Exam 3 – v1
Physics 2760
FS 2013

Lab Section

Last Name______________________________

First Name____________________________

ID # ___________________

Solutions

This is a closed book exam. I understand, pursuant to University Regulations on academic honesty, that I am not to use any notes or information other than what is in the official, non-annotated formula sheet.

Signature_______________________________________

→ For multiple choice questions, please make sure that you **circle the letter for the answer which you believe to be correct and only that answer**. If more than one answer is circled for the same problem, you will not receive credit for it.

→ **For full credit show your work for solutions to questions that require calculations**. Write the equation from where you start to solve the problem and show your math flowing from it for full credit. **No shown work, no credit!**

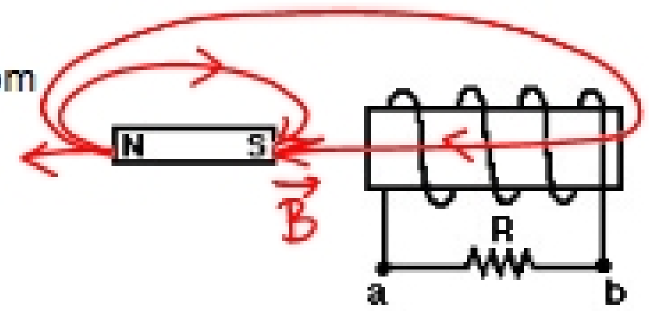
→ Surround your final answer with a box and **make sure you include units for your final answer**, otherwise you will be penalized!

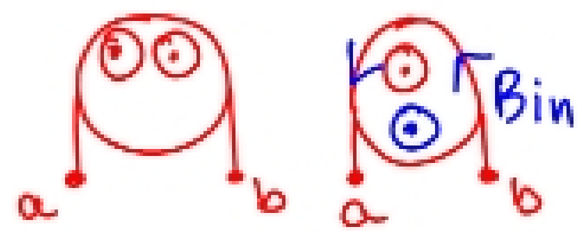
→ Don't get hung up on questions. If you find yourself spending too much time on a question, skip it and come back to it later. **Relax, read carefully, think – and then read everything again.**

→ During the exam, if you have questions please **raise your hand** and the instructor will come to you and provide help.

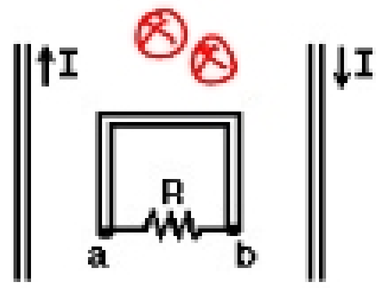
→ **The last page is the formula sheet.** Feel free to tear it off. You may keep the formula sheet after the exam.

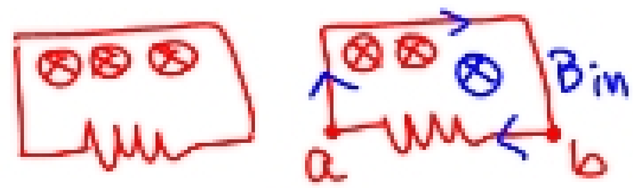
1. (2 points) In the figure, a bar magnet moves away (to the left) from the solenoid. The induced current through the resistor R is:
   A. zero
   B. from a to b
   C. from b to a



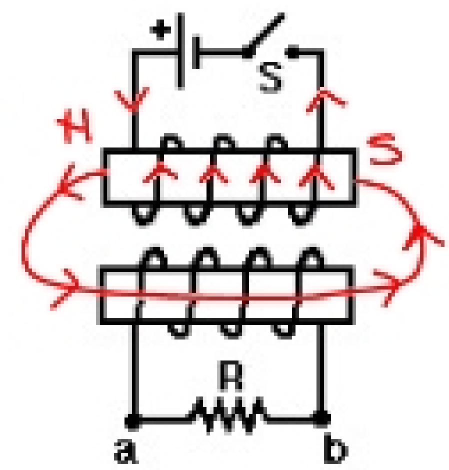


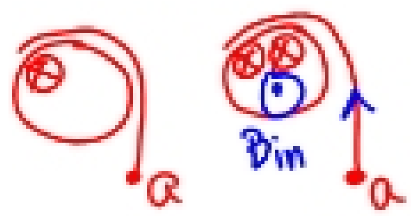
2. (2 points) In the figure, two parallel wires carry a current I in opposite directions. A rectangular loop is midway between the wires. The current I is decreasing. The induced current through the resistor R is:
   A. zero
   B. from a to b
   C. from b to a





