FINAL EXAM

Physics 9C-03

NAME:

March 23, 1999

Social Sec. #:

General Instructions: This examination is closed book. Only a calculator and one 8.5x11 sheet of notes are allowed. Please show all your work and box your answers. Credit will only be given for *complete* solutions. Answers must have correct units. There are 13 problems on 6 pages. Note that not all the problems are worth the same number of points.

- [20 points] 1. A point charge $Q_1 = +4\mu C$ is located at x=4,y=0. Another point charge $Q_2 = -10\mu C$ is located at x=0,y=6.
 - a. Find the electric field at x = 0, y = -3.
 - b. Find the potential at x = 0, y = -3.

[10 points] 2. If there is a vacuum between the plates of a parallel plate capacitor, the electric field is $E = 4\pi k\sigma$, where $\sigma = Q/A$ is the charge density on the plates. What happens to E when you stick some nonconducting material, like glass or oil between the plates? Why?

[30 points] 3. A thick, nonconducting	spherical	shell has	inner	radius a	a and	outer	radius b	and	uniform
charge density ρ .									

- a. State Gauss' law and show how it can be used to get the electric field for r < a, a < r < b, and r > b, where r is the distance to the center of the shell.
- b. Compute the potential V(r) for all r. Assume V=0 when $r=\infty$.

[5 points] 4. About how fast are the electric and magnetic fields oscillating in visible light?

once per hour.

once per sec.

 10^5 times per sec. 10^{15} times per sec.

[5 points] 5. About how long is the wavelength of visible light?

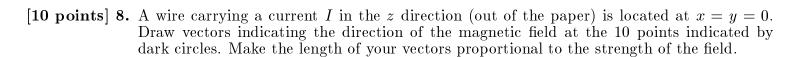
100 meters

1 meter

 10^{-2} meters

 10^{-7} meters.

[25 points] 6.	Find the current in the 10 Volt battery in the circuit shown. Find the potentials at the points \mathbf{b} , \mathbf{c} , and \mathbf{d} given that the potential at \mathbf{a} is $V_{\mathbf{a}} = 0$.
[15 points] 7.	In a certain region of space the electric field E is in the positive x direction and the magnetic field is in the positive z direction.
	a. In what direction is the electric force on a positive charge moving with zero velocity?
	b. In what direction is the magnetic force on a positive charge moving with zero velocity?
	c. In what direction is the electric force on a positive charge moving with velocity v in the positive y direction?
	d. In what direction is the magnetic force on a positive charge moving with velocity v in the positive y direction?
	e. In what direction is the electric force on a positive charge moving with velocity v in the positive z direction?
	f. In what direction is the magnetic force on a positive charge moving with velocity v in the positive z direction?



[20 points] 9. At a certain instant of time a particle with charge $q=50~\mu C$ is located at x=3,y=0 meters. Its velocity at that time is $\vec{v}=50~m/s~\hat{j}$. Find the magnetic field \vec{B} at (a) x=0,y=0; (b) x=3,y=10 meters; and (c) x=0,y=3 meters.

Hint: The formula for the field due to a point charge q moving with velocity \vec{v} is $\vec{B} = (\mu_0 \ q \ \vec{v} \times \hat{r})/(4\pi r^2)$, where $\mu_0 = 4\pi \times 10^{-7} \ T \ m/A$.

- [20 points] 10. A wire of radius 2.0 cm carries a current of 40 Amperes that is uniformly distributed over its cross sectional area.
 - a. State Ampere's law and show how it can be used to find the magnetic field B at a distance 1.0 cm from the center of the wire.
 - b. Do the same to obtain B at a distance 4.0 cm from the center of the wire.

[10 points] 11.

- a. An initially uncharged capacitor is in a circuit with a battery, as shown in the figure at the left. The switch S is closed suddenly at time t=4 seconds. Sketch the charge on the capacitor as a function of time. Indicate the final charge on the capacitor on the graph, and about how long it takes for the capacitor to charge up.
- b. An inductor is in a circuit with a battery, as shown in the figure at the right. The switch S is closed suddenly at time t=-2 seconds. Sketch the current in the circuit as a function of time. Indicate the final current on the graph, and about how long it takes for the current to ramp up.

15	points	12.	For	the	circuit	shown.	find	the	currents	I_1 .	I_2 .	. and	I_2
	O CITTO			OIL	CIICAIO	O110 11 11		ULLU	CGIICI	- 1 1	- / •	, corre	

- a. immediately after the switch is closed. (The capacitor is initially uncharged).
- b. a long time after the switch is closed.
- c. immediately after the switch is opened again.
- d. a long time after the switch is opened again.

In each case, state your reasoning.

- [15 points] 13. A loop of wire of area 0.6 m^2 lies in the xy plane, as shown. It has resistance 10 Ohms. The magnetic field depends on time and is given by $\vec{B}(t) = [0.4 0.1t^2](\hat{x} + 2\hat{y} + 3\hat{z})$ Tesla.
 - a. State Faraday's law and compute the magnitude of the current. $\,$
 - b. Explain how Lenz's law determines the direction of the current.