PHYSICS 208 Final Exam

Spring, 2017

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 (15) ____________
Problem 3 (20) ____________
Problem 4 (18)____________
Problem 5 (20) ____________
Problem 6 (20)____________
Problem 7 (7)____________

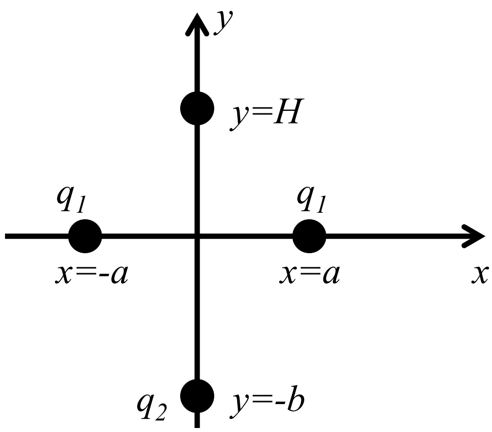
Total (105) ____________

Problem 1: (5 points)

Write Maxwell’s equations in the integral form.

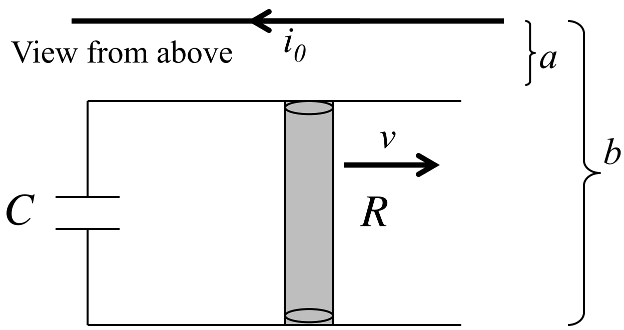
Problem 2: (15 points)

Three charges are placed as shown. The distances a and b are known. The charges q_1 on the x axis are known and positive. The charge q_2 at $y = -b$ is unknown.   What must be the unknown charge q_2 if the electric field is to be zero at x=0, y=H? Here H is known and positive.



Problem 3: (20 points)

A rod with resistance R slides without friction on two resistance-free tracks which are connected by a capacitor, C. A wire, carrying a constant current i_0, is parallel to the tracks, in the same plane.



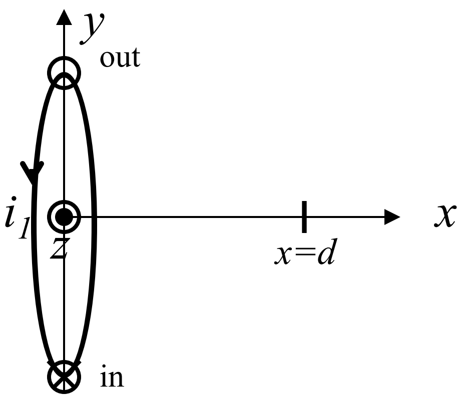
a) Find the direction of the current in the loop. Explain your answer within this box:

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

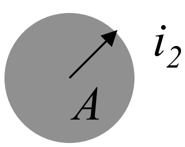
c) Plot the charge as a function of time schematically.

Problem 4: (18 points)

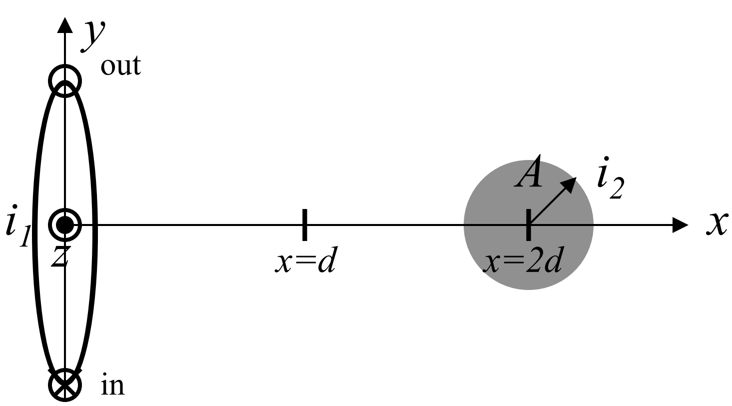
a) A loop with current i_1 has radius R. Find the magnetic field created by this current at $x=d$ (see the figure below).



b) An infinitely long wire of radius A has current i_2 out of the page. Find the magnetic field everywhere: at r<A and r>A.

