Question:	1	2	3	4	5	6	7	8	Total
Points:	30	20	15	30	15	30	30	20	190
Score:									

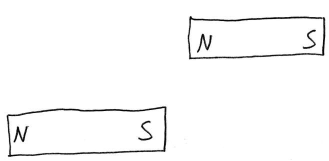
University of Rochester
PHY114 - General Physics II
Examination 2

July 27, 2008

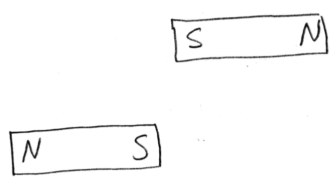
Answer the questions in the Blue Books provided. If you redo a problem, *clearly* indicate which attempt you wish graded and which ignored. We will only grade one attempt and will not search to find which is more correct.

If you cannot solve a problem because you need a previous result which you were unable to find, go ahead and describe what you would do if you had the needed result. If possible, work through the problem as far as possible using a generic form for the unknown result (e.g., just use $\vec{E}$ if you don't have the actual expression).

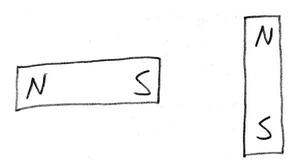
1. General Properties of Magnets
   (a) Draw the force acting on each end of each magnet shown. Indicate direction and make sure that if there is any difference in the strength of the forces, the lengths of your arrows reflect this.



(a) i



(b) ii



(c) iii

$\boxed{5}$ i. Parallel

$\boxed{5}$ ii. Anti-Parallel

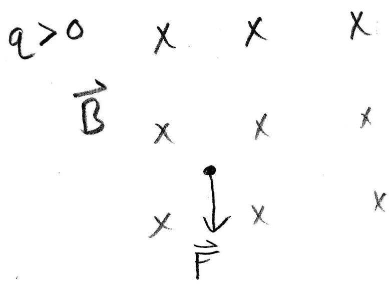
$\boxed{5}$ iii. Perpendicular

$\boxed{5}$ (b) Draw the magnetic field lines for a single bar magnet. Label the poles and include enough lines to clearly show the shape of the field.

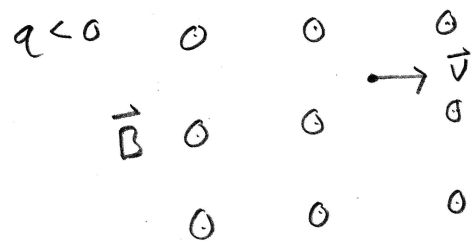
$\boxed{5}$ (c) What are the key differences between the field lines of magnets such as these, and the electric field lines we found in electrostatics? What are the key similarities?

$\boxed{5}$ (d) Can there ever be a north magnetic pole by itself? Which part of your previous answer is affected by this?

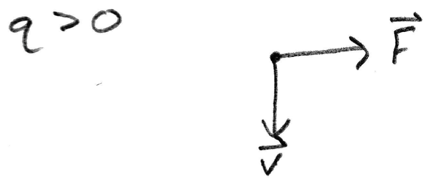
2. Right Hand Rule: You are given 2 of the 3 vectors $\vec{I}\,(\vec{v})$, $\vec{B}$, $\vec{F}$ for each charge in a field below. Identify the direction of the 3rd.



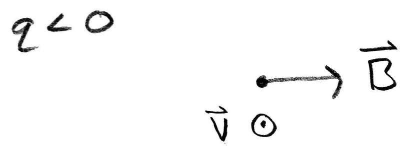
(a)



(b)



(c)



(d)

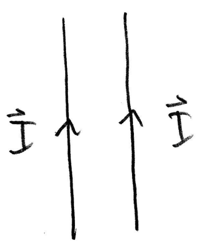
$\boxed{5}$ (a) Positive charge, find $\vec{v}$.

$\boxed{5}$ (b) Negative charge, find $\vec{F}$

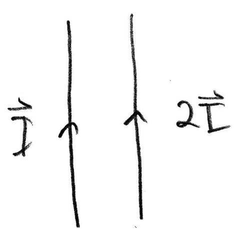
$\boxed{5}$ (c) Positive charge, find applied $\vec{B}$

$\boxed{5}$ (d) Negative charge, find $\vec{F}$

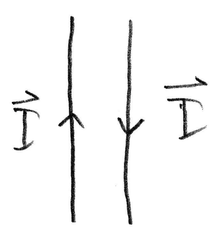
3. What are the forces between each set of wires show below?



