

# PHYSICS 208 Final Exam

Spring, 2014

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

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

E-mail: \_\_\_\_\_

Section Number: \_\_\_\_\_

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- 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 (21) \_\_\_\_\_

Problem 4 (22) \_\_\_\_\_

Problem 5 (21) \_\_\_\_\_

Problem 6 (12) \_\_\_\_\_

Total (105) \_\_\_\_\_

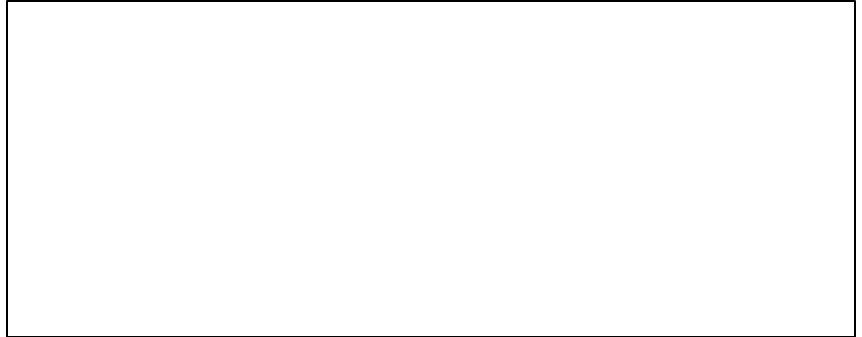
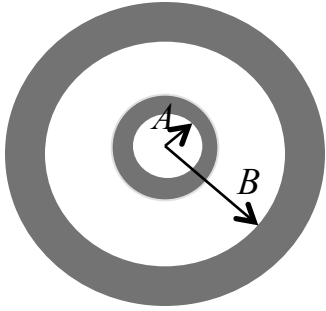
**Problem 1: (5 points)**

Write Maxwell's equations in the integral form.

## Problem 2: (24 points)

a) A conducting spherical shell has inner radius  $A$  and thickness  $T$ . There is a larger concentric spherical conducting shell with inner radius  $B$  and thickness  $T$ . The inner shell is given a charge  $-Q$ .

a) Find the charge per unit area on all surfaces.



b) Find the electric field at

i)  $r < A$

ii)  $A < r < A+T$

iii)  $A+T < r < B$

iv)  $B < r < B+T$

v)  $r > B+T$

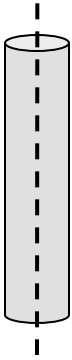
c) Sketch the electric field lines.

d) Find the difference in electric potential between  $r = A$  and  $r = B$ :  $V(B) - V(A)$ .

Result:  $V(B) - V(A) =$

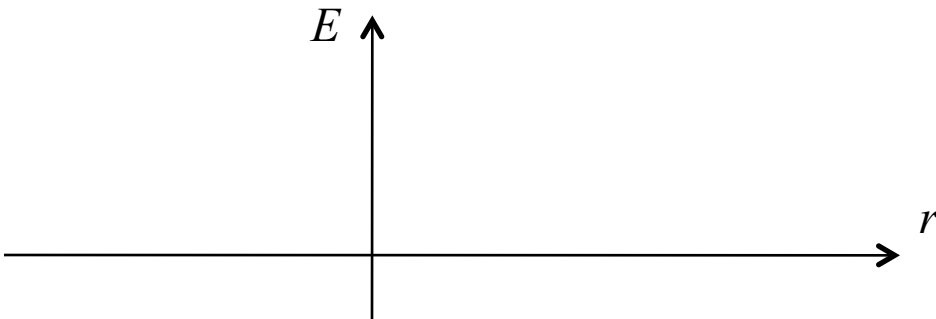
e) A very, very long insulating cylinder of radius  $A$  and length  $L$  has a charge  $Q$  uniformly spread throughout its volume. Consider only points very far from the ends so that the cylinder can be assumed to be infinitely long.

- i) Find the electric field as a function of  $r$ , the distance from the axis of the cylinder, for all values of  $r$ .



Result:

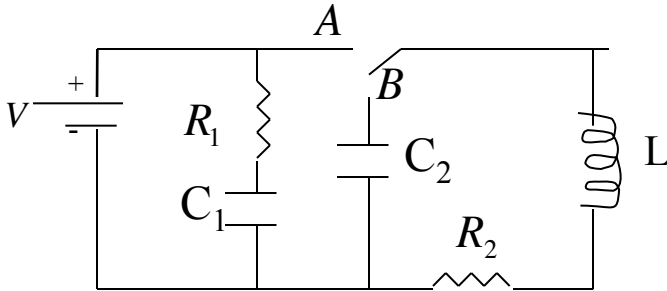
- ii) Sketch the magnitude of electric field as a function of  $r$ .



