Physics 208, Spring 2015 – 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.
- For the Multiple Choice questions, full credit (5 points) is only given if the correct answer or answers is (are) clearly marked.
- 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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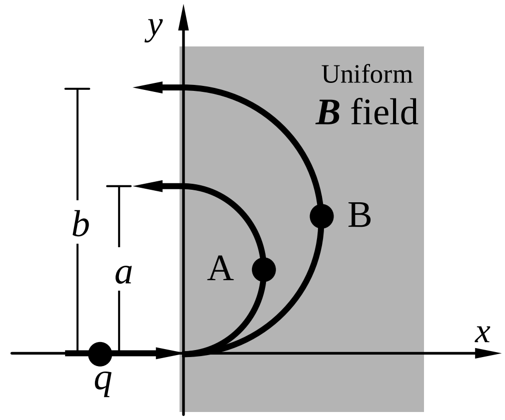
208 Mid-Term 3 POINTS TABLE	
Multiple Choice (out of 20)	
Problem 1 (out of 20)	
Problem 2 (out of 20)	
Problem 3 (out of 20)	
Problem 4 (out of 20)	
TOTAL SCORE (out of 100)	

MC1. (5 points) Two electrons, labeled A and B, are accelerated to different velocities and then sent into a region containing a constant, uniform magnetic field with unknown direction. The electrons' initial velocities are in the $+x$ direction, and they enter the B-field region at the origin. Within the field region, they follow <u>curved paths confined to the xy-plane</u> ($z = 0$), then emerge at different locations on the y-axis: electron A emerges at $y = a$, and electron B emerges at $y = b$, where $b > a$ as shown.



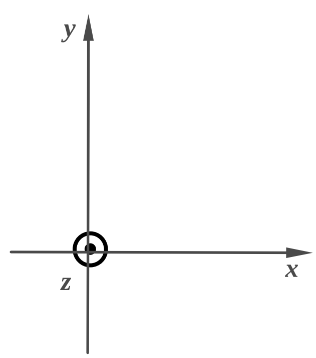
What is the <u>direction</u> of the uniform magnetic field in the region $x > 0$?

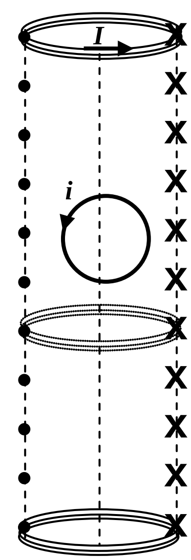
a. $+x$ direction (to the right)
b. $-x$ direction (to the left)
c. $+y$ direction (upward)
d. $-y$ direction (downward).
e. $+z$ direction (out of the page)
f. $-z$ direction (into the page)

MC2. (5 points) A tiny wire loop of radius a, carrying a counterclockwise current i, is placed inside a long solenoid as shown. The solenoid has N turns and carries a current I in the direction shown.

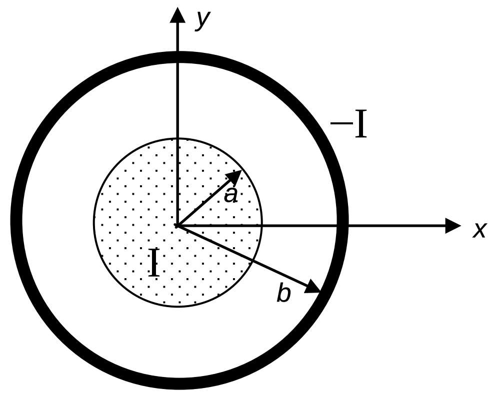
What is the direction of the torque on the loop?

a. $+\hat{x}$
b. $-\hat{x}$
c. $+\hat{y}$
d. $-\hat{y}$
e. $+\hat{z}$
f. $-\hat{z}$

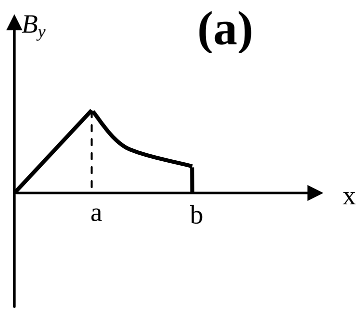


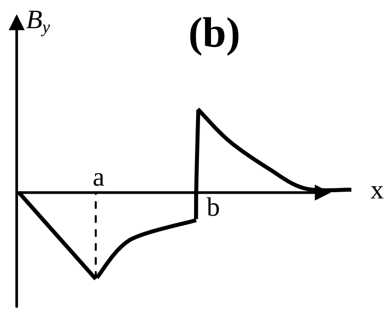


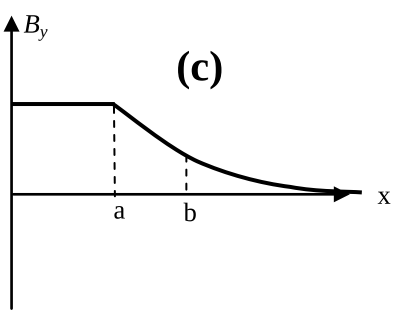
MC3. (5 points) A solid, infinitely long rod of radius *a* and lies along the *z* axis. It carries a current *I* in the +*z* direction (out of the page). The current is uniformly distributed across the rod. It is surrounded, at a distance *b*, by a thin coaxial conducting shell that carries a current of the same magnitude, but directed in the –*z* direction.

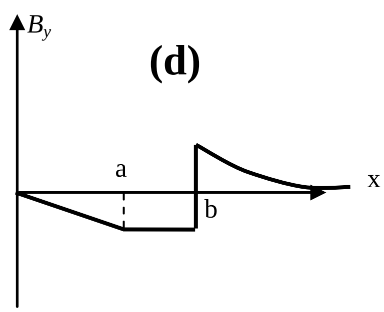


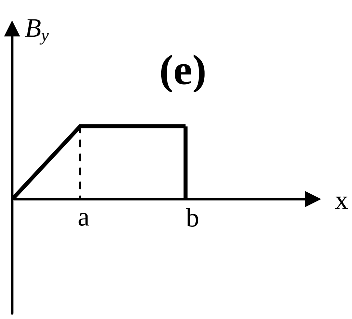
Which of the following drawings most accurately represents the component B_y of the magnetic field at points **on the positive *x*-axis**?



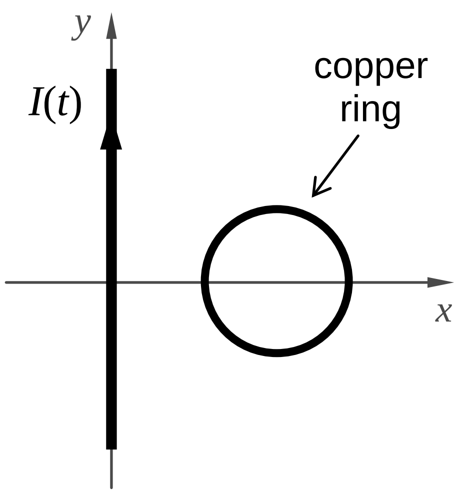


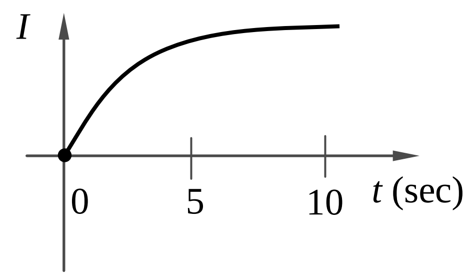






MC4. (5 points) A very long straight wire runs along the *y*-axis and carries a time-dependent current $I(t)$ in the upward ($+y$) direction, thereby creating a time-varying magnetic field. The graph on the right side of the figure below shows the time dependence of this current: it begins at zero at time $t = 0$, and is gradually increased in the manner shown. A circular copper ring is placed next to the straight wire and is oriented so that it lies in the *x*-*y* plane.





The magnitude of the EMF induced in the copper ring is:

a. smaller at time $t = 0$ than at time $t = 10$ seconds.
b. larger at time $t = 0$ than at time $t = 10$ seconds.
c. the same at times $t = 0$ and $t = 10$ seconds.

