicate your work to your grader.
- **All work must be shown to get credit for the answer marked. If the answer marked does not obviously follow from the shown work, even if the answer is correct, you will not get credit for the answer.**
- Clearly erase any unwanted marks. No credit will be given if we can't figure out which answer you are choosing, or which answer you want us to consider.
- Partial credit can be given only if your work is clearly explained and labeled. Partial credit will be given if you explain which law you use for solving the problem.

Put your initials here after reading the above instructions:

For grader use only:
Problem 1 (5) _____
Problem 2 (24) _____
Problem 3 (12) _____
Problem 4 (24)_____
Problem 5 (20) _____
Problem 6 (20)_____

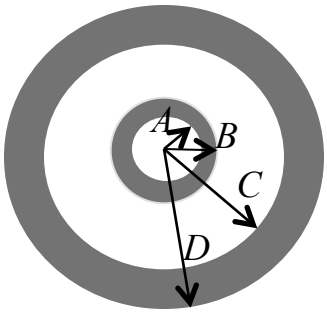
Total (105) _____

Problem 1: (5 points)

Write Maxwell's equations in the integral form.

Problem 2: (24 points)

a) A conducting spherical shell has inner radius A and outer radius B. It is concentric with another conducting spherical shell of inner radius C and outer radius D. The inner shell has charge +Q and the outer shell has charge -2Q.



Find the electric field at

i) $r < A$

ii) $A < r < B$

iii) $B < r < C$

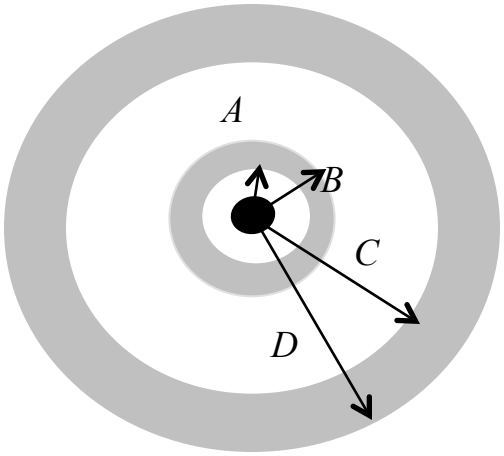
iv) $C < r < D$

v) $r > D$

b) Sketch the electric field lines.

c) Find the difference in electric potential between $r = A$ and $r = \infty$: $V(\infty)$-V(A).

d) A conducting spherical shell has inner radius A and outer radius B. It is concentric with another conducting spherical shell of inner radius C and outer radius D. The inner shell has charge +Q and the outer shell has charge -2Q. A positive charge +2Q is placed at the center of the inner shell. Find the charge density σ at



i) $r = A$

ii) $r = B$

iii) $r = C$

iv) $r = D$

e) A solid non-conducting sphere of radius R has charge spread throughout the volume so that the charge density is

$$\rho(r) = \rho_0 \frac{r}{R}$$

where ρ_0 is a known constant, r is a distance from the sphere's center.
Find the electric field everywhere.

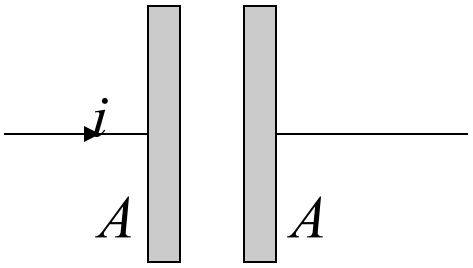
$r < R$

$r > R$

Sketch the magnitude of electric field as a function of r.

Problem 3: (12 points)

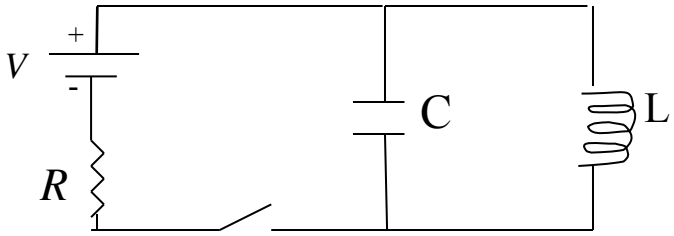
Consider two parallel plates of area A in some circuit:



The electric field between the plates is a function of time $E = E_0 \cos \omega t$. Find the current i in the wire and show that it is equal to the displacement current between the plates.

