Physics 208

Exam III

April 23, 2009

Family Name: ______________________________

First Name: ______________________________

Student ID Number: ______________________________

Your Section Number: ______________________________

USEFUL INFORMATION

$$\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r}, \qquad d\vec{B} = \frac{\mu_0 i}{4\pi}\frac{d\vec{s}\times\vec{r}}{r^3}$$

$$\frac{d\vec{r}}{dt} = \frac{dx}{dt}\vec{i}_x + \frac{dy}{dt}\vec{i}_y = \frac{dr}{dt}\vec{i}_r + r\frac{d\theta}{dt}\vec{i}_\theta$$

$$\oint \vec{E}\cdot d\vec{r} = -\frac{d}{dt}\Phi_B = -\frac{d}{dt}\int \vec{B}\cdot d\vec{S}$$

$$C = \frac{Q}{V}, \qquad R = \rho\frac{\ell}{A}. \qquad \text{For parallel plates } C = \frac{\epsilon_0 A}{d}$$

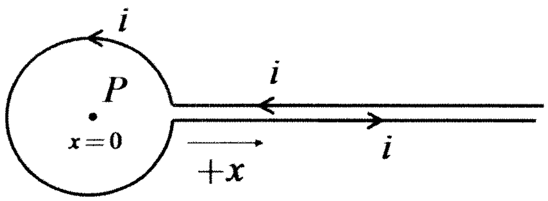
$$\int \vec{B}\cdot d\vec{S} = \pm Li, \qquad \oint \vec{B}\cdot d\vec{r} = \mu_0 i_{\text{enclosed}}$$

$$\vec{F} = q\left(\vec{v}\times\vec{B} + \vec{E}\right), \qquad d\vec{F} = i\left(d\vec{s}\times\vec{B}\right)$$

DO NOT WASTE TIME ON ARITHMETIC OR COMPLICATED INTEGRALS.

Prob. 1	Prob. 2	Prob. 3	Prob. 4	Total

[1] (25 points) An infinitely long, extremely thin wire carries a current i. It has the shape shown below, consisting of two straight, parallel segments, which are very close together, extending from $x = 0$ to infinity, and a circular section of radius R.



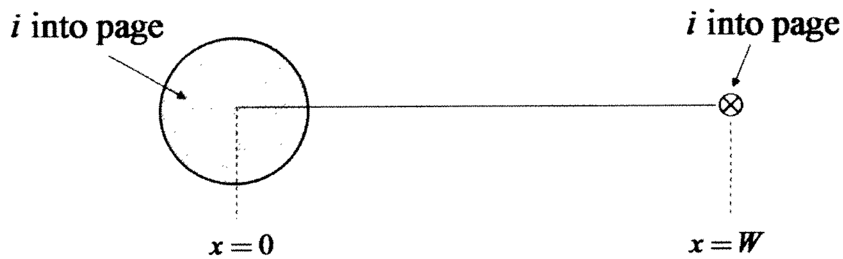
[Figure for (a) and (b)]

(a) Find the contribution to the magnetic field due to the circular part of the wire, at the point P, which is the center of the circle.

(b) Find the contribution to the magnetic field at P due to the rest of the wire.

(c) A particle with mass m, and charge q, is moving in the positive x direction with velocity of magnitude v_0. Ignoring gravity, if there were an electric field in the positive y direction with magnitude E_0, find a magnetic field that could be added so that the particle's velocity would be unchanged.

[2] (25 points) A very long wire has a current i which is uniformly spread over its cross section. It has a radius H. A second very long, thin wire is placed a distance W from the first wire. It also has a current i in the same direction.



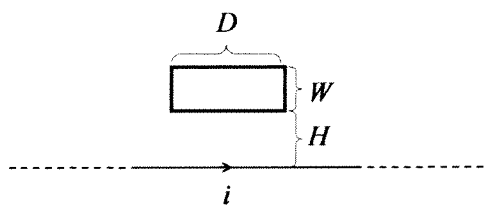
(a) Find the magnetic field made by the first wire everywhere.

(b) Find ***all*** of the points where the total magnetic field be zero.

[3] (25 points) The loop of wire shown below is made of wire with resistivity ρ and cross sectional area a. The self inductance of the loop is known to be L. A nearby very, very long wire carries a current which varies with time according to

$$i = i_0 (1 - \gamma t),$$

where γ is a known constant and t is the time.



(a) Find the flux of $\vec{B}$ through the loop due to the long wire.

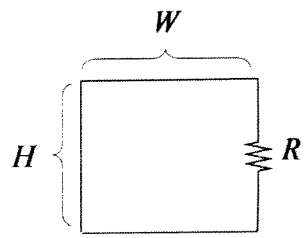
(b) Starting with some law, find the equation that ***could*** be solved for the current that flows in the loop.

(c) Solve for the current ***ignoring*** the self inductance of the loop.

[4] (25 points) The loop of wire shown below contains a resistor R. The self inductance of the loop is known to be L. A uniform, external magnetic field is created that is perpendicular to the loop, ***pointing into the page***. The magnitude of the magnetic field varies with time according to

$$B = B_0 (1 - \gamma t),$$

where B_0 and γ are known constants and t is the time.



(a) Find the flux of $\vec{B}$ through the loop due to the external magnetic field.

(b) Starting with some law, find the differential equation that ***could*** be solved for the current that flows in the loop.

(c) Solve for the current that flows in the loop as a function of time, given that at $t = 0$ the current in the loop is zero.