### Problem 3: (21 points)

In the circuit below the switch has been in the position A for a long time.

a) Find the current through the resistor  $R_2$ .



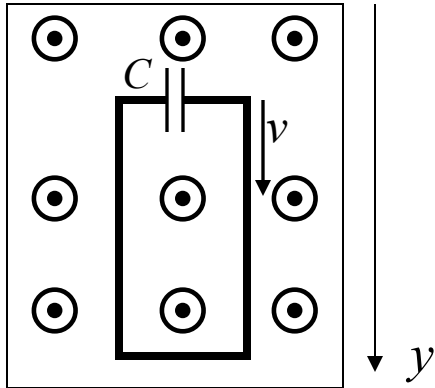
b) At  $t=0$  the switch is moved to the position B. Starting from some famous law, derive the equation that can be solved to find the charges on the capacitor  $C_2$  and current through  $R_2$ , as a function of time.

c) Replace  $C_2$  by a perfectly conducting wire. Find the current through  $R_2$ , as a function of time.

d) Plot the current as a function of time schematically.

### Problem 4: (22 points)

A vertically oriented loop with capacitance  $C$ , resistance  $R$ , length  $l$  and width  $w$ , falls from a region where the magnetic field of a given magnitude  $B$  is horizontal, uniform, and pointing out of the page as shown in the Figure. At  $t = 0$  the capacitor was uncharged. Ignore self-inductance. Note that the positive  $y$  direction is down.



a) Find the charges on the capacitor plates and current in the loop as a function of the velocity  $v$  if the loop is falling down but is completely within the region having magnetic field  $B$ .

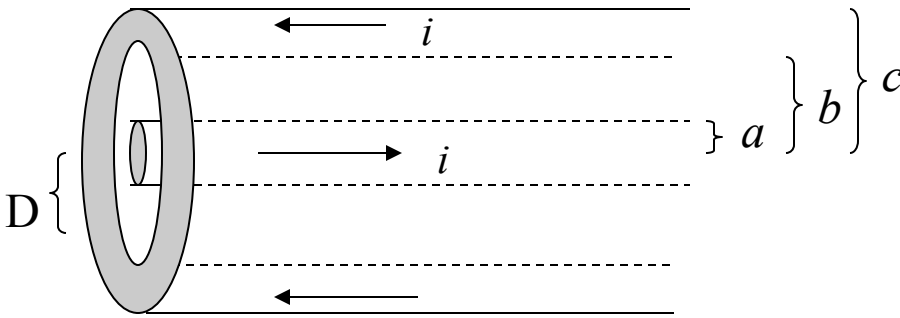
b) Once the lower segment leaves the region with magnetic field, find the direction of the current in the loop. Explain your answer within this box:

c) Find the equation that can be solved to find the charge on the capacitor as a function of the velocity of the loop  $v$  once the lower segment leaves the region with magnetic field.

d) Solve for the charge  $Q$  and current in the loop.

### Problem 5: (21 points)

a) Coaxial cable: Consider an infinitely long cylindrical conductor carrying a current  $i$  spread uniformly over its cross section and a cylindrical conducting shell around it with a current  $i$  flowing in the opposite direction. It is uniformly spread over the cross section of the shell.

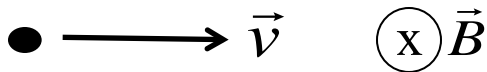


Find the magnetic field at

i)  $r < a$

ii)  $r > c$

b) Velocity selector: A proton moves with constant velocity  $v$  to the right through a region where there is a uniform magnetic field of magnitude  $B$  that points into the page. There is also an electric field in this region.



i) What is the direction of the electric field ?

ii) What is the magnitude of the electric field ?

c) How would your answer in part b) change if there were an electron instead of a proton?

i) What is the direction of the electric field ?

ii) What is the magnitude of the electric field ?



### Problem 6: (12 points)

A spherical capacitor is connected to a generator. The voltage between the capacitor's plates is changing according to  $V(t) = V_0 \cos \omega t$ . Find the displacement current through a sphere of an arbitrary radius  $r$ ,  $A < r < B$ ; radii  $A$  and  $B$  are given.