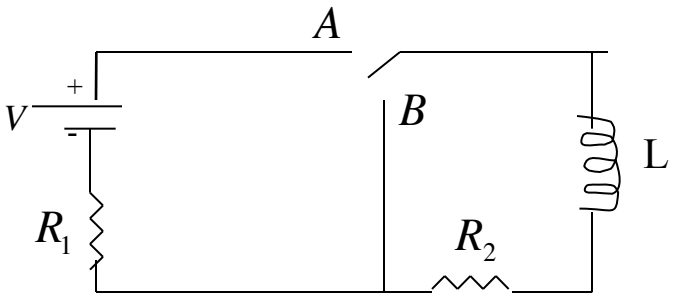
Problem 4: (24 points)

a) In the circuit below the switch has been closed for a long time so it may be assumed that the steady state has been reached. Find the current through the resistor and the charges on the capacitor plates.



b) At t=0 the switch is opened. Find the charge on the capacitor as a function of time. (Assume that L includes self-inductance).

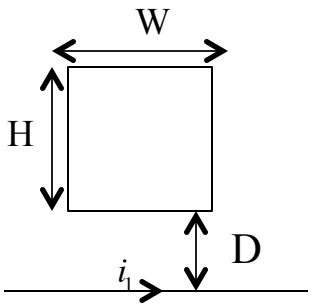
c) In the circuit below the switch has been in the position A for a long time. Find the current through the resistor R_2.



d) At t=0 the switch is moved to the position B. Find the current through R_2, as a function of time. (Assume that L includes self-inductance).

Problem 5: (20 points)

A rectangular loop lies in the plane of the page. It has dimensions shown in the figure below. There is a long straight wire distance D from the loop with current $i_1(t) = i_0 e^{-\beta t}$ where i_0 and β are known constants. The wire from which the loop is made has resistivity ρ and cross sectional area a.



a) Find the direction of current in the loop.

Explain your answer within this box:

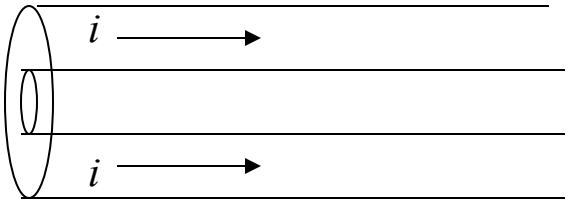
b) Calculate the current in the loop as a function of time. Ignore self-inductance.

c) Derive the equation describing the current in the loop if self-inductance of the loop is L. Do not solve it.

d) Bonus (3 points) Calculate the total energy dissipated in the loop from $t = 0$ to $t = \infty$. Ignore self-inductance.

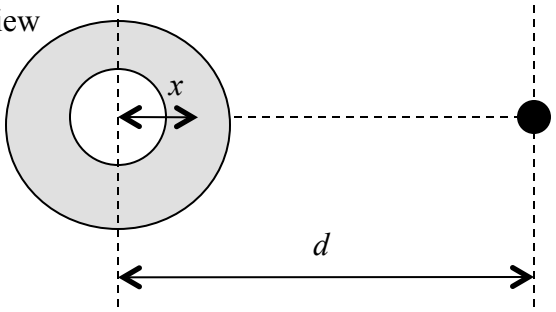
Problem 6: (20 points)

An infinitely long, hollow cylindrical wire has inner radius A and outer radius B. A current i is uniformly distributed over its cross-section. a) Find the magnetic field everywhere (r<A; A<r<B; r>B)



b) In addition to the hollow wire described above, there is a thin infinitely long wire positioned at a distance d from the center of the hollow wire. Both wires have currents i pointed into the page. Find the net magnetic field at an arbitrary point $A < x < B$ on the line connecting the centers of the wires.

Side view



c) There is a particle of positive charge q moving with velocity of magnitude v vertically up at the point located at the point $x = d/2$ in the middle of the line connecting the centers of the wires ($d/2 > B$) . Find the force acting on the particle at this point.