(a)



(b)



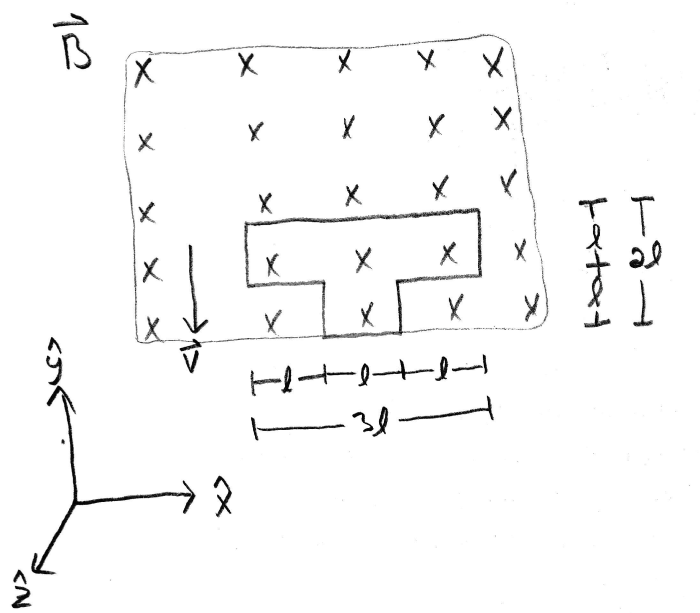
(c)

$\boxed{5}$ (a) Equal, Parallel

$\boxed{5}$ (b) Unequal, Parallel

$\boxed{5}$ (c) Equal, Antiparallel

4. Consider the wire loop in the constant, uniform magnetic field pictured. The magnetic field does not extend outside of the boundary line shown. The velocity is a constant. The position shown is for $t = 0$.



$\vec{B} = B(-\hat{z})$

$\vec{v} = v(-\hat{y})$

2 (a) What is the area of the loop? Make the area a vector by picking a direction (no correct/incorrect answer, just clearly indicate what you are defining to be positive).

3 (b) What is the magnetic flux through the loop at time $t = 0$?

5 (c) At what time is the magnetic flux through the loop 0? Call this time $t = t_2$

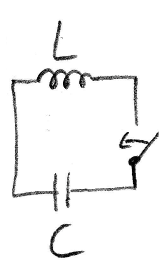
5 (d) What is the magnetic flux through the loop at time $t_1 = \frac{1}{2}t_2$?

5 (e) What is the average $\frac{d\Phi_B}{dt}$ from $t = 0$ to $t = t_2$? What is the $\mathscr{E}_{ind}$?

5 (f) What is the average $\frac{d\Phi_B}{dt}$ from $t = 0$ to $t = t_1$? What is the $\mathscr{E}_{ind}$?

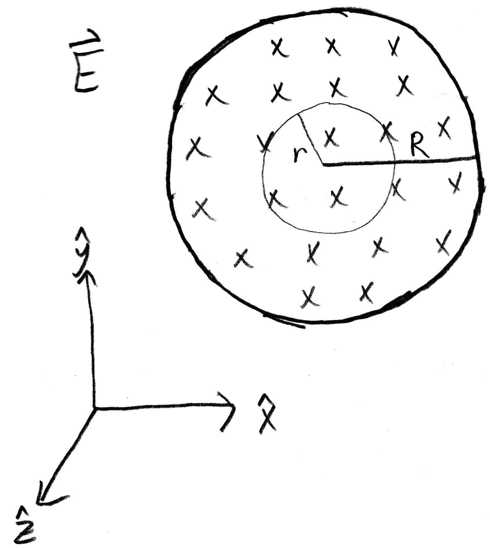
5 (g) What is the average $\frac{d\Phi_B}{dt}$ from $t = t_1$ to $t = t_2$? What is the $\mathscr{E}_{ind}$?

15 5. In the simple circuit below, the capacitor starts in a charged state with charge Q.



Plot the general behavior of the charge on the capacitor as a function of time when the switch is closed. Describe conceptually why this happens, and the role played by both the capacitor and inductor. Is the current large or small right after the switch is closed? Is it increasing or decreasing at this point? Why?

6. Consider a circular capacitor of radius R filled with a uniform electric field. The capacitor is being charged at a rate such that the electric field varies uniformly in time, $\vec{E} = E_0 t\,(-\hat{z})$.