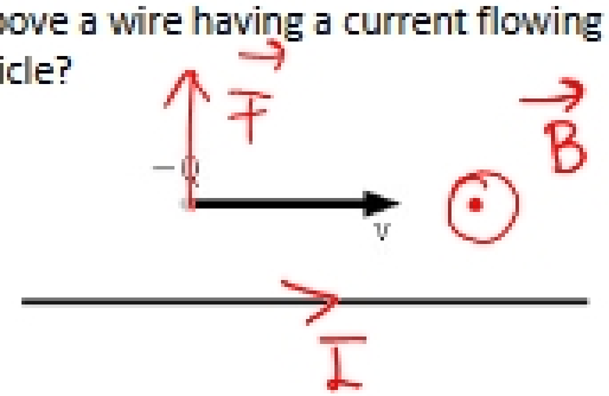
3. (2 points) In the figure, two solenoids are side by side. The switch S, initially open, is closed. The induced current through the resistor R is:
   A. zero
   B. from a to b
   C. from b to a





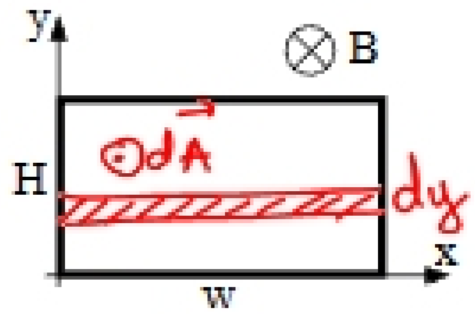
4. (2 points) A negatively charged particle is moving to the right, directly above a wire having a current flowing to the right. In which direction is the magnetic force exerted on the particle?
   A. into the page
   B. out of the page
   C. downward
   D. upward
   E. The magnetic force is zero since the velocity is parallel to the current.

$\vec{F} = q\vec{v} \times \vec{B}$



5. (2 points) Which of the following is an accurate statement?
   A. Magnetic field lines have as their sources north and south poles.
   B. A magnetic field line is, by definition, tangent to the direction of the magnetic force on a moving charge at a given point in space.
   C. The magnetic force on a moving charge does not change its energy.
   D. The magnetic force on a current-carrying wire is greatest when the wire is parallel to the magnetic field.
   E. A current-carrying loop of wire tends to line up with its plane parallel to an external magnetic field in which it is positioned.

7. (14 points) A rectangular loop of wire is immersed in a non-uniform magnetic field that is perpendicular to and into the page. The field's magnitude is given by $B = (2t^3)y^2$, with B in Teslas, t in seconds, and y in meters. The loop has width W = 4 m and height H = 2 m. What are the magnitude and direction of the induced *emf* around the loop at t = 0.2 s? Show your work clearly and step by step for full credit.



$$\Phi = \int \vec{B}\cdot d\vec{A} = \int B \cdot dA \cdot \underbrace{\cos 180^\circ}_{=-1} = -\int B \cdot dA$$

$$\begin{cases} dA = W \cdot dy \\ B = 2t^3 y^2 \end{cases}$$

$$\Rightarrow \Phi = -\int_0^H (2t^3 y^2)\, W\, dy \Rightarrow \Phi = -2t^3 W \int_0^H y^2\, dy$$

$$\Phi = -2t^3 W \cdot \frac{H^3}{3}$$

$$\Rightarrow \mathcal{E} = -\frac{d\Phi}{dt} = -\frac{d}{dt}\left(-2t^3 W \cdot \frac{H^3}{3}\right)$$

$$\mathcal{E} = 2W \cdot \frac{H^3}{\cancel{3}} \cdot \cancel{3}t^2 \Rightarrow \mathcal{E} = 2WH^3t^2$$

$$\mathcal{E}(t = 0.2s) = 2(4)(2)^3(0.2)^2$$

$$\boxed{\mathcal{E} = 2.56\ \text{V}} \quad \boxed{\text{CCW}}$$