Physics 208 – Exam III

Spring 2017 (all sections) **April 10$^{\text{th}}$, 2017**

Please fill out the information and read the instructions below, but **do not open the exam** until told to do so.

Rules of the exam:

1. You have 75 minutes (1.25 hrs) to complete the exam.
2. Formulae are provided to you with the exam on a separate sheet. Make sure you have one before the exam starts. You may *not* use any other formula sheet.
3. Check to see that there are 6 numbered (three double-sided) pages plus a blank page for additional work if needed, in addition to the scantron-like cover page. **Do not remove any pages.**
4. If you run out of space for a given problem, the last page has been left blank and may be used for extra space. Be sure to indicate *at the problem under consideration* that the extra space is being utilized so the graders know to look at it!
5. You will not be allowed to use calculators on this exam since all problems use symbols in their problem statements or the numbers have been chosen to make any required arithmatic calculations straight forward. If there are problems resulting in numerical answers you may leave them in fractional form.
6. **NOTE** that you **must** show your work clearly to receive full credit.
7. Cell phone use during the exam is strictly prohibited. Please turn off all ringers as calls during an exam can be quite distracting.
8. Be sure to put a box around your $\boxed{\text{final answer(s)}}$ and clearly indicate your work. Credit can be given **only** if your work is legible, clearly explained, and labelled.
9. All of the questions require you show your work and reasoning.
10. Have your TAMU ID ready when submitting your exam to the proctor.

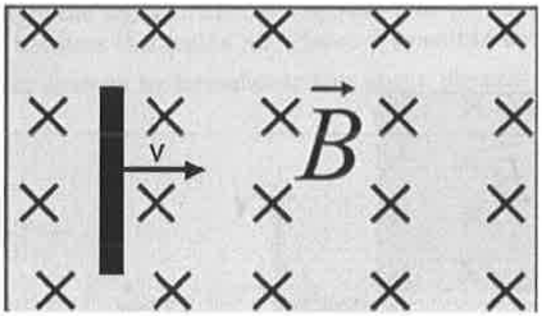
Fill out the information below and sign to indicate your understanding of the above rules

Name: ______________________ UIN: ______________________
(printed *legibly*)

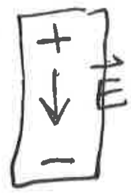
Signature: ______________________ Section Number: ______________

Instructor: (**circle one**) Holt Mioduszewski Kocharovskya Rogagchev

iii) A segment of copper wire of length, L, is moving through a uniform magnetic field with a constant velocity, v. Indicate in the figure the direction of the induced electric field that will arise in the wire due to this motion.



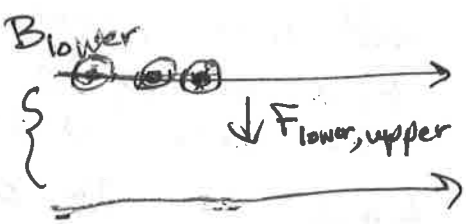
$q(\vec{v} \times \vec{B})$ is upwards creating charge separation:



electric field down

LO	S	U
61.1		

D) Two long parallel wires are located in the xy-plane separated by a distance d in the y-direction and with the current in both wires directed along the +x-direction. If the current in each wire is I, find the force per unit length (both magnitude and direction) of the lower wire (y = 0) on the upper wire (y = d) due to their magnetic fields.



$$B = \frac{\mu_0 I}{2\pi d}$$

$$F = ILB$$

$$\frac{F}{L} = IB = \frac{\mu_0 I^2}{2\pi d}$$

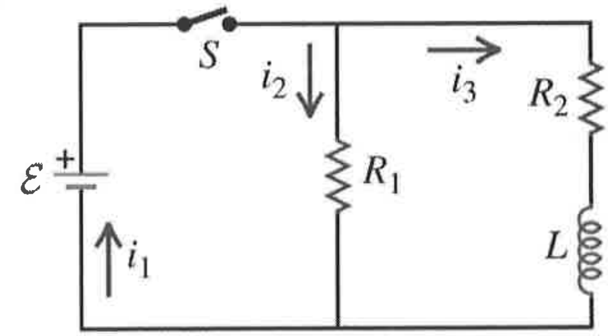
the force is attractive

force of lower on upper is down

LO	S	U
55.1		

Prob 1 An inductor with an inductance, L and negligible resistance is connected to a battery with a voltage $\mathcal{E}$, a switch, S and two resistors R_1 and R_2 as shown in the figure. Answer the following in terms of the quantities given, L, $\mathcal{E}$, R_1 and R_2.

(a) Find the currents, i_1, i_2, and i_3 **just** after closing the switch.



$i_3 = 0$

$i_1 = i_2$

$\mathcal{E} - I_2 R_1 = 0$

$I_2 = \frac{\mathcal{E}}{R_1}$

$i_1 = i_2 = \frac{\mathcal{E}}{R_1}$

(b) What are the currents, i_1, i_2, and i_3 after the switch has been closed a **long time**?