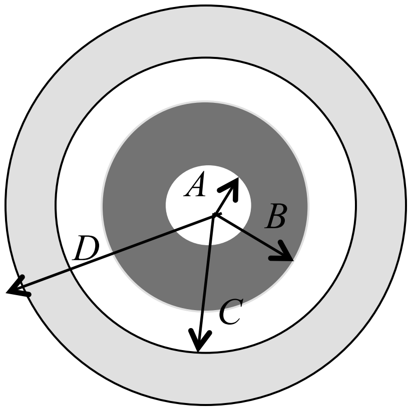


c) A **negatively** charged particle, $-q_0$ is at point $x = d$ with a velocity $\vec{v} = v_0\vec{i}_z$, where v_0 is a constant. Find the force acting on the particle at $x = d$.



Problem 5: (20 points)

A spherical conducting shell, inner radius A and outer radius B, is charged with charge $-Q_0$. It is surrounded by a conducting spherical shell of inner radius C and outer radius D, which is charged with charge $+2Q_0$.



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

b) Find the electric field at

i) $r < A$

ii) $A < r < B$

iii) $B < r < C$

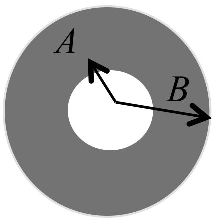
iv) $C < r < D$

v) $r > D$

c) Sketch the electric field lines.

d) Find the difference in electric potential between $r = 0$ and $r = \infty$, $V(\infty)-V(0)$.

d) A nonconducting spherical shell, inner radius A and outer radius B, has a nonuniform volume charge density $\rho = cr$ where c is a known positive constant.



a) Find the electric field at

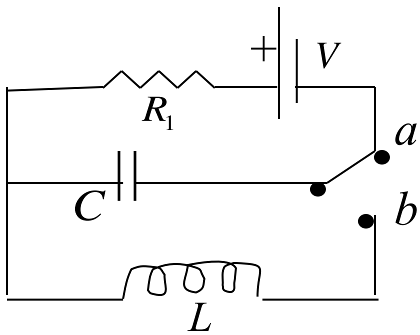
1) $r < A$

2) $A < r < B$

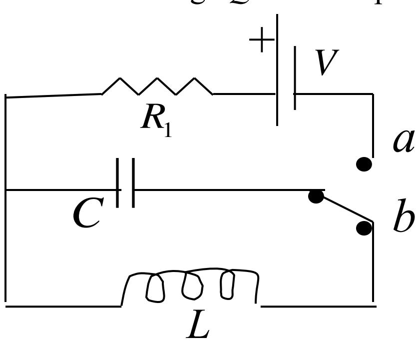
3) $r > B$

Problem 6: (20 points)

a) In a circuit below, R, C, L, and V are given. The switch is kept at position a for a long time. Find the current and the charge on the capacitor. *The problem will not be graded without a direction of current and charges on the capacitor indicated on the circuit.*



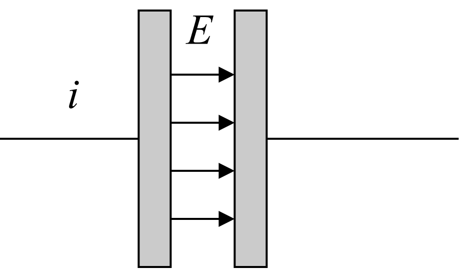
b) The switch is then thrown to position b. Starting from some famous law, derive the equation that describes charge Q on the capacitor as a function of time.



b) Solve for the charge on the capacitor as a function of time.

Problem 7: (7 points)

a) Find the displacement current and the current i in the wire if the electric field between the parallel plates of the capacitor is $E=E_0\sin(\omega t)$. The area of the plates is A.



$$i = \frac{dQ}{dt}$$

$$R = \frac{V}{i}$$

$$R = \rho \frac{l}{A}$$

$$\vec{E} = \rho \vec{j}$$

$$i = \int_S \vec{j} \cdot d\vec{S}$$

$$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$$

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{i(d\vec{s} \times \vec{r})}{r^3}$$

$$d\vec{F} = i d\vec{s} \times \vec{B}$$

$$\Phi_B = \int \vec{B} \cdot d\vec{S}$$

$$\Phi_B = \pm L i$$

$$C = \frac{Q}{\Delta V}$$

$$\left|\vec{F}_E\right| = \frac{1}{4\pi\varepsilon_0} \frac{|q_1 q_2|}{x^2}$$

$$\frac{d \ln U}{dt} = \frac{1}{U} \frac{dU}{dt}$$

$$V(\vec{r}_2) - V(\vec{r}_1) = -\int_{\vec{r}_1}^{\vec{r}_2} \vec{E} \cdot d\vec{r}$$