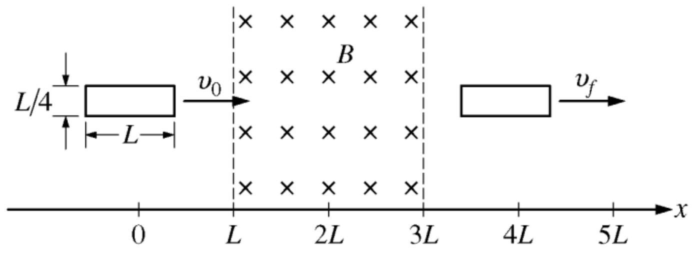
Student #: ___________________________ Student Name: _________________________________

AP PHYSICS C CLASS 19: MAGNETISM, PART 3
SECTION II
2 Questions

Directions: Answer all questions. The parts within a question may not have equal weight. All final numerical answers should include appropriate units. Credit depends on the quality of your solutions and explanations, so you should show your work. Credit also depends on demonstrating that you know which physical principles would be appropriate to apply in a particular situation. Therefore, you should clearly indicate which part of a question your work is for.



1. The rectangular loop of wire shown on the left in the figure above has mass M, length L, width $L/4$, and resistance R. It is initially moving to the right at constant speed v_0 , with no net force acting on it. At time $t = 0$ the loop enters a region of length $2L$ that contains a uniform magnetic field of magnitude B directed into the page. The loop emerges from the field at time t_f with final speed v_f . Express all algebraic answers to the following in terms of M, L, R, B, v_0, and fundamental constants, as appropriate.

   (a) Let x represent the position of the right end of the loop. Place a check mark in the appropriate box in each column in the table below to indicate whether the speed of the loop increases, decreases, or stays the same as the loop moves to the right.

Speed of Loop	$L < x < 2L$	$2L < x < 3L$	$3L < x < 4L$	$4L < x < 5L$
Increases				
Dereases				
Stays the Same				

   (b) Derive an expression for the magnitude of the current induced in the loop as its right edge enters the field.

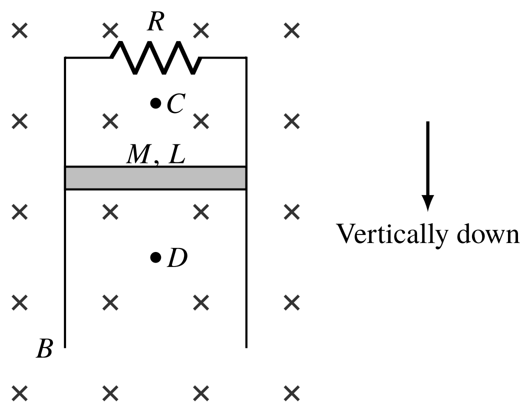
   (c) What is the direction of the induced current determined in part (b)? Justify your answer.

   _______ Clockwise _______ Counterclockwise

   (d) Write, but do not solve, a differential equation for the speed v as a function of time as the loop enters the field.

   (e) What is the direction of the acceleration of the loop just before its left edge leaves the field? Justify your answer.

   _______ Left _______ Right _______ Up _______ Down



2. A conducting bar of mass M, length L, and negligible resistance is connected to two long vertical conducting rails of negligible resistance. The two rails are connected by a resistor of resistance R at the top. The entire apparatus is located in a magnetic field of magnitude B directed into the page, as shown in the figure above. The bar is released from rest and slides without friction down the rails.

   (a) What is the direction of the current in the resistor?

   _______ Left _______ Right

   (b) i. Is the magnitude of the net magnetic field above the bar at point C greater than, less than, or equal to the magnitude of the net magnetic field before the bar is released? Justify your answer.

   _______Greater than _______Less than _______Equal to

   ii. While the bar is above point D, is the magnitude of the net magnetic field at point D greater than, less than, or equal to the magnitude of the net magnetic field before the bar is released? Justify your answer.

   _______Greater than _______Less than _______Equal to

   Express your answers to parts (c) and (d) in terms of M, L, R, B, and physical constants, as appropriate.

   (c) Write, but do NOT solve, a differential equation that could be used to determine the velocity of the falling bar as a function of time t.

   (d) Determine an expression for the terminal velocity v_T of the bar.

   Express your answers to parts (e) and (f) in terms of v_T, M, L, R, B, and physical constants, as appropriate.

   (e) Derive an expression for the power dissipated in the resistor when the bar is falling at terminal velocity.

   (f) Using your differential equation from part (d), derive an expression for the speed of the falling bar v_t as a function of time t.