$V_L = 0$ $\qquad$ $i_1 = i_2 + i_3$

$\mathcal{E} = i_2 R_1 = i_3 R_2$

$i_2 = \frac{\mathcal{E}}{R_1}$ $\qquad$ $i_3 = \frac{\mathcal{E}}{R_2}$ $\qquad$ $i_1 = \frac{\mathcal{E}}{R_1} + \frac{\mathcal{E}}{R_2}$

(c) What is the amount of energy stored in the inductor after S has been closed a long time?

$U_L = \frac{1}{2} L I^2 = \frac{1}{2} L \frac{\mathcal{E}^2}{R_2^2}$

LO	S	U
3.1		
36.1		
38.1		
41.1		
42.1		
69.1		
3.2		
36.2		
40.1		
41.2		
42.2		
69.2		
3.3		
68.1		

Prob 2 You are given the configuration of two parallel wires forming a circle of radius R centered at the origin, as shown in the figure below. The current in the top wire is I_1 and flows from left to right and the current in the bottom wire is I_2 and flows in the same direction. Answer the following in terms of, I_1, I_2, R and other known constants.

(a) Find the magnetic field at the point P **due to the top wire alone**(magnitude and direction).

from formula sheet OR $dB = \frac{\mu_0 I d\vec{l} \times \hat{r}}{4\pi r^2}$

$B = \frac{\mu_0 I_1}{2R}$ for full loop

$= \frac{\mu_0 I_1 R d\theta}{4\pi R^2}$

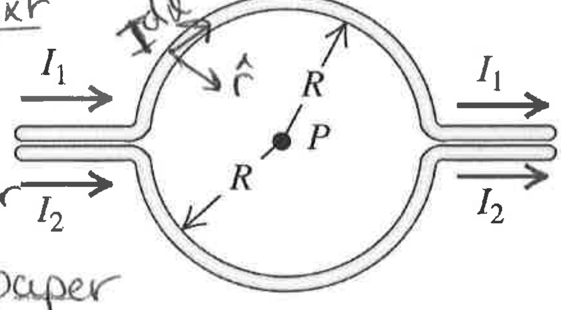
$\Rightarrow B = \frac{\mu_0 I_1}{4R}$ into paper

$\theta: 0 \to \pi$

into paper

from top loop

$\vec{B} = \frac{\mu_0 I_1}{4R}$ into paper



(b) Calculate the magnetic field due to **both** wires at point P (magnitude and direction).

$\vec{B}_2 = \frac{\mu_0 I_2}{4R}$ out of paper

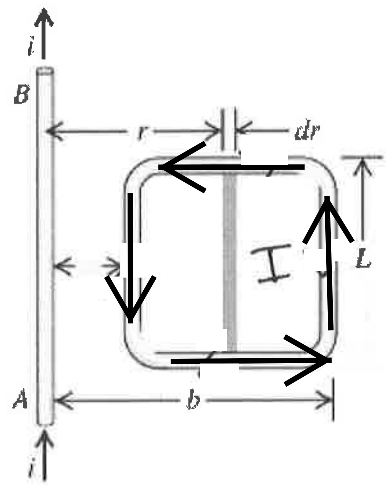
$\Rightarrow \vec{B}_{total} = \frac{\mu_0}{4R}(I_1 - I_2)$ into the paper

(c) We now change the direction of the current in the lower wire to be from right to left and set $I_1 = I_2$. Find the total magnetic field at point P under these new conditions (magnitude and direction).

$B_{total} = \frac{\mu_0 (2I_1)}{4R} = \frac{\mu_0 I}{2R}$ into the paper

LO	S	U
2.2		
3.4		
6.1		
54.1		
2.3		
6.2		
54.2		
2.4		
6.3		
54.3		

Prob 3 A long straight wire carries a current that depends on time. The current as a function of time has the following form, $I(t) = I_o + \alpha t^2$, where α is a positive constant. Located a distance away from this wire is a square loop of wire of side length L as shown in the figure.



(a) What is the flux, $d\Phi_B$, of the magnetic field due to the long wire through the shaded region of width dr located at a distance of r from the wire?

$$d\Phi_B = \vec{B} \cdot d\vec{A} = \frac{\mu_0 I}{2\pi r}(L\,dr)$$

(b) Find the induced emf produced in this loop due to the changing current in the long wire and indicate on the figure the direction that this current will flow.

$$\mathcal{E} = \frac{d\Phi_B}{dt}$$

$$\Phi_B = \int_a^b \frac{\mu_0 I}{2\pi r} L\,dr = \frac{\mu_0 I L}{2\pi} \ln\left(\frac{b}{a}\right)$$

flux into screen, decreasing

$$\mathcal{E} = \frac{d}{dt}\left[\frac{\mu_0 I L}{2\pi} \ln\left(\frac{b}{a}\right)\right], \quad I = I_0 + \alpha t^2$$

$$= \frac{\mu_0 L}{2\pi} \ln\frac{b}{a} \frac{dI}{dt} = \frac{\mu_0 L}{2\pi} \ln\left(\frac{b}{a}\right)(2\alpha t)$$

counterclockwise

LO	S	U
3.5		
49.3		
56.2		
57.2		
6.4		
6.5		
59.3		
60.3		

Extra Space: