Physics 208, Spring 2014 – Exam #3

A

Name (Last, First): ________________________________

ID #: __________________

Section #: _________________

- You have 75 minutes to complete the exam.
- Formulae are provided on a separate colored sheet. You may NOT use any other formula sheet.
- You may use only a simple calculator: one without memory, or with a memory demonstrated to be cleared.
- When calculating numerical values, be sure to keep track of units. Results must include proper units.
- Be alert to the number of significant figures in the information given. Results must have the correct number of significant figures.
- If you are unable to solve a problem whose solution is needed in another problem, then assign a symbol for the solution of the first problem and use that symbol in solving the second problem.
- If you need additional space to answer a problem, use the back of the sheet it is written on.
- Show your work. Without supporting work, the answer alone is worth nothing.
- Mark your answers clearly by drawing boxes around them.
- Please write clearly. You may gain marks for a partially correct calculation if your work can be deciphered.

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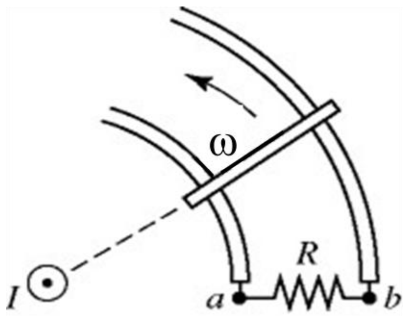
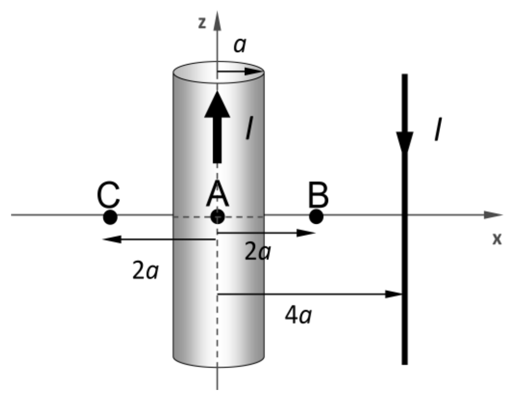
208 Mid-Term 1 POINTS TABLE	
Multiple Choice (out of 20)	
Problem 1 (out of 20)	
Problem 2 (out of 20)	
Problem 3 (out of 20)	
Problem 4 (out of 20)	
TOTAL SCORE (out of 100)	

MC1. (5 marks) In the figure, a straight wire carries a steady current *I* perpendicular to the plane of the page. A bar is in contact with a pair of circular rails, and rotates about the straight wire with angular velocity ω, in the direction indicated by the arrow. The direction of the induced current through the resistor *R* is



A. from *a* to *b*.
B. from *a* to *b*, but only if ω is increasing.
C. from *b* to *a*.
D. from *b* to *a*, but only if ω is increasing.
E. There is no induced current through the resistor.

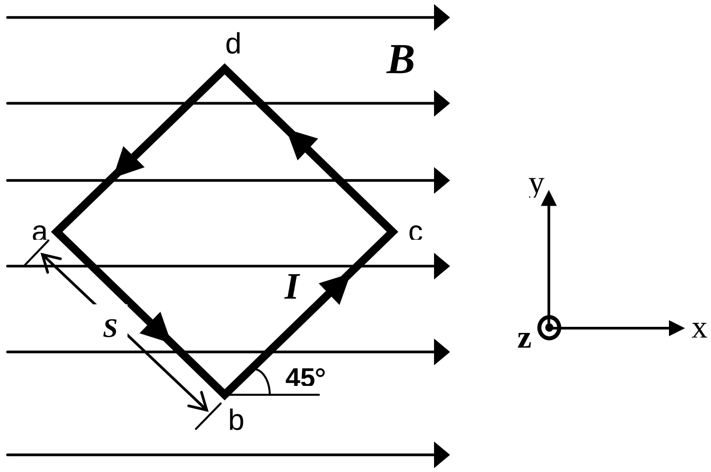
MC2. (5 marks) A very long wire of circular cross-section (with radius *a*) is placed so that its center runs along the *z*-axis. This wire carries a net current *I* in the upward (+z) direction; the current is uniformly distributed across the wire. Meanwhile, a very long thin wire is placed along the line $(x,y) = (+4a,0)$, and carries the same current *I* but in the downward (–z) direction. Both wires have length *L* (which is so much larger than the dimension *a* that it may be considered infinite).



Compare the magnitudes of the magnetic field at the point **A** (located at the origin), point **B** located at $(x,y,z) = (2a,0,0)$ (*i.e.*, halfway between the wire centers), and at point **C** located at $(x,y,z) = (-2a,0,0)$:

A. $|B_A| > |B_B| = |B_C|$
B. $|B_A| = |B_B| = |B_C|$
C. $|B_B| = |B_C| > |B_A|$
D. $|B_A| > |B_B| > |B_C|$
E. $|B_A| > |B_C| > |B_B|$
F. $|B_B| > |B_C| > |B_A|$
G. $|B_B| > |B_A| > |B_C|$
H. $|B_C| > |B_B| > |B_A|$

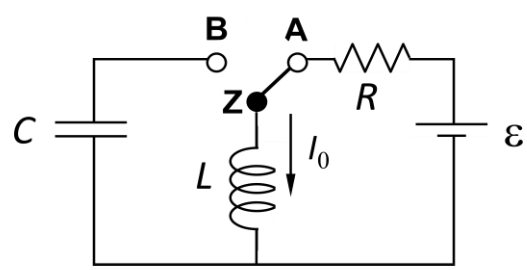
MC3. (5 marks) A square wire loop of side ***s*** lies in the *x*-*y* plane and carries a current of ***I*** flowing in the counter-clockwise direction (as viewed from $z > 0$). A constant, uniform magnetic field of magnitude ***B*** points in the +*x* direction, as shown in the figure.

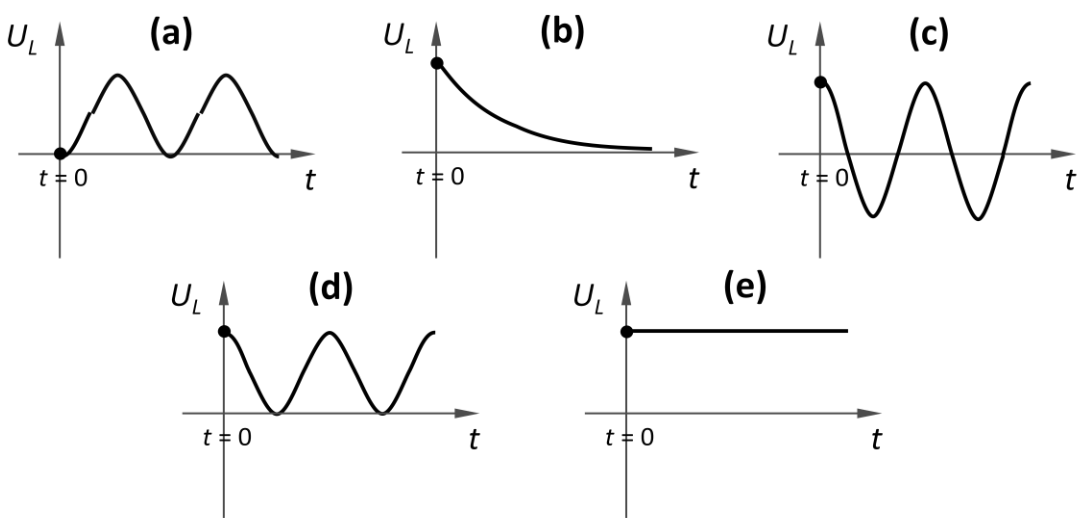


The torque vector caused by the magnetic field acting on this loop is in which direction?

A. zero
B. +x
C. –x
D. +y
E. –y
F. +z
G. –z

MC4. (5 marks) Which of the following graphs best depicts the time-dependence of the energy U_L stored in the inductor after the switch is thrown to connect position **Z** to **B**?





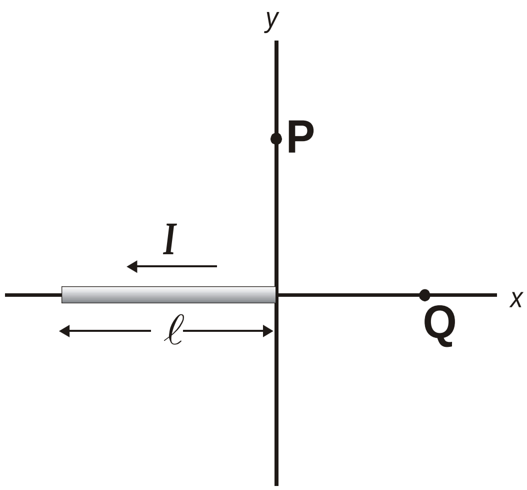
1. (20 marks) A doubly-charged helium atom, whose mass is 6.6×10^{-27} kg, is accelerated by a voltage of 3.4 kV.

a) What is its resultant velocity?
b) What will be its radius of curvature, if it moves in a plane perpendicular to a uniform 0.570-T field after exiting the electric field region?
c) What is its period of revolution?

2. (20 marks) A segment of wire of length ℓ carries a current I as shown in the figure.

a) What is the expression (or value) for the magnetic field [magnitude and direction] at any point such as Q along the positive *x* axis (the axis of the wire)?

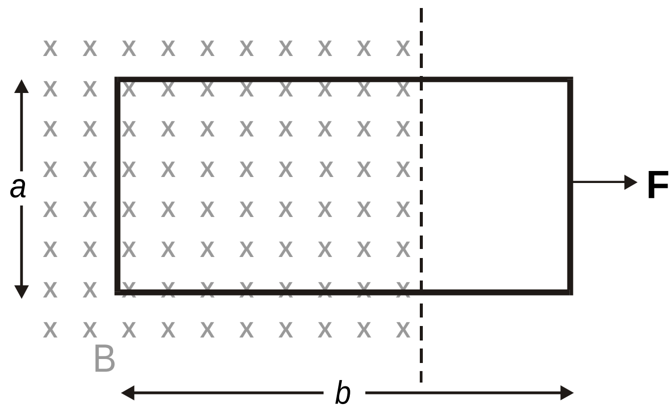
b) What is the expression (or value) for the magnetic field [magnitude and direction] at any point such as P along the positive *y* axis?



3. (20 marks) A single rectangular loop of wire of dimensions a = 180 cm and b = 620 cm is situated, as shown in the figure, with part inside a region with uniform magnetic field of 0.920 T, and part outside the field. The total resistance in the loop is 0.150 Ω. The loop is pulled to the right. (Neglect any effects of gravity.)

a) Give the direction of the current flow in the loop (clockwise or counterclockwise) and explain your reasoning.

b) What force is required to pull the loop at a constant velocity of 5.20 m/s?



4. **(20 marks)** An inductor and a resistor appear in series in a circuit (see figure). At one instant the potential difference, V_{ab} across the pair is 3.05 V while the current is 450 mA and is increasing at a rate of 200 mA/s. At a later instant, the potential difference is 2.15 V while the current is 400 mA and is decreasing at a rate of 260 mA/s. Determine the inductance, L, of the coil and the value, R, of the resistance.