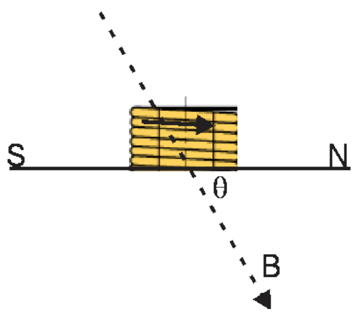
And at time $t = 3$ seconds, the current induced in the copper ring is:

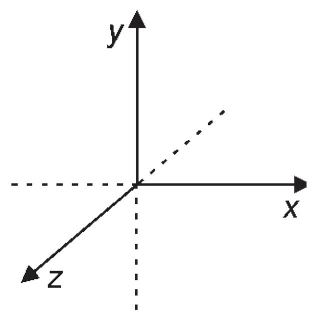
a. in the clockwise direction.
b. in the counter-clockwise direction.
c. zero.

(Note: Both questions above must be marked with the correct answer to receive credit.)

1. **(20 marks)** A circular coil 28.0 cm in diameter and containing 18 loops lies flat on the ground. The Earth's magnetic field at this location has magnitude 5.80×10^{-5} T and points into the earth at an angle of $\theta = 61.0°$ below a line pointing due north (see figure at left). If a 9.30-A counterclockwise (looking down on the coil) current passes through the coil, determine

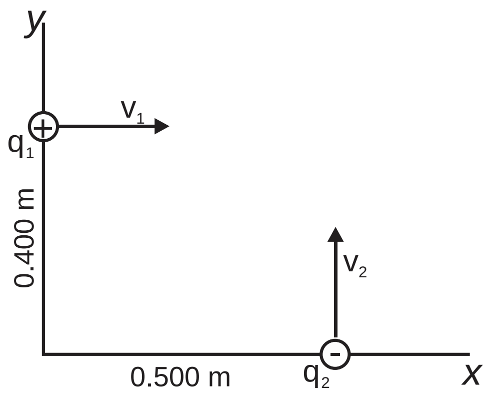
   a) the torque on the coil in vector notation (axes as indicated in figure on right); and
   b) which edge of the coil rises up, north, east, south or west (assuming negligible mass).





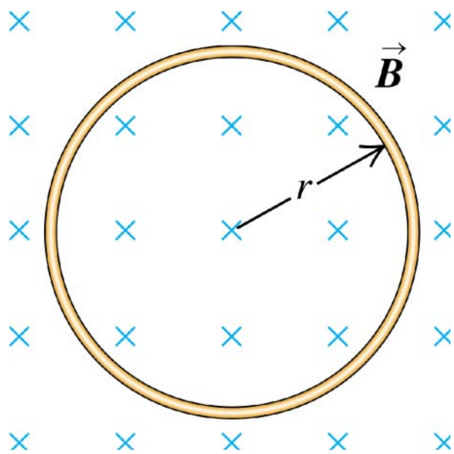
2. (20 marks) A pair of point charges, $q_1 = 9.00\mu C$ and $q_2 = -6.00\mu C$, are moving as shown in the figure with speeds $v_1 = 6.50 \times 10^4$ m/s and $v_2 = 4.60 \times 10^4$ m/s. When the charges are at the location shown in the figure, find:

a) the magnitude and direction of the magnetic field produced at the origin, and
b) the magnitude and direction of the magnetic force that q_2 exerts on q_1.



3. (20 marks) A circular coil containing 50 loops of wire with radius r = 35 cm and resistance R = 0.460 Ω is in a region of spatially uniform magnetic field directed into the plane of the figure. At $t = 0$, $B = 0$. The magnetic field then begins increasing, with $B(t) = (0.560\ \mathrm{T/s^3})\, t^3$.

a) What is the current in the loop (magnitude and direction) at the instant when B = 1.56T?
b) What is the power being dissipated in the loop at that instant?



4. **(20 marks)** A 1200-pF capacitor is charged to 100 V and then quickly connected to an inductor. The frequency of the subsequent oscillation is 720 kHz. Determine

   a) the inductance L of the inductor
   b) the peak value of the current in the inductor, and
   c) the maximum energy stored in its magnetic field.