PHYSICS 208 Final Exam

Spring, 2016

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 (18)____________
Problem 5 (20) ____________
Problem 6 (20)____________
Problem 7 (7)____________

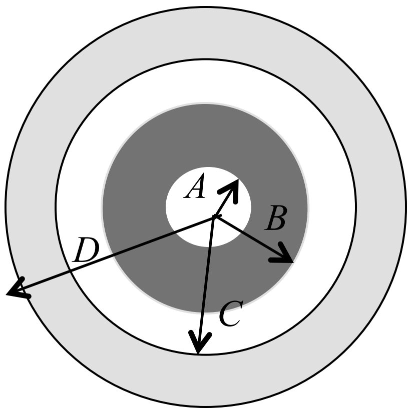
Total (105) ____________

Problem 1: (5 points)

Write Maxwell's equations in the integral form.

Problem 2: (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 surfaces.

b) Find the electric field at

i) $r < A$

ii) $A < r < B$

iii) $B < r < C$

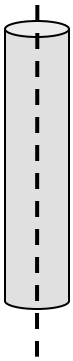
iv) $C < r < D$

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 long, nonconducting, solid cylinder of radius R has a nonuniform volume charge density $\rho = cr^2$.



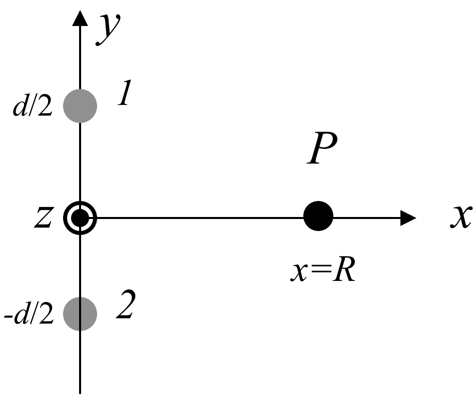
a) Find the electric field at

1) $r < R$

2) $r > R$

Problem 3: (15 points)

a) Two very long parallel wires are separated by distance d (see the figure below). Current in wire 1 has magnitude i and is out of the page. Current in wire 2 has the same magnitude i and is into the page. In unit-vector notation, what is the net magnetic field at point P at distance R due to the two currents?

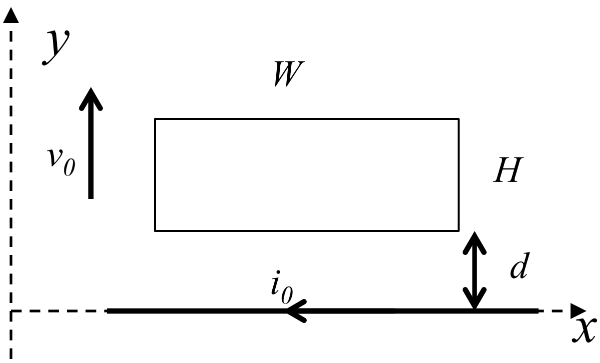


b) A negatively charged particle is injected at point P with a velocity $\vec{v} = v_0\vec{i}_y$, where v_0 is a constant. What constant electric field (magnitude and direction) would have to be applied for the particle to experience no net force? Ignore gravity.

c) A positively charged particle is injected at point P with a velocity $\vec{v} = v_0\vec{i}_y$, where v_0 is a constant. What constant electric field (magnitude and direction) would have to be applied for the particle to experience no net force? Ignore gravity.

Problem 4: (18 points)

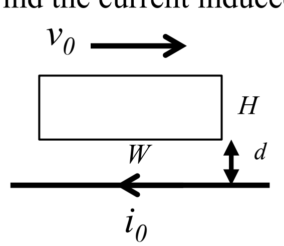
At $t = 0$ a rectangular loop of wire with length W, width H, and resistance R is located at distance d from an infinitely long wire carrying current i_0 . The loop is moved away from the wire at constant speed v_0.



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

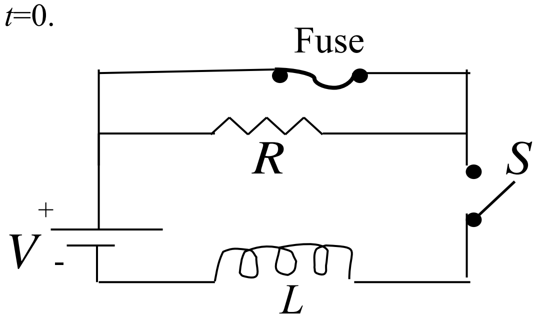
b) Find the current induced in the loop as a function of time. Ignore self-inductance.

b) Find the current induced in the loop if the loop is moving along the wire. Ignore self-inductance.



Problem 5: (20 points)

In the circuit below the fuse has zero resistance as long as the current through it remains less than i_0. If the current reaches i_0, the fuse "blows" and thereafter has infinite resistance. Switch S is closed at t=0.



a) Find the current as a function of time.

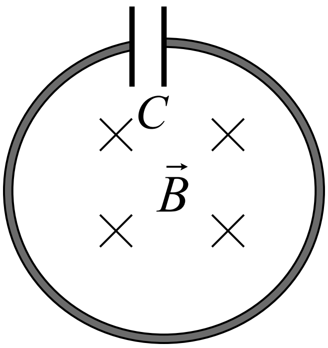
b) Find time t_1 when the fuse blows.

c) Redefine the moment of time when the fuse blows as t=0. The current in the circuit at t=0 is i_0. Find the current in the circuit as a function of time.

Problem 6: (20 points)

A single loop of wire with an area A is placed in the time varying magnetic field directed into the page. The magnitude of the magnetic field is given by $B=B_0+\alpha t,$ where B_0 and α are constants and t is time. The loop has a capacitor, capacitance C that was initially uncharged. **It also has resistance *R*.**

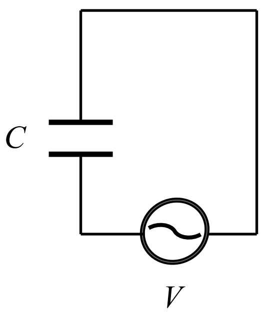
a) Starting from some famous law, derived the equation that could be solved to find the charges on the capacitor as a function of time if **the self-inductance of the loop is *L***. Do not solve it. Please note that the problem will not be graded without a direction of current and charges on the capacitor indicated on the circuit.



b) **Ignore the self-inductance**. Find the charge on the capacitor as a function of time.

Problem 7: (7 points)

A capacitor is connected to a battery with $V = V_m \sin \omega t$, V_m and ω are given constants. The maximum value of the displacement current is I_d. Ignore the resistance and self-inductance of the circuit.



a) What is the maximum value of the current i in the circuit?

b) Find the displacement current between the plates, i_d as a function of time if the distance between the plates is d and the area of the plates is A.

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

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

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

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

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

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

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

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

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

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

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

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

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