PHYSICS 208 Final Exam

Spring, 2009

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 (20) ___________
Problem 3 (15) ___________
Problem 4 (20)___________
Problem 5 (15) ___________
Problem 6 (15)___________
Problem 7 (15)___________

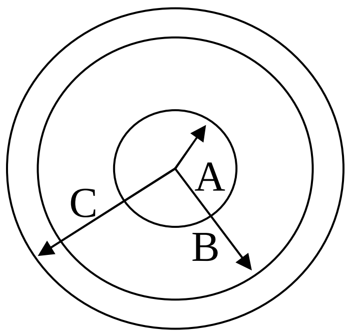
Total (105) ___________

Problem 1: (5 points)

Write Maxwell's equations in the integral form.

Problem 2: (20 points)

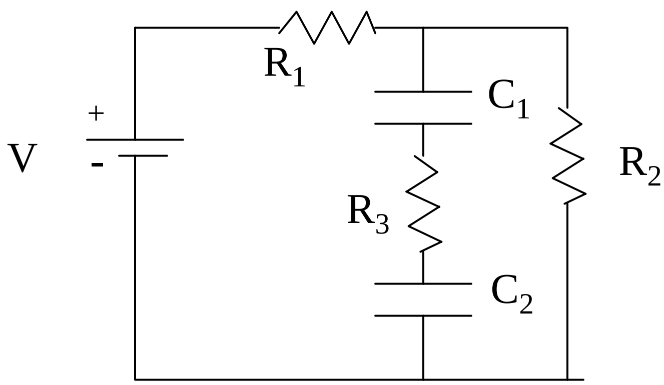
A solid sphere of radius A has a net charge Q uniformly spread throughout. It is surrounded by a conducting spherical shell with inner radius B and outer radius C.
a) Find the difference in the electric potential between a point at the center of the sphere and infinity.



b) If, instead, the sphere of radius A has a non-uniform, but spherically symmetric, distribution of charge with charge density $\rho(r) = \rho_0 \frac{r^2}{A^2}$, find the electric field everywhere (r<A, A<r<B, B<r<C, r>C).

Problem 3: (15 points)

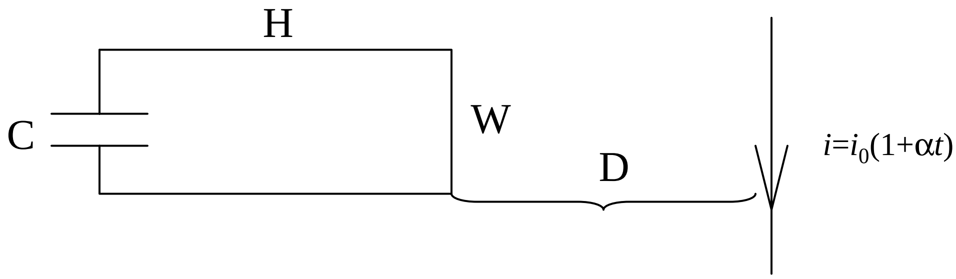
The circuit below was put together a long time ago so that the steady state has been reached.



Find all currents in the circuit and the charges on the capacitors.

Problem 4: (20 points)

There is an infinitely long wire with time-dependent current $i=i_0(1+\alpha t)$ where i_0 and α are known constants. It is placed near a circuit with a capacitor of capacitance C. The resistance of the wires in the circuit is R, the self-inductance is L. The dimensions of the loop are given (see the Figure).



a) What is the equation that would have to be solved to find the charge on the capacitor? DO NOT SOLVE IT

b) Find the charge on the capacitor as a function of time, ignoring the self-inductance of the loop and assuming that at t=0 the capacitor was uncharged.

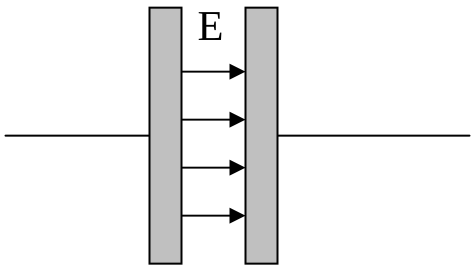
Problem 5: (15 points)

a) Which of the following equations is the wave equation?

$$\frac{\partial E_y}{\partial x} = C\frac{\partial E_y}{\partial y} \qquad \frac{\partial^2 E_y}{\partial x^2} = \mu_0\varepsilon_0\frac{\partial^2 E_y}{\partial t^2} \qquad \frac{\partial E_y}{\partial x} = -\frac{\partial B_z}{\partial t}$$

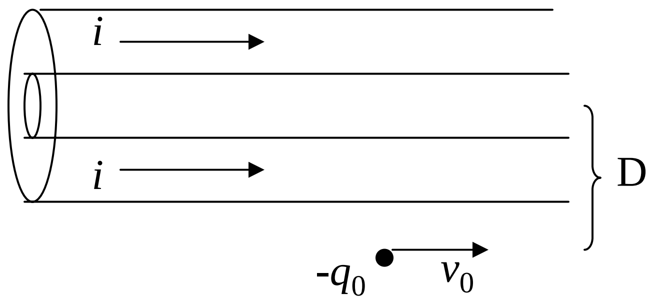
b) Find the relationship between α and β for $E_y = A\sin(\alpha x - \beta t)$ to be a solution of the wave equation.

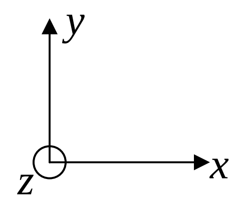
c) Find the displacement current if the electric field between parallel plate capacitor is $E=E_0\sin(\omega t+\gamma)$. The area of the plates is A.



Problem 6: (15 points)

A very long, hollow cylindrical wire, inner radius A and outer radius B, carries a constant current i, uniformly spread over its cross section.





a) Find the magnetic field everywhere (r<A; A<r<B; r>B)

b) A **<u>negatively</u>** charged particle, charge $-q_0$, is moving at the distance D from the center of the wire parallel to the axis of the wire with a constant velocity v_0. What constant electric field would have to be applied for the particle to experience no net force? Ignore gravity.

Problem 7: (15 points)

In the circuit below the switch has been **closed** for a long time. If at *t*=0 the switch is opened, find the charge on the capacitor plates as a function of time. (All self-inductance is included in L).