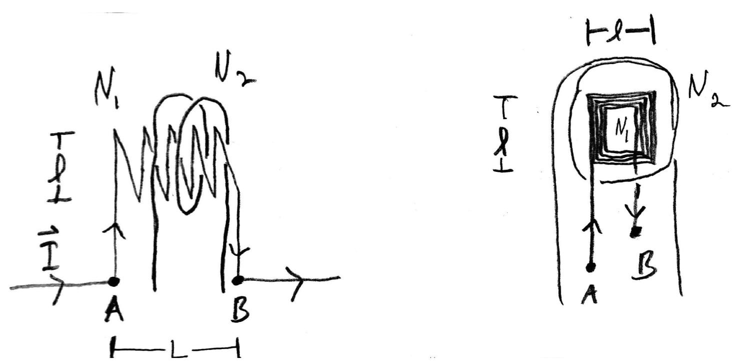
$\boxed{5}$ (a) What is the flux through a loop of radius $r < R$?

$\boxed{5}$ (b) What is the change in flux through that loop $\left(\frac{d\Phi_E}{dt}\right)$?

$\boxed{10}$ (c) What is the magnetic field inside the capacitor, as a function of r?

$\boxed{10}$ (d) Why must there be a magnetic field induced in this capacitor? Explain what the problem would be if the changing electric flux did not induce a magnetic field.

7. Consider the nested coils pictured. The inside coil is square rather than circular. You can assume that all of the flux from the inside coil passes through the outside coil. The inside coil has N_1 loops and each side of the square is ℓ. Assume the loops in both coils are wrapped tightly as in previous examples. There is a time varying current $\vec{I}$ in coil 1. Leave your results in terms of this variable.



$\boxed{5}$ (a) What is the magnetic field inside coil 1?

$\boxed{5}$ (b) What is the magnetic flux through each loop of coil 1? The total flux?

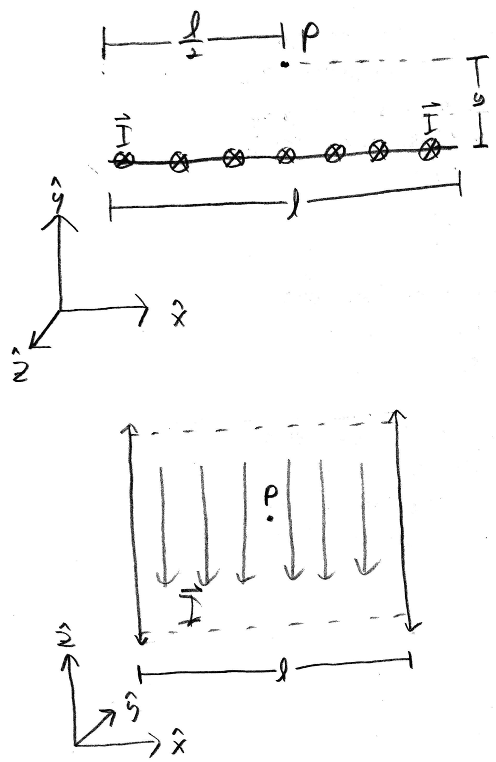
10 (c) What is the mutual inductance between the two coils?

10 (d) What is the induced $\mathscr{E}$ in coil 2?

8. *Extra Credit:* Consider the system pictured. We have a thin sheet of conductor which carries a total current $\vec{I}$ spread evenly across it. If it helps, think of this as a large number of thin wires packed together side by side. This sheet is ℓ wide. We see the system from 2 different perspectives. In the top perspective we are looking at the sheet edge on and the current is traveling into the page. In the second we are looking at the sheet from the top and the current is traveling down towards the bottom of the page. See the coordinate system drawn in each if you need to get a sense of the rotation. We see in the bottom perspective that the conducting sheet extends off to infinity up and down, allowing a continuous flow of current rather than a buildup of charge.

   In both perspectives, we have labeled a point P to be considered in the following questions. This point is located halfway between the two edges of the sheet, and a distance $y \ll \ell$ above the sheet.

   You should have no need to perform integrals for any part of this problem (tho it may be possible to interpret some of your steps as extremely simple integrals).



$y << \ell$

Total $\vec{I}$ spread over ℓ.

5 (a) What is the current per unit width flowing through the sheet?

5 (b) Why is it important that $y \ll \ell$? What assumptions can you make about the field, which you otherwise could not, if this is true?

5 (c) What is the magnetic field at point P?

5 (d) If a particle of charge $q < 0$ were placed at rest at point P, what force would it feel? What if it were moving with velocity $\vec{v} = v\hat{z}$?